BEFORE THE WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION

DOCKET NO. UE-12________

EXHIBIT NO._____(RJL-2)

ROBERT J. LAFFERTY

REPRESENTING AVISTA CORPORATION

August 31, 2011

2011 Electric INTEGRATED Resource Plan

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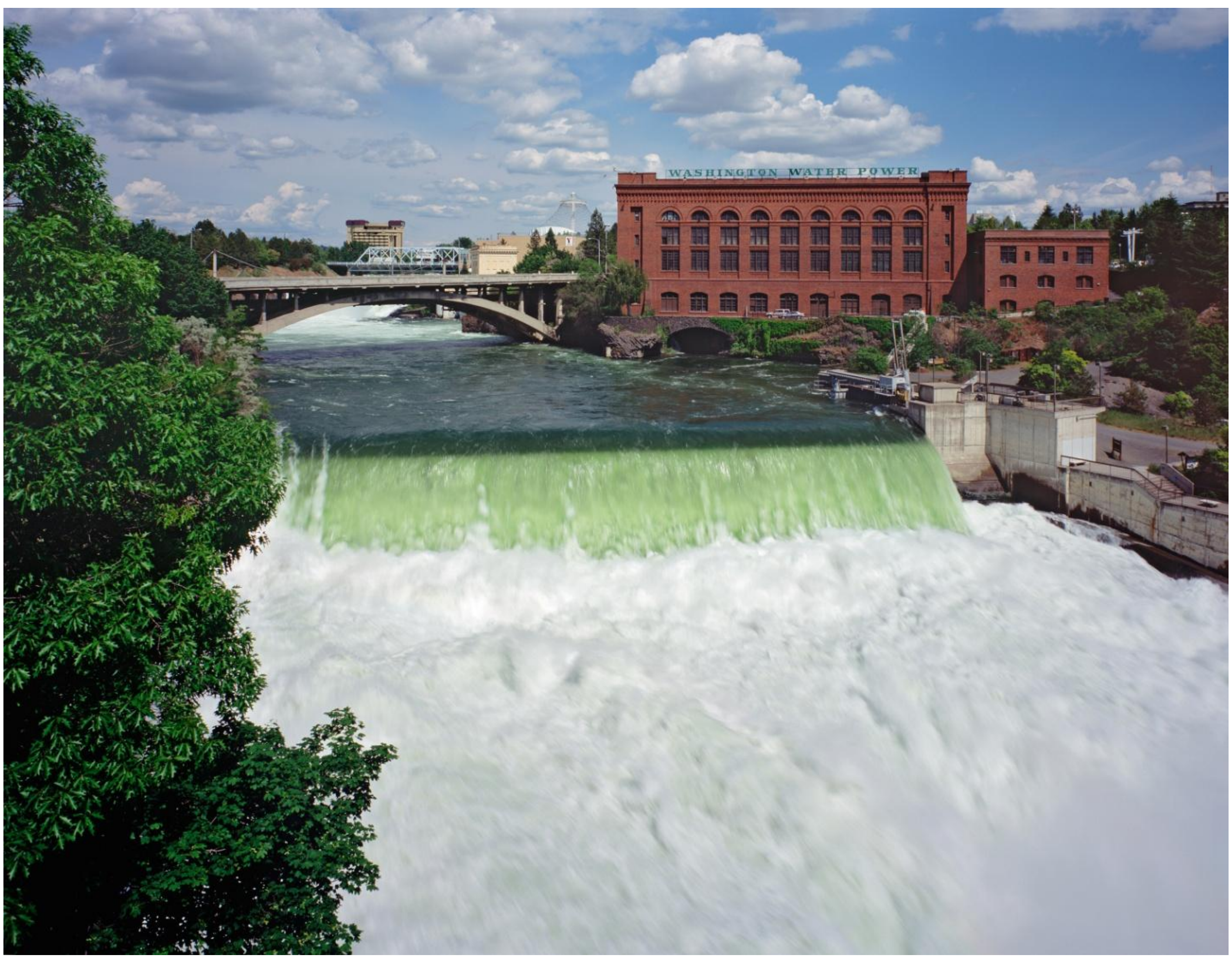

Safe Harbor Statement

This document contains forward-looking statements. Such statements are subject to a variety of risks, uncertainties and other factors, most of which are beyond the Company's control, and many of which could have a significant impact on the Company's operations, results of operations and financial condition, and could cause actual results to differ materially from those anticipated.

For a further discussion of these factors and other important factors, please refer to the Company's reports filed with the Securities and Exchange Commission. The forward-looking statements contained in this document speak only as of the date hereof. The Company undertakes no obligation to update any forward-looking statement or statements to reflect events or circumstances that occur after the date on which such statement is made or to reflect the occurrence of unanticipated events. New factors emerge from time to time, and it is not possible for management to predict all of such factors, nor can it assess the impact of each such factor on the Company's business or the extent to which any such factor, or combination of factors, may cause actual results to differ materially from those contained in any forward-looking statement.

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2011 Electric IRP Introduction

Avista has a long tradition of innovation as a provider of clean, renewable energy. The 2011 Integrated Resource Plan (IRP) continues the tradition by looking into the future energy needs of our customers. The IRP analyzes and outlines a strategy to meet projected demand and renewable portfolio standards through energy efficiency and a careful mix of new renewable and traditional energy resources.

Plant upgrades and conservation measures are an integral part of Avista's 2011 IRP resource strategy. Avista expects to add increasing amounts of new renewables to its generation portfolio in the coming years. Renewables represent viable energy sources that diversify our resource mix and reduce the need for fossil fuels.

The challenge of integrating renewable resources such as wind and solar is that they are intermittent resources, meaning the wind does not always blow and the sun does not always shine. Customers expect high reliability; therefore, utilities will still need energy from natural gas and hydropower to keep the lights on. This presents a challenge to resource planners, who must consider reliability as well as rate and environmental impacts.

Avista's electricity sales growth is expected to be 1.6 percent over the next two decades. The Company projects it will have sufficient resources to meet this growth through 2018.

Each IRP is a thoroughly researched and data-driven document to guide responsible resource planning for the Company. The IRP is updated every two years and looks 20 years into the future. This plan is developed by Avista's professional energy analysts using sophisticated modeling tools and input from interested community stakeholders.

The plan's Preferred Resource Strategy (PRS) section covers the Company's projected resource acquisitions over the next 20 years.

Some highlights of the PRS include:

- A newly signed contract for the Palouse Wind project located near Spokane, Washington will fulfill Avista's RPS obligations through 2019.
- An additional 42 aMW of wind or qualified renewable energy credits are required by 2020.
- Energy efficiency reduces load growth by 48 percent. Aggressive energy efficiency measures are expected to save 310 aMW of cumulative energy over the next 20 years.
- 756 MW of clean-burning natural gas-fired generation facilities are required between 2018 and 2031.
- Avista's grid modernization and distribution feeder upgrade programs are projected to reduce load by about five aMW by 2013.

- Transmission upgrades will be needed to carry the output from new generation. Avista will continue to participate in regional efforts to expand the region's transmission system.

This document is mostly technical in nature. The IRP has an Executive Summary and chapter highlights at the beginning of each section to help guide the reader. Avista expects to begin developing the 2013 IRP in early 2012. Stakeholder involvement is encouraged and interested parties may contact John Lyons at 509-495-8515 or john.lyons@avistacorp.com for more information on participating in the IRP process.

Executive Summary

Avista's 2011 Integrated Resource Plan (IRP) guides its strategy over the next two years and indicates the overall direction of resource procurements for the remainder of a 20-year planning horizon. It provides a snapshot of the Company's resources and loads and guidance for future resource acquisitions. The resultant Preferred Resource Strategy (PRS) is a mix of wind generation, energy efficiency, upgrades at existing generation and distribution facilities, and new gas-fired generation.

The PRS balances cost, reliability, rate volatility, and renewable resource requirements. Avista's management and the Technical Advisory Committee (TAC) stakeholders play a central role in guiding the development of the PRS and the IRP as a whole by providing significant input on modeling and planning assumptions, and the general direction of the planning process. TAC members include customers, commission staff, the Northwest Power and Conservation Counsel, consumer advocates, academics, utility peers, government agencies, and interested internal parties.

Resource Needs

Plant upgrades and conservation measures are an integral part of Avista's 2011 IRP resource strategy, but they are ultimately inadequate to meet all expected future load growth. Absent new resource additions or new conservation measures, annual energy deficits begin in 2020, with loads and a planning margin exceeding resource capability by 49 aMW. Energy deficits rise to 218 aMW in 2026 and 475 aMW in 2031. Absent new resource additions or new conservation measures, the Company will be short 98 MW of summer capacity in 2019.[1] In 2026 and 2031, capacity deficits rise to 352 MW and 774 MW, respectively. Winter capacity deficits begin at 42 MW in 2020 and increase to 401 MW in 2026 and 883 MW in 2031.[2]

Increasing deficits are a result of forecasted 1.6 percent energy and capacity load growth through 2031. The expiration of long-term purchase and sale contracts on a net basis also increases deficiencies. Figures 1 through 3 provide graphical representations of projected load and resource balances before the addition of PRS resources. The vertical bars in the figures show Avista's resource mix including hydroelectric, baseload thermal resources (such as Colstrip and Coyote Springs 2), peaking thermals (such as Northeast and Rathdrum), and net market transactions (includes long-term purchases and sales plus our expected short-term market transactions). The lower lines in the figures represent the load forecast and the upper lines include the load forecast plus a planning margin and operating reserves. The load forecast uses sustained 18-hour peaks.[3] The forecasted needs would be higher absent energy efficiency acquisitions. A more thorough discussion of loads and resources position is in Chapter 2.

[1] This position assumes Avista relies on its share of regional power surpluses through 2021 as identified by the Northwest Power and Conservation Council and documented further in Chapter 2.
[2] Ibid.
[3] The 18-hour sustained peak metric assumes six peak hours for three days in a row.

Figure 1: Load-Resource Balance—Winter 18 Hour Capacity

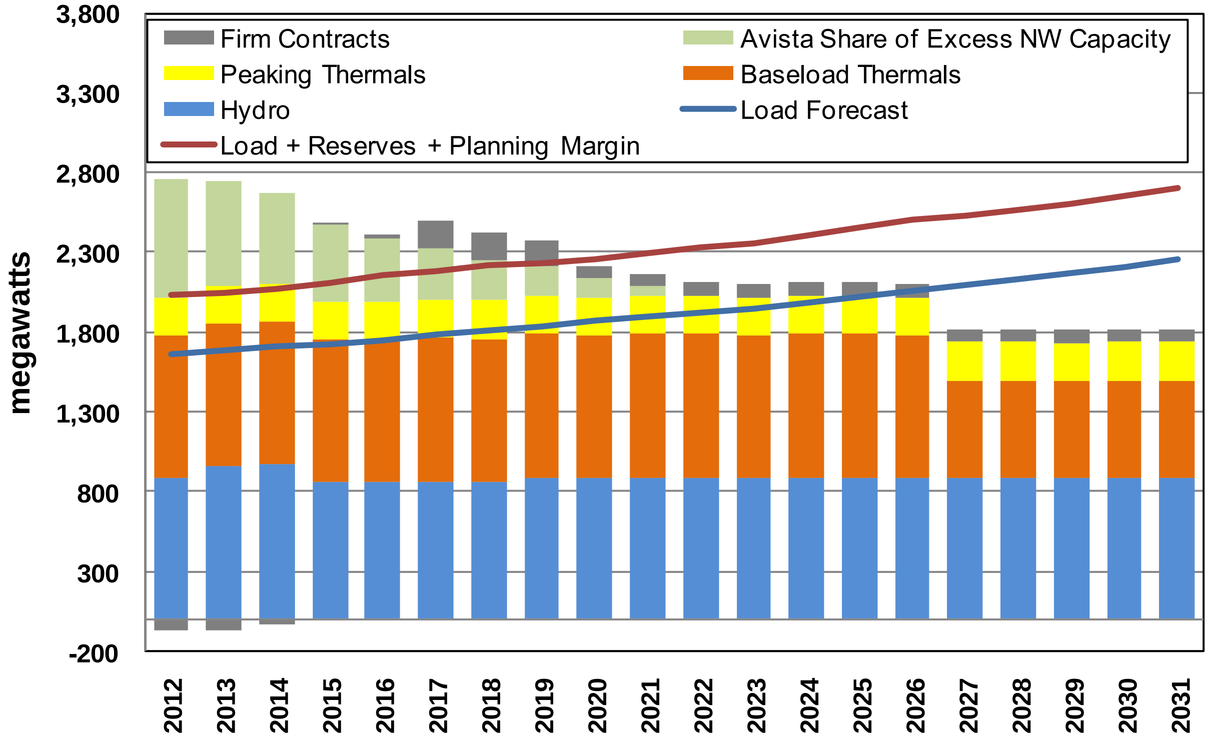


Figure 2: Load-Resource Balance—Summer 18 Hour Capacity

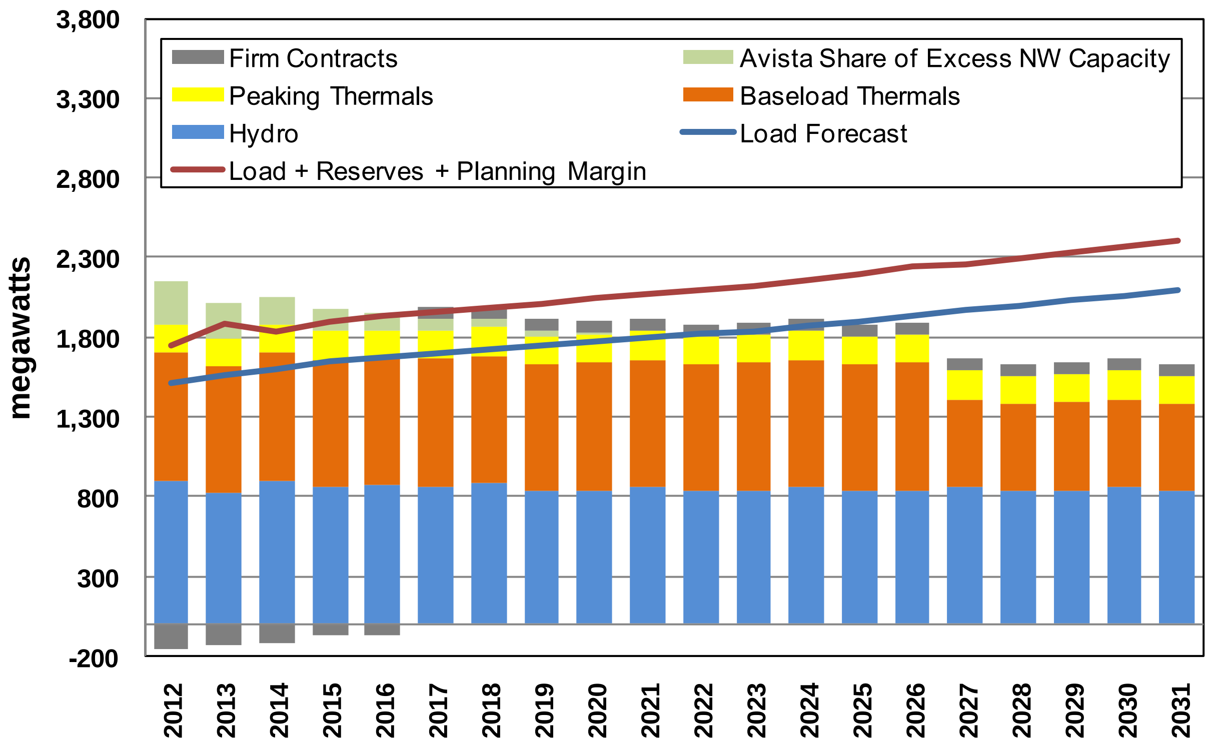
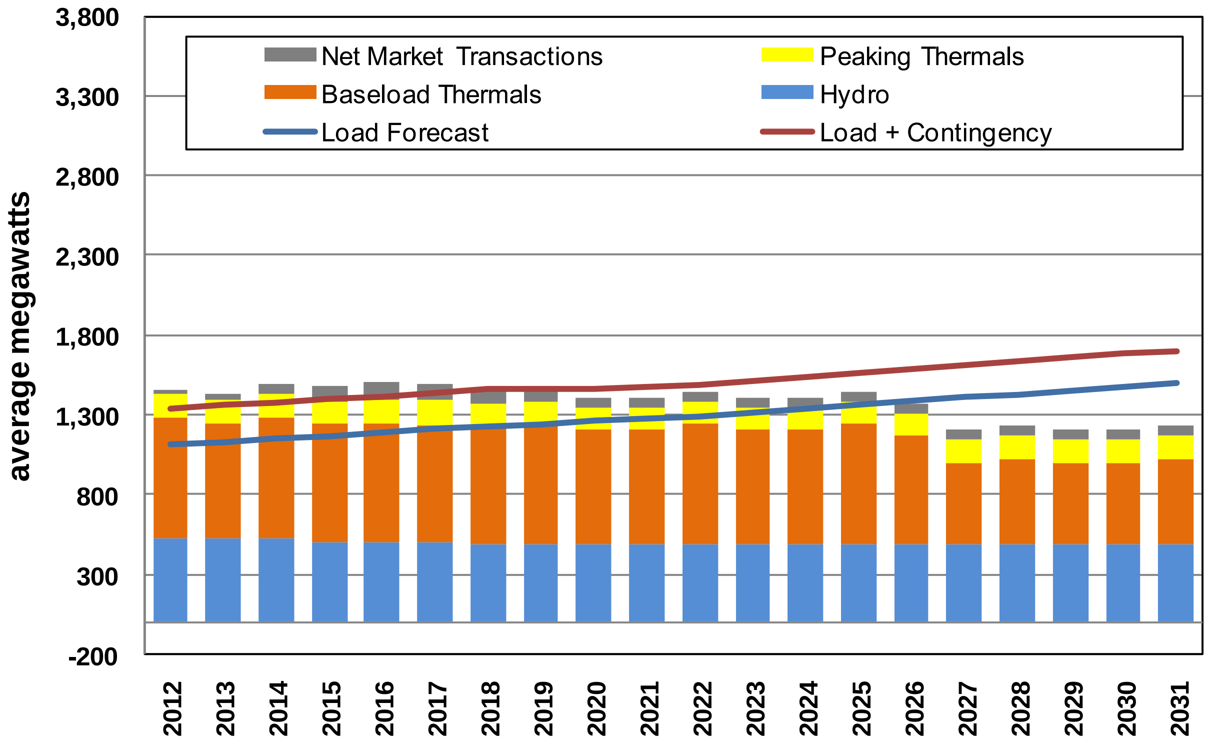


Figure 3: Load-Resource Balance—Energy



Modeling and Results

Avista uses a multiple-step approach to develop its Preferred Resource Strategy. It begins by identifying and quantifying potential new generation resources to serve projected demand needs across the West. A Western Interconnect-wide study explains the impact of regional markets on the Northwest electricity marketplace. Avista then maps its existing resources to the present transmission grid configuration in a model simulating hourly operations for the Western Interconnect from 2012 to 2031.

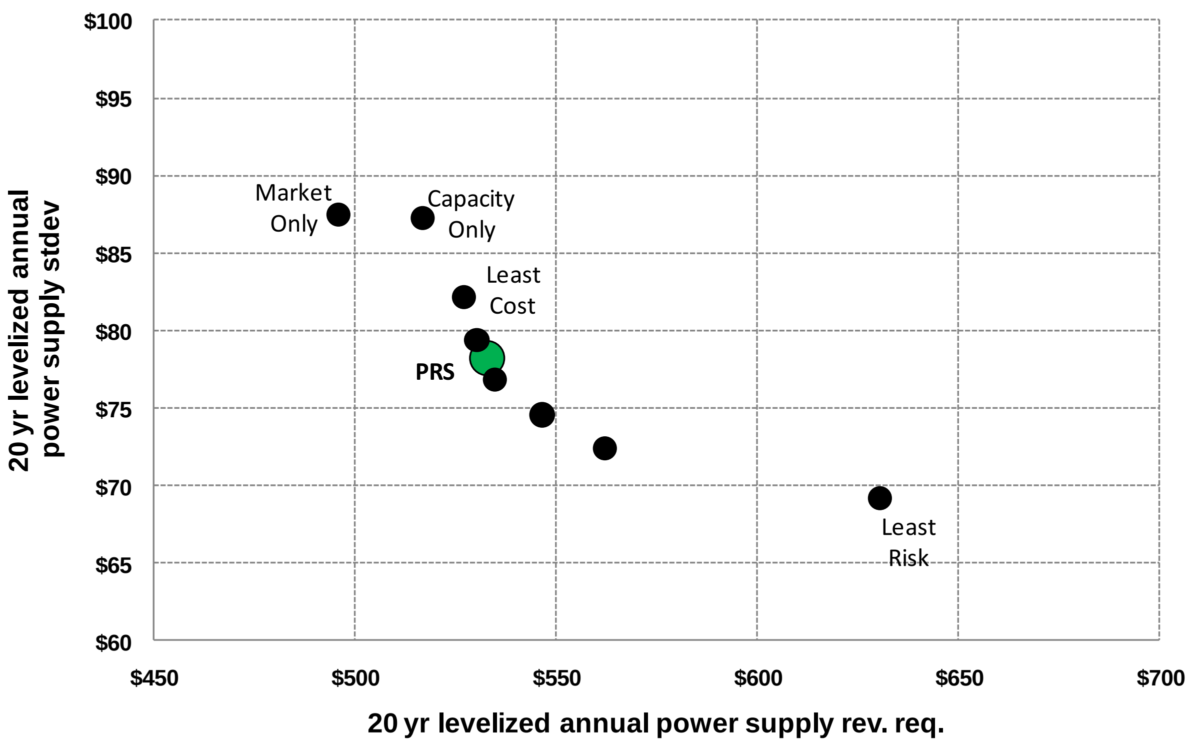
The model adds cost-effective new resources and transmission to meet growing loads. Monte Carlo-style analysis varies hydroelectric generation, wind generation, load, forced outages, greenhouse gas emission cost estimates, and natural gas price data over 500 iterations of potential future market conditions. The simulation estimates Mid-Columbia electricity markets, and the iterations collectively form the IRP Expected Case.

Each new resource and energy efficiency option is valued against the Expected Case Mid-Columbia electricity market to identify its future value to the Company, as well as its inherent risk measured as year-to-year cost volatility. These values, and their associated capital and fixed operation and maintenance (O&M) costs, form the input into Avista's Preferred Resource Strategy Linear Programming Model (PRiSM). PRiSM assists the Company by developing optimal mixes of new resources at each point on an efficient frontier.[4] The PRS provides a "least reasonable cost" portfolio that simultaneously minimizes future costs and risks given legislatively mandated or expected future environmental constraints. An efficient frontier helps determine the

[4] See Chapter 8 for a detailed discussion of the efficient frontier concept.

tradeoffs between risk and cost. The approach is similar to finding an optimal mix of risk and return when developing a personal investment portfolio. As expected returns increase, so do risks. Reducing risk reduces overall returns. Identifying the PRS is similar to an investor's dilemma. There is a trade-off between power supply costs and power supply cost variability. Figure 4 presents the change in cost and risk from the PRS on the Efficient Frontier. Lower power cost variability comes from investment in more expensive, but less risky, resources. The PRS selection is the location on the efficient frontier where the increased cost justified the reduction in risk.

Figure 4: Efficient Frontier

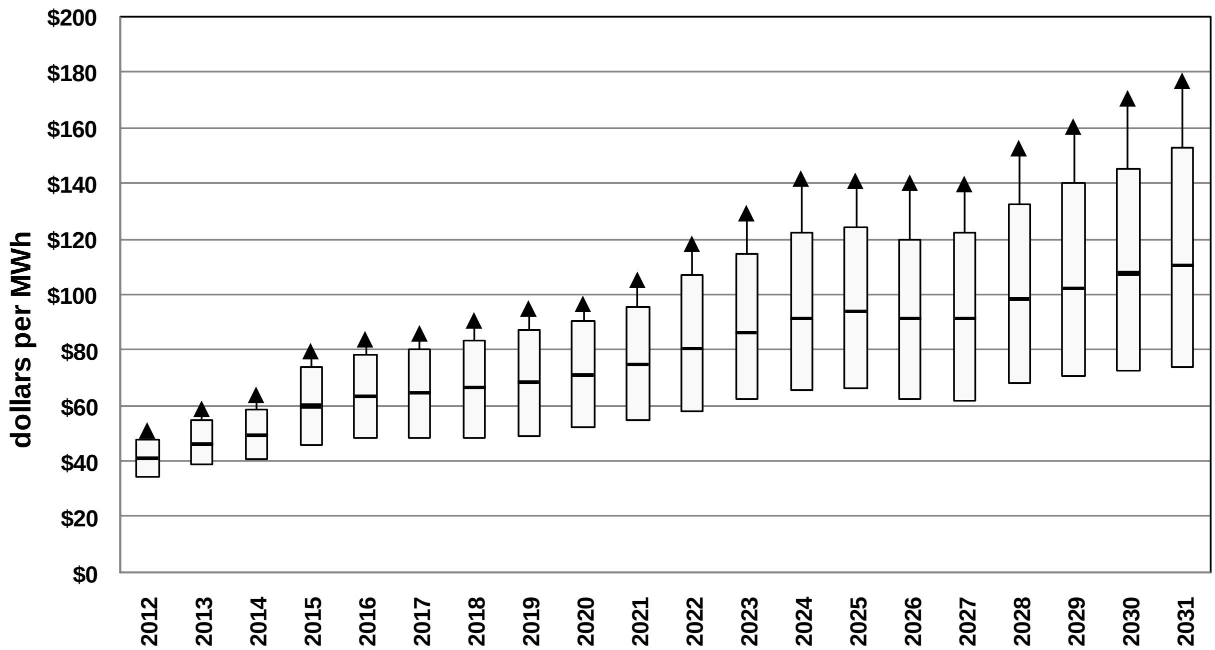


The IRP includes several scenarios that help identify tipping points where the PRS could change under alternative conditions to the Expected Case. Chapter 8 includes scenarios for load growth, capital costs, higher energy efficiency acquisitions, and greenhouse gas policies.

Electricity and Natural Gas Market Forecasts

Figure 5 shows the 2011 IRP electricity price forecast in the Expected Case, including the modeled range of prices over the 500 Monte Carlo iterations described previously. The forecasted levelized average Mid-Columbia market price is $70.50 per MWh in nominal dollars over the next 20 years; the off-peak price is $63.94 per MWh and the on-peak price is $75.42 per MWh. These prices include the market impacts of greenhouse gas mitigation beginning in 2015.[5]

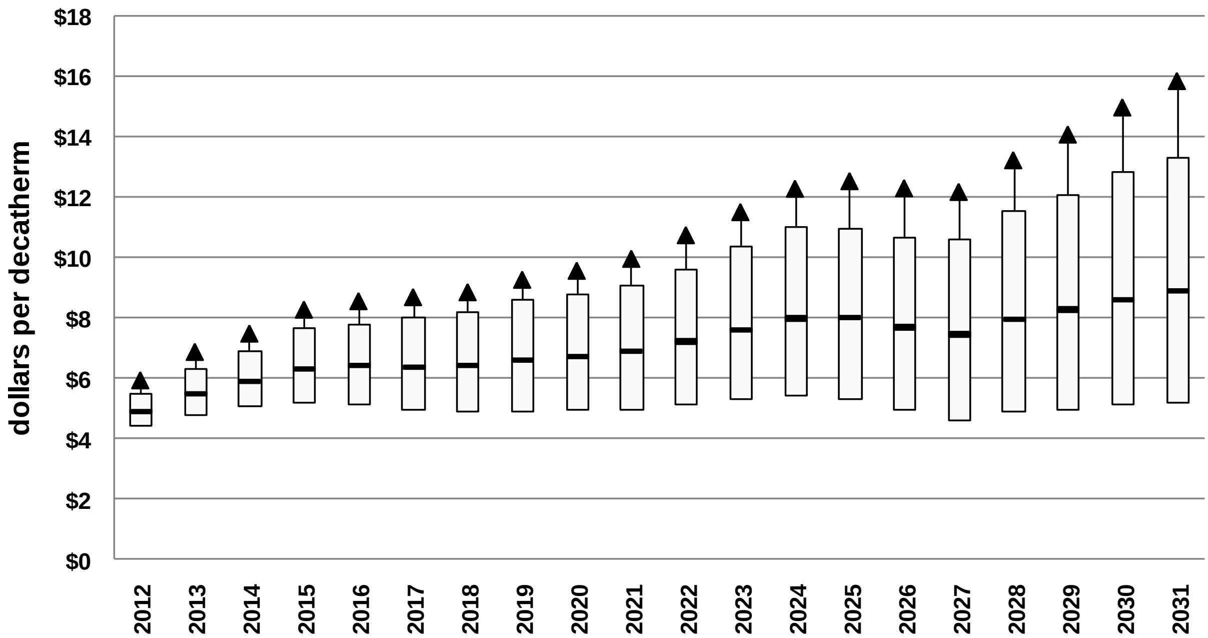
Figure 5: Average Mid-Columbia Electricity Price Forecast



Electricity and natural gas prices are highly correlated because natural gas fuels marginal generation resources in the northwest during most of the year. Figure 6 presents nominal levelized Expected Case natural gas prices at Henry Hub, as well as the range of forecasts from the 500 Monte Carlo iterations performed for the case. The average is $6.70 per decatherm over the next 20 years. See Chapter 7 for more detail on the Company's natural gas price forecast.

[5] The forecast assumes a western region reduction of 14 percent by 2032.

Figure 6: Henry Hub Natural Gas Price Forecast

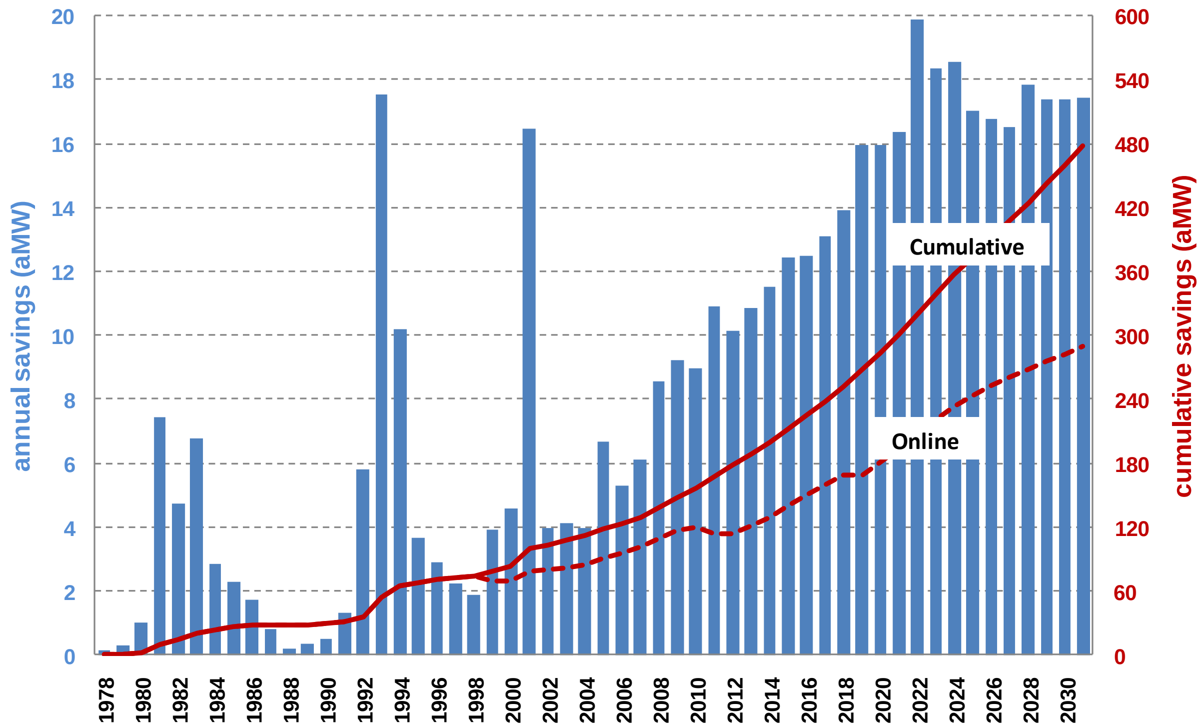


Energy Efficiency Acquisition

Avista commissioned a 20-year Conservation Potential Assessment in 2010. The study analyzed over 4,300 equipment and measure options for residential, commercial, and industrial applications. Data from this study formed the basis of the IRP conservation potential evaluations. Figure 7 shows how energy efficiency decreases Avista's energy requirements by 120.2 aMW, or approximately ten percent.[6] By 2031, energy efficiency reduces load by 310 aMW (288 aMW net after measure life expectancy adjustments). More detail about Avista's energy efficiency programs is contained in Chapter 3.

[6] The Company has acquired 156.3 aMW of conservation since 1978; however, the assumed 18-year average life of the conservation portfolio means that some of the measures have reached the end of their useful lives and are no longer reducing loads. The 18-year assumed life of measures accounts for the difference between the Gross and Net lines in Figure 7.

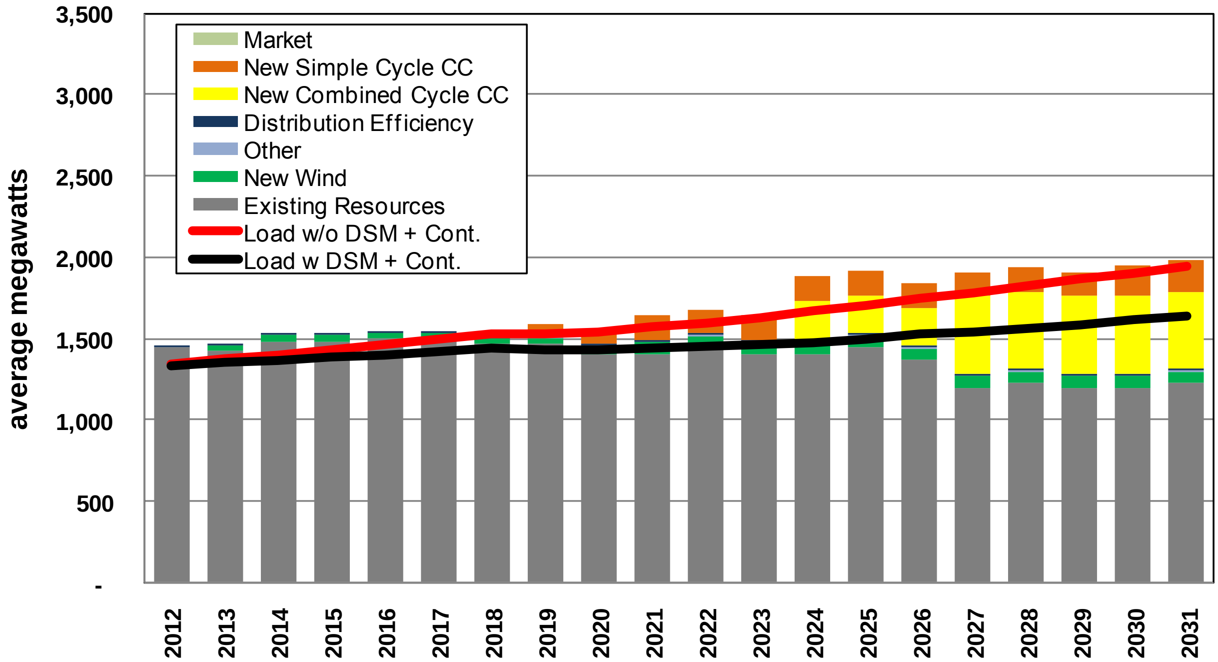
Figure 7: Cumulative Conservation Acquisitions



Preferred Resource Strategy

The PRS includes careful consideration by Avista's management and the Technical Advisory Committee of the information gathered and analyzed in the IRP process. It meets future load growth with efficiency upgrades at existing generation and distribution facilities, conservation, wind, and simple- and combined-cycle natural gas-fired combustion turbines. Figure 8 displays the resource mix for the 2011 Preferred Resource Strategy layered on top of Avista's current resources.

Figure 8: 2011 Preferred Resource Strategy (Annual Average Energy)



The PRS has changed only modestly from the 2009 IRP. The PRS resources of both the 2009 and 2011 IRPs, on a nameplate capacity basis, are in Tables 1 and 2 below.

Table 1: The 2011 Preferred Resource Strategy

Resource	By the End of Year	Nameplate (MW)	Energy (aMW)
NW Wind	2012	120	35
SCCT	2018	83	75
Existing Thermal Resource Upgrades	2019	4	3
NW Wind	2019-2020	120	35
SCCT	2020	83	75
CCCT	2023	270	237
CCCT	2026	270	237
SCCT	2029	46	42
Total		**996**	**739**
Efficiency Improvements	**By the End of Year**	**Peak Reduction (MW)**	**Energy (aMW)**
Distribution Efficiencies	2012-2031	28	13
Energy Efficiency	2012-2031	419	310
Total		**447**	**323**

Table 2: The 2009 Preferred Resource Strategy

Resource	By the End of Year	Nameplate (MW)	Energy (aMW)
Northwest Wind	2012	150	48
Little Falls Unit Upgrades	2013-2016	3	1
Northwest Wind	2019	150	50
Combined-Cycle Combustion Turbine	2019	250	225
Upper Falls	2020	2	1
Northwest Wind	2022	50	17
Combined-Cycle Combustion Turbine	2024	250	225
Combined-Cycle Combustion Turbine	2027	250	225
Total		**1,105**	**792**
Efficiency Improvements	**By the End of Year**	**Peak Reduction (MW)**	**Energy (aMW)**
Distribution Efficiencies	2010-2015	5	3
Energy Efficiency	2010-2029	339	226
Total		**344**	**229**

The present value of the investment required to support the 2011 PRS is just over $0.84 billion; the nominal total capital expense is $1.7 billion over the IRP timeframe. Avista also forecasts spending $1.4 billion over the IRP timeframe on conservation acquisitions.

Greenhouse Gas Emissions

As with all Avista IRPs since 2007, the costs of greenhouse gas policies are included in the Expected Case for this IRP. Since the 2009 IRP, less certainty exists around the direction of future of greenhouse gas policies. To address this uncertainty, the 2011 IRP considers four policies. Each represents a different policy alternative beginning in 2015. The policies are: 1) a regional cap and trade regime, 2) a national cap and trade regime, 3) a national carbon tax, and 4) the absence of any greenhouse gas policy. The impacts of greenhouse gas policies on the Expected Case are the result of a weighted average of these policies as included in the stochastic analysis of the IRP. Figure 9 presents emissions cost assumptions on a per-short ton basis.

Figure 9: Projected Price of Greenhouse Gas Emissions

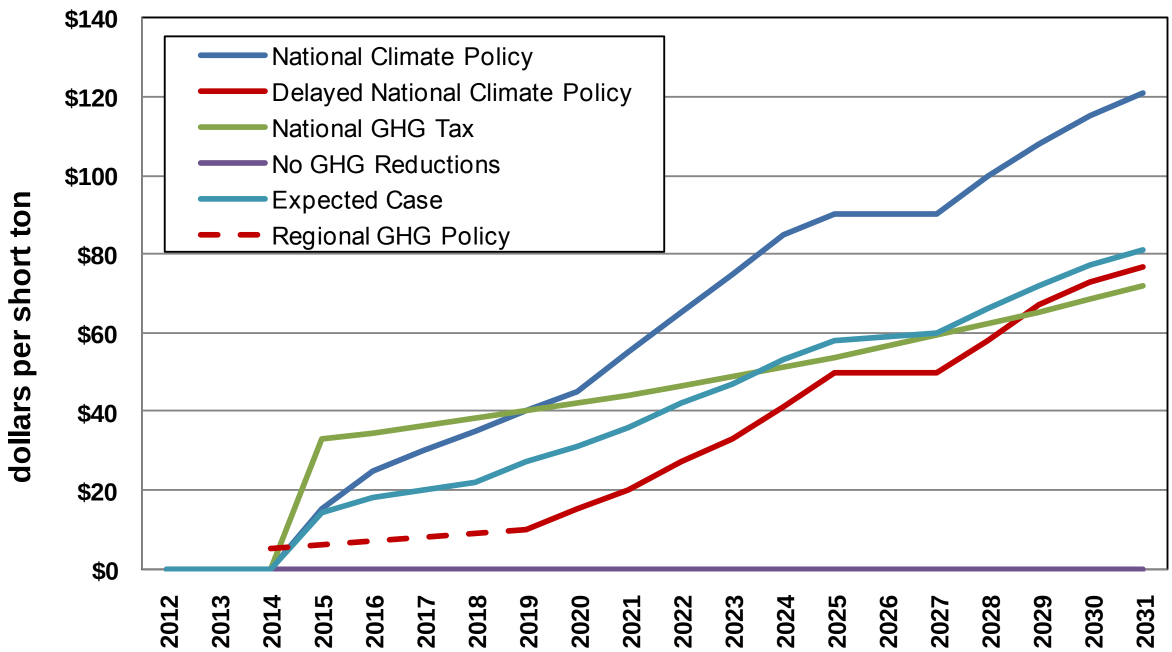
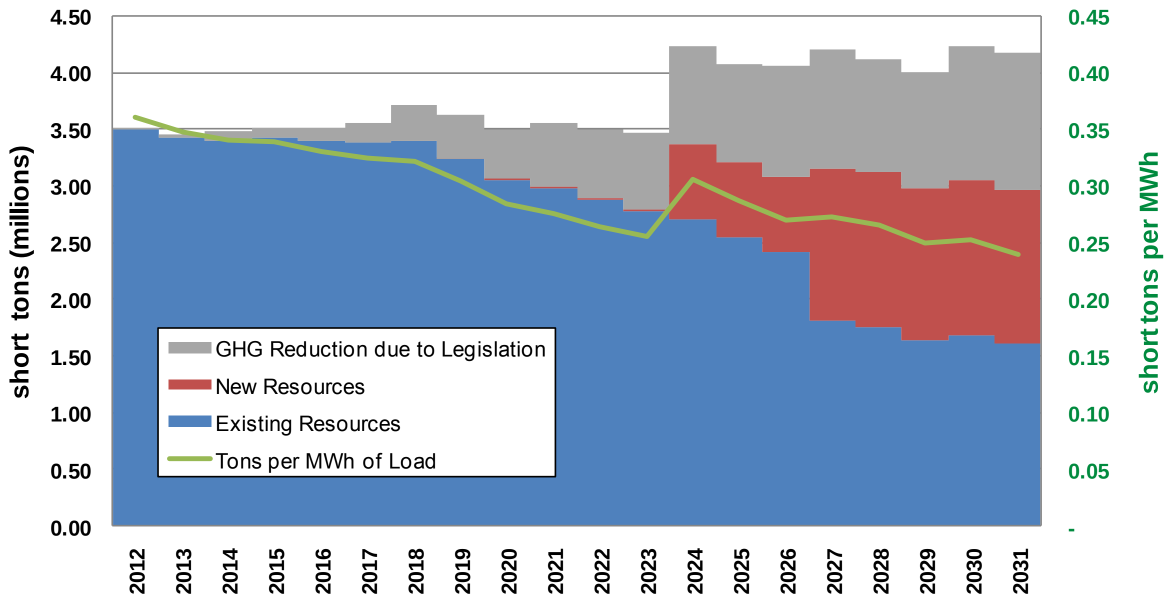


Figure 10 shows projected greenhouse gas emissions for existing and new Avista generation assets.[7] The grey area of Figure 10 represents incremental greenhouse gas emissions where there is no national or regional greenhouse gas policy.[8]

[7] Figure 10 does not include emissions from market or contract purchases. It also does not reduce Company emissions commensurate with market or contract sales.
[8] Existing Avista resources, and those selected to meet load growth, under a scenario without a greenhouse gas policy likely would generate higher emissions due primarily to increased operation at Colstrip.

Figure 10: Avista Owned and Controlled Resource's Greenhouse Gas Emissions



Action Items

The Company's 2011 Action Plan outlines activities and studies between now and the 2013 Integrated Resource Plan. It includes input from Commission Staff, the Company's management team, and the Technical Advisory Committee. Action Item categories include resource additions and analysis, demand side management, environmental policy, modeling and forecasting enhancements, and transmission planning. Chapter 9 contains 2011 IRP Action Items.

1. Introduction and Stakeholder Involvement

Avista Utilities submits a biennial Integrated Resource Plan (IRP) to the Idaho and Washington public utility commissions.[1] The 2011 IRP is Avista's twelfth plan. It identifies and describes a Preferred Resource Strategy (PRS) for meeting load growth while balancing cost and risk measures with environmental mandates.

The Company is statutorily obligated to provide reliable electricity service to its customers at rates, terms, and conditions that are just, reasonable, and sufficient. Avista assesses different resource acquisition strategies and business plans to acquire resources to meet resource adequacy requirements and optimize the value of its current resource portfolio. We use the IRP as a resource evaluation tool rather than a plan for acquiring a particular set of assets. The 2011 IRP continues refining our resource acquisition efforts.

IRP Process

The 2011 IRP is developed and written with the aid of a public process. Avista actively seeks input for its IRPs from a variety of constituents through the Technical Advisory Committee (TAC). The TAC list of 75 individuals includes Commission Staff from Idaho and Washington, customers, academics, government agencies, consultants, utilities, and other interested parties who accepted an invitation to join, or had asked to be involved in, the planning process.

The Company sponsored six TAC meetings for the 2011 IRP. The first meeting was on May 27, 2010, and the last was on June 23, 2011. TAC meetings covered different aspects of the 2011 IRP planning activities and solicited contributions to, and assessments of, modeling assumptions, modeling processes, and results. Table 1.1 contains a list of TAC meeting dates and the agenda items covered in each meeting.

[1] Washington IRP requirements are contained in WAC 480-100-238 Integrated Resource Planning. Idaho IRP requirements are outlined in Case No. U-1500-165 Order No. 22299, Case No. GNR-E-93-1, Order No. 24729, and Case No. GNR-E-93-3, Order No. 25260.

Table 1.1: TAC Meeting Dates and Agenda Items

Meeting Date	Agenda Items
TAC 1 – May 27, 2010	• Work Plan • Load & Resource Balance Update • Resource Planning Environment • 2011 IRP Topic Discussions – Analytical Process Changes, Hydro Modeling, Resource Adequacy, Loss of Load Probability, Energy Efficiency and Scoping the 2011 Plan
TAC 2 – September 8 and 9, 2010	• Lancaster Plant Tour • Upper Falls and Monroe Street Tour • Resource Assumptions • Reliability Planning • Sustainability Report • Combined Heat and Power Generation • Energy Efficiency
TAC 3 – December 2, 2010	• Transmission Costs and Issues • Potential Hydro Upgrades • Potential Thermal Upgrades • Load Forecast • Stochastic Modeling
TAC 4 – February 3, 2011	• Natural Gas Price Forecast • Electric Price Forecast • Resource Requirements Projections • Portfolio and Market Scenario Planning
TAC 5 – April 12, 2011	• Conservation Avoided Cost Methodology • Conservation • Smart Grid • Draft Preferred Resource Strategy • Portfolio Alternatives & Scenarios
TAC 6 – June 23, 2011	• High Wind Market Analysis • Preferred Resource Strategy and Scenario Analysis • IRP Action Items • IRP Section Highlights

Agendas and presentations from the TAC meetings are in Appendix A and on Avista's website at http://www.avistautilities.com/inside/resources/irp/electric. Past IRPs and TAC presentations are also here.

Avista wishes to acknowledge the contributions of a number of external TAC participants in Table 1.2.

Table 1.2: External Technical Advisory Committee Participants

Participant	Organization
Robin Toth	Greater Spokane Inc.
Dave Van Hersett	Resource Development Associates
John Dacquisto	Gonzaga University
Deborah Reynolds	Washington Utilities and Transportation Commission
Steve Johnson	Washington Utilities and Transportation Commission
David Nightingale	Washington Utilities and Transportation Commission
Rick Applegate	Washington Utilities and Transportation Commission
Nancy Hirsch	Northwest Energy Coalition
Kirsten Wilson	Washington State General Administration
Rick Sterling	Idaho Public Utilities Commission
Tom Noll	Idaho Power
Ken Corum	Northwest Power and Conservation Council
Keith Knitter	Grant County Public Utilities District
Becky King	Chelan County Public Utilities District
Villamour Gamponia	Puget Sound Energy
Kevin Rasler	Inland Empire Paper
Mike Connolley	Idaho Forest Group
Rob Haneline	McKinstry

Issue Specific Public Involvement Activities

In addition to the TAC meetings, Avista sponsors and participates in several other collaborative processes involving a range of public interests.

External Energy Efficiency ("Triple E") Board

The Triple E Board, formed in 1995, provides stakeholders and public groups biannual opportunities to discuss Avista's energy efficiency efforts. The Triple E Board grew out of the DSM Issues group. This predecessor group was influential in developing the country's first conservation distribution surcharge in 1995.

FERC Hydro Relicensing – Clark Fork River Projects

Over 50 stakeholder groups participated in the Clark Fork hydro-relicensing process beginning in 1993. This led to the first all-party settlement filed with a FERC relicensing application, and eventual issuance of a 45-year FERC operating license in February 2003. The nationally recognized Living License concept was a result of this process. This collaborative process continues in the implementation phase of the Living License, with stakeholders participating in various protection, mitigation, and enhancement efforts at the projects.

Low Income Rate Assistance Program (LIRAP)

LIRAP is coordinated with four community action agencies in Avista's Washington service territory. The program began in 2001 and reviews administrative issues and needs on a quarterly basis.

Regional Planning

The Pacific Northwest's generation and transmission system is operated in a coordinated fashion. Avista participates in the efforts of many organization's planning processes. Information from this participation supplements Avista's IRP process. Some of the organizations that Avista participates in are:

- Western Electricity Coordinating Council
- Northwest Power and Conservation Council
- Northwest Power Pool
- Pacific Northwest Utilities Conference Committee
- ColumbiaGrid
- Northwest Transmission Assessment Committee
- North American Electric Reliability Council

Future Public Involvement

As explained above, Avista actively solicits input from interested parties to enhance its IRP process. We continue to expand TAC membership and diversity, and maintain the TAC meetings as an open public process.

2011 IRP Outline

The 2011 IRP consists of nine chapters plus an executive summary and this introduction. A series of technical appendices supplement this report.

Executive Summary

This chapter summarizes the overall results and highlights of the key results of the 2011 IRP.

Chapter 1: Introduction and Stakeholder Involvement

This chapter introduces the IRP and details public participation and involvement in the integrated resource planning process.

Chapter 2: Loads and Resources

The first half of this chapter covers Avista's load forecast and related local economic forecasts. The last half describes the Company's owned generating resources, major contractual rights and obligations, capacity, energy and renewable energy credit tabulations, and reserve obligations.

Chapter 3: Energy Efficiency

This chapter discusses Avista's energy efficiency programs. It provides an overview of the conservation potential assessment and summarizes the energy efficiency modeling results for the 2011 IRP.

Chapter 4: Policy Considerations

This chapter focuses on some of the major policy issues for resource planning, such as state and federal greenhouse gas policies and environmental regulations.

Chapter 5: Transmission & Distribution

This chapter discusses Avista's distribution and transmission systems, as well as regional transmission planning issues. The chapter includes detail on transmission cost studies used in the IRP modeling, including a summary of our 10-year Transmission Plan. The chapter includes a discussion of Avista's distribution efficiency and grid modernization projects.

Chapter 6: Generation Resource Options

This chapter covers the costs and operating characteristics of the generation resource options modeled for the 2011 IRP.

Chapter 7: Market Analysis

This chapter details Avista's modeling and analysis of the various wholesale markets applicable to the 2011 IRP.

Chapter 8: Preferred Resource Strategy

This chapter details Avista's 2011 Preferred Resource Strategy (PRS) and explains how the PRS could change in response to scenarios differing from the Expected Case.

Chapter 9: Action Items

This chapter provides an overview of the progress made on Action Items from the 2009 IRP. It details new Action Items to start and/or complete between the issuance of the 2011 IRP and prior to the 2013 IRP.

Regulatory Requirements

The IRP process for Washington has several requirements documented in Washington Administrative Code (WAC). Table 1.3 summarizes where within the IRP the applicable WACs are addressed.

Table 1.1 Washington IRP Rules and Requirements

Rule and Requirement	Plan Citation
WAC 480-100-238(4) – Work plan filed no later than 12 months before next IRP due date. Work plan outlines content of IRP. Work plan outlines method for assessing potential resources.	Work plan submitted to the UTC on August 31, 2010; see Appendix B for a copy of the Work Plan.
WAC 480-100-238(5) – Work plan outlines timing and extent of public participation.	Appendix B
WAC 480-100-238(2)(a) – Plan describes mix of energy supply resources.	Chapter 6- Generation Resource Options
WAC 480-100-238(2)(a) – Plan describes conservation supply.	Chapter 3- Energy Efficiency
WAC 480-100-238(2)(a) – Plan addresses supply in terms of current and future needs of utility ratepayers.	Chapter 2- Loads & Resources
WAC 480-100-238(2)(b) – Plan uses lowest reasonable cost (LRC) analysis to select mix of resources.	Chapter 8- Preferred Resource Strategy
WAC 480-100-238(2)(b) – LRC analysis considers resource costs.	Chapter 8- Preferred Resource Strategy
WAC 480-100-238(2)(b) – LRC analysis considers market-volatility risks.	Chapter 4- Policy Considerations Chapter 7- Market Analysis Chapter 8- Preferred Resource Strategy
WAC 480-100-238 (2)(b) – LRC analysis considers demand side uncertainties.	Chapter 3- Energy Efficiency
WAC 480-100-238(2)(b) – LRC analysis considers resource dispatchability.	Chapter 6- Generation Resource Options Chapter 7- Market Analysis
WAC 480-100-238(2)(b) – LRC analysis considers resource effect on system operation.	Chapter 7- Market Analysis Chapter 8- Preferred Resource Strategy

WAC 480-100-238(2)(b) – LRC analysis considers risks imposed on ratepayers.	Chapter 4- Policy Considerations Chapter 6- Generation Resource Options Chapter 7- Market Analysis Chapter 8- Preferred Resource Strategy
WAC 480-100-238(2)(b) – LRC analysis considers public policies regarding resource preference adopted by Washington state or federal government.	Chapter 2- Loads & Resources Chapter 4- Policy Considerations Chapter 8- Preferred Resource Strategy
WAC 480-100-238(2)(b) – LRC analysis considers cost of risks associated with environmental effects including emissions of carbon dioxide.	Chapter 4- Policy Considerations Chapter 8- Preferred Resource Strategy
WAC 480-100-238(2)(c) – Plan defines conservation as any reduction in electric power consumption that results from increases in the efficiency of energy use, production, or distribution.	Chapter 3- Energy Efficiency Chapter 8- Preferred Resource Strategy
WAC 480-100-238(3)(a) – Plan includes a range of forecasts of future demand.	Chapter 2- Loads & Resources Chapter 8- Preferred Resource Strategy
WAC 480-100-238(3)(a) – Plan develops forecasts using methods that examine the effect of economic forces on the consumption of electricity.	Chapter 2- Loads & Resources Chapter 5- Transmission & Distribution Chapter 8- Preferred Resource Strategy
WAC 480-100-238-(3)(a) – Plan develops forecasts using methods that address changes in the number, type and efficiency of end-uses.	Chapter 2- Loads & Resources Chapter 3- Energy Efficiency Chapter 5- Transmission & Distribution
WAC 480-100-238(3)(b) – Plan includes an assessment of commercially available conservation, including load management.	Chapter 3- Energy Efficiency Chapter 5- Transmission & Distribution
WAC 480-100-238(3)(b) – Plan includes an assessment of currently employed and new policies and programs needed to obtain the conservation improvements.	Chapter 3- Energy Efficiency Chapter 5- Transmission & Distribution

WAC 480-100-238(3)(c) – Plan includes an assessment of a wide range of conventional and commercially available nonconventional generating technologies.	Chapter 6- Generator Resource Options Chapter 8- Preferred Resource Strategy
WAC 480-100-238(3)(d) – Plan includes an assessment of transmission system capability and reliability (as allowed by current law).	Chapter 5- Transmission & Distribution
WAC 480-100-238(3)(e) – Plan includes a comparative evaluation of energy supply resources (including transmission and distribution) and improvements in conservation using LRC.	Chapter 3- Energy Efficiency Chapter 5- Transmission & Distribution
WAC-480-100-238(3)(f) – Demand forecasts and resource evaluations are integrated into the long range plan for resource acquisition.	Chapter 3- Energy Efficiency Chapter 5- Transmission & Distribution Chapter 6- Generator Resource Options Chapter 8- Preferred Resource Strategy
WAC 480-100-238(3)(g) – Plan includes a two-year action plan that implements the long range plan.	Chapter 9- Action Items
WAC 480-100-238(3)(h) – Plan includes a progress report on the implementation of the previously filed plan.	Chapter 9- Action Items
WAC 480-100-238(5) – Plan includes description of consultation with commission staff. (Description not required)	Chapter 1- Introduction and Stakeholder Involvement
WAC 480-100-238(5) – Plan includes description of work plan. (Description not required)	Appendix B
WAC 480-107-015(3) – Proposed request for proposals for new capacity needed within three years of the IRP.	Chapter 8- Preferred Resource Strategy

2. Loads & Resources

Introduction & Highlights

An explanation and quantification of Avista's loads and resources are integral to the Integrated Resource Plan (IRP). The first half of this chapter summarizes customer and load forecasts, including forecast ranges, load growth scenarios, and an overview of enhancements to forecasting models and processes. The second half of the chapter covers Avista's current resource mix, including descriptions of owned and operated generation, as well as long-term power purchase contracts.

Section Highlights

- Historic conservation acquisitions are included in the load forecast; higher acquisition levels anticipated in the IRP reduce the load forecast further.
- Annual electricity sales growth from 2012 to 2031 averages 1.6 percent.
- Expected energy deficits begin in 2020, growing to 475 aMW by 2031.
- Expected capacity deficits begin in 2019, growing to 883 MW by 2031.
- Current conservation programs push the need for resources out by two years for energy and six years for capacity.
- Renewable portfolio requirements drive near-term resource needs.

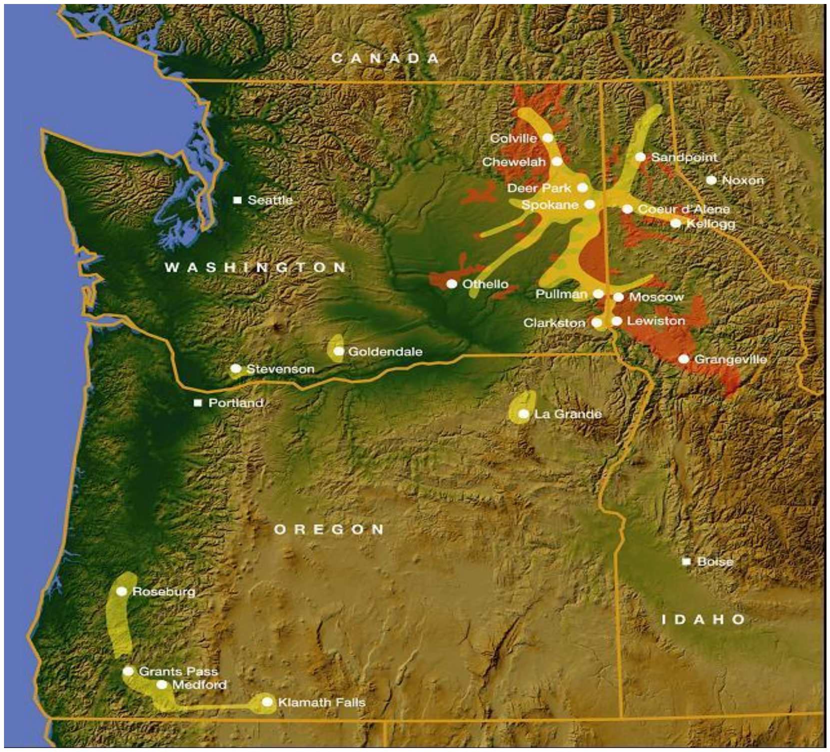
Economic Conditions in Avista's Service Territory

Avista serves electricity customers in most of the urban and suburban areas of 24 counties of eastern Washington and northern Idaho. The service territory is geographically and economically diverse. Figure 2.1 shows the Company's electricity and natural gas service territories.

The Inland Northwest has transformed over the past 25 years, from a natural resource-based manufacturing economy to a diversified light manufacturing and services economy. The United States Forest Service manages a significant portion of the mountainous areas of the region. Reduced timber harvests on federal lands have closed many local sawmills. Two pulp and paper plants served by Avista manage large forest holdings and face stiff domestic and international competition for their products.

Avista's service territory experienced periods of significant unemployment during the two national recessions of the 1980s. The 1991/92 national recession mostly bypassed Avista's service territory, but the 2001 recession greatly affected the area. The IRP Expected Case projects the present recession to end in 2011. The employment data reflects the effects of economic recession and expansion. Avista tracks employment data for the three principal counties in its electricity service territory: Bonner, Kootenai and Spokane.

Figure 2.1: Avista's Service Territory and Generation Resources



Population is generally more stable than employment during times of economic change; however, it can contract during severe economic downturns as people leave in search of employment opportunities. Over the past 25 years, the region experienced a net population loss only in 1987. Figure 2.2 details historic and projected annual population changes in Kootenai and Spokane counties. Figure 2.3 shows total population.

Figure 2.2: Population Percent Change for Spokane and Kootenai Counties

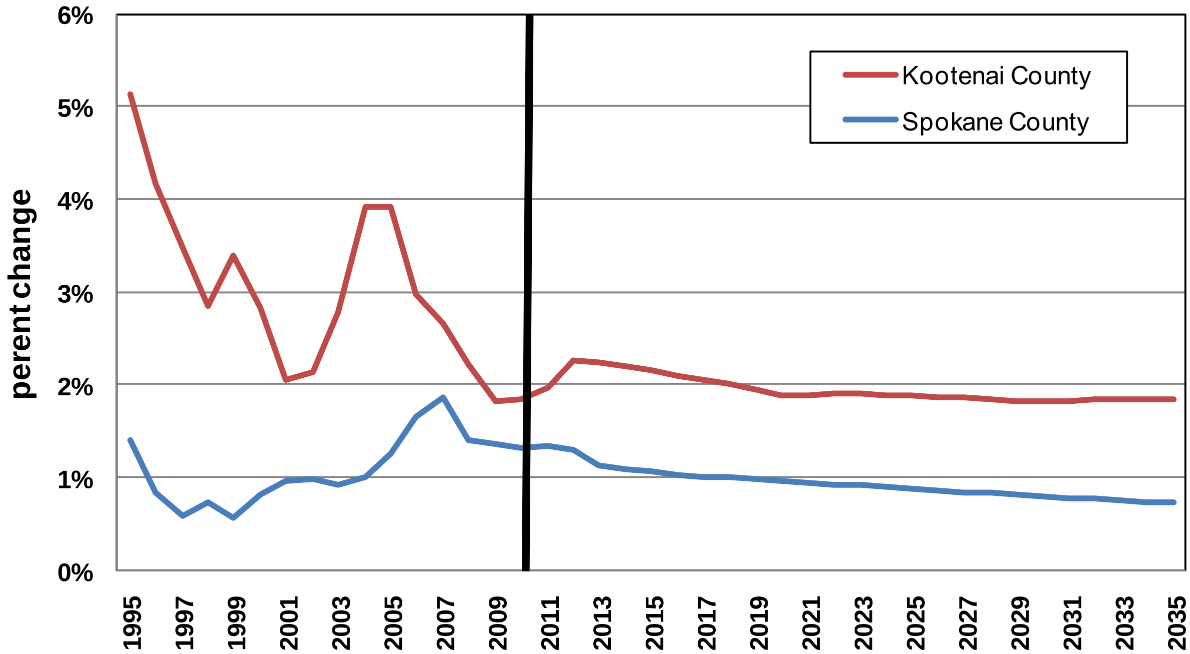
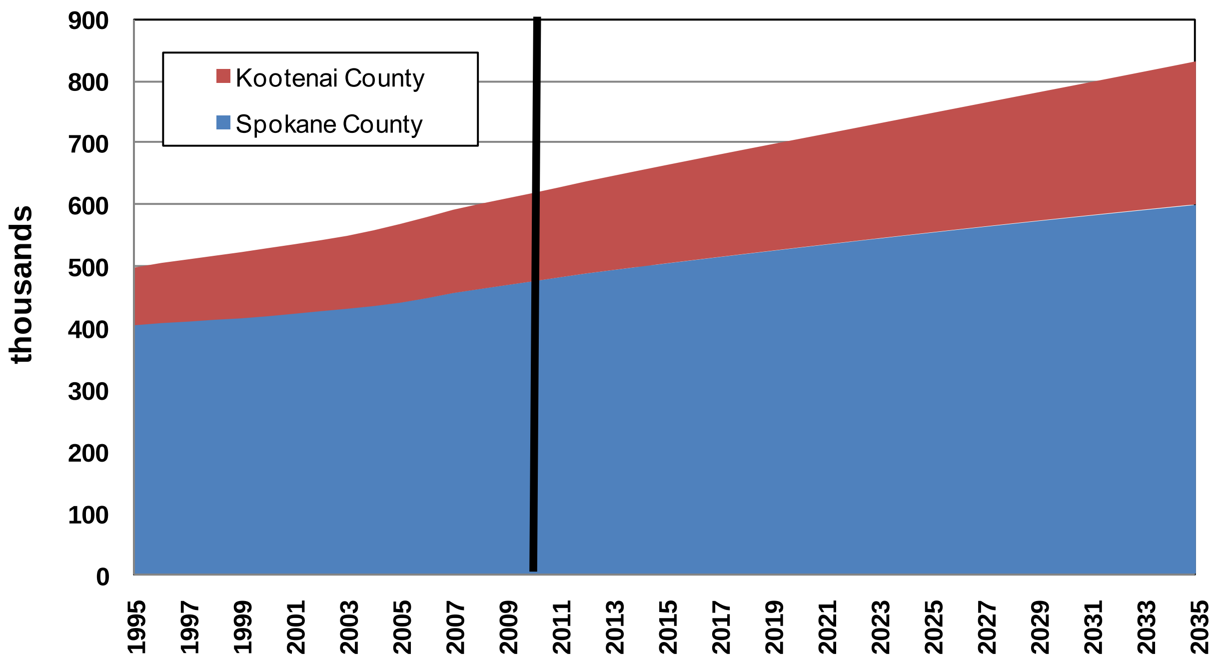


Figure 2.3: Total Population for Spokane and Kootenai Counties



People, Jobs and Customers

The October 2010 IRP forecast relies on an August 2010 national and September 2010 county-level forecasts. The data focus on two counties–Spokane County in Washington, and Kootenai County in Idaho–that comprise more than 80 percent of our service area economy. Avista purchases the employment and population forecasts from Global Insight, Inc., an internationally recognized economic forecasting consulting firm.

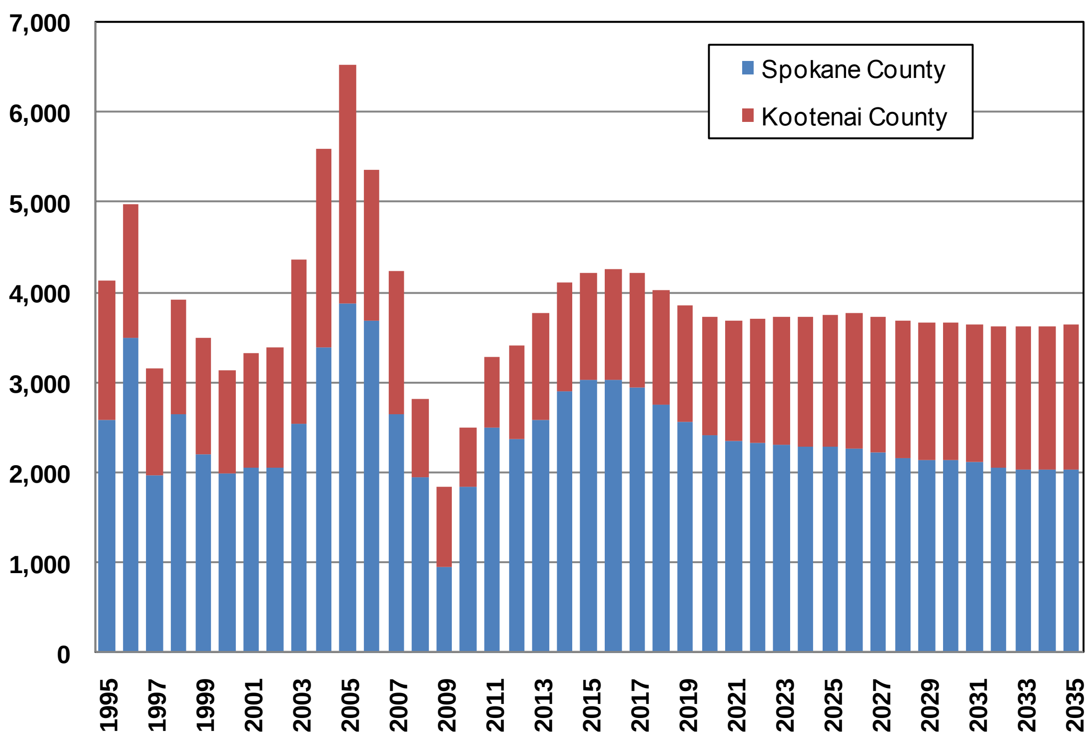
The Third Technical Advisory Committee included sections on the load forecast and its underlying assumptions. Table 2.1 presents the key forecast assumptions presented at that meeting.

Table 2.1: Global Insight National Long Range Forecast Assumptions

Assumption	Average	Assumption	Average
Gross Domestic Product	2.7%	Housing Starts (millions)	1.58/year
Consumer Price Index	1.9%	Job Growth	1.0%/year
Imported Crude 2000$	$70	Worker Productivity	2.0%
Federal Funds Rate	4.75%	Consumer Sentiment	90
Unemployment Rate	5.0%		

In 2010, as part of a revision in materials provided under contract to Avista, Global Insight began producing housing start forecasts consistent with the population and employment forecasts, as shown in Figure 2.4.

Figure 2.4: House Starts Total Private (SAAR)



Employment growth often drives population growth. Figure 2.5 shows historical employment trends from 1995, and forecast growth through 2035. Overall non-farm wage and salary employment over the past 15 years averaged 2.9 percent for Kootenai County and 1.0 percent for Spokane County.

Figure 2.5: Percent Change to Employment

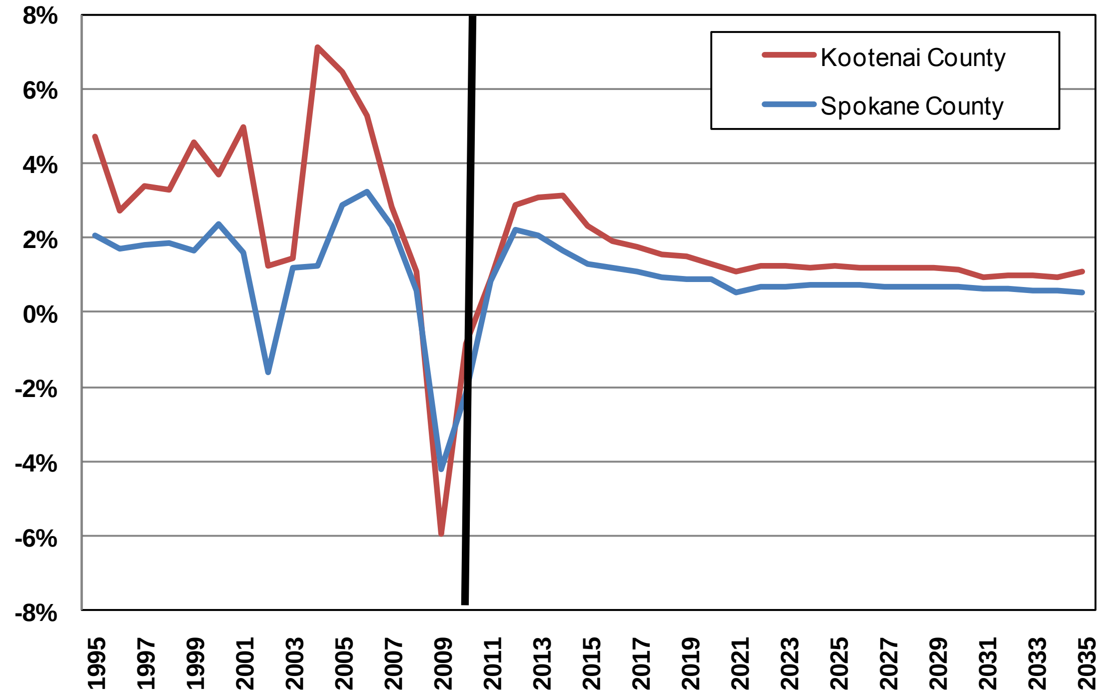
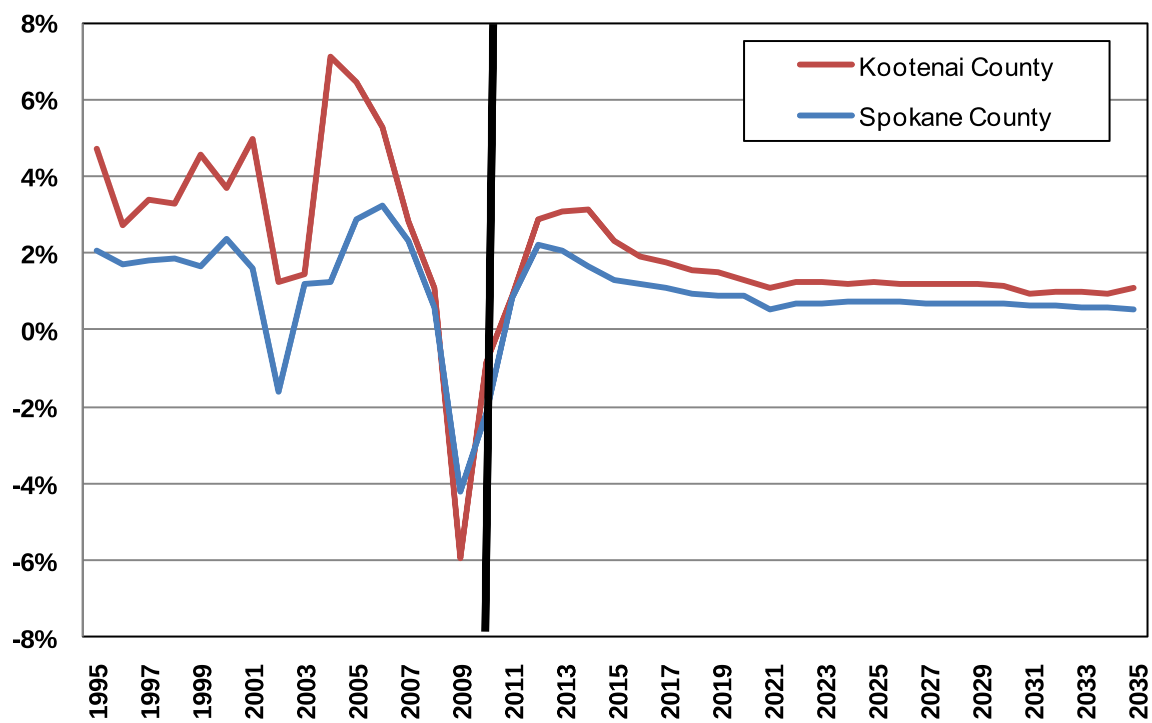


Figure 2.6 provides additional non-farm employment data. Over the forecast period, non-farm employment growth is 1.5 percent and 0.9 percent for Spokane and Kootenai counties, respectively. Employment growth is approximately 3,000 new jobs per year.

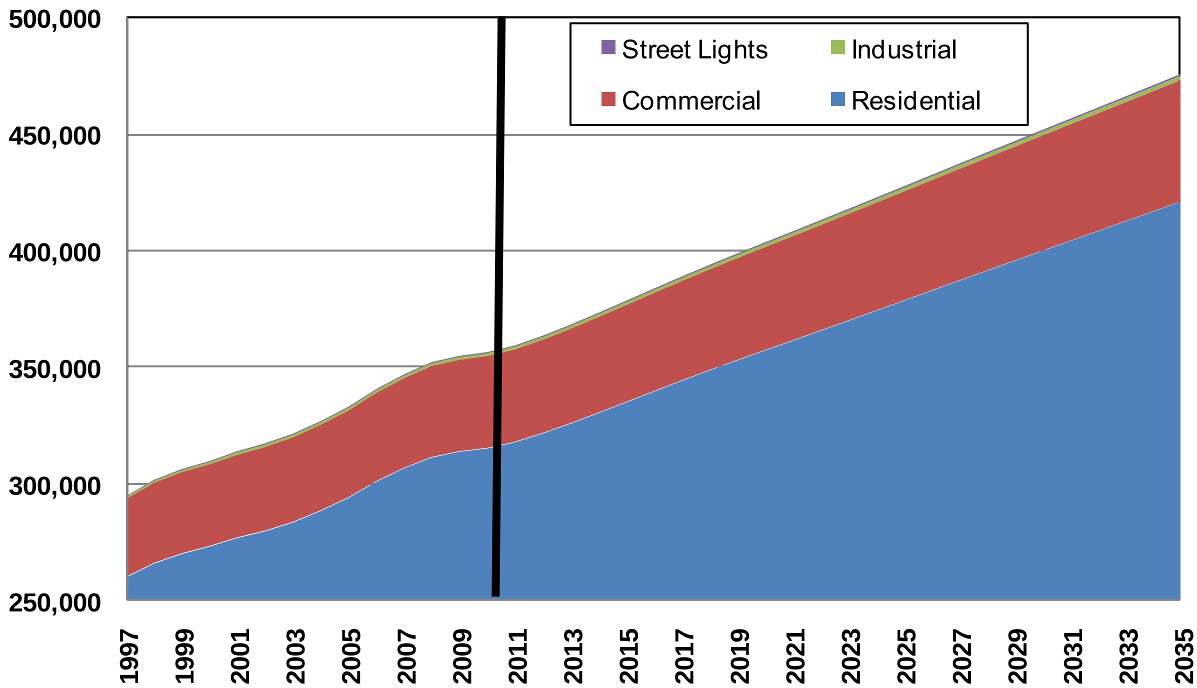
Figure 2.6: Non-Farm Employment



Customer growth projections follow baseline economic forecasts. Employment statistics have the greatest probability of near term change as the region emerges from the recession in 2011. Avista tracks four key customer classes: residential, commercial, industrial, and street lighting. A linear regression using housing starts as the independent variable is the basis for the residential customer forecasts. Commercial forecasts rely on a linear regression of residential growth. Industrial customer growth follows employment growth. Street lighting customer growth is trended with population growth.

Avista forecasts sales by rate schedule. Overall customer forecasts are a compilation of the various rate schedules. For example, the residential class forecast is comprised of separate forecasts prepared for rate schedules 1, 12, 22, and 32 for Washington and Idaho. See Figure 2.7 for annual customer growth levels by rate class.

Figure 2.7: Avista Customer Forecast



On average during calendar 2010, Avista served 356,567 retail customers: 315,275 residential, 39,488 commercial, 1,375 industrial and 449 street lighting. This is a 15 percent increase from 309,871 retail customers in 2000. In 2010, 33.4 percent of residential customers, 42.0 percent of commercial customers, 34.6 percent of industrial customers, and 27.7 percent of street lighting customers were located in Idaho; the balance was located in Washington. The 2035 forecast predicts 474,316 retail customers: 419,739 residential, 52,172 commercial, 1,635 industrial and 770 street lighting. The 25-year compound growth rate averages 1.1 percent, down from 1.7 percent in the 2009 IRP and consistent with a lower population forecast.

Weather Forecasts

The Expected Case electricity sales forecast uses 30-year monthly temperature averages recorded at the Spokane International Airport weather station through 2009. Several other weather stations are located in Avista's service territory, but their data are available for a much shorter duration and high correlations exist between the Spokane International Airport and these weather stations.

Sales forecasts are prepared using monthly data, as more granular load information is not available. Heating degree-days measure cold weather load sensitivity; cooling degree-days measure hot weather load sensitivity.

The load forecast includes projection of climate change impact. Ample evidence of cooling and warming trends exists in the historical record. The recent trend is a warming climate compared to the 30-year average. Avista relies on the University of Washington "Climate Change Scenarios" 2008 study converted to heating and cooling degree-days.[1] This study provides warming to 87.2 percent of the present 30-year average. Cooling degree-days are 144.3 percent.

Price Elasticity

Price elasticity is an important consideration in any electricity demand forecast. It measures the ratio between the demand for electricity and a change in its price. A consumer who is sensitive to price change has a relatively elastic demand profile. A customer who is unresponsive to price changes has a relatively inelastic demand profile. During the 2000-2001 Western Energy Crisis customers displayed increasing price sensitivity and reduced overall usage in response to relatively large changes in the price of electricity.

Cross elasticity of demand, or cross-price elasticity, measures the relationship between the quantities of electricity demanded and to the quantity of potential electricity substitutes (e.g., propane or natural gas for heat) when the price of electricity increases relative to the price of the substitute product. A positive cross elasticity coefficient indicates cross-price elasticity between electricity and the substitute. A negative cross elasticity coefficient indicates the absence of cross-price elasticity, and that considered product is not a substitute for electricity but is instead complementary to it. In other words, an increase in the price of electricity increases the use of the complementary good, and a decrease in the price of electricity decreases the use of the complementary good.

The principal application of cross elasticity impact in the IRP is its substitutability by natural gas in some applications, including water and space heating. The correlation between retail electricity prices and the commodity cost of natural gas has increased in recent years as the industry has become more reliant on gas-fired generation to meet load growth. This increased positive correlation has reduced the net effect of cross price elasticity between retail natural gas and electricity prices.

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[1] http://cses.washington.edu/cig/fpt/ccscenarios.shtml.

Income elasticity measures the relationship between a change in consumer income and the change in consumer demand for electricity. As incomes rise, the ability of a consumer to pay for more electricity increases. The ability to afford electricity-consuming appliances also increases. Simply stated, as incomes rise consumers are more likely to purchase more electricity-consuming equipment, live in larger dwellings that use more electricity, and use the electrical equipment they have more often. Two of the most cited present examples of income elasticity are the increased proliferation of mobile electronic devices and high definition televisions.

The IRP estimates price elasticity by customer class for use in our electricity and natural gas demand forecasts. The price elasticity statistics used in the 2011 IRP are negative 0.15 for residential and negative 0.10 for commercial customers. Natural gas and electricity cross-price elasticity is positive at 0.05. Income elasticity is positive 0.75, meaning electricity is more affordable as incomes rise.

The baseline forecast used in the Expected Case assumes that rising incomes offset rising electricity and natural gas prices. Thus, there is no net expected impact on electricity consumption other than that caused by climate change and energy efficiency programs.

Retail Price Forecast

The retail sales forecast assumes retail prices increase at an average annual rate of eight percent from 2010 to 2018, followed by increases at the rate of general economic inflation thereafter. Carbon legislation and renewable energy targets are responsible for approximately one-fourth of the rate rise.[2]

Conservation

It is difficult to separate the interrelated impacts of rising electricity and natural gas prices, rising incomes, and conservation programs on the load forecast. Avista collects data on total demand, and derives from this data consumption change impacts. Avista has encouraged its customers to conserve electricity by offering conservation programs to its customers since 1978. Electricity usage impacts of these programs affect historical data; therefore, we conclude that the forecast already contains the impacts of existing conservation levels (7.5 aMW per year of new acquisition). As the 2011 IRP forecasts increased levels of conservation acquisition relative to history, the increased quantities reduce retail loads below Expected Case forecast levels.

Use per Customer Projections

A database of monthly electricity sales and customer numbers by rate schedule forms the basis of the usage per customer forecasts by rate schedule, customer class, and state from 1997 to 2010. Historical data is weather-normalized to remove the impact of

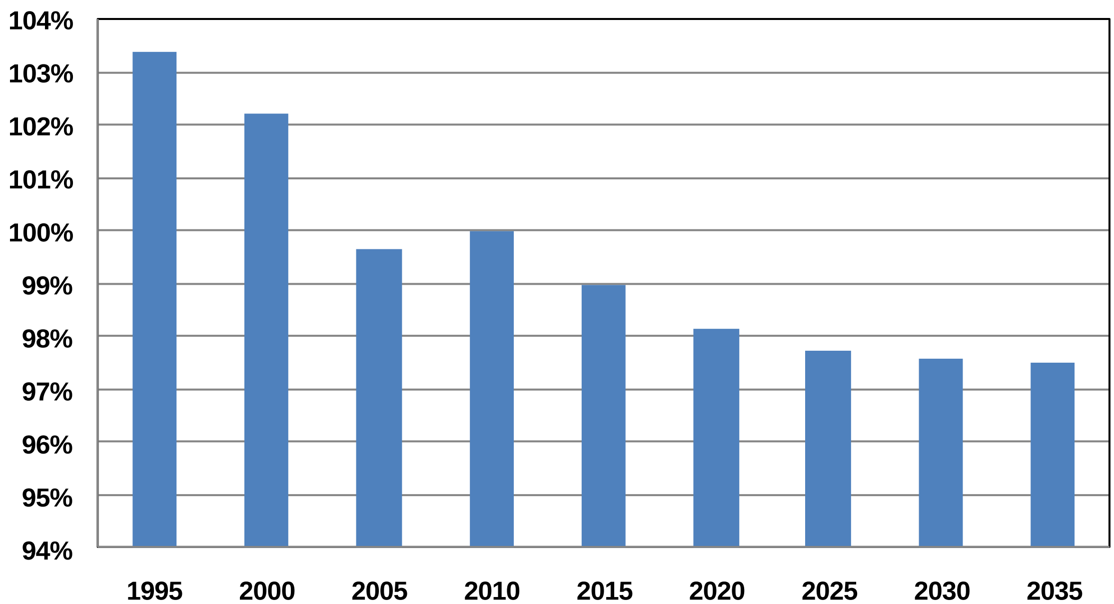
[2] This result assumes that the legislation does not mitigate the impacts of GHG legislation by issuing free utility allocations. Avista develops its load forecast independently of the IRP process. The load forecast mitigation assumption therefore differs from the Expected Case in the IRP where carbon mitigation legislation provides significant offsets and thereby limits the overall rate impact of carbon legislation. Avista does not expect this assumption difference to affect significantly the IRP results.

heating and cooling degree-day deviations from expected normal values, as discussed above. Retail electricity price increases reduce electricity usage per customer.

The 2011 IRP includes a forecast of electric vehicles in the Expected Case based on projections made by the Northwest Power and Conservation Council in its Sixth Power Plan. The electric fleet is a combination of plug-in hybrids and electric-only passenger vehicles.

The residential usage per customer forecast trends flat over the long term. This result is the combination of reductions from embedded conservation, warming temperatures, price elasticity effects, and increases from electricity vehicle use. The forecast of household size decreases over time, as shown in Figure 2.8.

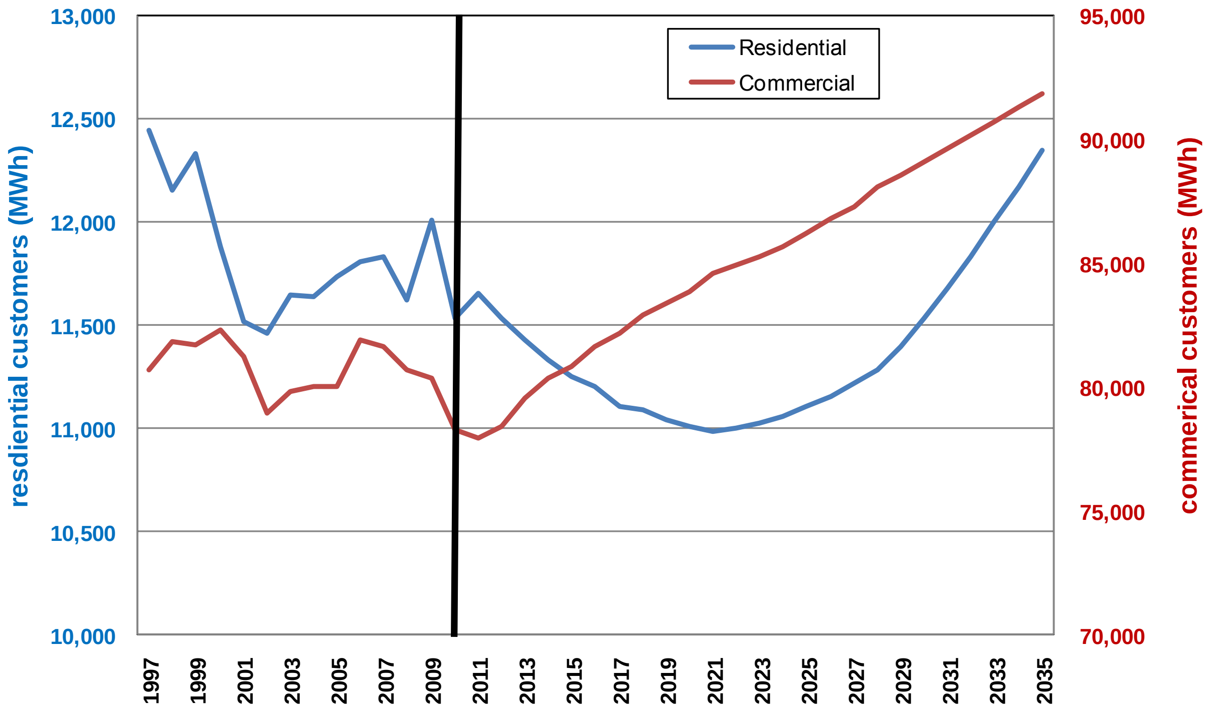
Figure 2.8: Household Size Index



Residential customers tend to be homogeneous relative to size of their dwellings. Commercial customers, on the other hand, are heterogeneous, ranging from small customers with varying electricity intensity per square foot of floor space to big box retailers with generally high intensities. The addition of new large commercial customers, including additions to largest universities and hospitals, can greatly skew average use per average customer statistics. Usage forecasts for the residential and commercial sectors are contained in Figure 2.9.

Estimates for residential usage per customer across all schedules are relatively smooth. Commercial usage per customer increases for several years due to additional existing and new buildings housing very large customers, including Washington State University and Sacred Heart Medical Center. Expected additions for very large customers are included in the forecast through 2015; no additions are included after 2015. Avista includes only publicly announced long lead-time buildings in its load forecast.

Figure 2.9: Electricity Usage per Customer



Retail Electricity Sales Forecast

Major economic changes between 1997 and 2010 affected the region, not the least of which was a marked increase in wholesale and retail electricity prices. The energy crisis of 2000-01 included widespread and permanent conservation efforts by our customers. Several large industrial facilities closed permanently during the 2001-02 economic recession. In 2004, rising retail electricity rates further reinforced conservation efforts. Recently, the economy has experienced a significant recession from which it is slowly emerging. The recession reduced loads below what they otherwise would be.

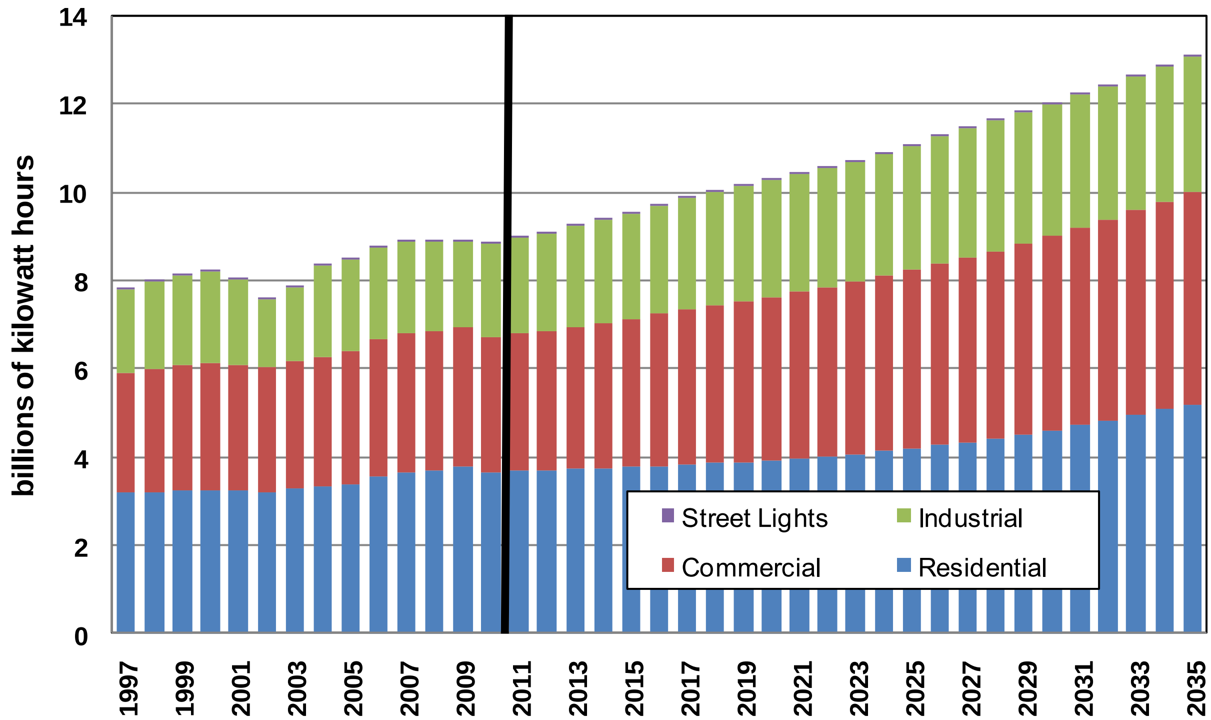
Retail electricity consumption rose from 8.2 million MWh in 2000 to 8.9 million MWh in 2010. This 0.75 percent annual average increase was net of the combined impacts of higher prices and resultant decreases in electricity demand from the Energy Crisis and economic recessions. Loads recover due to stabilizing electricity prices and recovery from the present recession. Forecasted average annual increase in retail sales over the 2010 to 2035 period is 1.6 percent.

The sales forecast takes a "bottom up" approach, summing individual customer class forecasts of customers and usage per customer to produce a retail sales forecast. Individual forecasts for our largest industrial customers (Schedule 25) include planned or announced production increases or decreases. Lumber and wood products industries have slowed down from very high production levels, consistent with the decline in housing starts at the national level caused by the present economic recession. Lumber and wood products sector load forecasts account for decreased production levels.

Anticipated sales to aerospace and aeronautical equipment suppliers have increased, and local plants have announced plans to hire more workers and increase their output.

The forecast for 2035 is 13.11 billion kWh, representing a 1.6 percent compounded increase in retail sales. See Figure 2.10 for Avista's retail sales forecast.

Figure 2.10: Avista's Retail Sales Forecast

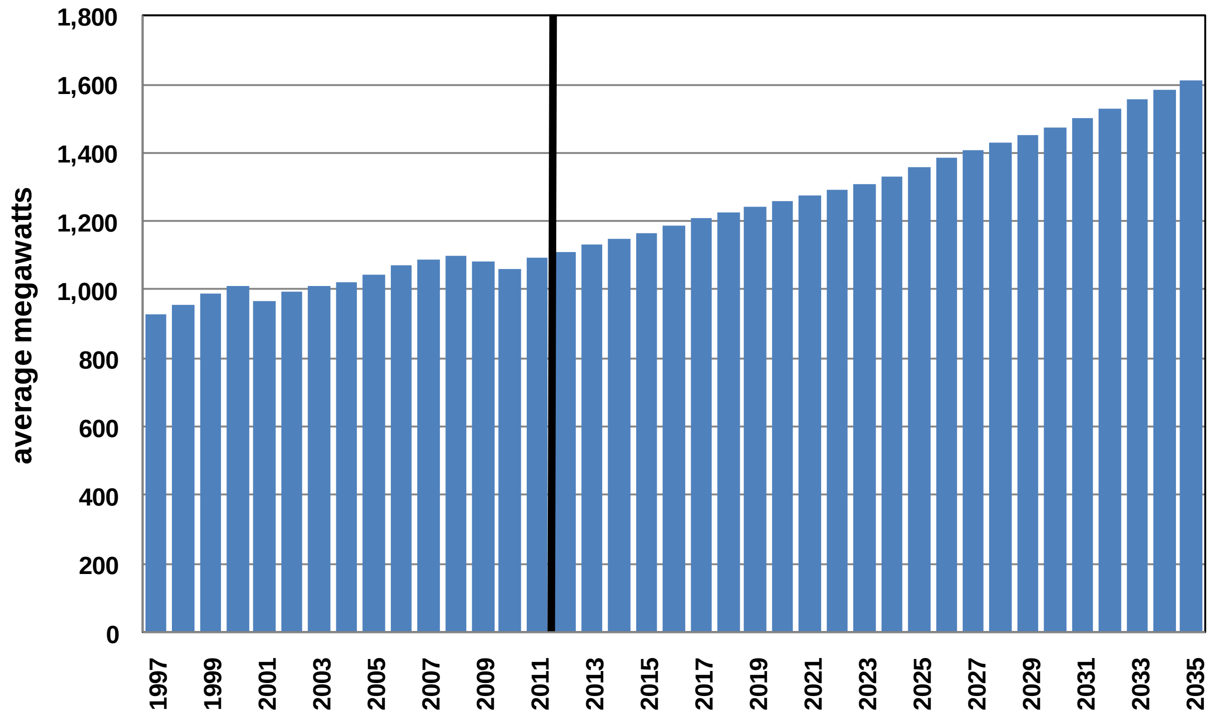


Load Forecast

Retail sales provide the data used to project load. Retail sales translate into average megawatt hours using a regression model ensuring monthly load shapes conform to history. The load forecast is a retail sales forecast combined with line losses across incurred in the delivery of electricity across the Avista transmission and distribution system.

Figure 2.11 presents annual net native load growth. Note the significant drop in the 2000-2001 Western Energy Crisis, and smaller declines in the 2009-10 recession period. Loads from 1997 to 2010 are not weather normalized. Annual growth is expected to be 1.7 percent compounded over the next twenty and twenty-five years, the same growth rate as the 2009 IRP but from a lower base of 2010 instead of 2008.

Figure 2.11: Annual Net Native Load

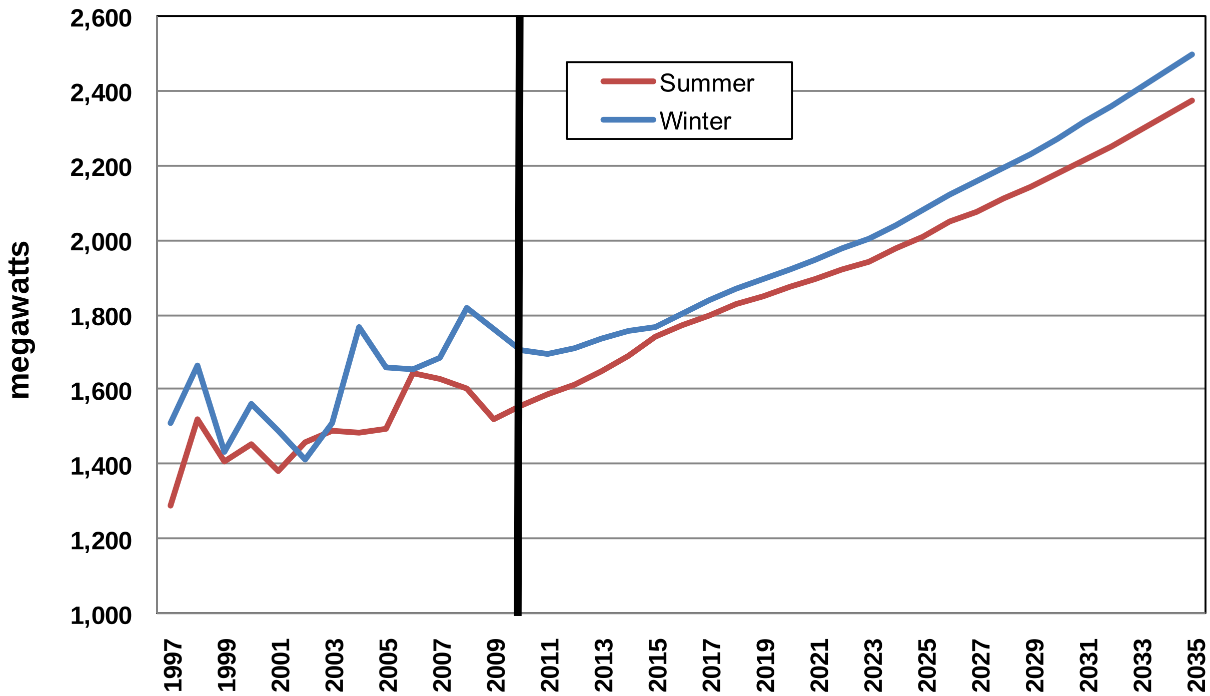


Peak Demand Forecast

The peak demand forecast represent expected peaks for each year of the IRP timeframe, not extreme weather peak demands.[3] The demand forecast is the product of an 11-year regression of actual peak demand and native load. Winter and summer peak demand forecasts are in Figure 2.12.[4] Peak loads grow at 1.2 percent compounded between 2010 and 2020 (219 MW), 1.5 percent over the 20-year IRP period (571 MW), and 1.55 percent over the 25-year forecast (796 MW).

[3] The expected peak demand has a 50 percent chance of exceedance in any year. Historical years present actual peak demands by year.
[4] Ibid.

Figure 2.12: Winter and Summer Peak Demand



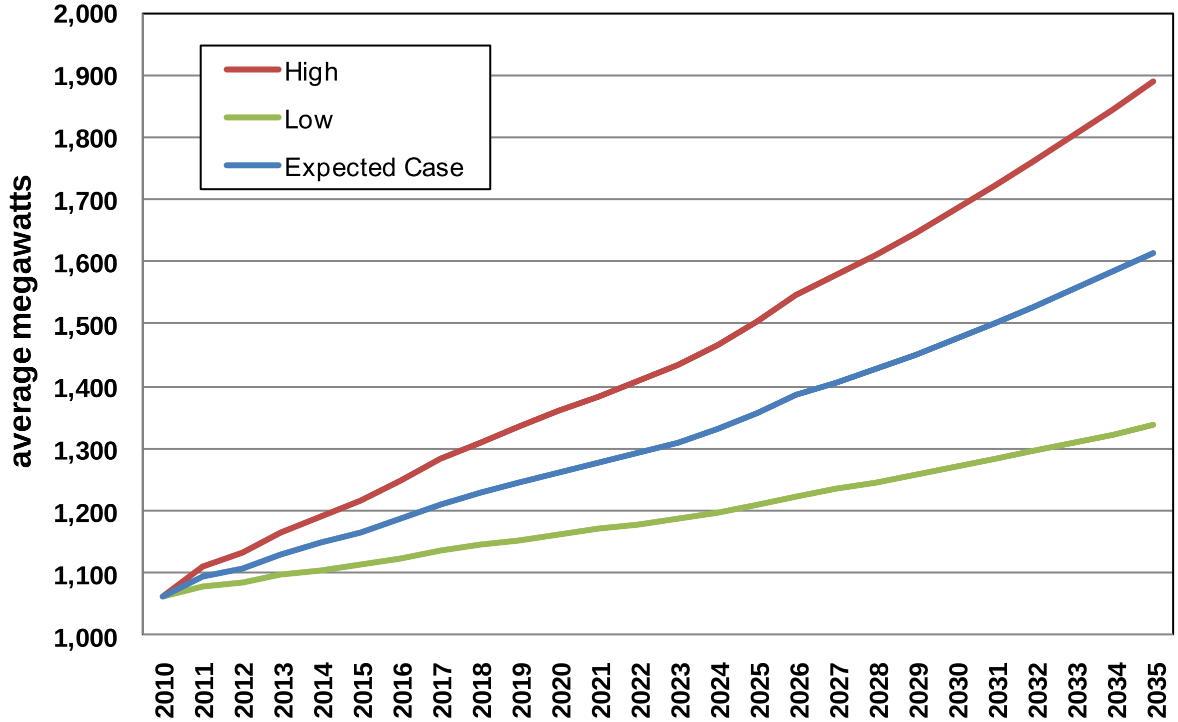
Extreme weather events influence historical peak load data. The comparatively low 1999 peak demand figure was the result of a warmer-than-average winter peak day; the peak in 2006 was the result of a below-average winter peak day. The 1999 and 2006 peak demand values illustrate why relying on compound growth rates and forecasted expected peak demand is an oversimplification, and why the Company plans to own or control enough generation assets and contracts to meet peak demand during extreme weather events.

Avista has witnessed significant summer load growth in recent years primarily due to rising air conditioning penetration in its service territory. However, Avista expects to remain a winter-peaking utility in the near future. It is possible, and we have seen it occur as recently as 2001, where very mild winter temperatures combined with extremely hot summer temperatures in a given calendar year results in our summer peak load exceeding our winter demand level.

The Company produced high and low load forecasts to test the IRPs Preferred Resource Strategy. These forecasts are very difficult to create because many factors influence the outcome, and because Avista is unable to obtain alternative economic forecasts at the county level from Global Insight. In past IRPs Avista used ranges from the Northwest Power and Conservation Council's Sixth Power Plan as a guide. This IRP relies on consultation with internal and external advisors and uses a growth multiplier on the Expected Case forecast of 1.5 for the high case and 0.5 for the low case.

The Expected Case load growth is 1.6 percent. The high growth case scenario is 2.33 percent and the low growth case scenario is 0.93 percent as shown in Figure 2.13. The Company believes these high and low growth ranges are consistent with the Sixth Power Plan's medium high and medium low ranges.

Figure 2.13: Electricity Load Forecast Scenario



Avista Resources and Contracts

Avista relies on a diverse portfolio of generating assets to meet customer loads, including owning and operating eight hydroelectricity projects located on the Spokane and Clark Fork Rivers. Its thermal assets include partial ownership of two coal-fired units in Montana, five natural gas-fired projects, and a biomass plant located near Kettle Falls, Washington.

Spokane River Hydroelectric Projects

Avista owns and operates six hydroelectric projects on the Spokane River. These projects received a new 50-year FERC operating license in June 2009. The following section describes the Spokane River projects and provides the maximum on-peak capacity and nameplate capacity ratings for each plant. The maximum on-peak capacity of a generating unit is the total amount of electricity a plant can safely generate. This is often higher than the nameplate rating for hydroelectric projects. The nameplate, or installed capacity, is the capacity of a plant as rated by the manufacturer. All six of the hydroelectric projects on the Spokane River connect to Avista's transmission system.

Post Falls

Post Falls is the upper most hydroelectricity facility on the Spokane River. It is located near the Washington/Idaho border. The project began operating in 1906, and during summer months maintains the elevation of Lake Coeur d'Alene. The project has six units, with the last unit added in 1980. The project is capable of producing 18.0 MW and has a 14.75 MW nameplate rating.

Upper Falls

The Upper Falls project began generating in 1922 in downtown Spokane, and now is within the boundaries of Riverfront Park. This project is comprised of a single 10.0 MW unit with a 10.26 MW maximum capacity rating.

Monroe Street

The Monroe Street facility was Avista's first generation facility. It began serving customers in 1890 near what is now Riverfront Park. Rebuilt in 1992, the single generating unit has a 15.0 MW maximum capacity rating and a 14.8 MW nameplate rating.

Nine Mile

A private developer built the Nine Mile project in 1908 near Nine Mile Falls, Washington, nine miles northwest of Spokane. The Company purchased the project in 1925 from the Spokane & Eastern Railway. Its four units have a 17.6 MW maximum capacity and a 26.4 MW nameplate rating.[5] The facility received a rubber dam in 2010, replacing the original flashboard system that maintained higher summer elevations.

The Nine Mile facility presently has major equipment outages. Unit 1 is out of service and Unit 2 is limited to half load. Unit 4 failed in the spring of 2011. Avista is evaluating options to restore the plant to full service. Restoration options include refurbishment of the existing powerhouse, including new turbine runners, or a new powerhouse located downstream from the existing powerhouse. A decision on the final configuration of Nine Mile is not yet determined. The Company expects any new generation at the plant will meet Washington State Energy Independence Act requirements.

Long Lake

The Long Lake project is located northwest of Spokane and maintains the Lake Spokane reservoir, also known as Long Lake. The facility was the highest spillway dam with the largest turbines in the world when completed in 1915. The plant received new runners in the 1990s, adding 2.2 aMW of additional energy. The project's four units provide 88.0 MW of combined capacity and have an 81.6 MW nameplate rating.

Little Falls

The Little Falls project, completed in 1910 near Ford, Washington, is the furthest downstream hydro facility on the Spokane River. A new runner upgrade in 2001 generates 0.6 aMW of renewable energy than the previous runner. The facility's four units generate 35.2 MW of on-peak capacity and have a 32.0 MW nameplate rating.

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[5] This is the de-rated capacity considering the outage of unit 1 and de-rate of unit 2

Clark Fork River Hydroelectric Project

The Clark Fork River Project includes hydroelectric projects located near Clark Fork, Idaho, and Noxon, Montana, 70 miles south of the Canadian border. The plants operate under a FERC license through 2046. Both of the hydroelectric projects on the Clark Fork River connect to Avista's transmission system.

Cabinet Gorge

The Cabinet Gorge project started generating power in 1952 with two units. The plant added two additional generators in the following year. The current maximum on-peak capacity of the plant is 270.5 MW; it has a nameplate rating of 265.2 MW. Upgrades at this project began with the replacement of the turbine for Unit 1 in 1994. Unit 3 received an upgrade in 2001. Unit 2 received an upgrade in 2004. Unit 4 received a turbine runner upgrade in 2007, increasing its generating capacity from 55 MW to 64 MW, and adding 2.1 aMW of additional energy.

Noxon Rapids

The Noxon Rapids project includes four generators installed between 1959 and 1960, and a fifth unit added in 1977. The project is in the middle of a major turbine upgrade, with one unit receiving a new runner in each calendar year beginning in 2009. The upgrades add 6.6 aMW of total energy and qualify under Washington State's Energy Independence Act renewable energy goals.

Total Hydroelectric Generation

In total, Avista's hydroelectric plants have 1,065.4 MW of on-peak capacity. Table 2.2 summarizes the location and operational capacities of the Company's hydroelectric projects. This table includes the average annual energy output of each facility based on the 70-year hydrologic record for the year ending 2012.

Table 2.2: Company-Owned Hydro Resources

Project Name	River System	Location	Nameplate Capacity (MW)	Maximum Capability (MW)	Expected Energy (aMW)
Monroe Street	Spokane	Spokane, WA	14.8	15.0	11.6
Post Falls	Spokane	Post Falls, ID	14.8	18.0	10.0
Nine Mile	Spokane	Nine Mile Falls, WA	26.0	17.5	12.5
Little Falls	Spokane	Ford, WA	32.0	35.2	22.1
Long Lake	Spokane	Ford, WA	81.6	89.0	53.4
Upper Falls	Spokane	Spokane, WA	10.0	10.2	7.5
Cabinet Gorge	Clark Fork	Clark Fork, ID	265.2	270.5	124.8
Noxon Rapids	Clark Fork	Noxon, MT	518.0	610.0	198.3
Total			**962.4**	**1,065.4**	**440.2**

Thermal Resources

Avista owns seven thermal assets located across the Northwest. Each thermal plant operates through the 20-year duration of the 2011 IRP. The resources provide dependable energy and capacity to serve base loads and provide peak load serving capabilities. A summary of Avista thermal resources is in Table 2.3.

Colstrip

The Colstrip plant, located in Eastern Montana, consists of four multi-owner coal-fired steam plants connected to the double circuit 500 kV BPA transmission line under a long-term wheeling agreement. PPL Global operates the facilities on behalf of the owners. Avista owns 15 percent of Units 3 and 4. Unit 3 began operating in 1984 and Unit 4 was finished in 1986. The Company's share of each Colstrip unit has a maximum net capacity of 111.0 MW and a nameplate rating of 123.5 MW. In 2006 and 2007 completed capital projects improved efficiency, reliability, and generation capacity at the plants. The upgrades include new high-pressure steam turbine rotors and digital (versus the old analog) control systems.

Rathdrum

Rathdrum is a two-unit simple-cycle combustion turbine. This natural gas-fired plant is located near Rathdrum, Idaho and connects to Avista's transmission system. It entered service in 1995 and has a maximum capacity of 178.0 MW in the winter and 126.0 MW in the summer. The nameplate rating is 166.5 MW.

Northeast

The Northeast plant, located in northeast Spokane, is a two-unit aero-derivative simple-cycle plant completed in 1978 and connects to Avista's transmission system. The plant is capable of burning natural gas or fuel oil, but current air permits prevent the use of fuel oil. The combined maximum capacity of the units is 68.0 MW in the winter and 42.0 MW in the summer, with a nameplate rating of 61.2 MW. The plant is currently limited to run no more than approximately 546 hours per year and provides reserve capacity to protect against reliability concerns and extreme market aberrations.

Boulder Park

The Boulder Park project entered service in Spokane Valley in 2002 and connects to Avista's transmission system. The site uses six natural gas-fired internal combustion reciprocating engines to produce a combined maximum capacity and nameplate rating of 24.6 MW.

Coyote Springs 2

Coyote Springs 2 is a natural gas-fired combined cycle combustion turbine located near Boardman, Oregon. This plant connects to BPA's 500 kV transmission system under a long-term transmission wheeling agreement. The plant began service in 2003. The maximum capacity is 274 MW in the winter and 221 MW in the summer and the duct burner provides the unit with an additional capacity of up to 28 MW. The plant's nameplate rating is 287.3 MW.

Kettle Falls and Kettle Falls Combustion Turbine

The Kettle Falls biomass facility entered service in 1983 near Kettle Falls, Washington and is among the largest biomass plants in North America. The plant connects to

Avista's 115 kV transmission system. The open-loop biomass steam plant uses waste wood products from area mills and forest slash, but can also burn natural gas. A combustion turbine (CT), added to the facility in 2002, burns natural gas and increases overall plant efficiency by sending exhaust heat to the wood boiler.

The wood-fired portion of the plant has a maximum capacity of 50.0 MW and its nameplate rating is 50.7 MW. The plant typically operates between 45 and 47 MW because of fuel quality issues. The plant's capacity increases to 57.0 MW when operated in combined-cycle mode with the CT. The CT produces 8 MW of peaking capability in the summer and 11 MW in the winter. The CT resource is limited in winter when the gas pipeline is constrained; for IRP modeling, the plant does not run when temperatures fall below zero and pipeline capacity serves local natural gas distribution.

Table 2.3: Company-Owned Thermal Resources

Project Name	Location	Fuel Type	Start Date	Winter Maximum Capacity (MW)	Summer Maximum Capacity (MW)	Nameplate Capacity (MW)
Colstrip 3 (15%)	Colstrip, MT	Coal	1984	111.0	111.0	123.5
Colstrip 4 (15%)	Colstrip, MT	Coal	1986	111.0	111.0	123.5
Rathdrum	Rathdrum, ID	Gas	1995	178.0	126.0	166.5
Northeast	Spokane, WA	Gas	1978	68.0	42.0	61.2
Boulder Park	Spokane, WA	Gas	2002	24.6	24.6	24.6
Coyote Springs 2	Boardman, OR	Gas	2003	302.0	249.0	287.3
Kettle Falls	Kettle Falls, WA	Wood/Gas	1983	47.0	47.0	46.0
Kettle Falls CT[6]	Kettle Falls, WA	Gas	2002	11.0	8.0	7.5
Total				**852.6**	**718.6**	**840.1**

Power Purchase and Sale Contracts

The Company utilizes power supply purchase and sale arrangements of varying lengths to meet some load requirements. This chapter describes the contracts in effect during the scope of the 2011 IRP. Contracts provide many benefits including environmentally low-impact and low-cost hydro and wind power. A 2012 annual summary of Avista large contracts is in Table 2.5.

Mid-Columbia Hydroelectric Contracts

During the 1950s and 1960s, public utility districts (PUDs) in central Washington developed hydroelectric projects on the Columbia River. Each plant was oversized compared to the loads then served by the PUDs. Long-term contracts with public, municipal, and investor-owned utilities throughout the Northwest assisted with project financing, and ensured a market for generated surplus power. The contract terms obligate the PUDs to deliver power to Avista's points of interconnection with each utility.

[6] Includes output of the gas turbine plus the benefit of its steam to the main unit's boiler.

Avista entered into long-term contracts for the output of four of these projects "at cost." Later, the Company competed in capacity auctions in 2009 through 2011 to purchase new short-term contracts at market-based prices. The Mid-Columbia contracts provide energy, capacity, and reserve capabilities; in 2012, contracts provide approximately 165 MW of capacity and 86 aMW of energy, see Table 2.4 for further details. Over the next 20 years the Douglas PUD (2018) and Chelan PUD (2015) contracts will expire. Avista may extend these contracts or even gain additional capacity in auctions; however, we have no assurance that we will be successful in extending our contract rights. Due to this uncertainty, the IRP does not include these contracts in the resource mix beyond their expiration dates.

Table 2.4: Mid-Columbia Capacity and Energy Contracts

Counter Party	Project(s)	Percent Share (%)	Start Date	End Date	Estimated Capacity (MW)	Annual Energy (aMW)
Grant PUD	Priest Rapids	3.7	12/2001	12/2052	34	16
Grant PUD	Wanapum	3.7	12/2001	12/2052	37	18
Chelan PUD	Rocky Reach	4.5	11/2011	06/2012	57	32
Chelan PUD	Rocky Reach	3.0	07/2011	12/2014	38	21
Chelan PUD	Rock Island	3.0	07/2011	12/2015	19	11
Douglas PUD	Wells	3.3	02/1965	08/2018	29	15
2012 Total Contracted Capacity and Energy					**165**	**86**

Lancaster Power Purchase Agreement

Avista acquired the output rights to the Lancaster combined-cycle generating station, located in Rathdrum, Idaho, as part of the sale of Avista Energy to Shell in 2007. Lancaster (sometimes referred to in the industry as the Rathdrum Generating Station). The plant connects to the BPA transmission system under a long-term wheeling agreement. Avista is working with BPA to interconnect the plant with Avista's transmission system at the BPA Lancaster substation. Avista has the sole right to dispatch the plant, and is responsible for providing fuel and energy and capacity payments, under a tolling PPA with Energy Investors Funds expiring in October 2026.

Bonneville Power Administration – WNP-3 Settlement

Avista (then Washington Water Power) signed settlement agreements with BPA and Energy Northwest (formerly the Washington Public Power Supply System or WPPSS) on September 17, 1985, ending construction delay claims against both parties. The settlement provides an energy exchange through June 30, 2019, with an agreement to reimburse Avista for WPPSS – Washington Nuclear Plant No. 3 (WNP-3) preservation costs and an irrevocable offer of WNP-3 capability under the Regional Power Act.

The energy exchange portion of the settlement contains two basic provisions. The first provision provides approximately 42 aMW of energy to the Company from BPA through 2019, subject to a contract minimum of 5.8 million megawatt-hours. Avista is obligated to pay BPA operating and maintenance costs associated with the energy exchange as determined by a formula that ranges from $16 to $29 per megawatt-hour in 1987-year constant dollars.

The second provision provides BPA approximately 32 aMW of return energy at a cost equal to the actual operating cost of the Company's highest-cost resource. A further discussion of this obligation, and how Avista plans to account for it, is under the Planning Margin heading of this chapter.

Table 2.5: Large Contractual Rights and Obligations

Contract	Type	End Date	Winter Capacity (MW)	Summer Capacity (MW)	2012 Est. Annual Energy (aMW)
Canadian Entitlement	Sale	n/a	8	8	5
Clearwater	PURPA	06/2013	75	75	52
Douglas Settlement	Purchase	09/2018	2	3	3
Lancaster	Purchase	10/2026	290	249	222
Nichols Pumping	Sale	n/a	7	7	7
PGE Capacity Exchange	Exchange	12/2016	150	150	0
Small Power	PURPA	varies	2	1	2
Stateline	Purchase	03/2014	0	0	9
Stimson Lumber	Purchase	09/2011	4	5	4
Upriver (net load)	Purchase	12/2011	8	-1	6
WNP-3	Purchase	06/2019	82	0	42
Total			**628**	**497**	**352**

Reserve Margins

Planning reserves accommodate situations when loads exceed and/or resource outputs are below expectations due to adverse weather, forced outages, poor water conditions, or other contingencies. There are disagreements within the industry on reserve margin levels utilities should carry. Many disagreements stem from system differences, such as resource mix, system size, and transmission interconnections

Reserve margins, on average, increase customer rates when compared to resource portfolios without reserves, because of the cost of carrying additional generating capacity that is rarely used. Reserve resources have the physical capability to generate electricity, but high operating costs limit their economic dispatch and revenues to offset purchase costs.

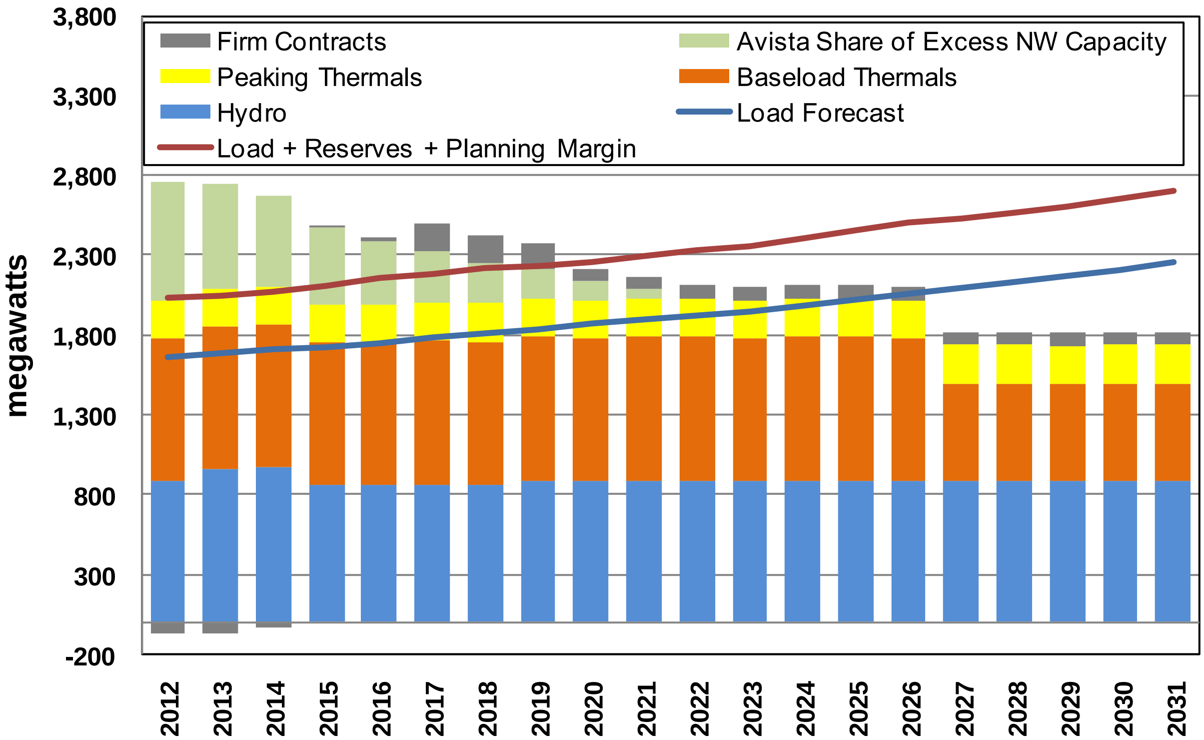
Avista Planning Margin

Avista retains two planning margin targets—capacity and energy. Capacity planning is a traditional metric ensuring that utilities can meet peak loads at times of system strain, and cover variability inherent in their generation resources with unpredictable fuel supplies, such as wind and hydro, and varying loads.

Capacity Planning

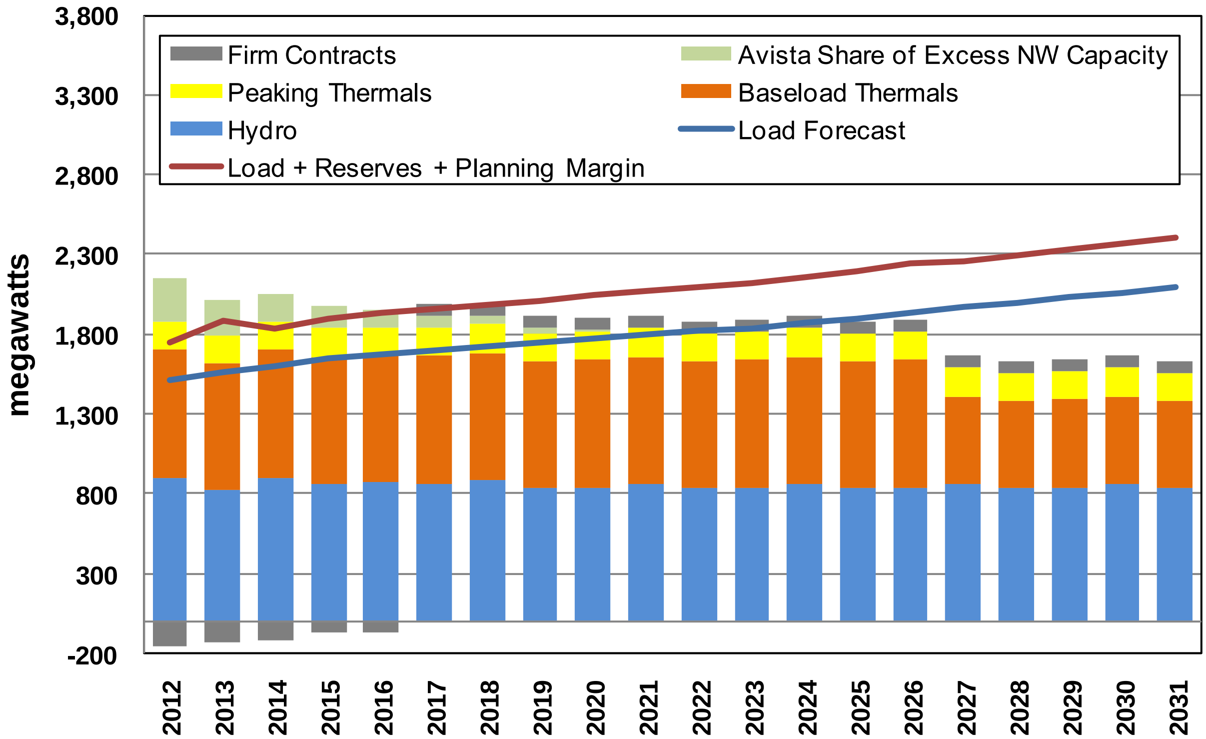
Avista plans for peak load events using the regional standard of an 18-hour peak event covering six hours each day for three consecutive days. Further, the IRP uses a planning margin level approximating the Northwest Power and Conservation Council's targets of 23 percent in the winter and 24 percent in the summer. Avista first estimates operating reserve requirements for on-system generation, load regulation, and wind integration. It then adds a planning margin of 15 percent to summer peak load and 14 percent to winter peak load. Adjustments to the net position include market purchases when surplus capacity exists in the Northwest, as represented by the green bars.[7] The planning margin equals 233 MW in 2012. Additional detail is in Appendix A. Figure 2.14 illustrates the winter peak position and Figure 2.15 shows the summer peak position.

Figure 2.14: Winter 18-Hour Capacity Load and Resources



[7] Avista relied on work by the Northwest Power and Conservation Council in its Resource Adequacy Forum exercises to determine the level of surplus summer energy and capacity. Reliance is limited to Avista's prorated share of regional load. See http://www.nwcouncil.org/energy/resource/Adequacy%20Assessment%2070908.xls. NPCC surplus estimates phase out over 10 years starting in 2013 by reducing its surplus by 10 percent, the 2014 surplus by 20 percent, the 2015 surplus by 30 percent, and so on. The phase out reflects Avista's opinion that outer-year surpluses might not be available for various reasons, including unanticipated load growth, the retirement of existing resources, or transmission interconnections enabling the export of more generation outside of the Northwest.

Figure 2.15: Summer 18-Hour Capacity Load and Resources



Energy Planning

For energy planning, resources must be adequate to meet customer requirements even where loads are high for extended periods or an outage limits the output of a resource. Extreme weather conditions can change monthly energy obligations by up to 30 percent. Where generation capability is not adequate to meet these variations, customers and the utility must rely on the volatile short-term electricity market. In addition to load variability, a planning margin accounts for variations in hydroelectricity generation.

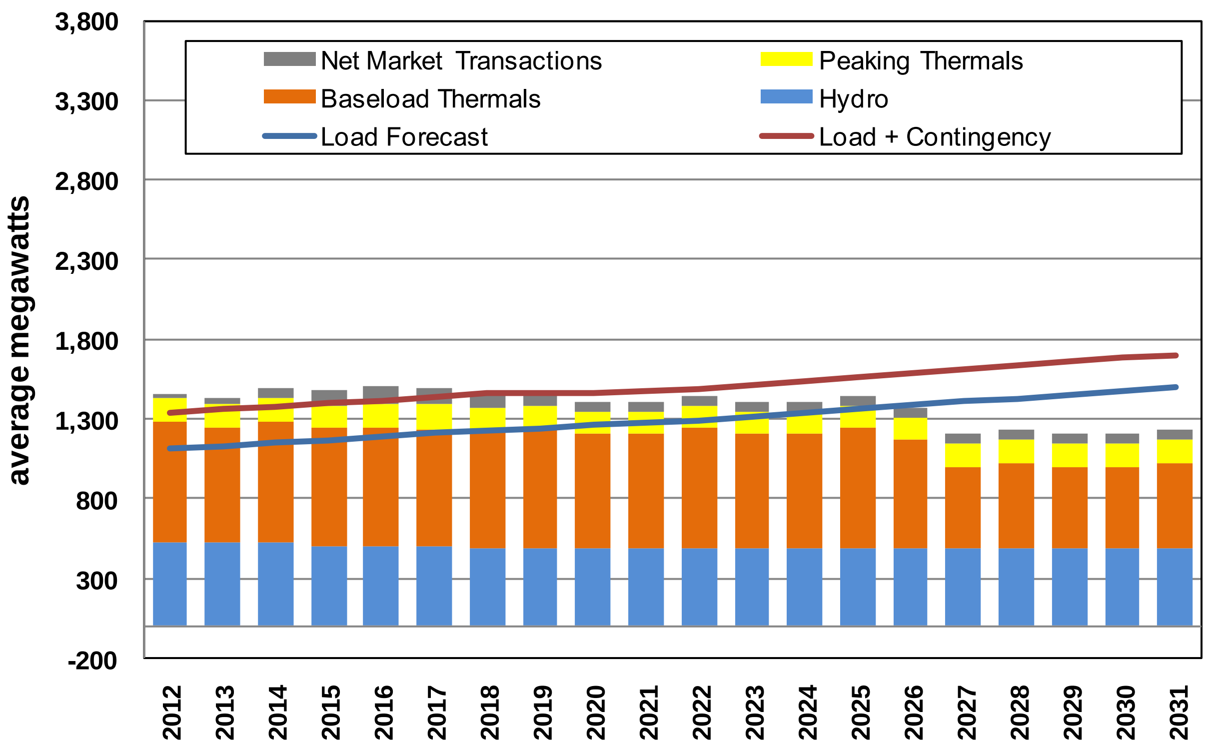
As with capacity planning, there are differences in regional opinion on a proper method for establishing resource planning margins. Many utilities in the Northwest base their planning on the amount of energy available during the critical water period of 1936/37.[8] The critical water year of 1936/37 is low on an annual basis, but it is not necessarily low in every month. The IRP could target resource development to reach a 99 percent confidence level on being able to deliver energy to its customers, and it would significantly decrease the frequency of its market purchases. However, this strategy requires investments in approximately 200 MW of generation in additional to the margins included in Expected Case of the IRP. Such expenditure to support this high level of reliability would put upward pressure on retail rates for a modest benefit. Avista instead targets a 90 percent monthly energy planning margin confidence interval based on load hydroelectricity variability. In other words, there is a 10 percent chance of needing to purchase energy from the market in any given month over the IRP

[8] The critical water year represents the lowest historical generation level in the streamflow record.

timeframe, but on average, the utility would have the ability to meet all of its energy requirements and be selling electricity into the marketplace.

Beyond load and hydroelectricity variability, Avista's WNP-3 contract with BPA contains supply risk. The contract includes a return energy provision in favor of BPA that can equal 32 aMW annually. Under adverse market conditions BPA almost certainly would exercise its rights. BPA last exercised its contract rights in 2001. To account for this contract risk, the energy planning margin is increased by 32 aMW until the contract expires in 2019. With the addition of WNP-3, load and hydroelectricity variability, the total energy planning margin equals 228 aMW in 2012. Additional detail is contained in Appendix A. See Figure 2.16 for the summary of the annual average energy load and resource net position.

Figure 2.16: Annual Average Energy Load and Resources



Loss of Load Analysis

In the Northwest, loss-of-load analysis tools help address the issue of how much planning margin is required. Typical results of these models are Loss of Load Probability (LOLP), Loss of Load Hours (LOLH), and Loss of Load Expectation (LOLE) measures. A reliable system has typically been defined as having no more than one interruption event in twenty years, or 5 percent. These analyses can be helpful, but usually have an inherent flaw due to the need to assume how much out-of-area generation is available for the study. Avista developed a loss of load analysis model to simulate reliability events due to poor hydro, forced outages, and extreme weather conditions on its system, finding that forced outages are the main driver of reliability events. Avista has robust transmission rights to the wholesale energy markets, but the amount of generation actually available for purchase from third parties is difficult to estimate in a model. To address this concern, a sophisticated regional model must estimate required regional planning margins. Avista will continue to monitor and contribute to such regional model development, with the intent of using the regional model when it becomes available.

Washington State Renewable Portfolio Standard

In the November 2006 general election, Washington State voters approved Citizens Initiative 937, now known as the Washington state Energy Independence Act. The initiative requires utilities with more than 25,000 customers to source 3 percent of their energy from qualified non-hydroelectric renewables by 2012, 9 percent by 2016, and 15 percent by 2020. Utilities also must acquire all cost effective conservation and energy efficiency measures. Even though Avista does not require any new generation resources to meet forecasted energy loads through 2019, this new law requires the Company to acquire additional qualified renewable generation, or renewable energy certificates (RECs), to meet the initiative's renewable goals. Table 2.6 at the end of this chapter details the forecast amount of RECs required to meet Washington state law, and the amount of qualifying resources has already in the generation portfolio. The sales forecast uses the current load forecast and does not include additional conservation as detailed in the Preferred Resource Strategy chapter. It also illustrates how the Company will maintain a REC reserve margin of approximately 10 aMW in 2016.

Resource Requirements

The resource requirements discussed in this section do not include additional energy efficiency acquisitions beyond what is in the load forecast. The Preferred Resource Strategy chapter discusses conservation beyond the assumptions contained in the load forecast. The following tables present loads and resources to illustrate future resource requirements.

During winter peak periods (Table 2.7), surplus capacity exists through 2019 after taking into account market purchases.[9] Without these purchases, a capacity deficit would exist in 2012. Avista believes that the present market can meet these minor winter capacity shortfalls and therefore will optimize its portfolio to postpone new resource investments for winter capacity until 2020.

The summer peak projection (Table 2.8) has lower loads than in winter, but resource capabilities are also lower due to lower hydroelectricity output and reduced capacity at natural gas-fired resources due to decreased performance during high-temperature events. The IRP shows persistent summer deficits throughout the 20-year timeframe, but regional surpluses are adequate to fill in these gaps. Many near-term deficits are from decreased hydroelectricity capacity during periods of planned maintenance and

[9] Avista relied on work by the Northwest Power and Conservation Council in its Resource Adequacy Forum exercises to determine the level of surplus summer energy and capacity. Reliance is limited to the Company's prorate share of regional load.

upgrades. Taking into account regional surpluses, the load and resource balance is 54 MW short only in 2016. After 2016, when the Portland General Electricity capacity sale contract expires, the next capacity need is in 2019 at 98 MW.

The traditional measure of resource need in the region is the annual average energy position. The energy position is in Table 2.9. There is enough energy on an annual average basis to meet customer requirements until 2020, when the utility is short 49 aMW. Avista will require 112 aMW of new energy by 2025, and 475 aMW in 2031.

Table 2.6: Washington State RPS Detail (aMW)

	On-line Year	Upgrade Energy	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
WA State Retail Sales Forecast			628	630	636	646	654	663	671	678	687	693	701	708	714	721	730	738	746	754	763	772	782	793
RPS %				0%	3%	3%	3%	3%	9%	9%	9%	9%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%
REQUIRED RENEWABLE ENERGY					**19**	**19**	**19**	**20**	**59**	**60**	**61**	**61**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**	**112**	**114**	**115**	**117**
Renewable Resources																								
Purchased RECs				0	6	6	6	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Lake 3	1999	2.2		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Little Falls 4	2001	0.6		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Cabinet 2	2004	2.9		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Cabinet 3	2001	4.5		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Cabinet 4	2007	2.0		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Noxon 1	2009	2.3		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Noxon 3	2010	1.9		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Noxon 2	2011	1.0		0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Noxon 4	2012	0.9		0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Nine Mile	2012	3.7		0	0	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Total Qualifying Resources				***17***	***23***	***26***	***28***	***28***	***22***	***22***	***22***	***22***	***22***	***22***	***22***	***22***	***22***	***22***	***22***	***22***	***22***	***22***	***22***	***22***
NET REC POSITION				**17**	**5**	**7**	**8**	**8**	**(37)**	**(38)**	**(39)**	**(39)**	**(82)**	**(83)**	**(84)**	**(85)**	**(86)**	**(87)**	**(88)**	**(89)**	**(90)**	**(92)**	**(93)**	**(95)**
REC Bank																								
Previous Year Balance				0	17	21	26	28	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
REC's Required				0	(19)	(19)	(19)	(20)	(59)	(60)	(61)	(61)	(104)	(105)	(106)	(107)	(108)	(109)	(110)	(111)	(112)	(114)	(115)	(117)
REC's Generated/Purchased				17	23	26	28	28	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
Expired/Sold RECs					0	(2)	(7)	(8)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NET REC BANK				**17**	**21**	**26**	**28**	**28**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
REC Reserve Requirement (95th PERCENTILE)																								
Load				0	1	1	1	1	3	3	3	3	5	5	5	5	5	5	5	5	5	5	6	6
Existing Hydro Upgrades				0	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Total REC Reserve Requirement				**0**	**7**	**8**	**8**	**8**	**10**	**10**	**10**	**10**	**12**	**12**	**12**	**12**	**12**	**12**	**13**	**13**	**13**	**13**	**13**	**13**
NET REC POSITION				**17**	**14**	**21**	**26**	**28**	**(20)**	**(48)**	**(49)**	**(50)**	**(94)**	**(95)**	**(96)**	**(97)**	**(98)**	**(99)**	**(101)**	**(102)**	**(103)**	**(105)**	**(106)**	**(108)**

Table 2.7: Winter 18-Hour Capacity Position (MW)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
TOTAL LOAD OBLIGATIONS																				
Native Load	-1,661	-1,688	-1,704	-1,718	-1,751	-1,784	-1,814	-1,839	-1,866	-1,892	-1,919	-1,946	-1,982	-2,020	-2,062	-2,094	-2,131	-2,168	-2,208	-2,249
Firm Power Sales	-242	-242	-211	-158	-158	-8	-8	-7	-7	-7	-7	-7	-6	-6	-6	-6	-6	-6	-6	-6
Total Requirements	**-1,903**	**-1,930**	**-1,915**	**-1,876**	**-1,909**	**-1,792**	**-1,822**	**-1,846**	**-1,873**	**-1,899**	**-1,925**	**-1,953**	**-1,988**	**-2,027**	**-2,068**	**-2,101**	**-2,137**	**-2,174**	**-2,214**	**-2,255**
RESOURCES																				
Firm Power Purchases	175	175	175	175	175	175	174	173	90	90	90	90	90	90	90	90	90	90	90	90
Hydro Resources	880	955	965	854	854	865	861	889	881	889	889	881	889	889	881	889	889	881	889	889
Base Load Thermals	895	895	895	895	895	895	895	895	895	895	895	895	895	895	895	606	606	606	606	606
Wind Resources	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peaking Units	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242
Total Resources	**2,192**	**2,267**	**2,277**	**2,166**	**2,166**	**2,177**	**2,172**	**2,199**	**2,108**	**2,116**	**2,116**	**2,108**	**2,116**	**2,116**	**2,108**	**1,826**	**1,826**	**1,818**	**1,826**	**1,826**
Peak Position Before Reserves Planning	**289**	**337**	**362**	**290**	**256**	**385**	**350**	**353**	**236**	**217**	**191**	**155**	**127**	**89**	**40**	**-275**	**-311**	**-356**	**-388**	**-429**
RESERVE PLANNING																				
Required Operating Reserves	-162	-164	-163	-162	-165	-159	-161	-163	-165	-167	-173	-176	-180	-182	-186	-170	-170	-171	-172	-173
Available Operating Reserves	23	42	42	8	8	8	8	34	34	34	34	34	34	34	34	34	34	34	34	34
Planning Margin	-233	-236	-239	-240	-245	-250	-254	-258	-261	-265	-269	-272	-277	-283	-289	-293	-298	-304	-309	-315
Total Reserves Planning	**-372**	**-358**	**-360**	**-394**	**-402**	**-400**	**-407**	**-387**	**-392**	**-398**	**-408**	**-414**	**-423**	**-431**	**-441**	**-429**	**-434**	**-441**	**-447**	**-454**
Peak Position With Reserves Planning	**-83**	**-21**	**2**	**-105**	**-146**	**-15**	**-57**	**-34**	**-157**	**-181**	**-216**	**-259**	**-296**	**-342**	**-401**	**-704**	**-746**	**-796**	**-835**	**-883**
Planning Margin Before NW Market	**16%**	**20%**	**21%**	**16%**	**14%**	**22%**	**20%**	**21%**	**14%**	**13%**	**12%**	**10%**	**8%**	**6%**	**4%**	**-11%**	**-13%**	**-15%**	**-16%**	**-18%**
Avista Share of Excess NW Capacity	737	656	565	477	400	326	255	186	115	56	0	0	0	0	0	0	0	0	0	0
Peak Position With NW Market	**654**	**635**	**567**	**373**	**254**	**311**	**199**	**152**	**-42**	**-125**	**-216**	**-259**	**-296**	**-342**	**-401**	**-704**	**-746**	**-796**	**-835**	**-883**
Peak Position With NW Market	**55%**	**54%**	**51%**	**41%**	**35%**	**40%**	**34%**	**31%**	**21%**	**16%**	**12%**	**10%**	**8%**	**6%**	**4%**	**-11%**	**-13%**	**-15%**	**-16%**	**-18%**

Table 2.8: Summer 18-Hour Capacity Position (MW)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
TOTAL LOAD OBLIGATIONS																				
Native Load	-1,514	-1,556	-1,597	-1,644	-1,673	-1,701	-1,727	-1,748	-1,771	-1,793	-1,815	-1,838	-1,868	-1,900	-1,937	-1,964	-1,995	-2,026	-2,059	-2,094
Firm Power Sales	-243	-218	-212	-159	-159	-9	-9	-8	-8	-8	-8	-8	-8	-7	-7	-7	-7	-7	-7	-7
Total Requirements	**-1,757**	**-1,774**	**-1,809**	**-1,804**	**-1,832**	**-1,710**	**-1,736**	**-1,756**	**-1,778**	**-1,800**	**-1,822**	**-1,846**	**-1,876**	**-1,908**	**-1,944**	**-1,971**	**-2,002**	**-2,033**	**-2,067**	**-2,102**
RESOURCES																				
Firm Power Purchases	85	85	85	85	85	85	85	83	83	82	82	82	82	82	82	82	82	82	82	82
Hydro Resources	900	819	902	859	866	864	885	833	840	859	833	840	859	833	840	859	833	840	859	833
Base Load Thermals	799	799	799	799	799	799	799	799	799	799	799	799	799	799	799	551	551	551	551	551
Wind Resources	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peaking Units	176	176	176	176	176	176	176	176	176	176	176	176	176	176	176	176	176	176	176	176
Total Resources	**1,960**	**1,880**	**1,962**	**1,919**	**1,926**	**1,924**	**1,945**	**1,891**	**1,897**	**1,916**	**1,891**	**1,896**	**1,916**	**1,890**	**1,896**	**1,668**	**1,642**	**1,648**	**1,668**	**1,642**
Peak Position Before Reserves Planning	**203**	**106**	**152**	**116**	**94**	**214**	**209**	**135**	**119**	**116**	**68**	**51**	**41**	**-18**	**-48**	**-304**	**-361**	**-385**	**-399**	**-460**
RESERVE PLANNING																				
Required Operating Reserves	-153	-157	-159	-160	-162	-155	-157	-160	-161	-163	-165	-167	-169	-171	-172	-157	-156	-157	-158	-158
Available Operating Reserves	155	66	171	159	159	159	161	158	158	161	158	158	161	158	158	161	158	158	161	158
Planning Margin	-227	-233	-240	-247	-251	-255	-259	-262	-266	-269	-272	-276	-280	-285	-290	-295	-299	-304	-309	-314
Total Reserves Planning	**-227**	**-325**	**-240**	**-248**	**-255**	**-255**	**-259**	**-264**	**-269**	**-271**	**-279**	**-285**	**-289**	**-298**	**-304**	**-295**	**-299**	**-304**	**-309**	**-314**
Peak Position With Reserves Planning	**-24**	**-220**	**-87**	**-132**	**-161**	**-41**	**-50**	**-129**	**-150**	**-155**	**-211**	**-234**	**-249**	**-316**	**-352**	**-599**	**-660**	**-689**	**-708**	**-774**
Planning Margin Before NW Market	**20%**	**10%**	**18%**	**15%**	**14%**	**22%**	**21%**	**17%**	**16%**	**15%**	**12%**	**11%**	**11%**	**7%**	**6%**	**-7%**	**-10%**	**-11%**	**-12%**	**-14%**
Avista Share of Excess NW Capacity	275	221	178	141	107	78	52	31	10	3	0	0	0	0	0	0	0	0	0	0
Peak Position With NW Market	**251**	**1**	**91**	**9**	**-54**	**36**	**2**	**-98**	**-140**	**-152**	**-211**	**-234**	**-249**	**-316**	**-352**	**-599**	**-660**	**-689**	**-708**	**-774**
Peak Position With NW Market	**36%**	**22%**	**28%**	**23%**	**20%**	**26%**	**24%**	**18%**	**16%**	**16%**	**12%**	**11%**	**11%**	**7%**	**6%**	**-7%**	**-10%**	**-11%**	**-12%**	**-14%**

Table 2.9: Average Annual Energy Position (aMW)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
TOTAL LOAD OBLIGATIONS																				
Native Load	-1,109	-1,131	-1,148	-1,165	-1,186	-1,209	-1,228	-1,244	-1,260	-1,277	-1,293	-1,310	-1,333	-1,357	-1,386	-1,406	-1,429	-1,452	-1,477	-1,502
Firm Power Sales	-140	-127	-109	-58	-58	-6	-6	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5
Total Requirements	**-1,249**	**-1,258**	**-1,258**	**-1,223**	**-1,244**	**-1,215**	**-1,234**	**-1,249**	**-1,266**	**-1,282**	**-1,298**	**-1,316**	**-1,338**	**-1,362**	**-1,391**	**-1,411**	**-1,434**	**-1,457**	**-1,482**	**-1,507**
RESOURCES																				
Firm Power Purchases	163	164	163	165	163	112	111	91	66	66	65	65	65	65	65	65	65	65	65	65
Hydro	522	525	527	495	495	495	490	481	481	481	481	481	481	481	481	481	481	481	481	481
Base Load Thermals	755	714	751	744	746	741	724	758	721	721	758	721	721	758	684	515	541	515	515	541
Total Resources	**1,441**	**1,403**	**1,442**	**1,405**	**1,404**	**1,348**	**1,325**	**1,330**	**1,268**	**1,268**	**1,304**	**1,266**	**1,267**	**1,304**	**1,229**	**1,060**	**1,087**	**1,060**	**1,060**	**1,087**
Energy Position Before Contingency Planning	**191**	**145**	**184**	**182**	**161**	**133**	**91**	**81**	**2**	**-14**	**6**	**-49**	**-71**	**-58**	**-162**	**-351**	**-347**	**-397**	**-421**	**-421**
CONTINGENCY PLANNING																				
Peaking Resources	153	153	153	138	153	154	153	147	146	145	147	146	145	147	146	145	147	146	145	147
Contingency	-228	-229	-230	-231	-232	-233	-233	-216	-197	-198	-198	-199	-200	-201	-202	-203	-204	-205	-206	-200
Energy Position With Contingency Planning	**116**	**69**	**108**	**89**	**82**	**54**	**11**	**13**	**-49**	**-67**	**-46**	**-103**	**-126**	**-112**	**-218**	**-408**	**-405**	**-456**	**-482**	**-475**
Energy Margin	**28%**	**24%**	**27%**	**26%**	**25%**	**24%**	**20%**	**18%**	**12%**	**10%**	**12%**	**7%**	**6%**	**7%**	**-1%**	**-15%**	**-14%**	**-17%**	**-19%**	**-18%**

3. Energy Efficiency

Introduction

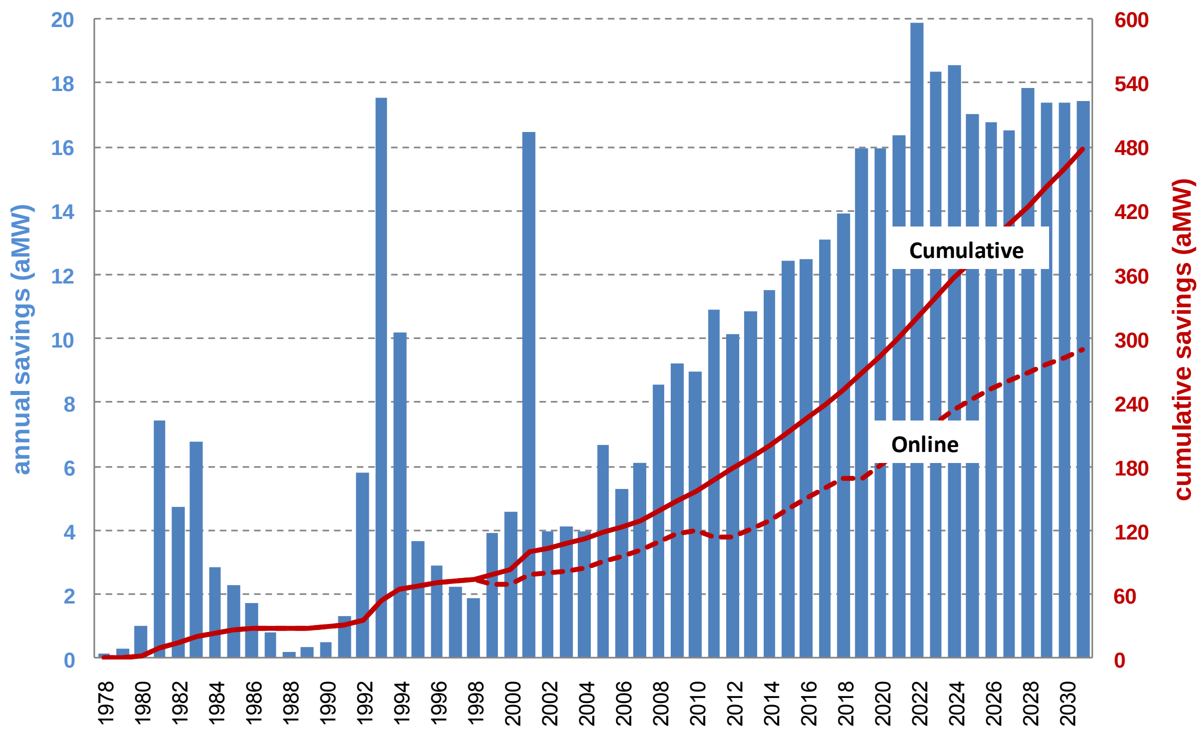
Avista began offering energy efficiency programs in 1978. Some of the most notable efficiency achievements include the Energy Exchanger program. It converted approximately 20,000 homes from electricity to natural gas space and/or water heating from 1992 to 1994. Avista pioneered the country's first system benefit charge for energy efficiency in 1995. Our conservation response during the 2001 Western Energy Crisis exceeded all expectations. Conservation programs regularly meet or exceed regional shares of energy efficiency gains as outlined by the Northwest Power Planning and Conservation Council (NPCC).

Section Highlights

- Avista began offering conservation programs in 1978.
- This IRP includes a Conservation Potential Assessment of the Company's Idaho and Washington service territories.
- Conservation reduces load growth by 48 percent through the IRP timeframe.
- Company-sponsored conservation reduces retail loads by approximately 10 percent, or 120 aMW.
- Avista evaluated over 2,800 equipment options and over 1,500 measure options covering all major end-use equipment, as well as devices and actions to reduce energy consumption for this IRP.

Figure 3.1 illustrates Avista's historical electricity conservation acquisitions. The Company has acquired 156.3 aMW of energy efficiency since 1978; however, the assumed 18-year average life of the conservation portfolio means that some of the measures have reached the end of their useful lives and are no longer reducing loads. The 18-year assumed measure life accounts for the difference between the Cumulative and Online lines in Figure 3.1.

Figure 3.1: Historical and Forecast Conservation Acquisition



Energy efficiency programs provide a range of conservation and education programs to residential, low-income, commercial, and industrial customer segments. The programs are either prescriptive or site-specific. Prescriptive programs, or standard offers, provide cash incentives for standardized products such as the installation of high-efficiency appliances. Prescriptive programs are suitable in situations where uniform products or offerings are applicable for large groups of homogeneous customers. Standardized programs are primarily for residential and small commercial customers. Site-specific programs, or customized services, provide cash incentives for any cost-effective energy savings measure or equipment with an economic payback greater than one year and less than eight years for lighting projects or between one and 13 years for all other end-uses and technologies.

Efficiency programs with paybacks of less than one year are not eligible for incentives, though Avista will assist a customer in program design and implementation. Site-specific programs require customized services for commercial and industrial customers because of the unique characteristics of customers' premises and processes. In some cases, when it can be established that similar applications of energy efficiency measures results in somewhat consistent savings estimates and the technically achievable savings potential is high, a prescriptive approach is offered. An example is prescriptive lighting for commercial and industrial applications. While this application is not purely prescriptive in the traditional sense, such as with a residential program, a more prescriptive approach for these types of similar energy efficiency installations provides for an ease of marketability to customers and vendors.

To be consistent with I-937 conservation targets (WAC 480-109 and RCW 19.285) and the NPCC Sixth Power Plan, Avista supplements its energy efficiency activities by including potentials for transmissions and distribution efficiency measures. More details about the transmission and distribution efficiency projects are in the Transmission & Distribution chapter of this IRP.

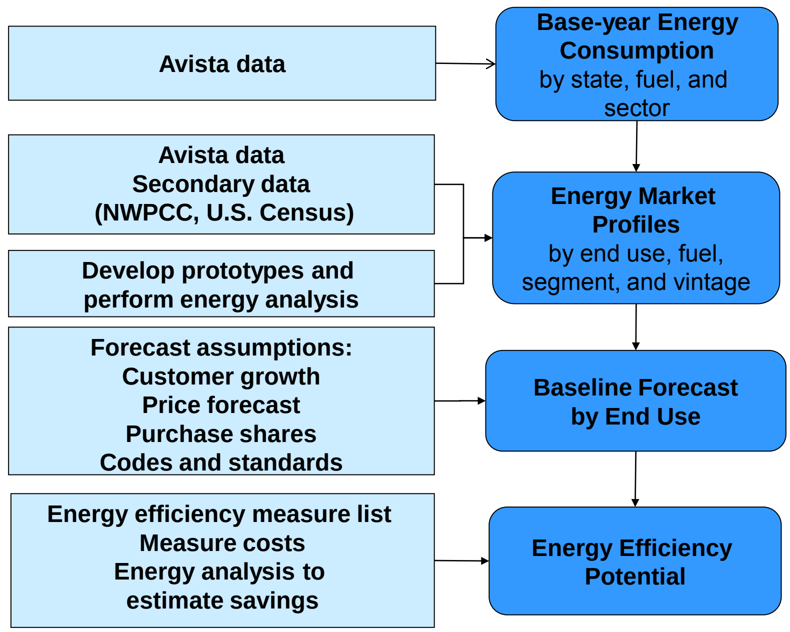
Conservation Potential Assessment Approach

After publication of the 2009 Electric IRP, the Washington Utilities and Transportation Commissions (UTC) requested an external Conservation Potential Assessment (CPA) study for the 2011 IRP. Avista in 2010 retained Global Energy Partners (Global) to conduct this study for its Idaho and Washington electric service territories. The CPA identifies a 20-year potentials study for energy efficiency and demand response and provides data on resources specific to Avista's service territory for use in the 2011 IRP and in accordance with the energy efficiency goals in Washington's Energy Independence Act (I-937). The energy efficiency potentials consider such things as the impacts of existing programs, naturally occurring energy savings, the impacts of known building codes and standards as of 2010, technology developments and innovations, changes to the economy and energy prices.

Global took the following steps to assess and analyze energy efficiency and demand response potentials in the Company's service territory. Figure 3.2 illustrates the steps.

1. Perform a market assessment of base year consumption for the residential (including low income), commercial, and industrial sectors. The assessment uses utility and secondary data to characterize customers' electric usage behavior in Avista's service territory. Global uses this market assessment to develop energy market profiles that describe energy consumption by market segment, vintage (existing versus new construction), end-use, and technology.
2. Develop a baseline energy forecast by sector and by end-use for the entire study period.
3. Identify and analyze energy-efficiency measures appropriate for Avista's service territory, including regional savings from energy efficiency measures acquired through the Northwest Energy Efficiency Alliance (NEEA) efforts.
4. Estimate technical, economic, and achievable energy efficiency potential. Technical potential involves choosing the most efficient measure, regardless of cost. Economic potential involves choosing the most efficient cost-effective measure. Achievable potential adjusts economic potential to account for factors other than pure economics, such as consumer behavior or market penetration rates.

Figure 3.2: Analysis Approach Overview



The CPA uses 2009 calendar year data, the first complete year of billing data available when the study began. Avista's recent load study, which also uses a 2009 baseline year, contributed to the selection of the 2009 baseline year for the CPA. This was Avista's first external CPA for its Idaho and Washington service territories.

The CPA segments Avista customers by state and by rate class. The rate classes used in this study included residential, commercial and industrial, general service, commercial and industrial large general service, extra large commercial, and extra large industrial. The residential class was further segmented into single family, multi-family, mobile home and low income customers. The low-income threshold used for this study was defined as 200 percent of the federal poverty level. Global used the NPCC calculator to determine future efficiency potentials for the pumping rate class, which represents 2 percent of total utility loads. Pumping schedules are included in the calculation of demand response potential, as discussed in the Demand Response section of this chapter. Within each segment, energy use was characterized by end-use (e.g., space heating, cooling, lighting, water heat, motors, etc.) and by technology (e.g., heat pump, resistance heating, or furnace for space heating).

The baseline forecast is the "business as usual" metric without new utility conservation programs. Energy savings from new energy efficiency measures are compared against this baseline. This baseline of annual electricity consumption and peak demand by customer segment and end-use supports projections of energy usage absent future efficiency programs. The baseline forecast includes projected impacts of known building codes and energy efficiency standards as of 2010 when the study was conducted that have direct bearings on the amount of utility program energy efficiency potential that exists over and above the effects of these efforts, including projected market condition changes. Market changes include customer and market growth, income growth, retail rates forecasts, trends in end-use and technology saturations, equipment purchase decisions, consumer price elasticity, income and persons per household, as well as customer potential estimates in the context of total energy use in the future so that projections of available energy efficiency savings can be derived.

The baseline forecast used in the CPA, prior to the consideration of efficiency potentials, projects overall electricity consumption growth of 48 percent. This compounded average annual growth rate of 1.7 percent during this 20-year period is consistent with Avista's current and previous IRP forecasts.

For each customer sector, a robust list of electrical energy efficiency measures was compiled, drawing upon the NPCC Sixth Power Plan, the Regional Technical Forum (RTF), and other measures considered applicable to Avista. This list of energy efficiency equipment and measures included 2,808 equipment options and 1,524 measure options, representing a wide variety of end-use equipment, as well as devices and actions able to reduce energy consumption. A comprehensive equipment list and measure options are in Appendix C. Measure cost, savings, estimated useful life, and other performance factors were characterized for the list of measures and economic screening was performed on each measure for every year of the study to develop the economic potential. Many measures do not pass the economic screen of avoided cost, but some measures might become part of the energy efficiency program as contributing factors evolve during the 20-year planning horizon.

Overview of Energy Efficiency Potentials

Global utilized an approach adhering to the conventions outlined in the National Action Plan for Energy Efficiency (NAPEE) Guide for Conducting Potential Studies (November 2007).[1] The NAPEE Guide represents the most credible and comprehensive national industry practice for specifying energy efficiency potential. Specifically, three types of potentials are in this study:

Technical Potential

Conservation potential uses the most efficient option commercially available to each purchase decision, regardless of cost. This theoretical case provides the broadest and highest definition of savings potential because it quantifies savings that would result if all current equipment, processes, and practices in all market sectors were replaced by the most efficient and feasible technology. Technical potential does not take into account the cost-effectiveness of the measures. Further, this study defines technical potential as "phase-in technical potential," assuming only that the portion of the current equipment stock that has reached the end of its useful life and is due for turnover is changed out by the most efficient measures available. Non-equipment measures, such as controls and other devices (e.g., programmable thermostats) phase-in over time, just like the equipment measures. Lighting retrofits, which are in

[1] National Action Plan for Energy Efficiency (2007). *National Action Plan for Energy Efficiency Vision for 2025:* Developing a Framework for Change. www.epa.gov/eeactionplan.

effect early replacements of existing lighting systems, count as a non-equipment measure in this CPA study.

Economic Potential[2]

Economical conservation results from the purchase of the most cost-effective option available for a given equipment or non-equipment measure. Cost effectiveness is determined by applying the Total Resource Cost (TRC) test using all quantifiable costs and benefits regardless of who accrues them and inclusive of non-energy benefits as identified by the Council.[3] The inclusion of non-energy benefits did not make any of the failing measures pass. Measures that passed the economic screen represent aggregate economic potential. As with technical potential, economic potential calculations use a phased-in approach. Economic potential is a hypothetical upper-boundary of savings potential representing only economic measures; it does not consider customer acceptance and other factors.

Achievable Potential

Achievable Potential refines economic potential by taking into account expected program participation, customer preferences, and budget constraints. For purposes of this particular CPA, Global provided two types of achievable potential – Maximum and Realistic.

Maximum Achievable Potential is the upper boundary of the achievable potential range or the maximum achievable savings that could be achieved through Avista's energy efficiency programs. Maximum Achievable Potential presumes incentives that are sufficient to ensure customer adoption. Oftentimes, incentives take the form of rebates that typically represent a substantial portion of the customer's extra cost for the energy efficient measure. These high incentives are combined with substantial administrative and marketing costs that are used for customer awareness campaigns and educational opportunities. It also considers a maximum participation rate by customers for the various energy efficiency programs designed to deliver the various measures. Global also developed a Market Acceptance Rate which is a factor based on the Council's ramp rate curves used in the Sixth Power Plan. These factors were applied to the estimate of economic potential from the CPA study to estimate Maximum Achievable Potential.

Realistic Achievable Potential represents the lower boundary of achievable potential or a forecast of achievable savings resulting from customer behavior and penetration rates of efficient technologies. It uses a set of Program Implementation Factors, which take into account existing market, financial, political and regulatory barriers that are likely to limit the amount of savings that may be achieved through energy efficiency programs.

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[2] The Industry definition of economic potential and the definition of economic potential referred to in this document are consistent with the definition of "realizable potential for all realistically achievable units".

[3] There are other tests that can be used to represent the economic potential (e.g., Participant or Utility Cost), but the TRC is generally accepted as the most appropriate representation of economic potential because it tends to be most representative of the net benefits of energy efficiency to society as a whole. The economic screen uses the TRC as a proxy for moving forward and representing achievable energy efficiency savings potential for those measures that are most widely cost-effective.

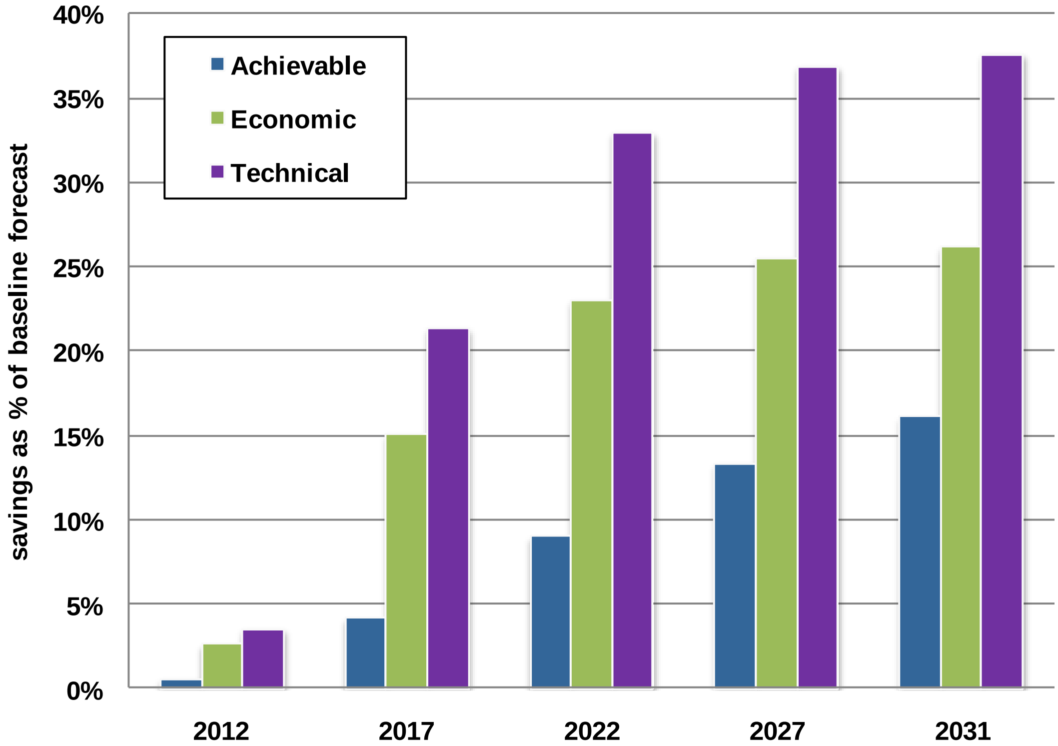
For example, it considers that other goals such as low rates and customer equity influence the development of final program designs and savings targets. It also considers customer incentive levels that are in line with typical industry practice, defined marketing campaigns, and internal budget constraints. Political barriers often reflect differences in regional attitudes toward energy efficiency and its value as a resource. The Realistic Achievable Potential also reflects recent utility experience and reported savings from past and present programs.

The CPA forecasts incremental annual Maximum Achievable Potential for all sectors at 9.8 aMW (85,824 MWh) in 2012, increasing to cumulative savings of 321.4 aMW (2,815,551 MWh) by 2031. The CPA forecasts annual Realistic Achievable Potential for all sectors at 5.7 aMW (or 49,804 MWh) in 2012, increasing to cumulative savings of 231.2 aMW (or 2,025,679 MWh) by 2031. Table 3-1 and Figure 3-3 show the CPA results for baseline energy use, technical, economic, and realistic achievable potential. The projected baseline electricity consumption forecast increases 43 percent during the 20-year planning horizon. Projected achievable energy savings, as a percentage of the baseline energy forecast, grows from 0.6 percent in 2012 to 16.1 percent in 2031. Figure 3.3 compares the technical, economic, achievable potentials, and cumulative first-year savings, at selected years. It is important to note, that in the early years, the difference between Maximum Achievable Potential and Realistic Achievable Potential is minimal and converges at the end of the 20-year planning horizon. Realistic Achievable Potential merely adjusts assumptions regarding the rate at which the savings are estimated to be acquired during the planning period.

Table 3.1: Energy Forecasts and Cumulative Savings (Across All Sectors for Selected Years)

Energy Forecasts (MWh)	2012	2017	2022	2027	2031
Baseline Forecast	8,799,039	9,463,880	10,417,347	11,536,869	12,574,182
Achievable	8,749,236	9,068,483	9,476,769	9,998,002	10,548,503
Economic	8,569,382	8,037,426	8,018,993	8,594,412	9,282,289
Technical	8,487,766	7,441,765	6,981,872	7,281,206	7,842,616
Energy Savings (MWh)	**2012**	**2017**	**2022**	**2027**	**2031**
Achievable	49,804	395,397	940,578	1,538,868	2,025,679
Economic	229,657	1,426,454	2,398,355	2,942,457	3,291,894
Technical	311,274	2,022,115	3,435,475	4,255,664	4,731,566
Energy Savings (% of Baseline)	**2012**	**2017**	**2022**	**2027**	**2031**
Achievable	0.6%	4.2%	9.0%	13.3%	16.1%
Economic	2.6%	15.1%	23.0%	25.5%	26.2%
Technical	3.5%	21.4%	33.0%	36.9%	37.6%

Figure 3.3: Cumulative Conservation Potentials, Selected Years



Conservation Targets

This IRP process includes conservation targets for Washington's energy efficiency portion of the Energy Independence Act (I-937) goal. Other components including conservation from distribution and transmission efficiency improvements also meeting this target would be additive to this conservation target for a complete target for Washington comparable to what is included in the Sixth Power Plan target. Additionally, since this IRP uses a methodology consistent with the NPCC methodology, the conservation target for Idaho is more aggressive than required.

Based on first year and incremental savings, Table 3.2 illustrates Avista's Realistic and Maximum Achievable Potential for 2012-2013, as well as a comparison with the Sixth Power Plan's calculator option 1. This calculator is intended to provide an approximation of the level of conservation that utilities should target in order to be consistent with the Council's regional goals. The CPA study completed for Avista incorporates this methodology into an Avista-specific estimate of savings potential to be acquired through its programs.

During the first five years, lighting and appliance standards slow residential baseline growth rates, reducing the potential for savings from residential energy efficiency programs. Commercial and industrial potential shows consistent growth.

For the 2012-2013 compliance period, the Sixth Power Plan goal is within the goal range developed in the CPA, with a floor of Realistic Achievable Potential and a ceiling of Maximum Achievable Potential. However, the Sixth Power Plan includes components other than conservation such as distribution system efficiencies. When savings due to these efficiencies are subtracted from the Sixth Power Plan goals, the resulting values are well within the range of the potential study.

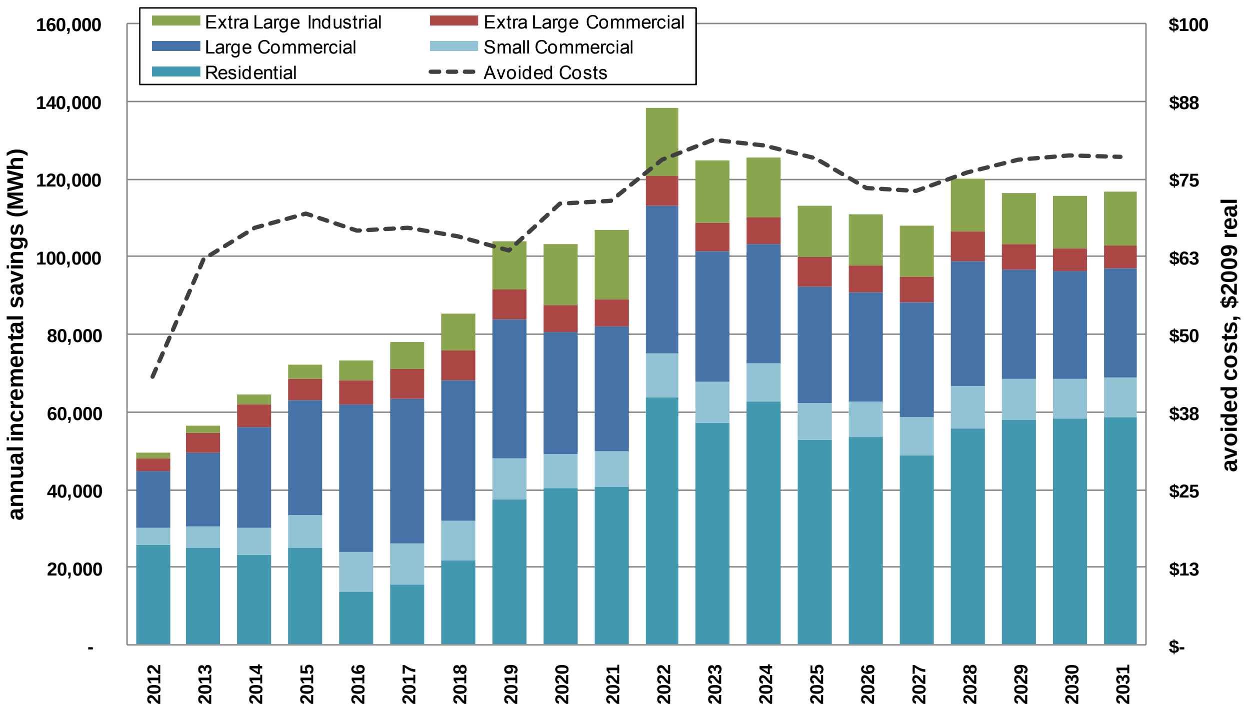
Table 3.2: Incremental Annual Achievable Potential Energy Efficiency (aMW)

	2012	2013
NPCC Sixth Power Plan Target		
Idaho	5.17	5.60
Washington	8.22	8.90
Total	**13.39**	**14.50**
Less Distribution Efficiency from the Sixth Plan		
Idaho	-0.22	-0.28
Washington	-0.47	-0.60
Total	**-0.69**	**-0.88**
Sixth Power Plan Target without Distribution Efficiency		
Idaho	4.95	5.32
Washington	7.75	8.30
Total	**12.70**	**13.62**
Incremental Achievable Potential Range[4]		
Idaho	1.95 – 3.50	2.17 – 4.51
Washington	3.74 – 6.30	4.31 – 8.58
Total	**5.69 – 9.80**	**6.48 – 13.09**
Achievable from Existing Programs		
Idaho	1.58	1.55
Washington	2.93	2.85
Total	**4.51**	**4.40**
Goal Range per Conservation Potential Assessment		
Idaho	3.53 – 5.09	3.72 – 6.06
Washington	6.67 – 9.23	7.16 – 11.43
Total	**10.20 – 14.32**	**10.88 – 17.49**

Figure 3.4 shows incremental annual achievable roughly tracking avoided costs throughout the study period, but factors in addition to avoided cost can influence achievable potential, particularly where programs are ramping up or are ramping down. These impacts are particularly relevant in the early years of the CPA study.

[4] Incremental Realistic Achievable Potential was used for purposes of modeling resource acquisition from conservation. For I-937, a range target will be presented with the ceiling of the range being Maximum Achievable Potential and the floor being Realistic Achievable Potential as determined by the independent CPA.

Figure 3.4: Incremental Annual Achievable Energy Efficiency (MWh) vs. Avoided Cost[5]



Electricity to Natural Gas Fuel Switching

Fuel switching from electricity to natural gas is included in the targets as described above. Tables 3.3 and 3.4 illustrate savings potentials from converting electric furnaces and water heaters to natural gas. Nearly all savings are in the residential sector. Conversion ramps up slowly, but because it removes most of the electricity use from two of the largest residential end uses (water heating and space heating), it accounts for a substantial portion of savings by 2031. For water heating, about one-fourth of the savings from gas conversions occurs in new construction. For furnaces, new construction accounts for roughly one-third of the total.

Table 3.3: Cumulative Achievable Savings from Conversion to Natural Gas

	2012	2017	2022	2027	2031
Water heater - convert to gas potential (MWh)	45.7	4,967	69,406	146,834	201,182
Water heater - convert to gas percentage of total potential	0.1%	1%	7%	10%	10%
Furnace - convert to gas potential (MWh)	10.1	2,527	45,979	108,447	158,470
Water heater - convert to gas percentage of total potential	0.0%	1%	5%	7%	8%

[5] Avoided costs are 2009 real dollars and include energy costs, risk, losses, avoided T&D, and the 10 percent Power Act premium.

Table 3.4: Cumulative Achievable Savings from Conversion to Natural Gas by State (MWh)

Washington Conversion Potential	2012	2017	2022	2027	2031
Water heater - convert to gas potential	36	3,966	55,623	117,942	161,411
Furnace - convert to gas potential	1	1,509	31,082	76,213	112,522
Total Washington conversion potential	37	5,475	86,705	194,155	273,933
Idaho Conversion Potential	**2012**	**2017**	**2022**	**2027**	**2031**
Water heater - convert to gas potential	10	1,001	13,783	28,893	39,770
Furnace - convert to gas potential	9	1,018	14,898	32,234	45,948
Total Idaho conversion potential	19	2,019	28,681	61,127	85,718

Comparison with the Sixth Power Plan Methodology

As required by Washington Administrative Code (WAC) Chapter 480-109-010 (3)(c), Avista below describes the technologies, data collection, processes, procedures and assumptions used to develop its I-937 biennial targets, along with changes in assumptions or methodologies used in the Company's IRP or the NPCC Sixth Power Plan. WAC Chapter 480-109-010 (4)(c) requires UTC approval, approval with modifications, or rejection of the targets.

Global met with the NPCC staff to compare methodologies and approaches to ensure methodological consistency. The CPA methodology is consistent with the Sixth Power Plan in several key ways. Both the NPCC Sixth Power Plan and Global's approaches utilized end-use models employing a bottom-up approach. The models draw on appliance stock, saturation levels and efficiencies information to construct future load requirements. Global conducted a thorough review of baseline and measure assumptions used by the NPCC and developed a baseline energy use projection, absent any additional energy efficiency measures while including the impact of known codes and standards currently approved. The study reviewed and incorporated NPCC assumptions when Avista-specific or more updated data was not available.

The CPA study developed a comprehensive list of energy-efficiency technologies and end-use measures, including those in the Sixth Power Plan. Since the efficiency measures, equipment, and other data used in the Sixth Power Plan are somewhat dated, information on measures and equipment specific to Avista were updated for this CPA. Global developed equipment saturations, measure costs, savings, estimated useful lifetimes and other parameters based on data from the Sixth Power Plan Conservation Supply Curve workbook databases, the Regional Technology Forum, NEEA reports, and other data sources. Similar to the Sixth Power Plan, the study accounts for the difference between lost and non-lost opportunities, and how this affects the rate at which energy efficiency measures penetrate the market. The study used the Total Resource Cost (TRC) test as the measure for judging cost-effectiveness. A comprehensive list of measures and equipment evaluated in the CPA study is included in Appendix C. For a more detailed discussion of measures and equipment evaluated within the potential study, please refer to the Conservation Potential Assessment report prepared by Global in Appendix D.

After screening measures for cost-effectiveness, the CPA applied a series of factors to evaluate realistic market acceptance rates and program implementation considerations. The resulting achievable potential reflects the realistic deployment rates of energy efficiency measures in Avista's service territory. These factors account for market barriers, customer acceptance, and the time required to implement programs. To develop these factors, Global reviewed the ramp rates used in the Sixth Power Plan Conservation Supply Curve workbooks and considered Avista's experience.

The Sixth Power Plan assesses a 20-year period beginning in 2010, while the CPA study begins in 2012. Where the Sixth Power Plan relies on average regional data, the CPA utilized data from Avista's service territory, as well as more recent economic data. Therefore, an allocation of regional potential based on sales, as applied in the Sixth Power Plan, would not necessarily account for Avista's unique service territory characteristics such as customer mix, use per customer, end-use saturations, fuel shares, current measure saturations, and expected customer and economic growth. In addition, some industries included in the Sixth Power Plan might not exist in Avista's service territory. While the Sixth Power Plan incorporates Distribution System efficiencies, the Avista CPA includes only energy efficiency from energy conservation while Distribution System efficiencies and Thermal System efficiencies would be incorporated into Avista's I-937 targets from other sources.

The Sixth Power Plan assumed that 85 percent of the cost-effective, or economic, non-lost opportunity potential will be achieved over the 20 years covered by the Sixth Power Plan. The projected achievement amount during the first 10 years (consistent with the I-937 timeframe) is approximately 60 percent. For lost opportunities, the plan assumes achievement of approximately 65 percent of the cost-effective, or economic, potential during the 20-year period. Due to ramp rates used within the plan, this equates to only 37 percent achievement within the first 10 years, the period considered for I-937. The CPA study assumed that cost-effective measures reach a maximum saturation level of 85 percent over the 20-year period for lost opportunities, and 65 percent to 85 percent for non-lost opportunities. These figures equal or exceed adoption rates assumed within the Sixth Power Plan.

Sensitivity of Potential to Customer and Economic Growth

The CPA study shows that energy efficiency offsets roughly 50 percent of load growth, whereas the Sixth Power Plan estimates that energy efficiency can offset 80 percent. While Avista's service territory differs from the larger region in many ways, including its climate and particular customer mix, there are other contributing factors to this difference. One significant factor may be the CPA customer and economic growth assumptions. To understand how growth affects the results of the study, Global LoadMAP modeled several scenarios with lower customer and economic growth, as indicated in Table 3.5.

Table 3.5: Varying Growth Scenario Descriptions

	Reference Scenario	Low Growth Scenario 1	Low Growth Scenario 2
Home size (physical size in square feet)	~ 1% per year growth	Capped at 110% of existing household size	Capped at 110% of existing household size
Per capita income growth	1.6% 2011–2015; 2.2% 2016–2020; 2.1% thereafter	1.6% after 2016	1.6% after 2016
Residential sector market growth	1.30% after 2015 (WA) 1.25% after 2015 (ID)	no change	1.0% after 2015 (WA & ID)
Commercial sector market growth, Washington & Idaho	~ 2.0% (varies by segment)	no change	1.0% all segments

Table 3.6 shows that as economic and customer growth decreases, the ability of energy efficiency to offset growth increases. In the reference scenario, energy efficiency offsets 54 percent of growth in consumption, while in the lower growth scenarios, energy efficiency offsets 55 percent and 77 percent of growth. This is the case because with reduced levels of new construction, both load growth and energy savings drop, but savings from the retrofit of existing buildings are a greater proportion of overall growth.

Table 3.6: Varying Growth Scenario Results (MWh)

	Reference Scenario	Low Growth Scenario 1	Low Growth Scenario 2
Baseline forecast 2012	8,799,039	8,799,039	8,799,033
Baseline forecast 2031	12,574,182	12,272,136	11,025,256
Load Growth 2012-2031	3,775,143	3,473,097	2,226,222
Achievable potential case forecast 2031	10,697,432	10,361,667	9,302,736
Achievable potential savings 2031	2,025,679	1,910,469	1,722,519
Percentage of growth offset	54%	55%	77%

Avoided Cost Sensitivities

Global modeled several scenarios with varying avoided costs assumptions in addition to the Expected Case used for the 2011 IRP to test sensitivity to changes in avoided costs. The scenarios included 150 percent, 125 percent, and 75 percent of the avoided costs relative to the Expected Case. Figure 3.5 illustrates the avoided cost scenarios. Overall, due to the technical potential ceiling, energy efficiency proved to be insensitive to avoided cost assumptions. In particular, acquiring incremental energy efficiency becomes increasingly expensive, so that increases in avoided costs do not provide equivalent percentage increases in achievable potential. The Expected Case achievable potential is approximately 16.8 percent of the baseline forecast by 2031. With the 150 percent avoided cost case, achievable potential increases by 15 percent compared with the Expected Case reference scenario, while the 125 percent and the 75 percent avoided cost cases yielded achievable potential equal to 79 percent and 108 percent of the reference scenario respectively. Table 3.5 shows achievable potential under the four avoided cost scenarios.

In 2012, 52 percent of the projected achievable potential is from residential class measures. By 2017, a shift occurs whereby 68 percent of the achievable potential comes from non-residential classes, with the significant portion of these savings, 42 percent, estimated to come through the large general service segment. In the residential sector in 2017, approximately 40 percent of projected savings come from interior lighting, followed by water heating, space heating and electronics. In subsequent years, residential savings from lighting decreases, with space and water heating providing greater relative savings potential.

In the commercial and industrial sectors, lighting accounts for approximately 62 percent of savings potential in 2017 followed by heating, ventilation and air conditioning (HVAC), office equipment, exterior lighting and machine drives. Over time, the savings potential from lighting decreases, but still remains close to half of the savings potential in 2031.

Figure 3.5: Energy Savings, Achievable Potential Case by Avoided Costs Scenario

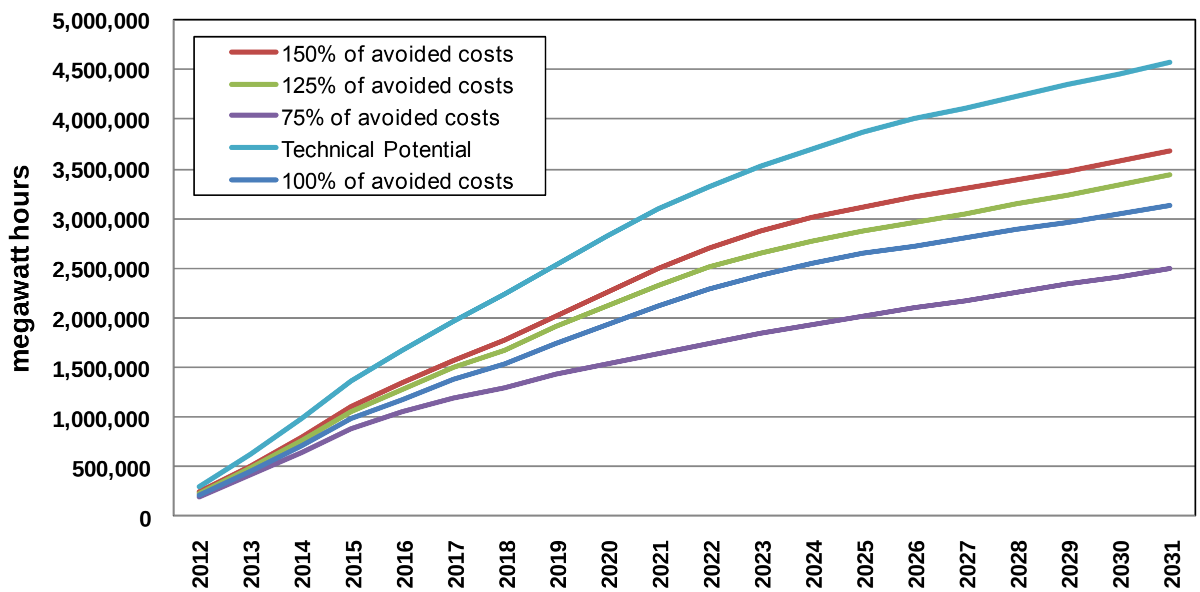


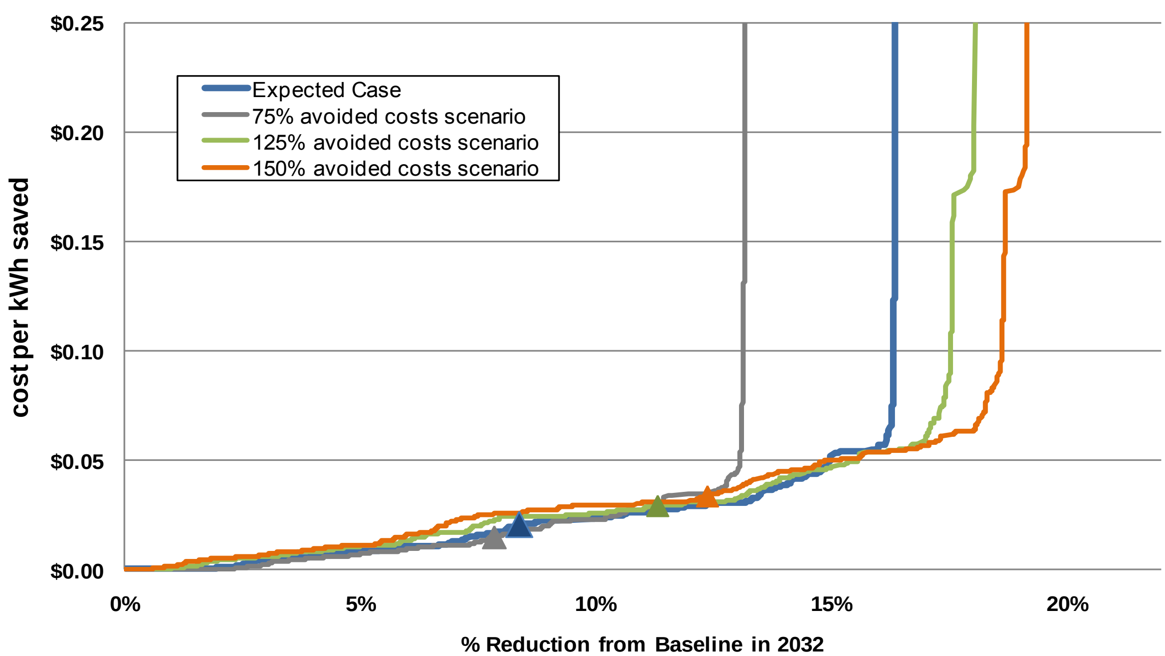
Table 3.7: Achievable Potential with Varying Avoided Costs

	Reference Scenario	75% of Avoided Costs	125% of Avoided Costs	150% of Avoided Costs
Achievable potential savings 2031 (MWh)	2,025,679	1,590,850	2,186,730	2,327,510
Percentage change in savings vs. 100% avoided cost scenario	n/a	-21%	8%	15%

Heat pump water heater measures in the Sixth Power Plan were projected to replace compact fluorescent lights (CFLs) contribution (i.e., significant savings at relatively low costs) in earlier plans. The CPA found that heat pump water heaters are not cost-effective, with the exception of new single-family homes, under the Expected Case. However, the measure becomes cost-effective for more market segments under the 150 percent of avoided cost scenario.

Figure 3.6 shows supply curves composed of the stacked measures and equipment in 2031 in ascending order of avoided cost. Since there is a gap in the cost of the energy efficiency measures moving up the supply curve, the measures with a very high cost cause a rapid sloping of the curve. The portfolio average cost for each case is shown as well. The shift of the supply curve toward the right as avoided costs increase is a consequence of increasing amounts of cost-effective potential, but the average cost of acquiring that potential is increasing also.

Figure 3.6: Supply Curves of the Evaluated Conservation Measures[6]



[6] The triangles in Figure 3.6 indicate the portfolio average cost for each avoided cost scenario.

Energy Efficiency-Related Financial Impacts

I-937 requires utilities with over 25,000 customers to obtain a fixed percentage of their electricity from qualifying renewable resources and to acquire all cost-effective and achievable energy conservation. For the first 24-month period under the law (2010-2011), this equaled a ramped-in share of the regional ten-year target identified in the Sixth Power Plan. Penalties of at least $50 per MWh exist for utilities not achieving Washington targets for conservation resource acquisition.

Regional discussions were under way regarding the definition of “pro-rata” during the 2009 IRP. Avista proposed ramping the 10-year targets identified in the Sixth Power Plan instead of acquiring 20 percent of the first ten-year target identified in the Sixth Power Plan. The “pro-rata” amount would have created drastic ramping challenges, especially in the early years. Due to inconsistencies between the 2009 IRP and the Council’s methodology, the Company elected to use the NPCC’s Option #1 of the Sixth Power Plan to establish its conservation acquisition target, adjusted to include electric-to-natural gas space and water heating fuel conversions. The acquisition target was 11 percent greater than Avista’s IRP energy efficiency target for the same period. In April 2010, the UTC approved the Company’s ten year Achievable Potential and Biennial Conservation Target Report in Docket UE-100176.

The I-937 requirement to acquire all cost-effective and achievable conservation poses significant financial implications for Washington customers. In 2012, the projected incremental annual cost to Washington customers is $2.0 million. This annual amount grows to $41.8 million by the tenth year, representing a total of $199.2 million over this ten-year period for Washington. Figure 3.7 shows the annual cost (in millions) for this acquisition of past and future conservation. As shown in the figure, future cost for new conservation reflects margin returns as compared to historical acquisition.

This incremental level of acquisition driven by Washington I-937 will result in annual rate increases to Washington electric customers of an approximate range of $8 to $302 per average customer across all classes. Figure 3.8 illustrate the annual cost associated with the energy efficiency acquisition required to meet I-937 goals.

Figure 3.7: Cost of Existing & Future Conservation

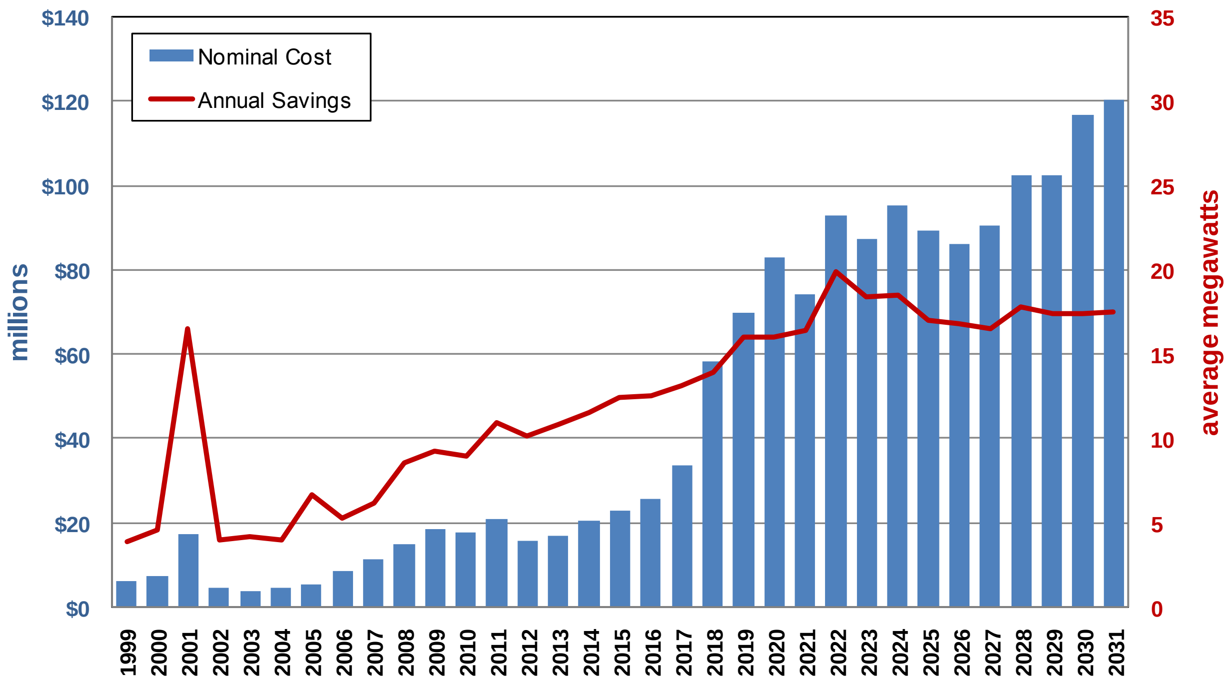
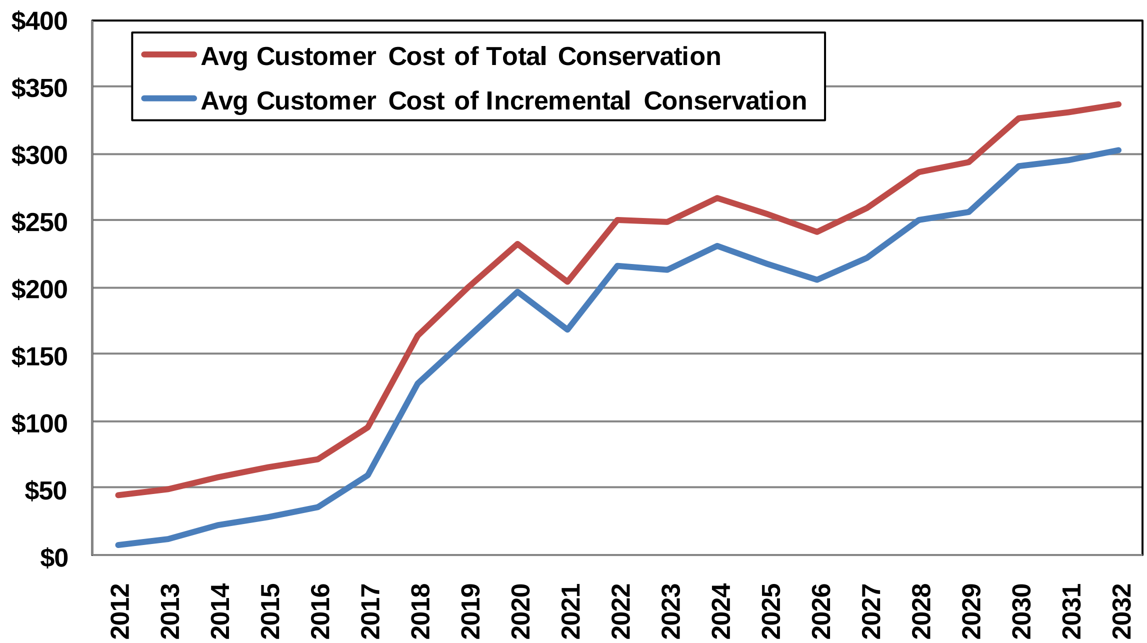


Figure 3.8: Cost of Conservation per Customer per I-937



Integrating Results into Business Planning and Operations

The CPA and IRP energy efficiency evaluation processes provide high-level estimates of cost-effective conservation acquisition opportunities. While results of the IRP analyses establish baseline goals for continued development and enhancement of conservation programs, the results are not detailed enough to form an acquisition plan. Avista uses IRP evaluation results to establish a budget for conservation measures, to help determine the size and skill sets necessary for future conservation operations, and for identifying general target markets for energy efficiency programs. This section provides an overview of recent operations of the individual sectors as well as conservation business planning.

For this IRP, the Company procured its first external conservation potential assessment study for Washington and Idaho from Global Energy Partners. This study is useful for the implementation of energy efficiency programs in the following ways.

- Identifying by sector, segment, end-use and measure where energy savings may come from during the next 20-year timeframe. The implementation staff can use CPA results to determine which segments and end-uses/measures to target through energy efficiency programs.
- Identifying measures with the highest TRC benefit-cost ratios and targeting those lowest cost resources with the greatest benefit.
- Identifying measures that appear to have great adoption barriers by looking at the economic versus achievable results by measure. Implementation staff can then better develop programs around barriers that may exist.
- Improving the design of current program offerings. Implementation staff can review the measure level results by sector and compare the savings with the largest-savings measures currently offered by the Company. This analysis may lead to the elimination of some programs or the addition of other programs. Consideration might be given to identifying lost opportunities (i.e. “low-hanging fruit”) and whether to target one particular measure over another measure. One possibility may be to offer higher incentives on measures with higher benefits and lower incentives on measures with lower benefits.

In addition to how the IRP results and the potential study flow into operational planning, an overview of 2010 and 2011 energy efficiency acquisitions by sector is given below. This is prior to the implementing the actions mentioned above.

Residential Sector Overview

Avista offers most residential energy efficiency programs through prescriptive, or standard offer, programs targeting a range of end-uses. Programs offered through this prescriptive approach by Avista during 2010 included space and water heating conversions, ENERGRY STAR® appliances, ENERGY STAR® homes, space and water equipment upgrades and home weatherization.

Avista offers the remaining residential energy efficiency programs through other channels. For example, a third party administer JACO operates the refrigerator/freezer recycling program. CFL and specialty CFL buy-downs at the manufacturer level provide customers access to lower-priced CFL bulbs. Home energy audits, subsidized by a grant from the American Recovery and Reinvestment Act (ARRA), began in 2010. This program offers home inspections that include numerous diagnostic tests and provides a leave-behind kit containing CFLs and weatherization materials. Finally, Avista provides educational tips and CFLs at various rural and urban events in an effort to reach all areas within its service territory.

Avista processed over 36,000 energy efficiency rebates in 2010, benefiting approximately 25,000 households. Nearly $6.3 million in customer rebates offset the cost of implementing energy efficiency upgrades. Residential programs contributed 24,247 MWh and nearly 1.1 million therms of energy savings.

The results of an Ecotope study resulted in several planned modifications to the 2011 residential programs. These modifications include the discontinuation of the windows program, contractor installed weatherization requirements (eliminating do-it-yourself projects), reducing incentives for electric to natural gas water heater conversion, and the inclusion of the rooftop damper program on the residential form. We address these efficiency program modifications below.

The CPA study illustrates potential markets and provides a list of cost-effective measures analyzed through the on-going energy efficiency business planning process. This review of residential program concepts and their sensitivity to more detailed assumptions will feed into program plans for target markets. Potential measures not currently considered at the time of the CPA that may arise in the future will be reevaluated for possible inclusion in the Business Plan.

Residential Energy Efficiency Offering In Depth

Avista encourages customers to take part in home energy audits. Employees and customers in Spokane County can sign up for a comprehensive home energy audit offered by Avista for as low as $49. Funding for this pilot program comes from a combination of Avista energy efficiency funds and federal stimulus dollars through the Energy Efficiency Community Block Grant program. Avista collaborated with the City of Spokane, Spokane County and the City of Spokane Valley to provide this program at a significantly reduced cost.

The home energy audits use certified professionals with state-of-the-art equipment and techniques to identify home energy use and safety improvements. The auditor discusses existing energy use, if there are any energy efficiency concerns, and areas of the home that are not as comfortable as owners would like them to be. Once the audit is complete, the customer receives a detailed report on the findings, along with recommendations to make their home more energy efficient.

In addition to a wealth of information, participating homeowners receive an energy efficiency/weatherization kit with a retail value of approximately $50. It contains compact fluorescent light bulbs, low-flow showerheads, expanding foam sealant and other energy-saving materials. Customers are able to visit www.avistautilties.com to find out more and to view a video about this and other energy efficiency programs.

Limited Income Sector Overview

Six Community Action Agencies (CAAs) administer low-income programs. During 2010 these programs targeted a range of end-uses including space and water heating conversions, ENERGY STAR refrigerators, space and water heating equipment upgrades, and weatherization which are offered site-specifically through individualized home audits. The Company also funds health and human safety investments considered necessary to ensure habitability of homes and protect investments in energy efficiency, as well as administrative fees enabling CAAs to continue to deliver these programs.

During 2010, the Company convened the Low Income Collaborative to explore new approaches promoting low-income conservation, identify barriers to its development and to address issues raised by The Energy Project in Avista's 2009 Washington General Rate Case. On September 1, 2010, the Company filed the conclusions of the Low Income Collaborative as requested by the UTC.

Issues addressed through the low income collaborative included defining the low-income customer class, identifying market barriers to the success of low income energy efficiency programs, identifying measures for success, and identifying low income energy efficiency delivery mechanisms and funding sources.

The CAAs had 2010 budgets of $1.3 million for Washington and $660,000 for Idaho. The Company processed about 1,500 rebates, benefitting approximately 550 households. During 2010, the Company paid $1.7 million in rebates to the CAAs to provide fully subsidized energy efficiency upgrades, health and human safety, and administrative costs for the CAAs to administer these programs. The CAAs spent nearly $144,000 on health and human safety, which was 8.3 percent of their total expenditures and within their 15 percent allowance for this spending category. Low Income energy efficiency programs contributed 2,102 MWh of electricity savings and 61,271 therms of natural gas savings.

All of the CAAs received a funding increase in 2011 resulting from recent rate cases in both Washington and Idaho making the total funding $2 million for Washington, $940,000 for Idaho, and an additional $40,000 for conservation education.

CAAs submitting for reimbursement in 2011 must include the age of the home and square footage to improve billing analysis and other evaluation efforts. Energy savings claims are now consistent with the regular residential programs, rather than CAAs using various models to estimate their energy savings. Impact evaluation led the Company to believe that these models were treating the installation of measures individually, rather than incrementally, resulting in overestimates of savings achieved. This change should provide for higher realization rates since the original estimates should be closer to actual observations in billing analysis. This modification was made in response to Ecotope's 2011 Energy Impact Evaluation Report of Select 2008 Programs.

The CAAs are required to submit marginally cost-effective measures for "pre-approval" to protect the cost-effectiveness of the portfolio. This process has been in effect for the past three years and has allowed the Company to manage on a monthly basis the overall TRC for the Low Income Portfolio. Examples of measures that need pre-approval include natural gas furnaces, natural gas water heaters and ENERGY STAR refrigerators.

Non-Residential Sector Overview

For the non-residential sectors (commercial, industrial and multi-family applications), energy efficiency programs are offered on a site-specific or custom basis. We can offer a more prescriptive approach when treatments result in similar savings and the technical potential is high. An example is the prescriptive lighting program. The applications are not purely prescriptive in the traditional sense, such as with residential applications where homogenous programs are provided for all residential customers; however, a more prescriptive approach can be applied for these similar applications.

Non-residential prescriptive programs offered by Avista include, but are not limited to, space and water heating conversions, space and water heating equipment upgrades, appliance upgrades, cooking equipment upgrades, personal computer network controls, commercial clothes washers, lighting, motors, refrigerated warehouses, traffic signals, and vending controls. Also included are residential program offerings such as multi-family direct install through UCONS (which ended in December 2009, however, a handful of projects were reported in 2010) and multi-family market transformation since these projects are implemented site-specifically unlike other residential programs.

During 2010, the Company processed approximately 2,400 energy efficiency projects resulting in the payment of $7.9 million in rebates paid directly to customers to offset the cost of their energy efficiency projects. These projects contributed 43,430 MWh of electricity and 742,559 therms of natural gas savings.

In January 2011, Avista launched two new prescriptive programs – commercial windows and insulation and commercial natural gas HVAC. Another prescriptive program, for standby generator block heaters, was evaluated and launched April 1, 2011. A survey of various municipalities in 2010 to determine saturation levels of light-emitting diode traffic signals and as a result, this program will end. Participants submitting paperwork by December 15, 2011, will still be eligible to receive an incentive payment. The Leadership in Energy and Environmental Design building rating program ended December 31, 2010. Projects completed by December 31, 2011 with paperwork submitted by March 31, 2012, will be eligible for an incentive.

Energy Smart Grocer is a regional, turnkey program administrated through PECI. This program has been operating for several years. This program will approach saturation levels during the early part of this 20-year planning horizon. We implement the remaining programs in the site-specific sector through the Company’s energy efficiency infrastructure.

The programs highlighted by the recently completed CPA study will be reviewed for the development of target marketing and the creation of new energy efficiency programs. All electric-efficiency measures with a simple payback exceeding one year and less than eight years for lighting measures or thirteen years for other measures automatically qualify for the non-residential portfolio. The IRP provides account executives, program managers/coordinators and energy efficiency engineers with valuable information regarding potentially cost-effective target markets. However, the unique and specific characteristics of a customer's facility override any high-level program prioritization for non-residential customers.

Non-Residential Energy Efficiency Example

The scope of this energy efficiency project included a solution to replace an existing compressor used to circulate water in Medical Lake. The existing equipment was a 50 horsepower screw compressor with a 1,750-RPM three-phase motor that operated 24 hours per day, seven days per week from May 1st through October 31st. The proposed replacement for the existing equipment was five Solar Bee solar-powered DC agitators used to circulate the lake. The compressor is projected to be removed after four of the five solar units have been installed. The estimated annual energy savings associated with this energy efficiency project is approximately 128,000 kWh, which is equivalent to the 50 horsepower compressor running at an estimated 80 percent of full load for six months. Non-quantified non-energy benefits (NEBs) associated with this project include improved water quality and reduced (or possibly eliminated) chemical treatment. The energy efficiency incremental measure cost for the customer is approximately $57,000 and estimated savings of $8,916 in annual energy costs at current rates. At completion, the customer would receive an estimated $25,000 incentive, which would reduce their 6.4-year simple payback to 3.6 years.

Demand Response

Prior to the addition of energy efficiency resources, additional capacity resources were estimated to be needed in 2013. Once energy efficiency resources were layered onto existing supply-side resources in the PRiSM model, this capacity need was moved out to 2019 for summer capacity and 2021 for winter capacity. This capacity need comes from expiring contracts as well as native load growth.

As part of the CPA study, Global evaluated typical demand response program options, including direct load control, curtailable and demand bidding/buy-back programs. Using the Company's capacity costs, prior to the inclusion of energy efficiency, Global found that these demand response programs were cost-effective. However, because energy efficiency is assumed to be acquired first consistent with I-937, the savings resulting from energy efficiency removed the need for additional capacity, making demand response not cost effective at this time.

Since Avista does not have an immediate capacity shortage, the Company will not continue to model demand response programs in the near term, but may continue to evaluate some of these demand response programs in the future.

4. Policy Considerations

Many environmental policy issues could significantly affect the operation of the Company's current generation resources and could affect the types of resources it might pursue in the future. Over time, the direction of these expected future policy considerations has changed, sometimes dramatically. The Company expects the nature and impact of future environmental policies to continue changing. The 2009 IRP included an Environmental Policy chapter that mainly focused on greenhouse gas policy and renewable portfolio standards. The current political and regulatory environments have changed significantly since the publication of the last IRP. The immediate prospects for implementation of cap and trade programs to reduce greenhouse gas emissions has diminished, leading to a new focus on regulatory measures pursued by the Environmental Protection Agency (EPA) and on political and legal initiatives commenced by environmental groups to apply pressure on thermal generation – specifically coal-fired generation. The areas of regulation have particular implications, as they involve regulation of emissions affecting regional haze, coal ash disposal, mercury emissions, water quality, as well as greenhouse gas emissions. This chapter provides an overview and discussion about some of the more pertinent environmental policy issues facing the Company.

Chapter Highlights

- Avista supports national greenhouse gas legislation that is workable, cost effective, and fair.
- Avista supports national greenhouse gas legislation that protects the economy, supports technological innovation, and addresses emissions from developing nations.
- The Company is a member of the Clean Energy Group.
- Avista's Climate Change Council monitors greenhouse gas legislation and environmental regulation issues.

Environmental Concerns

Environmental concerns, such as greenhouse gas emissions, present a unique resource planning challenge due to the continuously evolving nature of environmental regulation and its ever-changing projections of the scope and costs of various programs. If environmental concerns were the only issue faced by electric utilities, resource planning would be reduced to a determination of the required amounts and types of renewable generating technology and energy efficiency to acquire. However, the need to maintain system reliability, acquire resources at least cost, mitigate price volatility, meet renewable generation requirements and manage financial risks compound utility planning complexity. Each generating resource has distinctive operating characteristics, cost structures, and environmental challenges. Traditional generation technologies, like coal-fired and natural gas-fired plants, are well understood and provide capacity along with energy.

Coal-fired units have high capital costs, long permitting and construction lead times, and relatively low and stable fuel costs. They are difficult, if not impossible in some jurisdictions, to site due to state laws and local opposition, and environmental issues ranging from the impacts of coal mining to power plant emissions. Further, remote mine locations increase cost by either the transportation of coal to the plant or the transportation of the generated electricity to load. By comparison, natural gas-fired plants have relatively low capital costs as compared to coal, are typically located close to load centers, can be constructed in relatively short time frames, emit less than half the greenhouse gases emitted by coal, and are the only utility-scale baseload resource that can be developed in certain locations. However, fuel price volatility affects natural gas-fired plants. They are also challenged by having diminished performance during periods of hot weather, by the difficulty of securing water rights for their efficient operation, and by the fact that the plants still emit significant greenhouse gases relative to renewable resources.

Renewable energy technologies such as wind, biomass, and solar generation have different challenges. Renewable resources are attractive because they have low or no fuel costs and few, if any, emissions. However, renewable generation can have limited or no on-peak capacity contribution to the operation of the Company's system, and intermittent renewable resources can present integration challenges and require additional non-renewable generation capacity investment. These resources also generally have high upfront capital costs, and have their own environmental challenges to overcome, particularly with respect to siting. Similar to coal plants, renewable resource projects are located near their fuel sources. The need to site renewable resources in remote locations often requires significant investments in transmission interconnection and capacity expansion, as well as raising possible wildlife and aesthetic issues, such as those that utility-scale solar projects in the southwestern U.S. have encountered. Unlike coal or natural gas-fired plants, the fuel for non-biomass renewable resources cannot be transported from one location to another to better utilize existing transmission facilities or to minimize opposition to project development. Biomass facilities themselves can be particularly challenged because of their dependence on the health of the forest products industry and access to biomass materials located in publicly owned forests.

Furthermore, the long-term economic viability of renewable resources is uncertain for at least two important reasons. First, federal investment and production tax credits and direct grants in lieu of tax incentives are scheduled to expire in 2012 or 2013, depending on the technology. The continuation of credits and grants cannot be assumed in light of the impact such subsidies have on the finances of the federal government and the relative maturity of wind technology development. Second, the costs of renewable technologies are affected by many relatively unpredictable factors, such as renewable portfolio standard mandates, material prices and currency exchange rates, the effects of which cannot be accurately predicted. Capital costs for wind and solar have decreased since the 2009 IRP, but there are no guarantees that prices will continue to stay at current levels.

Though there appears to be very little, if any, chance that a national greenhouse gas cap and trade program being implemented soon, there still is a great deal of uncertainty around its regulation. There is strong regional and national support to address climate change. Since the 2009 IRP publication, many changes in the approach and potential for actual greenhouse gas emissions regulation have occurred, including:

- Consideration is presently being given toward a clean energy standard at the federal level, instead of a more direct form of greenhouse gas emission regulation, such as a cap and trade program;
- The current split of control between the U.S. House of Representatives and the Senate effectively postpones national cap and trade legislation for greenhouse gas emissions until after the 2012 election, at the earliest;
- The EPA has commenced actions to regulate greenhouse gas emissions under the Federal Clean Air Act, although some of these efforts have been delayed and the agency 's justification for advancing some of its initiatives are being judicially challenged ; and
- Development of economy-wide cap and trade regulation at the regional level now focus primarily on California and British Columbia rather than on the broader Western Climate Initiative.

Avista's Climate Change Policy Efforts

Avista's Climate Policy Council is a clearinghouse for all matters related to climate change. In regards to climate change, the Council:

- Facilitates internal and external communications on climate policy issues;
- Analyzes policy impacts, anticipates opportunities and evaluates strategy for Avista; and
- Develops recommendations on climate related policy positions and action plans.

The core team of the Climate Policy Council includes a designated chairperson, key officers, and representatives from Environmental Affairs, Government Relations, Corporate Communications, Engineering, Energy Solutions, Legal Affairs, and Resource Planning. Other areas of the Company participate as needed. The monthly meetings for this group include work divided into immediate and long-term concerns. The immediate concerns include such topics as reviewing and analyzing proposed or pending state and federal legislation, reviewing corporate climate change policy, and responding to internal and external data requests about climate change issues. Longer-term issues involve topics such as emissions tracking and certification, providing recommendations for greenhouse gas goals and activities, evaluating the merits of different greenhouse gas policies, actively participating in the development of legislation, and benchmarking climate change policies and activities against other organizations.

Avista maintains its membership in the Clean Energy Group, which includes Calpine, Entergy, Exelon, Florida Power and Light, Pacific Gas & Electric and Public Service Energy Group. This group collectively evaluates and supports different greenhouse gas policies. Avista also participates in national and regional discussions about hydroelectric and biomass issues through membership in national hydroelectric and biomass associations.

Avista's Position on Climate Change Legislation

Avista anticipates the passage of federal greenhouse gas (climate change) legislation in some form within the next five years. A comprehensive national climate change policy could assume the form of a cap and trade program, carbon tax, national portfolio standard, emissions performance standard, or some combination of the four. The Expected Case in this IRP uses 2015 as the starting date for greenhouse gas emissions costs. The 2015 start date was chosen early in the development of the modeling exercises for this plan, and the actual effective date will most likely be after 2015 by the time legislation could be enacted and rules promulgated. The Company chose to develop a weighted cost using four different cases for greenhouse gas emissions because of the uncertainty about the timing and scope of this legislation. The four cases include regional cap and trade, national cap and trade, national carbon tax and no greenhouse gas policies. Details about the different greenhouse gas policies modeled for this IRP are located at the end of this chapter.

The current lack of a definitive greenhouse policy direction makes an uncertain planning environment as Avista plans to meet future customer loads. Avista does not have a preferred form of greenhouse gas policy at this time, but supports federal legislation that is:

- Workable and cost effective;
- Fair;
- Protective of the economy and consumers;
- Supportive of technological innovation; and
- Includes emissions from developing nations.

Workable and cost effective legislation should be crafted to produce actual greenhouse gas reductions through a single system, as opposed to competing, if not conflicting, state, regional and federal systems. The legislation also needs equitable distribution across all sectors of the economy based on relative contribution to greenhouse gas emissions. Protecting the economy and consumers is of utmost importance. The legislation cannot be so onerous that it stalls the economy or fails to have any sort of adjustment mechanism in case the market solution fails causing allowance or offset prices to escalate at unmanageable rates. Supporting technological innovations should be a key component of any greenhouse gas legislation because innovation can help contain costs, as well as provide a potential economic boost to the manufacturing sector. Climate change legislation must involve developing nations with increasing greenhouse gas emissions and legislation should include strategies for working with other nations directly or through international bodies to control worldwide emissions.

Greenhouse Gas Emissions Concerns for Resource Planning

Resource planning in the context of greenhouse gas emissions regulation raises concerns about the balance between the Company's obligations for environmental stewardship and the cost implications for our customers. Consideration must be given to the cost effectiveness of resource decisions as well as the need to mitigate the financial impact of potential future emissions risks.

Complying with greenhouse gas regulations, particularly in the form of a cap and trade mechanism, involves two actions: ensuring the Company maintains sufficient allowances and/or offsets to correspond with its emissions during a compliance period, and undertaking measures to reduce the Company's future emissions. Enabling emission reductions on a utility-wide basis can entail any of the following:

- Increasing efficiency of existing fossil-fueled generation resources;
- Reducing emissions from existing fossil-fueled generation through fuel displacement including co-firing with biomass or biofuels;
- Permanently decreasing the output from existing fossil-fueled resources and substituting it with lower emitting resources;
- Decommissioning or divesting of fossil-fueled generation and substituting lower emitting resources;
- Reducing exposure to market purchases of fossil-fueled generation, particularly during periods of diminished hydropower production, by establishing larger reserves based on lower emitting technologies; and
- Increasing investments in energy efficiency measures.

With the exception of increasing Avista's commitment to energy efficiency, the costs and risks of the actions listed above cannot be adequately, let alone fully, be evaluated until the nature of greenhouse gas emission regulations is known; that is, after a regulatory regime has been implemented and the economic effects of its interacting components can be modeled. A specific reduction strategy as part of an IRP may be forthcoming when greater regulatory clarity and more precise modeling parameters exist. In the meantime, the model for this IRP uses the average cost of the weighted policies discussed at the end of this chapter. The 2011 IRP focuses on the costs and mitigation of carbon dioxide since it is the most prevalent and primary greenhouse gas emitted from fossil-fueled generation sources.

National Greenhouse Gas Emissions Legislation

Several themes have emerged from various climate change legislative proposals considered since publication of the 2009 IRP. These include:

- Climate change is now viewed as largely an anthropogenic or human-developed phenomenon.
- A preference in certain economic sectors towards application of greenhouse gas regulations on an economy-wide basis, rather than on piecemeal regulatory approaches that target specific sectors or technologies.
- Technology will be a key component to reducing overall greenhouse gas emissions, particularly in the electric sector. Significant investment in carbon capture and sequestration technology will be needed because coal will continue to be an important part of the U.S. generation fleet into the near future.

- Developing countries must be involved in reducing global emissions as greenhouse gas emissions generally increase along with economic growth.
- The longer federal legislation takes to enact, the higher the probability of inconsistent state and regional regulatory schemes. A patchwork of regulation may obstruct the operation of businesses serving multiple jurisdictions by causing market disruptions and increasing the uncertainty of how federal and disparate state and regional regulatory systems might interact.

These themes all point toward a need to develop national greenhouse gas legislation in a timely manner to ensure the best environmental and economic outcomes. The Waxman-Markey bill (H.R. 2454), passed in the U.S. House of Representatives in June 2009, importantly acknowledged these multi-jurisdiction problems by proposing to effectively supersede state and regional cap and trade regulation over emissions covered under federal law between 2012 and 2017.

Federal Policy Considerations

The direction of federal policies toward greenhouse gas emissions mitigation has changed since the 2009 IRP. In that document, the Company projected a national cap and trade program would be enacted and effective in 2012. This IRP assumes some version of a national greenhouse gas policy will be in place starting in 2015, but the type of policy is uncertain. If the models for this IRP did not have to be locked down early in the process, we would have pushed the timeframe out even further because of the uncertainty of any federal-level climate change policy with the current split between the House and the Senate, the soft state of the U.S. economy, and the upcoming 2012 elections. Given this low level of certainty, the Company developed four hypothetical greenhouse gas policy models. Details are provided later in this chapter.

Avista's main concern with any potential federal cap and trade legislation involves compliance costs, an issue centering primarily, though not exclusively, on emission allowances. Avista favors the Edison Electric Institute approach where half of the allowances allocated to electric utilities are load-based and the other half are emissions-based. This more equitable compromise would provide prevent a windfall for non-utility generators with large historical greenhouse gas emissions at the expense of utilities, like Avista, that already rely on non-emitting renewable energy. Administrative or direct allocation, at least in the beginning of the program, is also favored because it will mitigate compliance cost impacts on customers while the allowance markets and emissions reductions technologies are developed.

There currently is no pending federal climate change legislation before Congress. In lieu of comprehensive climate change legislation, early in 2011, President Obama endorsed the idea of a Clean Energy Standard that would result in the nation deriving 80 percent of its electricity by 2035 from renewable resources and lower greenhouse gas emitting generation, such as natural gas-fired generation, "clean coal" generation with captured and sequestered emissions, and nuclear power. Formal Clean Energy Standard legislation has yet to be introduced in Congress. At the time this IRP was prepared, members of the U.S. Senate had collected comments on a White Paper on a Clean Energy Standard and Senator Jeff Bingaman (D-New Mexico) was drafting legislation in coordination with the President's staff, which he said in early June 2011, likely would not pass the Senate Energy and Natural Resources Committee. Even greater doubts exist that such a proposal could pass the U.S. House of Representatives. Given that Clean Energy Standard legislation in not likely to be enacted during 2011and 2012, Avista did not model the Clean Energy Standard for this IRP.

The 111th Congress considered renewable energy standard legislation (RES), such as the Waxman-Markey bill; (H.R. 2454) and S. 1462 by Senator Bingaman. Such proposals contemplated a renewable energy standard of between 10 and 25 percent by specific dates. These measures generally included a "hydro netting" provision; this provision excludes loads served by hydropower energy from the RES requirement. For example, if a utility has 1,000 aMW of load, a 10 percent RES goal, and 200 aMW of hydroelectric generation; then the utility's RES goal would only be 80 aMW instead of 100 aMW because of the hydro-netting. Federal legislation has conceptually – and significantly – differed from the Energy Independence Act (I-937) in Washington State, in particular with respect to hydro-netting. The absence of hydro-netting in I-937 makes the Washington law more restrictive than proposed federal renewable energy requirements. Therefore, absent Idaho RPS legislation, Avista would need to meet only the federal renewable energy requirements for its Idaho service territory. National legislation so far also includes existing biomass generation resources, including Kettle Falls, against the renewable energy standard, as well as power from upgrades to hydropower facilities that were effectuated before 1999 (the date established in I-937 to determine resource eligibility). Treatment of renewable resources in federal legislation would not have allowed the Company to use renewable energy credits (RECs) from resources that were only eligible under federal law, but not I-937, to comply with Washington's renewable energy targets. However, Avista would be able to make REC sales from federally eligible facilities into a national market and into states governed solely by federal requirements (i.e., Idaho) and those states whose renewable energy eligibility requirements are similar to federal ones. More details about I-937 are included in the Washington policy consideration section later in this chapter.

The federal Production Tax Credit (PTC), Investment Tax Credit (ITC), and Treasury grant programs are key federal policy considerations for incenting the development of renewable generation. The current PTC and ITC programs are available through the end of 2012 for wind and through the end of 2013 for other renewable resources. We did not model an extension of these tax incentives because of the uncertainty of their continuation due to the current federal budget deficit situation. If extended, the PTC or ITC may accelerate the development of some regional renewable energy projects to meet the extended deadline.

State and Regional Level Policy Considerations

The failure of the federal government to enact greenhouse gas policies during the current decade encouraged several states, such as California and New Mexico, to develop their own climate change laws and regulations. Climate change legislation can take many forms, including economy-wide regulation in the form of a cap and trade system. However, comprehensive climate change policy can also have multiple individual components, such as renewable portfolio standards, energy efficiency standards, and emission performance standards; all of these standards have been enacted in Washington, but not necessarily in other jurisdictions where Avista operates. Individual state actions produce a patchwork of competing rules and regulations for utilities to follow, and may be particularly problematic for multi-jurisdictional utilities such as Avista. There are currently 29 states, including the District of Columbia, with active renewable portfolio standards.

One of the more notable state-level greenhouse gas initiatives outside of the Pacific Northwest include the Regional Greenhouse Gas Initiative (RGGI) agreement between ten northeastern and mid-Atlantic states (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont) to implement a cap and trade program for carbon dioxide emissions from power plants. The District of Columbia, Pennsylvania, and some Canadian provinces are also participating as RGGI observers. RGGI's cap and trade regulations have been effective since January 2009. New Jersey's Governor Christie announced in May 2011 that he was withdrawing his state from RGGI at the end of 2011. While the Governor still endorsed the need to reduce greenhouse gas emissions, he argues that RGGI is not the right mechanism for achieving reductions. Some claim that Governor Christie's action may severely undermine the future prospects for RGGI.

The Western Regional Climate Action Initiative, otherwise known as the Western Climate Initiative (WCI), began with a February 26, 2007, agreement to reduce greenhouse gas emissions through a regional reduction goal and market-based trading system. This agreement included the following signatory jurisdictions: Arizona, British Columbia, California, Manitoba, Montana, New Mexico, Oregon, Utah, Quebec and Washington. In July 2010, the WCI released its Final Design for a regional cap and trade regulatory system to cover 90 percent of the societal greenhouse gas emissions within the region by 2015. So far, the only state to enact legislation authorizing the regulation of greenhouse gas emissions under a cap and trade system is California (New Mexico adopted administrative regulations to regulate greenhouse gas emissions in conjunction with other states, but it did so absent legislative authorization).

At the municipal level, there are several cities participating in the U.S. Mayors Climate Protection Agreement to reduce GHG emissions to seven percent below 1990 levels by 2012.

A federal cap and trade program, such as that envisioned by the Waxman-Markey legislation, will not operate in isolation. Members of the Western Climate Initiative, such as Washington, Oregon, and Montana, can – as some of them have already – pursue complementary policies to regulate emission sources covered under cap and trade regulation, as well as those that will not be regulated under a cap and trade program.

The adoption of greenhouse gas goals and any associated regulations by Washington could directly affect the Company's generation assets in the state, which are largely comprised of the Kettle Falls Generating Station and the Northeast Combustion turbines and Boulder Park peaking facilities. Oregon's greenhouse gas goals and potential future regulations could apply to the Coyote Springs 2 project.

Idaho Policy Considerations

Idaho is not a member of the Western Climate Initiative and currently does not regulate greenhouse gases or have a renewable portfolio standard (RPS). However, the Idaho Department of Environmental Quality will be administering greenhouse gas standards under its Clean Air Act delegation from the EPA.

Montana Policy Considerations

Montana has a non-statutory goal to reduce greenhouse gas emissions to 1990 levels by 2020. In 2007, the Legislature passed House Bill 25. This law requires that new coal-fired facilities built in the state to sequester 50 percent of their emissions. Montana's renewable portfolio standard law, enacted through Senate Bill 415 in 2005, requires utilities to meet 10 percent of their load with qualified renewables from 2010 through 2014, and 15 percent beginning in 2015. While involved in the Western Climate Initiative, Montana has not considered any legislation to authorize its participation in and implementation of WCI's regional cap and trade system. The Montana Department of Environmental Quality does not handle regional haze issues affecting coal-fired generation located in the state, as the agency does not have delegation under the Clean Air Act to regulate regional haze. The federal EPA is responsible for the application of regional haze criteria to the Colstrip coal-fired plants.

Montana had already implemented a mercury emission standard under Rule 17.8.771 that applies to Colstrip. The standard requires mercury reductions to 0.9 pounds per trillion Btu beginning January 1, 2010. Avista's generation at Colstrip already has emissions controls that meet Montana's mercury emissions goals.

Oregon Policy Considerations

The State of Oregon has a history of considering greenhouse gas emissions and renewable portfolio standards legislation. The Legislature enacted House Bill 3543 in 2007, calling for reductions of greenhouse gas emissions to 10 percent below 1990 levels by 2020, and 75 percent below 1990 levels by 2050. These reduction goals are in addition to 1997 regulation requiring fossil-fueled generation developers to offset carbon dioxide (CO_2) emissions exceeding 83 percent of the emissions of a state-of-the-art gas-fired combined cycle combustion turbine (CCCT) by paying into the Climate Trust of Oregon. Senate Bill 838 created a renewable portfolio standard that requires large electric utilities to generate 25 percent of annual electricity sales with renewable resources by 2025. Intermediate term goals include five percent by 2011, 15 percent by 2015, and 20 percent by 2020. Oregon is an active member in the Western Climate Initiative, but it has not passed the legislation necessary to implement the WCI's cap and trade proposal. The Boardman Coal Plant, which is the only active coal-fired generation facility in Oregon, plans to cease using coal by 2020. Portland General Electric's decision to make near-term emissions control investments and to discontinue the use of coal serves as an example of how regulatory, environmental, political and economic pressure can culminate in an agreement that results in the early closure of a low-cost coal-fired power plant.

Washington State Policy Considerations

Circumstances similar to those that led to the close of the Boardman coal-fired facility in Oregon encouraged the owners of the Centralia Coal Plant (TransAlta) to agree to shut down one unit at the facility by December 31, 2020 and the other unit by December 31, 2025. The confluence of regulatory, environmental, political and economic pressure brought about the scheduled closure of the Centralia Plant. The State of Washington enacted several measures concerning fossil-fueled generation emissions and generation resource diversification. A law, enacted in 2004, requires new fossil-fueled thermal electric generating facilities of more than 25 MW of generation capacity to mitigate CO_2 emissions through third party mitigation, purchased carbon credits, or cogeneration. Washington's Energy Independence Act (I-937), was passed by the voters in the November 2006 General Election, established a requirement for utilities with more than 25,000 retail customers to use qualified renewable energy or renewable energy credits to serve three percent of retail load by 2012, nine percent by 2016 and 15 percent by 2020. Failure to meet these RPS requirements results in a $50 per MWh fine. The initiative also requires utilities to acquire all cost effective conservation and energy efficiency measures. Additional details about the energy efficiency portion of I-937 are located in the Energy Efficiency chapter.

Avista expects to meet or exceed its renewable requirements between 2012 and 2015 through a combination of qualified hydroelectric upgrades and renewable energy credit (REC) purchases. The 2011 IRP Expected Case ensures that the Company meets all I-937 RPS goals.

Governor Christine Gregoire signed Executive Order 07-02 in February 2007 establishing the following GHG emissions goals:

- 1990 levels by 2020;
- 25 percent below 1990 levels by 2035;
- 50 percent below 1990 levels by 2050 or 70 percent below Washington's expected emissions in 2050;
- Increase clean energy jobs to 25,000 by 2020; and
- Reduce statewide fuel imports by 20 percent.

The goals of this Executive Order became law when the Legislature enacted Senate Bill 6001 in 2007. This law prohibits electric utilities from entering into long-term financial commitments beyond five years duration for fossil-fueled generation with greenhouse gas emissions exceeding 1,100 pounds per MWh. Beginning in 2013, the emissions performance standard can be lowered every five years to reflect the emissions profile of the latest commercially available CCCT. The emissions performance standard effectively prevents utilities from developing new coal-fired generation and expanding the generation capacity of existing coal-fired generation, unless they can sequester emissions from the facility. The Legislature amended Senate Bill 6001 in 2009 to prohibit contractual long-term financial commitments for generation that contain more than 12 percent of the total power from unspecified sources. The Legislature further amended Senate Bill 6001 in 2011 to allow long-term contracts for output from the Centralia Coal Plant in conjunction with that plant making certain emission investments and ceasing to use coal in 2020 for one unit and 2025 for the other unit. This law change occurred after completion of the modeling for this IRP.

Taking the next step to achieve the State's greenhouse gas reduction goals, the governor introduced legislation (Senate Bill 5735 and House Bill 1819) during the 2009 Legislative Session to authorize the Department of Ecology to adopt rules, consistent from recommendations from the Western Climate Initiative, enabling the state to administer and enforce a regional cap and trade program. When that legislation failed, Governor Gregoire signed Executive Order 09-05 directing the Department of Ecology to develop emission reduction "strategies and actions", including complementary policies, to meet Washington's 2020 emission reduction target by October 1, 2010. This directive requires the agency to "provide to each facility that the Department of Ecology believes is responsible for the emission of 25,000 metric tons or more of carbon dioxide equivalent each year in Washington with an estimate of each facility's baseline emissions and to designate each facility's proportionate share of greenhouse gas emission reduction necessary to achieve the state's 2020 emission reduction" goal. The department is also asked, by December 1, 2009, to develop emission benchmarks, by industry sector, for facilities the Department of Ecology believes will be covered by a federal or regional cap and trade program. The state may advocate the use of these emission benchmarks in any federal or regional cap and trade program as an appropriate basis for the distribution of emission allowances. The department must submit recommendations regarding its industry benchmarks and their appropriate use to the Governor by July 1, 2011.

Greenhouse Emissions Measurement and Modeling

Greenhouse gas tracking is an important part of the IRP modeling process because emissions policy poses a significant risk to Avista. Reducing greenhouse gas emissions from power plants will fundamentally alter the resource mix as society moves towards a carbon constrained future. However, there are currently no federal laws limiting greenhouse gas emissions, estimated costs still need to be projected for planning purposes because expectations for greenhouse gas regulation can significantly alter resource decisions.

Figure 4.1 shows the carbon price forecast for this IRP. The 2011 IRP assumes greenhouse gas emissions policies will not take effect until 2015. To simulate the expected impacts of greenhouse gas regulation, the Company developed four policy models and estimated their assumed financial impact on the energy marketplace. Each policy represents a potential path governments could take over the next several years. We assigned weighting factors to each policy and the weighted average price of the policies is included in the Expected Case. The four greenhouse gas policies used in this IRP are defined in Table 4.1.

Figure 4.1: Annual Greenhouse Gas

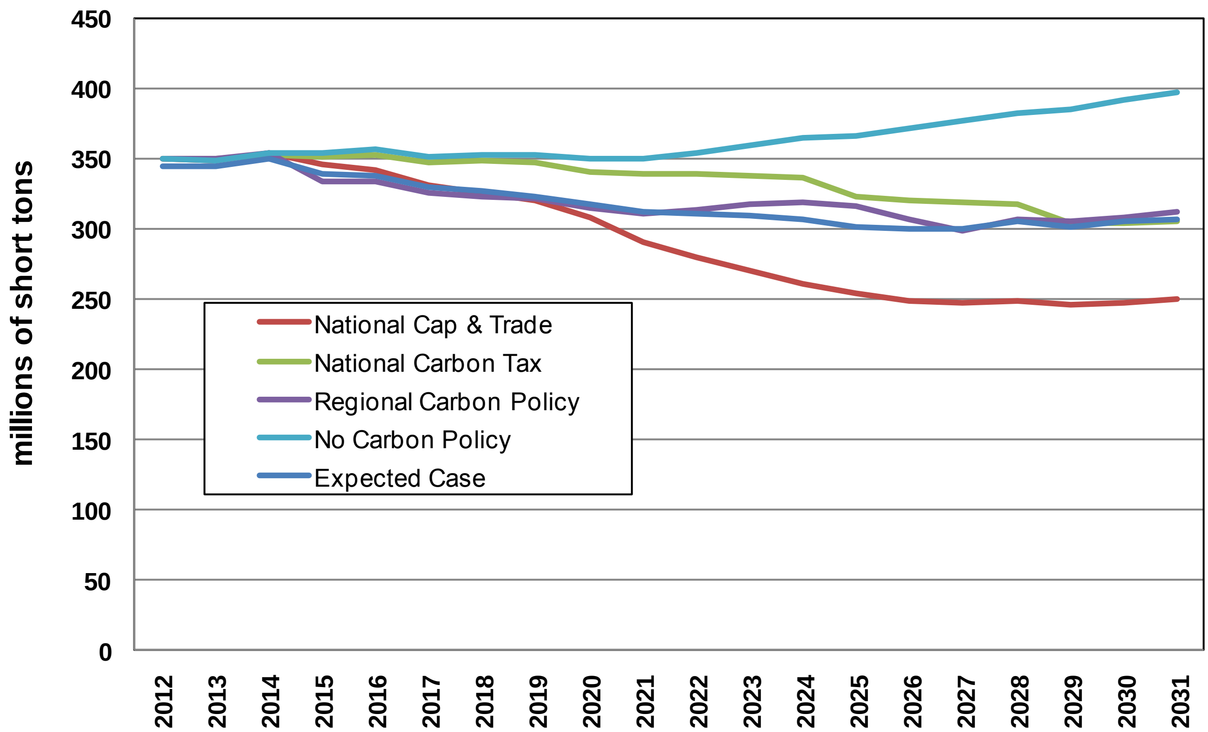


Table 4.1: Modeled Greenhouse Gas Policies

Strategy	Weighting (%)	Details
Regional Greenhouse Gas Policy	30	– Reductions in California, Oregon, Washington, and New Mexico between 2014 and 2019. – Shifts to National Climate Policy in 2020.
National Climate Policy	30	– Federal legislation only applies beginning in 2015 – About 15 percent below 2005 levels by 2020 and about 35 percent below 2005 levels by 2030.
National Carbon Tax	30	– Federal legislation only applies beginning in 2015. – $33 per short ton, then 5 percent per year escalation for the remainder of the study.
No Greenhouse Gas Reductions	10	– No carbon reduction program. – State-level emission performance standards apply and no new coal-plants are added in the Western U.S.

The Regional Greenhouse Gas policy simulates the decision by several western states to require greenhouse gas reductions under the auspices of the Western Climate Initiative (WCI) because a national policy has not been enacted. This policy does not include all of the WCI members because some states have enacted little, if any, legislation to allow their states to participate in the WCI cap and trade market. This policy begins in 2014 and is restricted to California, New Mexico, Oregon and

Washington. The policy is superseded in 2020 by a National Climate Policy, described below. The Regional Greenhouse Gas Policy results in a 10 percent reduction of electric generation greenhouse gas emissions below 2005 levels by 2020. Projected prices start at $5 per short ton of CO_2 in 2014 and escalate by $1 per year up to $9 per short ton in 2019. All greenhouse gas measurements and costs in this chapter are in short tons. In 2020, when the policy switches to a national focus, the price starts at $15 and escalates to $73 per ton in 2030. This policy was weighted by 30 percent in the model.

The National Climate Policy begins in 2015. This scenario assumes no state level cap and trade programs. The greenhouse gas emissions reductions are about 15 percent below 2005 levels by 2020 and about 35 percent below 2005 levels by 2030. Prices start at $15 per ton in 2015 and escalate to $115 per ton in 2030. This policy was weighted 30 percent in the model.

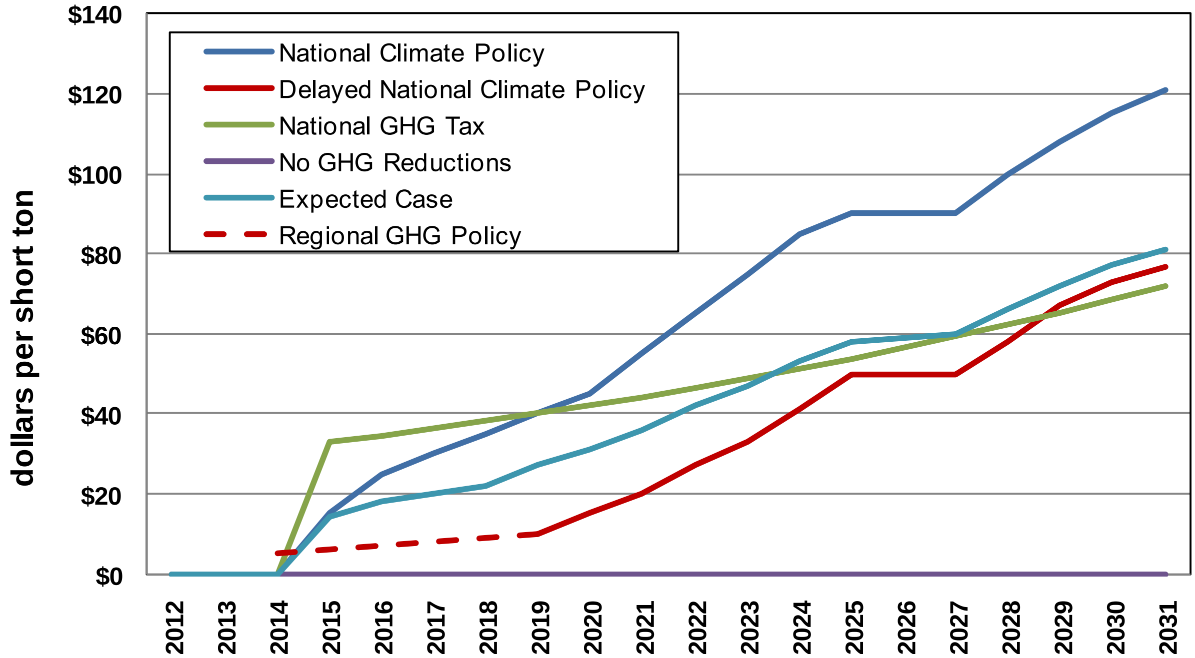
The design of the National Carbon Tax Policy loosely resembles the carbon tax in British Columbia and shows some of the implications of moving to a tax instead of a cap and trade program. The tax would start in 2015 at the national level and would supersede any state-level greenhouse gas cap and trade programs. The tax starts at $33 per ton in 2015 and increases to $69 in 2030. This policy was weighted 30 percent in the model.

The No Greenhouse Gas Reductions Policy is an unconstrained carbon case where there are no national or state-level greenhouse gas emissions reductions policies. This policy was included because there is a small probability of no greenhouse gas taxes or cap and trade program being instituted. This policy is also necessary to be able to determine the cost of the other greenhouse policies, since there is the actual cost of a tax or a credit, plus the additional cost of a less greenhouse gas intensive resource portfolio. Even though this unconstrained carbon policy does not have any national or state-level greenhouse gas policies, state-level emissions performance standards are still applied and no new coal plants were allowed in the model. This policy received a 10 percent weighting in the model.

We also considered the addition of a regulatory model, to represent in spirit of the direction the EPA is using through the Clean Air Act and through other EPA actions that are fostering the early closing of coal-fired plants, such as Boardman and Centralia. These actions include regional haze, mercury abatement, cash ash handling and disposal, among others. The unique nature of each coal-fired facility, combined with the different political and environmental climates in each of the western states, made this type of policy too complex to model at this time. Future IRPs may include some of these EPA-related regulations as they are developed.

Figure 4.2 shows the greenhouse gas emissions costs per short ton under each of the policies and under the Expected Case.

Figure 4.2: Price of Greenhouse Gas Credits in each Carbon Policy



5. Transmission & Distribution

Introduction

This chapter describes Avista's transmission system, completed and planned upgrades, transmission planning issues, and estimated costs and issues of new generation resource integration.

Coordinating transmission system operations and planning activities among regional transmission providers is necessary to maintain reliable and economic transmission service for Avista customers. Transmission providers and interested stakeholders continue to modify the region's approach to planning, constructing, and operating the transmission system under Federal Energy Regulatory Commission (FERC) rules, and state and local siting agencies guidance. This chapter complies with Avista's FERC Standards of Conduct compliance program governing communications between Avista merchant and transmission functions.

Chapter Highlights

- Projected costs of transmission upgrades are included in the 2011 Preferred Resource Strategy.
- The Company received matching federal grants and is investing in three grid modernization programs projected to reduce load by 5.57 aMW by 2013.
- Sixty distribution feeders passed preliminarily economic screening during the IRP timeframe, reducing system losses by 6.1 aMW.
- The Company participates in various regional transmission planning forums.
- Avista will upgrade various transmission paths over the next five years.

Avista's Transmission System

Avista owns and operates a system of over 2,200 miles of electric transmission facilities. This includes approximately 685 miles of 230 kilovolt (kV) line and 1,527 miles of 115 kV line. Figure 5.1 illustrates the Company's transmission system. The Company owns an 11 percent interest in 495 miles of a 500 kV line between Colstrip and Townsend, Montana. The transmission system includes switching stations and high-voltage substations with transformers, monitoring and metering devices, and other system operation-related equipment. The system transfers power from Avista's generation resources to its retail load centers. Avista also has network interconnections with the following utilities:

- Bonneville Power Administration (BPA)
- Chelan County PUD
- Grant County PUD
- Idaho Power Company
- NorthWestern Energy
- PacifiCorp
- Pend Oreille County PUD

Figure 5.1: Avista Transmission Map

Network interconnections enhance reliability and serve as points of receipt for power from generating facilities outside of a utility service area. Avista has interconnections to deliver its Colstrip, Coyote Springs 2, Lancaster, Washington Public Power Supply System Washington Nuclear Plant No. 3 settlement contract, and Mid-Columbia contract power. Avista serves various wholesale loads using government-owned and cooperative utility interconnections at transmission and distribution voltage levels.

Recent Transmission Improvements

Since the 2009 IRP, Avista made the following transmission enhancements:

- Added a 115 kV capacitor bank at Grangeville;
- Installed new 115 kV substation and transmission integration equipment at Idaho Road;
- Replaced a failed transformer at the Avondale 115 kV substation;
- Reconstructed the 115 kV switchyard and distribution substation, and added a capacitor bank to the Nez Perce 115 kV substation;
- Reconductored the Airway Heights to North Fairchild line section of the Airway Heights - Silver lake 115 kV line,
- Installed a new capacitor bank at the Airway Heights substation; and
- Reconductored selected portions of the Moscow area 115 kV system.

Future Upgrades and Interconnections

Station Upgrades

As reported in the 2009 IRP, Avista planned to upgrade its Moscow, Noxon, Pine Creek and Westside 230 kV substations. These stations have undersized transformers, do not provide 21st century reliability, and are near the end of their useful lives. The Moscow station upgrades, scheduled for completion in 2014, will result in a new facility with a single 250 MVA 230/115 kV station using a double bus-double breaker configuration for 230 kV service. The 115 kV yard is in a breaker-and-a-half configuration. Over the next five to 10 years, the three remaining stations will be upgraded. Beyond these, plans exist for several new 115 kV capacitor banks throughout Avista's transmission system in the near future.

Transmission Upgrades

Avista plans to complete several 115 kV reconductor projects throughout its transmission system over the next decade. These projects focus on replacing decades-old small conductor with conductor capable of greater load-carrying capability and more efficient (i.e., fewer electrical losses) service. A future IRP will discuss these savings and timeline after further analysis is completed.

South Spokane 230 kV Reinforcement

Transmission studies continue to support a need for an additional 230 kV line to the south and west of Spokane. Avista currently has no 230 kV source in these areas, and instead relies on its 115 kV system for load service as well as bulk power flows through the area. The project scope is under development, and preliminary studies indicate the need for the following (or similar) projects:

- A new 230/115 kV station near Garden Springs. Property acquisition for the Garden Springs station and preliminary geo-technical station design work has commenced;
- Tap of the Benewah-Boulder 230 kV line southwest of the Liberty Lake area and construction of a new 230 kV switching station (for later development of a 230/115 kV substation); alternatively, reconstruction of the 115 kV circuits between Beacon and Ninth & Central, and the installation of a 230/115 kV station at that site could be pursued;
- Connecting the Liberty Lake 230 kV station with the Garden Springs 230 kV station; alternatively, connecting the Ninth & Central station to the Garden Springs station;
- Construction of a new 230 kV line from Garden Springs to Westside; and
- Origination and termination of the 115 kV lines from the new Spokane 230/115 kV station(s).

The South Spokane 230 kV Reinforcement project will be scoped by the end of 2012 with planned energization by the end of 2018. The project will enter service in a staged fashion beginning in 2014

Additional Work Required from the Avista Five and Ten-Year Plans

Following are examples of additional improvements to the Avista System in the next five to ten years. Since load growth rates in the various areas of the system are unknown, items presently on the list may or may not occur in this timeframe; more certainty is gained as time passes.

- West Plains 115 kV Reinforcement
- Irvin 115 kV Project
- Glenrose Tap – Ninth and Central 115 kV line
- Beacon 230/115 kV Station Partial Rebuild
- New Distribution Stations:
  - Otis Orchards (2011)
  - Hillyard (2013)
  - Hawthorne (2013)
  - North Moscow Additional Transformer (2013)
  - Spokane Downtown West (2014)
  - Greenacres (2014)

Canada/Northwest/California 500 kV Transmission Project (CNC) and Devils Gap 500/230 kV Interconnection

The Transmission Coordination Work Group (TCWG, see below) continues to evaluate a new transmission line involving four major projects.

- 500 kV high voltage alternating current facilities from Selkirk in southeast British Columbia to the proposed Northeast Oregon (NEO) Station, with an intermediate interconnection with Avista at a new Devils Gap Substation, located near Spokane;
- 500 kV high voltage AC or high voltage direct current facilities running from the NEO Station to the Collinsville Substation in the San Francisco Bay Area;
- Interconnection near Cottonwood Substation in northern California (a direct current segment);
- Voltage support at the interconnecting substations; and
- Remedial actions for project outages.

The Canada-Northwest-California (CNC) project would allow access to new renewable resources in the Pacific Northwest, Canada, and, at times, the southwestern United States. Immediate and future environmental and resource needs of Avista and other Western interconnected utilities could be aided by this project. Further, Avista expects the project will increase the utilization of its existing transmission facilities. Through its participation in TCWG and other regional and sub-regional forums, Avista makes all project information available to group members, including resource developers, load serving entities, energy marketers, and independent transmission owners.

The CNC project continues to move forward with an altered set of ownership assumptions. The ultimate project size has not been determined. In late 2010, the CNC project was bifurcated into a northern section and a southern section. BC Hydro has taken responsible for the northern segment, comprised of the 500 kV interconnection between Selkirk and the proposed NEO station. The northern segment could be a double circuit 500 kV AC line with 3,000 MW of transfer capability, or a single circuit 500 kV AC line with 1,500 MW of capacity. Preferred line routing for the northern segment remains the "eastern route", this would utilize the Avista Addy-Devils Gap 115 kV line corridor. A 500 MVA bi-directional 500/230 kV phase shifted interconnection between the CNC project and Avista's transmission system remains the preferred option and would be the major impact to Avista.

The scope of the southern portion of the project has been reduced from a nominal 3,000 MW of transfer capability to 2,000 MW. Much work remains to determine if the southern portion should be an alternating current or a direct current line, and whether brownfield development (replacement of existing transmission with higher voltage and/or higher capacity facilities) can be accomplished while maintaining reliable system operation. Pacific Gas and Electric (PG&E) is no longer leading the southern segment project; the Western Area Power Administration (WAPA) has assumed its leadership.

Regional Transmission System

BPA owns and operates most of the regional transmission system in the Pacific Northwest. The federal entity operates over 15,000 miles of transmission-level facilities throughout the Pacific Northwest and owns the largest portion of the region's high voltage (230 kV or higher) transmission grid. Avista uses BPA transmission to transfer output from its remote generation sources to Avista's transmission system, including its Colstrip units, Coyote Springs 2, Lancaster and its Washington Public Power Supply System Washington Nuclear Plant No. 3 settlement contract. Avista also contracts with BPA for Network Integration Transmission Service to transfer power to 10 delivery points on the BPA system to serve portions of the Company's retail load.

The Company participates in the BPA transmission and rate case processes, and in BPA's Business Practices Technical Forum, to ensure charges remain reasonable and support system reliability and access. Avista also works with the BPA and other regional utilities to coordinate major transmission facility outages.

Future development likely will require new transmission assets by federal and other entities. BPA is developing several transmission projects in the Interstate 5 corridor, as well as projects in southern Washington that are necessary for integration wind generation resources located in the Columbia Gorge. Each project has the potential to increase BPA transmission rates and thereby affect Avista's costs.

FERC Planning Requirements and Processes

The Federal Energy Regulatory Commission (FERC) provides guidance to both regional and local area transmission planning. This section describes several requirements and processes of the federal regulator important to Avista's transmission planning.

Attachment K

FERC approved Attachment K to Avista's Open Access Transmission Tariff (OATT). The attachment satisfies nine transmission principles in FERC Order 890 ensuring open planning processes, and formalizes coordination of local, regional, and sub-regional transmission planning.

Avista regularly develops a biannual Local Planning Report (in coordination with Avista's five- and ten-year Transmission Plans). Avista encourages participation of its interconnected utilities, transmission customers, and other stakeholders in the Local Planning Process.

The Company uses ColumbiaGrid to coordinate planning with sub-regional groups. Regionally, Avista participates in several Western Electricity Coordinating Council (WECC) processes and groups, including Regional Review processes, Transmission Expansion Planning Policy Committee (TEPPC), Planning Coordination Committee (PCC), and the newly formed Transmission Coordination Work Group (TCWG). Participation in these efforts supports regional coordination of Avista's transmission projects.

Western Electricity Coordinating Council

The Western Electricity Coordinating Council (WECC) coordinates and promotes electric system reliability in the Western Interconnection. It also supports efficient and competitive power markets, assures open and non-discriminatory transmission access among its members, provides a forum for resolving transmission access or capacity ownership disputes, and provides an environment for coordinating the operating and planning activities of its members as set forth in WECC Bylaws. Avista participates in WECC's Planning, Operations, and Market Interface Committees, as well as various sub groups and other processes such as the TCWG.

Northwest Power Pool

Avista is a member of the Northwest Power Pool (NWPP). Formed in 1942 when the federal government directed utilities to coordinate operations in support of wartime production, NWPP committees include the Operating Committee, the Pacific Northwest Coordination Agreement (PNCA) Coordinating Group, and the Transmission Planning Committee (TPC). The TPC exists as a forum addressing northwest electric planning issues and concerns, including a structured interface with external stakeholders.

The NWPP serves as an electricity reliability forum, helping to coordinate present and future industry restructuring, promoting member cooperation to achieve reliable system operation, coordinating power system planning, and assisting the transmission planning process. NWPP membership is voluntary and includes the major generating utilities serving the Northwestern U.S., British Columbia and Alberta. Smaller, principally non-generating, utilities participate in an indirect manner through their member systems, such as the BPA.

ColumbiaGrid

ColumbiaGrid formed on March 31, 2006 to develop sub-regional transmission plans, assess transmission alternatives (including non-wires alternatives), provide a decision-making forum, and to provide a cost-allocation methodology for new transmission projects. This group formed in response to several FERC initiatives. Avista joined ColumbiaGrid in early 2007. The ColumbiaGrid agreements help different organizations and groups determine areas of transmission work, and establish agreements to carry out the plans.

Northern Tier Transmission Group

The Northern Tier Transmission Group (NTTG) formed on August 10, 2007. NTTG members include Deseret Power Electric Cooperative, Idaho Power, Northwestern Energy, PacifiCorp, Portland General Electric, and Utah Associated Municipal Power Systems. NTTG members coordinate with state governments to manage their transmission system operations, products, business practices, and high-voltage transmission network planning to meet and improve transmission delivery services. Avista's transmission network has a number of strong interconnections with three of the six NTTG member systems. Due to the geographical and electrical positions of Avista's transmission network related to NTTG members, Avista is evaluating membership in NTTG to foster collaborative relationships with our interconnected utilities.

Transmission Coordination Work Group

The Transmission Coordination Work Group (TCWG) is a joint effort of Avista, BPA, Idaho Power, Pacific Gas and Electric, PacifiCorp, Portland General Electric, Sea Breeze Pacific-RTS, and TransCanada to coordinate transmission project developments expected to interconnect at or near a proposed Northeast Oregon station near Boardman, Oregon. These projects follow WECC Regional Planning and Project Rating Guidelines. Detailed information on projects presently under consideration is at www.nwpp.org/tcwg.

Most of the projects developed through the TCWG transferred to their own Project Review Groups, placed on hold, or terminated. The TCWG work effort has been significantly reduced over the past year because of the number of terminated and on-hold projects.

Avista Transmission Reliability and Operations

Avista plans and operates its transmission system pursuant to applicable criteria established by the North American Electric Reliability Corporation (NERC), WECC and NWPP. Through involvement in WECC and NWPP standing committees and sub-committees, it participates in developing new and revised criteria, and coordinates transmission system planning and operation with neighboring systems.

Mandatory reliability standards promulgated through FERC and NERC, subject Avista to periodic performance audits through these regional organizations. Portions of Avista's transmission system are fully subscribed for retail load service. Transmission capacity not reserved and scheduled to move power to satisfy long-term (greater than one year) obligations is marketed on a short-term basis and used by Avista for short-term resource optimization or by third parties seeking short-term transmission service pursuant to FERC requirements under Orders 888, 889 and 890.

Transmission Construction Costs

The following sections provide an overview of Avista's estimated resource integration costs for the 2011 IRP. Integration points are divided into locations where interconnection study work has been completed and additional points where new resources might be interconnected. Rigorous analyses are not performed for off-system alternatives because of the breadth of study needed for those estimates. Limited study work has been completed, except for projects with existing generation interconnection requests to Avista's transmission group. Completing transmission studies without detailed project parameters is nearly impossible (and any decisions based on such work would be flawed) and it is therefore inappropriate to represent any figures as more than preliminary. Approximate worst-case estimates were developed based on engineering judgment for neighboring system impacts. Generation interconnection costs are for locations within the Avista transmission system. Internal cost estimates are in 2011 dollars and using engineering judgment with a 50 percent margin for error. Construction timelines are from the beginning of the permitting process to line energization.

Integration of Resources External to the Avista System

Avista's load serving entity function must submit generation interconnection and transmission service requests on third party transmission systems. The third party determines transmission system integration and wheeling service costs for delivering new resource power to Avista's system.

At BPA's present wheeling rate, integrating 300 MW (assuming the transmission service were available from the off system resource to the Avista transmission system) would cost about $4.4 million per year plus $2.5 million per year for line losses.

It is likely that the Company would invest $50 million for a 300 MW resource to increase capacity to third-party transmission systems. These investments may not need to be made at the time of interconnect, but will have to be upgraded in time to maintain FERC's market power requirements and maintain present levels of access to the energy market. If Avista acquires a resource located on a third-party network, detailed studies will need to be completed to understand system impacts.

Eastern Montana Resources

A regional study sponsored by the NWPP and Northwest Transmission Assessment Committee (NTAC) found that enhancement of existing 500 kV and 230 kV facilities would be required to integrate additional generation from Montana. Power transfer from eastern Montana to the Northwest is affected by several constraints. A more detailed study effort focusing on relieving constraints from central and eastern Montana continues as a joint effort by Avista, BPA, NorthWestern Energy, PacifiCorp, and Puget Sound Energy. Preliminary results indicate that perhaps as much as 480 MW of additional transfer from Montana can be achieved, however engineering-level construction cost estimates to fix constraints within the various transmission systems have not yet been completed. It should also be noted that various facilities in the Avista transmission system would need to be upgraded to achieve this additional transfer.

Integration of Resources on the Avista Transmission System

The Avista-LSE requested a number of generator interconnection studies in several areas of the Avista transmission system for the 2011 IRP. The following project and cost information was presented at the Third Technical Advisory Committee meeting on December 2, 2010, these cost estimates are presented in Table 5.1.

Table 5.1: New Resource Integration Costs

Location	Notes	Size (MW)	Cost ($ millions)
West of Spokane, WA	No transmission additions	4	0
West of Spokane, WA	Requires new 115 kV line	75	15
West of Spokane, WA	Requires two new 230 kV lines	254	30-55
Benewah, ID	No transmission additions	300	5
Rosalia, WA	No transmission additions	300	8
Rathdrum, ID	Requires generation dropping	300	5
Rathdrum, ID	Requires generation dropping	400	5
Othello, WA	No transmission additions	17	0
Othello, WA	Requires new 115 kV line and substation[1]	100	13-25
Othello, WA	Requires new 230 kV line and substation	250	21-32
Sandpoint, ID	Depends on BPA interconnection	50	2-5
Sandpoint, ID	Cost prohibitive and not studied	100	N/A
Cabinet Gorge, ID	115 kV reconductor	60	2-10
Spokane, WA	Monroe Street hydro project	20	3
Spokane, WA	Monroe Street hydro project	60	3
Post Falls, ID	Post Falls hydro project	14	1
Spokane, WA	Upper Falls hydro project	14	1

After the completion of the IRP's Preferred Resource Strategy and the preference for nearly 500 MW of natural gas capacity in North Idaho. The Resource Planning group requested further study work on specific transmission lines for a more detailed cost of interconnection. This study is in Appendix E. The study shows that in most locations, potential plants can be integrated at similar costs as presented in Table 5.1 as long as a RAS system (generation dropping) is in place. The study further identifies the cost of adding additional network facilities so a RAS system is no longer required.

[1] Note that the 100 MW estimate is for 115 kV integration, and the 250 MW estimate is for 230 kV integration, and does not include mitigation of contractual constraints on the Avista 230 kV system in the area.

Lancaster Integration

Avista has proposed and evaluated an interconnection with BPA at its Lancaster Substation. Avista and BPA have determined that the preferred alternative is to loop the Avista Boulder-Rathdrum 230 kV line into the BPA Lancaster 230 kV station. This interconnection will allow Avista to eliminate or offset BPA wheeling charges for moving the output from Lancaster to Avista's system. Besides reduced transmission payments to BPA by Avista, the interconnection benefit both Avista and the BPA by increasing system reliability, decreasing losses, and delaying the need for additional transformation at the BPA Bell Substation. The proposed plan of service also represents the best option for service from Avista's sole perspective. Studies also indicate that looping the Boulder-Rathdrum 230 kV line into the Lancaster Substation may allow more transfer capability across the combined transmission infrastructure of Avista and BPA. The present Colstrip Upgrade Project study indicates that all of the upgrades (from AVA, BPA, and NWE) could increase the Montana to Northwest path by as much as 800 MW—the associated projects include much more than the Lancaster loop-in work. Construction on the Lancaster project could be completed by the end of 2012 or at some point in 2013, depending on BPA's construction schedule. Avista is working closely with BPA to assure the timely construction of the BPA facilities required to facilitate this interconnection.

Distribution Efficiencies

Avista delivers electrical energy from generators to customer meters through a network of conductors (links) and stations (nodes). The network system is operated at different voltages depending upon the distance the energy must travel to reduce current losses across the system. A common rule to determine efficient energy delivery is one kV per mile. For example, a 115 kV power system commonly transfers energy over a distance of 115 miles while 13 kV power systems are generally limited to delivering energy 13 miles.

Avista's categorizes its energy delivery systems between transmission and distribution voltages. Avista's transmission system operates at 230 kV and 115 kV nominal voltages. Avista's distribution system operates between 4.16 kV and 34.5 kV, but typically at 13.2 kV in its urban service centers. In addition to voltages, the transmission system operates distinctly from the distribution system. For example, the transmission system is a network linking multiple sources with multiple loads, while the distribution system configuration uses radial feeders to link a single source to multiple loads.

System Efficiencies Team

In 2008 an Avista system efficiencies team of operational, engineering and planning staff developed a plan to evaluate potential energy savings from Transmission and Distribution (T&D) system upgrades. The first phase summarized potential energy savings from distribution feeder upgrades. The second phase, beginning in the summer of 2009, combined transmission system topologies with "right sizing" distribution feeders to reduce system losses, improve system reliability, and meet future load growth.

Distribution Feeders

Avista's distribution system consists of approximately 330 feeders covering 30,000 square miles. The feeders range in length from three to 73 miles. For rural distribution, feeder lengths vary widely to meet the electrical loads resulting from the startup and shutdown business swings of the timber, mining and agriculture industries.

The system efficiencies team evaluated several efficiency programs across the urban and rural distribution feeders. The programs consisted of the following system enhancements:

- Conductor losses;
- Distribution Transformers;
- Secondary Districts; and
- Var compensation.

The energy losses, capital investments, and reductions in operations and maintenance (O&M) costs resulting from the individual efficiency programs under consideration were combined on a per feeder basis. This approach provided a means to rank and compare the energy savings and net resource cost for each feeder.

Economic Analysis

Prior to the 2009 IRP an economic analysis was performed to determine the net resource costs to upgrade each feeder for the four program areas listed above. The net resource cost determines the avoided cost of a new energy resource levelized over the asset's life cycle expressed in dollars per megawatt. This economic value is calculated by estimating the capital investment, energy savings, and avoidance of operations and maintenance (O&M) and interim capital investments resulting from feeder upgrades.

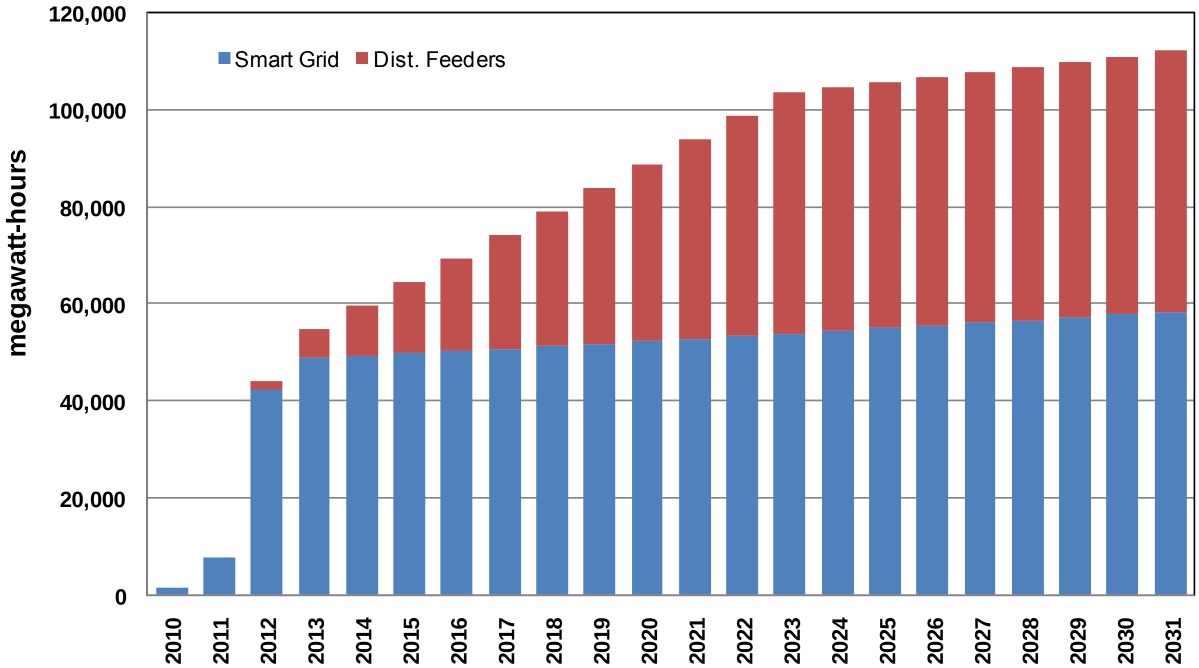
The O&M avoided costs for upgrades were determined by modeling existing feeders in the Availability Workbench program. This program is an expected value model combining a weighted average time and material cost of equipment failure with the probability of failure. The distribution feeder's conductor, transformers, and ancillary equipment were used to develop the failure model for each studied feeder. Customer, material and labor costs incurred by outages, and equipment failure were the parameters used to measure the economic risk of a failure. The results were calibrated to the expected value model by industry indexes and Avista's actual outage history. Many of the projects found to be cost effective in the study are now a part of the grid modernization project discussed below. There were 60 feeders remaining for potential re-builds and based upon preliminary energy and O&M savings estimates. All appear cost effective. However, these projects need further study to develop detailed cost and energy savings estimates, further improved reliability and replacing aging infrastructure may also contribute to the decision to proceed with rebuild projects. Based on the preliminary cost and energy estimates shown in Figure 5.2, losses could be reduced by 6.1 aMW by the end of the IRP planning period.

Grid Modernization

Avista is investing in grid modernization technology with the aid of three federal grants promoting the development of grid modernization applications. These grants require the

Company to invest in grid modernization training and grid improvement. The following is a discussion of the programs, and the progress of the investment. Figure 5.2 summarizes projected energy savings for Grid Modernization (Smart Grid) and Distribution Feeder Rebuild projects over the 20-year IRP planning period. Table 5.2 shows the projected loss savings for 2012 and 2013.

Figure 5.2: Cumulative Distribution Loss Savings from Grid Modernization and Feeder Upgrades



Washington's Energy Independence Act targets for energy efficiency capture first year energy savings. Avista will capture the first year energy savings entirely in the year when the assets are placed in service. The Evaluation, Measurement and Verification process will focus on the 12-month period extending forward from the date assets are place in service.

Table 5.2: Distribution Loss Energy Savings (MWh)

Location	2012	2013
Smart Grid	34,839	6,477
Distribution Feeders	1,626	4,351
Total	**36,465**	**10,828**

Smart Grid Workforce Training Grant

Avista received a three-year, $1.3 million government grant to invest in facility and training programs to educate workers for developing, managing, and maintaining the future grid. Workers are trained at the Jack Stewart Training Center, working in a model neighborhood and substation to learn about grid modernization technology. Avista is also developing a curriculum for local universities and an online portal to provide training opportunities outside of the organization. Another goal of this grant is to share best practices on Smart Grid training.

Smart Grid Investment Grant (SGIG)

The $20 million Smart Grid Investment Grant (SGIG) covers investment to the Spokane area grid improvement project. This project includes upgrades for 59 circuits, 14 substations, and 110,000 electric customers. Avista is contributing $42 million dollars to this project to automate the system. 42,000 MWh or 4.8 aMW of loss savings are expected. Conservation Voltage Reduction (CVR) makes up 83 percent of the loss savings. This project will enable Avista to remotely control and operate the distribution system through a series of wireless controls and fiber communication between switches, reclosers, capacitor banks, and voltage regulators. The Distribution Management System will remotely operate the system and will be able to automatically detect and restore faults.

Smart Grid Demonstration Project (SGDP)

Avista is a partner in the regional Smart Grid Demonstration Project (SGDP). Avista is using an $18.9 million government grant to employ grid modernization technology in Pullman, Washington, as part of the Pacific Northwest Smart Grid Demonstration Project. Avista is contributing $14.9 million to the Pullman project and other parties are contributing an additional $4.0 million. The partners are Itron, HP, Washington State University, and Spirae. This project encompasses 13 circuits, three substations, and includes network automation. The project involves replacement of 14,000 electric and 6,000 natural gas meters with digital meters with wireless communication. Customers with these new meters will be able to use a web portal to track energy usage in near real time. This project should reduce system losses by 6,763 MWh.

Feeder Rebuild Program

Beginning in 2012, Avista will begin rebuilding distribution feeders to capture energy savings from reducing losses, increase reliability, and decrease future O&M costs. In 2012, the Company will begin work on three feeders; the feeders include BEA12F1 and F&C12F2 (urban feeders located in Spokane) and a rural feeder in Wilbur, Washington (WIL12F2).

As an example, an 11-mile section of the Wilbur feeder (WIL12F2) was chosen as one of the initial feeder upgrades because of reliability and operational deficiencies. The Wilbur feeder has several issues. The small diameter conductor sags at unacceptable levels during frequent icing events in the area. The high impedance of this conductor also increases the difficulty of determining where faults occur. The average age of the transformers being replaces is over 50 years. Finally, this feeder is also difficult to repair quickly because of its remote location. Over the last five years, the feeder has averaged 50 outages per year with a 400-minute average outage duration.
The 2012 feeder rebuilds will be completed between June and December 2012 and we expect to reduce losses by 1,626 MWh annually. The schedule of feeders has yet to be determined for 2013, but will likely include five or six feeder upgrades for approximately 3,325 MWh of expected loss savings annually. These estimates range between plus or minus 30 percent depending on construction scheduling, feeder selection, load levels, and other factors. The ultimate scope and timing of the feeder rebuild programs will

depend on the actual results of the first several feeder rebuild projects and on the availability of resources and operational needs of the Company.

Transmission Topologies and Distribution Feeder Sizing

Avista is planning a new modeling system that will incorporate transmissions topology, station locations and load growth. Historically, Avista's power grid was designed and built to adhere to reliability and capacity guidelines resulting in the lowest upfront cost. This approach was reasonable considering the low electricity costs of that time. As the cost of energy increases, life cycle economic analyses are warranted to evaluate power system losses corresponding to different power grid configurations.

The new and comprehensive analysis will review several different transmission topologies to determine the most efficient configuration for moving bulk power through and by Avista's system. The transmission topologies will consider the efficiency between star network, hub and loop, southern loop and southern source. Avista's load service will be incorporated in this analysis by determining ideal substation placement and feeder sizes as well as forecasted load growth. The comprehensive analysis will evaluate many of the items listed below.

- Develop a performance criteria to determine system measures;
- Develop a base case to measure existing system performance;
- Develop a methodology to determine a full build out load case;
- Identify reasonable transmission topologies for evaluation;
- Identify reasonable guidelines for substation placement;
- Identify reasonable guidelines for distribution feeder sizes; and
- Bound the analysis to ensure the system remains reliable, compliant, and operationally flexible.

6. Generation Resource Options

Introduction

There are many generating resource options available to meet future resource deficits. Avista can upgrade existing resources, build new facilities, or contract with other energy companies for future delivery. This section describes the resources considered to meet future resource needs. The new resources described in this chapter are mostly generic. Actual resources may differ in size, cost, and operating characteristics due to siting or engineering requirements.

Section Highlights

- Only resources with well-defined costs and operating histories are in the PRS analysis.
- Wind and solar resources represent renewable options available to the Company; future RFPs might identify competing renewable technologies.
- Renewable resource costs assume present state and federal incentive levels, but no extensions.
- For the first time, thermal generation upgrades are included as resource options in the IRP.

Assumptions

For the Preferred Resource Strategy (PRS) analysis, Avista only considers commercially available resources with well-known cost, availability and generation profiles. These resources include gas-fired combined cycle combustion turbines (CCCT), simple cycle combustion turbines (SCCT), large-scale wind, and certain solar technologies proven on a large-scale commercial basis. Several other resource options described later in the chapter were not included the PRS analysis, but their costs were estimated for comparative analysis.

Levelized costs referred to throughout this section are at the generation busbar. The nominal discount rate used in the analyses is 6.8 percent. Nominal levelized costs result from discounting nominal cash flows at the rate of general inflation.

Renewable resources eligible for federal tax incentives receive such incentives based on the current federal law. Wind benefits end in 2012; solar tax benefits end in 2016, and all other renewable benefits end in 2013. The levelized costs in this chapter assume maximum available energy for each year instead of expected generation. For example, wind generation assumes 31 percent availability, CCCT generation assumes 90 percent availability, and SCCT generation assumes 92 percent availability. The following are definitions for the levelized cost components used in this chapter:

- *Capital Recovery and Taxes*: Includes depreciation, return on capital, income taxes, property taxes, insurance, and miscellaneous charges such as uncollectible accounts and state taxes for each of these items pertaining to generation asset investment.
- *Allowance for Funds Used During Construction (AFUDC):* The cost of money for construction payments before the utility can recover costs of prudently acquired generation resources.
- *Federal Tax Incentives:* The estimated federal tax incentive (per MWh), whether in the form of a production tax credit (PTC), a cash grant, or an investment tax credit (ITC), attributable to certain generation options.
- *Fuel Costs*: The cost of fuels such as natural gas, coal, or wood per the efficiency of the generator. Additional details on fuel prices are in the Market Modeling section.
- *Fuel Transport*: The cost to transport fuel to the plant, including pipeline capacity charges.
- *Greenhouse Gas Emissions Adder:* Cost of carbon dioxide (greenhouse gas) emissions based on Wood Mackenzie forecast.
- *Fixed Operations and Maintenance (O&M):* Costs related to operating the plant such as labor, parts, and other maintenance services (pipeline capacity costs are included for CCCT resources) that are not based on generation levels.
- *Variable O&M:* Costs per MWh related to incremental generation.
- *Interconnection Capital Recovery*: Includes depreciation, return on capital, income taxes, property taxes, insurance, and miscellaneous charges such as uncollectible accounts and state taxes for each of these items pertaining to transmission asset investments needed to interconnect the generator.
- *Excise Taxes and Other Overheads:* Includes miscellaneous charges for non-capital expenses.

At the end of this section, various tables show Incremental capacity, heat rates, generation capital costs, fixed O&M, variable costs, and peak credits.[1] Figure 6.2 shows the levelized costs of different resource types in comparison. All costs shown in this section are in nominal dollars unless otherwise noted. Further information on the plant assumptions used in this section is in the Northwest Power and Conservation Council's (NPCC) Sixth Power Plan.

[1] Peak credit is the amount of capacity a resource contributes at the time of system peak load.

Gas-Fired Combined Cycle Combustion Turbine (CCCT)

Gas-fired CCCT plants provide a reliable source of both capacity and energy for a relatively inexpensive capital investment. The main disadvantage is generation cost volatility due to a reliance on natural gas.

CCCTs in this IRP are of a "one-on-one" (1x1) configuration, using both water- and air-cooling technologies. The 1x1 configuration consists of a single gas turbine, a single heat recovery steam generator (HRSG), and a duct burner to gain more generation from the HRSG. These plants have nameplate ratings between 250 MW and 300 MW each. A "2x1" CCCT plant configuration is possible with two turbines and one HRSG, generating up to 600 MW. The most likely CCCT configuration for Avista is a 270 MW air-cooled plant located in the Idaho portion of Avista's service territory. Potential sites for a future combined cycle plant would likely be on the Avista transmission system to avoid third-party wheeling rates. Another advantage of siting a CCCT resource in Avista's service territory is access to a low cost natural gas pipeline and fuel sources. Within Avista's area, siting decisions then come down to choosing the state to locate a new plant. Most of Avista's load is in Washington, but the state's natural gas excise tax and carbon dioxide mitigation requirements place a gas-fired plant at an economic disadvantage relative to siting the same plant in an adjoining state. Siting a CCCT in Idaho economically benefits ratepayers with a lower sales tax rate, the absence of a natural gas excise tax, and no fees for carbon dioxide mitigation.

Cost and operational estimates for CCCTs modeled in the IRP use data from the NPCC's Sixth Power Plan, but adjusted to reflect air-cooled technology costs by Avista's engineering staff. The heat rate modeled for an air-cooled CCCT resource is 6,925 Btu/kWh in 2012. The projected CCCT heat rate falls by 0.5 percent annually to reflect an allowance for anticipated technological improvements. The plants include seven percent of rated capacity as duct firing at a heat rate of 9,690 Btu/kWh. If Avista were able to site a water-cooled plant, the heat rate would likely be two percent lower and net plant output might increase by five MW.

The IRP models forced outages at six percent per year, with 21 days of annual plant maintenance. CCCT plants are capable of backing down to 65 percent of nameplate capacity, and ramping from zero to full load in four hours. Carbon dioxide emissions are 117 pounds per decatherm of fuel burned. The maximum capability of each plant is highly dependent on ambient temperature and plant elevation. For modeling, winter capability is likely to increase by 4 percent and summer capability is likely to decrease by 6 percent, though these estimates are highly dependent upon ambient temperatures.

The capital cost used for this IRP for an air-cooled CCCT located in Idaho on Avista's transmission system with AFUDC is $1,323 per kW. Fixed O&M is $16 per kW-year. Table 6.1 shows the overnight-levelized cost for an air-cooled CCCT resource in nominal dollars per MWh.

Table 6.1: CCCT (Air Cooled) Levelized Costs

Item	Nominal $/MWh
Capital recovery and taxes	20.25
AFUDC	2.69
Federal Tax Incentives	0.00
Fuel Costs	48.81
Fuel Transport	5.18
Greenhouse Gas Emissions Adder	13.65
Fixed O&M	2.67
Variable O&M	2.35
Interconnection Capital Recovery	0.31
Excise taxes and Other Overheads	3.16
Total Cost	**99.07**

Gas-Fired Combustion Turbines and Reciprocating Engines

Gas-fired combustion turbines (CTs) and reciprocating engines, or peaking resources, provide low-cost capacity and are capable of providing energy as needed. Technology advances allow the plants to start and ramp quickly, enabling them to provide regulation services and reserves for load following and for variable resources such as wind generation.

The IRP models four peaking resource options: Frame (GE 7EA) and hybrid aero-derivative (GE LMS 100), Reciprocating Engines (Wartsila 20V34), and Aeroderivative (GE LM 6000). The different peaking technologies range in their abilities to follow load, their costs, their generating capabilities, and their energy-conversion efficiencies. Cost and operational estimates rely on the Northwest Planning and Conservation Council's Sixth Power Plan. Table 6.2 compares some of the peaking resource operating and cost characteristics. All plants assume the same 0.5 percent annual real dollar cost decrease and forced outage and maintenance rates. The levelized cost for each of the technologies is in Table 6.3.

Table 6.2: Simple Cycle Plant Cost and Operational Characteristics

Item	Frame	Hybrid	Reciprocating Engine	Aero-Derivative
Capital Cost with AFUDC ($/kW)	679	1,272	1,308	1,186
Fixed O&M ($/kW- yr)	12.70	9.20	15.00	15.00
Heat Rate (Btu/kWh)	11,841	8,782	8,762	9,276
Variable O&M ($/MWh)	$1.13	$5.63	$11.25	$4.50
Segment Size (MW)	83	94	99	46

The lowest cost resource in Table 6.3 is the hybrid CT technology. However, this comparison can be misleading, as a peaking resource does not operate at its theoretical maximum operating levels. Peaking resources generally operate a small percentage of the time. Therefore, a lower capacity cost resource may be more appropriate than a lower per unit cost resource when considering the number of expected operating hours in the broader IRP modeling process.

Table 6.3: Simple Cycle Plant Levelized Costs per MWh

Item	Frame	Hybrid	Reciprocating Engine	Aero-derivative
Capital Recovery and Taxes	10.33	19.37	19.38	18.06
AFUDC	0.89	1.67	1.67	1.56
Federal Tax Incentives	0.00	0.00	0.00	0.00
Fuel Costs	81.33	60.32	60.18	63.72
Fuel Transport	0.00	0.00	0.00	0.00
Greenhouse Gas Emissions Adder	22.75	16.87	16.84	17.83
Fixed O&M	2.00	1.46	2.30	2.37
Variable O&M	1.38	6.91	13.82	5.53
Interconnection Capital Recovery	0.44	0.44	0.43	0.44
Excise Taxes and Other Overheads	4.67	3.72	4.05	3.89
Total Cost	**123.81**	**110.76**	**118.66**	**113.39**

Wind

Concerns over the environmental impact of carbon-based generation technologies have increased demand for wind generation. Governments are promoting wind generation through a combination of tax credits, renewable portfolio standards, and climate change legislation. The 2009 American Recovery and Reinvestment Act extended the PTC for wind through December 31, 2012, and provided an option for wind generation owners to select a 30 percent investment tax credit (ITC) or cash grant instead of the PTC.

The IRP includes two wind generation resources: on-system and off-system. Both resources have the same capital costs and wind pattern, but differ in the cost of transmission to deliver the energy to Avista's system. On-system projects must pay only transmission interconnection costs, whereas off-system projects must pay both interconnection and third party wheeling costs.

Wind resources benefit from having no emissions profile or fuel costs, but they are not dispatchable, and have high capital and labor costs relative to other resource options. Wind capital costs in 2012, including AFUDC and transmission interconnection, are expected to be $1,850 per kW with annual fixed O&M costs of $51 per kW-yr (including costs due to intermittent generation). These estimates come from Avista's experience in the wind market at the time of the IRP. The capacity factors in the Northwest are likely to vary depending upon the location. Northwest wind has a 31.2 percent average capacity factor; on-system wind projects have a 29.75 percent capacity. A statistical method, based on regional wind studies, derives a range of annual capacity factors depending on the wind regime in each year (see stochastic modeling assumptions for more details.

Levelized costs, using these expected capacity factors and capital and operating costs are in Table 6.4. These wind generation cost estimates assume the use of the federal cash grant for any project brought online by the IRP models before 2013 and assume Avista system interconnection cost of approximately $150 per kW. Actual wind resource cost will vary depending on a project's capacity factor, interconnection point, and the tax incentive eligibility. Further, this plan assumes that any wind resources selected in the PRS include the 20 percent renewable energy credit (REC) apprenticeship adder for Washington State eligible renewable resources. This adder applies only in the state of Washington for compliance in meeting its Energy Independence Act (I-937), requiring 15 percent of the construction labor to be apprentice through a state-certified apprenticeship program to qualify. The costs shown below do not reflect the consumption of (i.e., wind integration) or lack of ancillary services generated by wind relative to other generation technologies.

Table 6.4: Northwest Wind Project Levelized Costs per MWh

Item	On-System	Off-System	Off-System Montana
Capital Recovery and Taxes	77.59	73.98	58.40
AFUDC	8.19	7.80	6.16
Federal Tax Incentives (2012 only)	-23.93	-22.82	-18.01
Fuel Costs	-	-	-
Fuel Transport	-	-	-
Greenhouse Gas Emissions Adder	-	-	-
Fixed O&M	27.59	26.31	22.37
Variable O&M	2.76	2.76	2.76
Interconnection Capital Recovery	7.99	18.67	26.78
Excise Taxes and Other Overheads	1.66	2.07	2.25
Total Cost (without tax incentive)	**125.78**	**131.60**	**118.72**
Total Cost (with tax incentive)	**101.85**	**108.78**	**100.71**

Solar

Solar generation technology costs have fallen substantially in the last several years owing to help from renewable portfolio standards and government tax incentives, both inside and outside of the United States. Solar costs in this IRP are 27 percent lower than in the 2009 IRP. Even with these large cost reductions, solar still is uneconomic when compared to other generation resources because of its low capacity factor and still-high capital cost. Solar does provide predictable on-peak generation that generally complements the loads of summer-peaking utilities.

Utility-scale photovoltaic generation can be optimally located for the best solar radiation. Solar thermal can produce a higher capacity factor than photovoltaic projects (up to 30 percent) and can store energy for several hours. Capital costs in the IRP, including AFUDC, for solar generation technologies are $5,802 per kW for photovoltaic and $5,538 for solar-thermal or concentrating solar projects. A well-placed utility-scale photovoltaic system located in the Pacific Northwest would achieve a capacity factor of less than 20 percent. Two solar technologies were studied for this IRP (photovoltaic and solar-thermal), but only utility-scale photovoltaic was included as an option for the PRS.

Avista does not believe that solar-thermal is an economically viable option in Avista's service territory given our modest solar resource.

The levelized costs of solar resources, including federal incentives, are in Table 6.5. Even with declining prices, solar will continue to struggle as a cost-competitive resource in the Northwest until technology improves capacity factors, installation costs decline at a more rapid pace, or government entities create further policies or tax incentives to make this resource more attractive. One advantage solar has in the state of Washington is if the total plant is less than five megawatts it can generate two RECs that qualify for the Washington State Energy Independence Act for every megawatt hour of generation.

Table 6.5: Solar Nominal Levelized Cost ($/MWh)

Item	Photovoltaic	Concentrating
Capital Recovery and Taxes	370.14	201.85
AFUDC	29.49	22.44
Federal Tax Incentives	(117.60)	(64.58)
Fuel Costs	-	-
Fuel Transport	-	-
Greenhouse Gas Emissions Adder	-	-
Fixed O&M	39.73	30.00
Variable O&M	-	1.38
Interconnection Capital Recovery	1.67	9.75
Excise Taxes and Other Overheads	1.79	1.78
Total Cost (without tax incentive)	**442.82**	**267.20**
Total Cost (with tax incentive)	**325.22**	**202.62**

Coal

The coal generation industry is at a crossroads. In many states, like Washington, new coal-fired generation is unlikely due to emissions performance standards.[2] In other parts of the country, coal remains a viable option, but the risks associated with future carbon legislation make investments in this technology potentially subject to significant upward price pressures. Avista assumes it will not build any new coal-fired generation resources due to the risk of future national carbon mitigation legislation and the effective prohibition in Washington state law. Technologies reducing or capturing greenhouse gas emissions in coal-fired resources might enable coal to become a viable technology in the future, but the technology is not commercially available. Although Avista will not pursue coal in this plan, three coal technologies are shown to illustrate their costs: super critical pulverized, integrated gasification combined cycle (IGCC), and IGCC with sequestration. IGCC plants gasify coal, thereby creating a more efficient use of the fuel lowering carbon emissions and removing other toxic substances before combustion. Sequestration technologies, if they become commercially available, might potentially sequester 90 percent of carbon dioxide (CO_2) emissions, effectively reducing CO_2

[2] The Washington State legislature passed Senate Bill 6001 in 2007, effectively prohibiting in-state electric utilities from developing coal-fired facilities that do not sequester emissions or purchasing long-term contracts from coal-fired facilities.

emissions from 205 pounds per MMBtu to 20.5 pounds per MMBtu. Table 6.6 shows the costs, heat rates, and CO_2 emissions of the three coal-fired technologies based on estimates from the NPCC's Sixth Power plan and adjusted for Avista's projected inflation rates. Table 6.7 shows the nominal levelized cost per MWh based on the capital costs and plant efficiencies shown in Table 6.6.

Table 6.6: Coal Capital Costs (2012$)

Technology	Capital Cost ($/kW includes AFUDC)	Heat Rate (Btu/kWh)	CO_2 (lbs/MMBtu)
Super-Critical	3,583	8,910	205
IGCC	4,001	8,594	205
IGCC with Sequestration	5,334	10,652	25

Table 6.7: Coal Project Levelized Cost per MWh

Item	Super-Critical	IGCC	IGCC w/ Sequestration
Capital Recovery and Taxes	56.82	64.70	86.27
AFUDC	9.66	13.06	17.41
Federal Tax Incentives	0.00	0.00	0.00
Fuel Costs	14.28	13.77	17.07
Fuel Transport	0.00	0.00	0.00
Greenhouse Gas Emissions Adder	30.00	28.93	4.30
Fixed O&M	11.87	12.10	12.10
Variable O&M	3.80	8.70	11.74
Interconnection Capital Recovery	10.31	10.46	4.79
Excise taxes and Other Overheads	3.04	3.20	2.16
Total Cost	**139.79**	**154.94**	**155.86**

Other Generation Resource Options

A thorough IRP considers generation resources that are not generally available in large quantities or those not commercially or economically ready for utility-scale development, but may be over the 20-year IRP planning horizon. This is particularly true for some emerging technologies that are attractive from an environmental perspective, but are currently higher-cost than other resources. Avista analyzed the following resources for this IRP using estimates from the NPCC's Sixth Power Plan but did not select them for the Preferred Resource Strategy: biomass, geothermal, co-generation, nuclear, landfill gas, and anaerobic digesters. It is possible that these resources could compete with those assumed in the IRP. If so, Avista's RFP processes will identify them and their selection will displace resources otherwise included in the IRP strategy. The expected cost of these resource options per MWh is in Table 6.8 and Table 6.9.

Woody Biomass

Avista's Kettle Falls Generation Station is a 50 MW wood-fired plant Avista built and has operated since 1983. The viability of another Avista biomass projects depends substantially on the availability and cost of the fuel supply. Many announced biomass projects fail because of problems securing long-term fuel sources. Where an RFP identifies a potential project, Avista will consider it for a future acquisition.

Geothermal

Northwest utilities have developed an increased interest in geothermal energy over the past several years. Geothermal energy provides renewable capacity and energy with minimal carbon dioxide emissions (zero to 200 pounds per MWh). The federal government has extended production tax credits to this technology through December 31, 2013. Geothermal energy struggles due to high upfront development costs and risks stemming from drilling several holes thousand feet below the earth's crust; each hole can cost over $3 million. Geothermal costs are low once drilling ends, but the risk capital required to locate and prove a viable site is significant. Costs shown in this section do not account for dry-hole risk associated with sites that do not prove to be viable resources after drilling has taken place.

Landfill Gas

The Northwest has successfully developed landfill gas resources. The Spokane area had a project, but it was retired after the fuel source depreciated to an unsustainable level. Based upon costs from the NPCC, landfill gas resources are economically promising, but are limited in their size, quantity, and location.

Anaerobic Digesters (Manure/Wastewater Treatment)

Like landfill gas, the number of anaerobic digesters is increasing in the Northwest. These plants typically capture methane from agricultural waste, such as manure or plant residuals, and burn the gas in reciprocating engines to power electricity generators. These facilities tend to be significantly smaller than utility-scale generation projects (less than five MW). A survey of Avista's service territory found no large-scale livestock operations capable of implementing this technology.

Wastewater treatment facilities can host anaerobic digesters. Digesters installed when a facility is constructed helps the economics of a project greatly, though costs range greatly depending on the system configuration. Retrofits to existing wastewater treatment facilities are possible, but tend to have higher costs. Many of these projects offset energy needs of the facility, so there may be little, if any, surplus generation capability.

Small Cogeneration

Avista has relatively few industrial customers capable of developing cost-effective cogeneration projects. If an interested customer was inclined to develop a small cogeneration project, it could provide benefits including reduced transmission and distribution losses, shared fuel/capital/emissions costs, and credit toward Washington's I-937 targets. The PRS does not include small cogeneration; where a customer pursues this resource, Avista will consider it along with other generation options.

Nuclear

Nuclear plants are not a resource option in the IRP given the uncertainty of their economics, the apparent lack of regional political support for the technology, U.S. policy implications, and the negative experience Avista had with its participation in WNP-3 in the 1980s. Like coal plants, nuclear resources could be in Avista's future because other utilities in the Western Interconnect may be able to incorporate nuclear power in their resource mix and offer Avista an ownership share. Given these considerations, Avista does not include any nuclear generation in its Preferred Resource Strategy. The viability of nuclear power could change as national policy priorities focus attention on de-carbonizing the nation's energy supply. Nuclear capital costs are difficult to forecast, as there have been no new nuclear facilities built in the United States since the 1980s. Projected costs are from industry studies and recent nuclear plant license proposals.

Table 6.8: Other Resource Options Levelized Costs

	Landfill Gas	Manure Digester	Waste Water Treatment
Capital Recovery and Taxes	31.56	67.15	63.40
AFUDC	2.45	4.66	4.88
Federal Tax Incentives	-8.49	-8.49	-8.49
Fuel Costs	32.66	0.00	0.00
Fuel Transport	0.00	0.00	0.00
Greenhouse Gas Emissions Adder	0.00	0.00	0.00
Fixed O&M	4.87	8.42	7.07
Variable O&M	26.25	33.16	41.45
Interconnection Capital Recovery	4.54	4.54	0.34
Excise Taxes and Other Overheads	2.96	2.00	2.11
Total Cost	**96.80**	**111.45**	**110.76**

Table 6.9: Other Resource Options Levelized Costs ($/MWh)

	Small Co-Gen	Wood Biomass	Geothermal	Nuclear
Capital Recovery and Taxes	53.91	57.59	65.86	97.88
AFUDC	5.36	6.02	11.39	27.26
Federal Tax Incentives	0.00	-8.49	-16.98	-16.98
Fuel Costs	30.60	53.59	0.00	10.36
Fuel Transport	3.19	0.00	0.00	0.00
Greenhouse Gas Emissions Adder	8.56	0.00	4.63	0.00
Fixed O&M	0.00	34.80	32.16	16.85
Variable O&M	11.05	5.11	6.22	1.38
Interconnection Capital Recovery	0.36	4.65	4.49	4.55
Excise Taxes and Other Overheads	2.33	4.25	2.06	1.43
Total Cost	**115.36**	**157.52**	**109.83**	**142.72**

New Resources Cost Summary

Avista has several resource alternatives to select from for this IRP. Each provides differing benefits, costs, and risks. The role of the IRP is to identify the relevant characteristics and choose a set of resources that are actionable, meet customer's energy and capacity needs, balance renewable energy requirements, and minimize customer costs. Figure 6.1 shows the comparative cost per MWh of each of the new resource alternatives. Tables 6.13 and 6.14 provide detailed assumptions for each type of resource. The ultimate resource selection goes beyond simple levelized cost analyses and considers the capacity contribution (or lack thereof for wind and solar) of each resource, among other items discussed in the IRP.

Figure 6.1: New Resource Levelized Costs

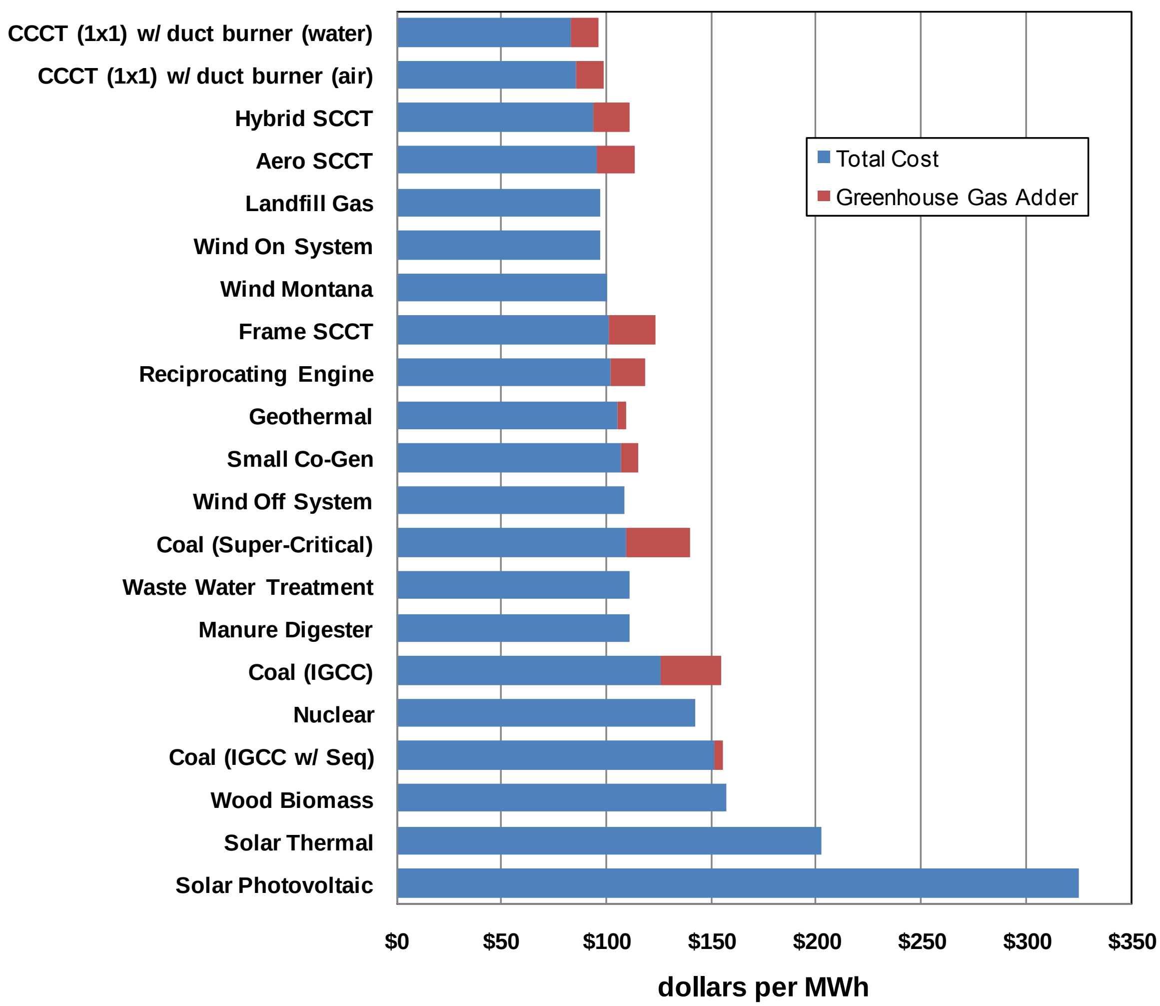


Table 6.10: New Resource Levelized Costs Considered in PRS Analysis

Resource	Size (MW)	Heat Rate (Btu/ kWh)	Capital Cost ($/kW)	Fixed O&M ($/kW-yr)	Variable O&M ($/MWh)	Peak Credit (Winter/ Summer)
CCCT (water cooled)	275	6,722	1,261	16.1	2.14	104/96
CCCT (air cooled)	270	6,856	1,324	16.1	1.91	104/96
Frame CT	83	11,841	708	12.7	1.13	104/96
Hybrid CT	94	8,782	1,326	9.2	5.63	104/96
Reciprocating Engines	99	8,762	1,364	15.0	11.25	100/100
Aero CT	46	9,276	1,237	15.0	4.50	104/96
Wind (on-system)	40	n/a	1,896	51.4	2.25	0/0
Wind (off-system)	40	n/a	1,896	51.4	2.25	0/0
Solar (photovoltaic)	5	n/a	6,092	46.8	0.00	5/60

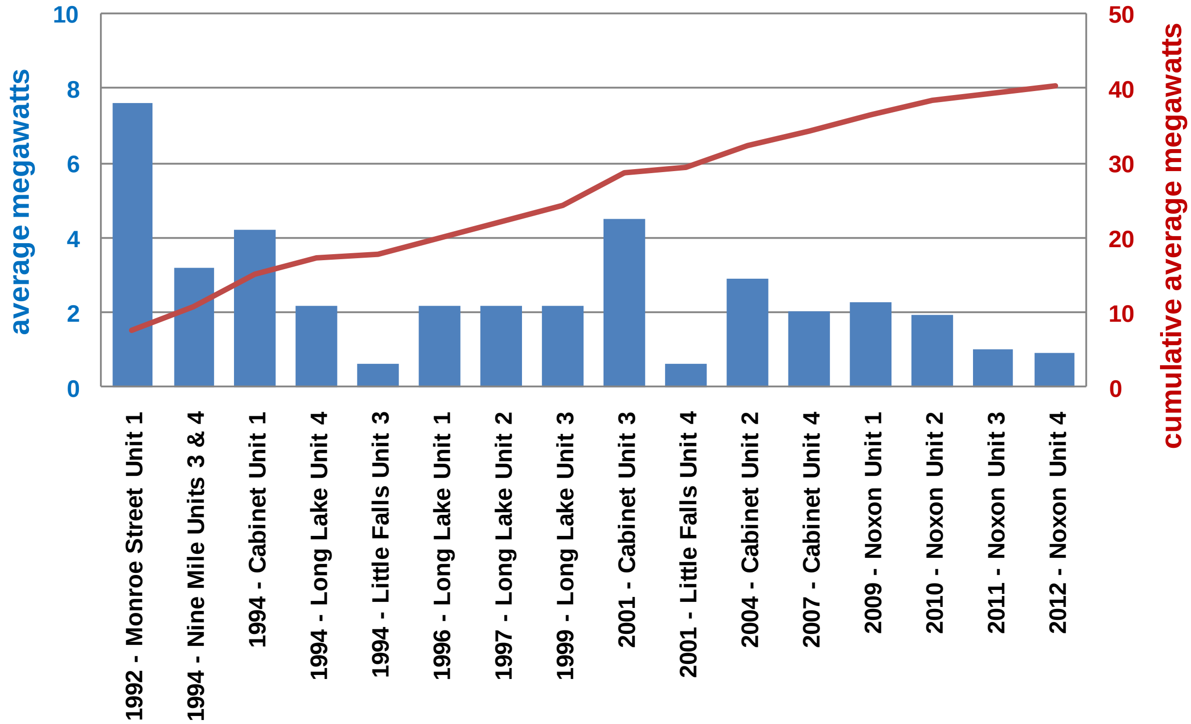
Table 6.11: New Resource Levelized Costs Not Considered in PRS Analysis

Resource	Size (MW)	Heat Rate (Btu/ kWh)	Capital Cost ($/kW)	Fixed O&M ($/kW-yr)	Variable O&M ($/MWh)	Peak Credit (Winter/ Summer)
Pulverized Coal	300	8,910	3,583	69.0	3.09	100/100
IGCC Coal	300	8,594	4,001	69.0	7.09	105/95
IGCC Coal w/ Seq.	250	10,652	5,334	69.0	9.56	100/100
Solar (thermal)	25	n/a	5,646	69.0	1.13	5/100
Wind (off-system MT)	40	n/a	1,760	51.4	2.25	0/0
Woody Biomass	25	13,500	4,170	207.0	4.16	100/100
Geothermal	15	n/a	5,017	201.3	5.06	110/90
Landfill Gas	3.2	10,600	2,285	29.9	21.38	100/100
Manure Digester	0.85	10,250	4,862	51.8	27.01	100/100
Wastewater Treatment	0.85	10,250	4,862	46.0	33.76	100/100
Small Co-Generation	5	4,456	3,922	0.0	9.00	104/96
Nuclear	500	10,400	6,522	103.5	1.13	100/100

Hydroelectric Project Upgrades

Avista continues to upgrade many of its hydroelectric facilities. The latest hydroelectric upgrade added nine MW to the Noxon Rapids Development in April 2011. Upgraded Noxon Rapids Unit 4 will enter service in April 2012. Figure 6.1 shows the history of upgrades to Avista's hydroelectric system in additional average megawatts by year and cumulatively. Avista will have added 40.1 aMW of incremental hydroelectric energy between 1992 and 2013.

Figure 6.2: Historical and Planned Hydro Upgrades



Following upgrades at Noxon Rapids, Avista expects to pursue an upgrade at Nine Mile and annual upgrades to the Little Falls project over a four-year period. The Little Falls upgrades will include new turbine runners, generators, and other electrical equipment. The upgrade at Nine Mile could be a new powerhouse or a replacing the current units. Several other potential hydroelectric upgrades might add capacity and energy at the Long Lake, Cabinet Gorge, Post Falls, and Monroe Street projects. These upgrades are not included in the portfolio analysis and no estimated costs are in this IRP because further study is required. Such studies are part of the IRP's Action Plan. Table 6.8 shows the hydroelectric upgrade studies. Large hydro upgrades can help meet Avista's renewable energy goals under I-937, benefit from federal tax incentives, and help mitigate dissolved gases.

Table 6.12: Hydro Upgrade Potential

Plant	Potential Capacity (MW)	Potential Energy (aMW)
Upper Falls	2	1
Long Lake Second Powerhouse	60 - 120	18 - 20
Cabinet Gorge Second Powerhouse	50	7
Post Falls New Powerhouse	19	4
Monroe Street Second Powerhouse	38	16

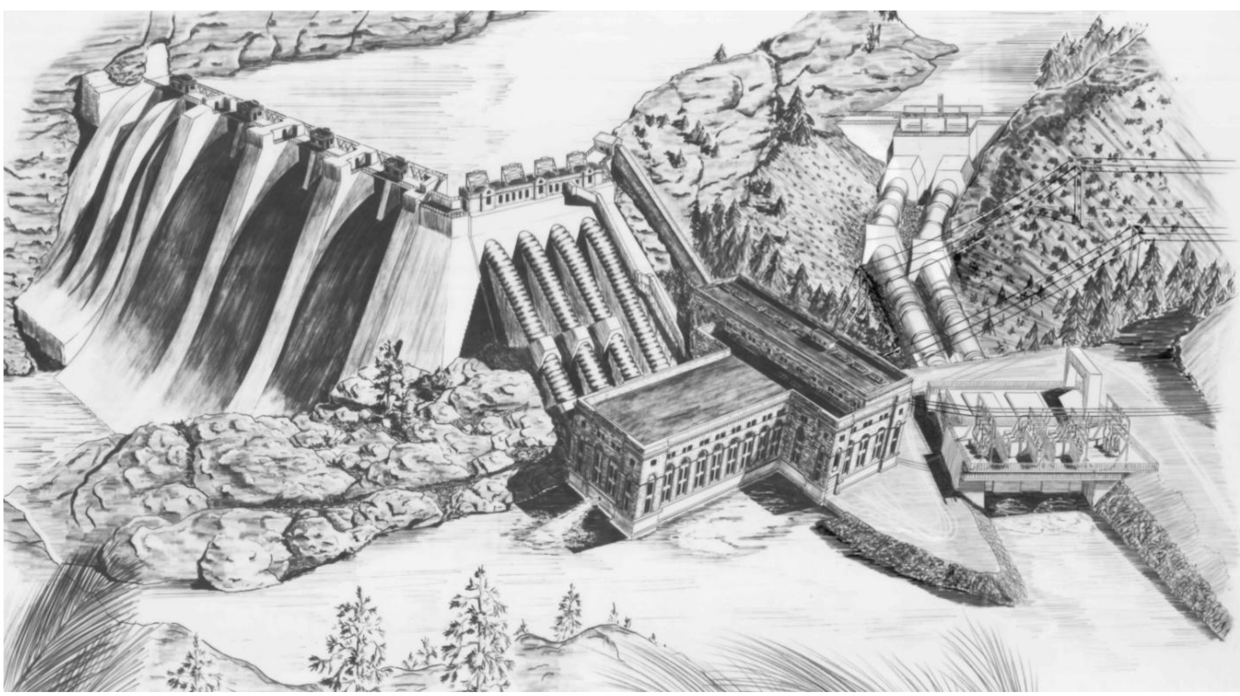
Upper Falls

The Upper Falls hydroelectric upgrade would consist of replacing the single unit's turbine runner and modifying the existing draft tube to improve efficiency. Initial costs estimates are $7 million or $3,500 per kW, for an additional two MW of capacity and 8,760 MWh of energy. This upgrade would require FERC licensing changes and help meet Avista's I-937 renewable energy goals.

Long Lake Second Powerhouse

Avista studied a second powerhouse at Long Lake about 20 years ago using a small arch dam located on the south end of the project site. See Figure 6.3 for a concept of the project. The potential cost of this resource could exceed $120 million and provide an additional 158,000 to 178,000 MWh of energy per year and 60 to 120 MW of added capacity. This project would be a major undertaking and would take several years to complete. It would require major changes to the Spokane River license, but could help reduce total dissolved gas concerns by reducing spill at the project. The incremental capacity would also help meet future winter peak loads, but may not contribute greatly to summer peak needs. The incremental energy might qualify under I-937.

Figure 6.3: Long Lake Second Powerhouse Concept Drawing



Cabinet Gorge Second Powerhouse

Avista is exploring the addition of a second powerhouse at the Cabinet Gorge project site to mitigate total dissolved gas. A new powerhouse would benefit from an existing diversion tube around the dam. The potential cost of this resource could be as high as $115 million. The new powerhouse could provide 57,000 MWh of additional energy per year, and 50 MW of additional capacity. This project would be a major engineering project, take several years to complete, and require major changes to the Clark Fork River FERC license. As with the other potential hydroelectric upgrade projects, this project might help Avista meet its I-937 renewable energy goals.

Post Falls Refurbishment

The Post Falls hydroelectric project is 105 years old. An upgrade to this project includes a total rebuild of the powerhouse and equipment while leaving the exterior intact. The project would remove the existing horizontal units, replacing them with higher efficiency and higher capacity vertical units. The cost of this upgrade could be as high as $75 million. It would add 33,000 MWh of energy each year and provide an additional 19 MW of capacity. Like the other potential hydroelectric projects, this would require a reopening of the Spokane River FERC license and might help meet Avista's I-937 renewable energy goals.

Monroe Street Second Power House

Avista replaced the powerhouse at its Monroe Street project on the Spokane River in 1992. An upgrade option would include the addition of a new powerhouse to capture additional flows and be a major undertaking requiring substantial cooperation with the city because of disruption in the Riverfront Park and downtown Spokane area during construction. This project would require dredging the river on the western edge of the park and creating a tunnel between city hall and the Monroe street substation. The expected cost for this project would be $95 million, and it could create an additional 142,000 MWh of energy per year and 37.5 MW of incremental capacity. The incremental generation of the upgraded facility might help meet Avista's I-937 renewable energy goals.

Thermal Resource Upgrades

Several upgrade opportunities exist in Avista's thermal fleet that would add capacity and/or increase operating efficiency. Avista plans an economic viability study for each option prior to the 2013 IRP. The following is a list of potential upgrades to the Rathdrum and Coyote Springs 2 projects that the Avista may consider. Table 6.9 is a summary of the nominal levelized costs of each of the upgrade options for the Rathdrum CT and Table 6.10 provides nominal levelized costs for the Coyote Springs 2 upgrade options.

Rathdrum CT to CCCT Conversion

The Rathdrum CT has two GE 7EA units in simple cycle configuration built in 1994 with an approximate 160 MW of combined output used to serve customers in peak load conditions. It is possible to convert this peaking facility to a combined cycle plant by adding between 78 and 91 MW of steam-turbine capacity (depending upon temperature) and increasing its operating efficiency from a heat rate of 11,612 Btu/kWh, in its existing configuration, to a heat rate of about 7,986 Btu/kWh. The capital cost for this upgrade is $81.5 million. Two major issues challenge this conversion. The first is cooling water. Avista does not have water rights adequate to cool the plant with water. Therefore, it is likely that air-cooling at the plant is necessary at higher cost. The second major issue is noise. Major residential development now exists at the plant site. Given these concerns, this option is not in the PRS.

Rathdrum CT Water Demineralizer

Another potential upgrade at Rathdrum is to add a water demineralizer to allow inlet fogging in the summer. This upgrade would increase plant capacity by 17.6 MW and increase its operating efficiency by 0.5 percent on hot summer days. The upgrade will cost approximately $1 million.

Table 6.13: Rathdrum CT Upgrade Options ($/MWh)

	Rathdrum CT: Convert to CCCT (Air Cooled)	Rathdrum CT: Convert to CCCT (Water Cooled)	Rathdrum CT: Add Demineralizer
Capital recovery and taxes	18.62	15.39	4.92
AFUDC	1.94	1.61	0.08
Federal Tax Incentives	0.00	0.00	0.00
Fuel Costs	54.31	53.25	80.89
Fuel Transport	5.53	5.42	8.06
Greenhouse Gas emissions adder	15.19	14.90	22.63
Fixed O&M	2.45	2.45	0.00
Variable O&M	1.62	1.87	1.24
Interconnection capital recovery	0.54	0.54	0.00
Other Emissions	0.00	0.00	0.00
Excise taxes and other overheads	3.45	3.39	4.88
Total Cost	**103.64**	**98.80**	**122.72**

Coyote Springs 2 Inlet Chiller

There are two potential inlet chiller options for increasing summer capacity at the Coyote Springs 2 CCCT plant in Boardman, Oregon. One option is to add an inlet chiller to cool the air going into the machine; the second option is to add a thermal unit in addition to a chiller to optimize chiller operations. Avista estimates this upgrade to add 30 MW of capacity on a 100-degree day at a cost of $10 million. Adding the thermal storage technology capacity in conjunction with an inlet chiller would increase plant capacity by an additional 2.2 MW for an additional $1.0 million.

Coyote Springs 2 Cold Day Controls

Another upgrade option at the Coyote Springs 2 plant is to install an upgraded CT control system to increase its operating performance on cold days. This software upgrade could increase capacity by 17.6 MW on a zero-degree day at an estimated cost of $4.5 million.

Coyote Springs 2 Advanced Hot Gas Path Components
Coyote Springs 2 could benefit from the installation of advanced hot gas path components. This upgrade could add approximately 8 MW of capacity around the year and increase efficiency by one percent. The estimated cost for this upgrade is $18 million with additional annual plant maintenance costs of $3.9 million.

Coyote Springs 2 Cooling Optimization Hardware
Adding cooling optimization hardware to Coyote Springs may add 2.6 MW of capacity around the year and improve plant efficiency by 0.5 percent. The estimated cost of this project is $7.2 million.

Table 6.14: Coyote Springs 2 Upgrade Options ($/MWh)

	Inlet Chiller	Inlet Chiller & Thermal Storage	Cold Day Controls	Enhanced Hot Gas Path Comp.	Optional Cooling Package
Capital recovery and taxes	53.23	55.79	20.20	17.41	47.12
AFUDC	0.91	0.95	0.17	0.30	0.80
Federal Tax Incentives	-	-	-	-	-
Fuel Costs	46.42	46.42	46.42	45.91	46.19
Fuel Transport	4.53	4.53	4.53	4.67	4.70
Greenhouse Gas emissions adder	12.99	12.99	12.99	12.84	12.92
Fixed O&M	-	-	-	36.10	-
Variable O&M	-	-	-	-	-
Interconnection capital recovery	4.32	4.32	4.32	4.44	4.44
Other Emissions	-	-	-	-	-
Excise taxes and other overheads	2.95	2.96	2.96	4.50	2.95
Total Cost	**125.35**	**127.96**	**91.60**	**126.18**	**119.13**

7. Market Analysis

Introduction

This section describes the electricity and natural gas market environment developed for the 2011 IRP. Contained in this chapter are risks Avista considers when meeting customer demands at lowest reasonable cost. The analytical foundation for the 2011 IRP is a fundamentals-based electricity model of the entire Western Interconnect. The market analysis compares potential resource options on their net value when operated in the wholesale marketplace, rather than on the simple summation of their installation, operation, maintenance, and fuel costs. The Preferred Resource Strategy (PRS) analysis uses these net values when selecting future resource portfolios.

Understanding market conditions in the geographic areas of the Western Interconnect is important, because regional markets are highly correlated because of large transmission linkages between load centers. This IRP builds on prior analytical work by maintaining the relationships between the various sub-markets within the Western Interconnect, and the changing values of company-owned and contracted-for resources. The backbone of the analysis is AURORAxmp, an electric market model that dispatches resources to loads across the Western Interconnect with given fuel prices, hydroelectric conditions, and transmission and resource constraints. The model's primary outputs are electricity prices at key market hubs (e.g., Mid-Columbia), resource dispatch costs and values, and greenhouse gas emissions.

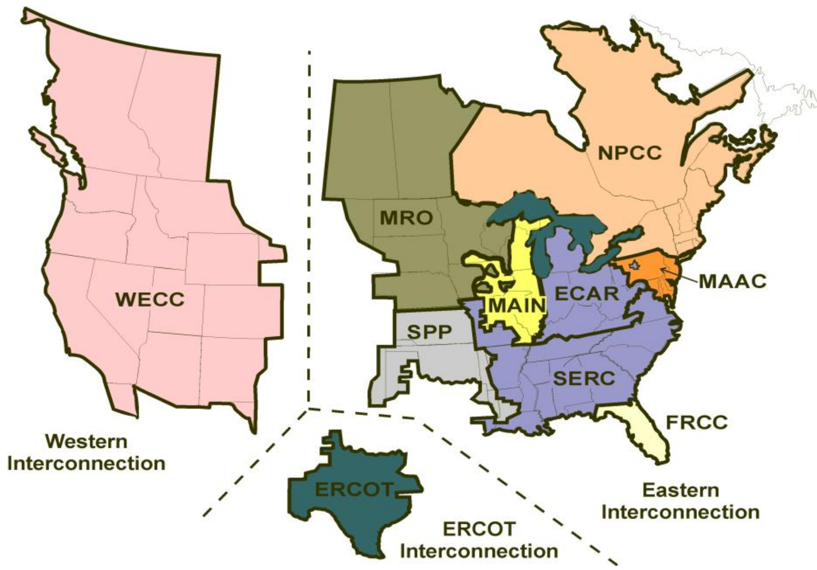
Section Highlights

- Gas and wind resources dominate new generation additions in the West.
- Shale gas lowers gas and electricity price forecasts from the previous IRP.
- A growing Northwest wind fleet reduces springtime market prices below zero in some hours.
- Federal greenhouse gas policy is uncertain; the IRP quantifies this uncertainty by modeling four different mitigation regimes.
- The Expected Case reduces Western Interconnect greenhouse gas emissions by 28 percent (18 percent from current levels) relative to a case without a carbon mitigation regime.
- Carbon mitigation policy increases Western Interconnect costs by $3.5 billion annually.

Marketplace

AURORAxmp is a fundamentals-based modeling tool used by Avista to simulate the Western Interconnect electricity market. The Western Interconnect includes the states west of the Rocky Mountains, the Canadian provinces of British Columbia and Alberta, and the Baja region of Mexico as shown in Figure 7.1. The modeled area has an installed resource base of approximately 240,000 MW.

Figure 7.1: NERC Interconnection Map



The Western Interconnect is separated from interconnects to the east and ERCOT except by eight inverter stations. The Western Interconnect follows operation and reliability guidelines administered by the Western Electricity Coordinating Council (WECC).

The Western Interconnect electric system is divided into 16 AURORAxmp modeling zones based on load concentrations and transmission constraints. After extensive study in the 2009 IRP, Avista models the Northwest region as a single zone because this configuration dispatches resources in a manner most reflective of historical operations. Table 7.1 describes the specific zones modeled in this IRP.

Table 7.1: AURORA^{XMP} Zones

Northwest- OR/WA/ID/MT	Southern Idaho
Eastern Montana	Wyoming
Northern California	Southern California
Central California	Arizona
Colorado	New Mexico
British Columbia	Alberta
North Nevada	South Nevada
Utah	Baja, Mexico

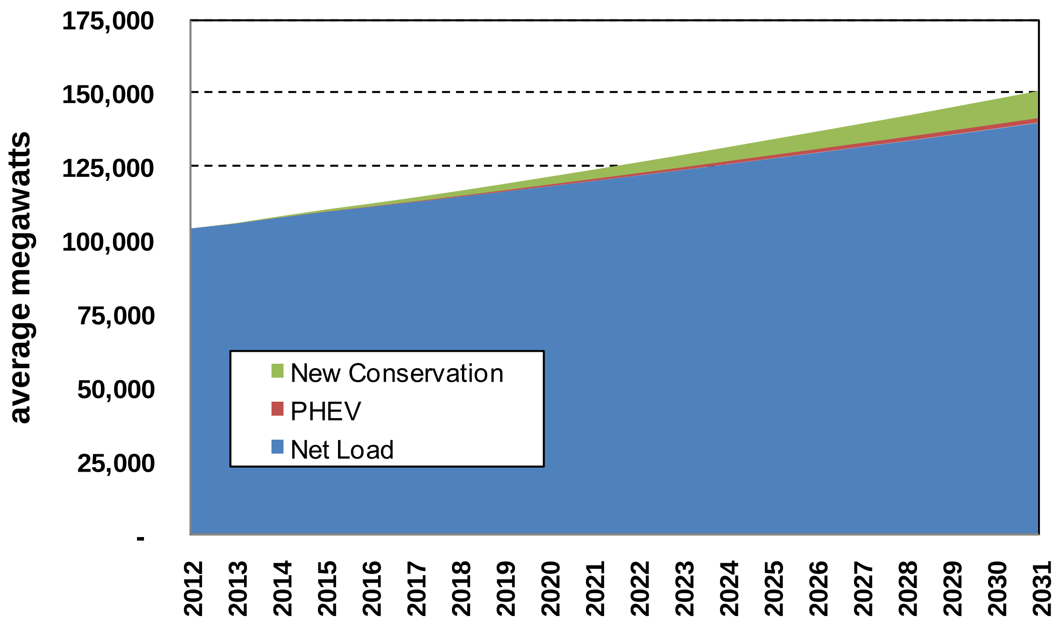
Fundamentals-based electricity models range in their abilities to emulate power system operations accurately. Some models account for every bus and transmission line, while other models utilize regions or zones. An IRP requires regional price and plant dispatch information but does not require detailed modeling at the bus level.

Western Interconnect Loads

The 2011 IRP relies on a load forecast for each zone of the Western Interconnect. Avista uses external sources to quantify load growth estimates across the west. These load estimates include impacts of increasing energy efficiency and demand destruction caused by potential emissions legislation and the associated price increases expected to reduce loads over time from their present trajectory.

Specific regional load growth levels are in Table 7.2. Avista projects that overall Western Interconnect loads rise 1.65 percent annually over the next 20 years, from 103,840 aMW in 2012 to 141,654 aMW in 2031. Included in this forecast are rising plug-in electric vehicle (PHEV) loads. Load growth rates without PHEV would be 1.57 percent. Absent conservation efforts, Western Interconnect loads are 9,000 aMW higher in 2031. Figure 7.2 illustrates the load forecast and the impacts of new conservation and PHEVs. The Northwest grows more slowly than the Western Interconnect at large. Loads rise one percent per year over the IRP timeframe.

Figure 7.2: 20-Year Annual Average Western Interconnect Energy



Transmission

The IRP reflects various regional transmission projects announced over the past several years. Many of these projects move distant renewable resources to load centers in support of state-level renewable portfolio standards (RPS). Transmission upgrades included in the IRP are in Table 7.2. Transmission upgrades within AURORAxmp zones were not included explicitly in the model, as they do not affect power transactions between zones.

Table 7.2: Western Interconnect Transmission Upgrades Included in Analysis

Project	From	To	Year Available	Capacity MW
Canada – PNW Project	British Columbia	Northwest	2018	3,000
PNW – California Project	Northwest	California	2018	3,000
Eastern Nevada Intertie	North Nevada	South Nevada	2015	1,600
Gateway South	Wyoming	Utah	2015	3,000
Gateway Central	Idaho	Utah	2015	1,320
Gateway West	Wyoming	Idaho	2016	1,500
SunZia/Navajo Transmission	Arizona	New Mexico	2016	3,000
Wyoming – Colorado Intertie	Wyoming	Colorado	2013	900
Hemingway to Boardman	Idaho	Northwest	2019	1,500

New Resource Additions

An estimate for new resource capacity in the Western Interconnect is forecasted as part of the long-term electric market price forecast. It accounts for load growth and various other mandates. These additions meet capacity, energy, ancillary services, and renewable portfolio mandates. To meet capacity requirements, gas-fired CCCT or SCCT, solar, wind, coal IGCC, coal IGCC with sequestration, and nuclear were options were considered.[1] For the first time, Avista assumes that no new pulverized coal additions in the Western Interconnect over the forecast horizon.

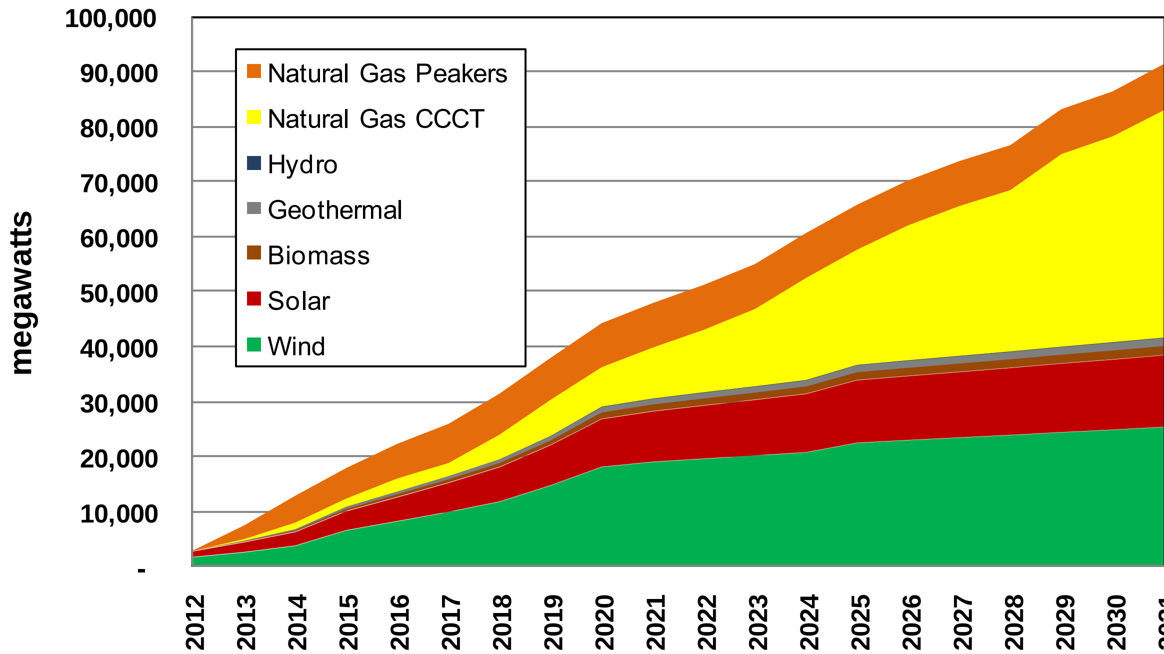
Many states have created RPS requirements promoting renewable generation to curb greenhouse gas emissions, provide jobs, and to diversify the energy mix of the United States. RPS legislation generally requires utilities to meet a portion of their load with qualified renewable resources. No federal RPS mandate exists presently; therefore, each state defines their RPS obligations differently. AURORAxmp cannot model RPS levels explicitly. Instead, Avista input RPS requirements into the model at levels satisfying state laws. Renewable resource portfolios adequate to meet Western Interconnect RPS obligations were input using work by the Northwest Power and Conservation Council (NPCC); these percentages formed the basis for RPS shortfalls in each state. Beyond the manually input RPS resources, the model selected no additional renewables.

Figure 7.3 illustrates new capacity and RPS additions made in the modeling process. Wind and solar facilities meet most renewable energy requirements.. Geothermal, biomass, and hydroelectric resources provide a more limited contribution to RPS needs. Renewable resource choices are modeled to differ by state depending on the requirements of state laws and the availability of renewable resources in a region. For example, the Southwest will meet RPS requirements with solar and wind given policy choices by those states. The Northwest will use a combination of wind and hydroelectric upgrades because the economic costs of these resources are the lowest. Rocky

[1] Wind receives a five percent capacity credit on a regional basis; it receives no capacity credit where selected to meet Avista requirements.

Mountain states will predominately use wind to meet RPS requirements, again due to the fact that wind is the least-cost renewable resource modeled in the IRP.

Figure 7.3: New Resource Added (Nameplate Capacity)



Fuel Prices and Conditions

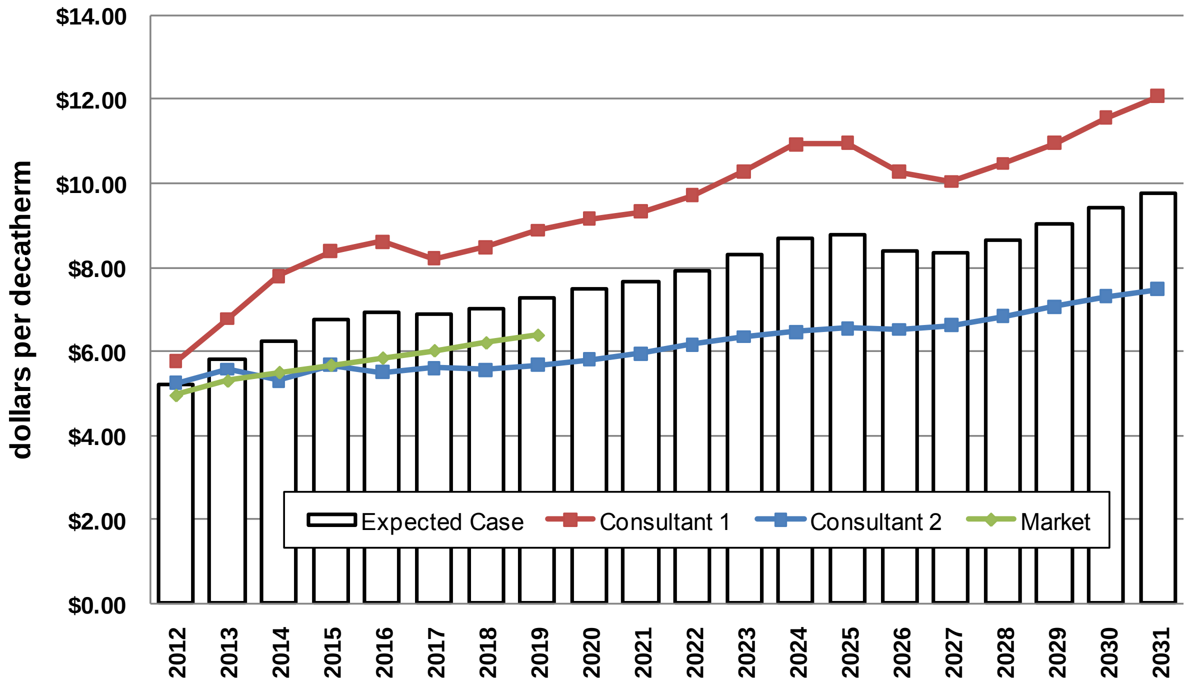
Fuel cost and availability are some of the most important drivers of resource values. Some resources, including geothermal and biomass, have limited fuel options or sources, while coal and natural gas have more fuel sources. Hydro and wind use free fuel sources, but are highly dependent on weather.

Natural Gas

The fuel of choice for new base load and peaking capability continues to be natural gas. Natural gas is subject to price volatility, though increasing unconventional sources may reduce future volatility. Avista uses forward market prices and a combination of two forecasts from prominent energy industry consultant to develop its natural gas price forecast for this IRP.[2] The forecast uses an equal weighting of the consultant forecasts and forward prices in 2012.[3] After 2012, the weighting of forward prices fell by 10 percent each year through 2016. After 2016, the forecast includes a 50/50 weighting of the two consultant forecasts. For example, in 2015 the price forecast is a weighted average of the market (20 percent), Consultant 1 (40 percent) and Consultant 2 (40 percent). The long-term forecasts include impacts of potential national carbon legislation. Carbon legislation will increase demand for natural gas as generation shifts away from coal. Figure 7.4 shows the price forecast for Henry Hub; the levelized nominal price is $7.30 per Dth. The forecast without carbon legislation is $6.78 per Dth.

[2] Consultant forecasts as of December 2010.
[3] The 50 percent weighting applies to the average of the two consultant forecasts.

Figure 7.4: Henry Hub Natural Gas Price Forecast



The forecast from Consultant 1 assumes a timely and moderate economic recovery and aggressive long term demand growth from the power sector in part due to an improved competitive position relative to coal. The forecast includes a modest federal carbon price of $14 per metric ton beginning 2016 and rising to $25/metric ton by 2025. This in turn results in accelerated coal retirements pressuring prices early in the forecast. A brief price respite occurs following carbon legislation but prices resume their build as competition for capital, equipment and labor from strong recovery in oil demand drive up gas drilling costs and supply growth from shale gas moderates. An Alaskan gas pipeline around 2026 produces a brief gas glut but is quickly absorbed and the uptrend in prices resumes.

The forecast from Consultant 2 assumes a more gradual and modest economic recovery including a more moderate rebound in power demand early in the forecast. Their outlook reflects an expectation of significant low cost supplies from shale gas resources that quickly respond to rising demand. The improved predictability of shale gas volumes and costs prompt active hedging by producers when prices escalate counteracting the trend and resulting in more stable pricing. This forecast does not include carbon legislation or an Alaskan natural gas pipeline.

Price differences across North America depend on demand at the trading hubs and the pipeline constraints between them. Many pipeline projects are in the works in the Northwest and the west to access historically cheaper gas supplies located in the Rocky Mountains. Table 7.3 presents western gas basin differentials from Henry Hub prices. Prices converge over the course of the study as new pipelines and new sources of gas come online. To illustrate the seasonality of natural gas prices, monthly Stanfield price shapes in Table 7.4 show various forecast years.

Table 7.3: Natural Gas Price Basin Differentials from Henry Hub

Basin	2012	2015	2020	2025	2030
Stanfield	93.4%	94.4%	90.3%	92.6%	90.6%
Malin	94.7%	95.7%	92.5%	94.9%	92.9%
Sumas	93.7%	94.6%	88.5%	90.5%	88.3%
AECO	89.1%	90.6%	86.3%	88.1%	85.8%
Rockies	93.6%	94.9%	90.6%	89.4%	87.2%
Southern CA	97.5%	99.3%	99.3%	100.0%	102.7%
Stanfield	93.4%	94.4%	90.3%	92.6%	90.6%

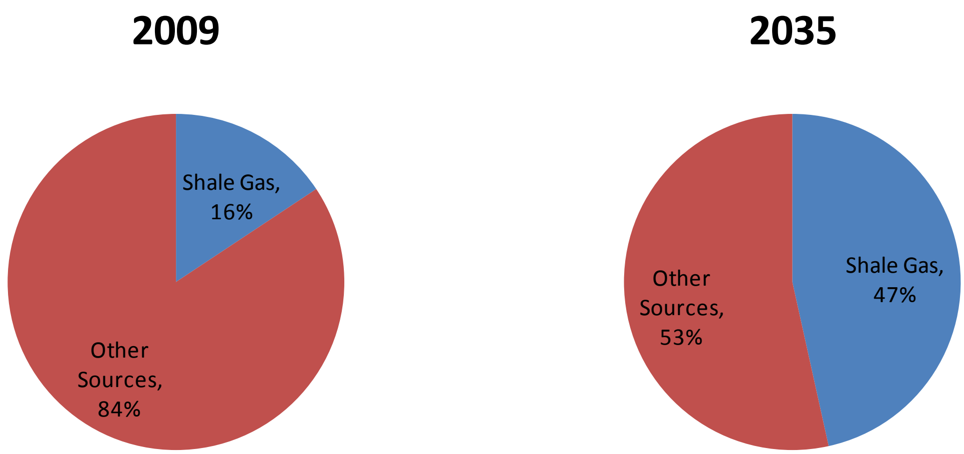
Table 7.4: Monthly Price Differentials for Stanfield

Month	2012	2015	2020	2025	2030
Jan	94.4%	95.9%	92.2%	94.7%	92.5%
Feb	94.4%	96.1%	92.0%	94.7%	92.5%
Mar	94.0%	95.6%	92.0%	94.3%	93.9%
Apr	92.6%	94.1%	89.4%	91.3%	90.0%
May	92.2%	93.1%	88.2%	90.4%	88.8%
Jun	92.3%	93.1%	88.2%	90.5%	88.5%
Jul	92.6%	92.9%	87.8%	90.0%	88.0%
Aug	92.7%	93.1%	88.0%	90.0%	88.3%
Sep	93.0%	93.9%	89.7%	92.1%	89.2%
Oct	93.3%	94.8%	90.6%	93.6%	90.4%
Nov	94.4%	95.0%	92.5%	95.3%	92.7%
Dec	94.9%	95.0%	92.7%	94.9%	92.5%

Unconventional Natural Gas Supplies

Shale natural gas production has game-changing impacts on the natural gas industry, dramatically revising the amount of economical natural gas production. Shale gas often is lower in cost than conventional natural gas production because of economies of scale, near elimination of exploration risks and standardized, sophisticated production techniques that streamline costs and minimize the time from drilling to market delivery. Shale gas could continue to greatly alter the natural gas marketplace, holding down both price and volatility over the long run as production quickly responds to changing market conditions. This in turn leads to numerous ripple effects, including longer-term bilateral hedging transactions, new financing structures including cost index pricing, and/or vertical integration by utilities choosing to limit their exposure to natural gas price increases and volatility through the acquisition of shale-gas reserves as illustrated by the recent purchase of reserves by Northwest Natural Gas Company. See Figure 7.5 for the projected change in contribution of shale to other sources of natural gas between 2009 and 2035.

Figure 7.5: Shale Gas Production Forecast[4]



Shale gas is not free of controversy. Concerns include water, air, noise, and seismic environmental impacts arising from unconventional extraction techniques. Water issues include availability, chemical mixing, groundwater contamination, and disposal. Air quality concerns stem from methane leaks during production and processing. Mitigating excessive noise in urban drilling and elevated seismic activity near drilling sites are also fomenting apprehension. State and federal agencies are reviewing the environmental impacts of this new production method. As a result, unconventional natural gas production in some areas has stopped. Increased environmental protections might increase costs and environmental uncertainty could precipitate increased price volatility.

Shale gas production influences the U.S. liquid natural gas (LNG) market. It has broken the link between North American natural gas global LNG prices. Numerous planned re-gasification terminals are on hold or cancelled. Some facilities now seek approvals to become LNG exporters rather than importers. These changes appear to affect gas storage and transportation infrastructure. For example, the Kitimat LNG export terminal in northern British Columbia, if built, will export significant LNG quantities to Asian markets. These exports will affect overall market conditions for natural gas in the United States and the Pacific Northwest.

Coal

As discussed earlier in this chapter, there are no new coal plants built for the Western Interconnect. Therefore, the coal price forecasts affect only existing coal facilities. Each plant's historical fuel costs escalate by rates contained in a consultant's study. The average annual price increase over the IRP timeframe is 1.4 percent. For the Colstrip facility, where Avista has access to project-specific information, Avista did not rely on the consultant study. Instead, it used an escalation rate based on existing contracts.

Woody Biomass

The future price and availability of woody biomass (or hog fuel) is critical to understanding the viability of new wood-fired facilities. Hog fuel availability is highly

[4] Source: Energy Information Administration (EIA)

dependent on overall lumber demand. Avista has operated its Kettle Falls wood-fired generator since 1983. When it was constructed, hog fuel was a waste product from area sawmills that procured at a near-zero cost. The plant had surplus fuel even into the mid-2000s, but has struggled since then to procure enough reasonably priced fuel because of the impacts of a recession on the housing market, and the resultant decrease in lumber demand. The IRP projects biomass prices in the west to extend from historical levels at a rate of three percent per year to reflect ongoing tight market conditions.

Hydroelectric

The Northwest and British Columbia have substantial hydroelectric generation capacity. A favorable characteristic of hydroelectric power is its ability to provide near-instantaneous generation up to and potentially beyond its nameplate rating. This characteristic is particularly valuable for meeting peak load demands, following general intra-day load trends, shaping energy for sale during higher-valued peak hours, and integrating variable generation resources. The key drawback to hydroelectricity is its output variability a month-to-month and year-to-year.

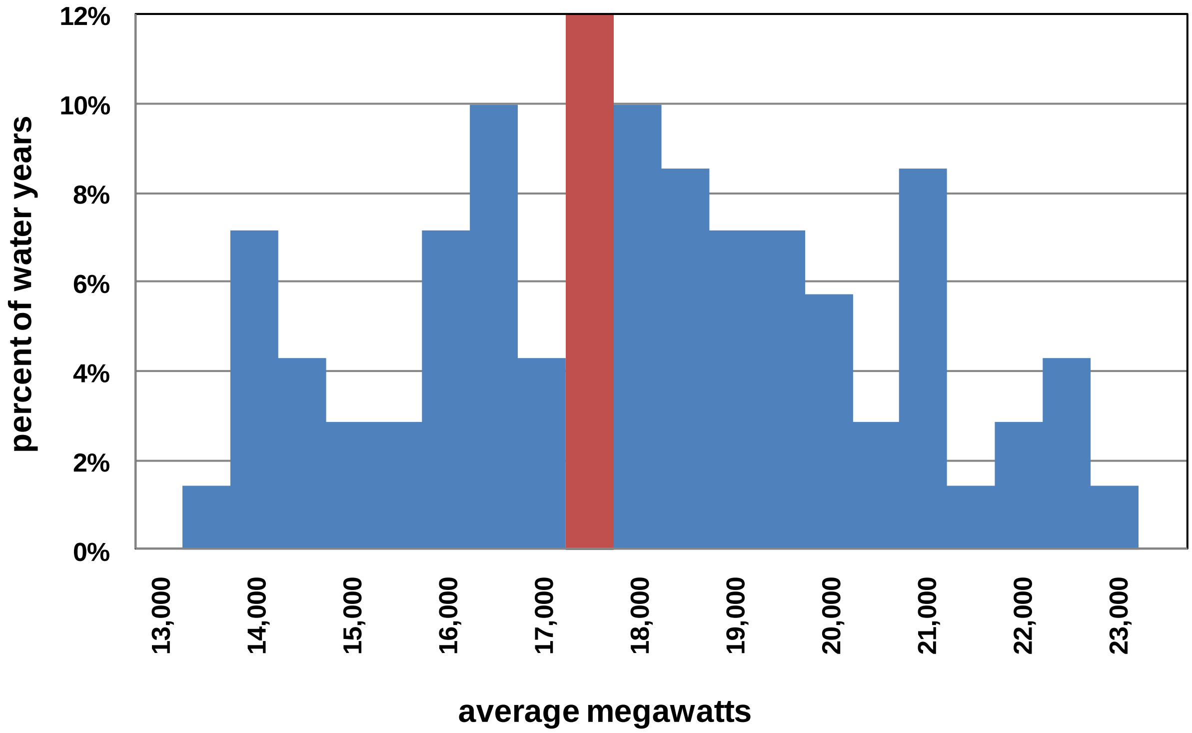
This IRP uses the results of the Northwest Power Pool's (NWPP) 2009-10 Headwater Benefits Study to model regional hydro availability. The NWPP study provides energy levels for each hydroelectric facility by month over a 70-year hydrological record spanning the years 1928 to 1999. British Columbia's hydroelectric plants are modeled using data from the Canadian government[5].

Many of the analyses in the IRP use an average of the 70-year hydroelectric record; whereas stochastic studies randomly draw from the 70-year record (see Risk Analysis later in this section), as the historical distribution of hydroelectric generation is not normally distributed. AURORAxmp maps each hydroelectric plant to a load zone.

For Avista hydroelectric plants, proprietary software provides a more detailed representation of operating characteristics and capabilities. Figure 7.6 shows average hydroelectric energy (in red) of 18,172 aMW in Washington, Oregon, Idaho, Western Montana, and British Columbia. The chart also show the range in potential energy used in the stochastic study, with a 10th percentile water year of 14,395 aMW (-21 percent), and a 90th percentile water year of 21,629 aMW (+40 percent).

[5] Statistics Canada, www.statcan.gc.ca

Figure 7.6: Northwest Expected Energy

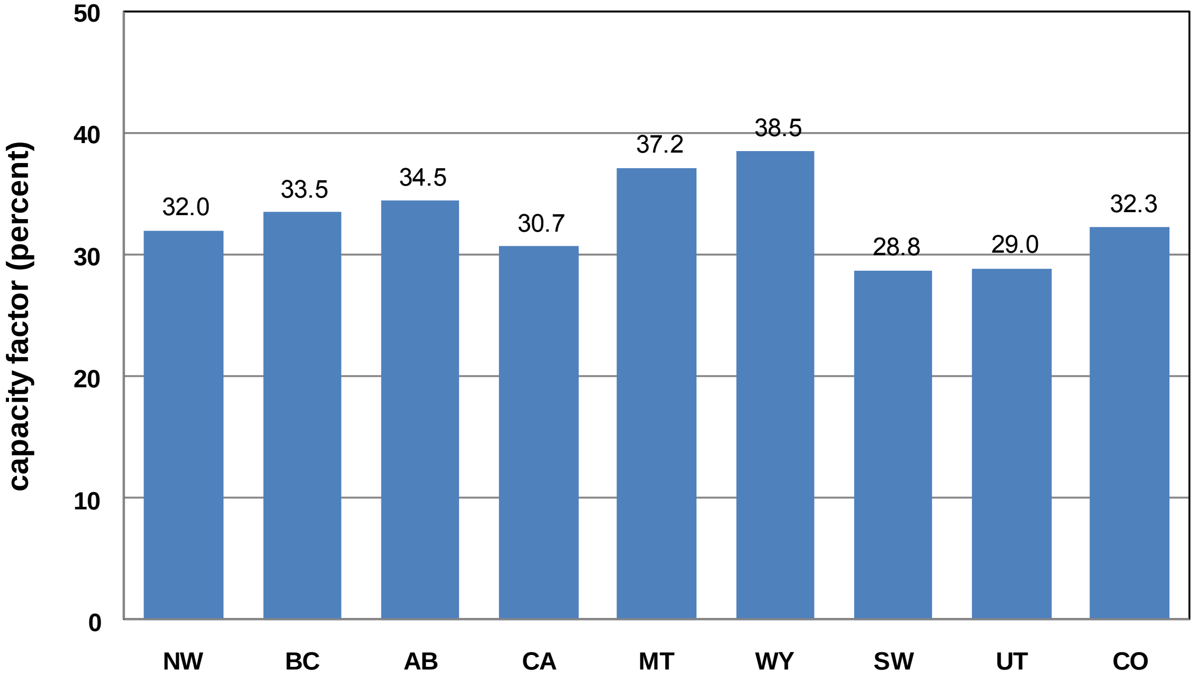


AURORAxmp represents hydroelectric plants using annual and monthly capacity factors, minimum and maximum generation levels, and sustained peaking generation capabilities. The model's objective, subject to constraints, is to move hydroelectric generation into peak hours to follow daily load changes; this maximizes the value of the system consistent with actual operations.

Wind

Additional wind resources are necessary to satisfy renewable portfolio standards. These additions mean significant competition for the remaining higher-quality wind sites. The capacity factors in Figure 7.7 present average generation for the entire area, not for specific projects. The IRP uses capacity factors from a review of the Bonneville Power Administration (BPA) and the National Renewable Energy Laboratory (NREL) data.

Figure 7.7: Regional Wind Expected Capacity Factors



Greenhouse Gas Emissions

Greenhouse gas regulation is one the greatest fundamental risks facing the electricity marketplace today because of the industry's heavy reliance on carbon-emitting thermal power generation plants. Reducing carbon emissions at existing power plants, and the construction of low- and non-carbon-emitting technologies, changes the resource mix over time. No federal regulations presently constrain greenhouse emissions, but federal legislation is still expected. In the interim, several western states and Canadian provinces are promoting the Western Climate Initiative as an alternative to federal legislation. The goal is to develop a multi-jurisdictional greenhouse gas policy.

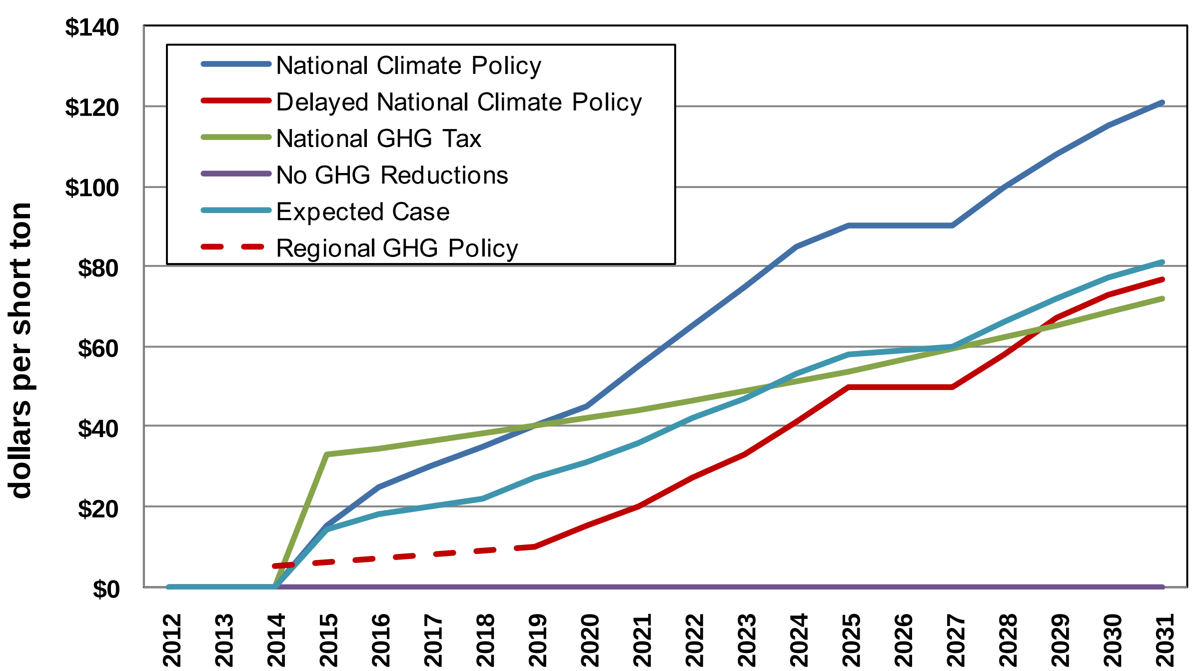
To simulate greenhouse gas regulation, Avista developed four policy models and their assumed financial impact on the energy marketplace. Each policy represents a potential path governments could take over the next several years. The policies received weighting factors, with the weighted average price of the policies forming the Expected Case. The four greenhouse gas policies used in this IRP are in Table 7.5:

Table 7.5: Monthly Price Differentials for Stanfield

Strategy	Weight (%)	Details
Regional Greenhouse Gas Policies	30	– Greenhouse gas reductions in California, Oregon, Washington, and New Mexico between 2014 and 2019. – About a 10 percent reduction below 2005 levels by 2020. – Beginning in 2020, shift to National Climate Policy with 15 percent below 2005 levels by 2030.
National Climate Policy	30	– Federal legislation only applies beginning in 2015 – About 15 percent below 2005 levels by 2020 and about 35 percent below 2005 levels by 2030.
National Carbon Tax	30	– Federal legislation only applies. – $33 per short ton, then 5 percent per year escalation for the remainder of the study. – Begins in 2015.
No Greenhouse Gas Reductions	10	– No carbon reduction program. – State-level emission performance standards apply and no new coal-plants added in the Western United States.

Figure 7.8 shows the expected price of greenhouse gas emission for each policy described in Table 7.5 and the weighted average price comprising of the Expected Case. The carbon policy in each stochastic study comes from the distribution of the four cases described above.

Figure 7.8: Price of Greenhouse Gas Credits in each Carbon Policy



Risk Analysis

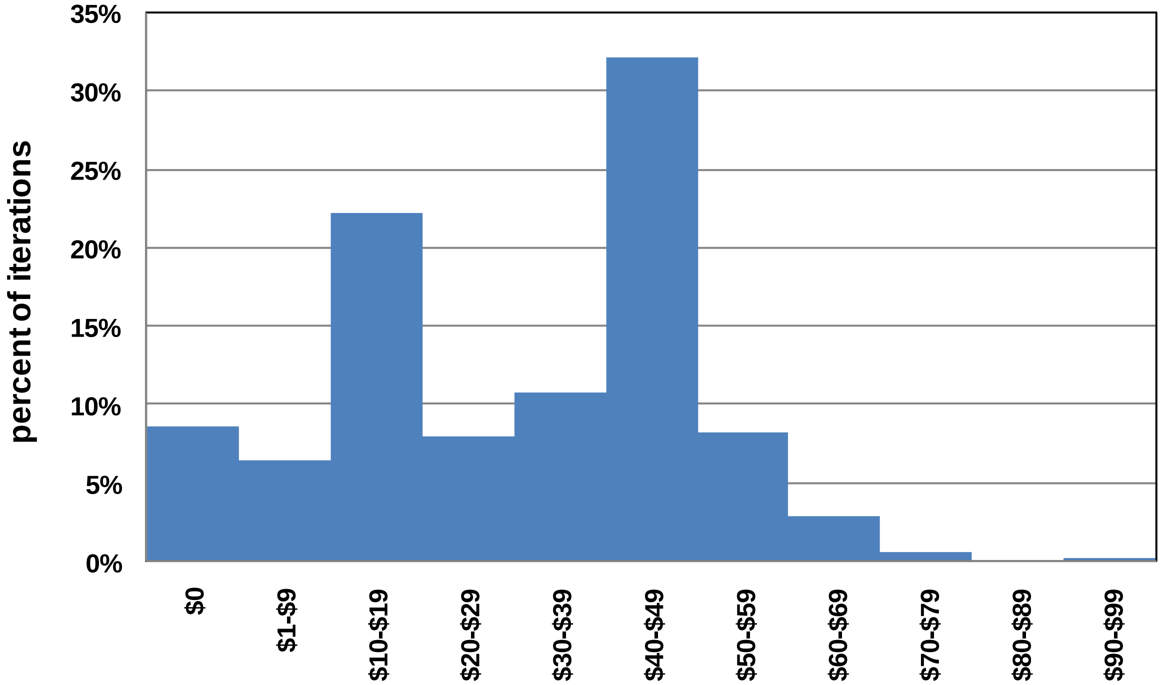
To account for the uncertainty of future electric prices, a stochastic study is preformed using the variables discussed earlier in this chapter. It is better to represent the electricity price forecast as a range rather than a point estimate. Point estimates are unlikely to forecast any of the underlying assumptions perfectly, whereas stochastic price forecasts develop a more robust resource strategy. For example, fuel price volatility and carbon risk directly affect natural gas-fired resources but not wind resources. Wind resources, on the other hand, are subject to varying output on an hourly, daily, monthly, and annual basis. In prior IRP's Avista modeled 250 to 300 stochastic iterations or scenarios. This IRP developed 500 iterations to provide a more robust results distribution to better illustrate potential tail outcomes. The increased number of studies will affect the overall results of the IRP, but should assist in explaining the results better, especially at the tails. The next several pages discuss input variables driving market prices, and describe the methodology and the range in inputs used in the modeling process.

Greenhouse Gas Prices

Without established federal legislation and no formal rules for western carbon markets, the expected price of carbon emission is difficult to determine without resorting to a macroeconomic model. Even with carbon rules in place, prices in a cap and trade program reflect the tradeoff and interaction between natural gas and coal prices and the ultimate maximum emissions level allowed by the program. Further, it is likely that certain states might stop pursuing cap and trade programs because of recent successes in shutting down northwest coal-fired facilitates. As discussed earlier, four possible legislative outcomes reflect the uncertainty surrounding future legislation. Each was included in the stochastic analysis based on its weighting.

The price of carbon mitigation will vary over time, as the natural gas price affects the cost efficiency of displacing coal-fired generation. When natural gas prices rise, so too must carbon prices. To account for this relationship, once the carbon policy is randomly selected based for each scenario the resultant carbon price is adjusted up or down to reflect the natural gas price forecast in a manner to attain the required carbon mitigation goal. An example of this adjustment is in Figure 7.9 for the year 2020. The predominant market prices are between $40 and $49 per short ton of carbon. The distribution reflected the Carbon Tax policy strategy by approximately 100 of these iterations has a price of $42.12 per short ton of carbon.

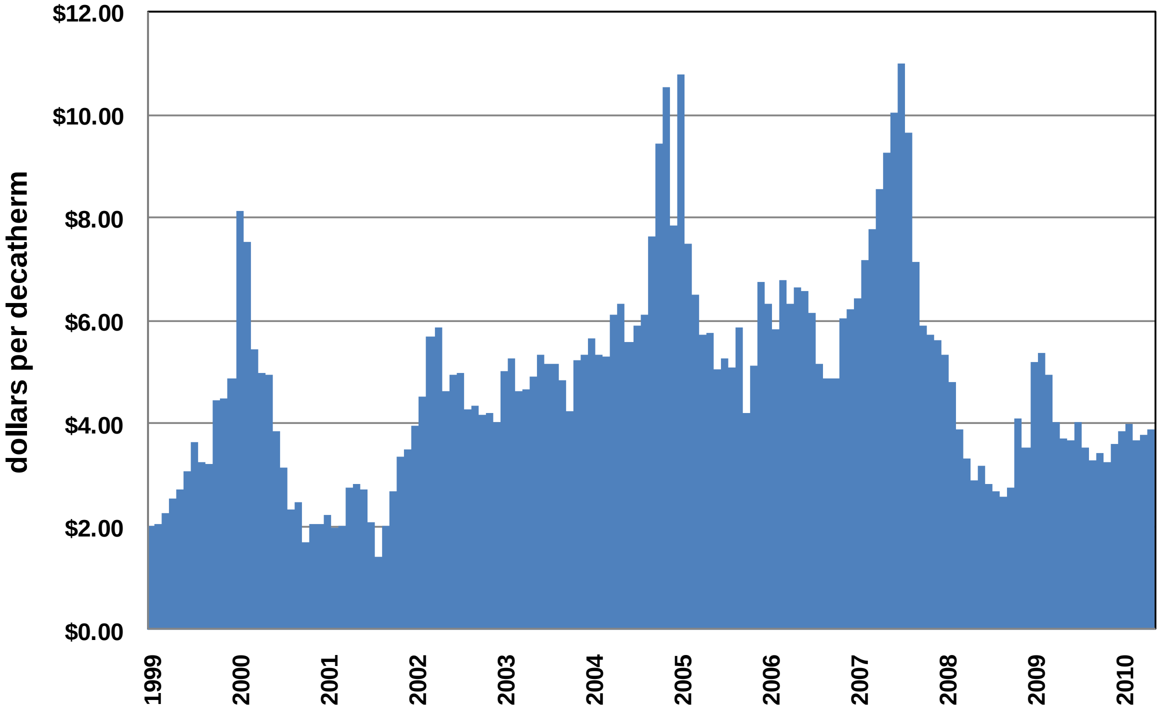
Figure 7.9: Distribution of Annual Average Carbon Prices for 2020



Natural Gas

Natural gas prices are among the most highly volatile of any traded commodity. Daily AECO prices ranged between $0.78 and $12.92 per Dth between 2002 and 2010. Average AECO monthly prices since December 1999 are in Figure 7.10. Prices retreated from their 2008 highs to a low of $2.69 per Dth in July 2009, but prices have stabilized in the $3 to $4 range over the past year. This stabilization likely is a result of both waning demand due to the U.S. recession and shale gas discoveries.

Figure 7.10: Historical AECO Natural Gas Prices



There are several valid methods to stochastically model natural gas prices. For this IRP, Avista uses a new method to represent the price history our industry has witnessed. The mean prices discussed above are the starting point. Prices then vary using historical month-to-month volatility using a lognormal distribution. The lognormal distribution's standard deviation differs monthly depending on historical month-to-month changes.

The Stanfield hub natural gas price distribution is in Figure 7.11 for 2012, 2020, and 2030. Mean prices in 2012 are $4.89 per Dth and the median level is $4.80 per Dth. The 90th percentile is $5.49 per Dth and the TailVar90, or average of the highest 10 percent of the iterations, is $5.92 per Dth. Figure 7.12 illustrates the range of gas prices for each year of the price forecast. Stanfield prices are black bars; white bars represent the range between the 10th and 90th percentiles; triangles represent TailVar90.

Figure 7.11: Stanfield Annual Average Natural Gas Price Distribution

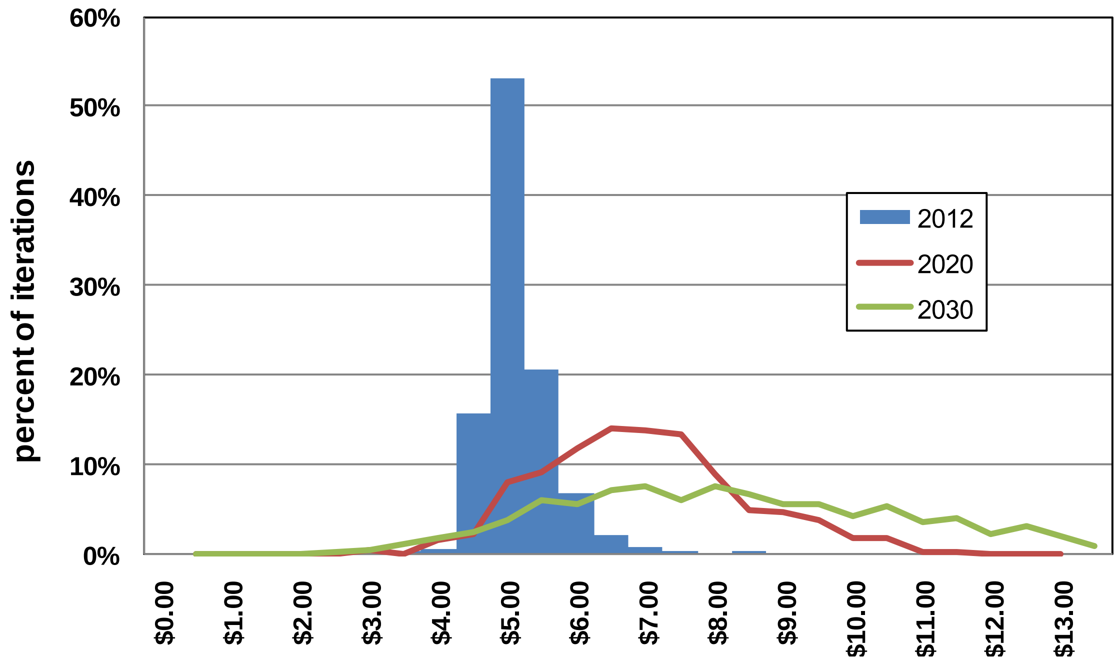
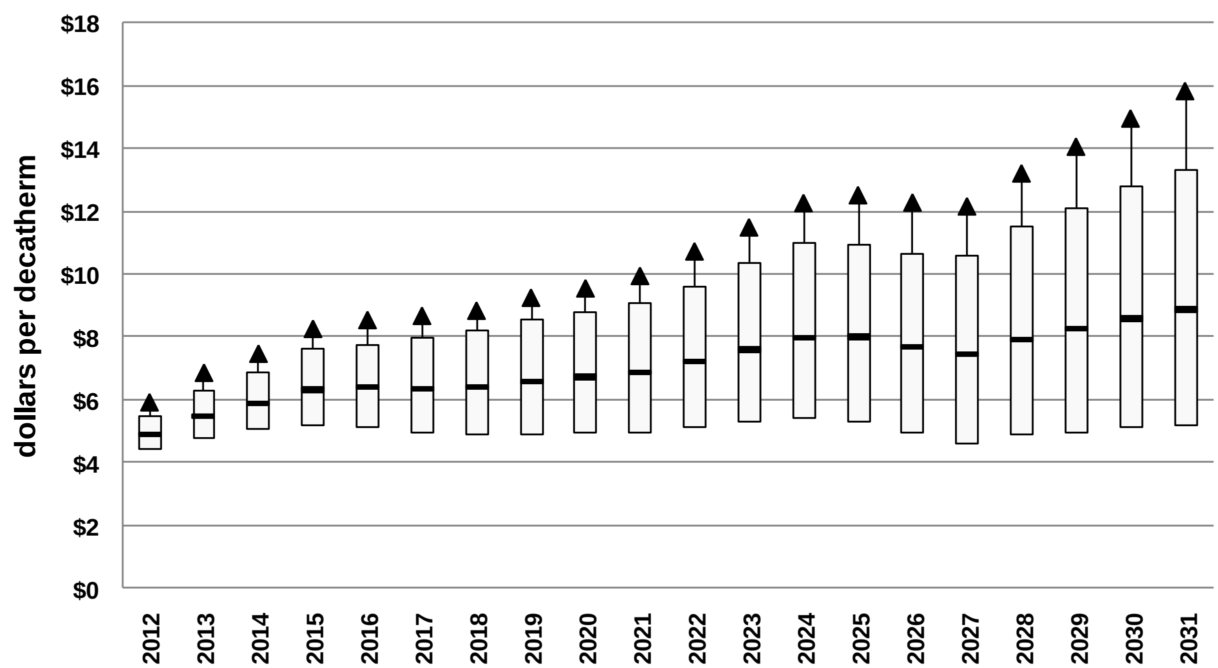


Figure 7.12: Stanfield Natural Gas Distributions



Load

Several factors drive load uncertainty. The largest short-run driver run is weather. Over the long-run economic conditions, such as the recent economic downturn, tend to have a more significant effect on the load forecast. Underlying IRP loads increase at the levels discussed earlier in this chapter, but risk analyses emulate the varying of weather conditions and resultant load impacts.

To model weather variation, Avista continues to use a method it adopted for its 2003 IRP. FERC Form 714 data for the years 2005 through 2009 for the Western Interconnect form the basis for the analysis. Correlations between the Northwest and other Western Interconnect load areas represent how loads move across the larger system. This method avoids oversimplifying the Western Interconnect load picture. Absent the use of correlation, stochastic models merely offset changes in one variable with changes in another, thereby virtually eliminating the possibility of modeling correlated excursions. Given the high degree of interdependency across the Western Interconnect created by significant intertie connections, the additional accuracy in modeling loads in this matter is crucial for understanding variation in wholesale electricity market prices. It is also crucial for understanding the value of resources used to meet variation (i.e., peaking generation).

Tables 7.6 and 7.7 present the load correlations. Statistics are relative to the Northwest load area (Oregon, Washington, and North Idaho). “NotSig” in the table indicates that no statistically valid correlation exists in the evaluated load data. “Mix” indicates the relationship was not consistent across the 2005 to 2009 period. For regions and periods with NotSig and Mix results, no correlation exists. Tables 7.8 and 7.9 provide the coefficient of determination (standard deviation divided by the average) values for each zone. The weather adjustments are consistent for each area, except for shoulder months where loads tend to diverge from one another.

Table 7.6: January through June Area Correlations

	Jan	Feb	Mar	Apr	May	Jun
Alberta	74%	29%	70%	64%	18%	65%
Arizona	73%	75%	74%	8%	Not Sig	8%
Avista	90%	87%	82%	80%	60%	42%
British Columbia	84%	84%	75%	46%	Not Sig	Mix
Colorado	Mix	Mix	Mix	Mix	Not Sig	Not Sig
Montana	82%	76%	69%	55%	33%	28%
New Mexico	8%	Not Sig	Not Sig	Not Sig	16%	Not Sig
North California	34%	36%	8%	Not Sig	34%	8%
North Nevada	73%	65%	Not Sig	8%	25%	27%
South California	74%	45%	69%	31%	10%	44%
South Idaho	87%	86%	65%	40%	66%	28%
South Nevada	67%	83%	37%	Not Sig	Mix	16%
Utah	25%	Not Sig	8%	Not Sig	17%	Not Sig
Wyoming	67%	54%	72%	36%	41%	18%

Table 7.7: July through December Area Correlations

	Jul	Aug	Sep	Oct	Nov	Dec
Alberta	39%	45%	68%	55%	66%	66%
Arizona	9%	26%	9%	Mix	Mix	55%
Avista	60%	54%	19%	78%	88%	89%
British Columbia	8%	Mix	Mix	9%	72%	77%
Colorado	Mix	Mix	Mix	54%	71%	49%
Montana	Mix	Not Sig	27%	53%	81%	86%
New Mexico	25%	27%	43%	17%	35%	Not Sig
North California	Not Sig	Mix	63%	Not Sig	26%	25%
North Nevada	29%	48%	Not Sig	8%	74%	67%
South California	26%	27%	18%	Not Sig	Mix	54%
South Idaho	44%	47%	Not Sig	46%	84%	83%
South Nevada	16%	18%	Not Sig	Mix	Mix	64%
Utah	Not Sig	16%	42%	27%	53%	17%
Wyoming	8%	9%	9%	8%	Not Sig	53%

Table 7.8: Area Load Coefficient of Determination (Std Dev/Mean)

	Jan	Feb	Mar	Apr	May	Jun
Alberta	2.7%	2.4%	2.8%	2.6%	2.9%	3.2%
Arizona	5.5%	4.2%	3.4%	6.1%	10.2%	9.5%
Avista	6.7%	5.3%	6.3%	5.6%	5.3%	6.4%
Baja Mexico	9.5%	7.9%	8.5%	9.2%	10.5%	7.6%
British Columbia	5.0%	3.9%	4.5%	5.2%	4.6%	4.0%
North California	5.1%	5.1%	5.0%	5.6%	8.7%	9.5%
Colorado	4.5%	4.2%	4.6%	4.0%	5.4%	8.4%
South Idaho	5.4%	5.7%	5.4%	6.0%	10.2%	13.9%
Montana	5.3%	4.1%	4.0%	4.4%	4.0%	5.9%
Northern Nevada	2.6%	3.0%	2.9%	2.8%	4.8%	5.7%
Southern Nevada	4.8%	3.6%	3.3%	6.6%	13.0%	11.2%
New Mexico	4.5%	4.1%	4.3%	4.5%	7.4%	6.9%
Pacific Northwest	6.6%	5.9%	5.9%	5.7%	4.9%	4.9%
South California	6.0%	5.6%	6.0%	7.0%	8.6%	8.8%
Utah	4.1%	4.3%	4.5%	4.4%	6.3%	9.0%
Wyoming	7.0%	6.7%	6.5%	5.9%	5.0%	8.3%

Table 7.9: Area Load Coefficient of Determination (Std Dev/Mean)

	Jul	Aug	Sep	Oct	Nov	Dec
Alberta	3.1%	3.2%	2.8%	2.7%	2.6%	3.3%
Arizona	7.0%	6.5%	8.4%	10.0%	4.7%	5.3%
Avista	6.9%	7.2%	5.8%	5.4%	6.6%	7.6%
Baja Mexico	6.4%	6.3%	11.6%	9.9%	7.6%	10.2%
British Columbia	4.7%	4.1%	4.4%	5.0%	6.2%	6.2%
North California	9.6%	7.9%	8.4%	5.3%	5.6%	5.6%
Colorado	7.2%	6.8%	5.8%	4.0%	5.1%	5.0%
South Idaho	5.9%	6.9%	10.5%	4.7%	6.8%	7.1%
Montana	5.1%	5.6%	3.7%	4.0%	5.0%	5.7%
Northern Nevada	5.1%	4.2%	4.9%	2.7%	3.6%	3.5%
Southern Nevada	6.9%	6.3%	12.0%	7.8%	3.8%	4.4%
New Mexico	6.0%	5.7%	5.8%	5.3%	5.0%	4.9%
Pacific Northwest	6.5%	5.2%	4.6%	5.3%	7.0%	8.6%
South California	7.7%	7.8%	10.3%	7.4%	6.8%	6.4%
Utah	5.1%	6.2%	6.7%	4.1%	4.9%	4.4%
Wyoming	8.3%	9.1%	6.1%	5.3%	7.1%	7.6%

Hydroelectric

Hydroelectric generation is historically the most commonly modeled stochastic variable in the Northwest because it has a large impact on regional electricity prices. The IRP uses a 70-year hydro record starting with the 1928-29 water year. A randomly drawn water year is selected from the record using a “bootstrapping” method, meaning that each water year is used approximately 143 times in the study (500 scenarios x 20 years / 70 water year records). There is some debate in the Northwest over whether the hydroelectric record has year-to-year correlation. Avista’s preliminary work in this area has not found significant year-over-year correlation; the 70-year water record shows a modest 41 percent correlation. Low correlation does not necessarily mean that the correlation is zero. Further study of year-to-year correlation is an action item coming out of this planning cycle.

Wind

Wind has the most volatile short-term generation profile of any resource presently available to utilities. Storage, apart from some integration with hydroelectric projects, is not a financially viable. This makes it necessary to capture wind volatility in the power supply model to determine its value and impacts on the wholesale power markets. Accurately modeling wind resources requires hourly and intra-hour generation shapes. For regional market modeling, the representation is similar to how AURORAxmp models hydroelectric resources. A single wind generation shape represents all wind resources in each load area. This shape is smoother than it would be for individual wind plant, but it closely represents the diversity that a large number of wind farms located across a zone would create.

This simplified wind methodology works well for forecasting electricity prices across a large market, but it does not accurately represent the volatility of specific wind resources

Avista might select as part of its Preferred Resource Strategy. Therefore individual wind farm shapes form the basis of resource options for Avista.

Ten potential 8,760-hour wind shapes represent each geographic region or facility. Each year contains a wind shape drawn from the ten representations, as is done with the hydro record. The IRP relies on two data sources for the wind shapes. The first is BPA balancing area wind data. The second is NREL-modeled data between 2004 and 2006.

Avista believes that an accurate representation of a wind shape across the West requires meeting several conditions:

1. The data is correlated between areas and reflective of history.
2. Data within load areas needs to be auto-correlated (each hour correlated to each other).
3. The average and standard deviation of each load area's wind capacity factor needs to be consistent with the expected amount of energy for a particular area in the year and in each month.
4. The relationship between on- and off-peak wind energy needs to be consistent with historic wind conditions. For example, more energy in off-peak hours than on-peak hours where this has been experience historically.
5. Capacity factors for a diversified wind region should never be greater than about 90 percent due to turbine outages and wind diversity within-area.

Absent meeting these conditions, it is unlikely that any wind study provides an adequate level of accuracy for planning efforts. The methodology developed for this IRP attempts to keep the five requirements by first using a regression model of the historic data for each region. The independent variables used in the analysis were month, hour type (night or day), and generation levels from the prior two hours. To reflect correlation between regions, a capacity factor adjustment reflects historic regional correlation using an assumed normal distribution with the historic correlation as the mean. After this adjustment, a capacity factor adjustment takes account of those hours with generation levels exceeding a 90 percent capacity factor. The resulting capacity factors for each region are in Table 7.10. A Northwest region example of an 8,760-hour wind generation profile is in Figure 7.13. This example, shown in blue, has a 33 percent capacity factor. Figure 7.14 shows actual 2010 generation recorded by BPA Transmission; in 2010, the average wind fleet in BPA's balancing authority had a 27.5 percent capacity factor.

Table 7.10: Expected Capacity factor by Region

Region	Capacity Factor	Region	Capacity Factor
Northwest	32.0%	Southwest	28.9%
California	30.9%	Utah	28.8%
Montana	37.2%	Colorado	32.2%
Wyoming	38.5%	British Columbia	33.4%
Eastern Washington	30.7%	Alberta	34.5%

Figure 7.13: Wind Model Output for the Northwest Region

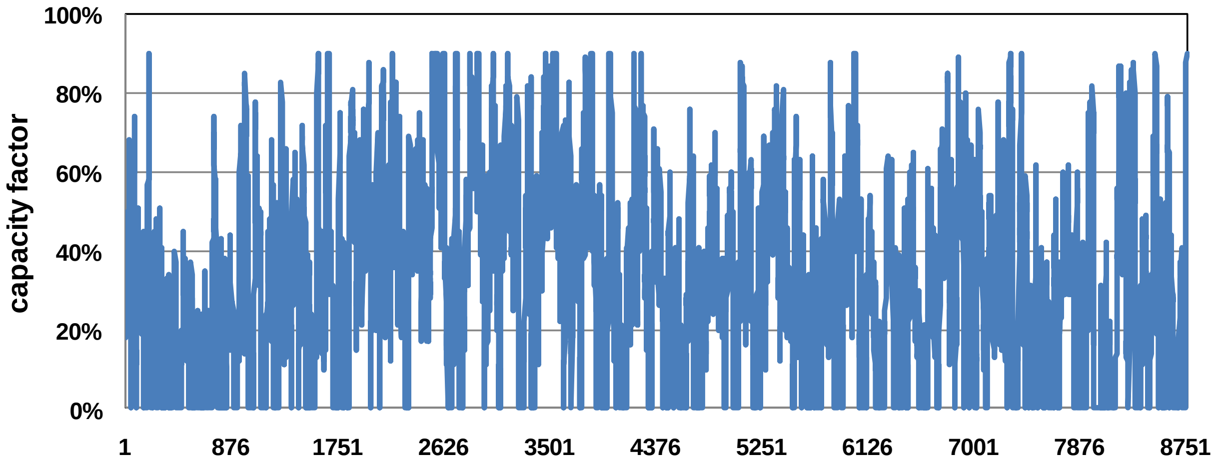
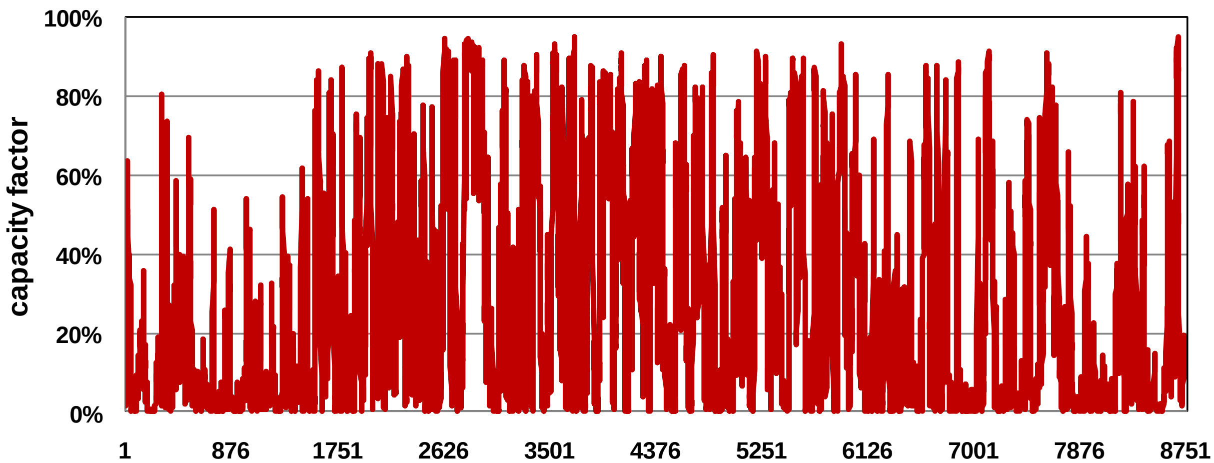


Figure 7.14: 2010 Actual Wind Output BPA Balancing Authority[6]



There is speculation that a correlation exists between wind and hydro, especially outside of the winter months where storm events bring both rain to the river system and wind to the wind farms. This IRP does not correlate wind and hydro due to a lack of historical data to test this hypothesis. Where correlation exists, it would be optimal to run the model 70 historical wind years with matching historical water years. A continual study of this relationship is an action item for this plan.

Forced Outages

In most deterministic market modeling studies, plant forced outages are represented by a simple average reduction to maximum capability. This over simplification generally represents expected values well; however, in stochastic modeling, it is better to represent the system more accurately by randomly placing non-hydro units out of service based on a mean time to repair and an average forced outage rate. Internal

[6] Chart data is from the BPA at: http://transmission.bpa.gov/Business/Operations/Wind/default.aspx.

studies show that this level of modeling detail is necessary only for large natural gas-fired (greater than 100 MW), coal, and nuclear plants. Forced outage rates and the mean time to repair data come from analyzing the North American Electric Reliability Corporation's Generating Availability Data System (GADS) database.

Other Variables

Coal, hog fuel, fuel oil, and variable O&M variables are modeled stochastically. These included either normal or lognormal distributions in the study. Due to their moderate affects on market prices, their details are not discussed here but are in Appendix A.

Market Price Forecast

An optimal resource portfolio cannot ignore the extrinsic value inherent in its resource choices. The 2011 IRP simulation compares each resource's expected hourly output using forecasted Mid-Columbia hourly prices over 500 iterations of Monte Carlo-style scenario analysis.

Hourly electricity prices are either the operating cost of the marginal unit in the Northwest or the economic cost to move power into or out of the Northwest. A forecast of available future resources helps create an electricity market price projection. The IRP uses regional planning margins to set minimum capacity requirements, rather than a summation of the capacity needs of individual utilities in the region. Western regions can have resource surpluses even where some utilities may be in deficit. This imbalance can be due in part to ownership of regional generation by independent power producers, and possible differences in planning methodologies used by utilities in the region.

AURORAxmp assigns market values to each resource alternative available to the PRS, but the AURORAxmp model does not itself select PRS resources. Several market price forecasts determine the value and volatility of a resource portfolio. As Avista does not know what will happen in the future, it relies on risk analysis to help determine an optimal resource strategy. Risk analysis uses several market price forecasts with different assumptions than the expected case or changes the underlying statistics of a study. The modeling splits alternate cases are into stochastic and deterministic studies.

A stochastic study uses Monte Carlo analysis to quantify the variability in future market prices. These analyses include 500 iterations of varying natural gas prices, loads, hydroelectric generation, thermal outages, wind generation shapes, and greenhouse gas emissions prices. Four stochastic studies—an Expected Case, one case without greenhouse gas limitations, a high natural gas volatility case, and an early coal plant retirement case are used. The remaining studies were deterministic scenario analyses.

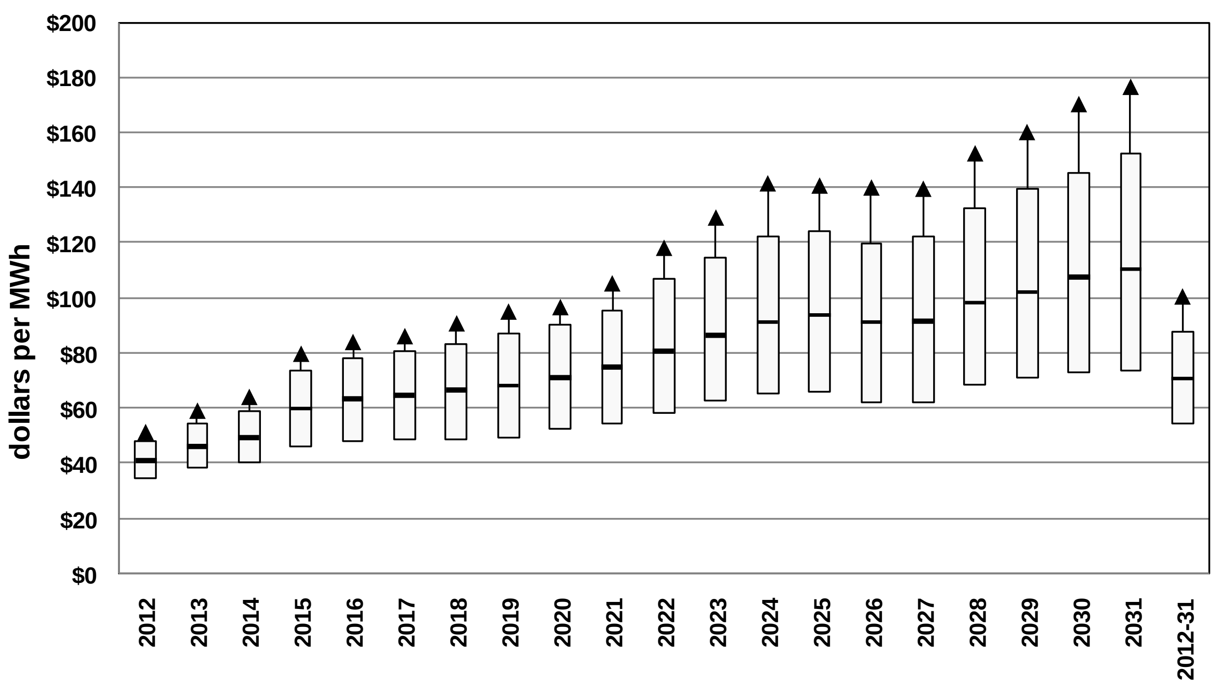
Mid-Columbia Price Forecast

The Mid-Columbia is Avista's primary electricity trading hub. The Western Interconnect also has trading hubs on the California/Oregon Border (COB), Four Corners, Palo Verde, SP15 (southern California), NP15 (northern California) and Mead. The Mid-Columbia market is usually least cost because of low cost hydroelectric generation, though other markets can at times be less expensive when Rocky Mountain area natural gas prices are low and gas-fired generation is setting marginal power prices.

Fundamentals-based market analysis is critical to understanding the market environment. The Expected Case includes two studies. The first is a deterministic market view using expected levels for the key assumptions discussed in the first part of this chapter. The second is a risk or stochastic study with 500 unique scenarios based on different underlining assumptions for gas prices, load, greenhouse gas emissions prices, wind generation, hydroelectric generation, forced outages, and others. Each study simulates the entire Western Interconnect hourly between 2012 and 2031. The analysis used 18 central processing units (CPUs) linked to a SQL server to simulate the studies, creating over 45 GB of data requiring 2,000 hours of computing time.

The resultant average market prices developed from the stochastic model are similar to the results from the deterministic model. Figure 7.15 shows the stochastic market price results as the horizontal bar and the vertical bars represent the 10th and 90th percentile for annual average prices. The triangle represents the Tail Var 90. The nominal levelized price for the 20-year expected prices is $70.50 per MWh. The deterministic prices are $0.87 per MWh lower than the stochastic prices presented in Figure 7.15.

Figure 7.15: Mid-Columbia Electric Price Forecast Range



The annual averages of the stochastic case on-peak, off-peak and levelized prices are in Table 7.10. The Mid-Columbia market price averages $70.50 per MWh over the next 20 years. The 2009 IRP annual average nominal price was $93.74 per MWh. Spreads between on- and off-peak prices are $11.48 per MWh over 20 years.

Table 7.11: Annual Average Mid-Columbia Electric Prices ($/MWh)

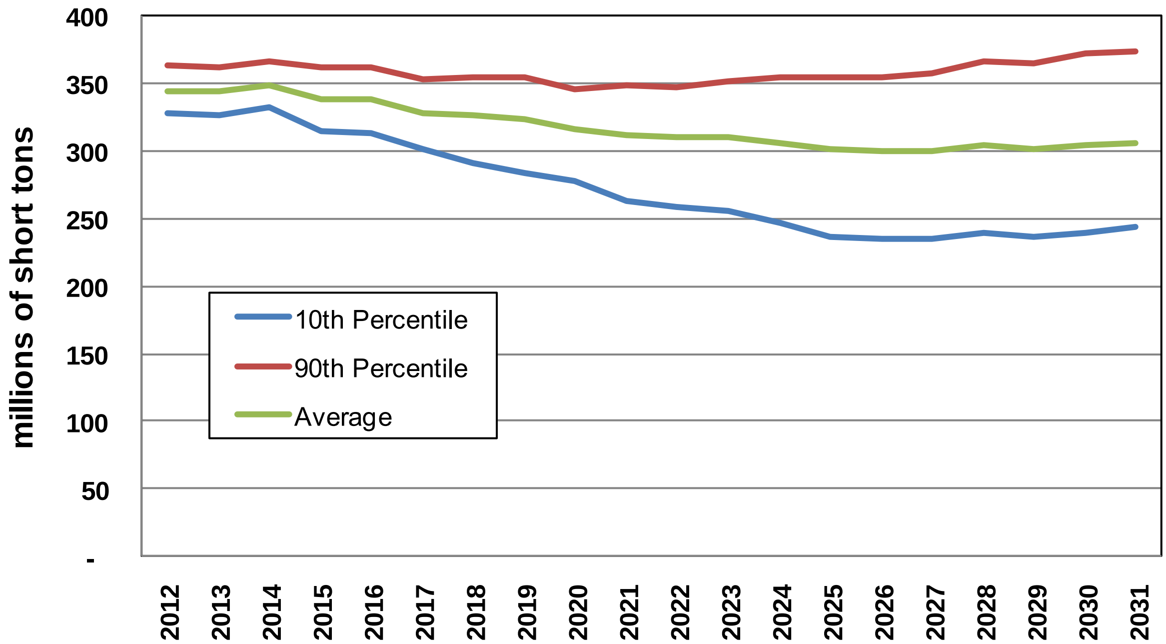
Year	On Peak	Off Peak	Flat
2012	40.87	36.51	44.16
2013	46.13	41.19	49.84
2014	49.11	43.62	53.23
2015	59.86	54.08	64.19
2016	63.25	57.12	67.84
2017	64.53	58.65	68.96
2018	66.55	60.33	71.21
2019	68.26	62.03	72.92
2020	71.05	64.56	75.91
2021	74.88	68.30	79.81
2022	80.49	73.65	85.62
2023	86.28	79.24	91.59
2024	91.26	83.55	97.04
2025	93.71	85.18	100.10
2026	91.35	83.08	97.54
2027	91.37	83.17	97.52
2028	98.30	89.92	104.63
2029	102.25	93.52	108.80
2030	107.56	97.77	114.89
2031	110.55	99.90	118.53
Nominal Levelized	**70.50**	**63.94**	**75.42**

Greenhouse Gas Emission Levels

Greenhouse gas levels increase over the study period absent social policies intended to reverse the trend. The compliance costs of meeting potential greenhouse gas mitigation discussed earlier in this chapter provide price signals to encourage reductions in greenhouse gas emissions. Figure 7.16 shows the expected greenhouse gas emissions from the 500 market forecast simulations. The average level of greenhouse gas emissions from electric generation decrease by 11.2 percent over the 20-year study. The figure also includes the 10th and 90th percentile statistics of the dataset. As discussed earlier, ten percent of the cases assume no future carbon mitigation policies; in these cases the incremental emissions are partly offset by now-expected coal plant retirements[7], low natural gas prices, and increased in wind generation that make coal resources uncompetitive in some months of the forecast.

[7] Recently announced retirements included in the 2011 IRP are 1,561 MW in Colorado, 585 MW in Oregon, and 172 MW in Utah. The 2011 IRP analyses occurred prior to the announcement of the future closure of the 1,376 MW Centralia Coal Plant in Washington State. Its closure should further carbon emission reductions beyond those projected in this plan.

Figure 7.16: Western States Greenhouse Gas Emissions

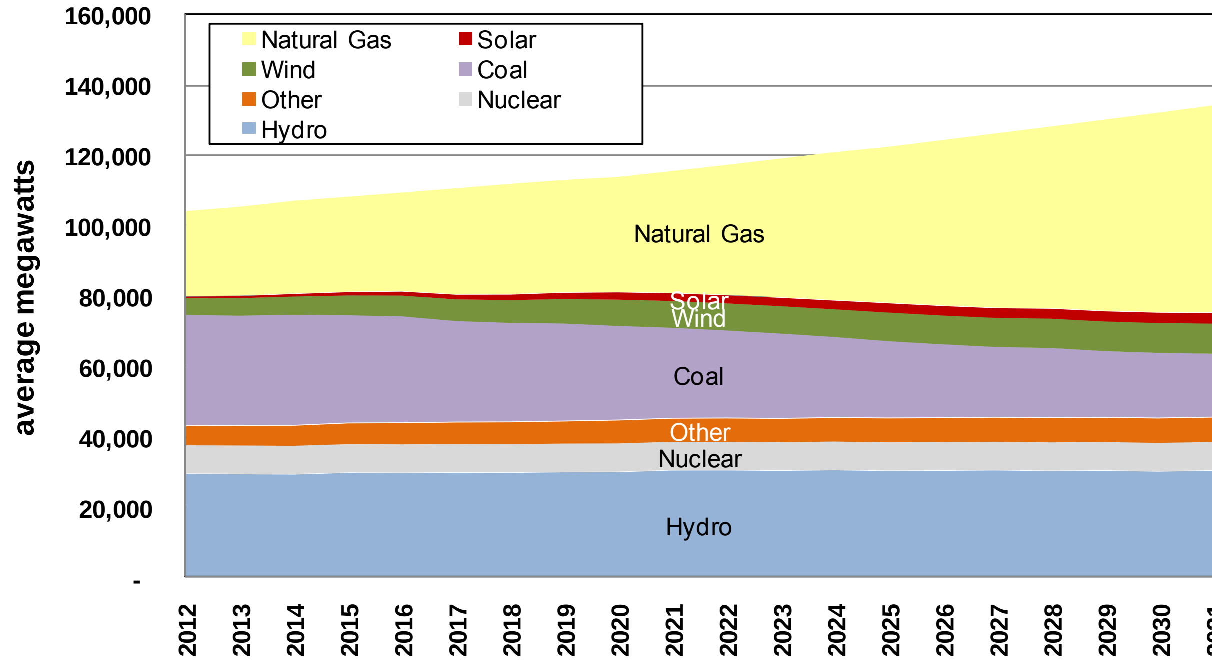


Resource Dispatch

State-level RPS goals and greenhouse gas legislation will change resource dispatch decisions and affect future power prices. The Northwest already is witnessing the market-changing effects of a 5,000+ MW wind fleet. Figure 7.17 illustrates that natural gas fuels 23 percent of total generation in 2012, and 41 percent in 2031. Coal generation decreases from 30 percent of Western Interconnect generation in 2012 to 13 percent in 2031. Solar and wind increase from 5 percent in 2012 to 13 percent in 2031. New renewable generation sources offset coal generation reductions, but natural gas-fired resources meet load growth.

Public policy changes to encourage renewable energy development and reduce greenhouse gas emissions have the potential to change the electricity marketplace. On its present trajectory, policy changes are likely to move the generation fleet toward its potentially most volatile contributor—natural gas. These policies will displace low-cost coal-fired generation with higher-cost renewables and gas-fired generation having lower capacity factors (wind) and higher marginal costs (natural gas). If history is our guide, regulated utilities will recover their costs from stranded coal plants, requiring customers to pay even more. Further, wholesale prices likely will increase with the effects of the changing resource dispatch driven by carbon emission limitations. New environmental policy driven investment, combined with higher market prices, will necessarily lead to retail rates that are higher than they would be absent greenhouse reduction policies.

Figure 7.17: Base Case Western Interconnect Resource Mix



Scenario Analysis

Scenario analysis evaluates the impact of specific changes in underlying assumptions on the market. Four stochastic studies were performed to help understand potential market price changes and to examine the potential risk to Avista's PRS if certain assumptions were changed. The scenarios studied used 500 iterations to model the effects of unconstrained carbon emissions, doubling of natural gas price volatility, and the early retirement of coal plants. In addition to the stochastic market scenarios, deterministic scenarios explained the impacts of low natural gas prices, high natural gas prices, and high wind penetration. Prior IPRs used market scenarios to stress test the PRS. Since the PRS accounts for a range of possible outcomes in its risk analysis, the market scenario section is more limited in this IRP. Additional scenarios illustrate the impacts potential policies might have on the industry, and how Avista could respond.

Unconstrained Carbon Emissions

The Unconstrained Carbon Emissions scenario is necessary to quantify projected greenhouse gas policy costs. The first study is a deterministic scenario. A second stochastic study models 500 individual iterations of varying natural gas prices, loads, wind generation, forced outages, and hydroelectric conditions. The assumptions are similar to the Expected Case with a few notable exceptions. First, natural gas prices are lower because of less demand for natural gas caused by the continued use of coal-fired generation. Without carbon legislation, natural gas prices are $0.52 per Dth lower levelized over 20 years, a 7.1 percent decrease.

Without projected greenhouse gas mitigation, Mid-Columbia market prices are lower and the total cost to serve customers is lower. The average of the 500 simulations finds wholesale market prices $17.64 per MWh lower, on a nominal levelized basis, compared to the Expected Case; this represents a 33.4 percent market price increase for greenhouse gas emissions mitigation (Figure 7.18). The total cost of fuel in the Western Interconnect with greenhouse gas mitigation is 7.65 percent higher than without the greenhouse gas mitigation.

Figure 7.18: Mid-Columbia Prices Comparison with and without Carbon Legislation

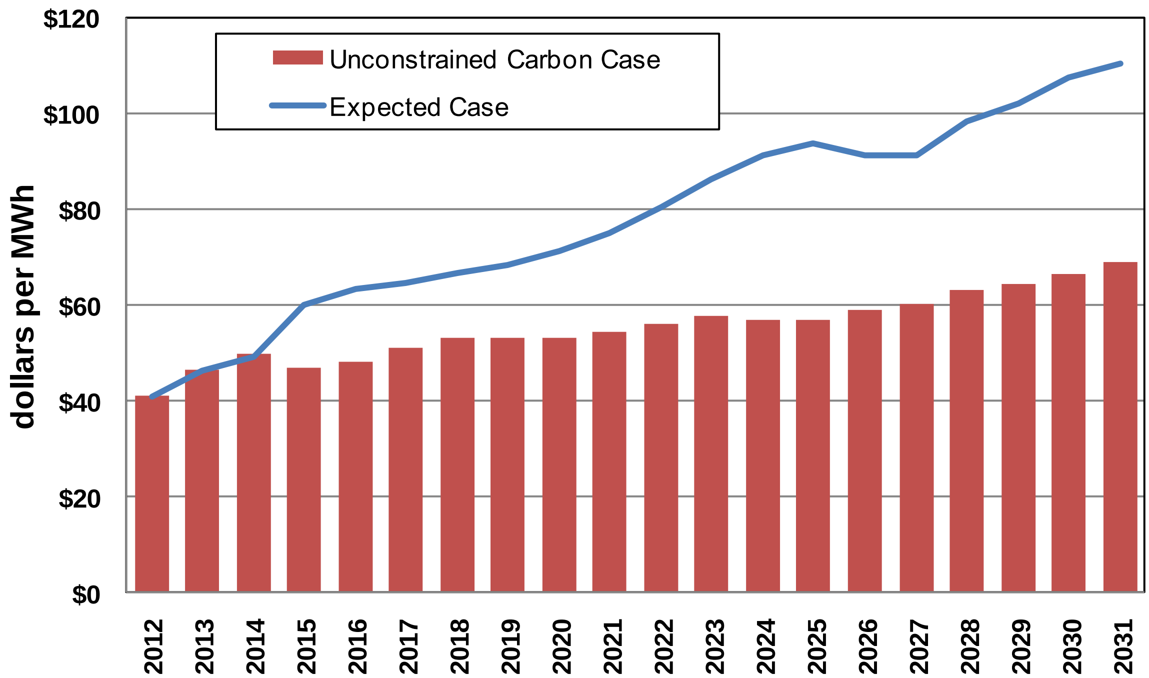


Figure 7.19 illustrates the difference between greenhouse gas emissions with and without the emissions costs included in the Expected Case. Based on the model results and assumptions, emissions would be 8.5 percent higher in 2020 and 21.5 percent higher in 2031 without the assumed greenhouse gas penalty. Increased greenhouse gas emissions from higher coal-fired dispatch levels are the cause (see Figure 7.20). The Expected Case, which includes greenhouse gas costs, reduces coal dispatch by 36 percent compared to the unconstrained greenhouse gas scenario, while natural gas generation production increases by 19 percent.

Figure 7.19: Western U.S. Carbon Emissions Comparison

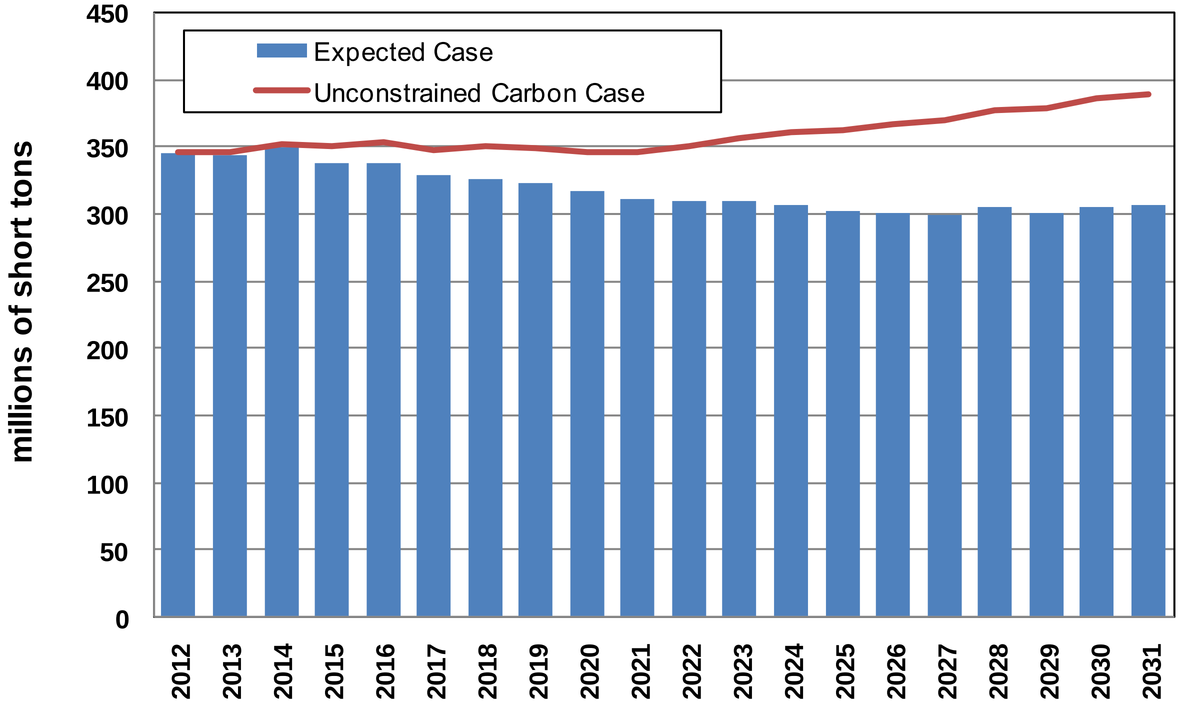
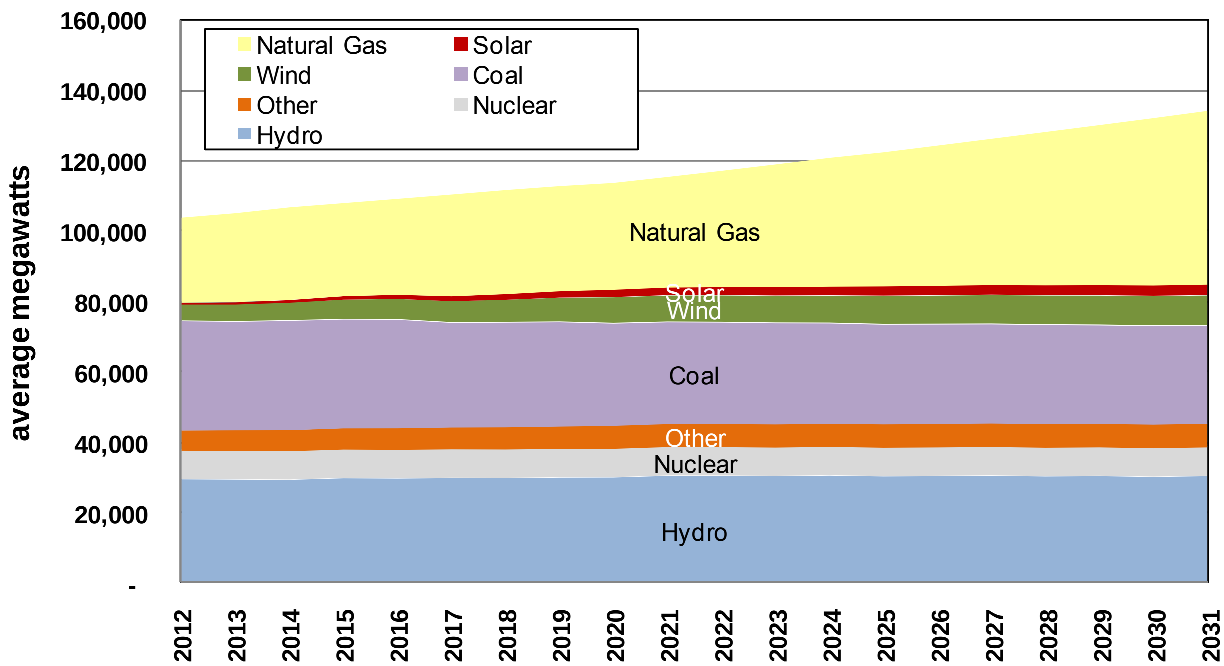


Figure 7.20: Unconstrained Carbon Scenario Resource Dispatch



Alternative Greenhouse Gas Mitigation Methods

As part of the development of the Expected Case's four greenhouse gas policies, market simulations were conducted to calculate the price of greenhouse gas required to meet the reduction goal. Figure 7.8, shown earlier, illustrates the prices required to meet the goals. Figure 7.21 illustrates the corresponding forecasted electric market prices at Mid-Columbia on an average annual basis. The Expected Case line is the average of the 500 simulations and the other lines represent the deterministic study results for each greenhouse gas policy modeled. The values shown in Figure 7.22 are discounted and levelized over the 20-year study period to represent the average price of power.

Figure 7.21: Average Annual Mid-Columbia Electric Prices for Alternative Greenhouse Gas Policies

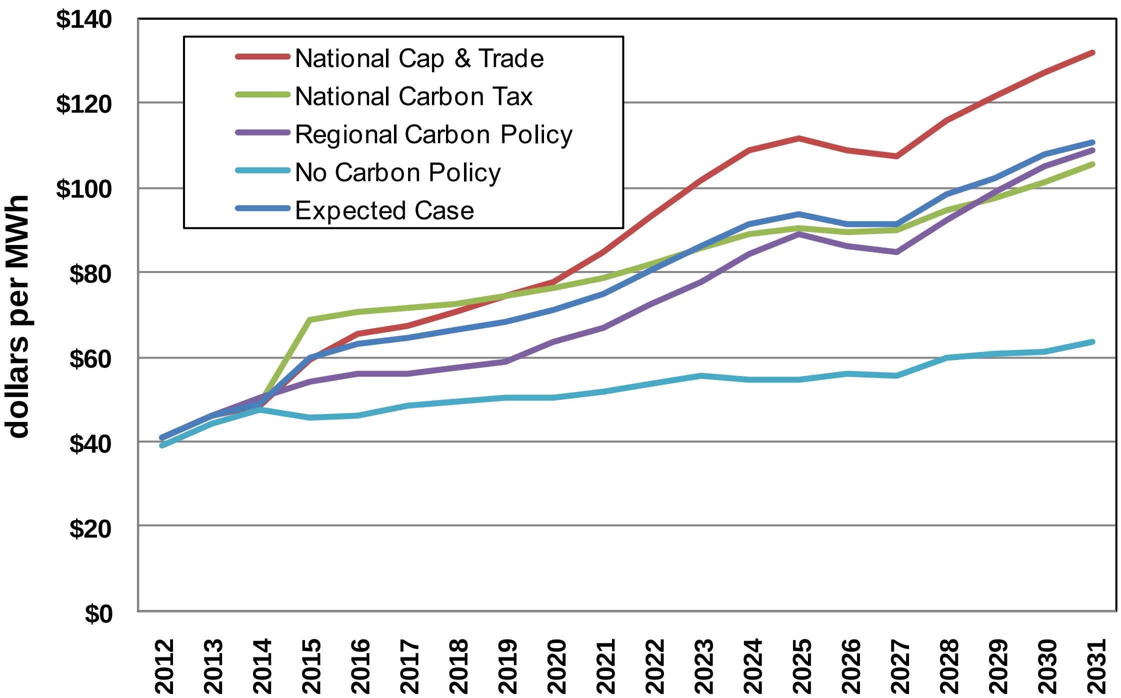


Figure 7.22: Nominal Levelized Mid-Columbia Electric Prices for Alternative Greenhouse Gas Policies

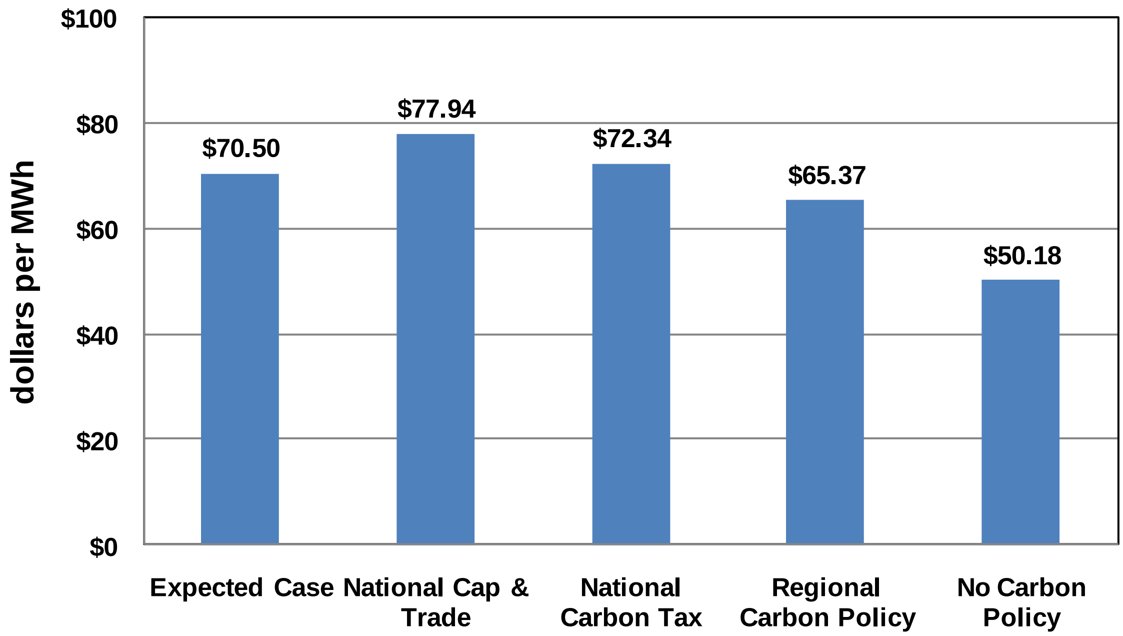
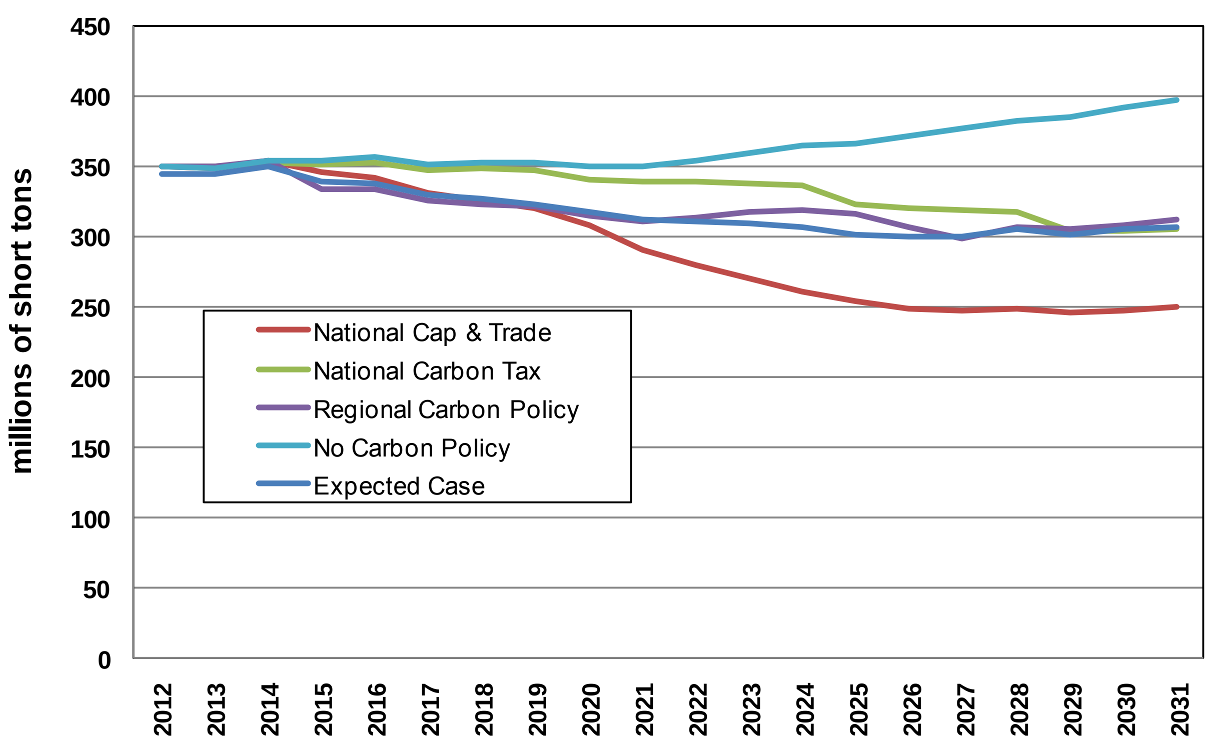


Figure 7.23 shows the annual expected greenhouse gas emissions levels for each of the policies in. The four potential outcomes represent a range of futures under different forms of greenhouse gas emissions legislation.

Figure 7.23: Annual Greenhouse Gas Emissions for Alternative Greenhouse Gas Policies



Mandatory Coal Retirement

Proposed federal greenhouse gas cap and trade legislation is not law. The Environmental Protection Agency and other organizations have pursued alternative methods to reduce greenhouse gases from electric generation through regulatory means. More details surrounding these policy alternatives are in the Planning Environment chapter. The goal of this scenario is to illustrate the affect on electricity market prices and system fuel costs where a policy is put in place requiring all coal plants to retire at the end of 40 years of life, or to be phased out by 2020 if the plant is already over 40 years old. The study uses 500 iterations as conducted on other studies.

In Figure 7.24 the average annual prices for this scenario are compared to the Expected Case. The resulting prices levelized are $57.01 per MWh, 19 percent lower than the Expected Case and 27 percent lower than the National Cap and Trade Strategy. The surprising fact about this greenhouse gas policy is that Mid-Columbia prices are only 7.3 percent higher than the no carbon penalty case and the policy still achieves substantial greenhouse gas reductions as shown in Figure 7.25. The driver of these results is that natural gas-fired units face no carbon costs. Without the emissions adder to natural gas, the marginal price of power remains as a natural gas-fired plant, and the increase in power cost is more driven by the increased demand driving natural gas prices higher and the inclusion of less low cost base load capacity in shoulder months. Although lower market prices make this greenhouse gas strategy appealing, it does have a negative consequence.

In Table 7.12 annual incremental costs of each potential strategy are compared and the Early Coal Plant Retirement strategy is $3.2 billion more costly for the Western Interconnect as compared to the National Cap and Trade strategy. This increase results from the forced addition of new resources to replace coal plants rather than letting coal plants remain on line, but instead dispatching them much less frequently, thus avoiding new capital investment. One thing to keep in mind, is this a 20 year study of the western interconnect. A longer-term national model may illustrate different results. Taking into account national economics may also change opinions on the results as well. In the end, any greenhouse reduction strategy needs to be a low cost solution that does not affect the electricity marketplace in a negative manner.

Figure 7.24: Average Annual Mid-Columbia Price Comparison of Greenhouse Gas Policies

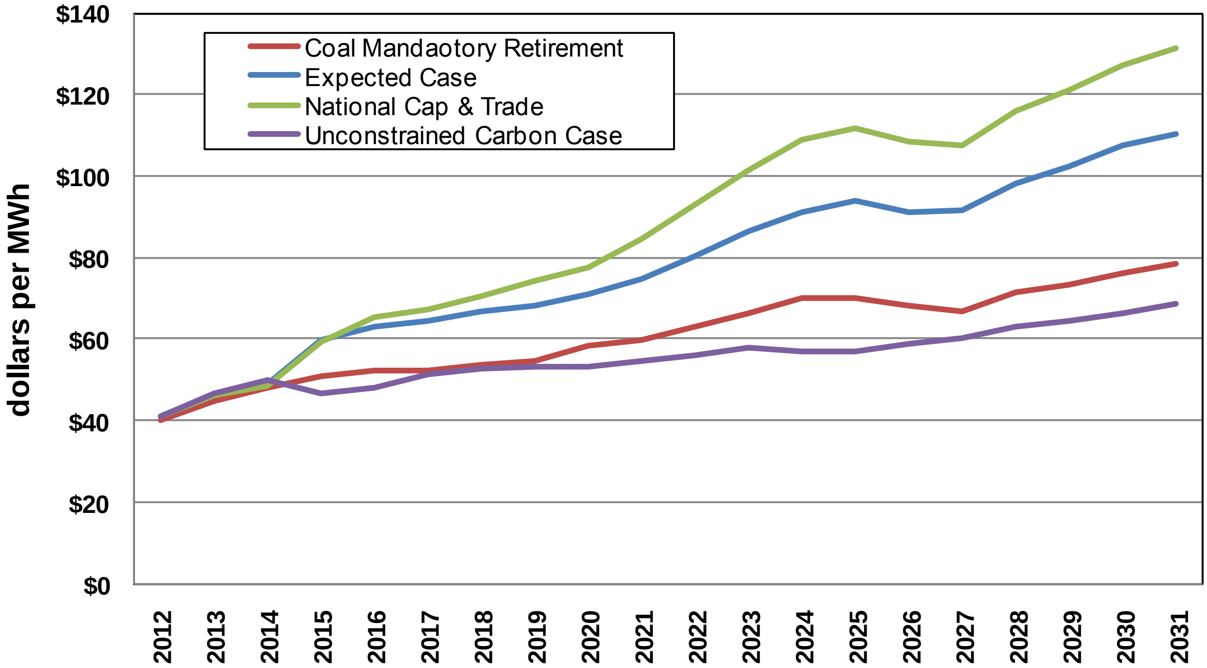


Figure 7.25: Expected Greenhouse Gas Emissions Comparison

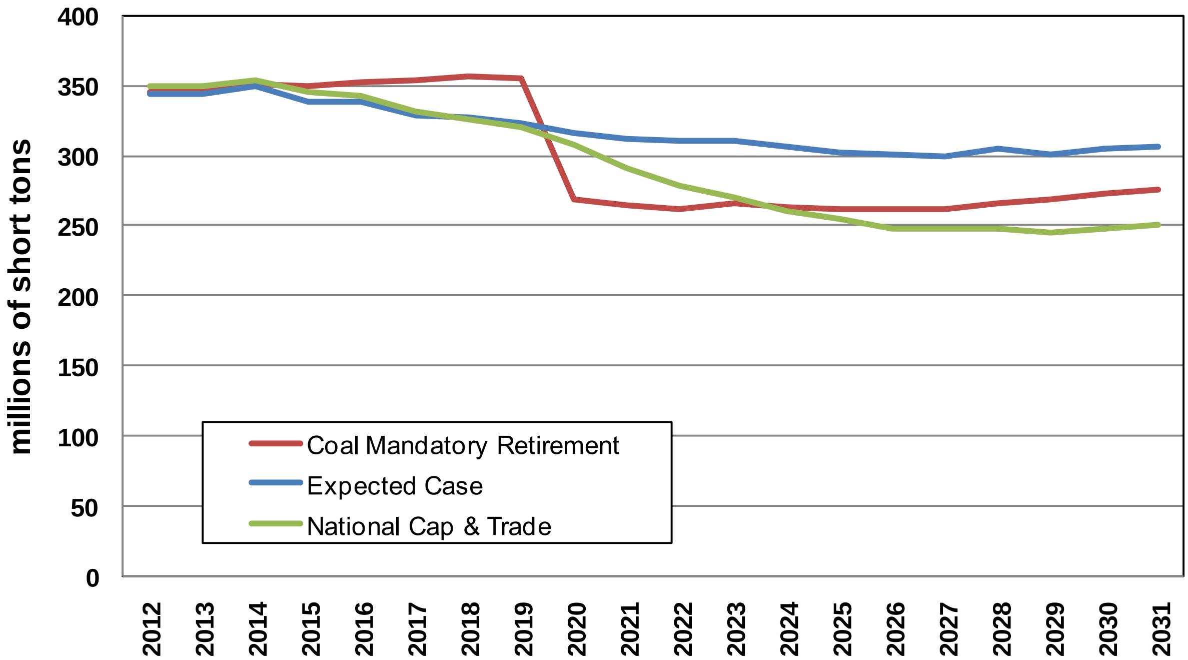


Table 7.12: Impacts of Greenhouse Gas Mitigation Policies in the West

Market Scenario	Change to GHG Emissions by 2031	Added Levelized Cost per Year (Billions)
Unconstrained Greenhouse Gas Case	14%	0.0
Expected Case	-18%	3.5
Coal Mandatory Retirement	-22%	8.1
National Cap & Trade	-29%	4.9

High and Low Natural Gas Price Scenarios

The High and Low Natural Gas Price scenarios illustrate Mid-Columbia electric prices for differing natural gas prices. These scenarios maintain carbon emissions at the same level as the Expected Case to determine carbon prices at lower natural gas prices. Figure 7.4, located earlier in the chapter, shows the low and high natural gas price forecasts used in this scenario as Consultant 1 and Consultant 2 prices. Using these prices, the resulting greenhouse gas price forecast assuming a cap and trade mechanism that achieves the same reductions as the Expected Case is in Figure 7.26. The natural gas prices in this scenario are approximately plus or minus 20 percent compared to the Expected Case, but greenhouse gas prices must increase or decrease, respectively, by approximately 31 percent to achieve the same greenhouse gas levels as the Expected Case. The Mid-Columbia market price forecasts for the high and low natural gas price cases are in Figure 7.27. The nominal levelized electric price for the low gas price case is $57.00 per MWh and $82.17 per MWh for the high gas price case.

Figure 7.26: Natural Gas Price Scenario's Greenhouse Gas Emission Prices

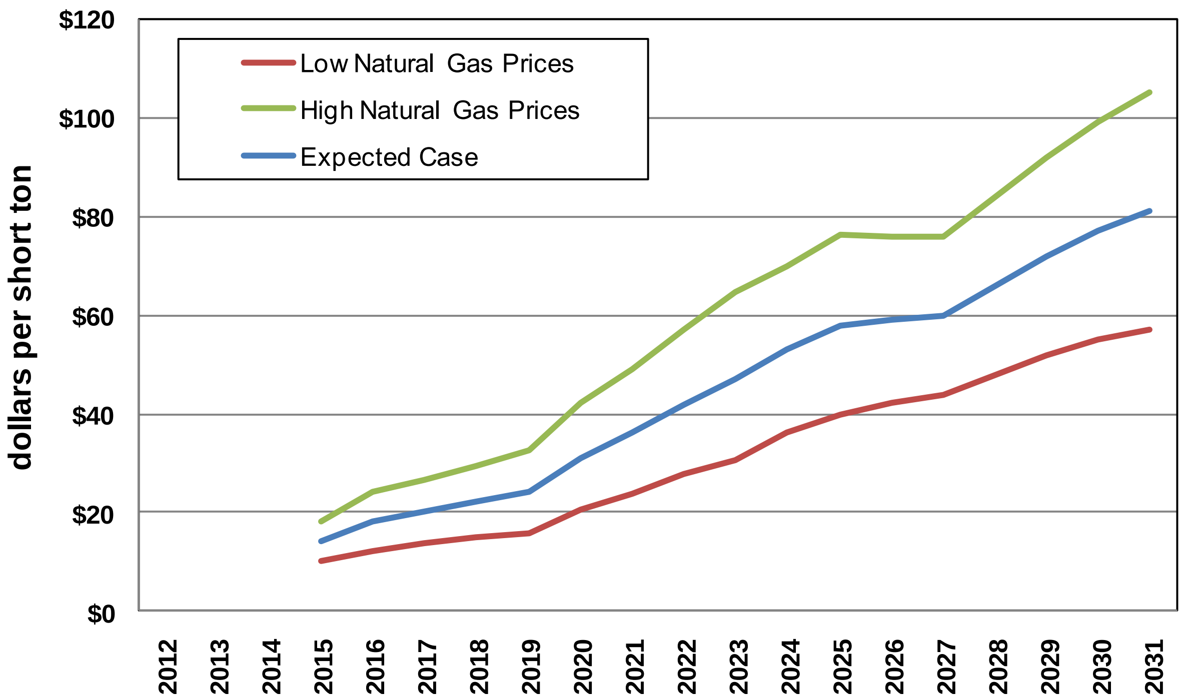
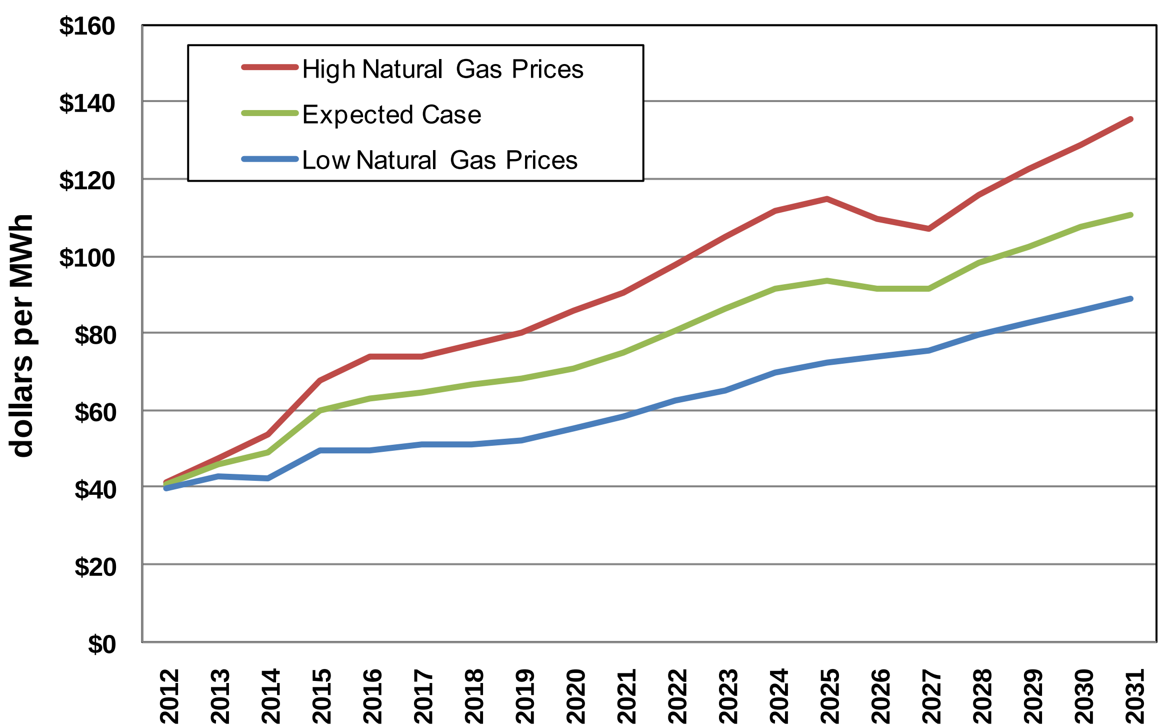


Figure 7.27: Natural Gas Price Scenario's Mid-Columbia Price Forecasts



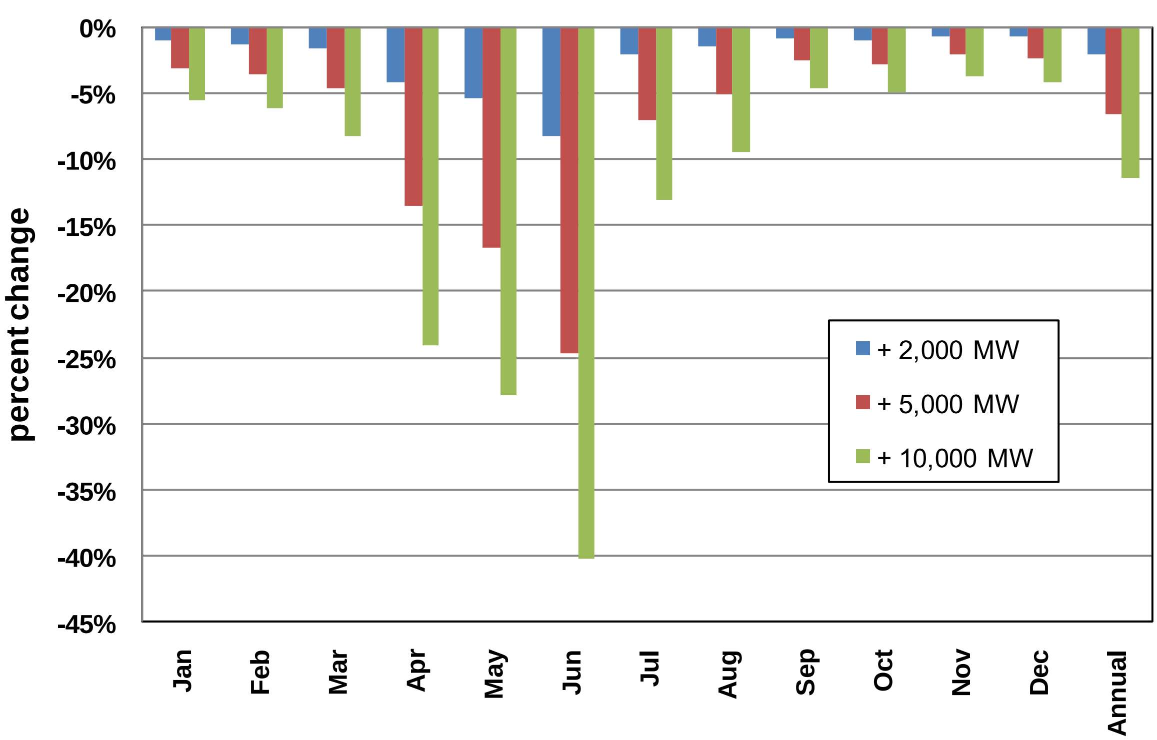
Wind Proliferation and Negative Pricing

Avista uses the IRP process to identify and understand the impacts of potential market changes, rather than only focusing on Avista's PRS. In past IRPs, Avista has studied the market impacts of electric cars and the addition of large amounts of solar generation to the grid. For this IRP, the non-PRS study focuses on the growing penetration of wind generation in the Northwest. 2015 was chosen as the period for this study and includes four sensitivities; the sensitivity included 100 iterations of potential outcomes.

The sensitivities in this case range from 7,000 MW to 17,000 MW (additions of between zero MW and 10,000 MW to the Expected Case wind penetration forecast) of total wind capacity in the Northwest. Currently, there is approximately 5,000 MW in the four northwest states and the Expected Case includes approximately 7,000 MW of wind by 2015. The key results of this study include the change in market prices, the amount of negative price episodes, and the overall effect of additional wind generation on the margins of existing Avista facilities.

The first major change to the power market by high wind penetration is the change to wholesale market prices. Based on the average of the 100 iterations of each case, Figure 7.28 illustrates the percent change to Mid-Columbia average monthly prices in cases that increase wind capacity by 2,000, 5,000, and 10,000 MW above the Expected Case forecast. The major price changes occur in the second quarter of the year. On average, market price changes are 2 percent lower than the Expected Case with 2,000 MW of additional wind by 2015, 7 percent lower with 5,000 MW, and 11 percent lower with 10,000 MW.

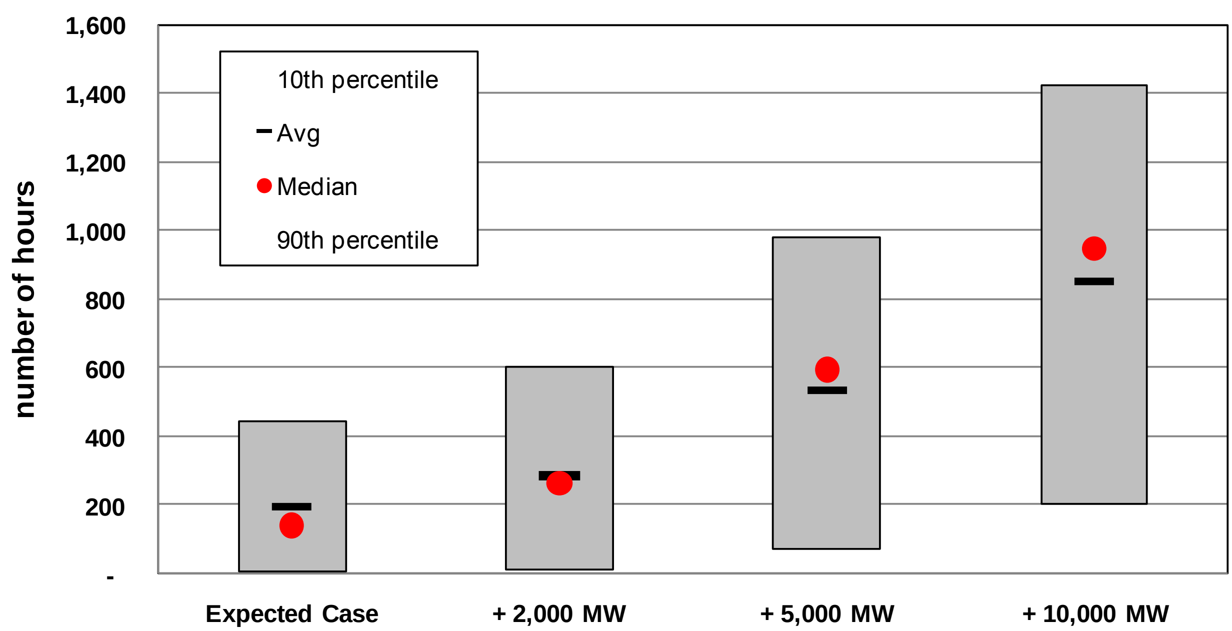
Figure 7.28: Wind Sensitivity Mid-Columbia Price Changes



The reduction in overall wholesale prices comes substantially from negative prices. Negative pricing can occur when resources must operate irrespective of the price offered in the wholesale marketplace, and when a resource receives economic benefit for generation beyond market prices (tax credits and RECs). In some markets negative prices occur when certain base-load generation resources (e.g., nuclear plants) in total exceed nighttime loads but must be operated to ensure their availability during the next day's peak demand periods. Negative pricing is an issue today in the Northwest when the region's hydroelectric system is experiencing high flow condition (generally during spring runoff) and when there is no wind generation curtailment.

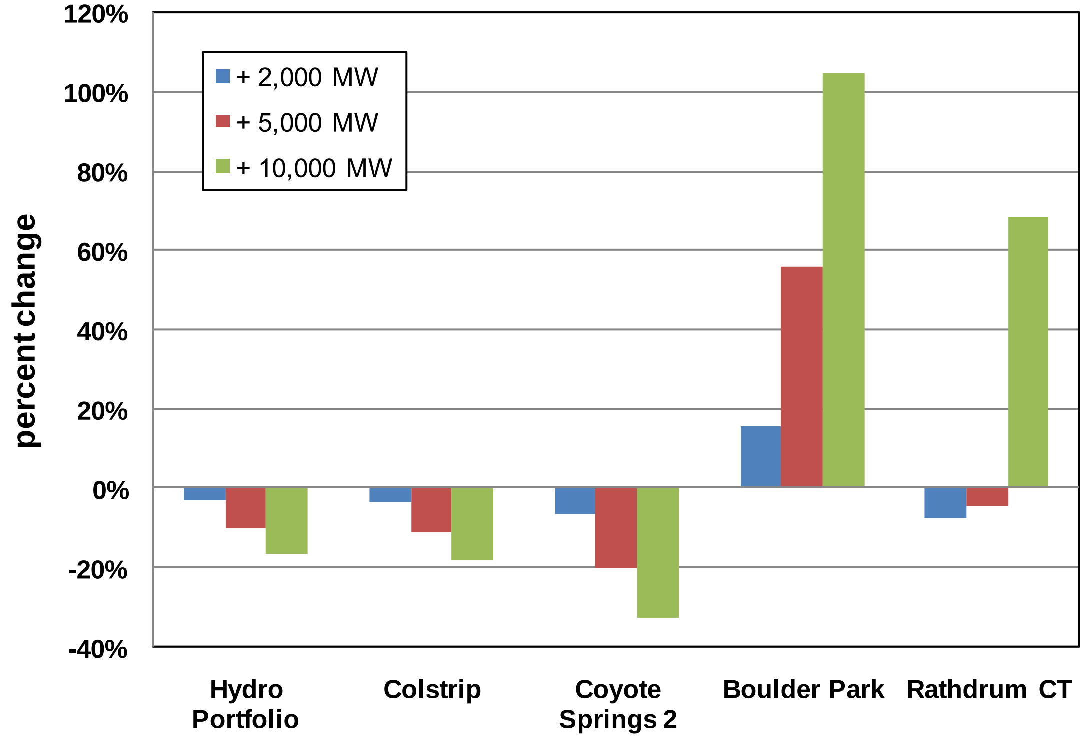
Many hydroelectric facilities must generate electricity and not spill water under varying licensing requirements. This situation compounds when generation resources, such as wind, receive federal production tax and renewable energy credits. Wind facilities in the Expected Case contribute to 193 hours of negative prices, or 2.2 percent of the hours, as shown in Figure 7.29. With 2,000 MW of additional wind capacity, the frequency of negative pricing increases to 3.2 percent. With 5,000 MW, prices fall by 6.1 percent. And with 10,000 MW, prices fall by 9.7 percent.

Figure 7.29: Wind Sensitivity Negative Pricing



The final item reviewed as part of this high wind penetration study is the effect to the profitability of non-wind and hydro resources and total power supply costs. Figure 7.30 shows that Avista's coal-fired, combined cycle natural gas-fired, and hydroelectric revenues decline, but that the value of gas-fired peaking resources will increase. The estimated impact of increased wind penetration to Avista net power supply cost is a net increase between 0.03 percent and 0.37 percent.

Figure 7.30: Change to Resource Revenues



Market Analysis Summary

Market analysis is a key component of the IRP. The market is where Avista trades its electricity surpluses and deficits. It is difficult to examine all potential resources evaluated by Avista for possible inclusion in the PRS without a firm understanding of the marketplace and how public policy and changes to resource and cost assumptions affect the market. As prices have declined since the 2009 IRP, and have the potential to fall farther, the market price forecasts could have an effect on the cost to bring new resources on to the Avista system and their potential rate effects.

New legislation and regulations affecting the electric system are on the horizon. Regardless of policies to decrease greenhouse gas emissions, make generation greener, promote energy independence or affect reliability—power costs will increase because new capacity and transmission resources are needed to replace aging infrastructure and serve new load growth. Greenhouse gas emissions and RPS legislation will diversify fuel supplies, but will also increase demand for natural gas-fired resources. Policymakers and the public will need to determine if the ultimate benefits of these types of legislation outweigh the increased costs.

8. Preferred Resource Strategy

Introduction

The Preferred Resource Strategy (PRS) chapter describes potential costs and financial risks of the Company's resource acquisition strategy. It details the planning and resource decision methodologies, describes strategy, considers climate change policy, and shows how the strategy may evolve if certain expected future conditions change.

The 2011 PRS describes a reasonable low-cost plan along the efficient frontier of potential resource portfolios accounting for fuel supply risk, price risk, and greenhouse gas mitigation. Major changes from the 2009 plan include reduced amounts of wind generation and the introduction of natural gas-fired peaking resources. The plan includes less wind because of lower expected retail loads resulting from the present economic downturn and increased conservation acquisition. Expected wind generation needs are lower due to a modest change in the modeling method used to represent annual variability from RPS-qualifying resources. The selection of gas-fired peaking resources resulted from a lower natural gas price forecast, lower retail loads, and the need for more flexible generation resources to manage the variability associated with renewable generation.

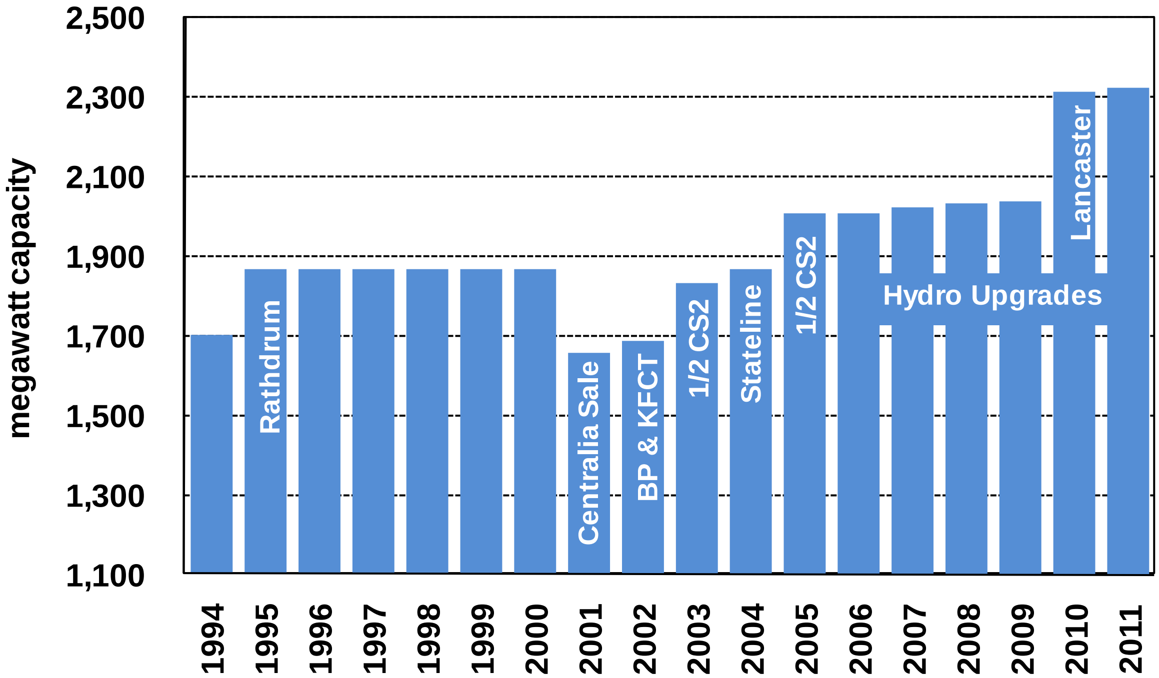
Section Highlights

- A newly signed contract for the Palouse Wind project located near Spokane, Washington will fulfill Avista's RPS obligations through 2019.
- Avista's first load-driven acquisition is a gas-fired peaking plant in 2019; total gas-fired acquisition is 756 MW over the IRP timeframe.
- The 2011 plan splits natural gas-fired generation between simple- and combined-cycle plants in anticipation of a growing need for system flexibility to integrate variable resources.
- Efficiency improvements, both on the customer and utility sides of the meter, are at the highest expected level in our planning history.
- Total capital needs for generation resources in the PRS are $1.7 billion.
- Conservation and system efficiency spending will increase over time; a total of $1.4 billion will acquire 310 aMW over 20 years.

Supply-Side Resource Acquisitions

Avista began its shift away from coal-fired resources with the sale of its 210 MW share of the Centralia coal plant in 2001 and its replacement with natural gas-fired projects (see Figure 8.1). After the Centralia sale, Avista acquired 32 MW of gas-fired peaking capacity and 287 MW of intermediate load gas-fired capacity. In addition, Avista contracted for 35 MW of wind capacity from the Stateline Wind Project and added 42 MW of new capacity to its hydroelectric fleet through project upgrades. Avista gained control of the output for the 270 MW Lancaster Generating Facility through a long-term tolling arrangement on January 1, 2010. The Company plans to upgrade its Nine Mile Falls project. The upgrade could involve replacement with in-kind equipment or a new powerhouse. Avista plans to complete the last turbine runner upgrade at Noxon Rapids in 2012, adding seven MW (1 aMW) to the project's capability.

Figure 8.1: Resource Acquisition History



Resource Selection Process

Avista uses several decision support systems to develop its resource strategy. The PRS relies on results from the PRiSM model whose objective function is to meet resource deficits while accounting for overall cost, risk, renewable energy requirements, and other constraints. The AURORAxmp model, discussed in detail in the Market Analysis chapter, calculates the operating margin (value) of every resource option considered in each of 500 potential future outcomes. PRiSM evaluates resource values by combining operating margins with capital and fixed operating costs. From an efficient frontier, Avista selects a resource mix meeting all capacity, energy, RPS, and other requirements.

PRiSM

Avista staff developed the PRiSM model in 2002 to support PRS selection. PRiSM uses a linear programming routine to support complex decision making with multiple objectives. Linear programming tools provide optimal values for variables, given system constraints.

Overview of the PRiSM Model

The PRiSM model requires a number of inputs:

1. Expected Future Deficiencies
    - Summer 18-hour capacity
    - Winter 18-hour capacity
    - Annual energy
    - I-937 RPS Requirements
2. Costs to Serve Future Retail Loads
3. Existing Resource Contributions
    - Operating margins
    - Carbon emission levels
4. Resource Options
    - Fixed operating costs
    - Return on capital
    - Interest expense
    - Taxes
    - Generation levels
    - Emission levels
5. Limitations
    - Market reliance (surplus/deficit limits on energy, capacity and RPS)
    - Resources available to meet future deficits
    - Resource retirement limits (function disabled for 2011 IRP)
    - Capital expenditure limits (function disabled for 2011 IRP)
    - Emission levels (function disabled for 2011 IRP)

PRiSM uses these inputs to develop an optimal resource mix over time at varying levels of cost and resultant risk levels. It weights the first decade more heavily than the later years to highlight the importance of near-term decisions. A simplified view of the PRiSM linear programming objective function is below.

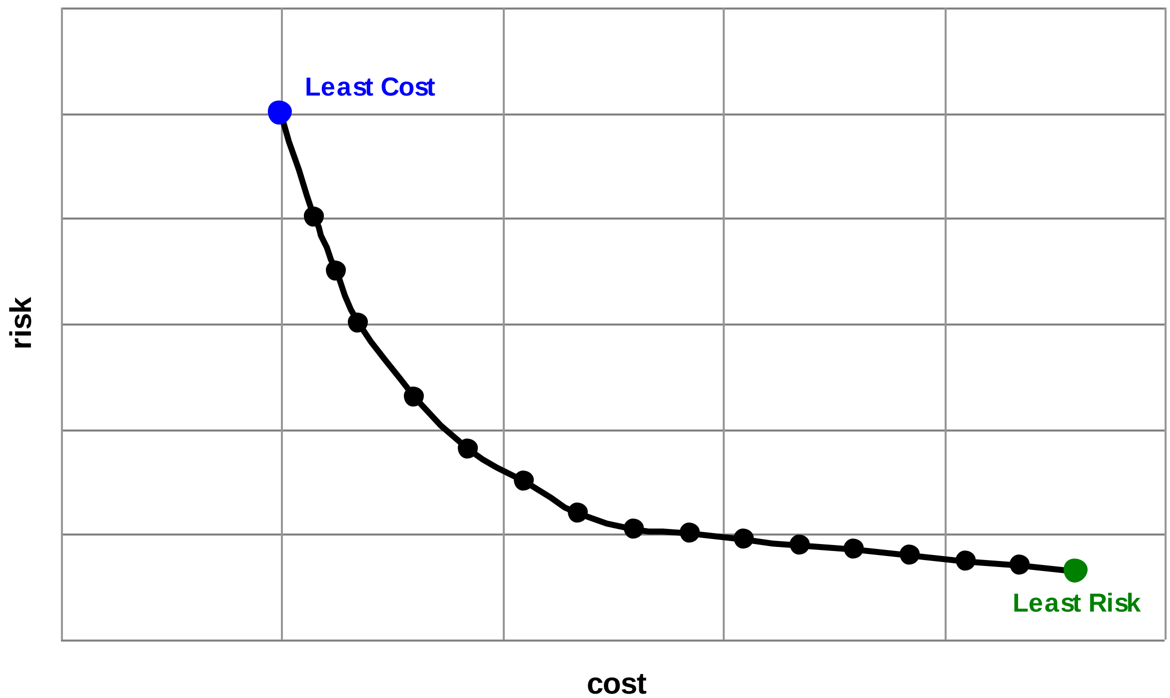
PRiSM Objective Function

Minimize: $(X_1 * NPV_{2012\text{-}2022}) + (X_2 * NPV_{2012\text{-}2031}) + (X_3 * NPV_{2012\text{-}2061})$

Where: X_1 = Weight of net costs over the first 10 years (75 percent)
X_2 = Weight of net costs over 20 years of the plan (20 percent)
X_3 = Weight of net costs over the next 50 years (5 percent)
NPV is the net present value of total cost (existing resource marginal costs, all future resource fixed and variable costs, and all future conservation costs and the net short-term market sales/purchases).

An efficient frontier captures the optimal mix of resources, given varying levels of cost and risk. Figure 8.2 illustrates the efficient frontier concept. The optimal point on the efficient frontier curve depends on the level of risk Avista and its customers are willing to accept. Environmental legislation, cost, regulation, and the availability of commercially ready technologies greatly limit utility-scale resource options. The model does not meet deficits with market purchases, or allow the construction of resources in any increment needed.[1] Instead, the model uses market purchases to fill short-term gaps and constructs resources in block sizes equal to the actual project capacities.

Figure 8.2: Conceptual Efficient Frontier Curve



Constraints

As discussed earlier in this chapter, reflecting real-world constraints in the model is necessary to create a realistic representation of the future. Some constraints are physical and others are societal. The major resource constraints are capacity and energy needs, Washington's RPS, and the greenhouse gas emissions performance standard.

The PRiSM model is limited to choosing resources by type and by size. It can select from combined- and simple-cycle natural gas-fired combustion turbines, wind, and upgrades to existing thermal resources, and conservation. Sequestered and non-sequestered coal plants are not an option in this IRP because of Washington's emissions performance standard. Detailed hydroelectric upgrade potentials were not available during PRS development and are not included as resource options.

Washington's RPS fundamentally changed how the Company meets future loads. Before the addition of an RPS obligation, the efficient frontier contained a least-cost strategy on one axis and the least-risk strategy on the other axis, and all of the points in between. Next, management used the efficient frontier to determine where they wanted to be on the cost-risk continuum. The least cost strategy typically consisted of gas-fired

[1] Market reliance, as identified in Section 2, is determined prior to PRiSM's optimization.

peaking resources. Portfolios with less risk generally replaced some of the gas-fired peaking resources with wind generation, other renewables, combined cycle gas-fired plants, or coal-fired resources. Past IRPs identified resource strategies that included all of these risk-reducing resources.

Added environmental and legislative constraints greatly reduce the ability to reduce future costs and/or risks and require the procurement of renewable generation resources that previously were included for risk-mitigation. Because significant levels of renewable generation are required under Washington law, the 2011 IRP strategy simply complies with environmental and legislative constraints.

Resource Deficiencies

Avista no longer uses a one-hour peak planning methodology, instead using the peak planning methodology recommended by the Northwest Power and Conservation Council – three-day, 18-hour (6 hours each day) peak events occurring both in the summer and winter. This method better emulates the Northwest and Avista's actual ability to meet short-term peak events with hydroelectric facilities. Avista accounts for the regional view of surplus power and includes a pro-rata share of regional surpluses when available. Finally, the peak planning methodology includes other operating reserves and a planning margin.

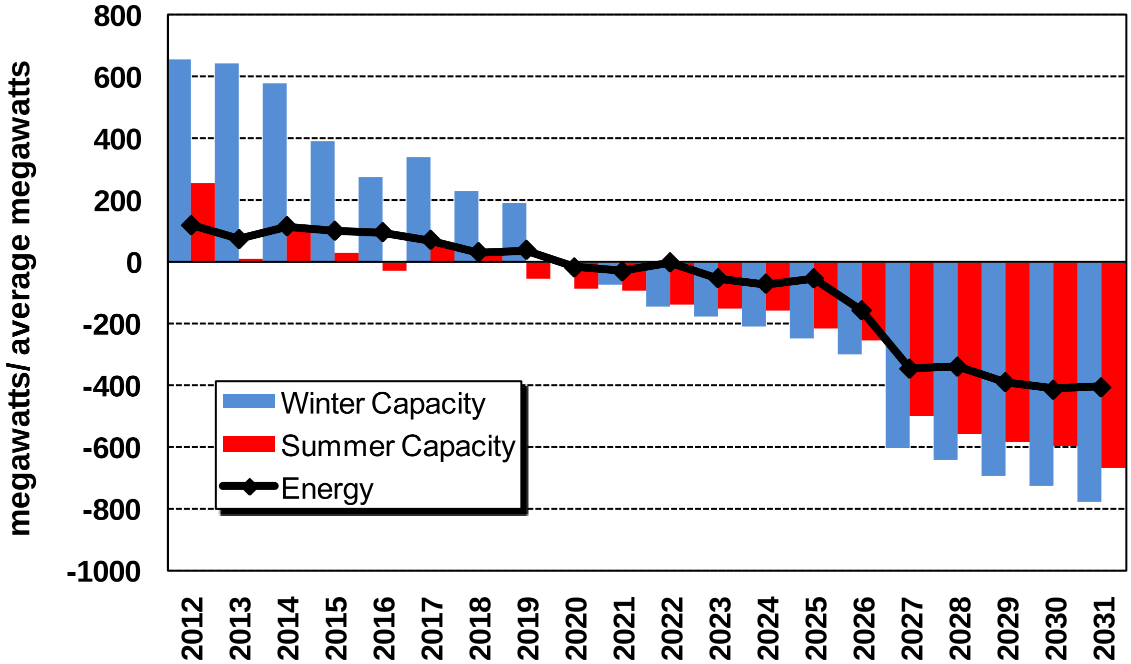
Even with the new peak planning methodology, Avista currently projects having adequate resources between owned and contractually controlled generation to meet annual physical energy and capacity needs until 2016.[2] See Figure 8.3 for Avista's physical resource positions for annual energy, summer capacity, and winter capacity. This figure accounts for the effects of new energy efficiency programs on the load forecast. Absent energy efficiency, our resource position would be deficient earlier. The first capacity deficit is short-lived because a 150 MW capacity sale contract ends in 2016. Avista likely will address the 2016 capacity deficit with market purchases as 2016 approaches; therefore, the first long-term capacity deficit begins in the summer of 2019.

Avista's resource portfolio has 281 MW of natural gas-fired peaking plants available to serve winter loads and 201 MW available in the summer. For long-term planning, these resources are available to generate energy at their full capabilities. Operationally, less expensive wholesale marketplace purchases may displace Avista's available resources. On an annual average basis, our loads and resources fall out of balance in 2020 for energy; the first quarterly energy deficit is in the first quarter of 2013.

PRiSM selects new resources to fill capacity and energy deficits, although the model may over- or under-build where economics support it. Because of acquisitions driven by capacity RPS compliance, large energy surpluses result. See Figure 8.3.

[2] See Chapter 2 for further details on this peak planning methodology.

Figure 8.3: Physical Resource Positions (Includes Conservation)



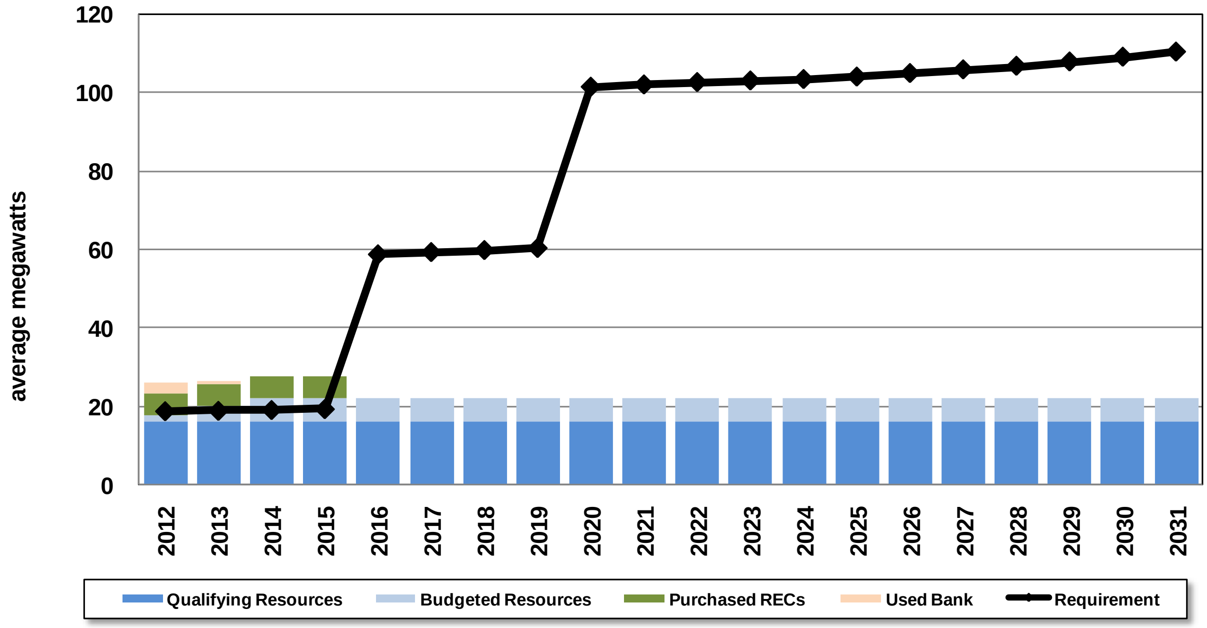
Renewable Portfolio Standards

Washington voters approved the Energy Independence Act through Initiative 937 (I-937) in the November 2006 general election. I-937 requires utilities with over 25,000 customers to meet three percent of retail load from qualified renewable resources by 2012, nine percent by 2016, and 15 percent by 2020. The initiative also requires utilities to acquire all cost-effective conservation and energy efficiency measures. The Company has been participating in the UTC's Renewable Portfolio Standard Workgroup at the Washington Commission.

Avista expects to meet or exceed its renewable energy requirements between 2012 and 2015 through a combination of qualifying hydroelectric upgrades, the Palouse Wind project, and a REC purchase. Projected REC positions are in Figure 8.4[3]. I-937 includes the flexibility to use RECs from the current year, from the previous year, or from the following year for compliance. REC contingency reserves will be "banked" each year to account for compliance variability driven by loads and hydroelectric and wind generation variation. Projected requirements and new resources used to meet future RPS obligations are in Table 8.31.

[3] Figure 8.4 does not show the expected RECs from the Palouse Wind contract, which was signed after the modeling for the 2011 was completed.

Figure 8.4: REC Requirements vs. Qualifying RECs for Washington State RPS



Preferred Resource Strategy

The 2011 PRS consists of existing thermal resource upgrades, wind, conservation, and natural gas-fired simple and combined cycle gas turbines. The first resource acquisition is approximately 42 aMW of wind by the end of 2012 to take advantage of federal tax incentives.[4]

Avista will rebuild distribution feeders over the next twenty years. The PRS includes 27 MW of peak capacity savings and 13 aMW of energy savings from smart grid and distribution feeder initiatives. More discussion on this topic is included in the distribution upgrades section of the Transmission and Distribution chapter.

The PRiSM model selected an 83 MW simple cycle combustion turbine as its first large capacity addition by the end of 2018. Another 83 MW simple cycle combustion turbine follows by the end of 2020. Also in the 2018 to 20 period, existing thermal unit upgrades add 4 MW of capacity. The PRS adds 43 aMW of additional wind by the end of 2019-20 to meet the 15 percent renewable energy goal.

The PRS includes a 270 MW natural gas-fired combined-cycle combustion turbine (CCCT) in 2023, and another 270 MW CCCT in 2026, to meet projected capacity deficits created by the expiration of the Lancaster tolling agreement. Following this need is a 46 MW simple cycle turbine. In total, the PRS adds 1,024 MW of new generation capacity by the end of the IRP forecast. Table 8.1 presents the 2011 PRS resource types, timing and sizes.

[4] Avista met this requirement through a 2011 RFP process that selected the Palouse Wind Project.

Table 8.1: 2011 Preferred Resource Strategy

Resource	By the End of Year	Nameplate (MW)	Energy (aMW)
NW Wind	2012	120	35
SCCT	2018	83	75
Existing Thermal Resource Upgrades	2019	4	3
NW Wind	2019-2020	120	35
SCCT	2020	83	75
CCCT	2023	270	237
CCCT	2026	270	237
SCCT	2029	46	42
Total		**996**	**739**
Efficiency Improvements	**By the End of Year**	**Peak Reduction (MW)**	**Energy (aMW)**
Distribution Efficiencies	2012-2031	28	13
Energy Efficiency	2012-2031	419	310
Total		**447**	**323**

Table 8.2 shows the 2009 Preferred Resource Strategy. The major differences in the 2011 plan are a reduction in the quantity of wind resources and a switch to a combination of simple and combined cycle resources from only combined cycle gas-fired resources.

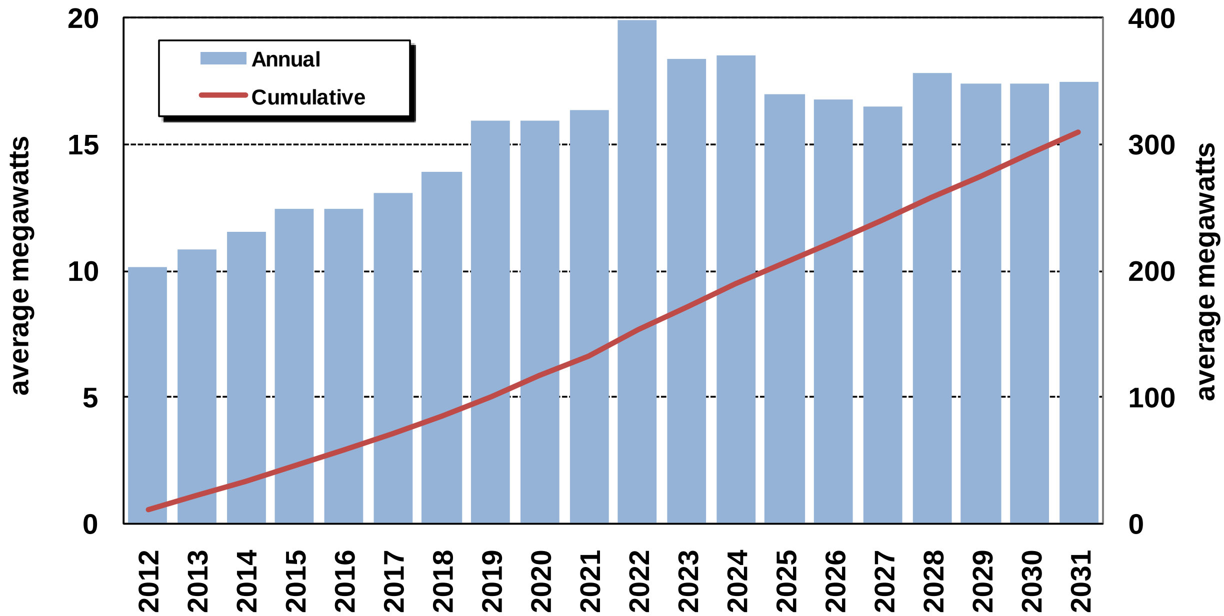
Table 8.2: 2009 Preferred Resource Strategy

Resource	By the End of Year	Nameplate (MW)	Energy (aMW)
Northwest Wind	2012	150	48
Little Falls Unit Upgrades	2013-2016	3	1
Northwest Wind	2019	150	50
Combined-Cycle Combustion Turbine	2019	250	225
Upper Falls	2020	2	1
Northwest Wind	2022	50	17
Combined-Cycle Combustion Turbine	2024	250	225
Combined-Cycle Combustion Turbine	2027	250	225
Total		**1,105**	**792**
Efficiency Improvements	**By the End of Year**	**Peak Reduction (MW)**	**Energy (aMW)**
Distribution Efficiencies	2010-2015	5	3
Energy Efficiency	2010-2029	339	226
Total		**344**	**229**

Energy Efficiency

Energy efficiency is an integral part of the PRS analytical process. Energy efficiency is also a critical component of I-937, where utilities are required to obtain all cost effective conservation. Avista developed avoided energy costs and compared those figures against a conservation supply curve developed by Global Energy Partners. The 20-year forecast of energy efficiency acquisitions is in Figure 8.5. Avista plans to acquire 133 aMW of energy efficiency over the next 10 years and 310 aMW over 20 years. These acquisitions will reduce system peak, shaving 207 MW from by 2022, and 419 MW in 2031. Please refer to Chapter 3 for a more detailed discussion of energy efficiency resources.

Figure 8.5: Energy Efficiency Annual Expected Acquisition



Palouse Wind

On February 22, 2011, Avista issued a request for proposals (RFP) for I-937-qualifying renewable energy. Following the RFP, Avista selected the Palouse Wind project located between Rosalia and Oakesdale, Washington. The project will have a maximum capability of approximately 100 MW and an expected annual average energy output of 40 aMW. The contract is a 30-year power purchase agreement with a purchase option after year 10. The project should be on-line in the second half of 2012. This new resource is not included in the PRS as it was under contract negotiation during the development of this plan, this resource meets the PRS Northwest Wind resource need in 2012.

Reardan Wind Project

Avista purchased development rights for a wind site located in its service territory near Reardan, Washington, from Energy Northwest in 2008. The fully permitted site has several years of meteorological data and is ready for construction. This wind site is competitive to higher capacity factor sites, as the project does not require any third-party transmission and is located near Avista work crews.[5] This site could supply between 50 MW and 100 MW of wind generation. With the acquisition of the Palouse Wind project, development at Reardan is not likely prior to 2018-19.

Little Falls Hydro Upgrades

The 2009 PRS included 0.9 aMW of incremental energy from upgrades to the Little Falls project between 2013 and 2016. When preparing this plan, Avista expected in-kind turbine replacements and no incremental energy. Additional study and modeling identified up to three aMW of incremental energy that will qualify for Washington's Energy Independence Act. Final decisions about the upgrades are still pending. Analysis around this option continues and an update will be in the 2013 IRP.

Distribution Feeder Upgrades

Distribution feeder upgrades were in the PRS for the first time in the 2009 IRP. The feeder upgrade process began with an upgrade to the Ninth & Central Streets feeder in Spokane. The decision to rebuild a feeder considers energy savings, operation and maintenance savings, the age of existing equipment, reliability indexes, and the number of customers on the feeder. Based on analyses performed for this IRP, Avista likely will rebuild many of its distribution feeders, limited to five or six per year due to financial and staffing limitations. Feeder rebuild projects will begin in 2012 or 2013 and the Company will allocate resources after prioritizing the projects. Savings are subject to change after further detailed cost analyses and rebuild schedules are completed and more information is provided in Chapter 5.

Simple Cycle Combustion Turbines

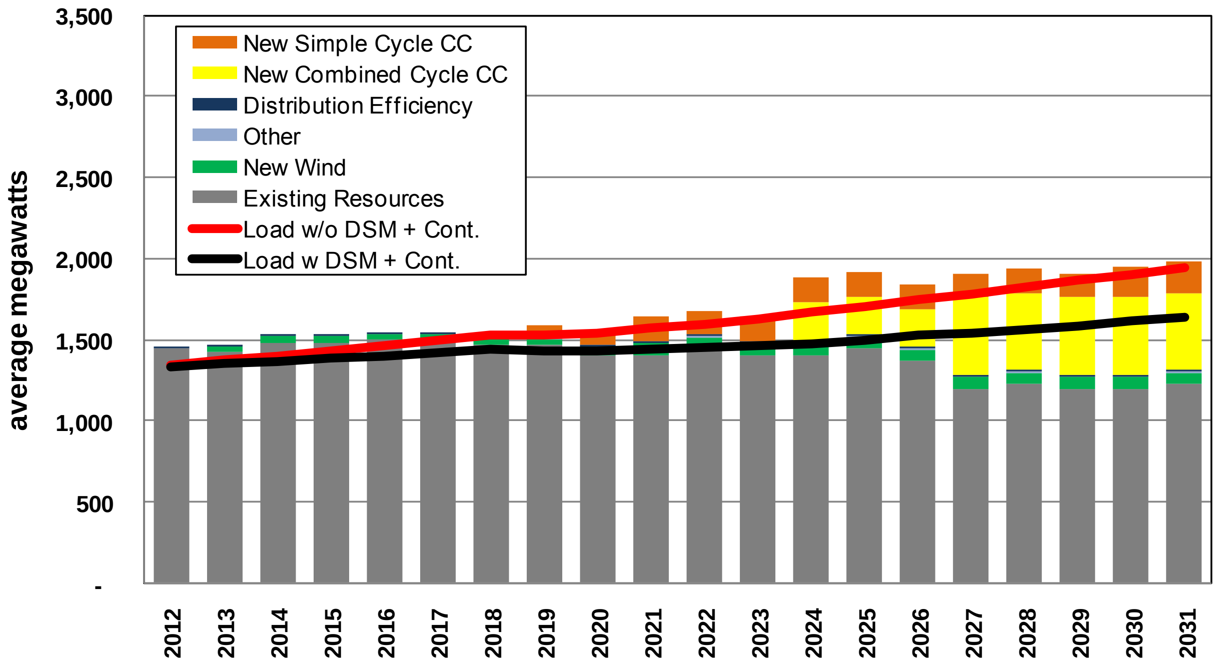
Avista plans to identify potential sites for new gas-fired generation capacity within its service territory ahead of an anticipated 2019 need. Avista's service territory has areas with different combinations of benefits and costs. Locations in Washington would have higher generation costs because of natural gas fuel taxes and carbon mitigation fees. However, the potential benefits of a Washington location, including proximity to natural gas pipelines and Avista's transmission system; lower project elevations that provide higher on-peak capacity contributions per investment dollar; and water to cool the facility, might outweigh the costs. In Idaho, lower taxes and fees decrease the cost of a potential facility, but there are fewer locations to site a facility near natural gas pipelines, fewer low cost transmission interconnections, and fewer sites with adequate cooling water. The identification and procurement of a natural gas project site option is an Action Item for this IRP.

Loads and Resources Positions

Conservation acquisitions identified in this IRP reduce the load forecast, as shown in Figure 8.6. The red line illustrates the Company's load obligation absent energy efficiency programs. Absent conservation, Avista would need new resources in 2018 rather than 2020.

[5] Higher capacity factor wind sites are generally located outside of Avista's service territory.

Figure 8.6: Annual Average Load and Resource Balance



The first winter peak deficit without the conservation resource would occur in 2020, but the deficit does not occur until 2022 with the acquisition of new energy efficiency measures (see Figure 8.7). Avista expects to have modest short-term resource deficits prior to 2022 and intends to meet these deficiencies with market purchases rather than acquiring a resource prior to a sustained need. An analysis of regional loads and resources support the Company's position that existing regional capacity should be available to support a robust short-term wholesale market in the timeframe required. A capacity resource could replace market purchases, without a significant impact on the long-term portfolio cost, if conditions change and the Company determines that it cannot depend on the regional market surplus during this period.

The summer peak load and resource position shows a capacity need prior to the first winter need. Avista's peak loads are lower in summer than in the winter, but the impacts on hydroelectric and thermal generation capacity in the summer, due to lower flow conditions and high temperatures, are greater than the load differences. As shown in Figure 8.8, summer resource deficits occur in 2013 without conservation and in 2016 (short-term) and 2019 (long-term) with conservation measures. The Company plans to fill the short-term summer capacity deficit in 2016 with market purchases. Beginning in 2022, summer deficits no longer drive Avista's capacity needs due to the expiration of the WNP-3 contract in 2019.

Figure 8.7: Winter Peak Load and Resource Balance

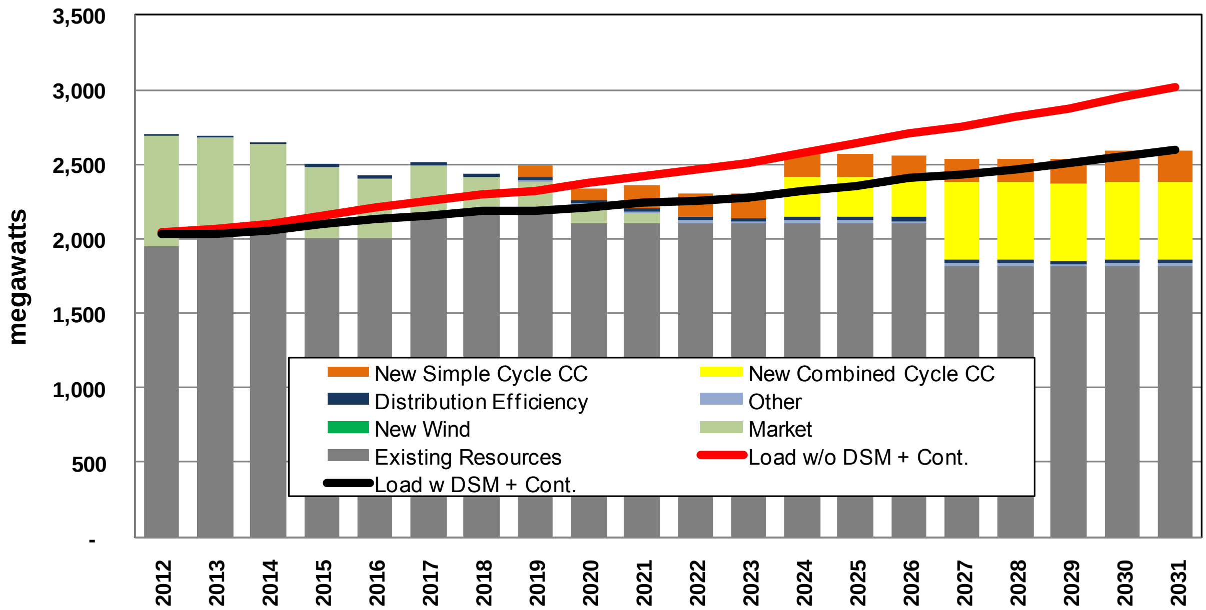
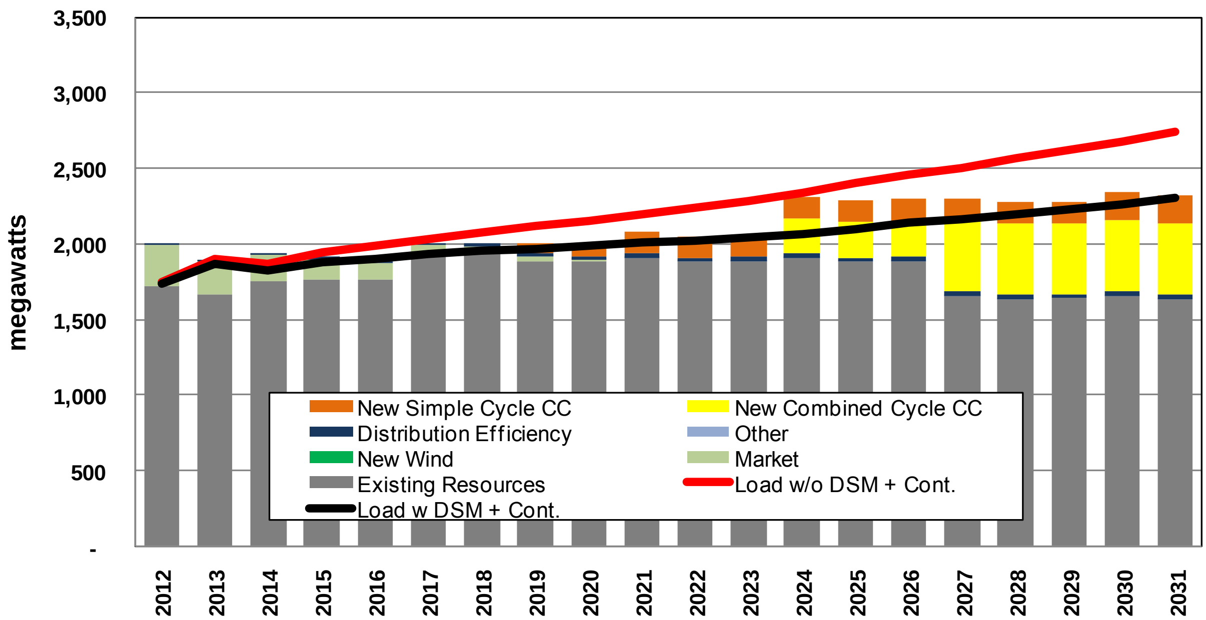


Figure 8.8: Summer Peak Load and Resource Balance



Under Washington regulation (WAC 480-107-15), utilities having generation capacity deficits within three years of an IRP filing must also file a proposed Request for Proposals (RFP) with the Washington Utilities and Transportation Commission (UTC). The RFP is due to the UTC no later than 135 days after the IRP filing. After UTC approval, bids to meet the anticipated capacity shortfall must be solicited within 30 days.

Tables 8.28 and 8.29, shown later in this section, detail Avista's capacity position over the IRP timeframe. With a portion of loads met by Avista's share of the regional capacity surplus, Avista does not require winter capacity until 2022. A summer capacity deficiency does not occur until 2016. Simplified summaries are below in Tables 8.3 and 8.4. They show Avista does not require capacity in the next three years; therefore an RFP is not required under WAC 480-107-15.

Table 8.3: Avista Medium-Term Winter Capacity Tabulation

	2012	2013	2014
Load Obligations	1,890	1,912	1,892
Reserves Planning	371	356	358
Total Obligations	**2,261**	**2,268**	**2,250**
Utility Resources	2,192	2,267	2,277
NW Market Share	737	656	565
Total Resources	**2,929**	**2,923**	**2,842**
Net Position	**668**	**655**	**592**

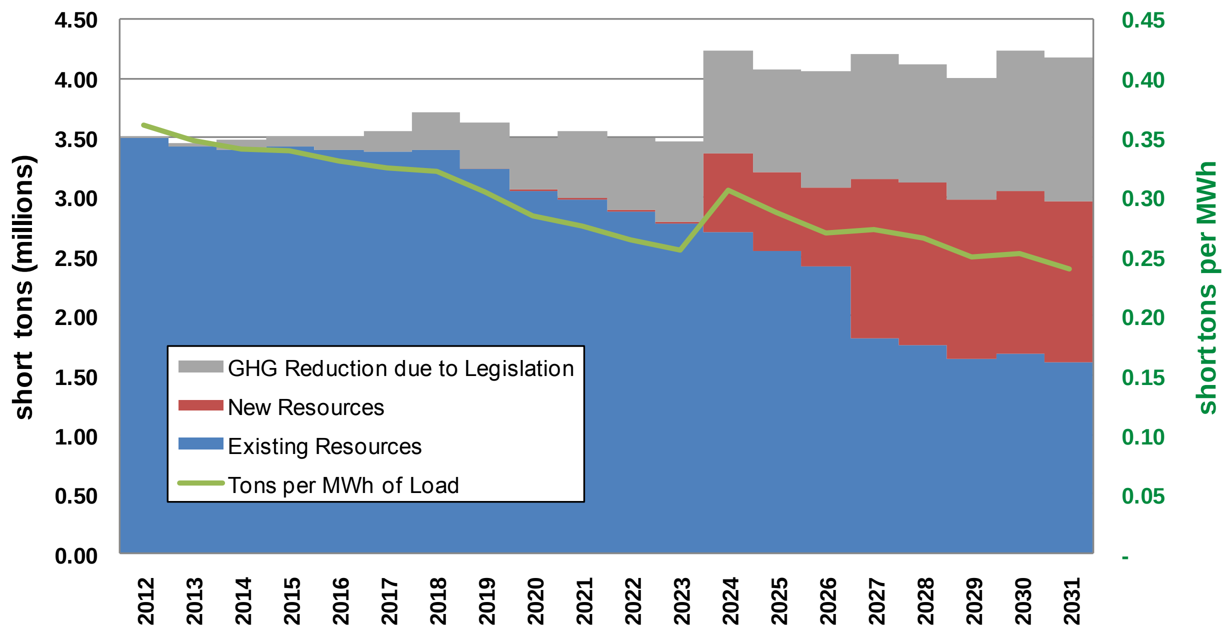
Table 8.4: Avista Medium-Term Summer Capacity Tabulation

	2012	2013	2014
Load Obligations	1,743	1,756	1,785
Reserves Planning	227	322	238
Total Obligations	**1,970**	**2,078**	**2,023**
Utility Resources	1,960	1,880	1,962
NW Market Availability	275	221	178
Total Resources	**2,235**	**2,101**	**2,140**
Net Position	**265**	**23**	**117**

Greenhouse Gas Emissions

The Market Analysis chapter discusses how greenhouse gas emissions from electric generation in the Western Interconnect decrease due to the addition of carbon emission penalties. Avista's greenhouse gas emissions should fall because of anticipated carbon reduction policies. Greenhouse gas policies will affect higher-cost coal facilities before affecting low operating cost facilities, such as Colstrip. New or underutilized natural gas-fired resources located closer to west coast load centers will replace the coal-fired facilities. Figure 8.9 presents expected greenhouse gas emissions with the addition of PRS resources. Overall Company greenhouse gas emissions should fall starting in 2020 as Colstrip output decreases and natural gas-fired generation increases. The 2024 increase in emissions shown in Figure 8.9 comes from a new CCCT resource. These emission estimates do not include emissions produced from purchased power or include a reduction in emissions for off-system sales. The Company expects its greenhouse gas emissions intensity from owned and controlled generation to fall from 0.36 short tons per MWh to 0.24 short tons per MWh with the current resource mix and the generation identified in the PRS[6].

Figure 8.9: Avista Owned and Controlled Resource's Greenhouse Gas Emissions



Greenhouse gas policy has a clear impact on Avista's future resource mix. Absent carbon policy, cumulative greenhouse gas emissions over the 20-year IRP timeframe would be 18 percent higher, with the difference growing each year of the forecast. By 2031, annual emissions would be 29 percent higher without carbon mitigation. The gray area illustrates these differences in Figure 8.9.

Efficient Frontier Analysis

Efficient frontier analysis is the backbone of the Preferred Resource Strategy. PRiSM helps develop the efficient frontier by simulating the costs and risks of several different resource portfolios. The analysis illustrates the relative performance of potential portfolios to each other on a cost and risk basis. Thought of a different way, the curve represents the least-cost strategy at each risk level. The PRS analyses examined the following portfolios, as detailed here and in Figure 8.10:

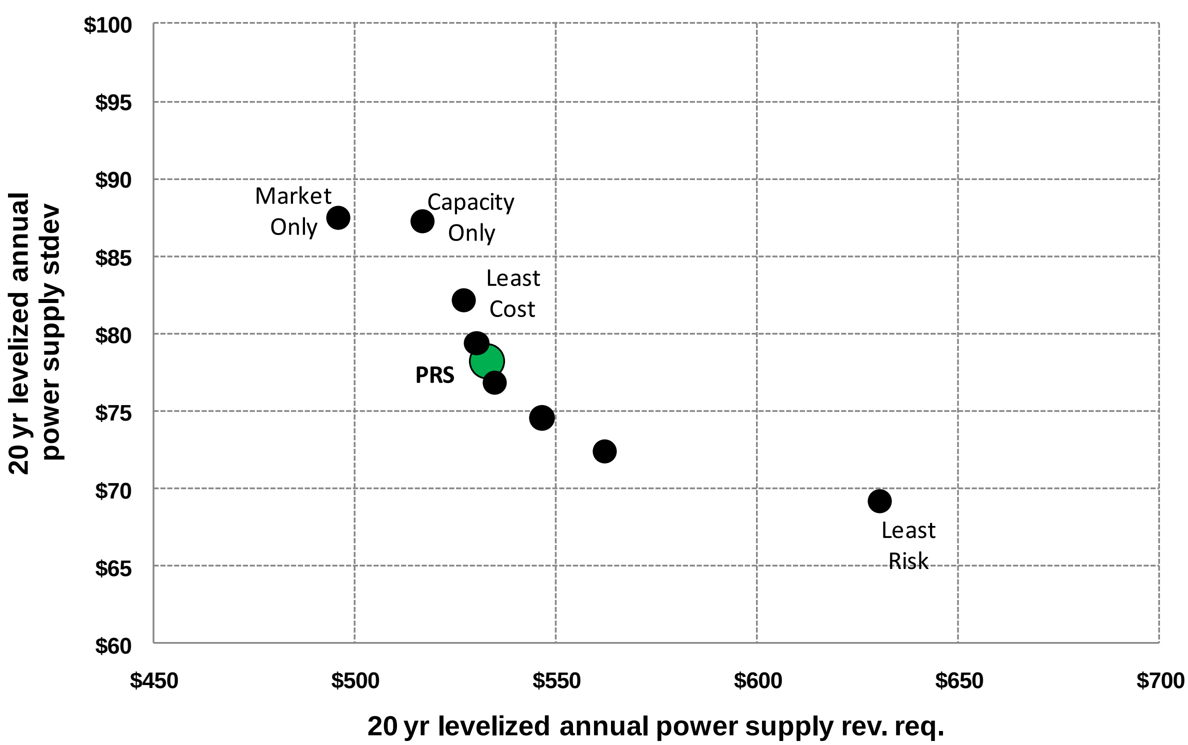
- **Market Only**: All resource deficits met with spot market purchases.
- **Capacity Only**: Only capacity deficits met with new resources. Energy and RPS requirements ignored.

[6] Greenhouse gas emissions are not included for the Kettle Falls plant because biomass is a carbon neutral resource.

- **Least Cost**: All capacity, energy and RPS requirements met with new least-cost resources. This portfolio ignores power supply expense volatility in favor of lowest cost resources.
- **Least Risk**: All capacity, energy and RPS requirements met with least-risk resources. This portfolio ignores the overall cost of the selected portfolio in favor of minimizing risk.
- **Efficient Frontier:** All capacity, energy and RPS requirements met with sets of intermediate portfolios between the least risk and least cost options.
- **Preferred Resource Strategy**: All capacity, energy and RPS requirements met while recognizing both the overall cost and risk inherent in the portfolio.

Figure 8.10 presents the Efficient Frontier. The x-axis is the levelized nominal cost per year for power supply costs and the y-axis is the levelized standard deviation of power supply costs.

Figure 8.10: Expected Case Efficient Frontier



The Market Only portfolio is least cost from a long-term financial perspective, but it has the highest level of risk. The strategy fails to meet capacity, energy, and RPS requirements with Company-controlled assets.

The Capacity Only strategy meets capacity requirements by adding gas-fired peaking plants, but wholesale market purchases displace them in most hours. This strategy does not meet RPS requirements and does not decrease power supply cost volatility, except at the tail of the distribution. The Least Cost strategy meets capacity, energy and RPS requirements at the lowest possible cost by adding gas-fired peaking plants and minimum levels of wind generation to meet Washington State RPS requirements. The Least Risk strategy substantially replaces gas-fired peaking plants with gas-fired combined-cycle combustion turbines, increases the quantity of wind resources, and adds solar resources to the mix.

All portfolios along the efficient frontier are the least cost portfolio for a given level of risk and portfolio constraints. The decision to select a particular portfolio along the efficient frontier curve focuses on volatility reductions gained by spending more capital. Avista management determines the ultimate selection of the PRS over other potential resource strategies in an effort to balance overall long-term customer costs with the risks of year-over-year expense variability. The PRS includes 1.2 percent more costs on average and 4.5 percent less volatility compared to the Least Cost portfolio.

Avoided Costs

The efficient frontier methodology can determine the avoided cost of new resource additions. There are two avoided cost calculations for this IRP; one for energy efficiency and one for new generation resources.

Avoided Cost of Conservation

Three portfolios are required to estimate the supply-side cost components necessary to estimate the avoided cost for conservation. The differences between each portfolio sum to the avoided cost of conservation:

- **Market Only:** This resource portfolio includes no new resource additions and the incremental cost of new power supply is the cost to buy power from the short-term market. The price difference between the Expected Case and the Unconstrained Carbon scenario is the greenhouse gas policy cost.
- **Capacity Only:** This resource portfolio builds new resource capacity to meet resource deficits to meet peak load. The difference between the Market Only and Capacity Only strategies equals the capacity value of the new resources. This estimate typically shows the incremental cost divided by the incremental kilowatts of installed capacity. For this example the $/kW adder is translated to $/MWh assuming a flat energy delivery.
- **Pre-Preferred Resource Strategy:** This resource portfolio is similar to the PRS resource mix assuming the Company does not pursue the conservation resource.

Table 8.5 shows the 20-year levelized avoided cost of conservation. The avoided cost for conservation includes value only for those periods realizing avoided costs. For example, the avoided costs of conservation programs only include a capacity value in the years where the Company is short capacity. Further, the market component (Energy Forecast) applies to each conservation program depending upon the timing of energy delivery. For example, an air conditioning program receives an energy value depending upon prices in the summer months when actual energy savings occur.

Table 8.5: Nominal Levelized Avoided Costs ($/MWh)

	2012-2031
Energy Forecast	52.86
Carbon Adder Forecast	17.64
Capacity Value	10.51
Risk Premium	7.38
Total	**88.39**

I-937 requires that the avoided costs used for conservation include additional items beyond the actual cost of avoided energy and capacity. Avoided costs increase by 10 percent to bias the IRP toward a preference for conservation. Additionally, reduced transmission and distribution losses, and operations and maintenance are also included. The following formula identifies the costs included in the avoided cost for energy efficiency measures.

$$\{(E + PC + R) * (1 + P)\} * (1 + L) + DC * (1 + L)$$

Where:

E = Market energy price. The price calculated with AURORAxmp is $70.50 per MWh and includes projected greenhouse gas costs.

PC = New resource capacity savings. This value is calculated using PRiSM and is estimated to be $10.51 per MWh.

R = Risk premium to account for RPS and rate volatility reductions. This PRiSM-calculated value is $7.38 per MWh.

P = Power Act preference premium. This is the additional 10 percent premium given as a preference towards energy efficiency measures.

L = Transmission and distribution losses. This component is 6.1 percent based on Avista’s estimated system average losses.

DC = Distribution capacity savings. This value is approximately $10/kW-year or $1.14 per MWh.

The following calculation shows the estimated levelized avoided cost for a theoretical conservation program that reduces load by one megawatt each hour of the year:

$$\{[(52.86 + 17.64 + 10.51 + 7.38) * (1 + 10\%)] * (1 + 6.1\%) + [1.14 * (1 + 6.1\%)]\}$$
$$= \$104.37 \text{ per MWh}$$

Preferred Resource Strategy Avoided Costs

An avoided cost calculation for supply-side resources is developed using conservation avoided cost estimates and methods, and final PRS data. However, the avoided cost values for generation resources represent a portfolio including conservation measures and excluding greenhouse gas emission adders.[7] The risk component of the avoided cost includes renewable energy credits and the difference in cost between combined and simple cycle CTs to reduce Avista's market risk. See Table 8.6 for the prices per MWh. The 20-year levelized cost equates to $84.64 per MWh.

Table 8.6: Preferred Resource Strategy Avoided Cost ($/MWh)

Year	Energy	Capacity	Risk	Total
2012	41.19	0.00	0.00	41.19
2013	46.58	0.00	15.20	61.78
2014	49.73	0.00	16.21	65.93
2015	46.76	0.00	17.28	64.04
2016	48.20	0.00	18.42	66.62
2017	51.15	0.00	19.64	70.79
2018	52.91	0.00	20.94	73.85
2019	52.97	16.16	22.33	91.46
2020	53.25	17.52	23.81	94.58
2021	54.45	17.00	25.39	96.83
2022	56.15	16.71	27.07	99.93
2023	57.82	17.18	28.86	103.86
2024	56.89	17.24	30.77	104.90
2025	56.80	17.16	32.81	106.77
2026	58.82	17.42	34.98	111.23
2027	60.36	17.72	37.30	115.38
2028	63.08	18.86	39.77	121.71
2029	64.51	18.54	42.41	125.45
2030	66.29	18.21	45.21	129.71
2031	68.89	17.70	48.21	134.79

New Resource Avoided Costs

Avoided costs are updated as new information becomes available, including changes to market prices, loads and resources. As such, Table 8.7 represents avoided costs after the acquisition of the Palouse Wind project. The updated avoided cost schedule is significantly lower than the preliminary value due substantially to the elimination of the risk premium. The risk premium is not included in the updated avoided cost table for three reasons. First, the largest component of the risk premium is the value of meeting environmental mandates. The risk premium reflects those resources meeting Washington state renewable performance standard, but there is no guarantee that a new resource will meet the requirements. Further, Avista's regulatory commissions have

[7] No further greenhouse gas mitigation policies beyond current state and federal regulations are included. As such, the resource avoided cost calculation does not include this adder. Only when state or federally imposed greenhouse gas costs are assessed on electric generation will the carbon adder be included in avoided costs.

not ruled that environmental benefits (i.e., renewable energy credits) from Public Utility Regulatory Policy Act of 1978 (PURPA) resources are owned by the purchasing utility. Similarly, the remaining portion of reduced risk is from the benefits of a combined-cycle combustion turbine relative to a simple-cycle combustion turbine. As with environmental attributes, there is no guarantee that a PURPA or other resource will include this benefit. Quantifying the risk benefits requires resource-specific evaluations through Avista's IRP models is part of a negotiated PURPA contract. The updated 20-year levelized avoided cost is $61.46 per MWh.

Table 8.7: Updated Annual Avoided Costs ($/MWh)

Year	Energy	Capacity	Total
2012	41.19	0.00	41.19
2013	46.58	0.00	46.58
2014	49.73	0.00	49.73
2015	46.76	0.00	46.76
2016	48.20	0.00	48.20
2017	51.15	0.00	51.15
2018	52.91	0.00	52.91
2019	52.97	16.16	69.13
2020	53.25	17.52	70.77
2021	54.45	17.00	71.44
2022	56.15	16.71	72.86
2023	57.82	17.18	75.00
2024	56.89	17.24	74.12
2025	56.80	17.16	73.96
2026	58.82	17.42	76.24
2027	60.36	17.72	78.08
2028	63.08	18.86	81.94
2029	64.51	18.54	83.05
2030	66.29	18.21	84.50
2031	68.89	17.70	86.59

Preferred Resource Strategy

Earlier in this chapter, the PRS and summary levelized costs and risk were illustrated and compared to portfolios along the efficient frontier. This section provides more detail about the PRS, the associated financial risks of the PRS, the cost of its resultant emissions, and an index of resultant power supply expenses.

Capital Spending Requirements

One of the major assumptions in this IRP is that Avista finances and owns all new resources. Using this assumption, and the resources identified in the PRS, the first capital addition to rate base is in 2013 for distribution feeder upgrades, followed by additional capital needs for PRS wind development[8]. Wind or other generation

[8] Avista acquired the Palouse Wind Project through a Purchase Power Agreement and this capital addition is no longer needed.

resources acquired via a power purchase agreement may reduce expected PRS capital spending. Distribution feeder upgrades may begin in 2012 depending upon operational availability of resources needed for the work, but 2013 will be the first full year of commercial operations.

The capital cash flows in Table 8.8 include allowance for funds used during construction (AFUDC) and account for tax incentives and sales taxes. Costs in Table 8.7 are shown when capital would be placed in rate base, rather than when capital is actually spent. The present value of the required investment is just over $0.84 billion and the nominal total capital expense is $1.7 billion over the IRP timeframe.

Table 8.8: PRS Rate Base Additions from Capital Expenditures (Millions of Dollars)[9]

Year	Investment	Year	Investment
2012	0	2022	6
2013	243	2023	6
2014	6	2024	448
2015	6	2025	0
2016	6	2026	0
2017	4	2027	461
2018	7	2028	0
2019	77	2029	0
2020	90	2030	74
2021	251	2031	0
2012-21 Total	**690**	**2022-31 Totals**	**994**

Annual Power Supply Expenses and Volatility

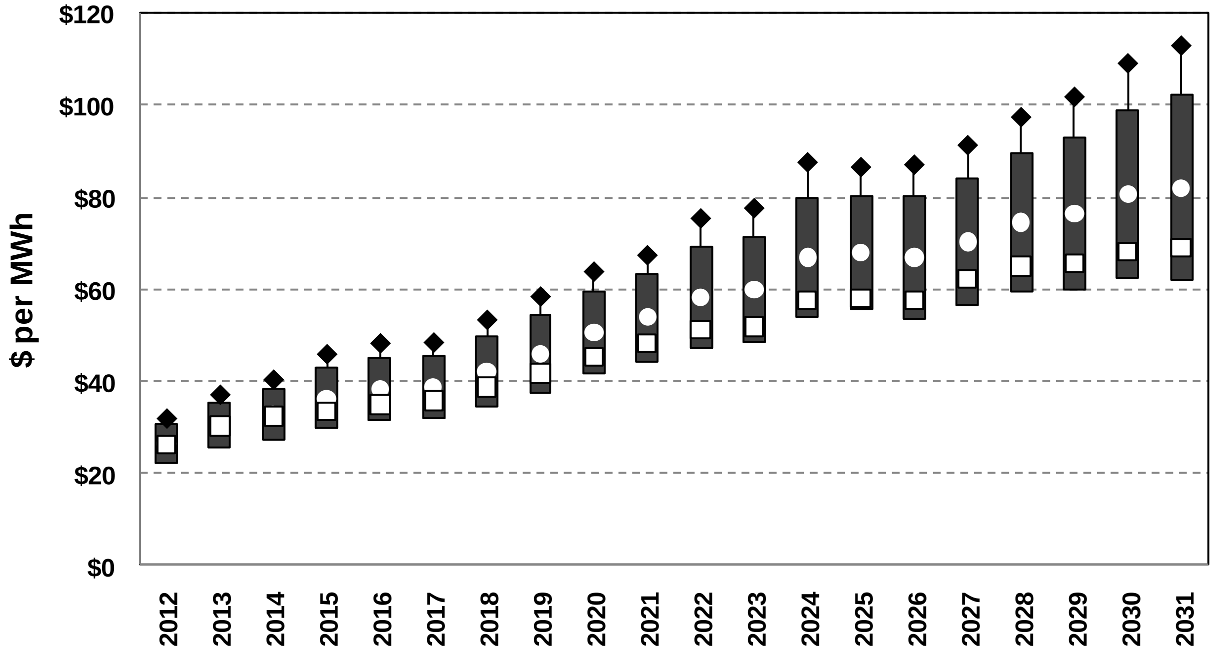
The PRS variance analysis tracks fuel, variable O&M, emissions, and market transaction costs for the existing resource portfolio. These costs are captured for each of the 500 iterations of the Expected Case risk analysis. In addition to existing portfolio costs, new resource capital, fuel, O&M, emissions, and other costs are tracked to provide a range of potential costs to serve future loads. Figure 8.11 shows expected PRS costs modeled through 2031 as the white circle (Nominal). In 2012, costs are expected to be $26 per MWh. The 80 percent confidence interval, represented as the black bar, ranges between $22 and $31 per MWh. The black diamonds in the figure represent the TailVar 90 risk level, or the average of the top 10 percent of the worst outcomes; the 2010 TailVar cost is $32 per MWh, or $6 per MWh above the expected value.

Power supply costs increase with natural gas and greenhouse gas price increases. Uncertainty increases over time and the confidence interval band expands. The white boxes in Figure 8.11 represent the cost per MWh without greenhouse gas costs. For example, in 2020 the average system costs would be 8.8 percent lower without carbon

[9] By acquiring a PPA for the Palouse Wind project, the Company forgoes the large capital investment shown in 2013.

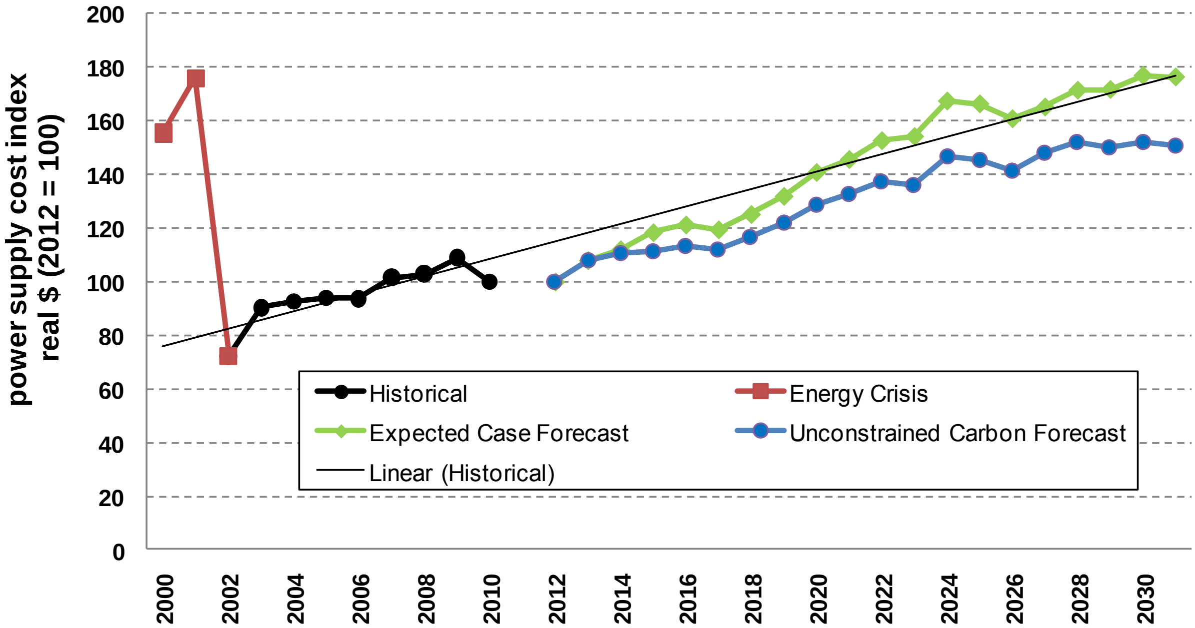
mitigation. The expected levelized cost for the expected case is $48.59 per MWh and $43.73 per MWh (10 percent lower) without greenhouse gas costs.

Figure 8.11: Power Supply Expense Range



A common question regarding IRPs is what will be the change to power supply costs over the time horizon of the plan. Figure 8.12 illustrates expected power supply cost changes compared to historical power supply costs under the Preferred Resource Strategy. It shows that power supply costs, on a per-MWh basis have increased 4.1 percent per year over inflation between 2002 and 2010. This 4.1 percent annual growth rate increase is in Figure 8.12 as a linear black line. By 2021, absent greenhouse gas emissions costs, power supply costs are expected to be 32 percent higher than 2010, but up to 41 percent higher with the addition of greenhouse gas emissions costs for an annual growth rate of 2.6 percent and 3.8 percent respectively.

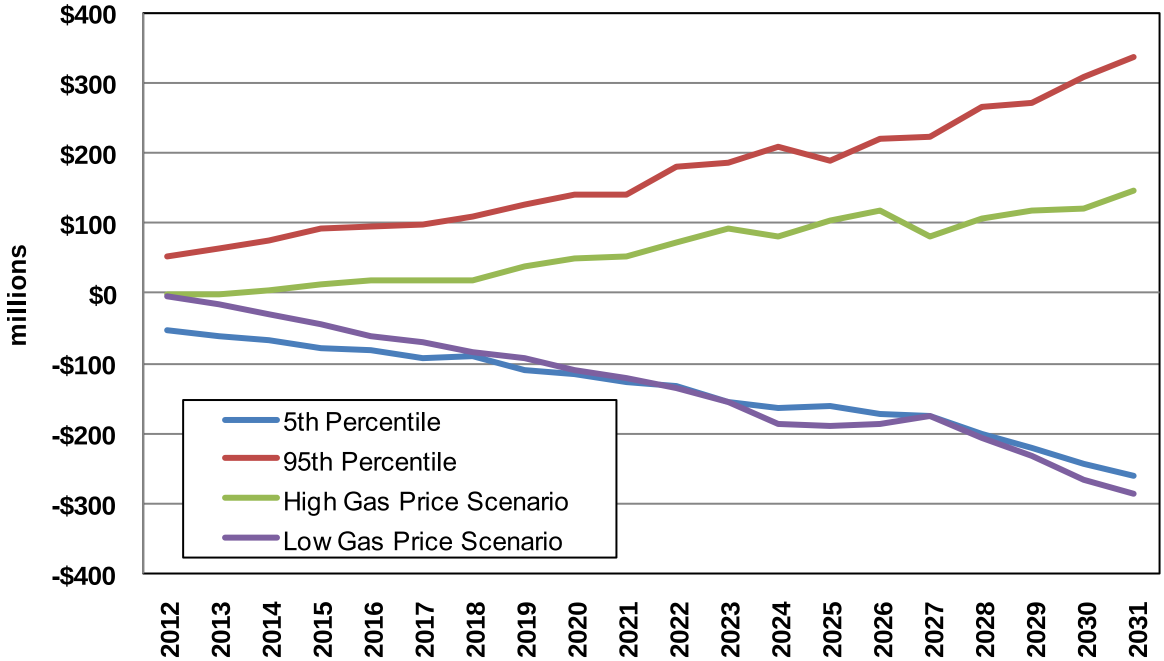
Figure 8.12: Real Power Supply Expected Rate Growth Index $/MWh (2012 = 100)



Natural Gas Price Risk

The Market Analysis chapter showed the results of high and low natural gas price forecasts. The PRS includes 752 MW of natural gas-fired resources and exposes Avista's customers to increasing levels of natural gas price risk. This section uses natural gas price forecast scenarios, including changes to expected greenhouse gas prices, to explain the range of costs resulting from the PRS. Figure 8.13 shows the total portfolio cost range using different natural gas scenarios compared to the expected cost of the PRS. The low natural gas price scenario reduces expected costs by 19.5 percent and the high gas price scenario increases costs by 8.7 percent on a present value basis. Lower natural gas prices have greater effect on prices than higher prices as the Using stochastic model results, rather than the deterministic scenarios, illustrates risk exposure to the wholesale market. The 5th and 95th percentiles reflect variability from natural gas and other variables. The low natural gas price scenario is reflective of a low cost future, but the high natural gas price scenario does not reflect the potential cost excursions that could affect the PRS that is not natural gas price related.

Figure 8.13: Power Supply Cost Sensitivities

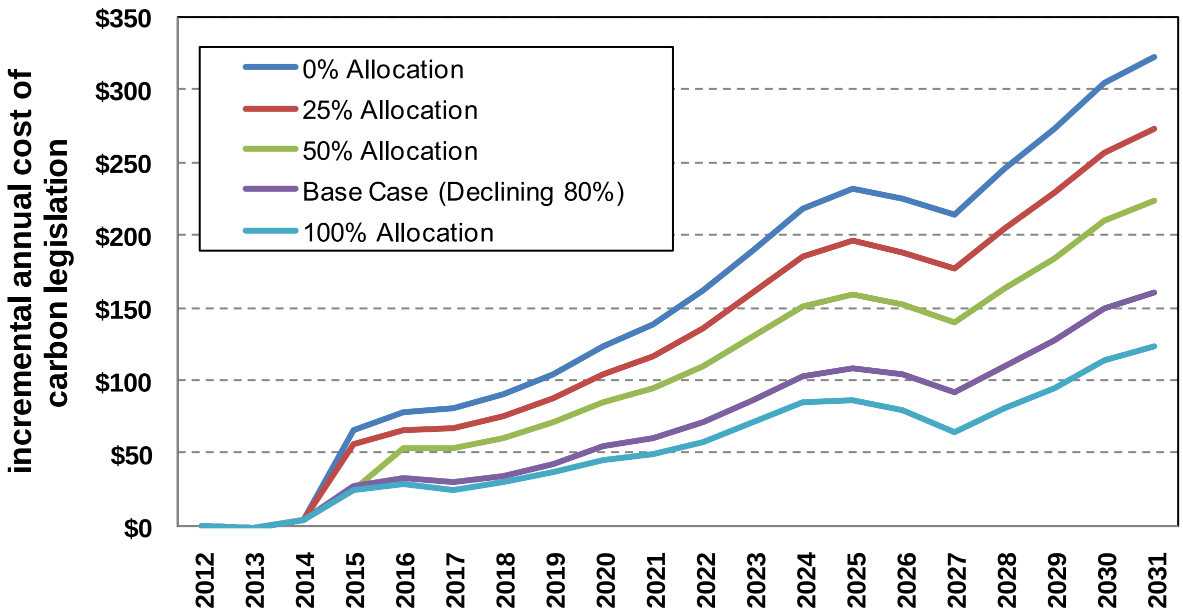


Greenhouse Gas Costs

Avista anticipates some form of federal greenhouse gas policy, although the exact nature, timing and scope are unknown. As described in the Market Analysis chapter, four potential greenhouse gas policies are modeled to estimate marginal electricity costs. The estimate of greenhouse gas emission costs depends on the number of free allowances provided by the government. Figure 8.14 illustrates the range of total annual greenhouse gas costs as the percent of free credits allocated to Avista are changed. For example, if no credits are allocated to Avista in 2022, Avista's cost to serve customers will be $91 million ($162 million in total) higher than the Expected Case where 80 percent of the credits are free and mitigation costs $71 million.

A reduction in output from the Colstrip generators, increased natural gas prices and increased wholesale electricity prices drive most of the greenhouse gas policy cost increases. In the marketplace, low marginal cost coal-fired plants dispatch less, or even turn off, and higher marginal cost natural gas-fired resources replaces their output. The cost of natural gas resources is higher than it would be absent greenhouse gas costs because of increased demand for gas-fired resources. These additional costs represent up to 11 percent of total power supply expenses in the Expected Case.

Figure 8.14: Greenhouse Gas Related Power Supply Expense



Efficient Frontier Comparison of Greenhouse Gas Policies

Three stochastic market studies studied the cost of different greenhouse gas policies: 1) the Expected Case, 2) Unconstrained Carbon, and 3) Mandatory Coal Retirement. These three stochastic market forecasts were than assumed to be potential markets in PRiSM and an efficient frontier for each market future was created, as shown in Figure 8.15. Table 8.9 provides more details about the study results. The PRS portfolio is the same in the Expected Case and the Unconstrained Carbon Case, but the Mandatory Coal Retirement Case retires Colstrip Unit 3 in 2023 and Unit 4 in 2026, replacing them with a CCCT. Colstrip decommissioning costs is not included in figures.

Figure 8.15: Efficient Frontier Comparison

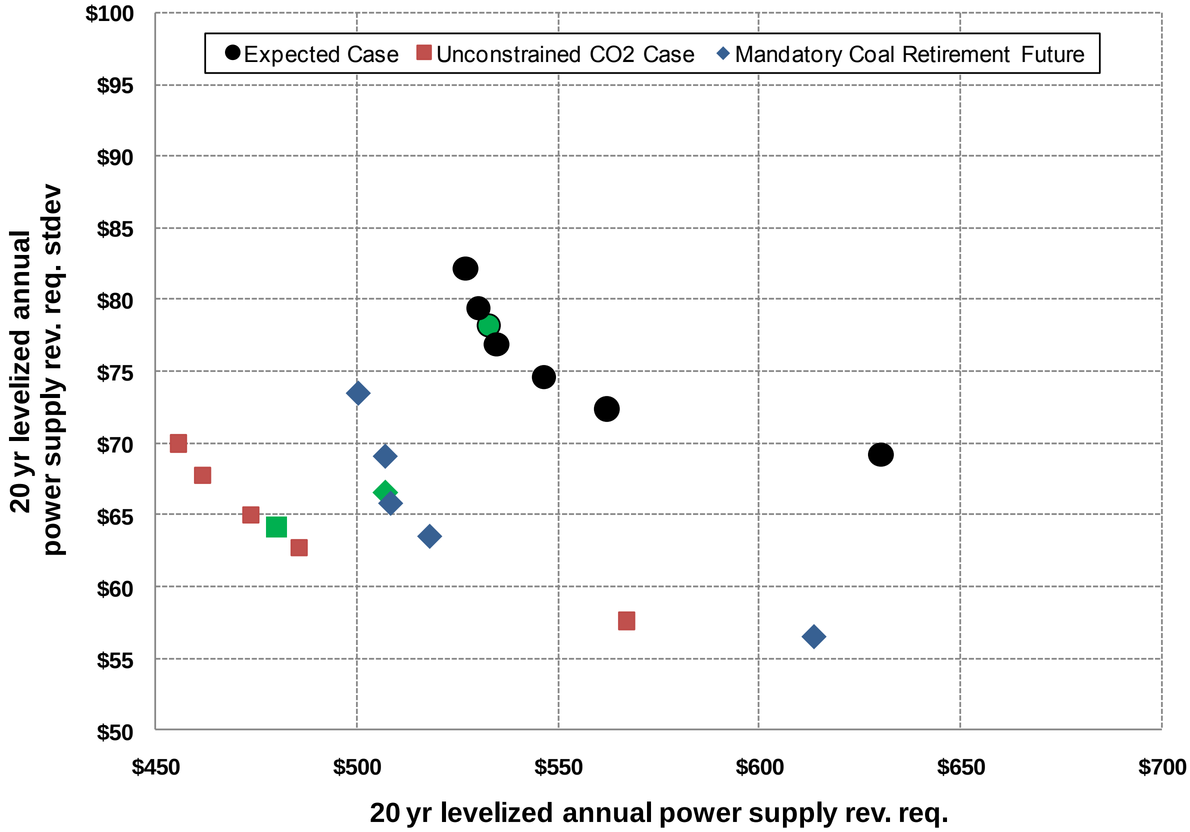


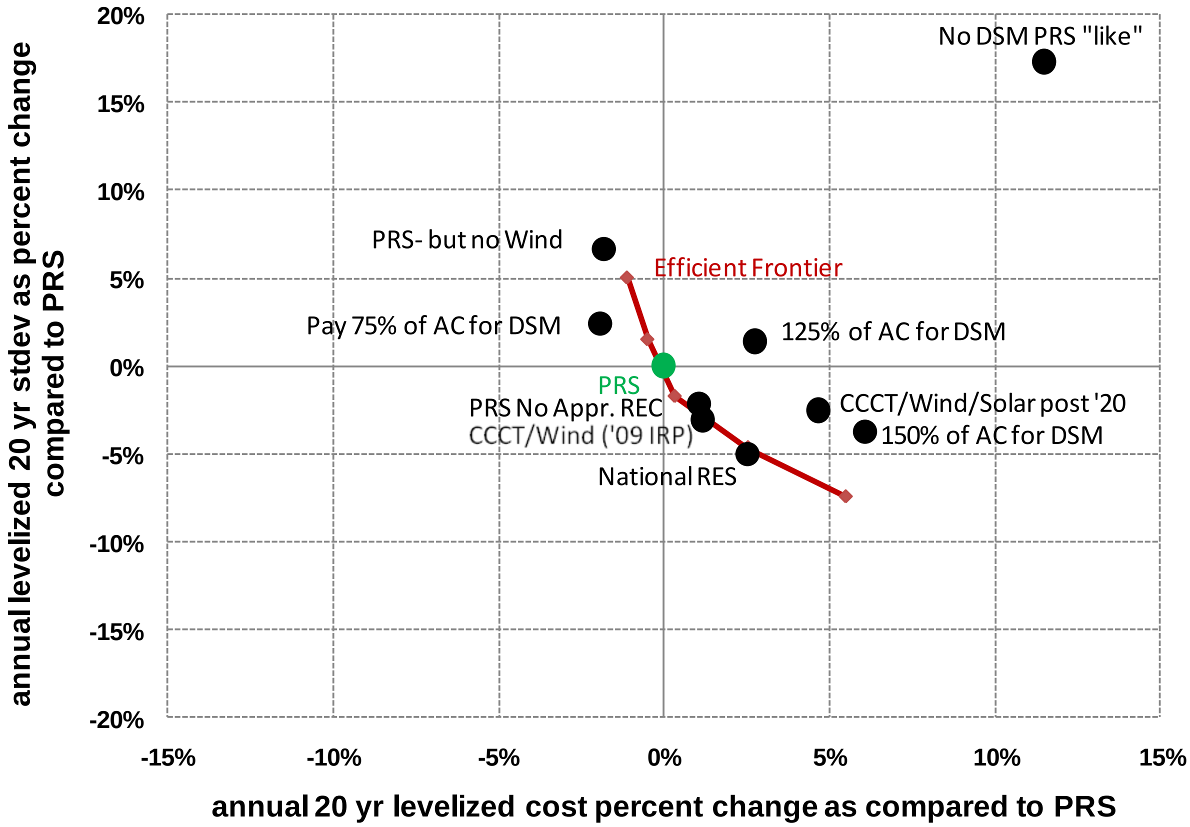
Table 8.9: Preferred Portfolio Cost and Risk Comparison (Millions $)

	Expected Case	Unconstrained Carbon	Coal Retirement
2012-2022 Cost NPV	3,094	2,886	2,937
2012-2031 Cost NPV	5,735	5,168	5,458
2022 Expected Cost	636	564	576
2022 Stdev	91	68	71
2022 Stdev/Cost	14%	12%	0
2022 CO_2 Emissions (000's)	2,894	3,498	3,752
2031 CO_2 Emissions (000's)	2,972	4,177	3,560

Portfolio Scenarios

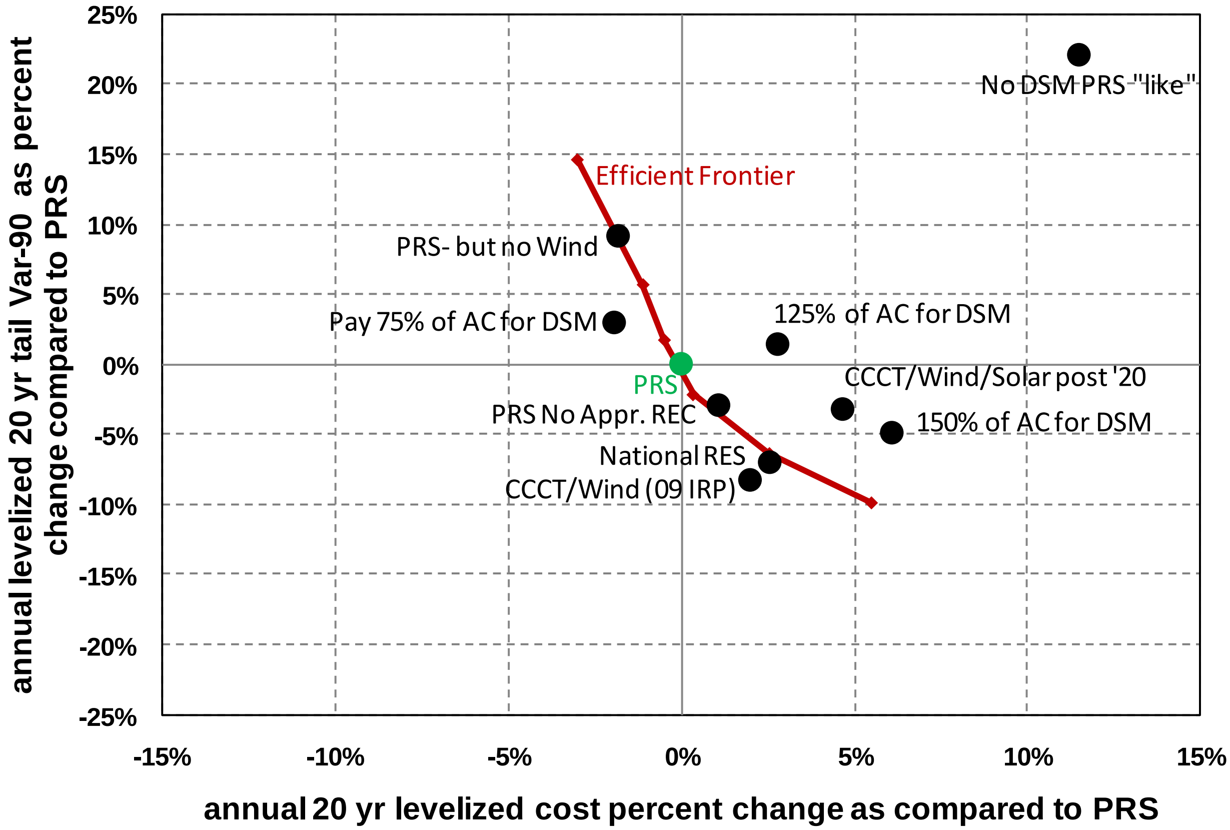
The efficient frontier analysis creates resource portfolios for alternative levels of risk and cost. Avista's management selected the PRS to balance costs and risk inherent in our resource portfolio. The following list of portfolios shows details of alternatives to the PRS, either along the efficient frontier or "hand-picked" so that the costs of these choices could be considered. Figure 8.16 illustrates the levelized cost percent change and the levelized annual standard deviation percent change for each of the portfolios in comparison to the PRS.

Figure 8.16: Efficient Frontier Comparison



The Technical Advisory Committee requested Avista to show the efficient frontier and other portfolios using Tail Var 90 rather than standard deviation as a measure of risk (Figure 8.17). The TAC wanted to know if we measured risk differently would the Company draw a different conclusion on its resource choice. The result of this study shows using Tail Var 90 changes the magnitude of risk as compared to the standard deviation, but the PRS remains the Company's best choice. Using Tail Var 90 magnifies the risk savings of moving from Simple Cycle CTs to Combined Cycle CTs, as the standard deviation method shows a 5 percent reduction in risk for 2 percent more in cost, while the Tail Var 90 method shows a 15 percent risk reduction for the same cost increase.

Figure 8.17: Efficient Frontier Comparison with Tail Var90



The following section describes the resources selected in each of the portfolios designated in Figure 8.16. Table 8.10 summarizes the PRS.

Table 8.10: Preferred Resource Strategy

Resource	2012-16	2017-21	2022-26	2027-31	First 10 Years	All 20 Years
SCCT (Nameplate)	0	166	0	46	**166**	**212**
CCCT (Nameplate)	0	0	270	270	**0**	**540**
Thermal Upgrades	0	4	0	0	**4**	**4**
Wind (Energy)	35	36	0	0	**71**	**71**
Solar (Energy)	0	0	0	0	**0**	**0**
Conservation (Energy)	57	75	91	87	**133**	**310**
Dist. Feeders (Energy)	8	3	2	1	**11**	**13**

Least Cost Portfolio

The Least Cost portfolio is the PRiSM model's resulting portfolio that meets capacity, energy and RPS needs at the least expected cost. This portfolio is a combination of wind and natural gas-fired SCCT generation. Table 8.11 illustrates the generation resources added in the Least Cost portfolio.

Table 8.11: Least Cost Portfolio

Resource	2012-16	2017-21	2022-26	2027-31	First 10 Years	All 20 Years
SCCT (Nameplate)	0	83	249	415	**83**	**747**
CCCT (Nameplate)	0	0	0	0	**0**	**0**
Thermal Upgrades	0	0	0	0	**0**	**0**
Wind (Energy)	35	24	12	0	**59**	**71**
Solar (Energy)	0	0	0	0	**0**	**0**
Conservation (Energy)	57	75	91	87	**133**	**310**
Dist. Feeders (Energy)	8	3	2	1	**11**	**13**

Least Risk Portfolio

The Least Risk portfolio is the portfolio selected by the PRiSM model meeting all capacity, energy and RPS needs at the least expected risk. PRiSM measures risk using levelized annual power supply cost variance. This portfolio is a combination of wind, solar, natural gas-fired SCCT and CCCT generation resources. Table 8.12 illustrates the resources added in the Least Risk portfolio.

Table 8.12: Least Risk Portfolio

Resource	2012-16	2017-21	2022-26	2027-31	First 10 Years	All 20 Years
SCCT (Nameplate)	0	0	3	184	**0**	**187**
CCCT (Nameplate)	0	270	270	0	**270**	**540**
Thermal Upgrades	0	3	14	0	**3**	**17**
Wind (Energy)	61	37	0	0	**98**	**98**
Solar (Energy)	25	27	6	6	**52**	**64**
Conservation (Energy)	57	75	91	87	**133**	**310**
Dist. Feeders (Energy)	8	3	2	1	**11**	**13**

50/50Cost and Risk Midpoint Portfolio

The 50/50 Cost and Risk Midpoint portfolio is the PRiSM model's portfolio selection that meets capacity, energy and RPS needs at the midpoint between the least risk and least cost resource portfolios. This resource portfolio is a combination of wind, solar and natural gas-fired SCCT and CCCT generation. Table 8.13 illustrates the resources added in this portfolio.

Table 8.13: 50/50 Cost and Risk Midpoint Portfolio

Resource	2012-16	2017-21	2022-26	2027-31	First 10 Years	All 20 Years
SCCT (Nameplate)	0	83	0	94	**83**	**177**
CCCT (Nameplate)	0	0	270	270	**0**	**540**
Thermal Upgrades	0	0	4	0	**0**	**4**
Wind (Energy)	35	23	23	12	**58**	**93**
Solar (Energy)	0	0	0	9	**0**	**9**
Conservation (Energy)	57	75	91	87	**133**	**310**
Dist. Feeders (Energy)	8	3	2	1	**11**	**13**

75/25 Cost and Risk Portfolio

The 75/25 Cost and Risk portfolio is the PRiSM model's portfolio selection that meets capacity, energy and RPS needs at the midpoint between the least cost portfolio and the 50/50 portfolio. This portfolio is similar to the PRS with a combination of wind and natural gas-fired SCCT generation. Table 8.14 illustrates the resources added under the 75/25 Cost and Risk portfolio.

Table 8.14: 75/25 Cost Risk Portfolio

Resource	2012-16	2017-21	2022-26	2027-31	First 10 Years	All 20 Years
SCCT (Nameplate)	0	83	249	0	**83**	**332**
CCCT (Nameplate)	0	0	0	540	**0**	**540**
Thermal Upgrades	0	0	0	0	**0**	**0**
Wind (Energy)	35	23	12	12	**58**	**82**
Solar (Energy)	0	0	0	0	**0**	**0**
Conservation (Energy)	57	75	91	87	**133**	**310**
Dist. Feeders (Energy)	8	3	2	1	**11**	**13**

25/75 Cost and Risk Portfolio

The 25/75 Cost Risk portfolio is the PRiSM model's portfolio selection meeting capacity, energy and RPS needs at the midpoint between the Least Risk portfolio and the 50/50 Cost and Risk portfolio. The 25/75 Cost and Risk portfolio includes a combination of wind, solar, and natural gas-fired SCCT and CCCT generation. Table 8.15 illustrates the resources added in the 25/75 Cost and Risk portfolio.

Table 8.15: 25/75 Cost Risk Portfolio

Resource	2012-16	2017-21	2022-26	2027-31	First 10 Years	All 20 Years
SCCT (Nameplate)	0	83	0	0	**83**	**83**
CCCT (Nameplate)	0	0	540	270	**0**	**810**
Thermal Upgrades	0	0	4	0	**0**	**4**
Wind (Energy)	35	23	37	0	**58**	**95**
Solar (Energy)	0	0	0	5	**0**	**5**
Conservation (Energy)	57	75	91	87	**133**	**310**
Dist. Feeders (Energy)	8	3	2	1	**11**	**13**

PRS without Apprentice Credits

The PRS without Apprentice Credits portfolio represents a resource strategy that assumes the Company is unable to contract for apprentice labor for new wind resources and therefore the acquisitions do not qualify for the 20 percent REC credit adder in I-937. This portfolio is a similar to the PRS, but includes 25 aMW of additional wind energy. Where wind resources have an average capacity factor of 31 percent, Avista would need to procure an additional 80 MW of nameplate wind capacity. Table 8.16 illustrates the PRS without Apprenticeship Credits portfolio resource additions.

Table 8.16: PRS without Apprentice Credits

Resource	2012-16	2017-21	2022-26	2027-31	First 10 Years	All 20 Years
SCCT (Nameplate)	0	166	0	46	**166**	**212**
CCCT (Nameplate)	0	0	270	270	**0**	**540**
Thermal Upgrades	0	4	0	0	**4**	**4**
Wind (Energy)	35	49	12	0	**84**	**96**
Solar (Energy)	0	0	0	0	**0**	**0**
Conservation (Energy)	57	75	91	87	**133**	**310**
Dist. Feeders (Energy)	8	3	2	1	**11**	**13**

2009 IRP Portfolio

The PRS from the 2009 IRP included 350 MW of wind generation and 750 MW of gas-fired CCCT generation. The 2009 IRP Portfolio emulates the 2009 PRS with 2011 IRP adjustments for lower load projections and lower natural gas and market electricity prices. Table 8.17 illustrates the resource additions under the 2009 IRP Portfolio.

Table 8.17: 2009 IRP Portfolio

Resource	2012-16	2017-21	2022-26	2027-31	First 10 Years	All 20 Years
SCCT (Nameplate)	0	0	0	0	**0**	**0**
CCCT (Nameplate)	0	270	270	270	**270**	**810**
Thermal Upgrades	0	0	0	0	**0**	**0**
Wind (Energy)	44	44	15	0	**87**	**102**
Solar (Energy)	0	0	0	0	**0**	**0**
Conservation (Energy)	57	75	91	87	**133**	**310**
Dist. Feeders (Energy)	8	3	2	1	**11**	**13**

PRS without Wind Portfolio

The PRS without Wind Portfolio illustrates the cost of wind additions to the PRS. This portfolio is the same as the 2011 PRS, but excludes the qualified renewable generation required by the Energy Independence Act. Table 8.18 illustrates the resources added under the PRS without Wind Portfolio.

Table 8.18: PRS without Wind Portfolio

Resource	2012-16	2017-21	2022-26	2027-31	First 10 Years	All 20 Years
SCCT (Nameplate)	0	166	0	46	**166**	**212**
CCCT (Nameplate)	0	0	270	270	**0**	**540**
Thermal Upgrades	0	4	0	0	**4**	**4**
Wind (Energy)	0	0	0	0	**0**	**0**
Solar (Energy)	0	0	0	0	**0**	**0**
Conservation (Energy)	57	75	91	87	**133**	**310**
Dist. Feeders (Energy)	8	3	2	1	**11**	**13**

CCCT with Solar after 2015 Portfolio

The CCCT with Solar after 2015 Portfolio illustrates the additional cost of using solar, rather than wind, to meet Washington's I-937 requirements. Table 8.19 shows the resources added under the CCCT with Solar after 2015 Portfolio.

Table 8.19: CCCT with Solar after 2015 Portfolio

Resource	2012-16	2017-21	2022-26	2027-31	First 10 Years	All 20 Years
SCCT (Nameplate)	0	0	0	0	**0**	**0**
CCCT (Nameplate)	0	0	270	540	**0**	**810**
Thermal Upgrades	0	7	3	0	**10**	**10**
Wind (Energy)	36	0	0	0	**36**	**36**
Solar (Energy)	0	26	7	0	**26**	**33**
Conservation (Energy)	57	75	91	87	**133**	**310**
Dist. Feeders (Energy)	8	3	2	1	**11**	**13**

National Renewable Energy Standard Portfolio

There have been several attempts to implement a federal renewable energy standard. The National Renewable Energy Standard Portfolio illustrates changes to the PRS needed to meet renewable requirements at the national level. Depending on the legislation, Avista may be required to secure an additional 106 aMW[10] to cover the Company's retail loads in the Idaho service territory. The actual level of wind required under a federal renewable energy standard would depend upon how the legislation treats our existing renewable resources and how it considers hydroelectric generation.[11] The portfolio assumes that hydroelectric netting would be included and that the federal law would not supersede state law. We did not model a national energy standard, as proposed by President Obama, because the PRS most likely would meet the standard because Avista is already subject to Washington's emission performance standards. Table 8.20 illustrates the resources added under the National Renewable Energy Standard portfolio.

Table 8.20: National Renewable Energy Standard

Resource	2012-16	2017-21	2022-26	2027-31	First 10 Years	All 20 Years
SCCT (Nameplate)	0	166	0	46	**166**	**212**
CCCT (Nameplate)	0	0	270	270	**0**	**540**
Thermal Upgrades	0	4	0	0	**4**	**4**
Wind (Energy)	47	47	35	49	**93**	**177**
Solar (Energy)	0	0	0	1	**0**	**1**
Conservation (Energy)	57	75	91	87	**133**	**310**
Dist. Feeders (Energy)	8	3	2	1	**11**	**13**

[10] 106 aMW is equal to 341 MW of nameplate capacity wind generation at a 31 percent capacity factor.
[11] Proposed federal legislation has allowed utilities to "net" hydroelectric generation against retail loads prior to calculating RPS obligations.

PRS without Conservation Portfolio

The PRS without Conservation Portfolio illustrates the benefits of conservation. This portfolio meets capacity, energy and RPS needs in a similar manner as the PRS. Table 8.21 illustrates the resources added under the PRS without Conservation Portfolio.

Table 8.21: PRS without Conservation

Resource	2012-16	2017-21	2022-26	2027-31	First 10 Years	All 20 Years
SCCT (Nameplate)	83	212	83	97	**295**	**475**
CCCT (Nameplate)	0	0	270	545	**0**	**815**
Thermal Upgrades	7	0	0	3	**7**	**10**
Wind (Energy)	35	36	23	0	**71**	**94**
Solar (Energy)	0	0	0	0	**0**	**0**
Conservation (Energy)	0	0	0	0	**0**	**0**
Dist. Feeders (Energy)	8	3	2	1	**11**	**13**

PRS Conservation Avoided Costs 25% Lower Portfolio

The PRS Conservation Avoided Costs 25% Lower Portfolio illustrates resulting changes to cost and risk if avoided costs for conservation was set at the avoided cost of generation resources, or if natural gas prices included in this IRP are too high. This portfolio represents conservation estimates without discretionary adders. Table 8.22 illustrates the resources added under this portfolio.

Table 8.22: PRS Conservation Avoided Costs 25% Lower

Resource	2012-16	2017-21	2022-26	2027-31	First 10 Years	All 20 Years
SCCT (Nameplate)	0	166	83	0	**166**	**249**
CCCT (Nameplate)	0	0	270	270	**0**	**540**
Thermal Upgrades	0	0	4	0	**0**	**4**
Wind (Energy)	35	24	23	0	**59**	**82**
Solar (Energy)	0	0	0	0	**0**	**0**
Conservation (Energy)	54	61	75	76	**115**	**266**
Dist. Feeders (Energy)	8	3	2	1	**11**	**13**

PRS Conservation Avoided Costs 25% Higher Portfolio

The PRS Conservation Avoided Costs 25% Higher Portfolio illustrates the resource changes that would occur if Avista spent additional dollars toward the acquisition of additional conservation. This portfolio represents the added conservation at a spending level of an additional 25 percent and the resulting offset in supply-side resources. Table 8.23 illustrates the resources added under this portfolio.

Table 8.23: PRS Conservation Avoided Costs 25% Higher

Resource	2012-16	2017-21	2022-26	2027-31	First 10 Years	All 20 Years
SCCT (Nameplate)	0	166	83	0	**166**	**415**
CCCT (Nameplate)	0	0	0	270	**0**	**270**
Thermal Upgrades	0	4	4	0	**4**	**7**
Wind (Energy)	35	23	12	0	**58**	**70**
Solar (Energy)	0	0	0	0	**0**	**0**
Conservation (Energy)	61	83	95	94	**144**	**334**
Dist. Feeders (Energy)	8	3	2	1	**11**	**13**

PRS Conservation Avoided Costs 50% Higher Portfolio

The PRS Conservation Avoided Costs 50% Higher Portfolio illustrates the resource changes that would occur if Avista spent an additional 50 percent on the acquisition of conservation resources. Table 8.24 illustrates the resources obtained in this portfolio.

Table 8.24: PRS Conservation Avoided Costs 50% Higher

Resource	2012-16	2017-21	2022-26	2027-31	First 10 Years	All 20 Years
SCCT (Nameplate)	0	46	0	83	**46**	**129**
CCCT (Nameplate)	0	0	270	270	**0**	**540**
Thermal Upgrades	0	0	4	0	**0**	**4**
Wind (Energy)	35	23	12	0	**58**	**70**
Solar (Energy)	0	0	0	0	**0**	**0**
Conservation (Energy)	62	91	103	94	**153**	**350**
Dist. Feeders (Energy)	8	3	2	1	**11**	**13**

Resource Tipping Point Analysis

In many resource plans, a PRS is presented with a comparison to other portfolios to help illustrate cost and risk trade-offs. This IRP extends the portfolio analysis beyond this simple exercise by focusing on how the portfolio might change if key assumptions were changed. This provides an array of strategies in reaction to fundamentally different futures instead of a single strategy. This section identifies assumptions that could alter the PRS, such as changes to load growth, varying resource capital costs, hydroelectric upgrade opportunities, the emergence of other non-wind and non-solar renewable options, or an expansion of the region’s nuclear generation fleet.

Solar Capital Costs Sensitivity

The capital costs of photovoltaic solar generation significantly decreased since the 2009 IRP and the 30 percent Investment Tax Credit for solar generation was extended through the end of 2015. Solar generation still is not competitive with wind in the Northwest, even with lower capital costs and tax credits. A sensitivity analysis determined the price reduction that would be necessary to make photovoltaic solar generation competitive with wind generation. The analysis reduced solar capital costs in the year 2020 until the PRiSM model selected solar over wind. This analysis also assumed the double solar REC credit for I-937. The results of the study were that the capital costs for solar would need to decrease 53 percent, to $2,020/kW (2020 nominal dollars including AFUDC), in order to make solar competitive with wind generation.

CCCT Capital Cost Sensitivity

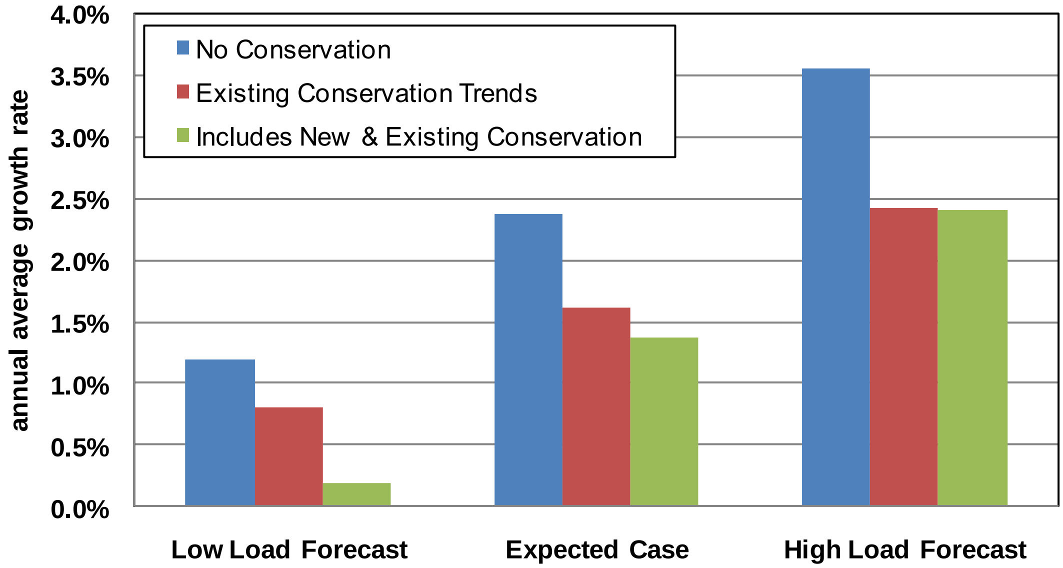
CCCTs were the lowest cost resource option in the 2009 IRP. SCCTs are again the lowest cost resource option, similar to all Avista IRPs prior to its 2009 IRP. A sensitivity analysis determined why CCCTs were more cost-effective than SCCTs in the 2009 IRP. The first test involved an analysis of capital costs. The model found that CCCT capital costs had to be 22 percent lower than forecasted in this IRP to be selected over SCCTs. Another indication of the change is that O&M cost estimates were lower in the 2009 IRP ($11/kW-year) as compared to the 2011 IRP ($16/kW-year). The 2009 IRP also assumed that a lower-cost water-cooled plant rather than an air-cooled plant would be developed. This IRP assumes an air-cooled CCCT due to the increasing difficulty in obtaining water rights near customer loads. Additional analysis could indicate that changes in the spark spread, fuel transportation costs, heat rates, or greenhouse gas policies could affect the selection of CCCTs over SCCTs more than changes in capital costs. Further, natural gas prices could affect this choice, such as lower or higher prices could affect this decision, to fully study this theory would require two additional stochastic studies and this scope of work would extend the timeline for this IRP's completion.

Load Forecast Alternatives

An important test in an IRP is its performance across varying load growth sensitivities. Avista's loads could grow faster with future development activity after the economy recovers, or could stagnate in a continued recession. This sensitivity analysis studies the impact to the PRS if loads grows faster or slower than the Expected Case estimate. Faster load growth will increase the need for capital and slower load growth will decrease the need for capital spending on new generation. This analysis focuses on understanding the changes in the timing of resource decisions based on changes in load growth.

Loads are expected to grow, net of conservation, at a rate of 1.37 percent over the IRP timeframe. The Low Load Growth scenario cuts the underlying load growth rate by 50 percent and the High Load Growth case increases expected load growth rate by 50 percent. The sensitivity analysis indicated that, net of conservation, the Low Load case's growth rate is 0.19% and the High Load Growth case is 2.4 percent. See Figure 8.18 for load forecast estimates in each case. The load forecast change is not linear since conservation will make up a greater amount of new load growth in the low case as conservation programs target existing load (85 percent of load growth). However, in a high case conservation only makes up 40 percent of load growth that is assumed to be code requirement driven energy efficiency. As a comparison, the Expected Case forecast assumes conservation meets 48 percent of new load.

Figure 8.18: Load Growth Scenario's Cost/Risk Comparison



The lower load growth case's resource strategy would not change near-term resource acquisitions (see Table 8.25), but would eliminate the need for some wind and gas-fired resources later in the IRP time horizon.

Table 8.25: Low Load Growth Resource Strategy

Resources	2012-16	2017-21	2022-26	2027-31	First 10 Years	All 20 Years
SCCT (Nameplate)	0	0	0	212	**0**	**212**
CCCT (Nameplate)	0	0	0	0	**0**	**0**
Thermal Upgrades	0	0	0	4	**0**	**4**
Wind (Energy)	35	12	24	0	**47**	**71**
Solar (Energy)	0	0	0	0	**0**	**0**
Conservation (Energy)	49	60	69	70	**108**	**247**
Dist. Feeders (Energy)	8	3	2	1	**11**	**13**

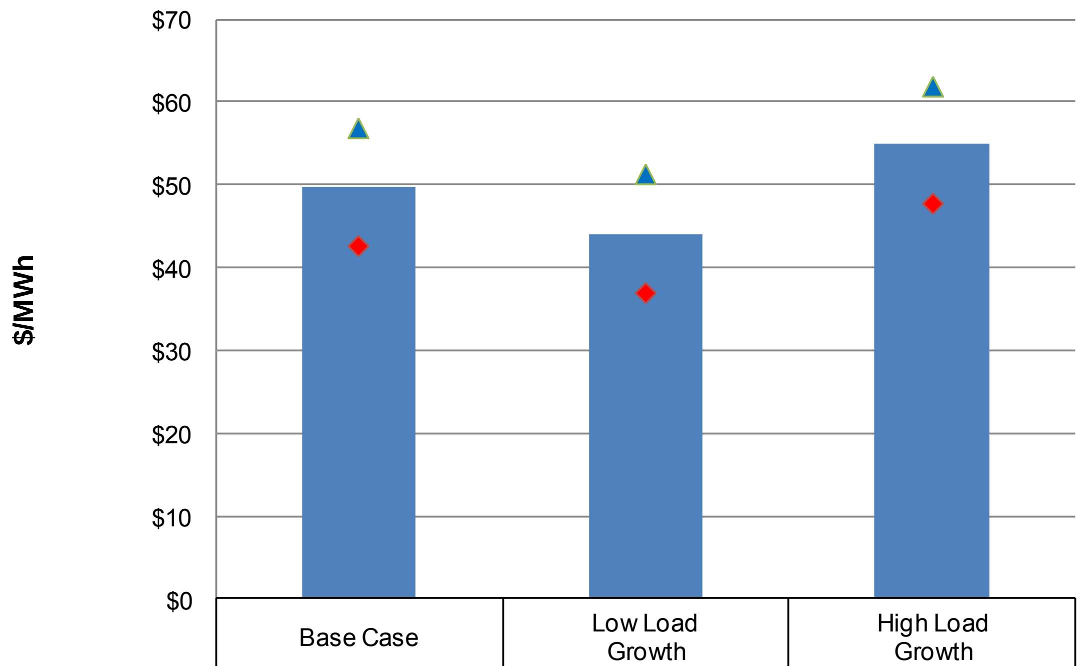
Table 8.26 shows the resource strategy with higher growth rates. The amount of wind acquisitions would increase by 22 aMW and additional peaking resources would be required to compensate for higher growth rates. In the later years of the study, additional gas-fired and wind generation resources would be needed to meet peak load growth and RPS requirements.

Table 8.26: High Load Growth Resource Strategy

Resources	2012-16	2017-21	2022-26	2027-31	First 10 Years	All 20 Years
SCCT (Nameplate)	83	298	83	46	**381**	**510**
CCCT (Nameplate)	0	0	270	540	**0**	**810**
Thermal Upgrades	4	6	0	0	**10**	**10**
Wind (Energy)	35	23	35	0	**58**	**93**
Solar (Energy)	0	0	0	1	**0**	**1**
Conservation (Energy)	71	94	122	156	**165**	**443**
Dist. Feeders (Energy)	8	3	2	1	**11**	**13**

Figure 8.19 shows the cost, and cost range, for each load growth scenario from a dollar per megawatt-hour perspective. The chart explains a positive correlation between load growth and the average cost to serve customers.

Figure 8.19: Load Growth Scenario's Cost/Risk Comparison



	Base Case	Low Load Growth	High Load Growth
Levelized Cost $/MWh	49.75	44.11	54.86
1 Sigma Lower	42.67	36.99	47.80
1 Sigma Higher	56.83	51.23	61.92

Summary

The Preferred Resource Strategy is the roadmap for a resource acquisition plan that which balances the tradeoff between cost and risk while preparing the Company to provide reliable electricity service to its customers. Table 8.27 provides a summary of the total resources selected for each of the portfolios discussed in this chapter. Distribution Feeder upgrades are included at the same level (13 aMW) in all portfolios but are not included in the table.

Table 8.27: Summary of Resource Portfolios

Portfolio	SCCT (Nameplate)	CCCT (Nameplate)	Thermal Upgrades	Wind (Energy)	Solar (Energy)	Conservation (Energy)
Preferred Resource Strategy	212	540	4	71	0	310
Least Cost	747	0	0	71	0	310
Least Risk	187	540	17	98	64	310
50/50 Cost Risk	177	540	4	93	9	310
75/25 Cost Risk	332	540	0	82	0	310
25/75 Cost Risk	83	810	4	95	5	310
PRS without Apprentice Credits	212	540	4	96	0	310
2009 PRS	0	810	0	102	0	310
PRS Without Wind	212	540	4	0	0	310
CCCT with Solar	0	810	10	36	33	310
National Renewable Energy Standard	212	540	4	177	1	310
PRS without Conservation	475	815	10	94	0	0
PRS Conservation A/C 25% Lower	249	540	4	82	0	266
PRS Conservation A/C 25% Higher	415	270	7	70	0	334
PRS Conservation A/C 50% Higher	129	540	4	70	0	350
Low Load Growth	212	0	4	71	0	247
High Load Growth	510	810	10	93	1	443

The IRP is a continual effort to select cost- and risk-minimizing resources complementing the Company's existing resource mix. Its results and insights help management and policy-makers formulate good decisions on behalf of ratepayers. The PRS includes a combination of conservation, efficiency improvements including feeder upgrades, hydroelectric upgrades, wind, and gas-fired simple and combined-cycle combustion turbines. The resource strategy identified in this report will change in response to new information, but Avista focuses decision making on near-term resource acquisitions where substantial changes concerning the data needed to make decisions are less likely to occur.

Table 8.28: Winter 18-Hour Capacity Position (MW) Net of Conservation with New Resources[12]

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
TOTAL LOAD OBLIGATIONS																				
Native Load (Net of Efficiency Programs)	-1,648	-1,670	-1,681	-1,688	-1,717	-1,744	-1,768	-1,785	-1,804	-1,823	-1,837	-1,856	-1,884	-1,918	-1,955	-1,985	-2,018	-2,053	-2,091	-2,132
Firm Power Sales	-242	-242	-211	-158	-158	-8	-8	-7	-7	-7	-7	-7	-6	-6	-6	-6	-6	-6	-6	-6
Total Requirements	**-1,890**	**-1,912**	**-1,892**	**-1,846**	**-1,875**	**-1,752**	**-1,776**	**-1,791**	**-1,811**	**-1,829**	**-1,844**	**-1,862**	**-1,890**	**-1,924**	**-1,962**	**-1,991**	**-2,024**	**-2,059**	**-2,097**	**-2,138**
RESOURCES																				
Firm Power Purchases	175	175	175	175	175	175	174	173	173	173	90	90	90	90	90	90	90	90	90	90
Hydro Resources	880	955	965	854	854	865	861	889	881	889	889	881	889	889	881	889	889	881	889	889
Base Load Thermals	895	895	895	895	895	895	895	895	895	895	895	895	895	895	895	606	606	606	606	606
Wind Resources	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peaking Units	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242
Total Resources	**2,192**	**2,267**	**2,277**	**2,166**	**2,166**	**2,177**	**2,172**	**2,199**	**2,191**	**2,199**	**2,116**	**2,108**	**2,116**	**2,116**	**2,108**	**1,826**	**1,826**	**1,818**	**1,826**	**1,826**
Peak Position Before Reserves Planning	**302**	**355**	**385**	**319**	**291**	**425**	**396**	**407**	**380**	**369**	**272**	**245**	**225**	**191**	**146**	**-165**	**-198**	**-240**	**-271**	**-312**
RESERVES PLANNING																				
Required Operating Reserves	-162	-164	-163	-161	-164	-156	-159	-160	-162	-163	-169	-171	-173	-176	-180	-168	-169	-169	-170	-171
Available Operating Reserves	23	42	42	8	8	8	8	34	34	34	34	34	34	34	34	34	34	34	34	34
Planning Margin	-232	-235	-237	-239	-243	-247	-250	-253	-256	-258	-261	-263	-267	-272	-277	-282	-286	-291	-297	-302
Total Reserves Planning	**-371**	**-356**	**-358**	**-392**	**-398**	**-395**	**-401**	**-379**	**-384**	**-387**	**-396**	**-400**	**-406**	**-414**	**-423**	**-416**	**-421**	**-426**	**-433**	**-439**
Peak Position With Reserves Planning	**-69**	**-1**	**27**	**-72**	**-107**	**30**	**-5**	**28**	**-4**	**-18**	**-123**	**-155**	**-181**	**-223**	**-277**	**-581**	**-620**	**-667**	**-703**	**-751**
Planning Margin Before NW Market	**17%**	**21%**	**23%**	**18%**	**16%**	**25%**	**23%**	**25%**	**23%**	**22%**	**17%**	**15%**	**14%**	**12%**	**9%**	**-7%**	**-8%**	**-10%**	**-11%**	**-13%**
Avista Share of Excess NW Market	737	656	565	477	400	326	255	186	115	56	0	0	0	0	0	0	0	0	0	0
Peak Position Witn NW Market	**668**	**655**	**592**	**405**	**293**	**356**	**250**	**214**	**111**	**38**	**-123**	**-155**	**-181**	**-223**	**-277**	**-581**	**-620**	**-667**	**-703**	**-751**
Planning Margin With NW Market	**56%**	**55%**	**52%**	**44%**	**37%**	**43%**	**37%**	**35%**	**29%**	**25%**	**17%**	**15%**	**14%**	**12%**	**9%**	**-7%**	**-8%**	**-10%**	**-11%**	**-13%**
NEW RESOURCES																				
New Simple Cycle CC	0	0	0	0	0	0	0	80	80	160	160	160	160	160	160	160	160	160	204	204
New Combined Cycle CC	0	0	0	0	0	0	0	0	0	0	0	0	260	260	260	520	520	520	520	520
New Wind	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thermal Resource Upgrades	0	0	0	0	0	0	0	16	16	16	16	16	16	16	16	16	16	16	16	16
Total New Resources	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**96**	**96**	**176**	**176**	**176**	**435**	**435**	**435**	**695**	**695**	**695**	**740**	**740**
Peak Position with New Resources	**668**	**655**	**592**	**405**	**293**	**356**	**250**	**310**	**207**	**213**	**52**	**21**	**254**	**213**	**158**	**114**	**76**	**29**	**36**	**-11**
Planning Margin With New Resources	**56%**	**55%**	**52%**	**44%**	**37%**	**43%**	**37%**	**40%**	**34%**	**35%**	**26%**	**24%**	**37%**	**34%**	**31%**	**28%**	**26%**	**24%**	**24%**	**22%**

[12] Native load includes forecasted savings from conservation and distribution efficiencies programs.

Table 8.29: Summer 18-Hour Capacity Position (MW) Net of Conservation with New Resources[13]

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
TOTAL LOAD OBLIGATIONS																				
Native Load (Net of Efficiency Programs)	-1,500	-1,538	-1,573	-1,614	-1,637	-1,660	-1,679	-1,692	-1,707	-1,721	-1,731	-1,745	-1,767	-1,795	-1,827	-1,852	-1,879	-1,907	-1,939	-1,973
Firm Power Sales	-243	-218	-212	-159	-159	-9	-9	-8	-8	-8	-8	-8	-8	-7	-7	-7	-7	-7	-7	-7
Total Requirements	**-1,743**	**-1,756**	**-1,785**	**-1,774**	**-1,797**	**-1,669**	**-1,688**	**-1,700**	**-1,715**	**-1,729**	**-1,739**	**-1,753**	**-1,775**	**-1,802**	**-1,834**	**-1,859**	**-1,886**	**-1,915**	**-1,946**	**-1,981**
RESOURCES																				
Firm Power Purchases	85	85	85	85	85	85	85	83	83	82	82	82	82	82	82	82	82	82	82	82
Hydro Resources	900	819	902	859	866	864	885	833	840	859	833	840	859	833	840	859	833	840	859	833
Base Load Thermals	799	799	799	799	799	799	799	799	799	799	799	799	799	799	799	551	551	551	551	551
Wind Resources	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peaking Units	176	176	176	176	176	176	176	176	176	176	176	176	176	176	176	176	176	176	176	176
Total Resources	**1,960**	**1,880**	**1,962**	**1,919**	**1,926**	**1,924**	**1,945**	**1,891**	**1,897**	**1,916**	**1,891**	**1,896**	**1,916**	**1,890**	**1,896**	**1,668**	**1,642**	**1,648**	**1,668**	**1,642**
Peak Position Before Reserves Planning	**217**	**124**	**176**	**146**	**130**	**255**	**257**	**191**	**183**	**187**	**152**	**144**	**141**	**88**	**62**	**-191**	**-244**	**-267**	**-279**	**-339**
RESERVES PLANNING																				
Required Operating Reserves	-153	-156	-158	-159	-161	-154	-155	-156	-158	-159	-160	-161	-163	-165	-168	-155	-154	-155	-157	-156
Available Operating Reserves	155	66	171	159	159	159	161	158	158	161	158	158	161	158	158	161	158	158	161	158
Planning Margin	-227	-232	-238	-244	-248	-252	-255	-257	-259	-262	-263	-266	-269	-273	-278	-282	-286	-290	-295	-300
Total Reserves Planning	**-227**	**-322**	**-238**	**-244**	**-251**	**-252**	**-255**	**-257**	**-259**	**-262**	**-265**	**-269**	**-271**	**-280**	**-288**	**-282**	**-286**	**-290**	**-295**	**-300**
Peak Position With Reserves Planning	**-10**	**-199**	**-62**	**-99**	**-122**	**3**	**2**	**-66**	**-77**	**-74**	**-114**	**-125**	**-130**	**-192**	**-226**	**-473**	**-530**	**-557**	**-574**	**-639**
Planning Margin Before NW Market	**21%**	**11%**	**19%**	**17%**	**16%**	**25%**	**25%**	**21%**	**20%**	**20%**	**18%**	**17%**	**17%**	**14%**	**12%**	**-2%**	**-5%**	**-6%**	**-6%**	**-9%**
Avista Share of Excess NW Market	275	221	178	141	107	78	52	31	10	3	0	0	0	0	0	0	0	0	0	0
Peak Position With NW Market	**265**	**22**	**117**	**42**	**-15**	**81**	**54**	**-35**	**-67**	**-71**	**-114**	**-125**	**-130**	**-192**	**-226**	**-473**	**-530**	**-557**	**-574**	**-639**
Planning Margin With NW Market	**37%**	**23%**	**29%**	**25%**	**22%**	**29%**	**28%**	**22%**	**20%**	**20%**	**18%**	**17%**	**17%**	**14%**	**12%**	**-2%**	**-5%**	**-6%**	**-6%**	**-9%**
NEW RESOURCES																				
New Simple Cycle CC	0	0	0	0	0	0	0	72	72	144	144	144	144	144	144	144	144	144	184	184
New Combined Cycle CC	0	0	0	0	0	0	0	0	0	0	0	0	235	235	235	470	470	470	470	470
New Wind	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thermal Resource Upgrades	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1
Total New Resources	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**73**	**73**	**145**	**145**	**145**	**380**	**380**	**380**	**615**	**615**	**615**	**655**	**655**
Peak Position with New Resources	**265**	**22**	**117**	**42**	**-15**	**81**	**54**	**38**	**6**	**74**	**32**	**20**	**250**	**188**	**154**	**142**	**85**	**58**	**81**	**16**
Planning Margin With New Resources	**37%**	**23%**	**29%**	**25%**	**22%**	**29%**	**28%**	**27%**	**25%**	**29%**	**26%**	**26%**	**38%**	**35%**	**33%**	**31%**	**28%**	**26%**	**28%**	**24%**

[13] Ibid

Table 8.30: Average Annual Energy Position (aMW) With New Resources[14]

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
TOTAL LOAD OBLIGATIONS																				
Native Load (Net of Efficiency Programs)	-1,102	-1,121	-1,135	-1,147	-1,165	-1,184	-1,199	-1,208	-1,220	-1,231	-1,239	-1,249	-1,266	-1,286	-1,312	-1,331	-1,351	-1,372	-1,396	-1,421
Firm Power Sales	-140	-127	-109	-58	-58	-6	-6	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5
Total Requirements	**-1,242**	**-1,248**	**-1,244**	**-1,205**	**-1,222**	**-1,190**	**-1,204**	**-1,214**	**-1,225**	**-1,236**	**-1,244**	**-1,254**	**-1,271**	**-1,291**	**-1,318**	**-1,336**	**-1,356**	**-1,377**	**-1,401**	**-1,426**
RESOURCES																				
Firm Power Purchases	163	164	163	165	163	112	111	91	66	66	65	65	65	65	65	65	65	65	65	65
Hydro Resources	522	525	527	495	495	495	490	481	481	481	481	481	481	481	481	481	481	481	481	481
Base Load Thermals	755	714	751	744	746	741	724	758	721	721	758	721	721	758	684	515	541	515	515	541
Wind Resources	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Resources	**1,441**	**1,403**	**1,442**	**1,405**	**1,404**	**1,348**	**1,325**	**1,330**	**1,268**	**1,268**	**1,304**	**1,266**	**1,267**	**1,304**	**1,229**	**1,060**	**1,087**	**1,060**	**1,060**	**1,087**
Energy Position Before Contingency Planning	**198**	**155**	**198**	**200**	**182**	**158**	**121**	**117**	**43**	**32**	**61**	**12**	**-4**	**12**	**-88**	**-275**	**-269**	**-317**	**-340**	**-339**
CONTINGENCY PLANNING																				
Peaking Resources	153	153	153	138	153	154	153	147	146	145	147	146	145	147	146	145	147	146	145	147
Contingency	-228	-229	-230	-231	-232	-233	-233	-216	-197	-198	-198	-199	-200	-201	-202	-203	-204	-205	-206	-200
Energy Position With Contingency Planning	**123**	**79**	**121**	**107**	**103**	**79**	**40**	**48**	**-9**	**-21**	**9**	**-42**	**-59**	**-42**	**-145**	**-333**	**-326**	**-376**	**-401**	**-393**
NEW RESOURCES																				
New Simple Cycle CC	0	0	0	0	0	0	0	75	75	151	151	151	151	151	151	151	151	151	192	192
New Combined Cycle CC	0	0	0	0	0	0	0	0	0	0	0	0	237	237	237	474	474	474	474	474
New Wind	0	35	35	35	35	35	35	35	47	71	71	71	71	71	71	71	71	71	71	71
Thermal Resource Upgrades	0	0	0	0	0	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3
Total New Resources	**0**	**35**	**35**	**35**	**35**	**35**	**35**	**114**	**126**	**225**	**225**	**225**	**462**	**462**	**462**	**699**	**699**	**699**	**741**	**741**
Peak Position with New Resources	**123**	**114**	**156**	**142**	**138**	**114**	**75**	**161**	**117**	**204**	**234**	**183**	**403**	**420**	**317**	**366**	**373**	**323**	**340**	**348**

[14] Ibid

Table 8.31: Washington State RPS Detail with New Resources (aMW)[15]

	On-line Year	Apprentice Labor Credit	Upgrade Energy	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
WA State Retail Sales Forecast				628	630	634	644	650	656	663	667	674	678	682	686	687	690	696	702	708	715	723	731	740	750
RPS %					0%	3%	3%	3%	3%	9%	9%	9%	9%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%
REQUIRED RENEWABLE ENERGY						**19**	**19**	**19**	**19**	**59**	**59**	**60**	**60**	**101**	**102**	**103**	**103**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**
Renewable Resources																									
Purchased RECs					0	6	6	6	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Lake	1999	1.0	2.2		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Little Falls	2001	1.0	0.6		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Cabinet 2	2004	1.0	2.9		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Cabinet 3	2001	1.0	4.5		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Cabinet 4	2007	1.0	2.0		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Noxon 1	2009	1.0	2.3		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Noxon 3	2010	1.0	1.9		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Noxon 2	2011	1.0	1.0		0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Noxon 4	2012	1.0	0.9		0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Nine Mile	2012	1.0	3.7		0	0	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
New Wind	2013+	1.2			0	0	42	42	42	42	42	42	42	57	85	85	85	85	85	85	85	85	85	85	85
Total Qualifying Resources					*17*	*23*	*68*	*70*	*70*	*64*	*64*	*64*	*64*	*79*	*107*	*107*	*107*	*107*	*107*	*107*	*107*	*107*	*107*	*107*	*107*
NET REC POSITION					**17**	**5**	**49**	**50**	**50**	**5**	**5**	**4**	**4**	**(23)**	**5**	**5**	**4**	**4**	**3**	**2**	**1**	**1**	**(1)**	**(2)**	**(3)**
REC Bank																									
Previous Year Balance					0	17	21	68	70	70	64	64	64	64	41	46	51	56	60	63	65	67	67	67	65
REC's Required					0	(19)	(19)	(19)	(19)	(59)	(59)	(60)	(60)	(101)	(102)	(103)	(103)	(103)	(104)	(105)	(106)	(107)	(108)	(109)	(110)
REC's Generated/Purchased					17	23	68	70	70	64	64	64	64	79	107	107	107	107	107	107	107	107	107	107	107
Expired/Sold RECs						0	(2)	(49)	(50)	(11)	(5)	(4)	(4)	0	0	0	0	0	0	0	0	0	0	0	0
NET REC BANK					**17**	**21**	**68**	**70**	**70**	**64**	**64**	**64**	**64**	**41**	**46**	**51**	**56**	**60**	**63**	**65**	**67**	**67**	**67**	**65**	**62**
REC Reserve Requirement (95th PERCENTILE)																									
Load					0	1	1	1	1	3	3	3	3	5	5	5	5	5	5	5	5	5	5	6	6
Existing Hydro Upgrades					0	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Total REC Reserve Requirement					**0**	**7**	**8**	**8**	**8**	**10**	**10**	**10**	**10**	**12**	**12**	**12**	**12**	**12**	**12**	**13**	**13**	**13**	**13**	**13**	**13**
NET REC POSITION					**17**	**14**	**63**	**110**	**112**	**65**	**59**	**58**	**57**	**29**	**34**	**39**	**43**	**47**	**50**	**53**	**54**	**55**	**54**	**52**	**49**

15 Retail sales forecast includes new conservation programs.

9. Action Items

The Integrated Resource Plan (IRP) is an ongoing and iterative process balancing regular publication timelines with pursuing the best 20-year resource strategies. The biennial publication date provides opportunities for ongoing improvements to the modeling and forecasting procedures and tools, as well as the opportunity to enhance the process with new research as the planning environment changes. This section provides an overview of the progress made on the 2009 IRP Action Plan and provides the 2011 Action Plan.

Summary of the 2009 IRP Action Plan

The 2009 Action Plan included five separate categories: resource additions and analysis, energy efficiency, environmental policies, modeling and forecasting enhancements, and transmission planning.

2009 Action Plan – Resource Additions and Analysis

- Continue to explore the potential for wind and non-renewable resources.
- Issue an RFP for turbines at Reardan and up to 100 MW of wind or other renewables in 2009.
- Finish studies on the costs and environmental benefits of hydro upgrades at Cabinet Gorge, Long Lake, Post Falls, and Monroe Street.
- Study potential locations for the natural gas-fired resource identified to be online between 2015 and 2020.
- Continue participation in regional IRP processes and where agreeable find resource opportunities to meet resource requirements on a collaborative basis.

Progress Report – Resource Additions and Analysis

After filing the 2009 IRP, the Company issued two RFPs: (1) a 35 aMW Renewable RFP and (2) a wind turbine RFP for the Reardan development. The 2009 RFP showed that the anticipated benefits of early construction of Reardan, or a third party acquisition, identified in the 2009 IRP were not available. The Company retains the Reardan Wind Project site as an option to meet future RPS goals. Site control provides a hedge against escalating costs and the limited number of viable Pacific Northwest wind sites. Additional studies on non-wind renewable energy sources continued throughout this planning cycle. More details about non-wind renewables are included in the Generation Resource Options and Preferred Resource Strategy chapters.

Following the 2009 RFP, several wind development firms asked when another RFP would be issued, indicating that wind turbine prices had fallen greatly since the 2009 RFP and that prices in a new RFP issuance would be competitive to the wholesale market prices (when including REC sales) when including federal and state tax subsidies. In response, the Company issued an RFP for approximately 35 aMW of Washington renewable portfolio standard-qualified renewable energy contracts. The Company did not include its Reardan Wind Project, as it could not be completed in time to take advantage of the expiring Federal tax subsidies.[1] The Company's February 2011

[1] Federal tax incentives for wind expire at the end of calendar year 2012.

RFP received bids for 774 MW of qualifying projects (769 MW of wind and 5 MW of landfill gas). The Company selected the 105 MW Palouse Wind Project, located near Oakesdale, Washington. The proposal is a 30-year power purchase agreement with a buyout option after year 10. Further details regarding this acquisition are contained in the Preferred Resource Strategy Chapter.

The Company is continuing to research system hydroelectric upgrade options. The results of these studies are not yet complete, and we therefore were unable to include the results of these studies in this IRP. Some preliminary results are in the Generation Resource Options Chapter, and in presentations to the third Technical Advisory Committee on December 2, 2010. The slides from that presentation are contained in Appendix A.

Preliminary work on identifying potential locations for future natural gas-fired resources identified in the 2009 IRP is complete, but a final site selection is not complete. The 2011 PRS pushes the need for the next gas-fired plant until 2019 and changes the technology from combined to simple cycle. This work will continue and an update given as an Action Item in the 2013 IRP.

The Company continues to participate in regional IRP processes, attending peer-utility meetings. Regional utilities participated in our Technical Advisory Committee meetings to share the latest concepts in resource planning.

2009 Action Plan – Energy Efficiency

- Pursue American Reinvestment and Recovery Act of 2009 (ARRA) funding for low income weatherization.
- Analyze and report on the results of the July 2007 through December 2009 demand response pilot in Moscow and Sandpoint.
- Have an external party perform a study on technical, economic, and achievable potential for energy efficiency in Avista's entire service territory.
- Study and quantify transmission and distribution efficiency concepts as they apply to meeting Washington's RPS goals.
- Update processes and protocols for conservation measurement, evaluation and verification.
- Determine the potential impacts and costs of load management options.

Progress Report – Energy Efficiency

Avista's Community Action Agencies received significant increases for low-income weatherization through ARRA funds. The Idaho Load Management Pilot Final Report, issued on March 1, 2010, provides details on the Moscow and Sandpoint demand response project. The pilot included ten successful trial events, including the cycling of heating and air conditioning units and the short-term interruption of water heaters. Five percent of the eligible participants agreed to participate in the volunteer program; two percent of customers participating in the study opted-out of the program during events. Even though the program successfully showed the capability of a load interruption program as a reliable capacity resource, the regional power market does not support the present costs of such a program at this time. The Company will continue to monitor the marketplace to determine if this type of load management program will become cost effective in the future.

Global Energy Partners (Global) completed a 20-year conservation potential assessment for our residential, commercial and industrial customers in Idaho and Washington. Global presented the assessment results at the fifth Technical Advisory Committee meeting on April 12, 2011. A copy of the presentation is included in Appendix D, and more details are in the Energy Efficiency chapter.

The study and quantification of transmission and distribution efficiency concepts, as they apply to meeting Washington's renewable portfolio standard goals is part of an ongoing process. It will be refined as the Company prepares its initial Washington Energy Independence Act compliance report to the Washington Utility and Transportation Commission. Additional details are in the Energy Efficiency and Transmission and Distribution chapters of this IRP.

The Company continues to update the processes and protocols for conservation measurement, evaluation and verification (EM&V). The Company participated in an EM&V Collaborative in 2010 resulting in an EM&V framework, annual EM&V plans and development of individual program EM&V plans. This continual EM&V loop will feed improved processes and protocols for conservation measurement, evaluation and verification. As part of the conservation potential study, Global Energy Partners looked at demand response potential and costs. More details about this work are in the Energy Efficiency chapter.

2009 Action Plan – Environmental Policy

- Continue to study the potential impact of state and federal climate change legislation.
- Continue and report on the work of Avista's Climate Change Council.

Progress Report – Environmental Policy

Avista's Climate Change Council and the Resource Planning team actively analyze state and federal greenhouse gas legislation. This work will continue until final rules are established and laws passed. The focus will then shift to mitigating the costs of meeting these laws and regulations. Avista has quantified its greenhouse gas emissions using the World Resources Initiative–World Business Council for Sustainable Development (WRI-WBCSD) inventory protocol in anticipation of state and federal greenhouse gas reporting mandates. Details about Climate Change Council efforts are in the Policy Considerations chapter.

2009 Action Plan – Modeling and Forecasting Enhancements

- Refine cost driver relationships in the stochastic model.
- Continue to refine PRiSM by developing a resource retirement capability to solve for other risk measurements and by adding more resource options.
- Continue developing Loss of Load Probability and Sustained Peaking analysis for inclusion in the IRP process, and confirm appropriateness of the 15 percent capacity planning margin assumed for this IRP.
- Continue studying the impacts of climate change on the load forecast.
- Study load growth trends and their correlation to weather patterns.

Progress Report – Modeling and Forecasting Enhancements

Improvements have continued on stochastic modeling for the IRP. This plan relies on new methods for modeling natural gas and wind. Work continues on developing a method to correlate temperature, wind and hydro in the stochastic model. This work will continue and results reported in the 2013 IRP.

The 2011 IRP includes several refinements to the PRiSM model. A resource retirement capability was developed, but not utilized for this IRP. We developed a method to evaluate the true standard deviation of power supply costs for the 2011 IRP, but long solution times prevented its adoption. This plan also includes more resource options, and modeling of generators by state and by location on the regional transmission system.

Loss of Load Probability (LOLP) and Sustained Peaking analysis models were developed and used for the 2011 IRP. This IRP uses an 18-hour sustained peak over three days to estimate the need for new resources. Avista developed an LOLP model for this IRP and presented it to the TAC on September 9, 2010; however, subsequent testing of the model found that the LOLP study was driven primarily by regional market availability assumptions that were beyond the scope of the study. The Company will continue to work with the Northwest Power and Conservation Council to determine the best methods for identifying regional market availability. More details are in the Loads & Resources and Preferred Resource Strategy chapters.

The IRP load forecast continues to estimate the impacts of climate change on customer load growth. More details are included in the Load and Resource chapter of this IRP. Any changes will be in the 2013 IRP.

Transmission Planning

- Work to maintain/retain existing transmission rights on the Company's transmission system, under applicable FERC policies, for transmission service to bundled retail native load.
- Continue to participate in BPA transmission practice processes and rate proceedings to minimize the costs of integrating existing resources outside of the Company's service area.

- Continue to participate in regional and sub-regional efforts to establish new regional transmission structures (ColumbiaGrid and other forums) to facilitate long-term expansion of the regional transmission system.
- Evaluate costs to integrate new resources across Avista's service territory and from regions outside of the Northwest.
- Study and implement distribution feeder rebuilds to reduce system losses.
- Study transmission reconfigurations that economically reduce system losses.

Progress Report – Transmission Planning

The 2009 IRP transmission planning action item studies continue and are included in the 2013 Action Plan. Details about progress made toward the maintenance of existing transmission rights, involvement in BPA processes, participation in regional transmission processes, and the evaluation of integrating different resources in the IRP are in the Transmission and Distribution chapter.

Avista has completed a feeder rebuild pilot project at its 9th and Central 12F4 feeder. The Company received federal stimulus dollars for several "Smart Grid" initiatives that include projects contained in the 2009 IRP. The Company is developing a program to rebuild additional feeders as outlined in this plan. Additional details on these projects are included in the Transmission and Distribution Chapter.

2011 IRP Action Plan

The Company's 2011 Preferred Resource Strategy provides direction and guidance for the type, timing and size of future resource acquisitions. The 2011 IRP Action Plan highlights the activities planned for possible inclusion in the 2013 IRP. Progress and results for each of the 2011 Action Plan items will be reported to the Technical Advisory Committee and the results will be included in Avista's 2013 IRP. The 2011 Action Plan includes input from Commission Staff, the Company's management team, and the Technical Advisory Committee.

Resource Additions and Analysis

- Continue to explore and follow potential new resources opportunities.
- Continue studies on the costs, energy, capacity and environmental benefits of hydro upgrades at both Spokane and Clark Fork River projects.
- Study potential locations for the natural gas-fired resource identified to be online by the end of 2018.
- Continue participation in regional IRP processes and, where agreeable, find opportunities to meet resource requirements on a collaborative basis with other utilities.
- Provide an update on the Little Falls and Nine Mile hydroelectric project upgrades.
- Study potential for demand response projects with industrial customers.
- Continue to monitor regional surplus capacity and Avista's reliance on this surplus for near- and medium-term needs.

Energy Efficiency

- Study and quantify transmission and distribution efficiency projects as they apply to Washington RPS goals.
- Update processes and protocols for conservation measurement, evaluation and verification.
- Continue to determine the potential impacts and costs of load management options.

Environmental Policy

- Continue studies of state and federal climate change policies.
- Continue and report on the work of Avista's Climate Change Council.

Modeling and Forecasting Enhancements

- Continue following regional reliability processes and develop Avista-centric modeling for possible inclusion in the 2013 IRP.
- Continue studying the impacts of climate change on retail loads.
- Refine the stochastic model for cost driver relationships, including further analyzing year-to-year hydro correlation and the correlation between wind, load, and hydro.

Transmission and Distribution Planning

- Work to maintain the Company's existing transmission rights, under applicable FERC policies, for transmission service to bundled retail native load.
- Continue to participate in BPA transmission processes and rate proceedings to minimize costs of integrating existing resources outside of Avista's service area.
- Continue to participate in regional and sub-regional efforts to establish new regional transmission structures to facilitate long-term expansion of the regional transmission system.
- Evaluate the costs to integrate new resources across Avista's service territory and from regions outside of the Northwest.
- Study and implement distribution feeder rebuilds to reduce system losses.
- Continue to study other potential areas to implement Smart Grid projects to other areas of the service territory.
- Study transmission reconfigurations that economically reduce system losses.

Production Credits

Primary Avista 2011 Electric IRP Team

Individual	Title	Contribution
Clint Kalich	Manager of Resource Planning & Analysis	Project Manager
James Gall	Senior Power Supply Analyst	Analysis/Author
John Lyons	Power Supply Analyst	Research/Author/Editor
Randy Barcus	Economic Analyst	Load Forecast
Lori Hermanson	Utility Resource Analyst	Energy Efficiency
Scott Waples	Director System Planning	Transmission & Distribution

Other Contributors

Name	Title
Reuben Arts	System Planning Engineer
Thomas Dempsey	Manager, Generation Joint Projects
Mike Gonnella	Manager of Engineering - Thermal
Jason Graham	Mechanical Engineer
Curt Kirkeby	Senior Engineer II
Mike Magruder	Substation Engineering Manger
Jon Powell	Partnership Solutions Manager
Greg Rahn	Manager of Natural Gas Planning
Xin Shane	Power Supply Analyst
Ken Sweigart	Transmission Design Manager
Steve Wenke	Chief Generation Engineer
Jessie Wuerst	Communications Manager

Contact contributors via email by placing the names in this email address format:
first.last@avistacorp.com

AVISTA

August 31, 2011

2011 Electric INTEGRATED Resource Plan

APPENDIX

Appendix Table of Contents

2011 Electric Integrated Resource Plan

Appendix A – Technical Advisory Committee Presentations

Avista's 2011 Electric Integrated Resource Plan

Technical Advisory Committee Meeting No. 1 Agenda

Thursday, May 27, 2010
Conference Room 130

Topic	Time	Staff
1. Introduction	10:30	Lafferty
2. Work Plan	10:35	Lyons
3. Load & Resource Balance Update	11:00	Shane
4. Resource Planning Environment	11:35	Lyons
5. Lunch	12:00	
6. 2011 IRP Topic Discussions	1:15	
• Analytical Process Changes		Gall
• Hydro Modeling		Shane
• Resource Adequacy		Kalich
• Loss of Load Probability		Gall
• Energy Efficiency		Hermanson
• Scoping the 2011 Plan		Kalich
7. Adjourn	3:30	

Work Plan

John Lyons

Technical Advisory Committee Meeting #1

2011 Electric Integrated Resource Plan

May 27, 2010

Technical Advisory Committee Meetings

May 27, 2010: Work plan, load & resource balance, resource planning environment, and 2011 IRP topic discussions (analytical process changes, hydro modeling, resource adequacy, loss of load probability, energy efficiency, and scoping the 2011 plan)

August 2010: Risk and resource assumptions, loss of load probability analysis, scenarios and futures, and energy efficiency

October 2010: Load forecast, preliminary electric and gas price forecasts, updated load & resource forecast balance, and transmission cost studies

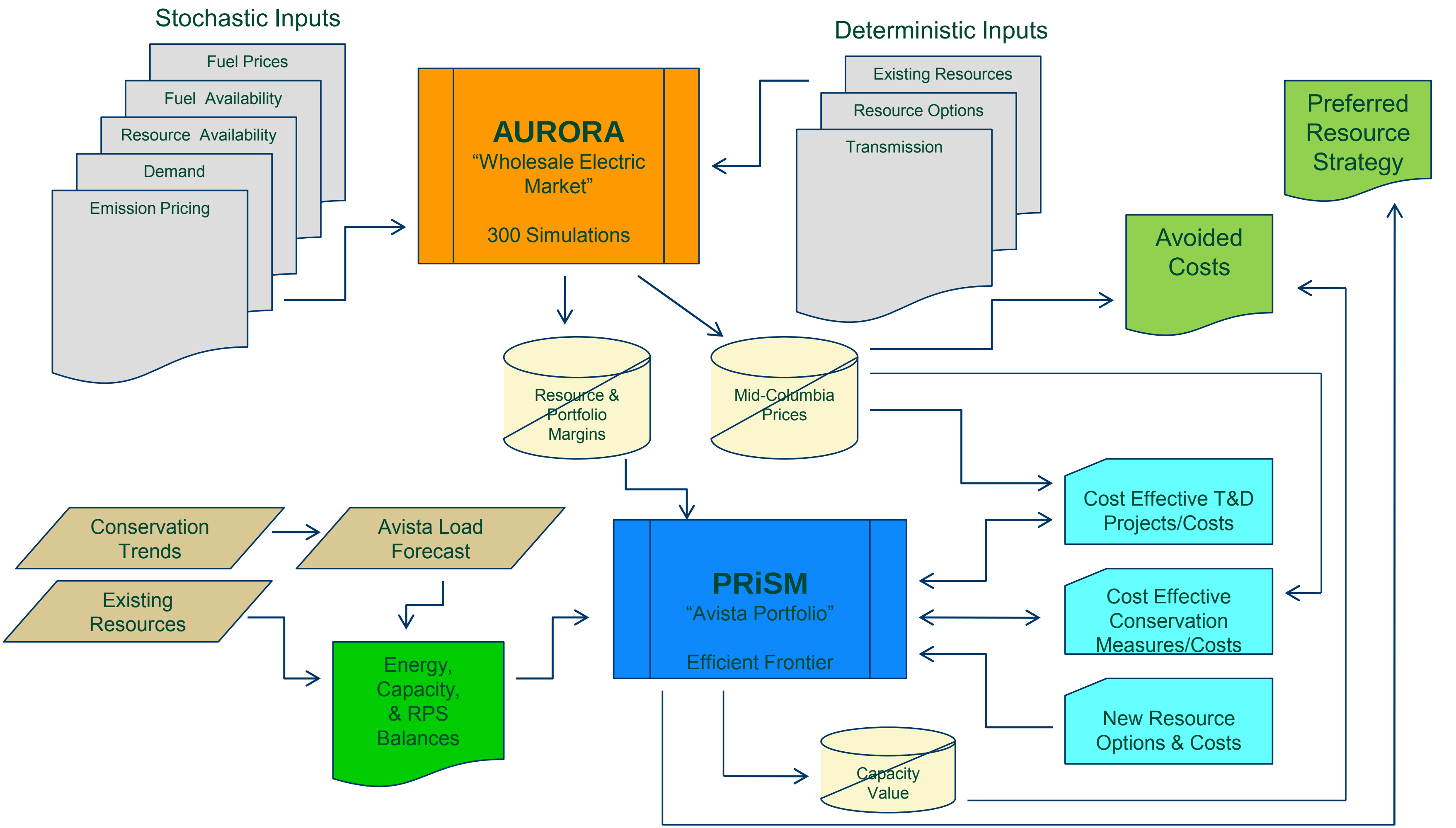
February 2011: Review of modeling and assumptions, and draft PRS

March 2011: Review of scenarios and futures, and portfolio analysis

April 2011: Review of final PRS and action items

June 2011: Review of the 2011 IRP

2011 Integrated Resource Plan Modeling Process



2011 Electric IRP Draft Outline

1. Executive Summary
2. Introduction and Stakeholder Involvement
3. Loads and Resources
    a) Load forecast and scenarios
    b) Existing resources
    c) Resource adequacy
4. Energy Efficiency and Demand Response
    a) Energy and capacity savings projections and methodology
    b) Two year energy savings target (I-937) & business planning process
    c) Demand response options and study results
    d) Risk and externalities
5. Environmental Issues
    a) Carbon emissions
    b) Other
6. Transmission Planning
    a) Resource integration
    b) Smart grid
    c) Other T&D efficiencies

2011 Electric IRP Draft Outline (cont)

7. Generation Resource Options
   a) New resource alternatives
   b) Thermal and hydro upgrades
8. Market Analysis
   a) Regional loads, transmission, resources
   b) Fuel price forecasts
   c) Risk modeling
   d) Market price forecasts
   e) Market scenario analysis
9. Preferred Resource Strategy
   a) The PRiSM Model and efficient frontier analysis
   b) Preferred Resource Strategy results and I-937 compliance
   c) Portfolio scenario analysis
10. Action Items

Load and Resource Balance Forecast

Xin Shane

Technical Advisory Committee Meeting #1

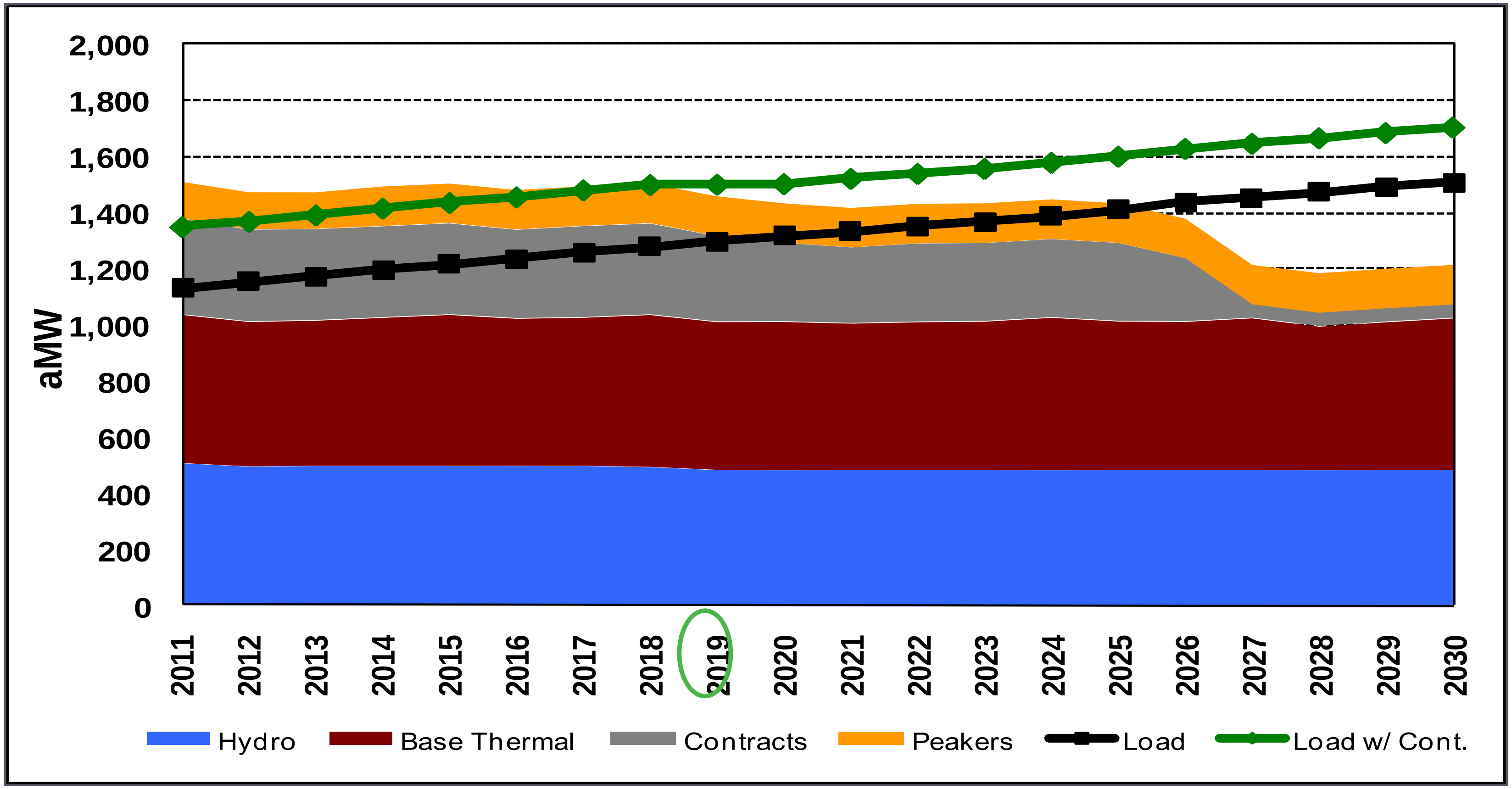
2011 Electric Integrated Resource Plan

May 27, 2010

L&R Changes From 2009 IRP

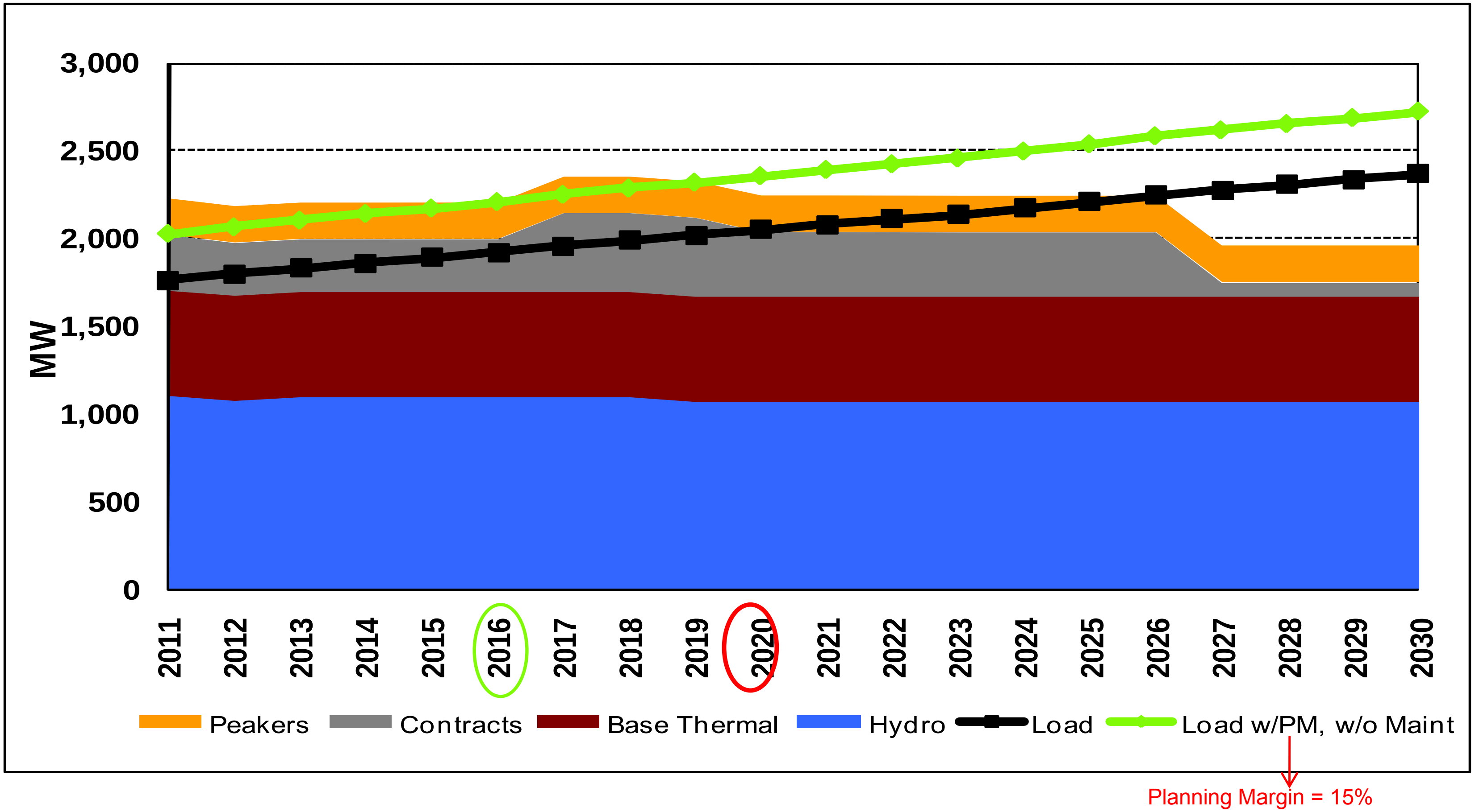
- **Load**- 10 year growth rate 1.8%, 20 year growth rate 1.6% for Peak and Energy. The forecast for year 2011 is 42 aMW lower than previous forecast or 3.6% lower
- **Hydro**- Uses Clark Fork Optimization Package Results
- **Thermal**- CS2 duct burner capacity is upgraded to 28 MW from 23 MW

Annual Average Energy Position
Base Case



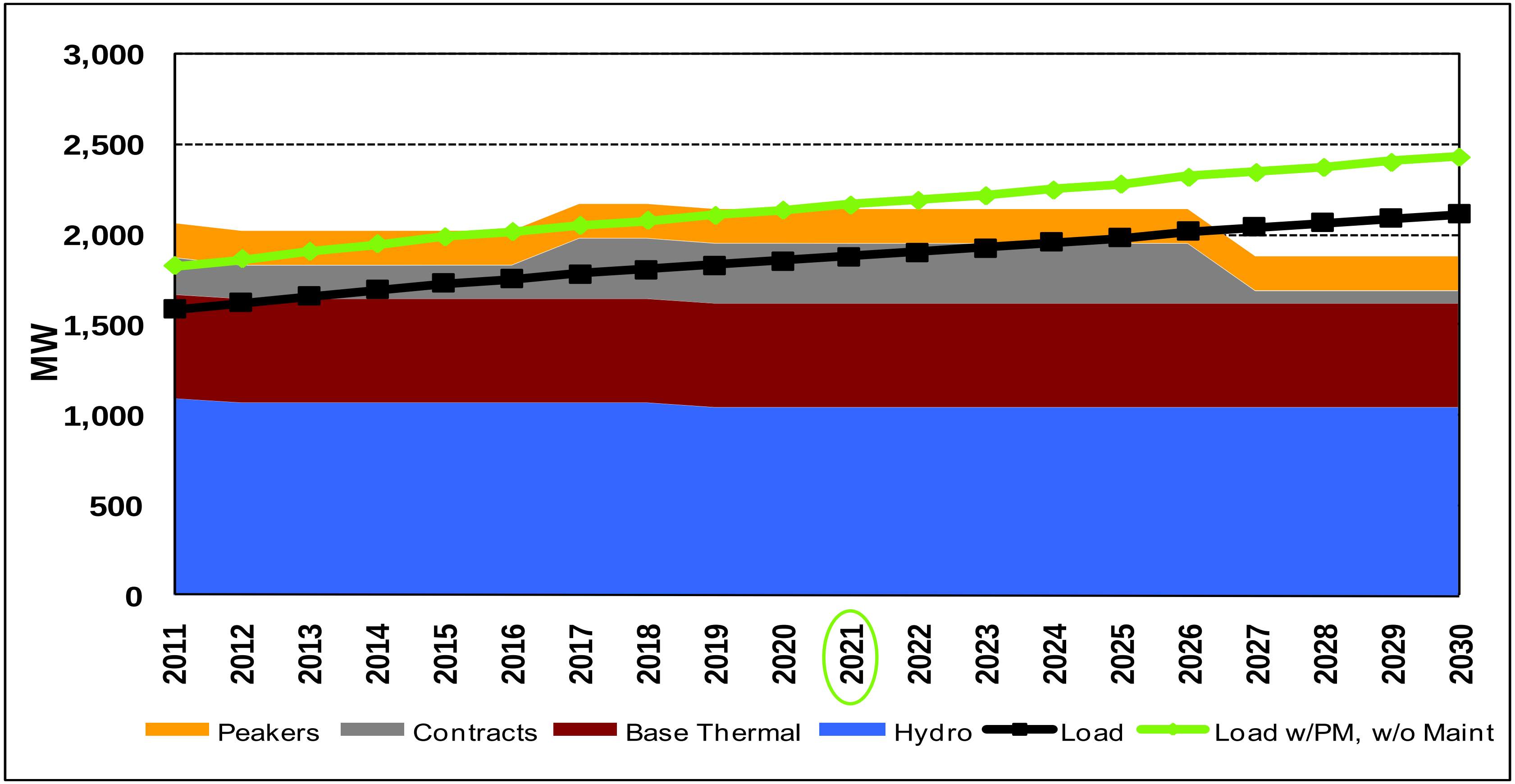
Winter Capacity Position

Base Case



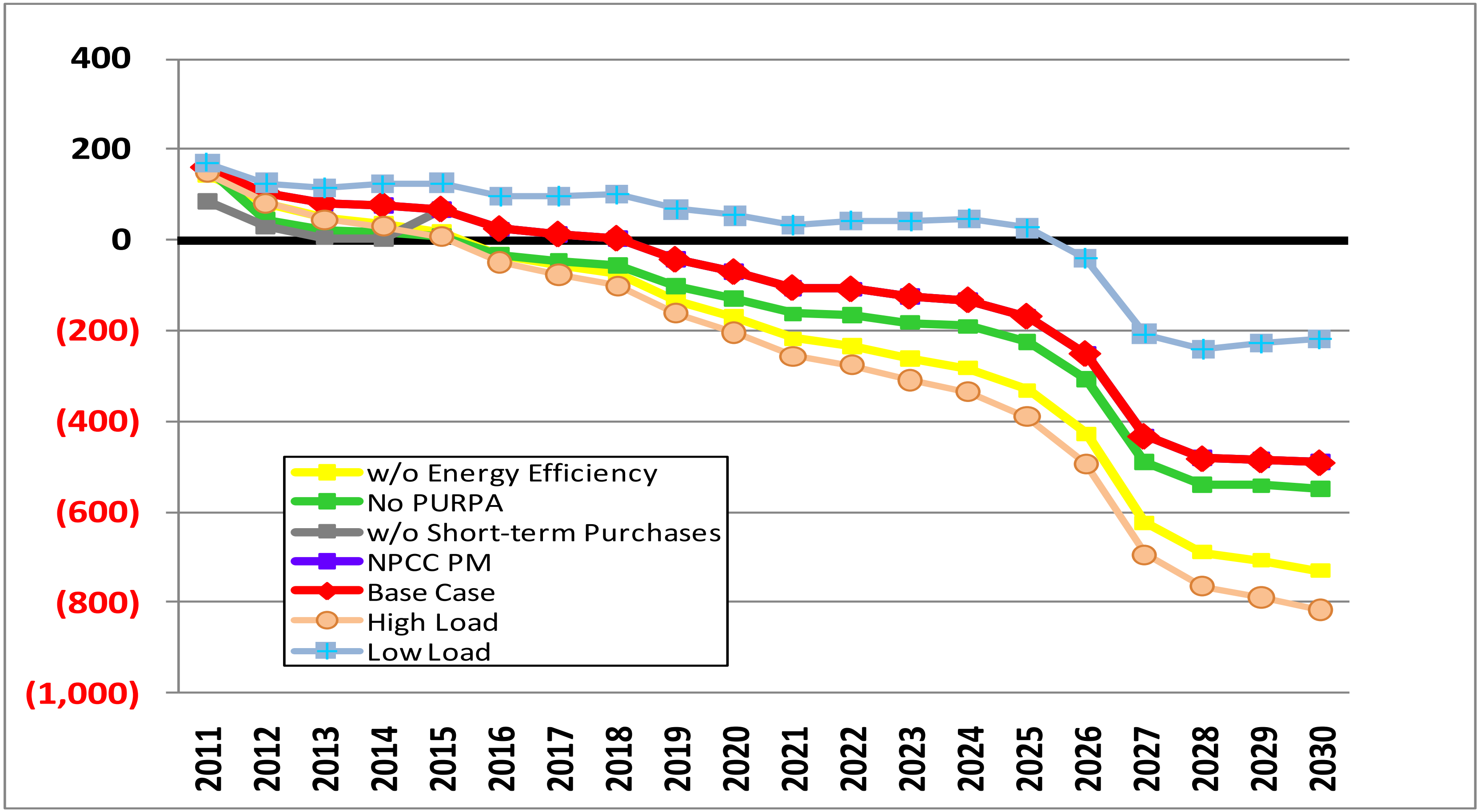
August Capacity Position

Base Case



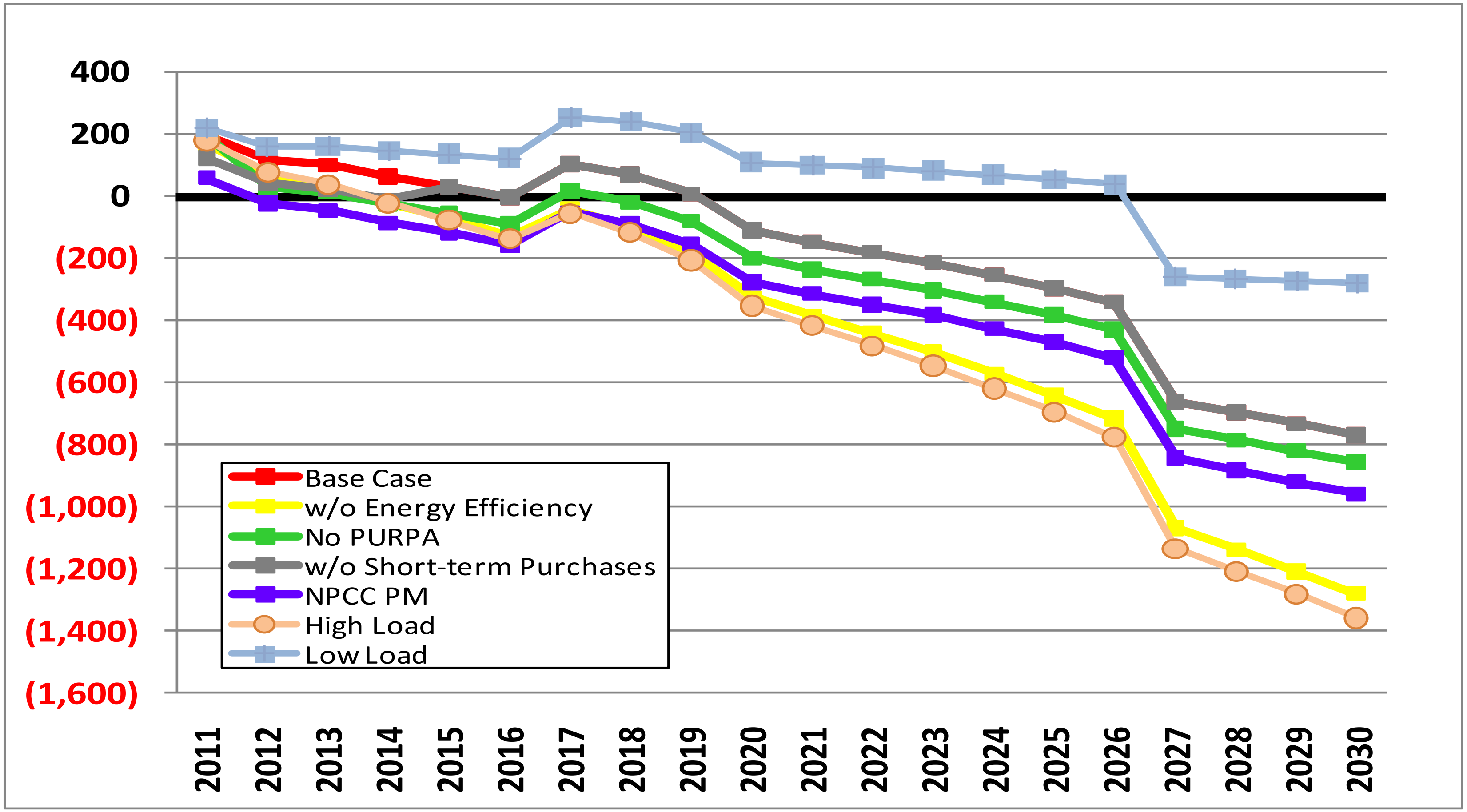
Energy Positions – 7 Scenarios

(aMW)



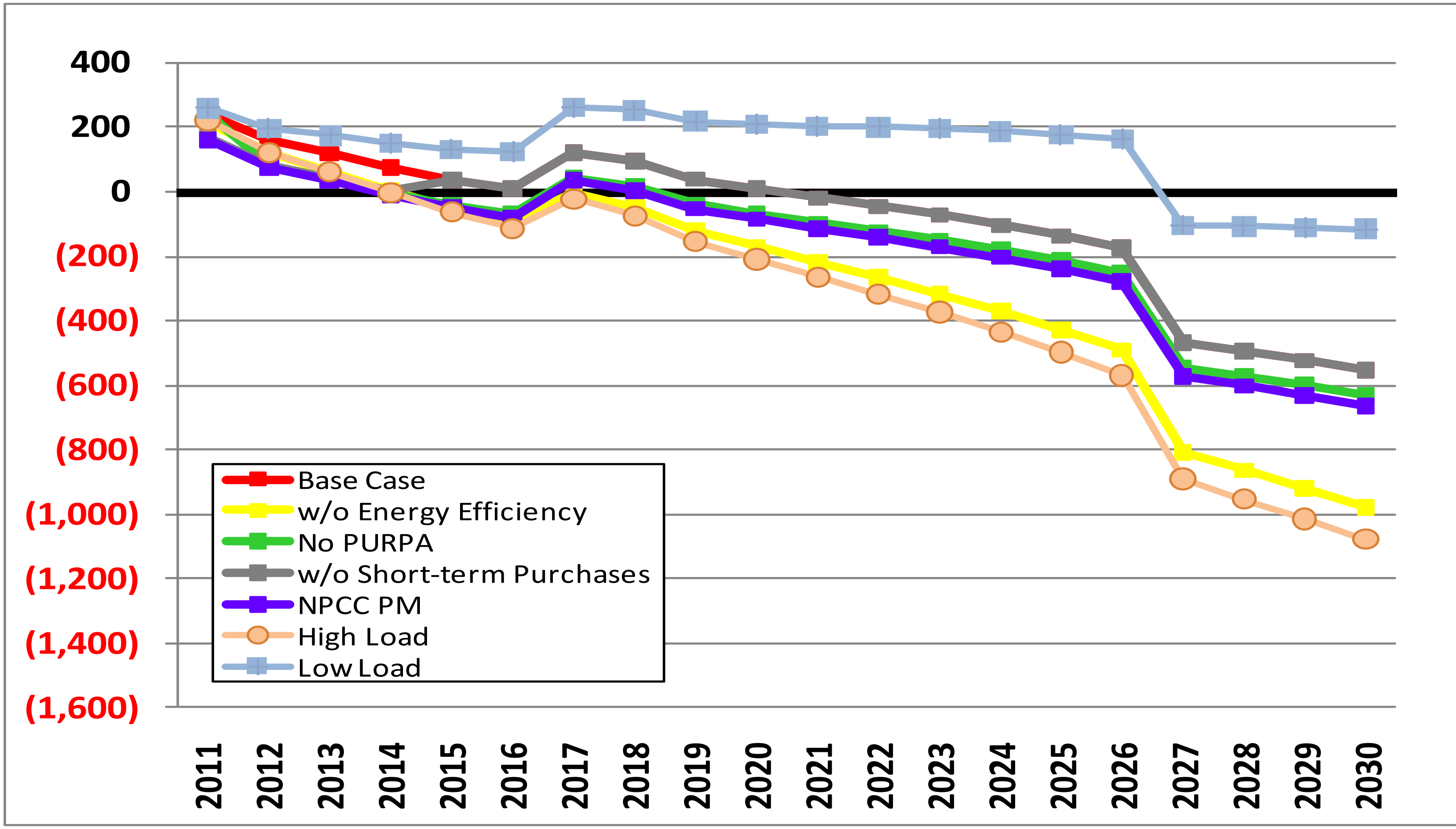
Winter Capacity Positions – 7 Scenarios

(MW)



August Capacity Positions – 7 Scenarios

(MW)



Washington State RPS (aMW)

	On-line Year	Apprentice Labor	Upgrade Energy	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
WA State Retail Sales Forecast				656	668	681	693	702	712	721	730	740	751
Load 10% Chance of Exceedance				29	30	30	31	31	32	32	33	33	34
Planning RPS Load				685	698	711	724	733	744	753	763	773	785
RPS %				0%	3%	3%	3%	3%	9%	9%	9%	9%	15%
Required Renewable Energy				**0.0**	**20.3**	**20.8**	**21.1**	**21.5**	**65.6**	**66.5**	**67.4**	**68.2**	**115.2**
Renewable Resources													
Purchased RECs				0.0	5.7	5.7	5.7	5.7	0.0	0.0	0.0	0.0	0.0
Kettle Falls	1983			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stateline	1999			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long Lake 3	1999			2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Little Falls 4	2001			0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Cabinet 2	2004			2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
Cabinet 3	2001			4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Cabinet 4	2007	1.0	1.99	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Noxon 1	2009	1.0	2.90	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
Reardan				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hydro 10% Chance of Exceedance				(4.2)	(4.2)	(4.2)	(4.2)	(4.2)	(4.2)	(4.2)	(4.2)	(4.2)	(4.2)
Total Qualifying Resources				***10.9***	***16.5***	***16.6***	***16.6***	***16.6***	***10.9***	***10.9***	***10.9***	***10.9***	***10.9***
Net REC Position (Completed)				**10.9**	**(3.8)**	**(4.2)**	**(4.6)**	**(5.0)**	**(54.7)**	**(55.6)**	**(56.5)**	**(57.4)**	**(104.4)**
Budgeted Hydro Upgrades													
Noxon 2	2011	1.0	1.00	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Noxon 3	2010	1.0	1.30	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Noxon 4	2012	1.0	1.20	0.0	0.6	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Nine Mile	2012	1.2	3.80	0.0	2.3	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
Hydro 10% Chance of Exceedance				(0.5)	(1.3)	(2.0)	(2.0)	(2.0)	(2.0)	(2.0)	(2.0)	(2.0)	(2.0)
Total Budgeted Hydro Upgrades				***1.3***	***3.8***	***6.1***	***6.1***	***6.1***	***6.1***	***6.1***	***6.1***	***6.1***	***6.1***
Rollover Credits				0.0	12.1	12.2	14.1	15.6	16.7	0.0	0.0	0.0	0.0
Net REC Postion (Budgeted Upgrades)	**with Rollover**			**12.1**	**12.2**	**14.1**	**15.6**	**16.7**	**(31.9)**	**(49.5)**	**(50.4)**	**(51.3)**	**(98.3)**
Net REC Postion (Budgeted Upgrades)	**w/o Rollover**			**12.1**	**0.1**	**1.9**	**1.5**	**1.1**	**(48.6)**	**(49.5)**	**(50.4)**	**(51.3)**	**(98.3)**

Planning Environment

John Lyons

Technical Advisory Committee Meeting #1

2011 Electric Integrated Resource Plan

May 27, 2010

Major Planning Issues

1. Renewable Portfolio Standards
   – State and federal
2. Greenhouse Gas Regulations
   – State, regional, and federal
   – Emissions performance standards and reporting
3. Energy Efficiency Requirements
4. Reliability Planning
5. Variable Resource Integration
6. Electric Vehicles
7. Smart Grid
8. PURPA

State & Federal Greenhouse Gas Reduction Goals

Percentage goals below 2005 greenhouse gas emissions

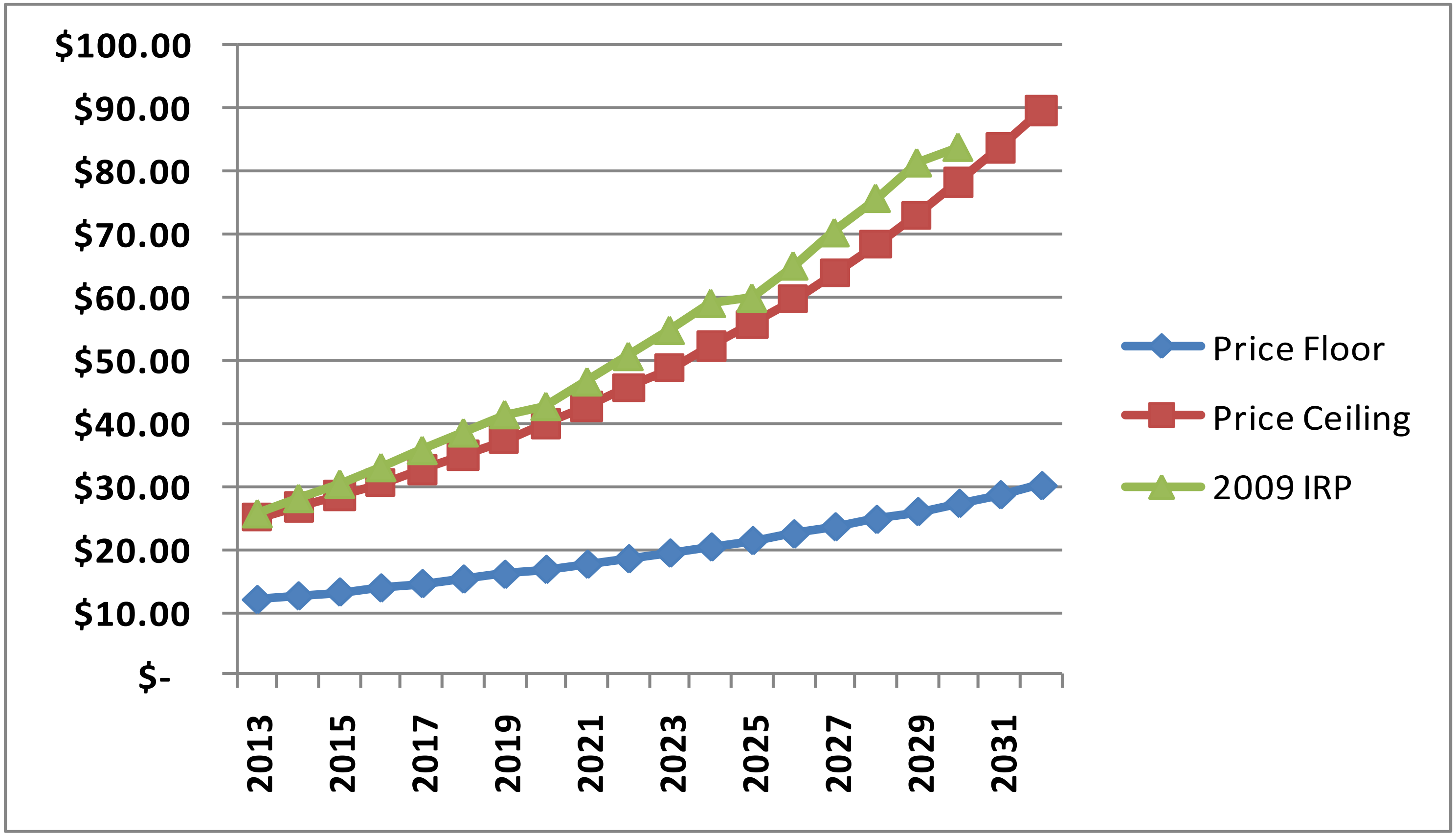
	Kerry-Lieberman	Waxman-Markey
2013	4.75%	3% (2012)
2020	17%	17%
2030	42%	42%
2050	83%	83%

	Washington Goals
2020	1990 emissions
2035	25% below 1990
2050	50% below 1990

Key Components Kerry-Lieberman (American Power Act)

- Allowances:
  - 75% emissions based and 25% load based
  - Prohibition from receiving excess allocations
  - Electricity sector begins in 2013, natural gas in 2016
  - Increased levels of free allocations
- Preemption of state cap-and-trade programs
- Preempt EPA regulation through Clean Air Act
- Carbon fees for petroleum
- Emissions credit limitations
- Emissions credit banking and borrowing

American Power Act – Price Collars



EPA Tailoring Rule

- Clean Air Act permitting requirements for greenhouse gas (GHG) emissions from large stationary sources
- January 2, 2011: Prevention of Significant Deterioration (PSD) requirements for GHG emissions for new and modified facilities needing non-GHG PSD permits and increasing GHG emissions 75,000 tons CO_2-e or more per year
- July 1, 2011: PSD requirements on new facilities emitting 100,000 tons CO_2-e and modifications increasing GHG emissions 75,000 tons
- Rulemaking in 2011 setting emission thresholds and permitting requirements for 2013

Analytical Process Changes

James Gall

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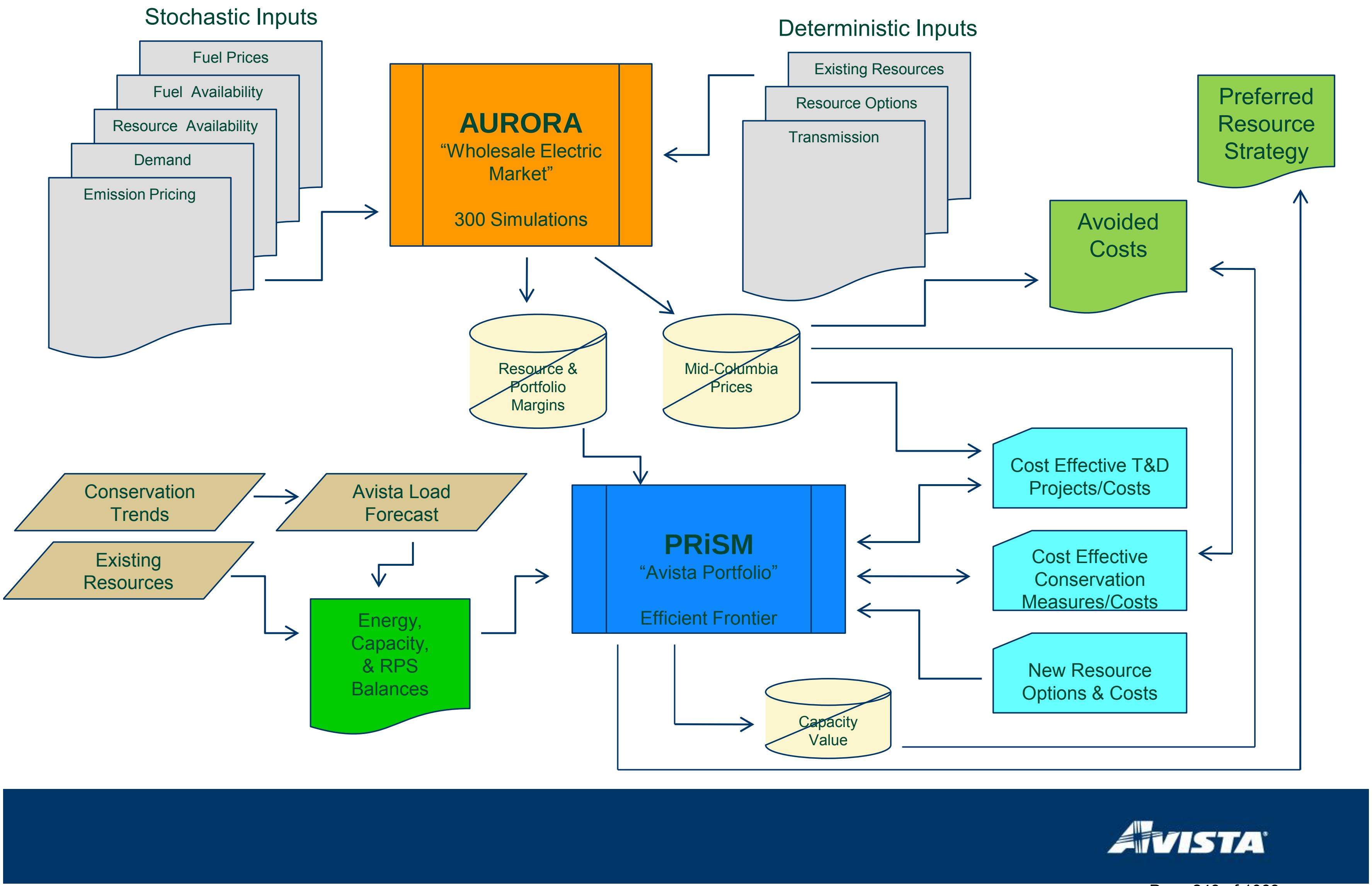
2011 Electric Integrated Resource Plan

May 27, 2010

2011 Integrated Resource Plan Modeling Process



Modeling Enhancements and Questions/Feedback

Modeling Enhancements

- Study period 2012 – 2031
- Use Loss of Load Probability/Expectation to target planning margins
- Resource retirements as an option in PRiSM
- Add other matrices to evaluate portfolio risk (i.e. Tail Var, CoVar, CO_2)
- Increased number of resource upgrades as options (thermal and hydro)
- Increased number of distribution efficiency programs
- Evaluate demand response programs
- Further enhance relationships of regional market variables (i.e. correlations)

Questions/Feedback

- Real versus nominal costs/prices reporting
- Market analysis (more, less, same- stochastic or scenario focused)
- Portfolio analysis (more, less, or same)
- Other requests

Hydro System Optimization Modeling

Xin Shane

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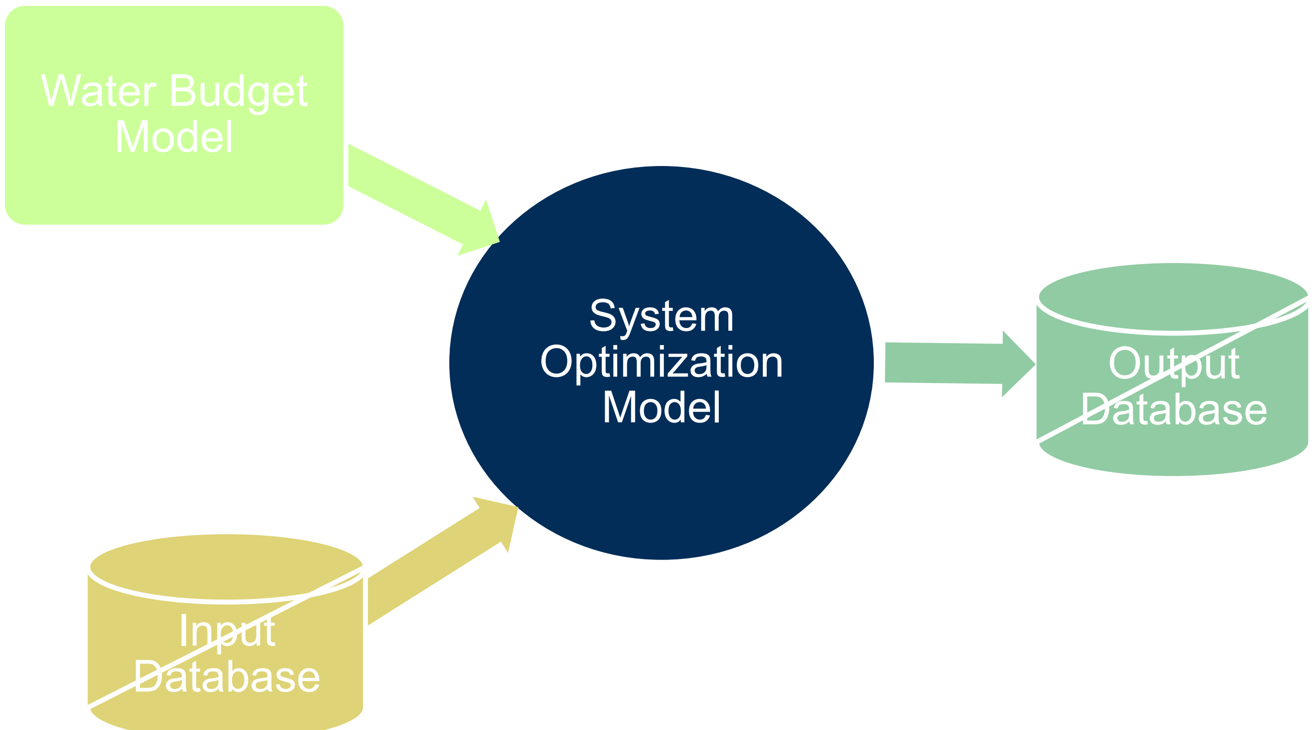
2011 Electric Integrated Resource Plan

May 27, 2010

Structure of Hydro System Optimization Package



Water Budget Model Overview

The Water Budget Model's primary goal is to recognize the storage capabilities inherent in system reservoirs, optimizing water releases to maximize generation values while enforcing project constraints.

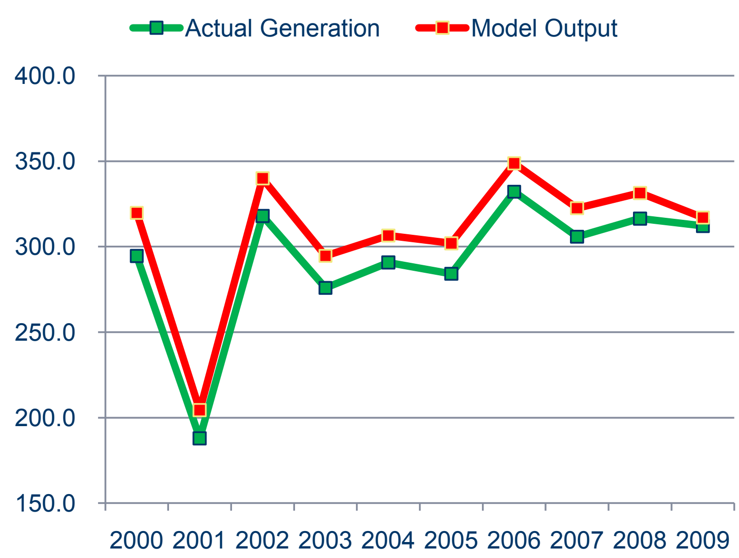
- Today's computers cannot optimize at an adequate detail level to extend the hourly Optimization Model to annual or multi-year timeframes
- Water Budget Model simplifies certain aspects, allowing optimization across many weeks to years
- Approach is a best practice, "industry standard"

System Optimization Model Overview

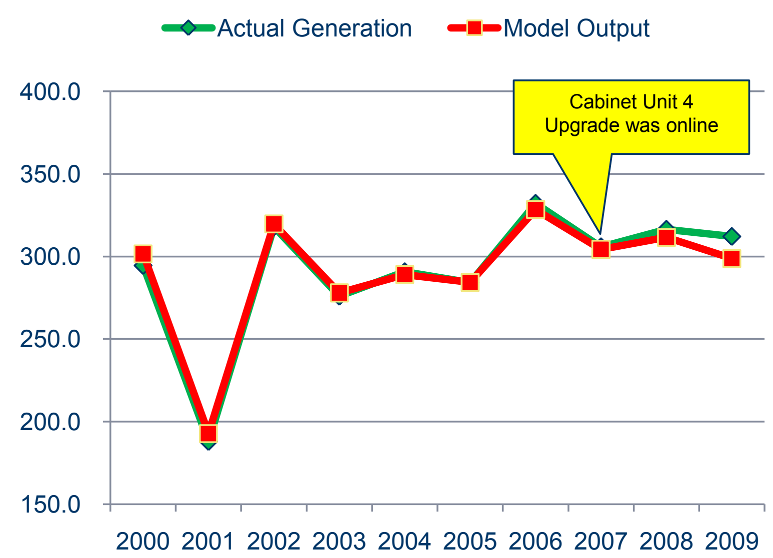
- Hourly model, with potential for more granularity (i.e., intra-hour analyses)
- Each project is represented in detail, including:
  - Accurate (piece-wise) reflection of individual turbine efficiency curves;
  - Physical and license-constrained reservoir elevations;
  - Tailrace elevations;
  - Minimum and maximum flow constraints; and
  - Other regulation constraints
- Shapes generation into the most beneficial (i.e., most economic) time periods using storage reservoirs
- Maximizes generation by flowing water through the most efficient points on each turbine's power curve

Model vs Actual Generation- Clark Fork Example (aMW)

Before Benchmarking



After Benchmarking



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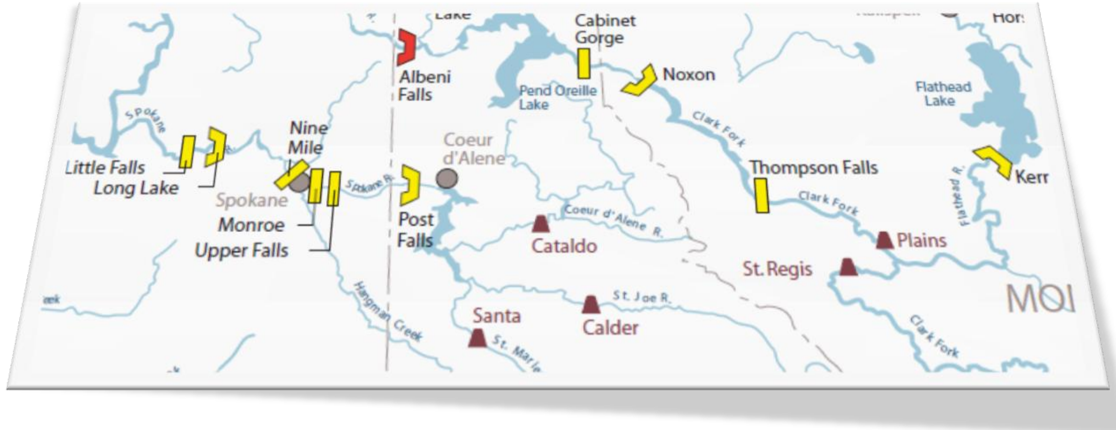
Next Steps



- **Complete Spokane River Model**
- **Complete Upgrade Analyses for the Following Projects**
  - Long Lake–new power house with 1 or 2 new units (30-120 MW, pumped storage)
  - Post Falls–replace powerhouse with between 1 and 3 new units (25-40 MW)
  - Monroe Street–one additional unit (~45 MW capacity)
  - Cabinet Gorge–one or 2 new units (60-120 MW, help with total dissolved gas mitigation)

Resource Adequacy

Clint Kalich

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May 27, 2010

Concepts

- Generator Capacity Services
  - Energy
  - Reserve for forced outages and extended load (i.e., hot and cold weather) excursions
  - Regulating
  - Load following
  - Energy imbalance (mismatches between scheduled and actual generation)

- Traditional Resource Planning Methodologies
  - Energy L&R
    - Average forecast
    - Plus contingency energy
  - Capacity L&R
    - Average peak load
    - Plus planning margin

Capacity Services Definitions

- Energy
  - Average capability to do work over a given time horizon
  - Conversion of fuel (water, wind, coal, gas, wood, etc.) to electricity

- Planning Reserves
  - Operating Reserve – capacity held back to cover forced outages and non-firm imports
    - 5%-7%-5% of online capacity for hydro-thermal-wind
    - at minimum half must be "spinning;" the remaining can be "non-spinning"
    - first hour of system contingency met through NWPP Reserve Sharing Group
  - Regulating Reserve – spinning reserve immediately responsive to AGC
    - generally a seconds-to-5-minute product

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Capacity Services Definitions, Cont.

- Planning Reserves, Cont.
  - Load Following
    - Reserve-like product to follow variations in load and resources across the trading hour
      - beyond 5 minutes
      - can be spinning or non-spinning (traditionally spinning in the NW)
  - Energy Imbalance
    - "Make-up energy"
    - Covers variations between hourly scheduled and actual generation levels

Potential Changes to L&R Planning Margin

- Operating Reserve
  - 5% hydro and wind
  - 7% thermal
- Regulating Reserve: ~25 MW
- Load Following: TBD
- Energy Imbalance
  - Wind and solar ~10-15%
  - Load ~2%
- Weather Variation: TBD

Key Considerations by Resource

- All Resources
  - Abilities to provide individual capacity services discussed above
  - Potential maintenance schedules
  - Forced outage characteristics

- Hydro
  - Sustained peaking capabilities
  - Run-of-river vs. reservoir storage vs. pumped storage
  - Upstream inflows during critical events

- Gas-Fired Thermals
  - Weather impacts
  - Resource type (peaking versus base-load, etc.)
  - Fuel availability over peak events

Key Considerations by Resource, Cont.

- Coal
  - Ramp rates

- Load Interruption (aka demand-side management)
  - Coincidence of measure with system peaking periods
  - Frequency of interruption rights
  - Duration of interruption rights
  - Sustainability of interruption savings
    - Especially when looking outside of industrial/large commercial classes

Key Considerations by Resource, Cont.

- Market Purchases
  - How much is available during critical events
    - Transmission constraints
    - Surpluses on 3rd party systems
  - "Firmness" of anticipated deliveries
    - Is 3rd party "firming" the sale?
    - In other words, will purchases be cut during critical events to serve 3rd-party system?

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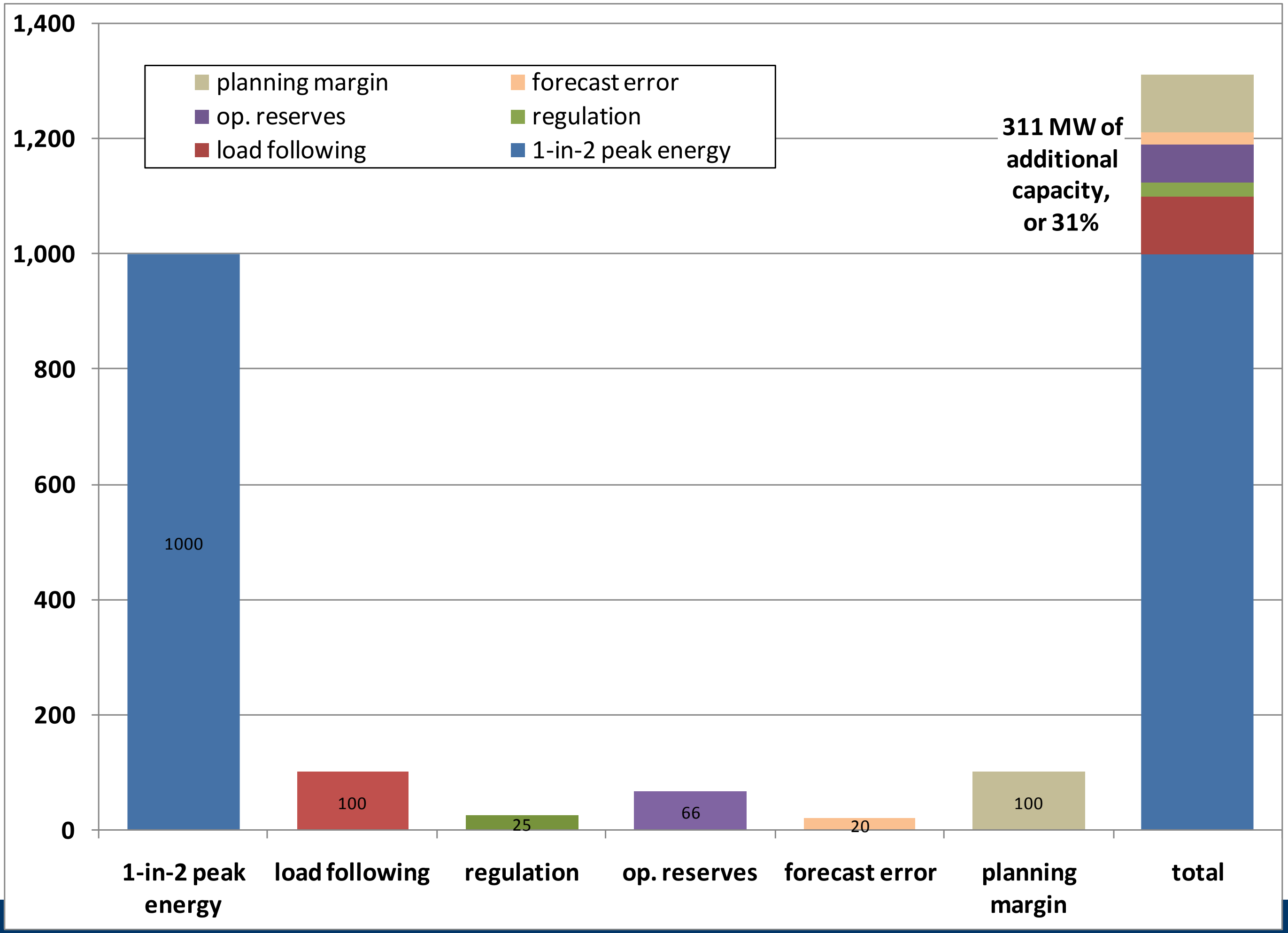
Illustration of Capacity Obligation



Metrics to Measure Resource Adequacy

- Loss of Load Probability (LOLP)
  – Percent of iterations that have at least one loss of load event
- Loss of Load Expectation (LOLE)
  – Days with an event; units are the number of days per year
- Loss of Load Hours (LOLH)
  – Hours with an event; units are the number of hours per year
- Expected or Equivalent Unserved Energy (EUE)
  – Average quantity of energy not served in each iteration (MWh)

Planning Margin Perspectives

- Avista Margin History
  - 10% of peak load, plus 90 MW (1980s-2008)
  - 15% of peak load (2009)

- FERC Standard Market Design: 12-18%

- Northwest Power and Conservation Council: 23% winter (January) , 24% summer (July)

- Avista 2011 IRP Margin
  - Based on probabilistic reliability study
    - LOLP, LOLE, LOLH, EUE metrics
      - 5% LOLP (proposed)
      - 1 day in 10 years LOLE (proposed)
      - LOLH and EUE (TBD)

Loss of Load Probability

James Gall

Technical Advisory Committee Meeting #1

2011 Electric Integrated Resource Plan

May 27, 2010

Overview

Why

Avista's capacity planning margin is 15% of peak load. Without conducting a statistical analysis regarding probability of no serving all customer load due to lack of generation, the 15% should be questioned- especially as additional variable generation is added.

Modeling

- 8,760 hours for ~1,000 potential outcomes (draws, games, iterations, etc)
- Study 2012, '16, '20, '24, and '28
- Randomizes: forced outages, temperature, loads, wind generation, and hydro conditions
- Takes into account hydro constraints, market purchases, and reserves including: within hour load variation, variable resource reserves, and operating reserves
- Can illustrate benefits using demand response and federal emergency hydro

For the Next TAC meeting

- Detailed presentation on how model works
- Finalize 2012 study (final load & wind modules)
- Market reliance scenarios
- Test 2009 IRP's Preferred Resource Strategy for later years

Energy Efficiency & Demand Response

Lori Hermanson

Technical Advisory Committee Meeting #1

2011 Electric Integrated Resource Plan

May 27, 2010

Energy Efficiency Progress Since Last IRP

- **Targets and Year-to-Date Achievement**
- **I-937 Plan for Washington accepted with conditions**
  - Target for Washington electric only
  - Year-to-date results toward I-937 targets
- **Demand Response Pilot**
  - Tested and improved equipment capability on Avista's system
  - Initiated 10 successful events of either cycling heating or AC or shutting off water heaters for 2-4 hrs
  - Proved customers' strong willingness to participate with few opt-outs
  - Low northwest on/off-peak price differentials makes these programs not cost effective

Next Steps for 2011 IRP

Conservation Potential Assessment (all states, gas/electric)

- Issue RFP in June
- Complete RFP by October
- Evaluate TRC cost-effectiveness with draft IRP electric price forecast in November
- Establish energy efficiency placeholder levels in early January
- Update with finalized IRP electric price forecast in late January
- Finalize energy efficiency levels in early February
- Draft energy efficiency and demand response section of IRP document

Avista's 2011 Electric Integrated Resource Plan

Technical Advisory Committee Meeting No. 2 Agenda

September 8th and 9th, 2010
Avista Headquarters – Spokane, Washington

Wednesday, September 8th

Leave from Avista	**8:30 am**
Lancaster Tour	**9:30 am**
Rathdrum CT & Boulder Park Stops	
Lunch – Sawtooth Grill	**12:30 pm**
Upper Falls & Monroe Street	**1:45 pm**
Return to Avista	**4:00 pm**

Thursday, September 9, 2010
Avista Conference Room 130

Topic	Time	Staff
1. Introduction	10:00	Storro
2. Resource Assumptions	10:05	Lyons
3. Reliability Planning	10:35	Gall
4. Lunch	11:30	
5. Sustainability Report	12:30	Wuerst
6. Combined Heat and Power Generation	1:30	Dempsey
7. Energy Efficiency	2:30	Hermanson
8. Adjourn	3:30	

Resource Assumptions

John Lyons

Technical Advisory Committee Meeting #2

2011 Electric Integrated Resource Plan

September 9, 2010

Supply Side Resource Data Sources

- Power Council – 6th Power Plan
- Resource lists developed internally from:
  - Trade journals
  - Press releases from other companies
  - Engineering studies and models
  - State commission announcements
  - Proposals from developers
- Consulting firms/reports
- State and federal resource studies
- Data sources are used to check and refine generic resource assumptions

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Resource Updates from 2009 IRP

- Focusing on resource options identified in the 6th Power Plan
- Lancaster PPA began serving Avista Utilities load on January 1, 2010
- 150 MW of Northwest based wind in the 2009 Preferred Resource Strategy has been postponed
- Noxon Rapids Unit #3 upgrade completed in April 2010; Unit #2 and #4 upgrades scheduled for April 2011 and April 2012
- Started work on the Nine Mile upgrade

Natural Gas-Fired Resources

Resource Type	First Year	Size (MW)	Levelized Overnight Costs (2012 $/MWh) *	Capital Cost Excludes AFUDC (Nominal 2012)
SCCT (aero)	2014	46	$106	$1,033/kW
SCCT (frame)	2014	83	$114	$591/kW
Hybrid SCCT	2014	94	$103	$1,107/kW
CCCT (air)	2016	270	$88	$1,105/kW
CCCT (water)	2016	275	$85	$1,053/kW
Small Cogeneration	2015	5	$112	$3,472/kW
Reciprocating Engine	2014	99	$111	$1,139 /kW

* Prices are based on a preliminary gas price forecast

Other Thermal Resources

Resource Type	First Year	Size (MW)	Levelized Overnight Costs (2012 $/MWh)	Capital Cost Excludes AFUDC (Nominal 2012)
Coal (Ultra-critical)	2018	300	$123	$3,250/kW
Coal (IGCC)	2014	300	$138	$3,252/kW
Coal (IGCC w/sequestration)	2018	250	$156	$4,722/kW
Nuclear	2021	500	$150	$5,802/kW

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Renewable Resources

Resource Type	First Year	Size (MW)	Levelized Overnight Costs (2012 $/MWh)	Capital Cost Excludes AFUDC (Nominal 2012)
Wind	2016	50	$106	$1,951/kW
Geothermal	2017	15	$110	$4,463/kW
Wood Biomass	2015	25	$166	$3,710/kW
Landfill Gas	2014	3.2	$60	$2,023/kW
Manure Digester	2013	0.85	$111	$4,304/kW
Waste Water Treatment	2014	0.85	$114	$4,304/kW
Solar Photovoltaic	2014	5	$429	$7,140/kW
Solar Thermal	2016	25	$195	$4,751/kW

Avista Hydro Upgrades

Resource Type	Year	Size (MW)
Little Falls 1 Upgrade	2014	1.0
Little Falls 2 Upgrade	2015	1.0
Little Falls 3 Upgrade	2016	1.0
Little Falls 4 Upgrade	2017	1.0
Post Falls New Powerhouse	TBD	TBD
Upper Falls Upgrade	2019	2.0
Long Lake Second Powerhouse / Pumped Storage	2020	60
Long Lake Second Powerhouse	2020	50 – 60
Cabinet Gorge Unit 5	2015	50
Monroe Street Unit 2	TBD	37.5

Cost estimates for these potential Avista resource upgrades will be presented at a later TAC meeting after the estimates are further developed

Reliability Planning

James Gall

Technical Advisory Committee Meeting #2

2011 Electric Integrated Resource Plan

September 9, 2010

Overview

Objective

Develop a planning tool to help quantify the amount of resources need above expected peak load

Why

A 15% capacity planning margin is currently added to forecast peak load. Without conducting a statistical analysis regarding the probability of not serving all customer load and reserve requirements, the 15% should be questioned- especially as variable generation is added.

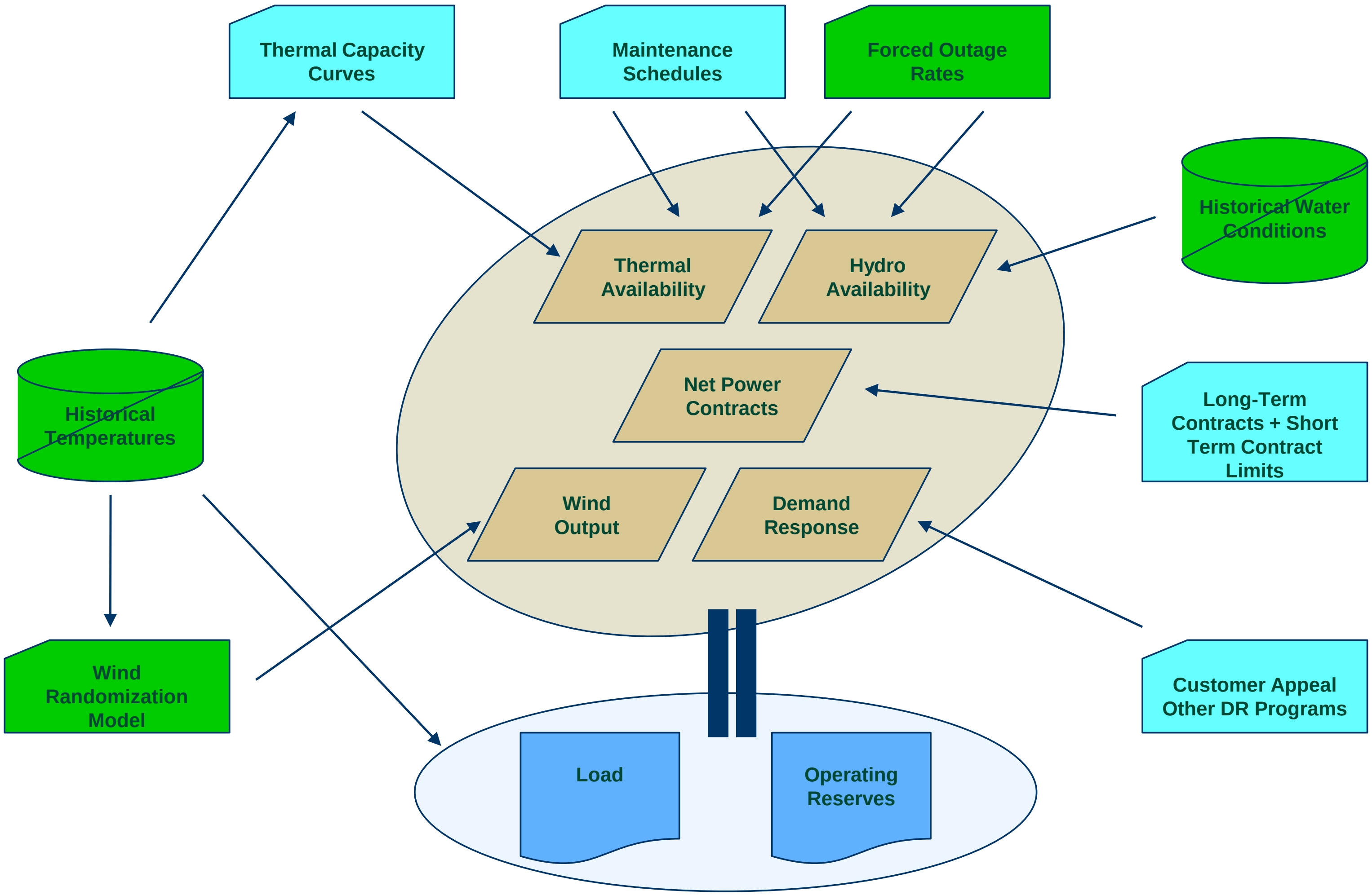
End Result

Determine load variation adder to include in long-term load & resource balance (In addition to regulating reserves and regulating margin)

Modeling

- 8,760 hours for 800 potential outcomes (draws, games, iterations, etc)
- This presentation includes 2012 and 2017
- Other years of interest 2016, 2020, 2025, 2027
- Randomizes: forced outages, temperature, loads, wind generation, and hydro conditions
- Includes hydro constraints, short-term market purchases, and reserves including: within hour load variation, variable resource reserves, and operating reserves
- Can illustrate benefits of using demand response and federal hydro

Reliability Model



Loads

- Load shapes are derived from historic daily high and low temperatures
- Uses 120 years of Spokane temperatures
- The average load of all iterations matches the energy load forecast
- The average of the peak load is within the standard error of the peak load forecast
- Hourly load forecast uses monthly regression model with coefficients:
  - hour, day, temperature, and major weather event triggers

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Hydro

- Randomly selects a hydro year between 1928 and 1999
- Each hydro year includes monthly energy averages
- Run-of-river facilities
  - Monthly energy average is used for all hours of the month
  - No shaping or reserves are assumed to be available
- Storage facilities
  - Monthly average generation equals the “drawn” hydro level
  - In case of planned/forced outage, water can be spilled
  - Linear program moves energy into hours needed to meet load
  - Reservoir min and max levels, ramping rates, and daily limits are enforced
  - Unused capacity is held as operating reserves

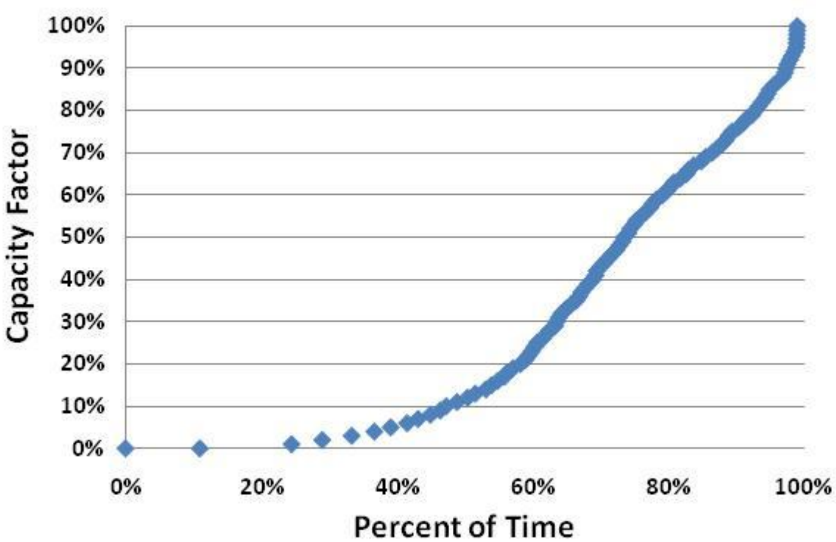
Thermal

- Plants are considered available rather than dispatched
- Temperature dependency
  - Gas-fired facilities use capacity based upon location temperature
  - Temperatures are randomly drawn and are the same as the temperatures used in the load calculation
- Forced outages
  - Input forced outage rate and mean-time-to-repair
  - Outages occur randomly using a frequency and duration method
  - Ramp rates are used following outages
- Maintenance schedules
  - Planned maintenance schedules are assumed
  - Typical outages are in April though June

Wind

- Uses monthly on/off peak duration curves *(see chart on left of January on-peak hours)*
- Random number selects position on curve
- Following hour is correlated to previous hour using a correlation factor and variation

January On-Peak Wind Duration Curve

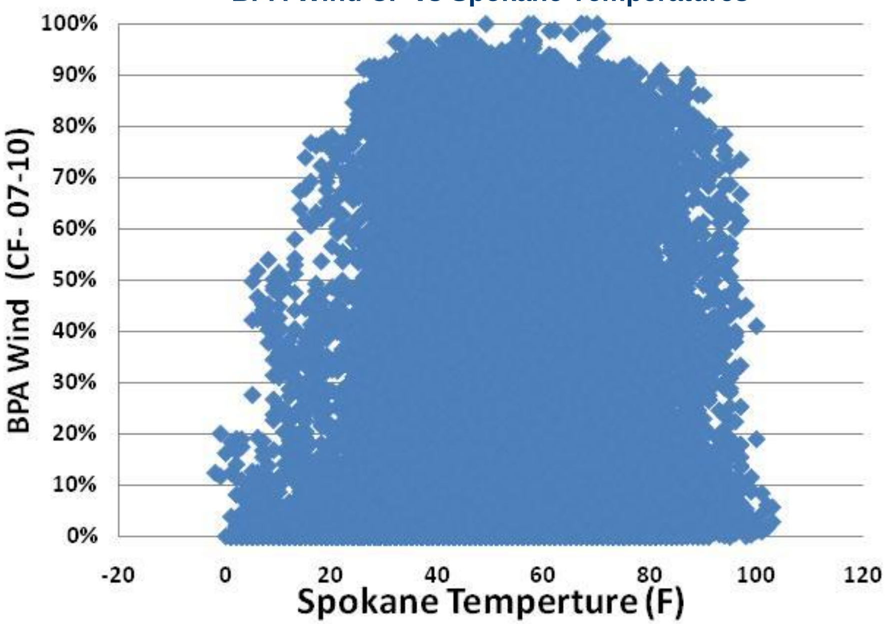


January Hourly Simulated Wind Generation

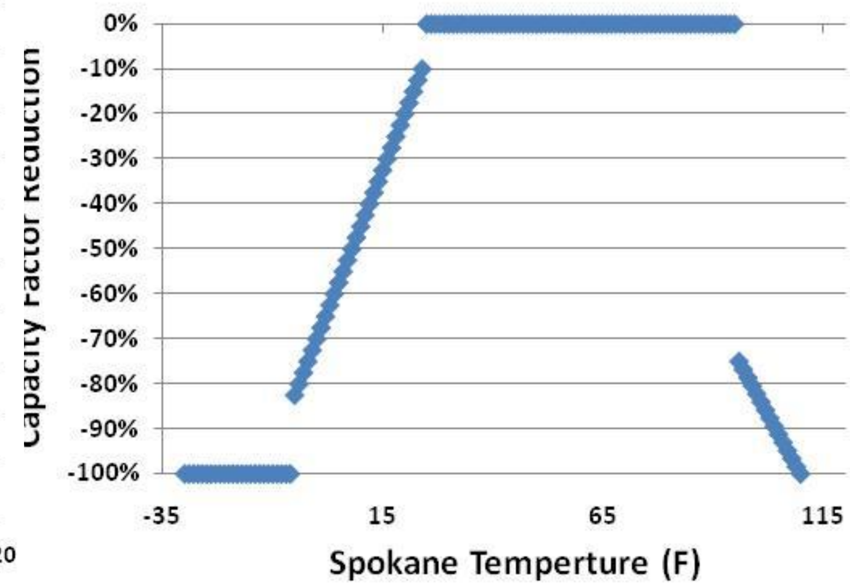
Wind *(continued)*

- Historical data from BPA control area shows generation is mitigated in below 32° F and above 95° F. *(see chart below on left)*
- Capacity factors are reduced at specified temps to model this phenomenon, *(see chart on right)*

BPA Wind CF vs Spokane Temperatures



Capacity Factor Adjustments for Specific Temperatures



Demand Curtailment

- Customer appeal
  - Public appeal to all customers to conserve energy, radio/TV broadcasts
  - Base case includes 25 MW reductions up to two times per year for hours across the peak
- Industrial process
  - Not included in base case
  - Designed to shift load from peak hours
- Sensitivities studies can help determine value of programs

Reserves

- Operating Reserves:
  - 5% hydro and 7% thermal are simplified to 6% of load minus market purchases
  - Simplification allows linearization of the objective function
- Regulating Margin:
  - 1.6% of average hourly load level (based on historical average of max load within hour versus average load)
  - Capacity is for within hour load variations
- Intermediate (Wind) Resource Regulation:
  - Lesser of 10% of nameplate capacity or generation amount
- Reserves are met by excess hydro capacity and thermal generation in excess of load

Third Party Transactions

- Long term firm power agreements are considered in the objective function
- Short-term transactions are treated as available market purchase, no short-term sales are considered
- In tight market conditions (low or high temperatures) market availability is limited to 300 MW on-peak and 500 MW off-peak.
- In other market conditions the market availability is limited to 500 MW on-peak and 750 MW off-peak.
- Scenario analysis will be performed to understand the change in loss of load given these assumptions

Objective Function

Load Serving

- Load [SM]
+ Available thermal capacity [RM]
+ Dispatched hydro capability [LP]
+ Wind generation [SM/RM]
+/- LT Contracts
+ Federal Hydro (optional)
+ Demand Curtailment (optional) [LP]
+ Market Purchases

>= 0 or event triggered

Operating Reserves

- Operating Reserve Requirement
- Intra-hour load regulation
- Wind regulation
+ Available thermal capacity
+ Unused hydro capacity

>= 0 or event triggered

SM: Stochastic Model
RM: Randomization Model
LP: Linear Program

Metrics

- Monthly and Annual Data
- Loss of Load Probability (LOLP): percent of iterations with a reserve or load loss
  - Calculation: iterations with event / # of iterations
  - Metric: 5% or less
- Loss of Load Hour (LOLH): expected number of hours each year with a load loss
  - Calculation: total hours with event / (# of iterations)
  - Metric: 0.24 (24 hours per 10 years)
- Loss of Load Expectation (LOLE): expected number of days each year with a load loss
  - Calculation: Days with event / # of iterations
  - Metric: 1 day in 10 years or 0.10 or less [or do we want 0.05, 1 in 20?]
- Equivalent Unserved Energy (EUE): average MWh of lost load over a year

2012 Assumptions

- Noxon Rapids 4 is on maintenance Jan – mid March
- 300 MW on-peak market
- No Federal hydro release

2012 Draft Results

Item	Annual Results	Target
LOLP	4.8%	Below 5%
LOLH	0.255	Not below 0.24
LOLE	0.066	Below 0.10
EUE	38.47	TBD

Results	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Iterations												
Load loss w/o reserves	7	2	3	0	0	0	2	1	0	0	0	1
Load loss w/ reserves	5	2	3	0	0	0	2	1	0	0	0	1
Reserve violatons	16	3	0	0	0	0	7	4	0	0	0	0
Total Load Loss or Reserve Violatons	**20**	**5**	**3**	**0**	**0**	**0**	**7**	**5**	**0**	**0**	**0**	**1**
LOLP	**2.5%**	**0.6%**	**0.4%**	**0.0%**	**0.0%**	**0.0%**	**0.9%**	**0.6%**	**0.0%**	**0.0%**	**0.0%**	**0.1%**
Hours at Loss												
Load loss w/o reserves	79	31	22	0	0	0	7	6	0	0	0	10
Load loss w/ reserves	64	27	20	0	0	0	6	6	0	0	0	8
Reserve violations	37	7	0	0	0	0	29	9	0	0	0	0
Total Load Loss or Reserve Violations	**98**	**34**	**20**	**0**	**0**	**0**	**29**	**15**	**0**	**0**	**0**	**8**
LOLH	**0.12**	**0.04**	**0.03**	**-**	**-**	**-**	**0.04**	**0.02**	**-**	**-**	**-**	**0.01**
Other Data												
Reserves Used (MWh/Iterations)	12	8	5	-	-	-	1	1	-	-	-	2
Unserved Energy (MWh/Iterations)	14	8	6	-	-	-	1	1	-	-	-	3
Reserve Violations (MWh/Iterations)	3	0	-	-	-	-	2	0	-	-	-	-
Unserved Energy (MWh/Iterations)	2	0	1	-	-	-	0	0	-	-	-	0
EUE: Unserved Energy/Reserves (MWh/Iteratons)	**4.7**	**0.7**	**1.2**	**0.0**	**0.0**	**0.0**	**2.2**	**0.3**	**0.0**	**0.0**	**0.0**	**0.1**
Market used (iterations)	286	120	39	6	518	548	349	374	92	56	91	37
Market used (hours)	5,100	1,450	968	19	5,785	6,136	4,072	8,246	1,179	727	2,055	332
Probability of market	35.8%	15.0%	4.9%	0.8%	64.8%	68.5%	43.6%	46.8%	11.5%	7.0%	11.4%	4.6%

2012 Draft Results

(What if Noxon 4 was not on Maintenance?)

Item	Annual Results	Target
LOLP	2.5%	Below 5%
LOLH	0.14	Below 0.24
LOLE	0.035	Below 0.10
EUE	18.99	TBD

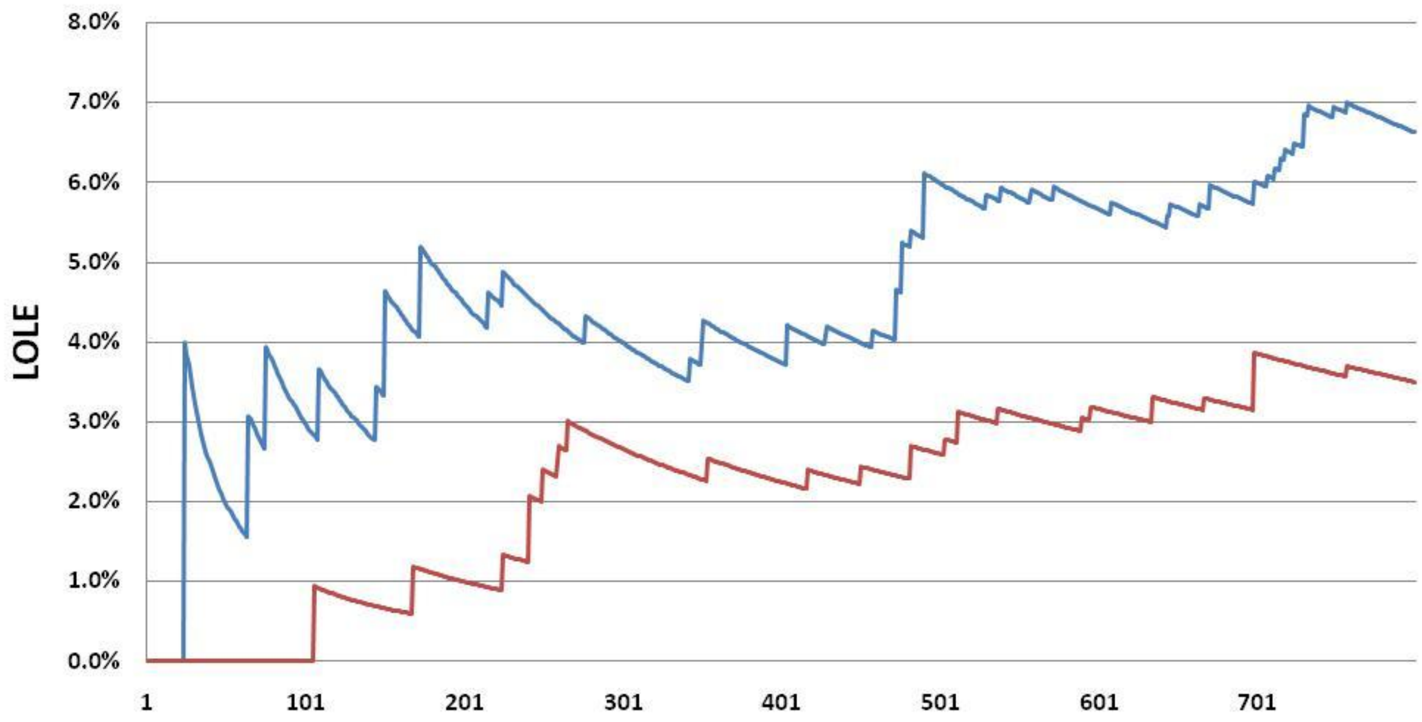
Results

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Iterations												
Load loss w/o reserves	1	1	0	0	0	0	0	0	0	0	2	0
Load loss w/ reserves	1	1	0	0	0	0	0	0	0	0	2	0
Reserve violatons	7	0	0	0	1	0	4	2	1	0	0	2
Total Load Loss or Reserve Violatons	**8**	**1**	**0**	**0**	**1**	**0**	**4**	**2**	**1**	**0**	**2**	**2**
LOLP	**1.0%**	**0.1%**	**0.0%**	**0.0%**	**0.1%**	**0.0%**	**0.5%**	**0.3%**	**0.1%**	**0.0%**	**0.3%**	**0.3%**
Hours at Loss												
Load loss w/o reserves	54	13	0	0	0	0	0	0	0	0	9	0
Load loss w/ reserves	51	12	0	0	0	0	0	0	0	0	6	0
Reserve violations	15	0	0	0	2	0	10	8	2	0	0	6
Total Load Loss or Reserve Violations	**66**	**12**	**0**	**0**	**2**	**0**	**10**	**8**	**2**	**0**	**6**	**6**
LOLH	**0.08**	**0.02**	**-**	**-**	**0.00**	**-**	**0.01**	**0.01**	**0.00**	**-**	**0.01**	**0.01**
Other Data												
Reserves Used (MWh/Iterations)	12	2	-	-	-	-	-	-	-	-	1	-
Unserved Energy (MWh/Iterations)	13	2	-	-	-	-	-	-	-	-	1	-
Reserve Violations (MWh/Iterations)	1	-	-	-	0	-	0	0	0	-	-	0
Unserved Energy (MWh/Iterations)	1	0	-	-	-	-	-	-	-	-	0	-
EUE: Unserved Energy/Reserves (MWh/Iteratons)	**2.1**	**0.3**	**0.0**	**0.0**	**0.0**	**0.0**	**0.5**	**0.4**	**0.0**	**0.0**	**0.4**	**0.2**
Market used (iterations)	203	83	49	6	539	560	352	382	82	41	95	34
Market used (hours)	3,954	1,110	985	8	5,712	5,971	3,822	8,183	1,039	485	2,353	267
Probability of market	25.4%	10.4%	6.1%	0.8%	67.4%	70.0%	44.0%	47.8%	10.3%	5.1%	11.9%	4.3%

Results (DRAFT)

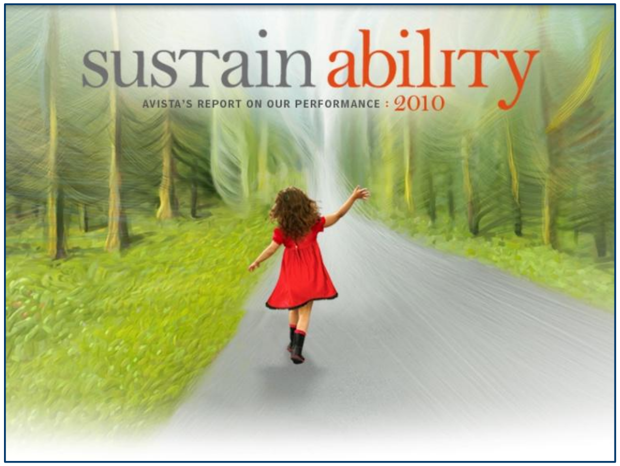
Study	LOLP (% of draws)	LOLH (Avg un-served hours)	LOLE (Avg un-served days)	EUE (Avg Un-served MWh)
2012	4.8%	0.255	0.066	38.47
2012 (Noxon Available all Year)	2.5%	0.140	0.035	18.99
2017 (with 150 MW wind)	1.5%	0.099	0.019	20.75
2017 (No Wind)	1.9%	0.110	0.028	20.17

How Many Iterations Is Enough?



Next Steps For Reliability Planning

- Study additional years
- Re-evaluate number of draws
- Run scenarios for different market availability amounts, demand curtailment, and wind penetration
- Evaluate moving model from Excel/WB to a different platform to increase speed
- Lock down acceptable metrics for load loss
- Develop new planning margin based upon results of the study
- More to come at a future TAC meeting



Avista's 2010 Sustainability Report

TAC Presentation

SEPT. 9, 2010

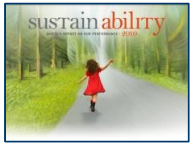
"To be persuasive, we must be believable; to be believable, we must be credible; to be credible, we must be truthful."

Edward R. Murrow

Our commitment to sustainability:

Avista's goal is to provide energy for today's customers while preserving the ability of future generations to do the same.

We strive to engage our stakeholders -- customers, investors, employees, communities and others – in achieving this goal.



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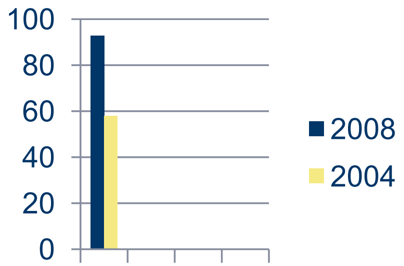
Why do a Corporate Sustainability Report?

“The time has come to usher in a new era…of responsibility.”
President Barak Obama

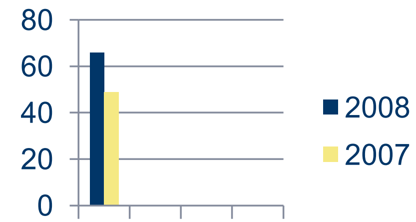
- Trust and transparency have been found to be as important to corporate reputation as service quality.

- CSR is a means to provide enterprise-wide information in a single location about our company’s strategies and actions impacting ***people, planet and performance*** – topics key to building trust.

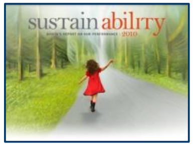
- An increasing number of investors, customers and other stakeholders and prospective employee are looking for this information.



# of S&P 100 companies including web-based sustainability information



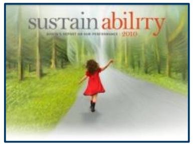
# of S&P 100 companies producing formal sustainability reports



Source: Social Investment Forum, Dec. 2009)

Objectives of Avista's Sustainability Report:

- Be a launch pad for initiating stakeholder conversations and enhancing engagement, internally and externally
- Provide information about Avista's environmental, operations, governance and socially responsible programs and actions and business practices
- Act as a catalyst for internal strategy and goal setting



What goes into a sustainability report?

- Sustainability Action Team – Internal, cross-enterprise

Environmental, Safety, Production & Generation, DSM/Energy Solutions, Power Supply, Facilities, Supply Chain, Human Resources, Finance, Corporate Communications

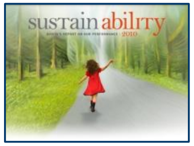
Global Reporting Initiative™

- Prioritizing topics for inclusion
  - Assess stakeholder interest
  - Assess society's interest
  - Determine business position
  - Determine impact on reputation
  - Public or reportable information

113 Performance indicators reported on

- Structure of the report

- Distribution of the report



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RESIDENTIAL HOME | BUSINESS HOME | INSIDE AVISTA | CONTACT US | QUESTIONS?
AVISTA
MY ACCOUNT
SERVICES & PRICING
ENERGY SAVINGS
YOUR SAFETY
OUR ENVIRONMENT
OUR COMMUNITY
Search
GO
Scott Morris on Avista's Sustainable Future
SUSTAINABILITY REPORT CONTENTS
Message from the Chairman/CEO
Our Company
Our Employees
Our Customers & Communities
Our Environment
About the Report
Global Reporting Initiative
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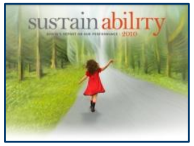
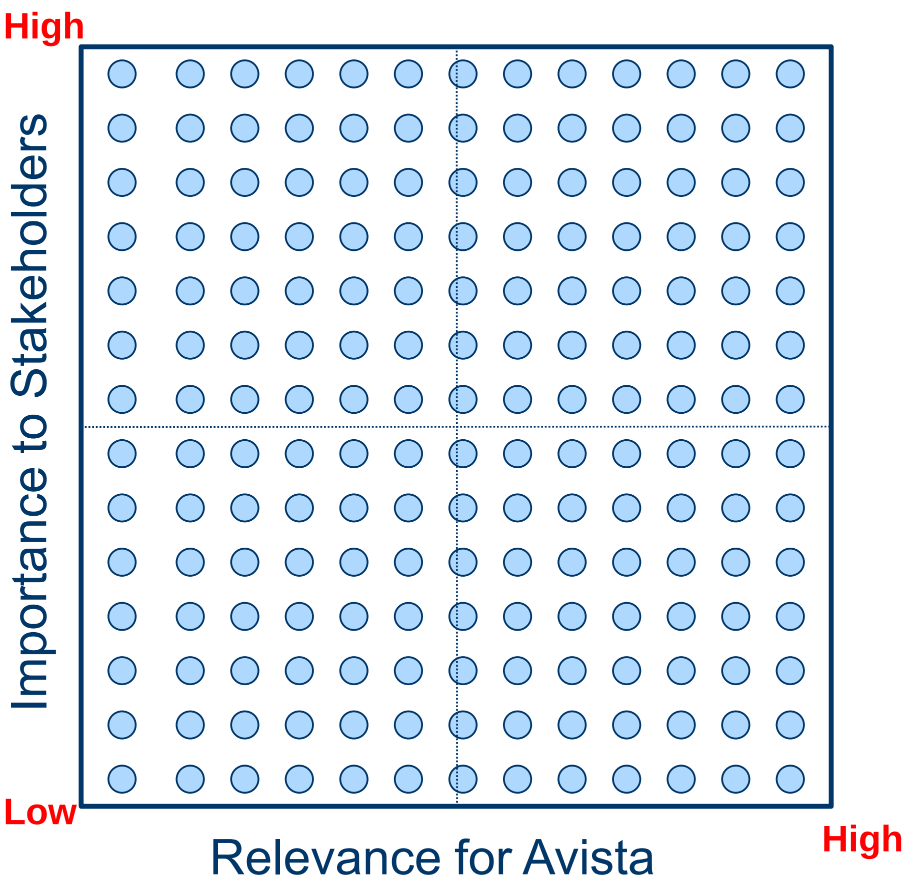
sustain ability
AVISTA'S REPORT ON OUR PERFORMANCE : 2010
B
GRI REPORT
GRI CHECKED
Investors | Careers | Site Map | Privacy Policy | About This Site

Considerations for Future Sustainability Reporting

- Review of 2010 report by GRI
- Determine project's scope and direction and align these with Avista's strategic direction
- Initiate in-depth conversations with departments across the company to determine additional reporting and data assurance opportunities
- Expand the number of external stakeholders who give feedback on the report
- Increase the visibility of Avista's sustainability report and practices across stakeholders and other audiences without "green washing"



Materiality: Which information to Include?



Topics to Consider

- Avista's Energy Efficiency
- Biodiversity
- Corporate Citizenship
- Customer Satisfaction
- Direct Use of Natural Gas
- DSM Programs
- Employee Satisfaction
- Energy Security
- Environmental Performance
- Ethical Business Practices
- Executive Compensation
- Financial Performance
- GHG Footprint
- Global Climate Change
- Governance
- Human Resources
- NGO Relations
- Public Policy
- Rates
- Resource Planning
- Safety
- Stakeholder Engagement
- System Reliability
- Supply Chain
- Waste Discharge
- Water use
- Work Force Diversity

Others??

Cogeneration Case Study

Thomas C. Dempsey, PE
Manager Generation Joint Projects
Technical Advisory Committee Meeting #2
2011 Electric Integrated Resource Plan
September 9, 2010

Cogeneration

"Cogeneration is the use of a heat engine or a power station to simultaneously generate both electricity and useful heat."- Wikipedia

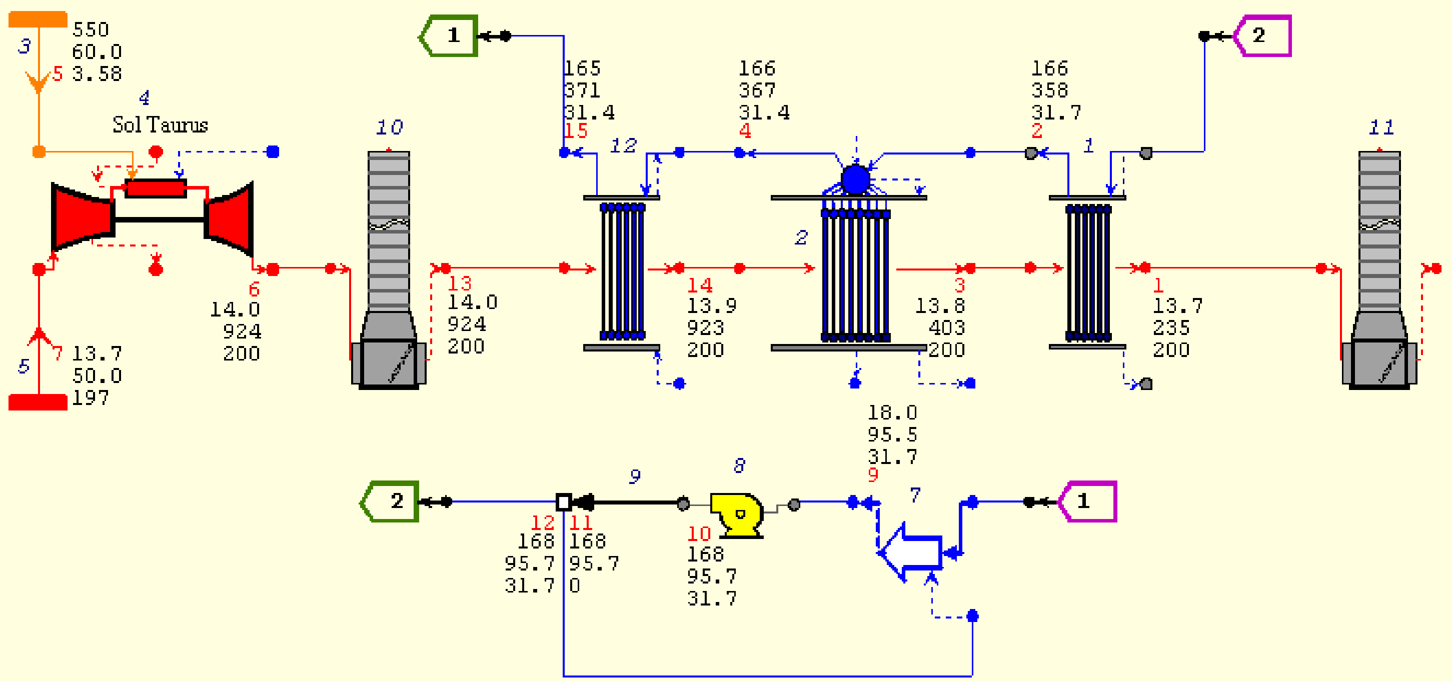
"A combined cycle is characteristic of a power producing engine or plant that employs more than one thermodynamic cycle"- Wikipedia

Cogeneration= Power [kW]+ Heat [Btu/hr]

Combined Cycle = Gas Turbine Power [kW] + Steam Turbine Power [kW]

Cogeneration Design

Solar Taurus 70 Combined Heat and Power



Net power	6801	kW
Net process output	35606	kBTU/h
CHP efficiency	82.62	%
PURPA efficiency	57.61	%
Net heat rate(HHV)	11587	BTU/kWh
Net fuel input(HHV)	78808	kBTU/h
Energy chargeable to power	32897	kBTU/h
Electric efficiency on chargeable energy	70.55	%

Efficiency of a Combined Cycle Plant

Efficiency = What you get/What you pay for
Heat Rate = What you pay for/What you get
Heat Rate = 1/Efficiency

How does the efficiency of a combined cycle plant compare with that of a cogeneration facility? Shown below are numbers typical to advanced combined cycle combustion turbine facilities. What we pay for is the fuel expressed in terms of British Thermal Units [Btu's]. What we "get" is *electrical* energy expressed in terms of kilowatt-hours [kWh's]. **Advanced combined cycle turbines have higher heating value net efficiencies around 50%.**

$$CombinedCycleEfficiency = \frac{1}{NetHeatRate}$$

$$CombinedCycleEfficiency = \frac{1}{6800\,\frac{Btu}{kWh}} \times 3412\,\frac{Btu}{kWh} = 50\%$$

NOTE: Btu's and kWh's are both units of "energy". We multiply by the unit conversion factor of 3412 in order to arrive at a dimensionless number which we can express as percent.

Efficiency of a Cogeneration Facility

Efficiency = What you get/What you pay for

There are many ways of looking at the efficiency of a cogeneration facility. The calculation below is calculated strictly in terms of useful energy divided by fuel energy. **For the example turbine modeled, the thermal efficiency as calculated below is much higher than the thermal efficiency for my example combined cycle plant.**

$$CogenEfficiency = \frac{Electricity + Heat}{Fuel}$$

$$CogenCycleEfficiency = \frac{6801kW \times \frac{3.412kBtu}{kWh} + 35606\frac{kBtu}{h}}{78808\frac{kBtu}{h}}$$

$$CogenCycleEfficiency = 75\%$$

NOTE: Solar Taurus 70, Spokane Elevation, 150 psig steam, no duct firing

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Comparing Combined Cycle with Cogen on Equivalent Terms

3.5 Energy Accounting

In a pure power plant, efficiency is simply defined as:

Electric Efficiency = Power Out/Fuel In

In most cases, this is expressed as a percentage, requiring that the numerator and denominator be quantified in the same units. Distinctions are made as to whether the 'power out' is the gross power (at the generator terminals) or the net power (that available to the grid after deducting plant auxiliary loads and transformer losses). Separate distinctions indicate whether the energy flow rate cited as 'fuel in' is the LHV or HHV fuel energy flow rate.

An alternate comparison of output power with fuel energy consumption is the heat rate, essentially the reciprocal of the efficiency.

Heat Rate = Fuel In/Power Out

Unlike efficiency, heat rate is generally left in a dimensional form, Btu/kWhr or kJ/kWhr.

The efficiency of a cogeneration plant, that produces useful heat as well as electric power, may be expressed as a *Total Efficiency*, also called the *CHP Efficiency* (Combined Heat & Power), or as a *PURPA Efficiency* (Public Utilities Regulatory Policy Act of 1979, a US regulatory measure of efficiency):

Total (CHP) Efficiency = (Power Out + Net Process Heat Out)/Fuel In

PURPA Efficiency = (Power Out + 1/2 Net Process Heat Out)/Fuel In

Comparing Combined Cycle with Cogen on Equivalent Terms

Assumptions

1. The boiler efficiency of the auxiliary boiler is assumed based on typical industry values.
2. Thermoflex 20 model of a Solar Taurus 70, 150 psig steam, Spokane Elevation

Constants:

Cogen simple cycle net heat rate $CGSS_{HR} := 11587 \frac{BTU}{kW \cdot hr}$ $SteamEnergy := 35.606 \cdot \frac{MillionBTU}{hr}$

Auxiliary boiler efficiency $B_{eff} := 82 \cdot \%$ $Power := 6801 \cdot kW$

Case 1 COMBINED CYCLE- In this case we are using a combined cycle unit to generate our electrical needs and a separate auxiliary boiler to generate the steam we need.

Combined cycle net heat rate $CC_{HR} := 6800 \frac{BTU}{kW \cdot hr}$

Combined cycle fuel consumption $CC_{gasin} := CC_{HR} \cdot Power$ $CC_{gasin} = 46.2 \cdot \frac{MillionBTU}{hr}$

AUXILIARY BOILER:

$$SteamEnergy = 35.6 \cdot \frac{MillionBTU}{hr}$$

$$AuxBoiler_{gasin} := \frac{SteamEnergy}{B_{eff}} \qquad AuxBoiler_{gasin} = 43.4 \cdot \frac{MillionBTU}{hr}$$

$$TotalGas := CC_{gasin} + AuxBoiler_{gasin} \qquad CCE\% := \frac{1}{CC_{HR}}$$

Case 2 COGENERATION- In this case we are using a COGEN unit to meet both power and steam needs.

Cogen turbine fuel consumption $CG_{gasin} := CGSS_{HR} \cdot Power$ Equivalent Electric Heat Rate $EEHR := \frac{CG_{gasin} - AuxBoiler_{gasin}}{Power}$

Cogen Equivalent Electric Efficiency $CGEE\% := \frac{1}{EEHR}$

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Comparing Combined Cycle with Cogen on Equivalent Terms

Summary: Although the efficiency of the Cogeneration facility is higher than that of the combined cycle, the equivalent efficiency of the cogen facility is significantly lower than its apparent thermal efficiency. Overall thermal efficiency is not comparable to combined cycle efficiency because steam energy is not equivalent to electric energy.

Combined Cycle Turbine

$$\text{TotalGas} = 89.7\,\frac{\text{MillionBTU}}{\text{hr}}$$

$$CC_{HR} = 6800\,\frac{\text{BTU}}{\text{kW}\cdot\text{hr}}$$

$$\text{CCE\%} = 50.2\,\%$$

Cogen Facility

$$CG_{gasin} = 78.8\,\frac{\text{MillionBTU}}{\text{hr}}$$

$$\text{EEHR} = 5202\,\frac{\text{BTU}}{\text{kW}\cdot\text{hr}}$$

$$\text{CGEE\%} = 65.6\,\%$$

For this example, the cogen facility uses only 87.8% if the gas that would be used by a combined cycle plant in conjunction with an auxiliary boiler to produce steam. At a gas price of $4.00 per Million Btu, the combined cycle would incur an additional $6.40 per MWh in fuel costs. In most cases this magnitude of reduction in costs is not enough to overcome the low economies of scale and other costs associated with cogen.

Cogeneration Fuel Savings in Context

- At $4.00 per MMBtu, this cogen case shows a reduction of $6.40/MWh in fuel costs.

- For an 80% capacity factor, maintaining 5 additional employees to operate the cogen facility around the clock will cost approximately $10.00/MWh (only 1 employee on shift most of the time). Labor costs for the combined cycle facility will be on the order of $2.50 per MWh due to enormous economies of scale effects.

- Maintenance costs for the cogen facility will be on the order of $4-$7 per MWh more than that of the combined cycle facility.

- Capital cost recovery on a per MWh basis is significantly higher for the cogen facility due to economy of scale effects.

- In the Pacific Northwest there are significant periods every year where it is uneconomic to run due to hydro run-off. A cogen facility would either have to run during uneconomic times or the plant would have to have complete redundancy with gas fired boilers.

Energy Efficiency Approach for the 2011 Electric Integrated Resource Plan

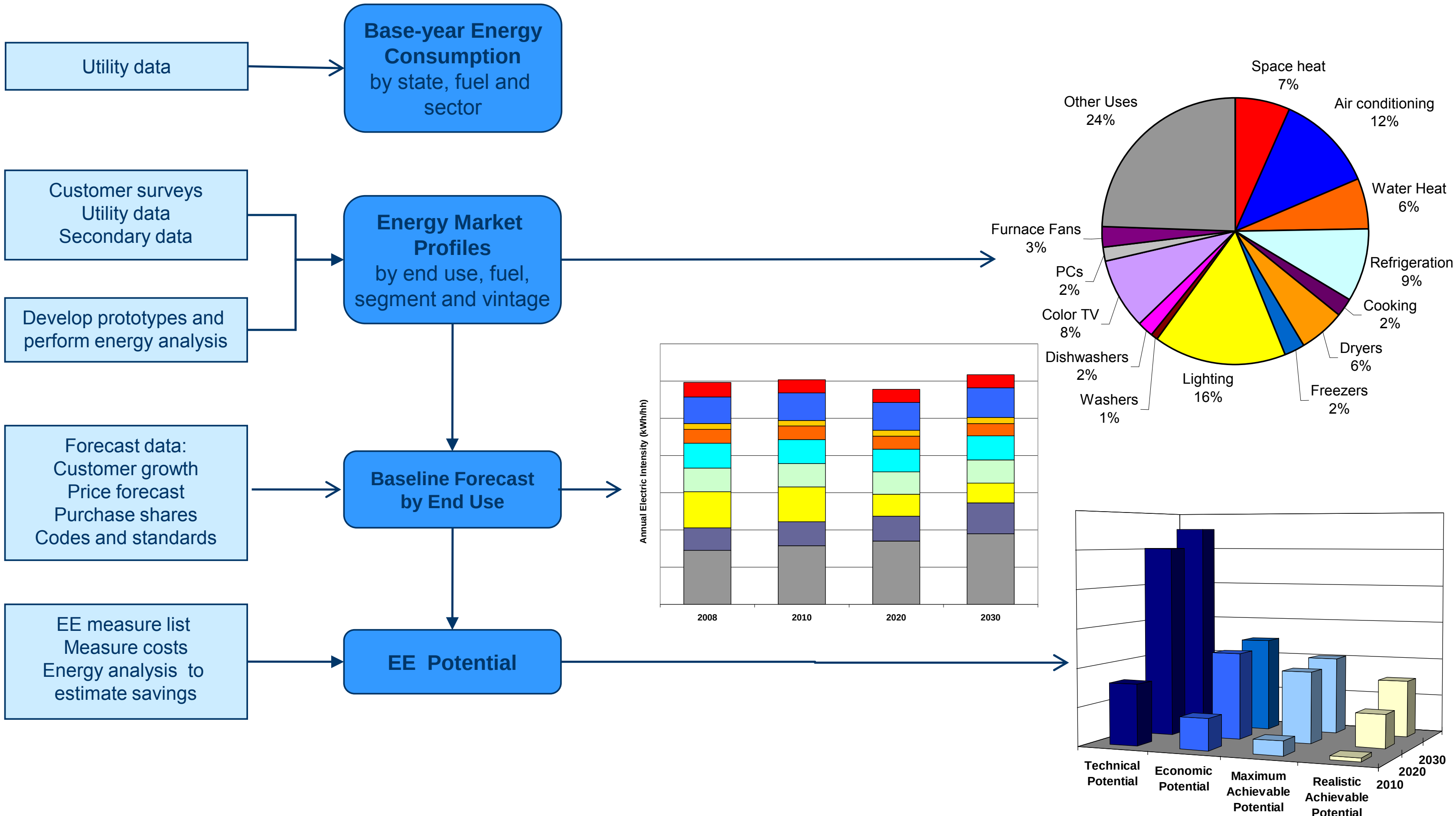
Lori Hermanson

Technical Advisory Committee Meeting #2
2011 Electric Integrated Resource Plan
September 9, 2010

Evolvement of Energy Efficiency

- Growth in annual tariff rider funding and program offerings over the last 10 years
  - Five times more electric funding
  - Nearly 12 times more natural gas funding
- Heightened regulatory requirements and increasing amounts of Evaluation, Measurement & Verification (EM&V)
  - Annual electric (I-937 conditions) and natural gas verification of savings (Washington decoupling)
  - EM&V Collaborative as required by the Washington Utilities and Transportation Commission (WUTC) – final paper filed 9/1/10
  - WUTC required 3-6% of conservation budget on EM&V
- IRP action item and one of the I-937 conditions – potential studies every two years

Approach for Estimating Energy Efficiency Potential



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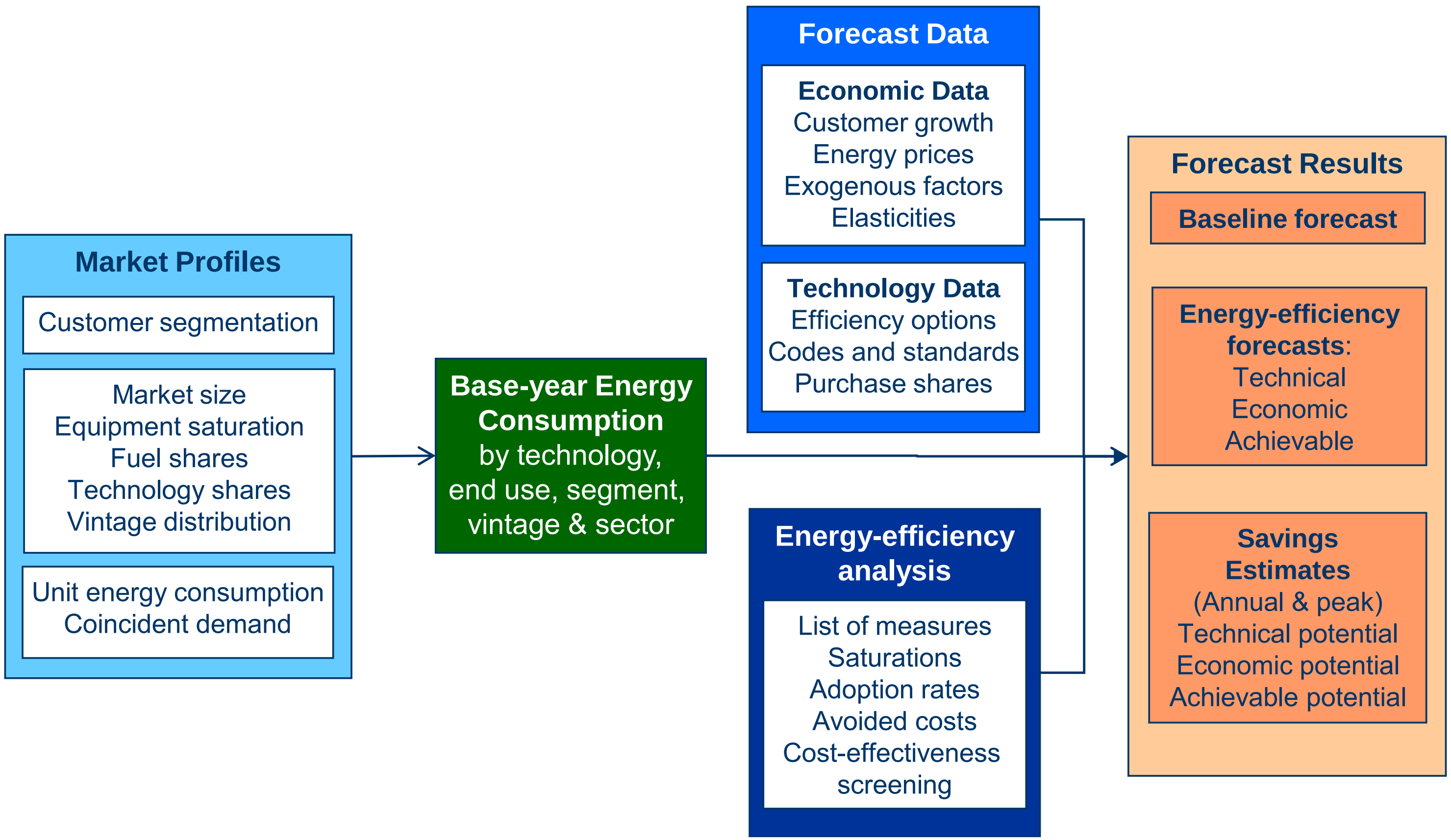
Global Energy Partners LoadMAP™ Analysis Framework

(**Load** **M**anagement **A**nalysis and **P**lanning tool)



Market Segmentation for Energy Efficiency

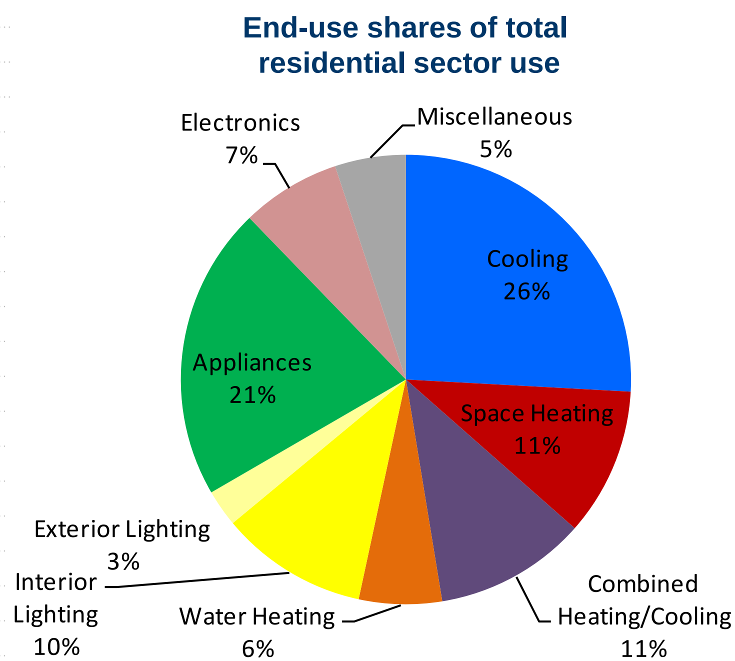
- State and fuels
- By sectors
  - Residential
    - Limited Income
    - Single-family housing
    - Multifamily housing
    - Mobile homes and manufactured housing
  - Commercial and industrial by rate class
  - Pumping
- Vintage (retrofit vs. lost-opportunity)
- Appliances/end uses (space heat, cooling, lighting, water heat, motors) and technologies (lamps, chillers, color TVs, etc)
- Equipment efficiency (old, standard, high efficiency)

Market Segmentation for Demand Response

- State
- Energy metric (peak demand) for annual, summer and winter
- Sector
  - Residential
  - Commercial and industrial combined
- Appliances/end uses (space heat, cooling, water heat, process, other)
- Enabling technology (with and without enabling technology)

Energy Market Profile Example: Residential

End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (GWh)
Cooling	Central AC	86%	3,985	3,433	1,587
Cooling	Room AC	13%	3,188	410	190
Space Heating	Electric Resistance	5%	18,214	910	421
Space Heating	Electric Furnace	0%	18,943	-	-
Combined Heat/Cool	Air Source Heat Pump	13%	14,004	1,820	842
Combined Heat/Cool	Geo-Thermal Heat Pump	0%	9,242	-	-
Water Heating	Water Heater	24%	2,793	663	307
Interior Lighting	Screw-in	100%	1,242	1,242	574
Interior Lighting	Linear Fluorescent	100%	243	243	112
Exterior Lighting	Screw-in	85%	374	318	147
Exterior Lighting	Linear Fluorescent	85%	73	62	29
Appliances	Refrigerator	100%	891	891	412
Appliances	Freezer	42%	376	157	73
Appliances	Second Refrigerator	20%	1,326	265	123
Appliances	Clothes Washer	96%	561	540	250
Appliances	Clothes Dryer	84%	821	693	321
Appliances	Combined Washer/Dryer	0%	786	-	-
Appliances	Dishwasher	61%	173	105	49
Appliances	Cooking	71%	750	533	247
Electronics	Personal Computer	65%	470	306	142
Electronics	Color TV	96%	313	300	139
Electronics	Other Electronics	100%	343	343	159
Miscellaneous	Pool Pump	13%	2,671	339	157
Miscellaneous	Furnace Fan	68%	431	293	136
Miscellaneous	Other Miscellaneous	100%	194	194	90
	Total			**14,069**	**6,505**



Baseline End-Use Forecast

Definition of **baseline forecast**:

- Comprehensive end-use forecast
- Forecast without future utility programs
- Incorporates appliance standards and building codes already on the books
- Typically includes naturally occurring efficiency (consistent with 6^{th} Plan)

Process for developing the baseline forecast

1. End-use segmentation
2. Energy market profiles – snapshot of current energy use
3. Technologies/efficiency options available today and in the future
4. Forecast data and assumptions
5. Assess and compare with existing forecasts

End-Use Segmentation Example

Residential	Commercial	Industrial
Cooling	**Cooling**	**Process Heating**
Central AC	*Central Chiller*	*Electric resistance*
Room AC	*Packaged AC*	*Radio frequency*
Space Heating	*PTAC*	**Process Cooling and Refrigeration**
Electric Resistance	**Space Heating**	**Machine Drive**
Electric Furnace	*Electric Resistance*	*1-5 hp motors*
Combined Heating/Cooling	**Combined Heating/Cooling**	*5-20 hp motors*
Air Source Heat Pump	*Air Source Heat Pump*	*20-50 hp motors*
Geothermal Heat Pump	*Geohermal Heat Pump*	*50-100 hp motors*
Water Heating	**Water Heating**	*100-200 hp motors*
Interior Lighting	**Interior Lighting**	*200-500 hp motors*
Screw-in	*Screw-in*	*500-1,000 hp motors*
Linear Fluorescent	*Linear Fluorescent*	*1,000-2,500 hp motors*
Exterior Lighting	**Exterior Lighting**	*>2,500 hp motors*
Screw-in	*Screw-in*	**Facility HVAC**
Linear Fluorescent	*Linear Fluorescent*	**Facility lighting**
Appliances	**Refrigeration**	*Incandescent*
Refrigerator	*Walk-in Refrigeration*	*Fluorescent*
Freezer	*Reach-in Refrigeration*	*HID*
Clothes Washer	**Office Equipment**	
Clothes Dryer	*PC*	
Combined Washer/Dryer	*Server*	
Dishwasher	*Monitor*	
Cooking	*Printer/Copier*	
Electronics	**Food Service**	
Personal Computer	**Ventilation**	
Color TV	**Miscellaneous**	
Other Electronics		
Miscellaneous		
Pool Pump		
Furnace Fan		
Other Miscellaneous		

Energy Market Profiles

Description

Energy market profiles describe how customers use energy in a recent base year

Market profile elements

- Market size
- Fuel shares/saturations by end use
- Unit energy consumption (UECs, EUIs) by end use/tech
- Peak factors

Profile elements are calibrated to match customer segments' use in base year from billing system

Key data sources

Market characterization data

Previous potential studies

Global's previous customer surveys

Prototypes and BEST™ analysis

Forecast Data and Assumptions

Forecast drivers

Customer growth

Other exogenous variables

- Energy prices
- Income

Usage elasticities by end use for each exogenous variable

Technology forecasts

Equipment purchase shares by decision type

- Replace on burnout
- New construction
- Non-owner acquisition

Shares are user defined

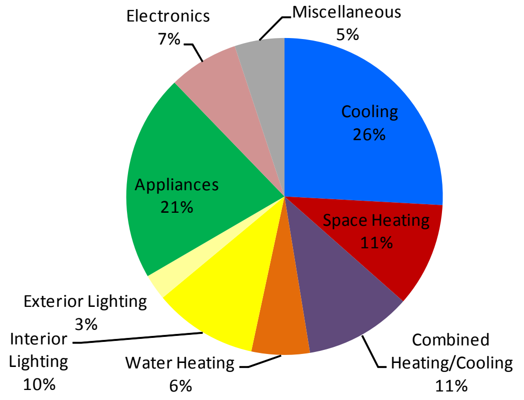
- Defaults based on trends in EIA's Annual Energy Outlook
- Incorporate existing appliance/equipment standards
- Will be refined using PNW and Avista data

Sample Baseline Forecast for Residential Sector

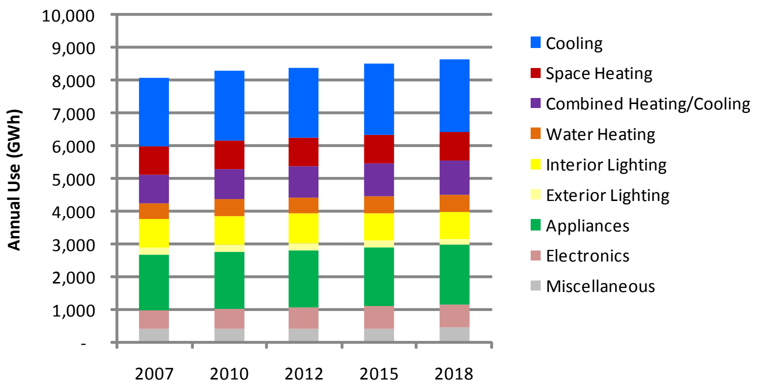
Residential Use by End Use (GWh)

	2007	2010	2012	2015	2018	% Change	Avg. growth rate
Cooling	2,093	2,128	2,151	2,186	2,227	6.4%	0.56%
Space Heating	862	863	864	867	871	1.1%	0.10%
Combined Heating/Cooling	883	923	951	989	1,029	16.5%	1.39%
Water Heating	482	495	503	515	528	9.7%	0.84%
Interior Lighting	858	872	880	840	802	-6.6%	-0.62%
Exterior Lighting	215	215	215	202	189	-11.8%	-1.14%
Appliances	1,711	1,741	1,760	1,787	1,816	6.1%	0.54%
Electronics	578	616	641	679	718	24.2%	1.97%
Miscellaneous	412	423	430	441	453	9.9%	0.86%
Total	**8,093**	**8,274**	**8,395**	**8,506**	**8,633**	**6.7%**	**0.59%**

Residential Use in the Base Year (2007)



Residential Forecast (GWh)



Energy Efficiency Potential

1. Characterize energy efficiency measures
2. Perform economic screen
3. Assemble data for estimating achievable potential
4. Calculate potential
5. Develop supply curves based on levelized costs of each individual measure (low, medium, high-case potential differentiations)

Definitions of Energy Efficiency Potential

Technical Potential – most efficient measures are adopted, regardless of cost or customer acceptance

Economic Potential – only cost-effective measures are adopted by customers

- Apply TRC test
- Avista avoided costs + 10% conservation adder (consistent with 6th Plan)

Achievable Potential

- Council's definition – 85% of economic potential at the end of ten years
- Other definition?

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Estimate Demand Response Potential

- Develop revised peak demand forecast
  - After savings from EE are applied
- Identify capacity-constraint time period
  - Winter peak day (cold weather)
  - Summer peak day (hot weather)
- Identify and characterize relevant DR options (e.g., direct load control, curtailable/interruptible tariffs, demand bidding)
- Estimate potentials

Estimating Demand Response Potential

- Develop baseline forecast by segment
  - Peak by segment
  - Customer by segment
- Program data
  - Participants in base year
  - Forecast of participants
  - Per customer impacts in base year
- Assess cost effectiveness
- Compute peak reduction

Deliverables that Feed IRP Process

- Report documenting entire study and presentation to Avista (electric – October, natural gas 2011)
- LoadMAP, fully populated for future updates
- Updated avoided costs from Aurora available in November as well as updated load and price forecasts
- Updated potentials for energy efficiency and demand response for final input in model

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Potential Study Timeline

Month	August				September				October				Nov	Dec	Jan	Feb	March	April
Week	1	2	3	4	1	2	3	4	1	2	3	4						
Kick-off meeting		M																
Final work plan				♦														
Gather data																		
Electricity Analysis																		
Market characterization					♦													
Baseline forecasts						♦												
EE measure list						♦												
Preliminary potential estimates								M										
Final potential estimates									♦									
Draft report w/supply curves										R								
Demand Response Analysis																		
Market characterization						♦												
Baseline forecasts							♦											
Identify DR programs								M										
Preliminary potential estimates									♦									
Draft report										R								
Natural Gas Analysis																		
EE measure analysis													♦					
Baseline forecasts														♦				
EE measure list															♦			
Preliminary potential estimates															♦M			
Final potential estimates																♦		
Draft report																	R	
Final Report (on all analyses)																		R, M

Meetings (in-person or webcast)	M
Memos, interim deliverables	♦
Reports	R

Avista's 2011 Electric Integrated Resource Plan
Technical Advisory Committee Meeting No. 3 Agenda
Avista Headquarters – Spokane, Washington

Thursday, December 2, 2010
Avista Conference Room 428

Topic	Time	Staff
1. Introduction	9:00	Storro
2. Transmission (costs & issues)	9:05	Waples
3. Potential Hydro Upgrades	10:00	Wenke
4. Potential Thermal Upgrades	10:45	Graham
5. Lunch	11:30	
6. Load Forecast	12:30	Barcus
7. Stochastic Modeling	1:30	Gall
8. Adjourn	2:30	

To participate by phone:
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Access Code: 271-248-826
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New Resource Integration – Transmission

Executive Level Summary of Avista 2010 Resource Integration Study Work

Scott Waples, Reuben Arts, and the Avista System Planning Group

Technical Advisory Committee Meeting #3

2011 Electric Integrated Resource Plan

December 2nd, 2010

Federal Standards of Conduct

- Mandatory Federal Standards of Conduct Require That:
  - No non-public transmission information be shared with the Avista Merchant Function.
  - Please note that there are Avista Merchant Personnel in attendance at this meeting.

- Meeting Notices:
  - This meeting was Posted on the Avista OASIS website on 11/19/2010.

Federal Standards, Requirements, and Risks

- Mandatory Federal Standards Include:
  - No overloads all lines and equipment in service (N-0).
  - No overloads or loss of load for one element out of service (N-1).
  - Some relaxation of the above for two elements out (N-2).
  - Resource Integration requirements (Avista or 3rd party generation) are the same as those for the general system – all Standards must be met.
- Potential Sanctions:
  - Up to $1M Per Day Per Occurrence.
  - Mitigation Plan must be provided and progress demonstrated.

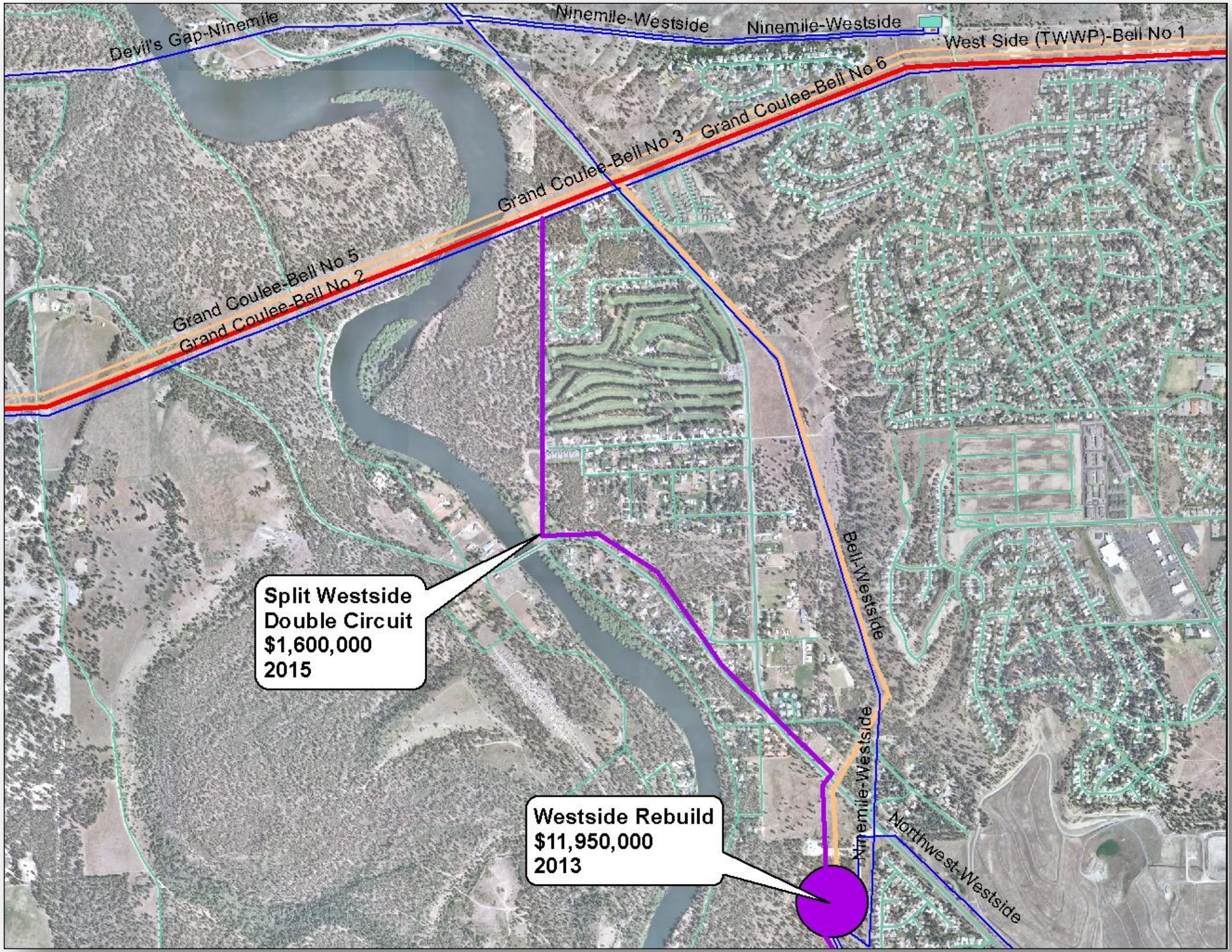
Recent Examples of Avista Construction

- Benewah Station:
  - 230 / 115 kV Station with a Single 125 MVA Transformer.
  - 230 kV Connections between the North and South Avista Load Centers.
  - 230 kV Double Breaker / Double Bus Configuration for increased reliability.
- Benewah – Shawnee 230 kV line:
  - Completes transmission required for both load service and the West of Hatwai transfer requirements.
  - Allows for resource integration in the center and south areas of the Avista system.

Examples of Future Construction Required to Meet NERC / WECC Reliability Standards

- Moscow Station:
  - 230 / 115 kV Station, single 250 MVA transformer.
  - Increases capacity to the Moscow / Pullman area and relieves loading on the Shawnee transformer.
- Westside Station:
  - 230 / 115 kV Station, two 250 MVA transformers.
  - Increases capacity and security to the West Plains area of Spokane County, and relieves heavy loading on large transformers in the central Spokane area.
- Irvin 115 kV and Associated 115 kV Reconductoring:
  - 115 kV Switching Station and other upgrades to meet additional load growth in the Spokane Valley.

Westside Rebuild – 2 x 250 MVA Transformers



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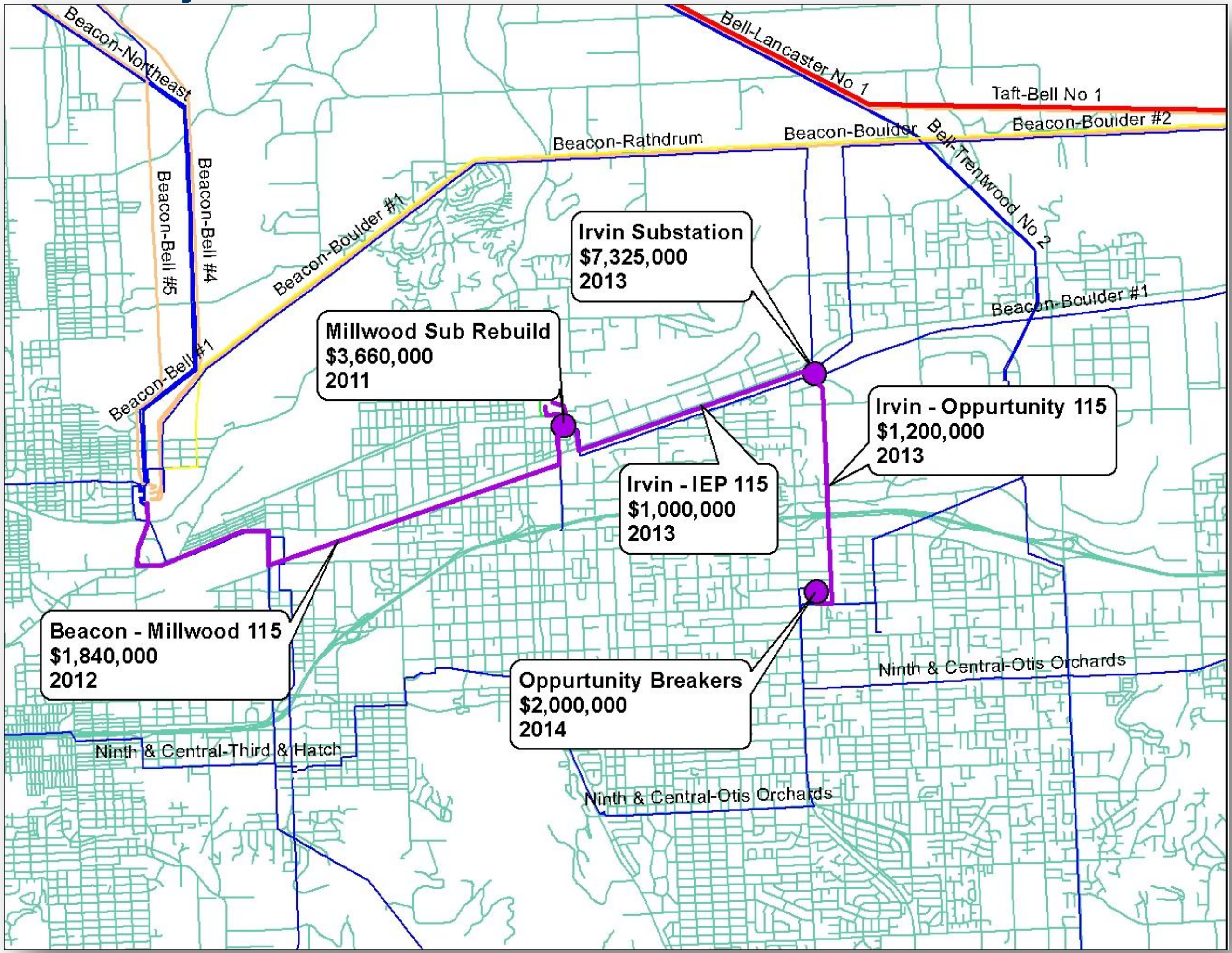
Moscow 230/115 kV Estimate and Schedule

	2010	2011	2012	2013	2014	total
Transmission				$575,000	$575,000	$1,150,000
Substation	$500,000	$1,500,000	$3,000,000	$4,775,000	$2,750,000	$12,525,000
Distribution					$25,000	$25,000
total	$500,000	$1,500,000	$3,000,000	$5,350,000	$3,350,000	$13,700,000

Irvin Project



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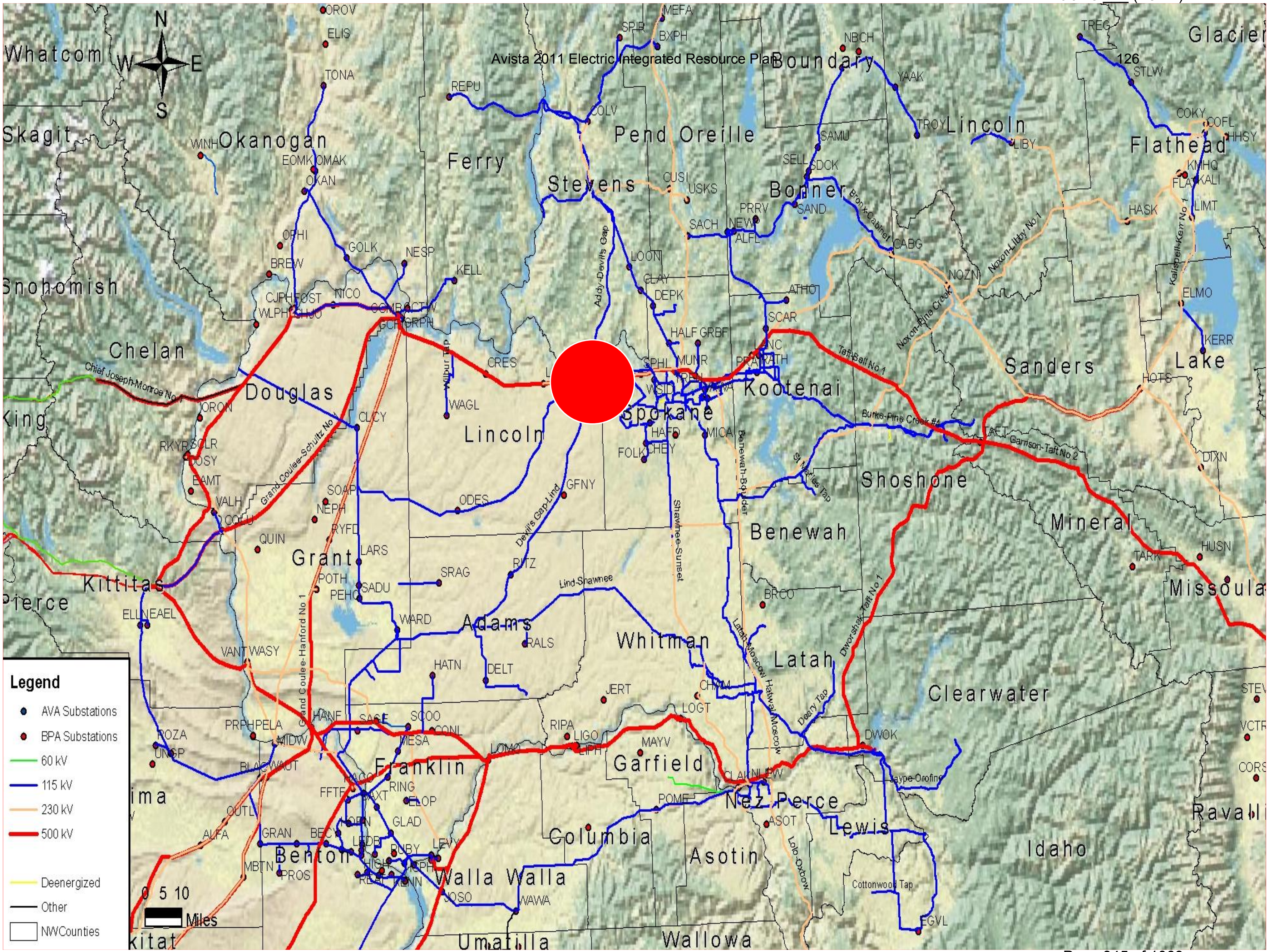
Avista Non-IRP Generation Queue

- **Active (see http://www.oatioasis.com/avat/index.html) :**
  - **Project # 08**:
    - 75 MW, in Facility Study Stage.
  - **Project # 14**:
    - 210 MW, in System Impact Study Stage (SIS).
  - **Project #17:**
    - 100 MW, in Facility Study Stage.
  - **Project # 26**:
    - 42MW, in SIS Stage.
  - **Project # 27**:
    - 10 MW, in SIS Stage.
  - **Project # 29**:
    - 6.5 MW, in SIS Stage.

Non-coincident IRP Interconnection Requests

- **Potential West Plains / Devils Gap Integration :**
  - **Reardan**:
    - 90 MW, 2014
    - +60 MW (150 MW total), 2014
  - **Long Lake**:
    - + 30 MW (118 MW total), 2018
    - + 60 MW (148 MW total), 2018
    - + 100 MW (188 MW total), 2018
  - **Little Falls**:
    - + 4MW (40 total), 2014-2017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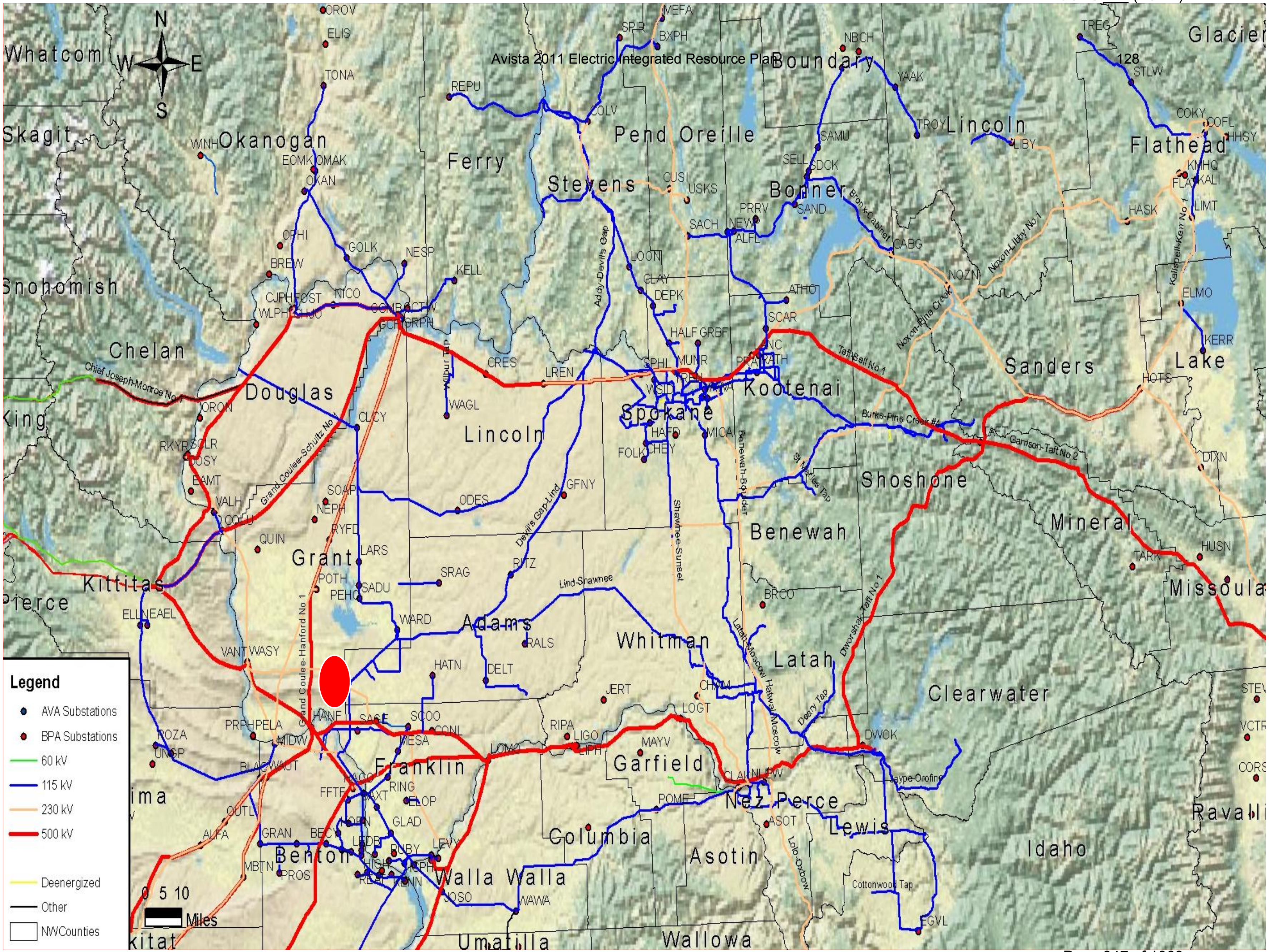
Lolo-Oxbow
Cottonwood Tap
Joype-Orofino

Non-coincident IRP Interconnection Requests

- **Potential "Far West" (Big Bend) Area Integration :**
  - **Othello Area**:
    - Up to 100 MW in 2014, 2015, or 2019 (2015 energization is the most probable)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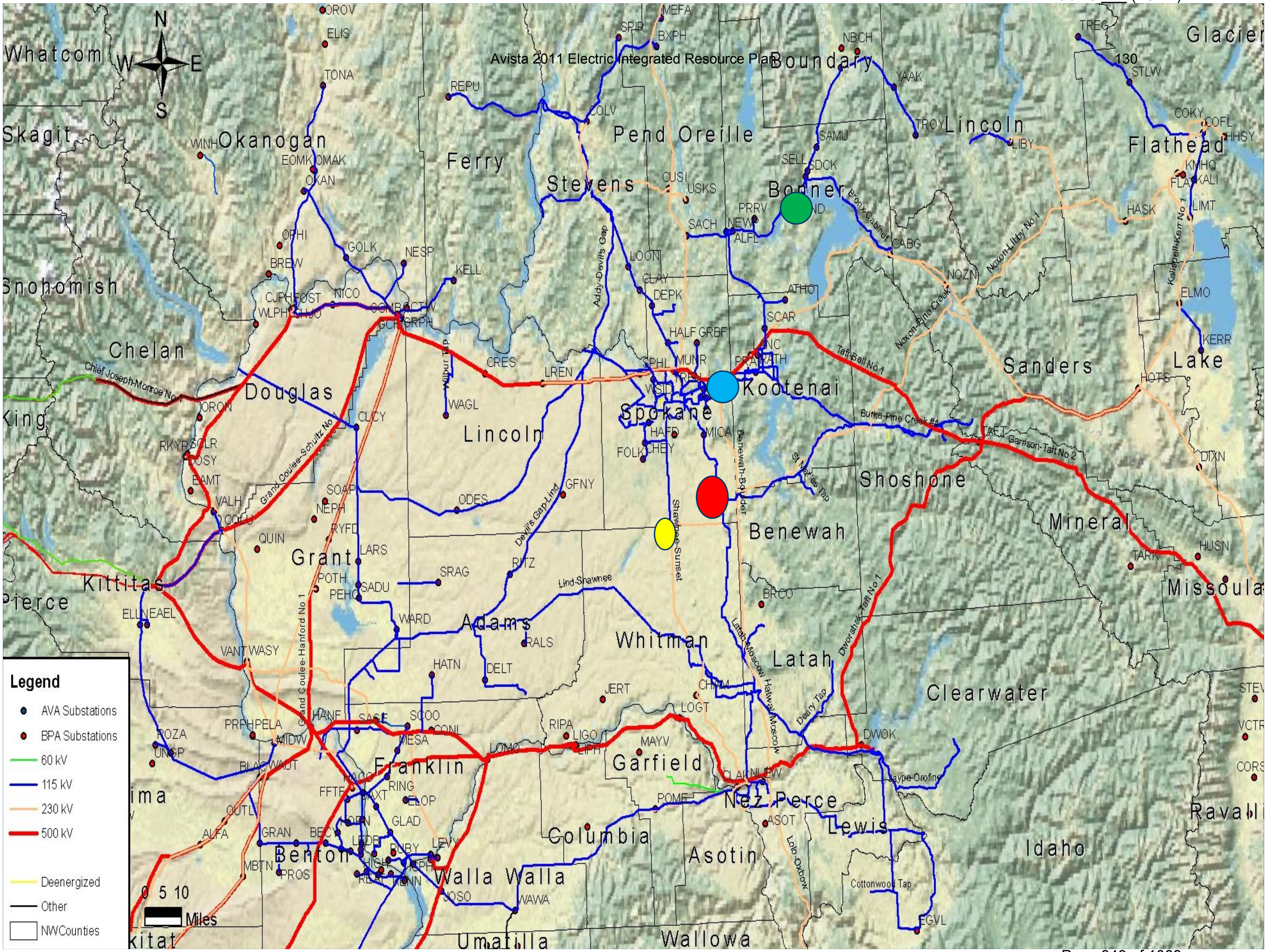
Non-coincident IRP Interconnection Requests

- **Potential "Central Area" Thermal or Wind Integration** :
  - **Benewah**:
    - 300 MW 2018
  - **Rosalia**:
    - 300 MW, 2018
- **Potential "East & North Area" Thermal or Wind Integration** :
  - **Rathdrum**:
    - 300 MW, 2018
    - + 100 MW (400 MW total), 2018
  - **Sandpoint**:
    - 100-300 MW, 2018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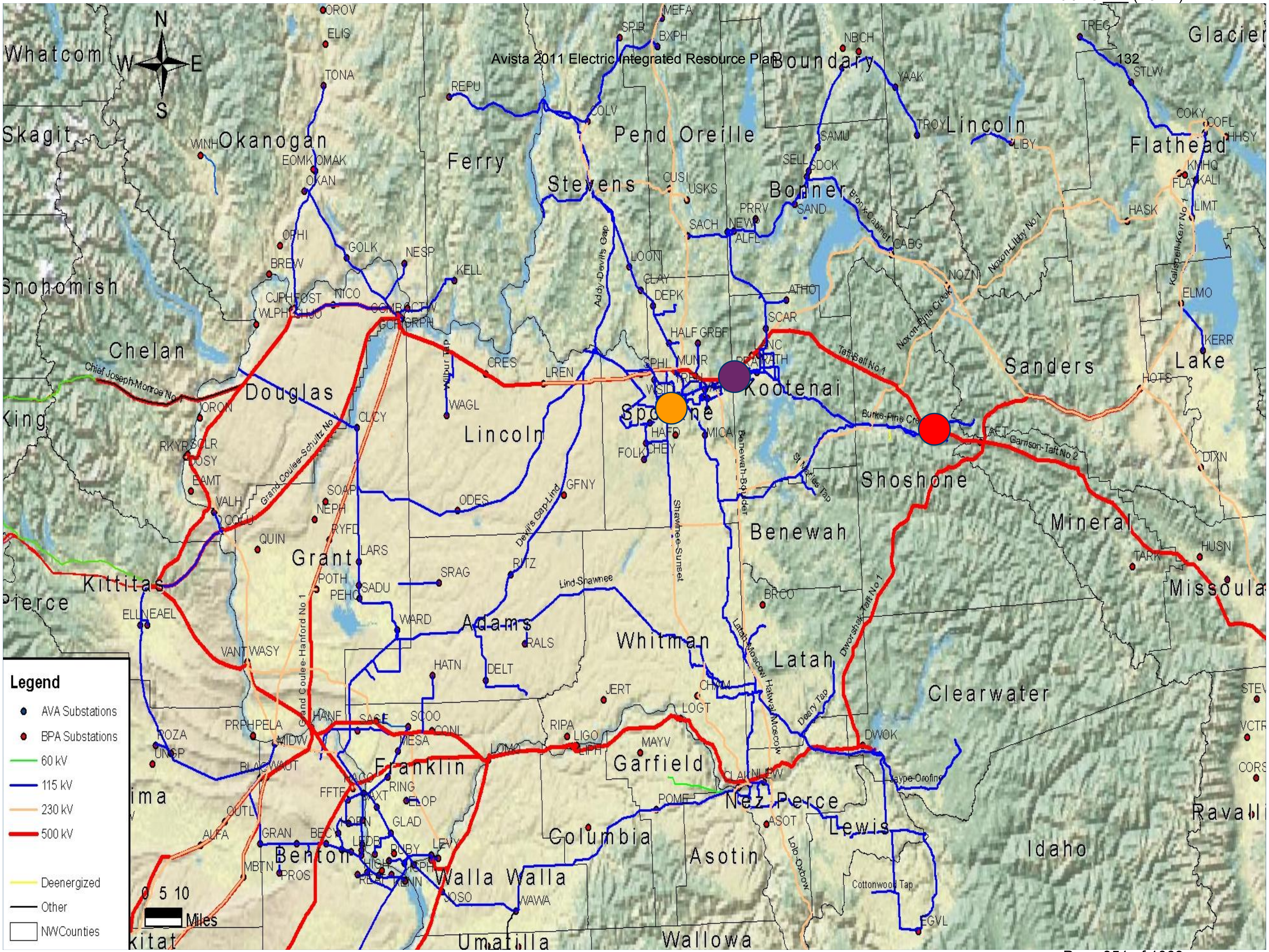
Jaype-Orofino

Non-coincident IRP Interconnection Requests

- **<u>Other "Large" Hydro Integration</u>** :
  - Cabinet Gorge ("East"): + 60 MW, 2018
  - Monroe Street (Spokane): + 20MW, 2018 or +60 MW, 2018
  - Post Falls (Coeur d' Alene): + 14 MW, 2018

- **<u>"Small" Hydro Integration</u>** :
  - Upper Falls (Spokane): + 2 MW, 2019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Study Process and Cost Estimates

- **Study Process:**
  - Avista System Planning does transmission system analysis using WECC approved “study cases” (which we modify) for all analyses and uses approved software tools (PTI, GE, PowerWorld) to “do the math” on various alternatives.
- **Pre-Engineering Cost Estimates:**
  - Avista Engineering does pre-engineering cost estimation.
  - Estimates are generally plus or minus 50% accuracy (no rights-of-way, soils analysis, firm quotes for equipment, etc.).
  - Transmission integration is often about 10% of total project costs (but can be much higher depending on where the resource is integrated).

Transmission Study Process With Respect to Resource Type

- **"We (Transmission) Don't Care"!**
  - **Transmission Analysis is "Resource Blind":**
    - Wind
    - Water
    - Gas
    - Pumped Storage
    - Other
  - **Transmission Integration Costs Will be the Same for ANY Resource.**

West Plains / Devils Gap Area

- Necessitates a "Tipping Point" Analysis:
  - Total potential generation is 4 MW to 254 MW – lots of options!
  - Voltage Level Analysis:
    - How much can be integrated at 115 kV:
      - At no cost?
      - At a "max 115 kV development" cost?
    - How much can be integrated at 230 kV:
      - Can it be done with only one 230 kV line?
      - What are the costs for one versus two lines?
  - What are the $/MW costs for the various options?

West Plains / Devils Gap Area

- **<u>115 kV Analysis</u>**:
  - 4 MW requires no transmission additions (one bookend).
  - 75 MW can be integrated for about $15M.
  - Requires new 115 kV line and station upgrades.
- **<u>230 kV Analysis</u>**:
  - 254 MW can be added for about $30-$55M (2-230 kV lines).
  - These costs don’t include the planned 230 kV Spokane Loop.
- **<u>“All Things Being Equal” $$/MW Comparison</u>**:
  - 75 MW @ 115 kV @ $15M => $200/kW
  - 254 MW @ 230 kV @ $30-$55M => $118-$217/kW

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"Central" and "East" Areas

- **230 kV Integration**:
  - Benewah: 300 MW @ about $5M
  - Rosalia: 300 MW @ about $8M
  - Rathdrum:
    - 300 MW @ about $5M (Will require Gen Dropping).
    - 400 MW @ about $5M (Will require Gen Dropping).
    - A concern is "too many eggs" on the Rathdrum Prairie:
      - Existing Rathdrum – 160 MW.
      - Existing Lancaster – 270 MW.
      - New Rathdrum – 300-400 MW.
  - All studies are post integration of the Lancaster generation into the Avista 230 kV system.

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"Far West" (Big Bend) Area

- **Othello 115 kV Analysis**:
  - 17 MW requires no transmission additions (one bookend).
  - 100 MW can be integrated for between $13-$25M.
  - Requires new 115 kV line, local 115 kV line reconductor, and a new POI 115 kV substation (the lower costs require generator dropping).
- **230 kV Analysis**:
  - 250 MW can be added for about $8M.
  - Requires a new POI 230 kV substation.
  - Does not consider contractual constraints on the Walla Walla – Wanapum 230 kV line

"North" and Other Hydro

- **Sandpoint, Idaho**:
  - Sandpoint: 50 MW @ about $2-5M (depending on BPA).
  - More than 50 MW is probably cost prohibitive.
- **Other "Large" Hydro**:
  - Cabinet Gorge: 60 MW @ about $2-$10M (Cabinet Gorge – Rathdrum @ 100 Degrees Centigrade & 115 kV reconductor).
  - Monroe Street: 20 MW @ about $3M (does not include Metro).
  - Monroe Street: 60MW @ about $3M (as above).
  - Post Falls: 14 MW @ about $1M
- **Other "Small" Hydro Integration** :
  - Upper Falls: 2 MW @ about $1M

"Off System" Resources

- **Integration of 100-300 MW:**
  - Potential at Bell, Hatwai, Hot Springs, or Mid Columbia:
  - Wheeling over the BPA system presently costs $4.4M/year plus $2.5M/year for losses (@$50/MW-hr) for 300 MW of BPA transmission service (if it is available). The BPA rate is expected to increase by about 9% in 2013. A BPA "Lines and Loads" Study (funded by AVA) is required to determine capacity in the BPA Grid.
  - A study similar to the FERC "Market Power Study" is used to determine at what cost these resources could be integrated into the Avista Grid. Recent studies have indicated that as much as $50M could be required for 300 MW of integration from BPA into the Avista system.

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Future Work?

- **Generic Break Point Studies for IRP / 3rd Party Developers:**
  - "How many MW can we integrate where for about what $$?"
    - Main Grid 230 kV Stations.
    - Select 115 kV Stations.
- **Potential Open Seasons:**
  - "Does anyone want to get to the Mid Columbia?"
  - "Does anyone want to get out of Montana?"
  - "Does anyone want to get to PAC or IPC?"
- **Canada – Northwest – California Transmission Project:**
  - "If this project is built, how should we interconnect?"
  - "What other markets would this project access?"

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Questions?

Hydro Upgrade Opportunities

Steve Wenke

Technical Advisory Committee Meeting #3

2011 Electric Integrated Resource Plan

December 2, 2010

Presentation Outline

- Background of Avista's Hydro System
- Looking Back on What has Been Done
- Current Upgrade Projects
- Other Opportunities
- Issues

Background

- Aging hydro system
- Advancements in hydro turbine technology
- Hydraulic size of facilities

Avista's Hydro Portfolio

- First project was Monroe Street that came on line in 1891.
- "Newest" Spokane River plant is Upper Falls which came on line in 1920.
- The larger Clark Fork River projects were developed in the mid to late 1950's

Aging Technology

Modern turbine designs convert the energy of falling water at a rate of about 94% efficiency

- Combined Cycle Gas Plant – 52%
- Wind Turbine 40-50%

1960 and earlier vintage hydro plants have efficiencies of abut 88% or lower

- Estimate 80% at Upper Falls
- Estimate 85% at Little Falls

Plant Hydraulic Designs

The older Spokane River Plants were sized based on the needs of the day

- Base loaded energy
- Ability to swing output to make loads (i.e. regulation)
- Generator island areas (i.e. generator were not networked together)

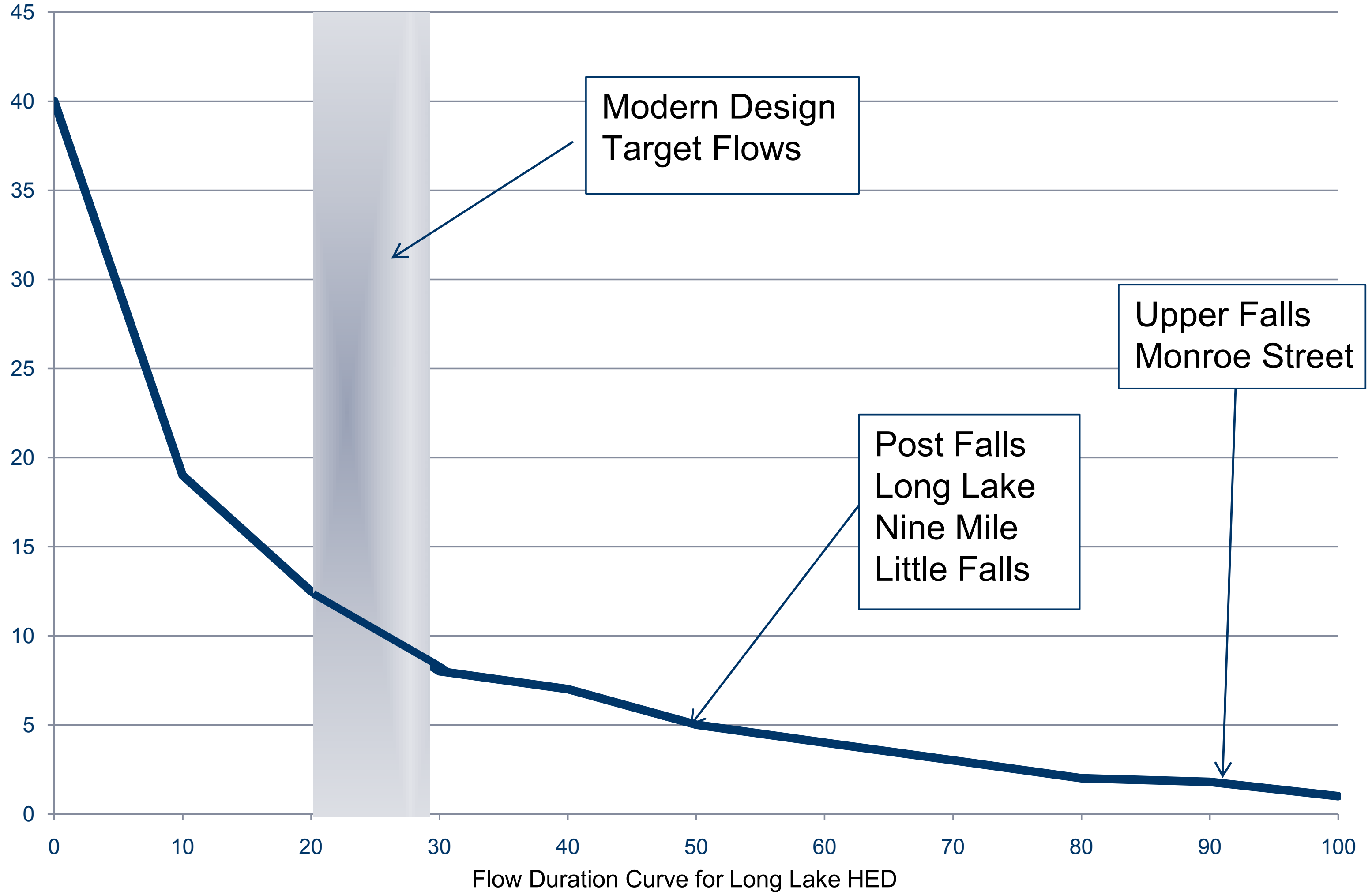
The result are plants that are relatively high on the flow exceedence curves

The Opportunity

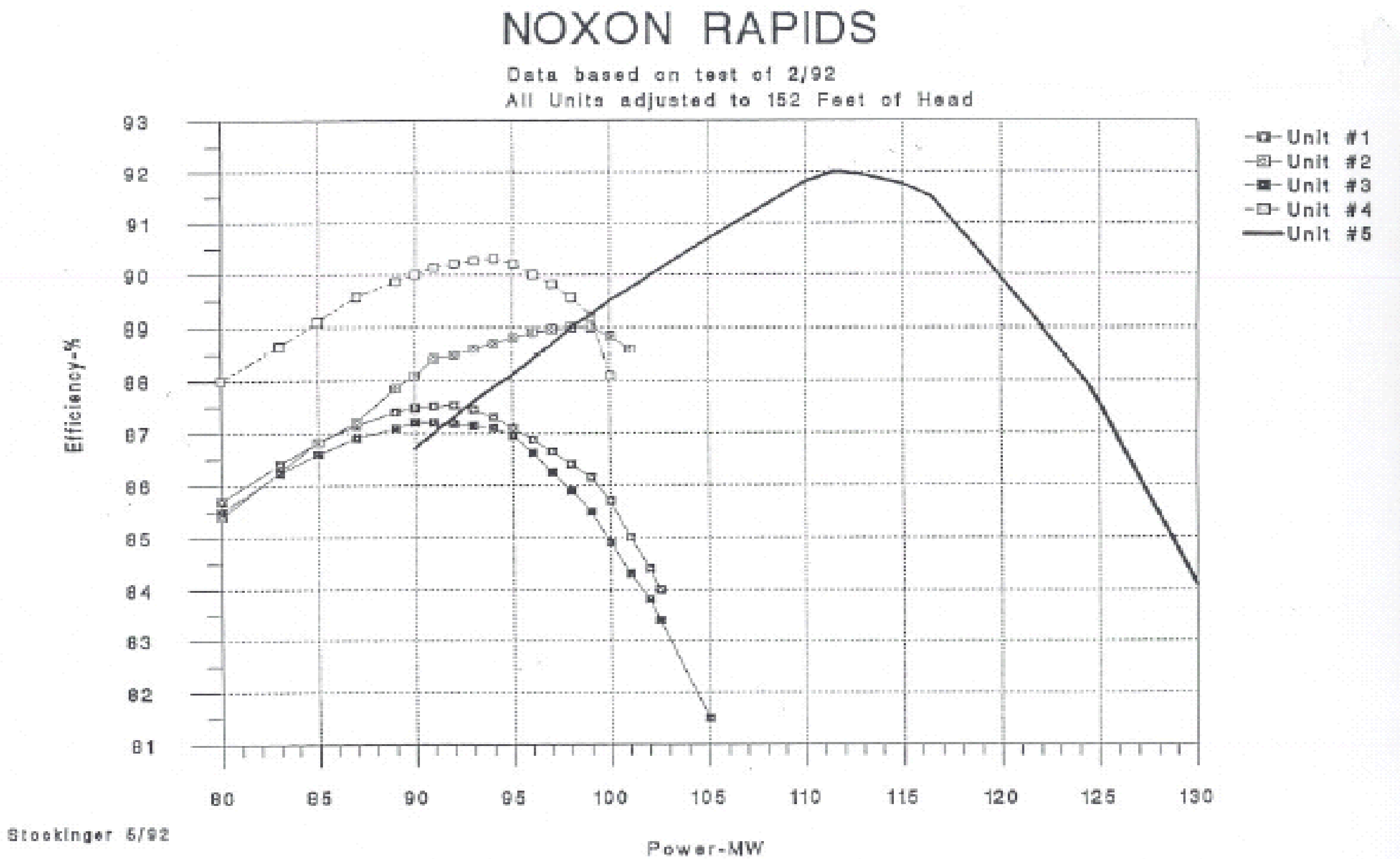
In simple terms, with unit flow capacity (cfs) and plant head (height of dam) the same, we should be able to improve the energy output of an older hydro unit by as much as 6% by replacing the old turbine with a modern designed unit.

- In fact, this does vary for each particular site based on the civil works of the specific dams

Plant Hydraulic Designs



Noxon Rapids Upgrades Variable Efficiency Curves



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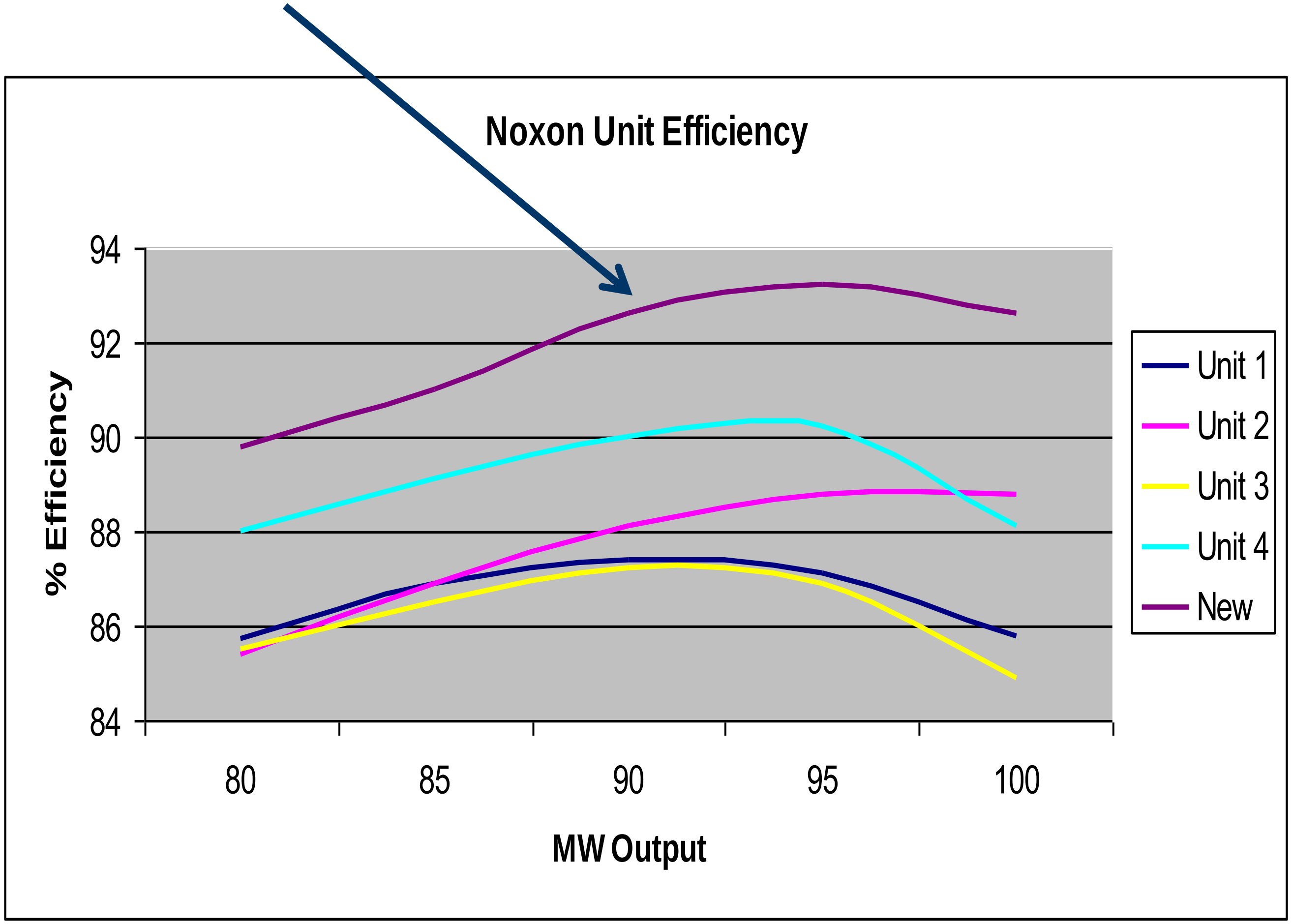
New Runner Comparison



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Looking Back

We have been actively pursuing hydro upgrades since 1989

- Monroe Street - 1992
- Nine Mile Units 3 and 4 - 1994
- Cabinet Gorge Unit 1 -1994
- Long Lake Units 1, 2, 3, and 4 – 1994 - 1999
- Little Falls Units 2 and 4 – 1994, 2001
- Cabinet Gorge Units 2, 3, and 4 – 2001 – 2004
- Noxon Rapids Units 1, 3 2009, 2010

Character of the Upgrades

Powerhouse Replacement

Powerhouse Refurbishment and Unit Replacement

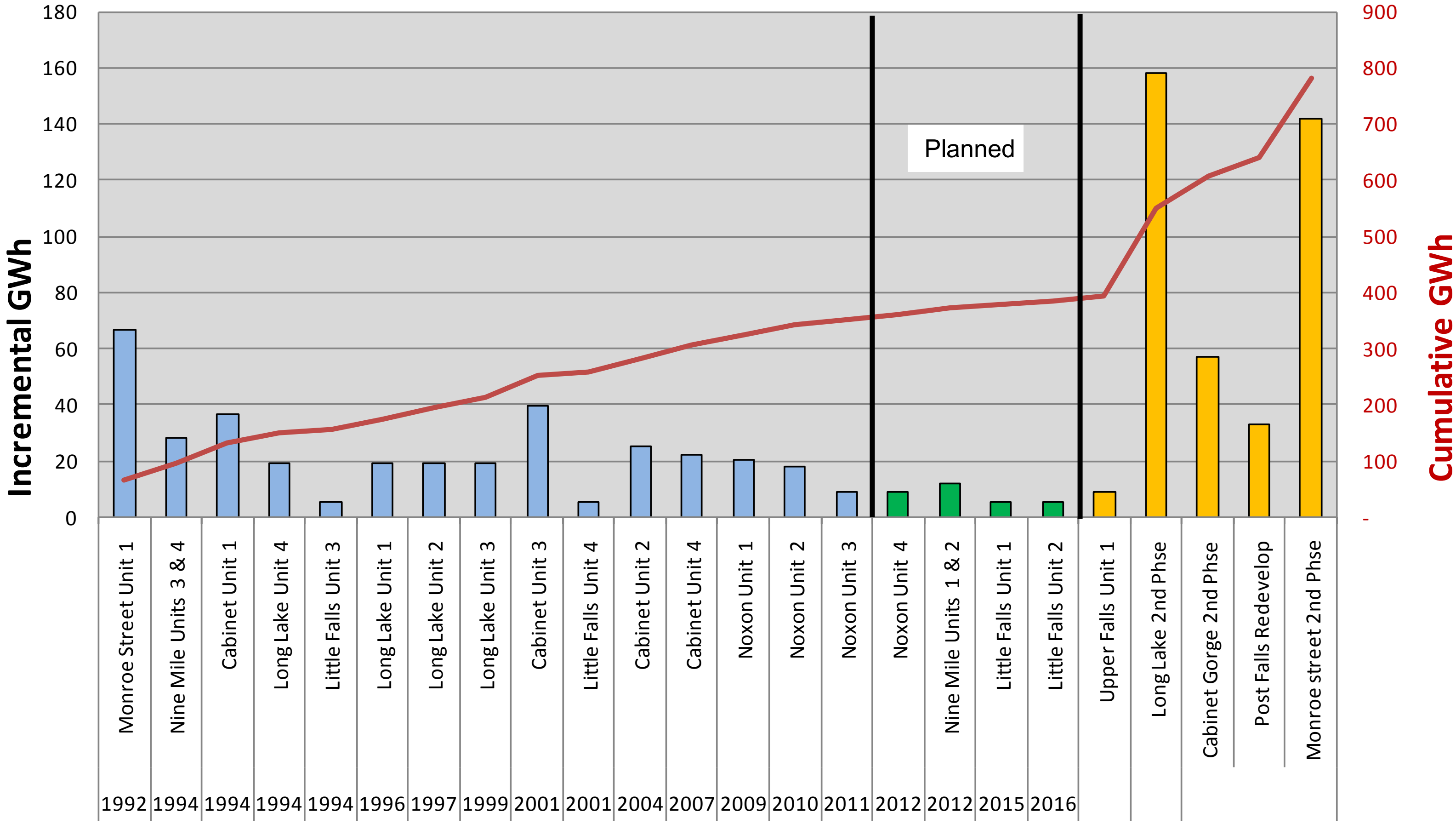
Runner Replacement

Unit Replacement

Powerhouse Additions

- To this point in time, we have not added new powerhouse additions to existing facilities

What we have done to date: Energy (GWh's)



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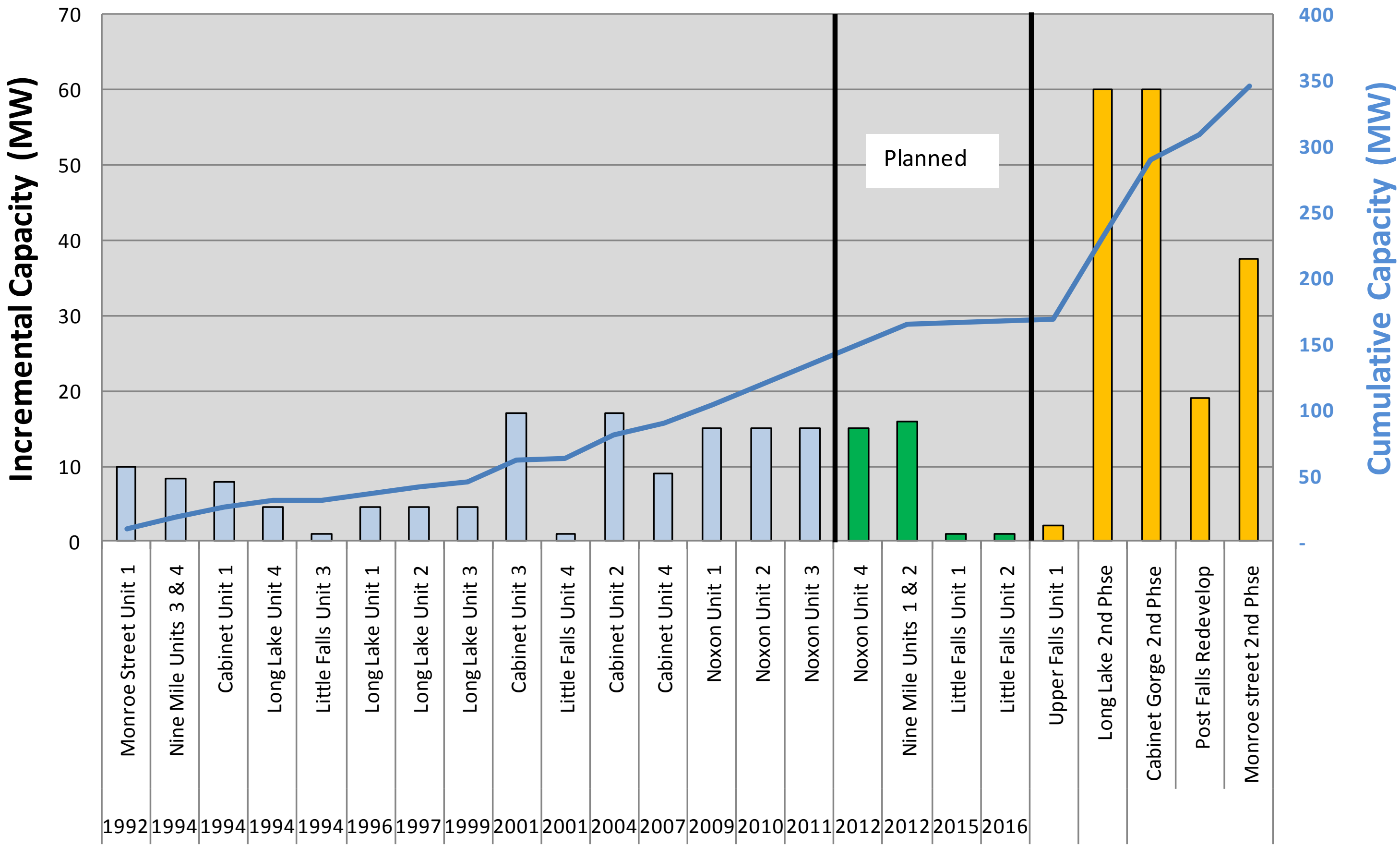
What we have done to date: Added Hydro Capacity (MW's)



Summary

- Over the past 20 years, we have added 334,000 MWh's and 120 MW's of hydro to our system
- We are currently planning to add an estimated 49,000 MWh's and 48 MW's
- There are considerations for an additional 116,000 MWh's and 176 MW's

Current Projects

- Little Falls Refurbishment
- Nine Mile Redevelopment

Little Falls Upgrade

- Seeking an increase in turbine efficiency
- Current estimated efficiency is 80%
- Upgraded runners are expected to be 85%
- Approximately 2 MW improvement expected

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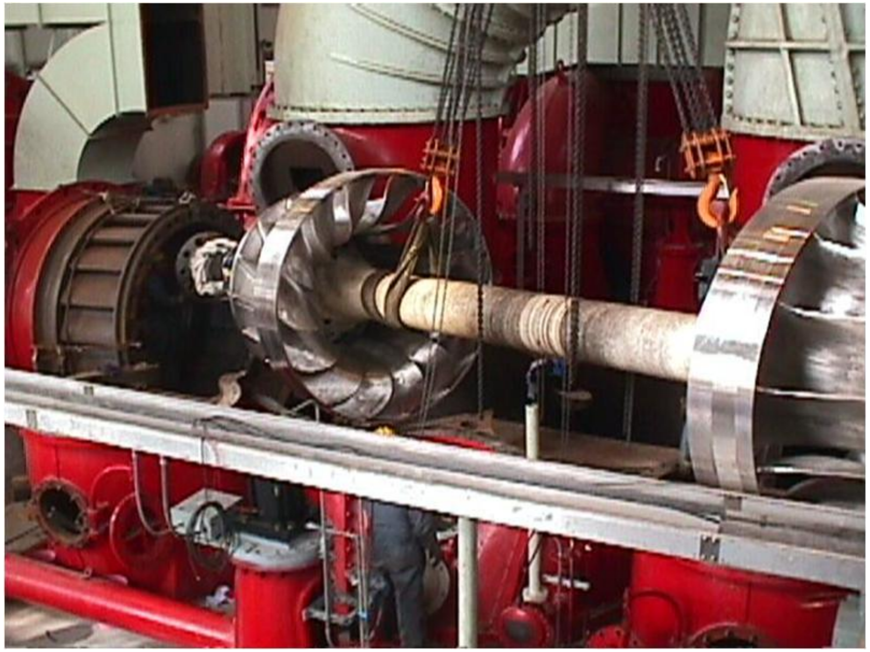
Little Falls Upgrade

General Scope of work would include replacement of all of the old equipment at the plant – a major undertaking

Photo Showing New Turbine Runners Being installed in Unit 4 in 2001



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Little Falls Upgrade

DRAFT

- Expected additional Capacity – 2 MW
- Expected additional Energy – 8,760 MWh
- Estimated Costs - $1.5 million
- Other Considerations:
  - Much of the existing equipment is at the end of its service life and will likely be replaced, significantly increasing the scope of this project work.
  - We have yet to explore expansion plans for this site, and may elect to do so.

Nine Mile Redevelopment

This project is to replace Units 1 and 2. These are original 1908 machines and are no longer repairable. The basic scope is to remove the old systems and install new turbines, generators, switchgear, and controls to update the plant.

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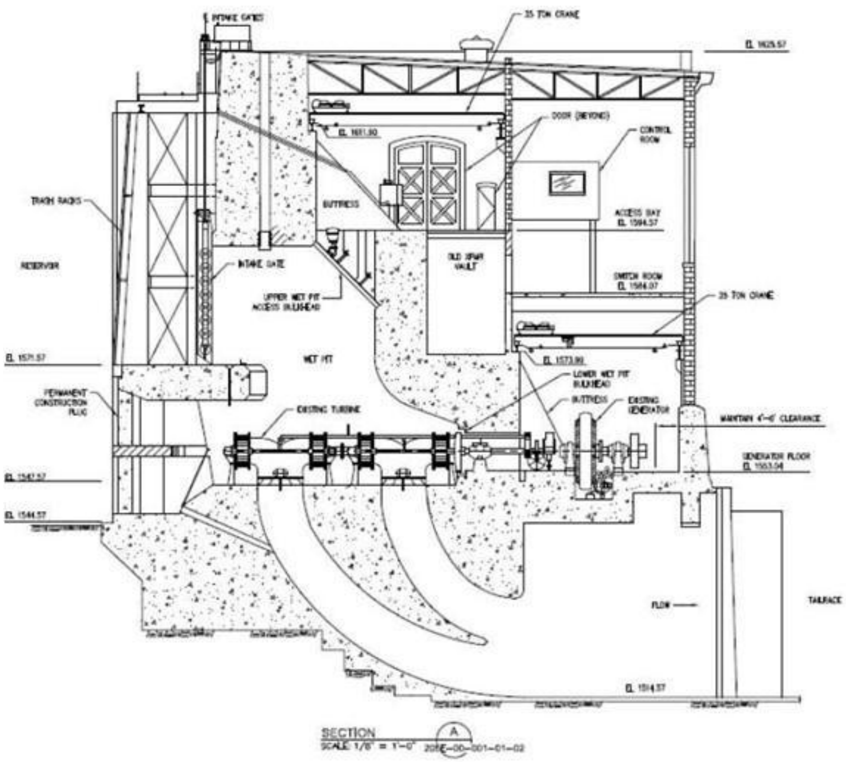
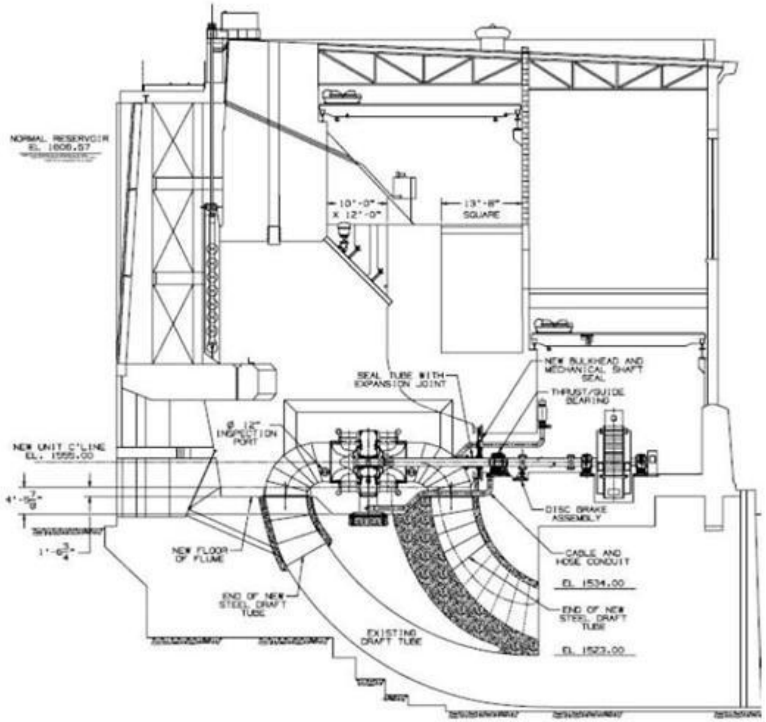
Nine Mile Redevelopment





Existing Units – Horizontal Quad Runner

Proposed American Hydro Seagull Units

Nine Mile Redevelopment

DRAFT

- Expected additional Capacity – 16 MW
- Expected additional Energy – 11,800 MWh
- Estimated Costs - $38 million
- Other Considerations:
  - This addresses Units 1 and 2. Units 3 and 4 were replaced in the 1994.
  - Sediment buildup in the river needs to be addressed.
  - Existing balance of plant equipment is also to be replaced with this project work
  - We just completed a "Obermeyer Gate" installation to eliminate the flashboard system

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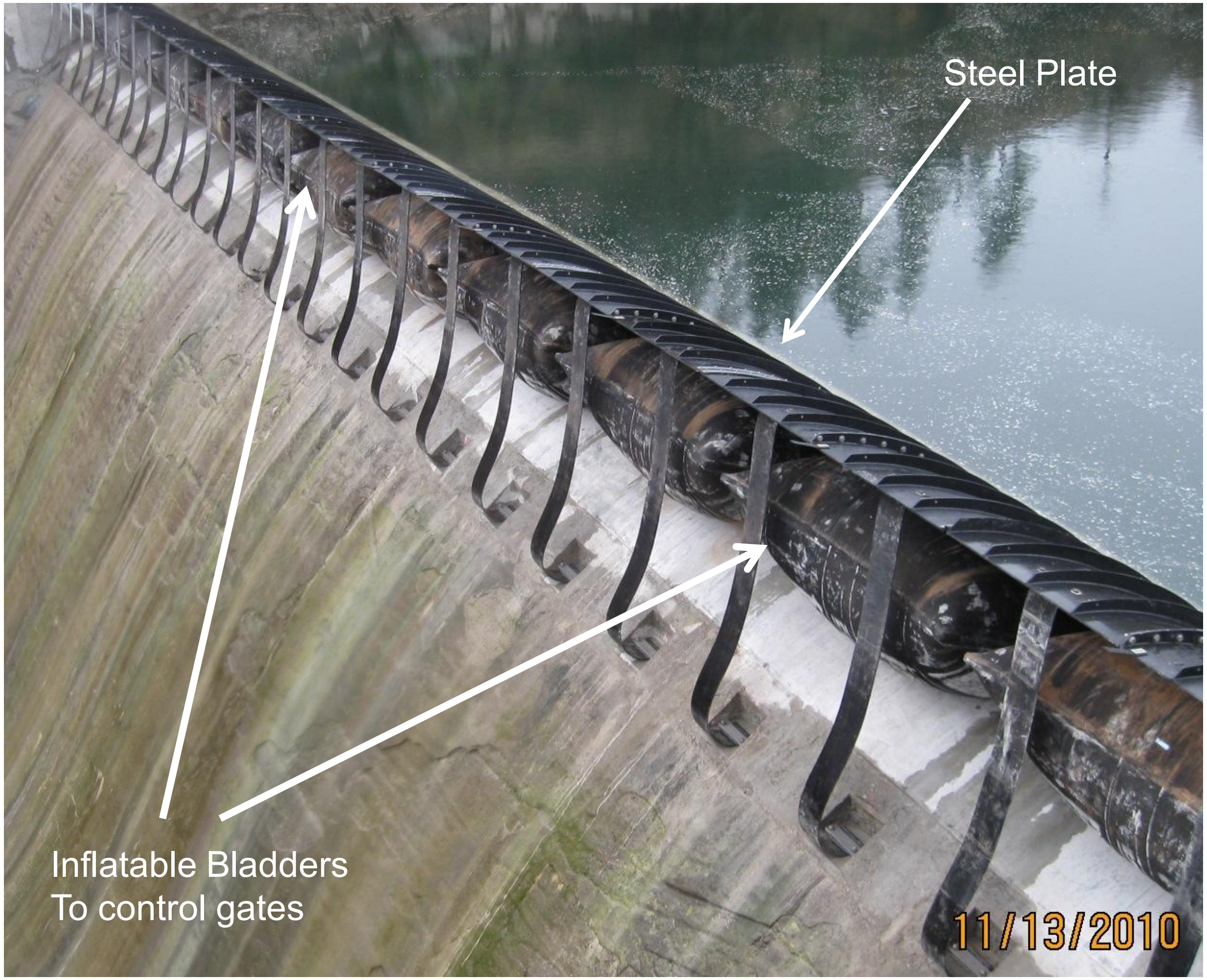
Nine Mile Sediment Impacts

Nine Mile Flashboard Replacement

From the 1940's until last year, we Would install wooden flashboards On the dam to get an additional 10 Feet of head. Each spring these Would be released and have to be Replaced each year.

Nine Mile Obermeyer Gate



Other Opportunities

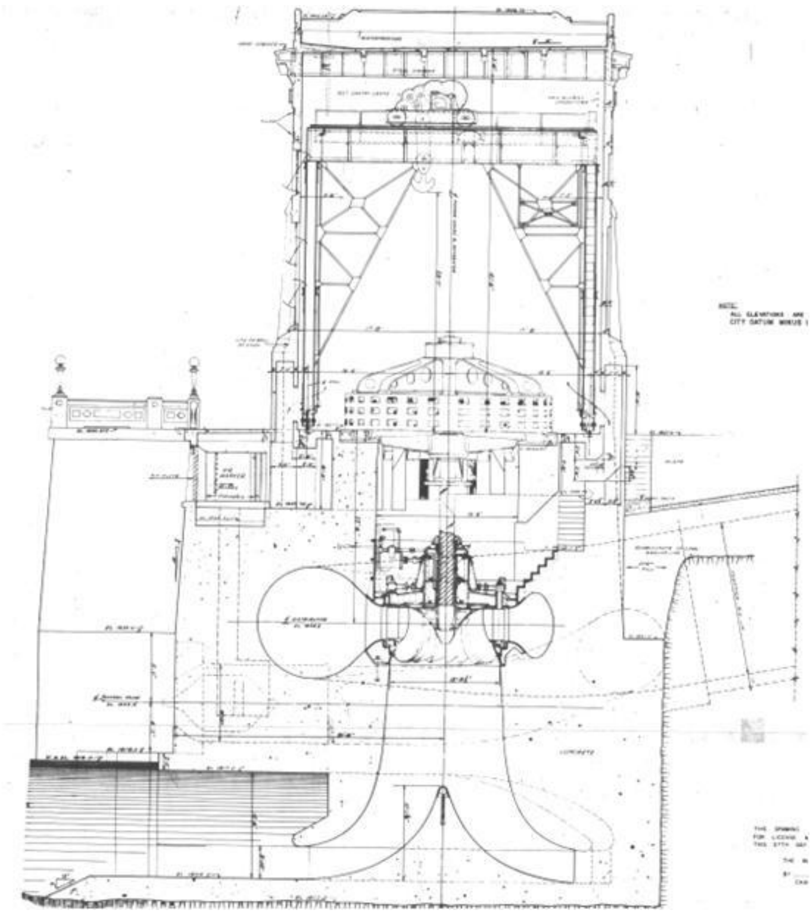
- Upper Falls Runner Replacement
- Long Lake Second Powerhouse Addition
- Cabinet Gorge Second Powerhouse Addition
- Post Falls Refurbishment
- Monroe Street Second Powerhouse Addition

Upper Falls Runner Replacement

Seeking to increase the output of the unit by replacing the turbine runner and modifying the existing draft tube to improve efficiency.

Upper Falls Runner Replacement

General Scope of Work would be to remove the old runner, modify the draft tube, stay vanes, and discharge area, and install a new runner



Upper Falls Runner Replacement

DRAFT

- Expected additional Capacity - 2 MW's
- Expected additional Energy 8,600 MWh's
- Estimated Costs - $6.8 million
- Other Considerations:
  - New license conditions have not yet been considered in this options.
  - Would require considerable modification to the existing draft tube system

Long Lake Second Powerhouse

Seek to increase plant capacity by the addition of a second powerhouse and large capacity unit

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Long Lake Second Powerhouse

Long Lake Second Powerhouse

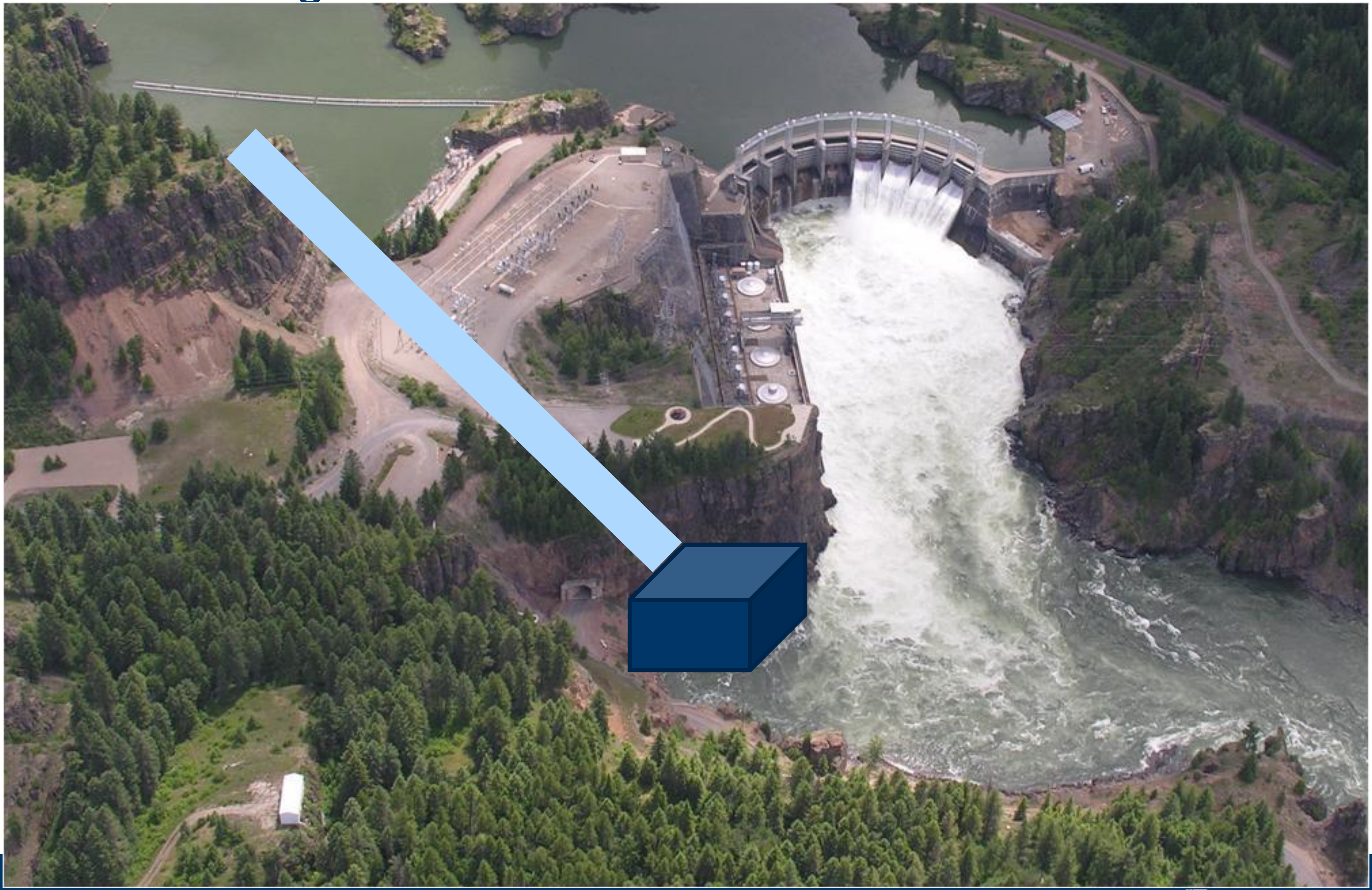
DRAFT

- Expected additional Capacity – 60 - 120 MW
- Expected additional Energy – 158,000 – 178,000 MWh
- Estimated Costs - $120+ million
- Other Considerations:
  - Impacts of construction to the existing plant
  - Condition of small arch dam to be used as a cofferdam

Cabinet Gorge Second Powerhouse

Seek to increase plant capacity by the addition of a second powerhouse and match Noxon Rapids flow capacity

Cabinet Gorge Second Powerhouse



Cabinet Gorge Second Powerhouse

DRAFT

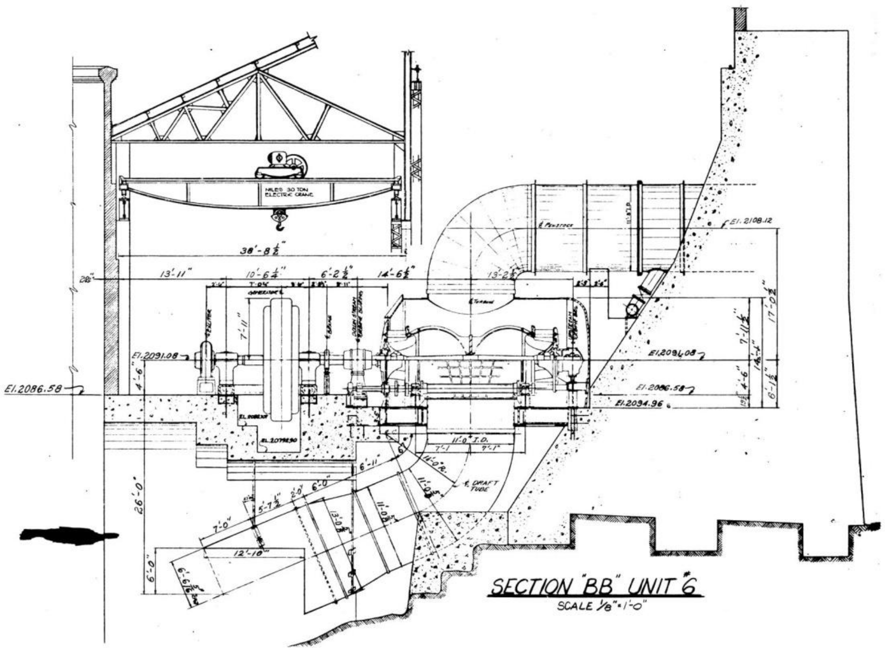
- Expected additional Capacity – 50 MW
- Expected additional Energy – 57,000 MWh
- Estimated Costs - $115 million
- Other Considerations:
  - This project would favorably impact the Total Dissolved Gas (TDG) issue at Cabinet Gorge and is currently under consideration by the Clark Fork License team.

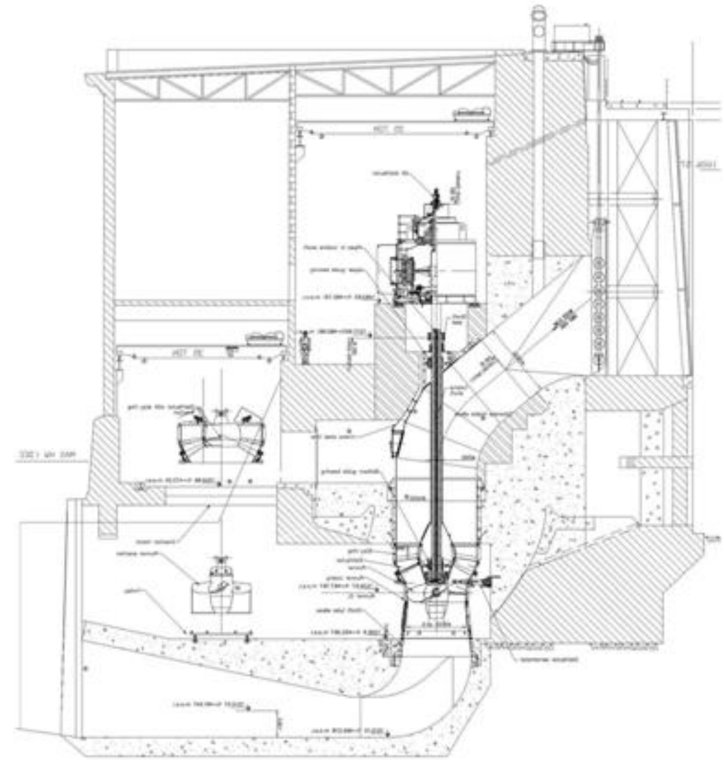
Post Falls Refurbishment

This would involve removing all of the old station equipment and replacing it with new units. The building exterior would remain intact

Post Falls Upgrade

The Scope is to remove the old horizontal units and replace them with high efficiency and higher capacity vertical units





Post Falls Upgrade

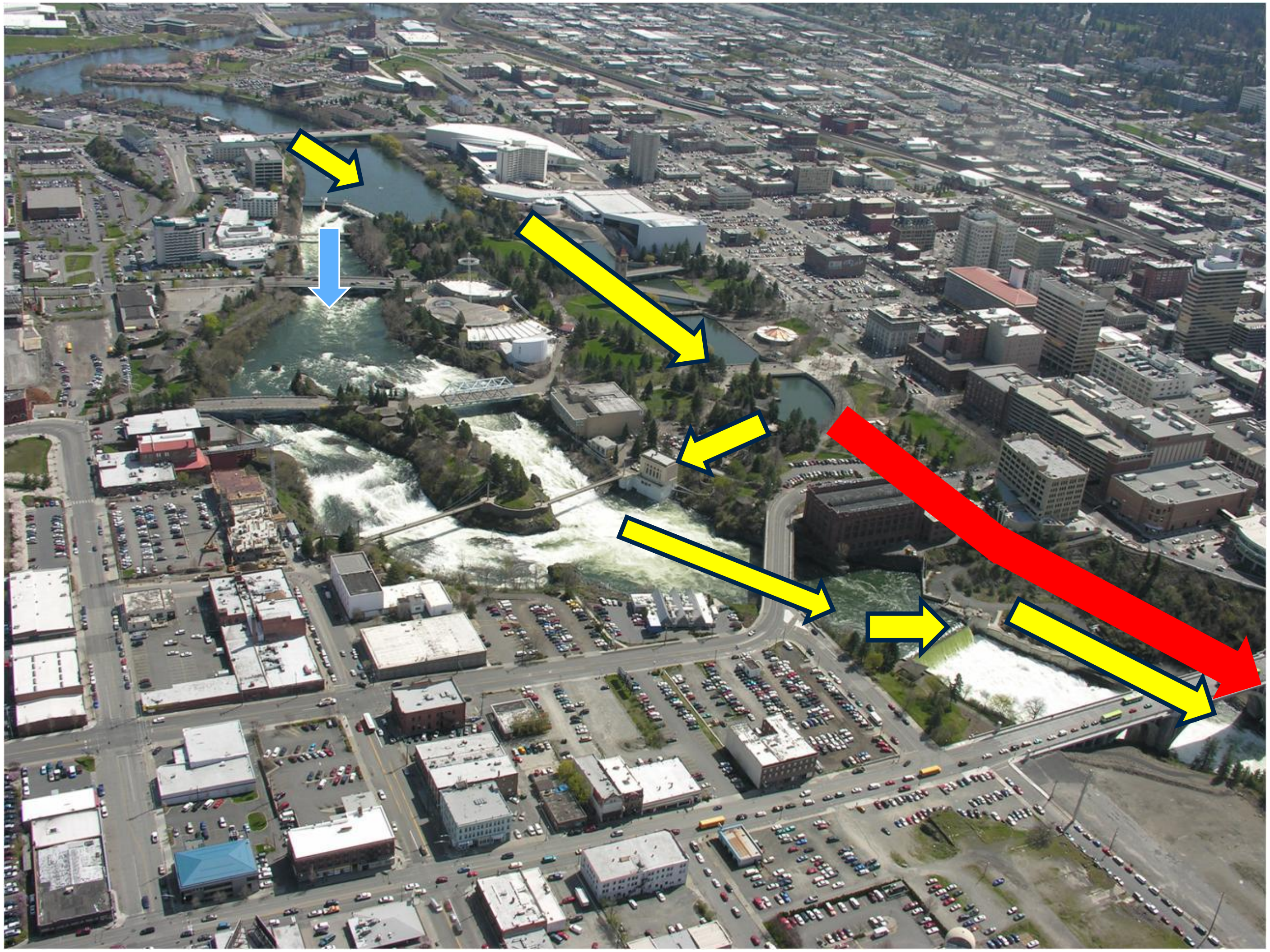
DRAFT

- Expected Additional Capacity – 19 MW's
- Expected additional Energy – 33,000 MWh's
- Estimated Costs - $75 million
- Other Considerations:
  - Need to evaluate this plan against new license conditions

Monroe Street Second Powerhouse

The basic project here is to harness the capacity of the 140 waterfall that the Spokane River drops in downtown Spokane

Monroe Street Second Powerhouse



Monroe Street Second Powerhouse

DRAFT

- Expected Additional Capacity – 37.5 MW's
- Expected additional Energy – 142,000 MWh's
- Estimated Costs - $95 million
- Other Considerations:
  – Downtown Spokane and Riverfront Park locations make this a challenging option
  – Would require a significant make over of the western edge of Riverfront Park, and channel dredging

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Hydro Upgrades – Other Issues

- Aging equipment is driving much of the work.
- Gaining valuable experience for our work force
- Current incentives for REC's and tax incentives are playing a part
- Needs for future capacity
- Environmental Drivers
  - Total Dissolved Gas – desire to reduce spill at some sites
  - Needs for more modern plants with appropriate systems to avoid possible releases
  - Licenses have provided some certainty around investment opportunities.
  - Significant permit time for second powerhouse projects

Potential Thermal Upgrades

Jason Graham
Generation Engineer

Overview

- Conversion of Rathdrum CT to a Combined Cycle Power Plant
- Water Demineralization System for Inlet Fogging at Rathdrum CT
- Inlet Chiller at Coyote Springs 2
- Cold Day Performance Software Upgrade at Coyote Springs 2
- Advanced Hot Gas Path Hardware Upgrade at Coyote Springs 2
- Cooling Optimization Hardware Upgrade at Coyote Springs 2
- Wood Fuel Gasification at Kettle Falls Generation Site

Rathdrum Combustion Turbine
Rathdrum, Idaho

- Two General Electric 7EA Combustion Turbines
- On Line in 1994
- Simple Cycle Configuration
- Approximately 160 MW Combined Output
- Heat Rate of 11,612 Btu/kWh (HHV)

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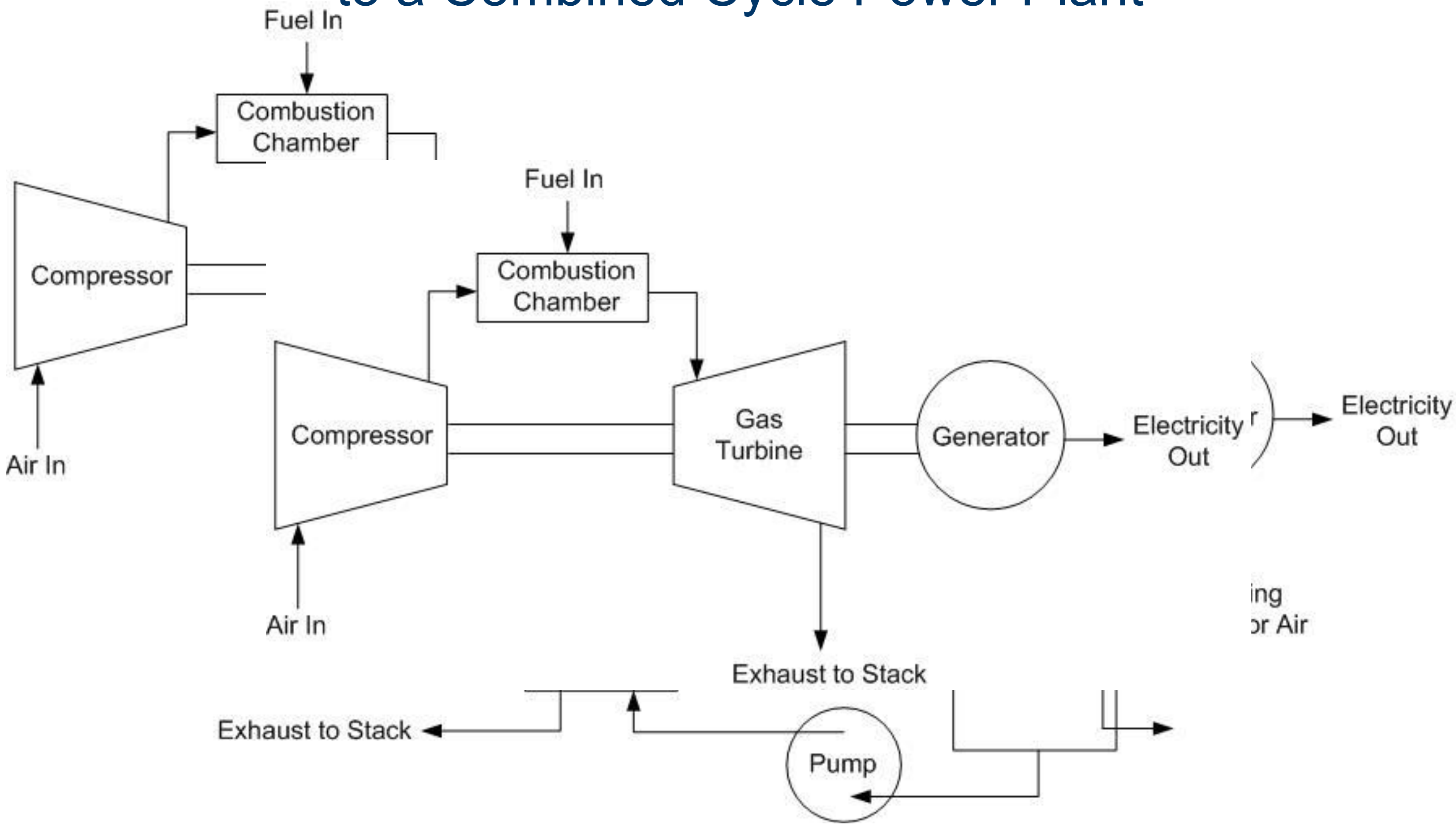
Conversion of Rathdrum CT to a Combined Cycle Power Plant



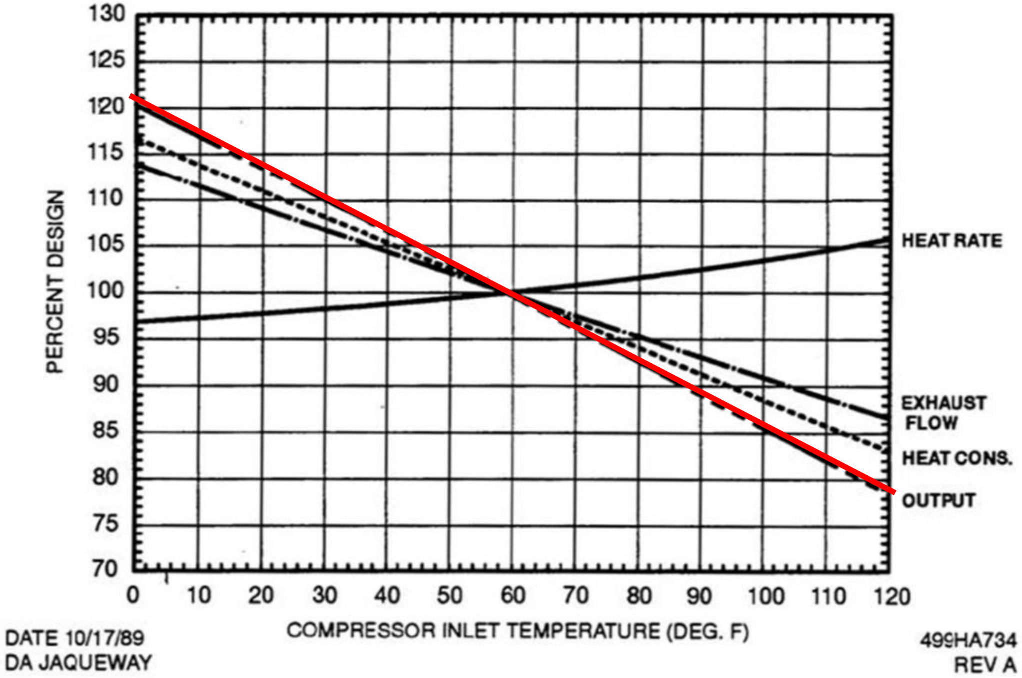
Conversion of Rathdrum CT to Combined Cycle Water Cooled Condenser

Incremental Output Increase:	78.4 MW At 5°F
	85.2 MW at 55°F
	91.4 MW at 100°F
Overall Plant Heat Rate Change:	-3782 Btu/kWhr (HHV)
Variable Operating Costs:	$1.50/MWh
Fixed Operating Costs:	$15/kWyr
Capital Cost:	$71M
Plant Unavailable Time:	6 Months

Conversion of Rathdrum CT to Combined Cycle Air Cooled Condenser

Incremental Output Increase:	77.9 MW At 5°F
	79.9 MW at 55°F
	82.4 MW at 100°F
Overall Plant Heat Rate Change:	-3626 Btu/kWhr (HHV)
Variable Operating Costs:	$1.30/MWh
Fixed Operating Costs:	$15/kWyr
Capital Cost:	$81.5M
Plant Unavailable Time:	6 Months

Water Demineralizer at Rathdrum CT for Inlet Fogging



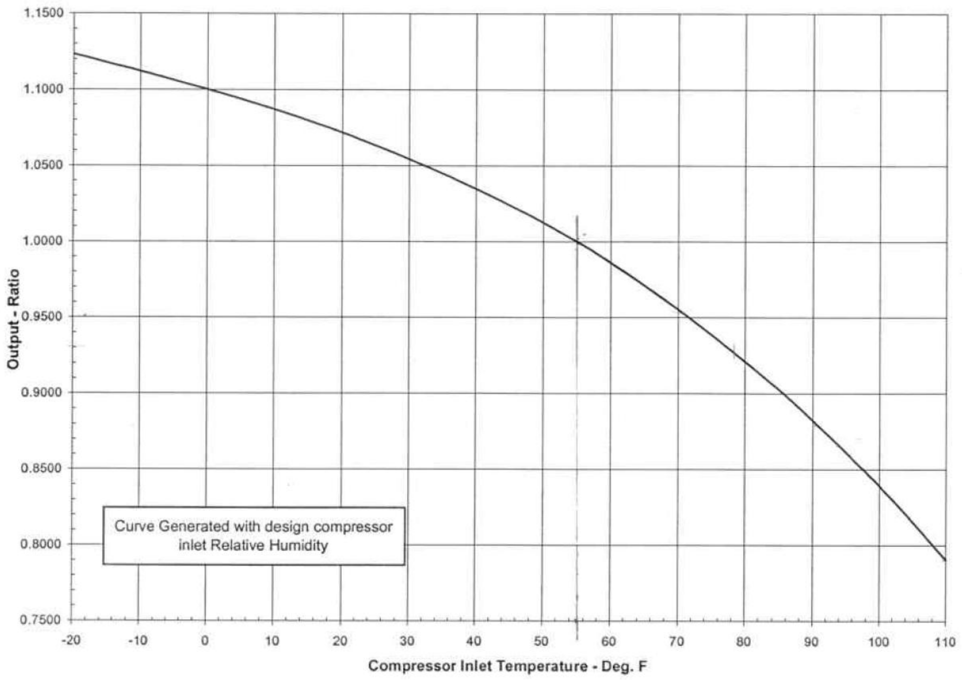
Water Demineralizer at Rathdrum CT for Inlet Fogging

Incremental Output Increase:	N/A At 5°F
	4.4 MW at 55°F
	17.6 MW at 100°F
Overall Plant Heat Rate Change:	-67 Btu/kWhr (HHV)
Variable Operating Costs:	$1.00/MWh
Fixed Operating Costs:	Insignificant
Capital Cost:	$1M
Plant Unavailable Time:	2 Months

Coyote Springs 2
Boardman, Oregon

- One General Electric 7FA Combustion Turbine
- Combined Cycle Configuration
- On Line in 2003
- Approximately 279 MW Combined Output (Duct Fired)
- Heat Rate of 6229 Btu/kWh (HHV)

Inlet Chiller at Coyote Springs 2



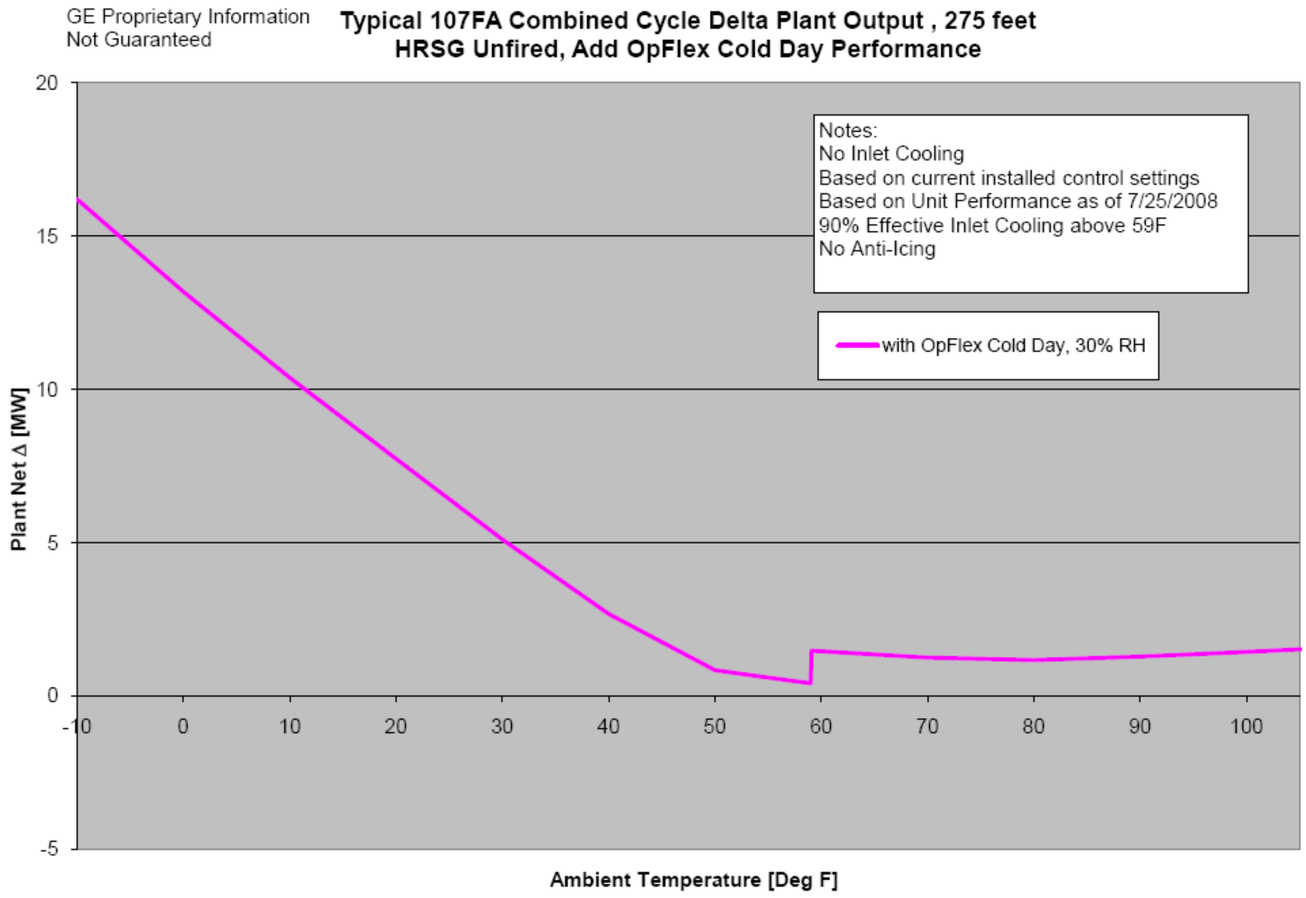
Inlet Chiller at Coyote Springs 2 w/o Thermal Storage

Incremental Output Increase:	N/A At 5°F
	0 MW at 55°F
	29.8 MW at 100°F
Overall Plant Heat Rate Change:	Insignificant
Variable Operating Costs:	Insignificant
Fixed Operating Costs:	Insignificant
Capital Cost:	$10M
Plant Unavailable Time:	3 Months

Inlet Chiller at Coyote Springs 2 With Thermal Storage

Incremental Output Increase:	N/A At 5°F
	0 MW at 55°F
	32.2 MW at 100°F
Overall Plant Heat Rate Change:	Insignificant
Variable Operating Costs:	Insignificant
Fixed Operating Costs:	Insignificant
Capital Cost:	$10M
Plant Unavailable Time:	3 Months

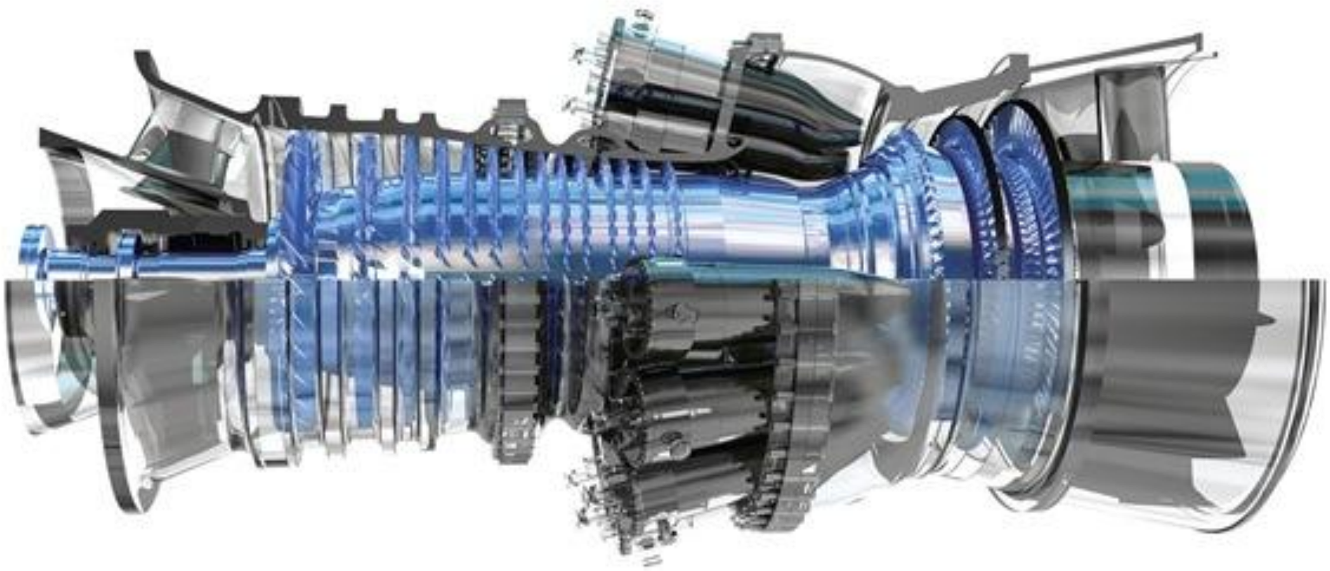
Cold Day Performance Software Upgrade at Coyote Springs 2



Cold Day Performance Software Upgrade at Coyote Springs 2

Incremental Output Increase:	17.6 MW At 5°F
	0.8 MW at 55°F
	1.2 MW at 100°F
Overall Plant Heat Rate Change:	Insignificant
Variable Operating Costs:	None
Fixed Operating Costs:	None
Capital Cost:	$4.5M
Plant Unavailable Time:	2 Months

Advanced Hot Gas Path Hardware Upgrade at Coyote Springs 2



Source: General Electric

Advanced Hot Gas Path Hardware Upgrade at Coyote Springs 2

Incremental Output Increase:	8.6 MW At 5°F
	8.0 MW at 55°F
	7.1 MW at 100°F
Overall Plant Heat Rate Change:	-76 Btu/kWhr
Variable Operating Costs:	None
Fixed Operating Costs:	$3.9M
Capital Cost:	$18M
Plant Unavailable Time:	None

Cooling Optimization Hardware Upgrade at Coyote Springs 2

7FA Cooling Optimization Package,
Image removed, GE Proprietary

Source: General Electric

Cooling Optimization Hardware Upgrade at Coyote Springs 2

Incremental Output Increase:	2.8 MW At 5°F
	2.6 MW at 55°F
	2.3 MW at 100°F
Overall Plant Heat Rate Change:	-35 Btu/kWhr
Variable Operating Costs:	None
Fixed Operating Costs:	None
Capital Cost:	$7.2M
Plant Unavailable Time:	2 Months

Kettle Falls Generating Station
Kettle Falls, Washington

- Wood Fired Boiler with General Electric Steam Turbine
- On Line in 1983
- Approximately 48 MW Output

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Gasification of Wood Fuel at Kettle Falls Generation Site

Nexterra Gasification System

1. Fuel In-Feed System
2. Gasifier
3. Automatic Ash Removal System
4. Syngas

Gasification of Wood Fuel at Kettle Falls Generation Site

- Gasification of wood fuel for use in turbines is in it's infancy
- Difficulty with adequately cleaning the syngas for use in a turbine
- No reliable data on expected costs or operational characteristics

Questions?

Load Forecast

Randy Barcus

Technical Advisory Committee Meeting #3

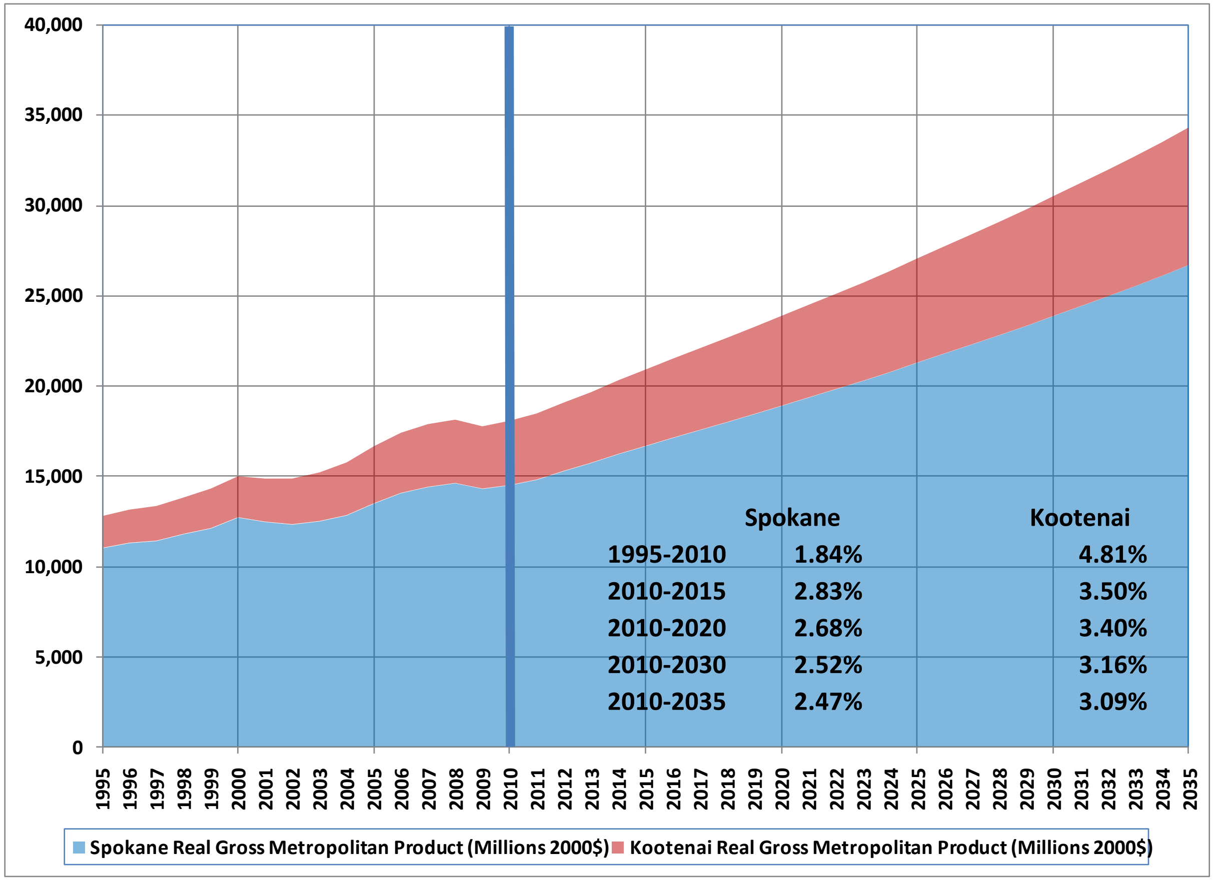
2011 Electric Integrated Resource Plan

December 2, 2010

Load Forecast 2011-2035 Outline

- Economy
- Weather
- Price Elasticity
- Customer Regressions
- Small Sector Forecasts
- Large Customer Forecasts
- Irrigation and Pumping Sales
- Sales Forecast
- Load Forecast
- Expected Peak Forecast
- Load Forecast Scenarios

Real Gross Metropolitan Product ($millions) History 1995-2010, Forecast 2010-2035



	Spokane	Kootenai
1995-2010	1.84%	4.81%
2010-2015	2.83%	3.50%
2010-2020	2.68%	3.40%
2010-2030	2.52%	3.16%
2010-2035	2.47%	3.09%

GLOBAL INSIGHT

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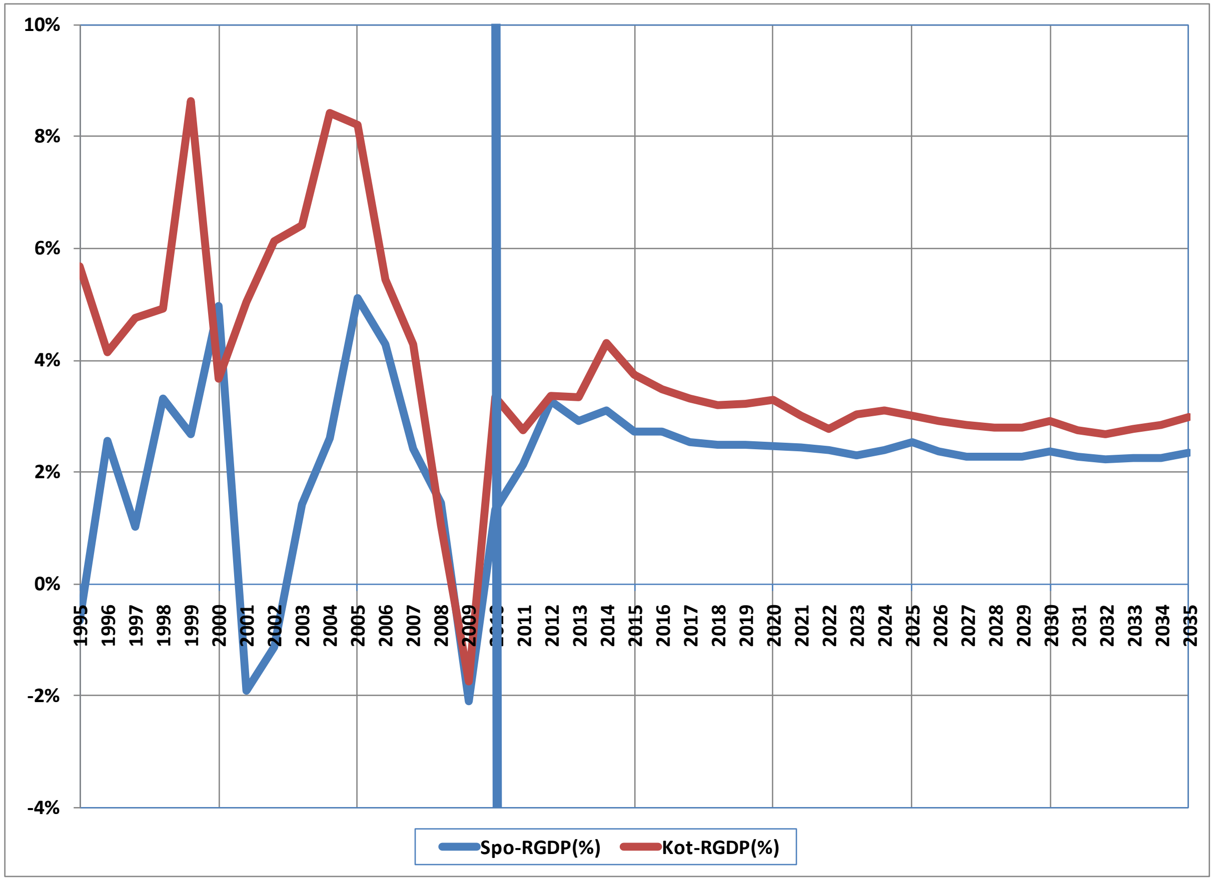
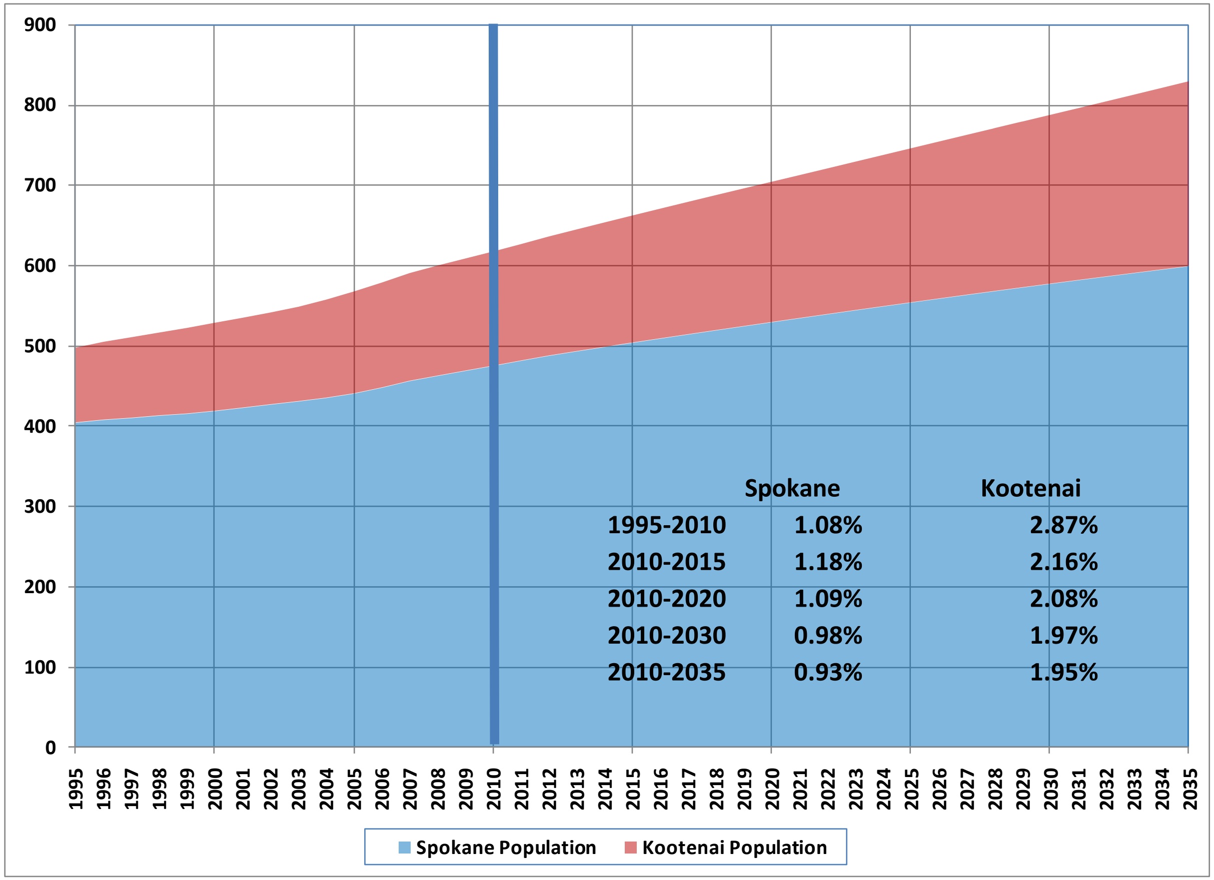
Real Gross Metropolitan Product Annual Percent Change



Annual Population—thousands of persons
History 1995-2010, Forecast 2010-2035



	Spokane	Kootenai
1995-2010	1.08%	2.87%
2010-2015	1.18%	2.16%
2010-2020	1.09%	2.08%
2010-2030	0.98%	1.97%
2010-2035	0.93%	1.95%

IHS GLOBAL INSIGHT

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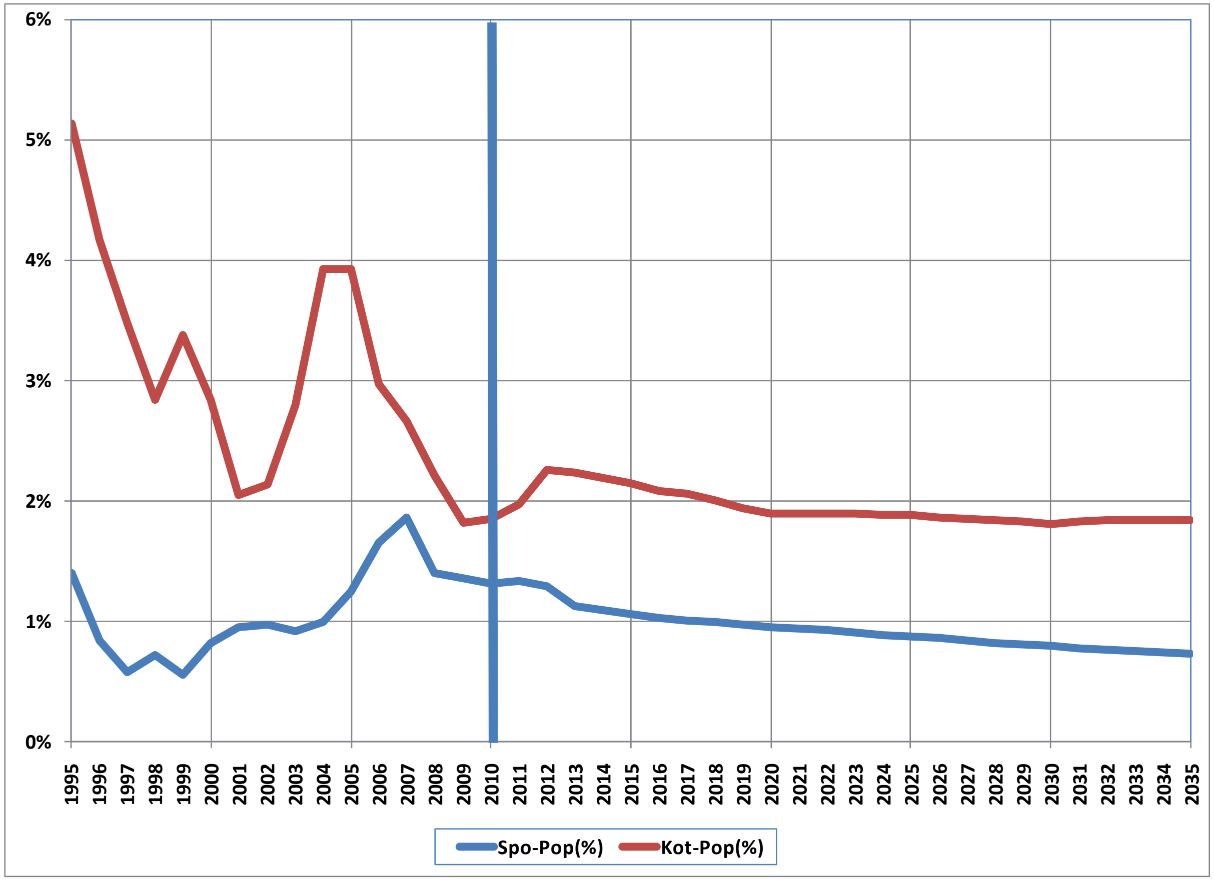
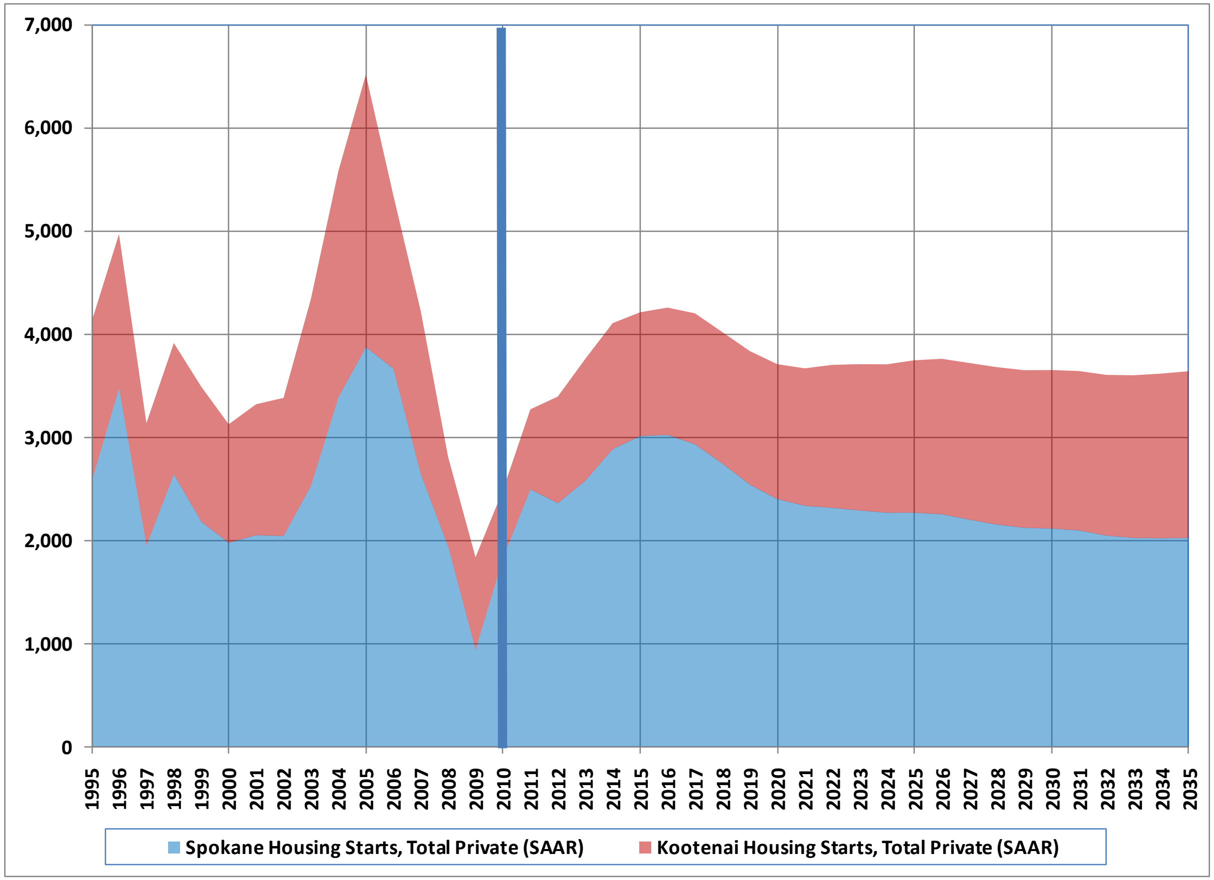
Population
Annual Percent Change



Annual Housing Starts
History 1995-2010, Forecast 2010-2035



IHS GLOBAL INSIGHT

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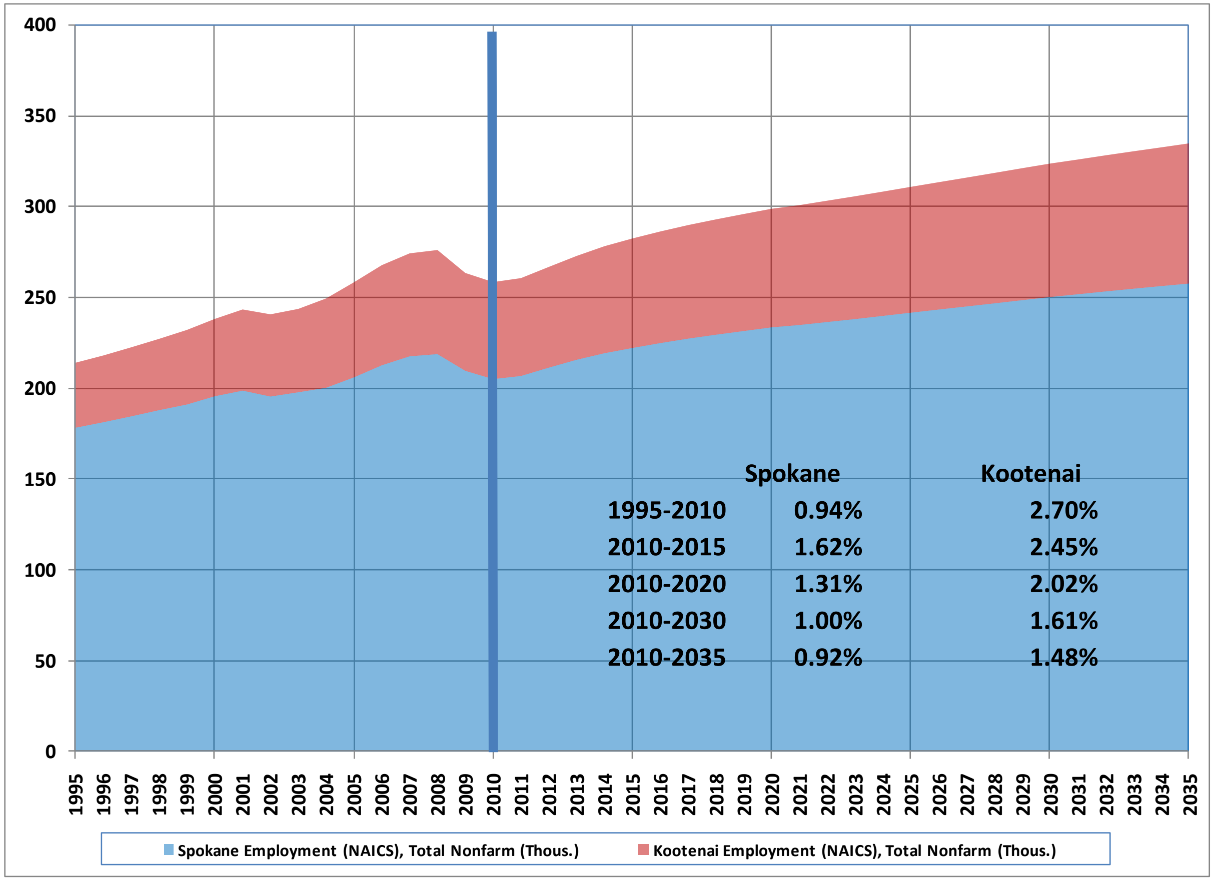
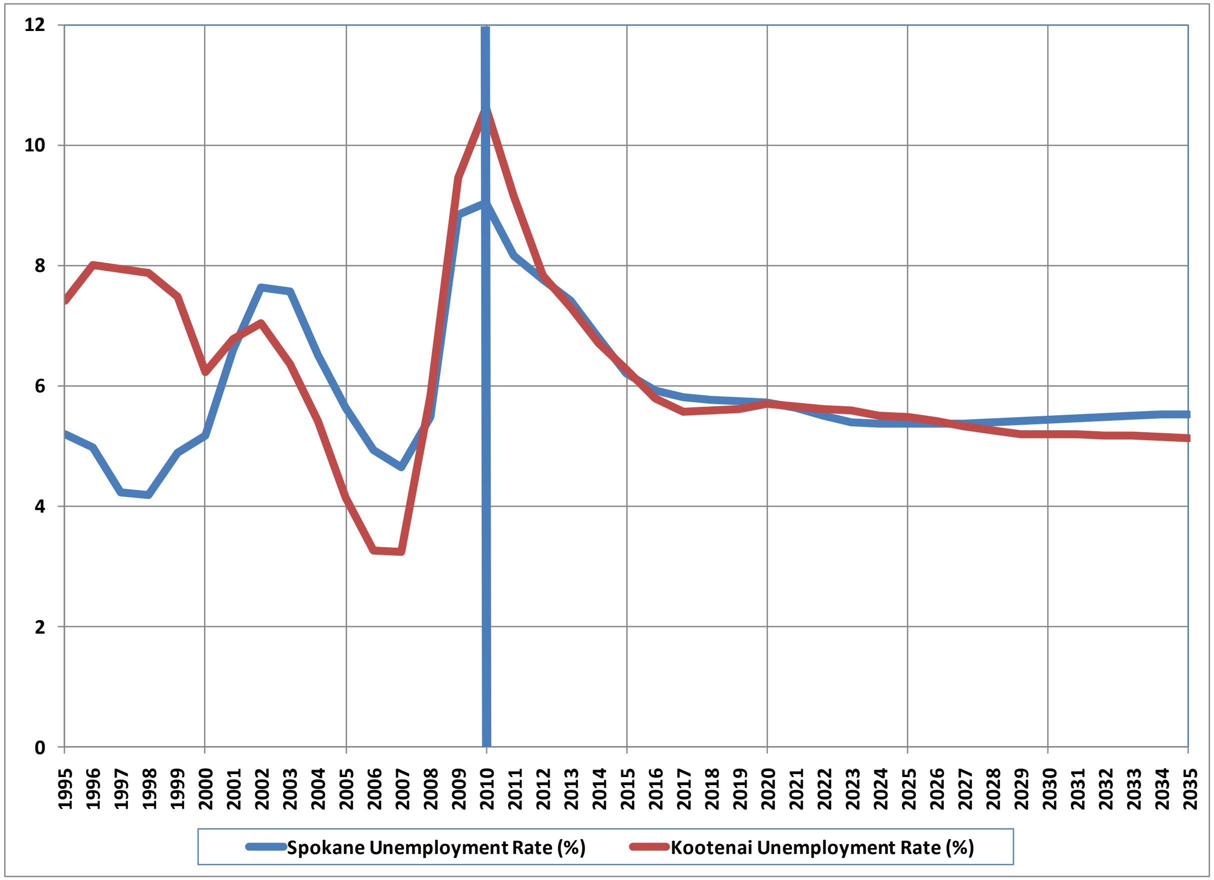
Average Annual Non-Ag Employment—thousands History 1995-2010, Forecast 2010-2035

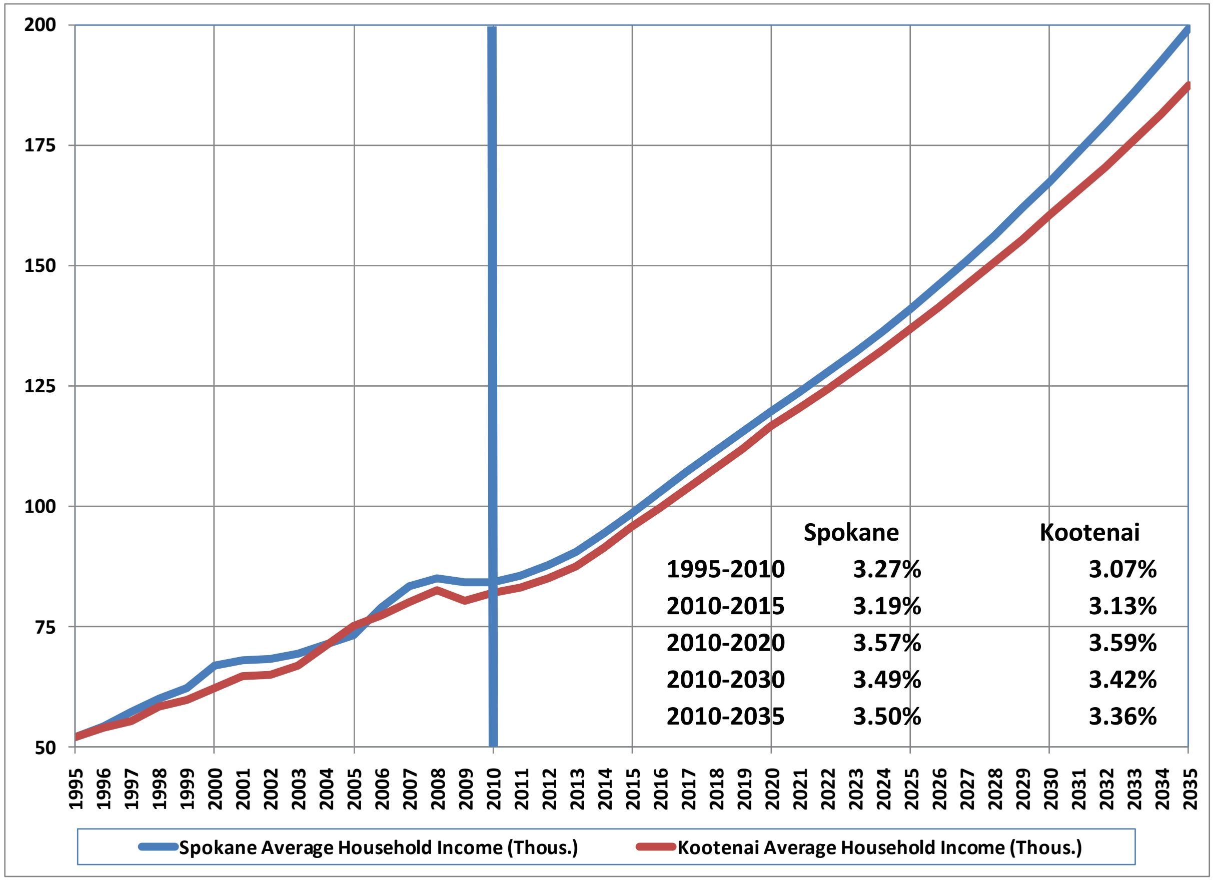


Non-Ag Employment Annual Percent Change

Average Annual Unemployment Rate--Percent



Average Annual Household Income—Thousands $



	Spokane	Kootenai
1995-2010	3.27%	3.07%
2010-2015	3.19%	3.13%
2010-2020	3.57%	3.59%
2010-2030	3.49%	3.42%
2010-2035	3.50%	3.36%

Average Household Income—Percent Change Compared to U.S. Consumer Price Index (CPIU)

GLOBAL INSIGHT

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Weather Assumptions

- We use degree days (heating and cooling) base 65 degrees
- We define "normal" as the average of the last 30 years of actual data; for this forecast, the period is 1980-2009
- We assume the first year (2011) of the forecast is "normal"
- A gradual warming trend in temperature equal to the University of Washington "Climate Change Scenarios" 2008 study Average case converted by us to heating and cooling degree days
- http://cses.washington.edu/cig/fpt/ccscenarios.shtml

Spokane HDD 1970-1999 Average			6,848	
	Low	1.1	6,547	95.6%
2025 Computation	Average*	2.0	6,300	92.0%
	High	3.3	5,944	86.8%
	Low	1.5	6,437	94.0%
2045 Computation	Average*	3.2	5,971	87.2%
	High	5.2	5,423	79.2%
	Low	2.8	6,081	88.8%
2085 Computation	Average*	5.3	5,396	78.8%
	High	9.7	4,190	61.2%

Spokane CDD 1970-1999 Average			411	
	Low	1.1	511	124.3%
2025 Computation	Average*	2.0	593	144.3%
	High	3.3	711	173.0%
	Low	1.5	548	133.2%
2045 Computation	Average*	3.2	702	170.8%
	High	5.2	884	215.1%
	Low	2.8	666	162.0%
2085 Computation	Average*	5.3	893	217.3%
	High	9.7	1,294	314.7%

Price Elasticity

- The price elasticity assumptions are unchanged from the prior IRP
  - Residential -0.15
  - Commercial -0.10
  - Cross-price +0.05
  - Income +0.75
- We monitor price elasticity estimates for consistency
  - Energy Information Administration
  - Itron Energy Forecasting Group
  - American Gas Association/Gas Forecasters Forum

Customer Regressions

- We use annual housing starts forecasts from Global Insight, Inc. to forecast residential customers—this method is new
  - The dependent variable is annual residential customer additions, the independent variable is annual housing starts
  - We forecast Idaho and Washington Schedule 1 customers using separate models
- We use annual residential customer additions to forecast commercial customer additions.
  - The dependent variable is annual commercial customer additions, the independent variable is residential customer additions
- For very large commercial customers, we add one in 2017, 2021, and 2028 in Washington and one in Idaho in 2025

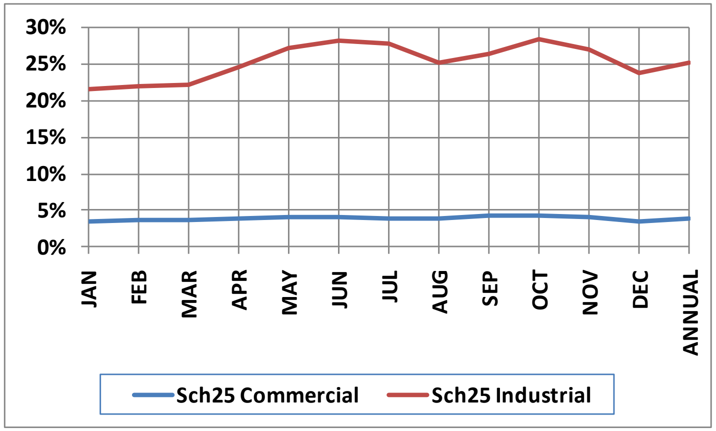
Small Sector Forecasts

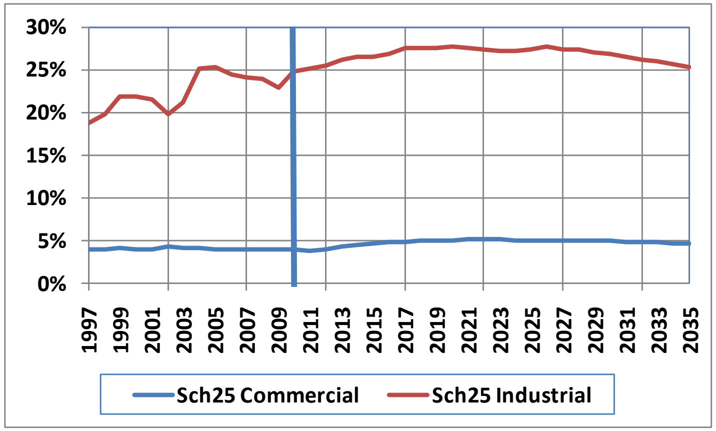
- We forecast electricity sales by state, by rate schedule
- We produce monthly sales forecasts until 2015, annual to 2035
- We define small sector sales in Washington as:
  - Residential schedule 1, 12, 22, 32 and 48
  - Commercial schedule 11, 21, 28, 31 and 47
  - Industrial schedule 11, 21, 31, 32 and 47
  - Street Lighting schedule 41, 42, 44, 45 and 46
- We define small sector sales in Idaho as:
  - Residential schedule 1, 12, 22, 32, 48 and 49
  - Commercial schedule 11, 21, 31, 47 and 49
  - Industrial schedule 11, 21, 31, 32, 47 and 49
  - Street Lighting schedule 41, 42, 43 44, 45 and 46
- *We define large sector sales as schedule 25 commercial and industrial in both states*

Large Customer Forecasts

- We are prohibited from disclosing individual large customer sales
- Sector groupings
  - Paper Manufacturers
  - Potato Processors
  - Lumber and Wood Producers
  - Hospitals
  - Aircraft Parts Manufacturers
  - Universities
  - Wastewater Treatment Facilities
  - Ammunition Manufacturers
  - Cabinetry Manufacturers
  - Foundries
  - Mines
  - Hotels
  - Electronic Equipment Manufacturers
  - Courthouse/Office Building
- All together there are 13 commercial and 18 industrial meter points

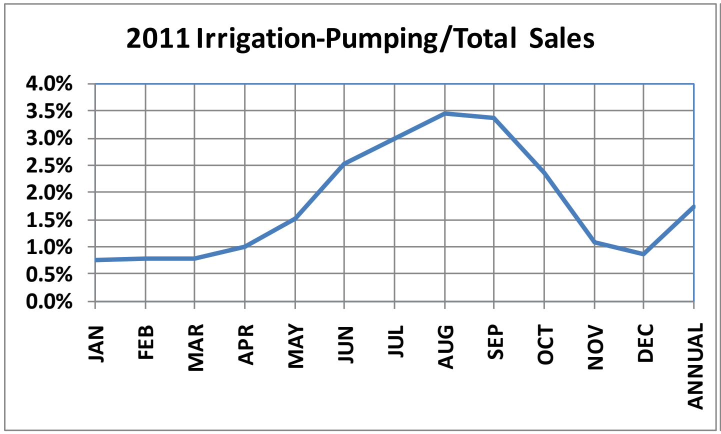
Large Customer Share of Total kWh Sales Commercial and Industrial Schedule 25

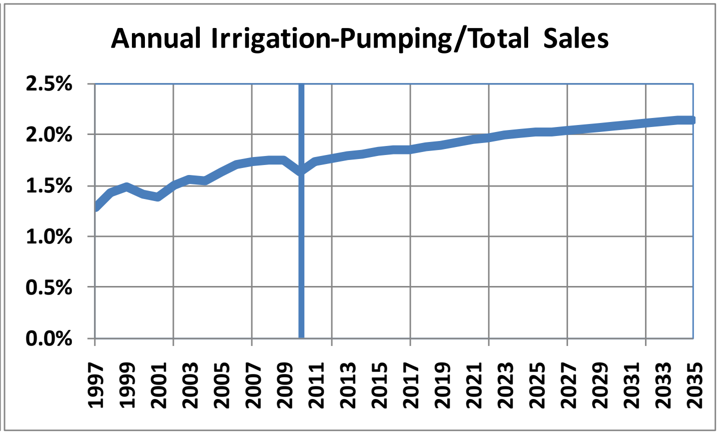




Note—the above charts are stacked line

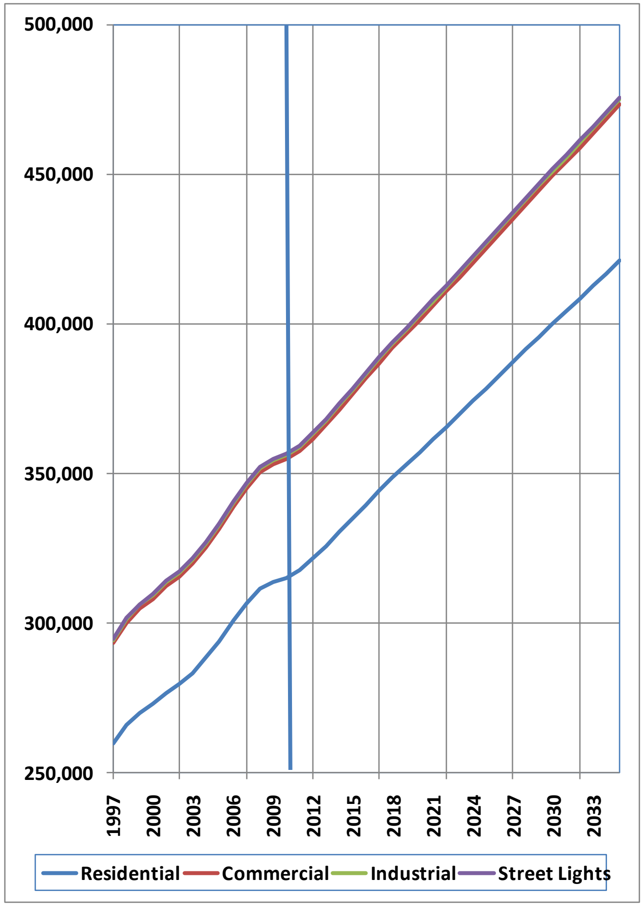
Irrigation and Pumping Sales Special Load Analysis

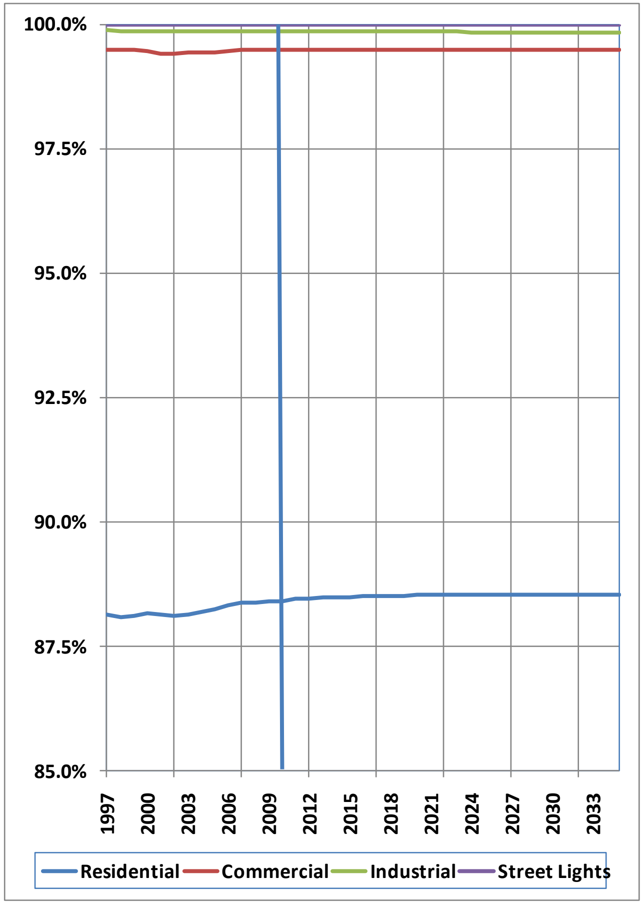




Customer Forecasts

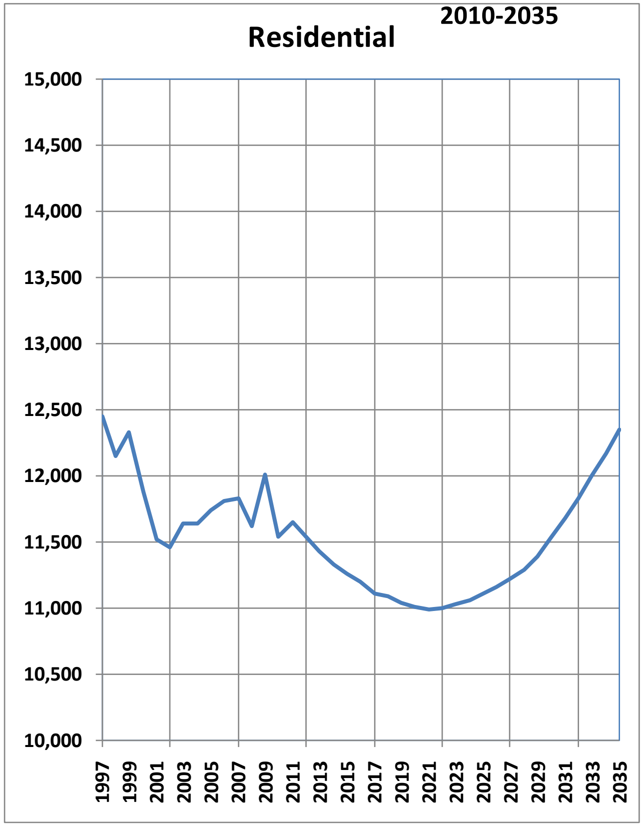
	Residential	Commercial	Industrial	Street Lights	Total Customers
2000-2010	1.44%	1.19%	0.94%	1.37%	1.41%
2010-2015	1.22%	1.06%	0.90%	2.63%	1.20%
2010-2020	1.26%	1.14%	0.85%	2.49%	1.24%
2010-2030	1.20%	1.14%	0.72%	2.27%	1.19%
2010-2035	1.17%	1.12%	0.69%	2.18%	1.16%

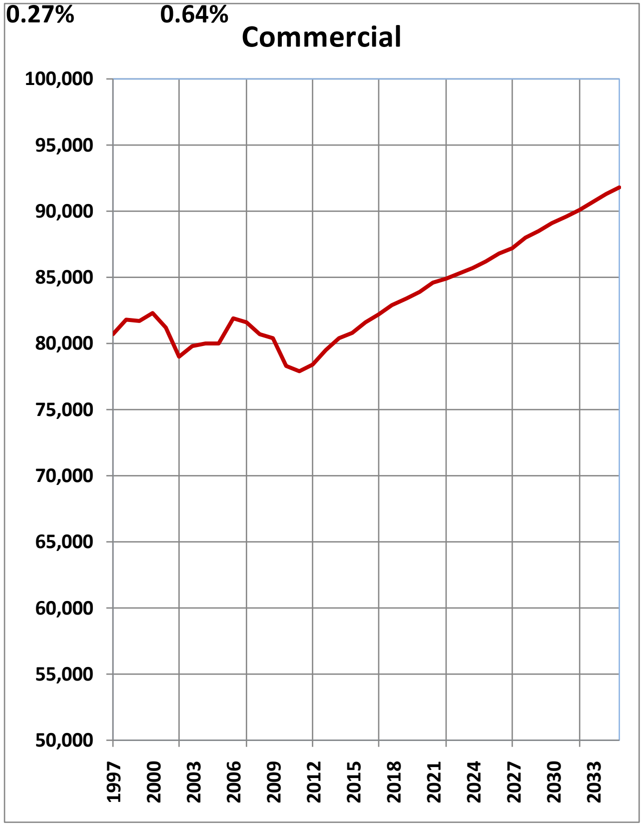




kWh Use per Average Residential Customer

	Residential	Commercial
2000-2010	-0.29%	-0.50%
2010-2015	-0.49%	0.65%
2010-2020	-0.47%	0.70%
2010-2030	0.00%	0.65%
2010-2035	0.27%	0.64%





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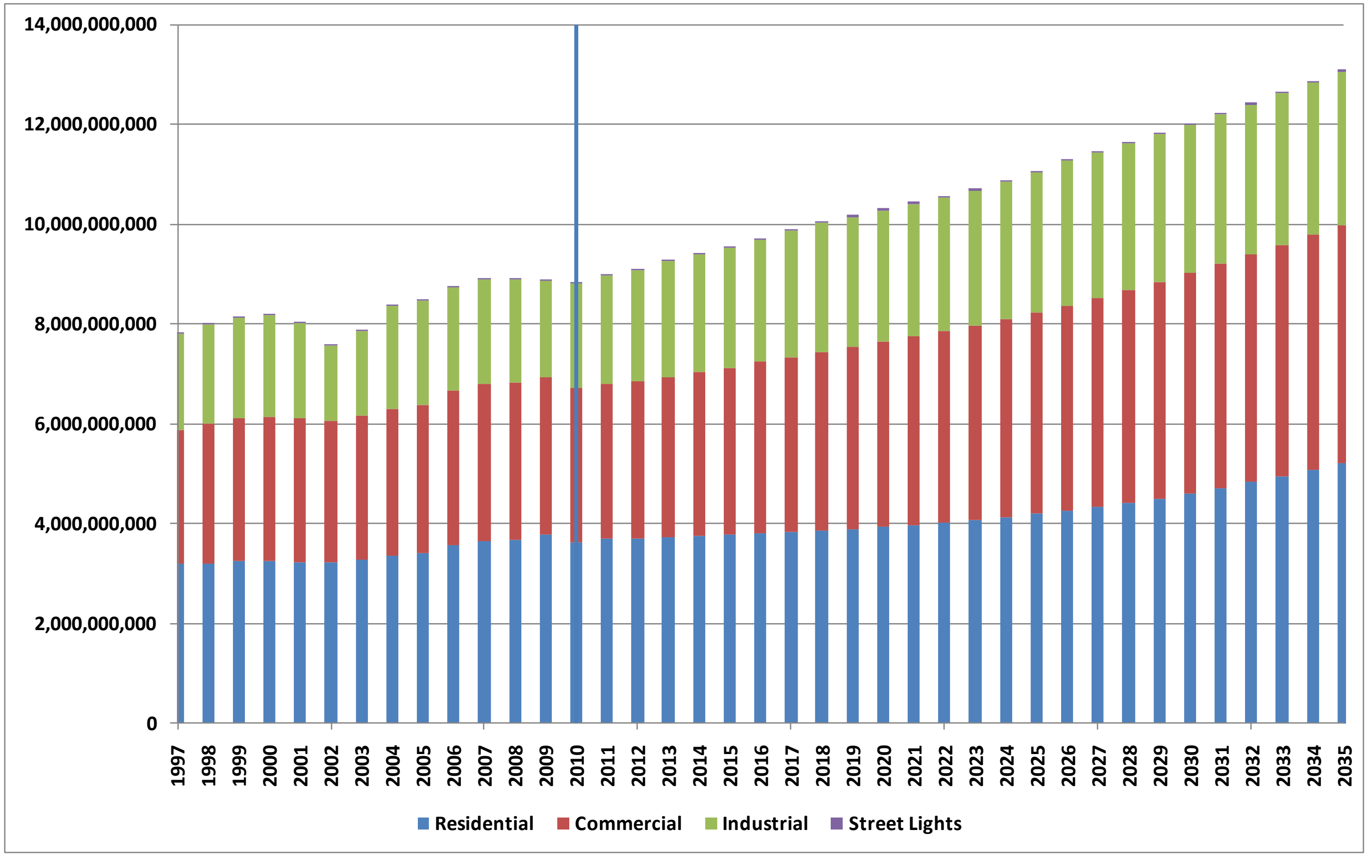
kWh Sales Customer Class

	Residential	Commercial	Industrial	Street Lights	Total Sales
2000-2010	1.11%	0.69%	0.23%	0.53%	0.75%
2010-2015	0.72%	1.71%	2.74%	2.49%	1.56%
2010-2020	0.79%	1.84%	2.38%	2.32%	1.56%
2010-2030	1.19%	1.79%	1.78%	2.03%	1.55%
2010-2035	1.44%	1.77%	1.56%	1.94%	1.59%



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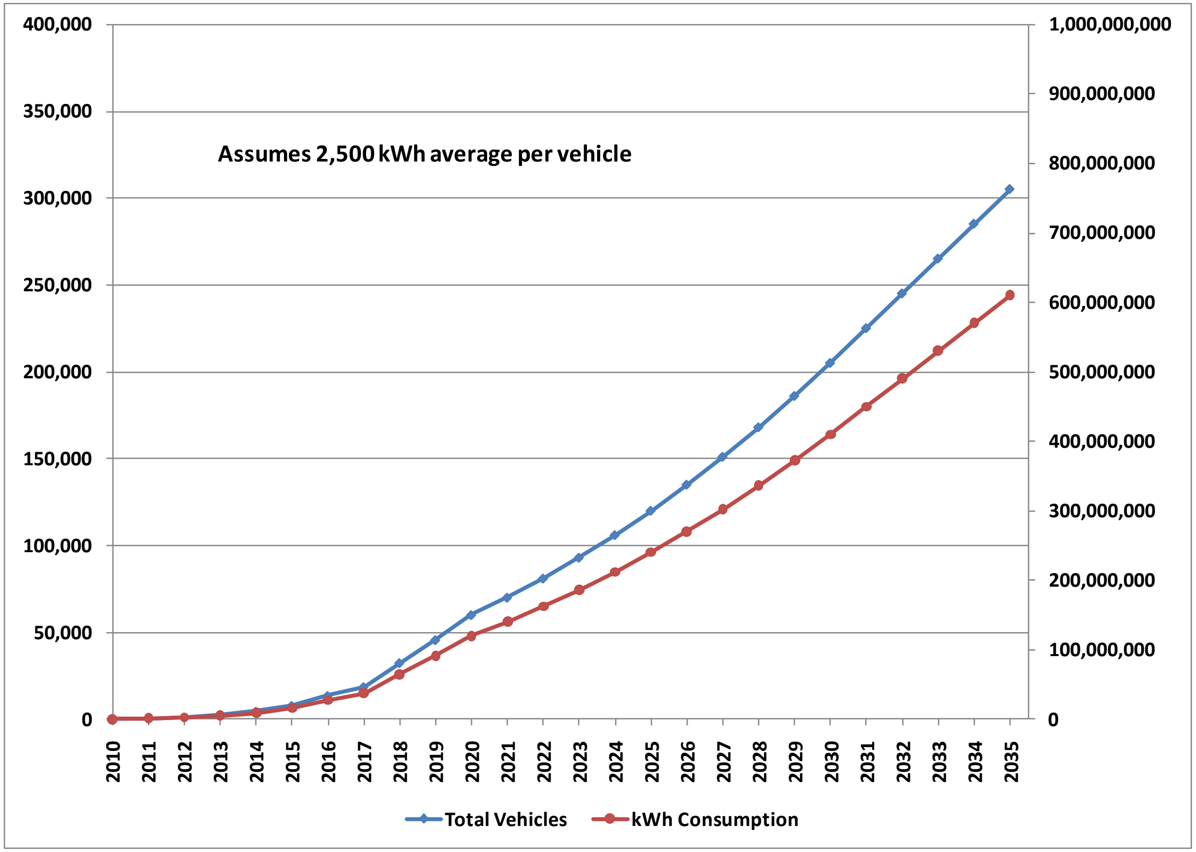
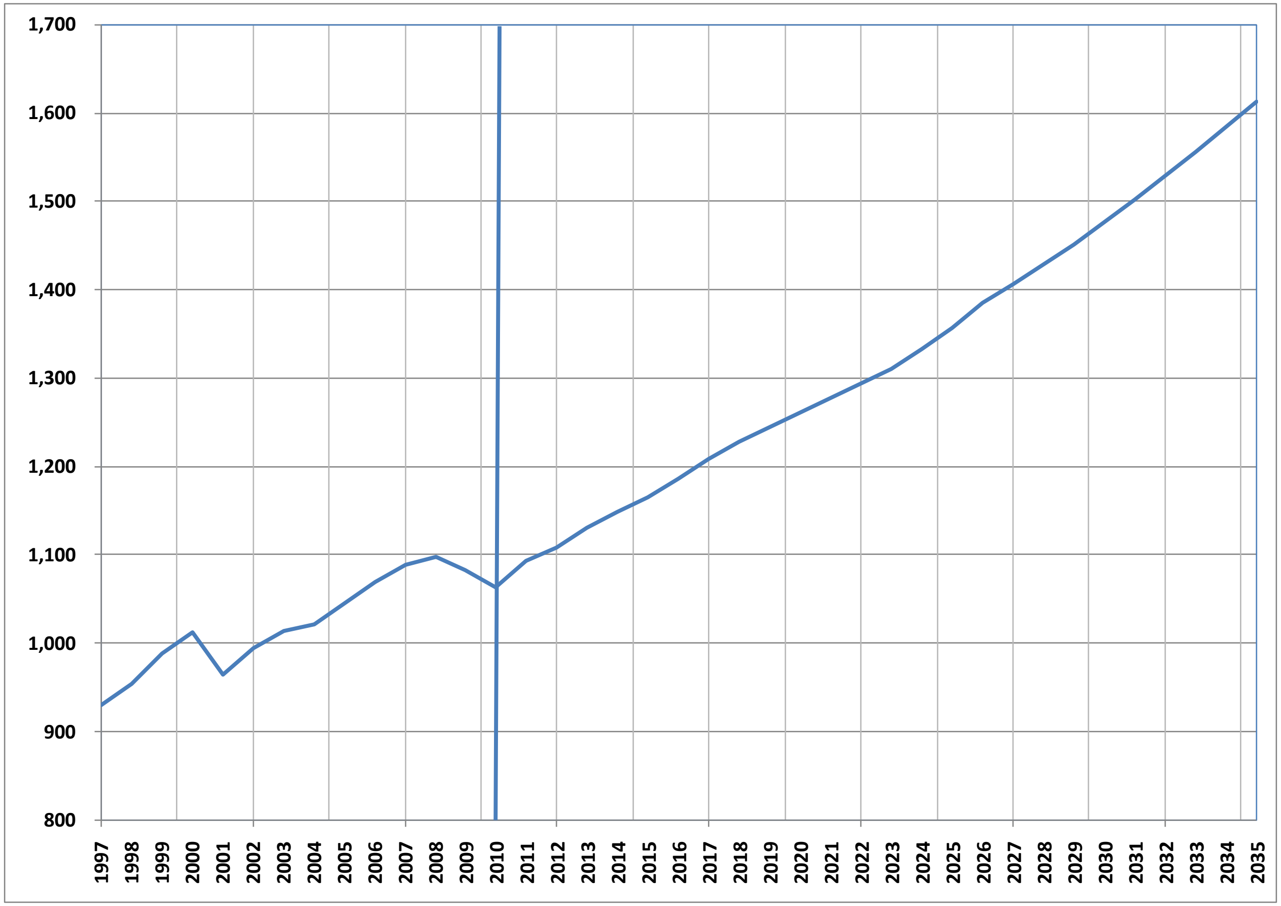
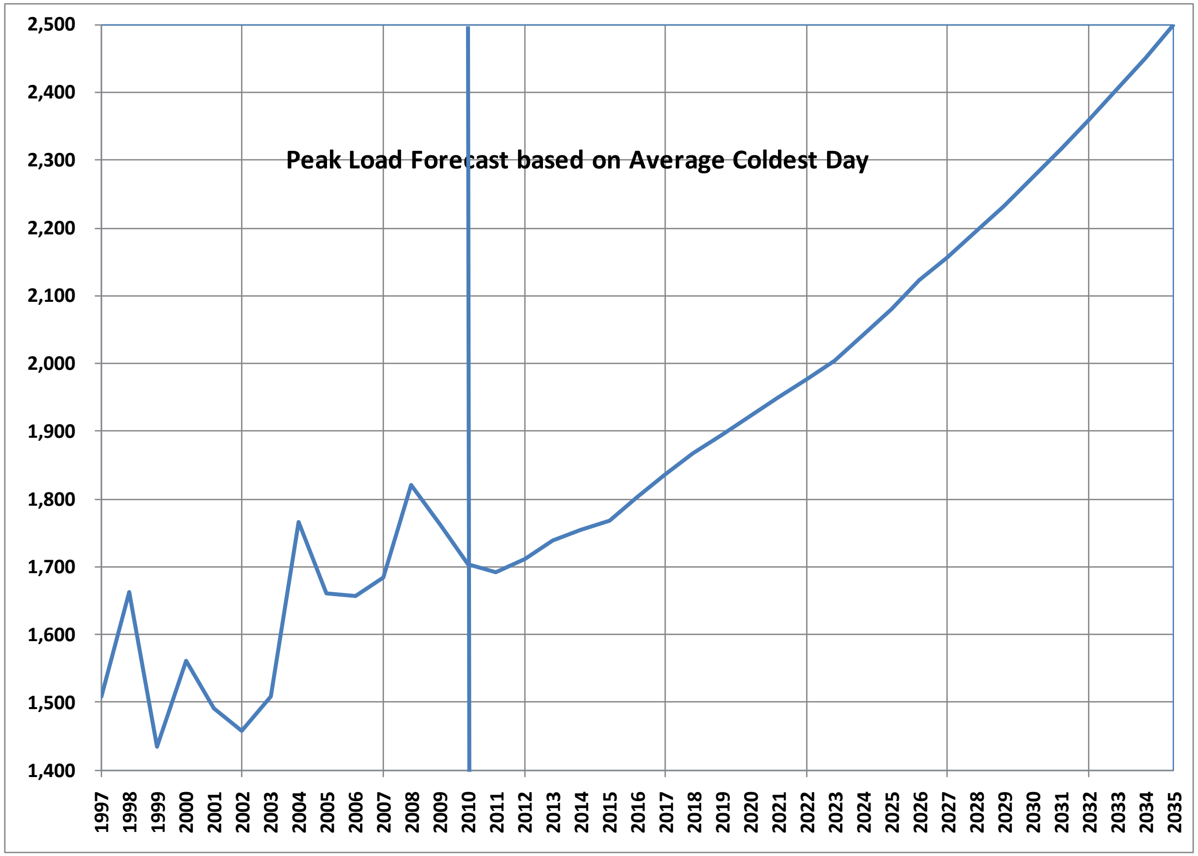
Electric Car Forecast (PIH & PEV)



Load Forecast in Average MW



Peak Demand in Megawatts



Medium Scenario Growth Rates

	Energy	Peak Demand
2000-2010	0.48%	0.87%
2010-2015	1.85%	0.76%
2010-2020	1.72%	1.22%
2010-2030	1.66%	1.46%
2010-2035	1.68%	1.55%

Load Forecast Prepared 10 Years Ago

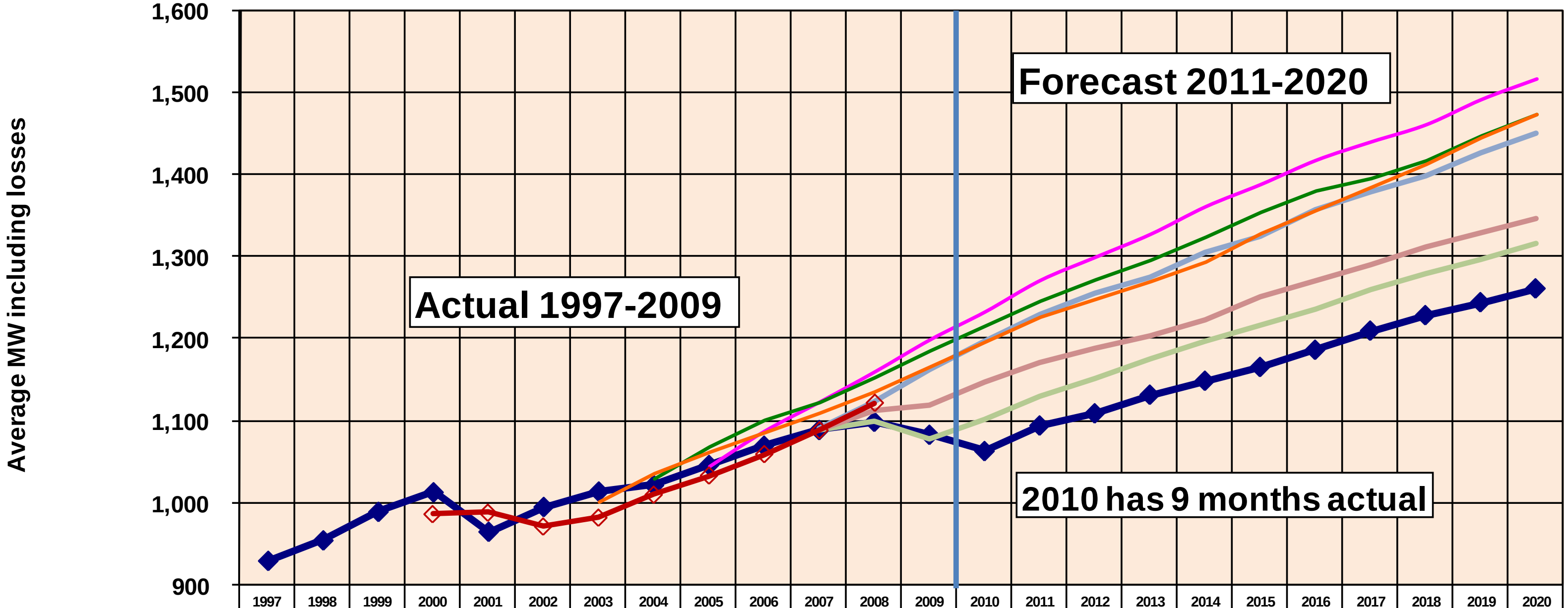
For		Forecast aMW	Days	Forecast MWH	Actual aMW	Days	Actual MWH	Percent Difference
2009	Jan	1,362	31	1,013,121	1,272	31	946,653	-6.6%
	Feb	1,266	28	850,592	1,186	28	796,895	-6.3%
	Mar	1,145	31	851,634	1,121	31	833,848	-2.1%
	Apr	1,080	30	777,278	980	30	705,751	-9.2%
	May	1,068	31	794,688	952	31	708,039	-10.9%
	Jun	1,089	30	783,858	979	30	704,569	-10.1%
	Jul	1,070	31	796,388	1,057	31	786,248	-1.3%
	Aug	1,074	31	798,938	1,034	31	769,272	-3.7%
	Sep	986	30	709,832	968	30	697,305	-1.8%
	Oct	1,109	31	825,286	1,014	31	754,464	-8.6%
	Nov	1,217	30	875,980	1,106	30	796,630	-9.1%
	Dec	1,335	31	993,573	1,321	31	982,507	-1.1%
				10,071,167			9,482,181	-5.8%

Forecast Comparisons

Net Native Load

with Electric Cars

2011 Forecast Growth Rates Base 2011
5 =1.63%, 10 =1.56%, 20 =1.60%, 24 =1.63%



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
F2011	929	954	989	1,013	965	995	1,013	1,021	1,046	1,069	1,088	1,098	1,082	1,063	1,094	1,109	1,131	1,148	1,165	1,186	1,209	1,228	1,244	1,260
F2010											1,088	1,098	1,076	1,101	1,130	1,151	1,174	1,197	1,216	1,235	1,260	1,278	1,296	1,315
F2009											1,088	1,113	1,119	1,148	1,171	1,188	1,202	1,222	1,252	1,270	1,289	1,311	1,329	1,347
F2007IRP											1,091	1,124	1,163	1,196	1,229	1,255	1,274	1,306	1,325	1,358	1,379	1,399	1,426	1,449
F2006									1,043	1,086	1,122	1,159	1,198	1,232	1,270	1,299	1,327	1,360	1,388	1,417	1,440	1,461	1,491	1,516
F2005								1,029	1,067	1,099	1,122	1,152	1,185	1,215	1,246	1,270	1,296	1,323	1,354	1,379	1,395	1,417	1,447	1,472
F2004							1,000	1,035	1,061	1,085	1,109	1,135	1,164	1,196	1,225	1,247	1,270	1,293	1,327	1,356	1,384	1,412	1,444	1,474
F1999				986	988	971	982	1,009	1,033	1,059	1,088	1,121												

F2011 F2010 F2009 F2007IRP F2006 F2005 F2004 F1999

Population Forecasts—Then and Now

		July 1st Estimates						
	Spokane County Census April 1st	OFM 1995	OFM 2007	Avista 2000	Avista 2010	Decade Medium Growth Rate	Decade Low Growth Rate	Decade High Growth Rate
1960	278,333							
1970	287,487					0.32%		
1980	341,835					1.75%		
1990	361,333	361,333		361,333		0.56%		
2000	417,939		417,939			1.47%		
2010*	470,300	476,400	466,724	449,300	475,646	1.19%		
2020			529,451		530,003	1.09%	0.54%	1.63%
2030			589,623		577,829	0.87%	0.43%	1.30%
2035					599,873			

Low, Medium and High Growth Scenarios

- Global Insight provides us with Medium Scenario economic forecasts
- We plan to overlay the 6th Power Plan range for Low and High
- NPPC Low 0.8%, Medium 1.4%, High 1.8% for 2010-2030
  - http://www.nwcouncil.org/energy/powerplan/6/final/SixthPowerPlan_Ch3.pdf page 3-5
- Avista's 2010-2030 growth rate medium scenario 1.66%
- Overlay Low 0.95%, Overlay High 2.13% by ratio method

Stochastic Modeling Assumption & Methodology Discussion

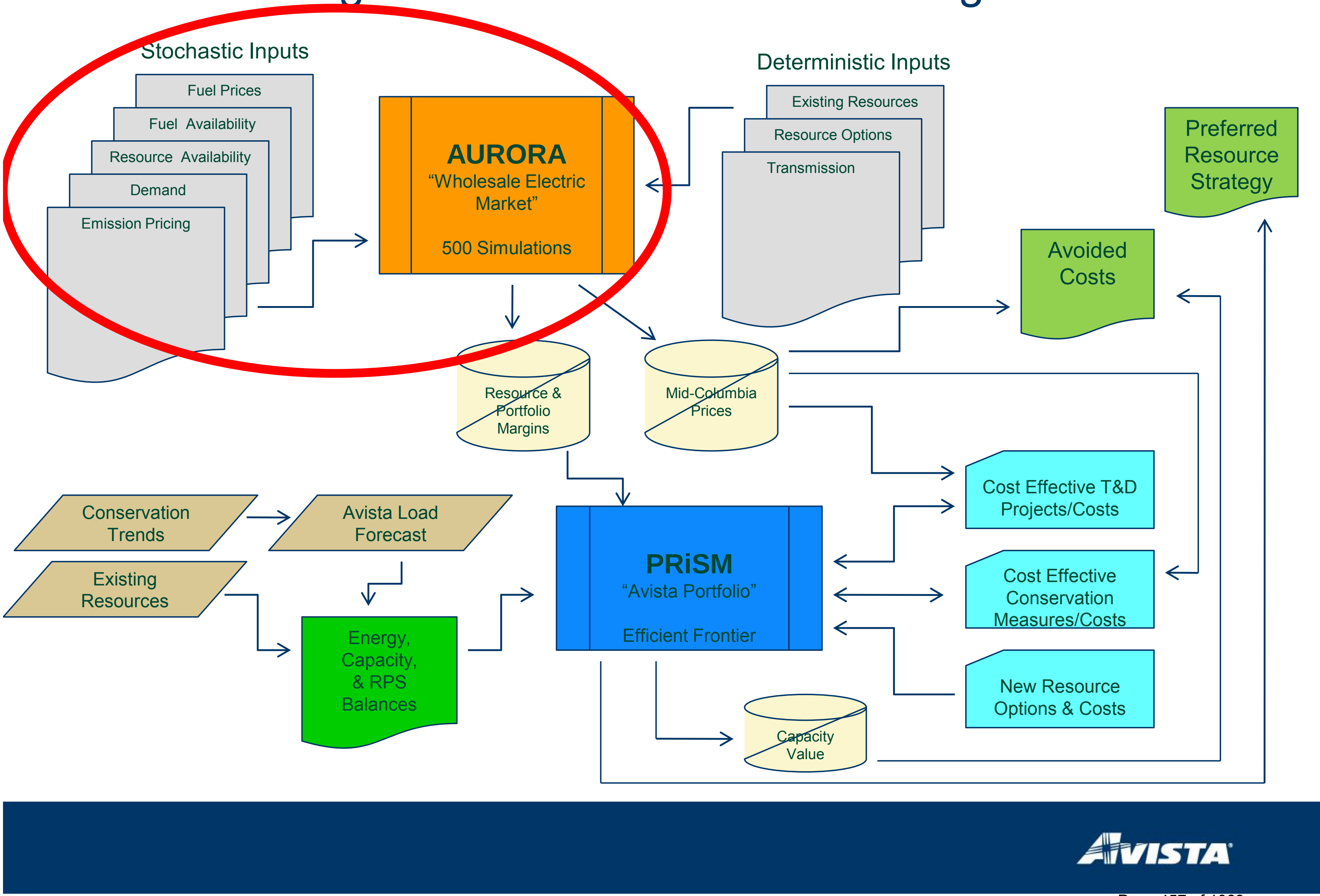
James Gall

Technical Advisory Committee Meeting #3

2011 Electric Integrated Resource Plan

December 2, 2010

2011 Integrated Resource Plan Modeling Process



Why Conduct a Stochastic Study

- Quantifies the risk (range in prices/costs) of the wholesale electric market.
- Determines range in potential market value of each resource option.
- Determines the range in potential cost to serve customers over the IRP time period.

IRP's objective is plan on a resource portfolio that is not only least cost but at an acceptable level of risk.

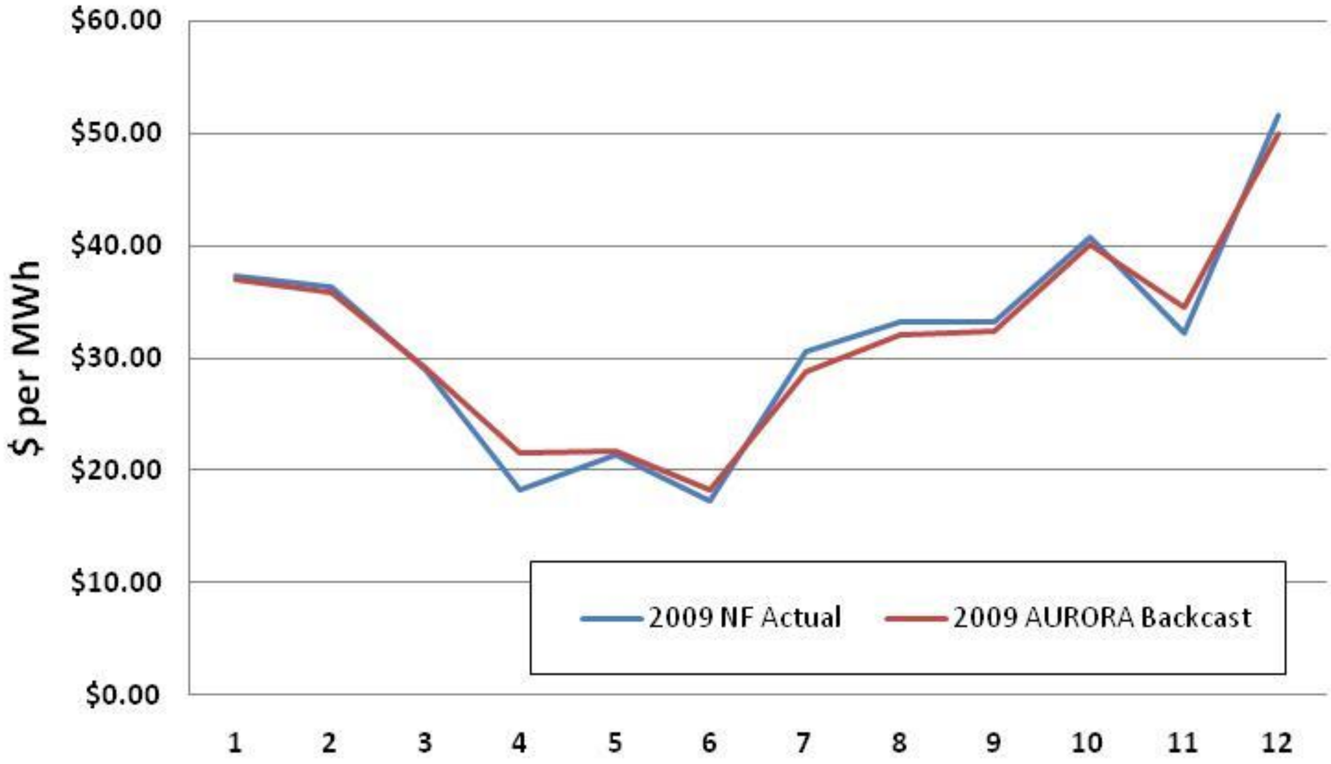
Measurements of Risk

- Standard Deviation
- Mean Absolute Error
- Value at Risk
- Tail Var “90”
- Percentile
- Probability

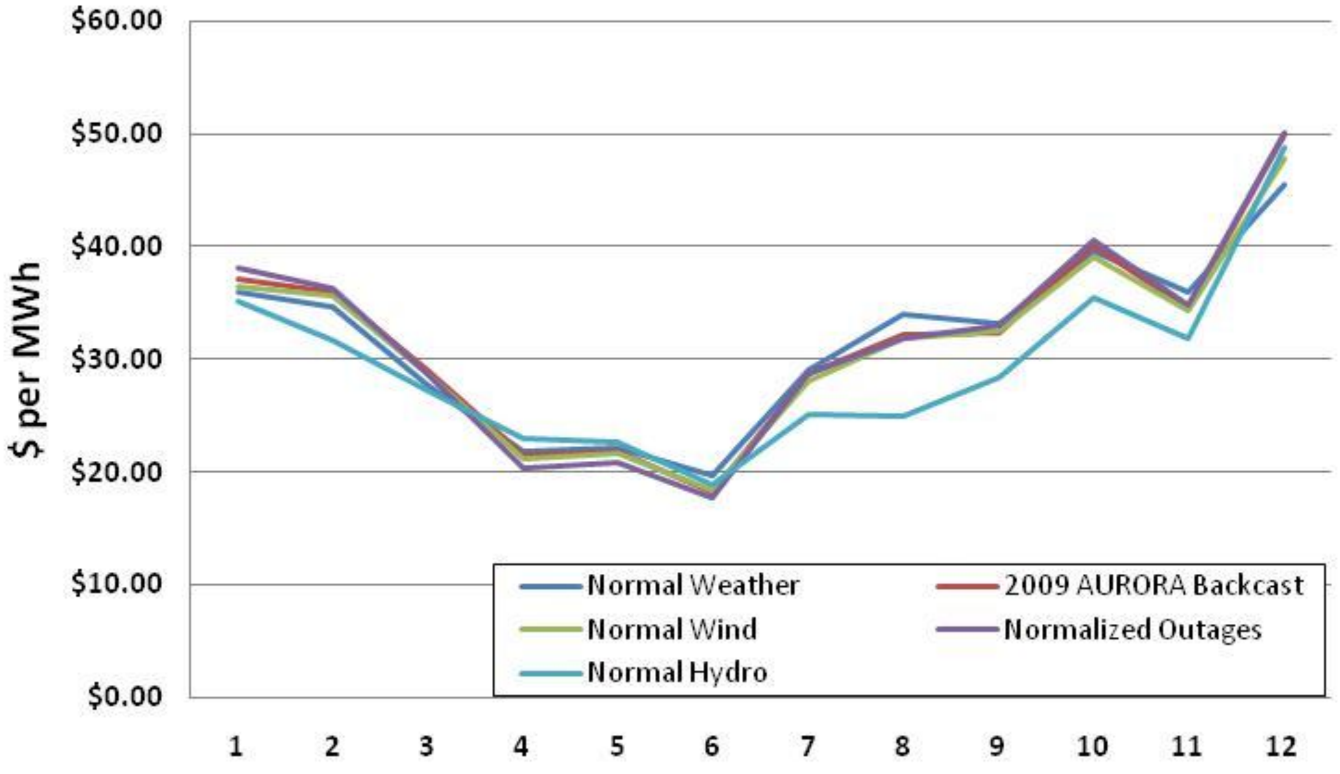
Market Stochastic Study Variables

- Hydro availability
- Wind availability
- Coal prices
- Wood prices
- Oil prices
- Inflation
- Forced outages
- Natural gas prices
- Weather (load)
- Economic growth (load)
- Conservation (load)
- Carbon legislation
- Resource Capital Costs (?)

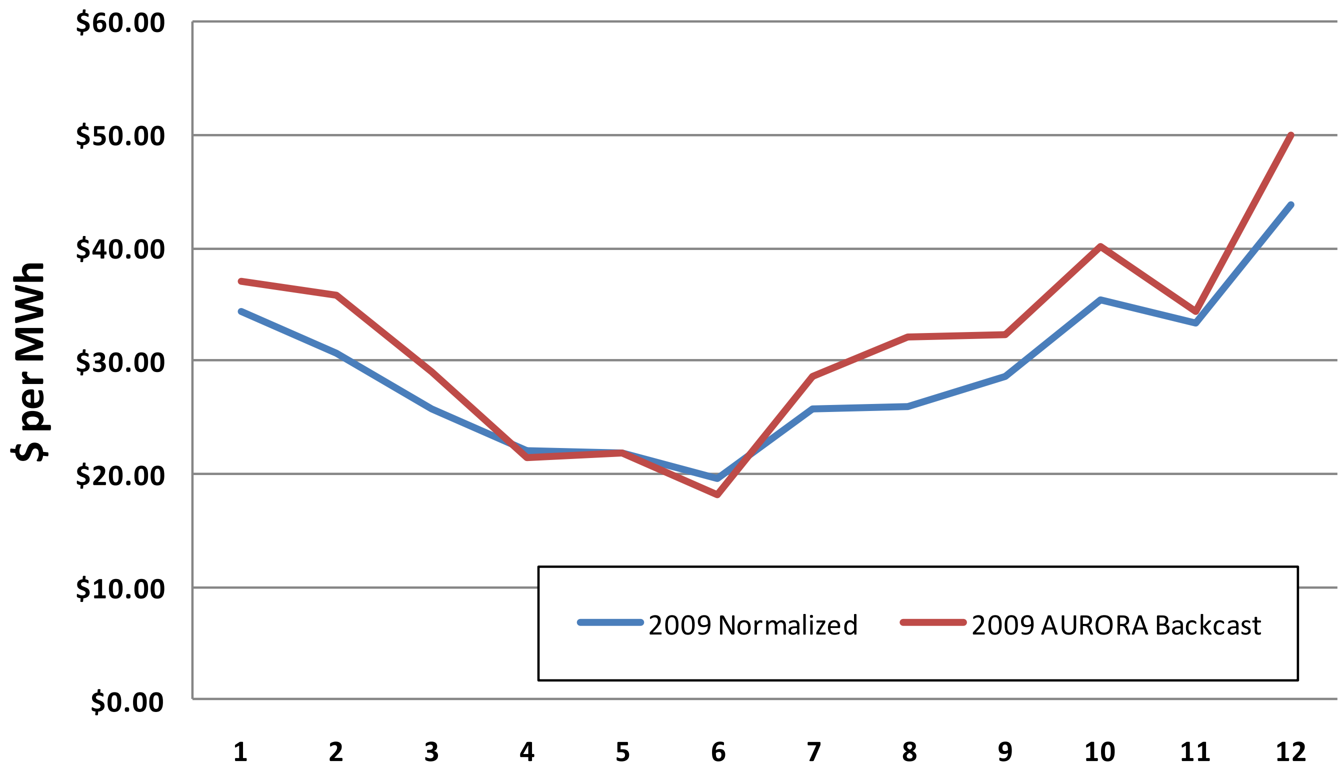
2009 Mid-Columbia Flat Electric Prices



2009 Mid-Columbia Flat Electric Prices with Individual Normalized Inputs

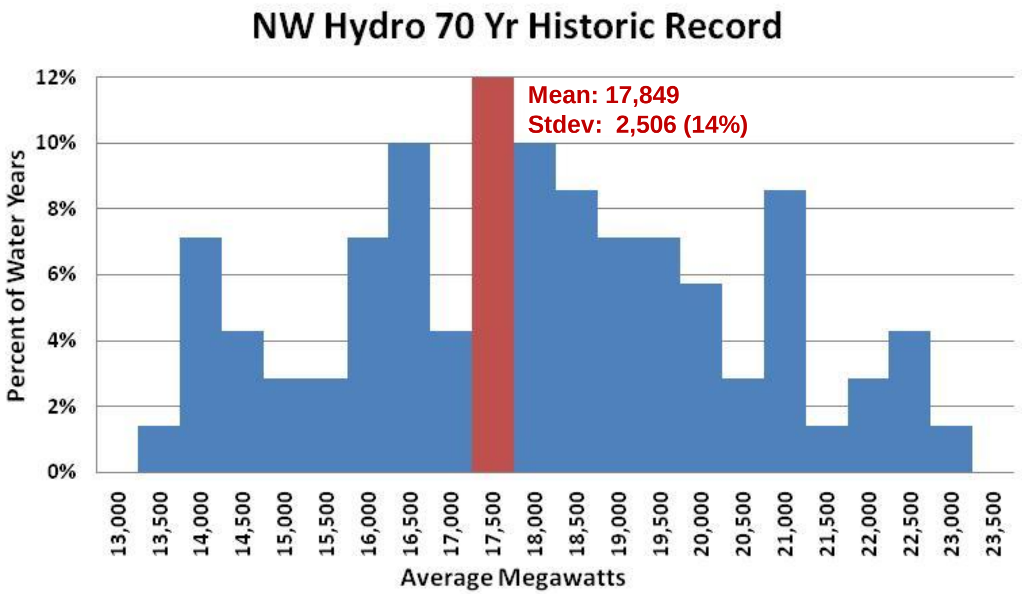


2009 Mid-Columbia Flat Normalized Electric Price

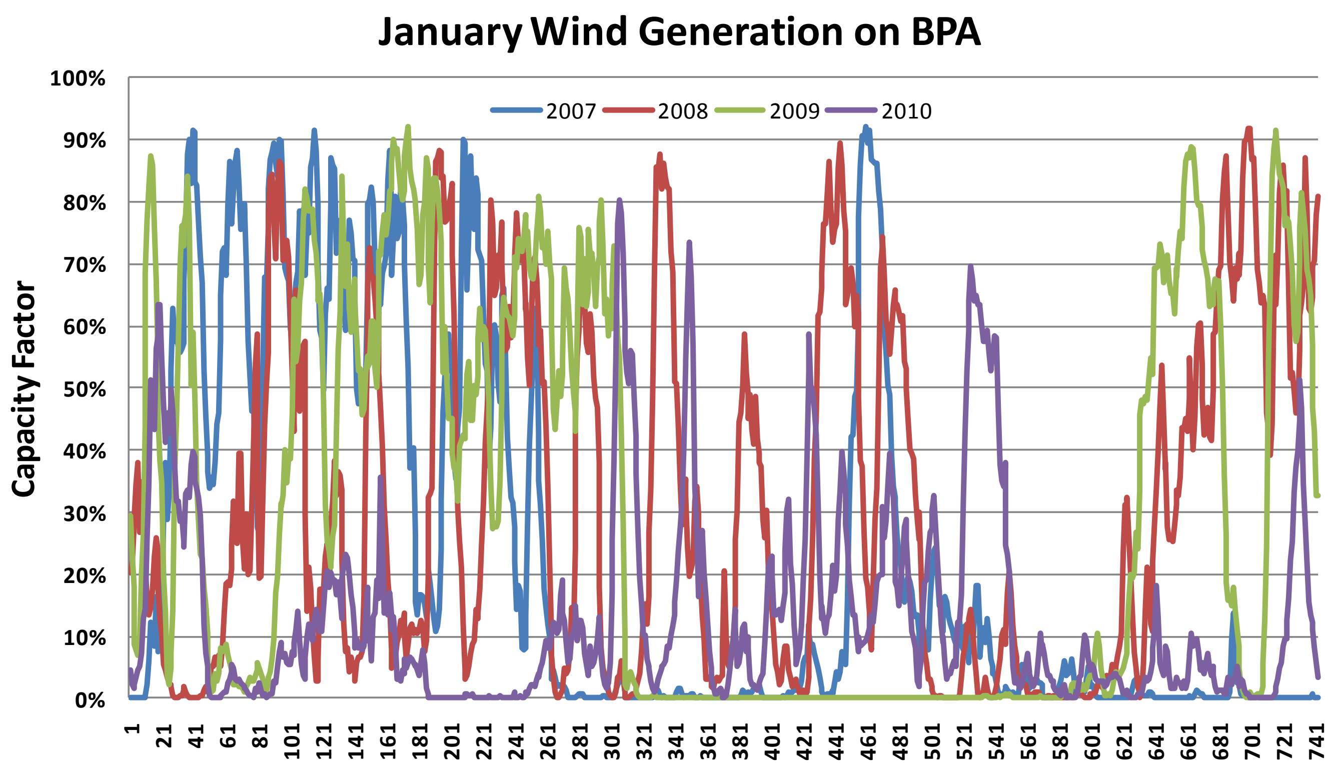


Hydro

- Random draw of 70 historical hydro years.
- Avista projects use results of Avista hydro model
- Regional projects uses Northwest Power Pool model



Historical Wind Generation



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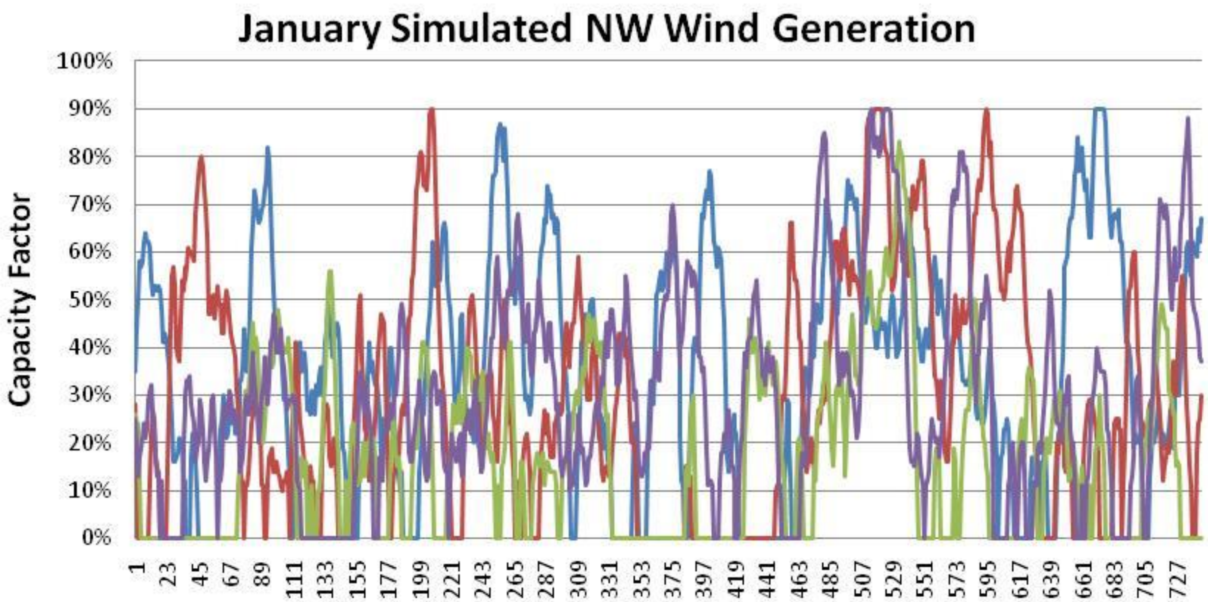
Wind

- Use 50 potential wind draws
- Each draw will be 8,760 hour shape
- Use separate wind shape available for most of the Western states and provinces
- NREL hourly simulated generation data (2004-06) is used to estimate capacity factors and correlations for non-NW areas

Area	CF		Area	CF
Northwest	31.8%		Southwest	28.8%
California	30.6%		Utah	29.0%
Montana	37.2%		Colorado	32.2%
Wyoming	38.2%		British Columbia	33.2%
Eastern WA	30.6%		Alberta	34.3%

Wind (Continued)

- Regression model using BPA/NREL data
  - Uses hour type, month, hour -1, hour -2 for the coefficients
  - Northwest: 97.5% R^2, 4.7% (CF standard error)
  - Random error with normal distribution to create variability



AVISTA

Coal, Oil, and Wood Prices

- Assume normal distribution of annual change in price
- Mean prices are based on Wood Mackenzie for oil and coal
- Standard Deviations:
  - Coal: 10%
  - Oil: 25%
  - Wood: 10%

Inflation

- Based on Global Insights forecast for average and standard deviation
- Average inflation is assumed to be 1.70%, w/ standard deviation of 1% (59% of mean)

Forced Outages

- Historical Outage rates are available from NERC's GAR Report
  - GADS- Generation Availability Report
- Data available for Coal, Nuclear, NG, and Oil by size of plant
  - Both planned and unplanned outages are tracked
  - Data is only available for all plants (no drill down option)
- AURORA's has random forced outage logic
  - Uses mean time to repair and annual forced outage rate
  - Both matrices can be derived from GADS data

Historical Monthly AECO Natural Gas Prices

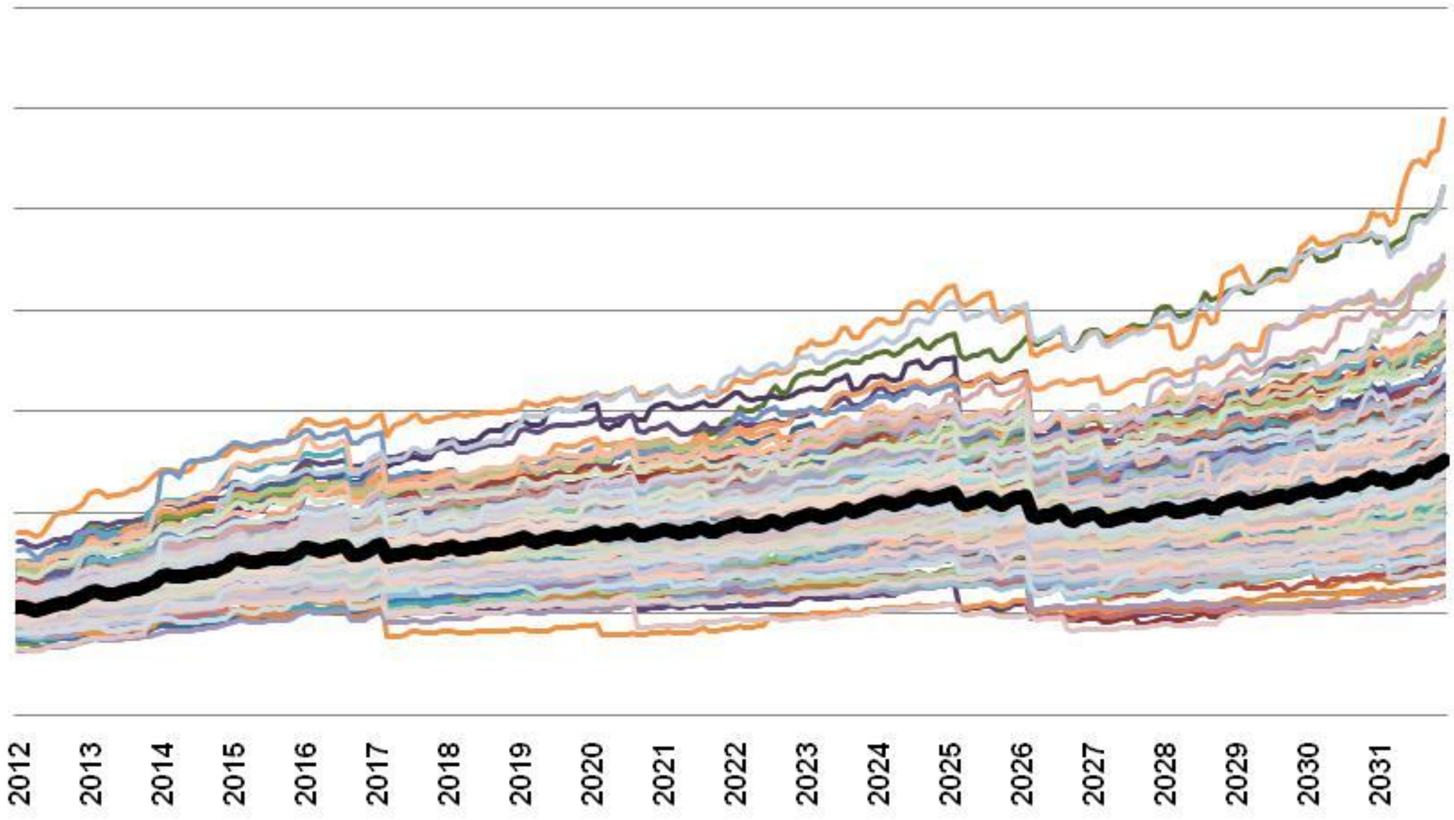
- Historical prices have been volatile
- Will volatility continue, or will shale gas flatten volatility?
- Will there still be boom/bust in natural gas prices?

Natural Gas Prices

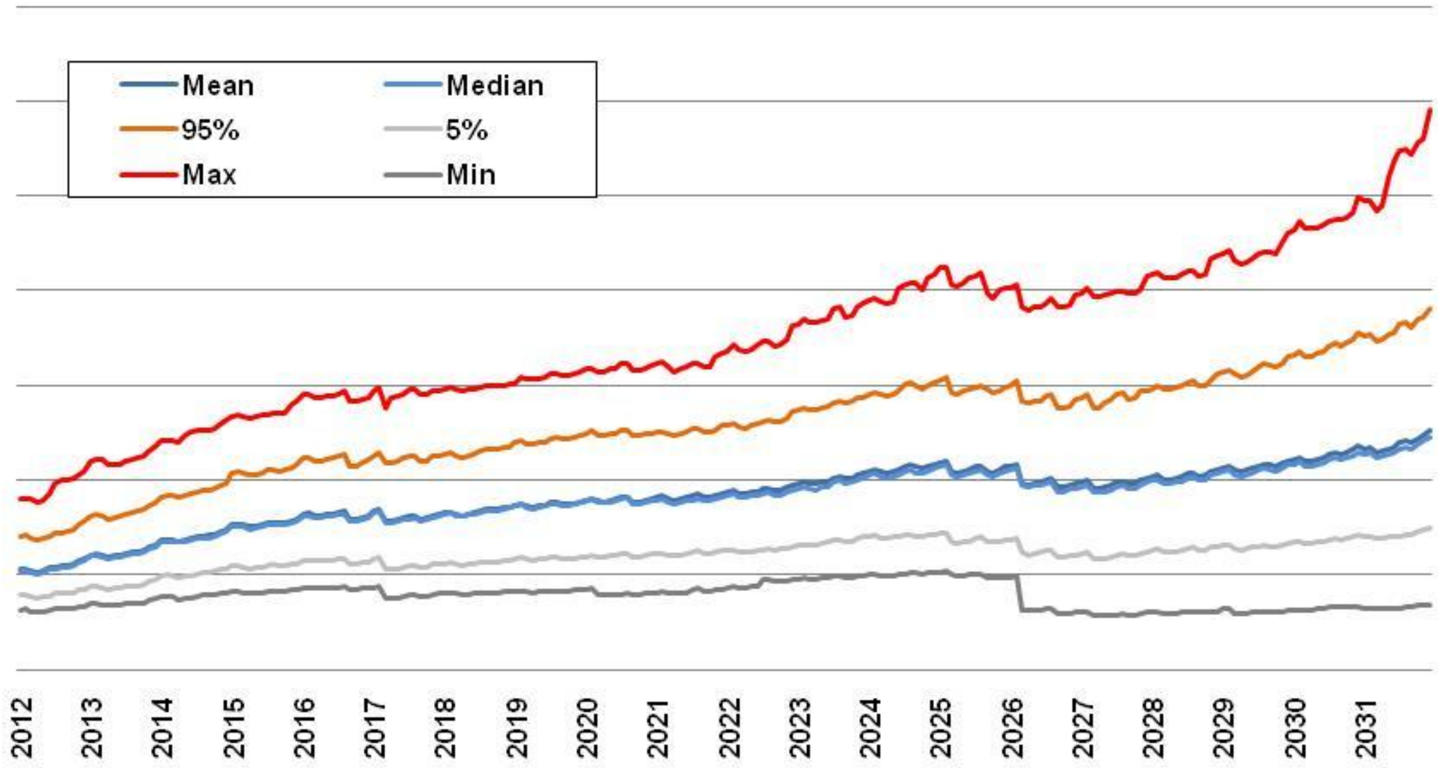
- Mean natural gas prices are yet to be finalized. Prices will be finalized by end of 2010 to take into account best available information for the plan
- To model the variability of prices will use a new method for this IRP.
  - Randomize the percent change between month to month prices based on a lognormal distribution
  - This method provides high month to month correlations as history demonstrates (90%+)

AVISTA

Natural Gas Forecast (individual draws)



Natural Gas Forecast (Statistics 500 draws)

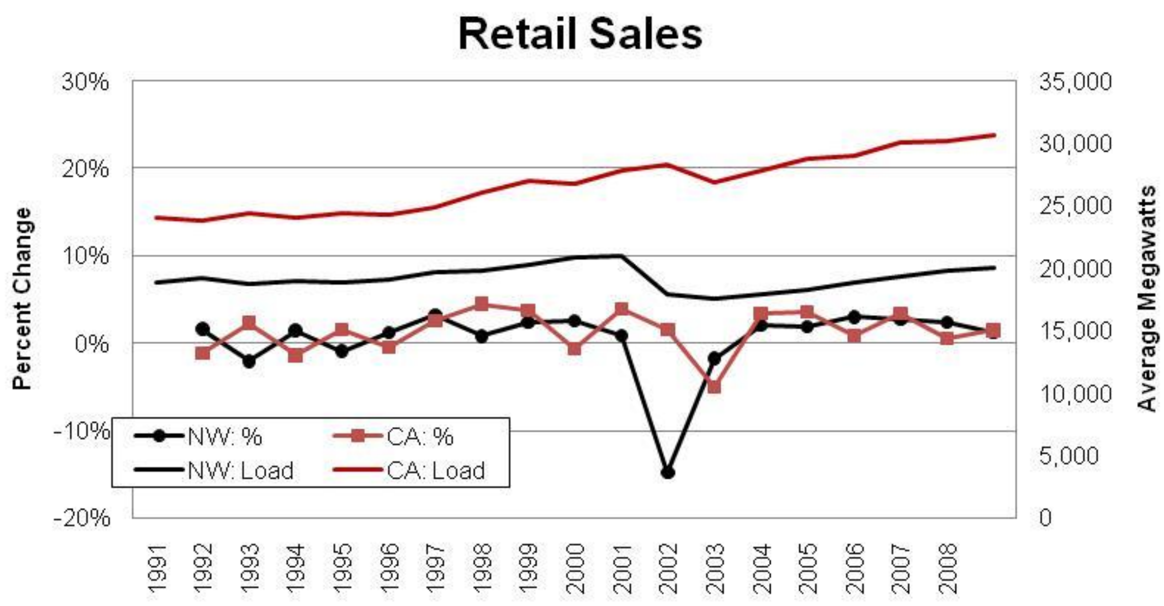


Load (Weather)

- Weather variation will be modeled in AURORA with monthly load variances for 2005 through 2009
- Weather is assumed to be normally distributed with standard deviation for each load area and a correlation to the Northwest area based on FERC Form 714 hourly load profiles
- Further detail on this methodology can be found in prior IRPs

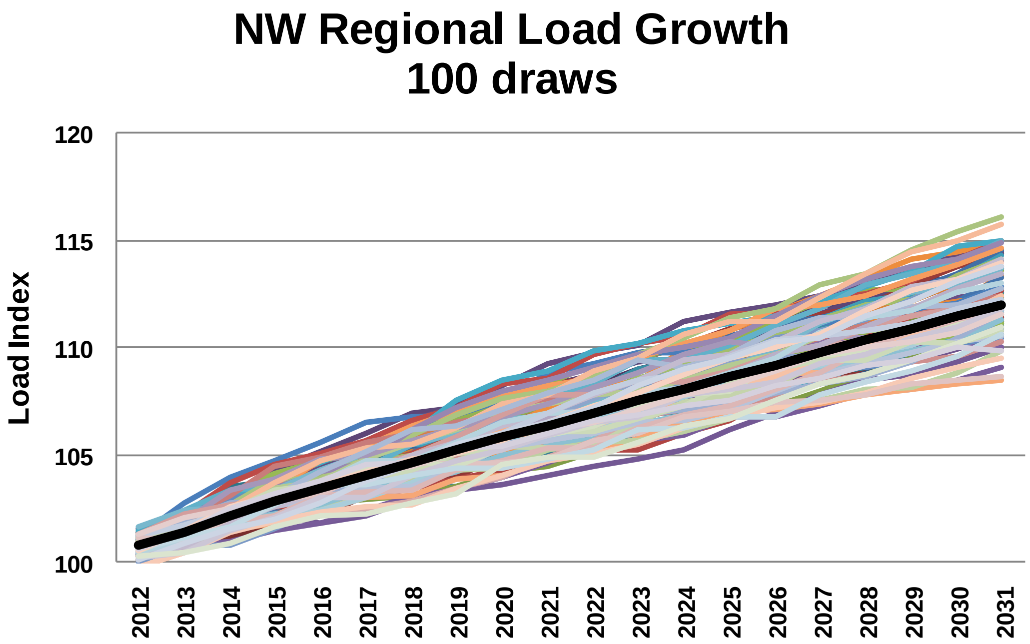
Load (Economic & Conservation)

- Weather is not the only driver in future loads, economic growth, electric cars, and conservation will affect energy demand
- Historical load growth is highly volatile (see chart below)



Load (Economic & Conservation)…. continued

- Expected load growth will assume Wood Mackenzie forecast
- Standard deviation is assumed to be 50% (same as last plan)



Carbon Legislation

- No national carbon legislation has been passed
- Many western states/provinces have passed some type of carbon reduction scheme
- For this plan..
  - 5 scenarios are developed based on potential outcomes.
  - Each scenario is assigned a weighting
  - The weighted average of the scenarios will be the base forecast
  - Natural gas prices and carbon prices will be correlated for national policy scenarios

Carbon Legislation Scenarios

1. Western Climate Initiative “WCI” (20% probability)
   - No federal legislation, carbon reduction in CA, OR, WA, NM only
   - 15% below 2005 levels by 2020
   - Begins in 2012, regional trading allowed
2. Regional Greenhouse Gas Initiative “RGGI” (20% probability)
   - No federal legislation, carbon reduction in CA, OR, WA, NM only
   - 187 million tons per year through 2014, then 10% reduction by 2018
   - Begins in 2012, within state trading only
3. National Climate Policy (20% probability)
   - Federal legislation only applies
   - 17% below 2005 levels by 2020, 42% below 2005 levels by 2030
   - Begins in 2015, national trading allowed
4. National Carbon Tax (15% probability)
   - Federal legislation only applies
   - $33 per short ton, than 5% per year escalation
   - Begins in 2015
5. No Carbon Reductions (5% probability)
   - No carbon reduction scheme
   - State level emission performance standards apply and no new coal in US West

Next Meeting

1. Finalize mean key driver assumptions
2. Implement stochastic modeling methodologies with AURORA
3. Simulate the market future 500 times between 2012-2031
4. Present results for electric market prices and other key results
5. Evaluate the potential of modeling capital costs stochastically

Avista's 2011 Electric Integrated Resource Plan
Technical Advisory Committee Meeting No. 4 Agenda
Avista Headquarters – Spokane, Washington

Thursday, February 3, 2011
Avista Conference Room 130

Topic	Time	Staff
1. Introduction	**9:30**	**Storro**
2. Natural Gas Price Forecast	**9:35**	**Rahn**
3. Electric Price Forecast	**10:30**	**Gall**
4. Lunch	**12:00**	
5. Resource Requirement Projections	**1:00**	**Kalich**
6. Portfolio and Market Scenario Planning	**2:30**	**Lyons**
7. Adjourn	**3:00**	

Conference Call Instructions:
1. Please join my meeting.
https://www2.gotomeeting.com/join/717354547

2. Join the conference call:

Dial +1 (714) 551-0020
Access Code: 717-354-547
Audio PIN: Shown after joining the meeting

Meeting ID: 717-354-547

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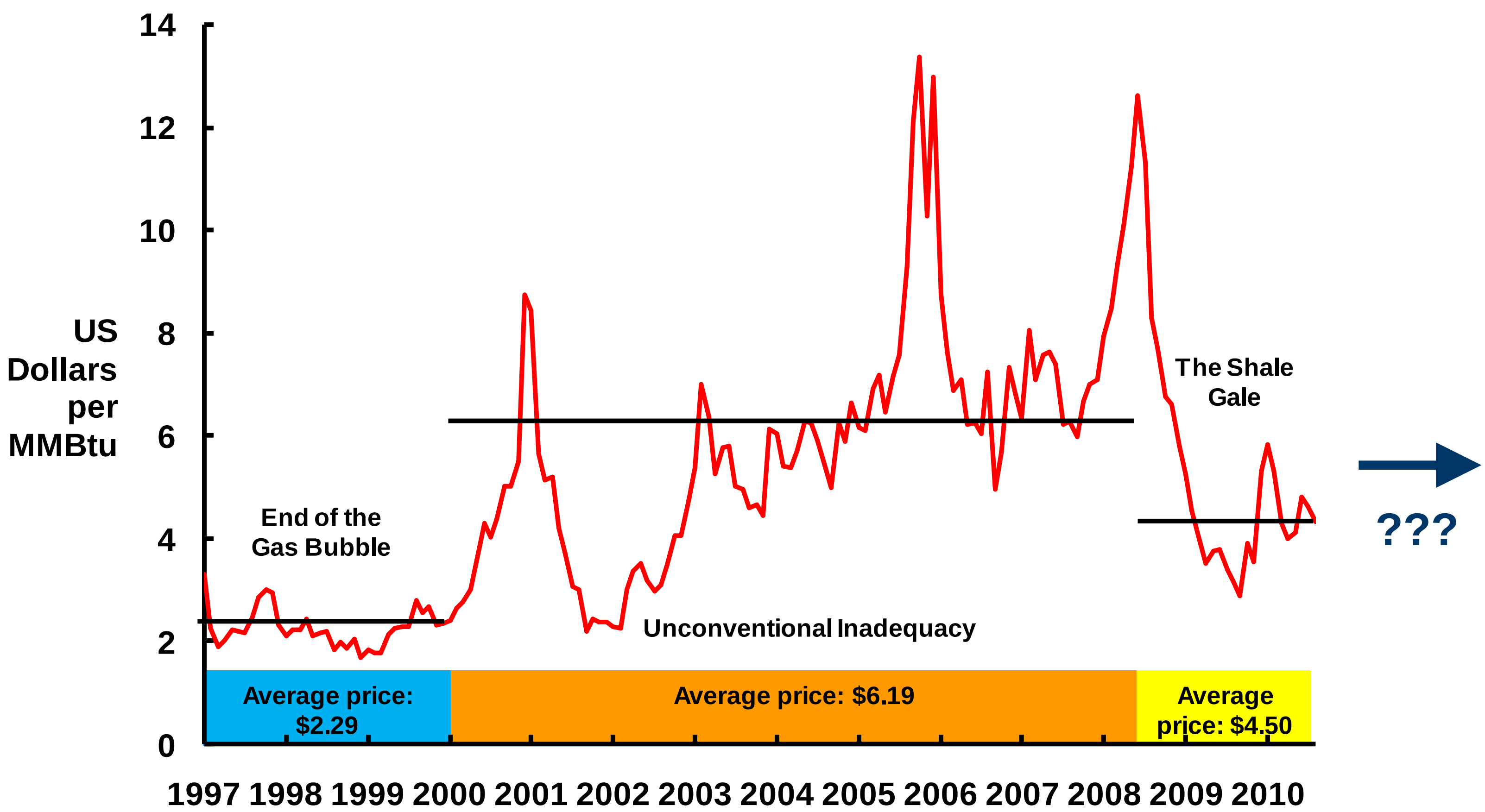
Avista Electric IRP
Natural Gas Price Forecast

Technical Advisory Committee Meeting

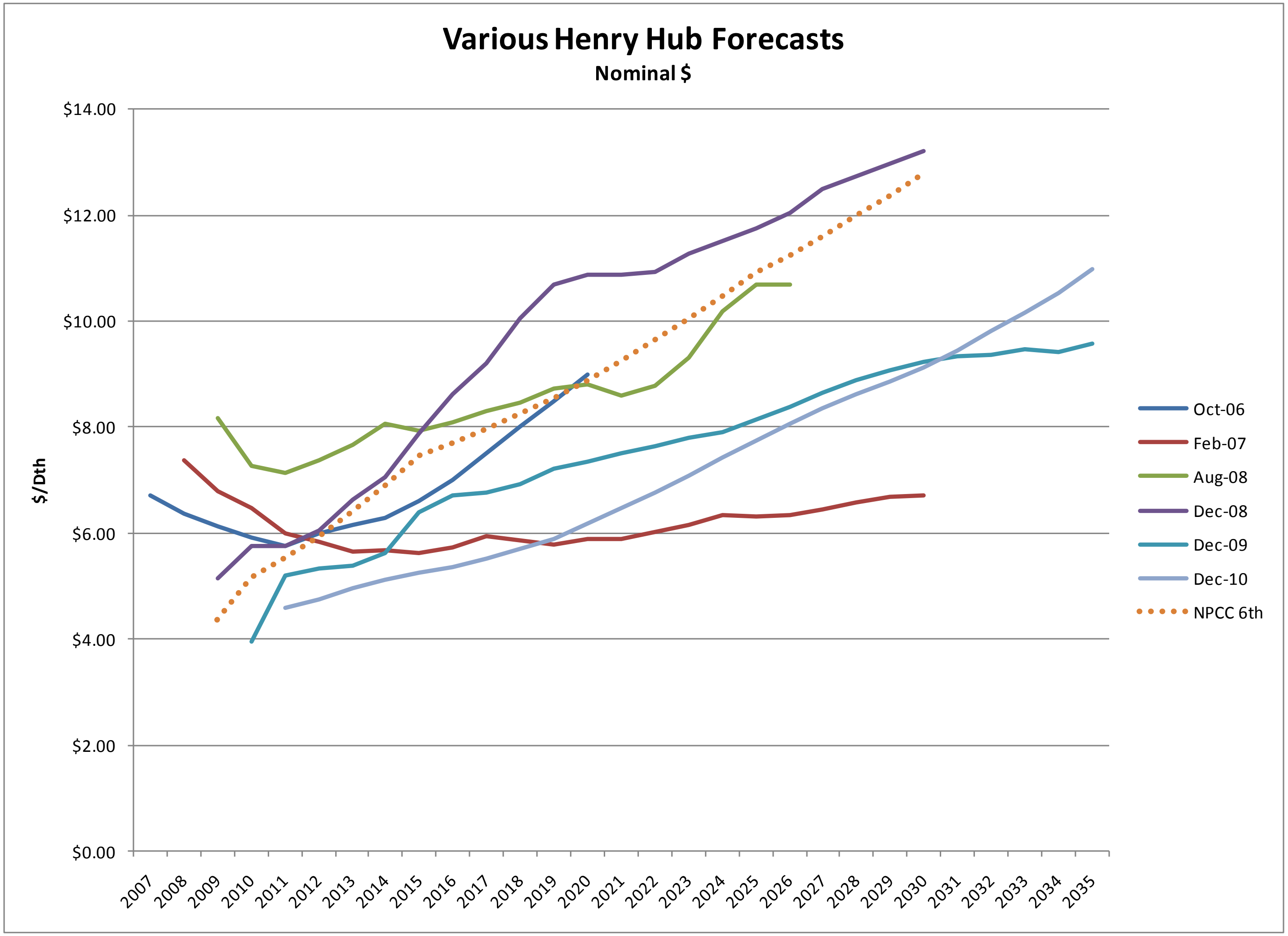
February 4, 2011

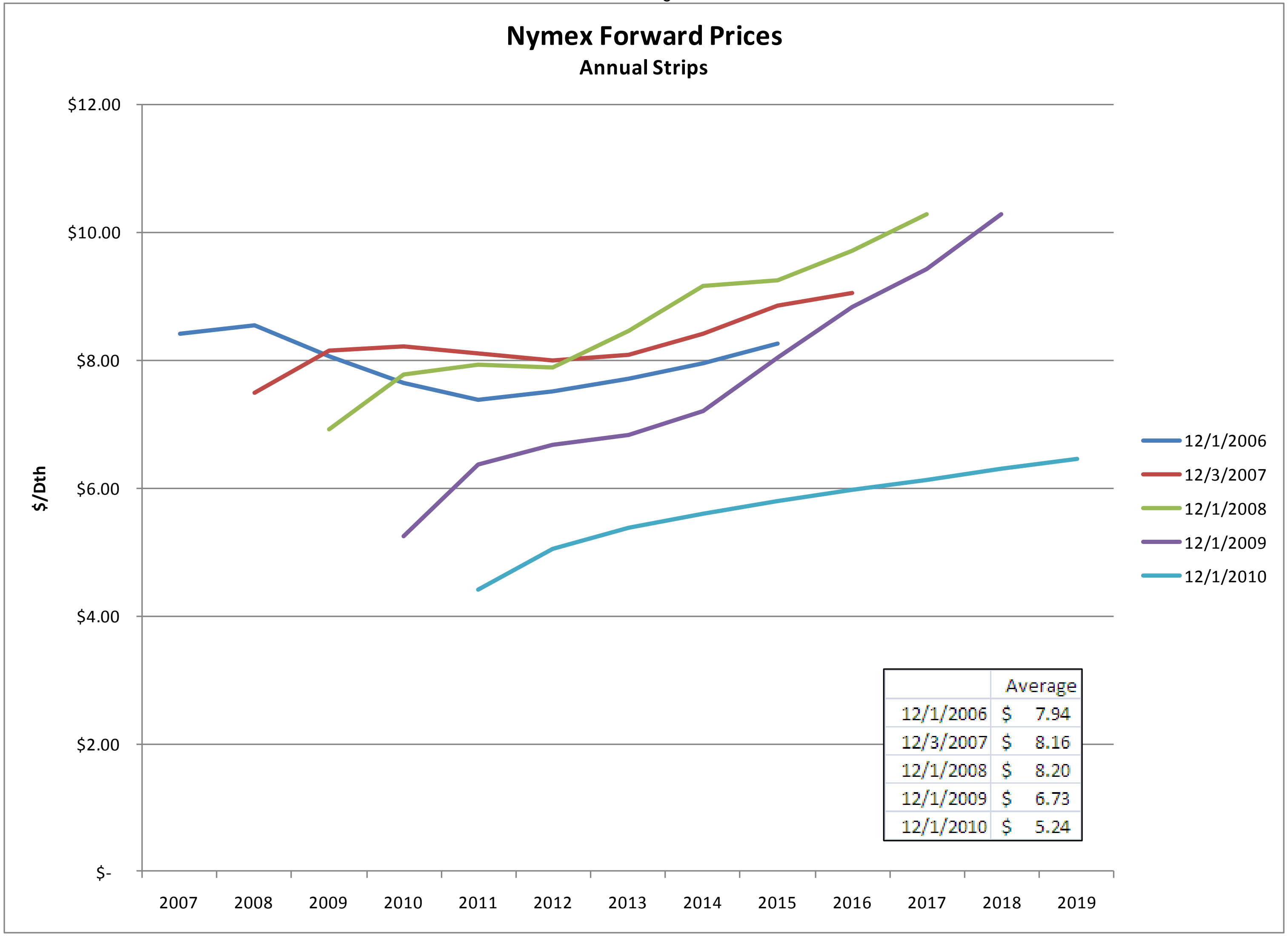
Henry Hub Historical Price Trend



Source: Platts.

Brief History of Forecasts





	Average
12/1/2006	$ 7.94
12/3/2007	$ 8.16
12/1/2008	$ 8.20
12/1/2009	$ 6.73
12/1/2010	$ 5.24

Long Term Natural Gas Price Drivers

DEMAND

- Economy
  - Industrial
  - Power Generation

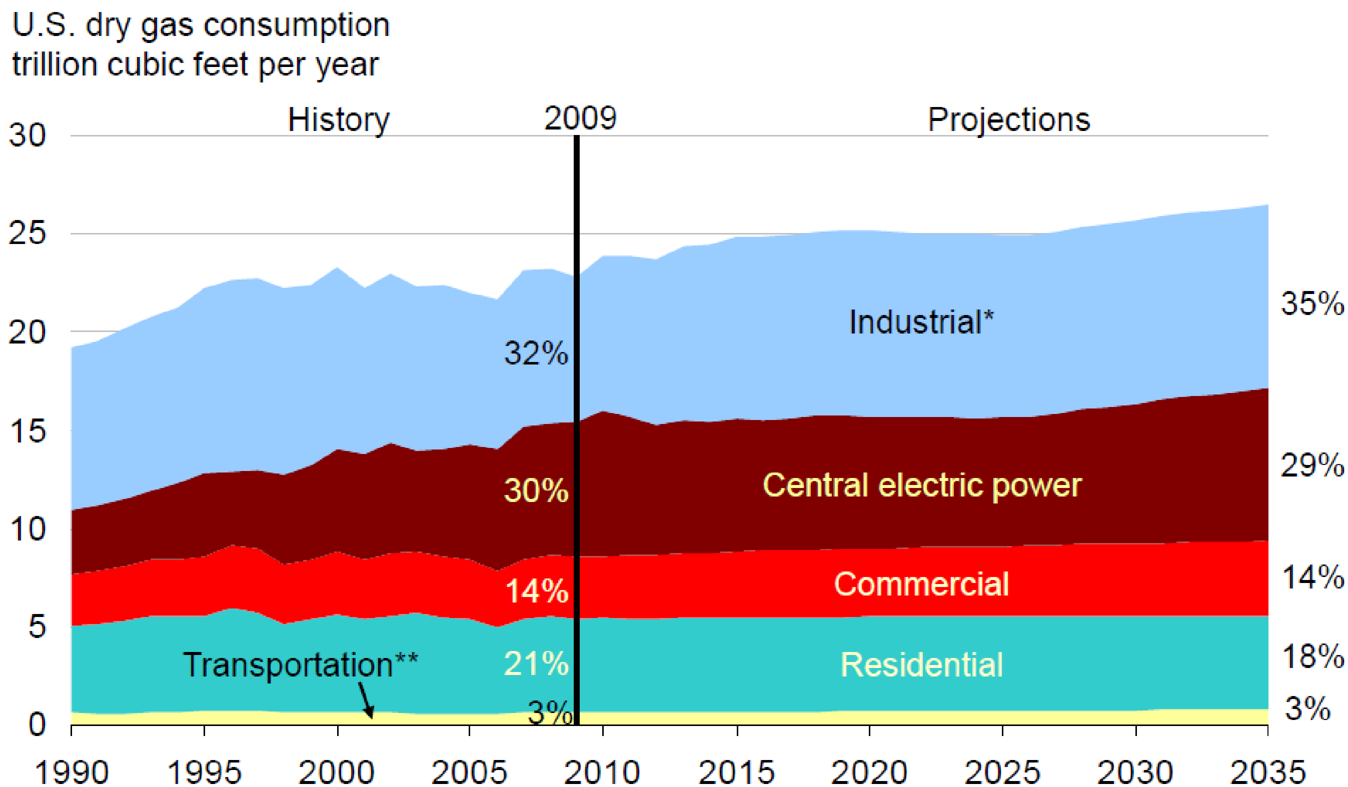
SUPPLY

- US Natural Gas Production
- Imports from Canada

OTHER FACTORS

- Oil and Coal Prices
- Carbon Legislation/Renewable Portfolio Standards
- Global Dynamics; LNG Imports (Exports?)

US Natural Gas Demand Forecast

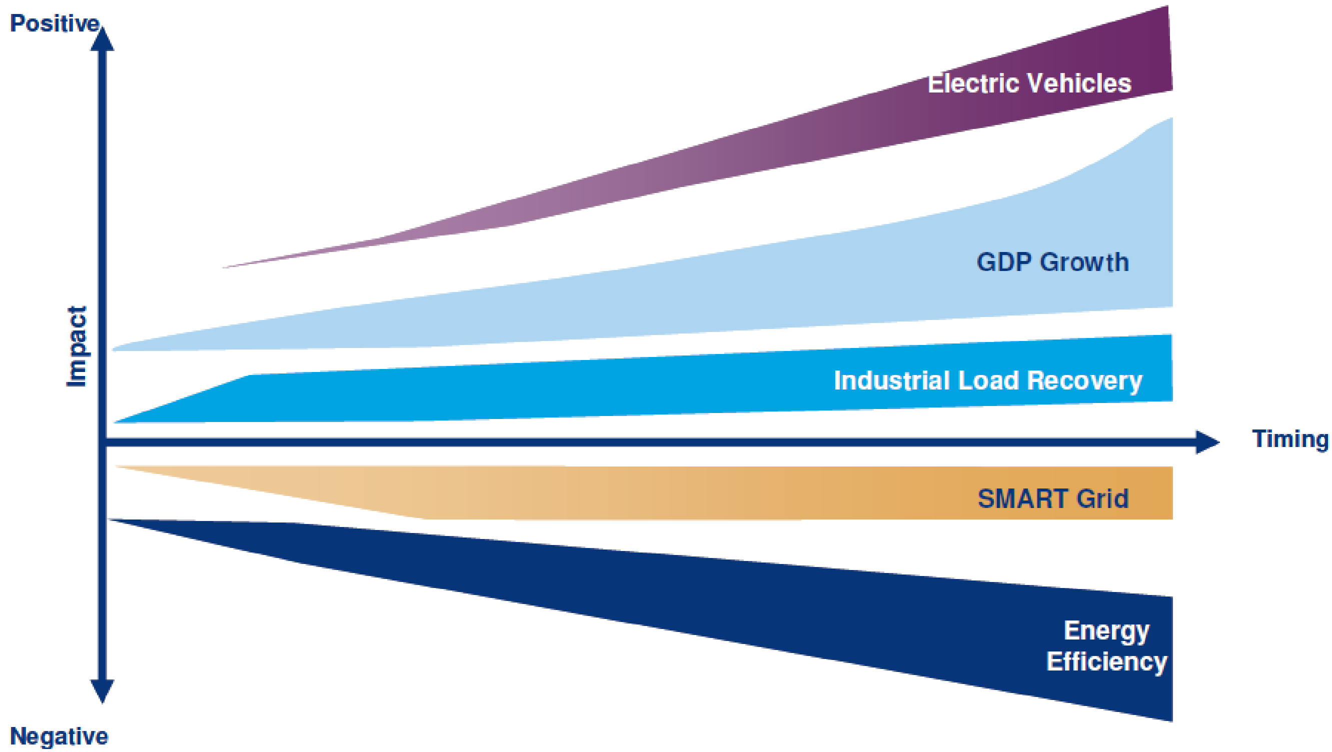


* Includes combined heat-and-power and lease and plant fuel. ** Includes pipeline fuel.

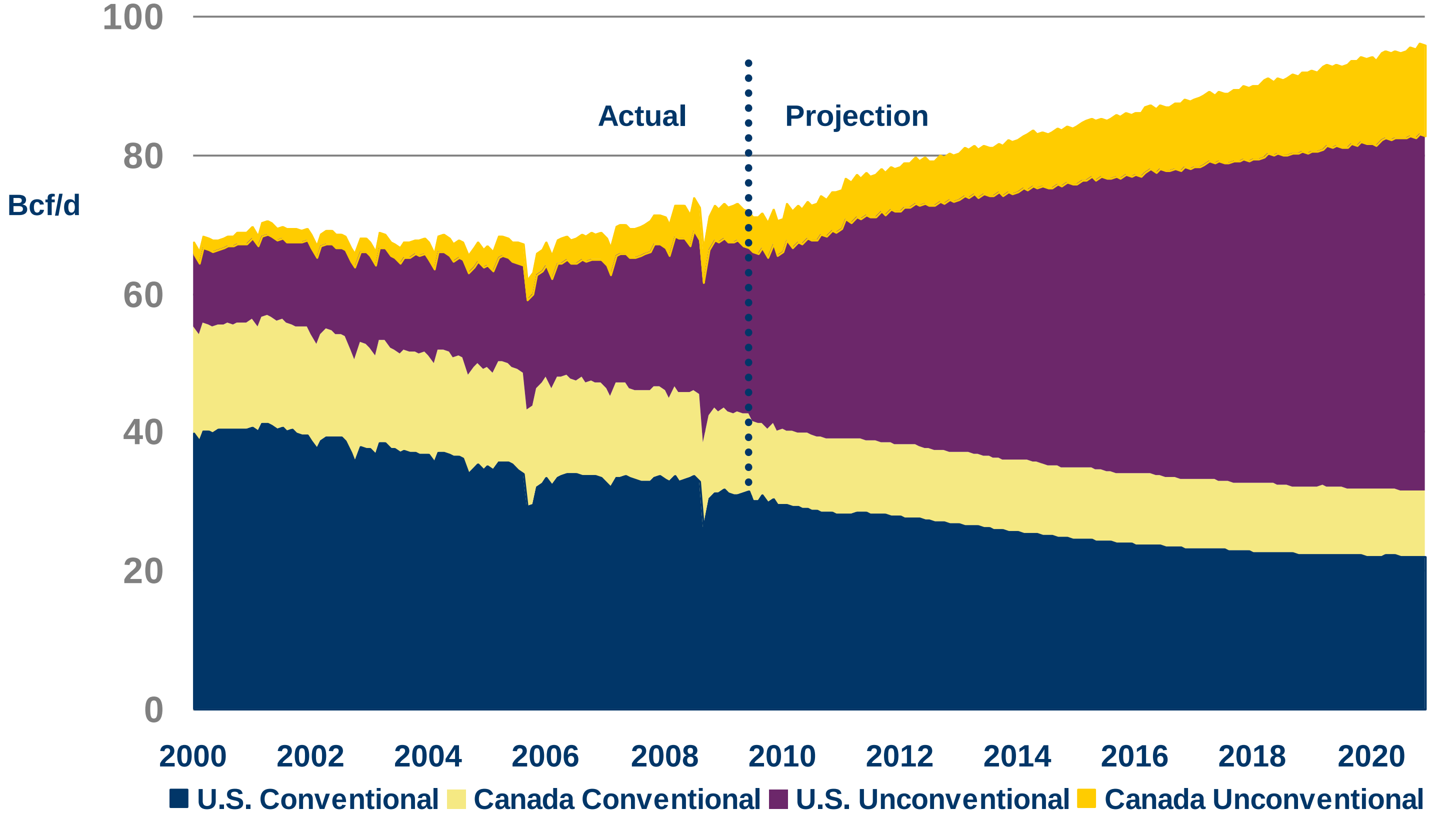
Richard Newell, December 16, 2010

Source: EIA, *Annual Energy Outlook 2011*

Power demand risks: a multitude of uncertainties



North American Natural Gas Production



Source: EIA & NEB historic data; Encana forecasts

Shale Gas Economics 101

Bigger Costs. Bigger Volumes.

Conventional Vertical Drilling

Unconventional Horizontal Drilling and Hydraulic Fracturing

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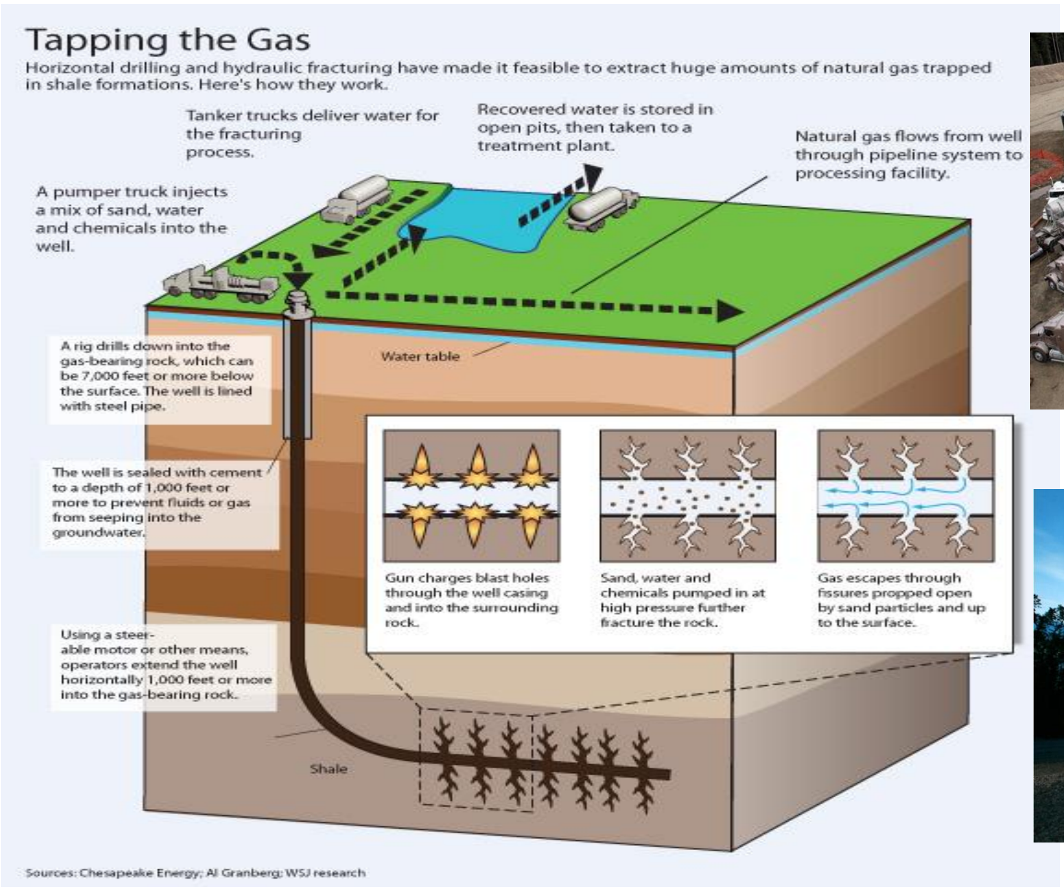
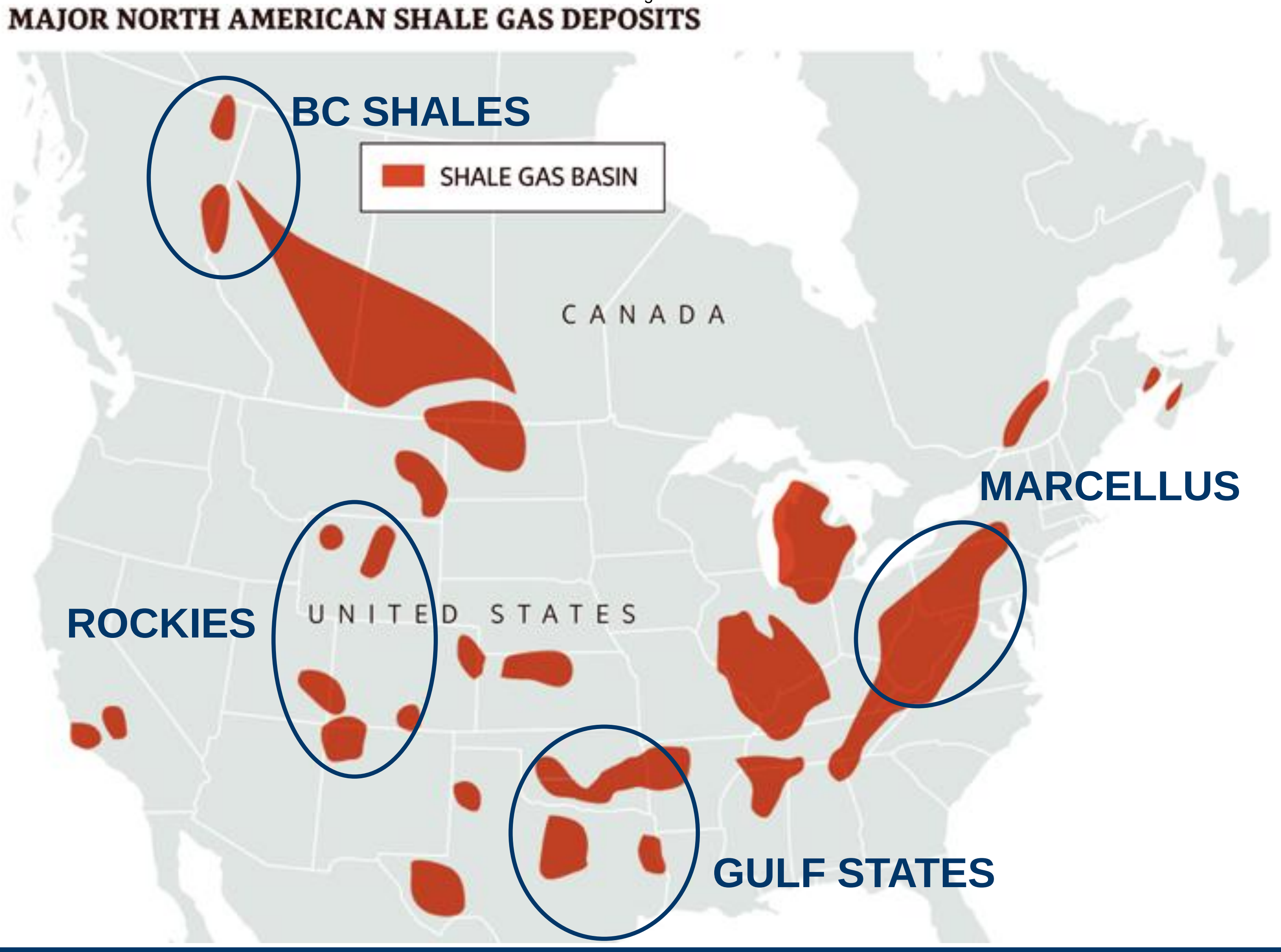
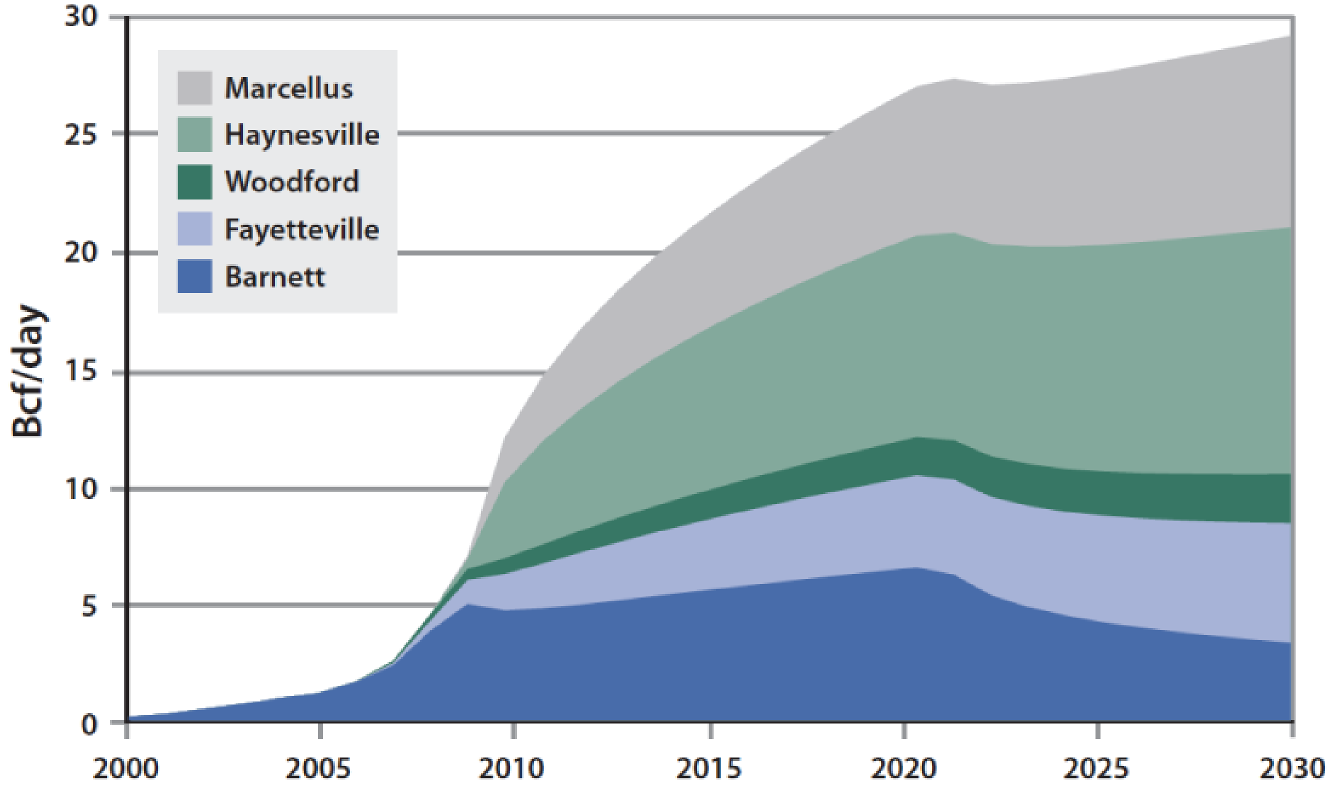
The Shale Drilling Process



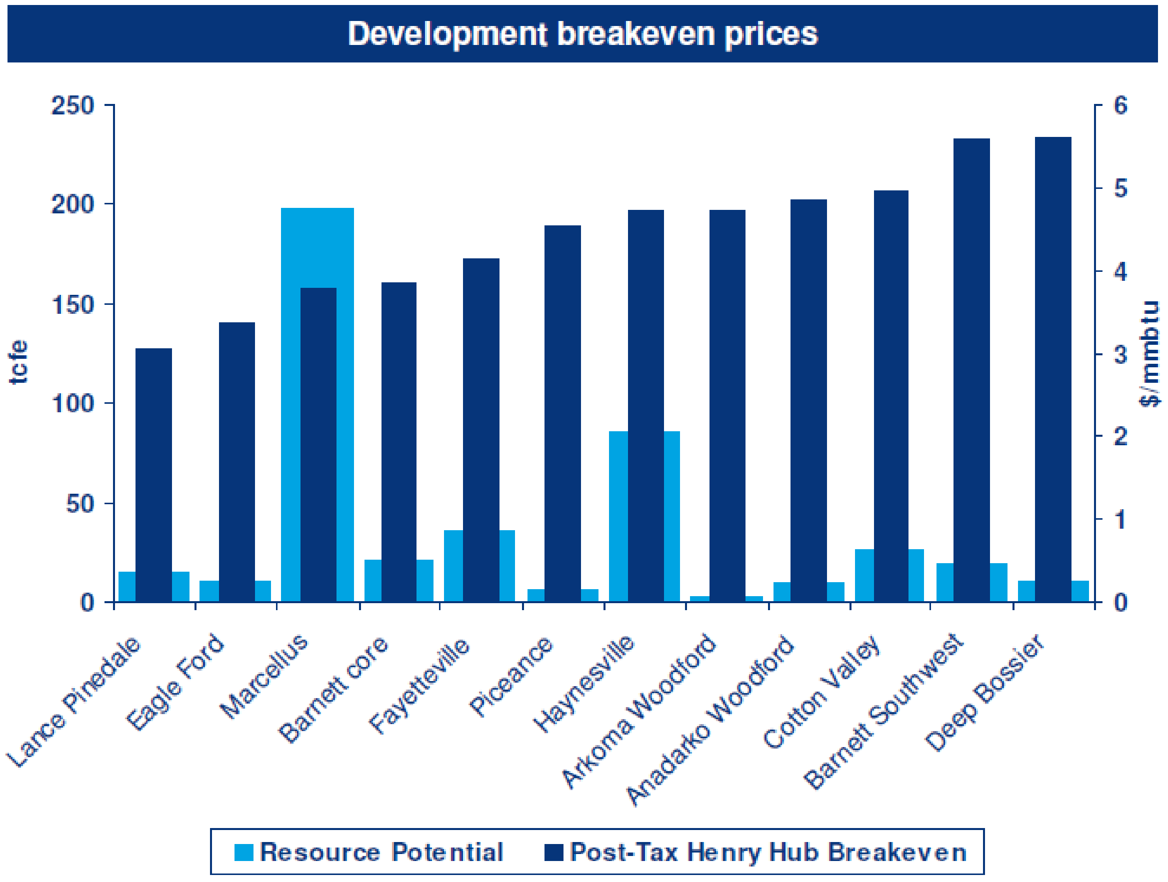

MAJOR NORTH AMERICAN SHALE GAS DEPOSITS
BC SHALES
SHALE GAS BASIN
CANADA
MARCELLUS
ROCKIES
UNITED STATES
GULF STATES

Growth in U.S. Shale Gas Production



Source: MIT Study The Future of Natural Gas

Costs and Volumes – Selected Gas Plays



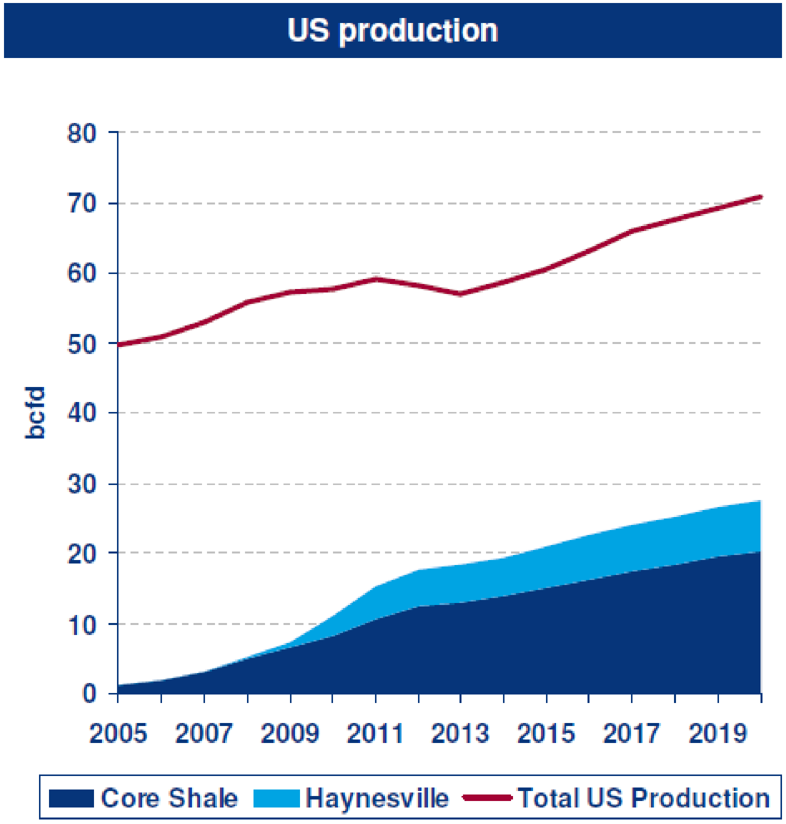
Source: Wood Mackenzie

The Gas Factory

Technology and Efficiency

1. **Drilling Days** - depending on vertical depth and lateral length, a typical 90-100 day turnaround has been reduced down to 18–45 days
2. **Lateral Length** - commonly going to about 4,000+ feet horizontal, pushing beyond 10,000 feet in some wells
3. **Wells per Pad/Simultaneous Operations** - each pad has up to 8 wells; simultaneous well work on multiple wellbores
4. **Number of Fracturing Stages** – 1 or 2 stage jobs in the past; now 8-10 stages or more
5. **Simultaneous Fracturing** – fracturing simultaneous wellbores to achieve acute stresses and more effective fracs

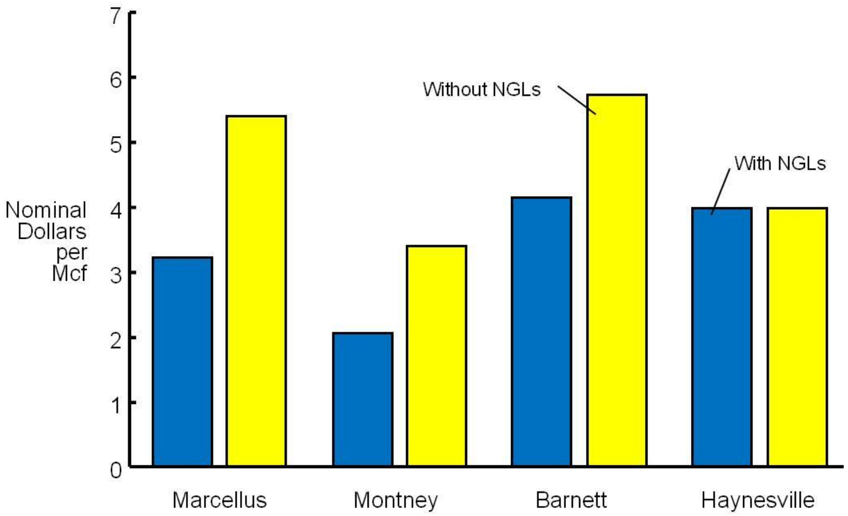
Shale Gas and US Production



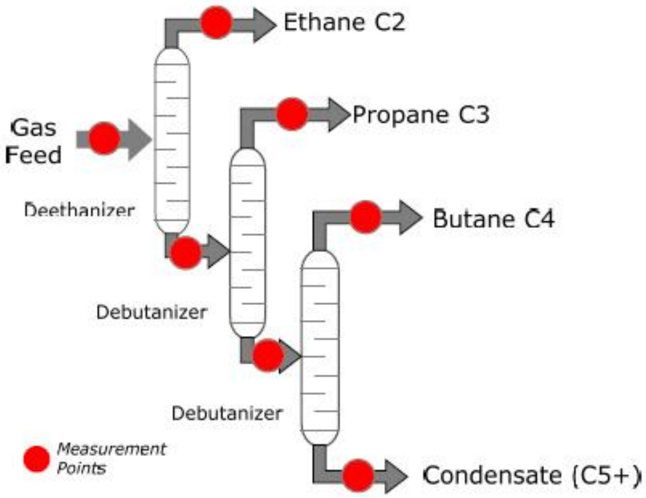
Source: Wood Mackenzie

Natural Gas Liquids (NGLs)
What are they?

Natural gas liquids (NGLs) are hydrocarbons often found resident with natural gas. They are recovered as liquids through a purification process at processing plants. They include ethane, propane, and butane and condensate (natural gasoline).

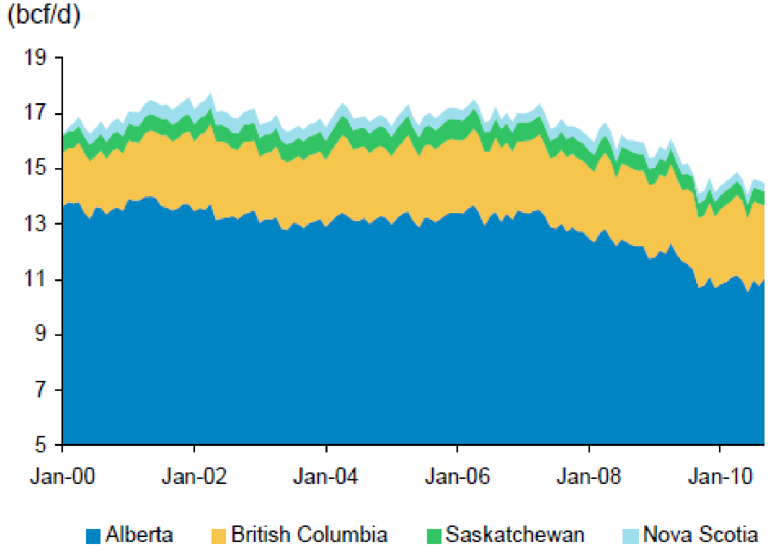


Source: IHS CERA



Canada Exports

Historical Trend – Declining Exports



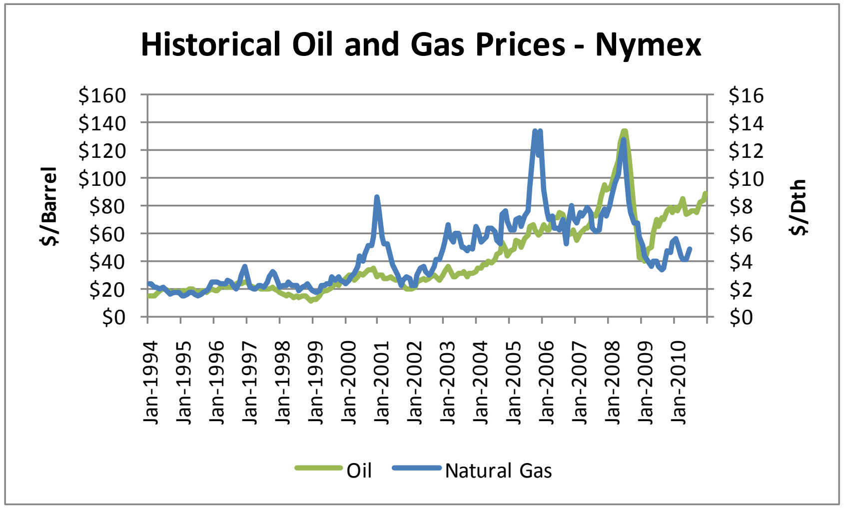
Source: National Energy Board, Morgan Stanley Commodity Research

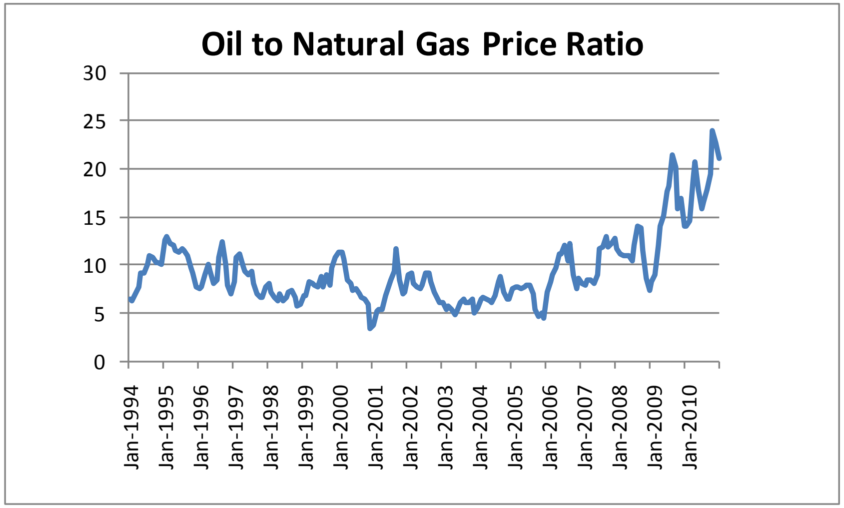
Recent Trends

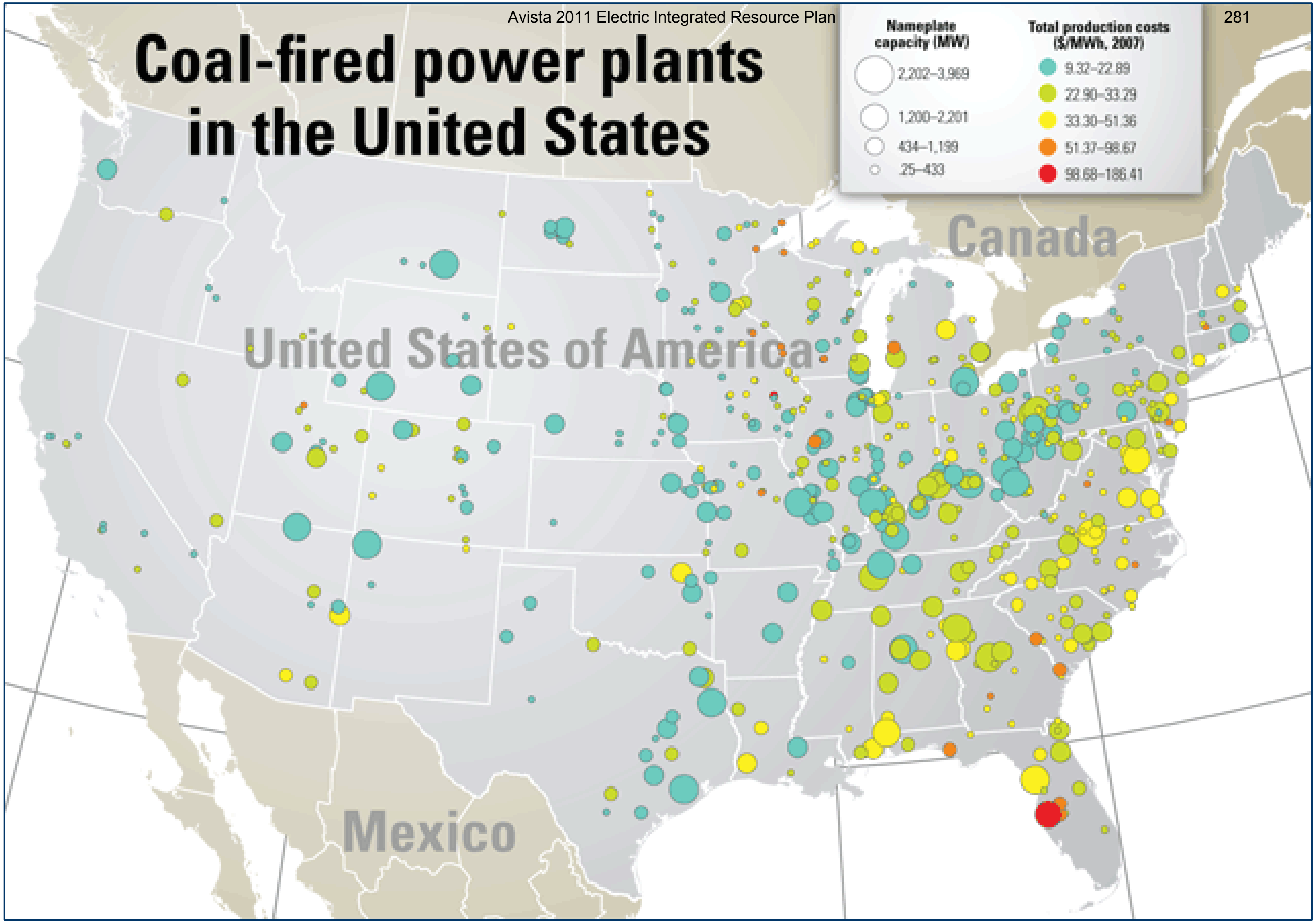
- **Imports declining slower than anticipated**
- **BC Shale larger and faster than anticipated**
- **Alberta royalties renegotiated**
- **Lower oil prices have slowed demand for oil sands production**

Oil vs. Natural Gas Relationship

- Strong long term price correlation historically
- Long term ratio of approx. 8 to 1 (1994-2008)
- Since Jan 2009 ratio has **doubled** to approx 17 to 1
- Shale gas could fundamentally and permanently change historic ratio
- Alternatively, increased demand from low prices could cure low prices






Coal-fired power plants in the United States
Nameplate capacity (MW)
2,202–3,969
1,200–2,201
434–1,199
.25–433
Total production costs ($/MWh, 2007)
9.32–22.89
22.90–33.29
33.30–51.36
51.37–98.67
98.68–186.41
Canada
United States of America
Mexico

AVISTA

Carbon Policy/Renewable Portfolio Standards

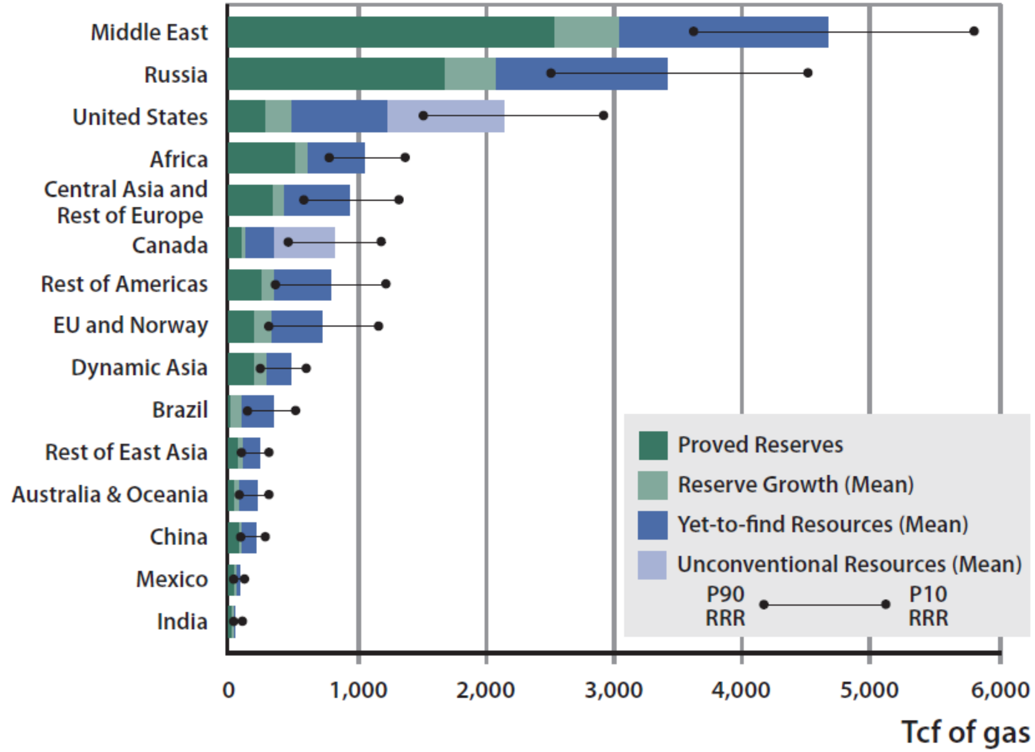
Natural Gas has a critical yet complex role in carbon policy creation and implementation.

- Numerous complex issues and uncertainties
- Need to balance economic challenges with policy objectives
- Complex issues within cap and trade vs. simpler carbon tax
- Long term role or interim bridge?

Natural Gas also has an important backup role for intermittent renewable generation sources

Global Natural Gas Estimates

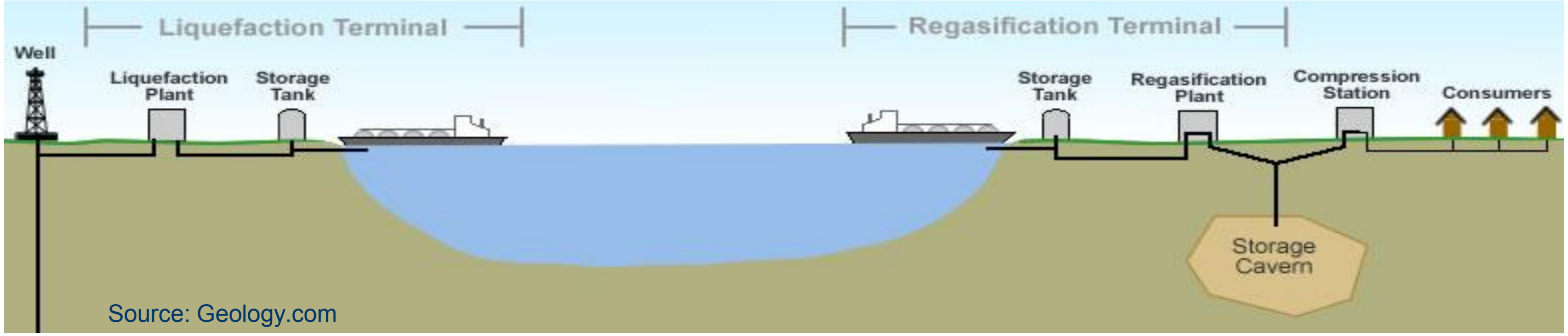
Figure 2.2 Global Remaining Recoverable Gas Resource (RRR) by EPPA Region, with Uncertainty[2] (excludes unconventional gas outside North America)



Source: MIT Study The Future of Natural Gas

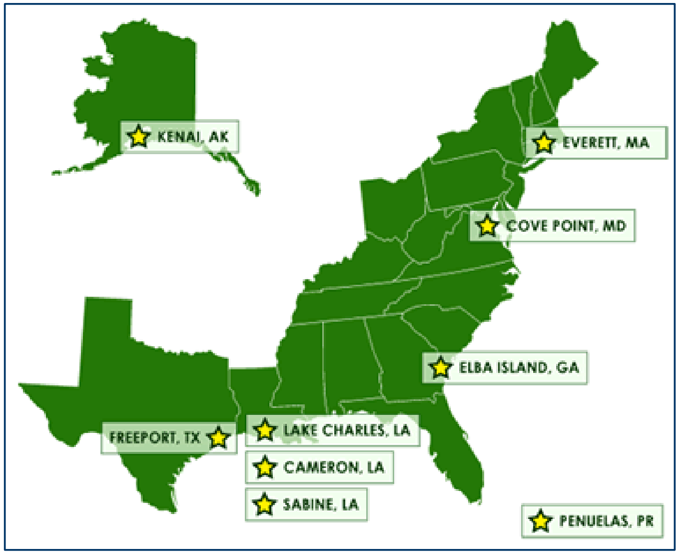
LNG Imports…or Exports?

LNG traditionally flows to North America after other higher-priced markets receive their share



Source: Geology.com

Source: Apache LNG

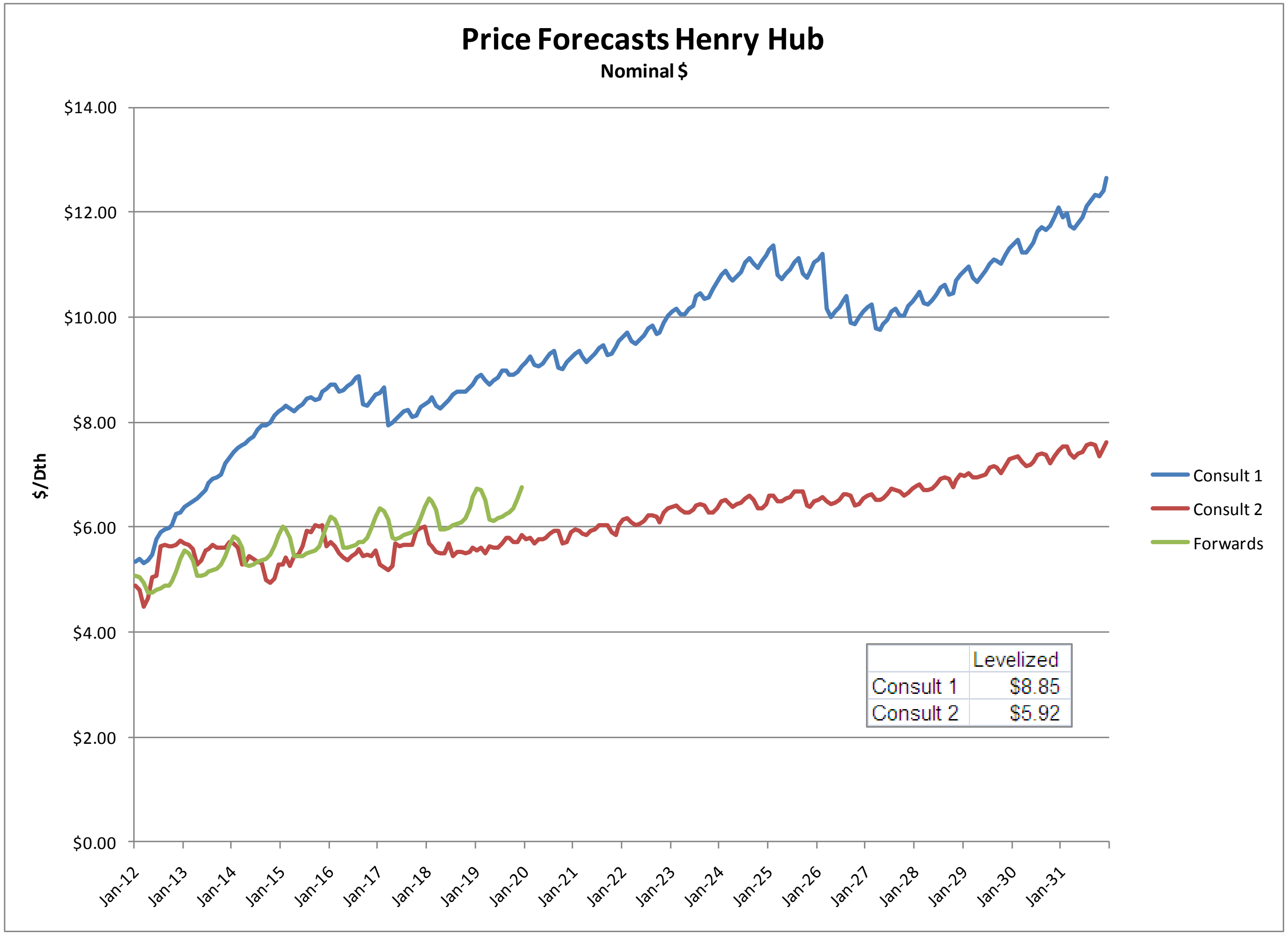


Source: Federal Energy Regulatory Commission

IRP Price Forecast Methodology

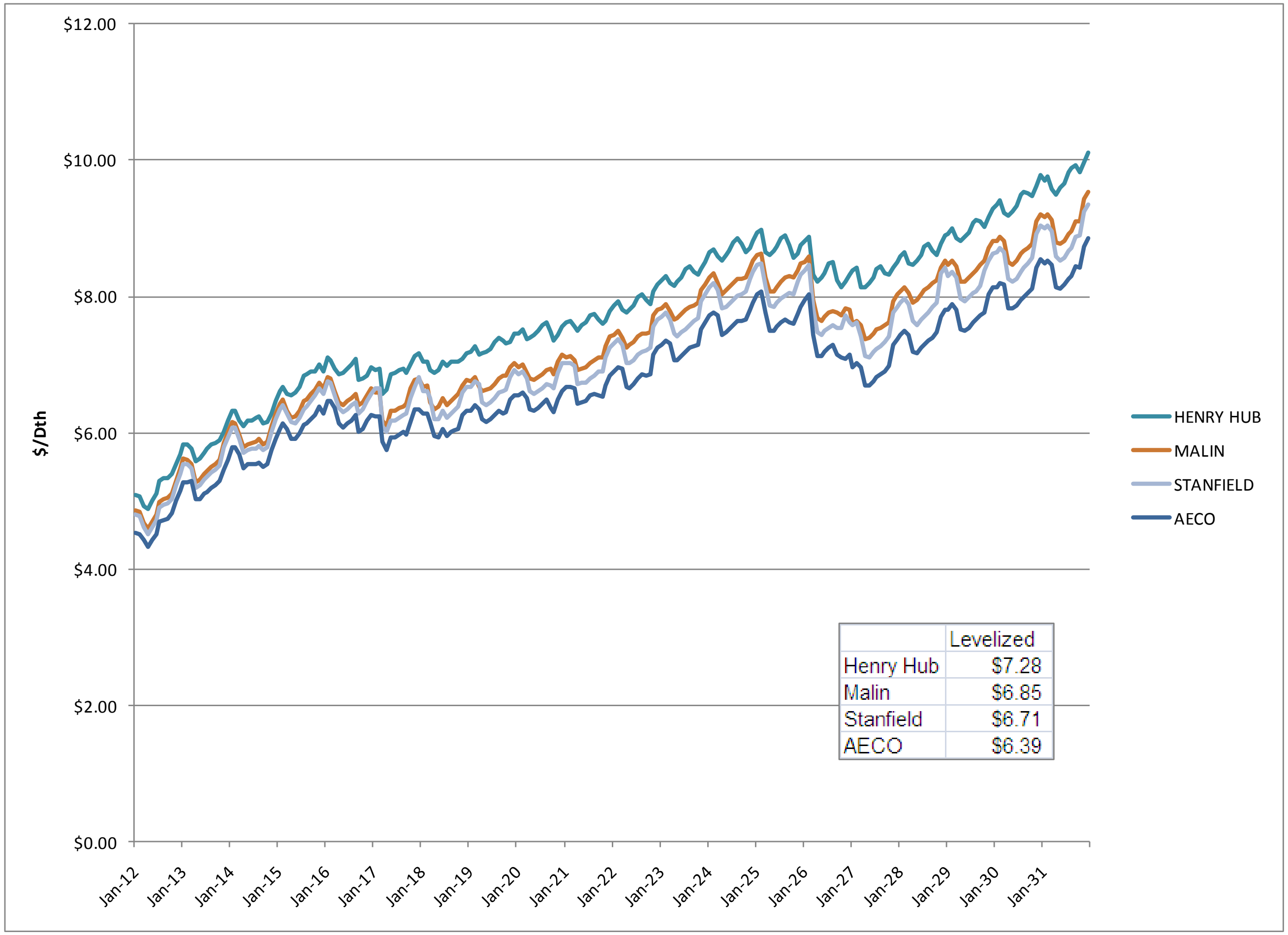
1. Two fundamental forecasts (Consultant #1 & Consultant #2)
2. Forward prices
3. 50/50 weighting fundamental and forwards year 1
4. Reduce forwards weighting 10% each year thereafter
5. By year 6, forecast is 50% Consultant #1, 50% Consultant #2

IRP Price Forecast Components



IRP Price Forecast – Selected Hubs

Nominal $



	Levelized
Henry Hub	$7.28
Malin	$6.85
Stanfield	$6.71
AECO	$6.39

Electric Market Forecast

(Preliminary Draft)

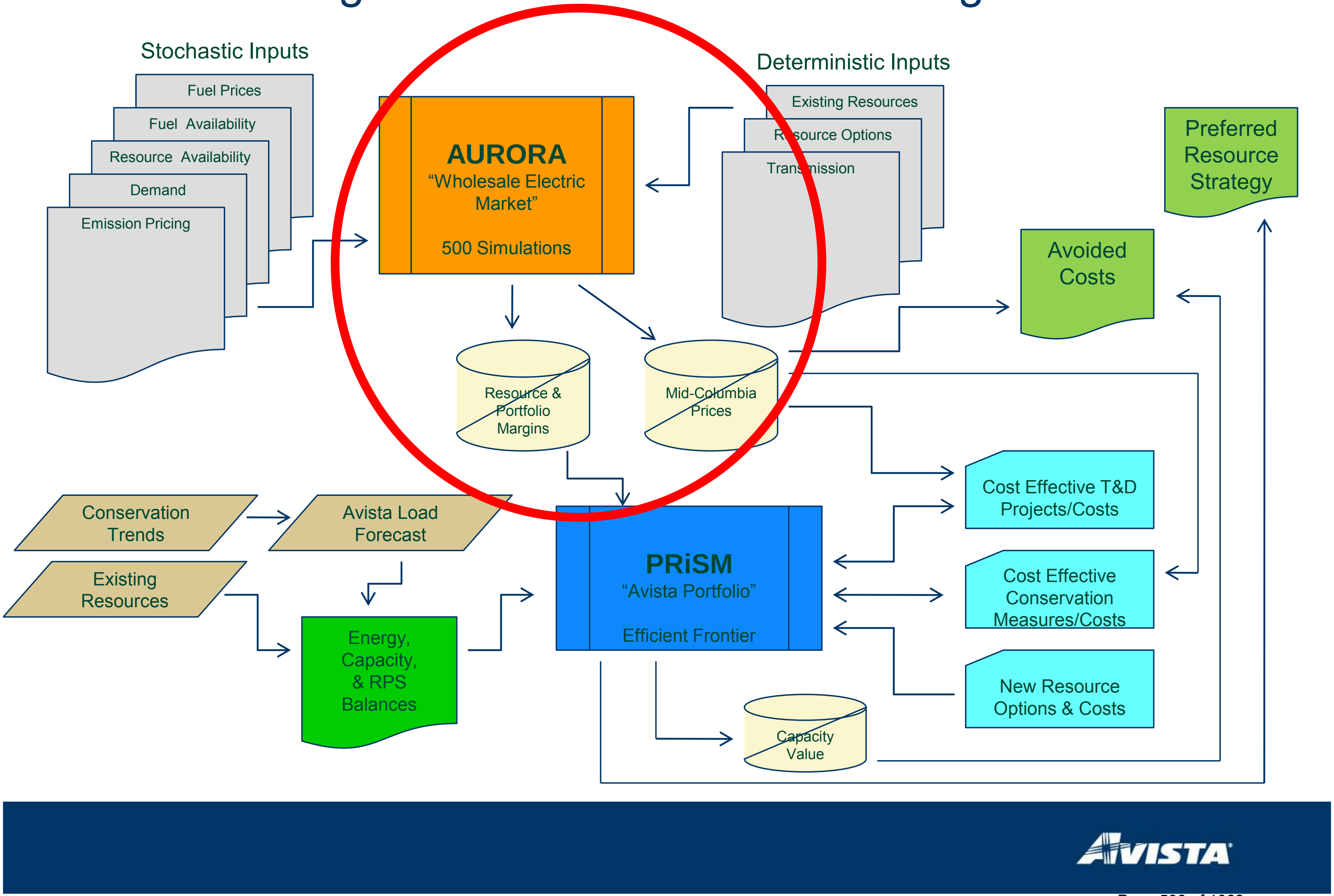
James Gall

Technical Advisory Committee Meeting #4

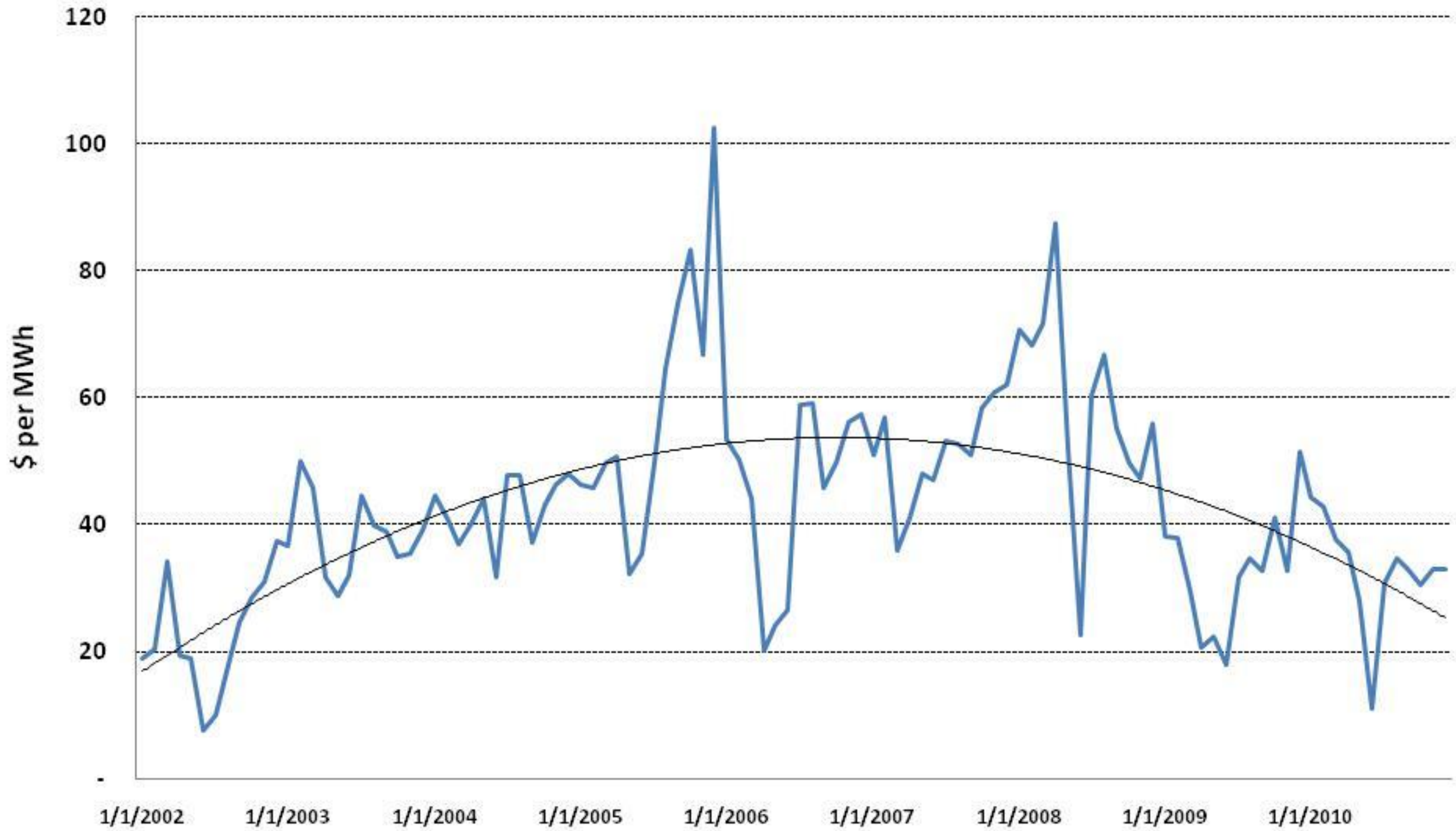
2011 Electric Integrated Resource Plan

February 3, 2011

2011 Integrated Resource Plan Modeling Process



Historical Monthly Flat Mid-Columbia Prices



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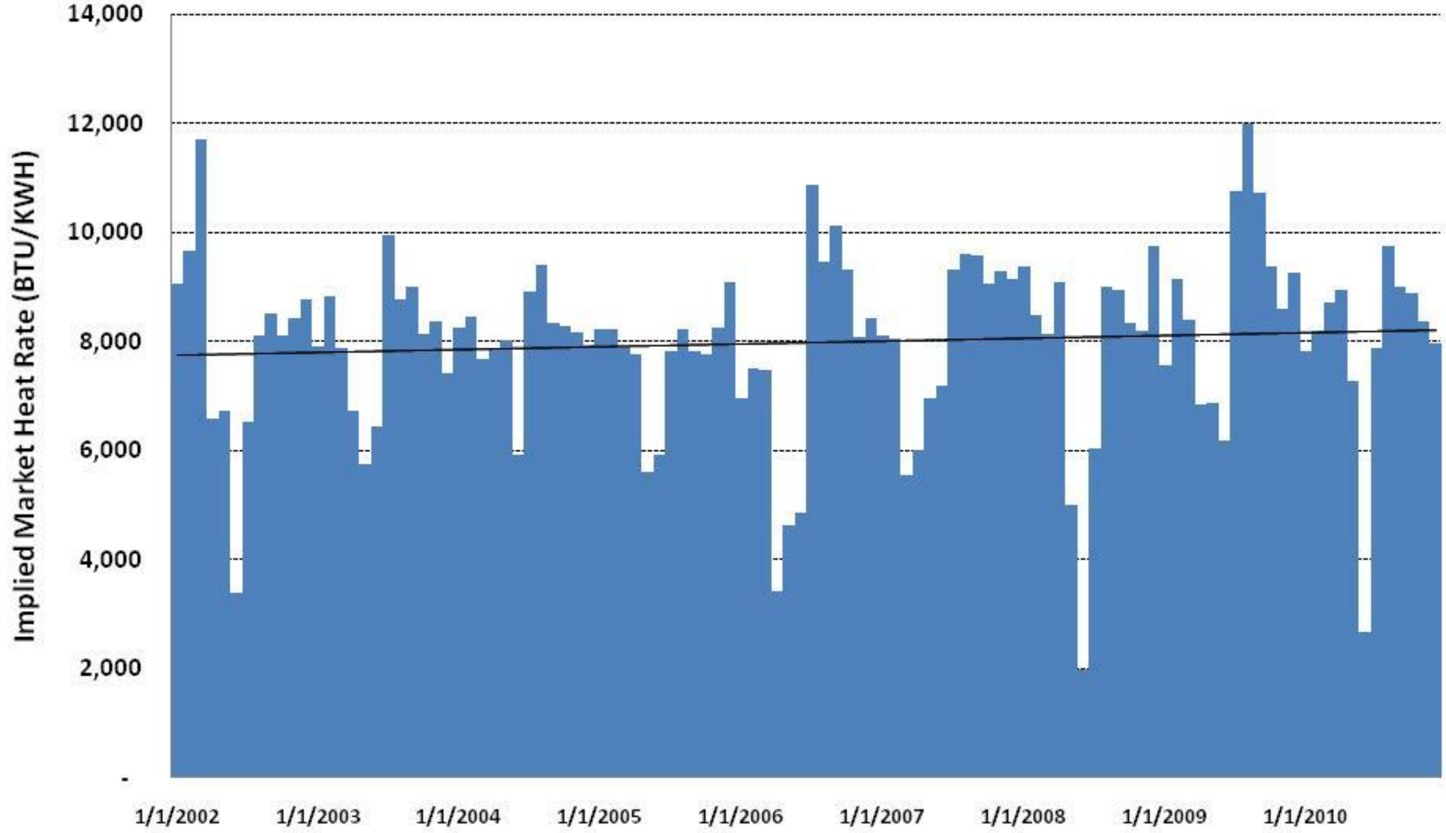
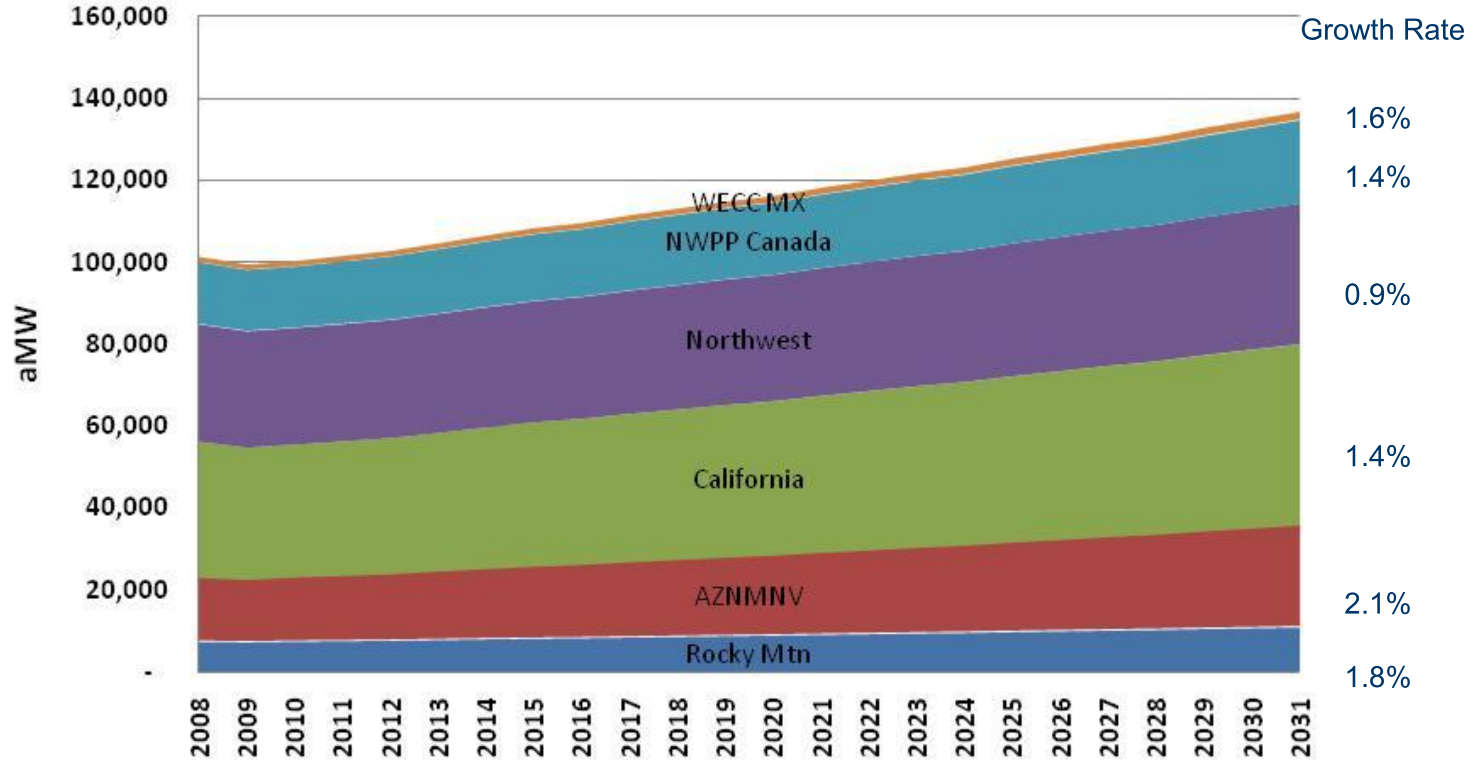
Historical Monthly Implied Market Heat Rates

(Mid-Columbia/Stanfield x 1,000)

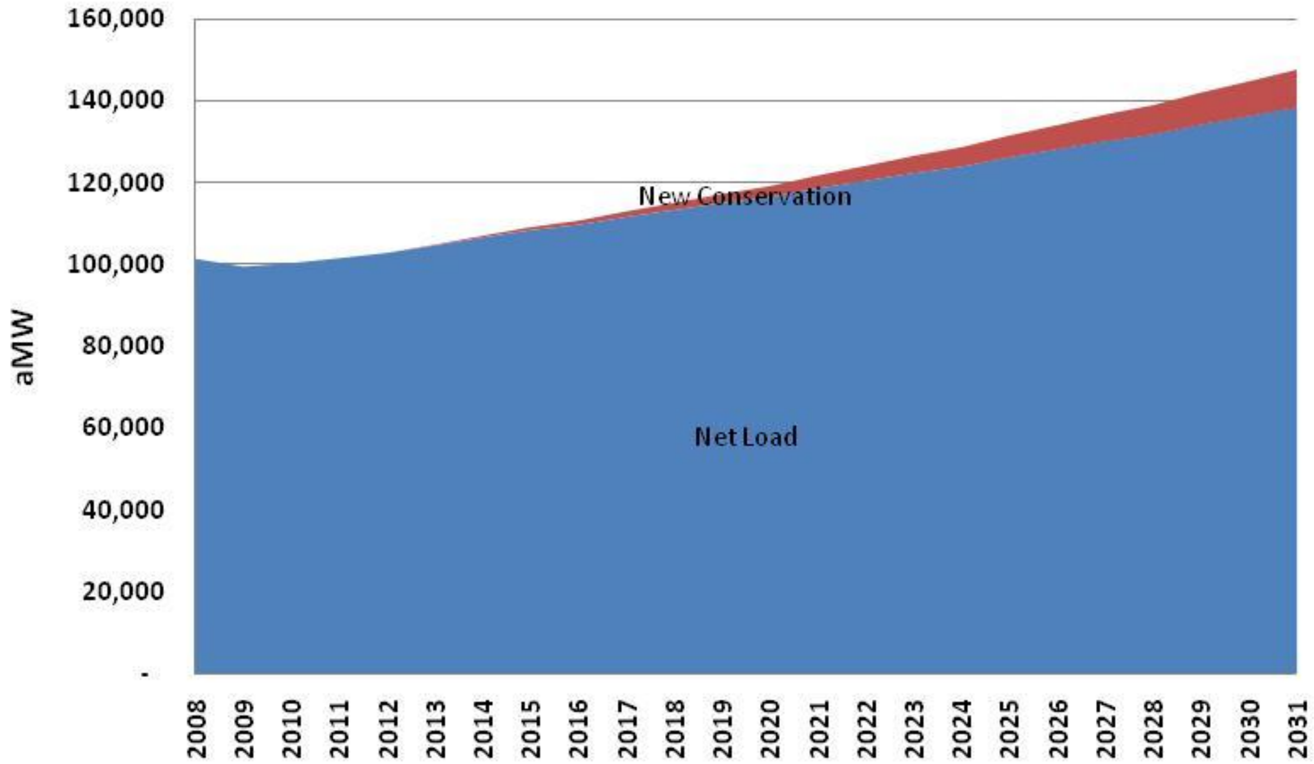


Western Interconnect Load Growth



Regional Load Growth Source: Wood Mackenzie

New Western Interconnect (WECC) Conservation



New conservation meets 21% of Load Growth

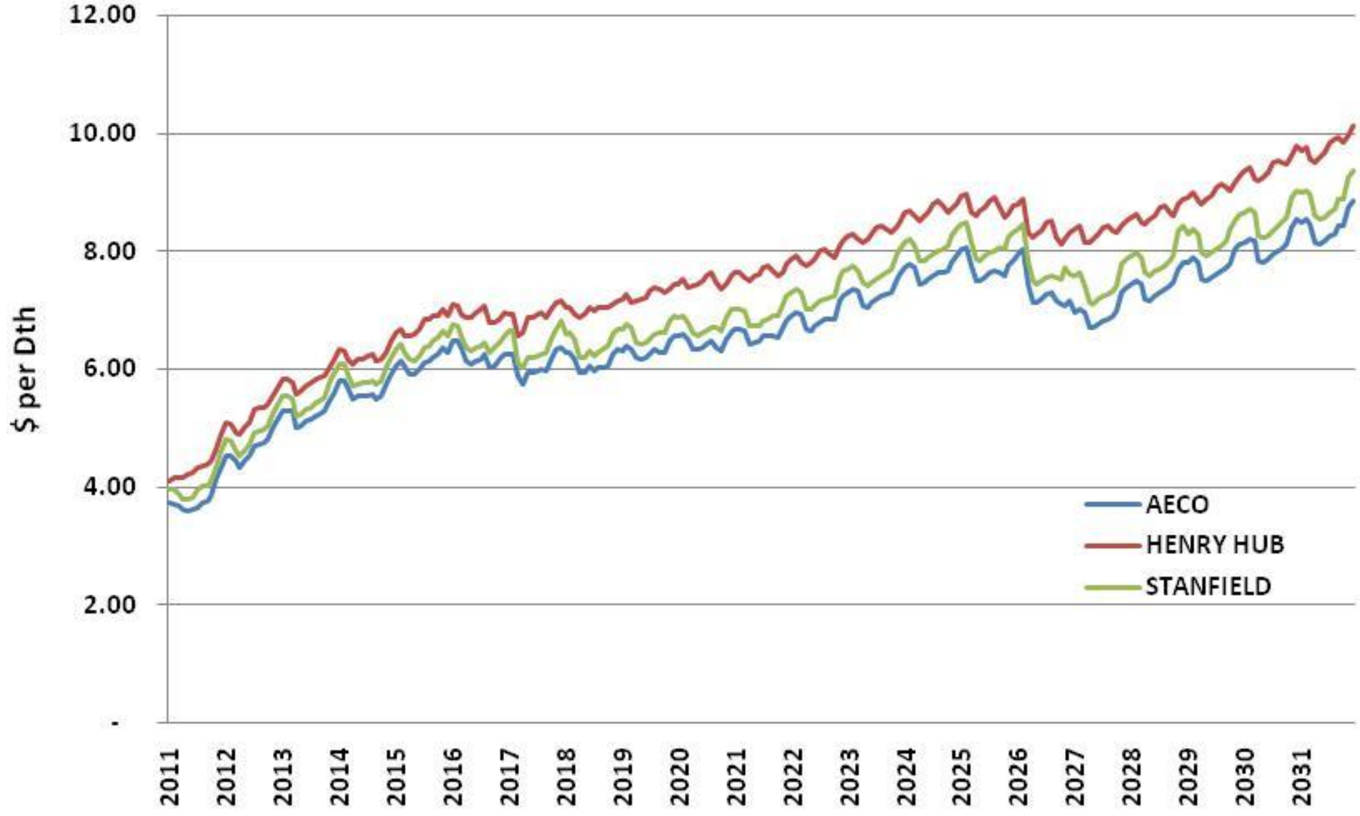
Regional Load Growth/Conservation Source: Wood Mackenzie

AVISTA

Western Interconnect Plug-in Electric Hybrid Vehicles Assumption

- Electric Cars are assumed to be adopted at the Northwest Power & Conservation Council estimate per the “Case 2” of the 6th Power Plan
  - 18% of cars by 2020 and 28% by 2030
- 95% of cars will charge at night and 5% during on-peak hours
- PHEV are not assumed to meet electric capacity needs

Natural Gas Price Re-Cap



2012-2031
Nominal
Levelized Price

$7.28- Henry Hub

$6.71- Stanfield

$6.39- AECO

Western Interconnect Transmission Additions

- Additional regional transmission additions are assumed to take place in the future, these are the additions assumed in the Base Case market analysis (MW)
  - Idaho - NW: 1,500 (2019)
  - Canada - NW - California: 3,000 (2018)
  - Wyoming - Utah: 3,000 (2015)
  - Wyoming - Idaho: 1,500 (2016)
  - Wyoming - Colorado: 900 (2013)
  - Idaho - Utah: 1,320 (2016)
  - N. Nevada - S. Nevada: 1,600 (2015)
  - New Mexico - Arizona: 3,000 (2016)

New Resource Alternatives

Western Interconnect

Resource alternatives to meet Renewable Portfolio Standards

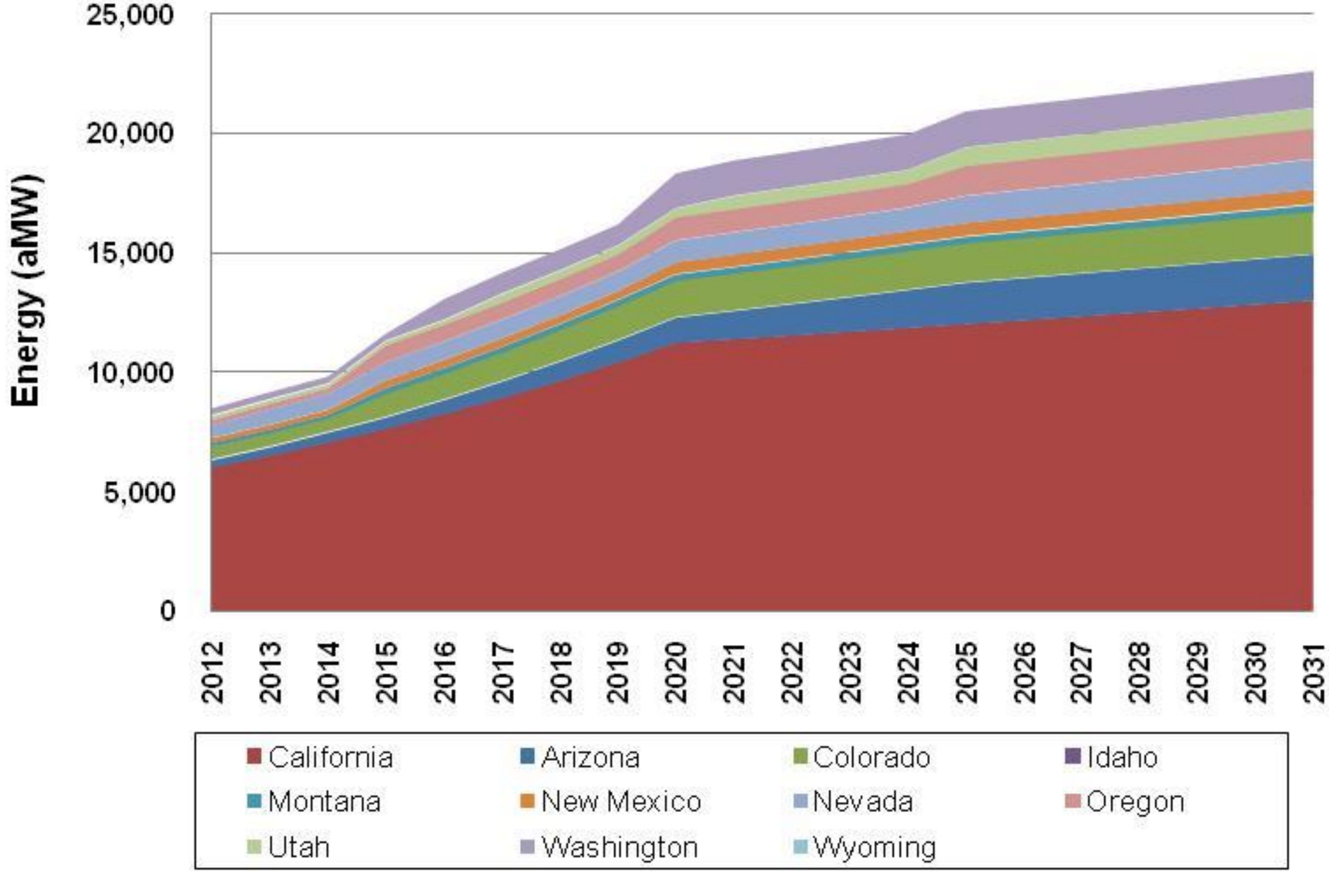
- Wind
- Solar
- Biomass
- Geothermal
- Hydro Upgrades

Resource alternatives to meet regional capacity requirements

- Combined Cycle
- Simple Cycle (Aero, Frame, Hybrid)
- Solar
- Wind (non RPS states)
- Nuclear
- Coal Pulverized
- Coal IGCC
- Coal IGCC with Sequestration

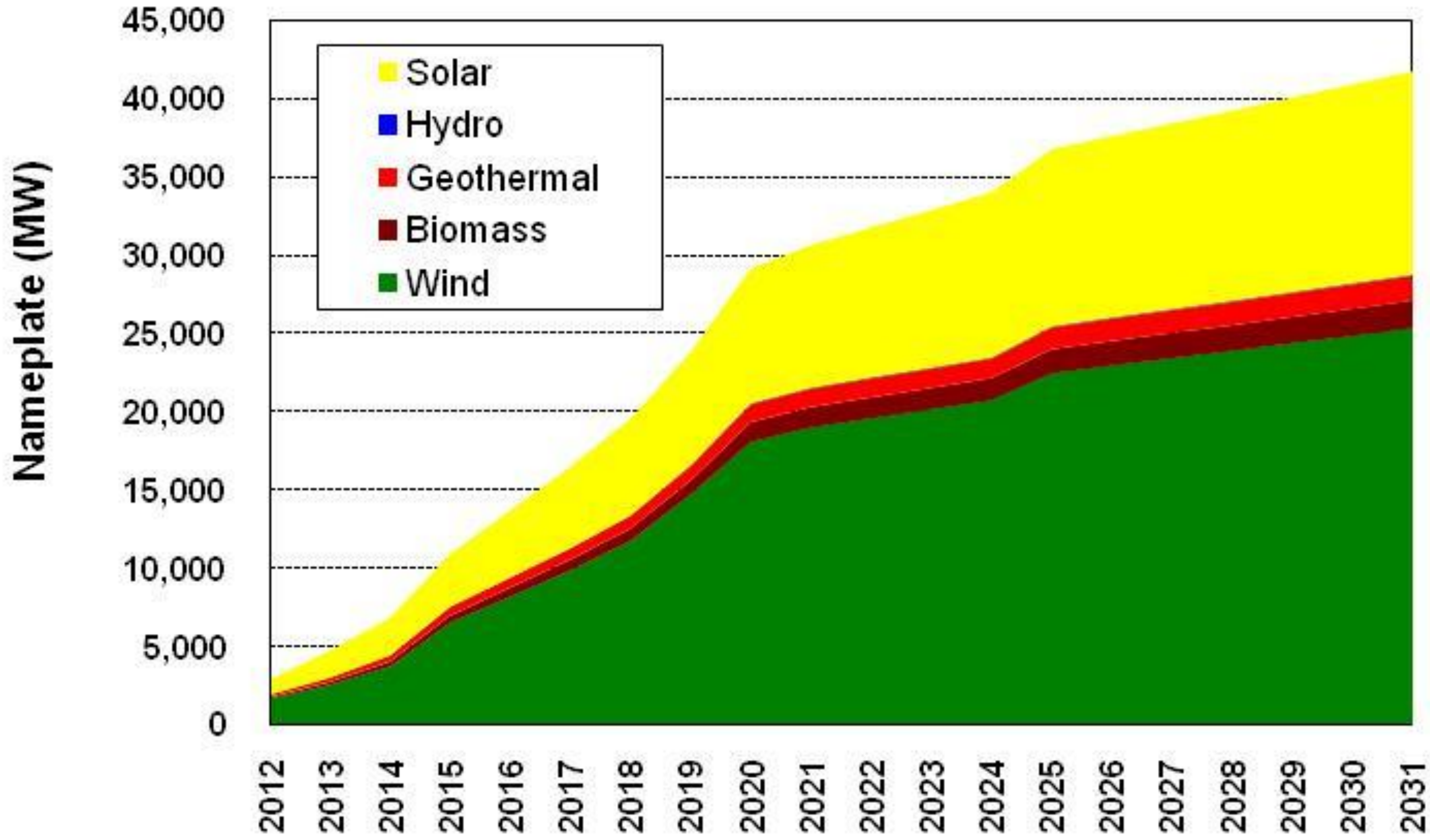
State Renewable Energy Requirements

Western Interconnect



New Renewable Resources Added for RPS by Type

Western Interconnect



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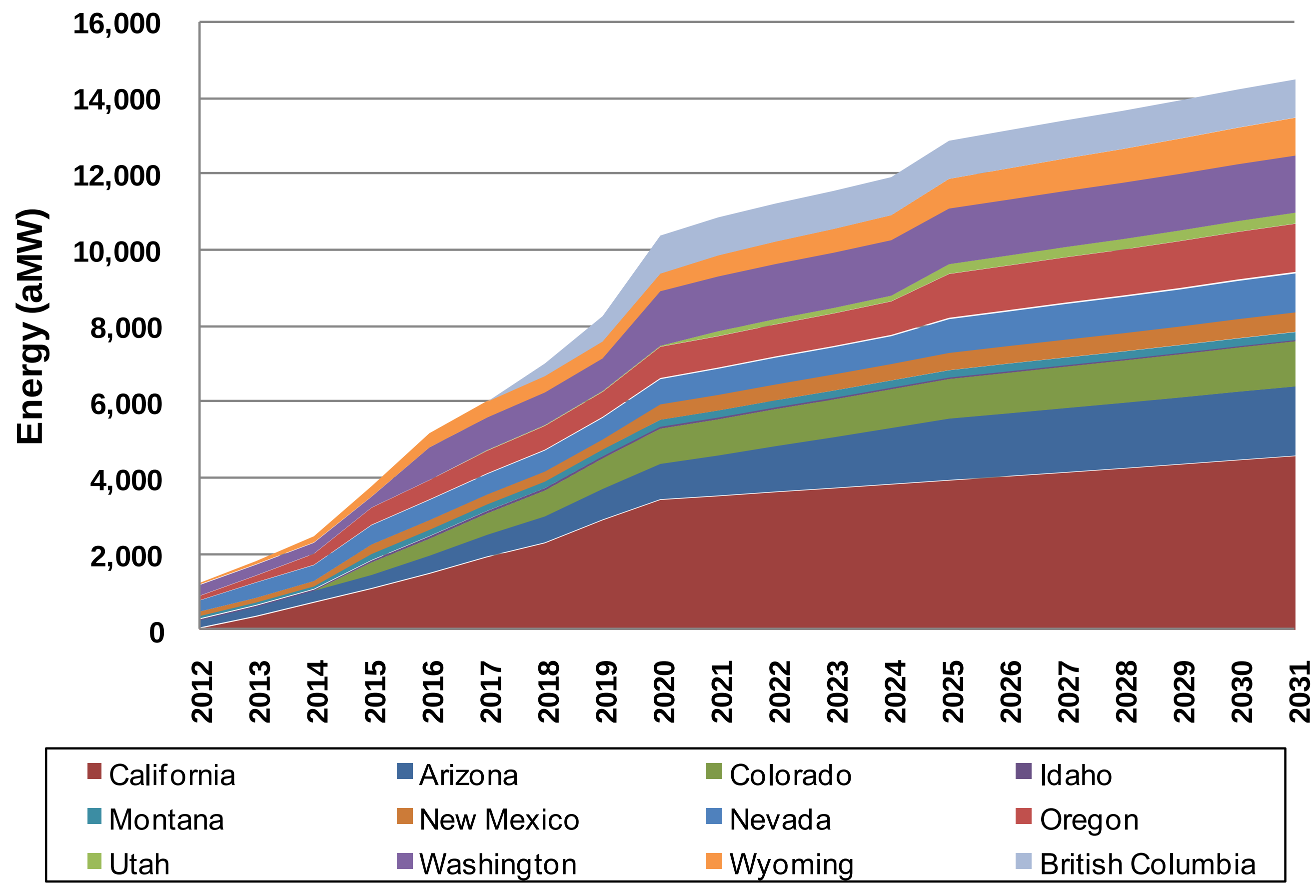
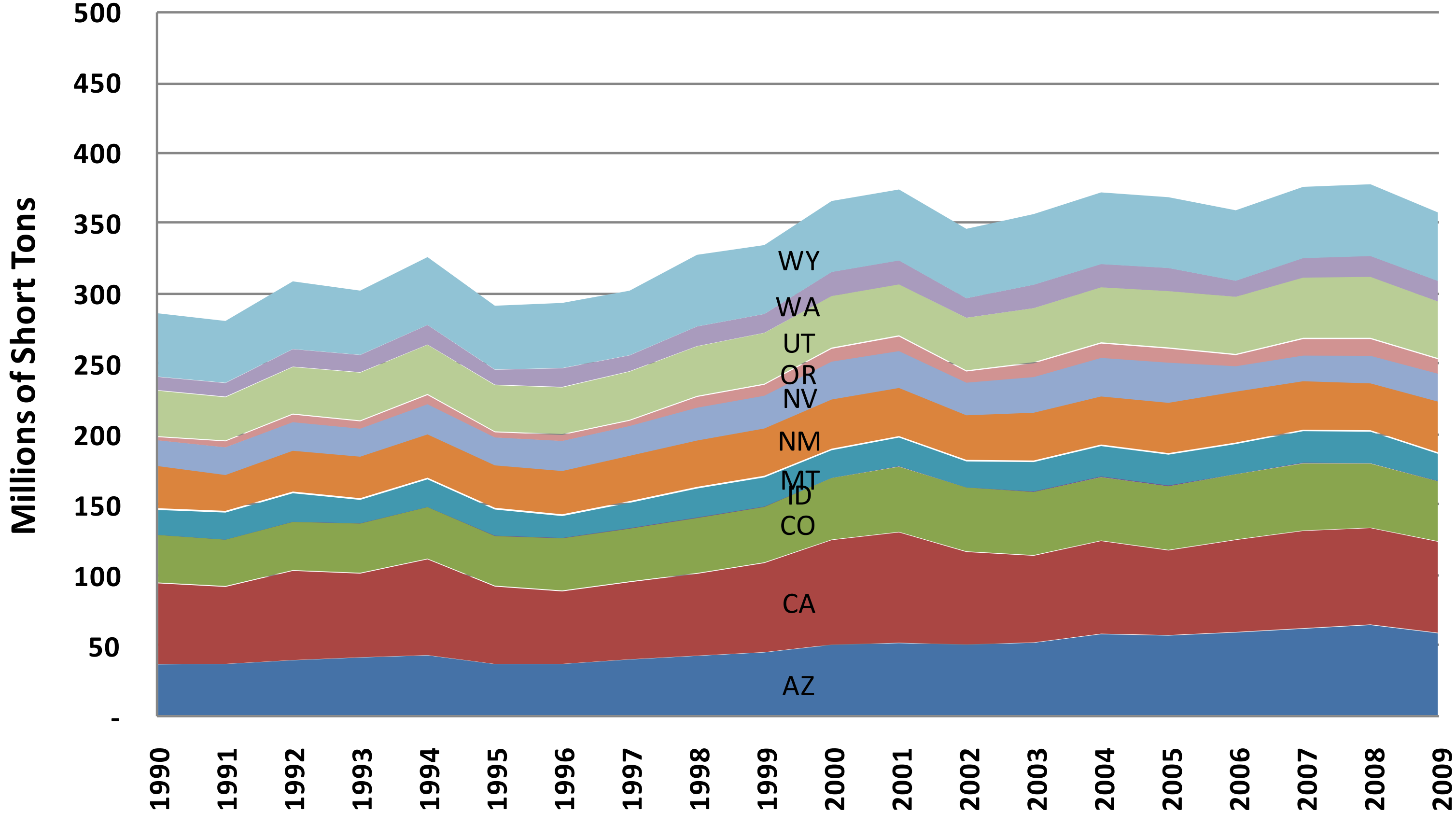
Location of New Renewable Resources

Western Interconnect



Generation Greenhouse (CO_2) Gas Emissions by State in the Western Interconnect



Source: EPA

Greenhouse Gas (CO_2) Reduction Schemes

Stochastic Case

1. Regional Greenhouse Gas Policies (30% probability)
    - State carbon reduction in CA, OR, WA, NM between 2014 and 2019
    - ~10% reduction below 2005 levels by 2020
    - Beginning in 2020 shift to National Climate Policy with 15% below 2005 levels by 2030
2. National Climate Policy (30% probability)
    - Federal legislation only applies beginning in 2015
    - ~15% below 2005 levels by 2020, ~35% below 2005 levels by 2030
3. National Carbon Tax (30% probability)
    - Federal legislation only applies
    - $33 per short ton, than 5% per year escalation
    - Begins in 2015
4. No Carbon Reductions (10% probability)
    - No carbon reduction scheme
    - State level emission performance standards apply and no new coal in US West

Deterministic Case

- Emissions reduced to the weighted average of four cases above

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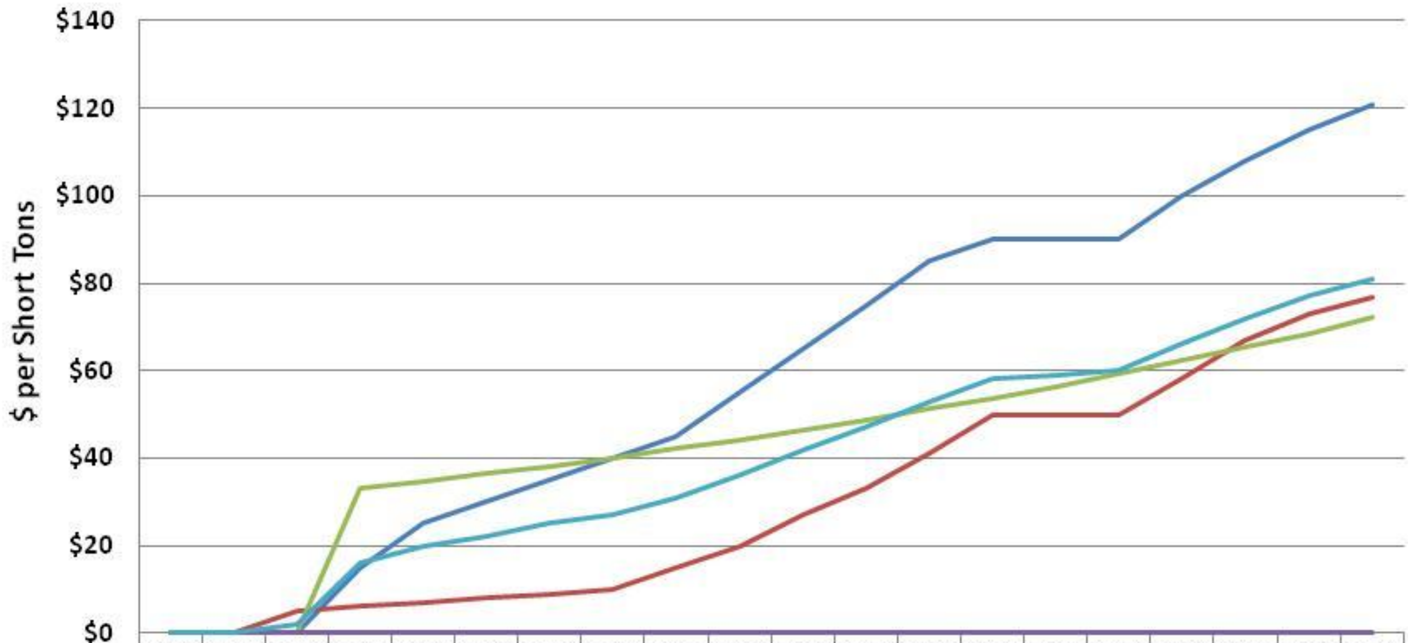
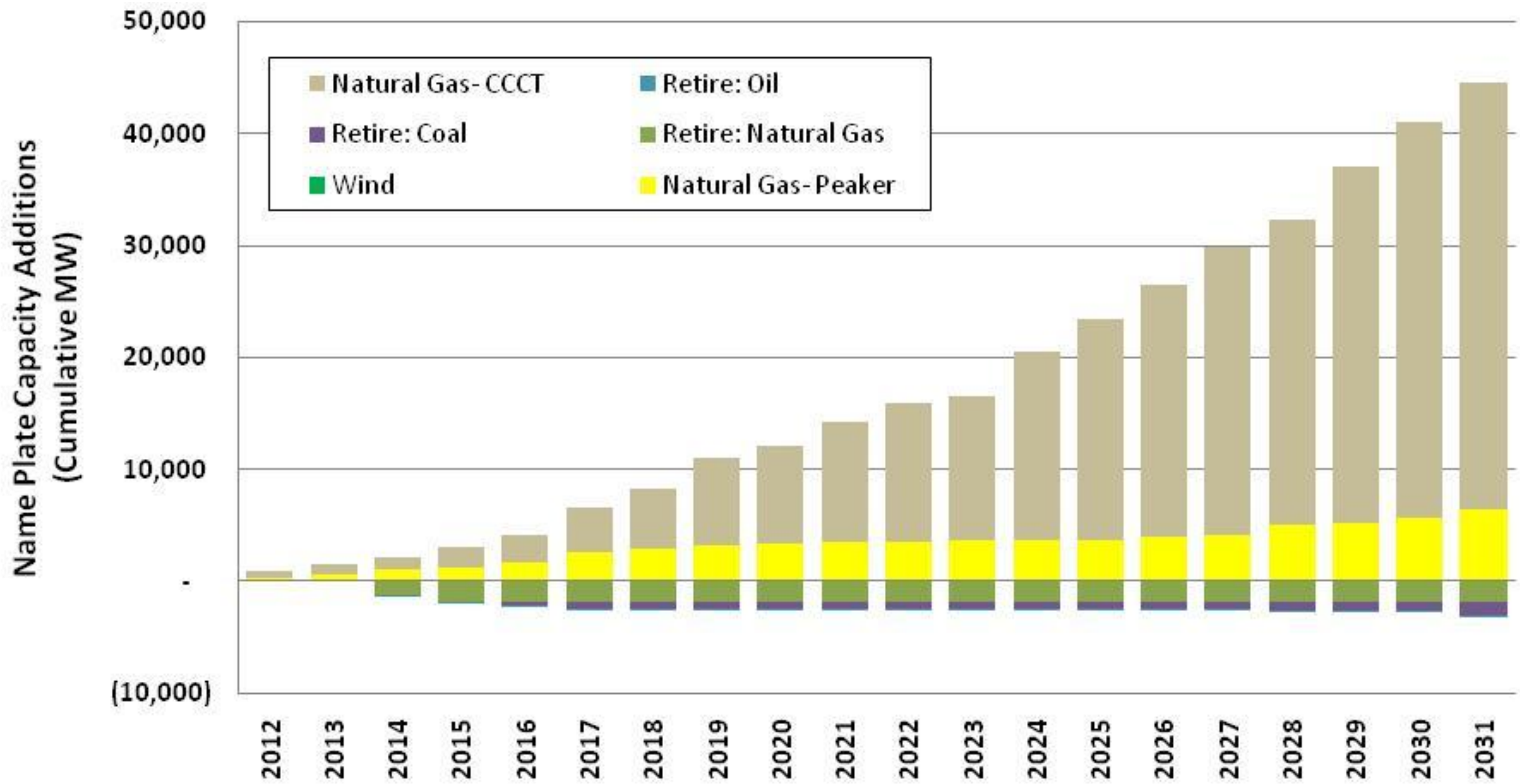
Resulting Greenhouse Gas (CO_2) Reduction Prices

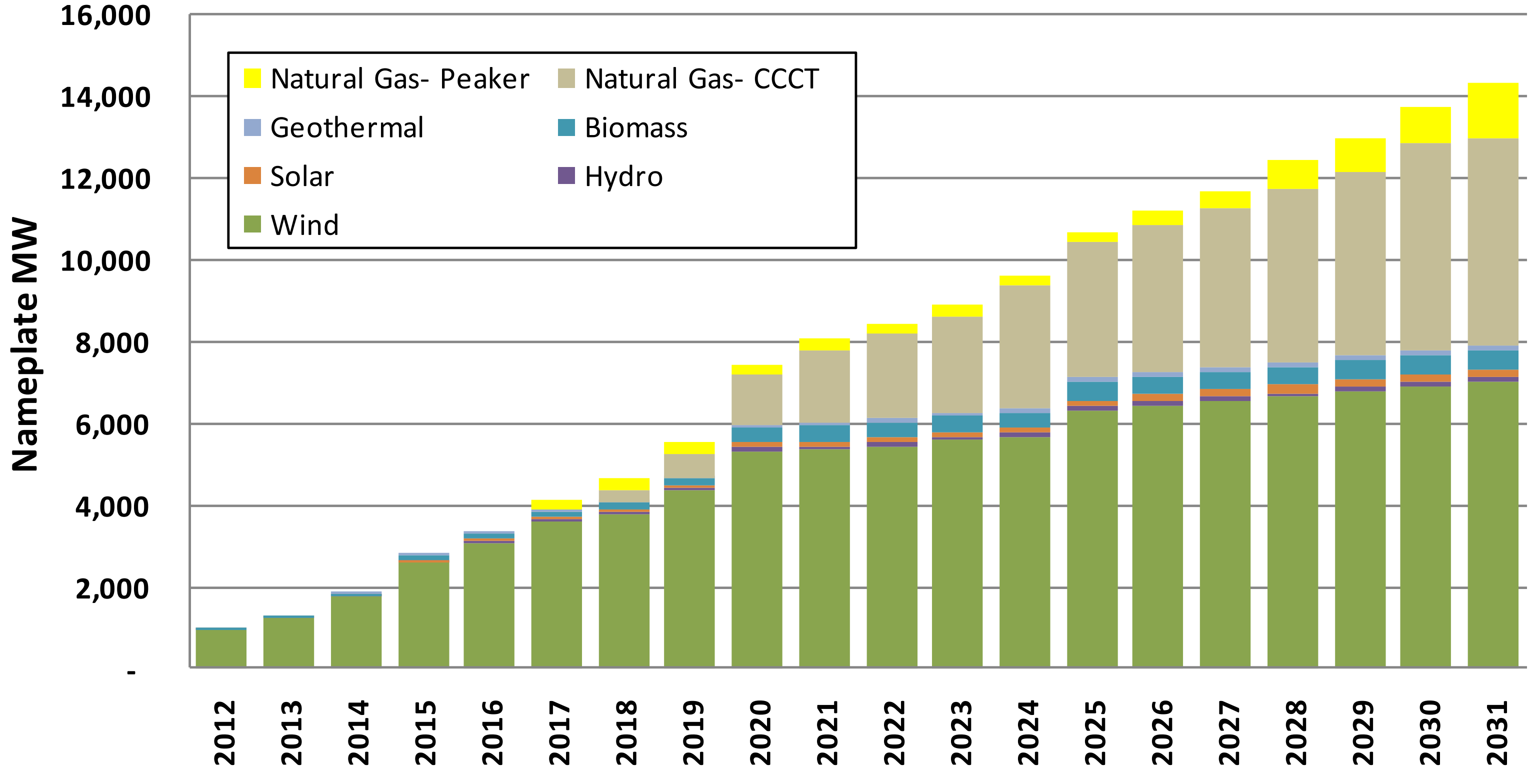


2015-2031 Levelized Price per Short Ton		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
$59.36	National Climate Policy	0	0	0	15	25	30	35	40	45	55	65	75	85	90	90	90	100	108	115	121
$28.02	Regional GHG Policies	0	0	5	6	7	8	9	10	15	20	27	33	41	50	50	50	58	67	73	77
$46.48	National Carbon Tax	0	0	0	33	35	36	38	40	42	44	46	49	51	54	56	59	62	65	69	72
$00.00	No GHG Reductions	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
$40.20	Expected Case	0	0	2	16	20	22	25	27	31	36	42	47	53	58	59	60	66	72	77	81

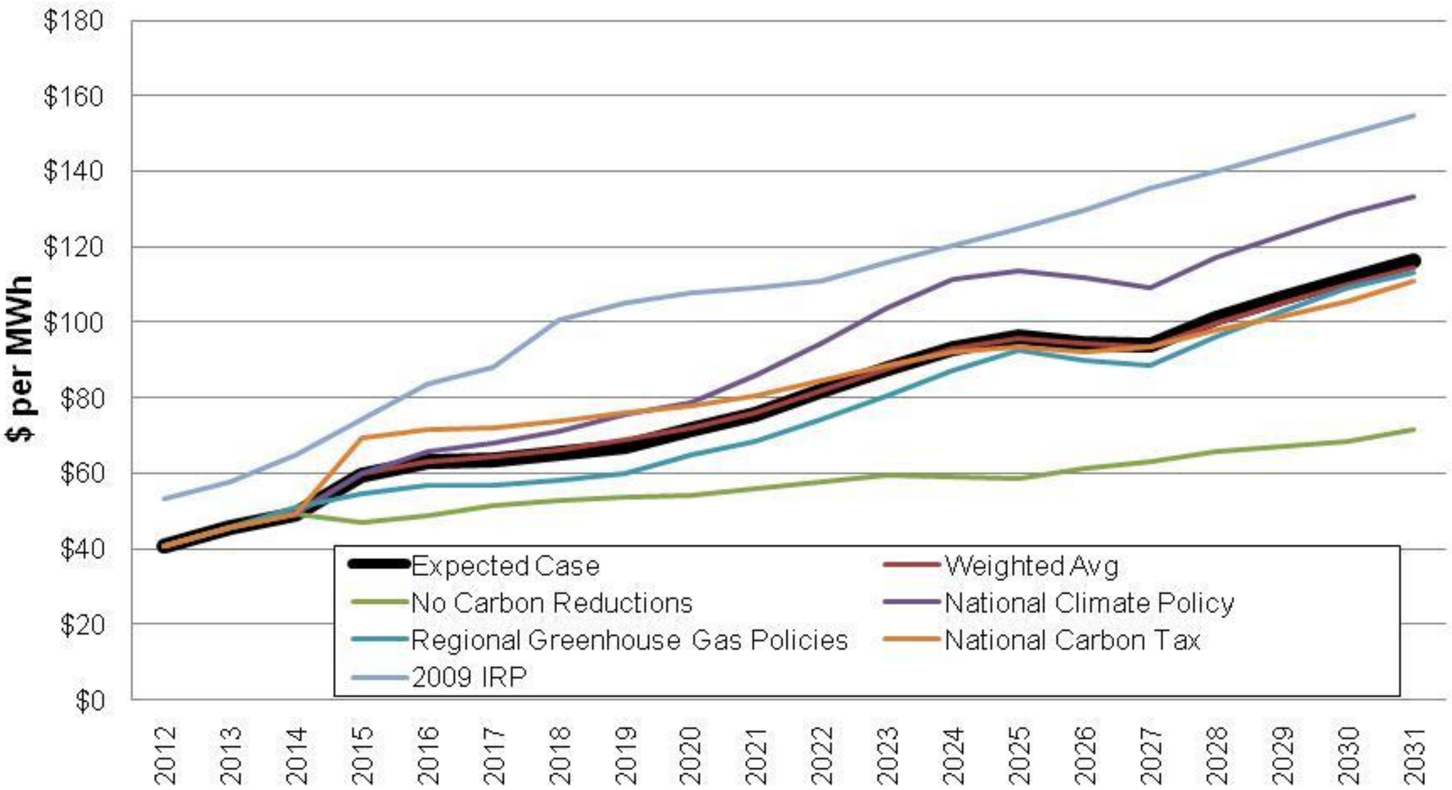
New Resource Selected to Meet Capacity Requirements in Western Interconnect



Northwest New Resources (RPS, Export, & Capacity)



Deterministic Mid-Columbia Annual Average Price Forecast



Deterministic Mid-C Annual Avg Price Forecast

Levelized Nominal Prices

Scheme	Levelized Price $/MWh 2012-31
2009 IRP Expected Case (Adjusted)	97.60
2011 IRP Expected Case	71.22
Scenarios	
Regional Greenhouse Gas Policies	66.91
National Climate Policy	78.94
National Carbon Tax	73.98
No Carbon Reductions	53.70
Weighted Average	71.32

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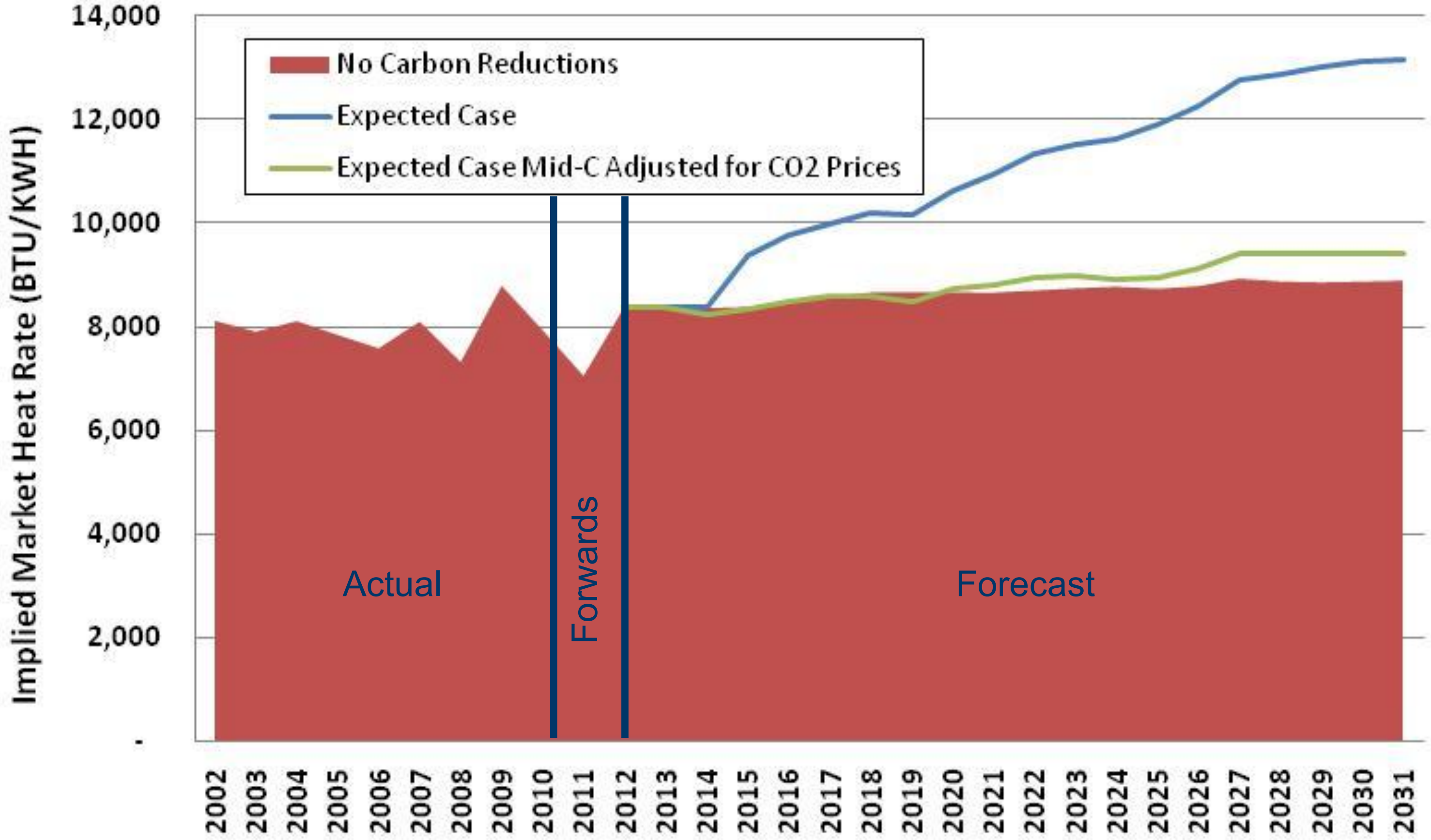
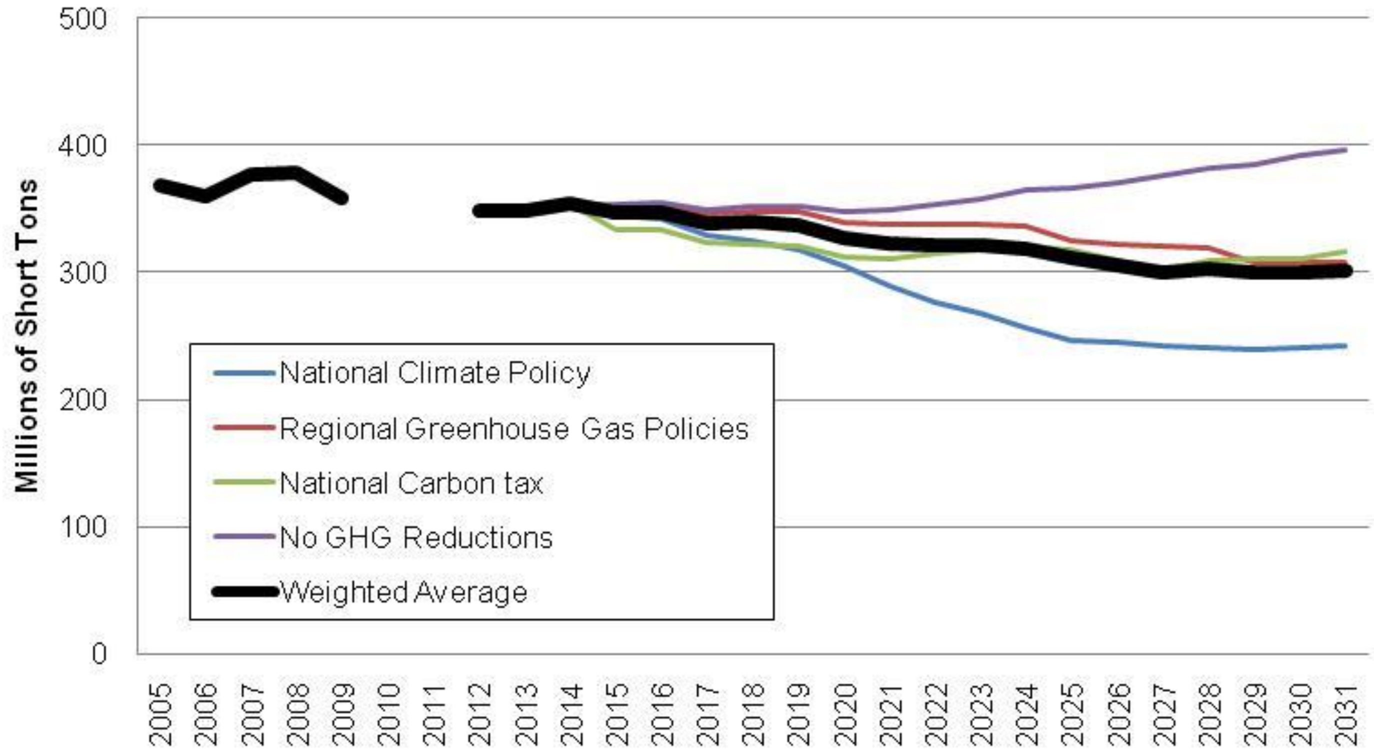
Deterministic Implied Market Heat Rates

(Mid-Columbia / Stanfield x 1,000)



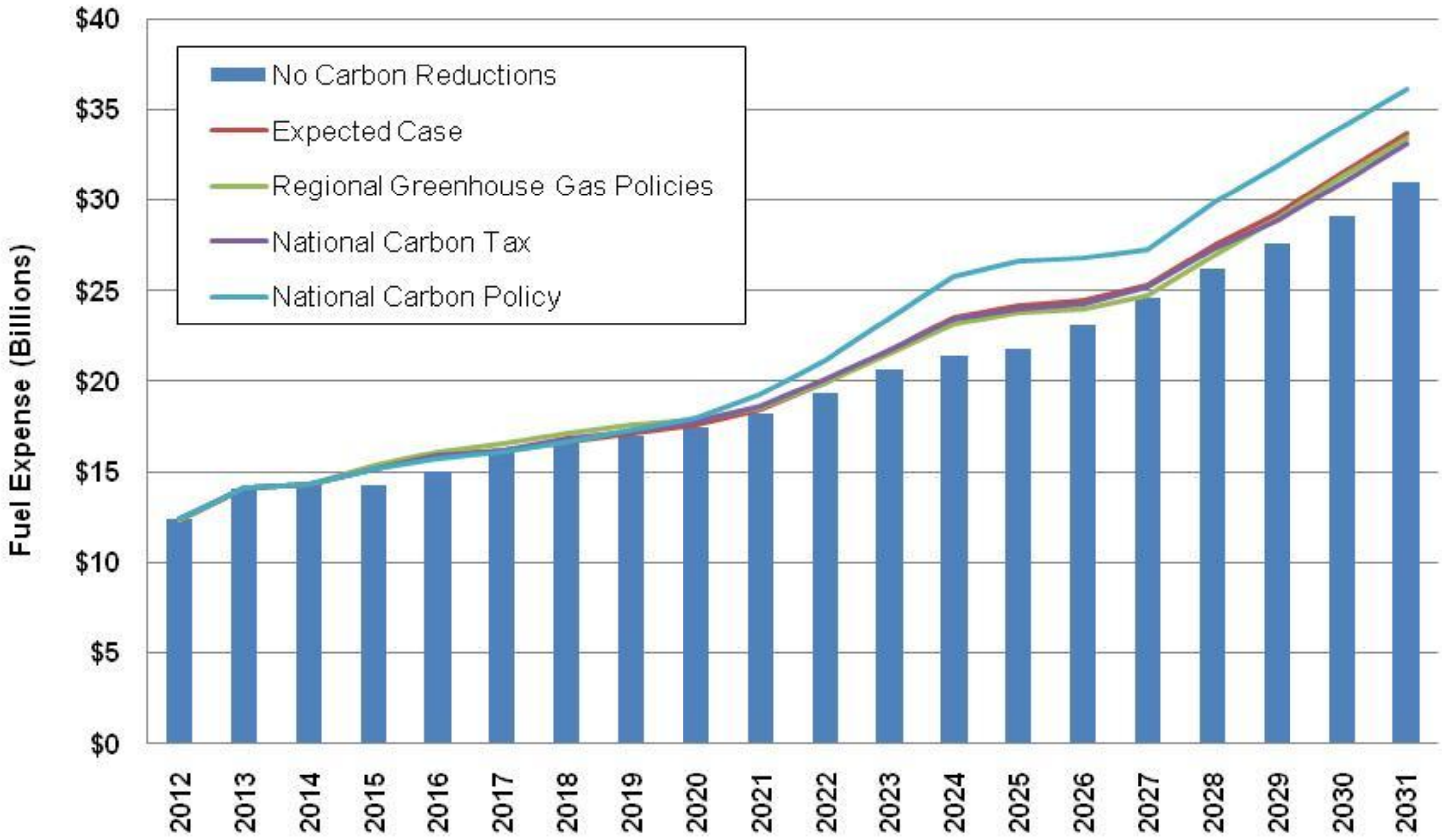
Deterministic Greenhouse Gas (CO_2) Levels

(US Western Interconnect)



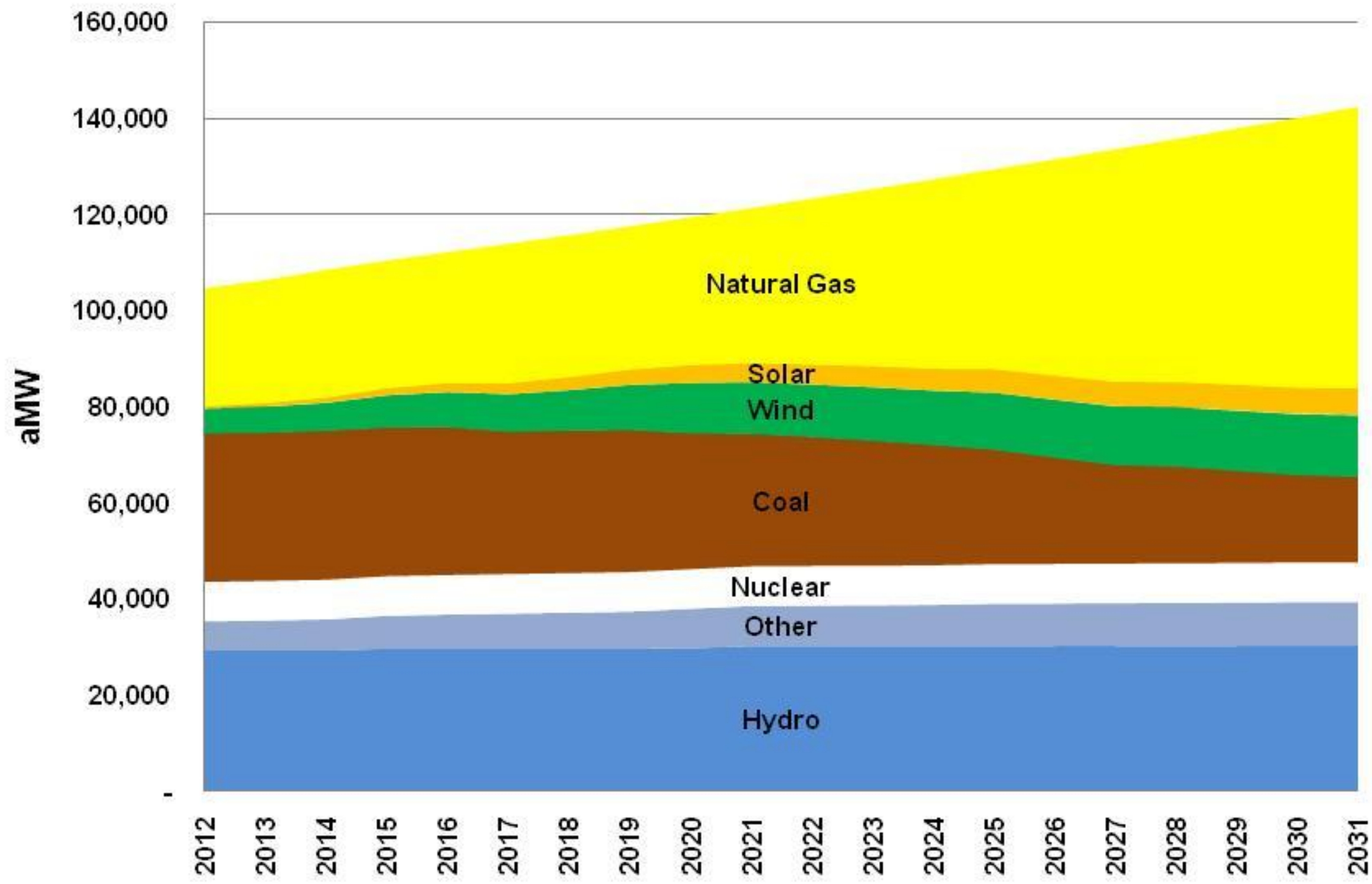
Total Generation Fuel Costs

US Western Interconnect



“Expected Case” Resource Energy Mix

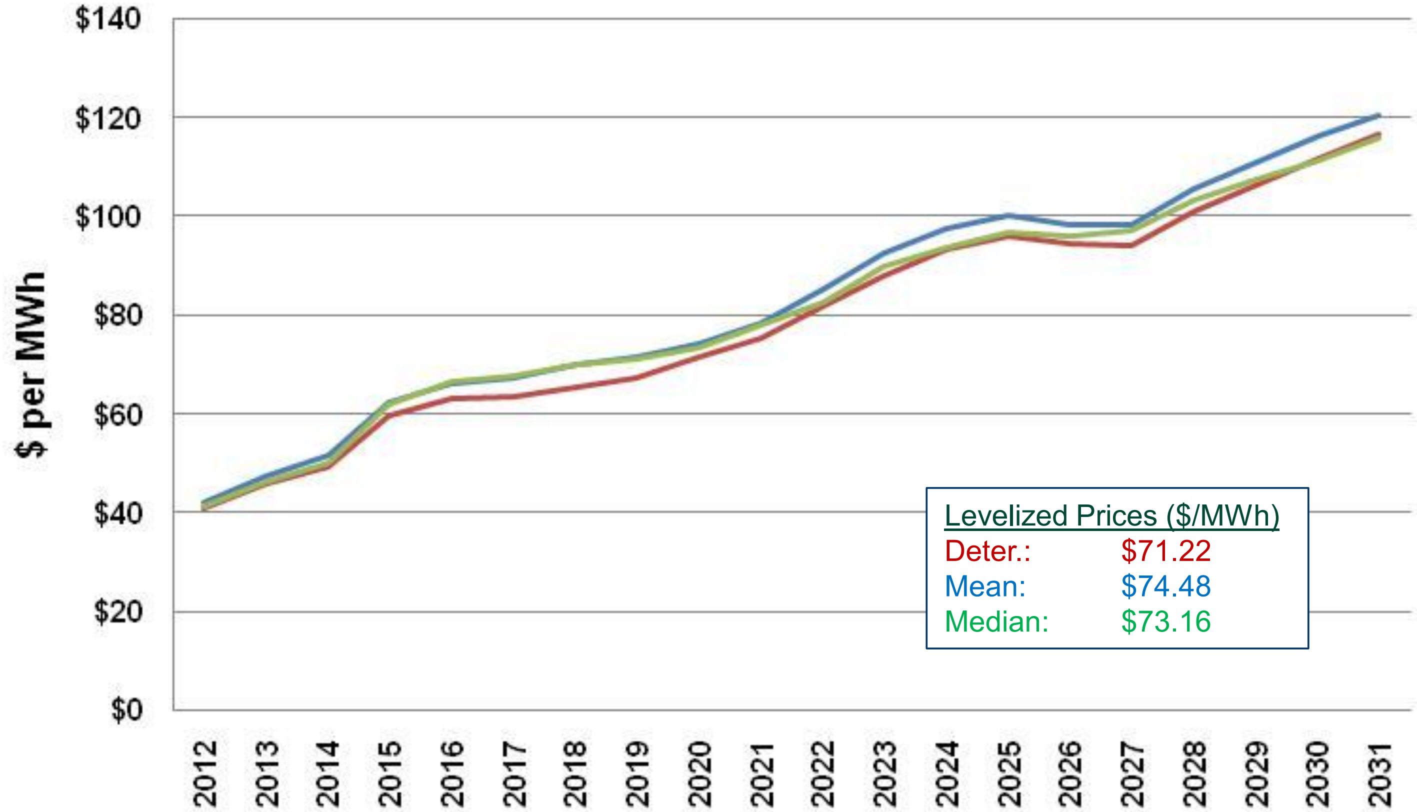
US Western Interconnect



Stochastic Modeling Changes From Last TAC Meeting

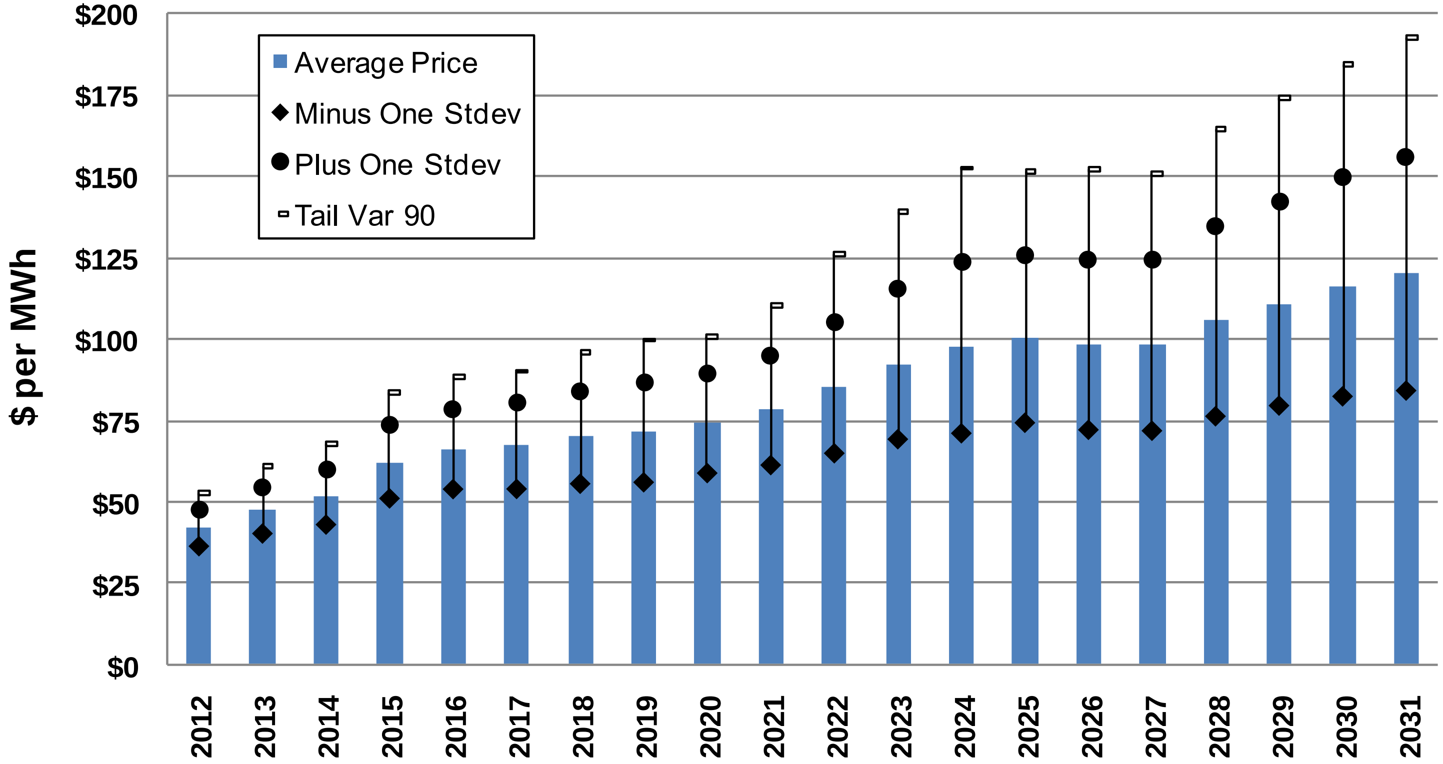
- Assumptions based on methodologies discussed in last TAC meeting, with some exceptions.
- Wind model randomly draws from 15 wind years for each study year, previous TAC discussed drawing from 50 wind years for the entire 20 years of each iteration.
- Oil and wood price escalation will use lognormal distributions.
- Natural gas price methodology is the same but will use historical month-to-month standard deviation.
- Adjustment developed for linking carbon prices to natural gas prices, no carbon reduction case will have ~10% reduction to natural gas prices

Stochastic Electric Market Prices Compared to Deterministic

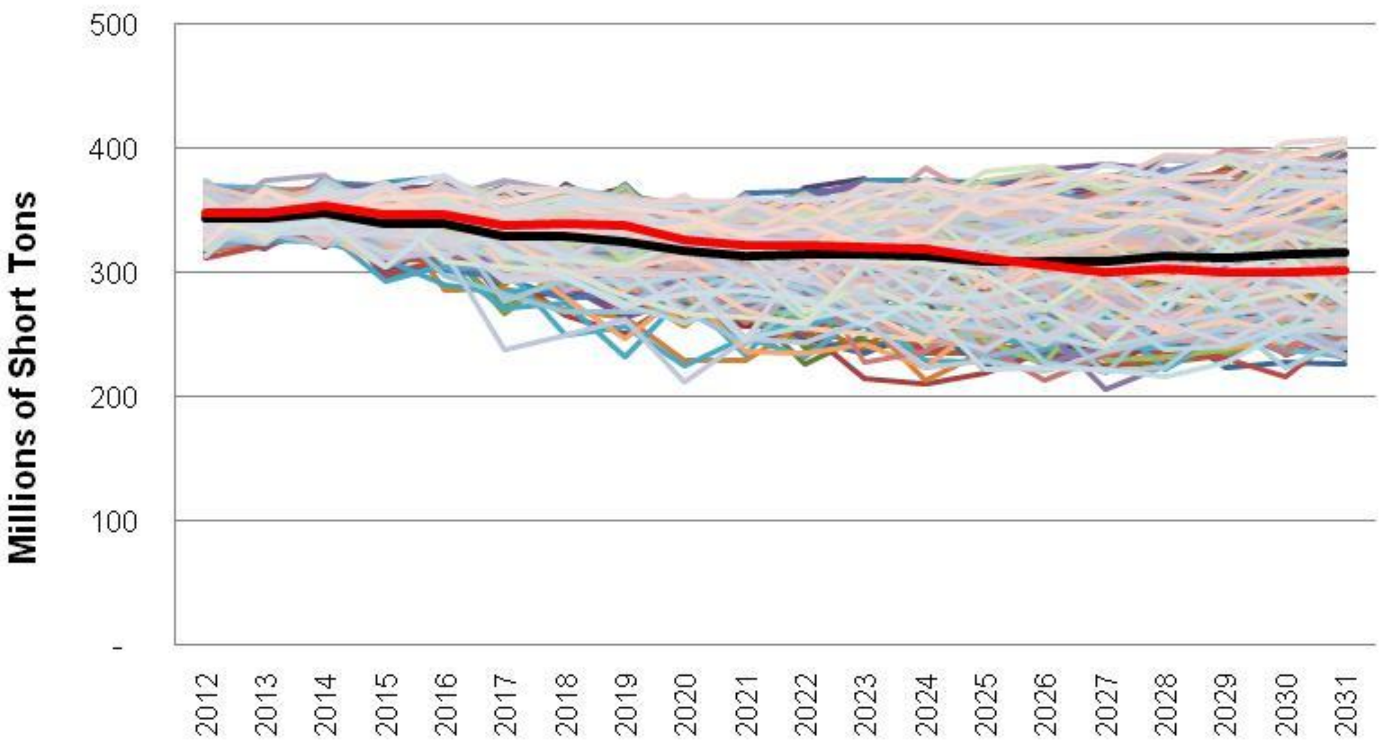


Range in Market Prices

Annual Flat Mid-Columbia



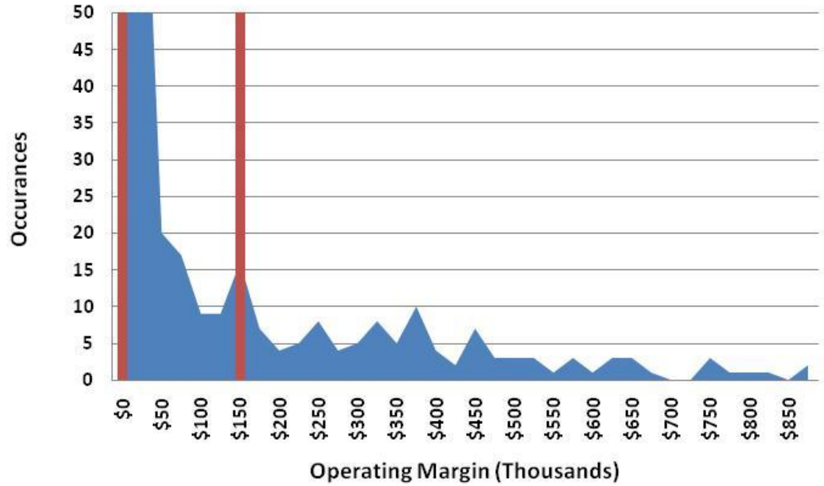
Range in US-Western Interconnect Carbon Emissions



Resource Valuations Deterministic vs Stochastic Example

Combined Cycle 2012 Operating Margin

Simple Cycle 2012 Operating Margin



Next Steps

1. Finalize "Expected Case" study
2. Portfolio Analysis
   - Preferred Resource Strategy
   - Efficient Frontier
   - Resource cost/availability sensitivities
3. Deterministic Market Scenario Studies
   - Resource portfolio scenario analysis
4. Stochastic Market Scenario Studies
   - Alternative "risk" markets; i.e. no carbon case, gas volatility
   - Alternative Efficient Frontier results

Resource Requirement Projections

Clint Kalich

Technical Advisory Committee Meeting #4

2011 Electric Integrated Resource Plan

February 3, 2011

Agenda

- Reliability Modeling Update
- Avista Reliance on Wholesale Marketplace
- Shift from 1-Hour to 18-Hour Peaking Period
- Regional Capacity Position
- Avista Reliance on Wholesale Marketplace
- Avista Resource Positions
- Conclusions

Reliability Modeling Update

- Completed Advanced Model Late 2010
  - Sophisticated hydro logic
  - Weather-dependent thermal logic
  - Robust representation of hourly loads
  - Time-series representation of data
- Numerous Runs of Reliability Model
- Results Indicate Key Assumption is Market Availability
  - More important than hydro, load, thermal resources
- Yet Don't Really Know What The Broader Market Looks Like
- Negates Most Benefits (at least for IRP) of Reliability Model
- Therefore a Simpler Approach Was Followed

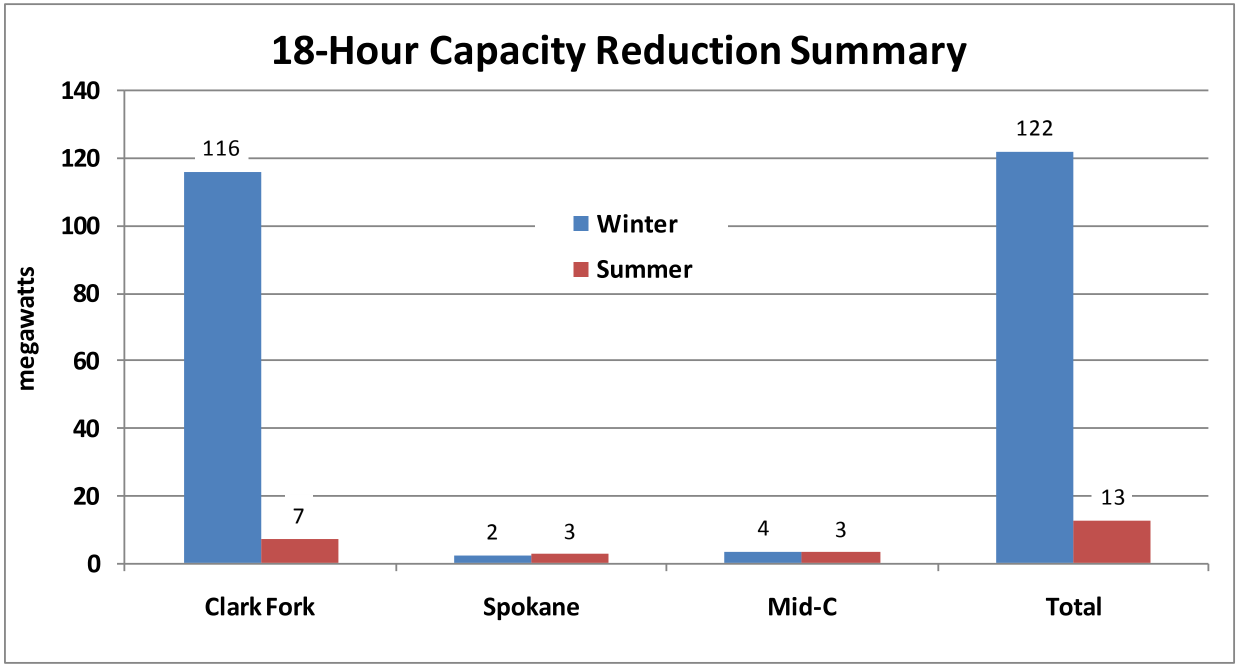
One-Hour vs. 18-Hour Sustained Peak

- Historically Region (and Avista) Has Planned on One-Hour Peak Demand Scenarios
- Similar to Other Regions in WECC & NERC
- Works Great for Thermal Systems Without Fuel Limits
- Doesn’t Work As Well for Hydro Systems with a Limited Fuel Source
- Region Has Shifted from a One-Hour Peak to a 3-Day, 6 Hours Per Day Sustained Demand Event
- AKA 18-Hour Sustained Peak Event

One-Hour vs. 18-Hour Sustained Peak

- Affects (Lowers) Hydro Resource and Load Capabilities
- No Assumed Impact on Thermal Operations
  - Except output is affected by assumed peak condition ambient temperatures
- Avista's Method Relies Substantially on Northwest Power and Conservation Council's ("NWPP") Work
  - 24% Winter and 23% Summer Planning Margin
  - Compares to 15% assumption in 2009 IRP
  - Essentially the same as 2009 IRP assumption but operating reserves are added

Hydro 18-Hour Sustained Capacity Impacts Avista's System



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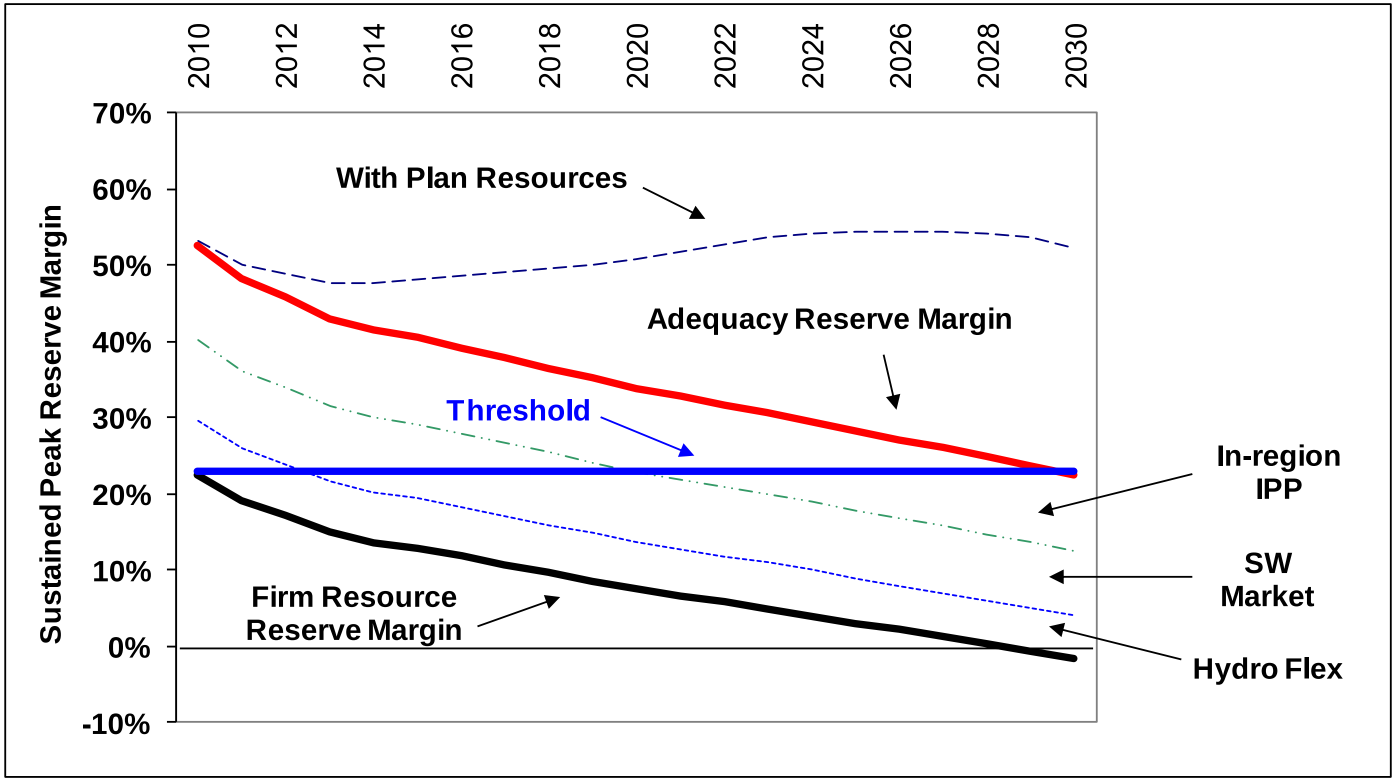
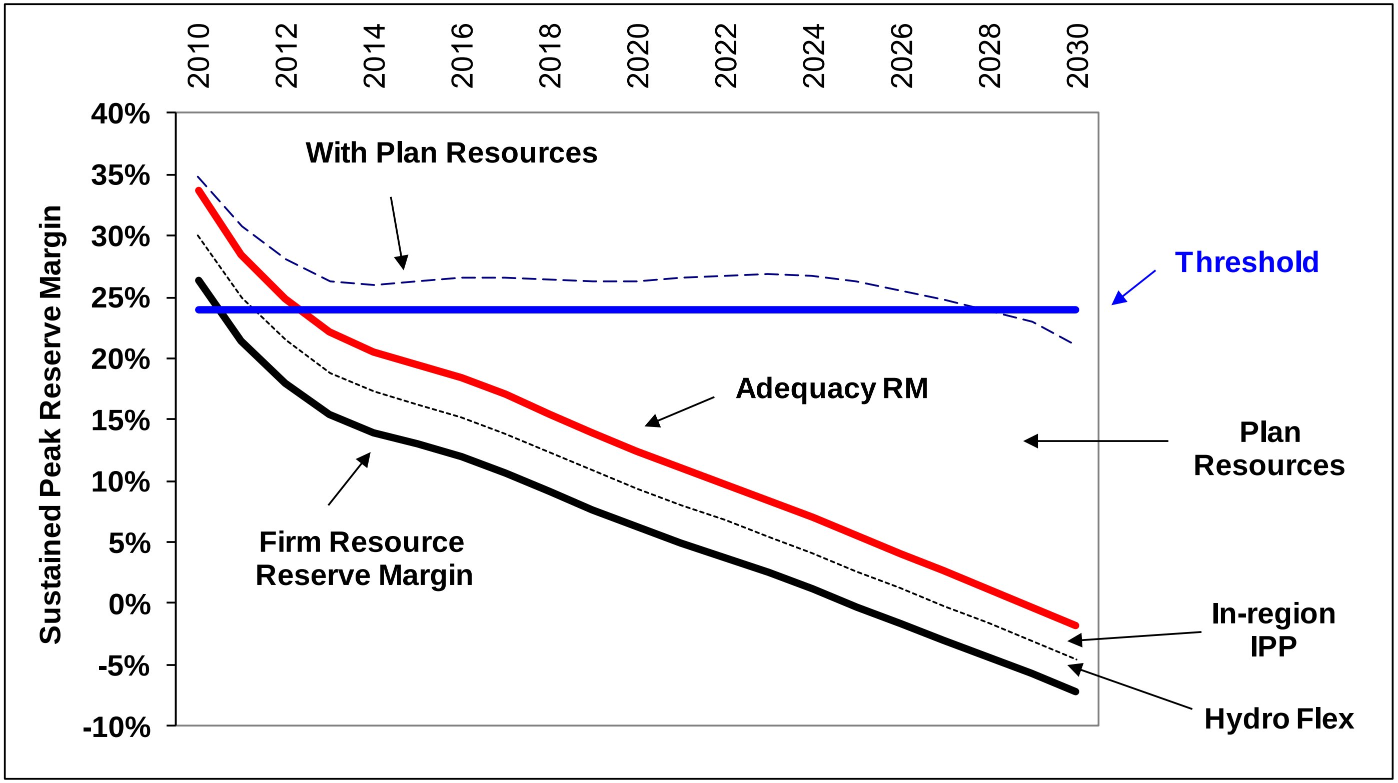
Regional Capacity Position
NPCC Winter Assessment



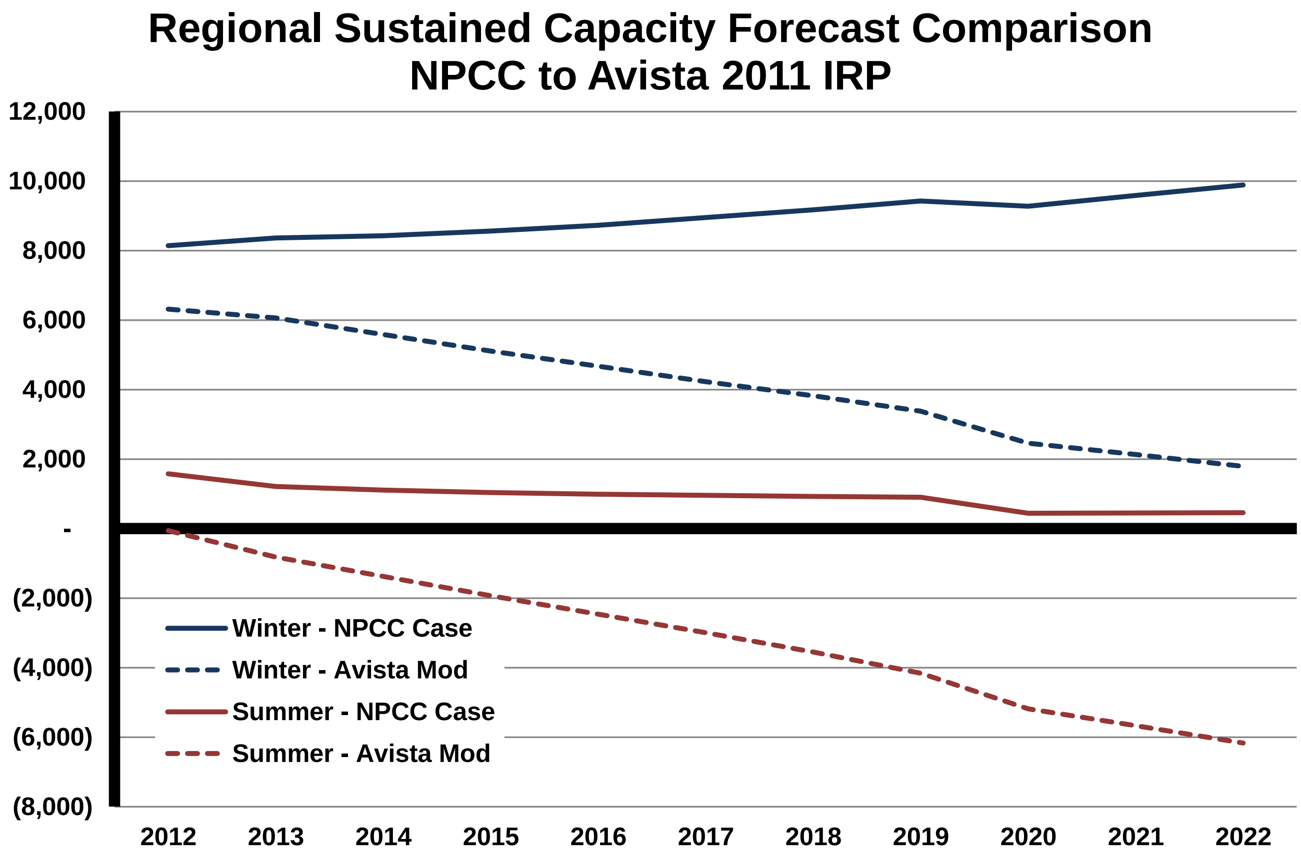
Regional Capacity Position
NPCC Summer Assessment



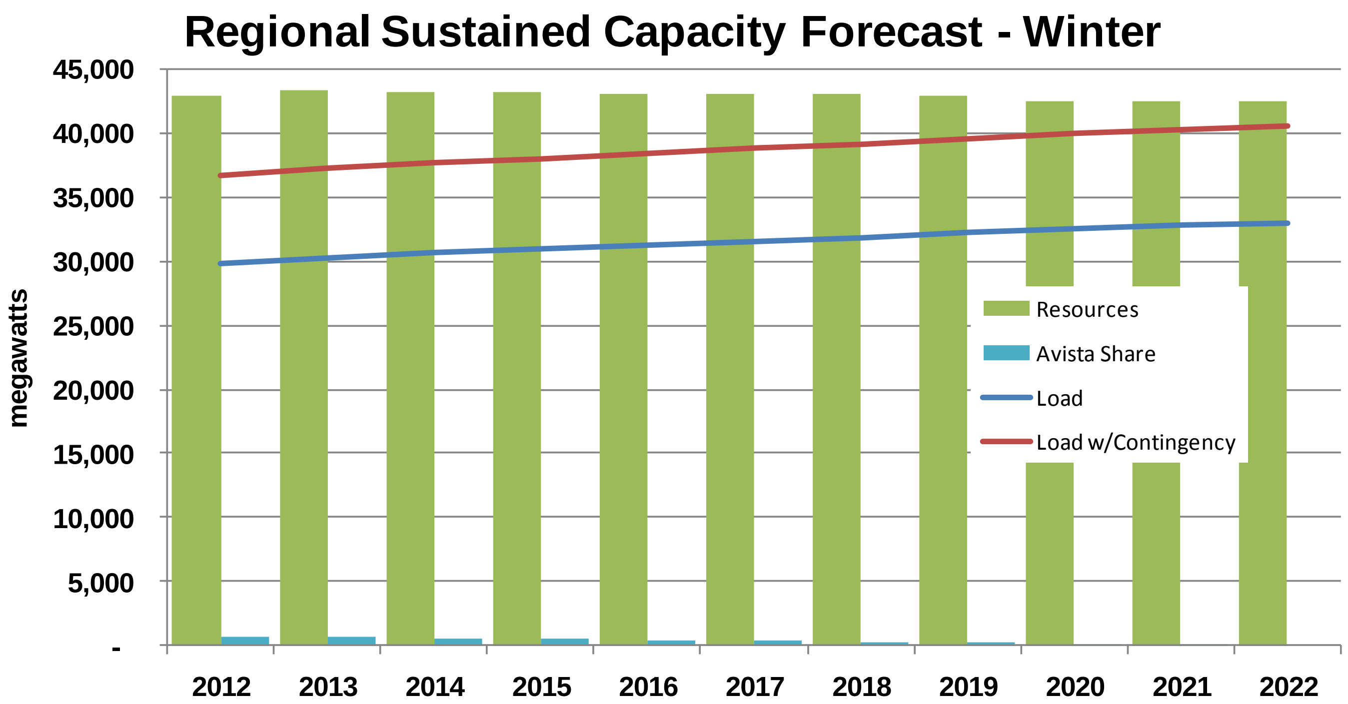
Avista Reliance On Wholesale Market

- Avista Relies on a “Modified” NWPP Load and Resource Balance
  - Ignore aggressive conservation assumption
    - use Wood-Mac forecast of 0.9% regional load growth
  - No capacity contribution for wind (-250 MW)
  - 10% wind capacity reserves (-500 MW)
    - Do not plan to interrupt wind at peak
- 5.5% of Regional Surplus is Available to Avista
  - Phased out over 10 years
    - 10% reduction per year

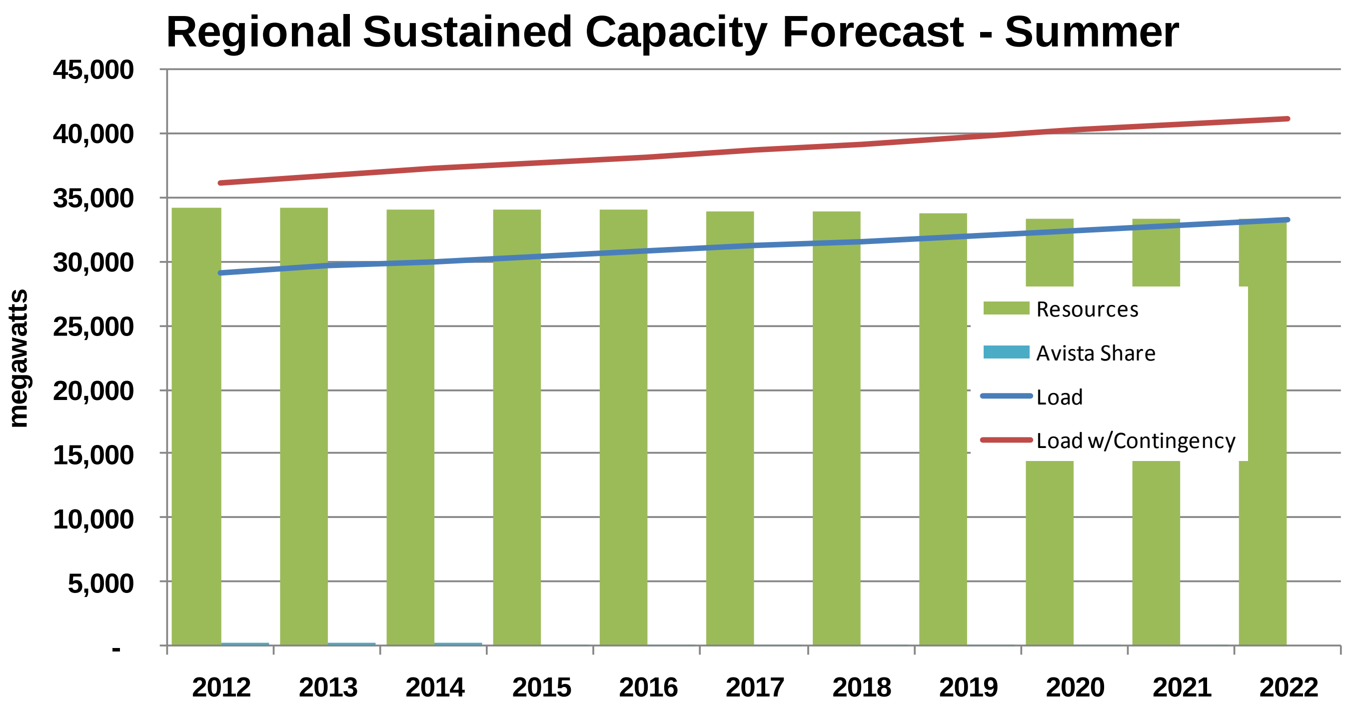
Regional Capacity Position Comparison



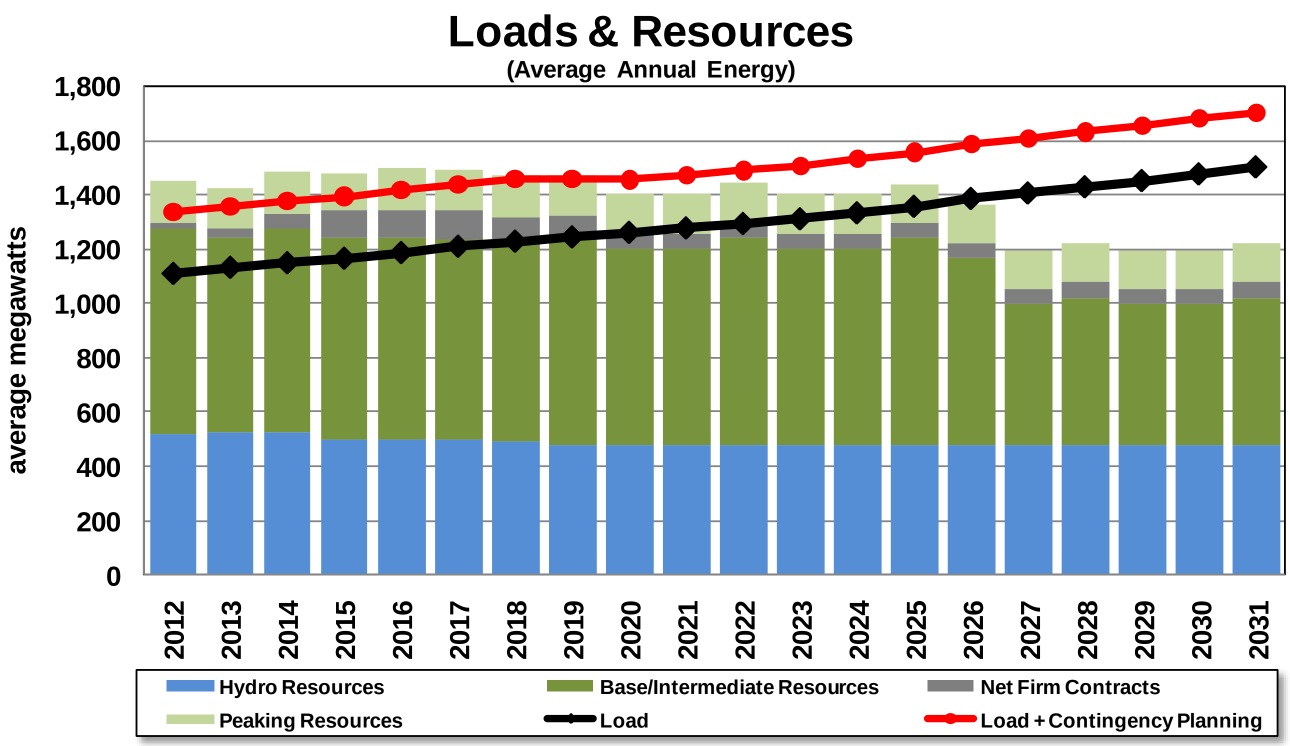
Regional Capacity Position Winter



Regional Sustained Capacity Position Summer



Avista Energy Position



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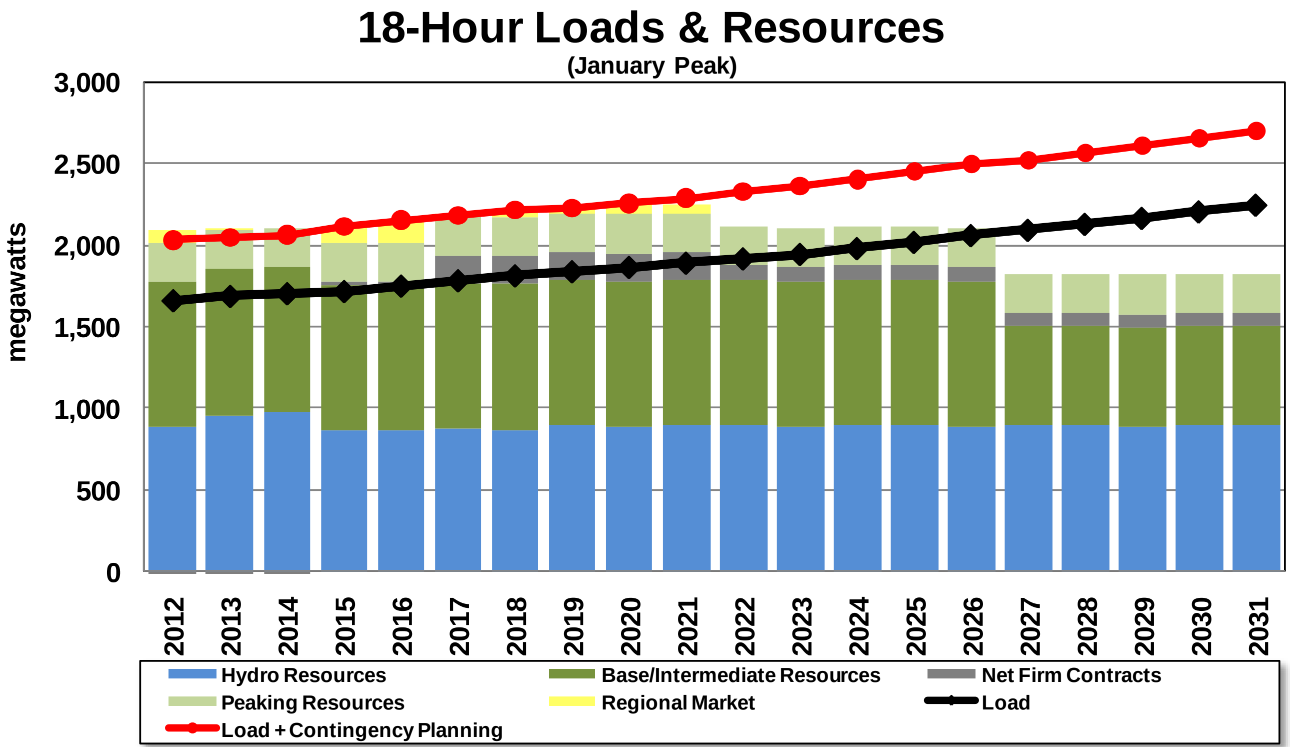
Avista Energy Position

		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
	REQUIREMENTS																				
1	Native Load	-1,109	-1,131	-1,148	-1,165	-1,186	-1,209	-1,228	-1,244	-1,260	-1,277	-1,293	-1,310	-1,333	-1,357	-1,386	-1,406	-1,429	-1,452	-1,477	-1,502
2	Firm Power Sales	-138	-124	-107	-57	-57	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5
3	**Total Requirements**	**-1,247**	**-1,256**	**-1,255**	**-1,222**	**-1,243**	**-1,214**	**-1,233**	**-1,249**	**-1,266**	**-1,282**	**-1,298**	**-1,316**	**-1,338**	**-1,362**	**-1,391**	**-1,411**	**-1,434**	**-1,457**	**-1,482**	**-1,508**
	RESOURCES																				
4	Firm Power Purchases	160	160	160	160	160	109	108	88	62	62	61	61	61	61	61	61	61	61	61	61
5	Hydro	519	525	528	496	496	496	492	481	481	481	481	481	481	481	481	481	481	481	481	481
6	Baseload/Intermediate Resources	755	714	751	744	746	741	724	758	721	721	758	721	721	758	684	515	541	515	515	541
7	Wind Resources	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	**Total Resources**	**1,435**	**1,399**	**1,439**	**1,401**	**1,402**	**1,346**	**1,324**	**1,327**	**1,264**	**1,264**	**1,301**	**1,263**	**1,263**	**1,300**	**1,226**	**1,057**	**1,083**	**1,057**	**1,057**	**1,083**
9	**POSITION**	**188**	**144**	**184**	**179**	**159**	**131**	**91**	**78**	**-2**	**-18**	**2**	**-53**	**-75**	**-62**	**-165**	**-354**	**-351**	**-400**	**-425**	**-425**
	CONTINGENCY PLANNING																				
10	Peaking Resources	153	153	153	138	153	154	153	147	146	145	147	146	145	147	146	145	147	146	145	147
11	Contingency	-227	-228	-228	-229	-230	-231	-232	-214	-195	-196	-197	-198	-199	-200	-201	-202	-203	-203	-204	-199
12	**CONTINGENCY NET POSITION**	**113**	**69**	**109**	**88**	**82**	**54**	**12**	**11**	**-51**	**-69**	**-48**	**-105**	**-128**	**-115**	**-221**	**-411**	**-407**	**-458**	**-484**	**-476**
	Energy Margin	**15%**	**11%**	**15%**	**15%**	**13%**	**11%**	**7%**	**6%**	**0%**	**-1%**	**0%**	**-4%**	**-6%**	**-5%**	**-12%**	**-25%**	**-24%**	**-27%**	**-29%**	**-28%**

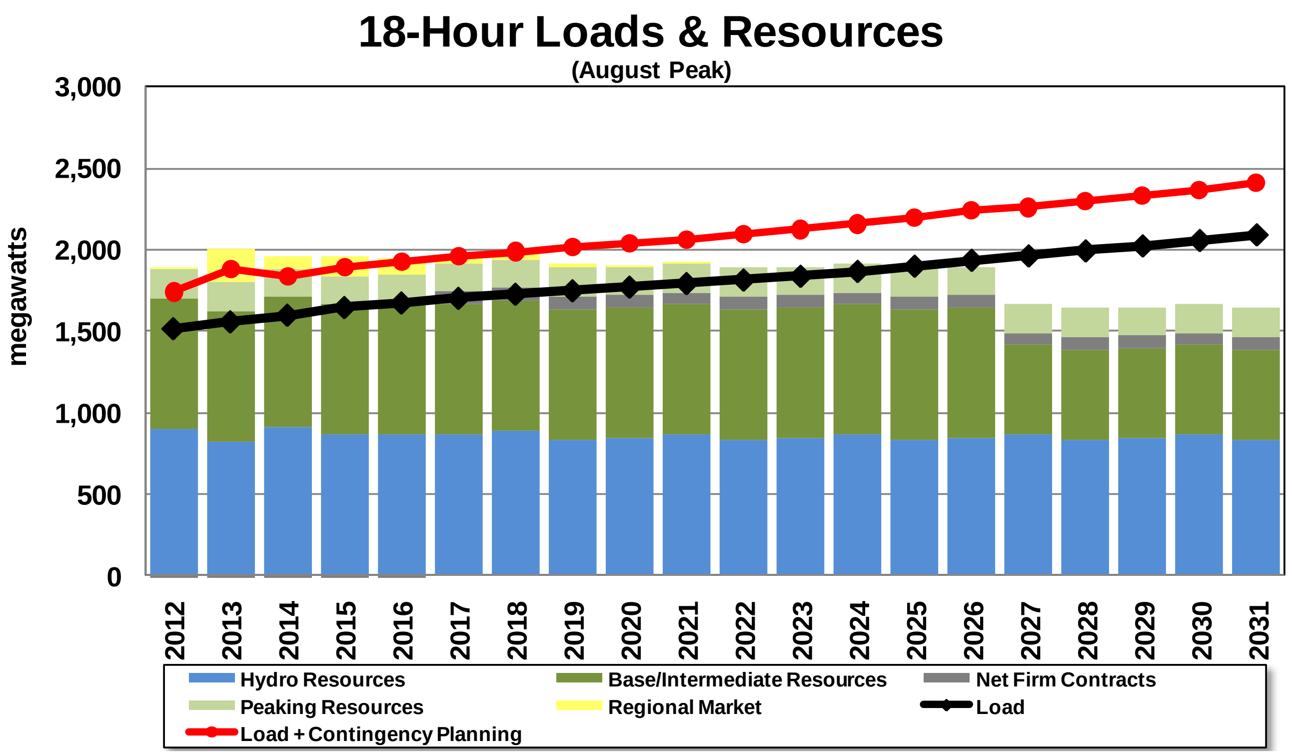
Avista Winter Capacity Positions



Avista Winter Capacity Positions

		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
	REQUIREMENTS																				
1	Native Load	-1,661	-1,688	-1,704	-1,718	-1,751	-1,784	-1,814	-1,839	-1,866	-1,892	-1,919	-1,946	-1,982	-2,020	-2,062	-2,094	-2,131	-2,168	-2,208	-2,249
2	Firm Power Sales	-238	-237	-207	-157	-157	-7	-7	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6
3	**Total Requirements**	**-1,899**	**-1,925**	**-1,911**	**-1,874**	**-1,908**	**-1,790**	**-1,821**	**-1,846**	**-1,873**	**-1,899**	**-1,925**	**-1,953**	**-1,988**	**-2,027**	**-2,068**	**-2,101**	**-2,138**	**-2,174**	**-2,214**	**-2,256**
	RESOURCES																				
4	Firm Power Purchases	175	175	175	175	175	175	175	173	173	173	90	90	90	90	90	90	90	90	90	90
5	Hydro Resources	882	957	973	861	861	872	868	896	887	896	896	887	896	896	887	896	896	887	896	896
6	Base Load Thermals	895	895	895	895	895	895	895	895	895	895	895	895	895	895	895	606	606	606	606	606
7	Wind Resources	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	Peaking Units	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242
9	**Total Resources**	**2,194**	**2,269**	**2,285**	**2,173**	**2,173**	**2,185**	**2,180**	**2,206**	**2,197**	**2,206**	**2,124**	**2,114**	**2,123**	**2,123**	**2,114**	**1,833**	**1,833**	**1,825**	**1,833**	**1,833**
10	**PEAK POSITION**	**295**	**344**	**374**	**299**	**266**	**394**	**360**	**360**	**325**	**307**	**199**	**162**	**135**	**96**	**46**	**-267**	**-304**	**-350**	**-381**	**-422**
	RESERVE PLANNING																				
11	Required Operating Reserves	-162	-164	-163	-162	-165	-158	-160	-163	-164	-167	-173	-176	-179	-182	-186	-170	-171	-171	-172	-173
12	Available Operating Reserves	23	42	42	8	8	8	8	34	34	34	34	34	34	34	34	34	34	34	34	34
13	Planning Margin	-233	-236	-239	-240	-245	-250	-254	-258	-261	-265	-269	-272	-277	-283	-289	-293	-298	-304	-309	-315
14	**Total Reserve Planning**	**-372**	**-358**	**-360**	**-394**	**-402**	**-399**	**-406**	**-387**	**-391**	**-398**	**-408**	**-414**	**-422**	**-431**	**-441**	**-429**	**-435**	**-441**	**-447**	**-454**
15	**Peak Position**	**-76**	**-14**	**14**	**-95**	**-136**	**-5**	**-46**	**-26**	**-67**	**-91**	**-209**	**-253**	**-288**	**-335**	**-395**	**-697**	**-739**	**-790**	**-828**	**-876**
16	**Planning Margin**	**16%**	**18%**	**20%**	**16%**	**14%**	**22%**	**20%**	**20%**	**17%**	**16%**	**10%**	**8%**	**7%**	**5%**	**2%**	**-13%**	**-14%**	**-16%**	**-17%**	**-19%**
17	**Avista Share of Excess NW Capacity**	737	656	565	477	400	326	255	186	115	56	0	0	0	0	0	0	0	0	0	0
18	**Peak Position Net Market**	**661**	**642**	**579**	**382**	**264**	**321**	**209**	**159**	**48**	**(35)**	**(209)**	**(253)**	**(288)**	**(335)**	**(395)**	**(697)**	**(739)**	**(790)**	**(828)**	**(876)**

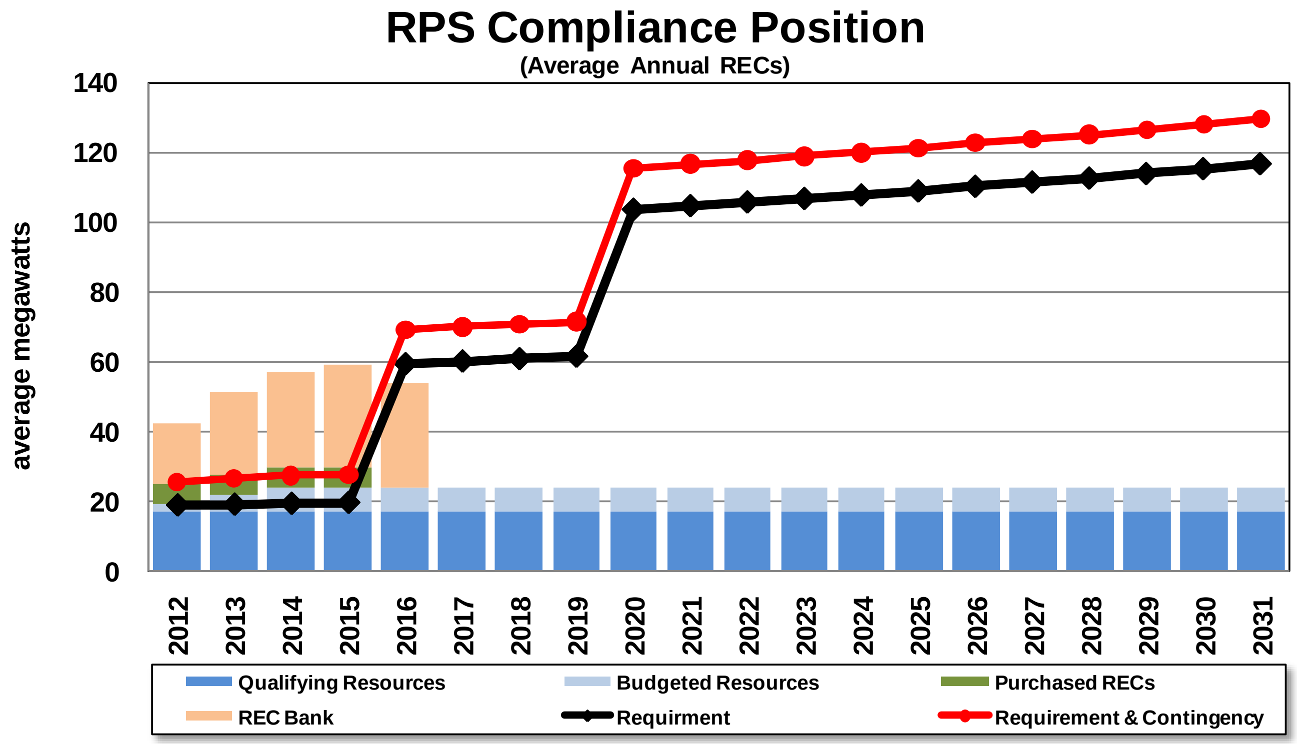
Avista Summer Capacity Positions



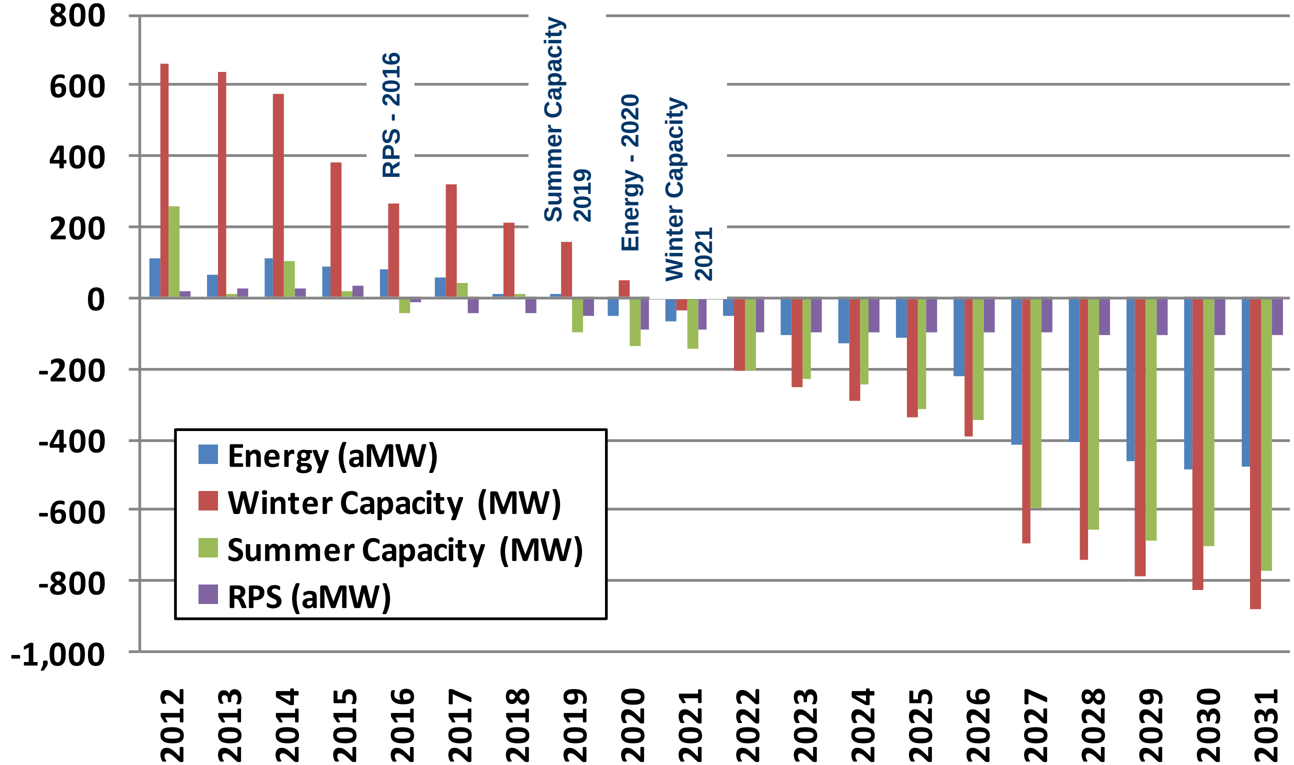
Avista Summer Capacity Positions

		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
	REQUIREMENTS																				
1	Native Load	-1,514	-1,556	-1,597	-1,644	-1,673	-1,701	-1,727	-1,748	-1,771	-1,793	-1,815	-1,838	-1,868	-1,900	-1,937	-1,964	-1,995	-2,026	-2,059	-2,094
2	Contracts Obligations	-239	-214	-208	-158	-158	-8	-8	-8	-8	-8	-8	-8	-8	-8	-8	-8	-8	-8	-8	-8
3	**Total Requirements**	**-1,753**	**-1,770**	**-1,805**	**-1,802**	**-1,831**	**-1,709**	**-1,735**	**-1,756**	**-1,778**	**-1,800**	**-1,822**	**-1,846**	**-1,876**	**-1,908**	**-1,944**	**-1,972**	**-2,002**	**-2,033**	**-2,067**	**-2,102**
	RESOURCES																				
4	Contracts Rights	86	86	86	86	86	86	86	82	82	82	82	82	82	82	82	82	82	82	82	82
5	Hydro Resources	904	823	907	864	871	866	887	837	845	864	837	845	864	837	845	864	837	845	864	837
6	Base Load Thermals	799	799	799	799	799	799	799	799	799	799	799	799	799	799	799	551	551	551	551	551
7	Wind Resources	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	Peaking Units	176	176	176	176	176	176	176	176	176	176	176	176	176	176	176	176	176	176	176	176
9	**Total Resources**	**1,964**	**1,884**	**1,968**	**1,925**	**1,932**	**1,927**	**1,948**	**1,895**	**1,903**	**1,922**	**1,895**	**1,902**	**1,921**	**1,894**	**1,902**	**1,673**	**1,646**	**1,653**	**1,673**	**1,646**
10	**PEAK POSITION**	**212**	**114**	**163**	**123**	**101**	**218**	**213**	**139**	**124**	**121**	**72**	**56**	**46**	**-14**	**-42**	**-299**	**-357**	**-380**	**-394**	**-456**
	RESERVE PLANNING																				
11	Required Operating Reserves	-153	-156	-159	-160	-162	-155	-157	-160	-161	-163	-165	-167	-169	-172	-173	-157	-156	-157	-159	-158
12	Available Operating Reserves	155	66	171	159	159	159	161	158	158	161	158	158	161	158	158	161	158	158	161	158
13	Planning Margin	-227	-233	-240	-247	-251	-255	-259	-262	-266	-269	-272	-276	-280	-285	-290	-295	-299	-304	-309	-314
14	**Total Reserve Planning**	**-227**	**-324**	**-240**	**-248**	**-255**	**-255**	**-259**	**-264**	**-269**	**-271**	**-279**	**-285**	**-289**	**-298**	**-305**	**-295**	**-299**	**-304**	**-309**	**-314**
15	**Peak Position**	**-16**	**-211**	**-77**	**-125**	**-154**	**-38**	**-46**	**-125**	**-144**	**-150**	**-207**	**-228**	**-244**	**-312**	**-348**	**-593**	**-656**	**-684**	**-703**	**-770**
16	**Planning Margin**	**12%**	**6%**	**9%**	**7%**	**6%**	**13%**	**12%**	**8%**	**7%**	**7%**	**4%**	**3%**	**2%**	**-1%**	**-2%**	**-15%**	**-18%**	**-19%**	**-19%**	**-22%**
17	**Avista Share of Excess NW Capacity**	275	221	178	141	107	78	52	31	10	3	0	0	0	0	0	0	0	0	0	0
18	**Peak Position Net Market**	**259**	**10**	**102**	**16**	**(47)**	**40**	**6**	**(94)**	**(134)**	**(147)**	**(207)**	**(228)**	**(244)**	**(312)**	**(348)**	**(593)**	**(656)**	**(684)**	**(703)**	**(770)**

Avista I-937 (Renewable Energy) Position



Deficits Summary



Avista 2011 IRP Positions Summary

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Energy (aMW)	113	69	109	88	82	54	12	11	(51)	(69)
Winter Capacity (MW)	661	642	579	382	264	321	209	159	48	(35)
Summer Capacity (MW)	259	10	102	16	(47)	40	6	(94)	(134)	(147)
RPS (aMW)	17	25	30	32	(16)	(46)	(47)	(47)	(92)	(93)

Impact of Resource Positions

- Positions Determine Future Resource Needs
  - Targets are 2016 RECs and 2019 summer capacity
- PRiSM Model Selects Resources Necessary to Fill Gaps That Meet Various Criteria
- Each New Resource Option Has Unique Capacity and Energy Characteristics
  - e.g., wind “consumes” 10% of nameplate
  - Gas-fired plants generate monthly based on ambient temperatures during peak weather events
- High and Low Cases Indicate Impacts of Varying Load Conditions

Portfolio and Market Scenario Planning

John Lyons

Technical Advisory Committee Meeting #4

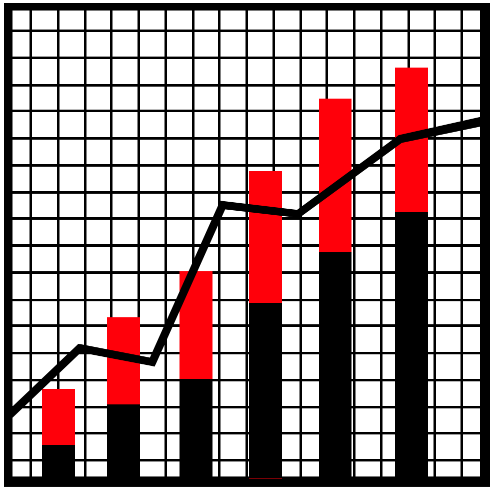
2011 Electric Integrated Resource Plan

February 3, 2011

Use of Scenarios in the IRP

Scenarios provide details about the impacts of different planning assumptions

- Avista's current load and resource portfolio
- Preferred Resource Strategy
- Wholesale electric market
- Different resource options



Scenario Types for the 2011 IRP

1. Deterministic Market Scenarios
2. Stochastic Market Scenarios
3. Portfolio Scenarios

2011 IRP Deterministic Market Scenarios

Deterministic scenarios test the Preferred Resource Strategy (PRS) across several different futures

- Low and High Gas Scenarios
- High Wind Penetration Scenarios
- Carbon Scenarios
- Western Coal Plant Phase Out Scenario

2011 IRP Stochastic Market Scenarios

- Expected Case – assumes average hydro, load, gas prices, wind, emissions prices and forced outages
- Volatile Fuel Scenario – test higher gas price volatility
- Unconstrained Carbon Scenario – determines the cost of different greenhouse gas emissions programs
- Mandatory Coal Retirement Scenario – Western coal plants automatically retired after 40 years of service

Portfolio Scenarios

- Market Reliance Only
- Capacity Only
- All CCCT and Wind
- All SCCT and Wind
- CO_2 Credit Allocations
- Nuclear Availability (2025)
- 2009 PRS
- National Renewable Energy Standard
- CT& CCCT Tipping Point
- Wind & Solar Tipping Point
- Nuclear Tipping Point Analysis
- Carbon Sequestration
- Colstrip Scenarios:
  - Different O&M charges;
  - Early Retirement;
  - Incremental Pollution Control, (sequestration); and
  - Railed coal
- Others?

Avista's 2011 Electric Integrated Resource Plan
Technical Advisory Committee Meeting No. 5 Agenda
Avista Headquarters – Spokane, Washington

Tuesday, April 12, 2011
Avista Conference Room 130

Topic	Time	Staff
1. Introduction	9:30	Storro
2. Conservation Avoided Cost Methodology	9:35	Gall
3. Conservation	9:45	Hermanson/ Global Energy Partners
4. Draft Preferred Resource Strategy Portfolio Alternatives & Scenarios	11:15	Gall
5. Lunch	12:15	
6. Draft Preferred Resource Strategy Portfolio Alternatives & Scenarios	1:00	Gall
7. Smart Grid	2:30	Kirkeby
8. Adjourn	3:30	

Conservation Avoided Costs

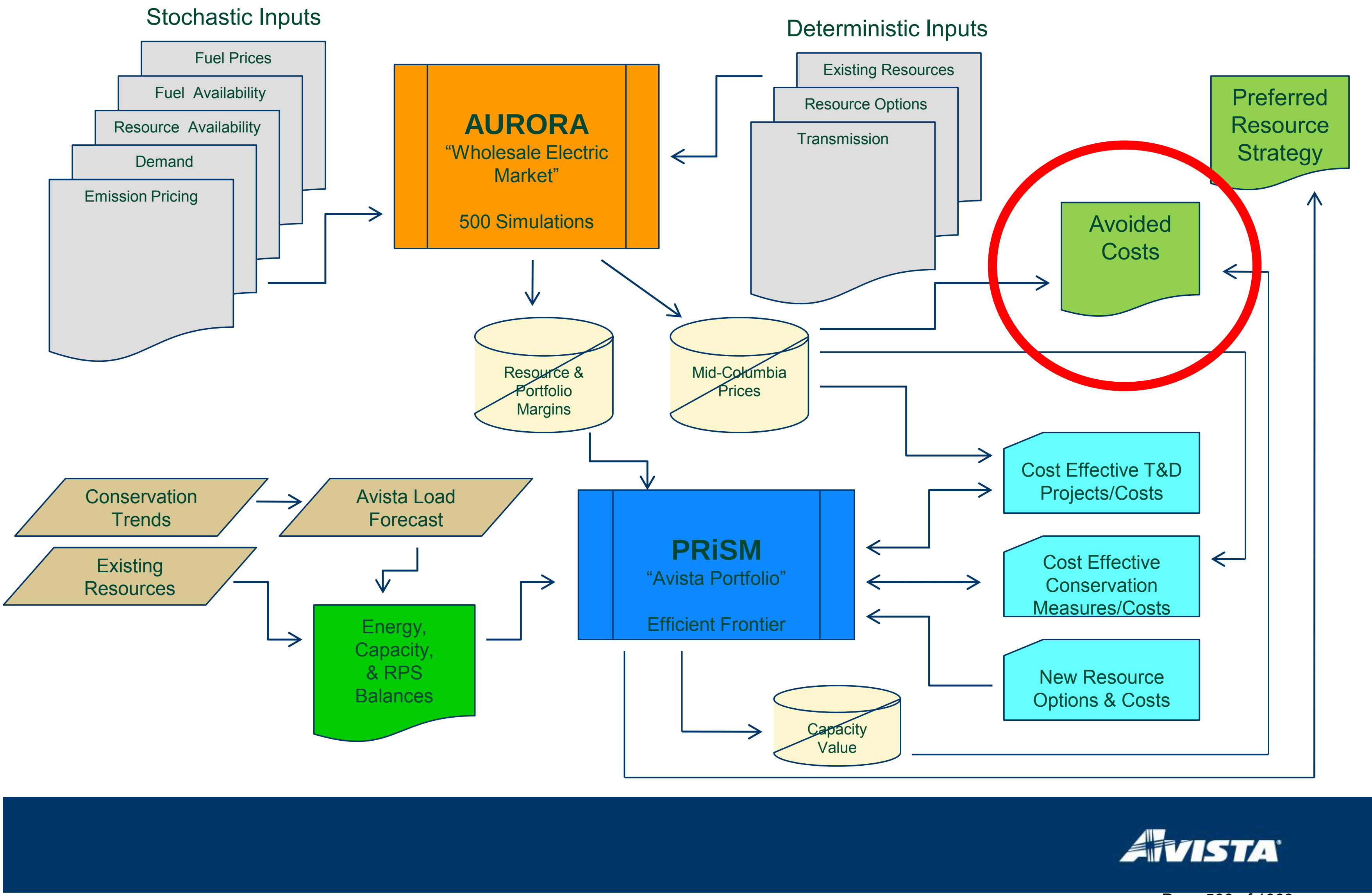
James Gall

Technical Advisory Committee Meeting #5

2011 Electric Integrated Resource Plan

April 12, 2011

2011 Integrated Resource Plan Modeling Process



How to Value Conservation

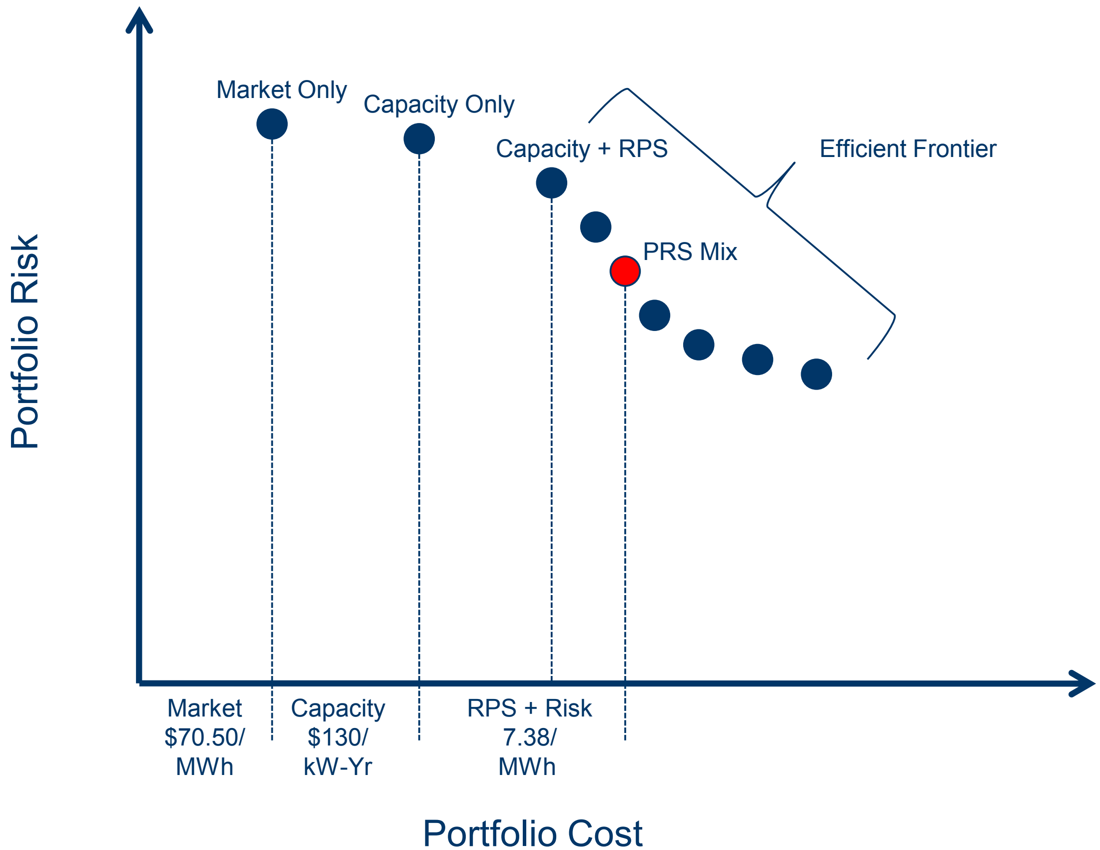
$$\{(E + PC + R) * (1 + P)\} * (1 + L) + DC * (1 + L)$$

Where:
E = market energy price (calculated by Aurora, including forecasted CO_2 mitigation)
PC = new resource capacity savings (calculated by PRISM)
R = Risk premium to account for RPS and rate volatility reduction (calculated by PRISM)
P = Power Act preference premium (10% assumption)
DC = distribution capacity savings (~$10/kW-year based on Heritage Project calculation)
L = transmission and distribution losses (6.1% assumption based on Avista's system average losses)

AVISTA

Efficient Frontier Approach

Assumes no additional Conservation Resources



Avoided Cost Calculation

For 1 MW Measure With Flat Delivery

Item	$/MWh
Energy Price	70.50
Capacity Savings	10.51
Risk Premium	7.38
Subtotal	**88.39**

Item	$/MWh
10% Preference	8.84
Distribution Capacity Savings	1.14
T&D losses	6.02
Subtotal	**16.00**

Avoided Cost:
$104.39
per
MWh

Avista Conservation Potential Assessment Electricity

Prepared for
Avista Utilities Technical Advisory Committee
by
Global Energy Partners
April 12, 2011

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An EnerNOC Company

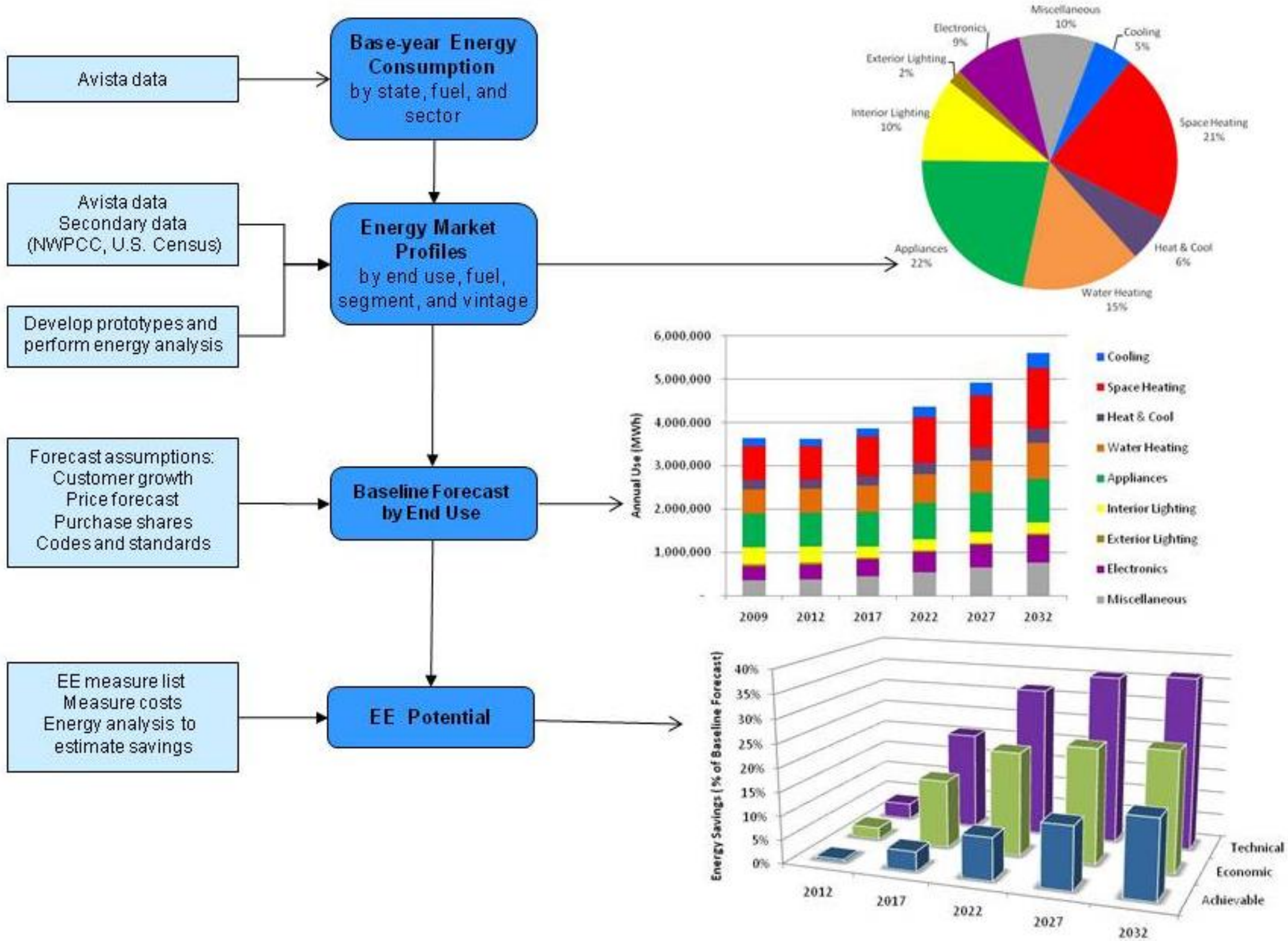
Topics

- Background and objectives
- Study approach
- Energy efficiency analysis results (electricity)
- Demand response analysis

Background and general objectives

- Assess and analyze 20-year cost-effective energy efficiency (EE) potentials
  - Support Avista IRP development
  - Meet Washington I-937 Conservation Potential Assessment requirements
- EE Potential assessment considers
  - Impacts of existing programs
  - Naturally occurring energy savings
  - Impacts of codes and standards
  - Technology developments and innovation
  - The economy and energy prices
- Assess and analyze DR potentials

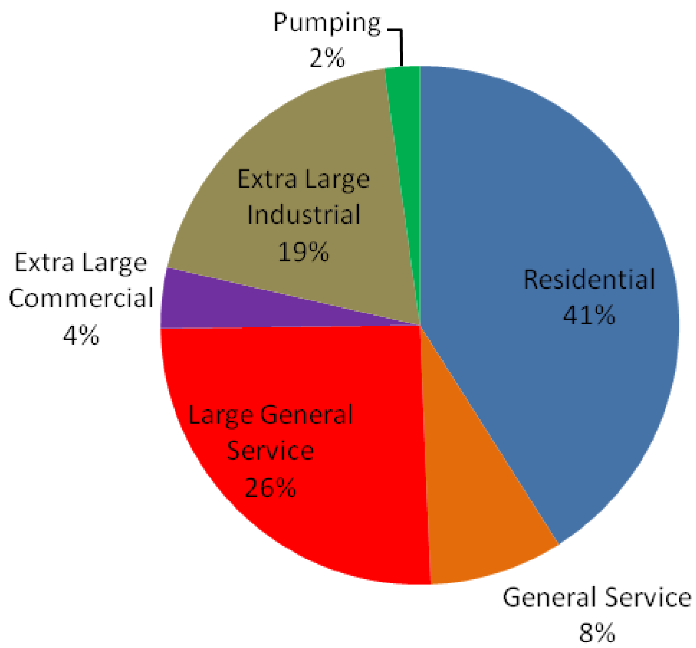
Overview of EE analysis approach

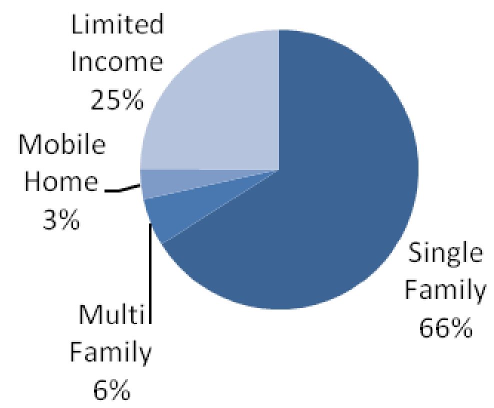


Base-year Energy Consumption

- Base year is 2009
  - Most recent year with complete sales and customer data when study began
  - 2009 also base year for Avista load research study
- Market segmentation, based on rate classes
  - Residential (rate class 001), segmented by housing type and income
    - Single Family
    - Multi Family
    - Mobile Home
    - Limited Income
  - Commercial and Industrial
    - General Service (rate classes 011, 012)
    - Large General Service (rate classes 021, 022)
    - Extra Large Commercial GS (rate class 025C)
    - Extra Large Industrial GS (rate class 025C)
  - Pumping (rate classes 031, 032)

Base-year Energy Consumption
2009 % of sales, Washington and Idaho





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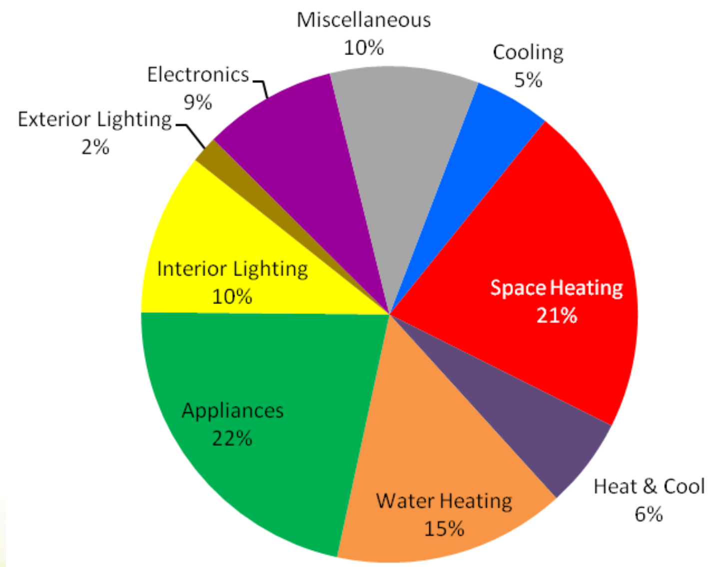
Energy Market Profiles

- Characterize energy use by sector, segment, end use, and technology
- Existing, replacement, and new construction
- Accounts for
  - Naturally occurring conservation
  - Codes and standards
  - Previous DSM results
  - Equipment saturation and fuel shares

Residential Energy Use by End Use, 2009



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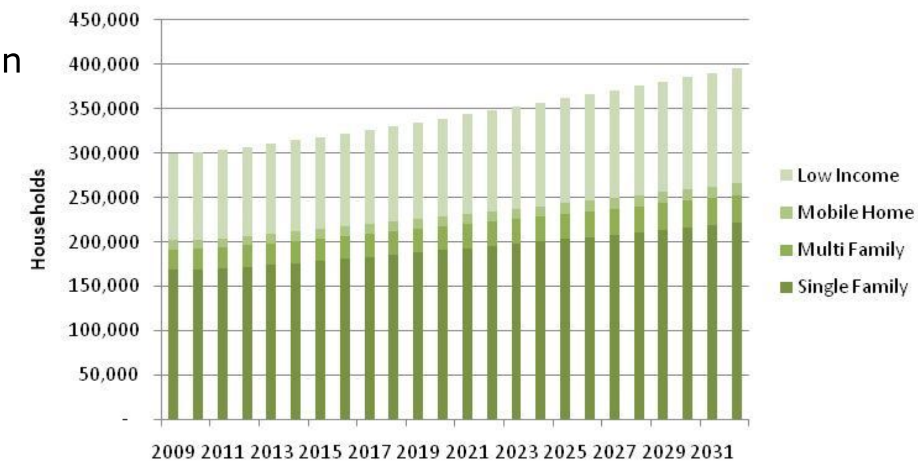
Baseline Forecast

- Incorporates
  - Customer / market growth
  - Income growth
  - Avista retail rates forecast
  - Trends in end-use/technology saturations
  - Equipment purchase decisions
  - Elasticities for retail rates, income, persons per household
- Accounts for
  - Naturally occurring conservation
  - Codes and standards
  - Previous DSM



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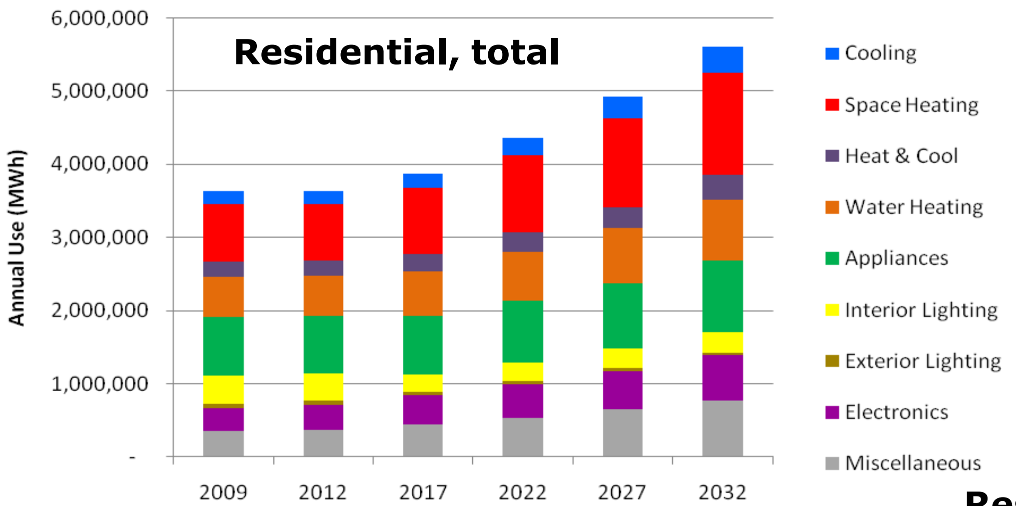
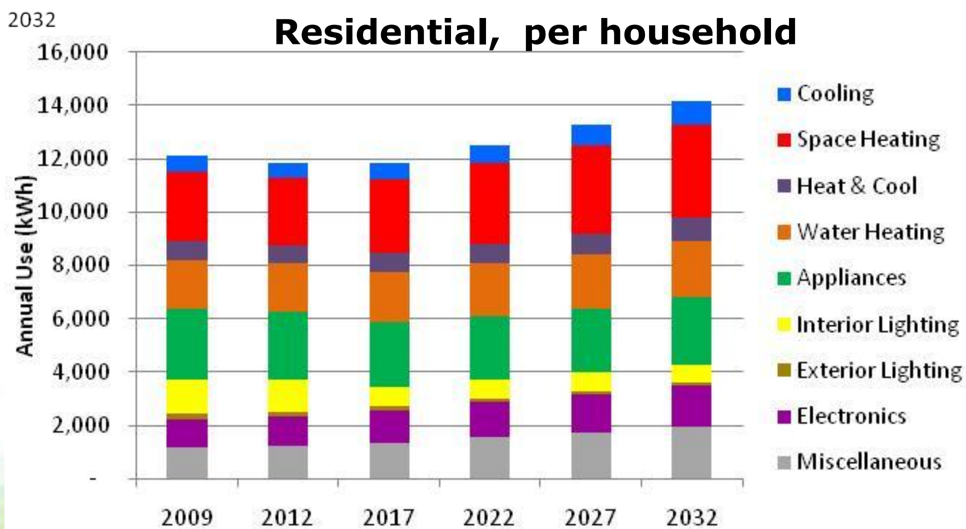
Baseline Forecast





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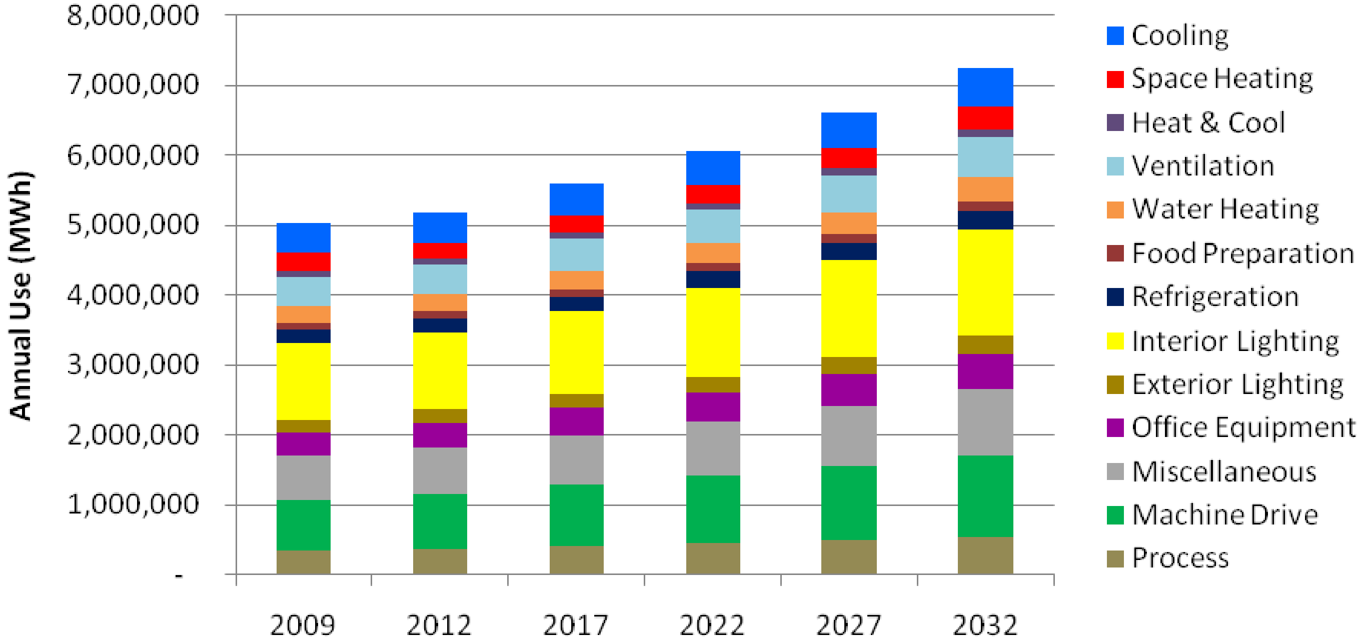
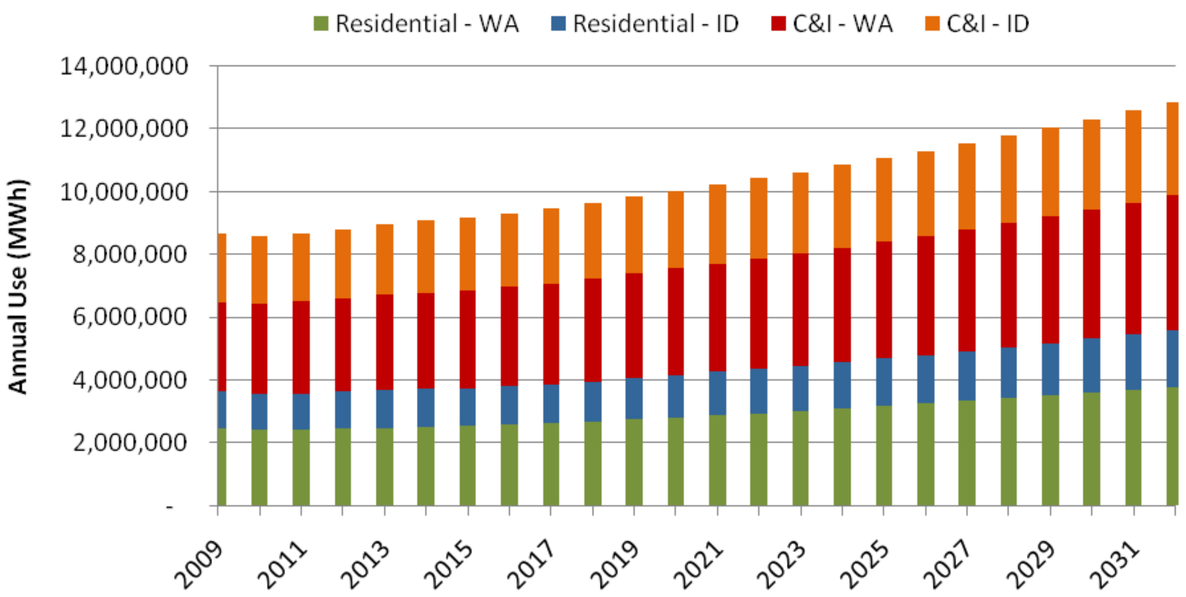
Baseline Forecast

Commercial & Industrial



Baseline Forecast

- Overall 48% growth in electricity use.
- Average annual growth rate of 1.7%
- Comparable with Avista 2009 IRP



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Energy Efficiency Potential

- Energy Efficient Equipment and Measures
  - 2,808 equipment options and 1,524 other measures
  - Avista existing DSM programs
  - NEEA RTF
  - Sixth Power Plan database
  - Other utility programs
- Measure characterization
  - Life
  - Energy and demand savings
  - Cost
  - Year off market (Standards)
  - Saturation
  - Applicability / Feasibility

Efficiency Level	Useful Life	Equipment Cost	Energy Usage (kWh/yr)	On Market	Off Market
SEER 13	15	$3,794	$1,619	2009	2014
SEER 14 (ENERGY STAR)	15	$4,072	$1,485	2009	2032
SEER 15 (CEE Tier 2)	15	$4,350	$1,435	2009	2032
SEER 16 (CEE Tier 3)	15	$4,628	$1,393	2009	2032
Ductless Mini-split System	20	$8,193	$1,214	2009	2032

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Consistency with Sixth Plan

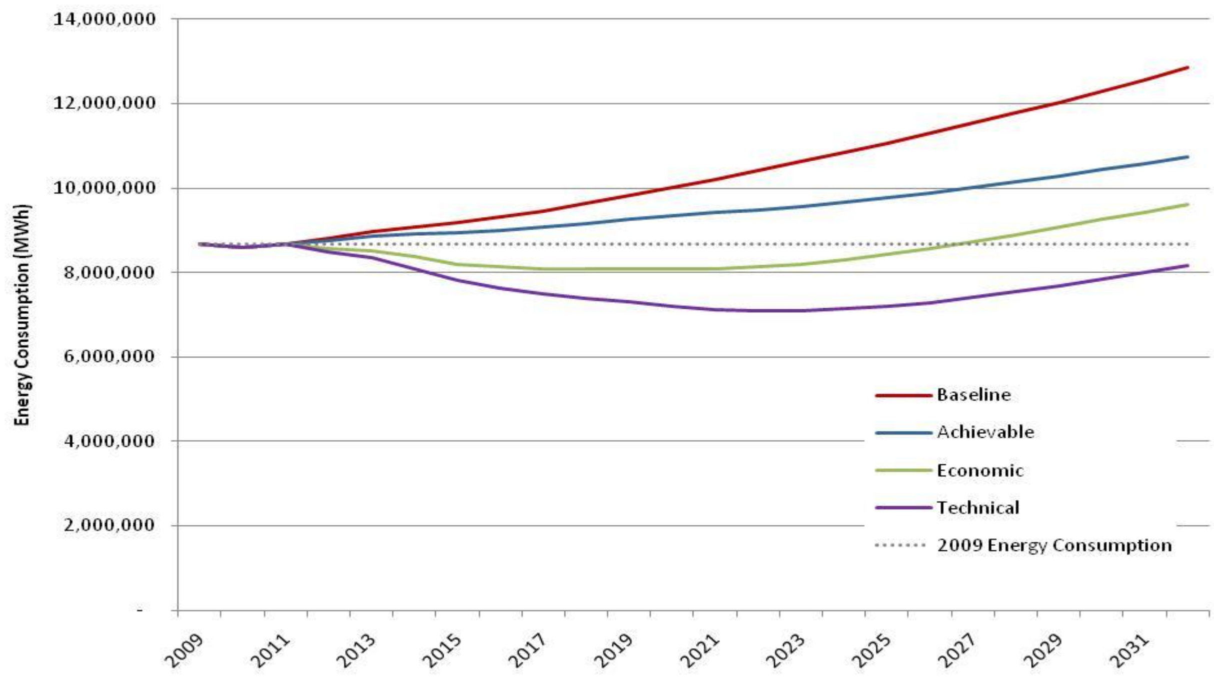
- End-use model — bottom-up approach to understanding savings
  - Measure life
  - Stock accounting
  - Measure saturation and applicability
- Accounts for
  - Naturally occurring conservation
  - Codes and standards
- Measures include those in Sixth Plan (other measures also)
- Considers both lost opportunity and non-lost opportunity
- Economic potential, based on Total Resource Cost (TRC) test
- Achievable potential considers realistic rate at which technologies can be deployed
- Maximum potential in 20 years is 85% of economic potential

Energy Efficiency Potential

- Savings could be acquired through a variety of means
  - Market transformation, including NEEA
  - Utility programs

Summary of EE results

- Baseline forecast — 48% growth (2032 vs. 2009)
- Achievable potential — 24% growth (2032 vs. 2009)
- Energy efficiency offsets 50% of growth



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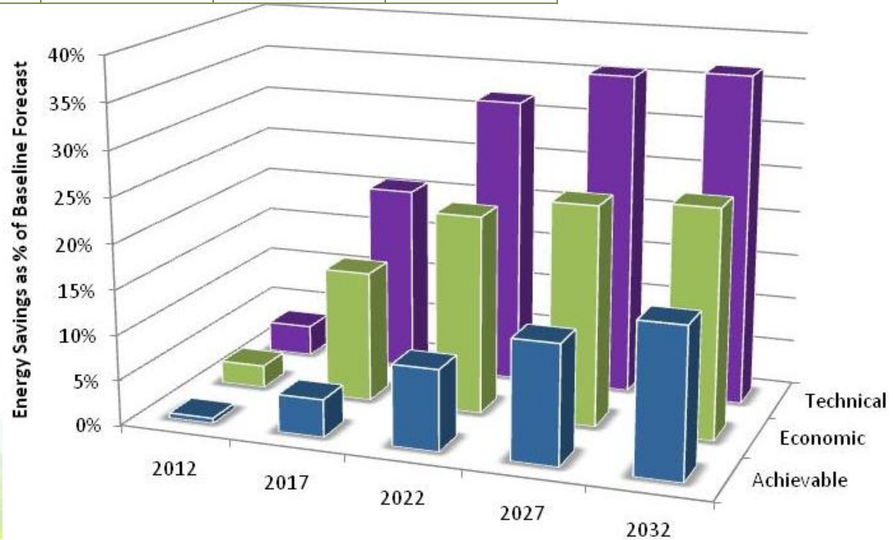
Summary of EE results (continued)

Summary of Energy Savings from Energy Efficiency

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	8,799,079	9,464,078	10,417,644	11,537,369	12,852,394
Cumulative Energy Savings (MWh)					
Achievable	49,428	393,796	931,744	1,514,569	2,105,572
Economic	219,482	1,371,691	2,289,256	2,802,046	3,228,731
Technical	301,070	1,967,390	3,327,203	4,116,738	4,697,328
Cumulative Energy Savings (% of Baseline)					
Achievable	0.6%	4.2%	8.9%	13.1%	16.4%
Economic	2.5%	14.5%	22.0%	24.3%	25.1%
Technical	3.4%	20.8%	31.9%	35.7%	36.5%



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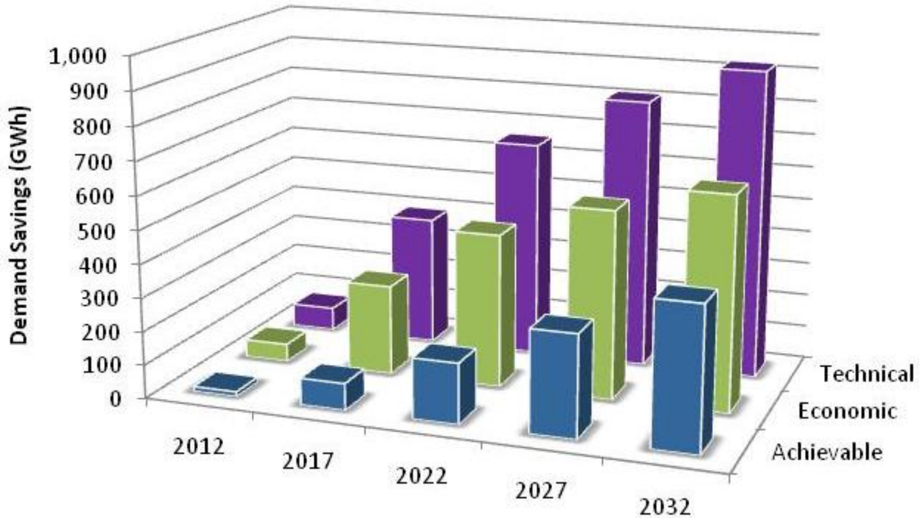
Summary of EE results (continued)

Summary of Peak Demand Savings from Energy Efficiency

	2012	2017	2022	2027	2032
Baseline Forecast (MW)	1,780	1,881	2,080	2,306	2,567
Peak Savings (MWh)					
Achievable	14	80	180	303	424
Economic	53	271	459	563	638
Technical	70	391	654	810	923
Peak Savings (% of Baseline)					
Achievable	0.8%	4.3%	8.7%	13.1%	16.5%
Economic	3.0%	14.4%	22.1%	24.4%	24.8%
Technical	3.9%	20.8%	31.5%	35.1%	35.9%



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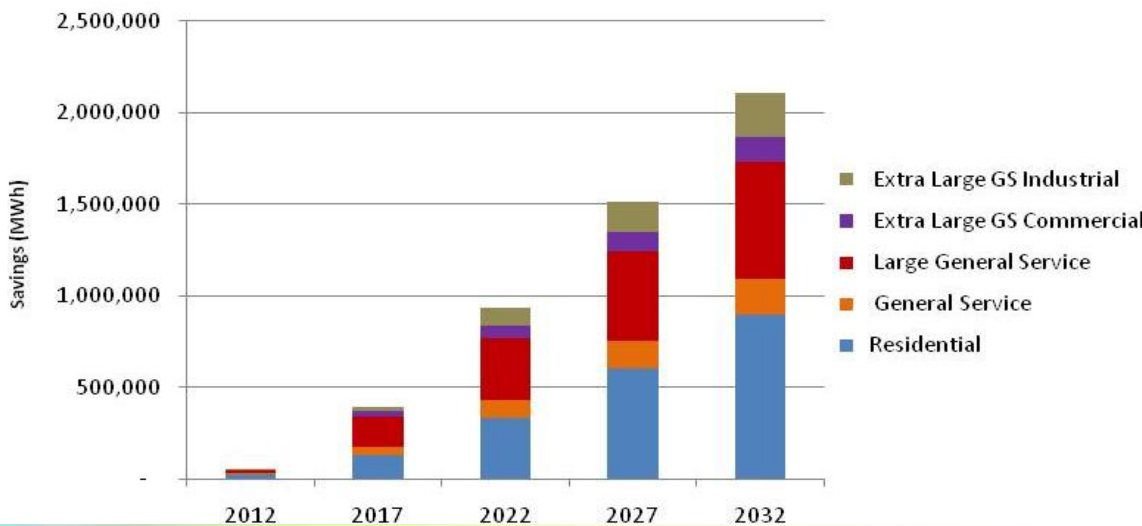
Savings by Sector

	2012	2017	2022	2027	2032
Cumulative Energy Savings (MWh)					
Residential	25,651	127,984	331,874	606,994	896,296
C&I Total	23,777	265,812	599,870	907,575	1,209,276
Cumulative Energy Savings (% of total)					
Residential	**52%**	**33%**	**36%**	**40%**	**43%**
General Service	9%	12%	10%	10%	9%
Large General Service	30%	42%	36%	32%	30%
Extra Large GS Commercial	7%	8%	8%	7%	7%
Extra Large GS Industrial	3%	5%	10%	11%	11%
C&I Total	**48%**	**67%**	**64%**	**60%**	**57%**



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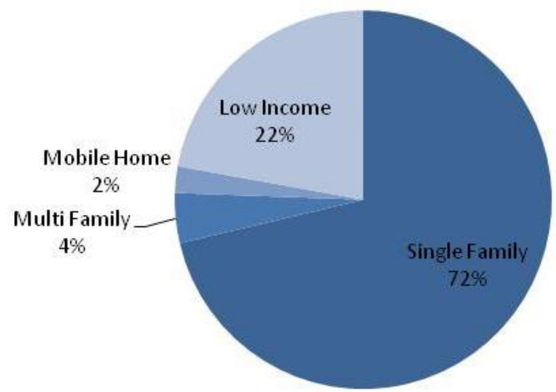
Residential EE Results

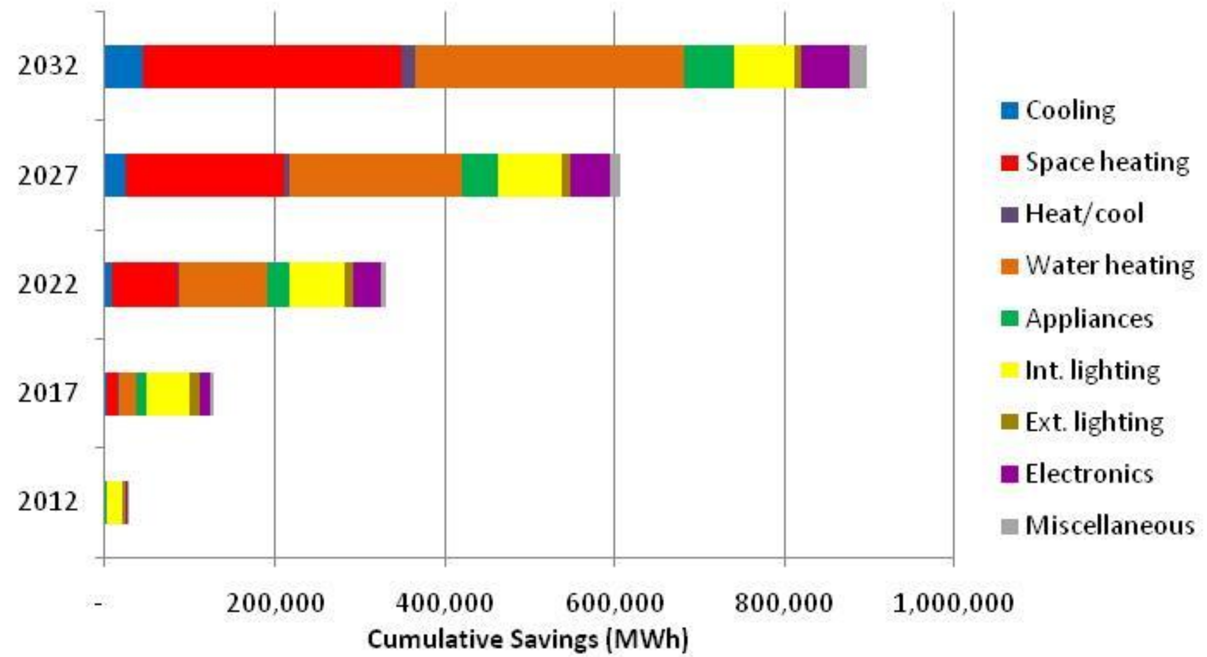
	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	3,626,735	3,871,491	4,356,537	4,919,347	5,601,421
Cumulative Energy Savings (MWh)					
Achievable	25,651	127,984	331,874	606,994	896,296
Economic	89,611	516,797	955,211	1,193,716	1,373,565
Technical	135,783	857,178	1,468,391	1,831,465	2,114,488
Cumulative Energy Savings (% of Baseline)					
Achievable	0.7%	3.3%	7.6%	12.3%	16.0%
Economic	2.5%	13.3%	21.9%	24.3%	24.5%
Technical	3.7%	22.1%	33.7%	37.2%	37.7%

Savings by housing type, 2022



Residential EE Results

Cumulative Energy Savings by End Use (MWh), Selected Years



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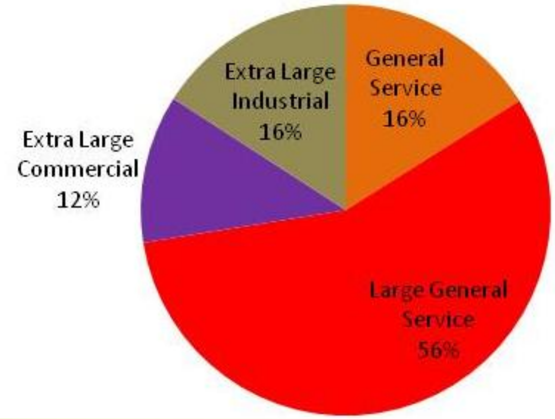
C&I EE Results

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	5,172,344	5,592,586	6,061,107	6,618,022	7,250,973
Cumulative Energy Savings (MWh)					
Achievable	23,777	265,812	599,870	907,575	1,209,276
Economic	129,871	854,893	1,334,045	1,608,330	1,855,166
Technical	165,288	1,110,212	1,858,812	2,285,273	2,582,839
Cumulative Energy Savings (% of Baseline)					
Achievable	0.5%	4.8%	9.9%	13.7%	16.7%
Economic	2.5%	15.3%	22.0%	24.3%	25.6%
Technical	3.2%	19.9%	30.7%	34.5%	35.6%

Savings by rate class, 2022



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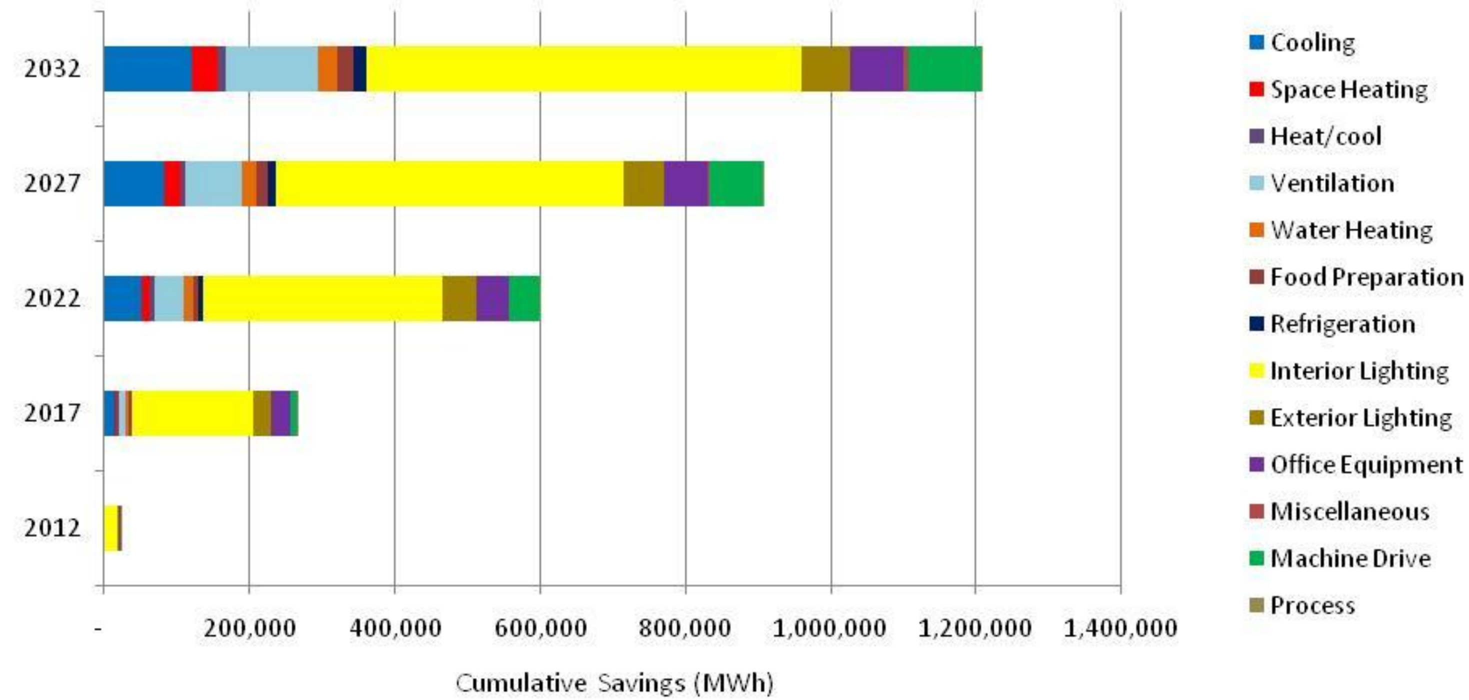
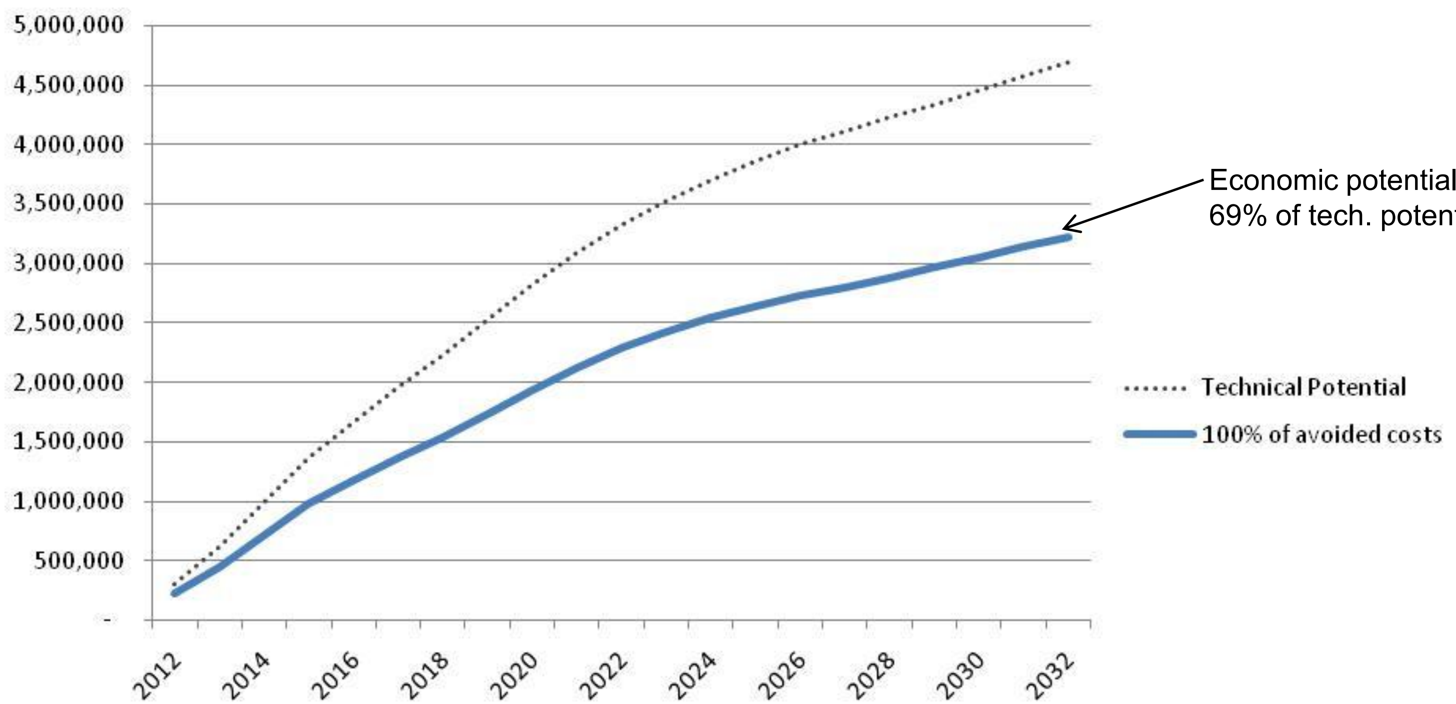
C&I EE Results

Cumulative Energy Savings by End Use (MWh), Selected Years



Avoided Cost Scenarios

Economic Potential, Cumulative Savings (MWh)



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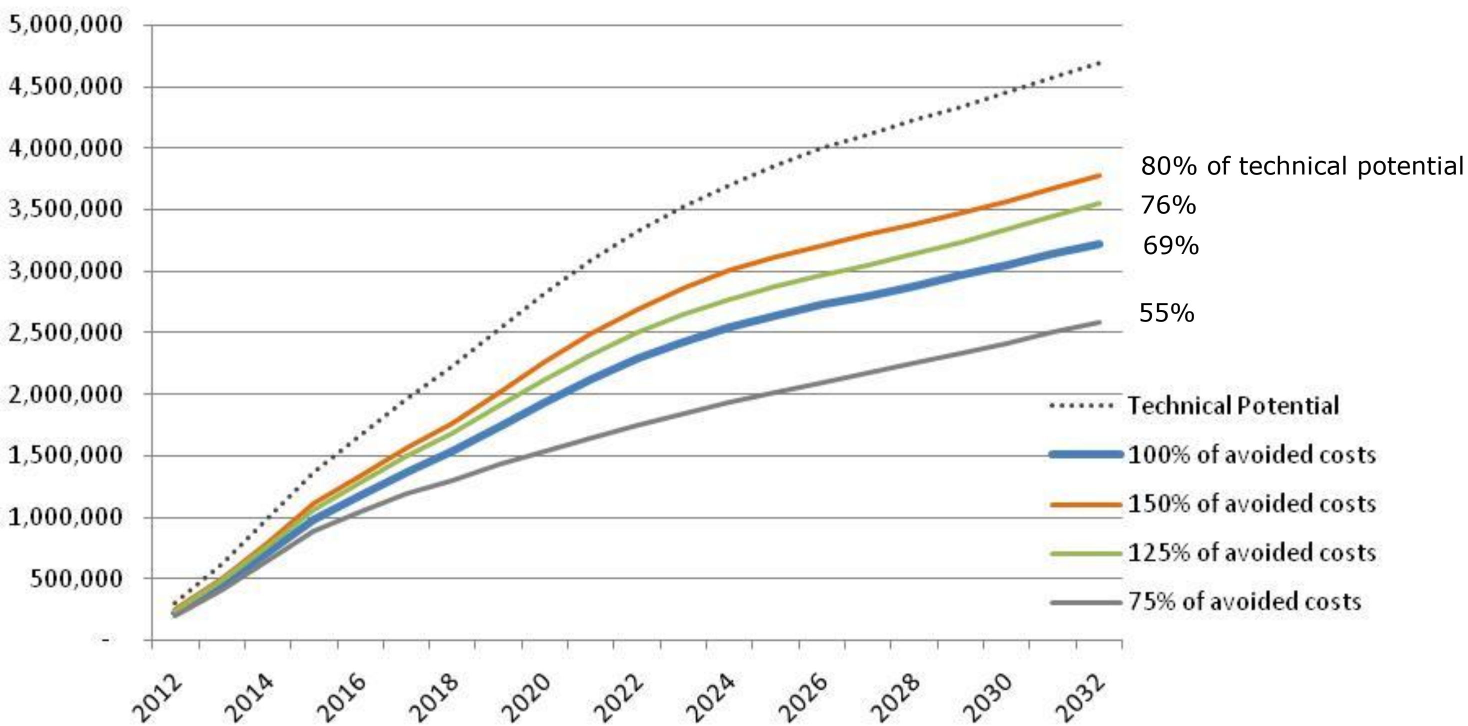
Avoided Cost Scenarios

Economic Potential Case, Cumulative Savings (MWh)



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Demand Response Analysis

- Define the types of DR programs most suitable for Avista
- Determine DR potential

Demand Response Program	Residential	General Service	Large General Service	Extra Large General Service	Pumping
Direct Load Control					
Mass Market Direct Load Control	x	x			
Direct Load Control			x	x	x
Other Programs					
Demand Bidding / Buyback			x	x	
Curtailable/Interruptible			x	x	
Auto DR / Fast DR	x	x	x	x	

Deliverables from CPA analysis

- Final report electricity
  - EE approach and results
  - DR approach and results
  - Appendices
- LoadMAP models
- Gas potential study

Contact Information

Ingrid Rohmund

irohmund@gepllc.com

760-943-1532

Jan Borstein

jborstein@gepllc.com

303-530-5195

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Preferred Resource Strategy & Scenario Analysis

(Preliminary Draft)

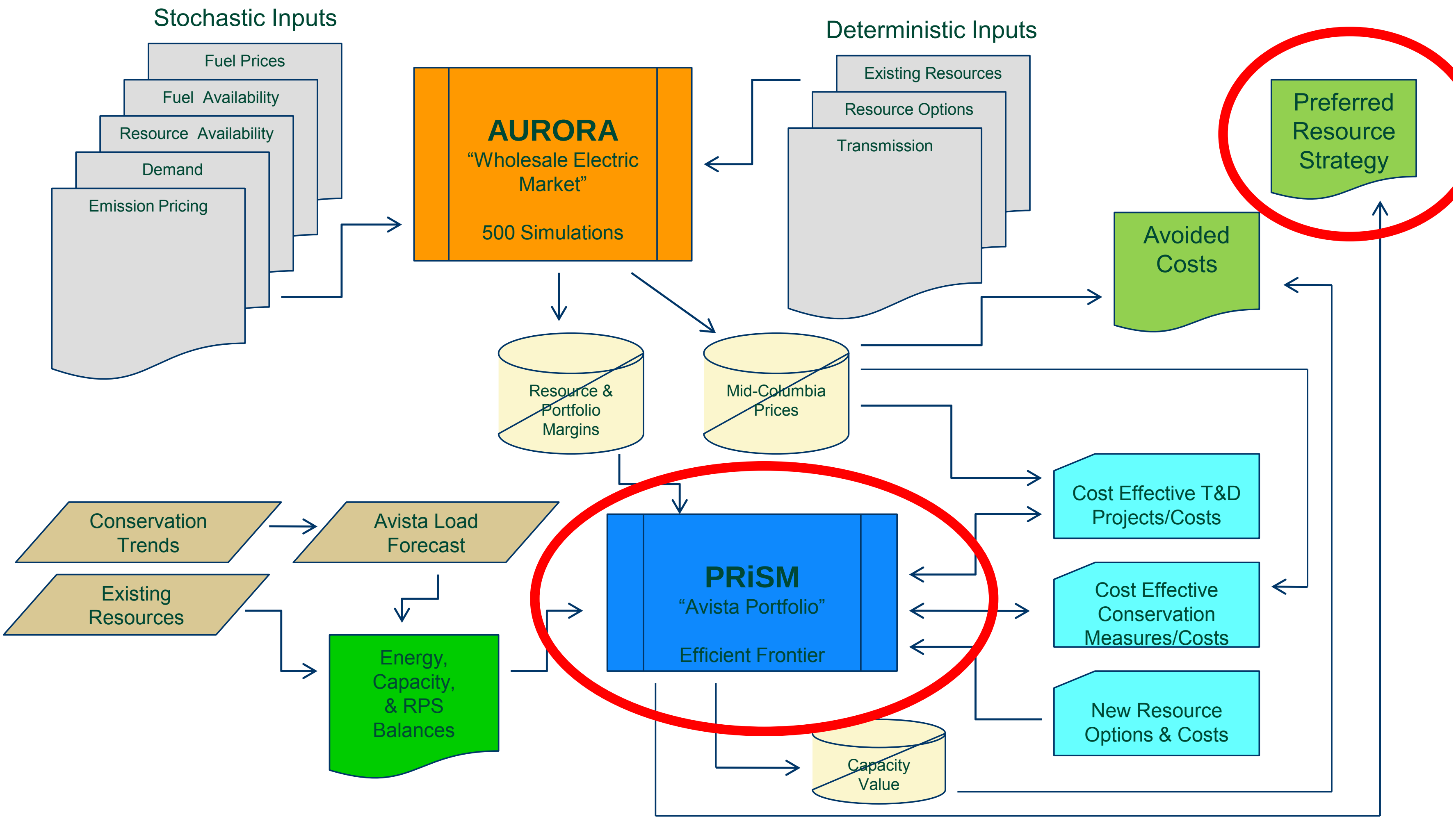
James Gall

Technical Advisory Committee Meeting #5

2011 Electric Integrated Resource Plan

April 12, 2011

2011 Integrated Resource Plan Modeling Process



PRiSM Objective Function

- Linear program solving for the optimal resource strategy to meet resource deficits over planning horizon.
- Model selects its resources to reduce cost, risk, or both.

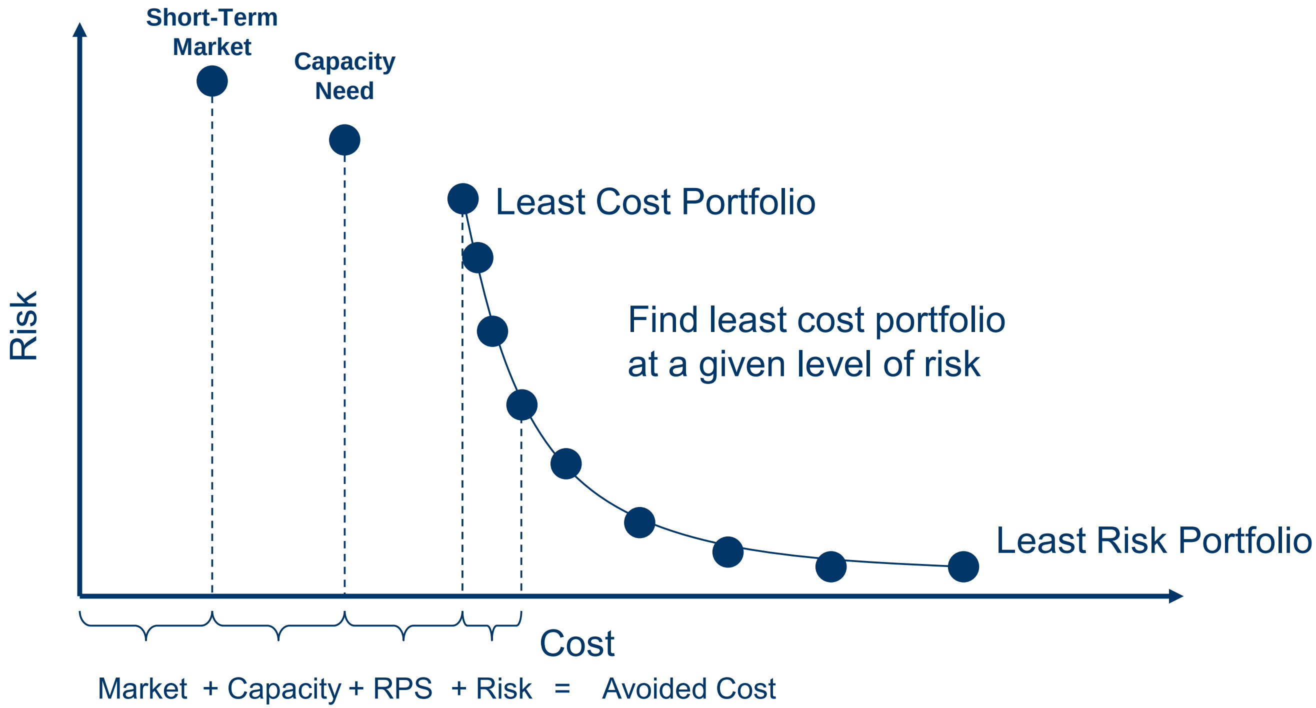
Minimize: Total Power Supply Cost on NPV basis (2012-2052 with emphasis on first 11 years of the plan)

Subject to:

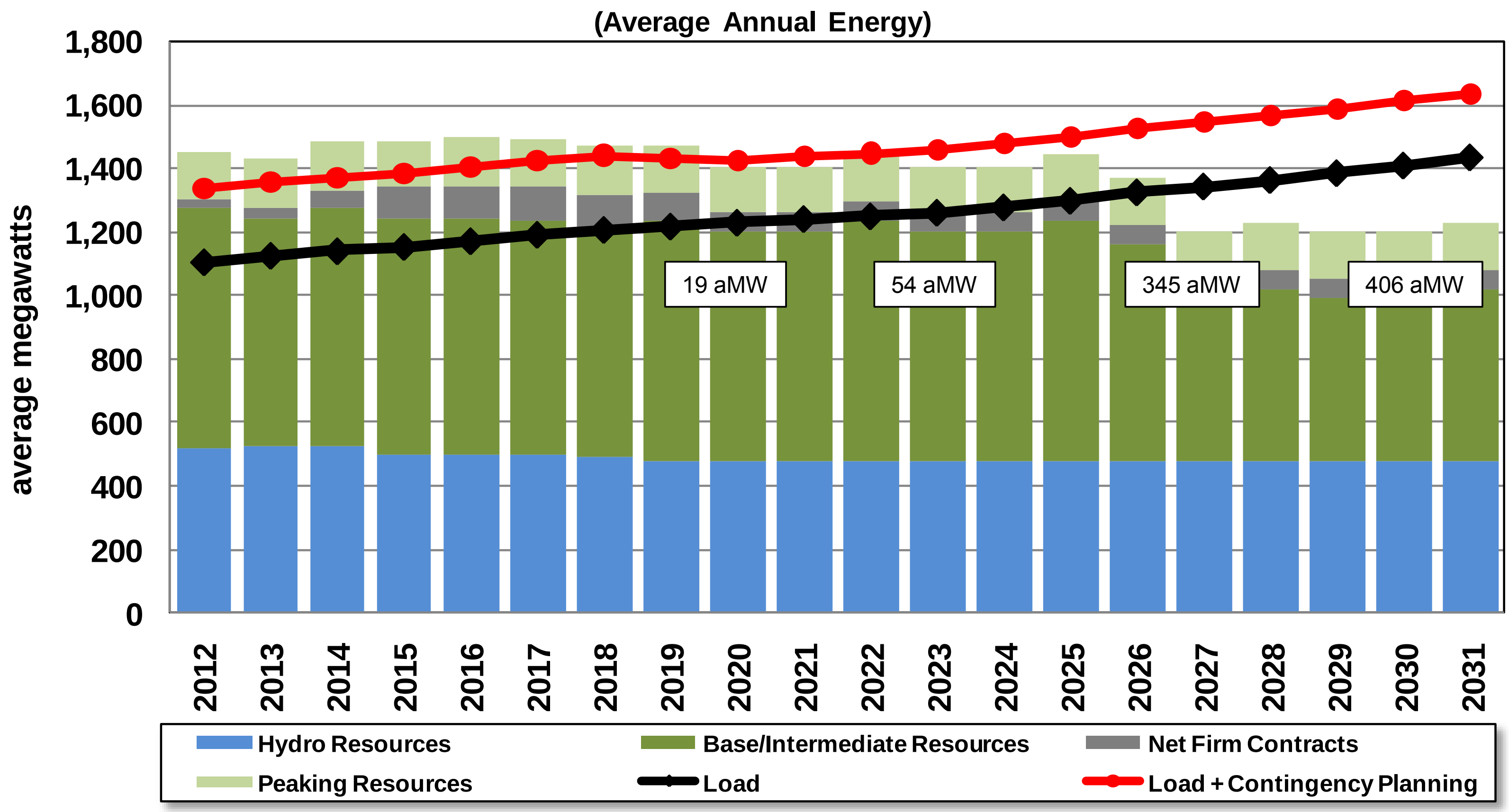
- Risk Level
- Capacity Need +/- deviation
- Energy Need +/- deviation
- Renewable Portfolio Standards
- Resource Limitations and Timing

Efficient Frontier

- Demonstrates the trade off of cost and risk
- Avoided Cost Calculation



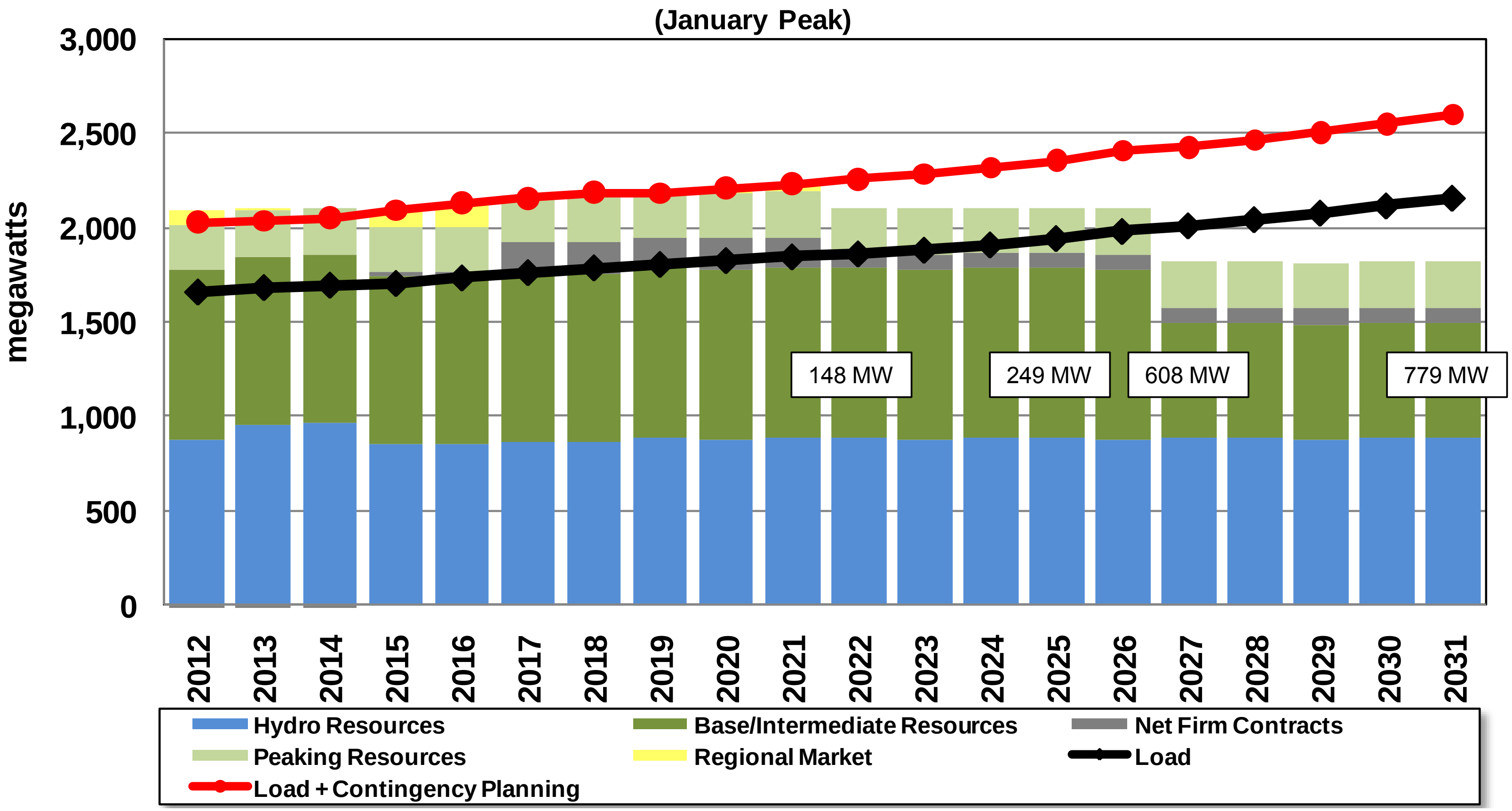
Energy Load & Resource Balance (Includes Conservation)



DRAFT

Winter 18 Hr Peak Load & Resource Balance

(Includes Conservation)



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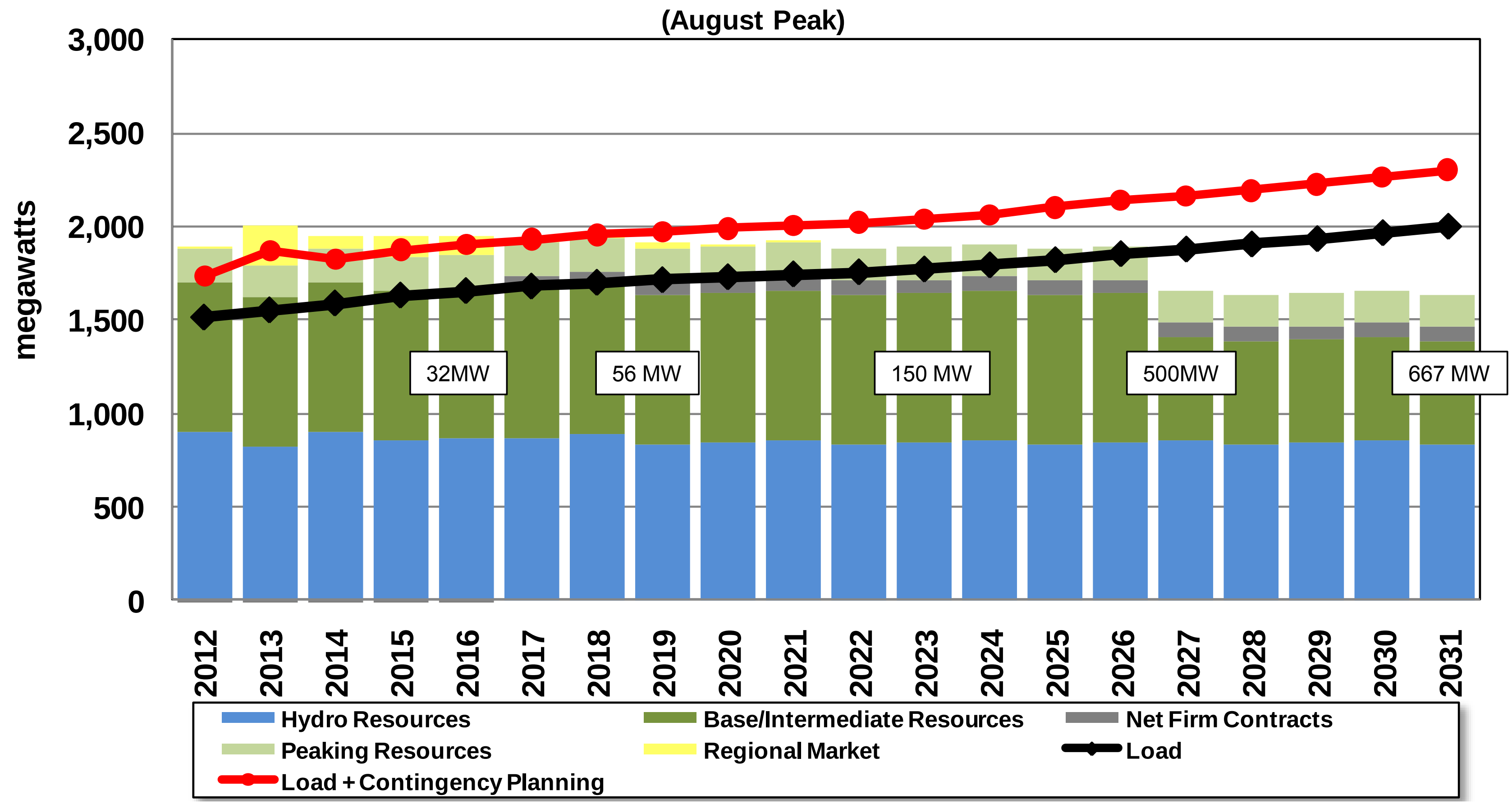
Summer 18 hr Peak Load & Resource Balance

(Includes Conservation)



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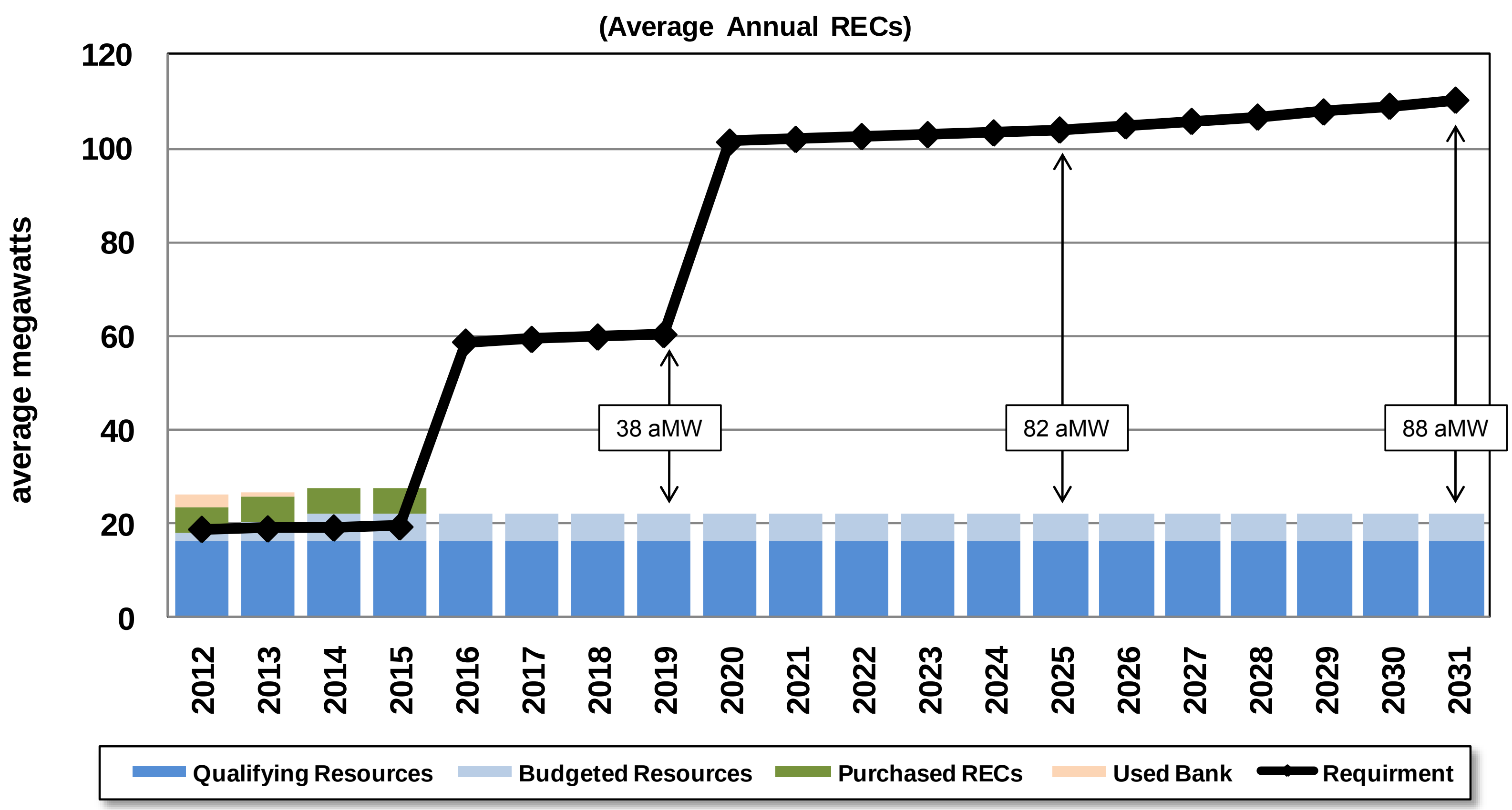
REC Contingency & Banking

- Reserve requirement- Must hold REC reserves in "REC Bank" each year.
  - Sales uncertainty (5%)
  - Hydro uncertainty (26%)
  - Wind uncertainty (30%)
  - Currently 8 aMW
- Roll over rights- RECs can be used for prior year or future year. Plan is to use 2011 REC for 2012, then excess 2012 RECs can be used for 2013.

WA State Renewable Portfolio Standard Compliance

(Does Not Include Contingency)



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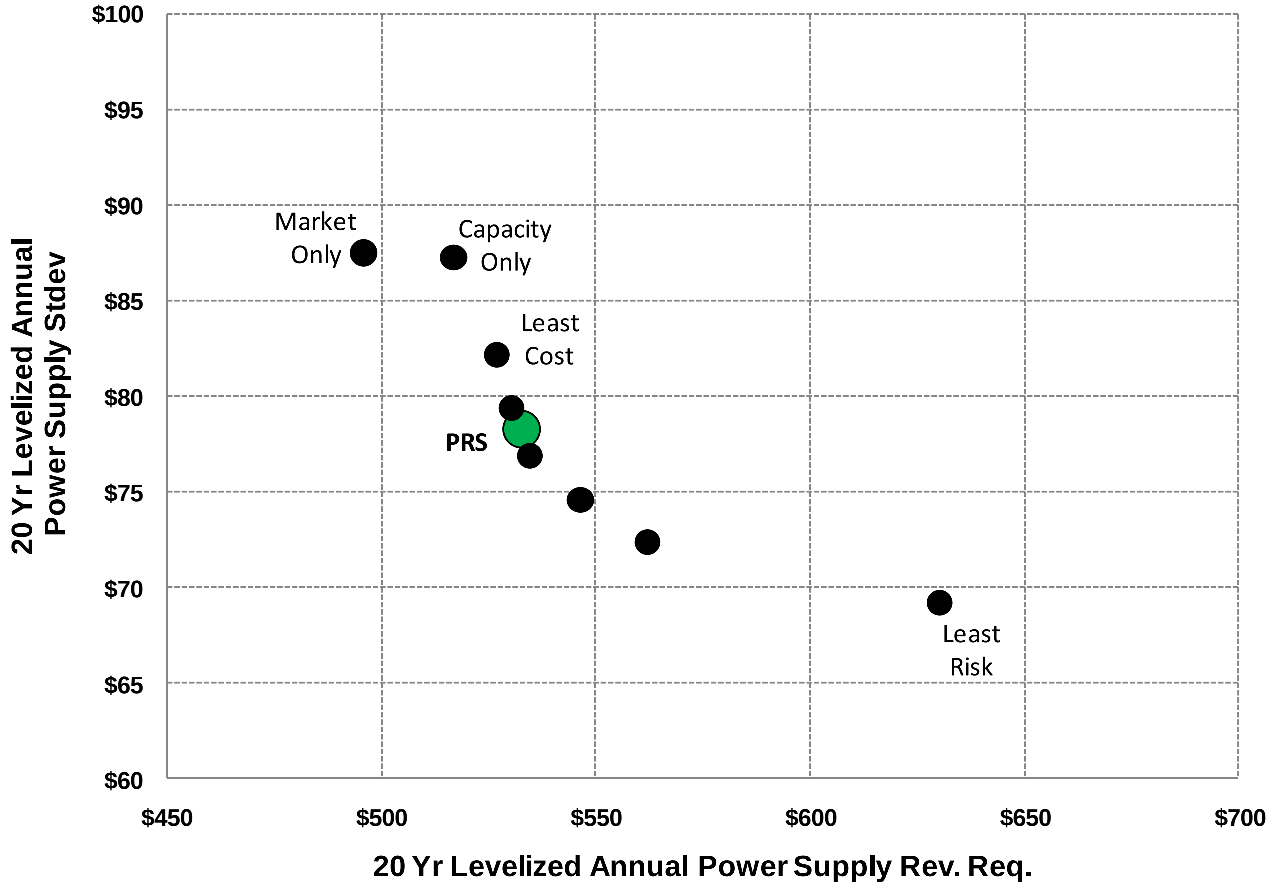
Actual Efficient Frontier Results



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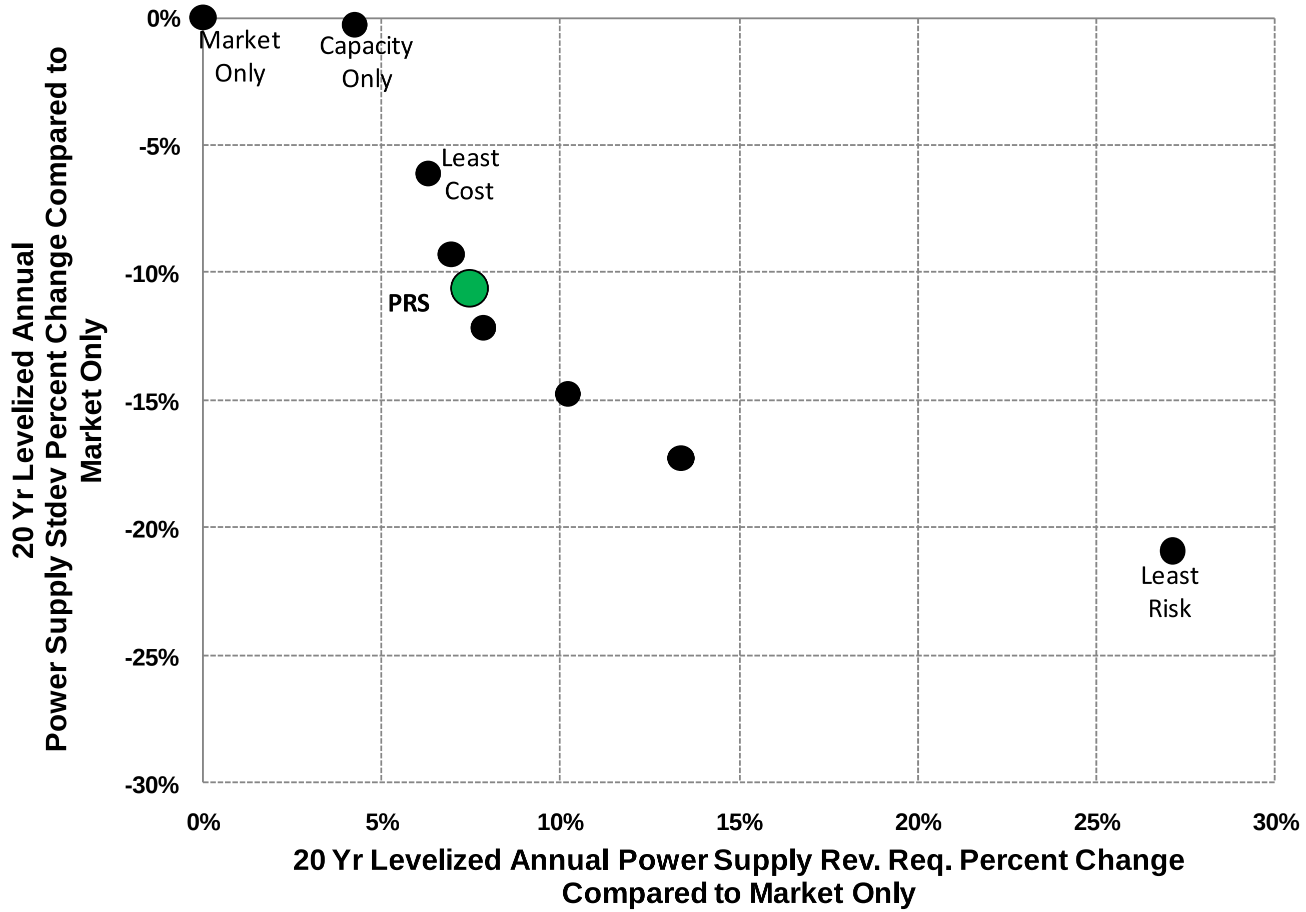
Actual Efficient Frontier Results As a Percent of Market Only Portfolio



2009 Draft Preferred Resource Strategy

Year Ending	Resource
2012	150 MW NW Wind (48 aMW)
2013-2015	Little Falls Unit Upgrades (0.9 aMW)
2019	150 MW NW Wind (50 aMW)
2019	Combined Cycle CT (250 MW)
2020	Upper Falls Upgrade (1 aMW)
2022	50 MW NW Wind (17 aMW)
2024	Combined Cycle CT (250 MW)
2026/27	Combined Cycle CT (250 MW)
2010+	Distribution Feeder Upgrades (2.7 aMW by 2029)
2010+	Conservation (226 aMW by 2029)

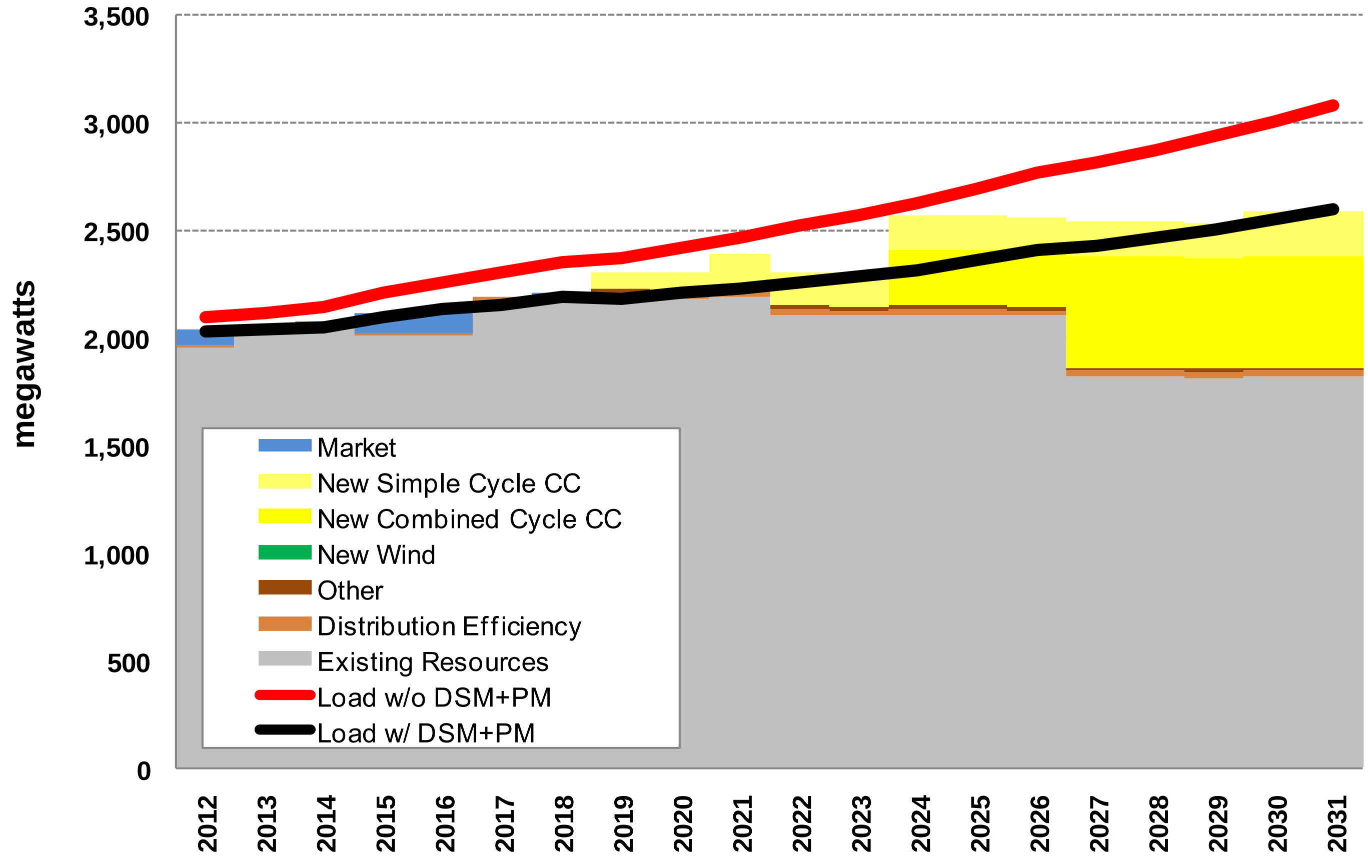
2011 Draft Preferred Resource Strategy

Year Ending	Resource
2012	Wind (~ 42 aMW REC)
2018	Simple Cycle CT(~ 83 MW)
2020	Simple Cycle CT (~ 83 MW)
2018-2019	Thermal Upgrades (~ 7 MW)
2018-2019	Wind (~ 43 aMW REC)
2023	Combined Cycle CT (~ 270 MW)
2026/27	Combined Cycle CT (~ 270 MW)
2029	Simple Cycle CT (~ 46 MW)
2012+	Distribution Feeder Upgrades (13 aMW by 2031)
2012+	Conservation (310 aMW by 2031)

2011 IRP Comparison to 2009 IRP

- 2019: CCCT Replaced With Two CTs Over 3 Years
- 2012: Less Wind (42 aMW vs. 48 aMW)
- 2024/2027: CCCT Need Remains
- 2020: Less Wind (43 aMW vs. 50 aMW)
- 2022: Wind Need Eliminated (-17 aMW)
- 2030: Additional 46 MW CT
- 84 aMW Increased Conservation Over 20 Years
- 10 aMW Increased Distribution Losses Savings over 20 years
- Changes in Hydro Upgrade Assumptions
  - Little Falls in-kind replacement instead of upgrade
  - Upper Falls upgrade removed pending further study

Winter Capacity Load and Resources



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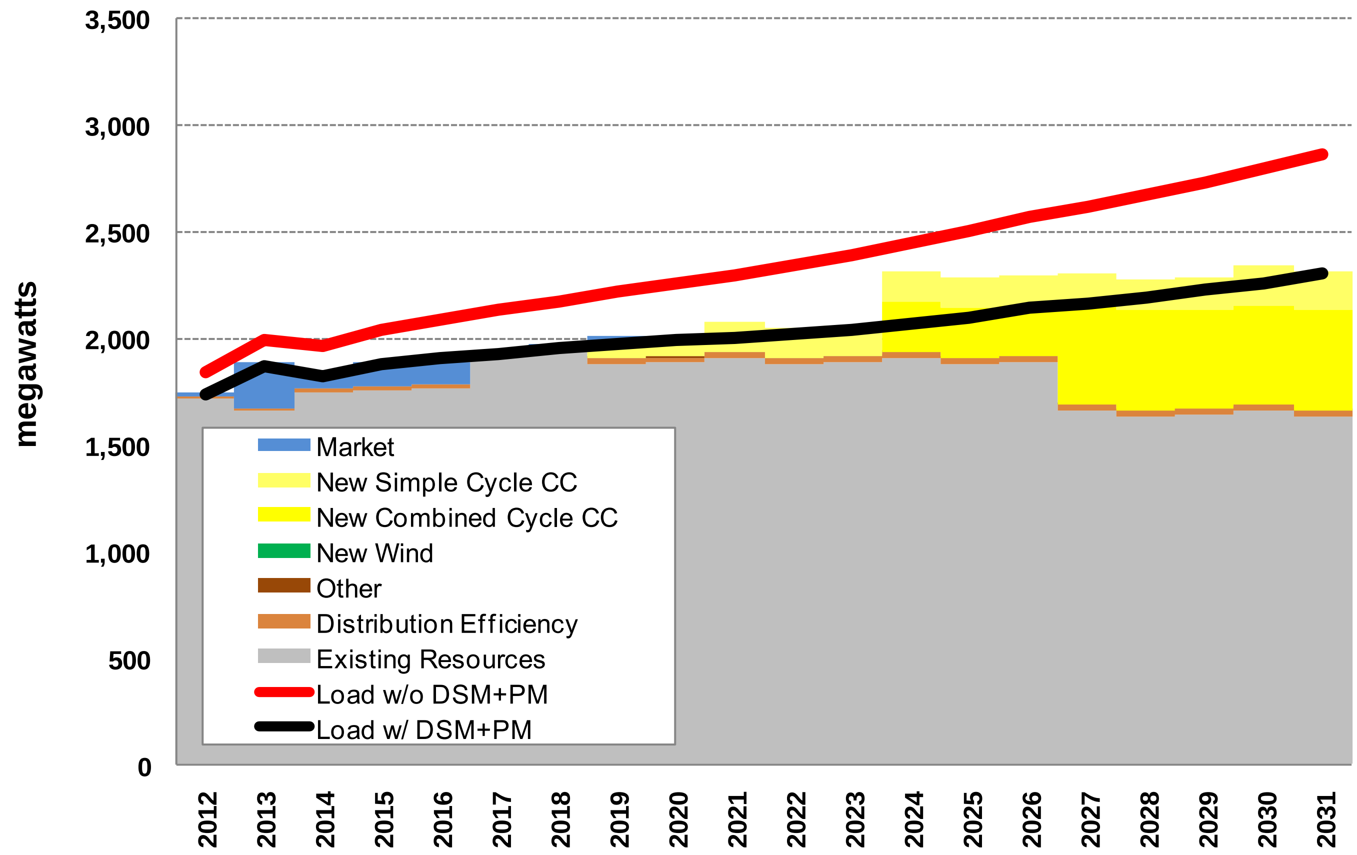
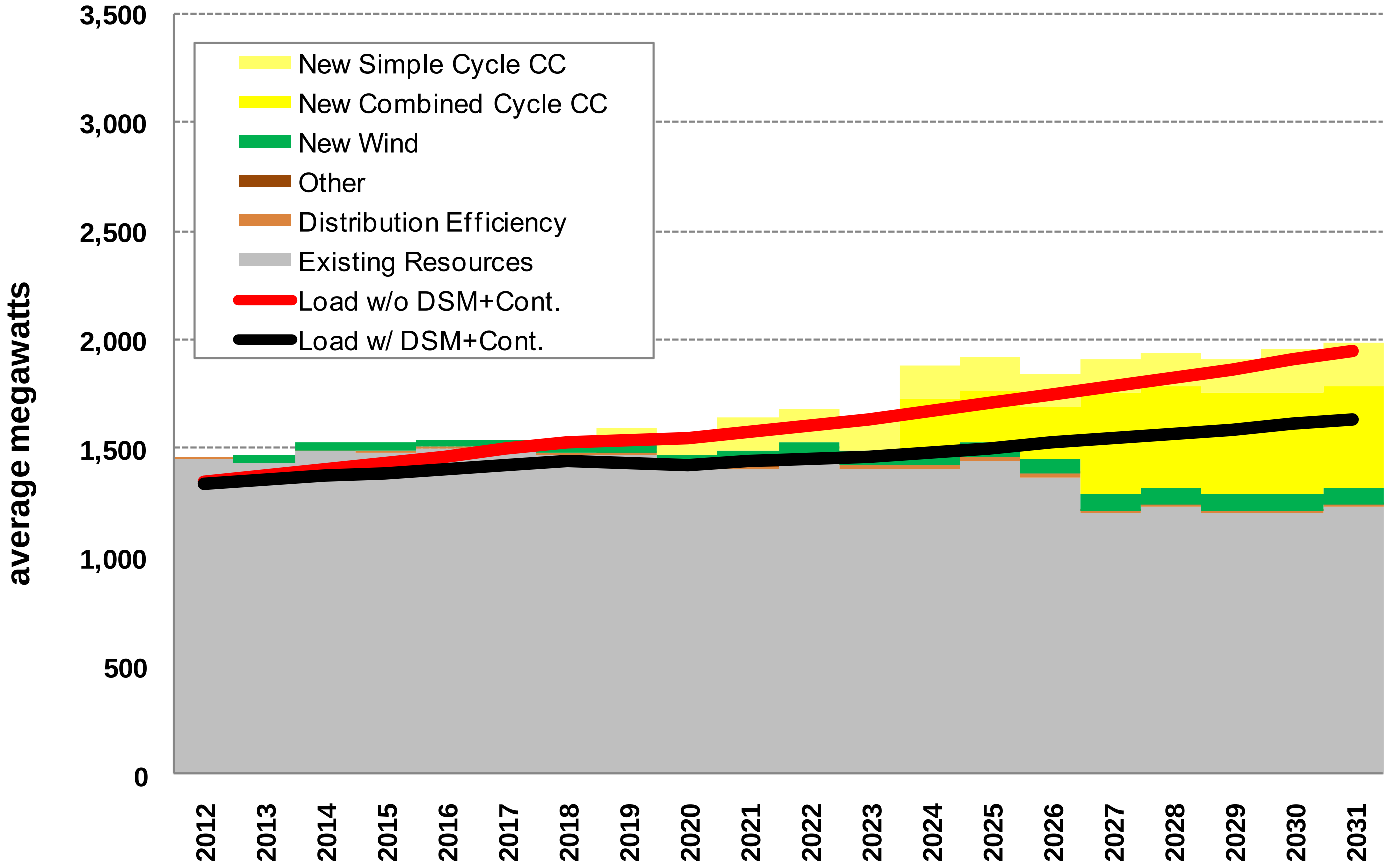
Summer Capacity Load and Resources



Annual Average Energy Load and Resources



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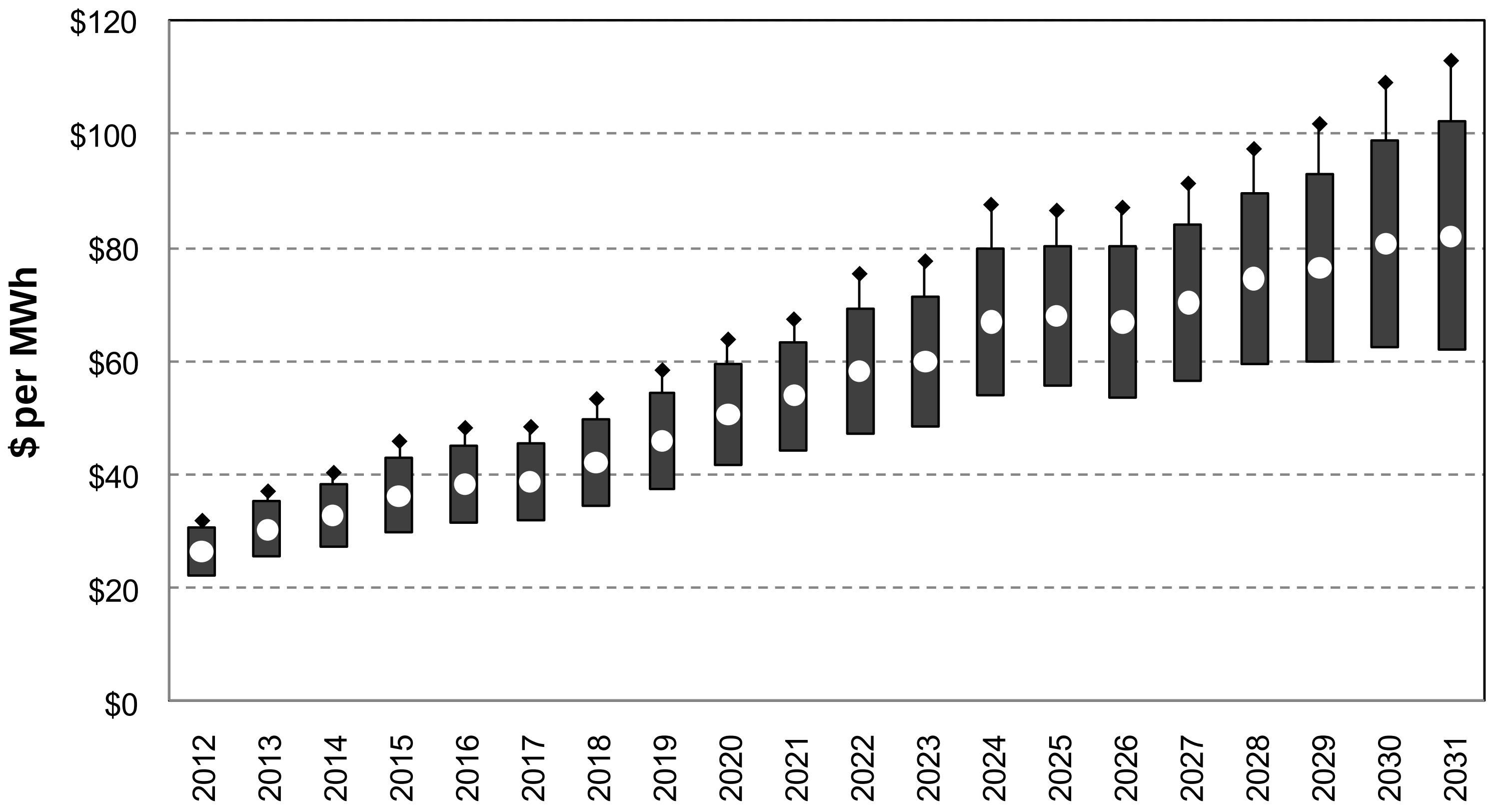
I-937 Table (aMW REC)

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Beginning Bank		17	7	19	19	42	47	51	55	59	36
Requirement	**0**	**(19)**	**(19)**	**(19)**	**(19)**	**(59)**	**(59)**	**(60)**	**(60)**	**(101)**	**(102)**
Current Available	17	23	26	28	28	22	22	22	22	22	22
New Qualifying RECs	0	0	42	42	42	42	42	42	42	57	85
Sold Qualifying RECs	0	(14)	(37)	(50)	(28)	0	0	0	0	0	(5)
End Bank	**17**	**7**	**19**	**19**	**42**	**47**	**51**	**55**	**59**	**36**	**36**
Contingency Bank	**0**	**7**	**8**	**8**	**8**	**23**	**23**	**23**	**23**	**36**	**36**

		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Beginning Bank		36	36	36	36	39	42	43	44	43	42
Requirement		**(103)**	**(103)**	**(103)**	**(104)**	**(105)**	**(106)**	**(107)**	**(108)**	**(109)**	**(110)**
Current Available		22	22	22	22	22	22	22	22	22	22
New Qualifying RECs		85	85	85	85	85	85	85	85	85	85
Sold Qualifying RECs		(5)	(4)	(4)	(0)	0	0	0	0	0	0
End Bank		**36**	**36**	**36**	**39**	**42**	**43**	**44**	**43**	**42**	**39**
Contingency Bank		**36**	**36**	**36**	**36**	**37**	**38**	**38**	**38**	**39**	**39**

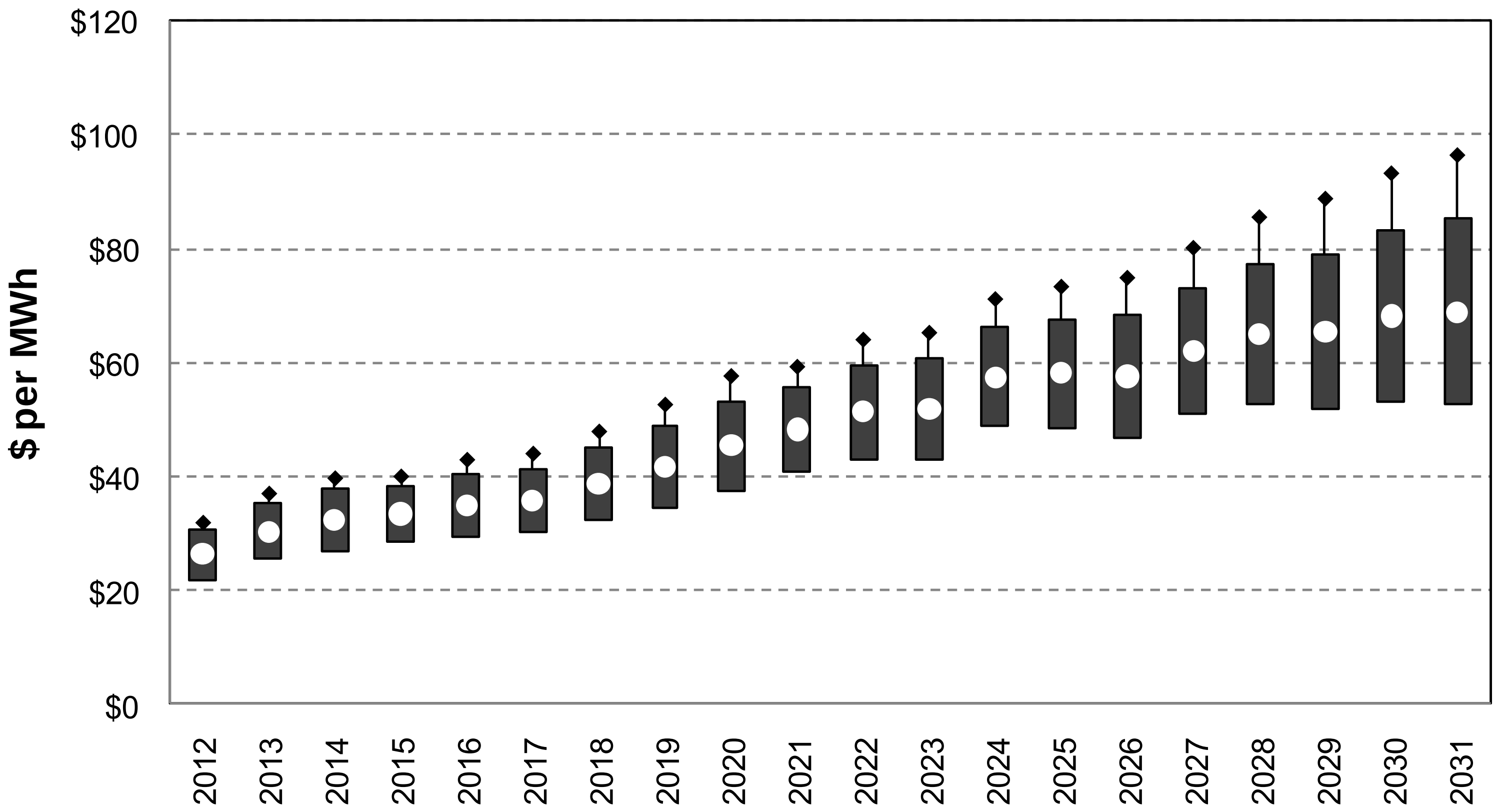
Preferred Resource Strategy Annual Costs per MWh Expected Market Conditions (80% Credit Allocation)

(Includes all Power Supply Costs except Capital Plant in Rate Base)



Preferred Resource Strategy Annual Costs per MWh No Carbon Legislation

(Includes Power Supply Costs except Capital Plant in Rate Base)



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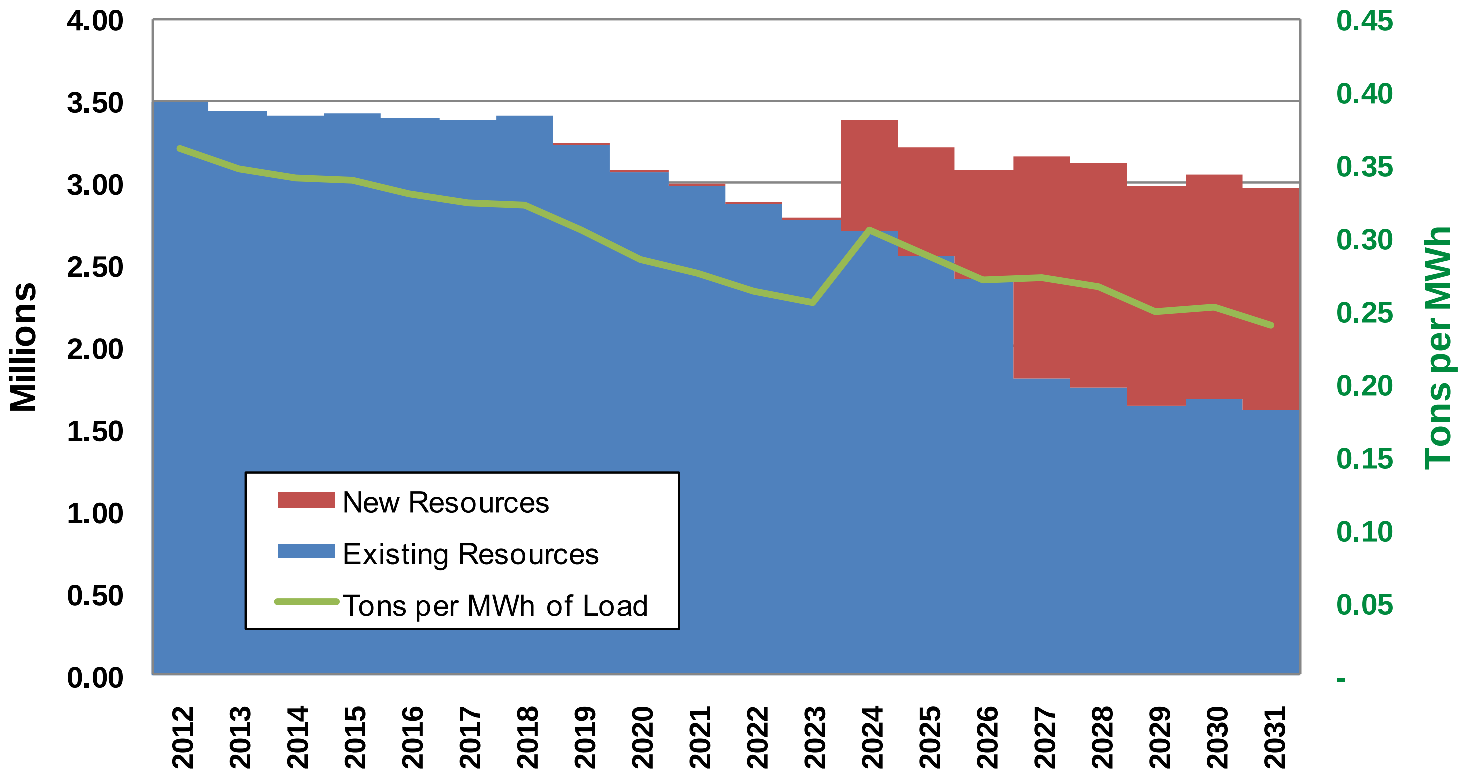
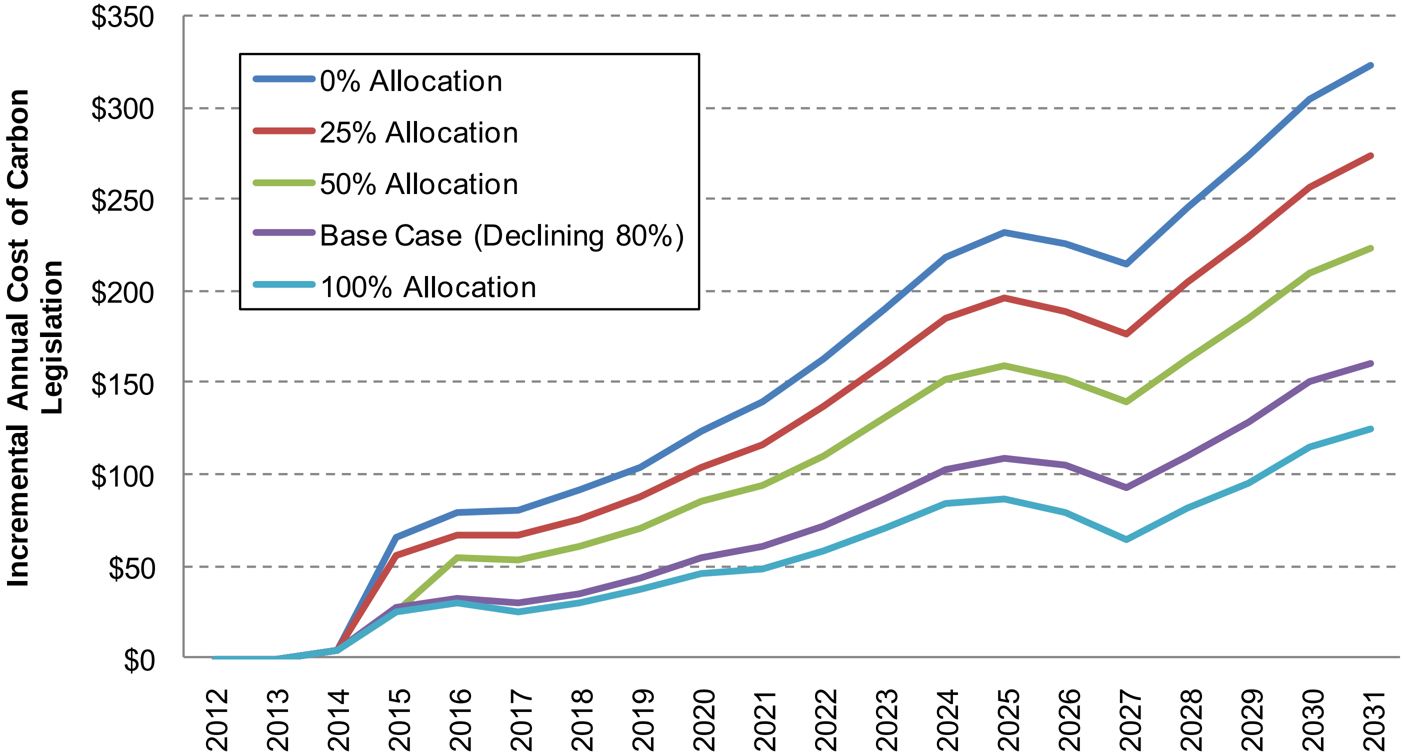
Greenhouse Gas Emissions (millions of short tons)



Greenhouse Gas Cost



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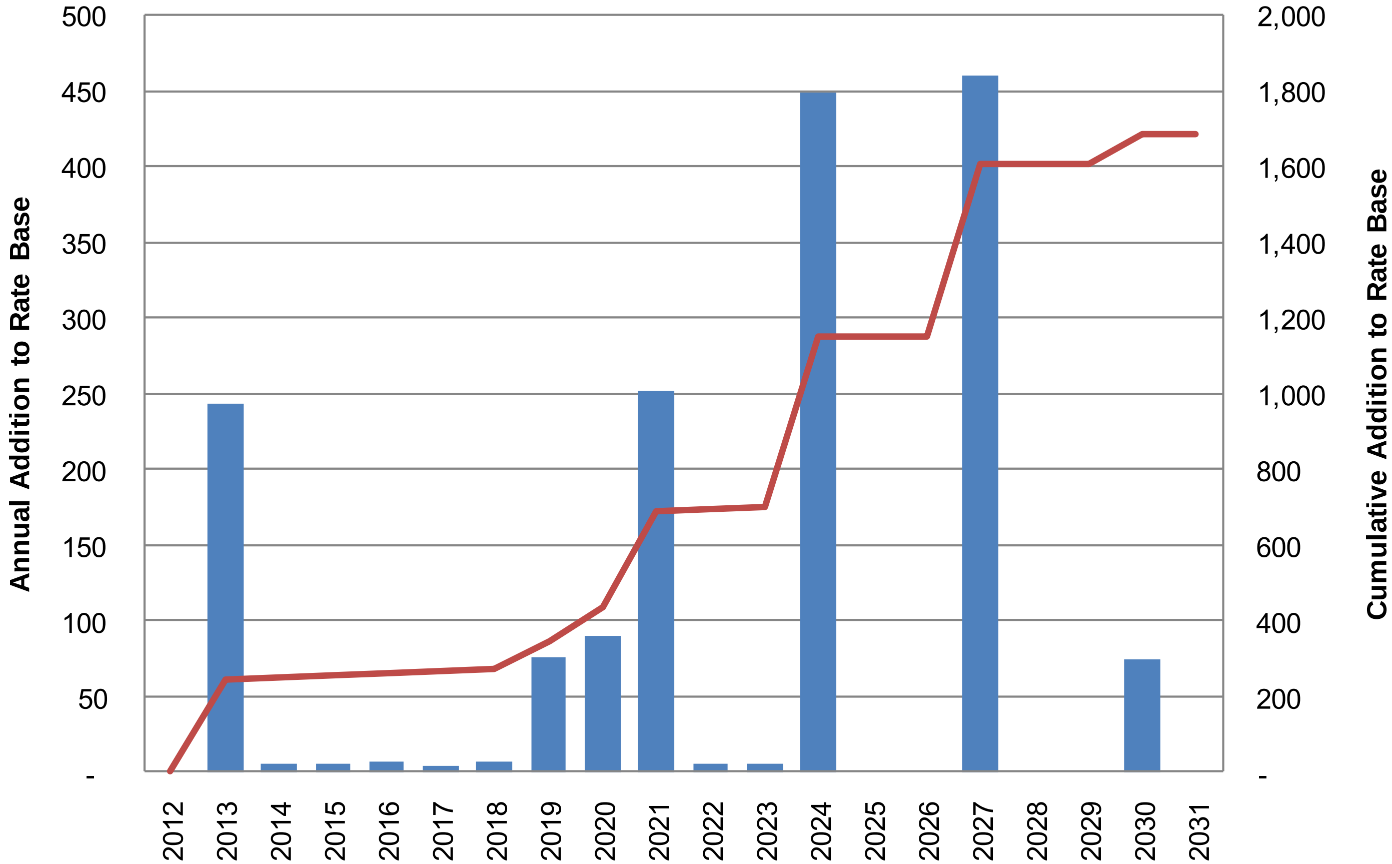
PRS Capital Requirements (millions $)



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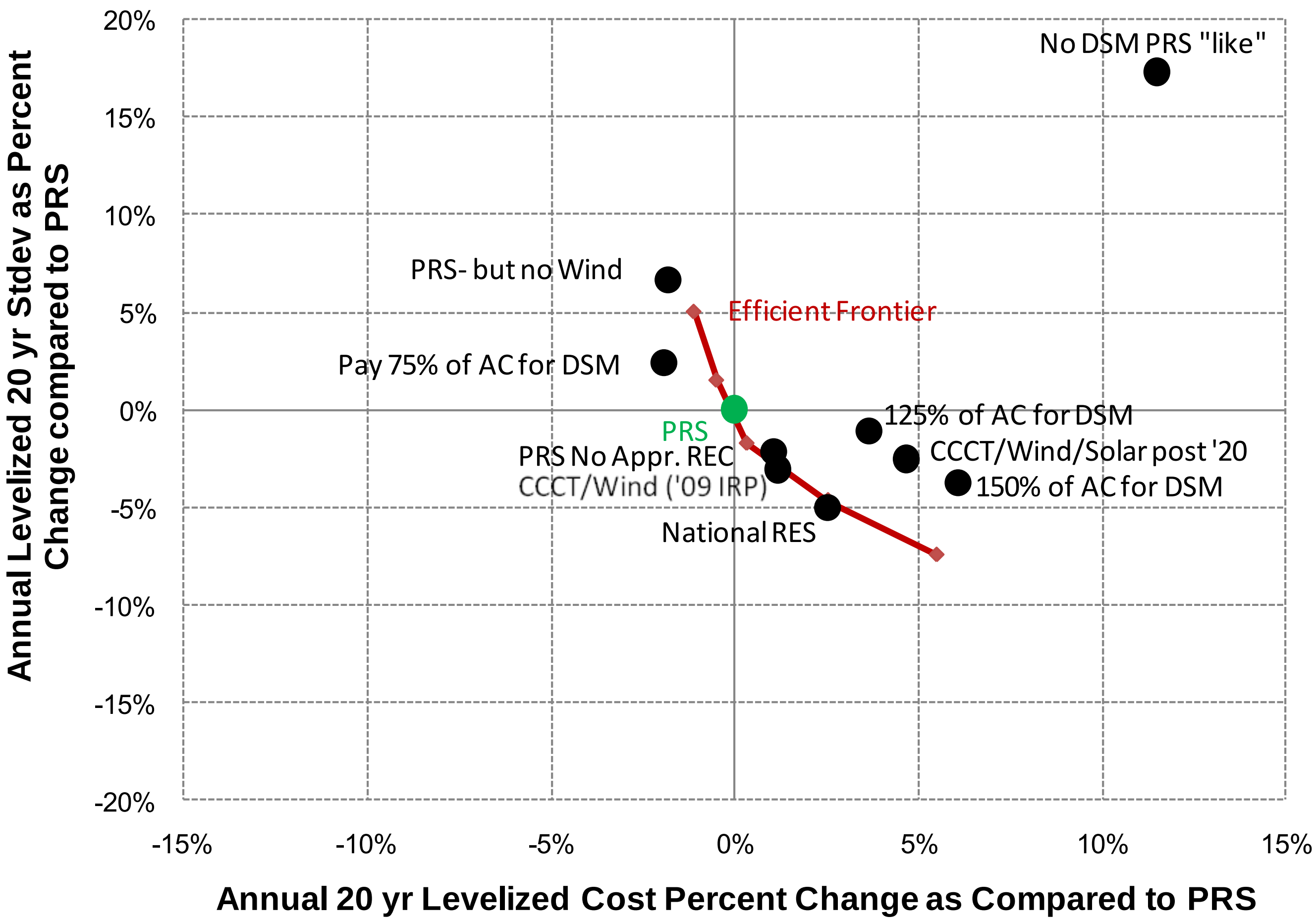
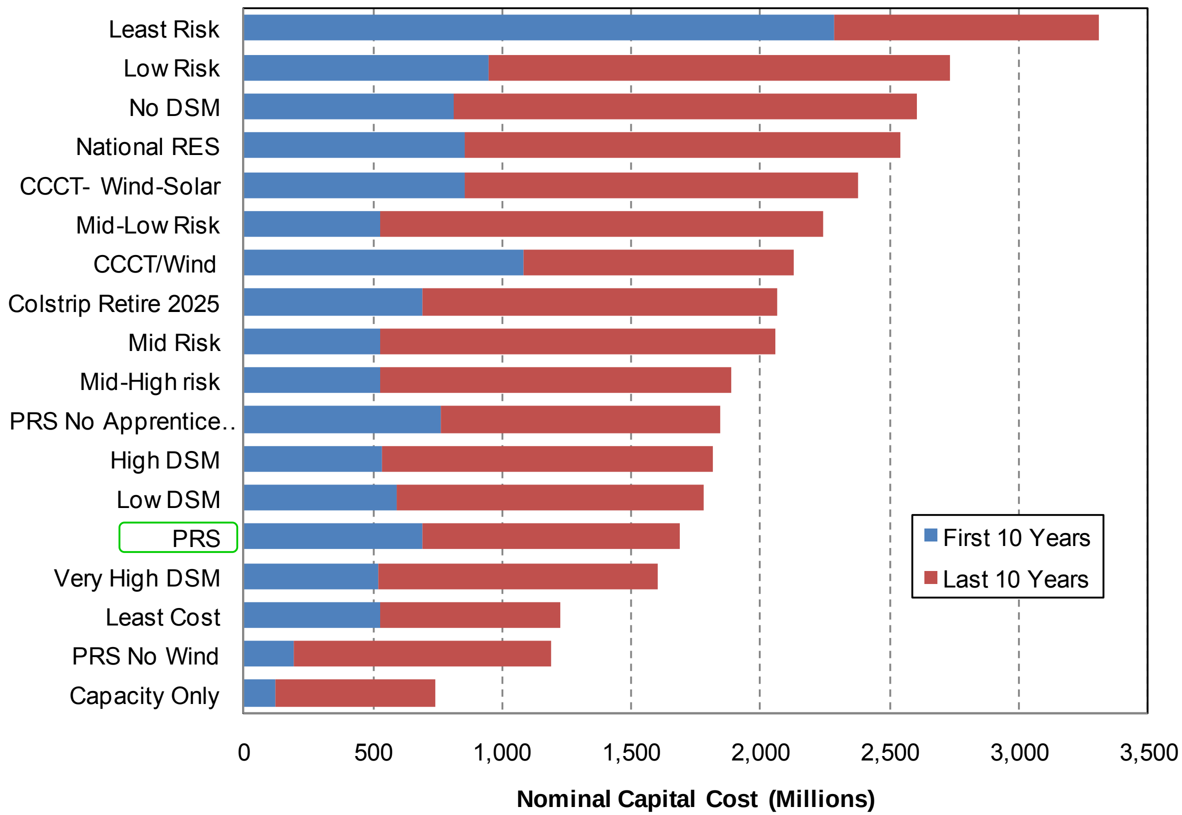
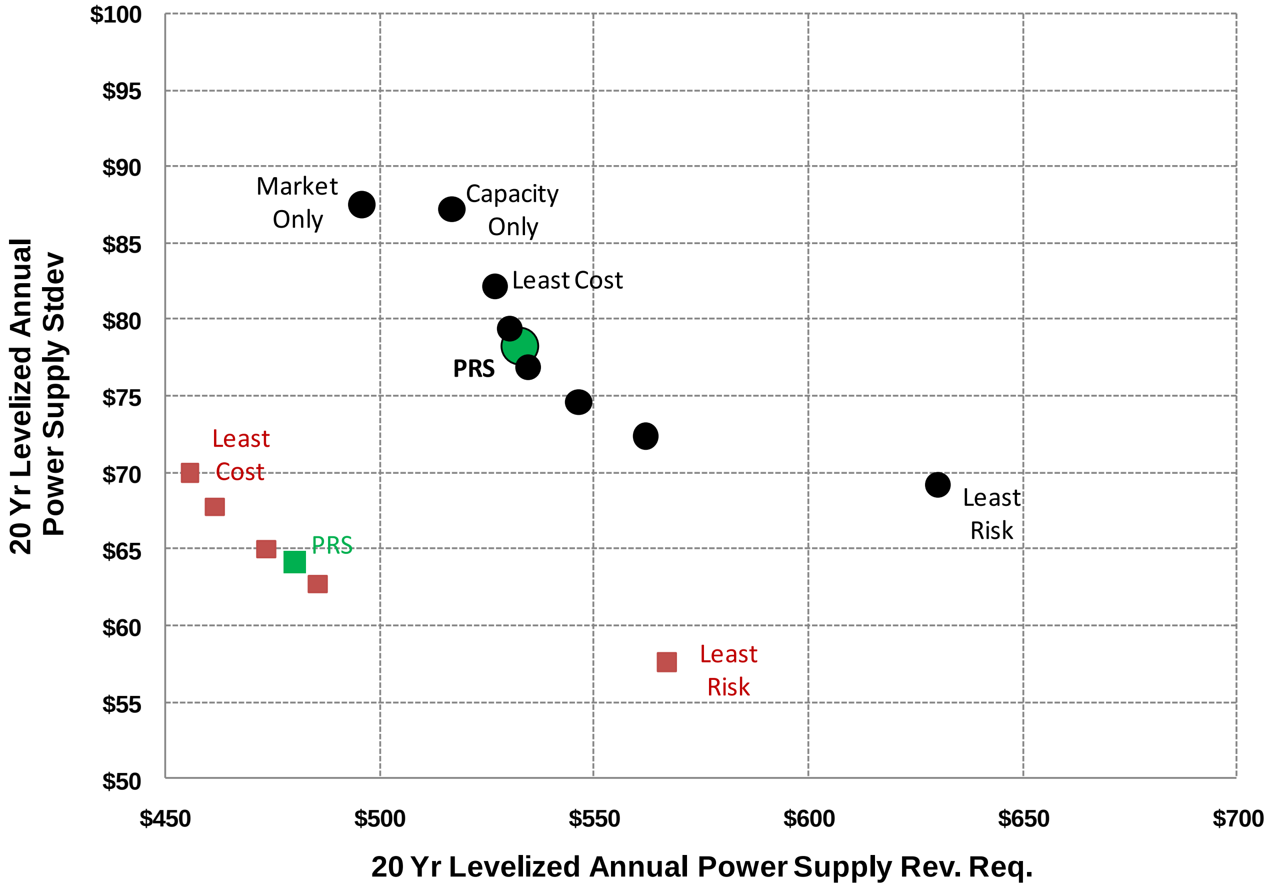
Alternative Strategies Comparison



Capital Expenditures (Alternative Portfolios)



Base Case Efficient Frontier Compared to No Carbon Costs Efficient Frontier



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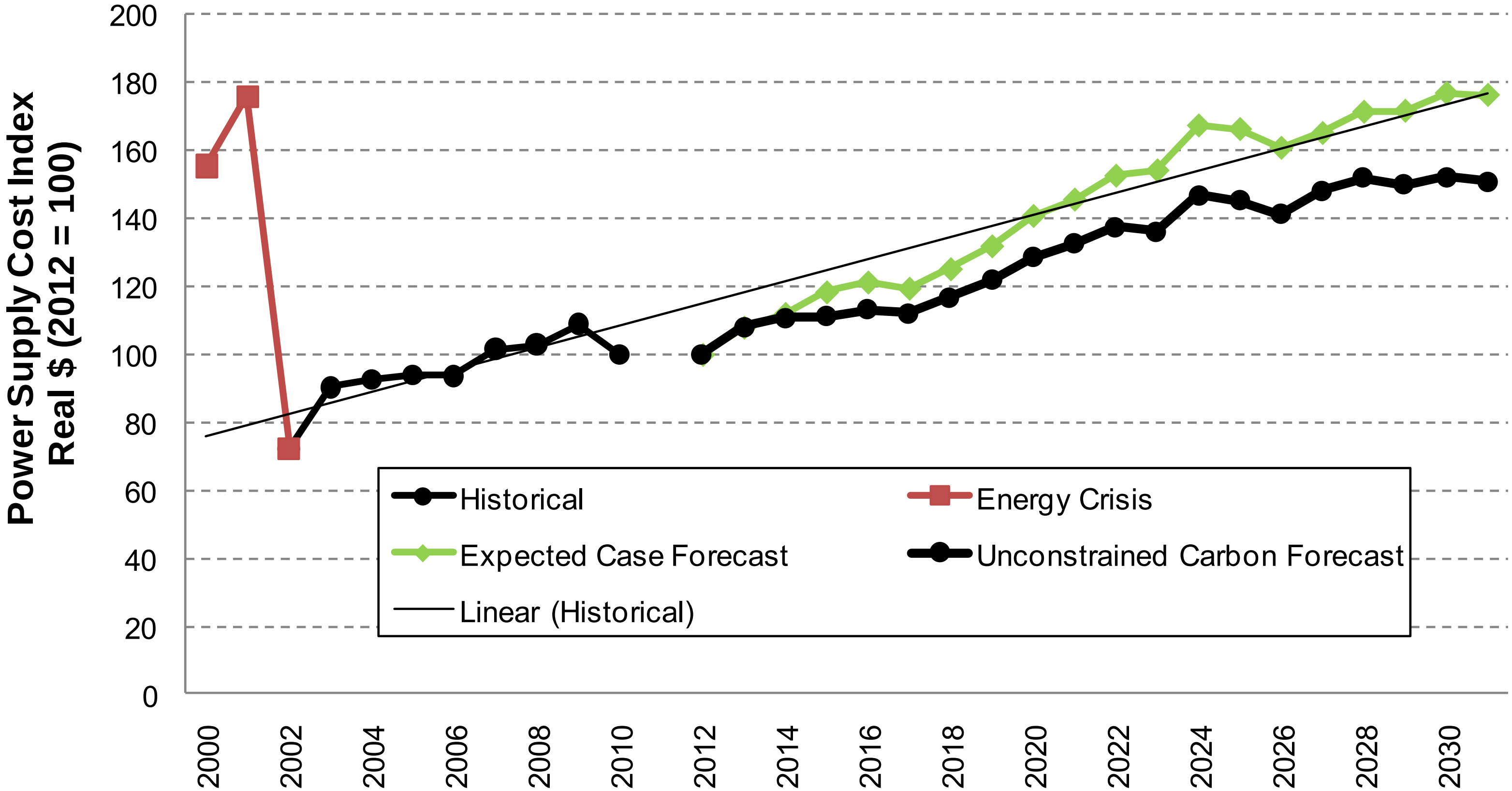
Power Supply Cost Expected and Historical Growth Index



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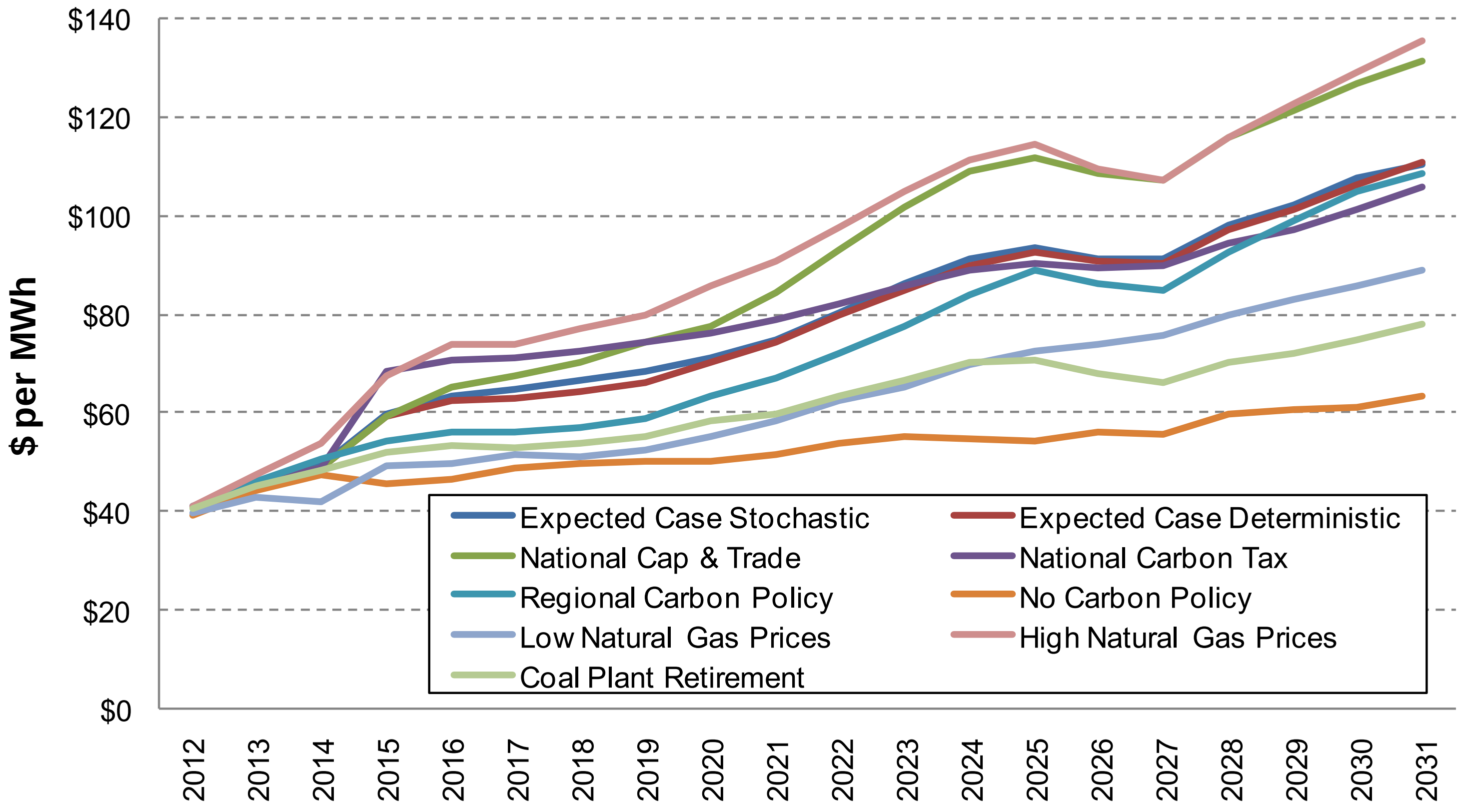
Resource Cost Tipping Point Analysis

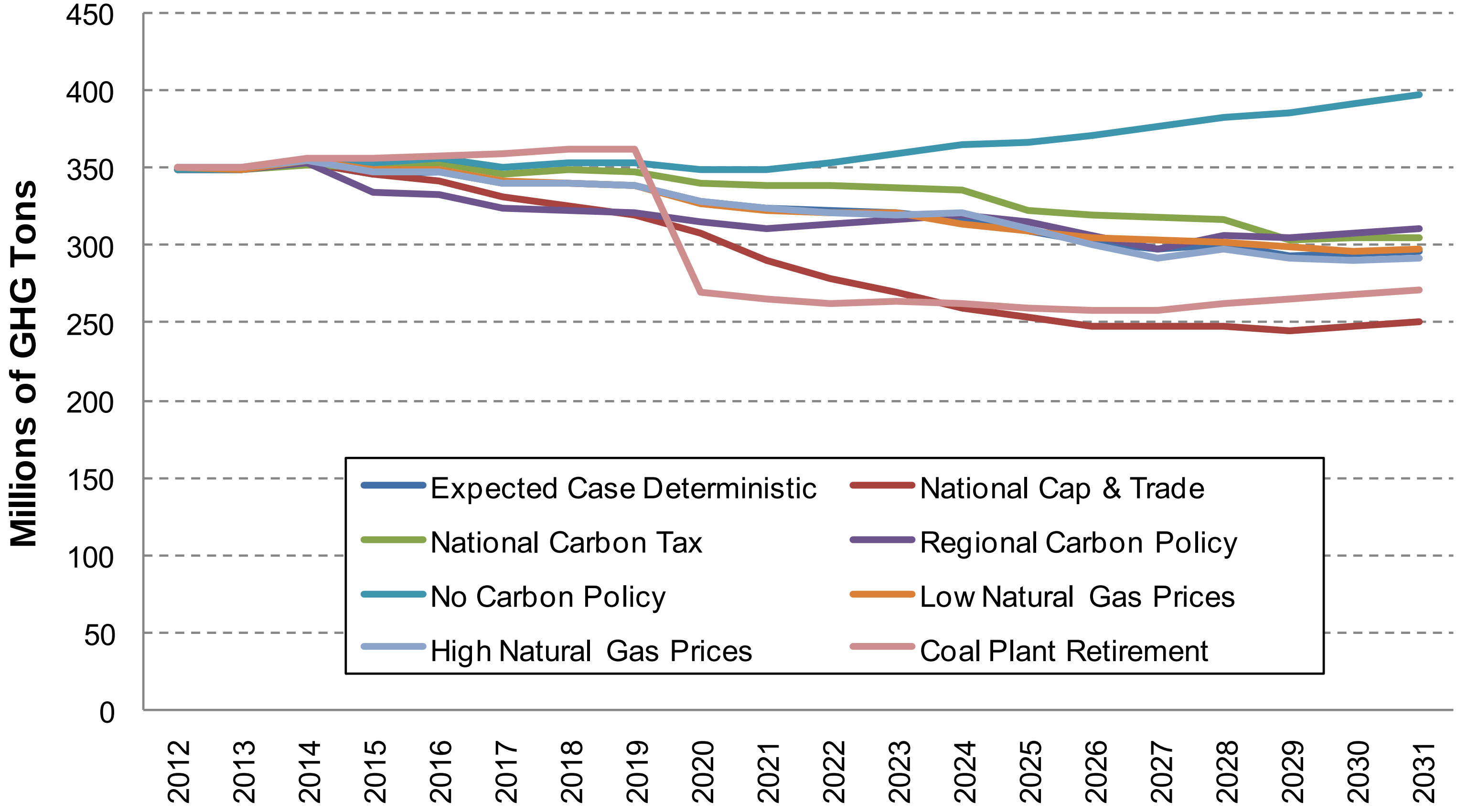
	Target Resource Capital Cost ($/kW)	Required Cost to be Selected ($/kW)	Percent Reduction
CCCT to replace SCCT to be least cost (2024)	$1,609	$1,255	-22%
Wind shift to Solar (2020) (2x REC included)	$4,371	$2,052	-53%

Market Scenario Analysis Update

Mid-Columbia Electric Price Forecast



US WECC GHG Emissions



Next Steps

- Obtain internal feedback and approvals of Preferred Resource Strategy
- Compare alternative resource portfolios using alternative market conditions
- Compare efficient frontier analysis with additional stochastic market analysis (i.e. coal plant retirement/Volatile NG)
- Further investigate Demand Response cost/benefits

Smart Grid Project Overview

TAC Meeting – April 12, 2011

Curtis Kirkeby, P.E.
Sr. Electrical Engineer – SGDP Principal Investigator

Avista Smart Grid Grants

Smart Grid Investment Grant (SGIG)

Spokane, WA

Smart Grid Demonstration Project (SGDP)

Pullman, WA

Smart Grid Workforce Training Grant

Jack Stewart Training Center - Spokane, WA

Smart Grid Workforce Training Grant

Five state partnership: Industry, Education, Labor

Benefits to Our Region –

- Local facility to train on new technology
- Leverage training needs of other Avista grants; build new curriculum
- Federal dollars to update existing training and facilities to up-skill current and future workers

Award:	$5.0 m over 3 years
Avista portion of award:	$1.3 m over 3 years
Grant Partner match	$6.8 m over 3 years

Grant Objectives

- Smart Grid Training Delivery
- Smart Grid Training Portal
- Share Best Practices on Smart Grid Training

"Create an effective and efficient electric power workforce proficient in smart grid competencies"

Avista Objectives

- Construct a training substation for training on smart grid technology
- Update training programs to incorporate smart grid technology
- On-line curriculum to be shared by utilities and colleges

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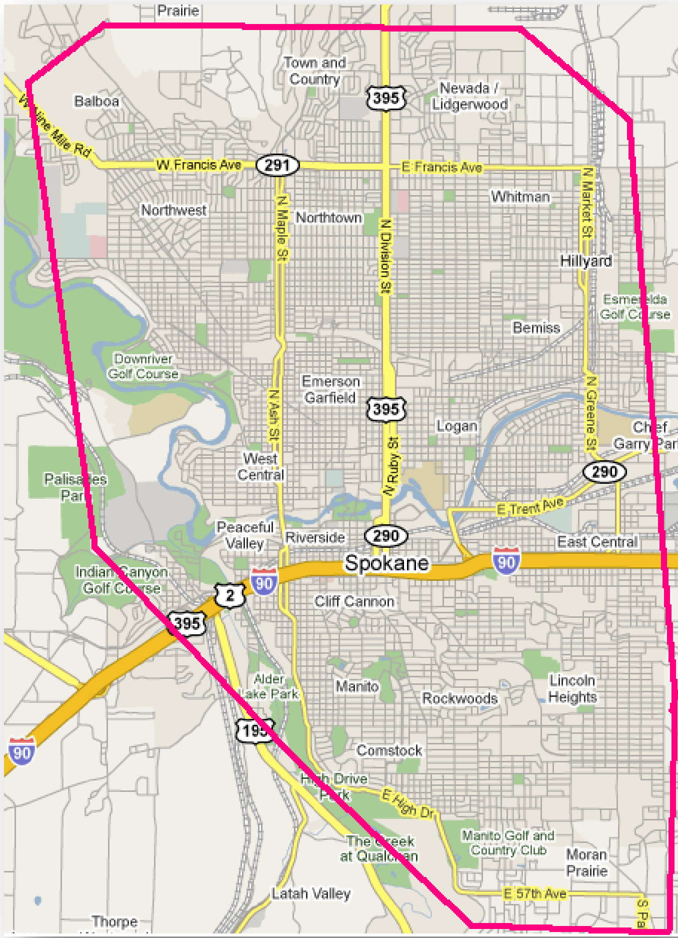
SGIG – Spokane, WA



- Target
- 59 Distribution Circuits
- 110,000 Electric Customers
- 14 Substations

Loss Reduction – 42,000 Mega watt hours/Year

2500 Homes/Year

Green House Gas Reduction: 14,000 Tons

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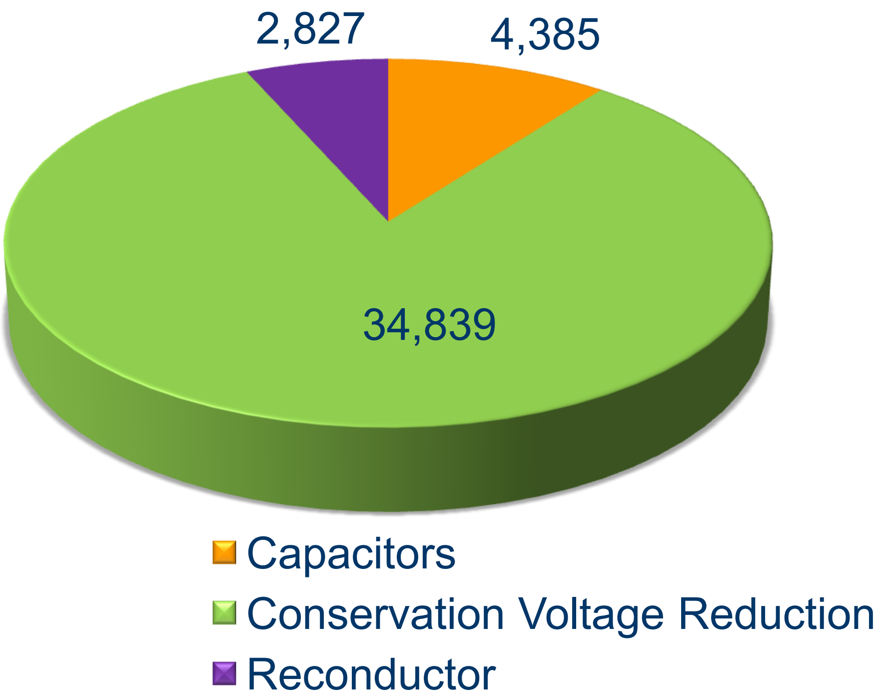
SGIG – Benefits

Carbon Reduction: 14,360 Tons a year.

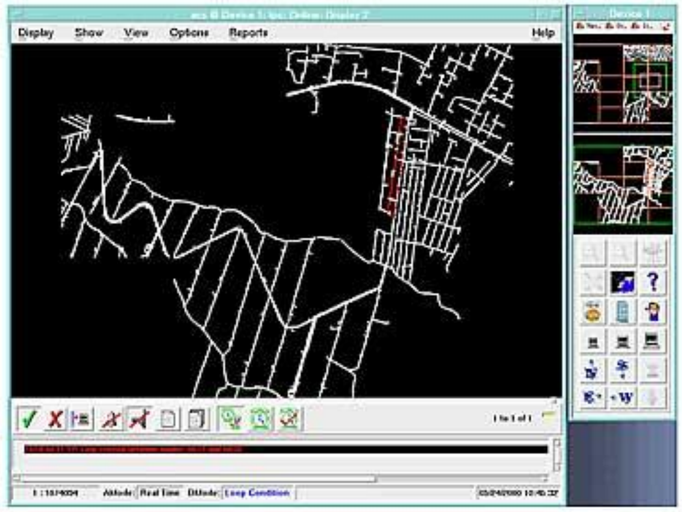
- $50/Ton to Sequester
- $718,000/year.

Savings (MWh)

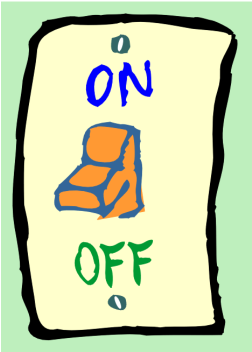


SGIG – Enabling Technologies

Communication:
- Wireless to Field Devices
- Fiber to Substations

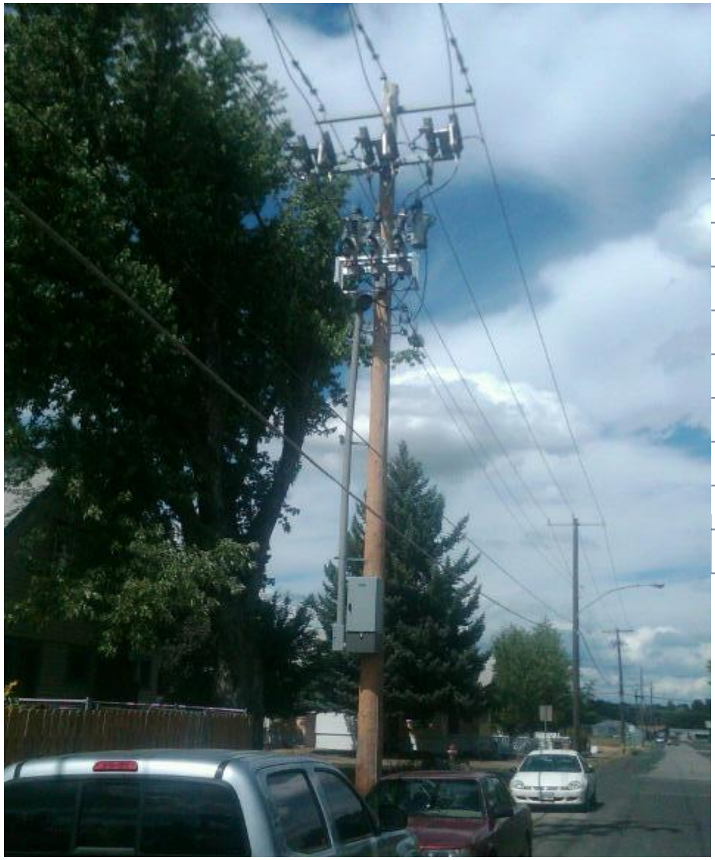


Field Equipment
- Switches and Reclosers
- Capacitor Banks
- Voltage Regulators



Distribution Management System (DMS)
- Remotely Control and Operate Distribution Equipment
- Continually Analyzing the System for Optimization
- Automated Fault Detection Isolation and Restoration

SGIG – Construction



Substation

Cap

■ Complete ■ To Be Completed

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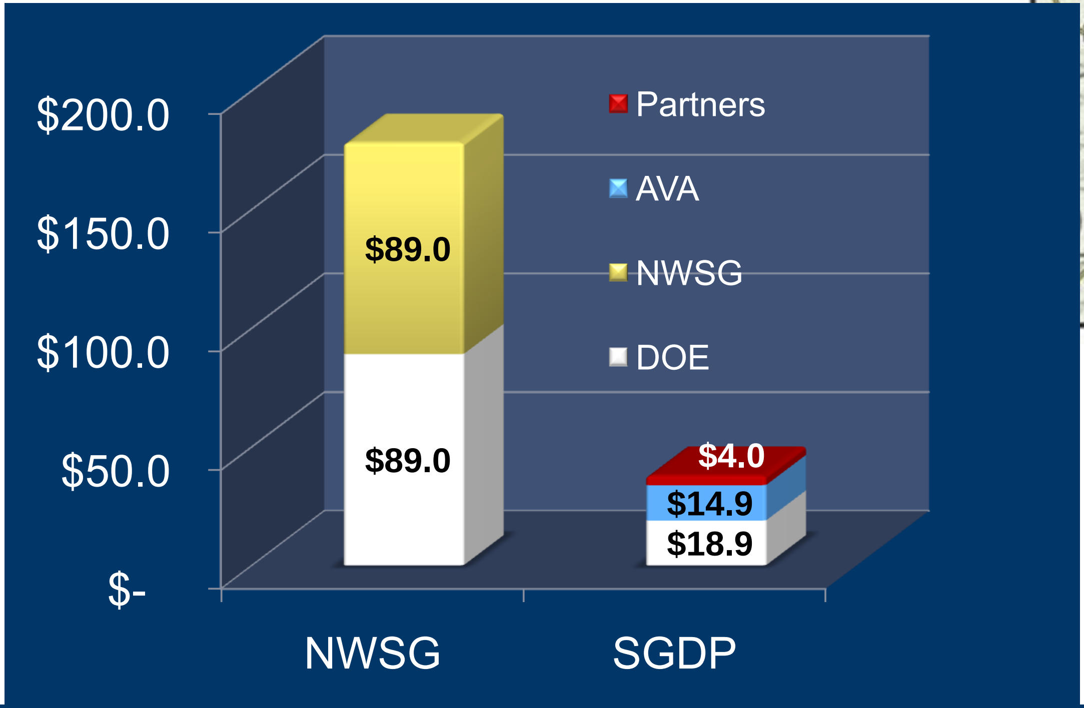
SGDP – Demonstration Project



SGDP – Regional Players

Pacific Northwest SMART GRID DEMONSTRATION PROJECT

National Energy Technology Laboratory

Battelle NW

Bonneville Power Administration

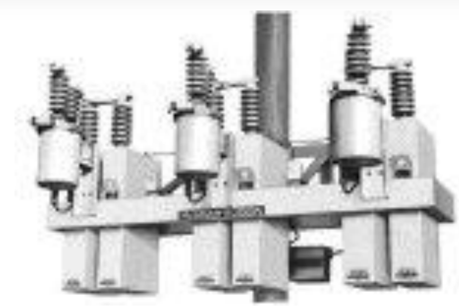
3 Tier
Areva
IBM
Netezza
Quality Logic

Utility Partners

- **Avista**
- Benton PUD
- City of Ellensburg
- Flathead Electric
- Idaho Falls Power
- Lower Valley Energy
- Milton-Freewater
- Northwestern Energy
- Peninsula Light
- PGE
- Seattle City Light (UW)

SGDP – System Elements

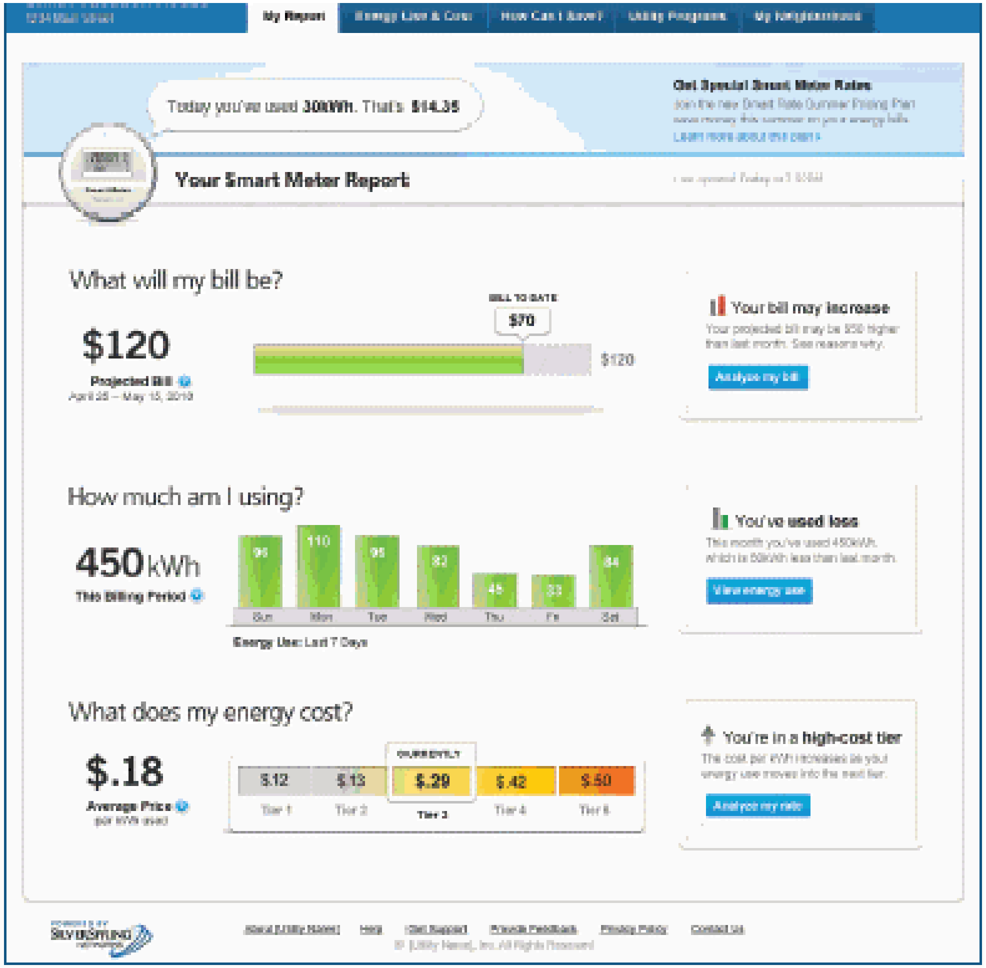
- 3 substations
  - Regulator controls
  - Reclosers/relays
- 13 circuits
  - 45 automated line switches & reclosers
  - 20 switched and fixed capacitor
  - Fault Indicators
  - Low loss transformers w/ communications
- Wireless & fiber communications



SGDP – Itron Open Way AMI

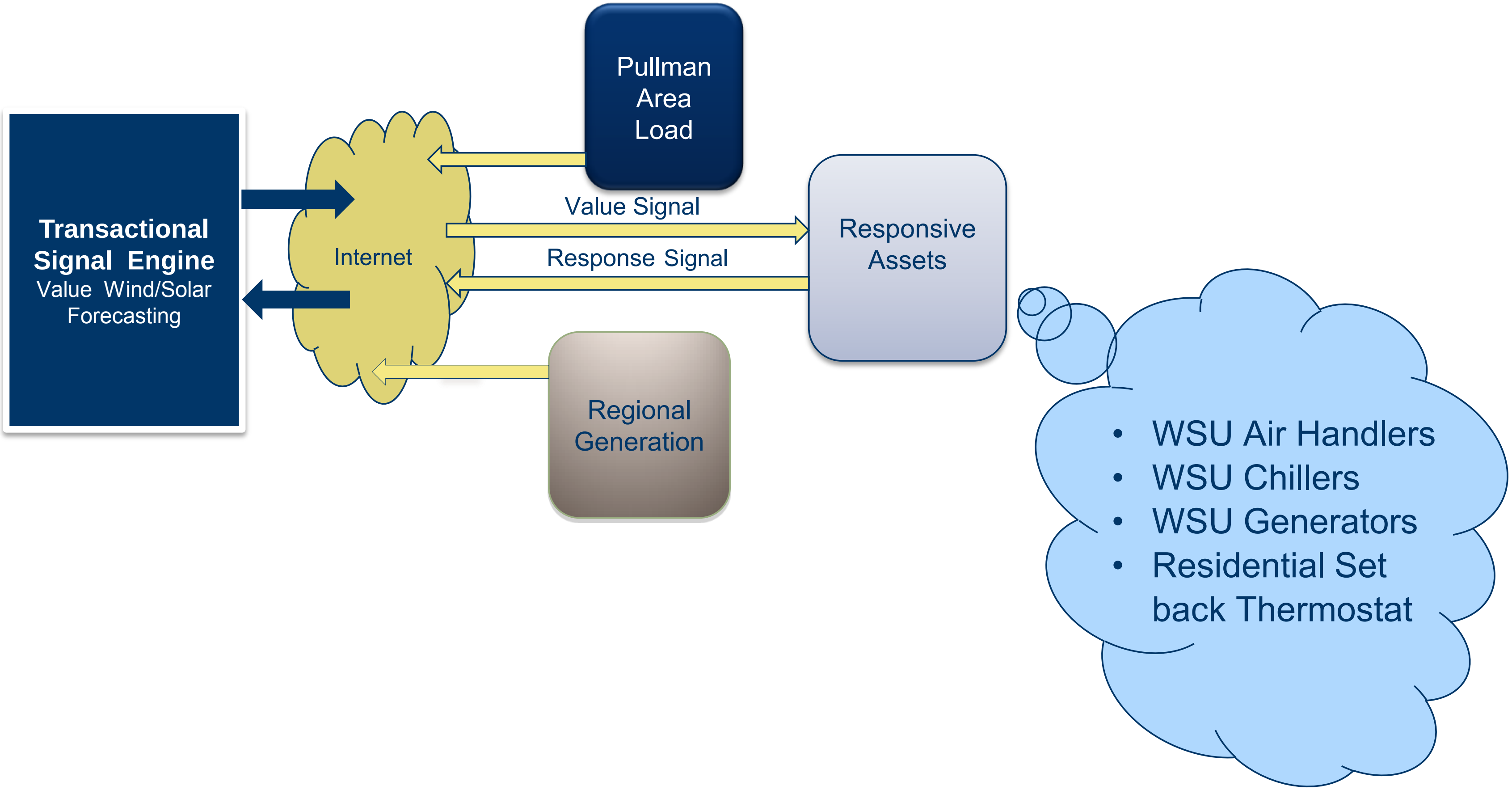
- ≈ 14,000 Residential / Commercial Electric Meters
- ≈ 6000 Residential / Commercial Gas Meter Registers
- Wireless Communication w/ Fiber Backhaul
- Remote Service Switch
- Back Office Software Systems

Customer Web Portals

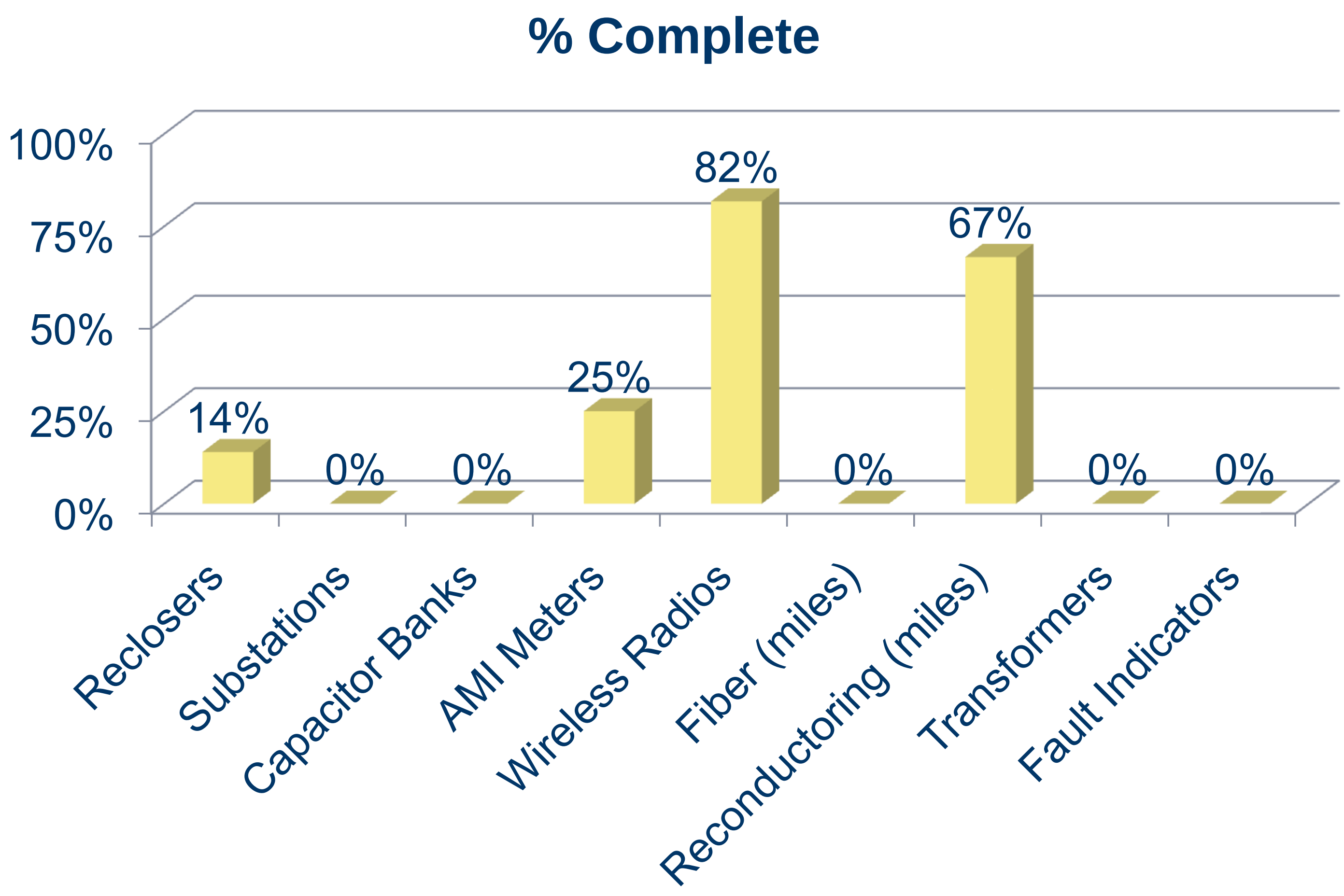


In-Home Displays

SGDP – Transactional Signal



SGDP – Construction



Smart Grid Energy Impacts

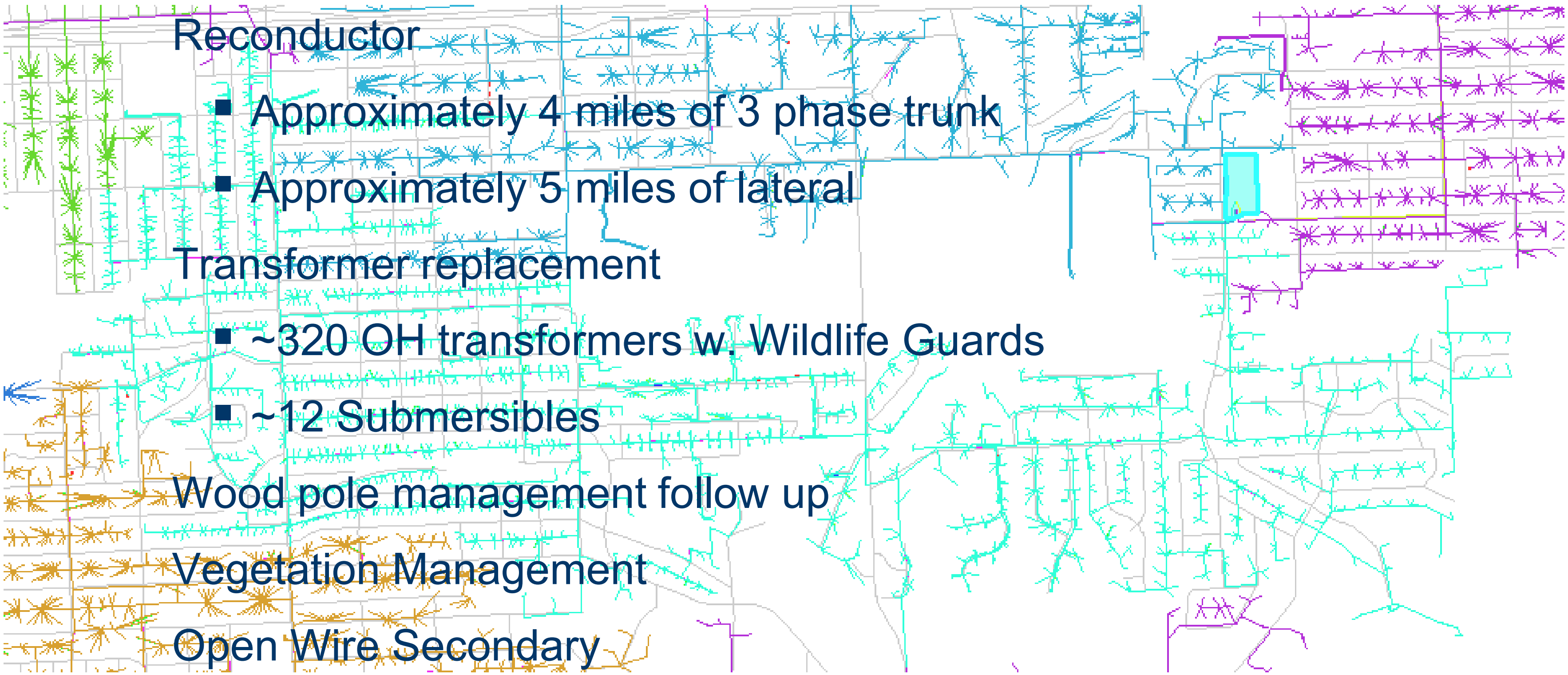
	SGIG (MWh)		SGDP (MWh)	
Year	Cumulative	I-937	Cumulative	I-937
2010	1500	1500	0	0
2011	7212	5712	286	286
2012	42051	34839	286	0
2013	42051	0	6763	6477

Future Programs

FEEDER REBUILDS

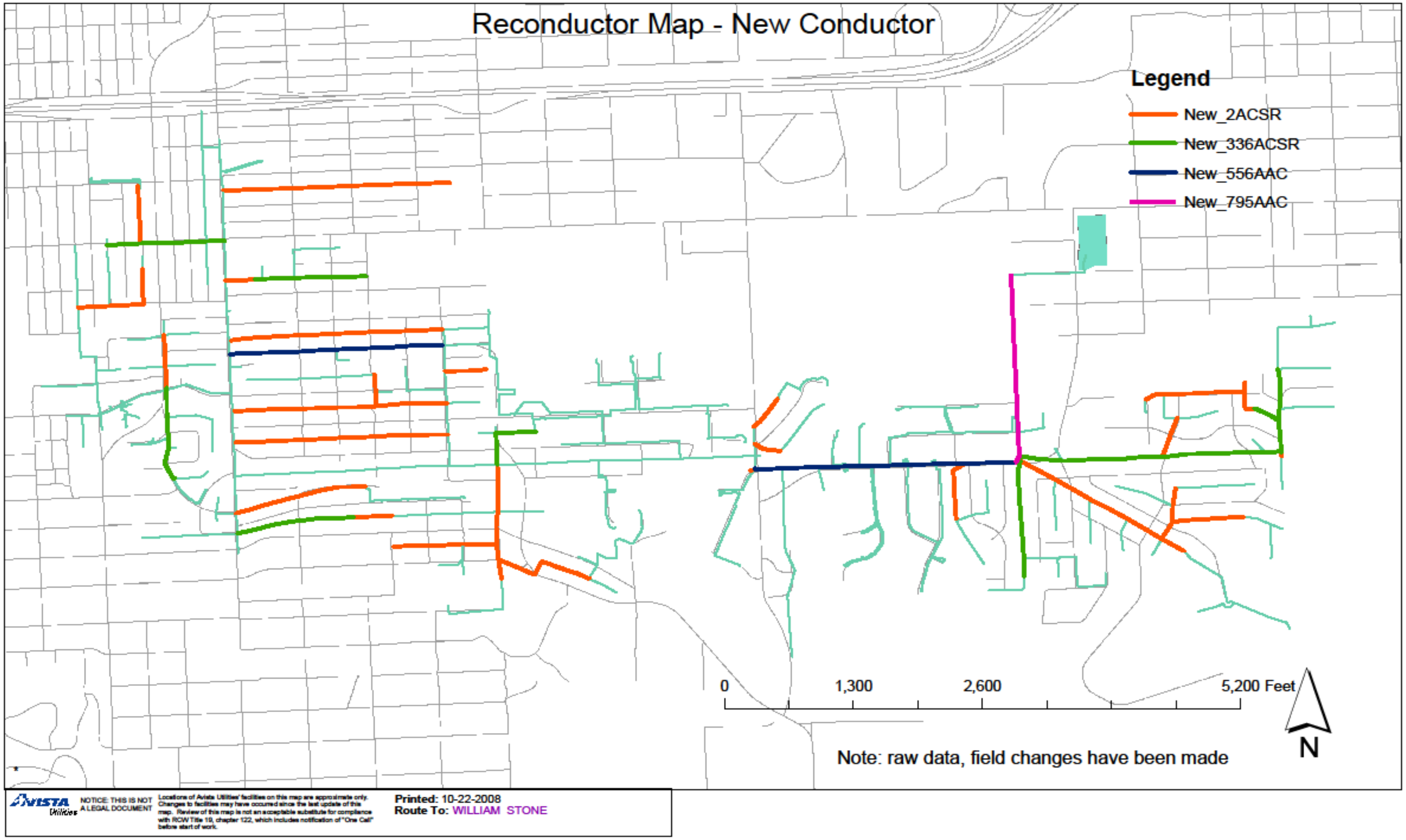
9th and Central 12F4 (9CE12F4) - 2009

Primary Goals



- Reconductor
  - Approximately 4 miles of 3 phase trunk
  - Approximately 5 miles of lateral
- Transformer replacement
  - ~320 OH transformers w. Wildlife Guards
  - ~12 Submersibles
- Wood pole management follow up
- Vegetation Management
- Open Wire Secondary

9CE12F4 Reconductor



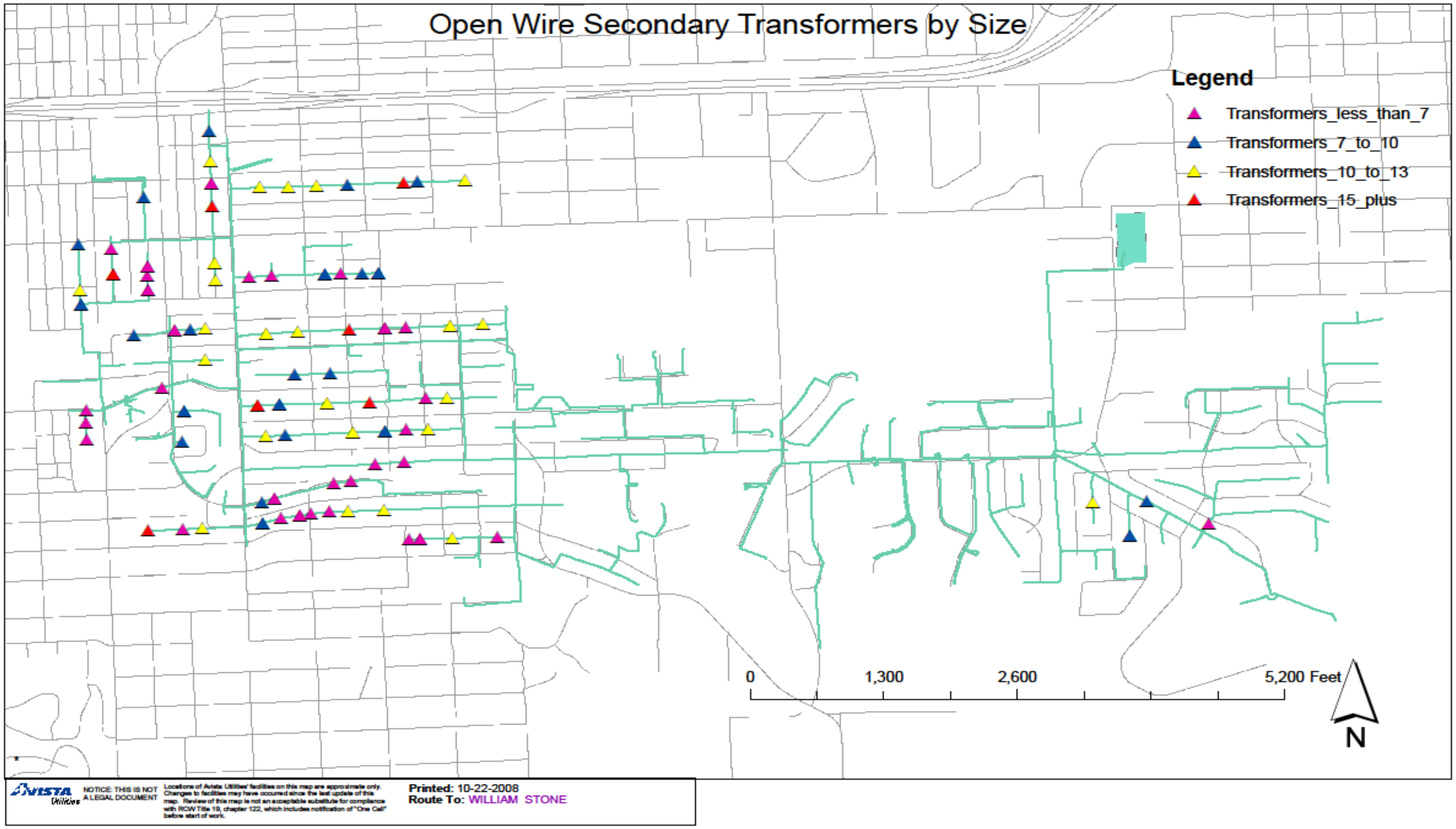
9CE12F4 Realignment

Good opportunity to move facilities where it makes sense for reliability and future maintenance and access

9CE12F4 Transformer Replacement

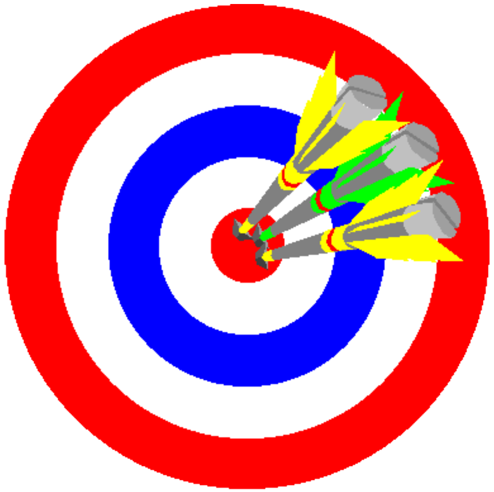
- All pre-2004 OH transformers replaced with new high efficiency units
- Lower core losses account for ~31 ave. kW

9CE12F4 Open Wire Secondary



9CE12F4 Outcome

- Clear understanding of the state of facility
- Understanding of work & resource staging
- Understanding of volt/var and voltage reduction opportunity
- Baseline for savings validation
- Future rebuilds are warranted



Future Programs

FEEDER REBUILDS

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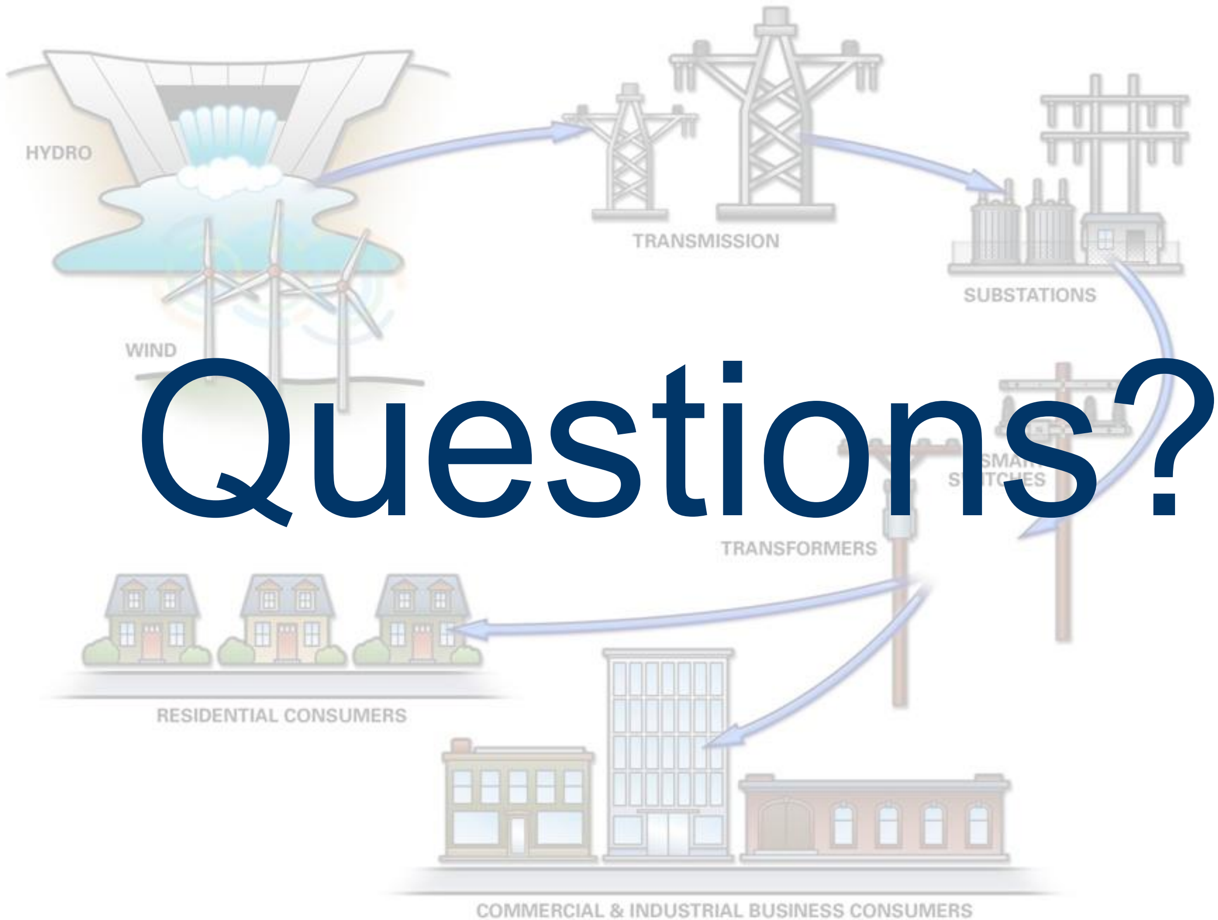
Feeder Rebuilds

- Detailed analysis has been completed for six feeders
- Results extrapolated to the remaining feeders
- The top 60 feeders targeted for energy savings in IRP
- Schedule is being developed based on resource availability
- Rebuilds to begin in 2013

Questions?



AVISTA

Avista's 2011 Electric Integrated Resource Plan
Technical Advisory Committee Meeting No. 6 Agenda
Avista Headquarters – Spokane, Washington

Thursday, June 23, 2011
Avista Conference Room 130

	Topic	Time	Staff
1.	Introduction	9:30	Storro
2.	High Wind Market Analysis	9:35	Kalich
3.	PRS & Scenario Analysis	10:15	Gall
4.	IRP Action Items	11:15	Lyons
5.	IRP Section Highlights	11:45	Kalich
6.	Lunch	12:15	
7.	Adjourn		

High Wind Market Analysis

James Gall

Technical Advisory Committee Meeting #6

2011 Electric Integrated Resource Plan

June 23, 2011

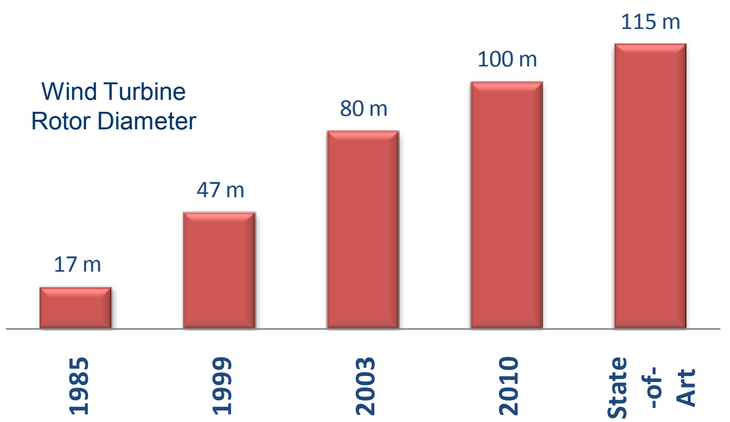
Northwest Wind Facts

- Pacific Northwest wind fleet by balancing authority (~5,200 MW)

Bonneville	~3,500 MW
PacifiCorp	~1,400 MW
Puget Sound Energy *	275 MW
Avista	35 MW

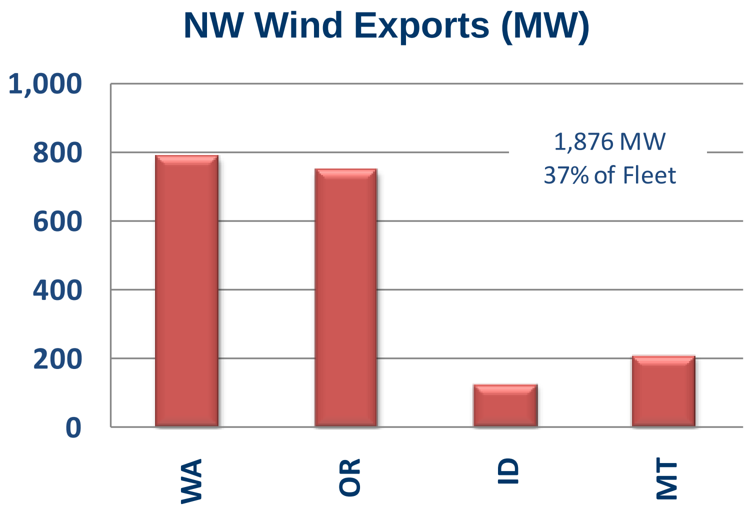
- 2/3 of NW wind fleet is on BPA system
  - 10,500 MW peak load
  - 80% exported to other utilities
  - BPA balance authority forecast
    - 5,250 MW in 2012
    - 8,700 MW in 2020

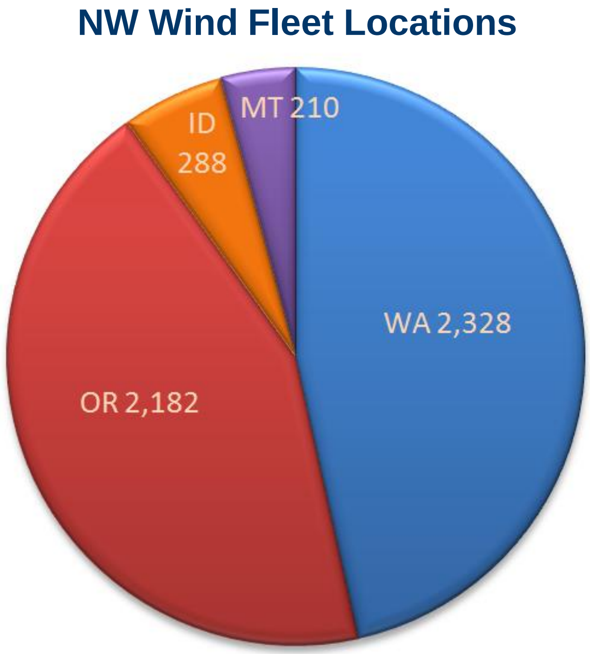
Wind Turbines Are Getting Bigger



* PSE has 430 MW of wind, 155 MW is in Bonneville's balancing area

Northwest Wind Resource Locations & Exports





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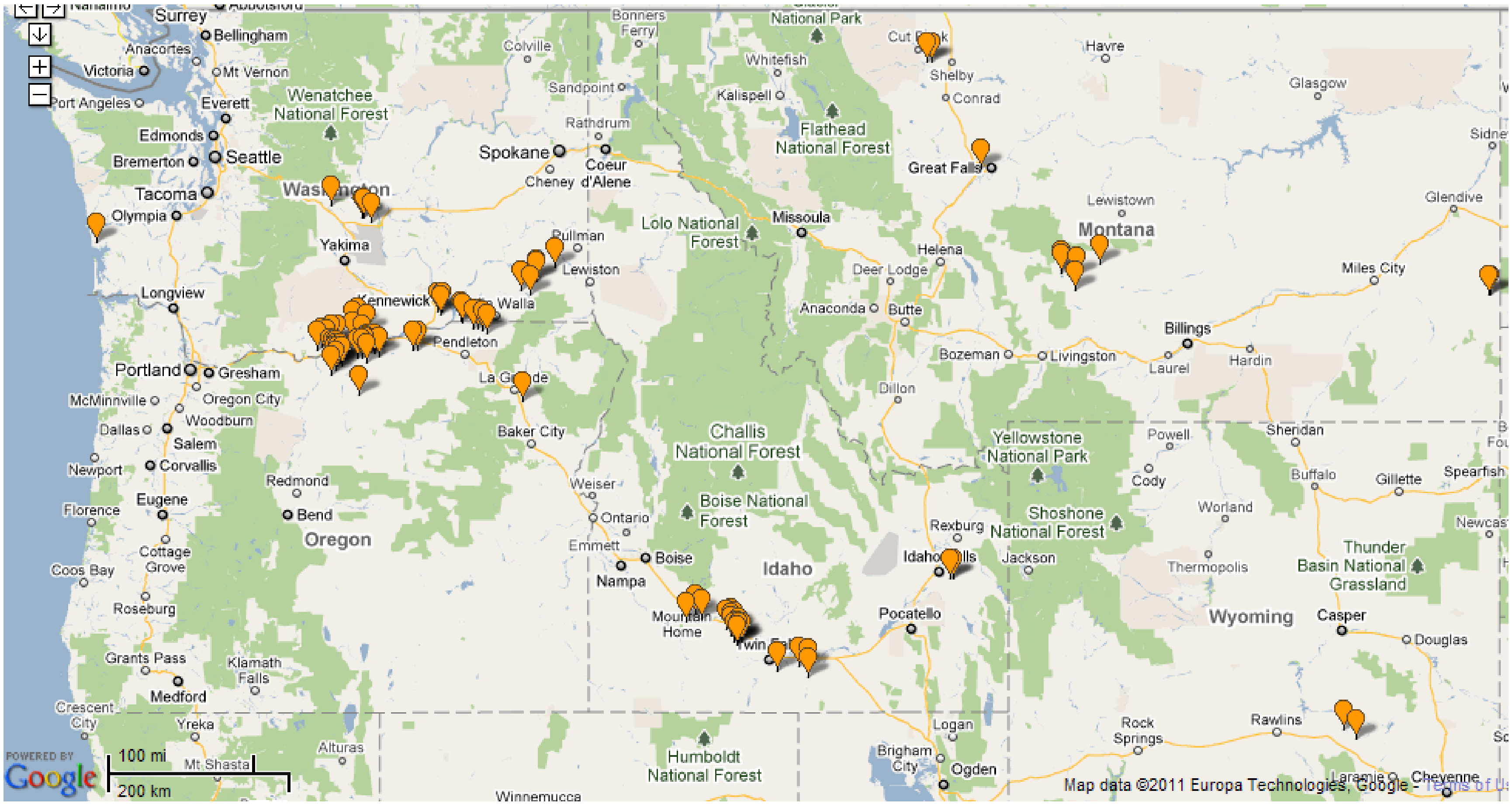
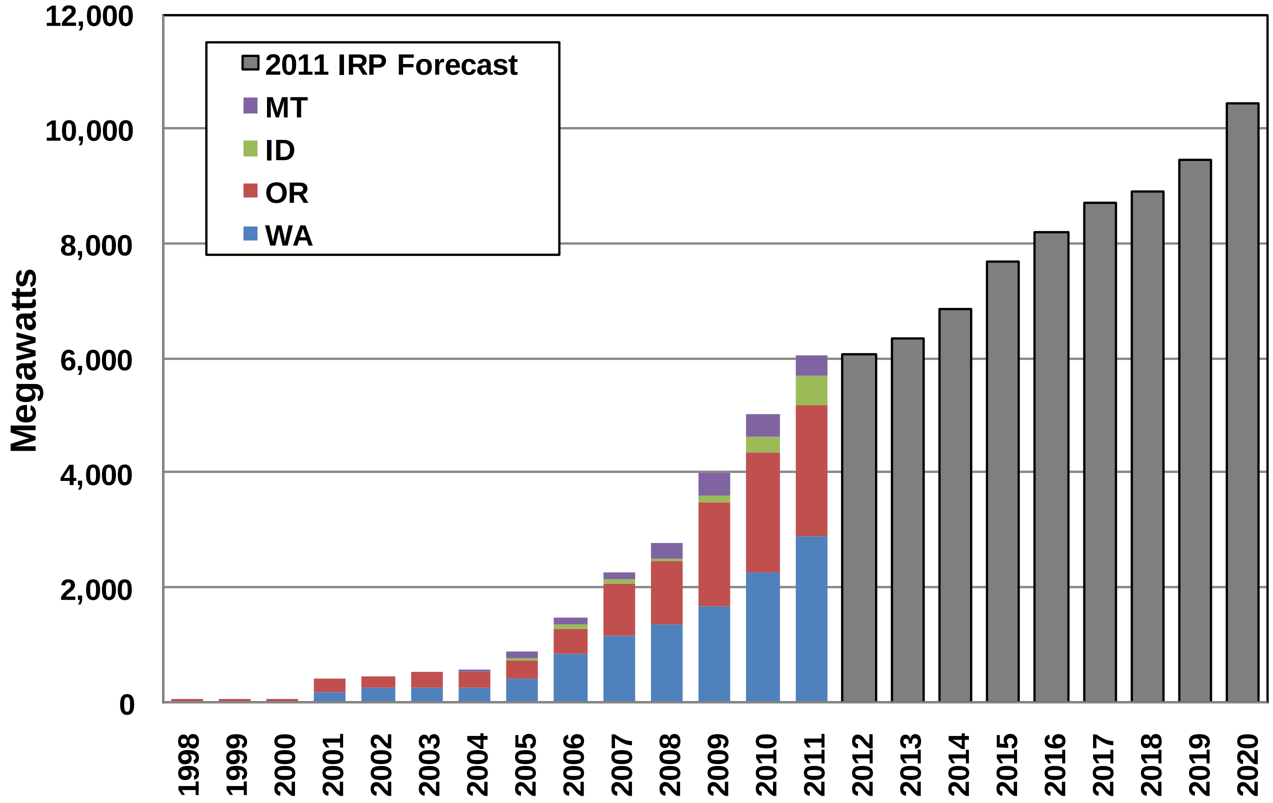
Northwest Wind Fleet Locations



Source: RNP.org

Northwest Wind Capacity Past and Future

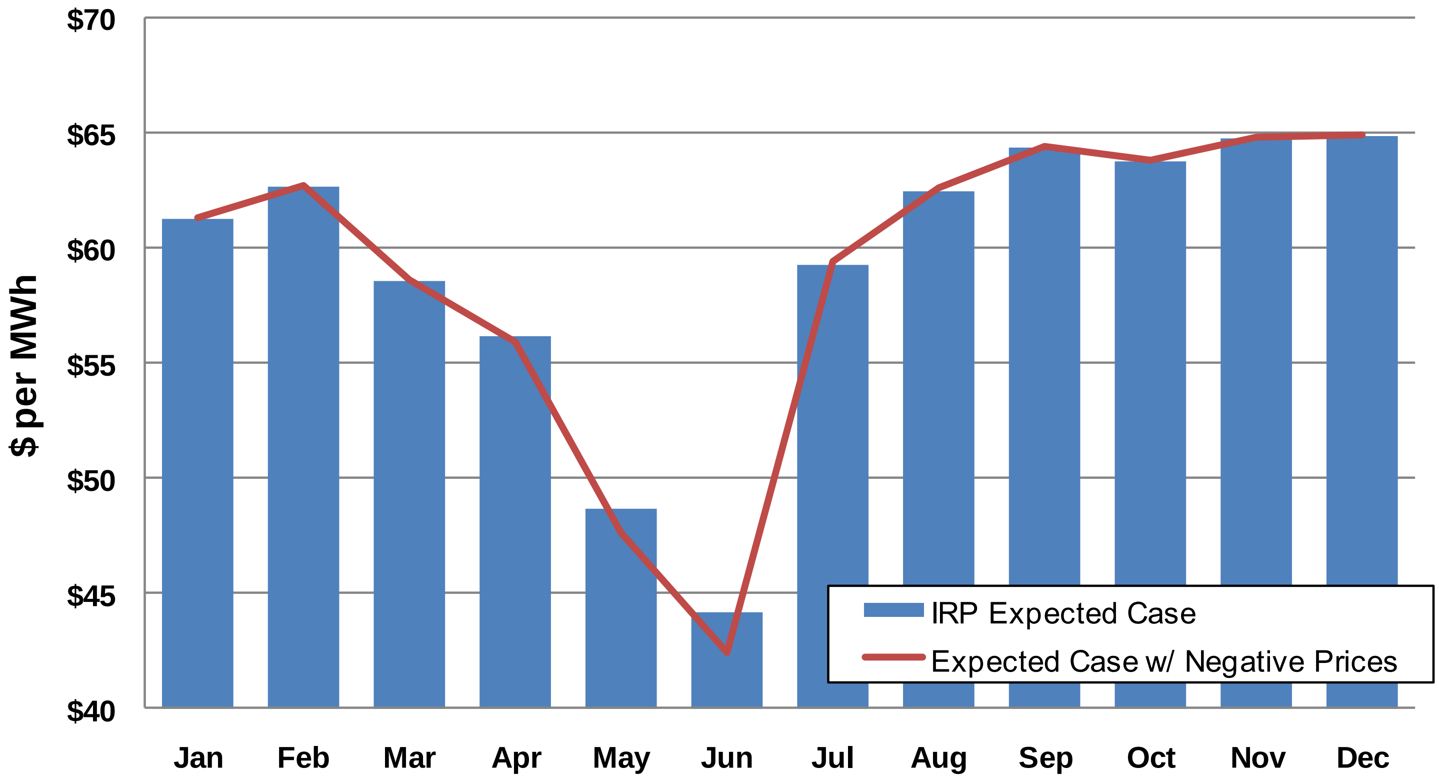


Historical data provided by RNP website

Study Scope

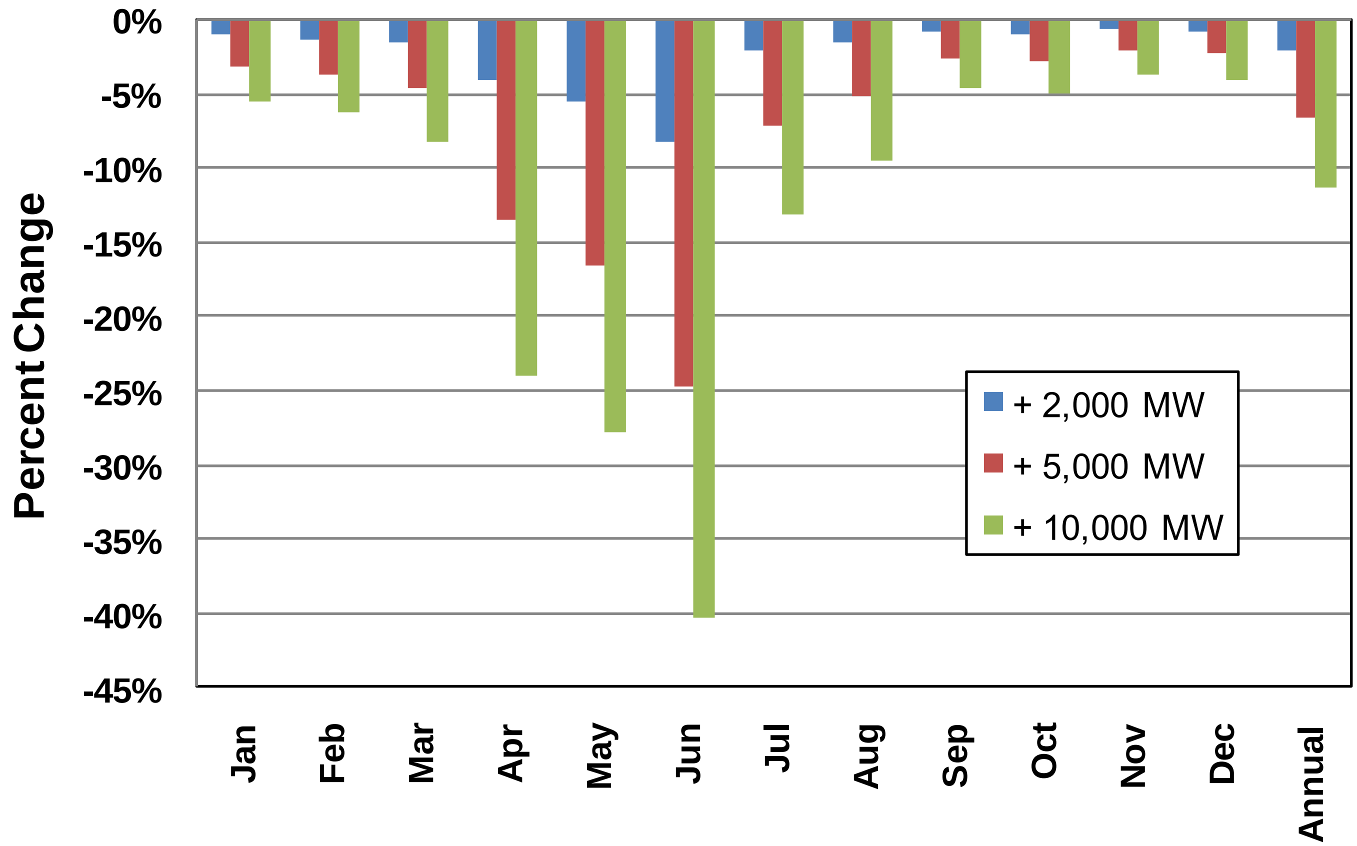
- Understand impact to the power system with more than forecasted amount of wind generation
- Uses IRP Expected Case for 2015
- Adjust model to allow for negative pricing using -$40/MWh for Northwest hydro projects and -$10 to -$30/MWh for wind projects
- Run 100 iterations for each of these scenarios
  - Add 2,000 MW of wind
  - Add 5,000 MW of wind
  - Add 10,000 MW of wind

Negative Price Impact to IRP Expected Case Market Forecast

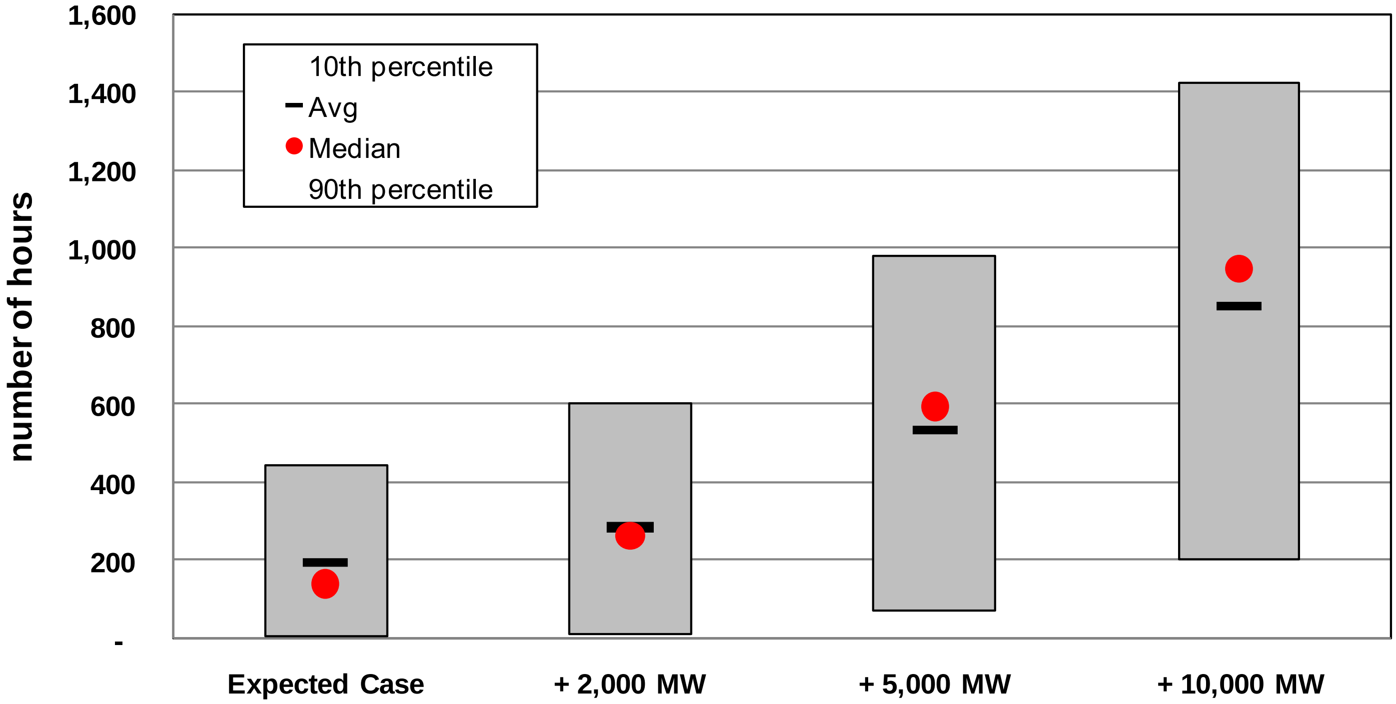


Annual price change is -0.3%, Q2 would be 2.2% lower

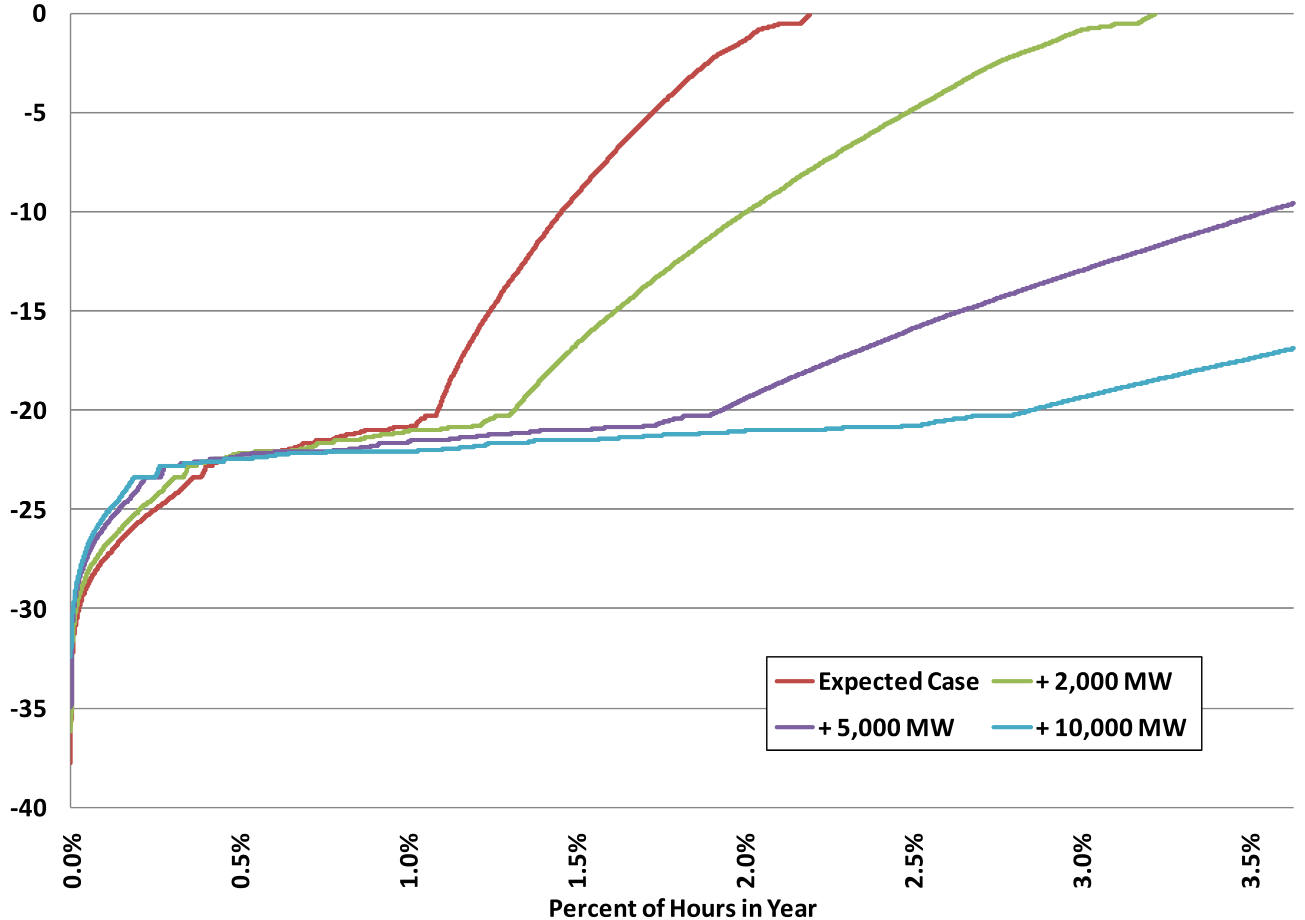
Wind Scenarios: Change to Monthly Average Mid-Columbia Electric Prices



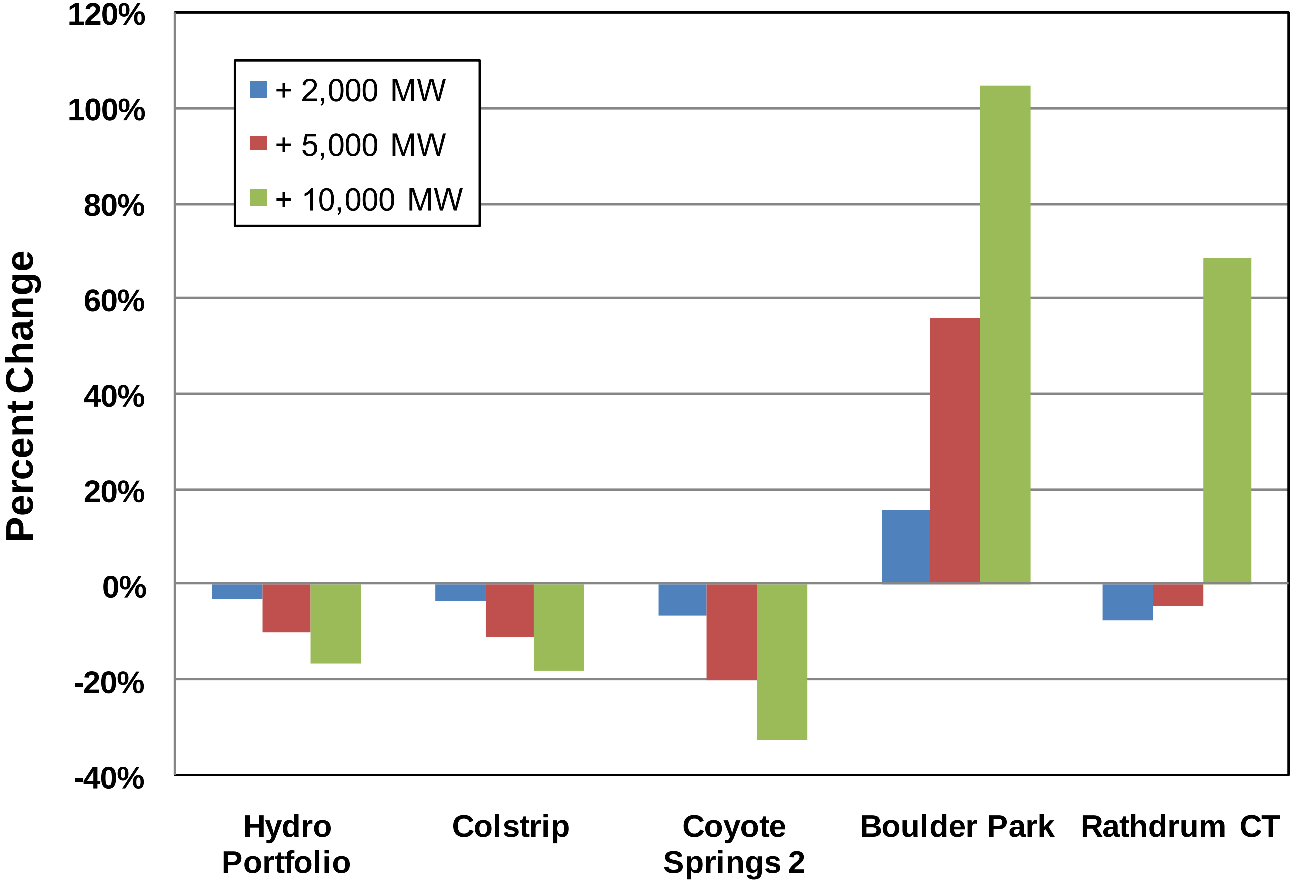
Wind Scenarios: Change to Occurrences of Negative Prices



Wind Scenarios: Negative Price Duration Curve



Wind Scenarios: Change to Avista Plant Operating Margins



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Preferred Resource Strategy & Scenario Analysis

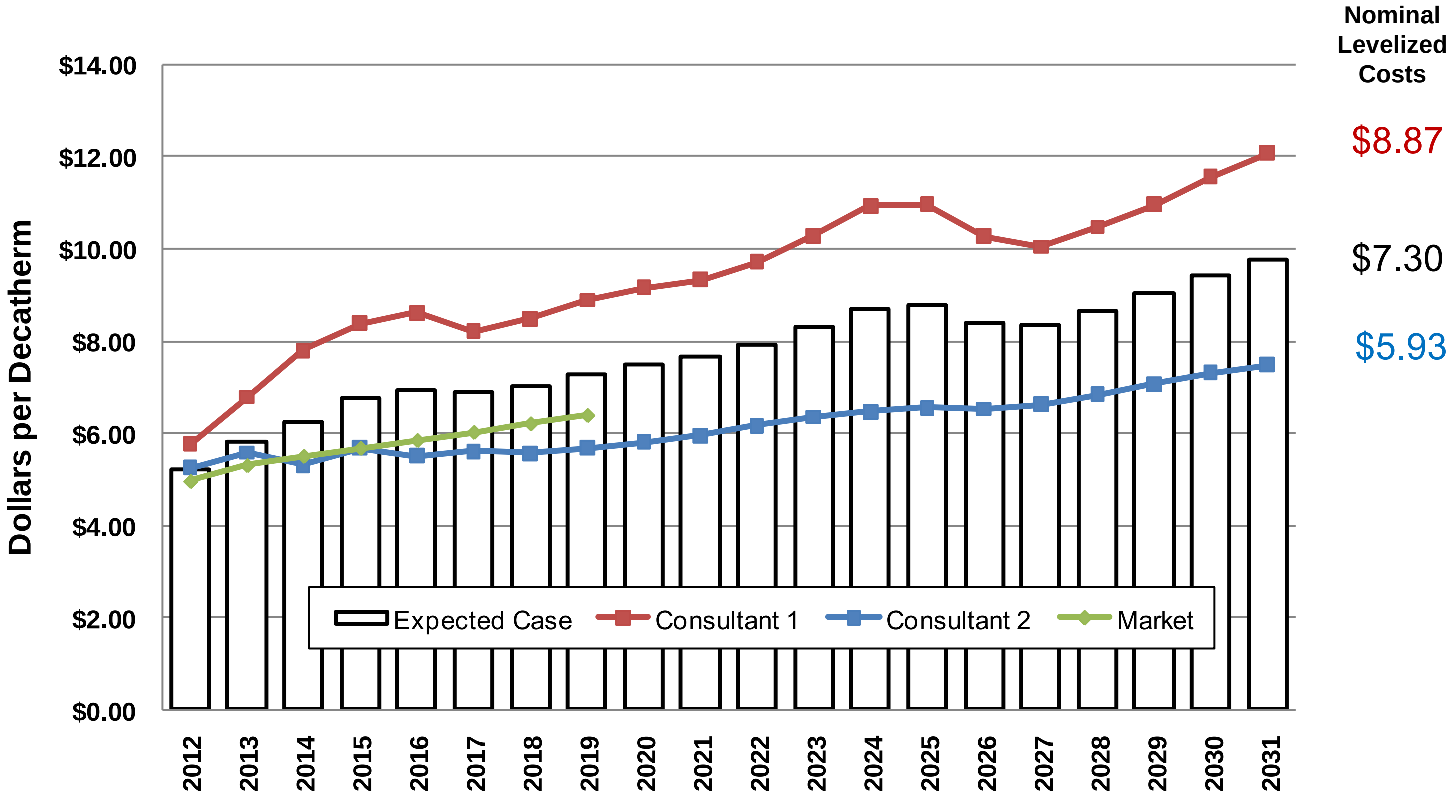
James Gall

Technical Advisory Committee Meeting #6

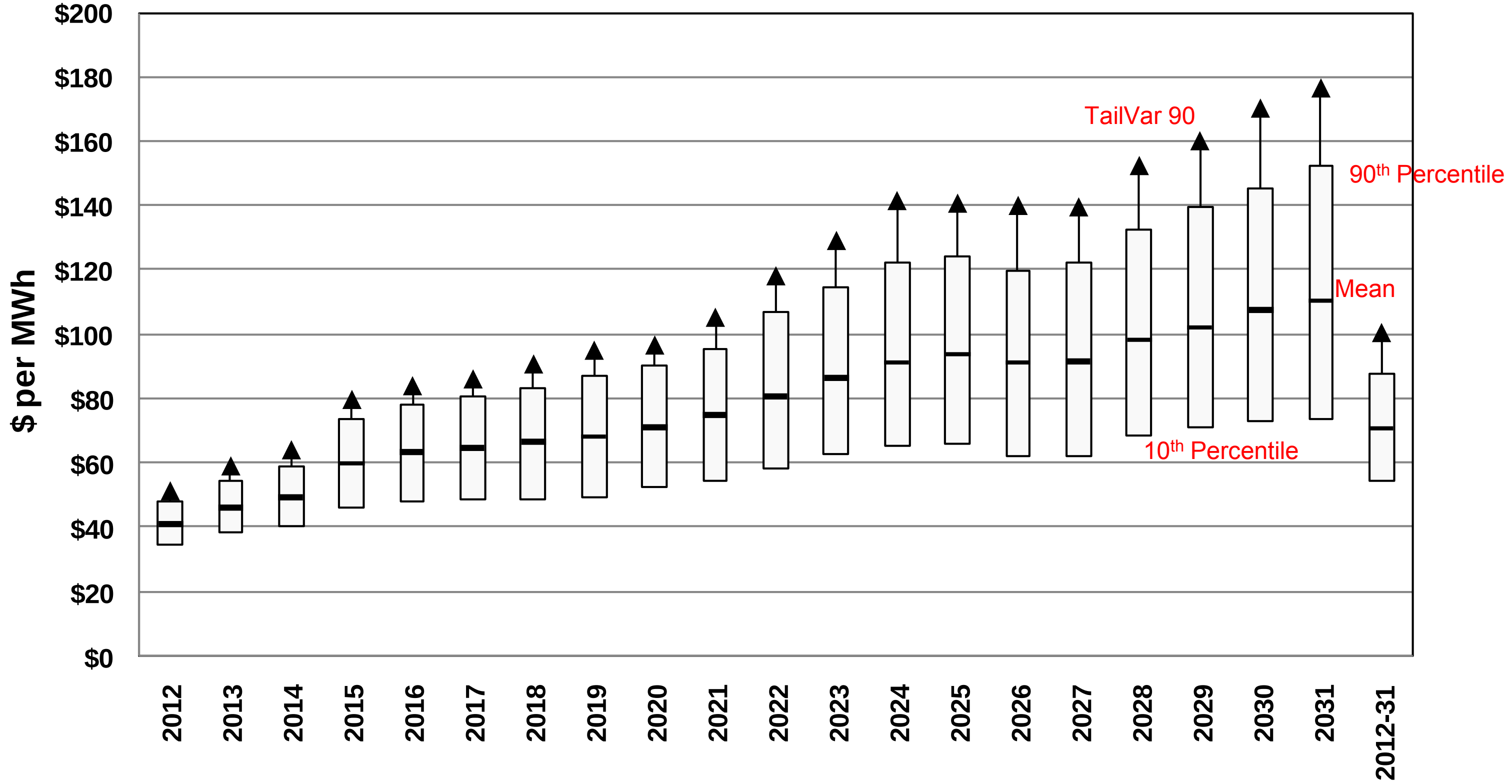
2011 Electric Integrated Resource Plan

June 23, 2011

Natural Gas Price Forecast (Henry Hub)

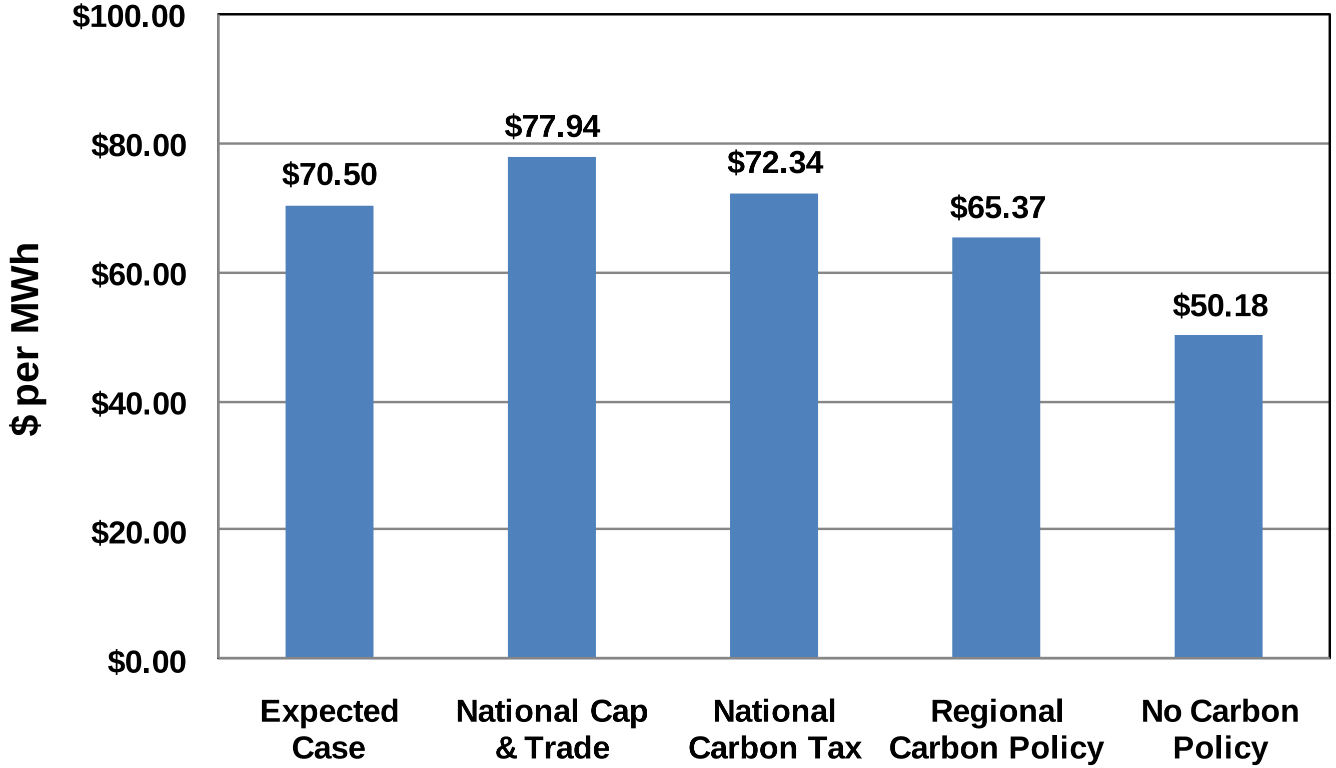


Expected Case: Mid-Columbia Electric Price Forecast



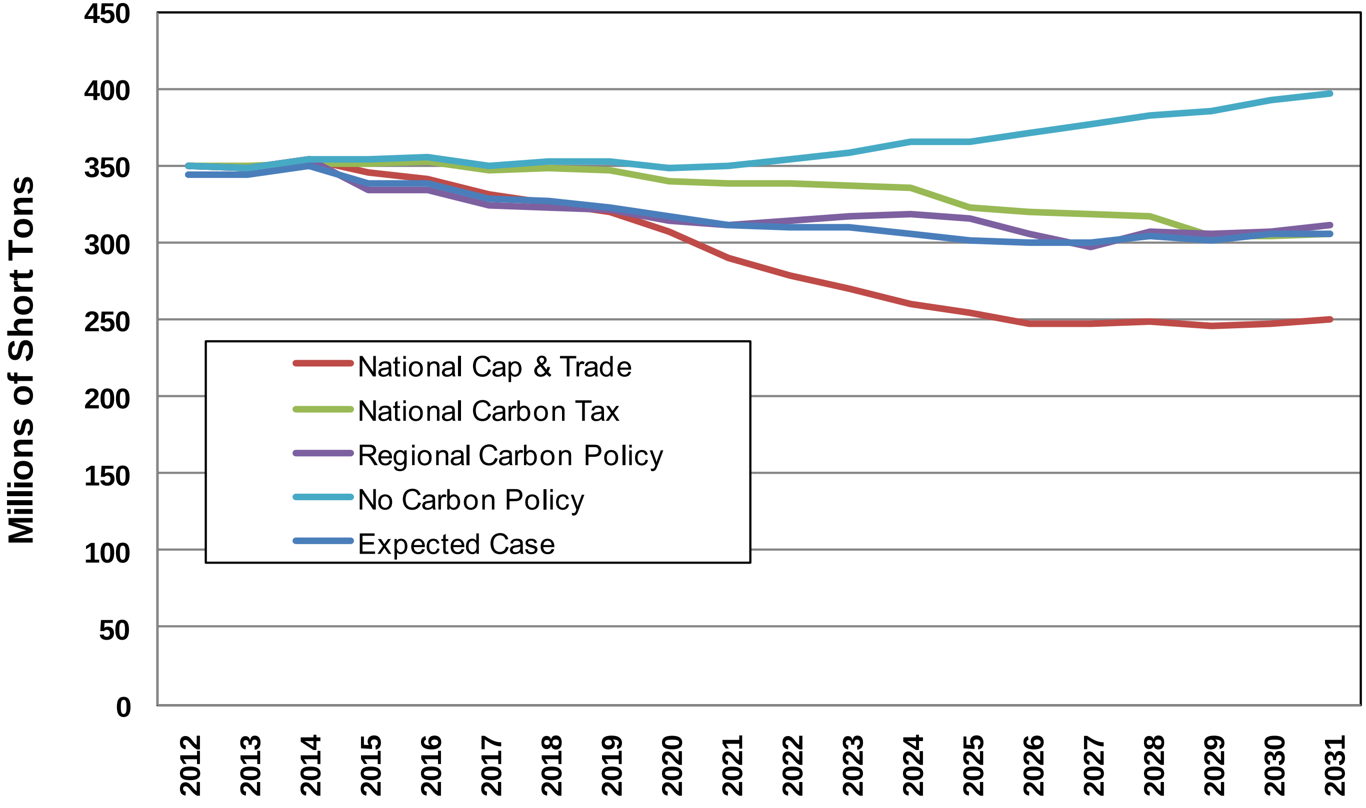
20 Year Levelized Price of $70.50 ($54 to $87) per MWh

Mid-Columbia Electric Price Forecast
Nominal 20 year Levelized Prices



Scenarios are deterministic study results

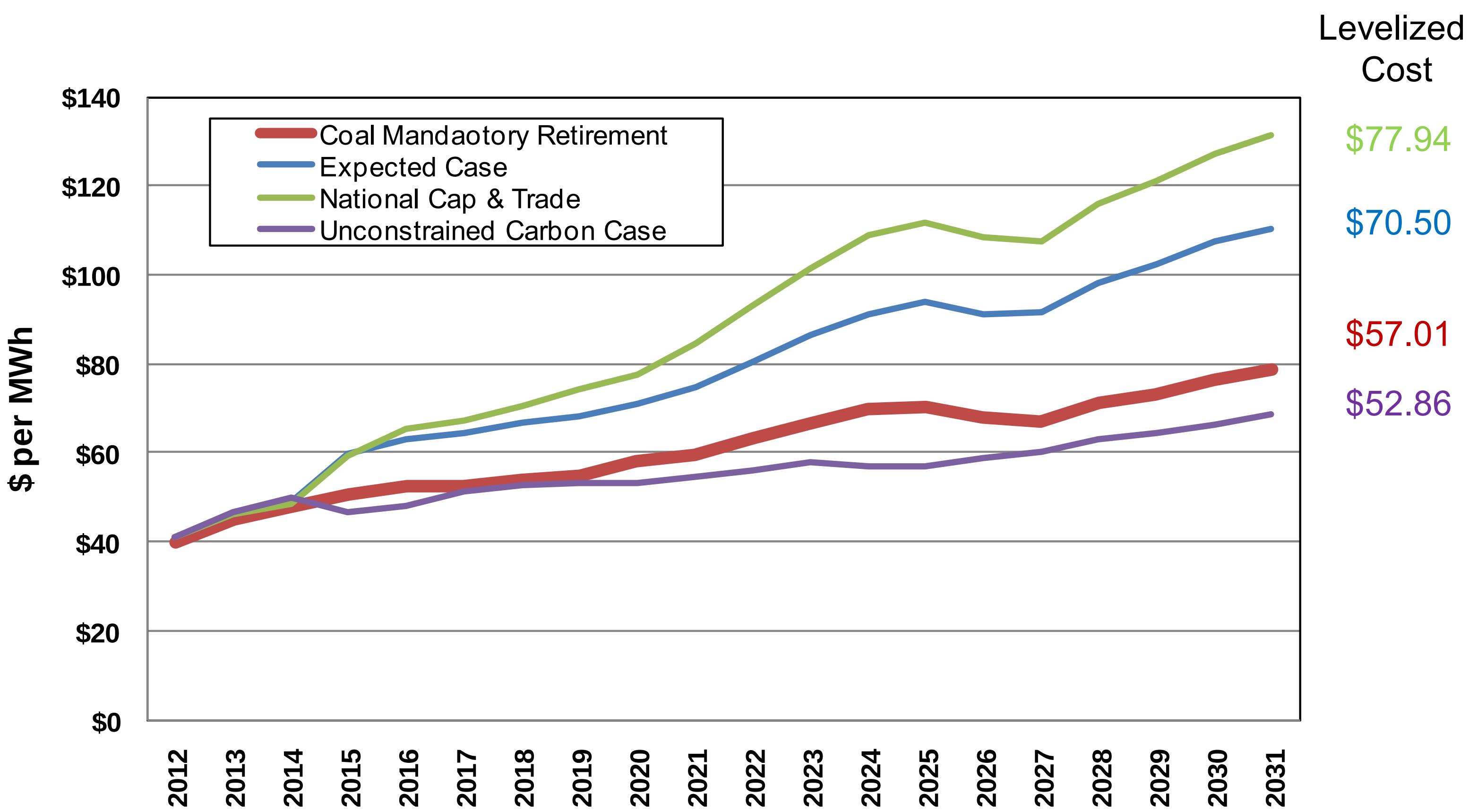
Western Interconnect Greenhouse Gas Forecast



Mandatory Coal Retirement Scenario

- Coal plants are to be phased out after 40 years of life.
- No greenhouse gas penalties
- Uses Expected Case’s natural gas forecast
- Modeled stochastically using 500 iterations

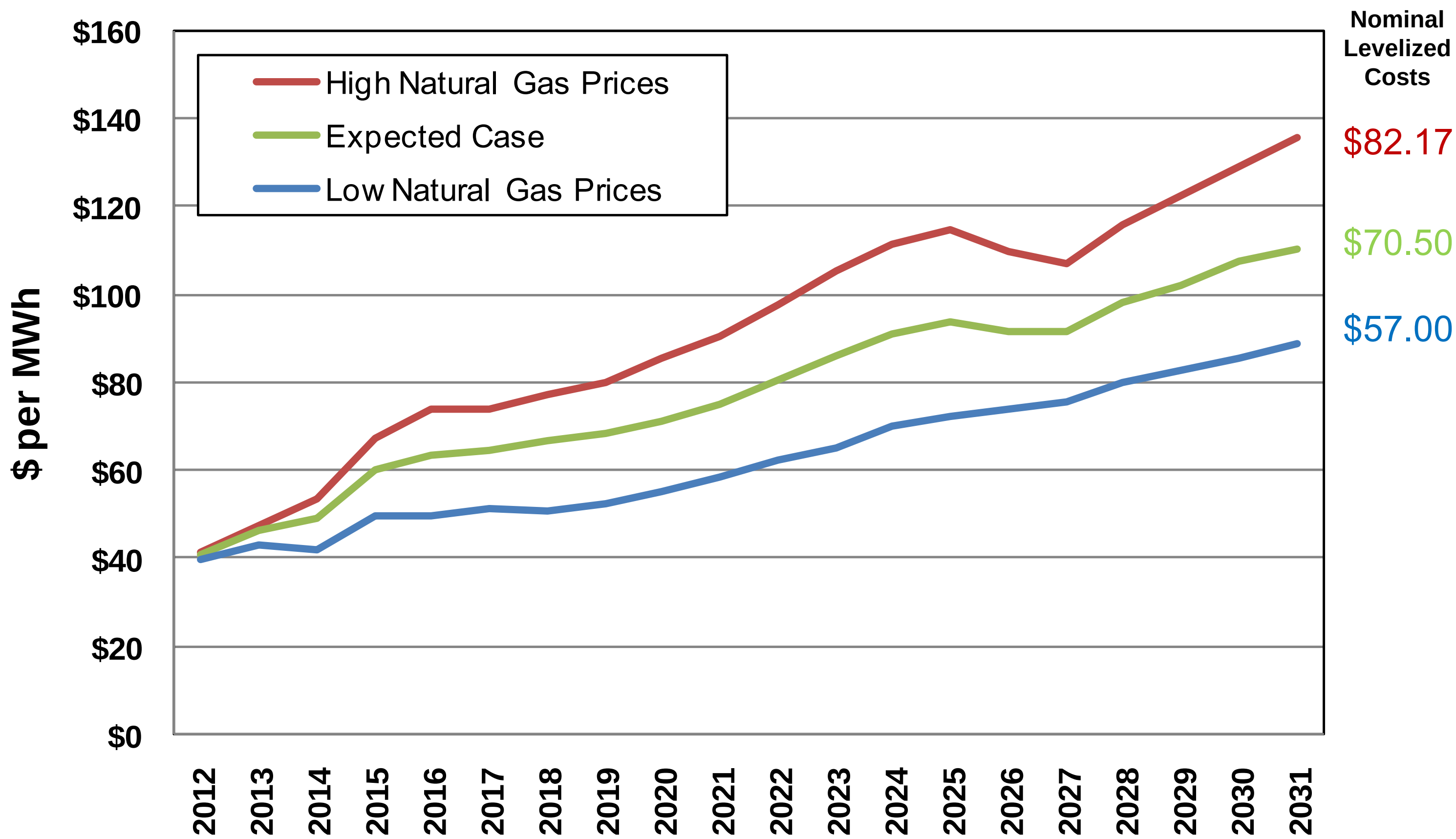
Mid-Columbia Electric Price Forecast



Greenhouse Gas and Costs of Carbon Mitigation Scenarios

Market Scenario	Change to GHG Emissions From 2012 by 2031	Added Levelized Cost per Year (Billions)
Unconstrained GHG Gas Case	14%	0.0
Expected Case	-18%	3.5
Coal Mandatory Retirement	-22%	8.1
National Cap & Trade	-29%	4.9

Mid-Columbia Price Forecast with Natural Gas Price Sensitivities

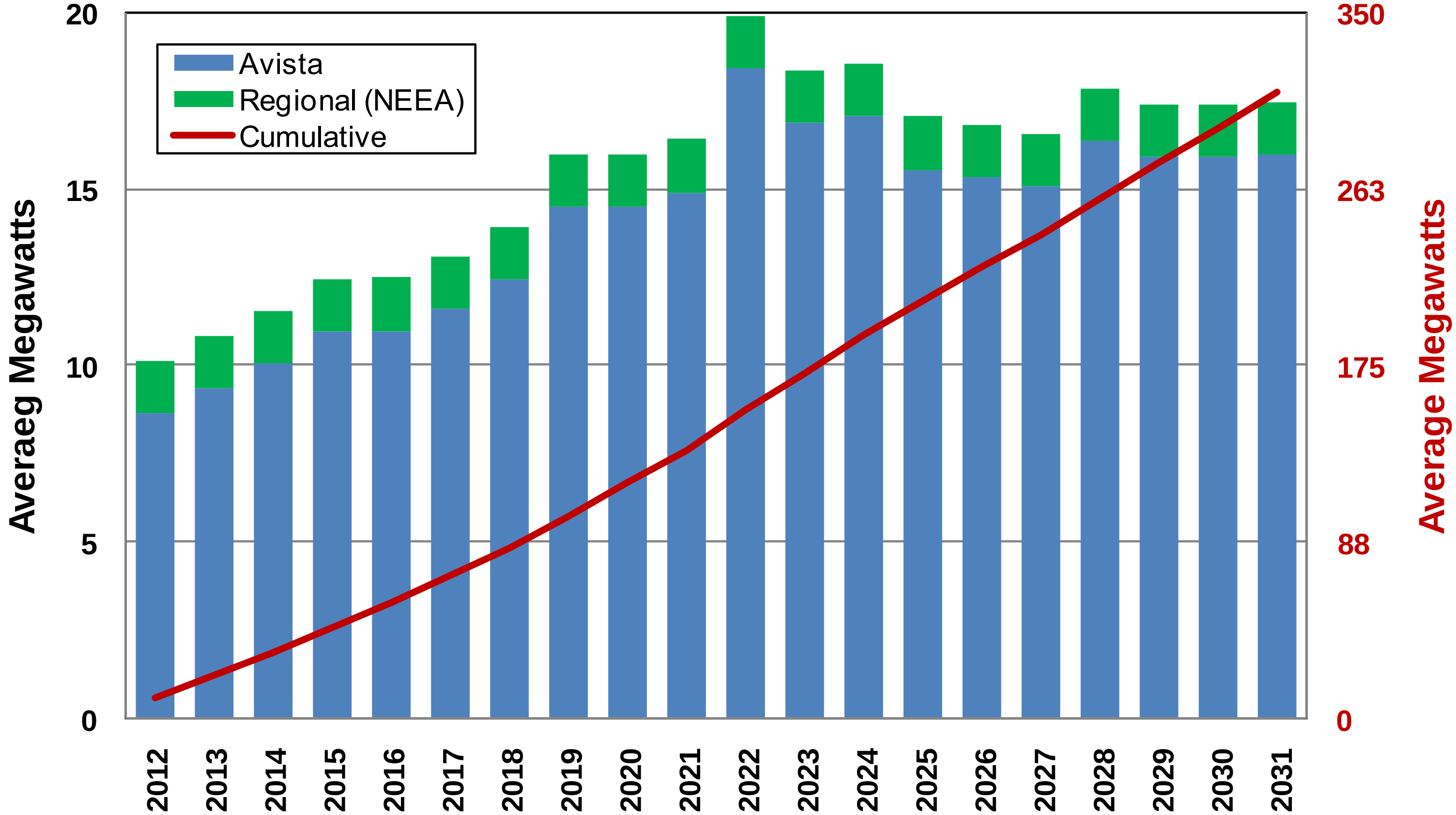


All cases have the same greenhouse reduction goal, but have different prices

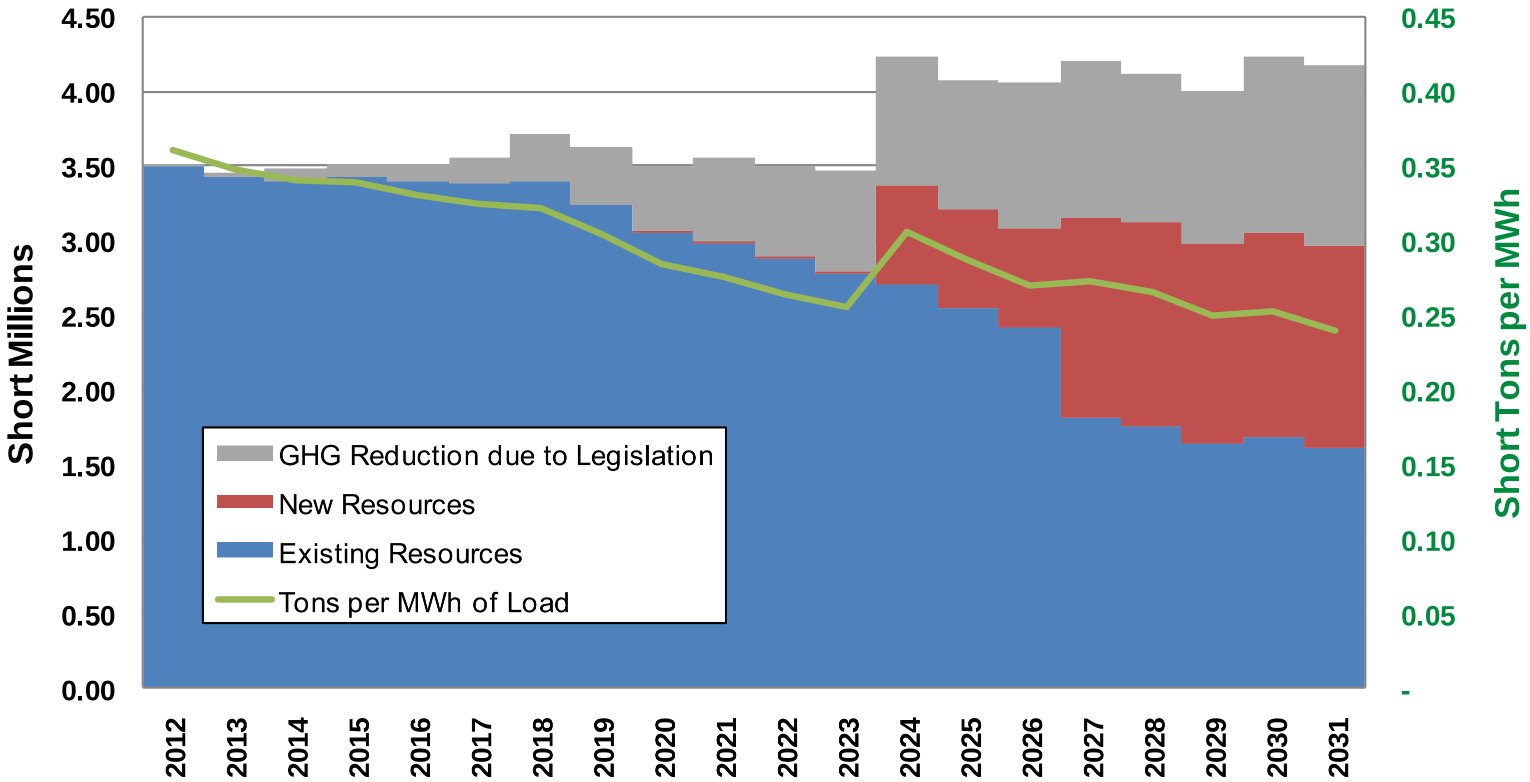
2011 Draft Preferred Resource Strategy

Year Ending	Resource
2012	Wind (~ 42 aMW REC)
2018	Simple Cycle CT(~ 83 MW)
2020	Simple Cycle CT (~ 83 MW)
2018-2019	Thermal Upgrades (~ 7 MW)
2018-2019	Wind (~ 43 aMW REC)
2023	Combined Cycle CT (~ 270 MW)
2026/27	Combined Cycle CT (~ 270 MW)
2029	Simple Cycle CT (~ 46 MW)
2012+	Distribution Feeder Upgrades (13 aMW by 2031)
2012+	Conservation (310 aMW by 2031)

Conservation Projection



Avista Resource's Greenhouse Gas Emissions



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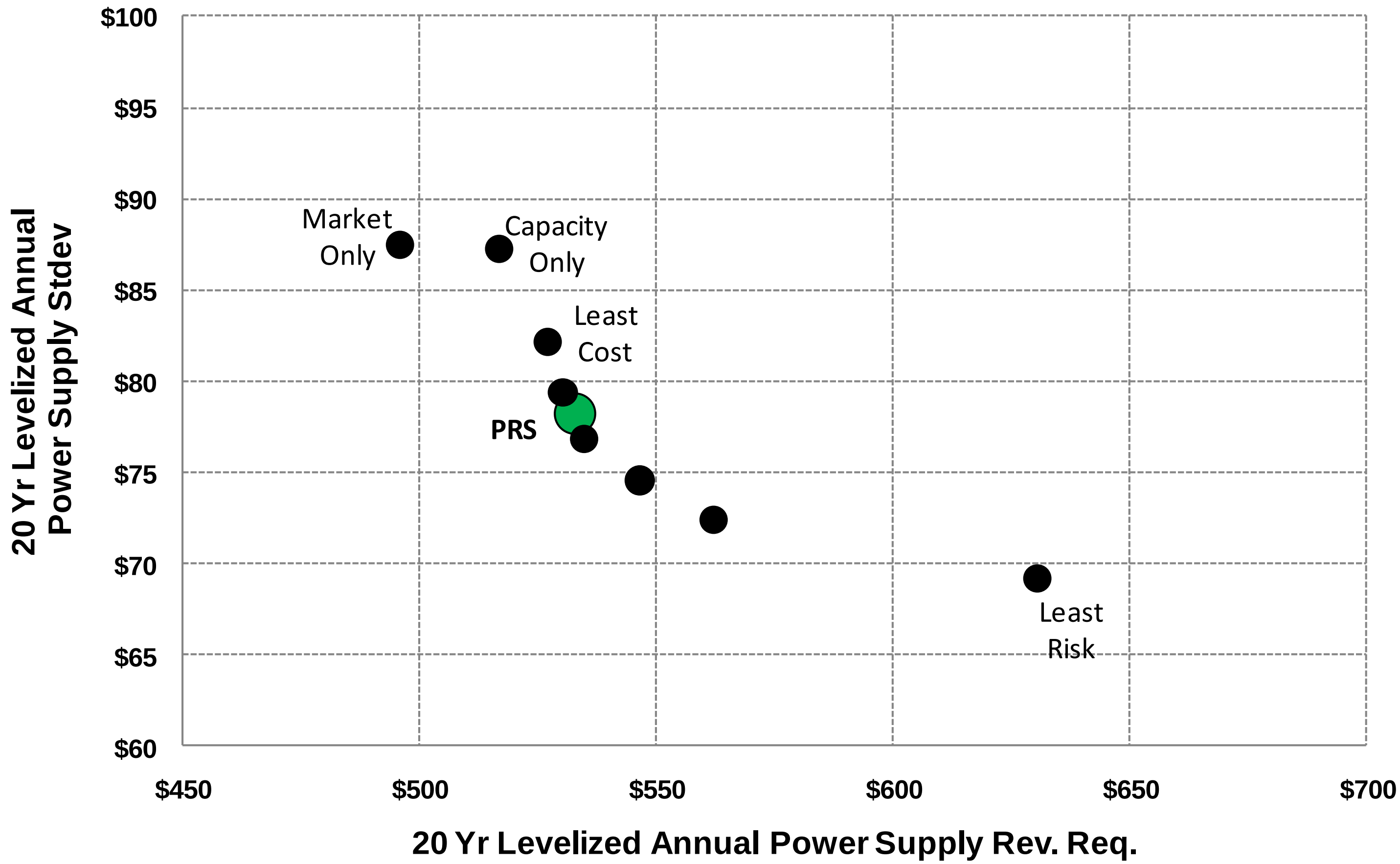
Efficient Frontier



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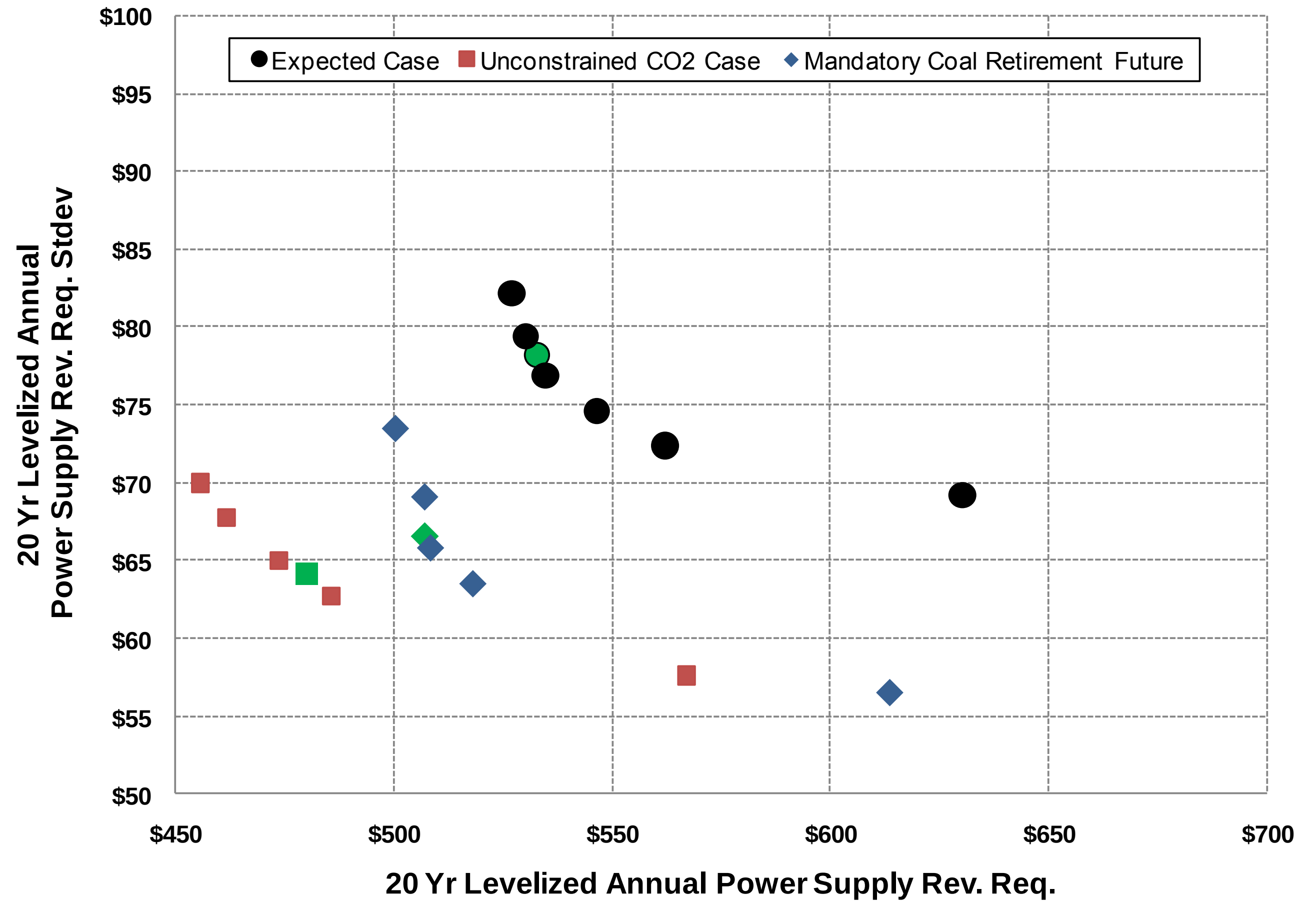
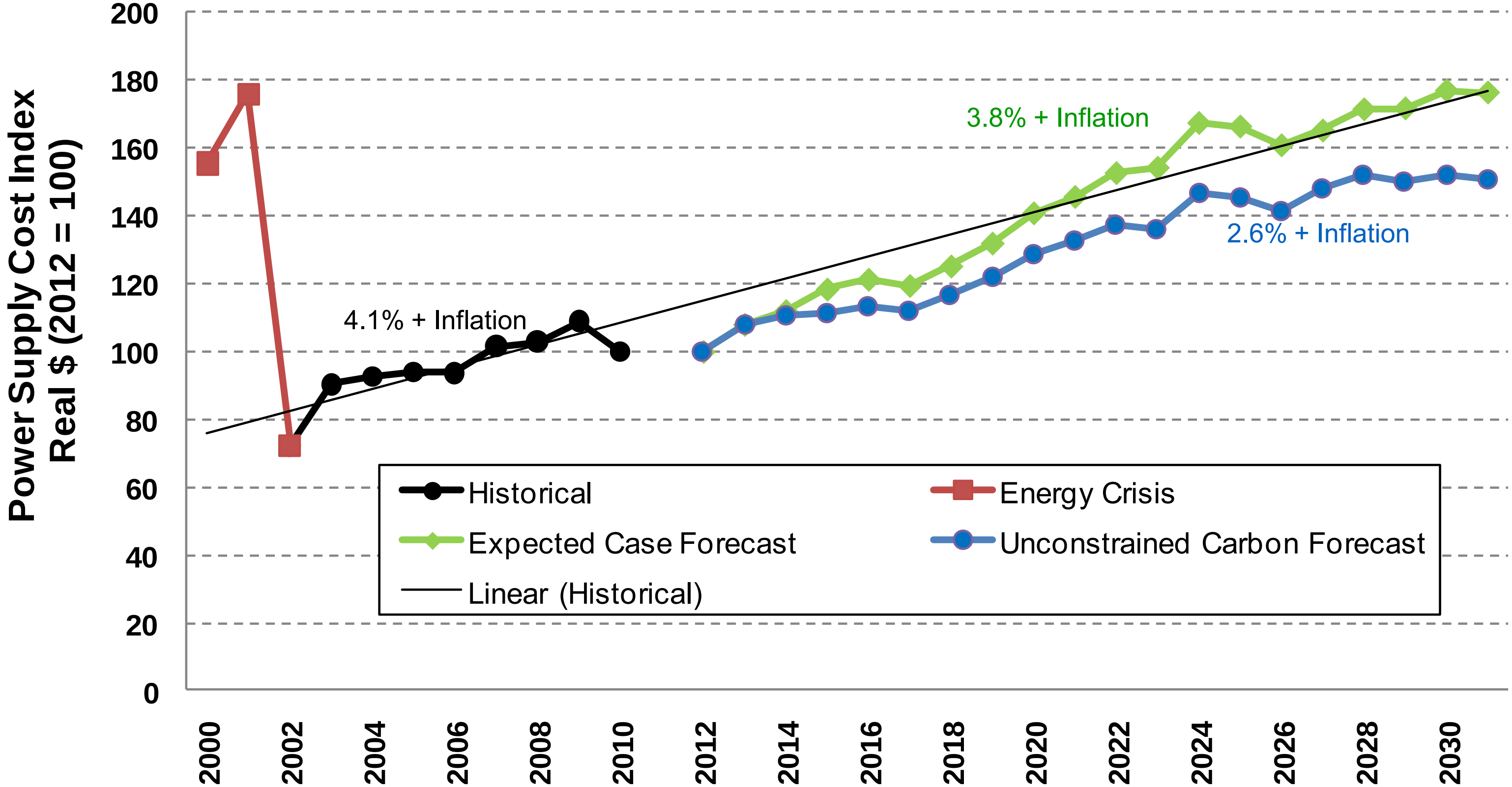
Efficient Frontier with Alternative Greenhouse Gas Methodologies



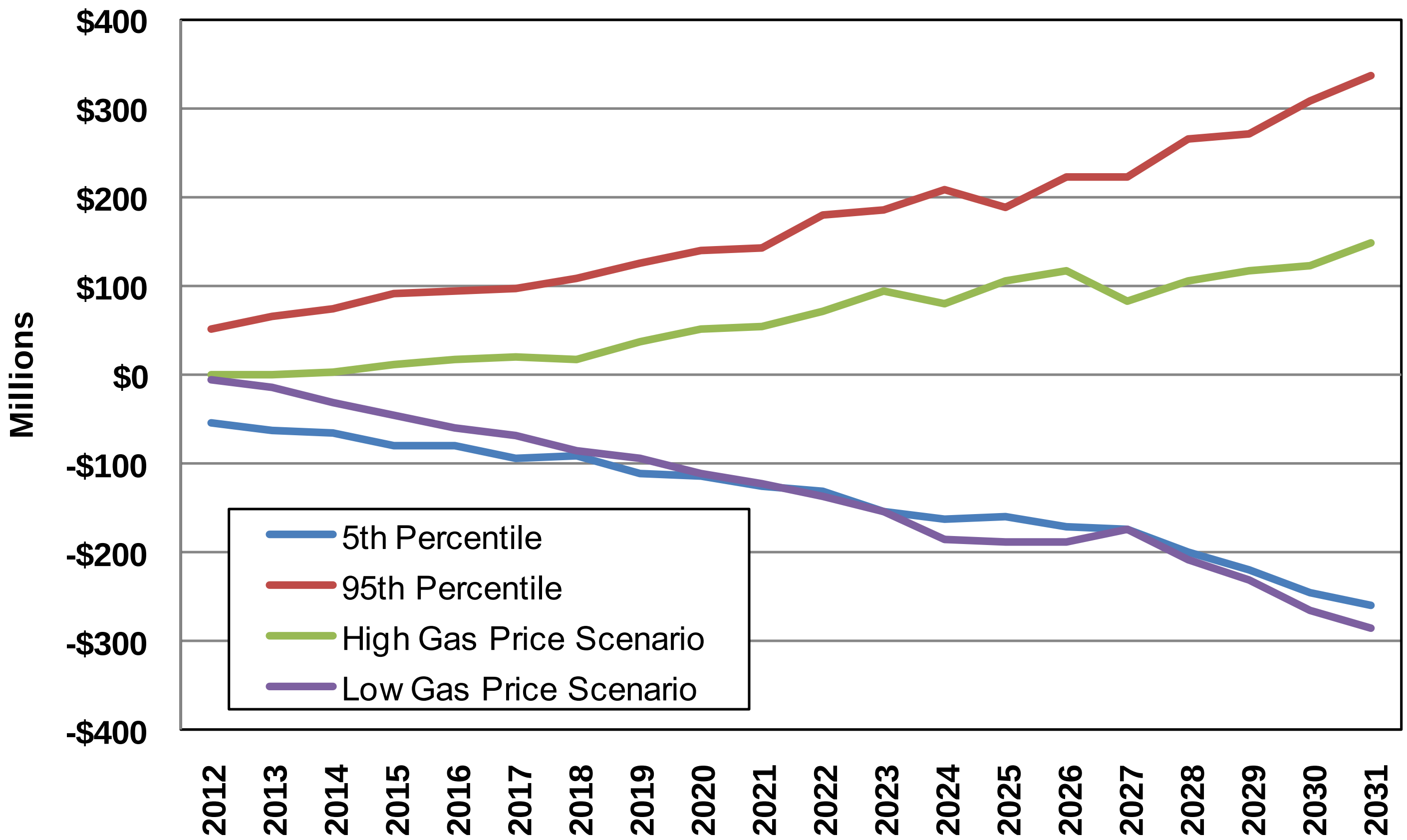
Greenhouse Gas Methodologies Summary

	Expected Case	Unconstrained Carbon	Coal Retirement
2012-2022 Cost NPV	3,094	2,886	2,937
2012-2031 Cost NPV	5,735	5,168	5,458
2022 Expected Cost	636	564	576
2022 Stdev	91	68	71
2022 Stdev/Cost	14%	12%	12%
2022 CO_2 Emissions (000's)	2,894	3,498	3,752
2031 CO_2 Emissions (000's)	2,972	4,177	3,560

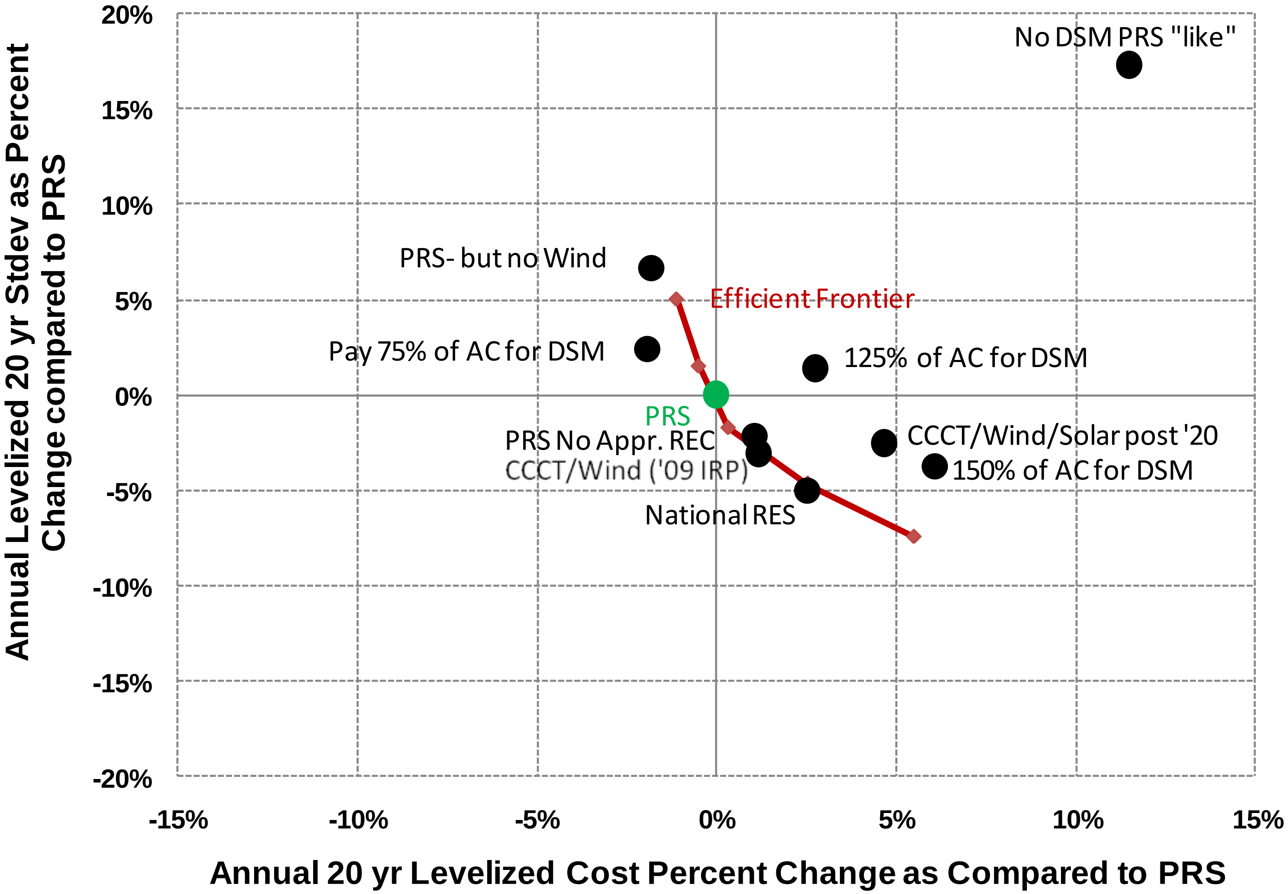
Power Supply Cost/MWh Index



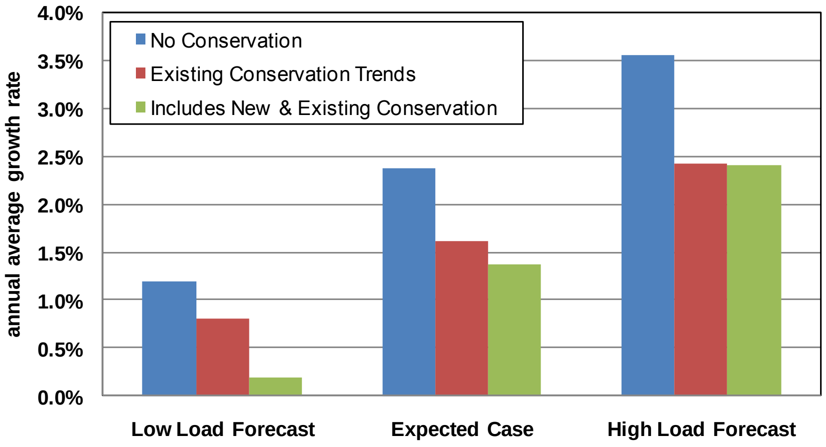
Power Supply Costs with Alternative Natural Gas Prices (Preferred Resource Strategy)

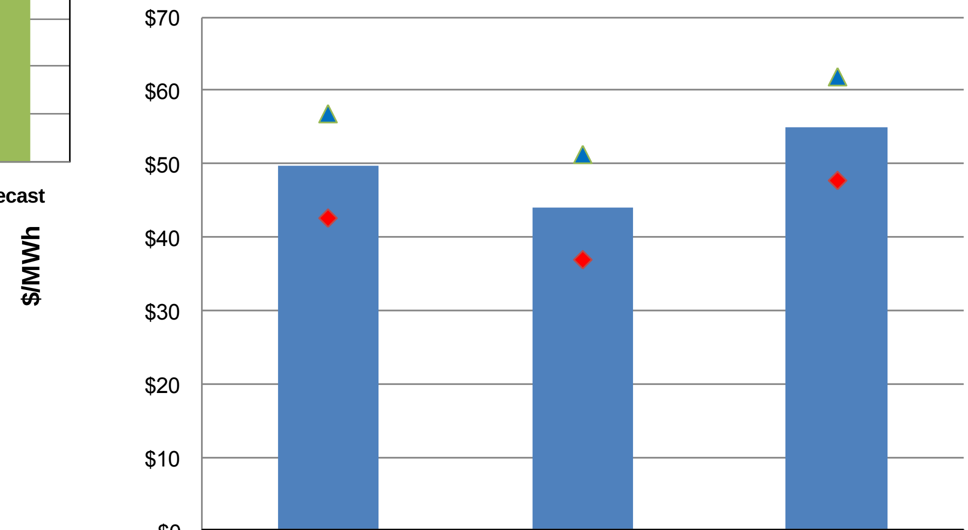


Efficient Frontier vs Alternative Portfolios



Load Growth Sensitivities





	Base Case	Low Load Growth	High Load Growth
Levelized Cost $/MWh	49.75	44.11	54.86
1 Sigma Lower	42.67	36.99	47.80
1 Sigma Higher	56.83	51.23	61.92

Portfolio Resources (MW)

Portfolio	SCCT (Nameplate)	CCCT (Nameplate)	Thermal Upgrades	Wind (Energy)	Solar (Energy)	Conservation (Energy)	Dist. Feeders (Energy)
Preferred Resource Strategy	212	540	4	71	0	310	13
Least Cost	747	0	0	71	0	310	13
Least Risk	187	540	17	98	64	310	13
50% Cost/50% Risk	177	540	4	93	9	310	13
75% Cost/ 25% Risk	332	540	0	82	0	310	13
25% Cost/ 75% Risk	83	810	4	95	5	310	13
PRS without Apprentice Credits	212	540	4	96	0	310	13
2009 IRP "Like"	0	810	0	102	0	310	13
PRS Without Wind	212	540	4	0	0	310	13
CCCT with Solar after 2015	0	810	10	36	33	310	13
PRS + Wind to meet National RES	212	540	4	177	1	310	13
PRS if no Conservation	475	815	10	94	0	0	13
PRS Conservation A/C 25% Lower	249	540	4	82	0	266	13
PRS Conservation A/C 25% Higher	415	270	7	70	0	334	13
PRS Conservation A/C 50% Higher	129	540	4	70	0	350	13
Low Load Growth	212	0	4	71	0	247	13
High Load Growth	510	810	10	93	1	443	13

2011 IRP Action Items

John Lyons

Technical Advisory Committee Meeting #6

2011 Electric Integrated Resource Plan

June 23, 2011

2009 IRP Action Item Review

2009 IRP Action Items

- Resource Additions and Analysis
- Energy Efficiency
- Environmental Policy
- Modeling and Forecasting Enhancements
- Transmission Planning

2009 Action Items – Resource Additions & Analysis

- Continue to explore the potential for wind and non-wind renewable resources.
- Issue an RFP for turbines at Reardan and up to 100 MW of wind or other renewables in 2009.
- Finish studies on the costs and environmental benefits of hydro upgrades at Cabinet Gorge, Long Lake, Post Falls, and Monroe Street.
- Study potential locations for the natural gas-fired resource identified to be online between 2015 and 2020
- Continue participation in the regional IRP processes and where agreeable find resource opportunities to meet resource requirements on a collaborative basis.

2009 Action Items – Energy Efficiency

- Pursue American Reinvestment and Recovery Act of 2009 (ARRA) funding for low income weatherization.
- Analyze and report on the results of the July 2007 through December 2009 demand response pilot in Moscow and Sandpoint.
- Have an external party perform a study on technical, economic, and achievable potential for energy efficiency in Avista's entire service territory.
- Study and quantify transmission and distribution efficiency concepts as they apply to meeting Washington's RPS goals.
- Update processes and protocols for conservation measurement, evaluation and verification.
- Determine the potential impacts and costs of load management options.

2009 Action Items – Environmental Policy

- Continue to study the potential impact of state and federal climate change legislation.
- Continue and report on the work of Avista's Climate Change Council.

2009 Action Items – Modeling & Forecasting

- Refine stochastic model cost driver relationships.
- Continue PRiSM refinements by developing a resource retirement capability to solve for other risk measurements and by adding more resource options.
- Continue developing Loss of Load Probability and Sustained Peaking analysis for inclusion in the IRP process, and confirm appropriateness of the 15% capacity planning margin assumed for this IRP.
- Continue studying the impacts of climate change on the load forecast.
- Study load growth trends and their correlation to weather patterns.

2009 Action Items – Transmission Planning

- Work to maintain/retain existing transmission rights on the Company's transmission system, under applicable FERC policies, for transmission service to bundled retail native load.
- Continue to participate in BPA transmission practice processes and rate proceedings to minimize the costs of integrating existing resources outside of the Company's service area.
- Continue to participate in regional and sub-regional efforts to establish new regional transmission structures (ColumbiaGrid and other forums) to facilitate long-term expansion of the regional transmission system.
- Evaluate costs to integrate new resources across Avista's service territory and from regions outside of the Northwest.
- Study and implement distribution feeder rebuild projects to reduce system losses.
- Study transmission reconfigurations to economically reduce system losses.

2011 IRP Action Items

2011 Action Items Resource Additions & Analysis

- Continue to explore and follow potential new resources opportunities.
- Continue studies on the costs, energy, capacity and environmental benefits of hydro upgrades at Cabinet Gorge, Long Lake, Post Falls, and Monroe Street.
- Study potential locations for the natural gas-fired resource identified to be online in 2019.
- Continue participation in regional IRP processes and, where agreeable, find opportunities to meet resource requirements on a collaborative basis with other utilities.
- Provide an update on the Little Falls and Nine Mile hydroelectric project upgrades.

2011 Action Items – Energy Efficiency

- Study and quantify transmission and distribution efficiency projects as they apply to Washington RPS goals.
- Update processes and protocols for conservation measurement, evaluation and verification.
- Continue to determine the potential impacts and costs of load management options.

2011 Action Items – Environmental Policy

- Continue studies of state and federal climate change policies.
- Continue and report on the work of Avista's Climate Change Council.

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2011 Action Items – Modeling & Forecasting

- Continue following regional reliability processes and develop Avista-centric modeling for possible inclusion in the 2013 IRP.
- Continue studying the impacts of climate change on retail loads.
- Refine the stochastic model for cost driver relationships, including further analyzing year-to-year hydro correlation and the correlation between wind, load, and hydro.

2011 Action Items – Transmission and Distribution Planning

- Work to maintain existing transmission rights, under applicable FERC policies, for transmission service to bundled retail native load.
- Continue to participate in BPA transmission processes and rate proceedings to minimize costs of integrating existing resources outside of Avista's service area.
- Continue to participate in efforts to establish new regional transmission structures to facilitate long-term expansion of the regional transmission system.
- Evaluate the costs to integrate new resources across Avista's service territory and from regions outside of the Northwest.
- Study and implement distribution feeder rebuild projects to reduce system losses.
- Study transmission reconfigurations to economically reduce system losses.

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2011 IRP Section Highlights

John Lyons

Technical Advisory Committee Meeting #6

2011 Electric Integrated Resource Plan

June 23, 2011

Loads & Resources Highlights

- Historic conservation acquisitions are included in the load forecast; higher acquisition levels anticipated in the IRP reduce the load forecast further.
- Annual electricity sales growth from 2012 to 2031 averages 1.6%.
- Expected energy deficits begin in 2020, growing to 475 aMW by 2031.
- Expected capacity deficits begin in 2019, growing to 883 MW by 2031.
- Conservation pushes the need for resources out by one year for energy and six years for capacity.
- Renewable portfolio standard deficiencies drive near-term resource needs.

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Energy Efficiency Highlights

- Conservation reduces load by 47 percent through the IRP timeframe.
- Avista began offering conservation programs in 1978.
- Company-sponsored conservation reduces retail loads by approximately 10 percent, or 120 aMW.
- More than 2,800 equipment options and over 1,500 measure options covering all major end-use equipment, as well as devices and actions to reduce energy consumption were evaluated for this IRP.
- This IRP includes a Conservation Potential Assessment of the Company's Idaho and Washington service territories.

Policy Considerations Highlights

- Avista supports national greenhouse gas legislation that is workable, cost effective and fair.
- Avista supports national greenhouse gas legislation that protects the economy, supports technological innovation, and addresses emissions from developing nations.
- The Company is a member of the Clean Energy Group
- Avista's Climate Change Council monitors greenhouse gas legislation and environmental regulation issues.

Transmission & Distribution Highlights

- Avista has received a total of 43 requests for non-Avista resource integration.
- Projected costs of transmission upgrades are included in the 2011 Preferred Resource Strategy.
- The Company has received matching federal grants and is investing in three Smart Grid programs projected to reduce load by 5.57 aMW by 2013.
- Sixty distribution feeders were found to be preliminarily economic during the IRP timeframe, reducing system losses by 6.1 aMW.
- The Company participates in various regional transmission planning forums.
- Various upgrades to our transmission system are planned over the next five years.

Generation Resource Options Highlights

- Only resources with well-defined costs and operating histories were considered in the PRS analysis.
- Wind and solar resources were evaluated as the renewable options available to the Company; other technologies will be considered in renewable RFP efforts.
- Renewable resource costs assume present state and federal incentive levels, but no extensions.
- For the first time, thermal generation upgrades were considered as resource options.

Market Analysis Highlights

- Gas and wind resources are expected to dominate new generation additions in the West for the foreseeable future.
- The massive growth in unconventional natural gas has lowered gas price forecasts and expected future electricity market prices.
- Expansion of the Northwest wind fleet is reducing the value of springtime hydroelectric generation and driving short-term market prices below zero.
- Federal greenhouse gas policy is uncertain; the IRP quantifies this uncertainty by modeling four different mitigation regimes.
- The Expected Case reduces greenhouse gas emissions by 18 percent and increases overall Western Interconnect costs by $3.5 billion per year. Absent mitigation, overall emissions are forecast to increase by 14 percent over the next 20 years.

Preferred Resource Strategy Highlights

- Avista's first load –driven acquisition is a natural gas-fired peaking plant in 2019; total gas-fired acquisition is 752 MW over the IRP timeframe.
- The 2011 plan splits natural gas-fired generation between simple- and combined-cycle plants in anticipation of a growing need for system flexibility to integrate variable resources.
- Efficiency improvements, both on the customer and utility sides of the meter, are at the highest expected level in our planning history.
- Total capital needs for generation resources in the PRS are $1.6 billion.
- Conservation and system efficiency spending will increase over time; a total of $1.5 billion will acquire 323 aMW.

Remaining 2011 IRP Schedule

- July 1, 2011 Management review of Internal Draft 2011 IRP complete
- July 8, 2011 distribution of Draft 2011 IRP to TAC participants
- August 1, 2011: External review by TAC complete
- August 8, 2011: Final 2011 IRP sent to print
- August 30, 2011: 2011 IRP documents sent to the Idaho and Washington Commissions
- August 31, 2011: 2011 IRP available to public, including publication on the Company's web site

2011 Electric Integrated Resource Plan

Appendix B – Work Plan

Work Plan for Avista's 2011 Electric Integrated Resource Plan

For the
Washington Utilities and Transportation Commission

August 31, 2010

2011 Integrated Resource Planning Work Plan

This Work Plan is submitted in compliance with the Washington Utilities and Transportation Commission's Integrated Resource Planning (IRP) rules (WAC 480-100-238). This work plan outlines the process Avista will follow to develop its 2011 Integrated Resource Plan to be filed with Washington and Idaho Commissions by August 31, 2011. Avista uses a public process to obtain technical expertise and guidance throughout the planning period through a series of public Technical Advisory Committee (TAC) meetings. The first of these meetings for the 2011 IRP was held on May 27, 2010.

The 2011 IRP process will be similar to those used to produce the previous three published plans. AURORA^{xmp} will be used for electric market forecasting, resource valuation, and for conducting Monte-Carlo style risk analyses. Results from AURORA^{xmp} will be used to select the Preferred Resource Strategy (PRS) using the proprietary PRiSM 3.0 model. This tool fills future capacity and energy (physical/renewable) deficits using an efficient frontier approach to evaluate quantitative portfolio risk versus portfolio cost while accounting for environmental legislation. Qualitative risk will be evaluated in a separate analysis. The process timeline is shown in Exhibit 1 and the process to identify the PRS is shown in Exhibit 2.

Avista intends to use both detailed site-specific and generic resource assumptions in this plan. These assumptions will be determined by using the 6th Power Plan for generic resources and site-specific assumptions developed by Avista will be used for existing resource upgrades. This plan will study renewable portfolio standards, environmental costs, sustained peaking requirements, and energy efficiency programs. This IRP will develop a strategy that meets or exceeds both the renewable portfolio standards and greenhouse gas emissions regulations.

Avista intends to test the PRS against several scenarios and stochastic futures. The TAC meetings will be an important factor to determine the underlying assumptions used in the scenarios and futures. The IRP process is very technical and data intensive; public comments are welcome and will require input in a timely manner for appropriate inclusion into the process so the plan can be submitted according to the tentative schedule.

Topics and meeting times may be changed depending on the availability of and requests for additional topics from the TAC members. The tentative timeline for public Technical Advisory Committee meetings:

- **May 27, 2010 –** Load & resource balance, climate change, loss of load probability analysis, work plan, and analytical process changes
- **September 8, 2010 –** Plant tours for TAC members
- **September 9, 2010 –** Generic resource assumptions, reliability planning, combined heat & power, sustainability, and energy efficiency
- **November 4, 2010 –** Load forecast, stochastic assumptions, resource upgrade costs, and transmission cost studies

- **January 20, 2011 –** Electric and gas price forecasts, load & resource forecast
- **March 10, 2011 –** Draft PRS, review of scenarios and futures, and portfolio analysis
- **April 28, 2011 –** Review of final PRS and action items
- **June 23, 2011 –** Review of the 2011 IRP

2011 Electric IRP Draft Outline

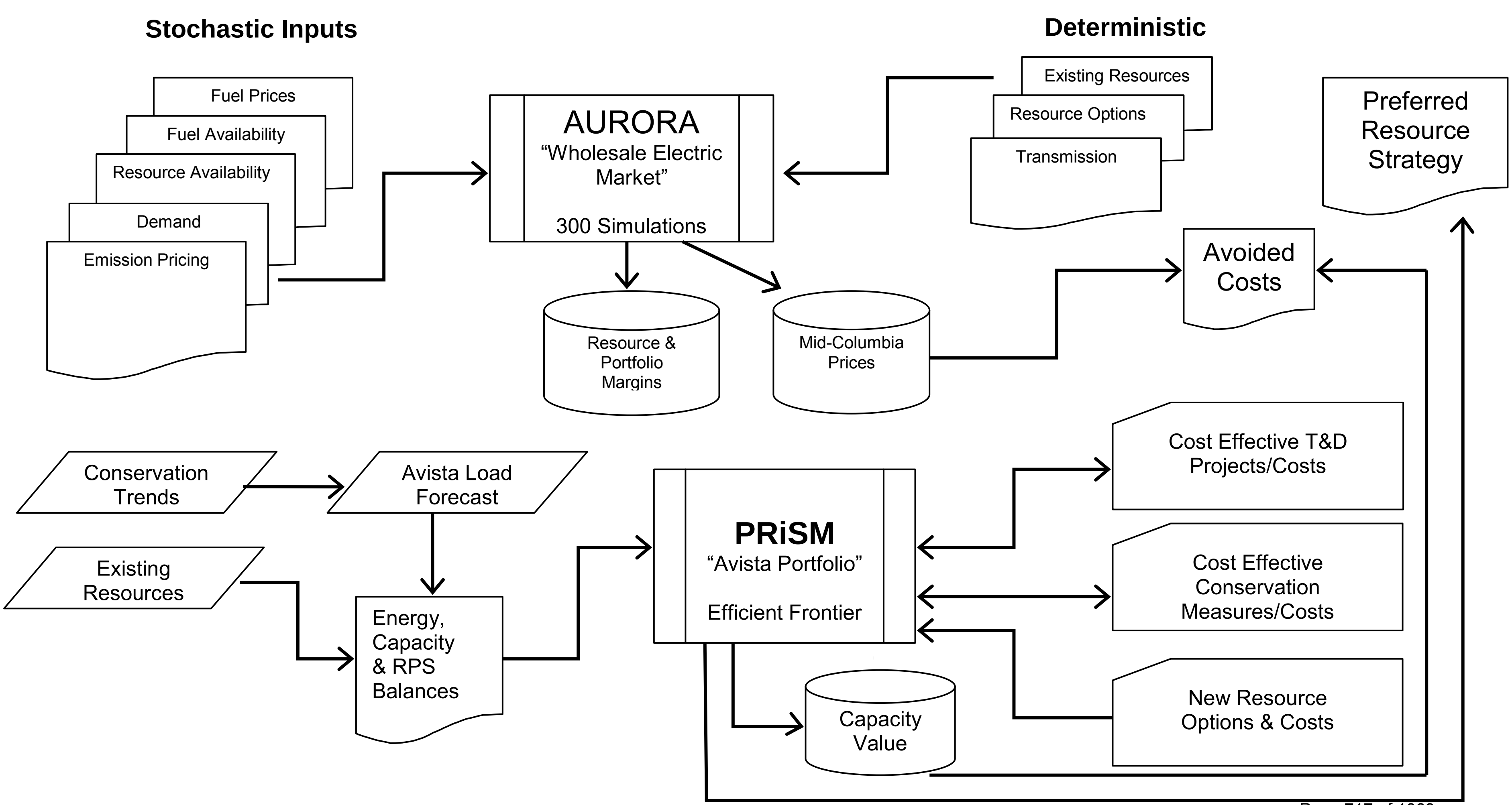
This section provides a draft outline of the major sections in the 2011 Electric IRP. This outline will be updated as IRP studies are completed and input from the Technical Advisory Committee has been received.

1. Executive Summary
2. Introduction and Stakeholder Involvement
3. Loads and Resources
    a. Economic Conditions
    b. Avista Load Forecast
    c. Load Forecast Scenarios
    d. Supply Side Resources
    e. Reserve Margins
    f. Resource Requirements
4. Energy Efficiency and Demand Response
5. Environmental Policy Issues
6. Transmission Planning
7. Modeling Approach
    a. Assumptions and Inputs
    b. Risk Modeling
    c. Resource Alternatives
    d. The PRiSM Model
8. Market Modeling Approach
    a. Futures
    b. Scenarios
    c. Avoided Costs
9. Preferred Resource Strategy & Stress Analysis
10. Action Items

Exhibit 1: 2011 Electric IRP Timeline

Task	Target Date
Preferred Resource Strategy (PRS)	
Finalize load forecast	July 2010
Identify regional resource options for electric market price forecast	September 2010
Identify Avista's supply & conservation resource options	September 2010
Update AURORA^{xmp} database for electric market price forecast	October 2010
Finalize datasets/statistics variables for risk studies	October 2010
Draft transmission study due	October 2010
Energy efficiency load shapes input into AURORA^{xmp}	October 2010
Final transmission study due	November 2010
Select natural gas price forecast	December 2010
Finalize deterministic base case	December 2010
Base case stochastic study complete	January 2011
Finalize PRiSM 3.0 model	January 2011
Develop efficient frontier and PRS	January 2011
Simulation of risk studies "futures" complete	February 2011
Simulate market scenarios in AURORA^{xmp}	February 2011
Evaluate resource strategies against market futures and scenarios	March 2011
Present preliminary study and PRS to TAC	March 2011
Writing Tasks	
File 2011 IRP work plan	August 2010
Prepare report and appendix outline	September 2010
Prepare text drafts	April 2011
Prepare charts and tables	April 2011
Internal draft released at Avista	May 2011
External draft released to the TAC	June 2011
Final editing and printing	August 2011
Final IRP submission to Commissions and distribution to TAC	August 31, 2011

Exhibit 2: 2011 Electric IRP Modeling Process



2011 Electric Integrated Resource Plan

Appendix C – Comprehensive Energy Efficiency Equipment List and Measure Options

APPENDIX | C

RESIDENTIAL ENERGY EFFICIENCY EQUIPMENT AND MEASURE DATA

This appendix presents detailed information for all residential energy efficiency equipment and measures that were evaluated in LoadMAP. Several sets of tables are provided.

Table C-1 provides brief descriptions for all equipment and measures that were assessed for potenital.

Tables C-2 through C-9 list the detailed unit-level data for the equipment measures for each of the housing type segments — single family, multi-family, mobile home, and limited income — and for existing and new construction, respectively. Savings are in kWh/yr/household, and incremental costs are in $/household, unless noted otherwise. The B/C ratio is zero if the measure represents the baseline technology or if the technology is not available in the first year of the forecast (2012). The B/C ratio is calculated within LoadMAP for each year of the forecast and is available once the technology or measure becomes available.

Tables C-10 through C-17 list the detailed unit-level data for the non-equipment energy efficiency measures for each of the housing type segments and for existing and new construction, respectively. Because these measures can produce energy-use savings for multiple end-use loads (e.g., insulation affects heating and cooling energy use) savings are expressed as a percentage of the end-use loads. Base saturation indicates the percentage of homes in which the measure is already installed. Applicability/Feasibility is the product of two factors that account for whether the measure is applicable to the building. Cost is expressed in $/household. The detailed measure-level tables present the results of the benefit/cost (B/C) analysis for the first year of the forecast. The B/C ratio is zero if the measure represents the baseline technology or if the measure is not available in the first year of the forecast (2012). The B/C ratio is calculated within LoadMAP for each year of the forecast and is available once the technology or measure becomes available.

Note that Tables C-2 through C-17 present information for Washington. For Idaho, savings and B/C ratios may be slightly different due to weather-related usage, differences in the states' market profiles, and different retail electricity prices. Although Idaho-specific values are not presented here, they are available within the LoadMAP files.

Table C–1 Residential Energy Efficiency Equipment/Measure Descriptions

End-Use	Equipment/ Measure	Description
Cooling	Air Conditioner — Central (CAC)	Central air conditioners consist of a refrigeration system using a direct expansion cycle. Equipment includes a compressor, an air-cooled condenser (located outdoors), an expansion valve, and an evaporator coil. A supply fan near the evaporator coil distributes supply air through air ducts to the building. Cooling efficiencies vary based on materials used, equipment size, condenser type, and system configuration. CACs may be unitary (all components housed in a factory-built assembly) or split system (an outdoor condenser section and an indoor evaporator section connected by refrigerant lines and with the compressor either indoors or outdoors). Energy efficiency is rated according to the size of the unit using the Seasonal Energy Efficiency Rating (SEER). Systems with Variable Refrigerant Flow further improve the operating efficiency. A high-efficiency option for a ductless mini-split system was also analyzed.
Cooling	Central Air Conditioner, Early Replacement	CAC systems currently on the market are significantly more efficient that older units, due to technology improvement and stricter appliance standards. This measure incents homeowners to replace an aging but still working unit with a new, higher-efficiency one.
Cooling	Central Air Conditioner Maintenance and Tune Up	An air conditioner's filters, coils, and fins require regular cleaning and maintenance for the unit to function effectively and efficiently throughout its life. Neglecting necessary maintenance leads to a steady decline in performance, requiring the AC unit to use more energy for the same cooling load.
Cooling	Air Conditioner - Room, ENERGY STAR or better	Room air conditioners are designed to cool a single room or space. They incorporate a complete air-cooled refrigeration and air-handling system in an individual package. Room air conditioners come in several forms, including window, split-type, and packaged terminal units. Energy efficiency is rated according to the size of the unit using the Energy Efficiency Rating (EER).
Cooling	Room AC — Removal of Second Unit	Homeowners may have a second room AC unit that is extremely inefficient. This measure incents homeowners to recycle the second unit and thus also eliminates associated electricity use.
Cooling	Attic Fan Attic Fan, Photovoltaic	Attic fans can reduce the need for AC by reducing heat transfer from the attic through the ceiling of the house. A well-ventilated attic can be several degrees cooler than a comparable, unventilated attic. An option for an attic fan equipped with a small solar photovoltaic generator was also modeled.
Cooling	Ceiling Fan	Ceiling fans can reduce the need for air conditioning. However, the house occupants must also select a ceiling fan with a high-efficiency motor and either shutoff the AC system or setup the thermostat temperature of the air conditioning system to realize the potential energy savings. Some ceiling fans also come with lamps. In this analysis, it is assumed that there are no lamps, and installing a ceiling fan will allow occupants to increase the thermostat cooling setpoint up by 2°F.
Cooling	Whole-House Fan	Whole-house fans can reduce the need for AC on moderate-weather days or on cool evenings. The fan facilitates a quick air change throughout the entire house. Several windows must be open to achieve the best results. The fan is mounted on the top floor of the house, usually in a hallway ceiling.

End-Use	Equipment/ Measure	Description
Space Heating	Convert to Gas	This fuel-switching measure is the replacement of an electric furnace with a gas-fired furnace. This measure will eliminate all electricity consumption and demand due to electric space heating. In this study, it is assumed that this measure can be implemented only in homes within 500 feet of a gas main.
Heat/Cool	Air Source Heat Pump	A central heat pump consists of components similar to a CAC system, but is usually designed to function both as a heat pump and an air conditioner. It consists of a refrigeration system using a direct expansion (DX) cycle. Equipment includes a compressor, an air-cooled condenser (located outdoors), an expansion valve, and an evaporator coil (located in the supply air duct near the supply fan) and a reversing valve to change the DX cycle from cooling to heating when required. The cooling and heating efficiencies vary based on the materials used, equipment size, condenser type, and system configuration. Heat pumps may be unitary (all components housed in a factory-built assembly) or a split system (an outdoor condenser section and an indoor evaporator section connected by refrigerant lines, with either outdoors or indoors. A high-efficiency option for a ductless mini-split system was also analyzed.
Heat / Cool	Geothermal Heat Pump	Geothermal heat pumps are similar to air-source heat pumps, but use the ground or groundwater instead of outside air to provide a heat source/sink. A geothermal heat pump system generally consists of three major subsystems or parts: a geothermal heat pump to move heat between the building and the fluid in the earth connection, an earth connection for transferring heat between the fluid and the earth, and a distribution subsystem for delivering heating or cooling to the building. The system may also have a desuperheater to supplement the building's water heater, or a full-demand water heater to meet all of the building's hot water needs.
Heat / Cool	Air Source Heat Pump Maintenance	A heat pump's filters, coils, and fins require regular cleaning and maintenance for the unit to function effectively and efficiently throughout its life. Neglecting necessary maintenance ensures a steady decline in performance while energy use steadily increases.
HVAC (all)	Insulation – Ducting	Air distribution ducts can be insulated to reduce heating or cooling losses. Best results can be achieved by covering the entire surface area with insulation. Several types of ducts and duct insulation are available, including flexible duct, pre-insulated duct, duct board, duct wrap, tacked, or glued rigid insulation, and waterproof hard shell materials for exterior ducts. This analysis assumes that installing duct insulation can reduce the temperature drop/gain in ducts by 50%.
HVAC (all)	Repair and Sealing – Ducting	An ideal duct system would be free of leaks. Leakage in unsealed ducts varies considerably because of differences in fabricating machinery used, methods for assembly, installation workmanship, and age of the ductwork. Air leaks from the system to the outdoors result in a direct loss proportional to the amount of leakage and the difference in enthalpy between the outdoor air and the conditioned air. This analysis assumes that over time air loss from ducts has doubled, and conducting repair and sealing of the ducts will restore leakage from ducts to the original baseline level.

End-Use	Equipment/ Measure	Description
HVAC (all)	Thermostat — Clock/Programmable	A programmable thermostat can be added to most heating/cooling systems. They are typically used during winter to lower temperatures at night and in summer to increase temperatures during the afternoon. The energy savings from this type of thermostat are identical to those of a "setback" strategy with standard thermostats, but the convenience of a programmable thermostat makes it a much more attractive option. In this analysis, the baseline is assumed to have no thermostat setback.
HVAC (all)	Doors — Storm and Thermal	Like other components of the shell, doors are subject to several types of heat loss: conduction, infiltration, and radiant losses. Similar to a storm window, a storm door creates an insulating air space between the storm and primary doors. A tight fitting storm door can also help reduce air leakage or infiltration. Thermal doors have exceptional thermal insulation properties and also are provided with weather-stripping on the doorframe to reduce air leakage.
HVAC (all)	Insulation — Infiltration Control	Lowering the air infiltration rate by caulking small leaks and weather-stripping around window frames, doorframes, power outlets, plumbing, and wall corners can provide significant energy savings. Weather-stripping doors and windows will create a tight seal and further reduce air infiltration.
HVAC (all)	Insulation —Ceiling	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation above ceilings can conserve energy by reducing the heat loss or gain into attics and/or through roofs. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose, loose-fill (blown) fiberglass, and rigid polystyrene.
HVAC (all)	Insulation — Radiant Barrier	Radiant barriers are materials installed to reduce the heat gain in buildings. Radiant barriers are made from materials that are highly reflective and have low emissivity like aluminum. The closer the emissivity is to 0 the better they will perform. Radiant barriers can be placed above the insulation or on the roof rafters.
HVAC (all)	Insulation — Foundation Insulation — Wall Cavity Insulation — Wall Sheathing	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation can conserve energy by reducing heat loss or gain from a building. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose, loose-fill (blown) fiberglass, and rigid polystyrene. Foundation, insulation, wall cavity insulation, and wall sheathing were modeled for new construction / major retrofits only.
Cooling	Roof — High Reflectivity	The color and material of a building structure surface determine the amount of solar radiation absorbed by that surface and subsequently transferred into a building. This is called solar absorptance. Using a roofing material with low solar absorptance or painting the roof a light color reduces the cooling load. This analysis assumes that implementing high reflectivity roofs will decrease the roof's absorptance of solar radiation by 45%.
Cooling	Windows — Reflective Film	Reflective films applied to the window interior help reduce solar gain into the space and thus lower cooling energy use.

End-Use	Equipment/ Measure	Description
HVAC (all)	Windows — High Efficiency / ENERGY STAR	High-efficiency windows, such as those labeled under the ENERGY STAR Program, are designed to reduce energy use and increase occupant comfort. High-efficiency windows reduce the amount of heat transfer through the glazing surface. For example, some windows have a low-E coating, a thin film of metallic oxide coating on the glass surface that allows passage of short-wave solar energy through glass and prevents long-wave energy from escaping. Another example is double-pane glass that reduces conductive and convective heat transfer. Some double-pane windows are gas-filled (usually argon) to further increase the insulating properties of the window.
Water Heating	Water Heater - Electric, High Efficiency	For electric hot water heating, the most common type is a storage heater, which incorporates an electric heating element, storage tank, outer jacket, insulation, and controls in a single unit. Efficient units are characterized by a high recovery or thermal efficiency and low standby losses (the ratio of heat lost per hour to the content of the stored water). Electric instantaneous water heaters are available, but are excluded from this study due to potentially high instantaneous demand concerns.
Water Heating	Water Heater, Heat Pump	An electric heat pump water heater (HPWH) uses a vapor-compression thermodynamic cycle similar to that found in an air-conditioner or refrigerator. Electrical work input allows a heat pump water heater to extract heat from an available source (e.g., air) and reject that heat to a higher temperature sink, in this case, the water in the water heater. Because a HPWH makes use of available ambient heat, the coefficient of performance is greater than one — typically in the range of 2 to 3. These devices are available as an alternative to conventional tank water heaters of 55 gallons or larger. By utilizing the earth as a thermal reservoir, ground source HPWH systems can reach even higher levels of efficiency. The heat pump can be integrated with a traditional water storage tank or installed remote to the storage tank.
Water Heating	Water Heating, Solar	Solar water heating systems can be used in residential buildings that have an appropriate near-south-facing roof or nearby unshaded grounds for installing a collector. Although system types vary, in general these systems use a solar absorber surface within a solar collector or an actual storage tank. Either a heat-transfer fluid or the actual potable water flows through tubes attached to the absorber and transfers heat from it. (Systems with a separate heat-transfer-fluid loop include a heat exchanger that then heats the potable water.) The heated water is stored in a separate preheat tank or a conventional water heater tank. If additional heat is needed, it is provided by a conventional water-heating system.
Water Heating	Convert to Gas	This fuel-switching measure is the replacement of an electric water heater with a gas-fired water heater. This measure will eliminate all electricity consumption and demand due to electric water heating. In this study, it is assumed that this measure can be implemented only in home within 500 feet of a gas main.
Water Heating	Faucet Aerators	Water faucet aerators are threaded screens that attach to existing faucets. They reduce the volume of water coming out of faucets while introducing air into the water stream. This measure provides energy saving by reducing hot water use, as well as water conservation for both hot and cold water.

End-Use	Equipment/ Measure	Description
Water Heating	Pipe Insulation	Insulating hot water pipes decreases energy losses from piping that distributes hot water throughout the building. I also results in quicker delivery of hot water and may allow lower the hot water set point, which saves energy. The most common insulation materials for this purpose are polyethylene and neoprene.
Water Heating	Low-Flow Showerheads	Similar to faucet aerators, low-flow showerheads reduce the consumption of hot water, which in turn decreases water heating energy use.
Water Heating	Tank Blanket	Insulating hot water tanks decreases standby energy losses from the tank. Pre-fitted insulating blankets are readily available.
Water Heating	Thermostat Setback / Timer	These measures use either a programmable thermostat or a timer to adjust the water heater setpoint at times of low usage, typically when a home is unoccupied.
Water Heating	Hot Water Saver	A hot water saver is a plumbing device that attaches to the showerhead and that pauses the flow of water until the water is hot enough for use. The water is re-started by the flip of a switch.
Interior Lighting / Exterior Lighting	Infrared Halogen Lamps	Infrared halogen lamps are designed to be a replacement for standards incandescent lamps. Also referred to as advanced incandescent lamps, these products meet the Energy Independence and Security Act (EISA) lighting standards and are phased in as the baseline technology screw-in lamp technology to reflect the timeline over which the EISA lighting standards take effect.
Interior Lighting / Exterior Lighting	Compact Fluorescent Lamps	Compact fluorescent lamps are designed to be a replacement for standard incandescent lamps and use about 25% of the energy used by standard incandescent lamps to produce the same lumen output. The can use either electronic or magnetic ballasts. Integral compact fluorescent lamps have the ballast integrated into the base of the lamp and have a standard screw-in base that permits installation into existing incandescent fixtures.
Interior Lighting / Exterior Lighting	Solid State Lighting, LEDs (Screw-in and linear)	Light-emitting diode (LED) lighting has seen recent penetration in specific applications such as traffic lights and exit signs. With the potential for extremely high efficiency, LEDs show promise to provide general-use lighting for interior spaces. Current models commercially available have efficacies comparable to CFLs. However, theoretical efficiencies are significantly higher. LED models under development are expected to provide improved efficacies.
Interior Lighting	Fluorescent, T8, Super T8, and T5 Lamps and Electronic Ballasts	T8 fluorescent lamps are smaller in diameter than standard T12 lamps, resulting in greater light output per watt. T8 lamps also operate at a lower current and wattage, which increases the efficiency of the ballast but requires the lamps to be compatible with the ballast. Fluorescent lamp fixtures can include a reflector that increases the light output from the fixture, and thus make it possible to use a fewer number of lamps in each fixture. T5 lamps further increase efficiency by reducing the lamp diameter to 5/8”.
Exterior Lighting	Metal Halide and High Pressure Sodium	These lamps technologies can provide slightly higher efficiencies than CFLs in exterior applications.
Interior Lighting	Occupancy Sensors	Occupancy sensors turn lights off when a space is unoccupied. They are appropriate for areas with intermittent use, such as bathrooms or storage areas.

End-Use	Equipment/ Measure	Description
Exterior Lighting	Photovoltaic Installation	Solar photovoltaic generation may be used to power exterior lighting and thus eliminate all or part of the electrical energy use.
Exterior Lighting	Photosensor Control	Photosensor controls turn exterior lighting on or off based on ambient lighting levels. Compared with manual operation, this can reduce the operation of exterior lighting during daylight hours.
Exterior Lighting	Timeclock Installation	Lighting timers turn exterior lighting on or off based on a preset schedule. Compared with manual operation, this can reduce the operation of exterior lighting during daylight hours.
Appliances	Refrigerator/Freezer, ENERGY STAR or better	Energy-efficient refrigerators/freezers incorporate features such as improved cabinet insulation, more efficient compressors and evaporator fans, defrost controls, mullion heaters, oversized condenser coils, and improved door seals. Further efficiency increases can be obtained by reducing the volume of refrigerated space, or adding multiple compartments to reduce losses from opening doors.
Appliances	Refrigerator/Freezer — Early Replacement	Refrigerators/freezers currently on the market are significantly more efficient that older units, due to technology improvement and stricter appliance standards. This measure incents homeowners to replace an aging but still working unit with a new, higher-efficiency one.
Appliances	Refrigerator/Freezer — Remove Second Unit	Homeowners may have a second refrigerator or freezer that is not used to full capacity and that, because of its age, is extremely inefficient. This measure incents homeowners to recycle the second unit and thus also eliminates associated electricity use.
Appliances	Dishwasher, ENERGY STAR or better	ENERGY STAR labeled dishwashers save by using both improved technology for the primary wash cycle, and by using less hot water. Construction includes more effective washing action, energy-efficient motors, and other advanced technology such as sensors that determine the length of the wash cycle and the temperature of the water necessary to clean the dishes.
Appliances	Clothes Washer, ENERGY STAR or better	ENERGY STAR labeled clothes washers use superior designs that require less water. Sensors match the hot water needs to the size and soil level of the load, preventing energy waste. Further energy and water savings can be achieved through advanced technologies such as inverter-drive or combination washer-dryer units.
Appliances	Clothes Dryer – Electric, High Efficiency	An energy-efficient clothes dryer has a moisture-sensing device to terminate the drying cycle rather than using a timer, and an energy-efficient motor is used for spinning the dryer tub. Application of a heat pump cycle for extracting the moisture from clothes leads to additional energy savings.
Appliances	Range and Oven – Electric, High Efficiency	These products have additional insulation in the oven compartment and tighter-fitting oven door gaskets and hinges to save energy. Conventional ovens must first heat up about 35 pounds of steel and a large amount of air before they heat up the food. Tests indicate that only 6% of the energy output of a typical oven is actually absorbed by the food.
Electronics	Color TVs and Home Electronics, ENERGY STAR or better	In the average home, electronic products consumed significant energy, even when they are turn off, to maintain features like clocks, remote control, and channel/station memory. ENERGY STAR labeled consumer electronics can drastically reduce consumption during standby mode, in addition to saving energy through advanced power management during normal use.

End-Use	Equipment/ Measure	Description
Electronics	Personal Computers, ENERGY STAR or better	Improved power management can significantly reduce the annual energy consumption of PCs and monitors in both standby and normal operation. ENERGY STAR and Climate Savers labeled products provide increasing level of energy efficiency.
Electronics	Reduce Standby Wattage	Representing a growing portion of home electricity consumption, plug-in electronics such as set-top boxes, DVD players, gaming systems, digital video recorders, and even battery chargers for mobile phones and laptop computers are often designed to supply a set voltage. When the units are not in use, this voltage could be dropped significantly (~1 W) and thereby generate a significant energy savings, assumed for this analysis to be between 4-5% on average. These savings are in excess of the measures already discussed for computers and televisions.
Misc.	Furnace Fans, Electronically Commutating Motor	In homes heated by a furnace, there is still substantial energy use by the fan responsible for moving the hot air throughout the ductwork. Application of an Electronically Commutating Motor (ECM) ensures that motor speed matches the heating requirements of the system and saves energy when compared to a continuously operating standard motor.
Miscellaneous	Pool Pump	High-efficiency motors and two-speed pumps provide improved energy efficiency for this load.
Miscellaneous	Pool Pump Timer	A pool pump timer allows the pump to turn off automatically, eliminating the wasted energy associated with unnecessary pumping.
Miscellaneous	Trees for Shading	Planting of shade trees, suitable to the local climate, can reduce the need for air conditioning and provide non-energy benefits as well.
Cooling / Space Heating / Interior Lighting	Home Energy Management System	A centralized home energy management system can be used to control and schedule cooling, space heating, lighting, and possibly appliances as well. Some designs also allow the homeowner to remotely control loads via the Internet.
Cooling / Space Heating	Solar Photovoltaic	Adding a solar photovoltaic (PV) system to the home can meet a portion of the home's electric load and in some cases nearly the entire load, depending on the PV system size, orientation, solar resource, and other factors. For this analysis, we assume a grid-connected system and apply the electricity savings to the home's cooling and space heating loads.
Cooling / Space Heating / Interior Lighting	Advanced New Construction Designs	Advanced new construction designs use an integrated approach to the design of new buildings to account for the interaction of building systems. Typically, designs specify the building orientation, building shell, building mechanical systems, and controls strategies with the goal of optimizing building energy efficiency and comfort. Options that may be evaluated and incorporated include passive solar strategies, increased thermal mass, natural ventilation, daylighting strategies, and shading strategies, This measure was modeled for new construction only.
Cooling / Space Heating / Interior Lighting	ENERGY STAR Homes	This measure was modeled for new construction only.
Cooling / Space Heating / Interior Lighting	Energy-Efficient Manufactured Homes	This measure was modeled for new construction only.

Table C-2 Energy Efficiency Equipment Data — Single Family, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	134	$278	15	0.41
Cooling	Central AC	SEER 15 (CEE Tier 2)	184	$556	15	0.28
Cooling	Central AC	SEER 16 (CEE Tier 3)	226	$834	15	0.23
Cooling	Central AC	Ductless Mini-Split System	405	$4,399	20	0.14
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	62	$104	10	0.33
Cooling	Room AC	EER 11	73	$282	10	0.15
Cooling	Room AC	EER 11.5	99	$626	10	0.09
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	492	$1,000	15	0.43
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	675	$2,318	15	0.26
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	829	$3,505	15	0.21
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	1,486	$5,655	20	0.45
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	516	$1,500	14	0.28
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	173	$41	15	5.79
Water Heating	Water Heater	Geothermal Heat Pump	2,269	$6,586	15	0.47
Water Heating	Water Heater	Solar	2,493	$5,653	15	0.60
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	14.44
Interior Lighting*	Screw-in	LED	40	$80	12	0.90
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.16
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.71
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.14
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Interior Lighting*	Pin-based	LED	14	$17	10	0.77
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	22.43
Exterior Lighting*	Screw-in	LED	37	$79	12	0.89
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	7.40
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	4.03
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	9.14
Exterior Lighting*	High Intensity/Flood	LED	66	$79	10	0.82
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	45	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	88	$487	10	0.16
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	98	$48	13	2.39
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	41	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	53	$1	9	31.05
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	108	$89	13	1.28
Appliances	Refrigerator	Baseline (2014)	144	$0	13	-
Appliances	Refrigerator	Energy Star (2014)	230	$89	13	-

* Savings and costs are per unit, e.g., per lamp.

Table C-2 Energy Efficiency Equipment Data — Single Family, Existing Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	114	$32	11	3.03
Appliances	Freezer	Baseline (2014)	152	$0	11	-
Appliances	Freezer	Energy Star (2014)	243	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	111	$89	13	1.31
Appliances	Second Refrigerator	Baseline (2014)	148	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	237	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	9	$2	13	7.00
Appliances	Stove	Induction (High Efficiency)	46	$1,432	13	0.05
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	108	$1	5	35.63
Electronics	Personal Computers	Climate Savers	154	$175	5	0.35
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	87	$1	11	133.21
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	138	$85	15	1.96
Miscellaneous	Pool Pump	Two-Speed Pump	551	$579	15	1.15
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	127	$1	18	281.65
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-3 Energy Efficiency Equipment Data — Multi Family, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost (/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	67	$93	15	0.62
Cooling	Central AC	SEER 15 (CEE Tier 2)	133	$185	15	0.61
Cooling	Central AC	SEER 16 (CEE Tier 3)	187	$278	15	0.57
Cooling	Central AC	Ductless Mini-Split System	245	$2,012	20	0.19
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	32	$52	10	0.35
Cooling	Room AC	EER 11	38	$141	10	0.15
Cooling	Room AC	EER 11.5	52	$313	10	0.09
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	238	$1,246	15	0.17
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	467	$2,315	15	0.18
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	659	$3,277	15	0.18
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	862	$5,022	20	0.27
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	248	$1,500	14	0.14
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	107	$41	15	3.61
Water Heating	Water Heater	Solar	1,539	$5,653	15	0.38
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	10.47
Interior Lighting*	Screw-in	LED	40	$80	12	0.65
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.16
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.71
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.14
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Interior Lighting*	Pin-based	LED	14	$17	10	0.77
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	32.52
Exterior Lighting*	Screw-in	LED	37	$79	12	1.29
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	7.40
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	4.03
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	9.14
Exterior Lighting*	High Intensity/Flood	LED	66	$79	10	0.82
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	23	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	44	$487	10	0.08
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	93	$48	13	2.28
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	15	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	19	$1	9	11.14
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	92	$89	13	1.09
Appliances	Refrigerator	Baseline (2014)	123	$0	13	-
Appliances	Refrigerator	Energy Star (2014)	196	$89	13	-

* Savings and costs are per unit, e.g., per lamp.

Table C-3 Energy Efficiency Equipment Data—Multi Family, Existing Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	108	$32	11	2.88
Appliances	Freezer	Baseline (2014)	145	$0	11	-
Appliances	Freezer	Energy Star (2014)	231	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	93	$89	13	1.11
Appliances	Second Refrigerator	Baseline (2014)	124	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	199	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	4	$2	13	2.99
Appliances	Stove	Induction (High Efficiency)	20	$1,432	13	0.02
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	86	$1	5	29.28
Electronics	Personal Computers	Climate Savers	123	$175	5	0.29
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	43	$1	11	67.65
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	-	$85	15	-
Miscellaneous	Pool Pump	Two-Speed Pump	-	$579	15	-
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	10	$1	18	21.87
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-4 Energy Efficiency Equipment Data — Mobile Home, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost (/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	80	$278	15	0.24
Cooling	Central AC	SEER 15 (CEE Tier 2)	110	$556	15	0.17
Cooling	Central AC	SEER 16 (CEE Tier 3)	134	$834	15	0.14
Cooling	Central AC	Ductless Mini-Split System	241	$4,399	20	0.08
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	37	$52	10	0.40
Cooling	Room AC	EER 11	44	$141	10	0.17
Cooling	Room AC	EER 11.5	59	$313	10	0.11
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	282	$1,246	15	0.20
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	387	$2,315	15	0.15
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	475	$3,277	15	0.13
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	852	$5,022	20	0.27
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	295	$1,500	14	0.16
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	88	$41	15	2.95
Water Heating	Water Heater	Solar	1,271	$5,653	15	0.31
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	13.00
Interior Lighting*	Screw-in	LED	40	$80	12	0.81
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.04
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.64
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.13
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Interior Lighting*	Pin-based	LED	14	$17	10	0.70
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	20.19
Exterior Lighting*	Screw-in	LED	37	$79	12	0.80
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	6.66
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	3.63
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	8.23
Exterior Lighting*	High Intensity/Flood	LED	66	$79	10	0.74
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	46	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	89	$487	10	0.16
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	99	$48	13	2.43
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	41	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	54	$1	9	31.57
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	110	$89	13	1.30
Appliances	Refrigerator	Baseline (2014)	146	$0	13	-
Appliances	Refrigerator	Energy Star (2014)	234	$89	13	-

* Savings and costs are per unit, e.g., per lamp

Table C-4 Energy Efficiency Equipment Data — Mobile Home, Existing Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	116	$32	11	3.08
Appliances	Freezer	Baseline (2014)	155	$0	11	-
Appliances	Freezer	Energy Star (2014)	248	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	113	$89	13	1.34
Appliances	Second Refrigerator	Baseline (2014)	150	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	241	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	8	$2	13	6.30
Appliances	Stove	Induction (High Efficiency)	41	$1,432	13	0.04
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	101	$1	5	33.39
Electronics	Personal Computers	Climate Savers	144	$175	5	0.33
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	87	$1	11	133.21
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	138	$85	15	1.96
Miscellaneous	Pool Pump	Two-Speed Pump	551	$579	15	1.15
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	127	$1	18	281.65
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-5 Energy Efficiency Equipment Data — Limited Income, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost (/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	76	$185	15	0.35
Cooling	Central AC	SEER 15 (CEE Tier 2)	104	$370	15	0.24
Cooling	Central AC	SEER 16 (CEE Tier 3)	127	$556	15	0.19
Cooling	Central AC	Ductless Mini-Split System	229	$2,394	20	0.15
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	65	$104	10	0.35
Cooling	Room AC	EER 11	77	$282	10	0.15
Cooling	Room AC	EER 11.5	104	$626	10	0.09
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	192	$1,246	15	0.13
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	263	$2,315	15	0.10
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	323	$3,277	15	0.09
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	579	$5,022	20	0.18
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	201	$1,500	14	0.11
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	116	$41	15	3.94
Water Heating	Water Heater	Solar	1,679	$5,653	15	0.41
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	13.85
Interior Lighting*	Screw-in	LED	40	$80	12	0.86
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.16
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.71
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.14
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Interior Lighting*	Pin-based	LED	14	$17	10	0.77
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	32.52
Exterior Lighting*	Screw-in	LED	37	$79	12	1.29
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	7.40
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	4.03
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	9.14
Exterior Lighting*	High Intensity/Flood	LED	66	$79	10	0.82
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	20	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	38	$487	10	0.07
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	104	$48	13	2.56
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	12	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	15	$1	9	9.07
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	92	$89	13	1.09
Appliances	Refrigerator	Baseline (2014)	123	$0	13	-
Appliances	Refrigerator	Energy Star (2014)	196	$89	13	-

* Savings and costs are per unit, e.g., per lamp

Table C-5 Energy Efficiency Equipment Data — Limited Income, Existing Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	108	$32	11	2.88
Appliances	Freezer	Baseline (2014)	145	$0	11	-
Appliances	Freezer	Energy Star (2014)	231	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	93	$89	13	1.11
Appliances	Second Refrigerator	Baseline (2014)	124	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	199	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	5	$2	13	3.59
Appliances	Stove	Induction (High Efficiency)	24	$1,432	13	0.02
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	89	$1	5	30.10
Electronics	Personal Computers	Climate Savers	127	$175	5	0.29
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	49	$1	11	77.80
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	57	$85	15	0.83
Miscellaneous	Pool Pump	Two-Speed Pump	226	$579	15	0.49
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	54	$1	18	123.18
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-6 Energy Efficiency Equipment Data —Single Family, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost (/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	180	$278	15	0.55
Cooling	Central AC	SEER 15 (CEE Tier 2)	240	$556	15	0.36
Cooling	Central AC	SEER 16 (CEE Tier 3)	290	$834	15	0.29
Cooling	Central AC	Ductless Mini-Split System	543	$4,399	20	0.19
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	76	$104	10	0.41
Cooling	Room AC	EER 11	90	$282	10	0.18
Cooling	Room AC	EER 11.5	122	$626	10	0.11
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	588	$1,000	15	0.51
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	783	$2,318	15	0.30
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	946	$3,505	15	0.24
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	1,775	$5,655	20	0.54
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	630	$1,500	14	0.35
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	219	$41	15	7.35
Water Heating	Water Heater	Geothermal Heat Pump	2,878	$6,586	15	0.60
Interior Lighting*	Water Heater	Solar	3,163	$5,653	15	0.77
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	14.05
Interior Lighting*	Screw-in	LED	40	$80	12	0.87
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.16
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.71
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.14
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Exterior Lighting*	Pin-based	LED	14	$17	10	0.77
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	21.82
Exterior Lighting*	Screw-in	LED	37	$79	12	0.87
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	7.40
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	4.03
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	9.14
Exterior Lighting	High Intensity/Flood	LED	66	$79	10	0.82
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	58	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	112	$487	10	0.21
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	117	$48	13	2.86
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	47	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	62	$1	9	36.25
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	102	$89	13	1.20
Appliances	Refrigerator	Baseline (2014)	135	$0	13	-

* Savings and costs are per unit, e.g., per lamp

Table C-6 Energy Efficiency Equipment Data —Single Family, New Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Refrigerator	Energy Star (2014)	217	$89	13	-
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	116	$32	11	3.08
Appliances	Freezer	Baseline (2014)	155	$0	11	-
Appliances	Freezer	Energy Star (2014)	248	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	116	$89	13	1.37
Appliances	Second Refrigerator	Baseline (2014)	154	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	247	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	11	$2	13	8.51
Appliances	Stove	Induction (High Efficiency)	56	$1,432	13	0.06
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	111	$1	5	36.63
Electronics	Personal Computers	Climate Savers	158	$175	5	0.36
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	96	$1	11	148.53
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	156	$85	15	2.22
Miscellaneous	Pool Pump	Two-Speed Pump	623	$579	15	1.30
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	155	$1	18	345.87
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-7 Energy Efficiency Equipment Data — Multi Family, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost (/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	85	$93	15	0.78
Cooling	Central AC	SEER 15 (CEE Tier 2)	166	$185	15	0.76
Cooling	Central AC	SEER 16 (CEE Tier 3)	234	$278	15	0.71
Cooling	Central AC	Ductless Mini-Split System	308	$2,012	20	0.24
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	37	$52	10	0.39
Cooling	Room AC	EER 11	43	$141	10	0.17
Cooling	Room AC	EER 11.5	59	$313	10	0.10
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	292	$1,246	15	0.21
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	571	$2,315	15	0.22
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	804	$3,277	15	0.21
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	1,058	$5,022	20	0.33
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	282	$1,500	14	0.15
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	124	$41	15	4.19
Water Heating	Water Heater	Solar	1,786	$5,653	15	0.44
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	10.18
Interior Lighting*	Screw-in	LED	40	$80	12	0.63
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.16
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.71
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.14
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Interior Lighting*	Pin-based	LED	14	$17	10	0.77
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	31.63
Exterior Lighting*	Screw-in	LED	37	$79	12	1.26
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	7.40
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	4.03
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	9.14
Exterior Lighting*	High Intensity/Flood	LED	66	$79	10	0.82
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	26	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	51	$487	10	0.09
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	105	$48	13	2.56
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	16	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	21	$1	9	12.38
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	108	$89	13	1.28
Appliances	Refrigerator	Baseline (2014)	144	$0	13	-
Appliances	Refrigerator	Energy Star (2014)	230	$89	13	-

* Savings and costs are per unit, e.g., per lamp

Table C-7 Energy Efficiency Equipment Data — Multi Family, New Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	115	$32	11	3.06
Appliances	Freezer	Baseline (2014)	154	$0	11	-
Appliances	Freezer	Energy Star (2014)	246	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	103	$89	13	1.21
Appliances	Second Refrigerator	Baseline (2014)	137	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	219	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	4	$2	13	3.31
Appliances	Stove	Induction (High Efficiency)	22	$1,432	13	0.02
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	88	$1	5	29.69
Electronics	Personal Computers	Climate Savers	125	$175	5	0.29
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	45	$1	11	71.54
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	-	$85	15	-
Miscellaneous	Pool Pump	Two-Speed Pump	-	$579	15	-
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	11	$1	18	24.36
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-8 Energy Efficiency Equipment Data — Mobile Home, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost (/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	100	$278	15	0.30
Cooling	Central AC	SEER 15 (CEE Tier 2)	133	$556	15	0.20
Cooling	Central AC	SEER 16 (CEE Tier 3)	161	$834	15	0.16
Cooling	Central AC	Ductless Mini-Split System	301	$4,399	20	0.11
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	42	$52	10	0.45
Cooling	Room AC	EER 11	50	$141	10	0.20
Cooling	Room AC	EER 11.5	67	$313	10	0.12
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	313	$1,246	15	0.22
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	417	$2,315	15	0.16
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	505	$3,277	15	0.13
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	946	$5,022	20	0.30
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	336	$1,500	14	0.18
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	102	$41	15	3.42
Water Heating	Water Heater	Solar	1,474	$5,653	15	0.36
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	12.64
Interior Lighting*	Screw-in	LED	40	$80	12	0.79
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.04
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.64
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.13
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Interior Lighting*	Pin-based	LED	14	$17	10	0.70
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	19.63
Exterior Lighting*	Screw-in	LED	37	$79	12	0.78
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	6.66
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	3.63
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	8.23
Exterior Lighting*	High Intensity/Flood	LED	66	$79	10	0.74
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	54	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	104	$487	10	0.19
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	111	$48	13	2.73
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	46	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	60	$1	9	35.11
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	129	$89	13	1.52
Appliances	Refrigerator	Baseline (2014)	172	$0	13	-
Appliances	Refrigerator	Energy Star (2014)	275	$89	13	-

* Savings and costs are per unit, e.g., per lamp

Table C-8 Energy Efficiency Equipment Data — Mobile Home, New Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	124	$32	11	3.28
Appliances	Freezer	Baseline (2014)	165	$0	11	-
Appliances	Freezer	Energy Star (2014)	263	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	124	$89	13	1.47
Appliances	Second Refrigerator	Baseline (2014)	165	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	264	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	9	$2	13	6.98
Appliances	Stove	Induction (High Efficiency)	46	$1,432	13	0.05
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	103	$1	5	33.86
Electronics	Personal Computers	Climate Savers	146	$175	5	0.33
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	91	$1	11	140.87
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	154	$85	15	2.20
Miscellaneous	Pool Pump	Two-Speed Pump	617	$579	15	1.29
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	141	$1	18	313.76
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-9 Energy Efficiency Equipment Data — Limited Income, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost (/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	95	$185	15	0.43
Cooling	Central AC	SEER 15 (CEE Tier 2)	126	$370	15	0.29
Cooling	Central AC	SEER 16 (CEE Tier 3)	152	$556	15	0.23
Cooling	Central AC	Ductless Mini-Split System	286	$2,394	20	0.18
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	74	$104	10	0.40
Cooling	Room AC	EER 11	87	$282	10	0.17
Cooling	Room AC	EER 11.5	118	$626	10	0.11
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	213	$1,246	15	0.15
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	284	$2,315	15	0.11
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	343	$3,277	15	0.09
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	643	$5,022	20	0.20
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	228	$1,500	14	0.13
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	135	$41	15	4.57
Water Heating	Water Heater	Solar	1,949	$5,653	15	0.48
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	13.47
Interior Lighting*	Screw-in	LED	40	$80	12	0.84
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.16
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.71
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.14
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Interior Lighting*	Pin-based	LED	14	$17	10	0.77
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	31.63
Exterior Lighting*	Screw-in	LED	37	$79	12	1.26
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	7.40
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	4.03
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	9.14
Exterior Lighting*	High Intensity/Flood	LED	66	$79	10	0.82
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	23	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	44	$487	10	0.08
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	117	$48	13	2.87
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	13	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	17	$1	9	10.08
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	108	$89	13	1.28
Appliances	Refrigerator	Baseline (2014)	144	$0	13	-
Appliances	Refrigerator	Energy Star (2014)	230	$89	13	-

* Savings and costs are per unit, e.g., per lamp

Table C-9 Energy Efficiency Equipment Data — Limited Income, New Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	115	$32	11	3.06
Appliances	Freezer	Baseline (2014)	154	$0	11	-
Appliances	Freezer	Energy Star (2014)	246	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	103	$89	13	1.21
Appliances	Second Refrigerator	Baseline (2014)	137	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	219	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	5	$2	13	3.98
Appliances	Stove	Induction (High Efficiency)	26	$1,432	13	0.03
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	90	$1	5	30.52
Electronics	Personal Computers	Climate Savers	129	$175	5	0.30
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	52	$1	11	82.28
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	63	$85	15	0.93
Miscellaneous	Pool Pump	Two-Speed Pump	254	$579	15	0.54
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	60	$1	18	137.23
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-10 Energy-Efficiency Measure Data—Single Family, Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Early Replacement	Cooling	10%	0%	0%	8%	$2,895	15	0.05
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	41%	100%	$125	4	0.70
Room AC - Removal of Second Unit	Cooling	100%	0%	0%	25%	$75	5	2.45
Attic Fan - Installation	Cooling	1%	0%	12%	23%	$116	18	0.08
Attic Fan - Photovoltaic - Installation	Cooling	1%	0%	13%	45%	$350	19	0.06
Ceiling Fan - Installation	Cooling	11%	0%	51%	75%	$160	15	0.81
Whole-House Fan - Installation	Cooling	9%	0%	7%	19%	$200	18	0.62
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$125	4	1.49
Insulation - Ducting	Cooling	3%	0%	15%	75%	$500	18	0.78
Insulation - Ducting	Space Heating	4%	4%	15%	75%	$500	18	0.78
Repair and Sealing - Ducting	Cooling	10%	0%	12%	50%	$500	18	2.08
Repair and Sealing - Ducting	Space Heating	15%	15%	12%	50%	$500	18	2.08
Thermostat - Clock/Programmable	Cooling	8%	0%	55%	56%	$114	11	2.89
Thermostat - Clock/Programmable	Space Heating	9%	5%	55%	56%	$114	11	2.89
Doors - Storm and Thermal	Cooling	1%	0%	38%	75%	$320	12	0.25
Doors - Storm and Thermal	Space Heating	2%	2%	38%	75%	$320	12	0.25
Insulation - Infiltration Control	Cooling	3%	0%	46%	90%	$266	12	1.72
Insulation - Infiltration Control	Space Heating	10%	10%	46%	90%	$266	12	1.72
Insulation - Ceiling	Cooling	3%	0%	68%	72%	$594	20	1.11
Insulation - Ceiling	Space Heating	10%	5%	68%	72%	$594	20	1.11
Insulation - Radiant Barrier	Cooling	5%	0%	5%	90%	$923	12	0.41
Insulation - Radiant Barrier	Space Heating	2%	1%	5%	90%	$923	12	0.41
Roofs - High Reflectivity	Cooling	6%	0%	5%	10%	$1,550	15	0.05
Windows - Reflective Film	Cooling	7%	0%	5%	45%	$267	10	0.21
Windows - High Efficiency/Energy Star	Cooling	12%	0%	83%	90%	$7,500	25	0.38
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	83%	90%	$7,500	25	0.38
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	24%	25%	$750	15	0.10
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	0%	10%	80%	$2,975	15	0.03
Exterior Lighting - Photosensor Control	Exterior Lighting	15%	0%	24%	45%	$90	8	0.21
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	10%	45%	$72	8	0.35
Water Heater - Faucet Aerators	Water Heating	4%	2%	53%	90%	$24	25	8.78
Water Heater - Pipe Insulation	Water Heating	6%	3%	17%	38%	$180	13	1.05
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	75%	80%	$96	10	4.56
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	54%	75%	$15	10	15.53
Water Heater - Thermostat Setback	Water Heating	9%	5%	17%	75%	$40	5	2.99
Water Heater - Timer	Water Heating	8%	4%	17%	40%	$194	10	1.06
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	3.28
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	1.76
Refrigerator - Early Replacement	Appliances	15%	15%	0%	20%	$1,203	13	0.08
Refrigerator - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	3.99
Freezer - Early Replacement	Appliances	15%	15%	0%	20%	$484	11	0.18
Freezer - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	3.76
Home Energy Management System	Cooling	10%	0%	20%	38%	$300	20	2.46
Home Energy Management System	Space Heating	10%	5%	20%	38%	$300	20	2.46
Home Energy Management System	Interior Lighting	10%	5%	20%	38%	$300	20	2.46
Photovoltaics	Cooling	50%	0%	0%	48%	$17,000	15	0.10
Photovoltaics	Space Heating	25%	25%	0%	48%	$17,000	15	0.10
Pool - Pump Timer	Miscellaneous	60%	0%	59%	90%	$160	15	4.92
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.43
Water Heater - Heat Pump	Water Heating	30%	15%	0%	25%	$1,500	15	0.75
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$3,675	15	1.22
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$13,769	15	0.95

Note: Costs are per household.

Table C-11 Energy-Efficiency Measure Data — Multi Family, Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Early Replacement	Cooling	10%	0%	0%	8%	$2,895	15	0.02
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	33%	100%	$100	4	0.59
Room AC - Removal of Second Unit	Cooling	100%	0%	0%	25%	$75	5	1.28
Ceiling Fan - Installation	Cooling	11%	0%	32%	75%	$80	15	0.49
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$100	4	1.05
Insulation - Ducting	Cooling	3%	0%	13%	75%	$375	18	1.16
Insulation - Ducting	Space Heating	4%	4%	13%	75%	$375	18	1.16
Repair and Sealing - Ducting	Cooling	4%	0%	12%	50%	$500	18	0.95
Repair and Sealing - Ducting	Space Heating	4%	4%	12%	50%	$500	18	0.95
Thermostat - Clock/Programmable	Cooling	8%	0%	27%	68%	$114	11	2.39
Thermostat - Clock/Programmable	Space Heating	6%	3%	27%	68%	$114	11	2.39
Doors - Storm and Thermal	Cooling	1%	0%	17%	75%	$320	12	0.35
Doors - Storm and Thermal	Space Heating	2%	2%	17%	75%	$320	12	0.35
Insulation - Infiltration Control	Cooling	1%	0%	19%	90%	$266	12	2.95
Insulation - Infiltration Control	Space Heating	13%	13%	19%	90%	$266	12	2.95
Insulation - Ceiling	Cooling	13%	0%	27%	30%	$215	20	5.67
Insulation - Ceiling	Space Heating	13%	13%	27%	30%	$215	20	5.67
Insulation - Radiant Barrier	Cooling	4%	0%	5%	90%	$923	12	0.52
Insulation - Radiant Barrier	Space Heating	4%	4%	5%	90%	$923	12	0.52
Roofs - High Reflectivity	Cooling	13%	0%	3%	10%	$1,550	15	0.03
Windows - Reflective Film	Cooling	7%	0%	5%	45%	$167	10	0.10
Windows - High Efficiency/Energy Star	Cooling	13%	0%	70%	90%	$2,500	25	0.56
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	70%	90%	$2,500	25	0.56
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	6%	10%	$256	15	0.14
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	0%	10%	50%	$2,975	15	0.00
Exterior Lighting - Photosensor Control	Exterior Lighting	20%	0%	7%	45%	$90	8	0.04
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	6%	45%	$72	8	0.05
Water Heater - Faucet Aerators	Water Heating	5%	2%	43%	90%	$24	25	6.63
Water Heater - Pipe Insulation	Water Heating	6%	3%	6%	38%	$180	13	0.65
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	71%	75%	$96	10	2.84
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	54%	75%	$15	10	9.66
Water Heater - Thermostat Setback	Water Heating	9%	5%	17%	75%	$40	5	1.86
Water Heater - Timer	Water Heating	8%	4%	5%	40%	$194	10	0.66
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	2.04
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	0.58
Refrigerator - Early Replacement	Appliances	15%	15%	0%	20%	$1,203	13	0.07
Refrigerator - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	3.36
Freezer - Early Replacement	Appliances	15%	15%	0%	20%	$484	11	0.17
Freezer - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	3.57
Home Energy Management System	Cooling	10%	0%	5%	13%	$300	20	2.46
Home Energy Management System	Space Heating	10%	5%	5%	13%	$300	20	2.46
Home Energy Management System	Interior Lighting	10%	5%	5%	13%	$300	20	2.46
Photovoltaics	Cooling	50%	0%	0%	12%	$8,500	15	0.22
Photovoltaics	Space Heating	25%	25%	0%	12%	$8,500	15	0.22
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.13
Water Heater - Heat Pump	Water Heating	30%	15%	0%	10%	$1,500	15	0.47
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$2,845	15	0.99
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$10,946	15	0.72

Note: Costs are per household.

Table C-12 Energy-Efficiency Measure Data — Mobile Home, Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Early Replacement	Cooling	10%	0%	0%	8%	$2,895	15	0.03
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	59%	100%	$100	4	0.63
Room AC - Removal of Second Unit	Cooling	100%	0%	0%	25%	$75	5	1.46
Ceiling Fan - Installation	Cooling	11%	0%	60%	75%	$80	15	0.79
Whole-House Fan - Installation	Cooling	9%	0%	5%	19%	$150	18	0.41
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$125	4	1.02
Insulation - Ducting	Cooling	3%	0%	15%	75%	$375	18	0.94
Insulation - Ducting	Space Heating	4%	4%	15%	75%	$375	18	0.94
Repair and Sealing - Ducting	Cooling	10%	0%	12%	50%	$500	18	2.08
Repair and Sealing - Ducting	Space Heating	15%	15%	12%	50%	$500	18	2.08
Thermostat - Clock/Programmable	Cooling	8%	0%	51%	56%	$114	11	2.78
Thermostat - Clock/Programmable	Space Heating	9%	5%	51%	56%	$114	11	2.78
Doors - Storm and Thermal	Cooling	1%	0%	38%	75%	$320	12	0.25
Doors - Storm and Thermal	Space Heating	2%	2%	38%	75%	$320	12	0.25
Insulation - Infiltration Control	Cooling	3%	0%	46%	90%	$266	12	1.80
Insulation - Infiltration Control	Space Heating	10%	10%	46%	90%	$266	12	1.80
Insulation - Ceiling	Cooling	3%	0%	79%	81%	$707	20	1.00
Insulation - Ceiling	Space Heating	10%	5%	79%	81%	$707	20	1.00
Insulation - Radiant Barrier	Cooling	2%	0%	5%	90%	$923	12	0.35
Insulation - Radiant Barrier	Space Heating	1%	1%	5%	90%	$923	12	0.35
Roofs - High Reflectivity	Cooling	6%	0%	5%	10%	$1,550	15	0.02
Windows - Reflective Film	Cooling	7%	0%	5%	45%	$167	10	0.16
Windows - High Efficiency/Energy Star	Cooling	12%	0%	47%	90%	$7,500	25	0.37
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	47%	90%	$7,500	25	0.37
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	67%	72%	$750	15	0.09
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	0%	10%	80%	$2,975	15	0.03
Exterior Lighting - Photosensor Control	Exterior Lighting	15%	0%	23%	45%	$90	8	0.19
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	10%	45%	$72	8	0.32
Water Heater - Faucet Aerators	Water Heating	4%	2%	79%	90%	$24	25	4.47
Water Heater - Pipe Insulation	Water Heating	6%	3%	17%	38%	$180	13	0.53
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	92%	95%	$96	10	2.32
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	54%	75%	$15	10	7.91
Water Heater - Thermostat Setback	Water Heating	9%	5%	17%	75%	$40	5	1.52
Water Heater - Timer	Water Heating	8%	4%	17%	40%	$194	10	0.54
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	1.67
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	1.65
Refrigerator - Early Replacement	Appliances	15%	15%	0%	20%	$1,203	13	0.08
Refrigerator - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	4.06
Freezer - Early Replacement	Appliances	15%	15%	0%	20%	$484	11	0.18
Freezer - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	3.82
Home Energy Management System	Cooling	10%	0%	20%	38%	$300	20	2.28
Home Energy Management System	Space Heating	10%	5%	20%	38%	$300	20	2.28
Home Energy Management System	Interior Lighting	10%	5%	20%	38%	$300	20	2.28
Photovoltaics	Cooling	50%	0%	0%	48%	$17,000	15	0.09
Photovoltaics	Space Heating	25%	25%	0%	48%	$17,000	15	0.09
Pool - Pump Timer	Miscellaneous	60%	0%	50%	90%	$160	15	4.92
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.21
Water Heater - Heat Pump	Water Heating	30%	15%	0%	10%	$1,500	15	0.38
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$2,616	15	0.88
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$11,135	15	0.62

Note: Costs are per household.

Table C-13 Energy-Efficiency Measure Data — Limited Income, Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Early Replacement	Cooling	10%	0%	0%	8%	$2,895	15	0.03
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	25%	100%	$100	4	0.61
Room AC - Removal of Second Unit	Cooling	100%	0%	0%	25%	$75	5	2.56
Attic Fan - Installation	Cooling	1%	0%	3%	23%	$116	18	0.05
Attic Fan - Photovoltaic - Installation	Cooling	1%	0%	2%	11%	$350	19	0.03
Ceiling Fan - Installation	Cooling	11%	0%	41%	75%	$80	15	0.89
Whole-House Fan - Installation	Cooling	9%	0%	5%	19%	$150	18	0.46
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$125	4	0.82
Insulation - Ducting	Cooling	3%	0%	13%	75%	$395	18	0.90
Insulation - Ducting	Space Heating	4%	4%	13%	75%	$395	18	0.90
Repair and Sealing - Ducting	Cooling	10%	0%	12%	50%	$500	18	2.07
Repair and Sealing - Ducting	Space Heating	15%	15%	12%	50%	$500	18	2.07
Thermostat - Clock/Programmable	Cooling	8%	0%	27%	68%	$114	11	2.63
Thermostat - Clock/Programmable	Space Heating	9%	5%	27%	68%	$114	11	2.63
Doors - Storm and Thermal	Cooling	1%	0%	17%	75%	$320	12	0.25
Doors - Storm and Thermal	Space Heating	2%	2%	17%	75%	$320	12	0.25
Insulation - Infiltration Control	Cooling	3%	0%	19%	90%	$266	12	1.78
Insulation - Infiltration Control	Space Heating	10%	10%	19%	90%	$266	12	1.78
Insulation - Ceiling	Cooling	3%	0%	36%	41%	$215	20	2.44
Insulation - Ceiling	Space Heating	10%	5%	36%	41%	$215	20	2.44
Insulation - Radiant Barrier	Cooling	2%	0%	5%	90%	$923	12	0.35
Insulation - Radiant Barrier	Space Heating	1%	1%	5%	90%	$923	12	0.35
Roofs - High Reflectivity	Cooling	6%	0%	3%	10%	$1,550	15	0.03
Windows - Reflective Film	Cooling	7%	0%	5%	45%	$167	10	0.18
Windows - High Efficiency/Energy Star	Cooling	12%	0%	68%	90%	$2,500	25	0.51
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	68%	90%	$2,500	25	0.51
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	8%	10%	$256	15	0.16
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	50%	10%	50%	$2,975	15	0.01
Exterior Lighting - Photosensor Control	Exterior Lighting	15%	0%	8%	45%	$90	8	0.06
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	6%	45%	$72	8	0.10
Water Heater - Faucet Aerators	Water Heating	4%	2%	46%	90%	$24	25	5.95
Water Heater - Pipe Insulation	Water Heating	6%	3%	6%	38%	$180	13	0.71
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	73%	75%	$96	10	3.09
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	54%	75%	$15	10	10.53
Water Heater - Thermostat Setback	Water Heating	9%	5%	17%	75%	$40	5	2.03
Water Heater - Timer	Water Heating	8%	4%	5%	40%	$194	10	0.72
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	2.23
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	0.77
Refrigerator - Early Replacement	Appliances	15%	15%	0%	20%	$1,203	13	0.07
Refrigerator - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	3.36
Freezer - Early Replacement	Appliances	15%	15%	0%	20%	$484	11	0.17
Freezer - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	3.57
Home Energy Management System	Cooling	10%	0%	5%	13%	$300	20	2.00
Home Energy Management System	Space Heating	10%	5%	5%	13%	$300	20	2.00
Home Energy Management System	Interior Lighting	10%	5%	5%	13%	$300	20	2.00
Photovoltaics	Cooling	50%	0%	0%	48%	$8,500	15	0.17
Photovoltaics	Space Heating	25%	25%	0%	48%	$8,500	15	0.17
Pool - Pump Timer	Miscellaneous	60%	0%	50%	90%	$160	15	2.02
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.24
Water Heater - Heat Pump	Water Heating	30%	15%	0%	20%	$1,500	15	0.51
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$2,970	15	1.03
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$10,798	15	0.69

Note: Costs are per household.

Table C-14 Energy-Efficiency Measure Data — Single Family, New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	41%	100%	$125	4	0.78
Attic Fan - Installation	Cooling	1%	0%	13%	23%	$97	18	0.15
Attic Fan - Photovoltaic - Installation	Cooling	1%	0%	4%	11%	$200	19	0.15
Ceiling Fan - Installation	Cooling	10%	0%	53%	75%	$160	15	1.09
Whole-House Fan - Installation	Cooling	9%	0%	4%	19%	$200	18	0.92
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$125	4	1.69
Insulation - Ducting	Cooling	3%	0%	50%	75%	$250	18	1.31
Insulation - Ducting	Space Heating	4%	4%	50%	75%	$250	18	1.31
Thermostat - Clock/Programmable	Cooling	8%	0%	91%	95%	$114	11	2.91
Thermostat - Clock/Programmable	Space Heating	8%	4%	91%	95%	$114	11	2.91
Doors - Storm and Thermal	Cooling	1%	0%	13%	75%	$180	12	0.45
Doors - Storm and Thermal	Space Heating	2%	2%	13%	75%	$180	12	0.45
Insulation - Ceiling	Cooling	3%	0%	68%	71%	$634	20	0.99
Insulation - Ceiling	Space Heating	8%	6%	68%	71%	$634	20	0.99
Insulation - Radiant Barrier	Cooling	2%	0%	25%	90%	$923	12	0.37
Insulation - Radiant Barrier	Space Heating	1%	1%	25%	90%	$923	12	0.37
Insulation - Foundation	Cooling	3%	0%	20%	90%	$358	20	1.35
Insulation - Foundation	Space Heating	6%	6%	20%	90%	$358	20	1.35
Insulation - Wall Cavity	Cooling	2%	0%	20%	90%	$236	20	1.15
Insulation - Wall Cavity	Space Heating	3%	3%	20%	90%	$236	20	1.15
Insulation - Wall Sheathing	Cooling	1%	0%	64%	90%	$300	20	0.89
Insulation - Wall Sheathing	Space Heating	3%	3%	64%	90%	$300	20	0.89
Roofs - High Reflectivity	Cooling	5%	0%	5%	90%	$517	15	0.17
Windows - Reflective Film	Cooling	7%	0%	2%	45%	$267	10	0.31
Windows - High Efficiency/Energy Star	Cooling	12%	0%	100%	100%	$2,200	25	0.62
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	100%	100%	$2,200	25	0.62
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	24%	27%	$500	15	0.16
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	0%	10%	80%	$2,975	15	0.04
Exterior Lighting - Photosensor Control	Exterior Lighting	13%	0%	13%	45%	$90	8	0.19
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	16%	45%	$72	8	0.36
Water Heater - Faucet Aerators	Water Heating	4%	2%	38%	90%	$24	25	11.03
Water Heater - Pipe Insulation	Water Heating	6%	3%	8%	41%	$50	13	4.71
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	90%	95%	$48	10	11.33
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$15	10	19.30
Water Heater - Thermostat Setback	Water Heating	9%	5%	5%	75%	$40	5	3.70
Water Heater - Timer	Water Heating	8%	4%	5%	40%	$194	10	1.31
Water Heater - Drainwater Heat Reocvery	Water Heating	9%	5%	1%	90%	$899	15	0.47
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	4.06
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	1.99
Home Energy Management System	Cooling	10%	0%	20%	68%	$250	20	3.16
Home Energy Management System	Space Heating	10%	5%	20%	68%	$250	20	3.16
Home Energy Management System	Interior Lighting	10%	5%	20%	68%	$250	20	3.16
Photovoltaics	Cooling	50%	0%	1%	48%	$15,800	15	0.12
Photovoltaics	Space Heating	25%	25%	1%	48%	$15,800	15	0.12
Pool - Pump Timer	Miscellaneous	60%	0%	55%	90%	$160	15	5.43
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.64
Advanced New Construction Designs	Cooling	40%	0%	2%	45%	$4,500	18	1.09
Advanced New Construction Designs	Space Heating	40%	40%	2%	45%	$4,500	18	1.09
Advanced New Construction Designs	Interior Lighting	20%	20%	2%	45%	$4,500	18	1.09
Energy Star Homes	Cooling	20%	0%	12%	75%	$5,000	18	0.75
Energy Star Homes	Space Heating	20%	20%	12%	75%	$5,000	18	0.75
Energy Star Homes	Interior Lighting	20%	20%	12%	75%	$5,000	18	0.75
Water Heater - Heat Pump	Water Heating	30%	15%	0%	25%	$1,500	15	0.94
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$3,675	15	1.53
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$13,769	15	1.14

Note: Costs are per household.

Table C-15 Energy-Efficiency Measure Data — Multi Family, New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	33%	100%	$100	4	0.62
Ceiling Fan - Installation	Cooling	10%	0%	18%	75%	$80	15	0.77
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$100	4	1.12
Insulation - Ducting	Cooling	2%	0%	50%	75%	$200	18	1.18
Insulation - Ducting	Space Heating	2%	2%	50%	75%	$200	18	1.18
Thermostat - Clock/Programmable	Cooling	8%	0%	77%	80%	$114	11	2.29
Thermostat - Clock/Programmable	Space Heating	5%	3%	77%	80%	$114	11	2.29
Doors - Storm and Thermal	Cooling	1%	0%	19%	75%	$180	12	0.66
Doors - Storm and Thermal	Space Heating	2%	2%	19%	75%	$180	12	0.66
Insulation - Ceiling	Cooling	12%	0%	27%	48%	$152	20	10.12
Insulation - Ceiling	Space Heating	16%	16%	27%	48%	$152	20	10.12
Insulation - Radiant Barrier	Cooling	2%	0%	5%	90%	$923	12	0.50
Insulation - Radiant Barrier	Space Heating	3%	3%	5%	90%	$923	12	0.50
Insulation - Wall Cavity	Cooling	2%	0%	4%	90%	$63	20	6.14
Insulation - Wall Cavity	Space Heating	4%	4%	4%	90%	$63	20	6.14
Insulation - Wall Sheathing	Cooling	1%	0%	55%	90%	$210	20	1.59
Insulation - Wall Sheathing	Space Heating	3%	3%	55%	90%	$210	20	1.59
Roofs - High Reflectivity	Cooling	8%	0%	0%	90%	$517	15	0.10
Windows - Reflective Film	Cooling	7%	0%	2%	45%	$167	10	0.17
Windows - High Efficiency/Energy Star	Cooling	13%	0%	100%	100%	$2,200	25	0.63
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	100%	100%	$2,200	25	0.63
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	6%	9%	$256	15	0.14
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	0%	10%	50%	$2,975	15	0.01
Exterior Lighting - Photosensor Control	Exterior Lighting	20%	0%	1%	45%	$90	8	0.04
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	11%	45%	$72	8	0.05
Water Heater - Faucet Aerators	Water Heating	5%	2%	11%	90%	$24	25	7.63
Water Heater - Pipe Insulation	Water Heating	6%	3%	0%	41%	$50	13	2.68
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	66%	75%	$48	10	6.45
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$15	10	10.99
Water Heater - Thermostat Setback	Water Heating	9%	5%	5%	75%	$40	5	2.11
Water Heater - Timer	Water Heating	8%	4%	5%	40%	$194	10	0.75
Water Heater - Drainwater Heat Reocvery	Water Heating	9%	5%	1%	90%	$899	15	0.27
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	2.31
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	0.63
Home Energy Management System	Cooling	10%	0%	5%	68%	$250	20	3.19
Home Energy Management System	Space Heating	10%	5%	5%	68%	$250	20	3.19
Home Energy Management System	Interior Lighting	10%	5%	5%	68%	$250	20	3.19
Photovoltaics	Cooling	50%	0%	0%	12%	$7,900	15	0.26
Photovoltaics	Space Heating	25%	25%	0%	12%	$7,900	15	0.26
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.23
Advanced New Construction Designs	Cooling	40%	0%	2%	45%	$2,500	18	1.47
Advanced New Construction Designs	Space Heating	40%	40%	2%	45%	$2,500	18	1.47
Advanced New Construction Designs	Interior Lighting	20%	20%	2%	45%	$2,500	18	1.47
Water Heater - Heat Pump	Water Heating	30%	15%	0%	10%	$1,500	15	0.53
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$2,845	15	1.13
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$10,946	15	0.84

Note: Costs are per household.

Table C-16 Energy-Efficiency Measure Data — Mobile Home, New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	59%	100%	$100	4	0.66
Ceiling Fan - Installation	Cooling	10%	0%	57%	75%	$80	15	0.95
Whole-House Fan - Installation	Cooling	9%	0%	4%	19%	$150	18	0.53
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$125	4	1.09
Insulation - Ducting	Cooling	3%	0%	50%	75%	$200	18	1.59
Insulation - Ducting	Space Heating	4%	4%	50%	75%	$200	18	1.59
Thermostat - Clock/Programmable	Cooling	8%	0%	57%	75%	$114	11	2.77
Thermostat - Clock/Programmable	Space Heating	8%	4%	57%	75%	$114	11	2.77
Doors - Storm and Thermal	Cooling	1%	0%	13%	75%	$180	12	0.49
Doors - Storm and Thermal	Space Heating	2%	2%	13%	75%	$180	12	0.49
Insulation - Ceiling	Cooling	3%	0%	79%	81%	$176	20	3.02
Insulation - Ceiling	Space Heating	8%	6%	79%	81%	$176	20	3.02
Insulation - Radiant Barrier	Cooling	2%	0%	25%	90%	$923	12	0.36
Insulation - Radiant Barrier	Space Heating	1%	1%	25%	90%	$923	12	0.36
Insulation - Wall Cavity	Cooling	2%	0%	20%	90%	$197	20	1.35
Insulation - Wall Cavity	Space Heating	3%	3%	20%	90%	$197	20	1.35
Insulation - Wall Sheathing	Cooling	1%	0%	64%	90%	$300	20	0.96
Insulation - Wall Sheathing	Space Heating	3%	3%	64%	90%	$300	20	0.96
Roofs - High Reflectivity	Cooling	5%	0%	5%	90%	$517	15	0.07
Windows - Reflective Film	Cooling	7%	0%	2%	45%	$167	10	0.21
Windows - High Efficiency/Energy Star	Cooling	12%	0%	85%	90%	$2,200	25	0.57
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	85%	90%	$2,200	25	0.57
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	67%	72%	$500	15	0.14
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	50%	10%	80%	$2,975	15	0.03
Exterior Lighting - Photosensor Control	Exterior Lighting	13%	0%	13%	45%	$90	8	0.17
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	16%	45%	$72	8	0.32
Water Heater - Faucet Aerators	Water Heating	4%	2%	57%	90%	$24	25	5.14
Water Heater - Pipe Insulation	Water Heating	6%	3%	8%	41%	$50	13	2.20
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	92%	95%	$48	10	5.28
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$15	10	9.00
Water Heater - Thermostat Setback	Water Heating	9%	5%	5%	75%	$40	5	1.72
Water Heater - Timer	Water Heating	8%	4%	5%	40%	$194	10	0.61
Water Heater - Drainwater Heat Reocvery	Water Heating	9%	5%	1%	90%	$899	15	0.22
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	1.89
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	1.79
Home Energy Management System	Cooling	10%	0%	20%	68%	$250	20	2.94
Home Energy Management System	Space Heating	10%	5%	20%	68%	$250	20	2.94
Home Energy Management System	Interior Lighting	10%	5%	20%	68%	$250	20	2.94
Photovoltaics	Cooling	50%	0%	1%	48%	$15,800	15	0.10
Photovoltaics	Space Heating	25%	25%	1%	48%	$15,800	15	0.10
Pool - Pump Timer	Miscellaneous	60%	0%	35%	90%	$160	15	5.38
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.28
Advanced New Construction Designs	Cooling	30%	0%	2%	45%	$4,500	18	0.52
Advanced New Construction Designs	Space Heating	30%	30%	2%	45%	$4,500	18	0.52
Advanced New Construction Designs	Interior Lighting	20%	20%	2%	45%	$4,500	18	0.52
Energy Efficient Manufactured Homes	Cooling	20%	0%	10%	75%	$3,500	18	0.88
Energy Efficient Manufactured Homes	Space Heating	20%	20%	10%	75%	$3,500	18	0.88
Energy Efficient Manufactured Homes	Interior Lighting	20%	20%	10%	75%	$3,500	18	0.88
Water Heater - Heat Pump	Water Heating	30%	15%	0%	10%	$1,500	15	0.44
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$2,616	15	1.00
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$11,738	15	0.69

Note: Costs are per household.

Table C-17 Energy-Efficiency Measure Data — Limited Income, New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	25%	100%	$100	4	0.65
Attic Fan - Installation	Cooling	1%	0%	15%	23%	$97	18	0.07
Attic Fan - Photovoltaic - Installation	Cooling	1%	0%	5%	11%	$200	19	0.07
Ceiling Fan - Installation	Cooling	10%	0%	33%	75%	$80	15	1.03
Whole-House Fan - Installation	Cooling	9%	0%	4%	19%	$150	18	0.58
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$125	4	0.87
Insulation - Ducting	Cooling	3%	0%	50%	75%	$210	18	1.47
Insulation - Ducting	Space Heating	4%	4%	50%	75%	$210	18	1.47
Thermostat - Clock/Programmable	Cooling	8%	0%	29%	30%	$114	11	2.54
Thermostat - Clock/Programmable	Space Heating	8%	4%	29%	30%	$114	11	2.54
Doors - Storm and Thermal	Cooling	1%	0%	19%	75%	$180	12	0.46
Doors - Storm and Thermal	Space Heating	2%	2%	19%	75%	$180	12	0.46
Insulation - Ceiling	Cooling	3%	0%	36%	48%	$152	20	3.20
Insulation - Ceiling	Space Heating	8%	6%	36%	48%	$152	20	3.20
Insulation - Radiant Barrier	Cooling	2%	0%	5%	90%	$923	12	0.36
Insulation - Radiant Barrier	Space Heating	1%	1%	5%	90%	$923	12	0.36
Insulation - Foundation	Cooling	3%	0%	4%	90%	$358	20	1.37
Insulation - Foundation	Space Heating	6%	6%	4%	90%	$358	20	1.37
Insulation - Wall Cavity	Cooling	2%	0%	4%	90%	$63	20	3.46
Insulation - Wall Cavity	Space Heating	3%	3%	4%	90%	$63	20	3.46
Insulation - Wall Sheathing	Cooling	1%	0%	59%	90%	$210	20	1.19
Insulation - Wall Sheathing	Space Heating	3%	3%	59%	90%	$210	20	1.19
Roofs - High Reflectivity	Cooling	5%	0%	0%	90%	$517	15	0.08
Windows - Reflective Film	Cooling	7%	0%	2%	45%	$167	10	0.23
Windows - High Efficiency/Energy Star	Cooling	12%	0%	78%	90%	$2,200	25	0.55
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	78%	90%	$2,200	25	0.55
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	8%	9%	$256	15	0.17
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	50%	10%	50%	$2,975	15	0.01
Exterior Lighting - Photosensor Control	Exterior Lighting	13%	0%	0%	45%	$90	8	0.06
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	11%	45%	$72	8	0.10
Water Heater - Faucet Aerators	Water Heating	4%	2%	11%	90%	$24	25	6.84
Water Heater - Pipe Insulation	Water Heating	6%	3%	0%	41%	$50	13	2.92
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	21%	75%	$48	10	7.03
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$15	10	11.97
Water Heater - Thermostat Setback	Water Heating	9%	5%	5%	75%	$40	5	2.29
Water Heater - Timer	Water Heating	8%	4%	5%	40%	$194	10	0.81
Water Heater - Drainwater Heat Reocvery	Water Heating	9%	5%	1%	90%	$899	15	0.29
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	2.52
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	0.83
Home Energy Management System	Cooling	10%	0%	5%	68%	$250	20	2.50
Home Energy Management System	Space Heating	10%	5%	5%	68%	$250	20	2.50
Home Energy Management System	Interior Lighting	10%	5%	5%	68%	$250	20	2.50
Photovoltaics	Cooling	50%	0%	0%	48%	$7,900	15	0.20
Photovoltaics	Space Heating	25%	25%	0%	48%	$7,900	15	0.20
Pool - Pump Timer	Miscellaneous	60%	0%	35%	90%	$160	15	2.21
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.30
Advanced New Construction Designs	Cooling	30%	0%	2%	45%	$2,500	18	1.25
Advanced New Construction Designs	Space Heating	30%	30%	2%	45%	$2,500	18	1.25
Advanced New Construction Designs	Interior Lighting	20%	20%	2%	45%	$2,500	18	1.25
Water Heater - Heat Pump	Water Heating	30%	15%	0%	20%	$1,500	15	0.58
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$2,970	15	1.18
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$10,798	15	0.81

Note: Costs are per household.

APPENDIX | **D**

COMMERCIAL ENERGY EFFICIENCY EQUIPMENT AND MEASURE DATA

This appendix presents detailed information for all commercial and industrial energy efficiency equipment and measures that were evaluated in LoadMAP. Several sets of tables are provided.

Table D-1 provides brief descriptions for all equipment and measures that were assessed for potenital.

Tables D-2 through D-9 list the detailed unit-level data for the equipment measures for each of the C&I segments — small/medium commercial, large commercial, extra-large commercial, and extra-large industial — and for existing and new construction, respectively. Savings are in kWh/yr/sq.ft., and incremental costs are in $/sq.ft. The B/C ratio is zero if the measure represents the baseline technology or if the technology is not available in the first year of the forecast (2012). The B/C ratio is calculated within LoadMAP for each year of the forecast and is available once the technology or measure becomes available.

Tables D-10 through D-17 list the detailed unit-level data for the non-equipment energy efficiency measures for each of the segments and for existing and new construction, respectively. Because these measures can produce energy-use savings for multiple end-use loads (e.g., insulation affects heating and cooling energy use) savings are expressed as a percentage of the end-use loads. Base saturation indicates the percentage of buildings in which the measure is already installed. Applicability/Feasibility is the product of two factors that account for whether the measure is applicable to the building. Cost is expressed in $/sq.ft. The detailed measure-level tables present the results of the benefit/cost (B/C) analysis for the first year of the forecast. The B/C ratio is zero if the measure represents the baseline technology or if the measure is not available in the first year of the forecast (2012). The B/C ratio is calculated within LoadMAP for each year of the forecast and is available once the technology or measure becomes available.

Note that Tables D-2 through D-17 present information for Washington. For Idaho, savings and B/C ratios may be slightly different due to weather-related usage, differences in the states' market profiles, and different retail electricity prices. Although Idaho-specific values are not presented here, they are available within the LoadMAP files.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Cooling	Central Cooling Systems	Commercial buildings are often cooled with a central chiller plant that creates chilled water for distribution throughout the facility. Chillers can be air source or water source, which include heat rejection via a condenser loop and cooling tower. Because of the wide variety of system types and sizes, savings and cost values for efficiency improvements in chiller systems represent an average over air- and water-cooled systems, as well as screw, reciprocating, and centrifugal technologies. Under this simplified approach, each central system is characterized by an aggregate efficiency value (inclusive of chiller, pumps, motors and condenser loop equipment), in kW/ton with a further efficiency upgrade through the application of variable refrigerant flow technology.
Cooling	Chilled Water Variable Flow System	The chilled water variable flow system is essentially a single chilled water loop with variable volume and speed. A single set of pumps operated by a VSD eliminates the need for separate distribution pumps and makes the chilled water flow throughout the entire system be variable. The use of adjustable flow limiting valves is designed to optimize water flow. Such valves provide flow limiting, shut-off and adjustment functions, automatically compensating for changes in system pressure to maximize energy efficiency.
Cooling	Packaged Cooling Systems / Rooftop Units (RTUs) and Heat Pumps	Packaged cooling systems are simple to install and maintain, and are commonly used in small and medium-sized commercial buildings. Applications range from a single supply system with air intake filters, supply fan, and cooling coil, or can become more complex with the addition of a return air duct, return air fan, and various controls to optimize performance. For packaged RTUs, varying Energy Efficiency Ratios (EER) were considered, as well as ductless or “mini-split” systems with variable refrigerant flow. For heat pumps, units with increasing EER and COP levels were evaluated, as well as a ductless mini-split system.
Cooling	Packaged Terminal Air Conditioners (PTAC)	Window (or wall) mounted room air conditioners (and heat pumps) are designed to cool (or heat) a single room or space. This type of unit incorporates a complete air-cooled refrigeration and air-handling system in an individual package. Conditioned air is discharged in response to thermostatic control to meet room requirements. Each unit has a self-contained, air-cooled direct expansion (DX) cooling system, a heat pump or other fuel-based heating system and associated controls. The energy savings increase with each incremental increase in efficiency, measured in terms of EER level.
Space Heating	Convert to Gas	This fuel-switching measure is the replacement of an electric furnace with a gas furnace. This measure eliminates all prior electricity consumption and demand due to electric space heating. In this study, it is assumed this measure can be implemented only in buildings within 500 feet of a gas main.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Cooling, Space Heating, Interior Lighting	Energy Management System	An energy management system (EMS) allows managers/owners to monitor and control the major energy-consuming systems within a commercial building. At the minimum, the EMS can be used to monitor and record energy consumption of the different end-uses in a building, and can control operation schedules of the HVAC and lighting systems. The monitoring function helps building managers/owners to identify systems that are operating inefficiently so that actions can be taken to correct the problem. The EMS can also provide preventive maintenance scheduling that will reduce the cost of operations and maintenance in the long run. The control functionality of the EMS allows the building manager/owner to operate building systems from one central location. The operation schedules set via the EMS help to prevent building systems from operating during unwanted or unoccupied periods. This analysis assumes that this measure is limited to buildings with a central HVAC system.
Cooling, Space Heating	Economizer	Economizers allow outside air (when it is cool and dry enough) to be brought into the building space to meet cooling loads instead of using mechanically cooled interior air. A dual enthalpy economizer consists of indoor and outdoor temperature and humidity sensors, dampers, motors, and motor controls. Economizers are most applicable to temperate climates and savings will be smaller in extremely hot or humid areas.
Cooling	VSD on Water Pumps	The part-load efficiency of chilled water loop pumps can be improved substantially by varying the speed of the motor drive according to the building demand for cooling. There is also a reduction in piping losses associated with this measure that has a major impact on the energy use for a building. However, pump speeds can generally only be reduced to a minimum specified rate, because chillers and the control valves may require a minimum flow rate to operate. There are two major types of variable speed drives: mechanical and electronic. An additional benefit of variable-speed drives is the ability to start and stop the motor gradually, thus extending the life of the motor and associated machinery. This analysis assumes that electronic variable speed drives are installed.
Cooling	Turbocor Compressor	Turbocor compressors use oil-free magnetic bearings to reduce friction losses and couples that with a two-stage centrifugal compressor to reduce central chiller energy consumption.
Cooling	High-Efficiency Cooling Tower Fans	High efficiency cooling tower fans utilize variable frequency drives in the cooling tower design. VFDs improve fan performance by adjusting fan speed and rotation as conditions change.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Cooling	Condenser Water Temperature Reset	Chilled water reset controls save energy by improving chiller performance through increasing the supply chilled water temperature, which allows increased suction pressure during low load periods. Raising the chilled water temperature also reduces chilled water piping losses. However, the primary savings from the chilled water reset measure results from chiller efficiency improvement. This is due partly to the smaller temperature difference between chilled water and ambient air, and partly due to the sensitivity of chiller performance to suction temperature.
Cooling	Maintenance	Filters, coils, and fins require regular cleaning and maintenance for the heat pump or roof top unit to function effectively and efficiently throughout its years of service. Neglecting necessary maintenance leads to a steady decline in performance while energy use increases. Maintenance can increase the efficiency of poorly performing equipment by as much as 10%.
Cooling	Evaporative Precooler	Evaporative precooling can improve the performance of air conditioning systems, most commonly RTUs. These systems typically use indirect evaporative cooling as a first stage to pre-cool outside air. If the evaporative system cannot meet the full cooling load, the air steam is further cooled with conventional refrigerative air conditioning technology.
Cooling	Roof- High Reflectivity (Cool Roof)	The color and material of a building structure surface will determine the amount of solar radiation absorbed by that surface and subsequently transferred into a building. This is called solar absorptance. By using a material or painting the roof with a light color (and a lower solar absorptance), the roof will absorb less solar radiation and consequently reduce the cooling load.
Cooling, Space Heating	Green Roofs	A green roof covers a section or the entire building roof with a waterproof membrane and vegetative material. Like cool roofs, green roofs can reduce solar absorptance and they can also provide insulation. They also provide non-energy benefits by absorbing rainwater and thus reducing storm water run-off, providing wildlife habitat, and reducing so-called urban heat island effects.
Cooling, Space Heating, Ventilation	HVAC Retrocommissioning	Over time, the performance of complex mechanical systems providing heating and cooling to existing commercial spaces degrades as a result of inappropriate changes to or overrides of controls, deteriorating equipment, clogged filters, changing demands and schedules, and pressure imbalances. Retrocommissioning is a comprehensive analysis of an entire system in which an engineer assesses shortcomings in system performance, and then optimizes through a process of tune-up, maintenance, and reprogramming of control or automation software. Energy efficiency programs throughout the country promote retrocommissioning as a means of greatly reducing energy consumption in existing buildings.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Cooling, Space Heating, Ventilation, Interior Lighting	Comprehensive Retrocommissioning	Comprehensive retrocommissioning covers not only HVAC and lighting, but other existing building systems as well. For example, it can improve efficiency of non-HVAC motors, vertical transport systems, and domestic hot water systems.
Cooling, Space Heating, Ventilation, Interior Lighting/Exterior Lighting	HVAC Commissioning Lighting Commissioning Comprehensive Commissioning	For new construction and major renovations, commissioning ensures that building systems are properly designed, specified, and installed to meet the design intent and provide high-efficiency performance. As the names suggests, HVAC Commissioning and Lighting Commissioning focus only on HVAC and lighting equipment and controls. Comprehensive commissioning addresses these systems but usually begins earlier in the design process, and may also address domestic hot water, non-HVAC fans, vertical transport, telecommunications, fire protection, and other building systems.
Cooling, Space Heating, Interior Lighting	Advanced New Construction Designs	Advanced new construction designs use an integrated approach to the design of new buildings to account for the interaction of building systems. Typically, architects and engineers work closely to specify the building orientation, building shell, building mechanical systems, and controls strategies with the goal of optimizing building energy efficiency and comfort. Options that may be evaluated and incorporated include passive solar strategies, increased thermal mass, daylighting strategies, and shading strategies, This measure was modeled for new construction only.
Cooling, Space Heating	Programmable Thermostat	A programmable thermostat can be added to most heating/cooling systems. They are typically used during winter to lower temperatures at night and in summer to increase temperatures during the afternoon. There are two-setting models, and well as models that allow separate programming for each day of the week. The energy savings from this type of thermostat are identical to those of a "setback" strategy with standard thermostats, but the convenience of a programmable thermostat makes it a much more attractive option. In this analysis, the baseline is assumed to have no thermostat setback.
Cooling, Space Heating	Duct Repair and Sealing	An ideal duct system would be free of leaks. Leakage in unsealed ducts varies considerably because of the differences in fabricating machinery used, the methods for assembly, installation workmanship, and age of the ductwork. Air leaks from the system to the outdoors result in a direct loss proportional to the amount of leakage and the difference in enthalpy between the outdoor air and the conditioned air. To seal ducts, a wide variety of sealing methods and products exist. Each has a relatively short shelf life, and no documented research has identified the aging characteristics of sealant applications. This analysis assumes that the baseline air loss from ducts has doubled, and conducting repair and sealing of the ducts will restore leakage from ducts to the original baseline level.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Cooling, Space Heating	Duct Insulation	Air distribution ducts can be insulated to reduce heating or cooling losses. Best results can be achieved by covering the entire surface area with insulation. Insulation material inhibits the transfer of heat through the air-supply duct. Several types of ducts and duct insulation are available, including flexible duct, pre-insulated duct, duct board, duct wrap, tacked, or glued rigid insulation, and waterproof hard shell materials for exterior ducts.
Cooling, Space Heating	Insulation – Radiant Barrier	Radiant barriers inhibit heat transfer by thermal radiation. When a radiant barrier is installed beneath the roofing material much of the heat radiated from a hot roof is reflected back to the roof limiting the amount of heat emitted downwards.
Cooling, Space Heating	High-Efficiency Windows	High-efficiency windows, such as those labeled under the ENERGY STAR Program, are designed to reduce a building's energy bill while increasing comfort for the occupants at the same time. High-efficiency windows have reducing properties that reduce the amount of heat transfer through the glazing surface. For example, some windows have a low-E coating, which is a thin film of metallic oxide coating on the glass surface that allows passage of short-wave solar energy through glass and prevents long-wave energy from escaping. Another example is double-pane glass that reduces conductive and convective heat transfer. There are also double-pane glasses that are gas-filled (usually argon) to further increase the insulating properties of the window.
Cooling, Space Heating	Ceiling and Wall Cavity Insulation	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation can conserve energy by reducing the heat loss or gain of a building. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose; loose-fill (blown) fiberglass; and rigid polystyrene.
Ventilation	Cooking – Exhaust Hoods with Sensor Controls	Improved exhaust hoods involve installing variable-speed controls on commercial kitchen hoods. These controls provide ventilation based on actual cooking loads. When grills, broilers, stoves, fryers or other kitchen appliances are not being used, the controls automatically sense the reduced load and decrease the fan speed accordingly. This results in lower energy consumption because the system is only running as needed rather than at 100% capacity at all times.
Ventilation	Variable Air Volume	A variable air volume ventilation system modulates the air flow rate as needed based on the interior conditions of the building to reduce fan load, improve dehumidification, and reduce energy usage.
Ventilation	Fans – Energy Efficient Motors	High-efficiency motors are essentially interchangeable with standard motors, but differences in construction make them more efficient. Energy-efficient motors achieve their improved efficiency by reducing the losses that occur in the conversion of electrical energy to mechanical energy. This analysis assumes that the efficiency of supply fans is increased by 5% due to installing energy-efficient motors.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Ventilation	Fans – Variable Speed Control (VSD)	The part-load efficiency of ventilation fans can be improved substantially by varying the speed of the motor drive. There are two major types of variable speed controls: mechanical and electronic. An additional benefit of variable-speed controls is the ability to start and stop the motor gradually, thus extending the life of the motor and associated machinery. This analysis assumes that electronic variable speed controls are installed.
Water Heating	High-Efficiency Water Heater Systems	Efficient electric water heaters are characterized by a high recovery or thermal efficiency (percentage of delivered electric energy which is transferred to the water) and low standby losses (the ratio of heat lost per hour to the content of the stored water). Included in the savings associated with high-efficiency electric water heaters are timers that allow temperature setpoints to change with hot water demand patterns. For example, the heating element could be shut off throughout the night, increasing the overall energy factor of the unit. In addition, tank and pipe insulation reduces standby losses and therefore reduces the demands on the water heater. This analysis considers conventional electric water heaters with efficiency greater than 96%, as well as geothermal heat pump water heaters for effective efficiency greater than one. Solar water heating was evaluated as well.
Water Heating	Convert to Gas	This fuel-switching measure is the replacement of an electric water heater with a gas-fired water heater. This measure will eliminate all prior electricity consumption and demand due to electric water heating. In this study, it is assumed that this measure can be implemented only in buildings within 500 feet of a gas main.
Water Heating	Heat Pump Water Heater	Heat pump water heaters use heat pump technology to extract heat from the ambient surroundings and transfer it to a hot water tank. These devices are available as an alternative to conventional tank water heaters of 55 gallons or larger.
Water Heating	Faucet Aerators/Low Flow Nozzles	A faucet aerator or low flow nozzle spreads the stream from a faucet helping to reduce water usage. The amount of water passing through the aerator is measured in gallons per minute (GPM) and the lower the GPM the more water the aerator conserves.
Water Heating	Pipe Insulation	Insulating hot water pipes decreases the amount of energy lost during distribution of hot water throughout the building. Insulating pipes will result in quicker delivery of hot water and allows lowering the water heating set point. There are several different types of insulation, the most common being polyethylene and neoprene.
Water Heating	High-Efficiency Circulation Pump	A high efficiency circulation pump uses an electronically commutated motor (ECM) to improve motor efficiency over a larger range of partial loads. In addition, an ECM allows for improved low RPM performance with greater torque and smaller pump dimensions.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Water Heating	Tank Blanket/Insulation	Insulation levels on domestic hot water heaters can be increased by installing a fiberglass blanket on the outside of the tank. This increase in insulation reduces standby losses and thus saves energy. Water heater insulation is available either by the blanket or by square foot of fiberglass insulation with R-values ranging from 5 to 14.
Water Heating	Thermostat Setback	Installing a setback thermostat on the water heater can lead to significant energy savings during periods when there is no one in the building.
Water Heating	Hot Water Saver	A hot water saver is a plumbing device that attaches to the showerhead and that pauses the flow of water until the water is hot enough for use. The water is re-started by the flip of a switch.
Interior Lighting, Exterior Lighting	Lamp Replacement (Interior Screw-in, HID, and Linear Fluorescent Exterior Screw-in, HID, and Linear Fluorescent)	Commercial lighting differs from the residential sector in that efficiency changes typically require more than the simple purchase and quick installation of a screw-in compact fluorescent lamp. Restrictions regarding ballasts, fixtures, and circuitry limit the potential for direct substitution of one lamp type for another. However, such replacements do exist. For example, screw-in incandescent lamps can readily be replaced with CFLs or LEDs. Also, during the buildout for a leased office space, the management could decide to replace all T12 lamps and magnetic ballasts with T8/electronic ballast configurations. This type of decision-making is modeled on a stock turnover basis because of the time between opportunities for upgrades.
Interior Lighting, Exterior Lighting	Lighting Retrocommissioning	Lighting retrocommissioning projects in existing commercial buildings do not require an event such as a tenant turnover, a major renovation, or an update to electrical circuits to drive its adoption. Rather, a decision-maker can decide at any time to perform a comprehensive audit of a facility's lighting systems, followed by an upgrade of equipment (lamps, ballasts, fixtures, reflectors), controls (occupancy sensors, daylighting controls, and central automation).
Interior Lighting	Delamping and Install Reflectors	While sometimes included in lighting retrofit projects, delamping is often performed as a separate energy efficiency measure in which a lighting engineer analyzes the lighting provided by current systems compared to the requirements of building occupants. This often leads to the removal of unnecessary lamps corresponding to an overall reduction in energy usage. .In addition, installing a reflector in each fixture can improve light distribution from the remaining lamps.
Interior Lighting, Exterior Lighting	Lighting Time Clocks and Timers	While outdoor lighting is typically required only at night, in many cases lighting remains on during daylight hours. A simple timer can set a diurnal schedule for outdoor lighting and thus reduce the operating hours by as much as 50%.
Interior Lighting	Central Lighting Controls	Central lighting control systems provide building-wide control of interior lighting to ensure that lights are properly scheduled based on expected building occupancy. Individual zones or circuits can be controlled.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Interior Lighting	Photocell Controlled T8 Dimming Ballasts	Photocells, in concert with dimming ballasts, can detect when adequate daylighting is available and dim or turn off lights to reduce electricity consumption. Usually one photocell is used to control a group of fixtures, a zone, or a circuit.
Interior Lighting	Bi-Level Fixture with Occupancy Sensor	Bi-level fixtures with occupancy sensors detect when a space is unoccupied and reduce light output to a lower level. These devices
Interior Lighting	High Bay Fixtures	Fluorescent fixtures designed for high-bay applications have several advantages over similar HID fixtures: lower energy consumption, lower lumen depreciation rates, better dimming options, faster start-up and restrike, better color rendition, more pupil lumens, and reduced glare.
Interior Lighting	Occupancy Sensor	The installation of occupancy sensors allows lights to be turned off during periods when a space is unoccupied, virtually eliminating the wasted energy due to lights being left on. There are several types of occupancy sensors in the market.
Interior Lighting	LED Exit Lighting	The lamps inside exit signs represent a significant energy end-use, since they usually operate 24 hours per day. Many old exit signs use incandescent lamps, which consume approximately 40 watts per sign. The incandescent lamps can be replaced with LED lamps that are specially designed for this specific purpose. In comparison, the LED lamps consume approximately 2-5 watts.
Interior Lighting	Task Lighting	In commercial facilities, individual work areas can use task lighting instead of brightly lighting the entire area. Significant energy savings can be realized by focusing light directly where it is needed and lowering the general lighting level. An example of task lighting is the common desk lamp. A 25W desk lamp can be installed in place of a typical lamp in a fixture.
Interior Lighting, Cooling	Hotel Guestroom Controls	Hotel guestrooms can be fitted with occupancy controls that turn off energy-using equipment when the guest is not using the room. The occupancy controls comes in several forms, but this analysis assumes the simplest kind, which is a simple switch near the room's entry where the guest can deposit their room key or card. If the key or card is present, then lights, TV, and air conditioning can receive power and operate. When the guest leaves and takes the key, all equipment shuts off.
Exterior Lighting	Daylighting Controls	Daylighting controls use a photosensor to detect ambient light and turn off exterior lights accordingly.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Exterior Lighting	Photovoltaic Lighting	Outdoor photovoltaic (PV) lighting systems use PV panels (or modules), which convert sunlight to electricity. The electricity is stored in batteries for use at night. They can be cost effective relative to installing power cables and/or step down transformers for relatively small lighting loads. The "nightly run time" listings on most "off-the-shelf" products are based on specific sunlight conditions. Systems located in places that receive less sunlight than the system is designed for will operate for fewer hours per night than expected. Nightly run times may also vary depending on how clear the sky is on any given day. Shading of the PV panel by landscape features (vegetation, buildings, etc.) will also have a large impact on battery charging and performance. Open areas with no shading, such as parking lots, are ideal places where PV lighting systems can be used.
Exterior Lighting	Cold Cathode Lighting	Cold cathode lighting does not use an external heat source to provide thermionic emission of electrons. Cold cathode lighting is typically used for exterior signage or where temperatures are likely to drop below freezing.
Exterior Lighting	Induction Lamps	Induction lamps use a contactless bulb and rely on electromagnetic fields to transfer power. This allows for the lamp to utilize more efficient materials that would otherwise react with metal electrodes. In addition, the lack of an electrode significantly extends lamp life while reducing lumen depreciation.
Office Equipment	Desktop and Laptop Computing Equipment	ENERGY STAR labeled office equipment saves energy by powering down and "going to sleep" when not in use. ENERGY STAR labeled computers automatically power down to 15 watts or less when not in use and may actually last longer than conventional products because they spend a large portion of time in a low-power sleep mode. ENERGY STAR labeled computers also generate less heat than conventional models. The ClimateSavers Initiative, made up of leading computer processor manufacturers, has stated a goal of reducing power consumption in active mode by 50% by integrating innovative power management into the chip design process.
Office Equipment	Monitors	ENERGY STAR labeled office equipment saves energy by powering down and "going to sleep" when not in use. ENERGY STAR labeled monitors automatically power down to 15 watts or less when not in use.
Office Equipment	Servers	In addition to the "sleep" mode a reductions and the efficient processors being designed by members of the ClimateSavers Initiative, servers have additional energy-saving opportunities through "virtualization" and other architecture solutions that involve optimal matching of computation tasks to hardware requirements

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Office Equipment	Printers/Copiers/ Fax/ POS Terminals	ENERGY STAR labeled office equipment saves energy by powering down and "going to sleep" when not in use. ENERGY STAR labeled copiers are equipped with a feature that allows them to automatically turn off after a period of inactivity, reducing a copier's annual electricity costs by over 60%. High-speed copiers that include a duplexing unit that is set to automatically make double-sided copies can reduce paper costs and help to save trees.
Office Equipment	ENERGY STAR Power Supply	Power supplies with an efficient ac-dc or ac-ac conversion process can obtain the ENERGY STAR label. These devices can be used to power computers, phones, and other office equipment.
Refrigeration	Walk-in Refrigeration Systems	Standard compressors typically operate at approximately 65% efficiency. High-efficiency models are available that can improve compressor efficiency by 15%.
Refrigeration	Glass Door and Solid Door Refrigeration Units (Reach-in /Open Display Case/Vending Machine) Door Gasket Replacement High Efficiency Case Lighting	In addition to walk-in, "cold-storage" refrigeration, a significant amount of energy in the commercial sector can be attributed to "reach-in" units. These stand-alone appliances can range from a residential-style refrigerator/freezer unit in an office kitchen or the breakroom of a retail store to the refrigerated display cases in some grocery or convenience stores. As in the case of residential units, these refrigerators can be designed to perform at higher efficiency through a combination of compressor equipment upgrades, default temperature settings, and defrost patterns. Other measures for these units are replacing aging door gaskets that no longer adequately seal the case, and replacing inefficient display lights with CFL or LED systems to reduce internal heat gains in the cases.
Refrigeration	Open Display Case	Glass doors can be used to enclose multi-deck display cases for refrigerated items in supermarkets. In addition, more efficient units are designed to perform at higher efficiency through a combination of compressor equipment upgrades, default temperature settings, and defrost patterns.
Refrigeration	Anti-Sweat Heater/ Auto Door Closer Controls	Anti-sweat heaters are used in virtually all low-temperature display cases and many medium-temperature cases to control humidity and prevent the condensation of water vapor on the sides and doors and on the products contained in the cases. Typically, these heaters stay on all the time, even though they only need to be on about half the time. Anti-sweat heater controls can come in the form of humidity sensors or time clocks.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Refrigeration	Floating Head Pressure Controls	Floating head pressure control allows the pressure in the condenser to "float" with ambient temperatures. This method reduces refrigeration compression ratios, improves system efficiency and extends the compressor life. The greatest savings with a floating head pressure approach occurs when the ambient temperatures are low, such as in the winter season. Floating head pressure control is most practical for new installations. However, retrofits installation can be completed with some existing refrigeration systems. Installing floating head pressure control increases the capacity of the compressor when temperatures are low, which may lead to short cycling.
Refrigeration	Bare Suction Lines	Insulating bare suction lines reduces heat
Refrigeration	Night Covers	Night covers can be used on open refrigeration cases when a facility is closed or few customers are in the store.
Refrigeration	Strip Curtain	Strip curtains at the entrances to large walk-in coolers or freezers, such as those used in supermarkets, reduce air transfer between the refrigerated space and the surrounding space.
Refrigeration	Icemakers	In certain building types (restaurant, hotel), the production of ice is a significant usage of electricity. By optimizing the timing of ice production and the type of output to the specific application, icemakers are assumed to deliver electricity savings.
Refrigeration	Vending Machine - Controller	Cold beverage vending machines usually operate 24 hours a day regardless of whether the surrounding area is occupied or not. The result is that the vending machine consumes energy unnecessarily, because it will operate all night to keep the beverage cold even when there would be no customer until the next morning. A vending machine controller can reduce energy consumption without compromising the temperature of the vended product. The controller uses an infrared sensor to monitor the surrounding area's occupancy and will power down the vending machine when the area is unoccupied. It will also monitor the room's temperature and will re -power the machine at one to three hour intervals independent of occupancy to ensure that the product stays cold.
Food Service	Kitchen Equipment	Commercial cooking and food preparation equipment represent a significant contribution to energy consumption in restaurants and other food service applications. By replacing old units with efficient ones, this energy consumption can be greatly reduced. These measures include fryers, commercial ovens, dishwashers, hot food containers and miscellaneous other food preparation equipment. Savings range between 15 and 65%, depending on the specific unit being replaced.
Cooling, Space Heating, Interior Lighting, Food Preparation, Refrigeration	Custom Measures	Custom measures were included in the CPA analysis to serve as a "catch all" for measures for which costs and savings are not easily quantified and that could be part of a program such as Avista's existing Site-Specific incentive program. Costs and energy savings were assumed such that the measures passed the economic screen.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Miscellaneous	Non-HVAC motor	Because the Small/Medium Commercial and Large Commercial segments include some industrial customers, the CPA analysis included equipment upgrades for non-HVAC motors. This equipment measure also incorporates improvements for vertical transport. Premium efficiency motors reduce the amount of lost energy going into heat rather than power. Since less heat is generated, less energy is needed to cool the motor with a fan. Therefore, the initial cost of energy efficient motors is generally higher than for standard motors. However their life-cycle costs can make them far more economical because of savings they generate in operating expense. Premium efficiency motors can provide savings of 0.5% to 3% over standard motors. The savings results from the fact that energy efficient motors run cooler than their standard counterparts, resulting in an increase in the life of the motor insulation and bearing. In general, an efficient motor is a more reliable motor because there are fewer winding failures, longer periods between needed maintenance, and fewer forced outages. For example, using copper instead of aluminum in the windings, and increasing conductor cross-sectional area, lowers a motor's I2R losses.
Miscellaneous	Pumps – Variable Speed Control	The part-load efficiency of chilled and hot water loop pumps can be improved substantially by varying the speed of the motor drive according to the building demand for heating or cooling. There is also a reduction in piping losses associated with this measure that has a major impact on the heating loads and energy use for a building. However, pump speeds can generally only be reduced to a minimum specified rate, because chillers, boilers, and the control valves may require a minimum flow rate to operate. There are two major types of variable speed controls: mechanical and electronic. An additional benefit of variable-speed drives is the ability to start and stop the motor gradually, thus extending the life of the motor and associated machinery. This analysis assumes that electronic variable speed controls are installed.
Miscellaneous	Laundry – High Efficiency Clothes Washer	High efficiency clothes washers use designs that require less water. These machines use sensors to match the hot water needs to the load, preventing energy waste. There are two designs: top-loading and front-loading. Further energy and water savings can be achieved through advanced technologies such as inverter-drive or combination washer-dryer units.
Miscellaneous	ENERGY STAR Water Cooler	An ENERGY STAR water cooler has more insulation and improved chilling mechanisms, resulting in about half the energy use of a standard cooler.
Miscellaneous	Industrial Process Improvements	Because the Avista C&I sector segmentation was based on Avista's rate classes, the commercial building segments include a small percentage or industrial business types. This measure was included to account for energy efficiency potential that could be achieved through various process improvements at these customers.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Machine Drive.	Motors, Premium Efficiency	Premium efficiency motors reduce the amount of lost energy going into heat rather than power. Since less heat is generated, less energy is needed to cool the motor with a fan. Therefore, the initial cost of energy efficient motors is generally higher than for standard motors. However their life-cycle costs can make them far more economical because of savings they generate in operating expense. Premium efficiency motors can provide savings of 0.5% to 3% over standard motors. The savings results from the fact that energy efficient motors run cooler than their standard counterparts, resulting in an increase in the life of the motor insulation and bearing. In general, an efficient motor is a more reliable motor because there are fewer winding failures, longer periods between needed maintenance, and fewer forced outages. For example, using copper instead of aluminum in the windings, and increasing conductor cross-sectional area, lowers a motor's I2R losses. This analysis assumes 75% loading factor (for peak efficiency) for 1800 rpm motor. Hours of operation vary depending on horsepower size. In addition, improved drives and controls are assumed to be implemented along with the motors, resulting in savings as high as 10% of annual energy consumption
Machine Drive	Motors – Variable Frequency Drive	In addition to energy savings, VFDs increase motor and system life and provide a greater degree of control over the motor system. Especially for motor systems handling fluids, VFDs can efficiently respond to changing operating conditions.
Machine Drive	Magnetic Adjustable Speed Drive	To allow for adjustable speed operation, this technology uses magnetic induction to couple a drive to its load. Varying the magnetic slip within the coupling controls the speed of the output shaft. Magnetic drives perform best at the upper end of the speed range due to the energy consumed by the slip. Unlike traditional ASDs, magnetically coupled ASDs create no power distortion on the electrical system. However, magnetically coupled ASD efficiency is best when power needs are greatest. VFDs may show greater efficiency when the average load speed is below 90% of the motor speed, however this occurs when power demands are reduced.
Machine Drive	Compressed Air – System Controls, Optimization and Improvements, Maintenance	Controls for compressed air systems can shift load from two partially loaded compressors to one compressor in order to maximize compression efficiency and may also involve the addition of VFDs. Improvements include installing high-efficiency motors. Maintenance includes fixing air leaks and replacing air filters.
Machine Drive	Fan Systems – Controls, Optimization and Maintenance	Certain practices require a consistent flow rate, such as indoor air quality and clean room ventilation. To achieve this, fan flow controls can be used to maintain precise volume flow control ensuring a constant air delivery even on fluctuating pressure conditions. This is done through programmable circuitry to electronically control fan motor speed. Motors can be configured to accept a signal from a controller that would vary the flow rate in direct proportion to the signal.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Machine Drive	Pumping Systems – Controls, Optimization and Maintenance	Pumping systems optimization includes installing VFDs, correctly resizing the motors, and installing timers and automated on-off controls. Maintenance includes repairing diaphragms and fixing piping leaks.
Process	Process Cooling/Refrigeration	Because of the customized nature of industrial cooling and refrigeration applications, a variety of opportunities are summarized as a general improvement in cooling and cold storage equipment. Costs and savings were developed using average values for this group of measures from the Sixth Plan industrial supply curve workbooks.
Process	Process Heating	Because of the customized nature of industrial heating applications, a variety of opportunities are summarized as a general improvement in process heating equipment, such as arc furnaces. Costs and savings were developed using average values for this group of measures from the Sixth Plan industrial supply curve workbooks.
Process	Electrochemical Process	Because of the customized nature of industrial electrochemical applications, a variety of opportunities are summarized as a general improvement in equipment and processes. Costs and savings were developed using average values for this group of measures from the Sixth Plan industrial supply curve workbooks.
Process	Refrigeration – System Controls, Maintenance, and Optimization	Because refrigeration equipment performance degrades over time and control settings are frequently overridden, these measures account for savings that can be achieved through system maintenance and controls optimization.

Table D-2 Energy Efficiency Equipment Data — Small/Medium Comm., Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	-
Cooling	Central Chiller	1.3 kw/ton, COP 2.7	0.29	$0.39	20	-
Cooling	Central Chiller	1.26 kw/ton, COP 2.8	0.35	$0.50	20	0.51
Cooling	Central Chiller	1.0 kw/ton, COP 3.5	0.73	$0.62	20	1.90
Cooling	Central Chiller	0.97 kw/ton, COP 3.6	0.77	$0.74	20	1.39
Cooling	Central Chiller	Variable Refrigerant Flow	1.01	$11.57	20	0.07
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.22	$0.18	16	-
Cooling	RTU	EER 11.2	0.43	$0.35	16	-
Cooling	RTU	EER 12.0	0.57	$0.58	16	0.49
Cooling	RTU	Ductless VRF	0.69	$5.12	16	0.05
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.09	$0.08	14	0.86
Cooling	PTAC	EER 10.8	0.21	$0.16	14	1.00
Cooling	PTAC	EER 11	0.25	$0.43	14	0.43
Cooling	PTAC	EER 11.5	0.33	$0.96	14	0.27
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	0.57	$0.39	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	0.90	$1.18	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	1.20	$1.57	15	0.98
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	1.31	$1.96	15	0.68
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	1.46	$11.50	20	0.10
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	1.30	$1.22	15	1.07
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.23	$0.09	4	-
Interior Lighting	Interior Screw-in	CFL	0.94	$0.03	7	16.50
Interior Lighting	Interior Screw-in	LED	1.04	$1.18	12	0.84
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.30	($0.07)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.30	($0.03)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.91	$0.25	6	1.73
Interior Lighting	Linear Fluorescent	T5	0.95	$0.43	6	1.06
Interior Lighting	Linear Fluorescent	LED	0.99	$3.74	15	0.33
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.14	$0.05	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.60	$0.02	7	17.60
Exterior Lighting	Exterior Screw-in	Metal Halides	0.60	$0.05	4	3.16
Exterior Lighting	Exterior Screw-in	LED	0.66	$0.64	12	0.90
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.22	($0.13)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.24	$0.55	9	0.37
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.01	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.04	$0.02	6	1.12
Exterior Lighting	Linear Fluorescent	T5	0.04	$0.03	6	0.69
Exterior Lighting	Linear Fluorescent	LED	0.05	$0.24	15	0.22
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.10	$0.02	15	5.23
Water Heating	Water Heater	Geothermal Heat Pump	1.33	$3.53	15	0.43
Water Heating	Water Heater	Solar	1.46	$3.03	15	0.55
Food Preparation	Fryer	Standard	-	$0.00	12	-
Food Preparation	Fryer	Efficient	0.03	$0.04	12	0.80
Food Preparation	Oven	Standard	-	$0.00	12	-

Note: Costs and savings are per sq. ft.

Table D-2 Energy Efficiency Equipment Data — Small/Med. Comm., Existing Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Food Preparation	Oven	Efficient	0.39	$0.36	12	1.02
Food Preparation	Dishwasher	Standard	-	$0.00	12	-
Food Preparation	Dishwasher	Efficient	0.02	$0.05	12	0.36
Food Preparation	Hot Food Container	Standard	-	$0.00	12	-
Food Preparation	Hot Food Container	Efficient	0.40	$0.16	12	2.29
Food Preparation	Food Prep	Standard	-	$0.00	12	-
Food Preparation	Food Prep	Efficient	0.00	$0.03	12	0.07
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	-
Refrigeration	Walk in Refrigeration	Efficient	-	$0.09	18	-
Refrigeration	Glass Door Display	Standard	-	$0.00	18	-
Refrigeration	Glass Door Display	Efficient	0.16	$0.00	18	56.08
Refrigeration	Solid Door Refrigerator	Standard	-	$0.00	18	-
Refrigeration	Solid Door Refrigerator	Efficient	0.19	$0.02	18	9.87
Refrigeration	Open Display Case	Standard	-	$0.00	18	-
Refrigeration	Open Display Case	Efficient	0.00	$0.00	18	0.24
Refrigeration	Vending Machine	Base	-	$0.00	10	-
Refrigeration	Vending Machine	Base (2012)	0.11	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency	0.13	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency (2012)	0.20	$0.00	10	46.48
Refrigeration	Icemaker	Standard	-	$0.00	12	-
Refrigeration	Icemaker	Efficient	0.05	$0.00	12	12.76
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	-
Office Equipment	Desktop Computer	Energy Star	0.19	$0.00	4	23.04
Office Equipment	Desktop Computer	Climate Savers	0.27	$0.36	4	0.23
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	-
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	7.34
Office Equipment	Laptop Computer	Climate Savers	0.03	$0.12	4	0.08
Office Equipment	Server	Standard	-	$0.00	3	-
Office Equipment	Server	Energy Star	0.12	$0.01	3	2.14
Office Equipment	Monitor	Standard	-	$0.00	4	-
Office Equipment	Monitor	Energy Star	0.22	$0.00	4	19.68
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	-
Office Equipment	Printer/copier/fax	Energy Star	0.09	$0.04	6	0.98
Office Equipment	POS Terminal	Standard	-	$0.00	4	-
Office Equipment	POS Terminal	Energy Star	0.03	$0.00	4	2.96
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.00	15	-
Miscellaneous	Non-HVAC Motor	High Efficiency	0.05	$0.06	15	0.95
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.06	$0.06	15	-
Miscellaneous	Non-HVAC Motor	Premium	0.07	$0.11	15	0.72
Miscellaneous	Non-HVAC Motor	Premium (2015)	0.08	$0.11	15	-
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-3 Energy Efficiency Equipment Data — Large Commercial, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	-
Cooling	Central Chiller	1.3 kw/ton, COP 2.7	0.30	$0.26	20	-
Cooling	Central Chiller	1.26 kw/ton, COP 2.8	0.36	$0.33	20	0.83
Cooling	Central Chiller	1.0 kw/ton, COP 3.5	0.75	$0.41	20	3.11
Cooling	Central Chiller	0.97 kw/ton, COP 3.6	0.79	$0.49	20	2.28
Cooling	Central Chiller	Variable Refrigerant Flow	1.04	$7.63	20	0.11
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.22	$0.13	16	-
Cooling	RTU	EER 11.2	0.45	$0.25	16	-
Cooling	RTU	EER 12.0	0.59	$0.41	16	0.75
Cooling	RTU	Ductless VRF	0.72	$3.67	16	0.07
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.09	$0.09	14	0.86
Cooling	PTAC	EER 10.8	0.21	$0.17	14	1.00
Cooling	PTAC	EER 11	0.25	$0.46	14	0.43
Cooling	PTAC	EER 11.5	0.34	$1.03	14	0.27
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	0.46	$0.18	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	0.73	$0.55	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	0.97	$0.73	15	1.85
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	1.07	$0.91	15	1.28
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	1.19	$5.35	20	0.19
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	1.03	$1.22	15	0.86
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.19	$0.08	4	-
Interior Lighting	Interior Screw-in	CFL	0.78	$0.03	7	14.13
Interior Lighting	Interior Screw-in	LED	0.87	$1.11	12	0.72
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.31	($0.08)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.30	($0.03)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.89	$0.25	6	1.66
Interior Lighting	Linear Fluorescent	T5	0.92	$0.42	6	1.02
Interior Lighting	Linear Fluorescent	LED	0.97	$3.67	15	0.32
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.08	$0.01	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.34	$0.01	7	34.02
Exterior Lighting	Exterior Screw-in	Metal Halides	0.34	$0.02	4	6.10
Exterior Lighting	Exterior Screw-in	LED	0.38	$0.19	12	1.73
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.19	($0.11)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.20	$0.45	9	0.37
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.01	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.04	$0.02	6	1.18
Exterior Lighting	Linear Fluorescent	T5	0.04	$0.03	6	0.72
Exterior Lighting	Linear Fluorescent	LED	0.05	$0.24	15	0.23
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.12	$0.02	15	5.71
Water Heating	Water Heater	Geothermal Heat Pump	1.54	$3.53	15	0.46
Water Heating	Water Heater	Solar	1.69	$3.03	15	0.60
Food Preparation	Fryer	Standard	-	$0.00	12	-
Food Preparation	Fryer	Efficient	0.07	$0.02	12	3.52
Food Preparation	Oven	Standard	-	$0.00	12	-

Note: Costs and savings are per sq. ft.

Table D-3 Energy Efficiency Equipment Data — Large Commercial, Existing Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Food Preparation	Oven	Efficient	0.75	$0.46	12	1.43
Food Preparation	Dishwasher	Standard	-	$0.00	12	-
Food Preparation	Dishwasher	Efficient	0.07	$0.10	12	0.58
Food Preparation	Hot Food Container	Standard	-	$0.00	12	-
Food Preparation	Hot Food Container	Efficient	0.35	$0.30	12	0.99
Food Preparation	Food Prep	Standard	-	$0.00	12	-
Food Preparation	Food Prep	Efficient	0.01	$0.03	12	0.24
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	-
Refrigeration	Walk in Refrigeration	Efficient	0.15	$1.26	18	0.13
Refrigeration	Glass Door Display	Standard	-	$0.00	18	-
Refrigeration	Glass Door Display	Efficient	0.13	$0.01	18	24.96
Refrigeration	Solid Door Refrigerator	Standard	-	$0.00	18	-
Refrigeration	Solid Door Refrigerator	Efficient	0.30	$0.08	18	4.39
Refrigeration	Open Display Case	Standard	-	$0.00	18	-
Refrigeration	Open Display Case	Efficient	0.00	$0.04	18	0.16
Refrigeration	Vending Machine	Base	-	$0.00	10	-
Refrigeration	Vending Machine	Base (2012)	0.13	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency	0.15	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency (2012)	0.23	$0.00	10	20.70
Refrigeration	Icemaker	Standard	-	$0.00	12	-
Refrigeration	Icemaker	Efficient	0.11	$0.02	12	5.62
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	-
Office Equipment	Desktop Computer	Energy Star	0.35	$0.00	4	47.46
Office Equipment	Desktop Computer	Climate Savers	0.50	$0.32	4	0.46
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	-
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	15.12
Office Equipment	Laptop Computer	Climate Savers	0.04	$0.06	4	0.17
Office Equipment	Server	Standard	-	$0.00	3	-
Office Equipment	Server	Energy Star	0.13	$0.01	3	4.41
Office Equipment	Monitor	Standard	-	$0.00	4	-
Office Equipment	Monitor	Energy Star	0.19	$0.01	4	9.14
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	-
Office Equipment	Printer/copier/fax	Energy Star	0.08	$0.02	6	2.02
Office Equipment	POS Terminal	Standard	-	$0.00	4	-
Office Equipment	POS Terminal	Energy Star	0.01	$0.00	4	2.94
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.00	15	-
Miscellaneous	Non-HVAC Motor	High Efficiency	0.06	$0.06	15	0.92
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.06	$0.06	15	-
Miscellaneous	Non-HVAC Motor	Premium	0.08	$0.13	15	0.69
Miscellaneous	Non-HVAC Motor	Premium (2015)	0.09	$0.13	15	-
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-4 Energy Efficiency Equipment Data — Extra Large Commercial, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	-
Cooling	Central Chiller	0.60 kw/ton, COP 5.9	0.43	$0.09	20	-
Cooling	Central Chiller	0.58 kw/ton, COP 6.1	0.49	$0.18	20	0.66
Cooling	Central Chiller	0.55 kw/Ton, COP 6.4	0.57	$0.25	20	0.91
Cooling	Central Chiller	0.51 kw/ton, COP 6.9	0.69	$0.44	20	0.78
Cooling	Central Chiller	0.50 kw/Ton, COP 7.0	0.72	$0.53	20	0.69
Cooling	Central Chiller	0.48 kw/ton, COP 7.3	0.77	$0.62	20	0.68
Cooling	Central Chiller	Variable Refrigerant Flow	1.00	$10.92	20	0.05
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.20	$0.24	16	-
Cooling	RTU	EER 11.2	0.41	$0.45	16	-
Cooling	RTU	EER 12.0	0.53	$0.75	16	0.37
Cooling	RTU	Ductless VRF	0.65	$6.64	16	0.03
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.08	$0.06	14	1.09
Cooling	PTAC	EER 10.8	0.19	$0.12	14	1.28
Cooling	PTAC	EER 11	0.22	$0.32	14	0.55
Cooling	PTAC	EER 11.5	0.30	$0.71	14	0.34
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	0.50	$0.24	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	0.79	$0.73	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	1.06	$0.97	15	1.34
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	1.16	$1.21	15	0.93
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	1.29	$7.10	20	0.14
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	1.21	$1.22	15	1.01
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.30	$0.14	4	-
Interior Lighting	Interior Screw-in	CFL	1.25	$0.06	7	13.22
Interior Lighting	Interior Screw-in	LED	1.38	$1.90	12	0.67
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.13	($0.05)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.20	($0.03)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.59	$0.21	6	1.31
Interior Lighting	Linear Fluorescent	T5	0.61	$0.35	6	0.80
Interior Lighting	Linear Fluorescent	LED	0.64	$3.08	15	0.25
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.02	$0.00	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.10	$0.00	7	37.00
Exterior Lighting	Exterior Screw-in	Metal Halides	0.10	$0.00	4	6.64
Exterior Lighting	Exterior Screw-in	LED	0.11	$0.05	12	1.89
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.26	($0.16)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.28	$0.64	9	0.37
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.00	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.01	$0.00	6	1.12
Exterior Lighting	Linear Fluorescent	T5	0.01	$0.01	6	0.69
Exterior Lighting	Linear Fluorescent	LED	0.01	$0.06	15	0.22
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.19	$0.02	15	9.79
Water Heating	Water Heater	Geothermal Heat Pump	2.47	$3.53	15	0.80
Water Heating	Water Heater	Solar	2.72	$3.03	15	1.02
Food Preparation	Fryer	Standard	-	$0.00	12	-

Note: Costs and savings are per sq. ft.

Table D-4 Energy Efficiency Equipment Data — Extra Large Commercial, Existing Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Food Preparation	Fryer	Efficient	0.03	$0.00	12	6.02
Food Preparation	Oven	Standard	-	$0.00	12	-
Food Preparation	Oven	Efficient	0.85	$0.38	12	2.11
Food Preparation	Dishwasher	Standard	-	$0.00	12	-
Food Preparation	Dishwasher	Efficient	0.03	$0.04	12	0.57
Food Preparation	Hot Food Container	Standard	-	$0.00	12	-
Food Preparation	Hot Food Container	Efficient	0.17	$0.22	12	0.73
Food Preparation	Food Prep	Standard	-	$0.00	12	-
Food Preparation	Food Prep	Efficient	0.00	$0.03	12	0.15
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	-
Refrigeration	Walk in Refrigeration	Efficient	0.06	$0.05	18	1.42
Refrigeration	Glass Door Display	Standard	-	$0.00	18	-
Refrigeration	Glass Door Display	Efficient	0.04	$0.00	18	78.11
Refrigeration	Solid Door Refrigerator	Standard	-	$0.00	18	-
Refrigeration	Solid Door Refrigerator	Efficient	0.27	$0.02	18	12.81
Refrigeration	Open Display Case	Standard	-	$0.00	18	-
Refrigeration	Open Display Case	Efficient	0.01	$0.03	18	0.34
Refrigeration	Vending Machine	Base	-	$0.00	10	-
Refrigeration	Vending Machine	Base (2012)	0.13	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency	0.16	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency (2012)	0.24	$0.00	10	68.21
Refrigeration	Icemaker	Standard	-	$0.00	12	-
Refrigeration	Icemaker	Efficient	0.05	$0.00	12	17.60
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	-
Office Equipment	Desktop Computer	Energy Star	0.25	$0.00	4	32.37
Office Equipment	Desktop Computer	Climate Savers	0.35	$0.33	4	0.32
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	-
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	10.31
Office Equipment	Laptop Computer	Climate Savers	0.04	$0.10	4	0.12
Office Equipment	Server	Standard	-	$0.00	3	-
Office Equipment	Server	Energy Star	0.06	$0.00	3	3.01
Office Equipment	Monitor	Standard	-	$0.00	4	-
Office Equipment	Monitor	Energy Star	0.11	$0.01	4	6.80
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	-
Office Equipment	Printer/copier/fax	Energy Star	0.02	$0.01	6	1.38
Office Equipment	POS Terminal	Standard	-	$0.00	4	-
Office Equipment	POS Terminal	Energy Star	0.00	$0.00	4	2.01
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.00	15	-
Miscellaneous	Non-HVAC Motor	High Efficiency	0.03	$0.03	15	1.02
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.04	$0.03	15	-
Miscellaneous	Non-HVAC Motor	Premium	0.05	$0.07	15	0.76
Miscellaneous	Non-HVAC Motor	Premium (2015)	0.05	$0.07	15	-
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-5 Energy Efficiency Equipment Data — Extra Large Industrial, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	-
Cooling	Central Chiller	0.60 kw/ton, COP 5.9	1.61	$0.33	20	-
Cooling	Central Chiller	0.58 kw/ton, COP 6.1	1.82	$0.66	20	0.68
Cooling	Central Chiller	0.55 kw/Ton, COP 6.4	2.15	$0.93	20	0.94
Cooling	Central Chiller	0.51 kw/ton, COP 6.9	2.58	$1.59	20	0.80
Cooling	Central Chiller	0.50 kw/Ton, COP 7.0	2.68	$1.92	20	0.71
Cooling	Central Chiller	0.48 kw/ton, COP 7.3	2.90	$2.25	20	0.70
Cooling	Central Chiller	Variable Refrigerant Flow	3.74	$39.62	20	0.06
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.56	$0.39	16	-
Cooling	RTU	EER 11.2	1.12	$0.73	16	-
Cooling	RTU	EER 12.0	1.47	$1.22	16	0.62
Cooling	RTU	Ductless VRF	1.79	$10.83	16	0.06
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.20	$0.06	14	2.79
Cooling	PTAC	EER 10.8	0.47	$0.11	14	3.27
Cooling	PTAC	EER 11	0.55	$0.31	14	1.41
Cooling	PTAC	EER 11.5	0.75	$0.69	14	0.87
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	1.07	$0.92	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	1.69	$2.75	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	2.25	$3.66	15	0.75
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	2.47	$4.58	15	0.52
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	2.74	$26.86	20	0.08
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	7.66	$1.22	15	6.38
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.09	$0.04	4	-
Interior Lighting	Interior Screw-in	CFL	0.38	$0.02	7	14.80
Interior Lighting	Interior Screw-in	LED	0.42	$0.52	12	0.75
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.46	($0.14)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.10	($0.01)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.31	$0.08	6	1.73
Interior Lighting	Linear Fluorescent	T5	0.32	$0.14	6	1.06
Interior Lighting	Linear Fluorescent	LED	0.33	$1.21	15	0.33
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.01	$0.00	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.02	$0.00	7	15.02
Exterior Lighting	Exterior Screw-in	Metal Halides	0.02	$0.00	4	2.69
Exterior Lighting	Exterior Screw-in	LED	0.03	$0.03	12	0.77
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.07	($0.04)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.08	$0.18	9	0.37
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.00	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.00	$0.00	6	1.16
Exterior Lighting	Linear Fluorescent	T5	0.00	$0.00	6	0.71
Exterior Lighting	Linear Fluorescent	LED	0.00	$0.01	15	0.22
Process	Process Cooling/Refrigera	Standard	-	$0.00	10	-
Process	Process Cooling/Refrigera	Efficient	18.88	$5.59	10	2.49
Process	Process Heating	Standard	-	$0.00	10	-
Process	Process Heating	Efficient	6.18	$0.57	10	7.97
Process	Electrochemical Process	Standard	-	$0.00	10	-

Note: Costs and savings are per sq. ft.

Table D-5 Energy Efficiency Equipment Data — Extra Large Industrial, Existing Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Process	Electrochemical Process	Efficient	13.16	$2.64	10	3.67
Machine Drive	Less than 5 HP	Standard	-	$0.00	10	-
Machine Drive	Less than 5 HP	High Efficiency	0.05	$0.02	10	2.08
Machine Drive	Less than 5 HP	Standard (2015)	0.07	$0.00	10	-
Machine Drive	Less than 5 HP	Premium	0.07	$0.03	10	1.66
Machine Drive	Less than 5 HP	High Efficiency (2015)	0.11	$0.02	10	-
Machine Drive	Less than 5 HP	Premium (2015)	0.14	$0.03	10	-
Machine Drive	5-24 HP	Standard	-	$0.00	10	-
Machine Drive	5-24 HP	High	0.11	$0.02	10	5.09
Machine Drive	5-24 HP	Premium	0.18	$0.03	10	4.07
Machine Drive	25-99 HP	Standard	-	$0.00	10	-
Machine Drive	25-99 HP	High	0.31	$0.02	10	13.72
Machine Drive	25-99 HP	Premium	0.49	$0.03	10	10.97
Machine Drive	100-249 HP	Standard	-	$0.00	10	-
Machine Drive	100-249 HP	High	0.12	$0.02	10	5.17
Machine Drive	100-249 HP	Premium	0.15	$0.03	10	3.44
Machine Drive	250-499 HP	Standard	-	$0.00	10	-
Machine Drive	250-499 HP	High	0.35	$0.02	10	15.66
Machine Drive	250-499 HP	Premium	0.47	$0.03	10	10.44
Machine Drive	500 and more HP	Standard	-	$0.00	10	-
Machine Drive	500 and more HP	High	0.59	$0.02	10	26.28
Machine Drive	500 and more HP	Premium	0.78	$0.03	10	17.52
Miscellaneous	Miscellaneous	Miscellaneous	-	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-6 Energy Efficiency Equipment Data — Small/Medium Commercial, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	-
Cooling	Central Chiller	1.3 kw/ton, COP 2.7	0.29	$0.39	20	-
Cooling	Central Chiller	1.26 kw/ton, COP 2.8	0.35	$0.50	20	0.51
Cooling	Central Chiller	1.0 kw/ton, COP 3.5	0.73	$0.62	20	1.90
Cooling	Central Chiller	0.97 kw/ton, COP 3.6	0.77	$0.74	20	1.39
Cooling	Central Chiller	Variable Refrigerant Flow	1.01	$11.57	20	0.07
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.22	$0.18	16	-
Cooling	RTU	EER 11.2	0.43	$0.35	16	-
Cooling	RTU	EER 12.0	0.57	$0.58	16	0.49
Cooling	RTU	Ductless VRF	0.69	$5.12	16	0.05
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.09	$0.08	14	0.86
Cooling	PTAC	EER 10.8	0.21	$0.16	14	1.00
Cooling	PTAC	EER 11	0.25	$0.43	14	0.43
Cooling	PTAC	EER 11.5	0.33	$0.96	14	0.27
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	0.57	$0.39	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	0.90	$1.18	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	1.20	$1.57	15	0.98
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	1.31	$1.96	15	0.68
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	1.46	$11.50	20	0.10
Combined Heating/Cooling	Heat Pump	Geothermal Heat Pump	1.75	$20.69	20	-
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	1.64	$1.22	15	1.35
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.20	$0.09	4	-
Interior Lighting	Interior Screw-in	CFL	0.85	$0.03	7	14.85
Interior Lighting	Interior Screw-in	LED	0.93	$1.18	12	0.76
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.27	($0.07)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.27	($0.03)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.82	$0.25	6	1.56
Interior Lighting	Linear Fluorescent	T5	0.85	$0.43	6	0.95
Interior Lighting	Linear Fluorescent	LED	0.89	$3.74	15	0.30
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.13	$0.05	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.54	$0.02	7	15.84
Exterior Lighting	Exterior Screw-in	Metal Halides	0.54	$0.05	4	2.84
Exterior Lighting	Exterior Screw-in	LED	0.60	$0.64	12	0.81
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.20	($0.13)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.22	$0.55	9	0.33
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.01	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.04	$0.02	6	1.01
Exterior Lighting	Linear Fluorescent	T5	0.04	$0.03	6	0.62
Exterior Lighting	Linear Fluorescent	LED	0.04	$0.24	15	0.20
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.10	$0.02	15	5.23
Water Heating	Water Heater	Geothermal Heat Pump	1.33	$3.53	15	0.43
Water Heating	Water Heater	Solar	1.46	$3.03	15	0.55
Food Preparation	Fryer	Standard	-	$0.00	12	-
Food Preparation	Fryer	Efficient	0.03	$0.04	12	0.80

Note: Costs and savings are per sq. ft.

Table D-6 Energy Efficiency Equipment Data — Small/Medium Commercial, New Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Food Preparation	Oven	Standard	-	$0.00	12	-
Food Preparation	Oven	Efficient	0.39	$0.36	12	1.02
Food Preparation	Dishwasher	Standard	-	$0.00	12	-
Food Preparation	Dishwasher	Efficient	0.02	$0.05	12	0.36
Food Preparation	Hot Food Container	Standard	-	$0.00	12	-
Food Preparation	Hot Food Container	Efficient	0.40	$0.16	12	2.29
Food Preparation	Food Prep	Standard	-	$0.00	12	-
Food Preparation	Food Prep	Efficient	0.00	$0.03	12	0.07
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	-
Refrigeration	Walk in Refrigeration	Efficient	-	$0.09	18	-
Refrigeration	Glass Door Display	Standard	-	$0.00	18	-
Refrigeration	Glass Door Display	Efficient	0.16	$0.00	18	56.08
Refrigeration	Solid Door Refrigerator	Standard	-	$0.00	18	-
Refrigeration	Solid Door Refrigerator	Efficient	0.19	$0.02	18	9.87
Refrigeration	Open Display Case	Standard	-	$0.00	18	-
Refrigeration	Open Display Case	Efficient	0.00	$0.00	18	0.24
Refrigeration	Vending Machine	Base	-	$0.00	10	-
Refrigeration	Vending Machine	Base (2012)	0.11	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency	0.13	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency (2012)	0.20	$0.00	10	46.48
Refrigeration	Icemaker	Standard	-	$0.00	12	-
Refrigeration	Icemaker	Efficient	0.05	$0.00	12	12.76
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	-
Office Equipment	Desktop Computer	Energy Star	0.19	$0.00	4	23.04
Office Equipment	Desktop Computer	Climate Savers	0.27	$0.36	4	0.23
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	-
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	7.34
Office Equipment	Laptop Computer	Climate Savers	0.03	$0.12	4	0.08
Office Equipment	Server	Standard	-	$0.00	3	-
Office Equipment	Server	Energy Star	0.12	$0.01	3	2.14
Office Equipment	Monitor	Standard	-	$0.00	4	-
Office Equipment	Monitor	Energy Star	0.22	$0.00	4	19.68
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	-
Office Equipment	Printer/copier/fax	Energy Star	0.09	$0.04	6	0.98
Office Equipment	POS Terminal	Standard	-	$0.00	4	-
Office Equipment	POS Terminal	Energy Star	0.03	$0.00	4	2.96
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.00	15	-
Miscellaneous	Non-HVAC Motor	High Efficiency	0.05	$0.06	15	0.95
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.06	$0.06	15	-
Miscellaneous	Non-HVAC Motor	Premium	0.07	$0.11	15	0.72
Miscellaneous	Non-HVAC Motor	Premium (2015)	0.08	$0.11	15	-
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-7 Energy Efficiency Equipment Data — Large Commercial, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	-
Cooling	Central Chiller	1.3 kw/ton, COP 2.7	0.32	$0.24	20	-
Cooling	Central Chiller	1.26 kw/ton, COP 2.8	0.39	$0.31	20	0.97
Cooling	Central Chiller	1.0 kw/ton, COP 3.5	0.80	$0.38	20	3.62
Cooling	Central Chiller	0.97 kw/ton, COP 3.6	0.85	$0.45	20	2.66
Cooling	Central Chiller	Variable Refrigerant Flow	1.12	$7.06	20	0.12
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.22	$0.13	16	-
Cooling	RTU	EER 11.2	0.45	$0.25	16	-
Cooling	RTU	EER 12.0	0.59	$0.41	16	0.75
Cooling	RTU	Ductless VRF	0.72	$3.67	16	0.07
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.09	$0.09	14	0.86
Cooling	PTAC	EER 10.8	0.21	$0.17	14	1.00
Cooling	PTAC	EER 11	0.25	$0.46	14	0.43
Cooling	PTAC	EER 11.5	0.34	$1.03	14	0.27
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	0.46	$0.18	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	0.73	$0.55	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	0.97	$0.73	15	1.85
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	1.07	$0.91	15	1.28
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	1.19	$5.35	20	0.19
Combined Heating/Cooling	Heat Pump	Geothermal Heat Pump	1.42	$9.62	20	-
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	1.30	$1.22	15	1.09
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.17	$0.08	4	-
Interior Lighting	Interior Screw-in	CFL	0.71	$0.03	7	12.72
Interior Lighting	Interior Screw-in	LED	0.78	$1.11	12	0.65
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.28	($0.08)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.27	($0.03)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.80	$0.25	6	1.49
Interior Lighting	Linear Fluorescent	T5	0.83	$0.42	6	0.92
Interior Lighting	Linear Fluorescent	LED	0.87	$3.67	15	0.29
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.07	$0.01	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.31	$0.01	7	30.62
Exterior Lighting	Exterior Screw-in	Metal Halides	0.31	$0.02	4	5.49
Exterior Lighting	Exterior Screw-in	LED	0.34	$0.19	12	1.56
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.17	($0.11)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.18	$0.45	9	0.34
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.01	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.04	$0.02	6	1.06
Exterior Lighting	Linear Fluorescent	T5	0.04	$0.03	6	0.65
Exterior Lighting	Linear Fluorescent	LED	0.04	$0.24	15	0.20
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.12	$0.02	15	5.71
Water Heating	Water Heater	Geothermal Heat Pump	1.54	$3.53	15	0.46
Water Heating	Water Heater	Solar	1.69	$3.03	15	0.60
Food Preparation	Fryer	Standard	-	$0.00	12	-
Food Preparation	Fryer	Efficient	0.07	$0.02	12	3.52

Note: Costs and savings are per sq. ft.

Table D-7 Energy Efficiency Equipment Data — Large Commercial, New Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Food Preparation	Oven	Standard	-	$0.00	12	-
Food Preparation	Oven	Efficient	0.75	$0.46	12	1.43
Food Preparation	Dishwasher	Standard	-	$0.00	12	-
Food Preparation	Dishwasher	Efficient	0.07	$0.10	12	0.58
Food Preparation	Hot Food Container	Standard	-	$0.00	12	-
Food Preparation	Hot Food Container	Efficient	0.35	$0.30	12	0.99
Food Preparation	Food Prep	Standard	-	$0.00	12	-
Food Preparation	Food Prep	Efficient	0.01	$0.03	12	0.24
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	-
Refrigeration	Walk in Refrigeration	Efficient	0.15	$1.26	18	0.13
Refrigeration	Glass Door Display	Standard	-	$0.00	18	-
Refrigeration	Glass Door Display	Efficient	0.13	$0.01	18	24.96
Refrigeration	Solid Door Refrigerator	Standard	-	$0.00	18	-
Refrigeration	Solid Door Refrigerator	Efficient	0.30	$0.08	18	4.39
Refrigeration	Open Display Case	Standard	-	$0.00	18	-
Refrigeration	Open Display Case	Efficient	0.00	$0.04	18	0.16
Refrigeration	Vending Machine	Base	-	$0.00	10	-
Refrigeration	Vending Machine	Base (2012)	0.13	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency	0.15	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency (2012)	0.23	$0.00	10	20.70
Refrigeration	Icemaker	Standard	-	$0.00	12	-
Refrigeration	Icemaker	Efficient	0.11	$0.02	12	5.62
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	-
Office Equipment	Desktop Computer	Energy Star	0.35	$0.00	4	47.46
Office Equipment	Desktop Computer	Climate Savers	0.50	$0.32	4	0.46
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	-
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	15.12
Office Equipment	Laptop Computer	Climate Savers	0.04	$0.06	4	0.17
Office Equipment	Server	Standard	-	$0.00	3	-
Office Equipment	Server	Energy Star	0.13	$0.01	3	4.41
Office Equipment	Monitor	Standard	-	$0.00	4	-
Office Equipment	Monitor	Energy Star	0.19	$0.01	4	9.14
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	-
Office Equipment	Printer/copier/fax	Energy Star	0.08	$0.02	6	2.02
Office Equipment	POS Terminal	Standard	-	$0.00	4	-
Office Equipment	POS Terminal	Energy Star	0.01	$0.00	4	2.94
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.00	15	-
Miscellaneous	Non-HVAC Motor	High Efficiency	0.06	$0.06	15	0.92
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.06	$0.06	15	-
Miscellaneous	Non-HVAC Motor	Premium	0.08	$0.13	15	0.69
Miscellaneous	Non-HVAC Motor	Premium (2015)	0.09	$0.13	15	-
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-8 Energy Efficiency Equipment Data — Extra Large Commercial, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	-
Cooling	Central Chiller	0.60 kw/ton, COP 5.9	0.43	$0.09	20	-
Cooling	Central Chiller	0.58 kw/ton, COP 6.1	0.49	$0.18	20	0.66
Cooling	Central Chiller	0.55 kw/Ton, COP 6.4	0.57	$0.25	20	0.91
Cooling	Central Chiller	0.51 kw/ton, COP 6.9	0.69	$0.44	20	0.78
Cooling	Central Chiller	0.50 kw/Ton, COP 7.0	0.72	$0.53	20	0.69
Cooling	Central Chiller	0.48 kw/ton, COP 7.3	0.77	$0.62	20	0.68
Cooling	Central Chiller	Variable Refrigerant Flow	1.00	$10.92	20	0.05
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.20	$0.24	16	-
Cooling	RTU	EER 11.2	0.41	$0.44	16	-
Cooling	RTU	EER 12.0	0.53	$0.73	16	0.37
Cooling	RTU	Ductless VRF	0.65	$6.51	16	0.04
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.08	$0.06	14	1.09
Cooling	PTAC	EER 10.8	0.19	$0.12	14	1.28
Cooling	PTAC	EER 11	0.22	$0.32	14	0.55
Cooling	PTAC	EER 11.5	0.30	$0.71	14	0.34
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	0.50	$0.24	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	0.79	$0.73	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	1.06	$0.97	15	1.34
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	1.16	$1.21	15	0.93
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	1.29	$7.10	20	0.14
Combined Heating/Cooling	Heat Pump	Geothermal Heat Pump	1.55	$12.77	20	-
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	1.52	$1.22	15	1.27
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.27	$0.14	4	-
Interior Lighting	Interior Screw-in	CFL	1.13	$0.06	7	11.90
Interior Lighting	Interior Screw-in	LED	1.24	$1.90	12	0.61
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.11	($0.05)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.18	($0.03)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.53	$0.21	6	1.18
Interior Lighting	Linear Fluorescent	T5	0.55	$0.35	6	0.72
Interior Lighting	Linear Fluorescent	LED	0.58	$3.08	15	0.23
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.02	$0.00	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.09	$0.00	7	33.30
Exterior Lighting	Exterior Screw-in	Metal Halides	0.09	$0.00	4	5.97
Exterior Lighting	Exterior Screw-in	LED	0.10	$0.05	12	1.70
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.24	($0.16)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.25	$0.64	9	0.33
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.00	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.01	$0.00	6	1.01
Exterior Lighting	Linear Fluorescent	T5	0.01	$0.01	6	0.62
Exterior Lighting	Linear Fluorescent	LED	0.01	$0.06	15	0.19
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.19	$0.02	15	9.79
Water Heating	Water Heater	Geothermal Heat Pump	2.47	$3.53	15	0.80
Water Heating	Water Heater	Solar	2.72	$3.03	15	1.02

Note: Costs and savings are per sq. ft.

Table D-9 Energy Efficiency Equipment Data — Extra Large Commercial, New Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Food Preparation	Fryer	Standard	-	$0.00	12	-
Food Preparation	Fryer	Efficient	0.03	$0.00	12	6.02
Food Preparation	Oven	Standard	-	$0.00	12	-
Food Preparation	Oven	Efficient	0.85	$0.38	12	2.11
Food Preparation	Dishwasher	Standard	-	$0.00	12	-
Food Preparation	Dishwasher	Efficient	0.03	$0.04	12	0.57
Food Preparation	Hot Food Container	Standard	-	$0.00	12	-
Food Preparation	Hot Food Container	Efficient	0.17	$0.22	12	0.73
Food Preparation	Food Prep	Standard	-	$0.00	12	-
Food Preparation	Food Prep	Efficient	0.00	$0.03	12	0.15
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	-
Refrigeration	Walk in Refrigeration	Efficient	0.06	$0.05	18	1.42
Refrigeration	Glass Door Display	Standard	-	$0.00	18	-
Refrigeration	Glass Door Display	Efficient	0.04	$0.00	18	78.11
Refrigeration	Solid Door Refrigerator	Standard	-	$0.00	18	-
Refrigeration	Solid Door Refrigerator	Efficient	0.27	$0.02	18	13.75
Refrigeration	Open Display Case	Standard	-	$0.00	18	-
Refrigeration	Open Display Case	Efficient	0.01	$0.03	18	0.34
Refrigeration	Vending Machine	Base	-	$0.00	10	-
Refrigeration	Vending Machine	Base (2012)	0.13	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency	0.16	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency (2012)	0.24	$0.00	10	68.21
Refrigeration	Icemaker	Standard	-	$0.00	12	-
Refrigeration	Icemaker	Efficient	0.05	$0.00	12	17.60
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	-
Office Equipment	Desktop Computer	Energy Star	0.25	$0.00	4	32.37
Office Equipment	Desktop Computer	Climate Savers	0.35	$0.33	4	0.32
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	-
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	10.31
Office Equipment	Laptop Computer	Climate Savers	0.04	$0.10	4	0.12
Office Equipment	Server	Standard	-	$0.00	3	-
Office Equipment	Server	Energy Star	0.06	$0.00	3	3.01
Office Equipment	Monitor	Standard	-	$0.00	4	-
Office Equipment	Monitor	Energy Star	0.11	$0.01	4	6.80
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	-
Office Equipment	Printer/copier/fax	Energy Star	0.02	$0.01	6	1.38
Office Equipment	POS Terminal	Standard	-	$0.00	4	-
Office Equipment	POS Terminal	Energy Star	0.00	$0.00	4	2.01
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.00	15	-
Miscellaneous	Non-HVAC Motor	High Efficiency	0.03	$0.03	15	1.02
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.04	$0.03	15	-
Miscellaneous	Non-HVAC Motor	Premium	0.05	$0.07	15	0.76
Miscellaneous	Non-HVAC Motor	Premium (2015)	0.05	$0.07	15	-
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-9 Energy Efficiency Equipment Data — Extra Large Industrial, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	-
Cooling	Central Chiller	0.60 kw/ton, COP 5.9	1.61	$0.33	20	-
Cooling	Central Chiller	0.58 kw/ton, COP 6.1	1.82	$0.66	20	0.68
Cooling	Central Chiller	0.55 kw/Ton, COP 6.4	2.15	$0.93	20	0.94
Cooling	Central Chiller	0.51 kw/ton, COP 6.9	2.58	$1.59	20	0.80
Cooling	Central Chiller	0.50 kw/Ton, COP 7.0	2.68	$1.92	20	0.71
Cooling	Central Chiller	0.48 kw/ton, COP 7.3	2.90	$2.25	20	0.70
Cooling	Central Chiller	Variable Refrigerant Flow	3.74	$39.62	20	0.06
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.56	$0.39	16	-
Cooling	RTU	EER 11.2	1.12	$0.74	16	-
Cooling	RTU	EER 12.0	1.47	$1.23	16	0.62
Cooling	RTU	Ductless VRF	1.79	$10.88	16	0.06
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.20	$0.06	14	2.79
Cooling	PTAC	EER 10.8	0.47	$0.11	14	3.27
Cooling	PTAC	EER 11	0.55	$0.31	14	1.41
Cooling	PTAC	EER 11.5	0.75	$0.69	14	0.87
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	1.07	$0.92	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	1.69	$2.75	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	2.25	$3.66	15	0.75
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	2.47	$4.58	15	0.52
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	2.74	$26.86	20	0.08
Combined Heating/Cooling	Heat Pump	Geothermal Heat Pump	3.29	$48.32	20	-
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	9.66	$1.22	15	8.05
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.08	$0.04	4	-
Interior Lighting	Interior Screw-in	CFL	0.34	$0.02	7	13.32
Interior Lighting	Interior Screw-in	LED	0.38	$0.52	12	0.68
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.41	($0.14)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.09	($0.01)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.28	$0.08	6	1.56
Interior Lighting	Linear Fluorescent	T5	0.29	$0.14	6	0.96
Interior Lighting	Linear Fluorescent	LED	0.30	$1.21	15	0.30
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.01	$0.00	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.02	$0.00	7	13.52
Exterior Lighting	Exterior Screw-in	Metal Halides	0.02	$0.00	4	2.42
Exterior Lighting	Exterior Screw-in	LED	0.02	$0.03	12	0.69
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.07	($0.04)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.07	$0.18	9	0.33
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.00	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.00	$0.00	6	1.05
Exterior Lighting	Linear Fluorescent	T5	0.00	$0.00	6	0.64
Exterior Lighting	Linear Fluorescent	LED	0.00	$0.01	15	0.20
Process	Process Cooling/Refrigera	Standard	-	$0.00	10	-
Process	Process Cooling/Refrigera	Efficient	18.88	$5.59	10	2.49
Process	Process Heating	Standard	-	$0.00	10	-
Process	Process Heating	Efficient	6.18	$0.57	10	7.97

Note: Costs and savings are per sq. ft.

Table D-9 Energy Efficiency Equipment Data — Extra Large Industrial, New Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Process	Electrochemical Process	Standard	-	$0.00	10	-
Process	Electrochemical Process	Efficient	13.16	$2.64	10	3.67
Machine Drive	Less than 5 HP	Standard	-	$0.00	10	-
Machine Drive	Less than 5 HP	High Efficiency	0.05	$0.02	10	2.08
Machine Drive	Less than 5 HP	Standard (2015)	0.07	$0.00	10	-
Machine Drive	Less than 5 HP	Premium	0.07	$0.03	10	1.66
Machine Drive	Less than 5 HP	High Efficiency (2015)	0.11	$0.02	10	-
Machine Drive	Less than 5 HP	Premium (2015)	0.14	$0.03	10	-
Machine Drive	5-24 HP	Standard	-	$0.00	10	-
Machine Drive	5-24 HP	High	0.11	$0.02	10	5.09
Machine Drive	5-24 HP	Premium	0.18	$0.03	10	4.07
Machine Drive	25-99 HP	Standard	-	$0.00	10	-
Machine Drive	25-99 HP	High	0.31	$0.02	10	13.72
Machine Drive	25-99 HP	Premium	0.49	$0.03	10	10.97
Machine Drive	100-249 HP	Standard	-	$0.00	10	-
Machine Drive	100-249 HP	High	0.12	$0.02	10	5.17
Machine Drive	100-249 HP	Premium	0.15	$0.03	10	3.44
Machine Drive	250-499 HP	Standard	-	$0.00	10	-
Machine Drive	250-499 HP	High	0.35	$0.02	10	15.66
Machine Drive	250-499 HP	Premium	0.47	$0.03	10	10.44
Machine Drive	500 and more HP	Standard	-	$0.00	10	-
Machine Drive	500 and more HP	High	0.59	$0.02	10	26.28
Machine Drive	500 and more HP	Premium	0.78	$0.03	10	17.52
Miscellaneous	Miscellaneous	Miscellaneous	-	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-10 Energy Efficiency Measure Data — Small/Med. Comm., Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
RTU - Maintenance	Cooling	14%	0%	14%	90%	$0.08	4	0.75
RTU - Evaporative Precooler	Cooling	10%	0%	0%	0%	$0.88	15	0.20
Chiller - Chilled Water Reset	Cooling	14%	0%	0%	0%	$0.86	4	0.08
Chiller - Chilled Water Variable-Flow System	Cooling	5%	0%	0%	0%	$0.86	10	0.07
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	0%	$0.90	20	0.70
Chiller - VSD	Cooling	27%	0%	0%	0%	$1.17	20	0.48
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	0%	0%	$0.04	10	0.01
Chiller - Condenser Water Temprature Reset	Cooling	10%	0%	0%	0%	$0.87	14	0.18
Cooling - Economizer Installation	Cooling	6%	0%	45%	49%	$0.15	15	0.71
Heat Pump - Maintenance	Combined Heating/Cooling	7%	7%	10%	95%	$0.03	4	5.00
Insulation - Ducting	Cooling	6%	0%	9%	50%	$0.41	20	0.71
Insulation - Ducting	Space Heating	3%	1%	9%	50%	$0.41	20	0.71
Repair and Sealing - Ducting	Cooling	2%	0%	5%	25%	$0.38	15	0.45
Repair and Sealing - Ducting	Space Heating	2%	1%	5%	25%	$0.38	15	0.45
Energy Management System	Cooling	6%	0%	24%	75%	$0.35	14	0.72
Energy Management System	Space Heating	5%	3%	24%	75%	$0.35	14	0.72
Energy Management System	Interior Lighting	2%	1%	24%	75%	$0.35	14	0.72
Cooking - Exhaust Hoods with Sensor Control	Ventilation	25%	13%	1%	15%	$0.04	10	7.36
Fans - Energy Efficient Motors	Ventilation	5%	5%	11%	90%	$0.05	10	1.38
Fans - Variable Speed Control	Ventilation	15%	5%	8%	90%	$0.20	10	0.89
Retrocommissioning - HVAC	Cooling	9%	0%	15%	90%	$0.60	4	0.50
Retrocommissioning - HVAC	Space Heating	9%	6%	15%	90%	$0.60	4	0.50
Retrocommissioning - HVAC	Ventilation	9%	6%	15%	90%	$0.60	4	0.50
Pumps - Variable Speed Control	Miscellaneous	1%	0%	0%	34%	$0.44	10	1.01
Thermostat - Clock/Programmable	Cooling	5%	0%	34%	50%	$0.13	11	1.12
Thermostat - Clock/Programmable	Space Heating	5%	1%	34%	50%	$0.13	11	1.12
Insulation - Ceiling	Cooling	2%	0%	10%	18%	$0.64	20	0.70
Insulation - Ceiling	Space Heating	17%	4%	10%	18%	$0.64	20	0.70
Insulation - Radiant Barrier	Cooling	3%	0%	7%	13%	$0.26	20	0.81
Insulation - Radiant Barrier	Space Heating	5%	2%	7%	13%	$0.26	20	0.81
Roofs - High Reflectivity	Cooling	15%	0%	2%	95%	$0.18	15	1.47
Windows - High Efficiency	Cooling	5%	0%	61%	75%	$0.44	20	0.63
Windows - High Efficiency	Space Heating	3%	2%	61%	75%	$0.44	20	0.63
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	81%	90%	$0.65	8	0.34
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	Interior Lighting	25%	13%	1%	45%	$0.50	8	0.90
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	2%	50%	$0.11	8	1.36
Interior Fluorescent - Delamp and Install Reflectors	Interior Lighting	20%	10%	18%	25%	$0.50	11	0.97
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	Interior Lighting	10%	5%	10%	23%	$0.50	8	0.36
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	23%	$0.70	11	1.73
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	7%	45%	$0.20	8	1.11
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.26
Interior Screw-in - Task Lighting	Interior Lighting	7%	4%	25%	75%	$0.24	5	0.09
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	9%	56%	$0.20	8	0.56
Water Heater - Faucet Aerators/Low Flow Nozzles	Water Heating	4%	1%	8%	90%	$0.01	9	4.28
Water Heater - Pipe Insulation	Water Heating	6%	3%	46%	50%	$0.28	15	0.37
Water Heater - High Efficiency Circulation Pump	Water Heating	5%	4%	0%	0%	$0.11	10	0.64
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	40%	50%	$0.02	10	5.87
Water Heater - Thermostat Setback	Water Heating	4%	2%	5%	75%	$0.11	10	0.47
Water Heater - Hot Water Saver	Water Heating	5%	1%	0%	0%	$0.02	5	1.56
Refrigeration - Anti-Sweat Heater/Auto Door Closer	Refrigeration	5%	3%	0%	75%	$0.20	16	1.10
Refrigeration - Floating Head Pressure	Refrigeration	7%	4%	18%	38%	$0.35	16	1.25
Refrigeration - Door Gasket Replacement	Refrigeration	4%	2%	5%	75%	$0.10	8	0.10
Insulation - Bare Suction Lines	Refrigeration	3%	2%	5%	75%	$0.10	8	0.21
Refrigeration - Night Covers	Refrigeration	6%	3%	5%	75%	$0.05	8	1.02
Refrigeration - Strip Curtain	Refrigeration	4%	2%	5%	56%	$0.02	8	0.00
Retrocommissioning - Comprehensive	Cooling	12%	0%	40%	90%	$0.70	4	0.71
Retrocommissioning - Comprehensive	Space Heating	12%	9%	40%	90%	$0.70	4	0.71
Retrocommissioning - Comprehensive	Interior Lighting	12%	9%	40%	90%	$0.70	4	0.71
Office Equipment - Energy Star Power Supply	Office Equipment	1%	1%	10%	95%	$0.00	7	61.20
Vending Machine - Controller	Refrigeration	15%	11%	2%	10%	$0.27	10	1.09
LED Exit Lighting	Interior Lighting	2%	2%	9%	86%	$0.00	10	12.75
Retrocommissioning - Lighting	Interior Lighting	9%	6%	5%	90%	$0.10	5	1.59
Retrocommissioning - Lighting	Exterior Lighting	9%	6%	5%	90%	$0.10	5	1.59
Refrigeration - High Efficiency Case Lighting	Refrigeration	4%	2%	5%	75%	$0.20	8	0.00
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	1.37
Exterior Lighting - Induction Lamps	Exterior Lighting	3%	3%	5%	56%	$0.00	5	8.10
Laundry - High Efficiency Clothes Washer	Miscellaneous	0%	0%	5%	10%	$0.00	10	36.95
Interior Lighting - Hotel Guestroom Controls	Interior Lighting	10%	5%	0%	0%	$0.14	8	0.33
Miscellaneous - Energy Star Water Cooler	Miscellaneous	0%	0%	5%	95%	$0.00	8	1.95
Industrial Process Improvements	Miscellaneous	10%	8%	0%	23%	$0.52	10	1.16
Custom Measures	Cooling	10%	0%	10%	45%	$1.50	15	0.59
Custom Measures	Space Heating	10%	8%	10%	45%	$1.50	15	0.59
Custom Measures	Interior Lighting	10%	6%	10%	45%	$1.50	15	0.59
Custom Measures	Food Preparation	10%	7%	10%	45%	$1.50	15	0.59
Custom Measures	Refrigeration	10%	5%	10%	45%	$1.50	15	0.59
Water Heater - Heat Pump	Water Heating	30%	15%	0%	19%	$0.80	15	0.69
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$4.00	15	0.54
Furnace - Convert to Gas	Space Heating	100%	100%	0%	47%	$8.04	15	1.08

Note: Costs are per sq. ft.

Table D-11 Energy Efficiency Measure Data — Large Commercial, Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
RTU - Maintenance	Cooling	14%	0%	27%	90%	$0.06	4	1.30
RTU - Evaporative Precooler	Cooling	10%	0%	0%	0%	$0.88	15	0.21
Chiller - Chilled Water Reset	Cooling	19%	0%	15%	75%	$0.18	4	0.50
Chiller - Chilled Water Variable-Flow System	Cooling	5%	0%	30%	34%	$0.18	10	0.31
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	66%	$0.90	20	0.64
Chiller - VSD	Cooling	32%	0%	15%	66%	$1.17	20	0.52
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	15%	41%	$0.04	10	0.01
Chiller - Condenser Water Temprature Reset	Cooling	9%	0%	5%	75%	$0.18	14	0.76
Cooling - Economizer Installation	Cooling	11%	0%	44%	49%	$0.15	15	1.29
Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	10%	95%	$0.06	4	3.04
Insulation - Ducting	Cooling	3%	0%	8%	50%	$0.41	20	0.52
Insulation - Ducting	Space Heating	3%	1%	8%	50%	$0.41	20	0.52
Repair and Sealing - Ducting	Cooling	2%	0%	5%	25%	$0.38	15	0.43
Repair and Sealing - Ducting	Space Heating	2%	1%	5%	25%	$0.38	15	0.43
Energy Management System	Cooling	23%	0%	37%	90%	$0.35	14	2.63
Energy Management System	Space Heating	18%	12%	37%	90%	$0.35	14	2.63
Energy Management System	Interior Lighting	9%	6%	37%	90%	$0.35	14	2.63
Cooking - Exhaust Hoods with Sensor Control	Ventilation	13%	7%	1%	11%	$0.04	10	2.97
Fans - Energy Efficient Motors	Ventilation	5%	5%	11%	90%	$0.05	10	1.11
Fans - Variable Speed Control	Ventilation	15%	5%	2%	90%	$0.20	10	0.71
Retrocommissioning - HVAC	Cooling	12%	0%	15%	90%	$0.30	4	0.72
Retrocommissioning - HVAC	Space Heating	12%	9%	15%	90%	$0.30	4	0.72
Retrocommissioning - HVAC	Ventilation	9%	6%	15%	90%	$0.30	4	0.72
Pumps - Variable Speed Control	Miscellaneous	1%	0%	0%	34%	$0.13	10	1.05
Thermostat - Clock/Programmable	Cooling	5%	0%	33%	50%	$0.13	11	1.02
Thermostat - Clock/Programmable	Space Heating	5%	1%	33%	50%	$0.13	11	1.02
Insulation - Ceiling	Cooling	1%	0%	9%	30%	$0.85	20	0.45
Insulation - Ceiling	Space Heating	12%	3%	9%	30%	$0.85	20	0.45
Insulation - Radiant Barrier	Cooling	2%	0%	7%	13%	$0.26	20	0.64
Insulation - Radiant Barrier	Space Heating	5%	2%	7%	13%	$0.26	20	0.64
Roofs - High Reflectivity	Cooling	5%	0%	2%	75%	$0.08	15	1.08
Windows - High Efficiency	Cooling	12%	0%	72%	75%	$0.88	20	0.74
Windows - High Efficiency	Space Heating	11%	8%	72%	75%	$0.88	20	0.74
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	86%	90%	$0.65	8	0.34
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	Interior Lighting	25%	13%	1%	45%	$0.45	8	0.96
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	2%	13%	$0.29	8	0.42
Interior Fluorescent - Delamp and Install Reflectors	Interior Lighting	30%	15%	17%	38%	$0.50	11	1.40
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	Interior Lighting	10%	5%	10%	23%	$0.40	8	0.43
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	23%	$0.63	11	1.85
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	13%	45%	$0.20	8	1.10
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.21
Interior Screw-in - Task Lighting	Interior Lighting	10%	5%	10%	75%	$0.24	5	0.13
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	9%	56%	$0.20	8	0.55
Water Heater - Faucet Aerators/Low Flow Nozzles	Water Heating	4%	1%	3%	90%	$0.03	9	1.62
Water Heater - Pipe Insulation	Water Heating	6%	3%	0%	0%	$0.28	15	0.42
Water Heater - High Efficiency Circulation Pump	Water Heating	5%	4%	0%	23%	$0.11	10	0.70
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$0.04	10	3.28
Water Heater - Thermostat Setback	Water Heating	4%	2%	0%	0%	$0.11	10	0.52
Water Heater - Hot Water Saver	Water Heating	5%	1%	0%	3%	$0.04	5	0.88
Refrigeration - Anti-Sweat Heater/Auto Door Closer	Refrigeration	5%	3%	0%	75%	$0.20	16	0.58
Refrigeration - Floating Head Pressure	Refrigeration	7%	4%	38%	45%	$0.35	16	0.95
Refrigeration - Door Gasket Replacement	Refrigeration	4%	2%	5%	75%	$0.10	8	0.65
Insulation - Bare Suction Lines	Refrigeration	3%	2%	5%	75%	$0.10	8	0.37
Refrigeration - Night Covers	Refrigeration	6%	3%	5%	75%	$0.05	8	0.65
Refrigeration - Strip Curtain	Refrigeration	4%	2%	5%	56%	$0.02	8	0.96
Retrocommissioning - Comprehensive	Cooling	12%	0%	40%	90%	$0.35	4	1.06
Retrocommissioning - Comprehensive	Space Heating	12%	9%	40%	90%	$0.35	4	1.06
Retrocommissioning - Comprehensive	Interior Lighting	12%	9%	40%	90%	$0.35	4	1.06
Office Equipment - Energy Star Power Supply	Office Equipment	1%	1%	10%	95%	$0.00	7	68.11
Vending Machine - Controller	Refrigeration	15%	11%	2%	10%	$0.27	10	1.11
LED Exit Lighting	Interior Lighting	2%	2%	9%	86%	$0.00	10	12.29
Retrocommissioning - Lighting	Interior Lighting	9%	6%	5%	90%	$0.05	5	3.07
Retrocommissioning - Lighting	Exterior Lighting	9%	6%	5%	90%	$0.05	5	3.07
Refrigeration - High Efficiency Case Lighting	Refrigeration	4%	2%	5%	75%	$0.20	8	0.52
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	1.14
Exterior Lighting - Induction Lamps	Exterior Lighting	3%	3%	5%	56%	$0.00	5	6.50
Laundry - High Efficiency Clothes Washer	Miscellaneous	0%	0%	5%	10%	$0.00	10	33.94
Interior Lighting - Hotel Guestroom Controls	Interior Lighting	10%	5%	1%	2%	$0.14	8	0.32
Miscellaneous - Energy Star Water Cooler	Miscellaneous	0%	0%	5%	95%	$0.00	8	1.78
Industrial Process Improvements	Miscellaneous	10%	8%	0%	5%	$0.52	10	1.18
Custom Measures	Cooling	10%	0%	10%	45%	$0.90	15	0.99
Custom Measures	Space Heating	10%	8%	10%	45%	$0.90	15	0.99
Custom Measures	Interior Lighting	10%	8%	10%	45%	$0.90	15	0.99
Custom Measures	Food Preparation	10%	8%	10%	45%	$0.90	15	0.99
Custom Measures	Refrigeration	10%	8%	10%	45%	$0.90	15	0.99
Water Heater - Heat Pump	Water Heating	30%	15%	0%	28%	$0.80	15	0.77
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	0%	$4.00	15	0.59
Furnace - Convert to Gas	Space Heating	100%	100%	0%	0%	$6.00	15	1.04

Note: Costs are per sq. ft.

Table D-12 Energy Efficiency Measure Data — Extra Large Comm., Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
RTU - Maintenance	Cooling	14%	0%	47%	90%	$0.06	4	1.15
RTU - Evaporative Precooler	Cooling	10%	0%	0%	0%	$0.88	15	0.19
Chiller - Chilled Water Reset	Cooling	15%	0%	30%	75%	$0.09	4	0.79
Chiller - Chilled Water Variable-Flow System	Cooling	8%	0%	30%	34%	$0.09	10	1.00
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	75%	$0.90	20	0.66
Chiller - VSD	Cooling	28%	0%	3%	75%	$1.17	20	0.47
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	25%	37%	$0.04	10	0.01
Chiller - Condenser Water Temprature Reset	Cooling	9%	0%	0%	75%	$0.09	14	1.49
Cooling - Economizer Installation	Cooling	11%	0%	73%	81%	$0.15	15	1.20
Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	5%	95%	$0.06	4	2.91
Insulation - Ducting	Cooling	8%	0%	2%	50%	$0.41	20	0.77
Insulation - Ducting	Space Heating	3%	1%	2%	50%	$0.41	20	0.77
Repair and Sealing - Ducting	Cooling	5%	0%	5%	25%	$0.38	15	0.65
Repair and Sealing - Ducting	Space Heating	5%	3%	5%	25%	$0.38	15	0.65
Energy Management System	Cooling	12%	0%	80%	90%	$0.35	14	1.21
Energy Management System	Space Heating	9%	6%	80%	90%	$0.35	14	1.21
Energy Management System	Interior Lighting	5%	3%	80%	90%	$0.35	14	1.21
Cooking - Exhaust Hoods with Sensor Control	Ventilation	13%	7%	1%	8%	$0.04	10	3.46
Fans - Energy Efficient Motors	Ventilation	5%	5%	11%	90%	$0.05	10	1.30
Fans - Variable Speed Control	Ventilation	15%	5%	2%	90%	$0.20	10	0.83
Retrocommissioning - HVAC	Cooling	12%	0%	15%	90%	$0.20	4	1.00
Retrocommissioning - HVAC	Space Heating	12%	9%	15%	90%	$0.20	4	1.00
Retrocommissioning - HVAC	Ventilation	9%	6%	15%	90%	$0.20	4	1.00
Pumps - Variable Speed Control	Miscellaneous	1%	0%	1%	34%	$0.44	10	1.01
Thermostat - Clock/Programmable	Cooling	3%	0%	25%	50%	$0.13	11	0.69
Thermostat - Clock/Programmable	Space Heating	3%	1%	25%	50%	$0.13	11	0.69
Insulation - Ceiling	Cooling	1%	0%	2%	9%	$0.85	20	0.48
Insulation - Ceiling	Space Heating	12%	3%	2%	9%	$0.85	20	0.48
Insulation - Radiant Barrier	Cooling	1%	0%	2%	13%	$0.26	20	0.57
Insulation - Radiant Barrier	Space Heating	4%	2%	2%	13%	$0.26	20	0.57
Roofs - High Reflectivity	Cooling	10%	0%	0%	95%	$0.18	15	0.90
Windows - High Efficiency	Cooling	6%	0%	95%	100%	$2.10	20	0.37
Windows - High Efficiency	Space Heating	2%	2%	95%	100%	$2.10	20	0.37
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	78%	90%	$0.65	8	0.26
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	Interior Lighting	25%	13%	3%	45%	$0.40	8	0.72
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	2%	10%	$0.29	8	0.45
Interior Fluorescent - Delamp and Install Reflectors	Interior Lighting	30%	15%	3%	25%	$0.50	11	0.93
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	Interior Lighting	10%	5%	10%	23%	$0.20	8	0.57
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	23%	$0.56	11	1.38
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	42%	45%	$0.20	8	0.84
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.23
Interior Screw-in - Task Lighting	Interior Lighting	10%	5%	5%	75%	$0.24	5	0.18
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	12%	56%	$0.20	8	0.42
Water Heater - Faucet Aerators/Low Flow Nozzles	Water Heating	4%	1%	2%	90%	$0.03	9	2.66
Water Heater - Pipe Insulation	Water Heating	6%	3%	0%	0%	$0.28	15	0.70
Water Heater - High Efficiency Circulation Pump	Water Heating	5%	4%	0%	23%	$0.11	10	1.19
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$0.04	10	5.48
Water Heater - Thermostat Setback	Water Heating	4%	0%	0%	0%	$0.11	10	0.72
Water Heater - Hot Water Saver	Water Heating	5%	1%	0%	0%	$0.04	5	1.45
Refrigeration - Anti-Sweat Heater/Auto Door Closer	Refrigeration	5%	3%	10%	75%	$0.20	16	0.02
Refrigeration - Floating Head Pressure	Refrigeration	7%	4%	10%	38%	$0.35	16	0.34
Refrigeration - Door Gasket Replacement	Refrigeration	4%	2%	5%	75%	$0.10	8	0.13
Insulation - Bare Suction Lines	Refrigeration	3%	2%	5%	75%	$0.10	8	0.28
Refrigeration - Night Covers	Refrigeration	6%	3%	5%	75%	$0.05	8	0.29
Refrigeration - Strip Curtain	Refrigeration	4%	2%	5%	56%	$0.02	8	0.18
Retrocommissioning - Comprehensive	Cooling	12%	0%	40%	90%	$0.25	4	1.21
Retrocommissioning - Comprehensive	Space Heating	12%	9%	40%	90%	$0.25	4	1.21
Retrocommissioning - Comprehensive	Interior Lighting	12%	9%	40%	90%	$0.25	4	1.21
Office Equipment - Energy Star Power Supply	Office Equipment	1%	1%	10%	95%	$0.00	7	39.11
Vending Machine - Controller	Refrigeration	15%	11%	2%	10%	$0.27	10	1.12
LED Exit Lighting	Interior Lighting	2%	2%	9%	86%	$0.00	10	18.34
Retrocommissioning - Lighting	Interior Lighting	9%	6%	5%	90%	$0.05	5	2.54
Retrocommissioning - Lighting	Exterior Lighting	9%	6%	5%	90%	$0.05	5	2.54
Refrigeration - High Efficiency Case Lighting	Refrigeration	4%	2%	5%	75%	$0.20	8	0.04
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	1.61
Exterior Lighting - Induction Lamps	Exterior Lighting	3%	3%	5%	56%	$0.00	5	6.95
Laundry - High Efficiency Clothes Washer	Miscellaneous	0%	0%	5%	10%	$0.00	10	20.31
Interior Lighting - Hotel Guestroom Controls	Interior Lighting	10%	5%	0%	0%	$0.14	8	0.47
Miscellaneous - Energy Star Water Cooler	Miscellaneous	0%	0%	5%	95%	$0.00	8	1.07
Industrial Process Improvements	Miscellaneous	10%	8%	0%	0%	$0.52	10	1.11
Custom Measures	Cooling	10%	0%	10%	45%	$0.67	15	1.09
Custom Measures	Space Heating	10%	8%	10%	45%	$0.67	15	1.09
Custom Measures	Interior Lighting	10%	8%	10%	45%	$0.67	15	1.09
Custom Measures	Food Preparation	10%	8%	10%	45%	$0.67	15	1.09
Custom Measures	Refrigeration	10%	8%	10%	45%	$0.67	15	1.09
Water Heater - Heat Pump	Water Heating	30%	15%	0%	41%	$0.80	15	1.28
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	0%	$4.00	15	1.00
Furnace - Convert to Gas	Space Heating	100%	100%	0%	0%	$4.00	15	1.66

Note: Costs are per sq. ft.

Table D-13 Energy Efficiency Measure Data — Extra Large Industrial, Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Refrigeration - System Controls	Process	11%	8%	5%	34%	$0.40	10	18.09
Refrigeration - System Maintenance	Process	3%	2%	5%	34%	$0.00	10	2,067.93
Refrigeration - System Optimization	Process	15%	11%	5%	34%	$0.80	10	12.92
Motors - Variable Frequency Drive	Machine Drive	13%	9%	25%	38%	$0.10	10	3.38
Motors - Magnetic Adjustable Speed Drives	Machine Drive	13%	9%	25%	38%	$0.10	10	3.38
Compressed Air - System Controls	Machine Drive	9%	7%	5%	34%	$0.40	10	0.59
Compressed Air - System Optimization and Improvements	Machine Drive	13%	9%	5%	34%	$0.80	10	0.42
Compressed Air - System Maintenance	Machine Drive	3%	2%	5%	34%	$0.20	10	0.34
Compressed Air - Compressor Replacement	Machine Drive	5%	4%	5%	34%	$0.20	10	0.68
Fan System - Controls	Machine Drive	4%	3%	10%	38%	$0.35	10	0.11
Fan System - Controls	Machine Drive	4%	3%	10%	38%	$0.35	10	0.11
Fan System - Optimization	Machine Drive	6%	5%	10%	38%	$0.70	10	0.08
Fan System - Optimization	Machine Drive	6%	5%	10%	38%	$0.70	10	0.08
Fan System - Maintenance	Machine Drive	1%	1%	10%	38%	$0.15	10	0.07
Fan System - Maintenance	Machine Drive	1%	1%	10%	38%	$0.15	10	0.07
Pumping System - Controls	Machine Drive	5%	4%	5%	34%	$0.38	12	0.43
Pumping System - Optimization	Machine Drive	13%	9%	5%	34%	$0.75	12	0.54
Pumping System - Maintenance	Machine Drive	2%	1%	5%	34%	$0.19	10	0.27
RTU - Maintenance	Cooling	14%	0%	22%	90%	$0.06	4	3.18
Chiller - Chilled Water Reset	Cooling	14%	0%	30%	75%	$0.09	4	2.69
Chiller - Chilled Water Variable-Flow System	Cooling	5%	0%	30%	34%	$0.20	10	1.05
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	67%	$0.90	20	2.48
Chiller - VSD	Cooling	26%	0%	15%	67%	$1.17	20	1.68
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	25%	50%	$0.04	10	0.03
Chiller - Condenser Water Temprature Reset	Cooling	10%	0%	0%	75%	$0.20	14	2.72
Cooling - Economizer Installation	Cooling	6%	0%	29%	34%	$0.15	15	2.02
Heat Pump - Maintenance	Combined Heating/Cooling	7%	7%	2%	95%	$0.03	4	8.67
Insulation - Ducting	Space Heating	6%	6%	12%	50%	$0.41	20	1.01
Insulation - Ducting	Cooling	3%	0%	12%	50%	$0.41	20	1.01
Repair and Sealing - Ducting	Cooling	2%	0%	5%	25%	$0.38	15	0.63
Repair and Sealing - Ducting	Space Heating	2%	1%	5%	25%	$0.38	15	0.63
Energy Management System	Cooling	6%	0%	11%	90%	$0.35	14	1.09
Energy Management System	Space Heating	5%	3%	11%	90%	$0.35	14	1.09
Energy Management System	Interior Lighting	2%	1%	11%	90%	$0.35	14	1.09
Fans - Energy Efficient Motors	Ventilation	5%	5%	2%	90%	$0.14	10	2.94
Fans - Variable Speed Control	Ventilation	15%	5%	3%	90%	$0.20	10	5.29
Retrocommissioning - HVAC	Cooling	12%	0%	1%	70%	$0.25	4	1.54
Retrocommissioning - HVAC	Space Heating	12%	9%	1%	70%	$0.25	4	1.54
Retrocommissioning - HVAC	Ventilation	9%	6%	1%	70%	$0.25	4	1.54
Pumps - Variable Speed Control	Machine Drive	5%	4%	0%	34%	$0.44	10	0.31
Thermostat - Clock/Programmable	Cooling	5%	0%	59%	70%	$0.13	11	2.11
Thermostat - Clock/Programmable	Space Heating	5%	1%	59%	70%	$0.13	11	2.11
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	84%	90%	$0.65	8	0.17
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	2%	27%	$0.08	8	0.46
Interior Fluorescent - Delamp and Install Reflectors	Interior Lighting	20%	10%	17%	38%	$0.50	11	0.31
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	38%	$0.20	11	1.95
LED Exit Lighting	Interior Lighting	2%	2%	9%	86%	$0.00	10	4.00
Retrocommissioning - Lighting	Interior Lighting	9%	6%	9%	70%	$0.05	5	1.44
Retrocommissioning - Lighting	Exterior Lighting	9%	6%	9%	70%	$0.05	5	1.44
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	15%	45%	$0.20	8	0.55
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.07
Interior Screw-in - Task Lighting	Interior Lighting	7%	4%	10%	75%	$0.24	5	0.03
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	2%	56%	$0.20	8	0.27
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	0.46
Custom Measures	Cooling	10%	0%	10%	45%	$1.60	15	1.63
Custom Measures	Space Heating	10%	8%	10%	45%	$1.60	15	1.63
Custom Measures	Interior Lighting	10%	8%	10%	45%	$1.60	15	1.63
Custom Measures	Machine Drive	10%	8%	10%	45%	$1.60	15	1.63
Furnace - Convert to Gas	Space Heating	100%	100%	0%	0%	$4.00	15	2.67

Note: Costs are per sq. ft.

Table D-14 Energy Efficiency Measure Data — Small/Medium Comm., New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
RTU - Maintenance	Cooling	14%	0%	14%	90%	$0.08	4	0.82
RTU - Evaporative Precooler	Cooling	10%	0%	0%	0%	$0.88	15	0.18
Chiller - Chilled Water Reset	Cooling	11%	0%	0%	0%	$0.86	4	0.06
Chiller - Chilled Water Variable-Flow System	Cooling	4%	0%	0%	0%	$0.86	10	0.05
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	0%	$0.90	20	0.63
Chiller - VSD	Cooling	26%	0%	0%	0%	$1.17	20	0.42
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	0%	0%	$0.04	10	0.01
Chiller - Condenser Water Temprature Reset	Cooling	8%	0%	0%	0%	$0.87	14	0.13
Cooling - Economizer Installation	Cooling	6%	0%	45%	49%	$0.15	15	0.65
Heat Pump - Maintenance	Combined Heating/Cooling	7%	7%	10%	95%	$0.03	4	4.32
Insulation - Ducting	Cooling	5%	0%	9%	50%	$0.41	20	0.64
Insulation - Ducting	Space Heating	3%	1%	9%	50%	$0.41	20	0.64
Energy Management System	Cooling	5%	0%	24%	75%	$0.35	14	0.55
Energy Management System	Space Heating	2%	1%	24%	75%	$0.35	14	0.55
Energy Management System	Interior Lighting	2%	1%	24%	75%	$0.35	14	0.55
Cooking - Exhaust Hoods with Sensor Control	Ventilation	25%	13%	1%	15%	$0.04	10	7.04
Fans - Energy Efficient Motors	Ventilation	5%	5%	11%	90%	$0.05	10	1.32
Fans - Variable Speed Control	Ventilation	15%	5%	8%	90%	$0.20	10	0.85
Commissioning - HVAC	Cooling	5%	0%	40%	75%	$0.90	25	0.33
Commissioning - HVAC	Space Heating	5%	4%	40%	75%	$0.90	25	0.33
Commissioning - HVAC	Ventilation	5%	4%	40%	75%	$0.90	25	0.33
Pumps - Variable Speed Control	Miscellaneous	1%	0%	5%	34%	$0.44	10	1.01
Thermostat - Clock/Programmable	Cooling	5%	0%	34%	50%	$0.13	11	1.06
Thermostat - Clock/Programmable	Space Heating	5%	1%	34%	50%	$0.13	11	1.06
Insulation - Ceiling	Cooling	1%	0%	10%	81%	$0.16	20	1.60
Insulation - Ceiling	Space Heating	15%	4%	10%	81%	$0.16	20	1.60
Insulation - Radiant Barrier	Cooling	2%	0%	7%	13%	$0.26	20	0.76
Insulation - Radiant Barrier	Space Heating	6%	2%	7%	13%	$0.26	20	0.76
Roofs - High Reflectivity	Cooling	7%	0%	5%	95%	$0.09	15	1.25
Windows - High Efficiency	Cooling	5%	0%	61%	75%	$0.35	20	0.69
Windows - High Efficiency	Space Heating	3%	2%	61%	75%	$0.35	20	0.69
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	81%	90%	$0.65	8	0.31
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	Interior Lighting	25%	13%	1%	45%	$0.38	8	1.07
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	10%	75%	$0.09	8	1.50
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	Interior Lighting	10%	5%	10%	23%	$0.50	8	0.32
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	23%	$0.70	11	1.56
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	7%	45%	$0.20	8	1.00
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.24
Interior Screw-in - Task Lighting	Interior Lighting	7%	4%	25%	75%	$0.24	5	0.08
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	9%	56%	$0.20	8	0.50
Water Heater - Faucet Aerators/Low Flow Nozzles	Water Heating	4%	1%	8%	90%	$0.01	9	4.22
Water Heater - Pipe Insulation	Water Heating	4%	2%	46%	50%	$0.28	15	0.24
Water Heater - High Efficiency Circulation Pump	Water Heating	5%	4%	0%	0%	$0.11	10	0.63
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	40%	50%	$0.02	10	5.80
Water Heater - Thermostat Setback	Water Heating	4%	0%	10%	75%	$0.11	10	0.38
Water Heater - Hot Water Saver	Water Heating	5%	1%	0%	0%	$0.02	5	1.53
Refrigeration - Anti-Sweat Heater/Auto Door Closer	Refrigeration	5%	3%	0%	75%	$0.20	16	1.09
Refrigeration - Floating Head Pressure	Refrigeration	7%	4%	18%	38%	$0.35	16	1.24
Refrigeration - Door Gasket Replacement	Refrigeration	4%	2%	5%	75%	$0.10	8	0.09
Insulation - Bare Suction Lines	Refrigeration	3%	2%	5%	75%	$0.10	8	0.20
Refrigeration - Night Covers	Refrigeration	6%	3%	5%	75%	$0.05	8	1.02
Refrigeration - Strip Curtain	Refrigeration	4%	2%	5%	56%	$0.02	8	0.00
Commissioning - Comprehensive	Cooling	10%	0%	40%	75%	$1.25	25	0.83
Commissioning - Comprehensive	Space Heating	10%	7%	40%	75%	$1.25	25	0.83
Commissioning - Comprehensive	Interior Lighting	10%	7%	40%	75%	$1.25	25	0.83
Office Equipment - Energy Star Power Supply	Office Equipment	1%	1%	10%	95%	$0.00	7	61.07
Vending Machine - Controller	Refrigeration	15%	11%	2%	10%	$0.27	10	1.08
LED Exit Lighting	Interior Lighting	2%	2%	85%	86%	$0.00	10	11.83
Commissioning - Lighting	Interior Lighting	5%	4%	30%	75%	$0.20	25	1.54
Commissioning - Lighting	Exterior Lighting	5%	4%	30%	75%	$0.20	25	1.54
Refrigeration - High Efficiency Case Lighting	Refrigeration	4%	2%	5%	75%	$0.20	8	0.00
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	1.23
Exterior Lighting - Induction Lamps	Exterior Lighting	3%	3%	5%	56%	$0.00	5	7.30
Laundry - High Efficiency Clothes Washer	Miscellaneous	0%	0%	5%	10%	$0.00	10	36.95
Interior Lighting - Hotel Guestroom Controls	Interior Lighting	10%	5%	0%	0%	$0.14	8	0.30
Miscellaneous - Energy Star Water Cooler	Miscellaneous	0%	0%	5%	95%	$0.00	8	1.95
Advanced New Construction Designs	Cooling	40%	0%	5%	75%	$2.00	35	2.01
Advanced New Construction Designs	Space Heating	40%	30%	5%	75%	$2.00	35	2.01
Advanced New Construction Designs	Interior Lighting	25%	19%	5%	75%	$2.00	35	2.01
Insulation - Wall Cavity	Cooling	1%	0%	10%	68%	$0.34	20	0.72
Insulation - Wall Cavity	Space Heating	10%	2%	10%	68%	$0.34	20	0.72
Roofs - Green	Cooling	7%	0%	2%	11%	$1.00	30	0.26
Roofs - Green	Space Heating	4%	3%	2%	11%	$1.00	30	0.26
Industrial Process Improvements	Miscellaneous	10%	8%	0%	23%	$0.52	10	1.16
Custom Measures	Cooling	8%	0%	10%	45%	$1.50	15	0.45
Custom Measures	Space Heating	8%	6%	10%	45%	$1.50	15	0.45
Custom Measures	Interior Lighting	8%	6%	10%	45%	$1.50	15	0.45
Custom Measures	Food Preparation	8%	6%	10%	45%	$1.50	15	0.45
Custom Measures	Refrigeration	8%	6%	10%	45%	$1.50	15	0.45
Water Heater - Heat Pump	Water Heating	30%	15%	0%	19%	$0.80	15	0.68
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$4.00	15	0.53
Furnace - Convert to Gas	Space Heating	100%	100%	0%	47%	$8.04	15	1.01

Note: Costs are per sq. ft.

Table D-15 Energy Efficiency Measure Data — Large Commercial, New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
RTU - Maintenance	Cooling	14%	0%	27%	90%	$0.06	4	1.13
RTU - Evaporative Precooler	Cooling	10%	0%	0%	0%	$0.88	15	0.19
Chiller - Chilled Water Reset	Cooling	18%	0%	30%	75%	$0.18	4	0.42
Chiller - Chilled Water Variable-Flow System	Cooling	5%	0%	30%	34%	$0.18	10	0.28
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	66%	$0.90	20	0.61
Chiller - VSD	Cooling	32%	0%	15%	66%	$1.17	20	0.50
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	15%	41%	$0.04	10	0.01
Chiller - Condenser Water Temprature Reset	Cooling	8%	0%	25%	75%	$0.18	14	0.63
Cooling - Economizer Installation	Cooling	11%	0%	44%	49%	$0.15	15	1.19
Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	10%	95%	$0.06	4	2.72
Insulation - Ducting	Cooling	4%	0%	8%	50%	$0.41	20	0.56
Insulation - Ducting	Space Heating	3%	1%	8%	50%	$0.41	20	0.56
Energy Management System	Cooling	21%	0%	48%	90%	$0.35	14	2.10
Energy Management System	Space Heating	8%	5%	48%	90%	$0.35	14	2.10
Energy Management System	Interior Lighting	9%	6%	48%	90%	$0.35	14	2.10
Cooking - Exhaust Hoods with Sensor Control	Ventilation	13%	7%	1%	11%	$0.04	10	2.84
Fans - Energy Efficient Motors	Ventilation	5%	5%	11%	90%	$0.05	10	1.07
Fans - Variable Speed Control	Ventilation	15%	5%	2%	90%	$0.20	10	0.68
Commissioning - HVAC	Cooling	5%	0%	50%	75%	$0.85	25	0.30
Commissioning - HVAC	Space Heating	5%	4%	50%	75%	$0.85	25	0.30
Commissioning - HVAC	Ventilation	5%	4%	50%	75%	$0.85	25	0.30
Pumps - Variable Speed Control	Miscellaneous	1%	0%	5%	34%	$0.13	10	1.05
Thermostat - Clock/Programmable	Cooling	5%	0%	33%	50%	$0.13	11	0.97
Thermostat - Clock/Programmable	Space Heating	5%	1%	33%	50%	$0.13	11	0.97
Insulation - Ceiling	Cooling	1%	0%	75%	81%	$0.35	20	0.60
Insulation - Ceiling	Space Heating	10%	3%	75%	81%	$0.35	20	0.60
Insulation - Radiant Barrier	Cooling	1%	0%	7%	13%	$0.26	20	0.56
Insulation - Radiant Barrier	Space Heating	5%	2%	7%	13%	$0.26	20	0.56
Roofs - High Reflectivity	Cooling	4%	0%	5%	95%	$0.05	15	1.28
Windows - High Efficiency	Cooling	12%	0%	72%	75%	$0.88	20	0.72
Windows - High Efficiency	Space Heating	11%	8%	72%	75%	$0.88	20	0.72
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	86%	90%	$0.65	8	0.30
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	Interior Lighting	25%	13%	1%	45%	$0.34	8	1.14
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	10%	19%	$0.19	8	0.57
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	Interior Lighting	10%	5%	10%	23%	$0.40	8	0.39
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	23%	$0.63	11	1.66
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	13%	45%	$0.20	8	0.99
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.19
Interior Screw-in - Task Lighting	Interior Lighting	10%	5%	10%	75%	$0.24	5	0.11
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	9%	56%	$0.20	8	0.49
Water Heater - Faucet Aerators/Low Flow Nozzles	Water Heating	4%	1%	3%	90%	$0.03	9	1.60
Water Heater - Pipe Insulation	Water Heating	4%	2%	0%	0%	$0.28	15	0.27
Water Heater - High Efficiency Circulation Pump	Water Heating	5%	4%	0%	23%	$0.11	10	0.69
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$0.04	10	3.23
Water Heater - Thermostat Setback	Water Heating	4%	0%	0%	0%	$0.11	10	0.44
Water Heater - Hot Water Saver	Water Heating	5%	1%	0%	3%	$0.04	5	0.87
Refrigeration - Anti-Sweat Heater/Auto Door Closer	Refrigeration	5%	3%	0%	75%	$0.20	16	0.58
Refrigeration - Floating Head Pressure	Refrigeration	7%	4%	38%	45%	$0.35	16	0.94
Refrigeration - Door Gasket Replacement	Refrigeration	4%	2%	5%	75%	$0.10	8	0.63
Insulation - Bare Suction Lines	Refrigeration	3%	2%	5%	75%	$0.10	8	0.35
Refrigeration - Night Covers	Refrigeration	6%	3%	5%	75%	$0.05	8	0.65
Refrigeration - Strip Curtain	Refrigeration	4%	2%	5%	56%	$0.02	8	0.94
Commissioning - Comprehensive	Cooling	10%	0%	40%	75%	$1.00	25	0.96
Commissioning - Comprehensive	Space Heating	10%	7%	40%	75%	$1.00	25	0.96
Commissioning - Comprehensive	Interior Lighting	10%	7%	40%	75%	$1.00	25	0.96
Office Equipment - Energy Star Power Supply	Office Equipment	1%	1%	10%	95%	$0.00	7	67.83
Vending Machine - Controller	Refrigeration	15%	11%	2%	10%	$0.27	10	1.09
LED Exit Lighting	Interior Lighting	2%	2%	85%	86%	$0.00	10	11.13
Commissioning - Lighting	Interior Lighting	5%	4%	60%	75%	$0.15	25	1.99
Commissioning - Lighting	Exterior Lighting	5%	4%	60%	75%	$0.15	25	1.99
Refrigeration - High Efficiency Case Lighting	Refrigeration	4%	2%	5%	75%	$0.20	8	0.52
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	1.03
Exterior Lighting - Induction Lamps	Exterior Lighting	3%	3%	5%	56%	$0.00	5	5.86
Laundry - High Efficiency Clothes Washer	Miscellaneous	0%	0%	5%	10%	$0.00	10	33.94
Interior Lighting - Hotel Guestroom Controls	Interior Lighting	10%	5%	1%	2%	$0.14	8	0.29
Miscellaneous - Energy Star Water Cooler	Miscellaneous	0%	0%	5%	95%	$0.00	8	1.78
Advanced New Construction Designs	Cooling	40%	0%	5%	75%	$2.00	35	1.84
Advanced New Construction Designs	Space Heating	40%	30%	5%	75%	$2.00	35	1.84
Advanced New Construction Designs	Interior Lighting	25%	19%	5%	75%	$2.00	35	1.84
Insulation - Wall Cavity	Cooling	1%	0%	9%	68%	$0.78	20	0.43
Insulation - Wall Cavity	Space Heating	10%	2%	9%	68%	$0.78	20	0.43
Roofs - Green	Cooling	4%	0%	2%	13%	$1.00	15	0.08
Roofs - Green	Space Heating	2%	2%	2%	13%	$1.00	15	0.08
Industrial Process Improvements	Miscellaneous	10%	8%	0%	5%	$0.52	10	1.18
Custom Measures	Cooling	8%	0%	10%	45%	$0.90	15	0.73
Custom Measures	Space Heating	8%	6%	10%	45%	$0.90	15	0.73
Custom Measures	Interior Lighting	8%	6%	10%	45%	$0.90	15	0.73
Custom Measures	Food Preparation	8%	6%	10%	45%	$0.90	15	0.73
Custom Measures	Refrigeration	8%	6%	10%	45%	$0.90	15	0.73
Water Heater - Heat Pump	Water Heating	30%	15%	0%	28%	$0.80	15	0.76
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	0%	$4.00	15	0.58
Furnace - Convert to Gas	Space Heating	100%	100%	0%	0%	$6.00	15	0.98

Note: Costs are per sq. ft.

Table D-16 Energy Efficiency Measure Data — Extra Large Commercial, New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
RTU - Maintenance	Cooling	14%	0%	47%	90%	$0.06	4	1.02
RTU - Evaporative Precooler	Cooling	10%	0%	0%	0%	$0.88	15	0.17
Chiller - Chilled Water Reset	Cooling	12%	0%	60%	75%	$0.09	4	0.61
Chiller - Chilled Water Variable-Flow System	Cooling	8%	0%	30%	34%	$0.09	10	0.95
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	75%	$0.90	20	0.64
Chiller - VSD	Cooling	28%	0%	3%	75%	$1.17	20	0.45
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	25%	37%	$0.04	10	0.01
Chiller - Condenser Water Temprature Reset	Cooling	8%	0%	25%	75%	$0.09	14	1.28
Cooling - Economizer Installation	Cooling	11%	0%	73%	81%	$0.15	15	1.14
Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	5%	95%	$0.06	4	2.61
Insulation - Ducting	Cooling	7%	0%	2%	50%	$0.41	20	0.71
Insulation - Ducting	Space Heating	3%	1%	2%	50%	$0.41	20	0.71
Energy Management System	Cooling	11%	0%	80%	90%	$0.35	14	0.94
Energy Management System	Space Heating	4%	2%	80%	90%	$0.35	14	0.94
Energy Management System	Interior Lighting	5%	3%	80%	90%	$0.35	14	0.94
Cooking - Exhaust Hoods with Sensor Control	Ventilation	13%	7%	1%	8%	$0.04	10	3.31
Fans - Energy Efficient Motors	Ventilation	5%	5%	11%	90%	$0.05	10	1.24
Fans - Variable Speed Control	Ventilation	15%	5%	2%	90%	$0.20	10	0.80
Commissioning - HVAC	Cooling	5%	0%	50%	75%	$0.70	25	0.42
Commissioning - HVAC	Space Heating	5%	4%	50%	75%	$0.70	25	0.42
Commissioning - HVAC	Ventilation	5%	4%	50%	75%	$0.70	25	0.42
Pumps - Variable Speed Control	Miscellaneous	1%	0%	1%	34%	$0.44	10	1.01
Thermostat - Clock/Programmable	Cooling	3%	0%	25%	50%	$0.13	11	0.67
Thermostat - Clock/Programmable	Space Heating	3%	1%	25%	50%	$0.13	11	0.67
Insulation - Ceiling	Cooling	1%	0%	2%	81%	$0.35	20	0.68
Insulation - Ceiling	Space Heating	10%	3%	2%	81%	$0.35	20	0.68
Insulation - Radiant Barrier	Cooling	1%	0%	2%	13%	$0.26	20	0.47
Insulation - Radiant Barrier	Space Heating	2%	1%	2%	13%	$0.26	20	0.47
Roofs - High Reflectivity	Cooling	10%	0%	5%	95%	$0.18	15	0.85
Windows - High Efficiency	Cooling	6%	0%	95%	100%	$1.69	20	0.38
Windows - High Efficiency	Space Heating	2%	2%	95%	100%	$1.69	20	0.38
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	78%	90%	$0.65	8	0.23
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	Interior Lighting	25%	13%	3%	45%	$0.30	8	0.86
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	10%	15%	$0.19	8	0.61
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	Interior Lighting	10%	5%	10%	23%	$0.20	8	0.52
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	23%	$0.56	11	1.24
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	42%	45%	$0.20	8	0.76
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.20
Interior Screw-in - Task Lighting	Interior Lighting	10%	5%	25%	75%	$0.24	5	0.16
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	12%	56%	$0.20	8	0.38
Water Heater - Faucet Aerators/Low Flow Nozzles	Water Heating	4%	1%	2%	90%	$0.03	9	2.63
Water Heater - Pipe Insulation	Water Heating	6%	3%	0%	0%	$0.28	15	0.69
Water Heater - High Efficiency Circulation Pump	Water Heating	5%	4%	0%	23%	$0.11	10	1.18
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$0.04	10	5.43
Water Heater - Thermostat Setback	Water Heating	4%	0%	0%	0%	$0.11	10	0.71
Water Heater - Hot Water Saver	Water Heating	5%	1%	0%	0%	$0.04	5	1.43
Refrigeration - Anti-Sweat Heater/Auto Door Closer	Refrigeration	5%	3%	10%	75%	$0.20	16	0.02
Refrigeration - Floating Head Pressure	Refrigeration	7%	4%	10%	38%	$0.35	16	0.32
Refrigeration - Door Gasket Replacement	Refrigeration	4%	2%	5%	75%	$0.10	8	0.12
Insulation - Bare Suction Lines	Refrigeration	3%	2%	5%	75%	$0.10	8	0.26
Refrigeration - Night Covers	Refrigeration	6%	3%	5%	75%	$0.05	8	0.27
Refrigeration - Strip Curtain	Refrigeration	4%	2%	5%	56%	$0.02	8	0.17
Commissioning - Comprehensive	Cooling	10%	0%	40%	75%	$0.80	25	1.05
Commissioning - Comprehensive	Space Heating	10%	7%	40%	75%	$0.80	25	1.05
Commissioning - Comprehensive	Interior Lighting	10%	7%	40%	75%	$0.80	25	1.05
Office Equipment - Energy Star Power Supply	Office Equipment	1%	1%	10%	95%	$0.00	7	38.86
Vending Machine - Controller	Refrigeration	15%	11%	2%	10%	$0.27	10	1.10
LED Exit Lighting	Interior Lighting	2%	2%	85%	86%	$0.00	10	16.52
Commissioning - Lighting	Interior Lighting	5%	4%	60%	75%	$0.10	25	2.47
Commissioning - Lighting	Exterior Lighting	5%	4%	60%	75%	$0.10	25	2.47
Refrigeration - High Efficiency Case Lighting	Refrigeration	4%	2%	5%	75%	$0.20	8	0.04
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	1.45
Exterior Lighting - Induction Lamps	Exterior Lighting	3%	3%	5%	56%	$0.00	5	6.26
Laundry - High Efficiency Clothes Washer	Miscellaneous	0%	0%	5%	10%	$0.00	10	20.31
Interior Lighting - Hotel Guestroom Controls	Interior Lighting	10%	5%	0%	0%	$0.14	8	0.42
Miscellaneous - Energy Star Water Cooler	Miscellaneous	0%	0%	5%	95%	$0.00	8	1.07
Advanced New Construction Designs	Cooling	40%	0%	5%	75%	$2.00	35	1.67
Advanced New Construction Designs	Space Heating	40%	30%	5%	75%	$2.00	35	1.67
Advanced New Construction Designs	Interior Lighting	25%	19%	5%	75%	$2.00	35	1.67
Insulation - Wall Cavity	Cooling	1%	0%	2%	68%	$0.09	20	1.73
Insulation - Wall Cavity	Space Heating	10%	2%	2%	68%	$0.09	20	1.73
Roofs - Green	Cooling	10%	0%	2%	13%	$1.00	15	0.20
Roofs - Green	Space Heating	5%	3%	2%	13%	$1.00	15	0.20
Industrial Process Improvements	Miscellaneous	10%	8%	0%	0%	$0.52	10	1.11
Custom Measures	Cooling	8%	0%	10%	45%	$0.67	15	0.81
Custom Measures	Space Heating	8%	6%	10%	45%	$0.67	15	0.81
Custom Measures	Interior Lighting	8%	6%	10%	45%	$0.67	15	0.81
Custom Measures	Food Preparation	8%	6%	10%	45%	$0.67	15	0.81
Custom Measures	Refrigeration	8%	6%	10%	45%	$0.67	15	0.81
Water Heater - Heat Pump	Water Heating	30%	15%	0%	41%	$0.80	15	1.27
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	0%	$4.00	15	1.00
Furnace - Convert to Gas	Space Heating	100%	100%	0%	0%	$4.00	15	1.57

Note: Costs are per sq. ft.

Table D-17 Energy Efficiency Measure Data — Extra Large Industrial, New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Refrigeration - System Controls	Process	11%	8%	5%	34%	$0.40	10	18.09
Refrigeration - System Maintenance	Process	3%	2%	5%	34%	$0.00	10	2,067.93
Refrigeration - System Optimization	Process	15%	11%	5%	34%	$0.80	10	12.92
Motors - Variable Frequency Drive	Machine Drive	13%	9%	25%	38%	$0.10	10	3.38
Motors - Magnetic Adjustable Speed Drives	Machine Drive	13%	9%	25%	38%	$0.10	10	3.38
Compressed Air - System Controls	Machine Drive	9%	7%	5%	34%	$0.40	10	0.59
Compressed Air - System Optimization and Improvements	Machine Drive	13%	9%	5%	34%	$0.80	10	0.42
Compressed Air - System Maintenance	Machine Drive	3%	2%	5%	34%	$0.20	10	0.34
Compressed Air - Compressor Replacement	Machine Drive	5%	4%	5%	34%	$0.20	10	0.68
Fan System - Controls	Machine Drive	4%	3%	10%	38%	$0.35	10	0.11
Fan System - Controls	Machine Drive	4%	3%	10%	38%	$0.35	10	0.11
Fan System - Optimization	Machine Drive	6%	5%	10%	38%	$0.70	10	0.08
Fan System - Optimization	Machine Drive	6%	5%	10%	38%	$0.70	10	0.08
Fan System - Maintenance	Machine Drive	1%	1%	10%	38%	$0.15	10	0.07
Fan System - Maintenance	Machine Drive	1%	1%	10%	38%	$0.15	10	0.07
Pumping System - Controls	Machine Drive	5%	4%	5%	34%	$0.38	12	0.42
Pumping System - Optimization	Machine Drive	13%	9%	5%	34%	$0.75	12	0.54
Pumping System - Maintenance	Machine Drive	2%	1%	5%	34%	$0.19	10	0.27
RTU - Maintenance	Cooling	14%	0%	22%	90%	$0.06	4	2.82
Chiller - Chilled Water Reset	Cooling	14%	0%	60%	75%	$0.09	4	2.53
Chiller - Chilled Water Variable-Flow System	Cooling	4%	0%	30%	34%	$0.20	10	0.80
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	67%	$0.90	20	2.40
Chiller - VSD	Cooling	27%	0%	25%	67%	$1.17	20	1.63
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	25%	50%	$0.04	10	0.04
Chiller - Condenser Water Temprature Reset	Cooling	10%	0%	5%	75%	$0.20	14	2.60
Cooling - Economizer Installation	Cooling	6%	0%	29%	34%	$0.15	15	1.92
Heat Pump - Maintenance	Combined Heating/Cooling	7%	7%	2%	95%	$0.03	4	7.76
Insulation - Ducting	Space Heating	5%	5%	12%	50%	$0.41	20	0.95
Insulation - Ducting	Cooling	3%	0%	12%	50%	$0.41	20	0.95
Energy Management System	Cooling	5%	0%	11%	90%	$0.35	14	0.88
Energy Management System	Space Heating	2%	1%	11%	90%	$0.35	14	0.88
Energy Management System	Interior Lighting	2%	1%	11%	90%	$0.35	14	0.88
Fans - Energy Efficient Motors	Ventilation	5%	5%	2%	90%	$0.14	10	2.81
Fans - Variable Speed Control	Ventilation	15%	5%	3%	90%	$0.34	10	2.97
Commissioning - HVAC	Cooling	5%	0%	60%	75%	$0.70	25	0.92
Commissioning - HVAC	Space Heating	5%	4%	60%	75%	$0.70	25	0.92
Commissioning - HVAC	Ventilation	5%	4%	60%	75%	$0.70	25	0.92
Pumps - Variable Speed Control	Machine Drive	5%	4%	0%	34%	$0.44	10	0.31
Thermostat - Clock/Programmable	Cooling	5%	0%	59%	70%	$0.13	11	2.02
Thermostat - Clock/Programmable	Space Heating	5%	1%	59%	70%	$0.13	11	2.02
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	84%	90%	$0.65	8	0.15
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	10%	40%	$0.08	8	0.42
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	38%	$0.20	11	1.76
LED Exit Lighting	Interior Lighting	2%	2%	85%	86%	$0.00	10	3.72
Commissioning - Lighting	Interior Lighting	5%	4%	60%	75%	$0.10	25	1.41
Commissioning - Lighting	Exterior Lighting	5%	4%	60%	75%	$0.10	25	1.41
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	15%	45%	$0.20	8	0.50
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.06
Interior Screw-in - Task Lighting	Interior Lighting	7%	4%	10%	75%	$0.24	5	0.03
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	2%	56%	$0.20	8	0.25
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	0.41
Advanced New Construction Designs	Cooling	40%	0%	5%	75%	$2.00	35	2.67
Advanced New Construction Designs	Space Heating	40%	30%	5%	75%	$2.00	35	2.67
Advanced New Construction Designs	Interior Lighting	25%	19%	5%	75%	$2.00	35	2.67
Custom Measures	Cooling	8%	0%	10%	45%	$1.60	15	1.28
Custom Measures	Space Heating	8%	6%	10%	45%	$1.60	15	1.28
Custom Measures	Interior Lighting	8%	6%	10%	45%	$1.60	15	1.28
Custom Measures	Machine Drive	8%	6%	10%	45%	$1.60	15	1.28
Furnace - Convert to Gas	Space Heating	100%	100%	0%	0%	$4.00	15	2.51

Note: Costs are per sq. ft.

2011 Electric Integrated Resource Plan

Appendix D – Avista Electric Conservation Potential Assessment Study

AVISTA ELECTRIC CONSERVATION POTENTIAL ASSESSMENT STUDY

Final Report — Electricity Potentials

August 19, 2011

J. Borstein, Project Manager
I. Rohmund, Director

Global Energy Partners™
An EnerNOC Company

Global Energy Partners
An EnerNOC Company
500 Ygnacio Valley Road, Suite 450
Walnut Creek, CA 94596

P: 925.482.2000
F: 925.284.3147
E: gephq@gepllc.com

This report was prepared by

Global Energy Partners
An EnerNOC Company
500 Ygnacio Valley Blvd., Suite 450
Walnut Creek, CA 94596

Principal Investigator(s):
I. Rohmund
J. Borstein
A. Duer
B. Kester
J. Prijyanonda
S. Yoshida

EXECUTIVE SUMMARY

Avista Corporation (Avista) engaged Global Energy Partners (Global) to conduct a Conservation Potential Assessment (CPA) Study. The CPA is a 20-year potentials study for energy efficiency (EE) and demand response (DR) to provide data on demand-side resources for developing Avista's 2011 Integrated Resource Plan (IRP), and in accordance with Washington I-937. The study used 2009, the first year for which complete billing data was available, as the baseline year and then developed potential estimates for the period 2012–2032. This report provides results of the electricity energy efficiency potential study only, and subsequent documents will address natural gas and DR potential.

Study Objectives

The study objectives included:

- Conduct a conservation potential study for electricity for Washington and Idaho, and natural gas for Washington, Idaho, and Oregon. The study will account for:
    - Impacts of existing Avista conservation programs
    - Avista's load forecasts and load shapes
    - Impacts of codes and standards
    - Technology developments and innovation
    - The economy and energy prices
    - Naturally occurring energy savings
- Assess and analyze cost-effective EE and DR potentials in accordance with the Northwest Power and Conservation Council's (NWPPC) 6th Power Plan and Washington I-937 requirements.
- Obtain supply curves showing the incremental costs associated with achieving higher levels of EE and stacking EE resources by cost of conserved energy.
- Analyze various market penetration rates associated with technical, economic, achievable, and naturally occurring potential estimates.

Study Approach

To execute this project, Global took the following steps, which are also shown in Figure ES-1.

1. Performed a market assessment to describe base year energy consumption for the residential and C&I sectors. This included using utility data and secondary data to understand customers in Avista's service territory and how these customers currently use electricity. Based on the market assessment, we developed energy market profiles for the study's base year, 2009.

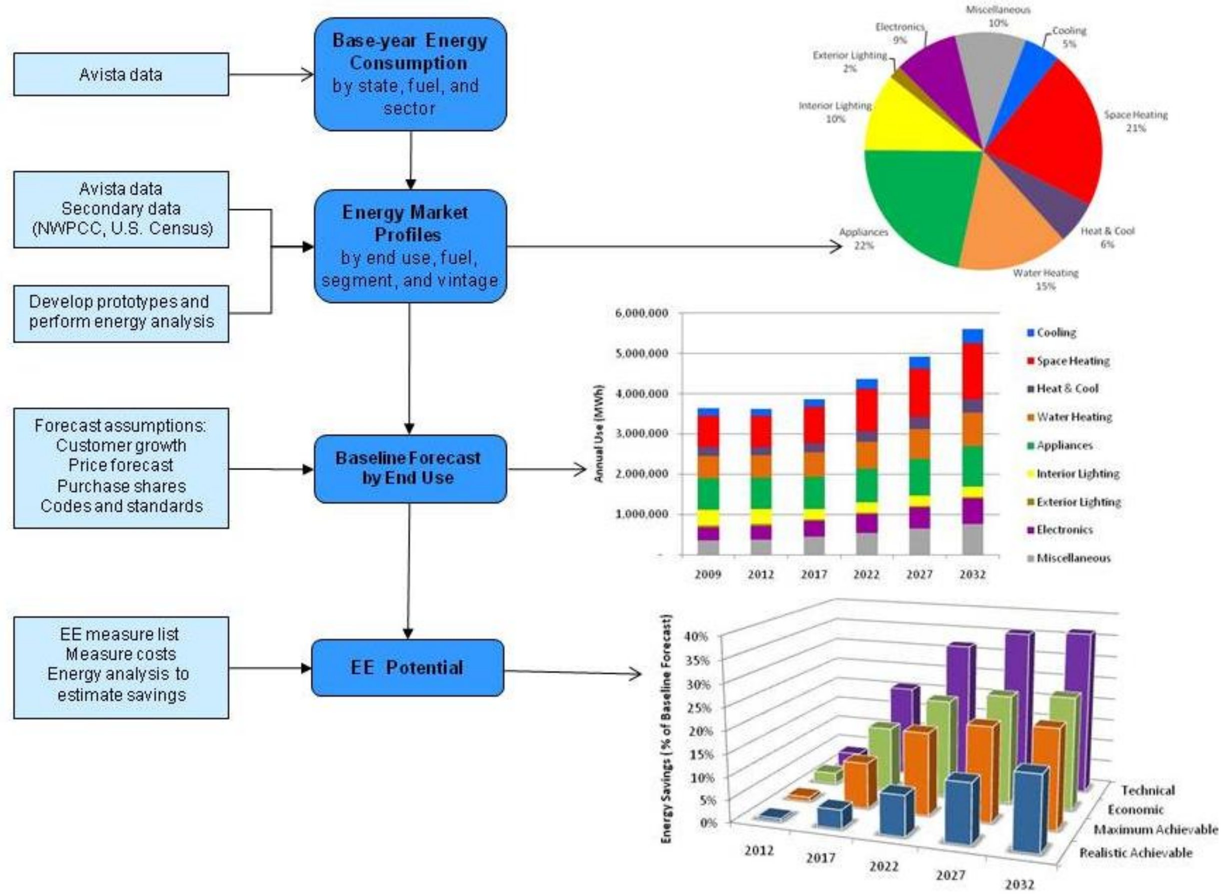
2. Developed a baseline energy forecast by sector and end use for the twenty-year study period.

3. Identified and analyzed energy-efficiency measures appropriate for the Avista service area.

4. Estimated four levels of energy-efficiency potential, *technical, economic, maximum achievable,* and *realistic achievable*.

The steps are described in further detail in Chapter 2.

Figure ES-1 Analysis Approach Overview



The study segmented Avista customers by state and rate class (Residential, Commercial & Industrial (C&I) General Service, C&I Large General Service, Extra Large Commercial, and Extra Large Industrial). In addition, the residential class was segmented by housing type and income (single family, multi-family, mobile home, and low income). The low-income threshold for purposes of this study was defined as 200% of the Federal poverty level. For the pumping rate classes, representing 2% of load, the Northwest Power and Conservation Council (NWPCC) Sixth Plan calculator was used to determine future EE potential. Within each segment, energy use was characterized by end-use (e.g., space heating, cooling, lighting, water heat, motors, etc.) and by technology (e.g., heat pump, resistance heating, furnace for space heating). This market characterization is detailed in Chapter 3.

The baseline forecast is the "business as usual" metric, without new utility conservation programs, against which energy savings from energy efficiency measures are compared. The baseline forecast includes the projected impacts of known codes and standards, as of 2010 when the study was conducted. These include the Energy Independence and Security Act (EISA), which mandates higher efficacies for lighting technologies starting in 2012, and a series of recent appliance standards agreed upon in 2010. These recent codes and standards have direct bearing on the amount of utility program potential over and above the effects of codes and standards and naturally occurring conservation. This process incorporates the changes in market conditions such as customer and market growth, income growth, Avista's retail rates forecast, trends in end-use and technology saturations, equipment purchase decisions, consumer price elasticity, and income and persons per household. The baseline forecast enables understanding customer potential estimates in the context of total energy use in the future.

For each customer sector, a robust list of electrical energy efficiency measures was compiled, drawing upon the Sixth Power Plan database, the Regional Technical Forum (RTF), and other measures considered applicable to Avista. This list of energy efficiency equipment and measures included 2,808 equipment options and 1,524 measure options and represented a wide variety of major types of end-use equipment, as well as devices and actions to reduce energy consumption. Considered against current avoided costs, many of these measures do not pass the economic screens, but may ultimately be part of Avista's energy efficiency program portfolio during this 20-year planning horizon. Measure cost, savings, estimated useful life, and other performance factors were characterized for the list of measures. Cost-effectiveness screening was performed, using the total resource cost (TRC) test, for each measure and each year of the study to develop economic potential. The measure analysis is discussed in Chapter 5.

Market Characterization and Baseline Forecast

During 2009, Avista served 354,615 residential, commercial, industrial, and pumping customers with a combined electricity use of approximately 8,862 GWh.

Residential Sector

The total number of 2009 residential customers was 200,134 in Washington and 99,579 in Idaho. Table ES-1 shows their distribution by housing type and income level. The limited income category, which is composed of single-family, multi-family, and mobile homes, represents households with income below $35,000 annually.

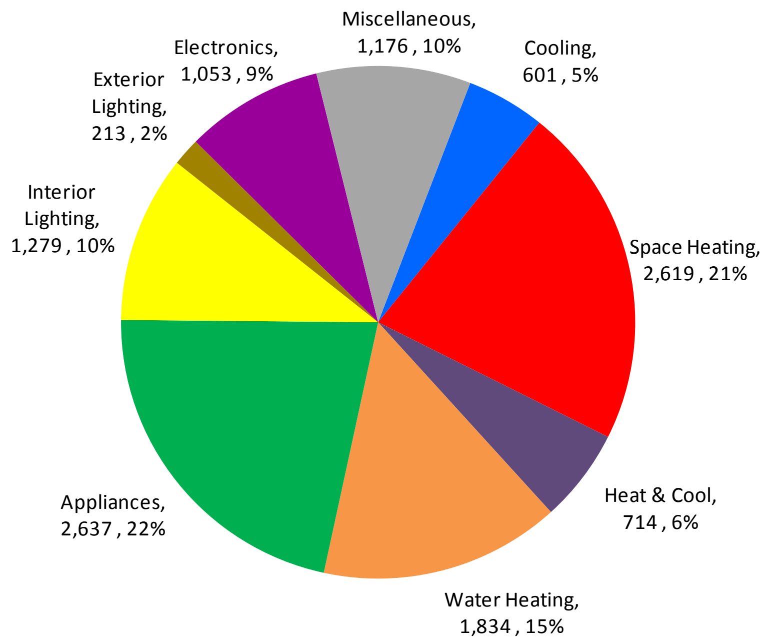
Table ES-1 Residential Electricity Usage and Intensity by Segment and State, 2009

Washington Segment	Intensity (kWh/Household)	Number of Customers	% of Customers	2009 Electricity Sales (MWh)	% of Sales
Single Family	14,547	109,134	54%	1,587,572	65%
Multi-Family	8,728	18,219	9%	159,019	6%
Mobile Home	13,092	5,248	3%	68,708	3%
Limited Income	9,424	67,533	34%	636,407	26%
Total	**12,250**	**200,134**	**100%**	**2,451,707**	**100%**

Idaho Segment	Intensity (kWh/Household)	Number of Customers	% of Customers	2009 Electricity Sales (MWh)	% of Sales
Single Family	13,703	59,205	59%	811,302	69%
Multi-Family	8,213	5,237	5%	43,013	4%
Mobile Home	12,320	4,774	5%	58,815	5%
Limited Income	8,868	30,363	31%	269,249	23%
Total	**11,874**	**99,580**	**100%**	**1,182,379**	**100%**

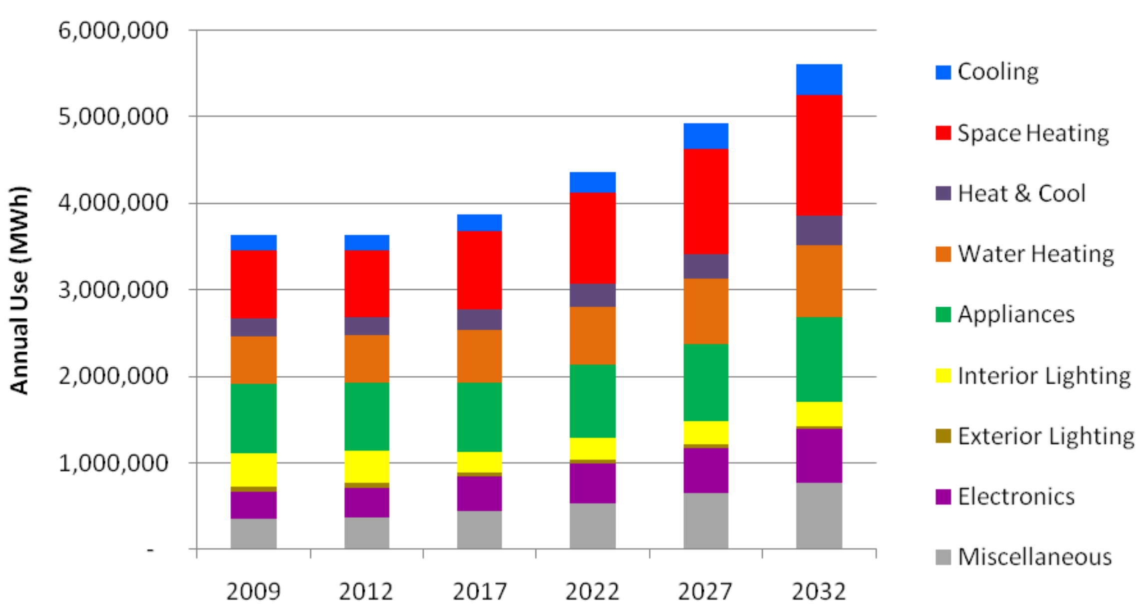
For each residential segment, a snapshot of electricity use by end use and technology was developed. Figure ES-2 presents the end-use breakout by household for the residential sector as a whole. The appliance end use accounts for the largest share of the usage, closely followed by space heating, with water heating the third largest end use. The miscellaneous end use includes such devices as furnace fans, pool pumps, and other "plug" loads (hair dryers, power tools, coffee makers, etc.). Interior and exterior lighting combined account for 12% of electricity use in 2009. The electronics end use, which includes personal computers, televisions, home audio, video game consoles, etc., also contributes significantly to household electricity usage. Cooling and combined heating and cooling through heat pumps make up the remainder.

Figure ES-2 Residential Electricity Use by End Use per Household, 2009 (kWh and %)



The residential baseline forecast incorporates the effects of future customer growth, trends in appliance ownership, building codes, federal appliance standards and customer usage response to changes in electricity prices and household income. As such, it includes naturally-occurring energy efficiency. Overall, residential use in both states and for all segments increases from 3,634,054 MWh in 2009 to 5,600,870 MWh in 2032, an average annual growth rate of 1.9%. This reflects projected growth in the number of households, home size, and income levels, as well as relatively low electricity prices. Figure ES-3 shows the residential baseline forecast by end use.

Figure ES-3 Residential Baseline Forecast by End Use



Commercial & Industrial Sector

Table ES-2 and Table ES-3 present the segmentation of C&I customers in Washington and Idaho respectively. Although the General Service 011 and Large General Service 021 rate classes include a small percentage of industrial customers, we treated them as primarily commercial building types. For the General Service segment, we assumed facilities were small to medium buildings, dominated by retail facilities. For the Large General Service segment, we assumed the typical facility was an office building.

Table ES-2 Commercial Sector Market Characterization Results, Washington 2009

Avista Rate Schedule		LoadMAP Segment and Typical Building	Electricity sales (MWh)	Intensity (kWh/sq.ft.)
General Service	011, 012	Small and Medium Commercial — Retail	415,935	17.5
Large General Service	021, 022	Large Commercial — Office	1,556,929	16.7
Extra Large General Service Commercial	025C	Extra Large Commercial — University	265,686	13.9
Extra Large General Service Industrial	025I	Extra Large Industrial	613,615	40.0
Total			**2,852,165**	

Table ES-3 Commercial Sector Market Characterization Results, Idaho 2009

Avista Rate Schedule		LoadMAP Segment and Typical Building	Electricity sales (MWh)	Intensity (kWh/sq.ft.)
General Service	011, 012	Small and Medium Commercial — Retail	322,570	17.5
Large General Service	021, 022	Large Commercial — Office	699,953	16.7
Extra Large General Service Commercial	025C	Extra Large Commercial — University	70,361	13.9
Extra Large General Service Industrial	025I, 025P	Extra Large Industrial	1,087,974	40.0
Total			**2,180,858**	

Figure ES-4 shows the breakdown of annual electricity usage by end use for the C&I sector as a whole. Lighting is the largest single end use in the sector, accounting for one fifth of total usage.

Figure ES-4 Commercial and Industrial Electricity Consumption by End Use, 2009

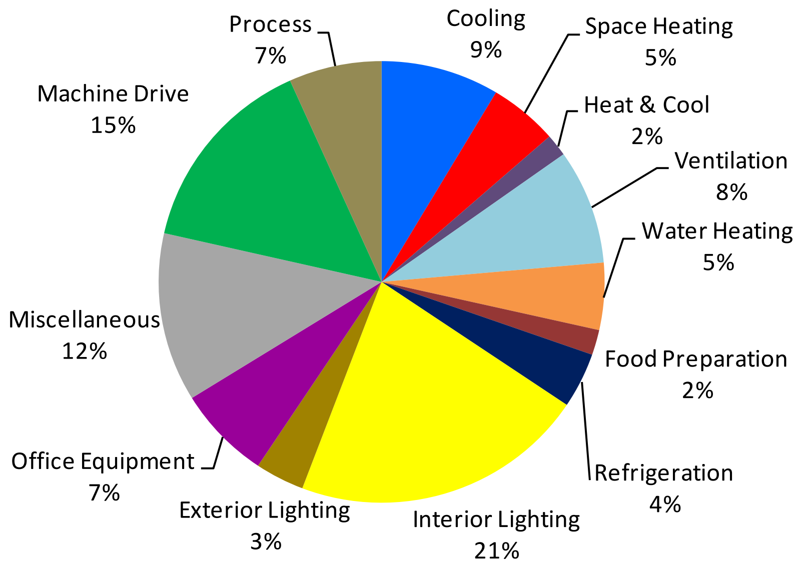
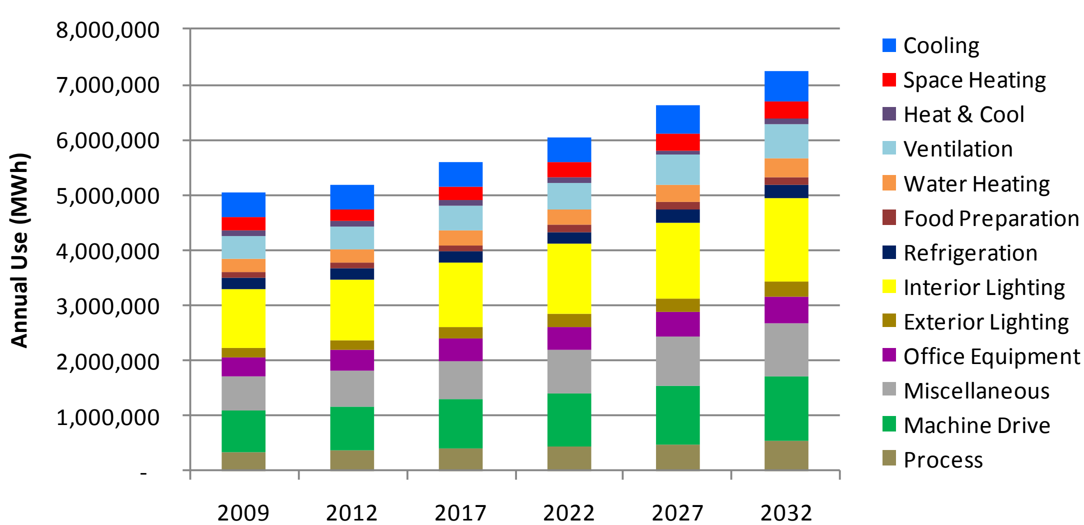


Figure ES-5 presents the baseline forecast at the end-use level for the C&I sector as a whole. Overall, C&I annual energy use increases from 5,033,023 MWh in 2009 to 7,239,694 MWh in 2032, a 43.8% increase. This reflects growth in floor space across all sectors. Interior screw-in lighting increases over the forecast period, but at a slower rate than other technologies as a result of the EISA lighting standard.

Figure ES-5 C&I Baseline Electricity Forecast by End Use



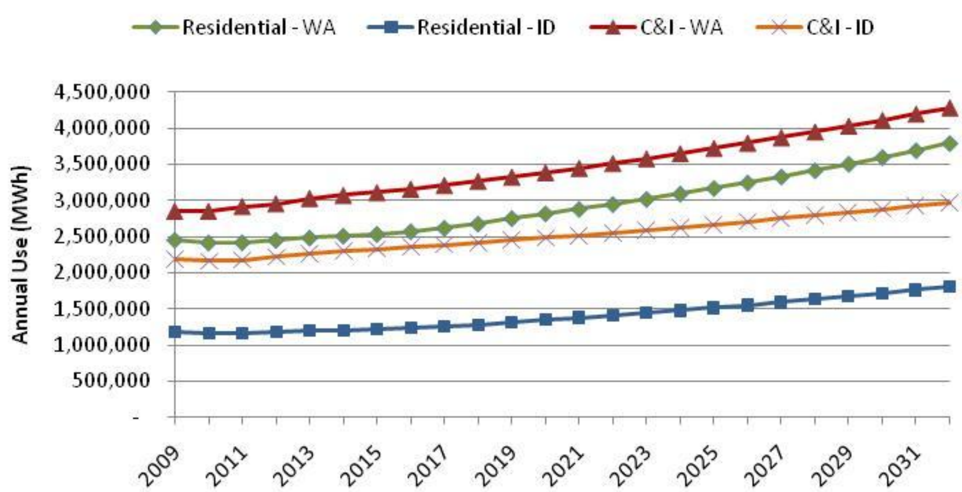
System-wide Baseline Forecast Summary

Table ES-4 and Figure ES-6 provide an overall summary of the baseline forecast by sector and for the Avista system as a whole. Overall, the forecast for the next 20 years shows substantial growth, reflecting projected increases in customers and income. This forecast is the metric against which the energy-efficiency savings potential is compared.

Table ES-4 Baseline Forecast Summary by Sector and State

End Use	2009	2012	2022	2032	% Change ('09–'32)	Avg. Growth Rate ('09–'32)
Res. WA	2,451,707	2,448,104	2,947,427	3,792,486	54.7%	1.9%
Res. ID	1,182,379	1,178,591	1,408,812	1,808,300	52.9%	1.8%
C&I WA	2,852,165	2,955,156	3,509,816	4,280,649	50.1%	1.8%
C&I ID	2,180,858	2,217,188	2,551,291	2,970,324	36.2%	1.3%
Total	**8,667,109**	**8,799,039**	**10,417,347**	**12,851,760**	**48.3%**	**1.7%**

Figure ES-6 Baseline Forecast Summary by Sector and State



The baseline forecast, prior to the consideration of potentials, projects overall growth of 48% in electric consumption. This compounded average annual growth rate of 1.7% during this 20 year period is consistent with Avista's current and previous Integrated Resource Plans. Chapter 4 provides details of the baseline forecast.

Definitions of Potential

In this study, we estimated four types of potential: *technical; economic;* and achievable potential, which is further divided into *maximum achievable,* and *realistic achievable*. Technical and economic potential are both theoretical limits to efficiency savings. Achievable potential embodies a set of assumptions about the decisions consumers make regarding the efficiency of the equipment they purchase, the maintenance activities they undertake, the controls they use for energy-consuming equipment, and the elements of building construction.

Technical potential is defined as the theoretical upper limit of energy efficiency potential. It assumes that customers adopt all feasible measures regardless of their cost. At the time of equipment failure, customers replace their equipment with the most efficient option available. In new construction, customers and developers also choose the most efficient equipment option. Examples of measures that make up technical potential in the residential sector include:

- Ductless mini-split air conditioners with variable refrigerant flow
- Ground source (or geothermal) heat pumps
- LED lighting for general service and linear applications

Technical potential also assumes the adoption of every available other measure, where applicable. For example, it includes installation of high-efficiency windows in all new construction opportunities and air conditioner maintenance in all existing buildings with central and room air conditioning.

Economic potential represents the adoption of all ***cost-effective*** energy efficiency measures. As described earlier, LoadMAP performs an economic screen to determine which measures are economically viable. LoadMAP incorporates the result of the screen into the purchase shares to reflect the most efficient measure that passes the screen. For our analysis, we apply the total resource cost (TRC) test, which compares lifetime energy and capacity benefits to the incremental cost, including the administrative costs associated with any energy-efficiency program. The benefits include non-energy benefits.

Achievable potential refines the economic potential by taking into account penetration rates of efficient technologies, expected program participation, and customer preferences and likely behavior. Two types of achievable potential were evaluated for this study:

- ***Maximum achievable potential (MAP)*** establishes an upper boundary of potential savings a utility could achieve through its energy efficiency programs. MAP presumes incentives that are sufficient to ensure customer adoption. It also considers a maximum participation rate by customers for the various energy efficiency programs that are designed to deliver the various measures. For this study, we developed market acceptance rate (MAR) factors, based on the ramp rate curves used in the Sixth Power Plan.1 These MAR factors were then applied to this study's estimates of economic potential to estimate MAP.
- ***Realistic achievable potential (RAP)*** represents a lower boundary forecast of potentials resulting from likely customer behavior and penetration rates of efficient technologies. It uses a set of program implementation factors (PIFs) to take into account existing barriers that are likely to limit the amount of savings that might be achieved through energy efficiency programs. The RAP also takes into account recent utility experience and reported savings from past and present programs.

[1] The Sixth Power Plan Conservation Supply Curve workbooks are available at http://www.nwcouncil.org/energy/powerplan/6/supplycurves/default.htm, with separate workbooks for specific sectors and end uses.

Potential Savings from Electric Energy Efficiency

Maximum achievable potential across all sectors is 88,760 MWh (10.1 aMW) in 2012 and increases to a cumulative value of 2,905,702 MWh (331.7 aMW) by 2032. These savings represents 1.0% of the baseline forecast in 2012 and 22.6% in 2032. Realistic achievable potential in 2012 is 50,261 MWh (5.7 aMW) and reaches a cumulative value of 2,155,133 MWh (246.0 aMW) by 2032, for savings that are 0.6% and 16.8% of the baseline in 2012 and 2032 respectively. Between 2012 and 2032, the baseline forecast shows overall electricity consumption growth of 46%, but the realistic achievable potential forecast reduces growth by half to 23%. Technical potential by 2032 is 37.8% of the baseline and economic potential savings are 26.4% of the baseline, or roughly 70% of technical potential savings. MAP and RAP savings in 2012 are 86% and 64% respectively of the economic potential savings.

Figure ES-7 displays the energy use forecast for the four potential levels versus the baseline forecast. Figure ES-8 summarizes the energy-efficiency savings for the four potential levels relative to the baseline forecast for selected years. Table ES-5 presents the energy consumption and peak demand for the potential levels across sectors.

Figure ES-7 Energy Efficiency Potential Forecasts, All Sectors

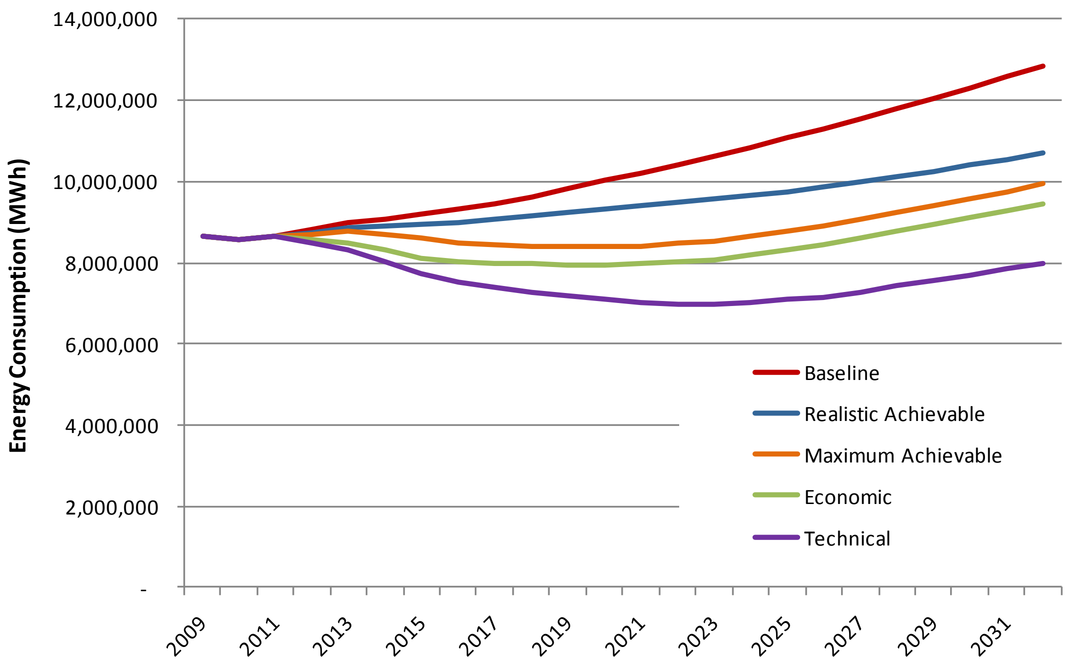


Figure ES-8 Summary of Energy Efficiency Potential Savings, All Sectors

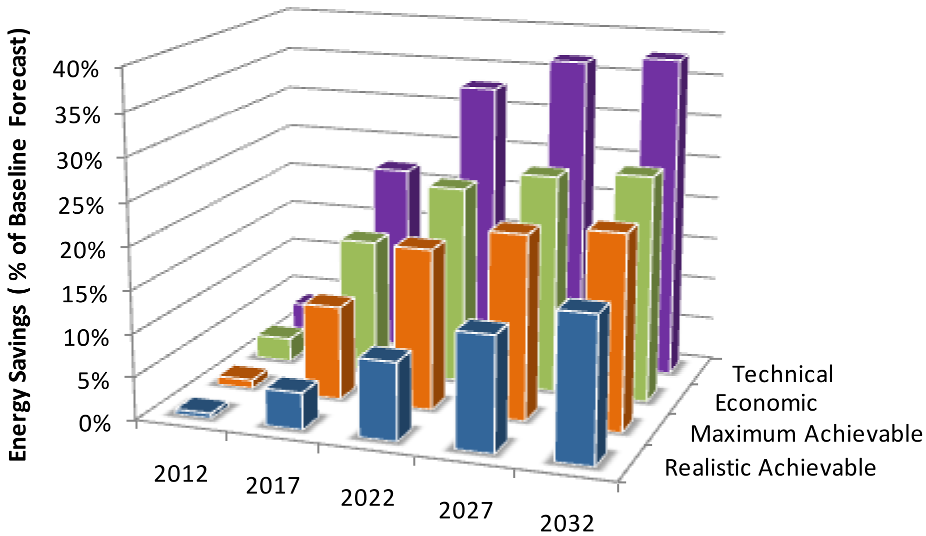


Table ES-5 Summary of Energy Efficiency Potential, All Sectors

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	8,799,039	9,463,880	10,417,347	11,536,869	12,851,760
Baseline Peak Demand (MW)	1,780	1,880	2,080	2,306	2,566
Cumulative Energy Savings (MWh)					
Realistic Achievable	50,261	405,985	945,183	1,536,357	2,155,133
Maximum Achievable	88,760	1,035,470	1,952,473	2,476,694	2,905,702
Economic	244,292	1,493,608	2,411,399	2,937,775	3,387,203
Technical	329,513	2,087,061	3,435,475	4,250,217	4,852,362
Cumulative Energy Savings (% of Baseline)					
Realistic Achievable	0.6%	4.3%	9.1%	13.3%	16.8%
Maximum Achievable	1.0%	10.9%	18.7%	21.5%	22.6%
Economic	2.8%	15.8%	23.1%	25.5%	26.4%
Technical	3.7%	22.1%	33.0%	36.8%	37.8%
Peak Savings (MW)					
Realistic Achievable	14	84	183	306	431
Maximum Achievable	22	207	386	492	566
Economic	60	302	479	580	659
Technical	78	422	669	826	943
Peak Savings (% of Baseline)					
Realistic Achievable	0.8%	4.5%	8.8%	13.3%	16.8%
Maximum Achievable	1.2%	11.0%	18.6%	21.3%	22.1%
Economic	3.4%	16.0%	23.0%	25.2%	25.7%
Technical	4.4%	22.4%	32.2%	35.8%	36.8%

Table ES-6 and Figure ES-9 summarize cumulative realistic achievable potential by sector. Initially, the residential sector accounts for about 52% of the savings, but by the end of the study, the C&I sector becomes the source of 58% of the savings.

Table ES-6 Realistic Achievable Cumulative Energy-efficiency Potential by Sector, MWh

Segment	2012	2017	2022	2027	2032
Residential, WA	17,413	94,529	238,739	431,973	637,029
Residential, ID	8,692	43,922	97,705	172,179	260,003
C&I, WA	15,733	173,433	378,252	575,328	774,619
C&I, ID	8,423	94,102	230,487	356,878	483,482
Total	**50,261**	**405,985**	**945,183**	**1,536,357**	**2,155,133**

Figure ES-9 Realistic Achievable Cumulative Potential by Sector

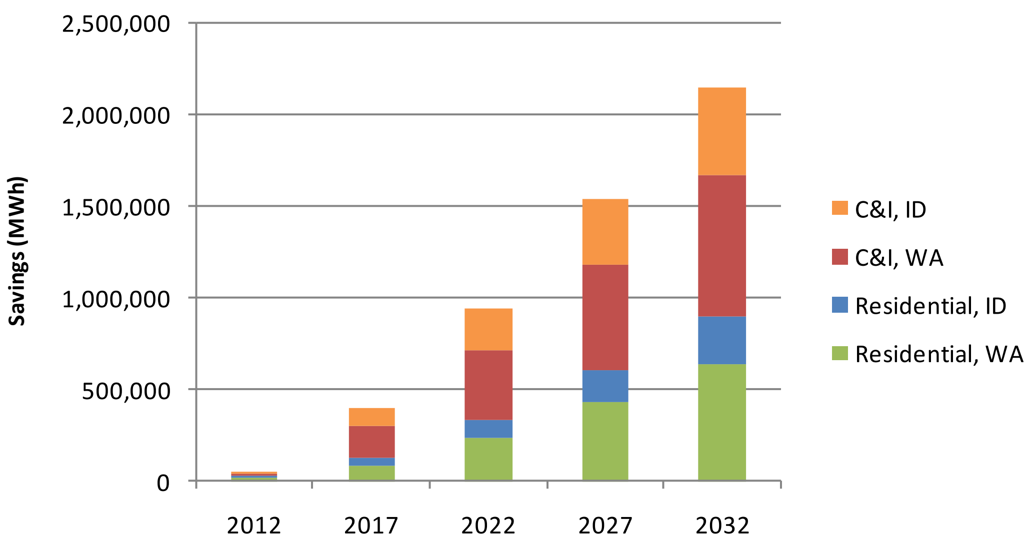


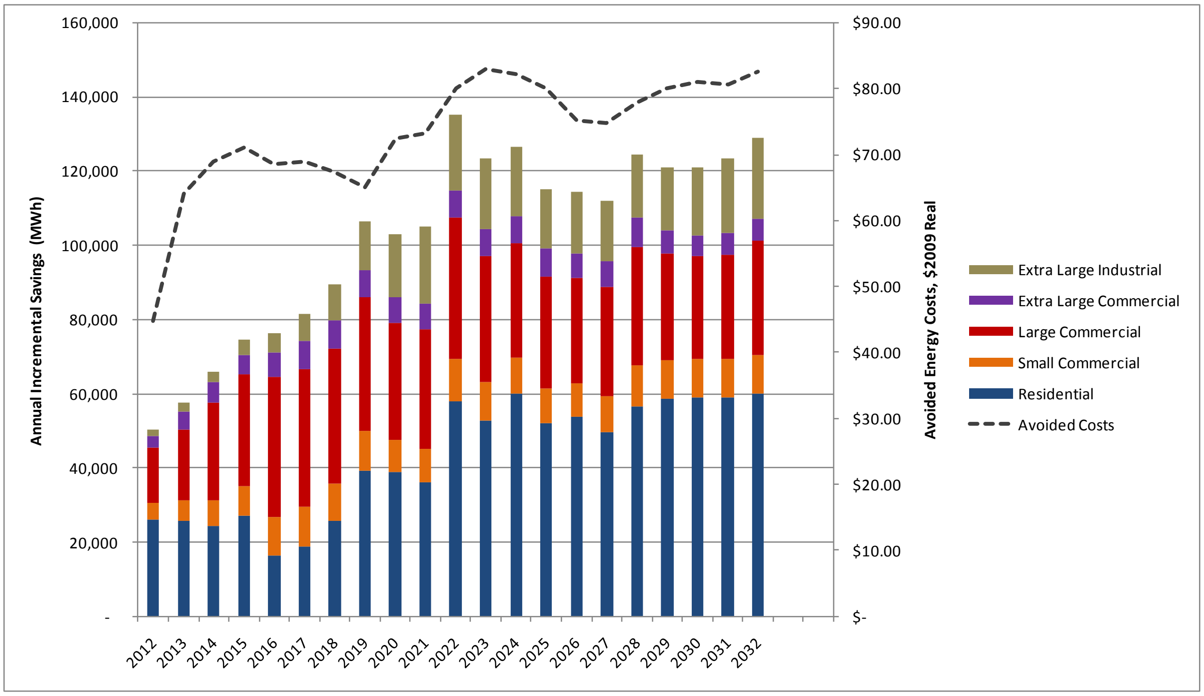
Table ES-7 shows the incremental annual realistic achievable potential by sector for 2012 through 2015. During this period, lighting and appliance standards slow the rate of growth in the residential baseline energy consumption, thus reducing the amount of incremental annual potential savings from residential conservation programs. On the other hand, C&I potential continues to grow. Complete annual incremental savings for Washington and Idaho appear in Appendices A and B respectively.

Table ES-7 Incremental Annual Realistic Achievable Energy-efficiency Potential by Sector, MWh

Segment	2012	2013	2014	2015
Residential, WA	17,413	17,161	16,488	18,514
Residential, ID	8,692	8,451	7,943	8,569
C&I, WA	15,733	21,165	26,869	30,393
C&I, ID	8,423	10,734	14,543	16,956
Total	**50,261**	**57,511**	**65,843**	**74,432**

Figure ES-10 illustrates how the annual incremental realistic achievable potential throughout the study tracks the avoided energy costs, with annual potential generally increasing or decreasing along with avoided costs. Note however that other factors also influence potential, particularly the rates at which programs can ramp up over time, which is particularly relevant to how potential changes from year to year in the early years of the study.

Figure ES-10 Incremental Annual Realistic Achievable Energy-efficiency (MWh) vs. Avoided Energy Cost



Note: Avoided costs are 2009 real dollars and include energy costs, risk, and the 10% Power Act premium.

Residential Sector Potential

Realistic achievable potential savings for the residential sector in both states is 26,105 MWh in 2012, or 0.7% of the sector's baseline forecast. It reaches 897,032 MWh, or 16.0% of the baseline forecast by 2032. Technical and economic potential savings are 37.7% and 24.5% respectively. Table ES-8 presents estimates for energy and peak demand under the four types of potential.

Table ES-8 Energy Efficiency Potential, Residential Sector

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	3,626,696	3,871,294	4,356,240	4,918,847	5,600,787
Baseline Peak Demand (MW)	991	1,026	1,150	1,288	1,449
Cumulative Energy Savings (MWh)					
Realistic Achievable	26,105	138,450	336,444	604,152	897,032
Maximum Achievable	36,300	429,065	798,829	1,024,671	1,192,794
Economic	104,111	583,427	967,788	1,188,497	1,373,869
Technical	153,100	918,965	1,468,041	1,825,587	2,112,855
Cumulative Energy Savings (% of Baseline)					
Realistic Achievable	0.7%	3.6%	7.7%	12.3%	16.0%
Maximum Achievable	1.0%	11.1%	18.3%	20.8%	21.3%
Economic	2.9%	15.1%	22.2%	24.2%	24.5%
Technical	4.2%	23.7%	33.7%	37.1%	37.7%
Peak Savings (MW)					
Realistic Achievable	10	44	100	179	262
Maximum Achievable	14	120	232	301	343
Economic	38	171	286	349	396
Technical	51	256	407	503	579
Peak Savings (% of Baseline)					
Realistic Achievable	1.1%	4.3%	8.7%	13.9%	18.1%
Maximum Achievable	1.4%	11.7%	20.2%	23.3%	23.7%
Economic	3.8%	16.7%	24.9%	27.1%	27.3%
Technical	5.1%	24.9%	35.4%	39.0%	40.0%

In terms of how residential potential is divided among the various end uses, we note the following:

- ***Water Heating*** offers the highest cumulative technical potential over the 20-year period, which reflects the high potential for conversion to natural gas in homes where gas is available (see discussion below) and use of heat pump water heaters where gas is not available, as well as a wide range of other water heating measures. Conversion to natural gas passes the TRC test throughout the study period for most Washington housing types and for single family homes in Idaho. In contrast, based on the study's assumptions of equipment cost and avoided cost, heat pump water heaters are cost-effective in new single family homes by 2014, but do not become cost-effective for existing homes until 2024 in Idaho and 2028 in Washington. Water heating also has the highest cumulative realistic achievable potential.

- ***Space Heating*** offers the second-highest cumulative technical potential over the study and its economic potential is slightly higher than water heating, again due to the potential for conversion to natural gas (see discussion below), but also due to shell measures, controls, and advanced new construction designs. Based on realistic achievable savings, space heating also ranks second.
- ***Interior lighting*** offers the fourth-largest technical potential savings, but the third-largest economic and realistic achievable potential. The lighting standard begins its phase-in starting in 2012, which coincides with the availability in the market place of advanced incandescent lamps that meet the minimum efficacy standard. The baseline forecast assumes that people will install both advanced incandescent and CFLs in screw-in lighting applications. For technical potential, LED lamps are the most efficient option, starting in 2012. However, LED lamps do not pass the economic screen until 2022, when they begin to become cost-effective for pin-based fixtures. Nonetheless, there is significant economic and realistic achievable lighting potential due to conversion from advanced incandescents to CFLs.
- ***Appliances*** rank sixth based on technical potential, but fourth in terms of realistic achievable potential. This reflects the cost-effectiveness of the highest-efficiency white-goods appliances for both new construction and for replacing failed units, as well as the market acceptance of high-efficiency appliances. Removal of second refrigerators and freezers also contributes to economic and realistic achievable potential within this end use.
- ***Cooling*** offers the third-highest technical potential, but is sixth based on realistic achievable potential. Initially technical potential is low but ramps up due to the assumption of increased saturation of air conditioning over time. Economic potential for cooling in 2031 is about 40% of technical potential because the higher SEER units do not pass the economic screen based on based on the study's assumptions of equipment cost and avoided cost.
- ***Home electronics*** also offer substantial savings opportunities. Technical potential reflects the purchase of ENERGY STAR units for all technologies, except PCs and laptops for which a super-efficient "climate saver" option is available in the marketplace. However, the climate saver options are not cost-effective during the forecast horizon, so economic potential reflects the purchase of ENERGY STAR units across all technologies in this end use.

Commercial and Industrial Sector Potential

Realistic achievable potential savings for the C&I sector in both states is 24,155 MWh in 2012, or 0.5% of the sector's baseline forecast. It reaches 1,258,101 MWh, or 17.4% of the baseline forecast by 2032. Technical and economic potential savings are 37.8% and 27.8% of the baseline forecast respectively. Table ES-9 presents estimates for the sector's energy and peak demand under the four types of potential.

In terms of how potential is divided among the various end uses, we note the following:

- ***Interior lighting*** offers the largest technical, economic, and achievable potential. The high technical potential of 892,840 MWh in 2032 is a result of LED lighting that is now commercially available in screw-in and linear lighting applications, as well as numerous fixture improvement and control options. However, LED lighting is not cost effective given the study's avoided cost assumptions, so economic potential reflects installation of CFL, T5, and Super T8 lamps throughout most of the commercial sector. Still, this results in realistic achievable potential of 598,564 MWh by 2032.
- ***Cooling*** has the third highest savings for technical potential at 302,301 MWh in 2032, and many of the cooling measures are cost effective, including installation of high-efficiency equipment, thermal shell measures, HVAC control strategies, and retrocommissioning. Because the market for cooling technologies is mature, these savings are relatively easy to capture, as reflected in the ramp rates for these measures. Thus realistic achievable potential for cooling, at 119,700 MWh, is the second highest among C&I end uses.

- ***Ventilation*** is second in terms of technical and economic potential due to conversion to variable air volume systems, high-efficiency and variable speed control fans, and retrocommissioning. Realistic achievable potential in 2032 of 117,020 MWh ranks this end use third, just behind cooling.
- ***Machine drive*** ranks fourth in realistic achievable potential at 101,018 MWh in 2032. Even though the National Electrical Manufacturer's Association (NEMA) standards make premium efficiency motors the baseline efficiency level, savings remain available from upgrading to still more efficient levels.
- ***Office equipment, exterior lighting, and industrial process improvements*** offer smaller but still significant realistic achievable potential by 2032 at 73,152 MWh, 68,467 MWh, and 60,759 MWh respectively.
- Savings from ***commercial refrigeration, food preparation, and water heating*** are relatively small across the C&I sector as a whole, though these end uses can offer significant savings in supermarkets, restaurants, hospitals, and other buildings where these end use constitute a larger portion of overall energy use.

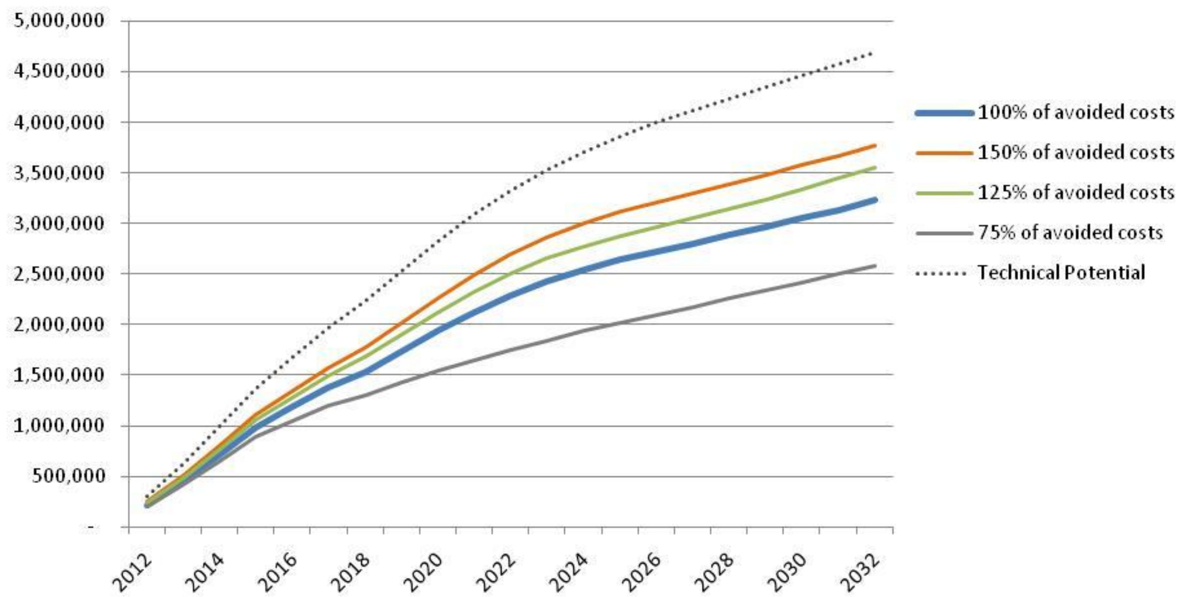
Table ES-9 Energy Efficiency Potential, Commercial and Industrial Sector

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	5,172,344	5,592,586	6,061,107	6,618,022	7,250,973
Cumulative Energy Savings (MWh)					
Realistic Achievable	24,155	267,535	608,739	932,205	1,258,101
Maximum Achievable	52,460	606,406	1,153,644	1,452,022	1,712,907
Economic	140,180	910,181	1,443,612	1,749,278	2,013,333
Technical	176,414	1,168,096	1,967,434	2,424,630	2,739,507
Cumulative Energy Savings (% of Baseline)					
Realistic Achievable	0.5%	4.8%	10.0%	14.1%	17.4%
Maximum Achievable	1.0%	10.8%	19.0%	21.9%	23.6%
Economic	2.7%	16.3%	23.8%	26.4%	27.8%
Technical	3.4%	20.9%	32.5%	36.6%	37.8%
Peak Savings (MW)					
Realistic Achievable	4	40	84	127	169
Maximum Achievable	8	88	154	191	223
Economic	22	130	193	231	263
Technical	27	166	262	324	364
Peak Savings (% of Baseline)					
Realistic Achievable	0.5%	4.7%	9.0%	12.4%	15.1%
Maximum Achievable	1.0%	10.3%	16.6%	18.8%	20.0%
Economic	2.7%	15.3%	20.8%	22.7%	23.6%
Technical	3.4%	19.4%	28.2%	31.8%	32.6%

Sensitivity of Potential to Avoided Costs

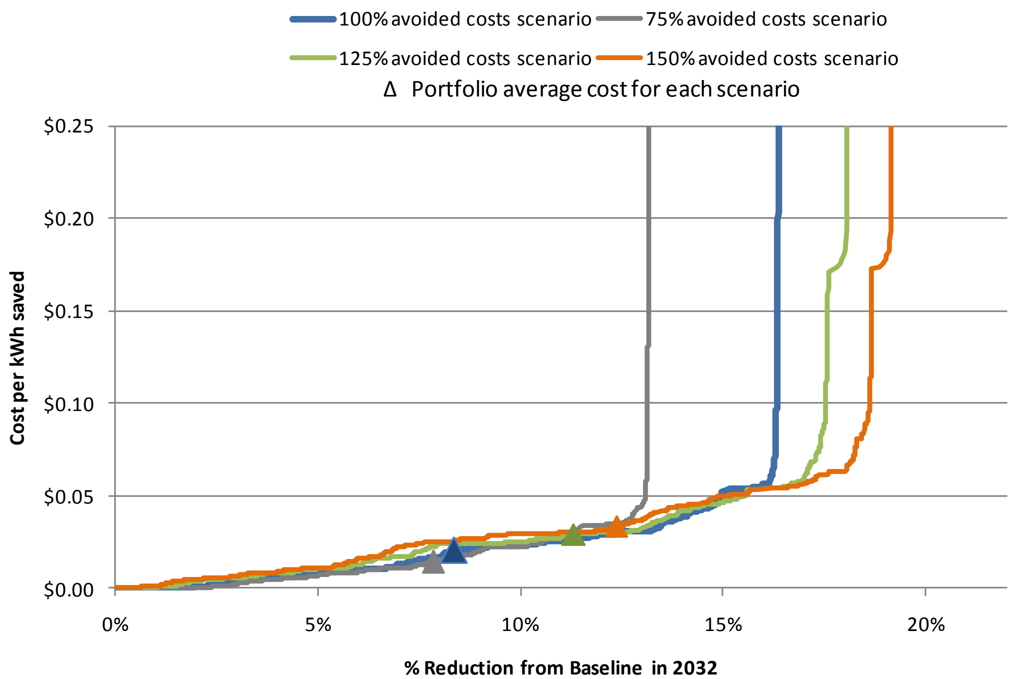
Global modeled several scenarios with varying levels of avoided costs in addition to the base case. The other scenarios included 150%, 125%, and 75% of the avoided costs used in the base case. Figure ES -11 shows how realistic achievable potential varies under the four scenarios. The base case realistic achievable potential is approximately 16.4% of the baseline forecast by 2032. With the 150% avoided cost case, realistic achievable potential increased to 19.2% of the baseline forecast, while the 125% avoided cost case and the 75% avoided cost case yielded realistic achievable potential equal to 18.1% and 13.2% of the baseline forecast respectively. While the changes are significant, the relationship between avoided cost and realistic achievable potential is not linear and increases in avoided costs do not provide equivalent percentage increases in realistic achievable potential. Technical potential imposes a limit on the amount of additional conservation and each incremental unit of conservation becomes increasingly expensive.

Figure ES -11 Energy Savings, Economic Potential Case by Avoided Costs Scenario (MWh)



The project developed a series of supply curves based on the four avoided cost scenarios, shown in Figure ES -12. Each supply curve is created by stacking measures and equipment over the 20-year planning horizon in ascending order of cost. As expected, this stacking of conservation resources produces a traditional upward-sloping supply curve. The 75% of avoided cost scenario provides roughly a 13% reduction in energy use compared with the baseline forecast in 2032, at a cost of $0.05/kWh or less. The other three scenarios track one another closely, providing just over 15% savings in 2032 at costs below $0.05/kWh.

Figure ES -12 Supply Curves for Evaluated EE Measures and Avoided Cost Scenarios



Sensitivity of Potential to Customer and Economic Growth

This conservation potential assessment shows that conservation offsets roughly 50% of growth in electrical energy use for the Avista system, whereas the Sixth Plan projects that conservation can offset 80% of growth. Of course, Avista's service territory differs from the region overall in many ways, including its climate. Another significant factor may be the CPA study's assumptions regarding customer and economic growth. To better understand how growth affects the study's results, the project team evaluated scenarios with lower customer and economic growth, as indicated in Table ES-10.

Table ES-10 Varying Growth Scenario Descriptions

	Reference Scenario	Low Growth Scenario 1	Low Growth Scenario 2
Home size	~ 1% per year growth	Capped at 110% of existing home size	Capped at 110% of existing home size
Per capita income growth	1.6% 2011–2015; 2.2% 2016–2020; 2.1% thereafter	1.6% after 2016	1.6% after 2016
Residential sector market growth	1.30% after 2015 (WA) 1.25% after 2015 (ID)	no change	1.0% after 2015 (WA & ID)
Commercial sector market growth, WA & ID	~ 2.0% (varies by segment)	no change	1.0% all segments

Table ES -11 shows that as economic and customer growth decreases, the ability of conservation to offset growth increases. In the reference scenario, energy efficiency offsets 52% of growth in consumption, while in the lower growth scenarios, EE offsets 54% and 76% of growth respectively. This is the case because with reduced new construction, load growth and achievable potential drop, but savings due to the retrofit of existing buildings constitute a greater proportion of load growth.

Table ES -11 Varying Growth Scenario Results

	Reference Scenario	Low Growth Scenario 1	Low Growth Scenario 2
Baseline forecast 2012 (MWh)	8,799,039	8,799,039	8,799,033
Baseline forecast 2032 (MWh)	12,851,760	12,523,843	11,178,008
Load growth 2012-2032 (MWh)	4,052,720	3,724,803	2,378,975
Realistic achievable potential forecast 2032 (MWh)	10,745,176	10,500,088	9,366,471
Realistic achievable potential savings 2032 (MWh)	2,106,584	2,023,754	1,811,538
Percentage of growth offset	52%	54%	76%

Note: Value of 2,106,548 MWh for 2032 realistic achievable potential was based on interim results and thus is different from the value shown elsewhere in this report.

Pumping Potential

As displayed in Table ES -12, pumping accounts represent 2.2% of Avista's total electricity sales and 0.8% of peak demand. Because pumping represents a relatively small percentage of Avista's total sales, the project team decided to use the NWPCC Sixth Plan calculator to estimate pumping energy efficiency potential.

Table ES -12 Pumping Rate Classes, Electricity Sales and Peak Demand 2009

Sector	Rate Schedule(s)	Number of meters (customers)	2009 Electricity sales (MWh)	Peak demand (MW)
Pumping, Washington	031, 032	2,361	135,999	10
Pumping, Idaho	031, 032	1,312	58,885	4
Pumping, Total		3,673	194,884	14
Percentage of System Total			**2.2%**	**0.8%**

The Sixth Plan Calculator estimates agricultural conservation targets through 2019, based on 2007 sales. We trended the data through 2022 to provide annual savings estimates for the ten-year period 2012–2022, with the results provided in Table ES -13 and Table ES -14.

Table ES -13 Sixth Plan Calculator Agriculture Incremental Annual Potential, Selected Years (MWh)

Segment	2012	2013	2014	2015
Pumping, Washington	1,567	1,484	1,402	1,835
Pumping, Idaho	690	654	618	809
Pumping, Total	**2,257**	**2,138**	**2,020**	**2,643**

Table ES -14 Sixth Plan Calculator Agriculture Cumulative Potential, Selected Years (MWh)

Measure	2012	2017	2022
Pumping, Washington	1,567	9,979	18,892
Pumping, Idaho	690	4,397	8,324
Pumping, Total	**2,257**	**14,375**	**27,217**

Report Organization

The body of the report is organized as follows:

- Chapter 1, Introduction
- Chapter 2, Study Approach for Energy Efficiency Analysis
- Chapter 3, Market Assessment and Market Profiles
- Chapter 4, Baseline Forecast
- Chapter 5, Energy Efficiency Measure Analysis
- Chapter 6, Energy Efficiency Potential Results
- Appendix A, Washington Results
- Appendix B, Idaho Results
- Appendix C, Residential Energy Efficiency Equipment and Measure Data
- Appendix D, Commercial Energy Efficiency Equipment and Measure Data
- Appendix E, Study References

Results of the demand response analysis and the natural gas potential assessment will be presented in separate forthcoming documents.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Avista Corporation (Avista) engaged Global Energy Partners (Global) to conduct a Conservation Potential Assessment (CPA) Study. The CPA is a 20-year potentials study for energy efficiency (EE) and demand response (DR) to provide data on demand-side resources for developing Avista's 2011 Integrated Resource Plan (IRP), and in accordance with Washington I-937. The study used 2009, the first year for which complete billing data was available, as the baseline year and then developed potential estimates for the period 2012-2032. Although the final report will address electricity and natural gas, this interim report provides results of the electricity potential study only.

1.2 OBJECTIVES

Key objectives for the study include:

- Conduct a conservation potential study for electricity for Washington and Idaho, and natural gas for Washington, Idaho, and Oregon. The study will account for:
  - Impacts of existing Avista conservation programs
  - Avista's load forecasts and load shapes
  - Impacts of codes and standards
  - Technology developments and innovation
  - The economy and energy prices
  - Naturally occurring energy savings
- Assess and analyze cost-effective EE and DR potentials in accordance with the Northwest Power and Conservation Council's (NWPPC) 6th Power Plan and Washington I-937 requirements.
- Obtain supply curves showing the incremental costs associated with achieving higher levels of EE and DR and stacking EE and DR resources by cost of conserved energy.
- Analyze various market penetration rates associated with technical, economic, achievable, and naturally occurring potential estimates.

1.3 REPORT ORGANIZATION

The remainder of this report presents the results of the electricity conservation potential assessment for Avista's Washington and Oregon service territory. In most cases, results for Avista's overall electric system are presented in the body of the report, and Washington- and Oregon-specific results are presented in Appendices A and B respectively. The report is organized as follows:

- Chapter 2, Study Approach for Energy Efficiency Analysis
- Chapter 3, Market Assessment and Market Profiles
- Chapter 4, Baseline Forecast
- Chapter 5, Energy Efficiency Measure Analysis
- Chapter 6, Energy Efficiency Potential Results
- Appendix A, Washington Results
- Appendix B, Idaho Results
- Appendix C, Residential Energy Efficiency Equipment and Measure Data
- Appendix D, Commercial Energy Efficiency Equipment and Measure Data
- Appendix E, Study References

Results of the demand response analysis and the natural gas potential assessment will be presented in separate forthcoming documents.

CHAPTER | 2

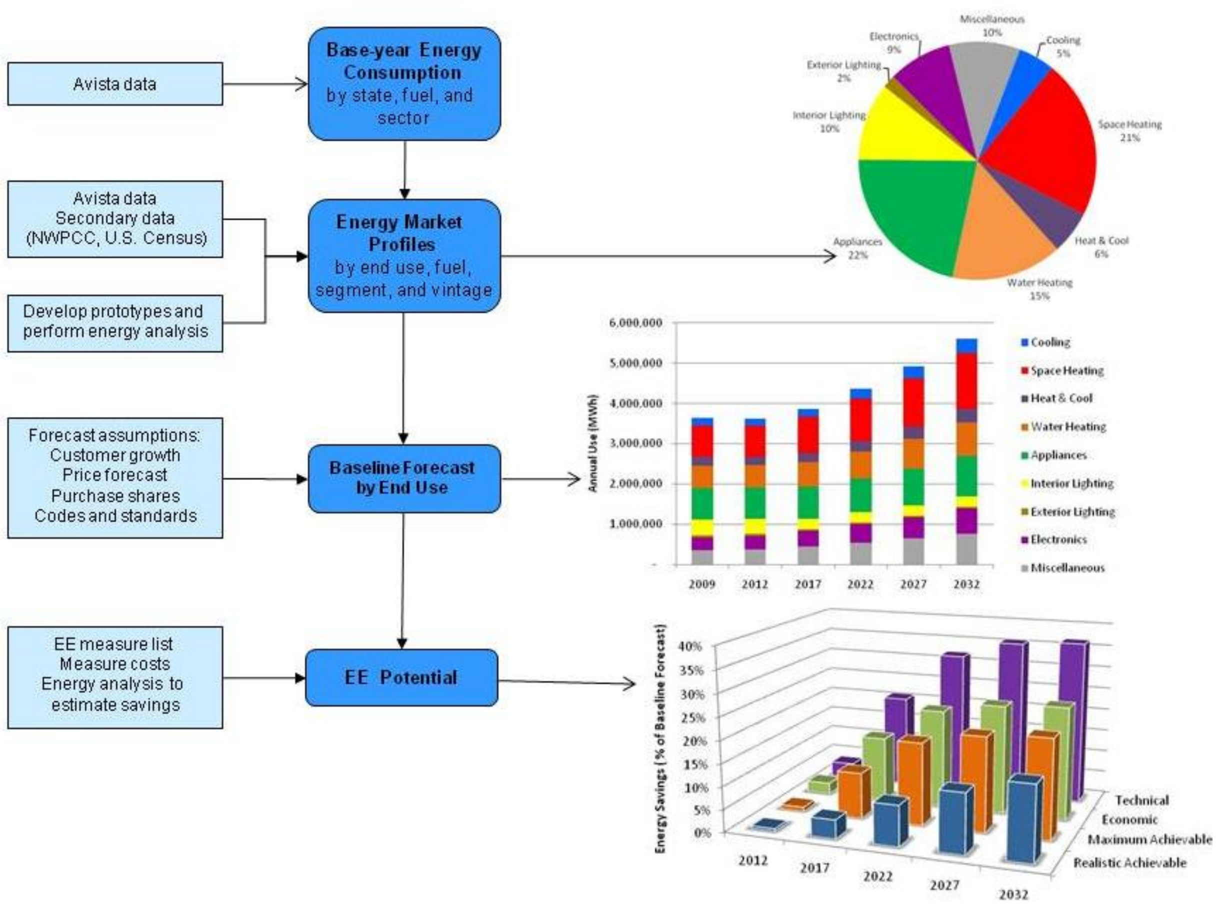
STUDY APPROACH FOR ENERGY EFFICIENCY ANALYSIS

To execute this project, Global took the following steps, which are also shown in Figure 2-1.

1. Performed a market assessment to describe base year energy consumption for the residential and C&I sectors. This included using utility data and secondary data to understand customers in Avista's service territory and how these customers currently use electricity. Based on the market assessment, we developed energy market profiles for the study's base year, 2009.
2. Developed a baseline energy forecast by sector and end use for the twenty-year study period.
3. Identified and analyzed energy-efficiency measures appropriate for the Avista service area.
4. Estimated four levels of energy-efficiency potential, *Technical, Economic, Maximum Achievable,* and *Realistic Achievable*.

The steps are described in further detail throughout the remainder of this section.

Figure 2-1 Analysis Approach Overview



2.1 MARKET ASSESSMENT AND MARKET PROFILES

It is absolutely critical to develop a good understanding of where Avista is today in terms of energy use and customer behavior before developing projections of potential EE savings. The purpose of the market assessment is to develop market profiles that describe current electricity use in terms of sector, customer segment, and end use. The base year for this study is 2009, the most recent year for which complete billing data was available at the start of the study.

We began the market assessment by defining the market segments (building types, end uses and other dimensions) that are relevant in the Avista service territory. The segmentation scheme employed for this project, as presented in Table 2-1, is based on Avista rate schedules. For the pumping rate classes, we determined to use the Northwest Power and Conservation Council (NWPCC) Sixth Plan calculator to determine future EE potential.

Table 2-1 Segmentation Framework for Electricity

Market Dimension	Segmentation Design	Dimension Examples
Dimension 1	Geographic Region	Washington, Idaho
Dimension 2	Sector / Rate Class	Residential — Rate Class 001 C&I General Service — Rate Class 011, 012 C&I Large General Service — Rate Classes 021, 022 Comm. Extra Large General Service — Rate Class 025 Ind. Extra Large General Service — Rate Classes 025, 025P Pumping — Rate Classes 030, 031, 032
Dimension 3	Building Type	Residential: single-family, multi-family, mobile home, limited income No further segmentation of C&I and pumping, except for XLarge General Service, which was divided into commercial and industrial segments
Dimension 4	Vintage	Existing and new construction (as appropriate for residential and commercial sectors)
Dimension 5	End Uses	Cooling, lighting, water heat, motors, etc. (as appropriate by sector)
Dimension 6	Appliances/End Uses and Technologies	Cooling, lighting, water heat, motors, etc. (as appropriate by sector); Technologies such as types of lamps, chillers, color TVs, etc.
Dimension 7	Equipment Efficiency Levels	Old, Standard (minimum standard), Maximum Efficiency

With the segmentation scheme defined, we set out to populate the market profiles. The first step was to identify the electricity sales in the base year for each segment using Avista's 2009 historical customer billing data by rate class. In order to further divide the residential sector, we relied upon regional demographic and economic data from secondary sources (see below).

Then, we developed the data for the remaining market profile elements, which include market size, annual electricity use, electric appliance and equipment saturations, technology shares, and end-use consumption estimates (unit energy consumption or UEC for residential customers and energy use index or EUI for C&I customers). We calibrated the elements of the market profile for each segment to match the segment and sector-level sales we developed in the previous step. We developed market profiles for the entire existing market, as well as new construction in each segment.

While this study did not involve any primary market research, a wealth of primary data is available for the Pacific Northwest region from NEEA and a recent customer saturation survey from Inland Power and Light, a neighboring utility. In addition, data were available from a residential survey conducted as part of Inland Power's December 2009 CPA. We used these sources together with other secondary data, including the Energy Information Agency's Residential Energy Consumption Survey (RECS), the Annual Energy Outlook (AEO), the California's Residential Appliance Saturation Survey (RASS), and the California Commercial End Use Survey (CEUS), to develop the market profiles.

In addition to information about annual electricity use, we also needed estimates of peak demand by segment and end use in order to calculate peak-demand savings from EE measures. We developed a set of peak factors, factors that represent the fraction of annual energy use that occurs during the peak hour, and apply them to annual electricity use to calculate peak demand by end use. Peak factors for this study were developed for each sector, customer segment and end use using Global's EnergyShape™ database and information from Avista regarding its load shapes and peak demand.[2]

Table 2-2 summarizes the data required for the market profiles. This information is required for each segment within each sector, as well as for new construction and existing dwellings/buildings. Additional details regarding sources appear in Appendix E.

Table 2-2 Data Needs for the Market Profiles

Model Inputs	Description	Key Sources
Base-year data		
Market size	Base-year residential dwellings and C&I floor space	Avista billing data, NEEA Reports
Appliance/equipment saturations	Fraction of dwellings with an appliance/technology; Percentage of C&I floor space with equipment/technology	NEAA reports, Inland Power & Light residential saturation survey, RECS, and other secondary data
UEC/EUI for each end-use technology	UEC: Annual electricity use for a technology in dwelling that have the technology; EUI: Annual electricity use per square foot for a technology in floor space that has the technology	NEAA reports, RASS, CEUS, engineering analysis, prototype simulations, engineering analysis
Appliance/equipment vintage distribution	Age distribution for each technology	NEEA reports, RASS, CEUS, secondary data (DEEM, EIA, EPRI, DEER, etc.)
Efficiency options for each technology	List of available efficiency options and annual energy use for each technology	Prototype simulations, engineering analysis, appliance/equipment standards, secondary data (DEEM, EIA, EPRI, DEER, etc.)
Peak factors	Share of technology energy use that occurs during the peak hour	Avista data; Global's EnergyShape database

The quality of data inputs is critical. To ensure the best results, we pursued the following course during the data-development process.

[2] The peak factors were used to compute peak demand savings only and they were not used to develop a stand-alone peak-demand forecast.

1. Used NEEA reports, the Inland Power & Light survey of its residential customers, and RECS to provide information about market size for customer segments, appliance and equipment saturations, appliance and equipment characteristics, UECs, building characteristics, customer behavior, operating characteristics, and energy-efficiency actions already taken.
2. Incorporated secondary data sources to supplement and corroborate the research in items 1 and 2 above.
3. Compared and cross-checked with data obtained as part of other northwest utility studies, the EPRI National Potential Study, and other regional sources.
4. Ensured calibration to control totals such as total usage values by segment, available through the billing data.
5. Worked with the Avista staff and the extended project team to vet the data against their knowledge and experience.

The market assessment, market segmentation, and resulting market profiles are presented in Chapter 3.

2.2 BASELINE FORECAST

The next step of the energy efficiency potential study was to develop the baseline forecast which is the metric against which savings from energy-efficiency measures are compared. The baseline case forecasts annual electricity use and peak demand by customer segment and end use under a "business as usual" (without new utility programs) scenario for the 20-year planning horizon starting in 2012. This process is crucial as it allows for projections to be determined in the absence of future conservation programs. This puts the changes in market conditions and customer potentials estimates in context of total energy use in the future and also allows us to project where the energy-efficiency savings will come from. The end-use forecast also includes the expected impacts of codes and standards, which affect what is possible through utility programs. Given the recent extensive attention to energy efficiency at the national level through Smart Grid and American Reinvestment and Recovery Act (ARRA) stimulus efforts and promulgated through the implementation of more stringent codes and standards both nationally and in local jurisdictions, we have taken steps in our modeling framework to capture the effects of market influences in our baseline forecast assessments. This is an important issue for this study, as the adoption of future codes and standards will have a direct bearing on how much utility program EE potential there can be over and above the effects of those efforts. This study includes standards in effect as of late 2010, which were not taken into account during the development of the Sixth Plan.

Inputs to the baseline forecast include:

- Current economic growth forecasts
- New construction forecasts
- Appliance and equipment standards
- Existing and approved changes to building codes and standards
- Forecasted changes in fuel share and equipment saturation
- The (future) effects of utility programs offered prior to 2010
- Avista's electricity price and sales forecasts

2.2.1 Modeling Approach

We used the Load Management Analysis and Planning tool (LoadMAP™) to develop the baseline forecast, as well as forecasts of energy-efficiency potential. Global developed LoadMAP in 2007 and has used it for the EPRI National Potential Study and numerous utility-specific forecasting and potential studies. Built in Excel, the LoadMAP framework is both accessible and transparent and has the following key features.

- Embodies the basic principles of rigorous end-use models (such as EPRI's REEPS and COMMEND) but in a more simplified, accessible form.
- Includes stock-accounting algorithms that treat older, less efficient appliance/equipment stock separately from newer, more efficient equipment. Equipment is replaced according to the measure life defined by the user.
- Balances the competing needs of simplicity and robustness by incorporating important modeling details related to equipment saturations, efficiencies, vintage, and the like, where market data are available, and treats end uses separately to account for varying importance and availability of data resources.
- Isolates new construction from existing equipment and buildings and treats purchase decisions for new construction, replacement upon failure, early replacement, and non-owner acquisition separately.
- Uses a simple logic for appliance and equipment decisions. Other models available for this purpose embody complex decision choice algorithms or diffusion assumptions, and the model parameters tend to be difficult to estimate or observe and sometimes produce anomalous results that require calibration or even overriding. The LoadMAP approach allows the user to drive the appliance and equipment choices year by year directly in the model. This flexible approach allows users to import the results from diffusion models or to input individual assumptions. The framework also facilitates sensitivity analysis.
- Includes appliance and equipment models customized by end use. For example, the logic for lighting equipment is distinct from refrigerators and freezers.
- Can accommodate various levels of segmentation. Analysis can be performed at the sector level (e.g., total residential) or for customized segments within sectors (e.g., housing type or income level).

Consistent with the segmentation scheme and the market profiles we describe above, the LoadMAP model provides forecasts of baseline energy use by sector, segment, end use and technology for existing and new buildings. It provides forecasts of total energy use and energy-efficiency savings associated with the four types of potential. It also provides forecasts of peak-demand savings for each type of potential.[3]

Table 2-3 summarizes the LoadMAP model inputs required for the baseline forecast. These inputs are required for each segment within each sector, as well as for new construction and existing dwellings/buildings.

[3] The model computes a peak-demand forecast for each type of potential for each end use as an intermediate calculation. Peak-demand savings are calculated as the difference between the peak-demand value in the potential forecast (e.g., technical potential) and the peak-demand value in the baseline forecast.

Table 2-3 Data Needs for the Baseline Forecast and Potentials Estimation in LoadMAP

Model Inputs	Description	Key Sources
Customer growth forecasts	Forecasts of new construction in residential and C&I sectors	Avista 2009 IRP, Sixth Power Plan, Regional census data
Equipment purchase shares for baseline forecast	For each equipment/technology, purchase shares for each efficiency level; specified separately for equipment replacement (replace-on-burnout), non-owner acquisition, and new construction	Shipments data, AEO forecast assumptions, appliance/efficiency standards analysis
Electricity prices	Forecast of average electricity prices	Avista price forecast data
Utilization model parameters	Price elasticities, elasticities for other variables (income, weather)	EPRI's REEPS and COMMEND models; Avista forecasting data

We present the results of the baseline forecast development in Chapter 4. As with the development of the market profiles, we reviewed the baseline forecast results with the Avista staff.

2.3 ENERGY EFFICIENCY MEASURES ANALYSIS

The framework for assessing savings, costs, and other attributes of energy-efficiency measures involves identifying the list of measures to include in the analysis, determining their applicability to each market sector and segment, fully characterizing each measure, and performing cost-effectiveness screening. Potential measures include the replacement of a unit that has failed or is at the end of its useful life with an efficient unit, retrofit/early replacement of equipment, improvements to the building envelope and other actions resulting in improved energy efficiency, and the application of controls to optimize energy use.

We compiled a robust listing of energy efficiency measures for each customer sector, drawing upon a variety of secondary sources:

- The Sixth Power Plan database of EE measure costs and savings
- NEEA's Regional Technical Forum
- Database for Energy Efficient Resources (DEER). The California Energy Commission and California Public Utilities Commission (CPUC) sponsor this database, which is designed to provide well-documented estimates of energy and peak demand savings values, measure costs, and effective useful life (EUL) all with one data source for the state of California.
- Global's Database of Energy Efficiency Measures (DEEM). In 2004, Global prepared a database of energy efficiency measures for residential and commercial segments across the U.S. This is analogous to the DEER database developed for California. Global updates the database on a regular basis as it conducts new energy efficiency potential studies.
- EPRI National Potential Study (2009). In 2009, Global conducted an assessment of the national potential for energy efficiency, with estimates derived for the four DOE regions (including the Pacific region that includes California).

Based on this compilation of information, Global assembled a broad and inclusive universal list of EE measures, covering all major types of end-use equipment, as well as devices and actions to reduce energy consumption. If considered today, many of these measures would not pass the economic screens, but may ultimately be part of Avista's EE program portfolios.

Once we assembled the list of EE measures, the project team assessed their energy-saving characteristics. For energy-saving measures not already specified in the databases above, we used Global's Building Energy Simulation Tool (BEST), a derivative of the DOE 2.2 building simulation model, to estimate measure savings. We used building prototypes for the Northwest region to estimate energy savings.

For each measure we also characterized incremental cost, service life, and other performance factors. Following the measure characterization, we performed an economic screening of each measure, which serves as the basis for developing the economic potential.

We provide further descriptions of EE measures analysis and the economic screening process in Chapter 5.

2.4 ASSESSMENT OF ENERGY-EFFICIENCY POTENTIAL

A key objective of this study is to estimate the potential for energy savings through energy efficiency activities in the Avista electric service territory. The potential impact of EE activities is the cumulative total of all energy-related projects.

The approach we used for this study adheres to the approaches and conventions outlined in the National Action Plan for Energy-Efficiency (NAPEE) Guide for Conducting Potential Studies (November 2007).[4] The NAPEE Guide represents the most credible and comprehensive industry practice for specifying energy-efficiency potential. Specifically, four types of potentials were developed as part of this study.

Technical potential is calculated by applying the most efficient option commercially available to each purchase decision, regardless of cost. It is a theoretical case that provides the broadest and highest definition of savings potential since it quantifies the savings that would result if all current equipment, processes, and practices in all sectors of the market were replaced by the most efficient feasible type. Technical potential does not take into account the cost-effectiveness of the measures. Further, technical potential is specifically defined as "phase-in technical potential," which assumes that only the portion of the current stock of equipment that has reached the end of its useful life and is due for turnover is changed out by the most efficient measures available (i.e., replacement). Non-equipment measures, such as controls and other devices (e.g., programmable thermostats) are not adopted all at once but are phased-in over time, just like the equipment measures. Lighting retrofits, which are in effect early replacements of existing lighting systems, are considered a non-equipment measure.

Economic potential results from the purchase of the most efficient *cost-effective* option available for a given equipment or non-equipment measure. Cost effectiveness is determined by applying an economic test. In this report, the total resource cost (TRC) test[5] was used to assess the cost-effectiveness of individual measures. Measures that passed the economic screen were then represented in the aggregate for economic potential. As with technical potential, economic potential is a phased-in approach. Economic potential is still a hypothetical upper-boundary of savings potential as it represents only measures that are economic but does not yet consider customer acceptance and other factors.

Achievable potential refines the economic potential by taking into account penetration rates of efficient technologies, expected program participation, and customer preferences and likely behavior. Two types of achievable potential were evaluated for this study:

- ***Maximum achievable potential (MAP)*** establishes an upper boundary of potential savings a utility could achieve through its energy efficiency programs. MAP presumes incentives that are sufficient to ensure customer adoption. It also considers a maximum

[4] National Action Plan for Energy Efficiency (2007). *National Action Plan for Energy Efficiency Vision for 2025:* Developing a Framework for Change. www.epa.gov/eeactionplan.

[5] While there are other tests that can be used to represent the economic potential (e.g., Participant or Utility Cost), the TRC is generally seen as the most appropriate representation of economic potential since it tends to be most representative of the net benefits of energy efficiency to society as a whole. The TRC is used in the economic screen as a proxy for moving forward and representing achievable energy efficiency savings potential for those measures that are most widely cost-effective.

participation rate by customers for the various energy efficiency programs that are designed to deliver the various measures. For this study, we developed market acceptance rate (MAR) factors, based on the ramp rate curves used in the Sixth Power Plan. These MAR factors were then applied to this study's estimates of economic potential to estimate MAP.

- ***Realistic achievable potential (RAP)*** represents a lower boundary forecast of potentials resulting from likely customer behavior and penetration rates of efficient technologies. It uses a set of program implementation factors (PIFs) to take into account existing barriers that are likely to limit the amount of savings that might be achieved through energy efficiency programs. The RAP also takes into account recent utility experience and reported savings from past and present programs.

2.4.1 Modeling Approach

We used LoadMAP to develop the estimates of technical, economic, and achievable potential. LoadMAP calculates results in terms of annual energy saved (kWh) and peak demand reduction (MW) for each level of potential by market segment, end use, and measure type. Figure 2-2 illustrates the LoadMAP process for developing both the baseline forecast the potentials forecasts.

For the ***technical potential***, LoadMAP "chooses" the most efficient option for each purchase decision involving major end-use equipment (refrigerators, air conditioners) during the forecast period. It also phases in all non-equipment measures during the forecast period.

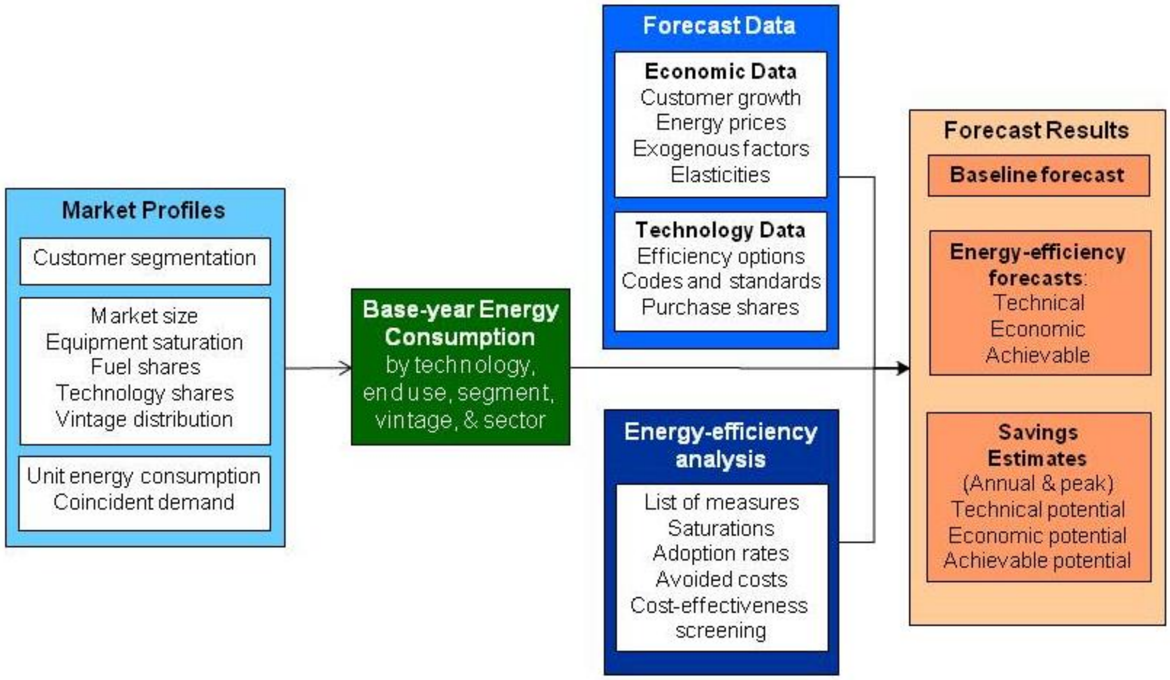
For the ***economic potential***, LoadMAP applies the TRC, which tests each measure in terms of its lifetime benefits (i.e., energy savings multiplied by the avoided cost) relative to the initial capital cost required to install the measure. If the benefit/cost ratio is greater than or equal to 1.0, then the measure passes the screen and it is included in the calculation of economic potential. If the B/C ratio is less than 1.0, the measure is screened out of economic potential. To allow for the changing characteristics of individual, new measures, we perform the economic screen during each year of the forecast period. Therefore, a measure than may not pass the screen in 2010 may pass in some future year. If more than one efficiency option passes the economic screen, for example if SEER 15 and SEER 16 both pass, then the most efficient option, SEER 16, is included in the calculation of economic potential.

Economic potential still does not take into account the acceptance of those measures by customers, so it is still a hypothetical upper-boundary of EE potential. But again, this exercise is important as it provides useful insights as to how much potential is economic and oftentimes can be compared with other studies of economic potential.

To develop estimates for ***maximum and realistic achievable potential***, we specify market adoption rates and program implementation factors for each measure as described above. For this study, we based these factors on the Sixth Power Plan's conservation curve ramp rates, and the past experience at Avista and at other utility EE programs. We also tapped into our recently completed market research for two EE potential studies in which we assessed customer acceptance rates taking into account some degree of financial intervention on the part of the utility to bring down customer paybacks to a level that motivates their participation in various EE programs. While there is a significant degree of uncertainty associated with these adoption rates, we believe that the approach is reasonable and is bounded by the experience gained from other utility EE efforts. Because the adoption rates are model inputs, they can be modified as new information becomes available.

The LoadMAP model provides a forecast of annual electricity use and peak demand under the four types of potential. The energy and peak-demand savings from energy efficiency measures are calculated as the difference between the values for the baseline forecast and the potential forecast.

Figure 2-2 LoadMAP Baseline and Potential Modeling



Results of the potentials assessment are presented in Chapter 6.

CHAPTER | 3

MARKET ASSESSMENT AND MARKET PROFILES

Avista Utilities, headquartered in Spokane, Washington is an investor-owned utility with annual revenues of more than $1.3 billion. Avista provides electric and natural gas service to about 481,000 customers in a service territory of more than 30,000 square miles. Avista uses a mix of hydro, natural gas, coal and biomass generation delivered over 2,100 miles of transmission line, 17,000 miles of distribution line, and 6,100 miles of natural gas distribution mains. Avista currently operates a portfolio of electric and natural gas conservation programs in Washington, Idaho, and Oregon for residential, low-income, and non-residential customers that is funded by a non-bypassable systems benefits charge.

The base year for this study is 2009, the most recent year for which complete billing data were available at the beginning of the study. Table 3-1 and Table 3-2 show the breakdown, for Washington and Idaho respectively, of 2009 electricity sales among the major sectors and rate classes, drawn from billing data provided by Avista. Peak demand data was taken from the 2009 *System Load Research Project* report.[6] Figure 3-1and Figure 3-2 show similar data, but with the Extra Large General Service customers (rate class 025) further divided into commercial and industrial. In Figure 3-2 for Idaho, Extra Large General Service also includes Potlatch, rate class 25P.

Table 3-1 Electricity Sales and Peak Demand by Rate Class, Washington 2009

Sector	Rate Schedule(s)	Number of meters (customers)	2009 Electricity sales (MWh)	Peak demand (MW)
Residential	001	200,134	2,451,687	710
General Service	011, 012	27,142	415,935	64
Large General Service	021, 022	3,352	1,556,929	232
Extra Large General Service	025	22	879,233	134
Pumping	031, 032	2,361	135,999	10
Total		**233,011**	**5,439,850**	**1,150**

Table 3-2 Electricity Use and Peak Demand by Rate Class, Idaho 2009

Sector	Rate Schedule(s)	Number of meters (customers)	2009 Electricity sales (MWh)	Peak demand (MW)
Residential	001	99,580	1,182,368	283
General Service	011, 012	19,245	322,570	61
Large General Service	021, 022	1,456	699,953	115
Extra Large General Service	025, 025P	10	266,044	40
Extra Large GS Potlatch	025P	1	892	101
Pumping	031, 032	1,312	58,885	4
Total		**121,604**	**3,422,111**	**603**

[6] Avista Corp. *System Load Research Project* report, March 2010, prepared by KEMA.

Figure 3-1 Electricity Sales by Rate Class, Washington 2009

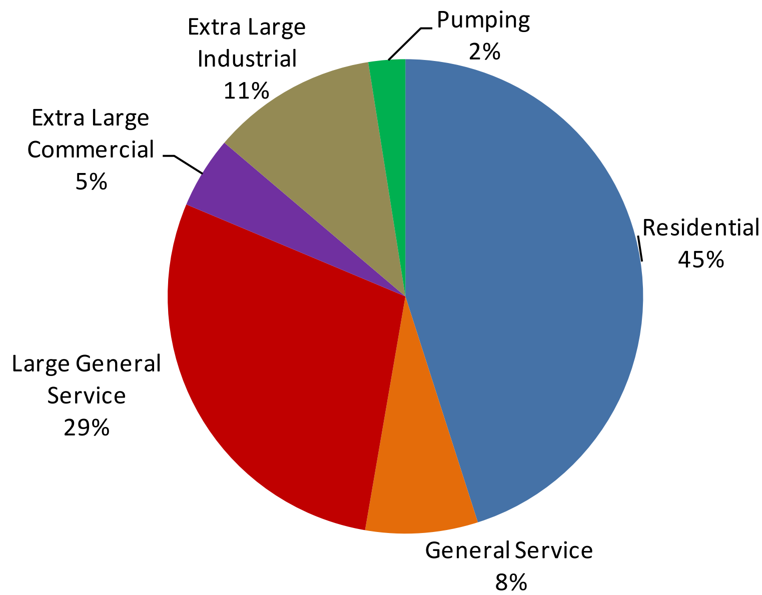
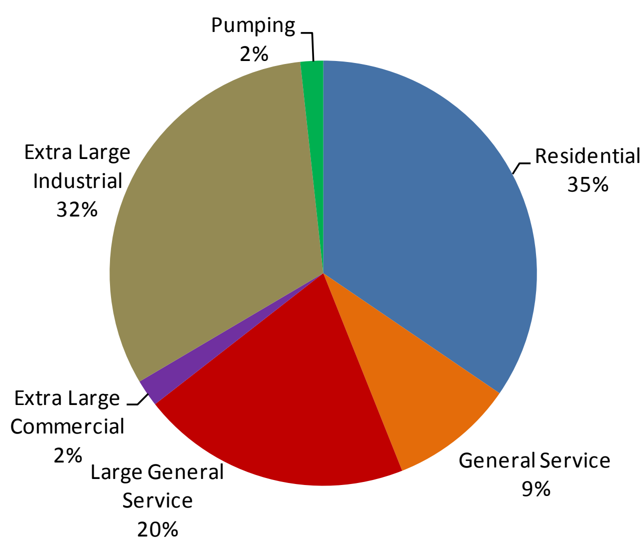


Figure 3-2 Electricity Sales by Rate Class, Idaho 2009



For this study, the project team decided not to explicitly model the EE potential for pumping customers but instead to use the Northwest Power and Conservation Council (NPCC) standard calculator to estimate EE potential. Results of that calculation appear in Chapter 6.

Below we discuss the market characterization and development of market profiles for the Residential and C&I sectors.

3.1 RESIDENTIAL SECTOR

This section characterizes the residential market at a high level, and then provides a profile of how customers in each residential segment use electricity by end use.

3.1.1 Market Characterization

The total number of residential customers was 200,134 in Washington and 99,579 in Idaho, based on the average number of rate class 001 monthly customers for 2009 provided by Avista.[7] We segmented these customers into four groups based on housing type and level of income: single family, multi family, mobile home, and limited income. The single family segment includes single-family detached homes, townhouses, and duplexes or row houses. The multi family segment includes apartments or condos in buildings with more than two units. The limited income segment is composed of all three housing types: single-family homes, multi-family homes, and mobile homes.

Because Avista does not maintain information on housing type or income level, we relied on a variety of survey and demographic sources for segmenting the residential market, including the U.S. Census American Community Survey 2006-2008, a 2009 Inland Power customer survey, and other sources (see Appendix E). Avista defines the limited-income category as those customers with annual income less than or equal to two times the poverty level. For an average household size of 2.5 persons, two times the poverty level is $32,880. For the purpose of our analysis, we used a slightly higher income level cutoff of $35,000 to define this segment, which allowed us to take advantage of the data sources listed above.

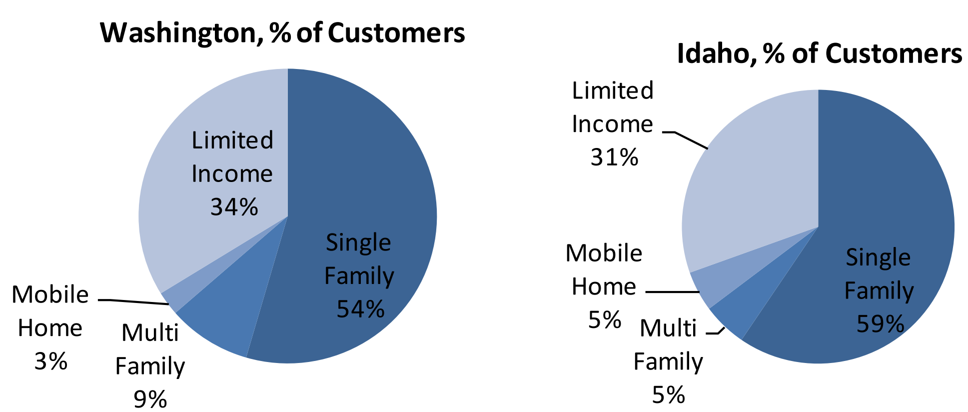
The resulting residential customer allocation by segment appears in Table 3-3 and in Figure 3-3.

Table 3-3 Residential Sector Allocation by Segments

	Washington		Idaho	
Segment	**Allocation of Customers**	**% of Total**	**Allocation of Customers**	**% of Total**
Single Family	109,134	54%	59,205	59%
Multi Family	18,219	9%	5,237	5%
Mobile Home	5,248	3%	4,774	5%
Limited Income	67,533	34%	30,363	31%
Total	**200,134**	100%	**99,579**	**100%**

Note: Minor difference with Idaho residential customer total 99,580 Table 3-2 due to calibration.

Figure 3-3 Residential Sector Allocation by Segments, Percentage of Customers



[7] Rate classes 12 and 22, although they include homes, are included with rates classes 11 and 21 respectively, which corresponds with how customer classes were combined for Avista's *System Load Research Project* report.

Next, to determine the residential whole building energy intensity (kWh/household) by segment, we drew upon data from the Energy Information Agency, a NEEA residential billing analysis report, and the Inland Power & Light 2009 Conservation Potential Assessment. Based on these sources, we developed the segment level energy intensities shown in Table 3-4. The selected energy intensity values multiplied by the number of households equal the annual sales for each segment. These values sum to the total annual energy use for the residential sector in each state. Figure 3-4 presents the resulting energy sales by segment. The single-family segment used just over half the total residential sector electricity in 2009.

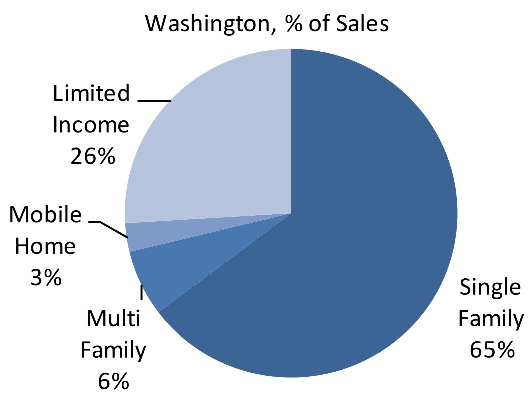
Table 3-4 Residential Electricity Usage and Intensity by Segment and State, 2009

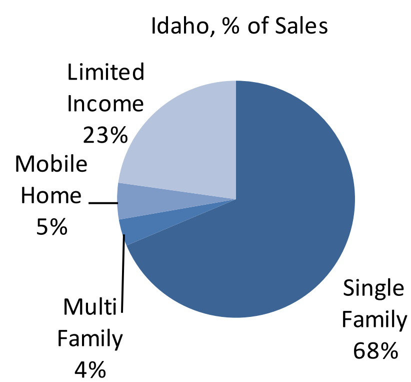
Washington Segment	Intensity (kWh/Household)	Number of Customers	% of Customers	2009 Electricity Sales (MWh)	% of Sales
Single Family	14,547	109,134	54%	1,587,572	65%
Multi-Family	8,728	18,219	9%	159,019	6%
Mobile Home	13,092	5,248	3%	68,708	3%
Limited Income	9,424	67,533	34%	636,407	26%
Total	**12,250**	**200,134**	**100%**	**2,451,707**	**100%**

Idaho Segment	Intensity (kWh/Household)	Number of Customers	% of Customers	2009 Electricity Sales (MWh)	% of Sales
Single Family	13,703	59,205	59%	811,302	69%
Multi-Family	8,213	5,237	5%	43,013	4%
Mobile Home	12,320	4,774	5%	58,815	5%
Limited Income	8,868	30,363	31%	269,249	23%
Total	**11,874**	**99,580**	**100%**	**1,182,379**	**100%**

Note: Minor differences with totals in Table 3-1 and Table 3-2 due to calibration.

Figure 3-4 Residential Electricity Use by Customer Segment, Percentage of Sales 2009





3.1.2 Residential Market Profiles

As we describe in the previous chapter, the market profiles provide the foundation upon which we develop the baseline forecast. For each segment, we created a market profile, which includes the following elements:

- ***Market size*** represents the number of customers in the segment
- ***Saturations*** embody the fraction of homes with the electric technologies. (e.g., homes with electric space heating). We developed these using a combination of survey data from sources including Inland Power & Light, NEEA, and Puget Sound Energy (PSE). The results were cross-checked and validated against various other secondary sources.
- ***UEC (unit energy consumption)*** describes the amount of electricity consumed in 2009 by a specific technology in homes that have the technology (in kWh/household). As above, we used data from Inland Power & Light, NEEA, and PSE. We also used data from various utility potential studies that Global has recently completed. As needed, some minor adjustments were made to calibrate to whole-building intensities.
- ***Intensity*** represents the average use for the technology across all homes in 2009. It is computed as the product of the saturation and the UEC and is defined as kWh/household.
- ***Usage*** is the annual electricity use by a technology/end use in the segment. It is the product of the number of households and intensity and is quantified in GWh.

Table 3-5 presents the average existing home market profile for the entire Avista residential sector. The table shows data captured directly from LoadMAP. Values in red are inputs to LoadMAP. The existing-home profile represents all the housing stock in the Avista service area in 2009. Market profiles for each of the residential segments in Washington and Idaho respectively appear in Appendix A and B.

Figure 3-5 presents the end-use breakout for the residential sector as a whole. The appliance end use accounts for the largest share of the usage, closely followed by space heating, with water heating the third largest end use. The miscellaneous end use includes such devices as furnace fans, pool pumps, and other "plug" loads (hair dryers, power tools, coffee makers, etc.). Interior and exterior lighting combined account for 12% of electricity use in 2009. The electronics end use, which includes personal computers, televisions, home audio, video game consoles, etc., also contributes significantly to household electricity usage. Cooling and combined heating and cooling through heat pumps make up the remainder.

Figure 3-5 Residential Electricity Use by End Use per Household, 2009 (kWh and %)

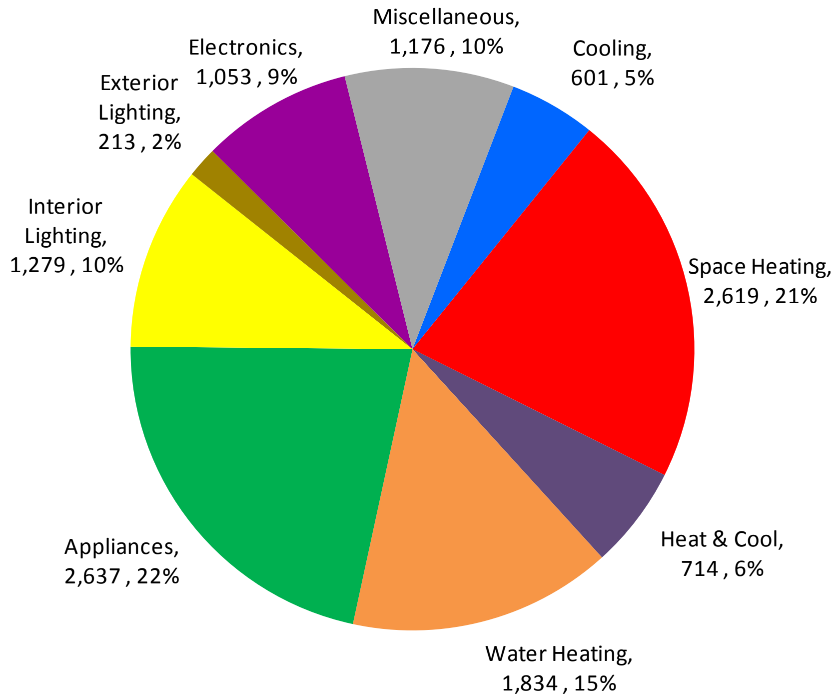


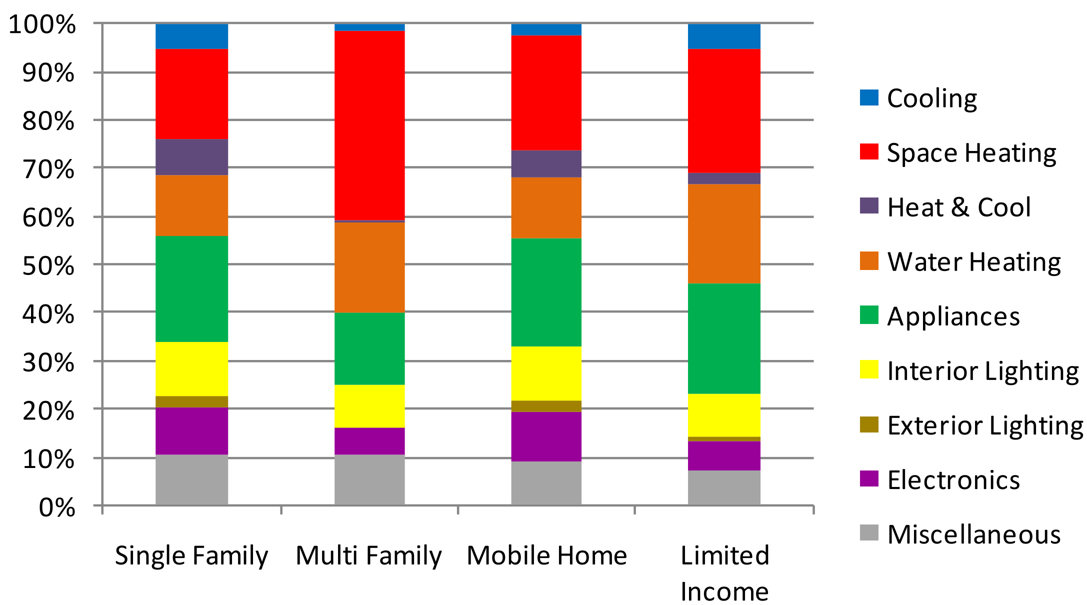
Table 3-5 Average Residential Sector Market Profile

Average Market Profile - Residential Sector

End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (GWh)
Cooling	Central AC	29%	1,613	470	141
Cooling	Room AC	20%	643	131	39
Combined Heating/Cooling	Air Source Heat Pump	14%	5,051	699	209
Combined Heating/Cooling	Geothermal Heat Pump	0%	3,715	15	4
Space Heating	Electric Resistance	18%	6,114	1,119	335
Space Heating	Electric Furnace	22%	6,779	1,492	447
Space Heating	Supplemental	9%	83	8	2
Water Heating	Water Heater	66%	2,796	1,834	550
Interior Lighting	Screw-in	100%	1,144	1,144	343
Interior Lighting	Linear Fluorescent	66%	121	80	24
Interior Lighting	Pin-based	92%	59	55	16
Exterior Lighting	Screw-in	70%	301	211	63
Exterior Lighting	High Intensity/Flood	2%	116	2	1
Appliances	Clothes Washer	84%	105	88	26
Appliances	Clothes Dryer	80%	621	498	149
Appliances	Dishwasher	86%	185	160	48
Appliances	Refrigerator	100%	746	746	224
Appliances	Freezer	62%	760	474	142
Appliances	Second Refrigerator	35%	787	277	83
Appliances	Stove	86%	299	257	77
Appliances	Microwave	95%	144	137	41
Electronics	Personal Computers	121%	263	317	95
Electronics	TVs	222%	311	688	206
Electronics	Devices and Gadgets	100%	48	48	14
Miscellaneous	Pool Pump	10%	1,328	130	39
Miscellaneous	Furnace Fan	26%	404	107	32
Miscellaneous	Miscellaneous	100%	940	940	282
Total				**12,125**	**3,634**

Figure 3-6 presents the end-use shares of total electricity use for each housing type. Space heating is the largest single use in all housing types except single family homes where it is lower relative to other uses. Appliances are the largest energy consumer in the single family segment and are a significant energy use in the other segments as well.

Figure 3-6 End-Use Shares of Total Electricity Use by Housing Type, 2009



3.2 COMMERCIAL AND INDUSTRIAL SECTORS

The approach we used for the C&I sectors is analogous to the residential sector. It begins with segmentation, then defines market size and annual electricity use, and concludes with market profiles.

3.2.1 C&I Market Characterization

We developed the non-residential energy use by segment using Avista 2009 billing data by rate class. Table 3-6 and Table 3-7 present the results for the market characterization for Washington and Idaho respectively. Although the General Service 011 and Large General Service 021 rate classes include a small percentage of industrial customers, we chose to model these as primarily commercial building types. For the General Service segment, we assumed facilities were small to medium buildings, dominated by retail facilities. For the Large General Service segment, we assumed the typical facility was an office building. When developing the market profiles, as further described below, we began with these assumed prototypical building types, but adjusted them to account for the diversity in each segment. For the Extra Large General Service rate class 025, we divided customers into separate commercial and industrial segments and included the Potlatch facility, Idaho rate class 025P, with the other Idaho Extra Large industrial customers. This grouping enabled better modeling of the industrial customers.

We then used data from NEEA, the California Commercial End Use Study (CEUS), and other recently completed studies to develop estimates of floor space and annual intensities (in kWh/square foot) for each segment. Because of the heterogeneous nature of the C&I sectors and the wide variation in customer size (compared to residential homes), floor space is used as the unit of measure to quantify energy use and equipment inventories on a per-square-foot basis. Note that we are not concerned with absolute square footage, as the purpose of this study is not to estimate C&I floor space, but with the relative size of each segment and its growth over time.

Table 3-6 Commercial Sector Market Characterization Results, Washington 2009

Avista Rate Schedule		LoadMAP Segment and Typical Building	Electricity sales (MWh)	Intensity (kWh/sq.ft.)
General Service	011, 012	Small and Medium Commercial — Retail	415,935	17.5
Large General Service	021, 022	Large Commercial — Office	1,556,929	16.7
Extra Large General Service Commercial	025C	Extra Large Commercial — University	265,686	13.9
Extra Large General Service Industrial	025I	Extra Large Industrial	613,615	40.0
Total			**2,852,165**	

Table 3-7 Commercial Sector Market Characterization Results, Idaho 2009

Avista Rate Schedule		LoadMAP Segment and Typical Building	Electricity sales (MWh)	Intensity (kWh/sq.ft.)
General Service	011, 012	Small and Medium Commercial — Retail	322,570	17.5
Large General Service	021, 022	Large Commercial — Office	699,953	16.7
Extra Large General Service Commercial	025C	Extra Large Commercial — University	70,361	13.9
Extra Large General Service Industrial	025I, 025P	Extra Large Industrial	1,087,974	40.0
Total			**2,180,858**	

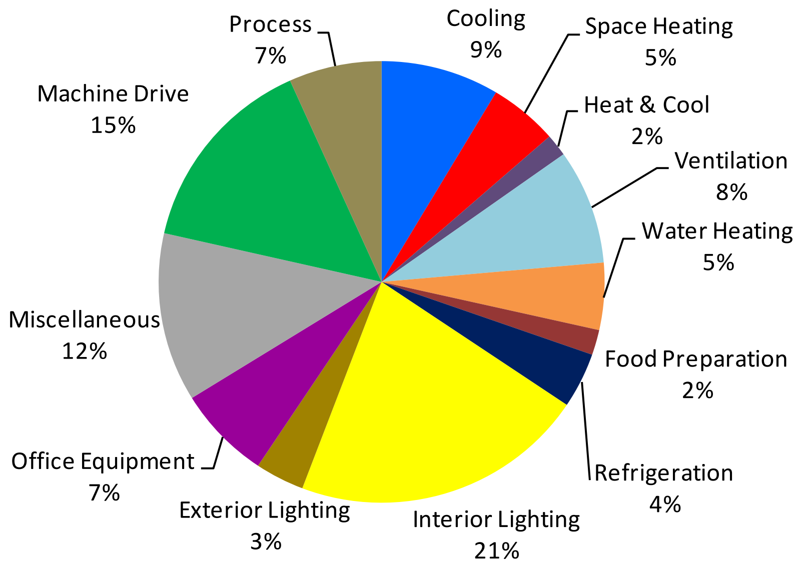
3.2.2 C&I Market Profiles

For the C&I sector, the approach we used to develop market profiles is similar to what we described above for residential.

- ***Saturations*** are the percentage of floor space with each electric end use. For space heating, cooling and water heating, this embodies the electric fuel share. For space heating and cooling, it also embodies the fraction of conditioned space. The saturation values for each end use are from NEEA reports, supplemented with other secondary sources to develop the technology-level saturations. For the industrial segments, we drew upon U.S. Industrial Electric Motor Systems Market Opportunities Assessment from the US Department of Energy (US DOE) and the EIA Annual Energy Outlook.
- ***EUIs (end-use indices)*** represent the amount of electricity used per square foot of floor space in buildings where the equipment is present. Data from NEEA. US DOE, EIA, and other secondary sources provided EUIs by end use. We developed the technology-level EUIs using our engineering model BEST and other secondary sources. Finally, we adjusted the EUIs to calibrate to Avista's overall building type intensity.
- ***Intensity*** is the average use across all floor space (computed as the product of saturation and EUI). For the industrial sector, we calibrate
- ***Annual use*** is the total consumption in 2009 for each end use (computed as the product of the intensity and the floor space for the segment.

Figure 3-7 shows the breakdown of annual electricity usage by end use for the C&I sector as a whole. Lighting is the largest single end use in the sector, accounting for one fifth of total usage.

Figure 3-7 Commercial and Industrial Electricity Consumption by End Use, 2009



This information is further detailed in Figure 3-8, which shows the end-use breakdown for the composite of the three commercial segments — Small/Medium, Large, and Extra Large — and Figure 3-9, which shows similar information for the Extra Large Industrial segment.

Observations include the following:

- Commercial buildings
  - Lighting is the largest single energy use across all of the commercial buildings, accounting for 29% of energy use.
  - Space conditioning, including heating, cooling, and ventilation, is close behind with 27% of energy use.
  - Miscellaneous and office equipment are the next largest energy uses.
  - Water heating, refrigeration, and food preparation are only a small portion of energy use in the commercial sector overall, though they are more significant in specific building types (supermarkets, restaurants, hospitals, lodging).
- Extra Large Industrial facilities
  - Machine drive and process loads dominate in this segment, together accounting for 65% of energy use.
  - HVAC and interior lighting consume 17% and 6% of energy respectively.

Figure 3-8 Commercial End Use Consumption, 2009

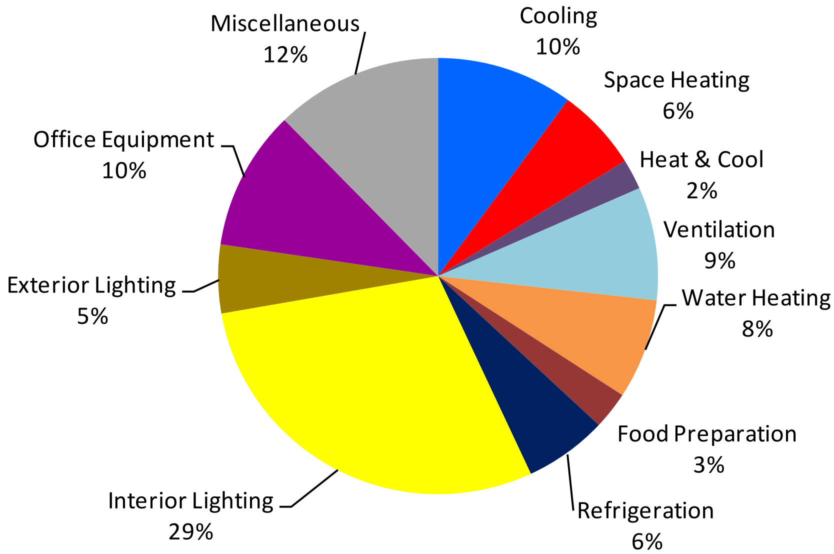


Figure 3-9 Extra Large Industrial End Use Consumption, 2009

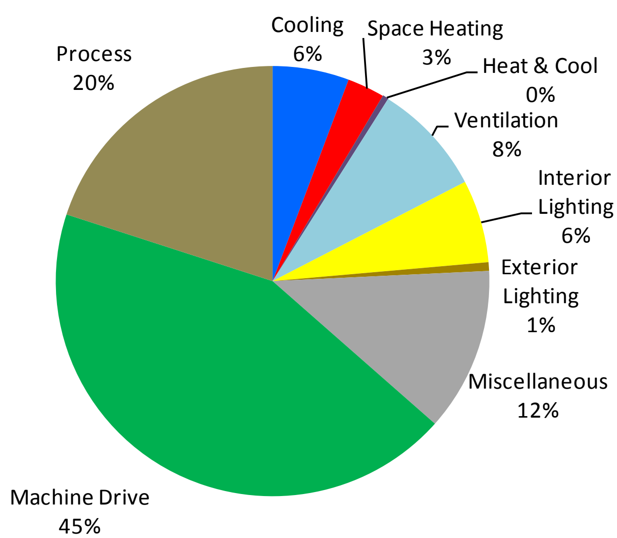


Table 3-8 shows an example commercial average base year market profile, in this case for the Washington Small/Medium Commercial Segment. The table show data captured from LoadMAP, where values shown in red are inputs to the model. The market profiles for each of the Washington and Idaho C&I segments are shown in Appendices A and B respectively.

Table 3-8 Small/Medium Commercial Segment Market Profile, Washington, 2009

Average Market Profiles

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Usage (GWh)
Cooling	Central Chiller	13.8%	2.39	0.33	8
Cooling	RTU	63.1%	2.46	1.55	37
Cooling	PTAC	3.3%	2.44	0.08	2
Combined Heating/Cooling	Heat Pump	3.6%	6.19	0.22	5
Space Heating	Electric Resistance	5.9%	6.72	0.39	9
Space Heating	Furnace	17.7%	7.05	1.25	30
Ventilation	Ventilation	76.9%	2.09	1.61	38
Interior Lighting	Interior Screw-in	100.0%	1.00	1.00	24
Interior Lighting	HID	100.0%	0.68	0.68	16
Interior Lighting	Linear Fluorescent	100.0%	3.37	3.37	80
Exterior Lighting	Exterior Screw-in	82.6%	0.20	0.16	4
Exterior Lighting	HID	82.6%	0.76	0.63	15
Exterior Lighting	Linear Fluorescent	82.6%	0.16	0.13	3
Water Heating	Water Heater	63.0%	2.00	1.26	30
Food Preparation	Fryer	25.8%	0.16	0.04	1
Food Preparation	Oven	25.8%	0.98	0.25	6
Food Preparation	Dishwasher	25.8%	0.06	0.01	0
Food Preparation	Hot Food Container	25.8%	0.31	0.08	2
Food Preparation	Food Prep	25.8%	0.01	0.00	0
Refrigeration	Walk in Refrigeration	0.0%	-	-	-
Refrigeration	Glass Door Display	52.4%	0.45	0.23	6
Refrigeration	Solid Door Refrigerator	52.4%	0.50	0.26	6
Refrigeration	Open Display Case	52.4%	0.04	0.02	1
Refrigeration	Vending Machine	52.4%	0.30	0.16	4
Refrigeration	Icemaker	52.4%	0.34	0.18	4
Office Equipment	Desktop Computer	99.9%	0.48	0.48	11
Office Equipment	Laptop Computer	99.9%	0.06	0.06	1
Office Equipment	Server	99.9%	0.36	0.36	9
Office Equipment	Monitor	99.9%	0.25	0.25	6
Office Equipment	Printer/copier/fax	99.9%	0.24	0.24	6
Office Equipment	POS Terminal	99.9%	0.27	0.27	7
Miscellaneous	Non-HVAC Motor	40.2%	1.22	0.49	12
Miscellaneous	Other Miscellaneous	100.0%	1.43	1.43	34
Total				**17.50**	**416**

CHAPTER | 4

BASELINE FORECAST

Prior to developing estimates of energy-efficiency potential, a baseline end-use forecast was prepared to quantify how electricity is used by end use in the base year and what electricity is likely to be in the future in absence of new utility programs. The baseline forecast serves as the metric against which energy-efficiency potentials — technical, economic, and achievable — are compared.

4.1 RESIDENTIAL SECTOR

4.1.1 Residential Baseline Forecast Drivers

In general, the baseline forecast incorporates assumptions about economic growth, electricity prices, appliance/equipment standards and building codes already mandated, and naturally occurring conservation. The key inputs we used to develop the forecast for Avista include:

- Customer growth: provided by Avista through 2015, and rate of growth assumed constant thereafter
- Forecasts of electricity prices: provided by Avista through 2015, with rate of increases thereafter based on the Annual Energy Outlook (AEO)
- Forecasts of household size: from Census data and the 6th Plan
- Forecast of income: from Washington state data
- Trends in end-use/technology saturations: developed from the AEO
- Equipment purchase decisions: developed from AEO

Table 4-1 presents the assumptions used in the forecast regarding market size growth, household size, median household income, and electricity prices. The market size growth rate was applied equally to each of the four segments.

Table 4-1 Residential Market Size Forecast (number of households)

Driver	2009	2012	2017	2022	2027	2032	Average Growth (%/yr)
Market Size WA (number of households)	200,134	204,530	217,921	232,414	247,871	264,356	1.21%
Market Size ID (number of households)	99,579	102,077	108,592	115,553	122,960	130,842	1.19%
Persons per household	2.50	2.50	2.50	2.50	2.50	2.50	–
Electricity price WA (cents per kWh)	$0.0721	$0.0796	$0.0804	$0.0825	$0.0845	$0.0867	0.80%
Electricity price ID (cents per kWh)	$0.0742	$0.0855	$0.0876	$0.0898	$0.0921	$0.0944	1.05%
Per capita income ($ real, 2000)	$34,506	$35,787	$39,202	$43,623	$48,400	$53,700	1.92%

In addition to forecasts for household size, electricity price, and median household income, the model also requires elasticities for these variables. The elasticities for prices and persons per household are based on the REEPS model developed by the Electric Power Research Institute (EPRI). The income elasticity was provided by Avista. The values are as follows:

- –0.151 for electricity prices
- 0.75 for income for all end uses except for appliances, where we use 0.375
- 0.20 for persons per household

In addition, we implemented the following assumptions for the residential sector[8]:

- In 2006, a Federal standard for central air conditioners and heat pumps went into effect, requiring all newly manufactured air conditioners and heat pumps to meet SEER 13 or better. This standard applies to replace-upon-burnout in existing construction and new construction. In 2016, the standard becomes SEER 14[9].
- In April 2010, DOE released updated water heater standards that go into effect April 16, 2015. The new standard for water heaters with volume at or below 55 gallons requires an energy factor (EF) equal to 0.96 minus 0.0003 times the rated storage volume in gallons.
- DOE is scheduled to make a final ruling on refrigerator and freezer standards on December 31, 2010. We incorporated this anticipated ruling into the forecast and assumed that refrigeration and freezer consumption will decrease by 20% in 2014[10]. This forecast does not include anticipated standards for room air conditioners, clothes washers, clothes dryers and dishwashers because DOE rulings on the standards have not yet been set.
- Residential lighting is affected by the passage of the Energy Independence and Security Act (EISA) in 2007, which mandates higher efficacies for lighting technologies starting in 2012. Several lighting technologies are anticipated to meet this standard when it goes into effect, including compact fluorescent lamps (CFL) and white light-emitting diodes (LED). As a result, the share of incandescent lamps decreases while CFL and LED purchases increase. CFLs dominate over the forecast period, but LEDs account for about 20% of purchases by 2020.
- In November 2008, ENERGY STAR 3.0 for color televisions went into effect. This standard sets the rules for becoming ENERGY STAR qualified. One such criterion is that TVs must not exceed 1 watt of power in standby mode.

4.1.2 Residential Baseline Forecast Results

Overall, residential use in both states and for all segments increases from 3,634,054 MWh in 2009 to 5,600,870 MWh in 2032, an average annual growth rate of 1.9%. This is slightly higher than the 1.5% annual growth rate in Avista's 2009 IRP for the period 2009 through 2030. Because the IRP forecast includes future conservation activities and LoadMAP's baseline forecast does not, we would generally expect LoadMAP's baseline forecast to be somewhat higher. This increase is also more than double the AEO forecast of 0.8% average growth.

[8] These assumptions reflect standards in effect as of late 2010 or scheduled to take effect over the course of the 20-year study period. Because some of these standards were not yet announced when the NWPCC Sixth Plan was developed, this study's baseline incorporates reduced baseline energy usage compared with the Sixth Plan.

[9] This assumption was included in the 2010 Annual Energy Outlook (AEO) forecast. The SEER 14 standard level used in the AEO forecast was established in a 2009 consensus agreement made between equipment manufacturers and energy efficiency advocacy organizations. DOE is required to publish the final rule on central air conditioners and heat pump standards in 2011.

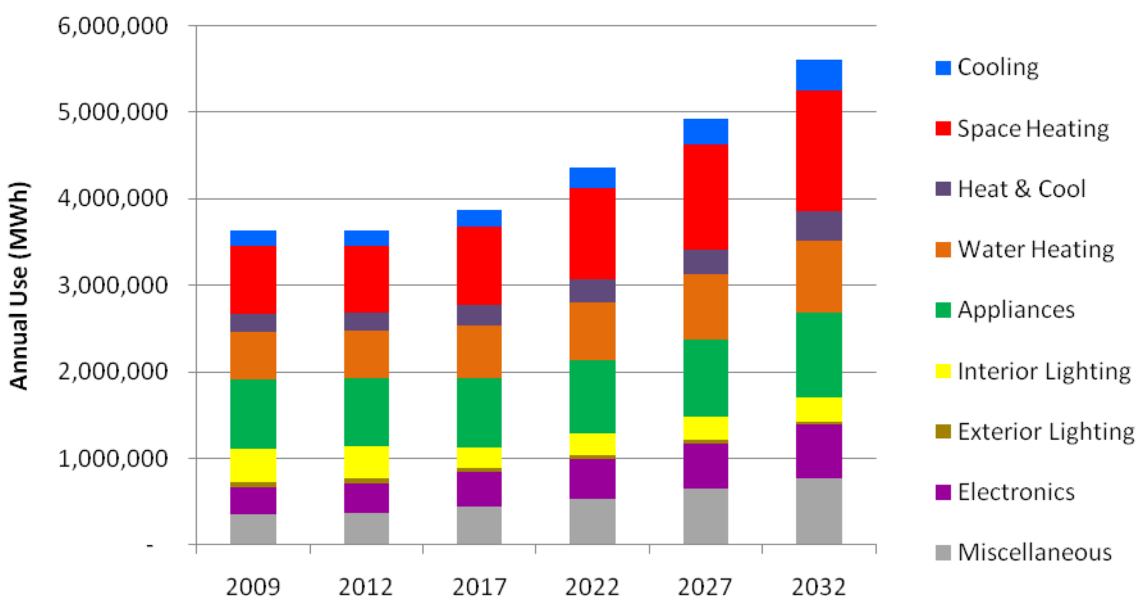
[10] This level is consistent with the standard recently agreed upon in a joint proposal by home appliance manufacturers and energy efficiency advocates which states that refrigeration and freezer consumption must decrease by 20-30% effective in 2014.

General observations about this forecast include the following:

- Overall, household growth is robust, with a nearly 32% increase between 2009 and 2032. The AEO forecast is somewhat lower, with a 26% increase in the number of households.
- The factors that impact usage — relatively low electricity prices and strong income growth — result in strong residential consumption growth over the forecast period.
- New homes are larger than existing homes, based on data from the AEO and other studies. However, equipment and appliances are more efficient, so the combined effect is slightly positive.

Figure 4-1 presents the baseline forecast at the end-use level for the residential sector as a whole, in both Washington and Idaho.

Figure 4-1 Residential Baseline Forecast by End Use



End-use specific observations include:

- The drop in all space conditioning loads from 2009 to 2012 is due to the transition from actual weather in 2009 (589 cooling degree days and 6,976 heating degree days) to the normal weather forecast (434 cooling degree days and 6,657 heating degree days) thereafter.
- Cooling grows due to increasing saturation of central air conditioning in new homes and larger home sizes, as well as the addition of central air conditioning to existing homes.
- Space heating, combined heating and cooling, and water heating grow, but at a slightly moderate rate compared to cooling, again due to the growth in households and to larger home sizes.
- Beginning in 2012, the federal lighting standards cause a decline in electricity for interior lighting use of 29% and exterior lighting use by 41% over the forecast period. The AEO 2010 forecast projects a 26% decline in lighting energy use over the same period. The AEO reduction is less than that shown here, again due to increasing home size.
- Appliances decrease, reflecting efficiency gains, particularly in the refrigeration appliances due to standards that offset the small increases in saturations of dishwashers, clothes washers, and clothes dryers.

- Growth in electricity use in electronics is strong and reflects an increase in the saturation of electronics and the trend toward higher-powered computers and larger televisions.
- Growth in miscellaneous use is also substantial. This has been a long-term trend and we incorporate growth assumptions that are consistent with the AEO.

Figure 4-2 presents the forecast of use per household. Most noticeable is that lighting use decreases significantly after 2010, as the lighting standard from EISA comes into effect and as LED lamps begin to gain traction in the later years of the forecast. Appliance use also decreases over the forecast period due to appliance standards. Use in electronics and miscellaneous increase over the forecast period, reflecting the trend that households continue to add various electronics to the home.

Figure 4-2 Residential Baseline Electricity Use per Household by End Use

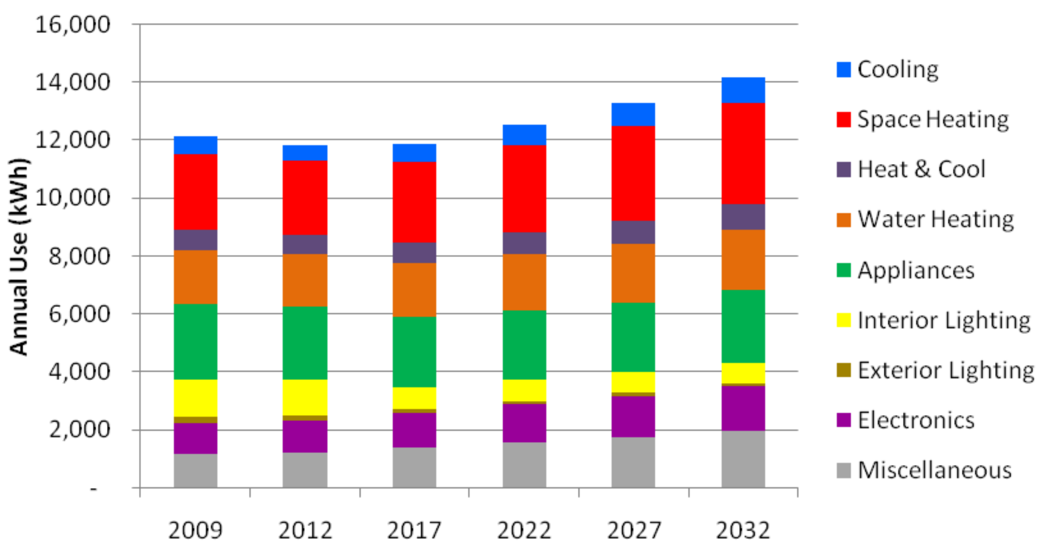


Table 4-2 shows the forecast by end use, while Table 4-3 provides additional detail by technology within each end use. Central AC increases during the forecast as more households add air conditioning. Screw-in lighting decreases as a result of the EISA lighting standard. Over the forecast period there is strong growth in usage from electronics due to the increase in saturation.

Table 4-2 Residential Baseline Forecast Electricity Consumption by End Use (MWh)

End Use	2009	2012	2017	2022	2027	2032	% Change ('09–'32)	Avg. growth rate
Cooling	180,022	164,865	197,394	239,439	292,044	355,171	97%	3.0%
Space Heating	784,854	783,258	906,261	1,051,822	1,210,093	1,383,665	76%	2.5%
Heat & Cool	213,860	201,410	229,160	258,676	295,177	341,644	60%	2.0%
Water Heating	549,606	557,022	611,950	675,037	748,494	830,988	51%	1.8%
Interior Lighting	790,377	776,482	795,594	835,023	894,245	989,025	25%	1.0%
Exterior Lighting	383,305	371,610	246,575	256,864	262,823	271,374	-29%	-1.5%
Appliances	63,864	61,321	41,763	39,795	38,430	37,735	-41%	-2.3%
Electronics	315,599	336,152	394,727	459,538	529,485	616,688	95%	2.9%
Miscellaneous	352,599	374,575	447,870	540,047	648,055	774,496	120%	3.4%
Total	**180,022**	**164,865**	**197,394**	**239,439**	**292,044**	**355,171**	**54%**	**1.9%**

Table 4-3 Residential Baseline Electricity Forecast by End Use and Technology (MWh)

End Use	Technology	2009	2012	2017	2022	2027	2032	% Change ('09–'32)	Avg. Growth Rate
Cooling	Central AC	140,731	130,669	161,085	199,996	249,120	308,429	119%	3.4%
	Room AC	39,291	34,196	36,310	39,443	42,924	46,742	19%	0.8%
Space Heating	Electric Furnace	447,317	447,255	520,409	606,695	700,178	801,899	79%	2.5%
	Electric Resistance	335,280	333,732	383,172	441,947	506,164	577,358	72%	2.4%
	Supplemental	2,257	2,272	2,680	3,180	3,750	4,409	95%	2.9%
Heat & Cool	Air Source Heat Pump	209,371	197,111	224,050	252,476	287,663	332,619	59%	2.0%
	Geothermal Heat Pump	4,489	4,299	5,109	6,200	7,514	9,025	101%	3.0%
Water Heating	Water Heater	549,606	557,022	611,950	675,037	748,494	830,988	51%	1.8%
Appliances	Refrigerator	223,654	213,517	204,566	204,184	209,933	231,329	3%	0.1%
	Freezer	141,950	137,910	137,084	136,274	143,528	158,560	12%	0.5%
	Second Refrigerator	83,117	77,296	72,374	70,707	69,137	73,789	-11%	-0.5%
	Clothes Washer	26,332	26,102	27,746	30,875	34,868	39,019	48%	1.7%
	Clothes Dryer	149,267	150,677	163,829	180,582	199,465	221,428	48%	1.7%
	Dishwasher	47,886	48,894	54,242	60,691	68,105	76,321	59%	2.0%
	Stove	77,079	79,792	89,107	99,966	111,884	125,081	62%	2.1%
	Microwave	41,092	42,294	46,647	51,744	57,325	63,498	55%	1.9%
Interior Lighting	Screw-in	342,923	329,329	198,253	200,264	196,856	194,811	-43%	-2.5%
	Linear Fluorescent	24,025	25,171	29,266	34,273	39,944	46,451	93%	2.9%
	Pin-based	16,358	17,110	19,056	22,326	26,023	30,112	84%	2.7%
Exterior Lighting	Screw-in	63,165	60,629	41,255	39,254	37,834	37,069	-41%	-2.3%
	High Intensity/Flood	698	692	508	540	596	666	-5%	-0.2%
Electronics	Personal Computers	94,922	101,516	120,451	143,627	170,677	202,632	113%	3.3%
	TVs	206,326	219,527	256,515	294,816	333,825	384,485	86%	2.7%
	Devices and Gadgets	14,351	15,110	17,761	21,095	24,983	29,572	106%	3.1%
Miscellaneous	Furnace Fan	32,029	33,795	39,817	47,004	54,841	63,046	97%	2.9%
	Pool Pump	38,852	39,438	44,334	51,331	59,964	69,728	79%	2.5%
	Miscellaneous	281,718	301,342	363,719	441,712	533,250	641,722	128%	3.6%
Grand Total		**3,634,086**	**3,626,696**	**3,871,294**	**4,356,240**	**4,918,847**	**5,600,787**	**54%**	**1.9%**

4.2 COMMERCIAL AND INDUSTRIAL SECTOR

4.2.1 C&I Baseline Forecast Drivers

As is the case with the residential sector, the C&I baseline forecast incorporates assumptions about economic growth, electricity prices, equipment standards and building codes already mandated, and naturally occurring conservation. The key inputs we used to develop the forecast for Avista include:

- Floor space growth for Commercial segments derived from Avista customer and load growth projections through 2015 and from Avista IRP projections regarding expansion of existing Extra Large Customer facilities; after 2015 assumed constant growth rate of 2% based on Avista IRP[11]
- Floor space growth for Extra Large Industrial segment derived from Avista customer and load growth projections through 2015; thereafter based on based on employment growth of 2.8% in Washington and 1.4% in Idaho[12]
- Forecasts of electricity prices provided by Avista through 2015, with rate of increases thereafter based on the Annual Energy Outlook (AEO)
- Trends in end-use/technology saturations developed from the AEO
- Equipment purchase decisions developed from AEO[13]

Table 4-4 presents the growth and electricity price assumptions used in the C&I forecast. Market size growth is shown as an indexed value where 2009 equals 1.0

Table 4-4 Commercial Market Size Growth and Electricity Price Forecast

Indexed Market Size 2009 = 1.0	2009	2012	2017	2022	2027	2032	Avg. Growth (%/yr)
Small/Med. Comm., WA	1.00	1.04	1.14	1.26	1.39	1.53	1.85%
Large Comm., WA	1.00	1.01	1.10	1.22	1.34	1.48	1.72%
Extra Large Comm., WA	1.00	1.05	1.34	1.48	1.63	1.80	2.57%
Extra Large Industrial, WA	1.00	1.16	1.31	1.51	1.73	1.99	2.99%
Small/Med. Comm., ID	1.00	1.03	1.13	1.25	1.38	1.53	1.84%
Large Comm., ID	1.00	1.03	1.15	1.27	1.40	1.54	1.88%
Extra Large Comm., ID	1.00	1.04	1.25	1.38	1.52	1.68	2.26%
Extra Large Industrial, ID	1.00	1.04	1.13	1.21	1.30	1.39	1.44%

Electricity Price	2009	2012	2017	2022	2027	2032	Avg. Growth (%/yr)
Electricity price, WA (cents per kWh)	$0.0700	$0.0698	$0.0703	$0.0727	$0.0752	$0.0778	0.46%
Electricity price, ID (cents per kWh)	$0.0566	$0.0586	$0.0600	$0.0621	$0.0642	$0.0664	0.69%

[11] Avista 2009 IRP, p. 2-10: Commercial usage per customer is forecast to increase for several years due to additional buildings either built or anticipated to be built by existing very large customers, such as Washington State University and Sacred Heart Hospital. Expected additions for very large customers are included in the forecast through 2015, and no additions are included in the forecast after 2015.

[12] Avista 2009 IRP p. 2-6.

[13] We developed baseline purchase decisions using the Energy Information Agency's *Annual Energy Outlook* report (2010), which utilizes the National Energy Modeling System (NEMS) to produce a self-consistent supply and demand economic model. We calibrated equipment purchase options to match manufacturer shipment data for recent years and trended forward.

4.2.2 C&I Baseline Forecast Results

Figure 4-3 and Table 4-5 present the baseline forecast at the end-use level for the C&I sector as a whole. Overall, C&I annual energy use increases from 5,033,023 MWh in 2009 to 7,239,694 MWh in 2032, a 43.8% increase. This reflects growth in floor space across all sectors. Table 4-6 presents the C&I forecast by technology. Interior screw-in lighting increases over the forecast period, but at a slower rate than other technologies as a result of the lighting standard.

Figure 4-3 C&I Baseline Electricity Forecast by End Use

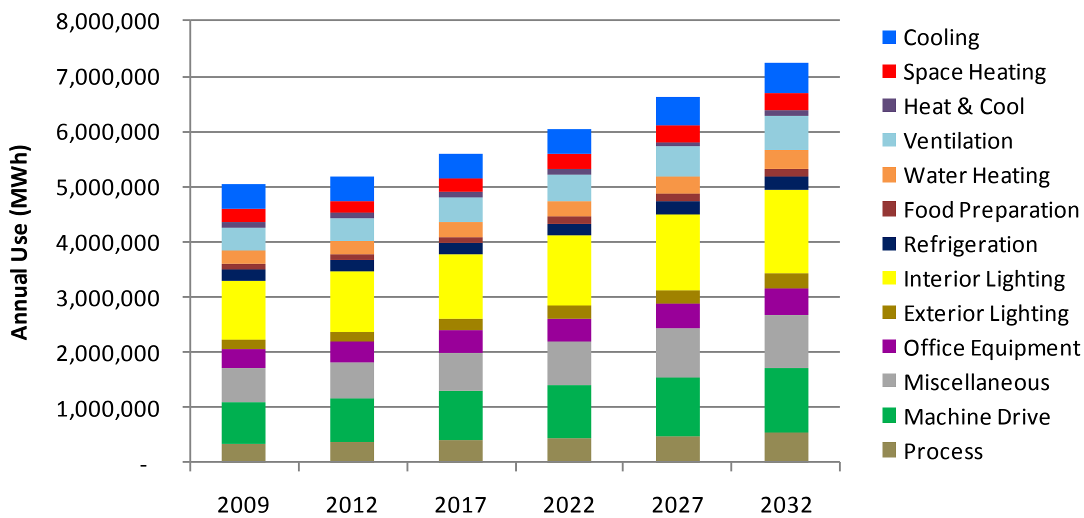


Table 4-5 C&I Electricity Consumption by End Use (MWh)

End Use	2009	2012	2017	2022	2027	2032	% Change ('09–'32)	Avg. growth rate
Cooling	433,257	429,715	453,330	473,311	504,446	550,621	27.1%	1.04%
Space Heating	250,919	224,970	249,918	273,638	300,093	330,065	31.5%	1.19%
Heat & Cool	81,984	80,104	82,263	86,559	94,007	103,167	25.8%	1.00%
Ventilation	421,805	426,987	457,118	487,582	534,845	588,427	39.5%	1.45%
Water Heating	246,022	244,232	266,435	289,253	315,002	344,844	40.2%	1.47%
Food Preparation	92,263	94,294	104,419	114,396	125,186	136,992	48.5%	1.72%
Refrigeration	203,660	204,139	213,050	224,372	242,222	264,431	29.8%	1.14%
Interior Lighting	1,079,050	1,106,035	1,175,567	1,274,090	1,388,871	1,513,165	40.2%	1.47%
Exterior Lighting	179,595	183,933	202,023	219,529	239,546	261,703	45.7%	1.64%
Office Equipment	344,351	363,758	387,164	421,052	458,189	498,560	44.8%	1.61%
Miscellaneous	619,607	645,918	714,601	785,490	863,772	950,463	53.4%	1.86%
Machine Drive	740,191	800,303	881,202	966,387	1,061,952	1,169,146	58.0%	1.99%
Process	340,318	367,955	405,497	445,447	489,890	539,389	58.5%	2.00%
Total	**433,257**	**429,715**	**453,330**	**473,311**	**504,446**	**550,621**	**27.1%**	**1.04%**

Table 4-6 C&I Baseline Electricity Forecast by End Use and Technology (MWh)

End Use	Technology	2009	2012	2017	2022	2027	2032	% Change ('09–'32)	Avg. Growth Rate
Cooling	Central Chiller	161,468	161,651	175,544	184,829	194,228	210,874	30.6%	1.16%
	PTAC	18,631	18,428	18,862	19,691	21,069	23,036	23.6%	0.92%
	RTU	253,158	249,637	258,925	268,791	289,149	316,711	25.1%	0.97%
Space Heating	Electric Resistance	102,223	191,387	212,950	234,235	257,713	283,617	177.5%	4.44%
	Furnace	148,697	33,583	36,969	39,403	42,380	46,447	-68.8%	-5.06%
Heat & Cool	Heat Pump	81,984	80,104	82,263	86,559	94,007	103,167	25.8%	1.00%
Ventilation	Ventilation	421,805	426,987	457,118	487,582	534,845	588,427	39.5%	1.45%
Water Heating	Water Heater	246,022	244,232	266,435	289,253	315,002	344,844	40.2%	1.47%
Food Preparation	Dishwasher	5,561	5,675	6,260	6,889	7,580	8,341	50.0%	1.76%
	Fryer	10,938	11,160	12,267	13,442	14,715	16,107	47.3%	1.68%
	Oven	64,439	65,882	73,158	80,123	87,640	95,864	48.8%	1.73%
	Hot Food Container	10,600	10,838	11,915	13,043	14,260	15,590	47.1%	1.68%
	Food Prep	724	739	818	900	991	1,090	50.5%	1.78%
Refrigeration	Walk in Refrigeration	26,545	26,356	27,877	29,977	32,721	35,993	35.6%	1.32%
	Glass Door Display	29,998	29,887	31,549	33,927	37,032	40,736	35.8%	1.33%
	Solid Door Refrigerator	56,389	55,997	58,578	61,819	66,199	71,682	27.1%	1.04%
	Open Display Case	18,136	18,080	19,502	20,983	22,909	25,201	39.0%	1.43%
	Vending Machine	28,068	28,373	25,594	23,005	23,392	24,849	-11.5%	-0.53%
	Icemaker	44,524	45,447	49,951	54,661	59,969	65,969	48.2%	1.71%
Interior Lighting	HID	175,721	181,398	198,158	215,929	235,578	257,305	46.4%	1.66%
	Linear Fluorescent	686,924	702,882	771,014	840,371	916,893	1,001,311	45.8%	1.64%
	Interior Screw-in	216,406	221,755	206,395	217,790	236,400	254,549	17.6%	0.71%

Table 4-6 C&I Baseline Electricity Forecast by End Use and Technology (MWh) (continued)

End Use	Technology	2009	2012	2017	2022	2027	2032	% Change ('09–'32)	Avg. Growth Rate
Exterior Lighting	HID	132,407	135,795	150,576	164,140	179,105	195,616	47.7%	1.70%
	Linear Fluorescent	25,393	25,871	28,196	30,732	33,529	36,611	44.2%	1.59%
	Exterior Screw-in	21,795	22,266	23,250	24,657	26,912	29,475	35.2%	1.31%
Office Equipment	Monitor	41,029	53,265	46,532	50,891	55,743	61,060	48.8%	1.73%
	Server	74,853	76,495	84,537	93,022	102,358	112,632	50.5%	1.78%
	Desktop Computer	154,994	158,861	173,772	187,271	201,951	217,747	40.5%	1.48%
	Laptop Computer	13,081	13,425	14,794	15,996	17,306	18,722	43.1%	1.56%
	Printer/copier/fax	39,520	40,314	44,034	48,018	52,383	57,096	44.5%	1.60%
	POS Terminal	20,873	21,398	23,495	25,853	28,448	31,304	50.0%	1.76%
Miscellaneous	Other Miscellaneous	263,934	269,935	298,454	328,409	361,370	397,639	50.7%	1.78%
	Miscellaneous	208,493	225,425	248,425	272,900	300,128	330,453	58.5%	2.00%
	Non-HVAC Motor	147,180	150,558	167,722	184,182	202,275	222,371	51.1%	1.79%
Machine Drive	Less than 5 HP	35,529	38,415	41,579	44,045	47,585	52,286	47.2%	1.68%
	5-24 HP	76,980	83,231	91,723	100,760	110,813	122,010	58.5%	2.00%
	25-99 HP	188,009	203,277	224,017	246,087	270,640	297,986	58.5%	2.00%
	100-249 HP	106,588	115,244	127,002	139,514	153,434	168,937	58.5%	2.00%
	250-499 HP	116,950	126,448	139,349	153,078	168,351	185,361	58.5%	2.00%
	500 and more HP	216,136	233,688	257,531	282,903	311,129	342,566	58.5%	2.00%
Process	Process Cooling/Refrigeration	102,095	110,387	121,649	133,634	146,967	161,817	58.5%	2.00%
	Process Heating	153,143	165,580	182,474	200,451	220,451	242,725	58.5%	2.00%
	Electrochemical Process	85,079	91,989	101,374	111,362	122,473	134,847	58.5%	2.00%
Grand Total		**5,033,023**	**5,172,344**	**5,592,586**	**6,061,107**	**6,618,022**	**7,250,973**	**44.1%**	**1.59%**

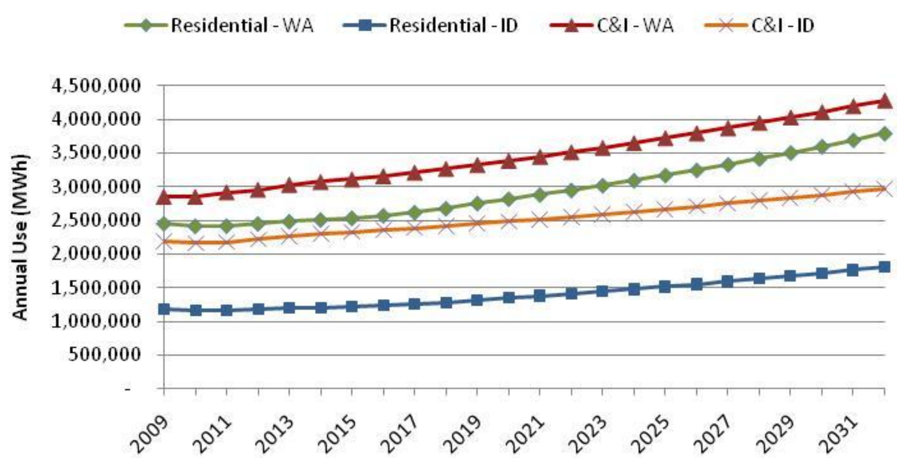
4.3 BASELINE FORECAST SUMMARY

Table 4-7 and Figure 4-4 provide an overall summary of the baseline forecast by sector and for the Avista system as a whole. Overall, the forecast for the next 20 years shows substantial growth, reflecting projected increases in customers and income. This forecast is the metric against which the energy-efficiency savings potential is compared.

Table 4-7 Baseline Forecast Summary by Sector and State

End Use	2009	2012	2017	2022	2027	2032	% Change ('09–'32)	Avg. Growth Rate ('09–'32)
Res. WA	2,451,707	2,448,104	2,617,630	2,947,427	3,329,882	3,792,486	54.7%	1.9%
Res. ID	1,182,379	1,178,591	1,253,664	1,408,812	1,588,965	1,808,300	52.9%	1.8%
C&I WA	2,852,165	2,955,156	3,209,083	3,509,816	3,869,176	4,280,649	50.1%	1.8%
C&I ID	2,180,858	2,217,188	2,383,504	2,551,291	2,748,846	2,970,324	36.2%	1.3%
Total	8,667,109	8,799,039	9,463,880	10,417,347	11,536,869	12,851,760	48.3%	1.7%

Figure 4-4 Baseline Forecast Summary by Sector and State



4.3.1 Comparison of Baseline Forecast with Avista 2009 IRP

Table 4-8 compares the Avista 2009 IRP forecast, the LoadMAP baseline forecast for Washington and Idaho combined, and the regional forecast from the Sixth Plan. For the LoadMAP baseline and Avista forecast, the table shows data for the period 2009 through 2030, the last year of the IRP forecast. The Sixth Plan forecast is the medium case scenario for 2010 through 2030.

Table 4-8 Comparison of LoadMAP Baseline, Avista IRP, and Sixth Plan Energy Forecasts (MWh)

	LoadMAP Baseline			Avista IRP[14]			Sixth Plan[15]
Sector	**2009**	**2030**	**Avg. Growth ('09-'30)**	**2009**	**2030**	**Avg. Growth ('09-'30)**	**Avg. Growth ('10-'30)**
Residential	3,634,086	5,314,970	1.8%	3,700,000	5,048,000	1.5%	1.4%
Commercial	3,331,433	4,457,968	1.4%	3,400,000	4,773,000	1.6%	1.6%
Industrial	1,701,589	2,530,353	1.9%	1,900,000	3,029,000	2.2%	0.8%
Total	**8,667,109**	**12,303,291**	**1.7%**	**9,002,009**	**12,852,030**	**1.7%**	**1.4%**

The LoadMAP and IRP forecasts do not match exactly for the base year, likely due to the slightly different ways in which the study team selected rate classes to include and how we grouped them. Also, the IRP was prepared in September 2009, before final results for 2009 were available.

Overall growth in energy usage agrees well between LoadMAP and the IRP, at approximately 1.7% annual average growth. However, Global's forecast for the Residential sector produces greater growth than the IRP's projections, while the opposite is true for Commercial and Industrial sectors. Because the LoadMAP baseline excludes future additional conservation activities, we would generally expect it to be somewhat higher than the IRP forecast, as is the case with the Residential sector. In general, the Sixth Plan forecast, which also excludes additional conservation, is lower than both the LoadMAP and Avista IRP forecasts, with the exception of the Commercial sector, where the Sixth Plan and the Avista IRP agree.

Retail Electricity Prices

Table 4-9 compares retail electricity prices used in the LoadMAP model and those projected in the IRP.

Table 4-9 Comparison of Retail Electricity Prices

	LoadMAP						Avista IRP[16]	
Sector	**2009 ($/kWh)**	**2018 ($/kWh)**	**Avg. Growth ('09-'18)**	**2019 ($/kWh)**	**2032 ($/kWh)**	**Avg. Growth ('19-'32)**	**Avg. Growth ('19-'32)**	**Avg. Growth ('19-'30)**
Res. WA	$0.072	$0.080	1.2%	$0.0818	$0.087	0.5%	10.0%	Inflation
Res. ID	$0.074	$0.088	1.8%	$0.089	$0.094	0.5%	10.0%	Inflation
C&I WA	$0.0700	$0.0703	0.1%	$0.0713	$0.0778	0.7%	10.0%	Inflation
C&I ID	$0.0566	$0.0600	0.6%	$0.0608	$0.0664	0.7%	10.0%	inflation

[14] Avista forecast from 2009 IRP, Figure 2.10 and p. 2-12.
[15] NPCC Sixth Northwest Conservation and Electric Power Plan, p. C-6, table C-3.
[16] Avista 2009 IRP, p. 2-9.

Avista's IRP forecast "is based on retail prices increasing an average of 10 percent annually from 2010 to 2018, followed by increases at the rate of inflation thereafter." However, Avista's most recent load forecast for 2011–2015 shows lower annual rate increases. For this study, Global used the rates from the 2011–2015 load forecast and thereafter, based on data from the AEO, increased rates by 0.50% and 0.68% respectively for residential and C/I customers.

Residential Energy Use per Household

As mentioned above, the LoadMAP residential baseline energy use forecast is higher than the IRP residential forecast. Furthermore, the baseline forecast of energy use per household is notably different, with average growth of 0.6% compared with Avista IRP showing that energy use per household decreases over time.[17]

Long-Term Weather

This study used the 30-year normal weather data. In contrast, the IRP mentions warming trends in recent weather. Although the model does not directly account for climate changes, the residential market profiles show an increase in air conditioning saturation over time, which indirectly reflects weather trends.

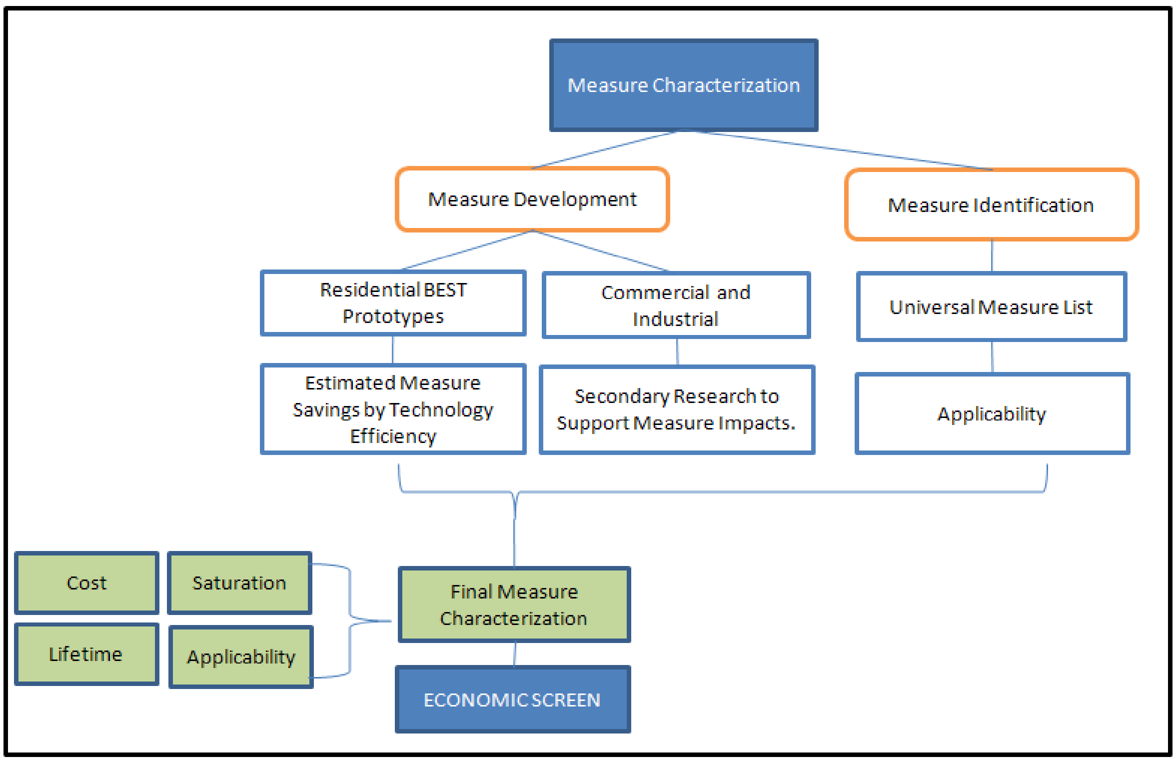
[17] Avista 2009 IRP Figure 2.9, p. 2-11.

CHAPTER | 5

ENERGY-EFFICIENCY MEASURE ANALYSIS

This section describes the framework used to assess the savings, costs, and other attributes of energy-efficiency measures. These characteristics form the basis for measure-level cost-effectiveness analyses as well as for determining measure-level savings. For all measures, Global assembled information to reflect equipment performance, incremental costs, and equipment lifetimes. We used this information, along with the avoided costs, in the economic screen to determine economically feasible measures. Figure 5-1 outlines the framework for measure analysis.

Figure 5-1 Approach for Measure Assessment



5.1 SELECTION OF ENERGY EFFICIENCY MEASURES

The first step of the energy efficiency measure analysis was to identify the list of all relevant energy efficiency measures that should be considered for the Avista CPA. Sources consulted to develop the list for this study included:

- Avista's existing conservation programs
- The Sixth Power Plan database of EE measure costs and savings
- NEEA's Regional Technical Forum
- Database for Energy Efficient Resources (DEER): The California Energy Commission and California Public Utilities Commission (CPUC) sponsor this database, which is designed to provide well-documented estimates of energy and peak demand savings values, measure costs, and effective useful life (EUL) all with one data source for the state of California.

- Global's Database of Energy Efficiency Measures (DEEM). In 2004, Global prepared a database of energy efficiency measures for residential and commercial segments across the U.S., analogous to the DEER database developed for California. Global updates the database on a regular basis as it conducts new energy efficiency potential studies.
- EPRI National Potential Study (2009). Global's assessment of the national potential for energy efficiency derived for the four DOE regions (including the Pacific region.
- Other recent Global potential studies

Measures can be categorized into one of two types, equipment measures and non-equipment measures, according to the LoadMAP taxonomy:

Equipment measures, or efficient energy-consuming equipment, save energy by providing the same service with a lower energy requirement. An example is the replacement of a standard efficiency refrigerator with an ENERGY STAR model. For equipment measures, many efficiency levels are available for a specific technology that range from the baseline unit (often determined by code or standard) up to the most efficient product commercially available. For instance, in the case of central air conditioners, this list begins with the federal standard SEER 13 unit and spans a broad spectrum of efficiency, with the highest efficiency level represented by a ductless mini-split system with variable refrigerant flow (at SEER levels of 18 or greater).

Non-equipment measures save energy by reducing the need for delivered energy but do not involve replacement or purchase of major end-use equipment (such as a refrigerator or air conditioner). An example would be a programmable thermostat that is pre-set, for example, to run the air conditioner only when people are home. Non-equipment measures fall into one of the following categories:

- Building shell (windows, insulation, roofing material)
- Equipment controls (thermostat, occupancy sensors)
- Equipment maintenance (cleaning filters, changing setpoints)
- Whole-building design (natural ventilation, passive solar lighting)
- Lighting retrofits (included as a non-equipment measure because retrofits are performed prior to the equipment's normal end of life)
- Displacement measures (ceiling fan instead of central air conditioner)

Non-equipment measures can apply to more than one end use. For example, insulation levels will affect both cooling and space heating energy consumption.

Global prepared a preliminary list of measures for Avista's review and revised the list based on Avista's input.

5.1.1 Residential Measures

Table 5-1 and Table 5-2 show the residential equipment and non-equipment measure options respectively and the segments for which they were modeled. Residential measures are described in Appendix C.

5.1.2 Commercial and Industrial Measures

Table 5-3and Table 5-4 list the C&I equipment and non-equipment measures, respectively. Measures were modeled for nearly all C&I building types, both new and existing, with only a few exceptions as shown. For all C&I segments, a custom measure category was included to serve as a "catch all" for measures for which costs and savings are not easily quantified and that could be part of a program such as Avista's existing Site-Specific incentive program. In addition, because the Small/Medium Commercial and Large Commercial segments also include some industrial customers, we included a non-equipment measure called Industrial Process Improvements to capture potential savings from these customers. C&I Measures are described in Appendix D.

Table 5-1 Summary of Residential Equipment Measures

End Use	Technology	Efficiency Option	Efficiency	Lifetime	On Market	Off Market	Single Family (existing & new)	Mulfi Family (existing & new)	Mobile Home (existing & new)	Low Income (existing & new)
Cooling	Central AC	SEER 13	100%	15	2009	2014	●	●	●	●
	Central AC	SEER 14 (ENERGY STAR)	92%	15	2009	2032	●	●	●	●
	Central AC	SEER 15 (CEE Tier 2)	89%	15	2009	2032	●	●	●	●
	Central AC	SEER 16 (CEE Tier 3)	86%	15	2009	2032	●	●	●	●
	Central AC	Ductless Mini-Split System	75%	20	2009	2032	●	●	●	●
	Room AC	EER 9.8	100%	10	2009	2032	●	●	●	●
	Room AC	EER 10.8 (ENERGY STAR)	91%	10	2009	2032	●	●	●	●
	Room AC	EER 11	89%	10	2009	2032	●	●	●	●
	Room AC	EER 11.5	85%	10	2009	2032	●	●	●	●
Heat & Cool	Air Source Heat Pump	SEER 13	100%	15	2009	2014	●	●	●	●
	Air Source Heat Pump	SEER 14 (ENERGY STAR)	92%	15	2009	2032	●	●	●	●
	Air Source Heat Pump	SEER 15 (CEE Tier 2)	89%	15	2009	2032	●	●	●	●
	Air Source Heat Pump	SEER 16 (CEE Tier 3)	86%	15	2009	2032	●	●	●	●
	Air Source Heat Pump	Ductless Mini-Split System	75%	20	2009	2032	●	●	●	●
	Geothermal Heat Pump	Standard	100%	14	2009	2032	●	●	●	●
	Geothermal Heat Pump	High Efficiency	86%	14	2009	2032	●	●	●	●
Space Heating	Electric Resistance	Electric Resistance	100%	20	2009	2032	●	●	●	●
	Electric Furnace	3400 BTU/KW	100%	15	2009	2032	●	●	●	●
	Supplemental	Supplemental	100%	5	2009	2032	●	●	●	●
Water Heating	Water Heater	Baseline (EF=0.90)	100%	15	2009	2015	●	●	●	●
	Water Heater	High Efficiency (EF=0.95)	95%	15	2009	2032	●	●	●	●
	Water Heater	Geothermal Heat Pump	32%	15	2009	2032	●			
	Water Heater	Solar	25%	15	2009	2032	●	●	●	●
Interior Lighting	Screw-in	Incandescent	100%	4	2009	2014	●	●	●	●
	Screw-in	Infrared Halogen	81%	5	2015	2020	●	●	●	●
	Screw-in	CFL	22%	6	2009	2032	●	●	●	●
	Screw-in	LED	14%	12	2009	2032	●	●	●	●
	Linear Fluorescent	T12	100%	6	2009	2032	●	●	●	●
	Linear Fluorescent	T8	91%	6	2009	2032	●	●	●	●
	Linear Fluorescent	Super T8	74%	6	2009	2032	●	●	●	●
	Linear Fluorescent	T5	73%	6	2009	2032	●	●	●	●
	Linear Fluorescent	LED	72%	10	2009	2032	●	●	●	●
	Pin-based	Halogen	100%	4	2009	2032	●	●	●	●
	Pin-based	CFL	23%	6	2009	2032	●	●	●	●
	Pin-based	LED	16%	10	2009	2032	●	●	●	●
Exterior Lighting	Screw-in	Incandescent	100%	4	2009	2014	●	●	●	●
	Screw-in	Infrared Halogen	79%	5	2015	2020	●	●	●	●
	Screw-in	CFL	20%	6	2009	2032	●	●	●	●
	Screw-in	LED	14%	12	2009	2032	●	●	●	●
	High Intensity/Flood	Incandescent	100%	4	2009	2014	●	●	●	●
	High Intensity/Flood	Infrared Halogen	88%	4	2015	2020	●	●	●	●
	High Intensity/Flood	CFL	29%	5	2009	2032	●	●	●	●
	High Intensity/Flood	Metal Halide	27%	5	2009	2032	●	●	●	●
	High Intensity/Flood	High Pressure Sodium	19%	5	2009	2032	●	●	●	●
	High Intensity/Flood	LED	18%	10	2009	2032	●	●	●	●

Table 5-1 Summary of Residential Equipment Measures (continued)

End Use	Technology	Efficiency Option	Efficiency	Lifetime	On Market	Off Market	Single Family (existing & new)	Multi Family (existing & new)	Mobile Home (existing & new)	Low Income (existing & new)
Appliances	Clothes Washer	Baseline	100%	10	2009	2032	●	●	●	●
	Clothes Washer	ENERGY STAR (MEF > 1.8)	70%	10	2009	2032	●	●	●	●
	Clothes Washer	Horizontal Axis	42%	10	2009	2032	●	●	●	●
	Clothes Dryer	Baseline	100%	13	2009	2032	●	●	●	●
	Clothes Dryer	Moisture Detection	85%	13	2009	2032	●	●	●	●
	Dishwasher	Baseline	100%	9	2009	2032	●	●	●	●
	Dishwasher	ENERGY STAR	85%	9	2009	2010	●	●	●	●
	Dishwasher	ENERGY STAR (2011)	81%	9	2011	2032	●	●	●	●
	Refrigerator	Baseline	100%	13	2009	2013	●	●	●	●
	Refrigerator	ENERGY STAR	85%	13	2009	2013	●	●	●	●
	Refrigerator	Baseline (2014)	80%	13	2014	2032	●	●	●	●
	Refrigerator	ENERGY STAR (2014)	68%	13	2014	2032	●	●	●	●
	Freezer	Baseline	100%	11	2009	2013	●	●	●	●
	Freezer	ENERGY STAR	85%	11	2009	2013	●	●	●	●
	Freezer	Baseline (2014)	80%	11	2014	2032	●	●	●	●
	Freezer	ENERGY STAR (2014)	68%	11	2014	2032	●	●	●	●
	Second Refrigerator	Baseline	100%	13	2009	2013	●	●	●	●
	Second Refrigerator	ENERGY STAR	85%	13	2009	2013	●	●	●	●
	Second Refrigerator	Baseline (2014)	80%	13	2014	2032	●	●	●	●
	Second Refrigerator	ENERGY STAR (2014)	68%	13	2014	2032	●	●	●	●
	Stove	Baseline	100%	13	2009	2032	●	●	●	●
	Stove	Convection Oven	98%	13	2009	2032	●	●	●	●
	Stove	Induction (High Efficiency)	88%	13	2009	2032	●	●	●	●
	Microwave	Microwave	100%	9	2009	2032	●	●	●	●
Electronics	Personal Computers	Baseline	100%	5	2009	2032	●	●	●	●
	Personal Computers	ENERGY STAR	65%	5	2009	2032	●	●	●	●
	Personal Computers	Climate Savers	50%	5	2009	2032	●	●	●	●
	TVs	Baseline	100%	11	2009	2032	●	●	●	●
	TVs	ENERGY STAR	80%	11	2009	2032	●	●	●	●
	Devices and Gadgets	Devices and Gadgets	100%	5	2009	2032	●	●	●	●
Miscellaneous	Pool Pump	Baseline Pump	100%	15	2009	2032	●		●	●
	Pool Pump	High Efficiency Pump	90%	15	2009	2032	●		●	●
	Pool Pump	Two-Speed Pump	60%	15	2009	2032	●		●	●
	Furnace Fan	Baseline	100%	18	2009	2032	●	●	●	●
	Furnace Fan	Furnace Fan with ECM	75%	18	2009	2032	●	●	●	●
	Miscellaneous	Miscellaneous	100%	5	2009	2032	●	●	●	●

Table 5-2 Summary of Residential Non-equipment Measures

End Use	Measure	Single Family Existing	Single Family New Construction	Multi Family Existing	Multi Family New Construction	Mobile Home Existing	Mobile Home New Construction	Low Income Existing	Low Income New Construction
HVAC	Central AC - Early Replacement	●		●		●	●	●	
	Central AC - Maintenance and Tune-Up	●	●	●	●	●	●	●	●
	Room AC - Removal of Second Unit	●		●		●	●	●	
	Air Source Heat Pump - Maintenance	●	●	●	●	●	●	●	●
	Furnace - Convert to Gas	●	●	●	●	●	●	●	●
	Attic Fan - Installation	●	●					●	●
	Attic Fan - Photovoltaic - Installation	●	●					●	●
	Ceiling Fan - Installation	●	●	●	●	●	●	●	●
	Whole-House Fan - Installation	●	●			●	●	●	●
	Thermostat - Clock/Programmable	●	●	●	●	●	●	●	●
	Insulation - Ceiling / Attic	●	●	●	●	●	●	●	●
	Insulation - Radiant Barrier	●	●	●	●	●	●	●	●
	Insulation - Infiltration Control	●		●		●		●	●
	Insulation - Ducting	●	●	●	●	●	●	●	●
	Repair and Sealing - Ducting	●		●		●		●	
	Insulation - Foundation		●						●
	Insulation - Wall Cavity		●		●		●		●
	Insulation - Wall Sheathing		●		●		●		●
	Doors - Storm and Thermal	●	●	●	●	●	●	●	●
	Windows - Reflective Film	●	●	●	●	●	●	●	●
	Windows - High Efficiency/ENERGY STAR	●	●	●	●	●	●	●	●
	Roofs - High Reflectivity	●	●	●	●	●	●	●	●
	Trees for Shading	●	●	●	●	●	●	●	●
Int. Lighting	Interior Lighting - Occupancy Sensors	●	●	●	●	●	●	●	●
Exterior Lighting	Exterior Lighting - Photovoltaic Installation	●	●	●	●	●	●	●	●
	Exterior Lighting - Photosensor Control	●	●	●	●	●	●	●	●
	Exterior Lighting - Timeclock Installation	●	●	●	●	●	●	●	●
Water Heating	Water Heater - Faucet Aerators	●	●	●	●	●	●	●	●
	Water Heater - Pipe Insulation	●	●	●	●	●	●	●	●
	Water Heater - Low Flow Showerheads	●	●	●	●	●	●	●	●
	Water Heater - Tank Blanket/Insulation	●	●	●	●	●	●	●	●
	Water Heater - Thermostat Setback	●	●	●	●	●	●	●	●
	Water Heater - Timer	●	●	●	●	●	●	●	●
	Water Heater - Hot Water Saver	●	●	●	●	●	●	●	●
	Water Heater - Drainwater Heat Recovery		●		●		●		●
	Water Heater - Convert to Gas	●	●	●	●	●	●	●	●
	Water Heater - Heat Pump Water Heater	●	●	●	●	●	●	●	●
Appliances	Refrigerator - Early Replacement	●		●		●		●	
	Refrigerator - Remove Second Unit	●		●		●		●	
	Freezer - Early Replacement	●		●		●		●	
	Freezer - Remove Second Unit	●		●		●		●	
Electronics	Electronics - Reduce Standby Wattage	●	●	●	●	●	●	●	●
Misc.	Pool - Pump Timer	●	●			●	●	●	●
Multiple End Uses	Home Energy Management System	●	●	●	●	●	●	●	●
	Advanced New Construction Designs		●		●		●		●
	Energy Efficient Manufactured Homes						●		
	ENERGY STAR Homes		●						
	Photovoltaic System	●	●	●	●	●	●	●	●

Table 5-3 Summary of Commercial and Industrial Equipment Measures

End Use	Technology	Efficiency Option	Small/Med. Comm. (existing & new)	Large Comm. (existing & new)	Extra Large Comm. (existing & new)	Extra Large Ind. (existing & new)
Cooling	Central Chiller	1.5 kW/ton, COP 2.3	●	●		
	Central Chiller	1.3 kW/ton, COP 2.7	●	●		
	Central Chiller	1.26 kW/ton, COP 2.8	●	●		
	Central Chiller	1.0 kW/ton, COP 3.5	●	●		
	Central Chiller	0.97 kW/ton, COP 3.6	●	●		
	Central Chiller	0.75 kw/ton, COP 4.7			●	●
	Central Chiller	0.60 kw/ton, COP 5.9			●	●
	Central Chiller	0.58 kw/ton, COP 6.1			●	●
	Central Chiller	0.55 kw/Ton, COP 6.4			●	●
	Central Chiller	0.51 kw/ton, COP 6.9			●	●
	Central Chiller	0.50 kw/Ton, COP 7.0			●	●
	Central Chiller	0.48 kw/ton, COP 7.3			●	●
	Central Chiller	Variable Refrigerant Flow	●	●	●	●
	RTU	EER 9.2	●	●	●	●
	RTU	EER 10.1	●	●	●	●
	RTU	EER 11.2	●	●	●	●
	RTU	EER 12.0	●	●	●	●
	RTU	Ductless VRF	●	●	●	●
Heat & Cool	PTAC	EER 9.8	●	●	●	●
	PTAC	EER 10.2	●	●	●	●
	PTAC	EER 10.8	●	●	●	●
	PTAC	EER 11	●	●	●	●
	PTAC	EER 11.5	●	●	●	●
	Heat Pump	EER 9.3, COP 3.1	●	●	●	●
	Heat Pump	EER 10.3, COP 3.2	●	●	●	●
	Heat Pump	EER 11.0, COP 3.3	●	●	●	●
	Heat Pump	EER 11.7, COP 3.4	●	●	●	●
	Heat Pump	EER 12, COP 3.4	●	●	●	●
	Heat Pump	Ductless Mini-Split System	●	●	●	●
	Heat Pump	Geothermal*	●	●	●	●
Space Heating	Electric Resistance	Standard	●	●	●	●
	Furnace	Standard	●	●	●	●
Ventilation	Ventilation	Constant Volume	●	●	●	●
	Ventilation	Variable Air Volume	●	●	●	●

*** New construction only**

Table 5-3 Summary of Commercial and Industrial Equipment Measures (continued)

End Use	Technology	Efficiency Option	Small/Med. Comm. (existing & new)	Large Comm. (existing & new)	Extra Large Comm. (existing & new)	Extra Large Ind. (existing & new)
Interior Lighting	Interior Screw-in	Incandescents	●	●	●	●
	Interior Screw-in	Infrared Halogen	●	●	●	●
	Interior Screw-in	CFL	●	●	●	●
	Interior Screw-in	LED	●	●	●	●
	HID	Metal Halides	●	●	●	●
	HID	High Pressure Sodium	●	●	●	●
	Linear Fluorescent	T12	●	●	●	●
	Linear Fluorescent	T8	●	●	●	●
	Linear Fluorescent	Super T8	●	●	●	●
	Linear Fluorescent	T5	●	●	●	●
	Linear Fluorescent	LED	●	●	●	●
Exterior Lighting	Exterior Screw-in	Incandescents	●	●	●	●
	Exterior Screw-in	Infrared Halogen	●	●	●	●
	Exterior Screw-in	CFL	●	●	●	●
	Exterior Screw-in	Metal Halides	●	●	●	●
	Exterior Screw-in	LED	●	●	●	●
	HID	Metal Halides	●	●	●	●
	HID	High Pressure Sodium	●	●	●	●
	HID	Low Pressure Sodium	●	●	●	●
	Linear Fluorescent	T12	●	●	●	●
	Linear Fluorescent	T8	●	●	●	●
	Linear Fluorescent	Super T8	●	●	●	●
	Linear Fluorescent	T5	●	●	●	●
	Linear Fluorescent	LED	●	●	●	●
Water Heating	Water Heater	Baseline (EF=0.90)	●	●	●	
	Water Heater	High Efficiency (EF=0.95)	●	●	●	
	Water Heater	Geothermal Heat Pump	●	●	●	
	Water Heater	Solar	●	●	●	
Food Preparation	Fryer	Standard	●	●	●	
	Fryer	Efficient	●	●	●	
	Oven	Standard	●	●	●	
	Oven	Efficient	●	●	●	
	Dishwasher	Standard	●	●	●	
	Dishwasher	Efficient	●	●	●	
	Hot Food Container	Standard	●	●	●	
	Hot Food Container	Efficient	●	●	●	
	Food Prep Misc.	Standard	●	●	●	
	Food Prep Misc.	Efficient	●	●	●	

Table 5-3 Summary of Commercial and Industrial Equipment Measures (continued)

End Use	Technology	Efficiency Option	Small/Med. Comm. (existing & new)	Large Comm. (existing & new)	Extra Large Comm. (existing & new)	Extra Large Ind. (existing & new)
Refrigeration	Walk in Refrigeration	Standard	●	●	●	
	Walk in Refrigeration	Efficient	●	●	●	
	Glass Door Display	Standard	●	●	●	
	Glass Door Display	Efficient	●	●	●	
	Solid Door Refrigerator	Standard	●	●	●	
	Solid Door Refrigerator	Efficient	●	●	●	
	Open Display Case	Standard	●	●	●	
	Open Display Case	Efficient	●	●	●	
	Vending Machine	Base	●	●	●	
	Vending Machine	Base (2012)	●	●	●	
	Vending Machine	High Efficiency	●	●	●	
	Vending Machine	High Efficiency (2012)	●	●	●	
	Icemaker	Standard	●	●	●	
	Icemaker	Efficient	●	●	●	
Office Equipment	Desktop Computer	Baseline	●	●	●	
	Desktop Computer	ENERGY STAR	●	●	●	
	Desktop Computer	Climate Savers	●	●	●	
	Laptop Computer	Baseline	●	●	●	
	Laptop Computer	ENERGY STAR	●	●	●	
	Laptop Computer	Climate Savers	●	●	●	
	Server	Standard	●	●	●	
	Server	ENERGY STAR	●	●	●	
	Monitor	Standard	●	●	●	
	Monitor	ENERGY STAR	●	●	●	
	Printer/copier/fax	Standard	●	●	●	
	Printer/copier/fax	ENERGY STAR	●	●	●	
	POS Terminal	Standard	●	●	●	
	POS Terminal	ENERGY STAR	●	●	●	
Miscellaneous	Non-HVAC Motor	Standard	●	●	●	
	Non-HVAC Motor	Standard (2015)	●	●	●	
	Non-HVAC Motor	High Efficiency	●	●	●	
	Non-HVAC Motor	High Efficiency (2015)	●	●	●	
	Non-HVAC Motor	Premium	●	●	●	
	Non-HVAC Motor	Premium (2015)	●	●	●	
	Other Miscellaneous	Miscellaneous	●	●	●	●
	Other Miscellaneous	Miscellaneous (2013)	●	●	●	

Table 5-3 Summary of Commercial and Industrial Equipment Measures (continued)

End Use	Technology	Efficiency Option	Small/Med. Comm. (existing & new)	Large Comm. (existing & new)	Extra Large Comm. (existing & new)	Extra Large Ind. (existing & new)
Machine Drive	Less than 5 HP	Standard				●
	Less than 5 HP	High Efficiency				●
	Less than 5 HP	Standard (2015)				●
	Less than 5 HP	Premium				●
	Less than 5 HP	High Efficiency (2015)				●
	Less than 5 HP	Premium (2015)				●
	5-24 HP	Standard				●
	5-24 HP	High				●
	5-24 HP	Premium				●
	25-99 HP	Standard				●
	25-99 HP	High				●
	25-99 HP	Premium				●
	100-249 HP	Standard				●
	100-249 HP	High				●
	100-249 HP	Premium				●
	250-499 HP	Standard				●
	250-499 HP	High				●
	250-499 HP	Premium				●
	500 and more HP	Standard				●
	500 and more HP	High				●
	500 and more HP	Premium				●
Process	Process Cooling/Refrig.	Standard				●
	Process Cooling/Refrig.	Efficient				●
	Process Heating	Standard				●
	Process Heating	Efficient				●
	Electrochemical Process	Standard				●
	Electrochemical Process	Efficient				●

Table 5-4 Summary of Commercial and Industrial Non-equipment Measures

End Use	Measure	Commercial Existing Buildings	Commercial New Construction	Industrial Existing Buildings	Industrial New Construction
HVAC	RTU - Maintenance	●	●	●	●
	RTU - Evaporative Precooler	●	●		
	Chiller - Chilled Water Reset	●	●	●	●
	Chiller - Chilled Water Variable-Flow System	●	●	●	●
	Chiller - Condenser Water Temprature Reset	●	●	●	●
	Chiller - High Efficiency Cooling Tower Fans	●	●	●	●
	Chiller - Turbocor Compressor	●	●	●	●
	Chiller - VSD	●	●	●	●
	Cooling - Economizer Installation	●	●	●	●
	Heat Pump - Maintenance	●	●	●	●
	Insulation - Ducting	●	●	●	●
	Repair and Sealing - Ducting	●		●	
	Insulation - Ceiling	●	●		
	Insulation - Radiant Barrier	●	●		
	Insulation - Wall Cavity		●		
	Cooking - Exhaust Hoods with Sensor Control	●	●		
	Fans - Energy Efficient Motors	●	●	●	●
	Fans - Variable Speed Control	●	●	●	●
	Pumps - Variable Speed Control	●	●		
	Thermostat - Clock/Programmable	●	●	●	●
	Roofs - High Reflectivity	●	●		
	Roofs - Green		●		
	Windows - High Efficiency	●	●		
	Retrocommissioning - HVAC	●		●	
	Commissioning - HVAC		●		●
	Furnace - Convert to Gas	●	●	●	●
Interior Lighting	Interior Fluorescent - Photocell Controlled T8 Dimming	●	●		
	Interior Fluorescent - Delamp and Install Reflectors	●		●	
	Interior Fluorescent - Bi-Level Fixture w/Occupancy Sen	●	●		
	Interior Fluorescent - High Bay Fixtures	●	●	●	●
	Interior Screw-in - Task Lighting	●	●	●	●
	Central Lighting Controls	●	●	●	●
	Occupancy Sensors	●	●	●	●
	Time Clocks and Timers	●	●	●	●
	LED Exit Lighting	●	●	●	●
	Hotel Guestroom Controls	●	●		
	Retrocommissioning - Lighting	●		●	
	Commissioning - Lighting		●		●
Exterior Lighting	Daylighting Controls	●	●	●	●
	Photovoltaic Installation	●	●	●	●
	Cold Cathode Lighting	●	●	●	●
	Induction Lamps	●	●		

Note: Conversion of electric furnaces to gas was only modeled for Small/Medium Commercial segment.

Table 5-4 Summary of Commercial and Industrial Non-equipment Measures (continued)

End Use	Measure	Commercial Existing Buildings	Commercial New Construction	Industrial Existing Buildings	Industrial New Construction
Water Heating	Faucet Aerators/Low Flow Nozzles	●	●		
	Hot Water Saver	●	●		
	Pipe Insulation	●	●		
	Tank Blanket/Insulation	●	●		
	Thermostat Setback	●	●		
	Convert to Gas	●	●		
	Heat Pump Water Heater	●	●		
Refrigeration	Floating Head Pressure	●	●		
	Insulation - Bare Suction Lines	●	●		
	Demand Defrost	●	●		
	High Efficiency Case Lighting	●	●		
	Evaporator Fan Controls	●	●		
	Anti-Sweat Heater/Auto Door Closer	●	●		
	Door Gasket Replacement	●	●		
	Night Covers	●	●		
	Strip Curtain	●	●		
	Vending Machine - Controller	●	●		
Office Equipment	ENERGY STAR Power Supply	●	●		
Miscellaneous	Laundry - High Efficiency Clothes Washer	●	●		
	Miscellaneous - Energy Star Water Cooler	●	●		
Machine Drive	Motors - Variable Frequency Drive			●	●
	Motors - Magnetic Adjustable Speed Drives			●	●
	Compressed Air - System Controls			●	●
	Compressed Air - System Optimization & Improvements			●	●
	Compressed Air - System Maintenance			●	●
	Compressed Air - Compressor Replacement			●	●
	Fan System - Controls			●	●
	Fan System - Optimization			●	●
	Fan System - Maintenance			●	●
	Pumping System - Controls			●	●
	Pumping System - Optimization			●	●
	Pumping System - Maintenance			●	●
	Pumps - Variable Speed Control	●	●	●	●
Industrial Process	Industrial Process Improvements	●	●		
	Refrigeration - System Controls			●	●
	Refrigeration - System Maintenance			●	●
	Refrigeration - System Optimization			●	●
Multiple End Uses	Energy Management System	●	●	●	●
	Retrocommissioning - Comprehensive	●			
	Advanced New Construction Designs		●		●
	Commissioning - Comprehensive		●		
	Pumps - Variable Speed Control	●	●	●	●
	Custom Measures	●	●	●	●

Note: Conversion of electric water heaters to gas only modeled for Small/Medium Commercial segment.

5.2 MEASURE CHARACTERISTICS

For each measure considered, the Global team developed the following data for input to the LoadMAP model:

- ***Energy Impacts:*** The energy-savings impacts represent the annual reduction in consumption attributable to each specific measure. Savings were developed as a percentage of the energy end use that the measure affects. This approach takes into account the efficiency of the equipment that is providing that end use. For example, savings due to increased insulation will be greater if heating is provided by electric resistance, and lower if heating is provided by a heat pump. For the residential and commercial sectors, the BEST simulation model was used to determine the savings impacts. The key advantage of utilizing BEST is that interactive effects between HVAC measures and other measures such as lighting and building construction are captured and quantified. In addition, the prototype modeling combines the primary market data with Spokane-specific Typical Meteorological Year (TMY) weather data to derive savings. For the industrial sector, secondary data resources such as the EPRI National Potential Study and DEEM were used to develop assessments of savings at the end-use level.
- ***Peak Demand Impacts:*** Savings during the peak demand periods are specified for each measure. These impacts relate to the energy savings and depend on each measure's "coincidence" with the system peak. To accurately express the peak impacts of the energy efficiency measures considered, the project used a combined approach of prototype simulation (BEST model) and Global's proprietary end-use load shape database, EnergyShape.
- ***Costs:*** For equipment measures, the measure characterization includes the full cost of purchasing and installing the equipment on a per-unit or per-square-foot basis for the residential and C&I sectors, respectively. For non-equipment measures in existing buildings, the cost likewise represents the full installed cost. For non-equipment measures in new construction, the approach is slightly different; the costs may be either the full cost of the measure, for example a programmable thermostat, or as appropriate, it may be the incremental cost of upgrading from a standard level to a higher efficiency level, such as upgrading from R13 to R26 insulation. These costs were developed specifically for the Spokane area and drew upon sources including the Sixth Plan databases.
- ***Measure Lifetimes:*** These estimates were derived from the technical data and secondary data sources that support the measure demand and energy savings analysis. Values were obtained from the Sixth Plan database, DEER database, DEEM, and other secondary sources.
- ***Applicability:*** This factor is an estimate of the percentage of either dwellings in the residential sector or square feet in the C&I sectors where it is technically feasible for the specific measure to be implemented. These figures are based on secondary data sources such as NEEA reports, California's DEER database, DEEM, and others.
- ***On Market and Off Market Availability:*** To account for the fact that some equipment will no longer be available for sale due to changes in appliance standards, or that some high-efficiency equipment is expected to enter the market during the study period, the project also developed on market and off market inputs, expressed as years, for the equipment measures.

5.2.1 Measure Cost Data Development

Costs for equipment and non-equipment measures include both material and labor costs associated with the measure's installation. These costs draw upon national construction cost averages.

The following references were used to develop the equipment and measure costs:

- Sixth Northwest Conservation and Electric Power Plan Conservation Supply Curves workbooks
- DEER – California Database for Energy Efficient Resources
- RS Means Facilities Maintenance and Repair Cost Data
- RS Means Mechanical Construction Costs
- RS Means Building Construction Cost Data
- USGBC — LEED New Construction & Major Renovation (2008)
- RS Means Green Buildings Project Planning & Cost Estimating Second Edition (2008)
- Grainger Catalog Volume 398, (2007-2008)

5.2.2 Representative Measure Data Inputs

To provide an example of the measure data, Table 5-5 and Table 5-6 present samples of the detailed data inputs behind equipment and non-equipment measures, respectively, for the case of residential central air conditioning in single-family homes. Table 5-5 displays the various efficiency levels available as equipment measures, as well as the corresponding useful life, usage, and cost estimates. These values all contribute to the outcome of the stock accounting model, in which the purchase of an above-standard unit is first analyzed for cost-effectiveness (comparing incremental cost to lifetime benefits) and then, for the levels that pass the screen, incorporated into the new units purchased.

Table 5-5 Sample Equipment Measures for Central Air Conditioning — Single Family Home Segment

Efficiency Level	Useful Life	Equipment Cost	Energy Usage(kWh/yr)	On Market	Off Market
SEER 13	15	$3,794	1,619	2009	2014
SEER 14 (ENERGY STAR)	15	$4,072	1,485	2009	2032
SEER 15 (CEE Tier 2)	15	$4,350	1,435	2009	2032
SEER 16 (CEE Tier 3)	15	$4,628	1,393	2009	2032
Ductless Mini-split System	20	$8,193	1,214	2009	2032

Table 5-6 lists the non-equipment measures affecting an existing single-family home's central air conditioning electricity use. These measures are also evaluated for cost-effectiveness based on the lifetime benefits relative to the cost of the measure. The total savings are calculated for each year of the model and depend on the base year saturation of the measure, the overall applicability of the measure, and the savings as a percentage of the relevant energy end uses. Residential central air conditioning provides energy savings, but no demand savings due to Avista's existing heating season peak. In addition to the Applicability factor, a Feasibility factor is applied to account for the feasibility of installing the measure.

Table 5-6 Sample Non-Equipment Measures – Single Family Homes, Existing

End Use	Measure	Saturation in 2009[18]	Applicability	Feasibility	Lifetime (years)	Measure Installed Cost	Energy Savings (%)	Demand Savings (%)
Cooling	Central AC — Early Replacement	0%	80%	10%	15	$2,895	10.0%	0%
Cooling	Central AC — Maintenance and Tune-Up	41%	100%	100%	4	$125	10.0%	0%
Cooling	Attic Fan — Installation	11%	50%	45%	18	$116	0.7%	0%
Cooling	Attic Fan — Photovoltaic	13%	100%	45%	19	$350	1.4%	0%
Cooling	Ceiling Fan	52%	100%	75%	15	$160	11.0%	0%
Cooling	Whole-House Fan	7%	25%	75%	18	$200	9.0%	0%
Cooling	Insulation — Ducting	15%	100%	75%	18	$500	3.0%	0%
Cooling	Repair and Sealing — Ducting	12%	100%	50%	18	$500	10.0%	0%
Cooling	Doors — Storm and Thermal	38%	100%	75%	11	$320	1.0%	0%
Cooling	Insulation — Infiltration Control	46%	100%	90%	12	$266	3.0%	0%
Cooling	Insulation — Ceiling	68%	90%	80%	20	$594	3.0%	0%
Cooling	Insulation — Radiant Barrier	5%	100%	90%	12	$923	5.0%	0%
Cooling	Roofs — High Reflectivity	5%	100%	10%	15	$1,550	6.1%	0%
Cooling	Windows — Reflective Film	5%	50%	90%	10	$267	7.0%	0%
Cooling	Windows — High Efficiency/ENERGY STAR	83%	100%	90%	25	$7,500	12.0%	0%
Cooling	Thermostat — Clock/Programmable	55%	75%	75%	11	$114	8.0%	0%
Cooling	Home Energy Management System	20%	50%	75%	20	$300	10.0%	0%
Cooling	Photovoltaics	0%	80%	60%	15	$17,000	50.0%	0%
Cooling	Trees for Shading	10%	90%	75%	20	$40	1.1%	0%

5.2.3 Conversion to Natural Gas

Conversion to natural gas (fuel switching) for both space heating and water heating was evaluated as a special case. These options were evaluated as non-equipment measures, though of course, they are in fact equipment changes. Modeling conversion to gas as a non-equipment measure allowed using the applicability and feasibility factors to better account for customers' real ability to implement these technologies.

For conversion of water heaters to natural gas, an applicability factor was developed based on Avista GIS data combined with the market profiles to indicate that approximately 63% of Washington homes and 57% of Idaho homes with electric water heating are within 500 feet of a gas main. The feasibility factor of 80% assumes that other factors, such as inability to accommodate venting, would prevent 20% of customers from making the switch to gas water heating. For heat pump water heaters, we assumed the technology is applicable to the remaining customers (100% – (63% * 80%) = 50% in Washington and 54% using a similar calculation for

[18] Note that saturation levels reflected for 2009 change over time as more measures are adopted.

Idaho). However, the feasibility factor is 50% for single family homes because only about half of these customers have water heating systems with tanks larger than 55 gallons that are suitable for heat pump water heaters. For the other housing types, the feasibility factors were lower due to the still lower saturation of larger than 55 gallon water heating systems. Conversion of electric furnaces to gas was modeled using similar assumptions.

Table 5-7 shows assumptions for water heating non-equipment measures in Washington single-family homes, including the conversion to gas and heat pump measures discussed above.

Table 5-7 Sample Non-Equipment Water Heating Measures – Single Family Homes, Existing, Washington

End Use	Measure	Saturation in 2009[19]	Applicability	Feasibility	Lifetime (years)	Measure Installed Cost	Energy Savings (%)	Demand Savings (%)
Water Heating	Faucet Aerators	53%	100%	90%	25	$24	3.7%	1.9%
Water Heating	Pipe Insulation	17%	100%	38%	13	$180	5.7%	2.9%
Water Heating	Low Flow Showerheads	75%	100%	80%	10	$96	17.1%	8.6%
Water Heating	Tank Blanket/Insulation	17%	100%	75%	10	$15	9.1%	4.6%
Water Heating	Thermostat Setback	17%	100%	75%	5	$40	9.1%	4.6%
Water Heating	Timer	17%	100%	40%	10	$194	8.0%	4.0%
Water Heating	Hot Water Saver	5%	100%	50%	5	$35	8.8%	4.4%
Water Heating	Convert to Gas	0%	63%	80%	15	$3,675	100.0%	100.0%
Water Heating	Heat Pump	0%	50%	50%	15	$1,500	30.0%	15.0%

The equipment measure data tables for all energy efficiency measures assessed in this study are presented in Appendix C for the residential sector and Appendix C for the C&I sectors.

5.3 APPLICATION OF MEASURES FOR TECHNICAL POTENTIAL

Technical potential, as we defined it in Chapter 2, is a theoretical construct that assumes the highest efficiency measures that are technically feasible to install are adopted by customers, regardless of cost or customer preferences. Thus, determining the technical potential is relatively straightforward; LoadMAP uses the energy use associated with the most efficient equipment options for each end use and technology, as well as the energy savings for all defined non-equipment measures that apply to that end use and technology, to calculate energy use at the technical potential level. For example, for residential central air conditioning, as shown in Table 5-5, the most efficient option is a ductless mini-split system. The multiple non-equipment measures shown in Table 5-7 are then applied to the energy used by the ductless mini-split system to further reduce CAC energy use. LoadMAP applies the savings due to the non-equipment measures one-by-one to avoid double counting of savings. The measures are evaluated in order of their B/C ratio, with the measure with the highest B/C ratio applied first. Each time a measure is applied, the baseline energy use for the end use is reduced and the percentage savings for the next measure is applied to the revised (lower) usage.

5.4 APPLICATION OF MEASURES FOR ECONOMIC POTENTIAL

Next, to determine the economic level of efficiency potential, it is necessary to perform an economic screen on each individual measure. The economic screen applied in this study for non-

[19] Note that saturation levels reflected for 2009 change over time as more measures are adopted.

equipment measures is a total resource cost (TRC) test that compares the lifetime benefits (both energy and peak demand) of each applicable measure with installed cost (including material, labor, and administration of a delivery mechanism, such as an energy efficiency program).[20] The lifetime benefits are obtained by multiplying the annual energy and demand savings for each measure by all appropriate avoided costs for each year, and discounting the dollar savings to the present value equivalent. Global assigns each measure values for savings, costs, and lifetimes as part of our measure characterization process. For economic screening of measures, incentives are not included because they represent a simple transfer from one party to another but have no effect on the overall measure cost.

The lifetime benefits of each energy efficiency measure depend on the forecast of Avista avoided costs. Avista provided projected avoided costs for energy and capacity over the study period. Figure 5-2 shows the avoided energy costs for the residential and C&I segments, which are 2009 real $/MWh and include Avista's adjustments for risk and the 10% Power Act premium. The avoided energy costs differ by segment due to the segments' differing load shapes. Figure 5-2 also shows the avoided capacity costs for Avista's overall system in 2009 real $/kW.

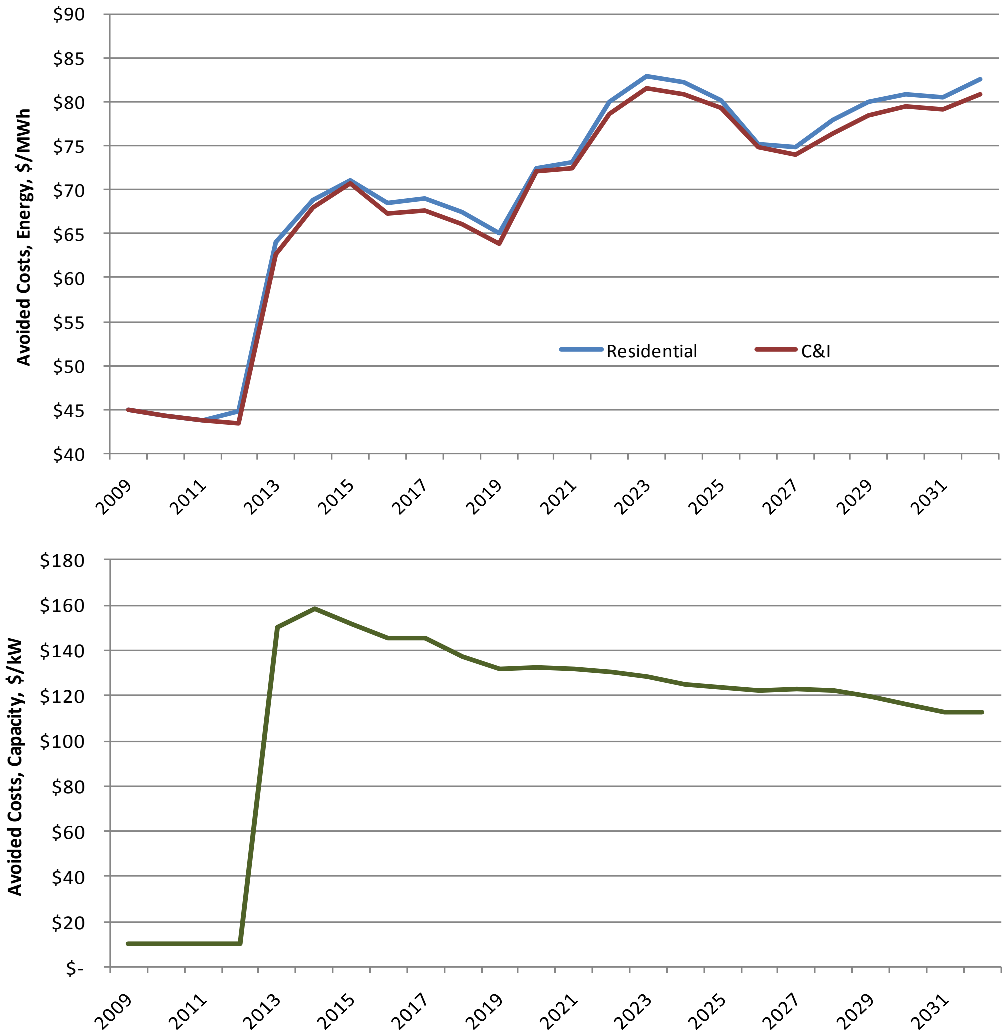
The LoadMAP model performs the economic screening dynamically, taking into account changing savings and cost data over time. Thus, some measures pass the economic screen for some — but not all — of the years in the forecast.

It is important to note the following about the economic screen:

- The economic evaluation of every measure in the screen is conducted relative to a baseline condition. For instance, in order to determine the kilowatt-hour (kWh) savings potential of a measure, kWh consumption with the measure applied must be compared to the kWh consumption of a baseline condition.
- The economic screening was conducted only for measures that are applicable to each building type and vintage; thus if a measure is deemed to be irrelevant to a particular building type and vintage, it is excluded from the respective economic screen table.

[20] Note that the TRC test is typically the industry standard for evaluating measure-level cost-effectiveness. There are other test perspectives that are often considered in energy efficiency potential studies. The Participant test measures the benefits and costs from the perspective of program participants as a whole. The Ratepayer Impact Measure (RIM) test measures the difference between the change in total revenues paid to a utility and the change in total costs to a utility resulting from the energy efficiency and demand response programs. The Utility Cost (UC) test measures the costs and benefits from the perspective of the utility administering the program. Neither the RIM nor UC tests are typically applied in the context of measure-level economic screens, but rather in the broader context of energy efficiency programs and initiatives put into place to deliver the energy efficiency measures.

Figure 5-2 Avoided Costs for Energy and Capacity



5.4.1 Equipment Measures Economic Screening

For equipment measures, LoadMAP evaluates the cost-effectiveness of each measure option, compared to the efficiency option that immediately precedes it. Continuing with the example of residential central air conditioning, as shown in Table 5-5, the standard efficiency option in 2010 is SEER 13. LoadMAP calculates the lifetime benefits and costs associated with each of the higher efficiency options to select the option with the highest net present value.

Table 5-8 shows the results of the economic screen for CAC for selected years, as well as results for two interior lighting technologies. In 2010, the most cost-effective option is SEER 14, while in 2012, due to rising energy costs, it changes to SEER 15. However, in 2015, due to federal energy efficiency standards, the SEER 13 unit goes off the market and SEER 14 becomes the standard efficiency unit. In 2015 and beyond, the economic screen selects the SEER 14 option because the marginal savings between the standard efficiency SEER 14 unit and the higher-efficiency options are not sufficient to make the higher-efficiency units economical. The table also shows how the economic choice for two of the lighting technology options varies over the study period.

Table 5-8 Economic Screen Results for Selected Residential Equipment Measures

Technology	2012	2017	2022	2027	2032
Central AC	SEER 13	SEER 14	SEER 14	SEER 14	SEER 14
Interior Lighting Screw-in	CFL	CFL	CFL	LED	LED
Interior Lighting Linear Fluorescent	T8	T8	T8	Super T8	Super T8

5.4.2 Non-equipment Measures Economic Screening

For non-equipment measures, LoadMAP evaluates the cost-effectiveness of each measure. The kWh savings are computed as the percent savings from the measure applied to the relevant end-use energy. If the measure passes the screen (has a B/C ratio greater than or equal to 1.0), the measure is included in economic potential. Otherwise, it is screened out for that year.

5.5 TOTAL MEASURES EVALUATED

Table 5-9 summarizes the number of equipment and non-equipment measures evaluated for each sector. In total, the project evaluated 4,332 energy efficiency measures.

Table 5-9 Number of Measures Evaluated

	Residential	C&I	Total Number of Measures
Equipment Measures Evaluated	1,284	608	1,892
Non-Equipment Measures Evaluated	1,524	916	2,440
Total Measures Evaluated	**2,808**	**1,524**	**4,332**

Appendix C shows the results of the economic screening process by segment, vintage, end use and measure for the residential sector. Appendix D shows the equivalent information for the commercial and industrial sectors.

CHAPTER 6

ENERGY EFFICIENCY POTENTIAL RESULTS

This chapter presents the results of the energy-efficiency analysis. Before we provide the overall and sector-level results, we review the four levels of potential developed for this study.

6.1 DEFINITIONS OF POTENTIAL

In this study, we estimated four types of potential: *technical; economic;* and achievable potential, which is further divided into *maximum achievable,* and *realistic achievable*. Technical and economic potential are both theoretical limits to efficiency savings. Achievable potential embodies a set of assumptions about the decisions consumers make regarding the efficiency of the equipment they purchase, the maintenance activities they undertake, the controls they use for energy-consuming equipment, and the elements of building construction. Two types of achievable potential were developed for this study, maximum achievable and realistic achievable, to bound the range of achievable potential. For details on the types of potentials, see Chapter 2.

As with the baseline forecast, we developed the estimates of energy-efficiency potential using the LoadMAP model. We present high-level results in the rest of this chapter for the overall Avista electricity system. Separate results for Washington and Idaho are presented in Appendices A and B.

6.2 OVERALL ENERGY EFFICIENCY POTENTIAL

Maximum achievable potential across all sectors is 88,760 MWh (10.1 aMW) in 2012 and increases to a cumulative value of 2,905,702 MWh (331.7 aMW) by 2032. These savings represents 1.0% of the baseline forecast in 2012 and 22.6% in 2032. Realistic achievable potential in 2012 is 50,261 MWh (5.7 aMW) and reaches a cumulative value of 2,155,133 MWh (246.0 aMW) by 2032, for savings that are 0.6% and 16.8% of the baseline in 2012 and 2032 respectively. Between 2012 and 2032, the baseline forecast shows overall electricity consumption growth of 46%, but the realistic achievable potential forecast reduces growth by half to 23%. Technical potential by 2032 is 37.8% of the baseline and economic potential savings are 26.4% of the baseline, or roughly 70% of technical potential savings. MAP and RAP savings in 2012 are 86% and 64% respectively of the economic potential savings.

Figure 6-1 summarizes the energy-efficiency savings for the four potential levels relative to the baseline forecast for selected years. Figure 6-2 displays the energy use forecast for the four potential levels versus the baseline forecast. Table 6-1 presents the energy consumption and peak demand for the potential levels across sectors.

Figure 6-1 Summary of Energy Efficiency Potential Savings, All Sectors

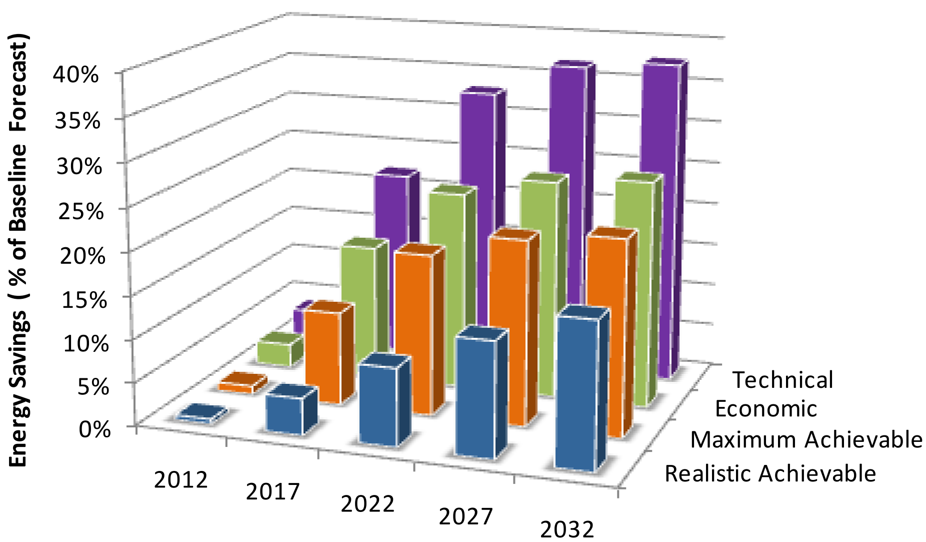


Figure 6-2 Energy Efficiency Potential Forecasts, All Sectors

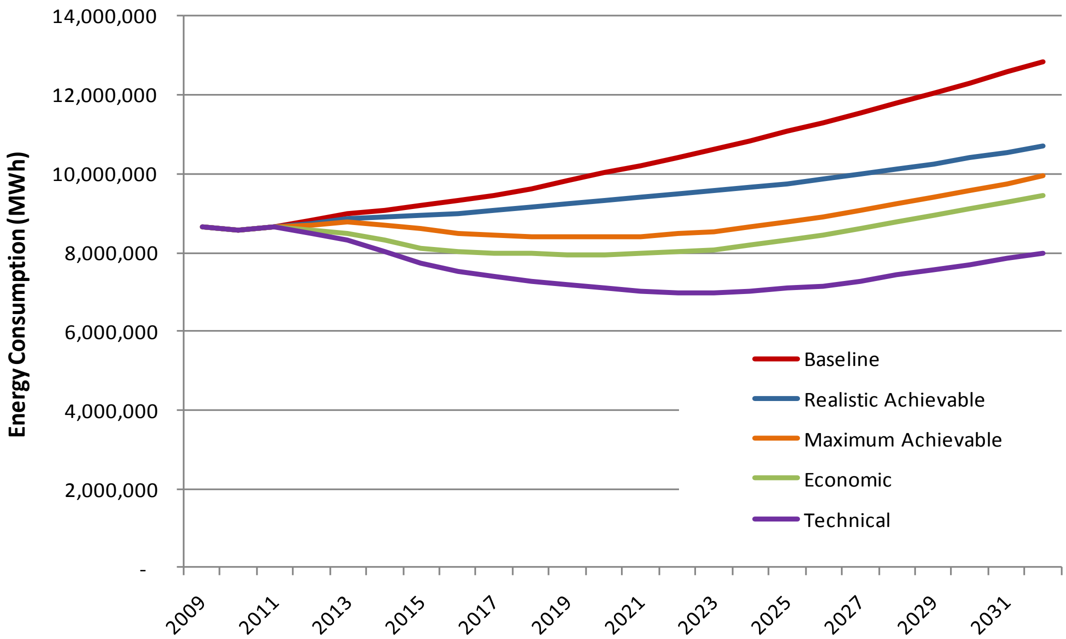


Table 6-1 Summary of Energy Efficiency Potential, All Sectors

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	8,799,039	9,463,880	10,417,347	11,536,869	12,851,760
Baseline Peak Demand (MW)	1,780	1,880	2,080	2,306	2,566
Cumulative Energy Savings (MWh)					
Realistic Achievable	50,261	405,985	945,183	1,536,357	2,155,133
Maximum Achievable	88,760	1,035,470	1,952,473	2,476,694	2,905,702
Economic	244,292	1,493,608	2,411,399	2,937,775	3,387,203
Technical	329,513	2,087,061	3,435,475	4,250,217	4,852,362
Cumulative Energy Savings (% of Baseline)					
Realistic Achievable	0.6%	4.3%	9.1%	13.3%	16.8%
Maximum Achievable	1.0%	10.9%	18.7%	21.5%	22.6%
Economic	2.8%	15.8%	23.1%	25.5%	26.4%
Technical	3.7%	22.1%	33.0%	36.8%	37.8%
Peak Savings (MW)					
Realistic Achievable	14	84	183	306	431
Maximum Achievable	22	207	386	492	566
Economic	60	302	479	580	659
Technical	78	422	669	826	943
Peak Savings (% of Baseline)					
Realistic Achievable	0.8%	4.5%	8.8%	13.3%	16.8%
Maximum Achievable	1.2%	11.0%	18.6%	21.3%	22.1%
Economic	3.4%	16.0%	23.0%	25.2%	25.7%
Technical	4.4%	22.4%	32.2%	35.8%	36.8%

Table 6-2 and Figure 6-3 summarize cumulative realistic achievable potential by sector. Initially, the residential sector accounts for about 52% of the savings, but by the end of the study, the C&I sector becomes the source of 58% of the savings.

Table 6-2 Realistic Achievable Cumulative Energy-efficiency Potential by Sector, MWh

Segment	2012	2017	2022	2027	2032
Residential, WA	17,413	94,529	238,739	431,973	637,029
Residential, ID	8,692	43,922	97,705	172,179	260,003
C&I, WA	15,733	173,433	378,252	575,328	774,619
C&I, ID	8,423	94,102	230,487	356,878	483,482
Total	50,261	405,985	945,183	1,536,357	2,155,133

Figure 6-3 Realistic Achievable Cumulative Potential by Sector

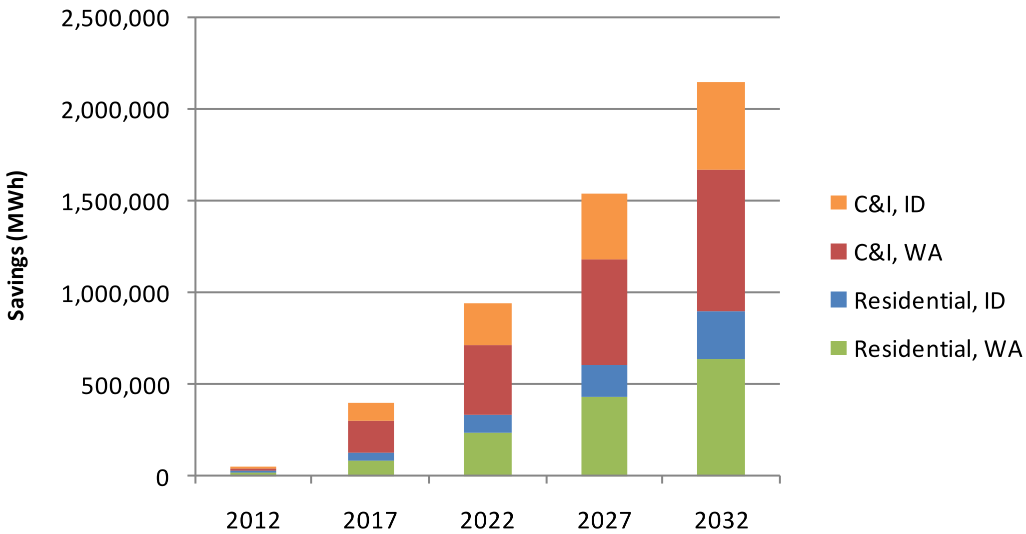


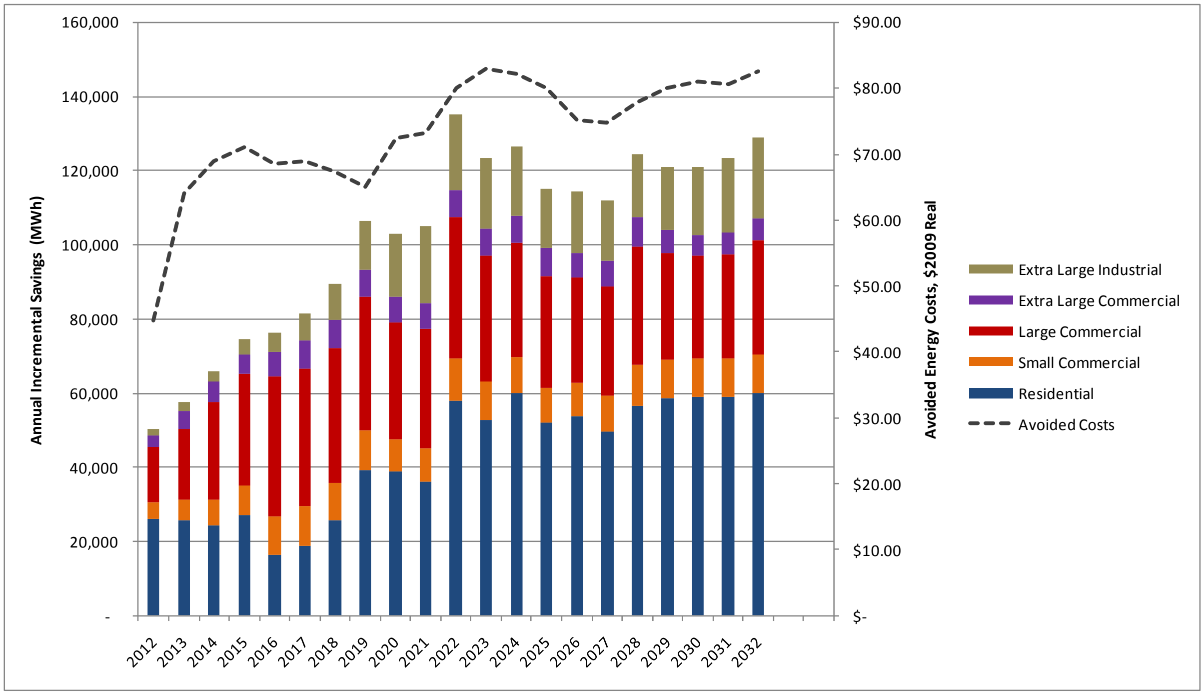
Table 6-3 shows the incremental annual realistic achievable potential by sector for 2012 through 2015. During this period, lighting and appliance standards slow the rate of growth in the residential baseline energy consumption, thus reducing the amount of incremental annual potential savings from residential conservation programs. On the other hand, C&I potential continues to grow. Complete annual incremental savings for Washington and Idaho appear in Appendices A and B respectively.

Table 6-3 Incremental Annual Realistic Achievable Energy-efficiency Potential by Sector, MWh

Segment	2012	2013	2014	2015
Residential, WA	17,413	17,161	16,488	18,514
Residential, ID	8,692	8,451	7,943	8,569
C&I, WA	15,733	21,165	26,869	30,393
C&I, ID	8,423	10,734	14,543	16,956
Total	**50,261**	**57,511**	**65,843**	**74,432**

In Figure 6-4, we can see how the annual incremental realistic achievable potential throughout the study tracks the avoided energy costs, with annual potential generally increasing or decreasing along with avoided costs. Note however that other factors also influence potential, particularly the rates at which programs can ramp up over time, which is particularly relevant to how potential changes from year to year in the early years of the study.

Figure 6-4 Incremental Annual Realistic Achievable Energy-efficiency (MWh) vs. Avoided Energy Cost



Note: Avoided costs are 2009 real dollars and include energy costs, risk, and the 10% Power Act premium.

6.3 RESIDENTIAL SECTOR

Realistic achievable potential savings for the residential sector in both states is 26,105 MWh in 2012, or 0.7% of the sector's baseline forecast. It reaches 897,032 MWh, or 16.0% of the baseline forecast by 2032. Technical and economic potential savings are 37.7% and 24.5% respectively. Figure 6-5 depicts the potential savings estimates graphically. Figure 6-6 shows the energy use forecasts under the four types of potential versus the baseline forecast. Table 6-3 presents estimates for energy and peak demand under the four types of potential.

Figure 6-5 Energy Efficiency Potential Savings, Residential Sector

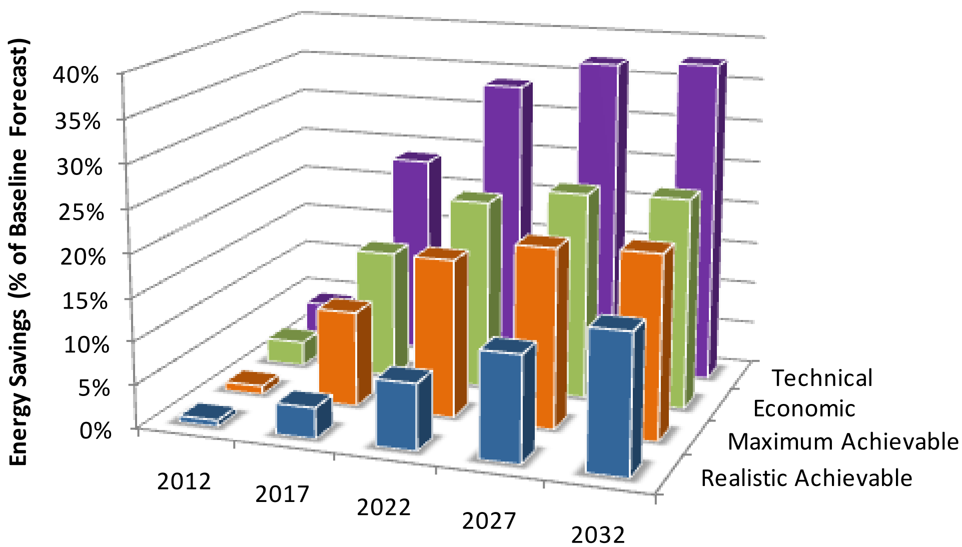


Figure 6-6 Energy Efficiency Potential Forecast, Residential Sector

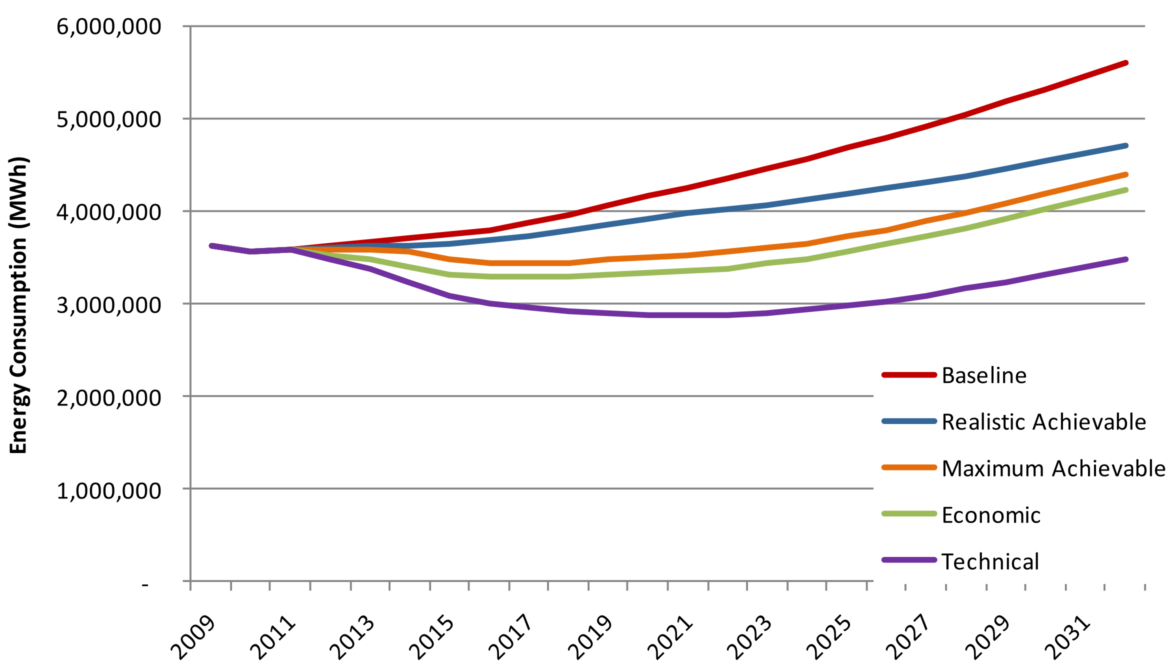


Table 6-4 Energy Efficiency Potential, Residential Sector

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	3,626,696	3,871,294	4,356,240	4,918,847	5,600,787
Baseline Peak Demand (MW)	991	1,026	1,150	1,288	1,449
Cumulative Energy Savings (MWh)					
Realistic Achievable	26,105	138,450	336,444	604,152	897,032
Maximum Achievable	36,300	429,065	798,829	1,024,671	1,192,794
Economic	104,111	583,427	967,788	1,188,497	1,373,869
Technical	153,100	918,965	1,468,041	1,825,587	2,112,855
Cumulative Energy Savings (% of Baseline)					
Realistic Achievable	0.7%	3.6%	7.7%	12.3%	16.0%
Maximum Achievable	1.0%	11.1%	18.3%	20.8%	21.3%
Economic	2.9%	15.1%	22.2%	24.2%	24.5%
Technical	4.2%	23.7%	33.7%	37.1%	37.7%
Peak Savings (MW)					
Realistic Achievable	10	44	100	179	262
Maximum Achievable	14	120	232	301	343
Economic	38	171	286	349	396
Technical	51	256	407	503	579
Peak Savings (% of Baseline)					
Realistic Achievable	1.1%	4.3%	8.7%	13.9%	18.1%
Maximum Achievable	1.4%	11.7%	20.2%	23.3%	23.7%
Economic	3.8%	16.7%	24.9%	27.1%	27.3%
Technical	5.1%	24.9%	35.4%	39.0%	40.0%

6.3.1 Residential Potential by Market Segment

Table 6-5 shows the baseline forecast and realistic achievable potential energy savings for the four residential segments in selected years. Single-family homes in Washington and Idaho account for 65% and 68% of each state's residential sector total sales during the base year and throughout the forecast. Thus, as one would expect, single-family homes account for the largest share of potential savings. Table 6-6 takes a closer look at savings by segment and potential level in 2022, the mid-point of the 20-year period.

Table 6-5 Residential Sector, Baseline and Realistic Achievable Potential by Segment

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)					
Single Family	2,394,930	2,551,956	2,876,301	3,252,564	3,709,958
Multi Family	203,544	222,114	253,265	288,585	330,209
Mobile Home	126,939	133,923	149,975	168,639	191,313
Limited Income	901,283	963,301	1,076,699	1,209,059	1,369,306
Total	3,626,696	3,871,294	4,356,240	4,918,847	5,600,787
Cumulative Energy Savings, Realistic Achievable Potential (MWh)					
Single Family	18,783	96,418	240,911	426,483	630,128
Multi Family	1,066	5,833	14,343	28,236	42,801
Mobile Home	985	4,280	7,677	13,381	20,040
Limited Income	5,272	31,920	73,512	136,051	204,063
Total	26,105	138,450	336,444	604,152	897,032
% of Total Residential Cumulative Energy Savings					
Single Family	72.0%	69.6%	71.6%	70.6%	70.2%
Multi Family	4.1%	4.2%	4.3%	4.7%	4.8%
Mobile Home	3.8%	3.1%	2.3%	2.2%	2.2%
Limited Income	20.2%	23.1%	21.8%	22.5%	22.7%

Table 6-6 Residential Realistic Achievable Potential by Housing Type, 2022

Forecast	Single Family	Multi Family	Mobile Home	Limited Income	Total
Baseline Forecast (MWh)	2,876,301	253,265	149,975	1,076,699	4,356,240
Cumulative Energy Savings (MWh)					
Realistic Achievable	240,911	14,343	7,677	73,512	336,444
Economic Potential	679,288	46,859	21,400	220,241	967,788
Technical Potential	950,449	77,463	52,154	387,975	1,468,041
Cumulative Energy Savings % of Baseline					
Realistic Achievable	8.4%	5.7%	5.1%	6.8%	7.7%
Economic Potential	23.6%	18.5%	14.3%	20.5%	22.2%
Technical Potential	33.0%	30.6%	34.8%	36.0%	33.7%

6.3.2 Residential Potential by End Use, Technology, and Measure Type

Table 6-7 provides estimates of savings for each end use and type of potential.

- ***Water Heating*** offers the highest cumulative technical potential over the 20-year period, which reflects the high potential for conversion to natural gas in homes where gas is available (see discussion below) and use of heat pump water heaters where gas is not available, as well as a wide range of other water heating measures. Conversion to natural gas passes the TRC test throughout the study period for most Washington housing types and for single family homes in Idaho. In contrast, based on the study's assumptions of equipment cost and avoided cost, heat pump water heaters are cost-effective in new single family homes by 2014, but do not become cost-effective for existing homes until 2024 in Idaho and 2028 in Washington. Water heating also has the highest cumulative realistic achievable potential.
- ***Space Heating*** offers the second-highest cumulative technical potential over the study and its economic potential is slightly higher than water heating, again due to the potential for conversion to natural gas (see discussion below), but also due to shell measures, controls, and advanced new construction designs. Based on realistic achievable savings, space heating also ranks second.
- ***Interior lighting*** offers the fourth-largest technical potential savings, but the third-largest economic and realistic achievable potential. The lighting standard begins its phase-in starting in 2012, which coincides with the availability in the market place of advanced incandescent lamps that meet the minimum efficacy standard. The baseline forecast assumes that people will install both advanced incandescent and CFLs in screw-in lighting applications. For technical potential, LED lamps are the most efficient option, starting in 2012. However, LED lamps do not pass the economic screen until 2022, when they begin to become cost-effective for pin-based fixtures. Nonetheless, there is significant economic and realistic achievable lighting potential due to conversion from advanced incandescents to CFLs.
- ***Appliances*** rank sixth based on technical potential, but fourth in terms of realistic achievable potential. This reflects the cost-effectiveness of the highest-efficiency white-goods appliances for both new construction and for replacing failed units, as well as the market acceptance of high-efficiency appliances. Removal of second refrigerators and freezers also contributes to economic and realistic achievable potential within this end use.
- ***Cooling*** offers the third-highest technical potential, but is sixth based on realistic achievable potential. Initially technical potential is low but ramps up due to the assumption of increased saturation of air conditioning over time. Economic potential for cooling in 2031 is about 40% of technical potential because the higher SEER units do not pass the economic screen based on based on the study's assumptions of equipment cost and avoided cost.
- ***Home electronics*** also offer substantial savings opportunities. Technical potential reflects the purchase of ENERGY STAR units for all technologies, except PCs and laptops for which a super-efficient "climate saver" option is available in the marketplace. However, the climate saver options are not cost-effective during the forecast horizon, so economic potential reflects the purchase of ENERGY STAR units across all technologies in this end use.

Table 6-7 Residential Cumulative Savings by End Use and Potential Type (MWh)

End Use	Case	2012	2017	2022	2027	2032
Cooling	Realistic Achievable	14	2,443	8,588	23,412	44,892
	Economic	364	22,925	41,690	60,482	82,185
	Technical	4,155	63,885	102,963	147,309	200,588
Space Heating	Realistic Achievable	306	17,366	81,141	187,511	304,466
	Economic	9,645	157,044	303,749	401,120	480,554
	Technical	13,047	206,921	390,626	523,886	650,322
Heat/Cool	Realistic Achievable	12	872	2,353	6,048	15,539
	Economic	447	12,872	15,291	18,697	27,916
	Technical	3,334	27,773	47,801	66,829	76,389
Water Heating	Realistic Achievable	636	25,578	102,451	201,179	317,521
	Economic	12,121	135,781	297,102	388,156	462,418
	Technical	35,027	281,264	527,056	667,224	745,280
Appliances	Realistic Achievable	1,282	12,411	26,859	42,554	59,056
	Economic	5,548	61,277	80,081	85,195	91,618
	Technical	7,229	78,554	105,335	113,831	120,932
Interior Lighting	Realistic Achievable	18,569	52,269	64,439	74,958	71,445
	Economic	55,377	107,842	116,225	106,057	86,182
	Technical	64,748	148,015	146,127	136,520	126,690
Exterior Lighting	Realistic Achievable	3,281	10,532	10,777	10,042	8,058
	Economic	9,770	21,965	17,611	13,313	9,494
	Technical	11,200	28,680	24,906	22,638	22,320
Electronics	Realistic Achievable	1,780	13,544	32,080	45,568	57,382
	Economic	8,967	45,853	67,702	76,036	87,323
	Technical	12,390	65,526	93,981	106,595	122,734
Miscellaneous	Realistic Achievable	225	3,435	7,756	12,880	18,673
	Economic	1,871	17,869	28,336	39,442	46,180
	Technical	1,970	18,348	29,247	40,754	47,600
Total	Realistic Achievable	26,105	138,450	336,444	604,152	897,032
	Economic	104,111	583,427	967,788	1,188,497	1,373,869
	Technical	153,100	918,965	1,468,041	1,825,587	2,112,855

Figure 6-7 focuses on realistic achievable potential by end use in selected years. As discussed above, by the end of the study period, water heating and space heating are the largest contributors to realistic achievable potential. In the early years of the study period, lighting maintains its historic role as the largest contributor to residential sector savings, due to remaining opportunities for conversion from incandescent lighting (both today's standard lamps and the new advanced incandescents) to CFLs. By 2022, however, the percentage of savings due to lighting is projected to drop off as advanced incandescents become the new baseline.

Figure 6-7 Residential Realistic Achievable Potential by End Use, Selected Years

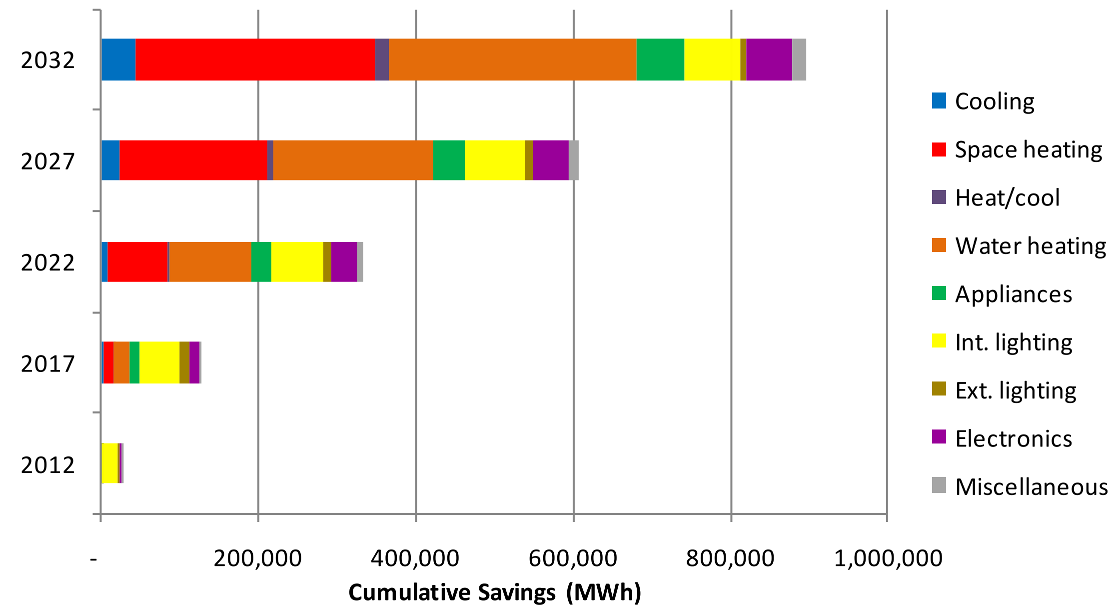


Table 6-8 shows the savings by end use and market segment in 2022. The segments are similar in terms of the savings opportunities by end use, but there are a few notable differences. Single-family homes have more exterior lighting and so have more savings potential for this end use. Similarly, single-family homes have swimming pools and therefore have more potential for savings in pool pumps, which are included in miscellaneous loads. Water heating is a higher proportion of potential savings in multi-family homes, mobile homes, and limited income homes, reflecting the smaller home sizes and thus diminished savings potential for space conditioning and appliances, compared to single family homes.

Table 6-8 Residential Potential by End Use and Market Segment, 2022 (MWh)

	Single Family	Multi Family	Mobile Home	Limited Income	Total
Cooling	4,975	258	129	3,226	8,588
Space heating	63,291	3,985	908	12,957	81,141
Heat/cool	2,138	12	88	114	2,353
Water heating	65,162	6,257	1,293	29,739	102,451
Appliances	19,090	529	950	6,290	26,859
Interior lighting	45,467	2,415	2,203	14,354	64,439
Exterior lighting	8,875	127	480	1,295	10,777
Electronics	25,054	754	1,302	4,970	32,080
Miscellaneous	6,860	6	324	566	7,756
Total	**240,911**	**14,343**	**7,677**	**73,512**	**336,444**

As described in Chapter 5, using our LoadMAP model, we develop separate estimates of potential for equipment and non-equipment measures. Table 6-9 presents results for equipment at the technology level, for which realistic chievable potential is greater than zero.

Table 6-9 Residential Cumulative Realistic Achievable Potential by End Use and Equipment Measures, Selected Years (MWh)

End Use	Technology	2012	2017	2022
Cooling	Central AC	-	152	167
Heat/Cool	Air Source Ht. Pump	-	-	-
Water Heating	Water Heater	140	1,047	1,096
Appliances	Clothes Washer	83	1,014	2,552
	Clothes Dryer	103	708	1,299
	Dishwasher	115	1,074	2,621
	Refrigerator	438	1,999	4,064
	Freezer	333	1,651	3,592
	Second Refrigerator	154	747	1,424
	Stove	22	165	371
Interior Lighting	Screw-in	17,292	42,771	48,939
	Linear Fluorescent	173	1,906	3,576
	Pin-based	1,102	7,398	11,079
Exterior Lighting	Screw-in	3,256	10,404	10,606
	High Intensity/Flood	25	128	171
Electronics	Personal Computers	1,148	9,279	15,975
	TVs	620	3,260	6,039
Miscellaneous	Pool Pump	171	1,581	3,896
	Furnace Fan	45	560	1,668
Total		**25,220**	**85,845**	**119,135**

Conversion of electric water heaters and electric furnaces to natural gas was modeled as a special case within the measure analysis to allow consideration of feasibility (e.g., homes too far from a natural gas line), as well as to allow the option of a heat pump water heater for homes where conversion to gas is not feasible. Table 6-10 shows the residential sector achievable savings from converting electric furnaces and water heaters to natural gas. Conversion ramps up slowly, but because it completely removes use of electricity from two of the largest ends uses, it accounts for a substantial portion of savings by 2032: For water heating, about one-fourth of the savings from conversion to gas occurs in new construction. For furnaces, the fraction due to new construction is roughly one-third.

Table 6-10 Residential Realistic Achievable Savings from Conversion to Natural Gas (MWh)

	2012	2017	2022	2027	2032
Water heater —convert to gas Realistic achievable potential (MWh)	267	10,214	69,745	145,049	216,351
Water heater –convert to gas (% of Res. Achievable potential)	0.5%	2.5%	7.4%	9.4%	10.0%
Furnace — convert to gas Realistic achievable potential (MWh)	244	7,803	49,719	106,607	171,095
Furnace — convert to gas (% of Res. Achievable potential)	0.5%	1.9%	5.3%	6.9%	7.9%

Table 6-11 presents savings results for non-equipment measures for which realistic achievable potential is greater than zero, sorted by cumulative potential in 2032. Note that because a measure such as insulation provides both space cooling and space heating savings, Table 6-11 does not break down savings by end use.

Table 6-11 Residential Realistic Achievable Savings for Non-equipment Measures (MWh), Selected Years

Measure	2012	2017	2022
Water Heater - Convert to Gas	267	10,214	69,745
Furnace - Convert to Gas	244	7,803	49,719
Advanced New Construction Designs	1	180	4,206
Repair and Sealing - Ducting	20	2,713	7,763
Insulation - Infiltration Control	20	2,731	7,696
Water Heater - Thermostat Setback	142	8,150	13,721
Home Energy Management System	7	1,175	4,146
Water Heater - Hot Water Saver	6	426	5,447
Freezer - Remove Second Unit	22	3,246	6,959
Electronics - Reduce Standby Wattage	13	1,004	10,066
Thermostat - Clock/Programmable	21	2,859	7,907
Insulation - Foundation	1	438	1,979
Air Source Heat Pump - Maintenance	12	872	2,353
Refrigerator - Remove Second Unit	13	1,807	3,977
Water Heater - Faucet Aerators	12	978	2,341
Insulation - Ducting	1	195	1,024
Insulation - Wall Cavity	1	275	1,234
Water Heater - Tank Blanket/Insulation	49	2,596	4,051
Ceiling Fan - Installation	0	87	743
Room AC - Removal of Second Unit	6	919	2,280
Water Heater - Heat Pump	-	23	793
Water Heater - Timer	8	1,152	2,477
Insulation - Ceiling	2	400	1,201
Water Heater - Low Flow Showerheads	9	887	1,762
Central AC - Maintenance and Tune-Up	-	-	-
Pool - Pump Timer	8	1,294	2,192
Insulation - Wall Sheathing	0	50	230
Water Heater - Pipe Insulation	2	105	1,018
Whole-House Fan - Installation	0	27	278
Total	**885**	**52,605**	**217,309**

Looking at both the equipment (Table 6-9) and non-equipment measure results (Table 6-11), we see that initially nearly all of the savings come from the equipment measures, particularly lighting, but over time an increasing proportion of the savings come from conversion of water heating and space heating to natural gas. At the study mid-point in 2022, the four measures with the greatest realistic achievable poential are:

- Water heater conversion to gas (69,745 MWh)
- Furnace conversion to gas (49,719 MWh)
- Replacement of interior screw in lamps (48,939 MWh)
- Replacement of personal computers with ENERGY STAR units (15,975 MWh)

These four measures provide realistic achievable potential of 184,378 MWh in 2022, which is approximately 55% of the total 2022 potential for the residential sector.

6.4 COMMERCIAL AND INDUSTRIAL SECTOR POTENTIAL

Realistic achievable potential savings for the C&I sector in both states is 24,155 MWh in 2012, or 0.5% of the sector's baseline forecast. It reaches 1,258,101 MWh, or 17.4% of the baseline forecast by 2032. Technical and economic potential savings are 37.8% and 27.8% of the baseline forecast respectively. Figure 6-8 depicts the potential savings estimates graphically. Figure 6-9 shows the energy use forecasts under the four types of potential versus the baseline forecast. Table 6-12 presents estimates for the sector's energy and peak demand under the four types of potential.

Figure 6-8 Energy Efficiency Potential Savings, Commercial and Industrial Sector

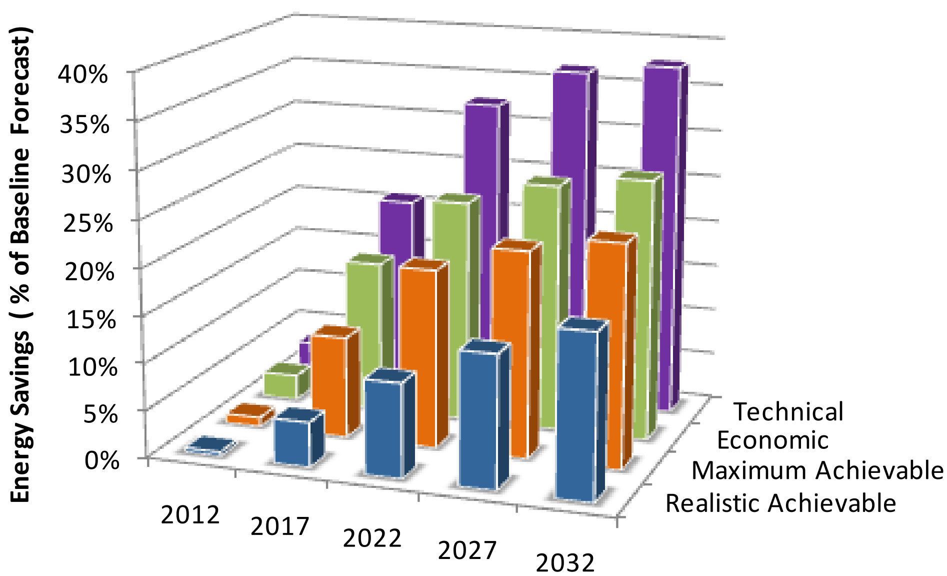


Figure 6-9 Energy Efficiency Potential Forecast, Commercial and Industrial Sector

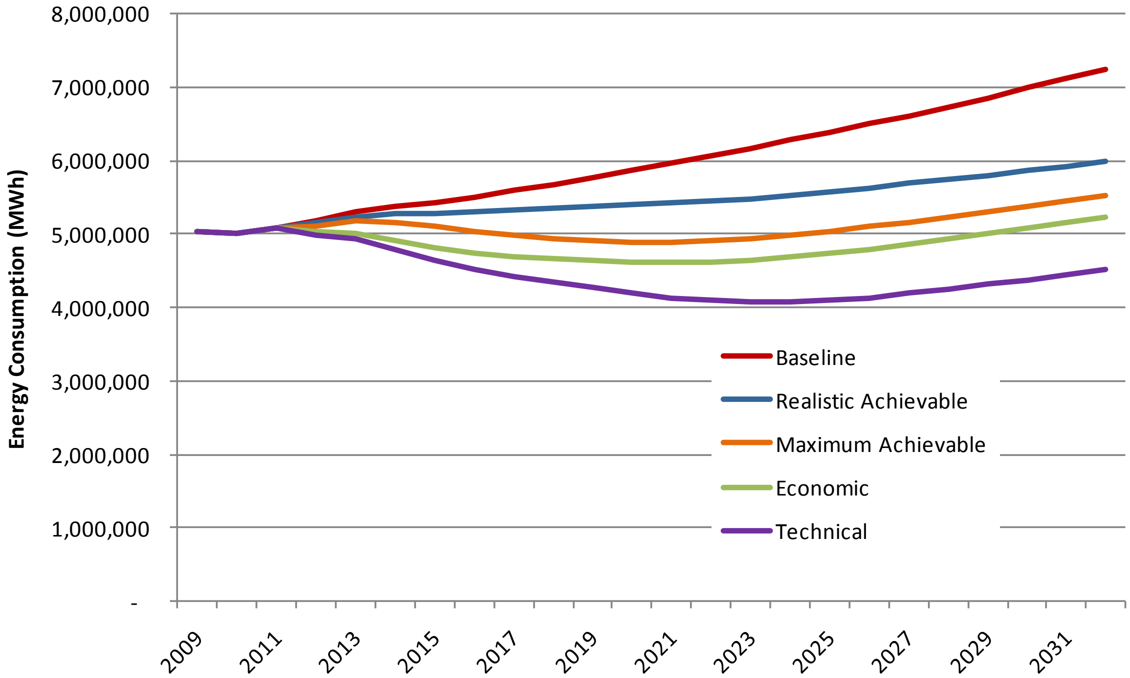


Table 6-12 Energy Efficiency Potential, Commercial and Industrial Sector

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	5,172,344	5,592,586	6,061,107	6,618,022	7,250,973
Cumulative Energy Savings (MWh)					
Realistic Achievable	24,155	267,535	608,739	932,205	1,258,101
Maximum Achievable	52,460	606,406	1,153,644	1,452,022	1,712,907
Economic	140,180	910,181	1,443,612	1,749,278	2,013,333
Technical	176,414	1,168,096	1,967,434	2,424,630	2,739,507
Cumulative Energy Savings (% of Baseline)					
Realistic Achievable	0.5%	4.8%	10.0%	14.1%	17.4%
Maximum Achievable	1.0%	10.8%	19.0%	21.9%	23.6%
Economic	2.7%	16.3%	23.8%	26.4%	27.8%
Technical	3.4%	20.9%	32.5%	36.6%	37.8%
Peak Savings (MW)					
Realistic Achievable	4	40	84	127	169
Maximum Achievable	8	88	154	191	223
Economic	22	130	193	231	263
Technical	27	166	262	324	364
Peak Savings (% of Baseline)					
Realistic Achievable	0.5%	4.7%	9.0%	12.4%	15.1%
Maximum Achievable	1.0%	10.3%	16.6%	18.8%	20.0%
Economic	2.7%	15.3%	20.8%	22.7%	23.6%
Technical	3.4%	19.4%	28.2%	31.8%	32.6%

6.4.1 Commercial Potential by Market Segment and State

Table 6-13 shows the baseline forecast and realistic achievable potential energy savings for the four C&I segments. Large Commercial customers account for the largest portion of the baseline forecast and thus also have the largest realistic achievable potential. In 2012 the Large Commercial segment's realistic achievable potential is 14,754 MWh or 61.1% of C&I total realistic achievable potential. By 2032 its share of C&I potential has dropped slightly to 50.8%. In contrast, the Extra Large Industrial customers increase their role in savings over the study period, beginning with only 1,673 MWh of realistic achievable potential or 6.9% of total C&I potential in 2012, but growing by 2032 to cumulative realistic achievable savings of 285,178 MWh or 22.7% of the C&I sector savings. Table 6-14 takes a closer look at savings by segment and potential level in 2022, the mid-point of the 20-year period.

Table 6-13 C&I Sector, Baseline and Realistic Achievable Potential by Segment

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)					
Small/Med. Commercial	730,499	772,442	832,324	906,807	992,374
Large Commercial	2,266,380	2,403,446	2,592,110	2,822,788	3,088,354
Extra Large Commercial	347,860	421,489	457,725	497,943	541,389
Extra Large Industrial	1,827,605	1,995,209	2,178,948	2,390,485	2,628,857
Total	5,172,344	5,592,586	6,061,107	6,618,022	7,250,973
Cumulative Energy Savings, Realistic Achievable Potential (MWh)					
Small/Med. Commercial	4,513	46,375	96,231	144,812	197,619
Large Commercial	14,754	164,668	338,450	491,020	638,562
Extra Large Commercial	3,216	33,198	69,605	105,163	136,743
Extra Large Industrial	1,673	23,294	104,453	191,210	285,178
Total	24,155	267,535	608,739	932,205	1,258,101
% of Total C&I Cumulative Energy Savings					
Small/Med. Commercial	18.7%	17.3%	15.8%	15.5%	15.7%
Large Commercial	61.1%	61.6%	55.6%	52.7%	50.8%
Extra Large Commercial	13.3%	12.4%	11.4%	11.3%	10.9%
Extra Large Industrial	6.9%	8.7%	17.2%	20.5%	22.7%

Table 6-14 C&I Realistic Achievable Potential by Segment, 2022

Forecast	Small/Med. Commercial	Large Commercial	Extra Large Commercial	Extra Large Industrial	Total
Baseline Forecast (MWh)	832,324	2,592,110	457,725	2,178,948	6,061,107
Cumulative Energy Savings (MWh)					
Realistic achievable	96,231	338,450	69,605	104,453	608,739
Economic Potential	193,950	646,644	144,275	458,743	1,443,612
Technical Potential	308,119	951,283	184,560	523,472	1,967,434
Cumulative Energy Savings % of Baseline					
Realistic achievable	12%	13%	15%	5%	10%
Economic Potential	23%	25%	32%	21%	24%
Technical Potential	37%	37%	40%	24%	32%

6.4.2 C&I Potential by End Use, Technology, and Measure Type

Table 6-15 presents the C&I sector savings by end use and potential type. Recall that the Small/Medium Commercial and Large Commercial Segments include a small percentage of industrial-type customers. Hence, we included a non-equipment measure called Industrial Process Improvements to capture potential savings from these customers. In addition, the miscellaneous category includes non-HVAC motors to capture motor use within small industrial facilities. For all C&I customers, a custom measure category was included to serve as a "catch all" for measures for which costs and savings are not easily quantified and that could be part of a program such as Avista's existing Site-Specific incentive program. In terms of how potential is divided among the various end uses, we note the following:

- ***Interior lighting*** offers the largest technical, economic, and achievable potential. The high technical potential of 892,840 MWh in 2032 is a result of LED lighting that is now commercially available in screw-in and linear lighting applications, as well as numerous fixture improvement and control options. However, LED lighting is not cost effective given the study's avoided cost assumptions, so economic potential reflects installation of CFL, T5, and Super T8 lamps throughout most of the commercial sector. Still, this results in realistic achievable potential of 598,564 MWh by 2032.
- ***Cooling*** has the third highest savings for technical potential at 302,301 MWh in 2032, and many of the cooling measures are cost effective, including installation of high-efficiency equipment, thermal shell measures, HVAC control strategies, and retrocommissioning. Because the market for cooling technologies is mature, these savings are relatively easy to capture, as reflected in the ramp rates for these measures. Thus realistic achievable potential for cooling, at 119,700 MWh, is the second highest among C&I end uses.
- ***Ventilation*** is second in terms of technical and economic potential due to conversion to variable air volume systems, high-efficiency and variable speed control fans, and retrocommissioning. Realistic achievable potential in 2032 of 117,020 MWh ranks this end use third, just behind cooling.
- ***Machine drive*** ranks fourth in realistic achievable potential at 101,018 MWh in 2032. Even though the National Electrical Manufacturer's Association (NEMA) standards make premium efficiency motors the baseline efficiency level, savings remain available from upgrading to still more efficient levels.
- ***Office equipment, exterior lighting, and industrial process improvements*** offer smaller but still significant realistic achievable potential by 2032 at 73,152 MWh, 68,467 MWh, and 60,759 MWh respectively.
- ***Commercial refrigeration, food preparation, and water heating*** savings are relatively small across the C&I sector as a whole, though these end uses can offer significant savings in supermarkets, restaurants, hospitals, and other buildings where these end use constitute a larger portion of overall energy use.

Table 6-15 C&I Cumulative Savings by End Use and Potential Type, Selected Years, (MWh)

End Use	Case	2012	2017	2022	2027	2032
Cooling	RAP	205	14,595	50,416	82,103	119,700
	Economic	2,848	51,234	108,395	146,209	191,484
	Technical	7,425	96,886	200,488	252,951	302,301
Space Heating	RAP	17	2,185	11,476	22,223	36,932
	Economic	346	11,546	31,407	45,917	66,710
	Technical	571	18,000	51,975	71,620	94,893
Heat/Cool	RAP	47	3,765	6,874	8,352	10,413
	Economic	541	8,928	11,319	13,415	15,092
	Technical	743	10,317	13,864	16,814	18,949
Ventilation	RAP	457	7,102	35,467	69,845	117,020
	Economic	7,544	56,221	144,530	201,459	237,313
	Technical	10,719	82,071	220,464	294,789	323,008
Water Heating	RAP	205	6,315	13,969	20,663	27,581
	Economic	1,907	19,044	27,780	34,762	36,791
	Technical	13,251	96,031	174,865	249,540	274,478
Food Preparation	RAP	213	2,665	7,608	14,695	22,009
	Economic	2,824	17,789	32,528	39,188	42,755
	Technical	3,215	19,520	35,976	43,195	47,322
Refrigeration	RAP	185	1,877	6,192	11,901	17,567
	Economic	2,768	13,518	25,844	33,360	37,422
	Technical	3,273	17,982	40,008	51,933	58,855
Interior Lighting	RAP	17,619	166,503	328,877	477,040	598,564
	Economic	78,200	461,679	609,517	700,595	803,195
	Technical	85,734	504,965	681,379	784,870	892,840
Exterior Lighting	Achievable	1,634	23,519	46,019	57,477	68,467
	Economic	7,096	67,172	78,193	81,864	86,650
	Technical	7,893	73,413	87,263	98,652	110,984
Office Equipment	RAP	2,642	27,112	44,602	58,637	73,152
	Economic	19,053	86,895	91,341	95,389	99,348
	Technical	25,452	119,267	126,773	134,377	142,248
Machine Drive	RAP	581	9,104	42,030	72,656	101,018
	Economic	6,560	57,477	158,387	196,285	214,864
	Technical	6,994	67,404	204,459	258,683	286,647
Process	RAP	345	2,590	14,014	33,699	60,759
	Economic	10,390	57,275	120,473	154,151	172,559
	Technical	10,390	57,275	120,473	154,151	172,559
Miscellaneous	RAP	7	204	1,194	2,914	4,921
	Economic	103	1,403	3,897	6,684	9,150
	Technical	753	4,964	9,446	13,056	14,423
Total	RAP	24,154	267,494	608,739	932,221	1,258,104
	Economic	140,121	909,897	1,443,612	1,749,309	2,013,338
	Technical	175,565	1,165,177	1,967,434	2,424,763	2,739,528

Figure 6-10 focuses on achievable potential by end use in selected years. Interior lighting remains the largest source of potential in the C&I sector throughout the study. Cooling, ventilation, and machine drive are the next largest contributors as discussed above.

Figure 6-10 C&I Realistic Achievable Potential by End Use, Selected Years

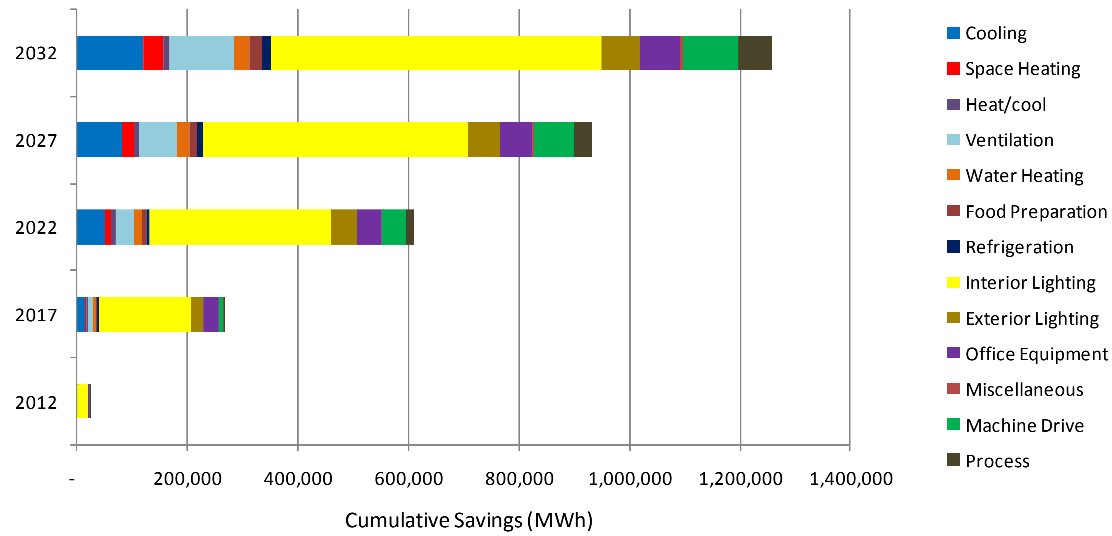


Table 6-16 shows the savings by end use and C&I market segment in 2022. As one would expect, the Extra Large Industrial segment differs significantly from the other segments. Machine drive and process improvements constitute 40% and 13% of realistic achievable potential for this segment. Note that the three commercial building segments, which are based on Avista's rate structure, do include a small percentage of industrial businesses. For these customers, the miscellaneous savings end-use includes non-HVAC motors.

Table 6-16 C&I Realistic Achievable Potential by End Use and Market Segment, 2022 (MWh)

	Small/Med. Commercial	Large Commercial	Extra Large Commercial	Extra Large Industrial	Total
Cooling	3,823	26,225	5,151	15,217	50,416
Space Heating	778	6,727	1,521	2,450	11,476
Combined Heating/Cooling	572	5,264	583	455	6,874
Ventilation	8,757	5,663	5,627	15,420	35,467
Water Heating	2,190	5,825	5,954	-	13,969
Food Preparation	1,238	5,563	807	-	7,608
Refrigeration	1,313	4,383	496	-	6,192
Interior Lighting	58,481	218,078	38,555	13,764	328,877
Exterior Lighting	10,719	27,639	6,557	1,103	46,019
Office Equipment	8,011	32,404	4,187	-	44,602
Machine Drive	-	-	-	42,030	42,030
Process	-	-	-	14,014	14,014
Miscellaneous	349	678	168	-	1,194
Total	**96,231**	**338,450**	**69,605**	**104,453**	**608,739**

Table 6-17 presents realistic achievable potential savings for equipment measures for which realistic achievable potential is greater than zero. These results provide additional detail at the technology level. For example, within interior lighting, screw-in lamps initial provide the greatest share of savings, but the EISA standards move the baseline in that category to a higher efficiency level. Consequently, in the long run, fluorescent lamps offer the greatest savings potential.

Table 6-17 C&I Cumulative Realistic Achievable Potential by End Use and Equipment Measures, Selected Years (MWh)

End Use	Technology	2012	2017	2022
Cooling	Central Chiller	81	855	3,288
	PTAC	6	6	6
Heat/Cool	Heat Pump	21	391	1,172
Ventilation	Ventilation	140	1,047	1,096
Water Heater	Water Heater	174	2,019	4,463
Food Preparation	Fryer	13	147	392
	Hot Food Container	13	275	763
	Oven	187	2,203	5,881
Refrigeration	Glass Door Display	32	434	1,248
	Icemaker	25	324	961
	Solid Door Refrigerator	43	497	1,331
	Vending Machine	83	455	1,111
	Walk in Refrigeration	2	26	63
Interior Lighting	Interior Screw-in	10,283	66,690	101,556
	HID	2,837	25,587	50,762
	Linear Fluorescent	4,319	53,111	104,450
Exterior Lighting	Screw-in	230	3,155	5,265
	HID	1,267	16,135	31,807
	Linear Fluorescent	124	2,230	3,784
Office Equipment	Desktop Computer	1,546	14,363	22,986
	Laptop Computer	111	1,031	1,649
	Monitor	317	1,139	1,970
	POS Terminal	37	514	939
	Printer/copier/fax	110	1,626	2,988
	Server	511	7,235	11,670
Machine Drive	Less than 5 HP	34	236	663
	5-24 HP	73	532	1,536
	25-99 HP	183	1,325	3,825
	100-249 HP	51	373	1,077
	250-499 HP	55	397	1,145
	500 and more HP	103	748	2,160
Process	Electrochem. Process	49	358	1,869
	Process Cooling/Refrig.	65	479	2,500
	Process Heating	231	1,707	8,907
Miscellaneous	Non-HVAC Motor	6	95	520
Total		**23,654**	**212,346**	**405,630**

Table 6-18 presents savings results for non-equipment measures for which realistic achievable potential is greater than zero, sorted by cumulative potential in 2032. Note that, because a measure such as insulation provides both space cooling and space heating savings, Table 6-18 does not break down savings by end use.

Table 6-18 C&I Cumulative Realistic Achievable Savings for Non-equipment Measures, Selected Years (MWh)

Measure	2012	2017	2022
Energy Management System	39	2,372	25,108
Advanced New Construction Designs	1	106	1,626
Retrocommissioning - Lighting	57	11,775	21,760
Interior Fluorescent - High Bay Fixtures	21	1,262	13,307
Custom Measures	4	829	11,321
Retrocommissioning - Comprehensive	41	8,649	15,523
Fans - Variable Speed Control	12	553	5,368
RTU - Maintenance	63	7,964	14,458
Fans - Energy Efficient Motors	10	651	6,782
Photocell Controlled T8 Dimming Ballasts	0	61	535
Retrocommissioning - HVAC	5	580	5,758
Pumping System - Optimization	11	507	4,907
Compressed Air - System Optimization and Improvements	11	506	4,837
Interior Lighting - Occupancy Sensors	19	726	5,616
Motors - Variable Frequency Drive	18	2,220	4,618
Motors - Magnetic Adjustable Speed Drives	8	367	3,707
Water Heater - Faucet Aerators/Low Flow Nozzles	27	3,964	8,101
Interior Fluorescent - Delamp and Install Reflectors	18	728	5,429
Commissioning - Comprehensive	0	368	2,614
Compressed Air - System Controls	7	355	3,457
Chiller - Turbocor Compressor	4	276	3,008
Heat Pump - Maintenance	26	3,374	5,702
Roofs - High Reflectivity	2	54	426
Pumps - Variable Speed Control	5	250	2,395
Chiller - Condenser Water Temperature Reset	7	419	3,987
Chiller - VSD	3	208	2,116
Compressed Air - Compressor Replacement	4	203	1,982
Pumping System - Controls	4	202	1,942
Thermostat - Clock/Programmable	5	762	1,499
Exterior Lighting - Daylighting Controls	4	161	1,309
Commissioning - Lighting	0	248	842
Office Equipment - Energy Star Power Supply	9	1,205	2,400
Compressed Air - System Maintenance	13	717	1,198
Insulation - Ducting	1	145	1,221
Chiller - Chilled Water Reset	4	645	1,142

Measure	2012	2017	2022
Water Heater - Heat Pump	1	69	870
Cooking - Exhaust Hoods with Sensor Control	1	14	127
Pumping System - Maintenance	-	43	606
Furnace - Convert to Gas	2	80	527
Cooling - Economizer Installation	3	125	1,138
Exterior Lighting - Induction Lamps	0	29	430
Refrigeration - System Optimization	0	24	388
Insulation - Ceiling	0	2	29
Refrigeration - System Controls	0	17	272
Industrial Process Improvements	0	28	332
LED Exit Lighting	25	932	1,028
Insulation - Wall Cavity	0	12	177
Commissioning - HVAC	-	-	20
Water Heater - Tank Blanket/Insulation	4	255	449
Miscellaneous - Energy Star Water Cooler	0	59	173
Refrigeration - Floating Head Pressure	0	10	105
Refrigeration - Strip Curtain	-	1	34
Refrigeration - System Maintenance	0	5	78
Refrigeration - Anti-Sweat Heater/Auto Door Closer	0	8	81
Water Heater - Hot Water Saver	-	-	4
Water Heater - High Efficiency Circulation Pump	0	8	83
Vending Machine - Controller	0	39	66
Chiller - Chilled Water Variable-Flow System	0	6	51
Exterior Lighting - Cold Cathode Lighting	0	2	24
Laundry - High Efficiency Clothes Washer	0	9	16
Refrigeration - Night Covers	0	1	9
Total	501	55,189	203,109

By the mid-point of the study period, 2022, the greatest savings come from:

- Replacement of interior lamps (linear fluorescent, screw in, and HID systems: 42,202 MWh)
- Replacement of office equipment with more efficient units (101,556 MWh)
- Replacement of exterior lamps (40,855 GWh)
- Installation of Energy Management Systems (25,108 MWh)
- Retrocommissioning of lighting systems (21,760 MWh)

Together, these five measures account for 285,137 MWh or 47% of the realistic achievable potential savings in the commercial sector in 2022.

6.5 SENSITIVITY ANALYSIS

Global conducted two sets of sensitivity analyses to better understand the effects of changing assumptions on conservation potential. The first looked at changes in avoided costs, and the second considered lower rates of customer and economic growth in Avista's service territory. Because these sensitivity analyses were conducted using an interim, earlier set of potential results, the potential levels in the discussion below are slightly lower than the potential levels presented elsewhere in this chapter. For example, the 2032 realistic achievable cumulative potential in 2032 shown above is 2,155,133 MWh, but the value in the sensitivity analyses is 2,106,548 MWh or 2% less. However, the project team agreed that the general results of the sensitivity analyses would be essentially unchanged, and therefore the sensitivity analyses based on interim results are presented here.

6.5.1 Sensitivity of Potential to Avoided Cost

Global modeled several scenarios with varying levels of avoided costs in addition to the base case. The other scenarios included 150%, 125%, and 75% of the avoided costs used in the base case. Figure 6-11 illustrates how realistic achievable potential varies under the four scenarios. The dotted line in Figure 6-11 indicates the technical potential, which is not affected by avoided costs. The four other lines illustrate how economic potential changes over time with avoided costs. While the changes are significant, the relationship between avoided cost and achievable potential is not linear and increases in avoided costs do not provide equivalent percentage increases in economic potential, and therefore in achievable potential also. Technical potential imposes a limit on the amount of additional conservation and each incremental unit of conservation becomes increasingly expensive.

Figure 6-11 Energy Savings, Economic Potential Case by Avoided Costs Scenario (MWh)

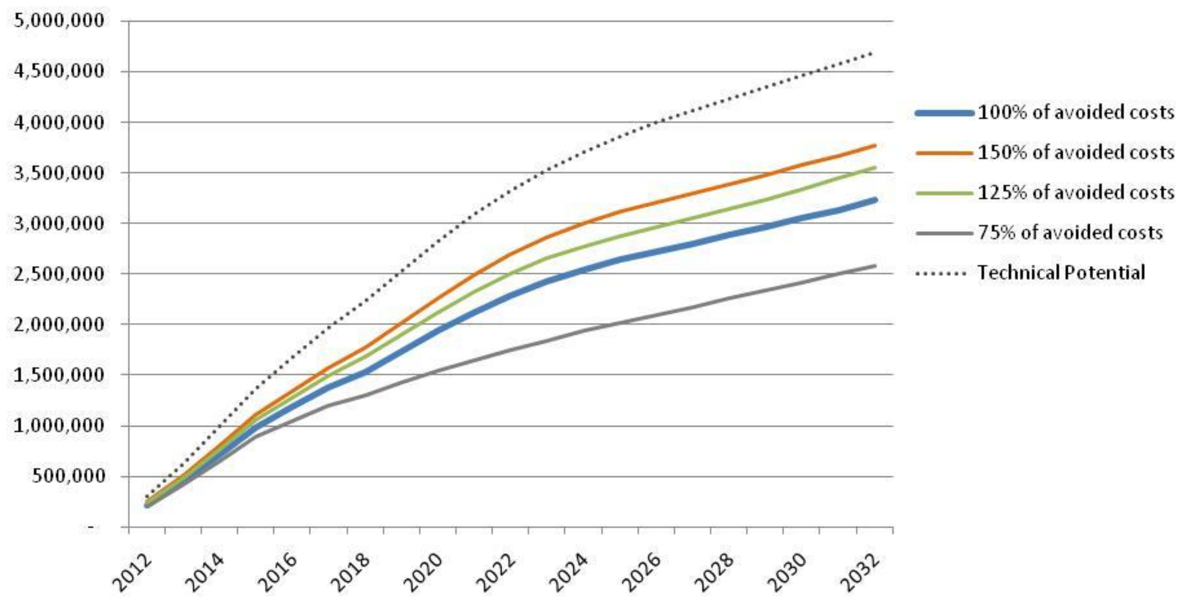


Table 6-19 provides additional information on how avoided cost changes affect realistic achievable potential. In the reference case, realistic achievable potential is approximately 16.4% of the baseline forecast by 2032. With the 150% avoided cost case, realistic achievable potential increased to 19.2% of the baseline forecast, while the 125% avoided cost case and the 75% avoided cost case yielded realistic achievable potential equal to 18.1% and 13.2% of the baseline forecast respectively.

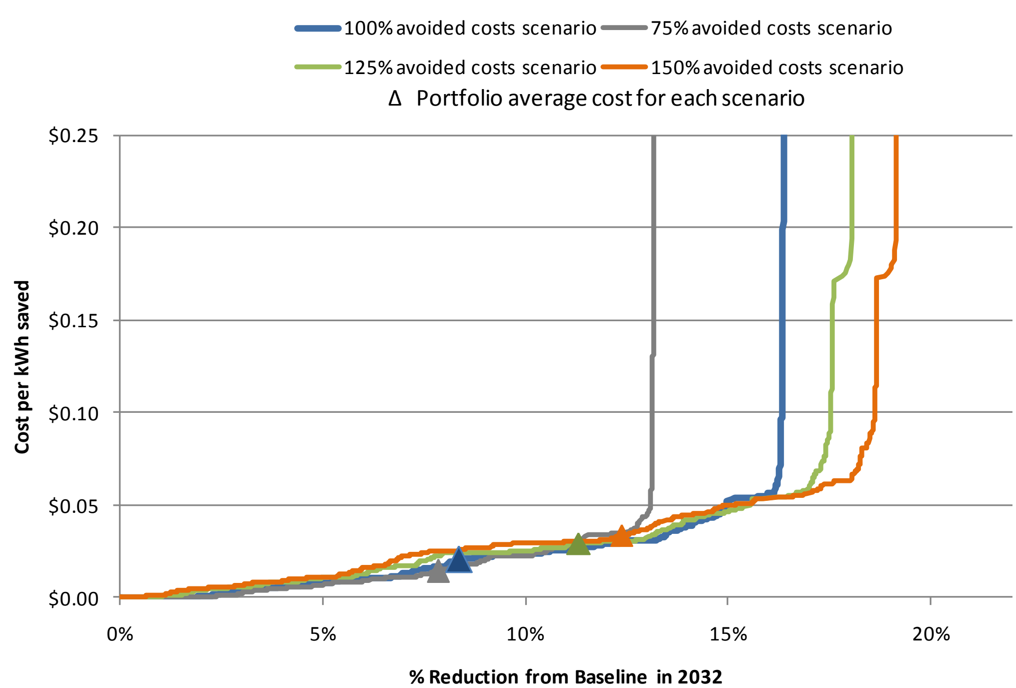
Table 6-19 Realistic Achievable Potential with Varying Avoided Costs

	Reference Scenario	75% of avoided costs	125% of avoided costs	150% of avoided costs
Realistic achievable potential savings 2032 (MWh)	2,106,584	1,690,671	2,320,926	2,464,465
Realistic achievable potential, percentage of baseline forecast, 2032	16.4%	13.2%	18.1%	19.2%
Percentage change in savings vs. 100% avoided cost scenario		-20%	10%	17%

Note: Value of 2,106,548 MWh for 2032 realistic achievable potential was based on interim results and thus is different from the value shown elsewhere in this report.

The project developed a series of supply curves based on the four avoided cost scenarios, shown in Figure 6-12. Each supply curve is created by stacking measures and equipment over the 20-year planning horizon in ascending order of cost. As expected, this stacking of conservation resources produces a traditional upward-sloping supply curve. Because there is a gap in the cost of the energy efficiency measures as you move up the supply curve, the measures with a very high cost cause a rapid sloping of the supply curve. The 75% of avoided cost scenario provides roughly a 13% reduction in energy use compared with the baseline forecast in 2032, at a cost of $0.05/kWh or less. The other three scenarios track one another closely, providing just over 15% savings in 2032 at costs below $0.05/kWh. Results do not differ greatly until the curves begin to reach the increasingly high-cost measures.

Figure 6-12 Supply Curves for Evaluated EE Measures and Avoided Cost Scenarios



6.5.2 Sensitivity of Potential to Customer and Economic Growth

This conservation potential assessment shows that conservation offsets roughly half of growth in electrical energy use for the Avista system, whereas the Sixth Plan projects that conservation can offset 80% of growth. Of course, Avista's service territory differs from the region overall in many ways, including its climate. Another significant factor may be the CPA study's assumptions regarding customer and economic growth. To better understand how growth affects the study's results, we used the LoadMAP model to evaluate several scenarios with lower customer and economic growth, as indicated in Table 6-20. Low Growth Scenario 1 assumes that home size (in square footage) grows 1% per year but is then capped at 110% of home size in the base year. This scenario also assumes lower rates of income growth, as shown in Table 6-20. The Low Growth Scenario 2 uses the same assumptions but in addition assumes lower customer growth in terms of total households for the residential sector and total square footage for the C&I sector.

Table 6-20 Varying Growth Scenario Descriptions

	Reference Scenario	Low Growth Scenario 1	Low Growth Scenario 2
Home size	~ 1% per year growth	Capped at 110% of existing home size	Capped at 110% of existing home size
Per capita income growth	1.6% 2011–2015; 2.2% 2016–2020; 2.1% thereafter	1.6% after 2016	1.6% after 2016
Residential sector market growth	1.30% after 2015 (WA) 1.25% after 2015 (ID)	no change	1.0% after 2015 (WA & ID)
Commercial sector market growth, WA & ID	~ 2.0% (varies by segment)	no change	1.0% all segments

Table 6-21 shows that as economic and customer growth decreases, the ability of conservation to offset growth increases. In the reference scenario, energy efficiency offsets 52% of growth in consumption, while in the lower growth scenarios, EE offsets 54% and 76% of growth respectively. This is the case because with reduced new construction, load growth and realistic achievable potential drop, but savings due to the retrofit of existing buildings constitute a greater proportion of load growth.

Table 6-21 Varying Growth Scenario Results

	Reference Scenario	Low Growth Scenario 1	Low Growth Scenario 2
Baseline forecast 2012 (MWh)	8,799,039	8,799,039	8,799,033
Baseline forecast 2032 (MWh)	12,851,760	12,523,843	11,178,008
Load growth 2012-2032 (MWh)	4,052,720	3,724,803	2,378,975
Realistic achievable potential forecast 2032 (MWh)	10,745,176	10,500,088	9,366,471
Realistic achievable potential savings 2032 (MWh)	2,106,584	2,023,754	1,811,538
Percentage of growth offset	52%	54%	76%

Note: Value of 2,106,548 MWh for 2032 realistic achievable potential was based on an interim results reference case and thus is different from the value shown elsewhere in this report. The general effects would be the same with the revised reference case.

6.6 PUMPING POTENTIAL

Table 6-22 displays the 2009 electricity sales and peak demand of Avista's pumping customers. These customers include mostly municipal water systems and some irrigation customers. The pumping accounts represent 2.2% of total electricity sales and 0.8% of peak demand. (Total in this case refers to the rate classes listed in Table 3-1 and Table 3-2: residential, commercial, industrial, and pumping). Because pumping represents a relatively small percentage of Avista's total sales, the project team decided to use the NWPCC Sixth Plan calculator to estimate pumping energy efficiency potential.

Table 6-22 Pumping Rate Classes, Electricity Sales and Peak Demand 2009

Sector	Rate Schedule(s)	Number of meters (customers)	2009 Electricity sales (MWh)	Peak demand (MW)
Pumping, Washington	031, 032	2,361	135,999	10
Pumping, Idaho	031, 032	1,312	58,885	4
Pumping, Total		3,673	194,884	14
Percentage of System Total			**2.2%**	**0.8%**

The Sixth Plan Calculator estimates agricultural conservation targets based on 2007 sales. It provides annual conservation targets through 2019. Therefore, we trended the data through 2022 to provide annual savings estimates for the ten-year period 2012–2022, with the results shown in Figure 6-13. Table 6-23 displays incremental annual savings potential for 2012–2015, while Table 6-24 provides cumulative potential for selected years.

Figure 6-13 Sixth Plan Calculator Agriculture Incremental Annual Potential

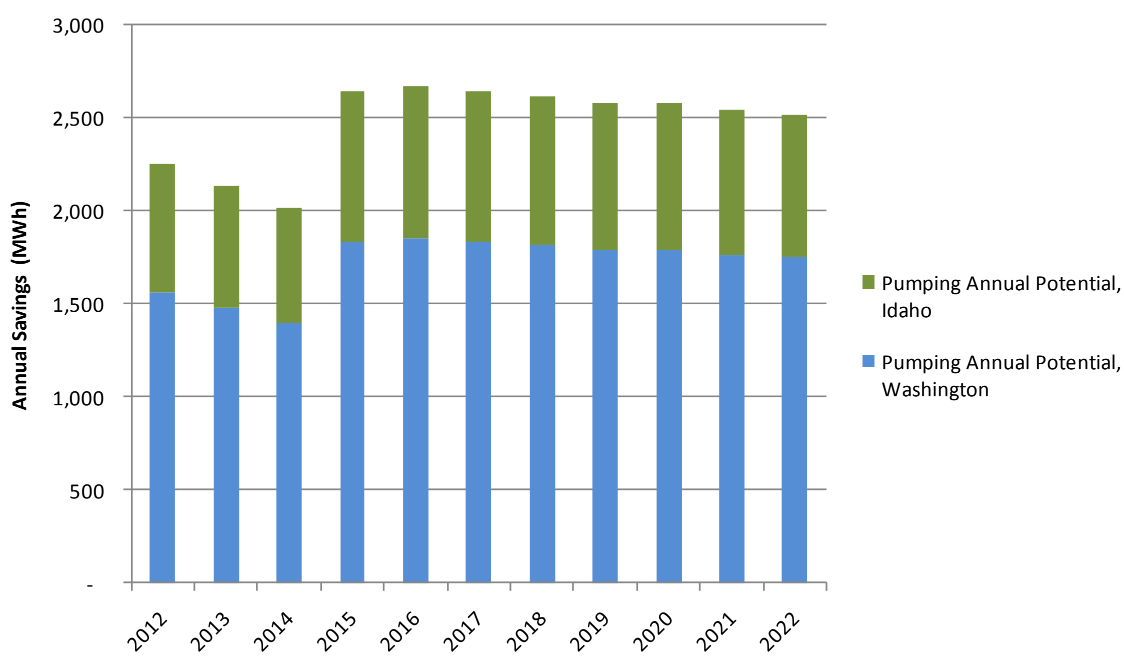


Table 6-23 Sixth Plan Calculator Agriculture Incremental Annual Potential, Selected Years (MWh)

Segment	2012	2013	2014	2015
Pumping, Washington	1,567	1,484	1,402	1,835
Pumping, Idaho	690	654	618	809
Pumping, Total	**2,257**	**2,138**	**2,020**	**2,643**

Table 6-24 Sixth Plan Calculator Agriculture Cumulative Potential, Selected Years (MWh)

Measure	2012	2017	2022
Pumping, Washington	1,567	9,979	18,892
Pumping, Idaho	690	4,397	8,324
Pumping, Total	2,257	14,375	27,217

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Global Energy Partners
An EnerNOC Company
500 Ygnacio Valley Road, Suite 450
Walnut Creek, CA 94596

P: 925.482.2000
F: 925.284.3147
E: gephq@gepllc.com

AVISTA CONSERVATION POTENTIAL ASSESSMENT APPENDICES

Final Report — Electricity Potentials

August 19, 2011

J. Borstein, Project Manager
I. Rohmund, Director

Global Energy Partners™
An EnerNOC Company

Global Energy Partners
An EnerNOC Company
500 Ygnacio Valley Road, Suite 450
Walnut Creek, CA 94596

P: 925.482.2000
F: 925.284.3147
E: gephq@gepllc.com

This report was prepared by

Global Energy Partners
An EnerNOC Company
500 Ygnacio Valley Blvd., Suite 450
Walnut Creek, CA 94596

Principal Investigator(s):
I. Rohmund
J. Borstein
A. Duer
B. Kester
J. Prijyanonda
S. Yoshida

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WASHINGTON MARKET PROFILES, BASELINE FORECAST, AND POTENTIAL RESULTS

This appendix contains Washington-specific tables that summarize the study assumptions, inputs, and results for Avista's Washington service territory only. These tables either repeat Washington-specific information provided previously within the body of the report, or provide Washington-specific information that corresponds to Avista system-level information in the report.

Table A–1 Electricity Sales and Peak Demand by Rate Class, Washington 2009

Sector	Rate Schedule(s)	Number of meters (customers)	2009 Electricity sales (MWh)	Peak demand (MW)
Residential	001	200,134	2,451,687	710
General Service	011, 012	27,142	415,935	64
Large General Service	021, 022	3,352	1,556,929	232
Extra Large General Service	025	22	879,233	134
Pumping	031, 032	2,361	135,999	10
Total		**233,011**	**5,439,850**	**1,150**

Table A-2 Residential Electricity Usage and Intensity by Segment, Washington 2009

Washington Segment	Intensity (kWh/Household)	Number of Customers	% of Customers	2009 Electricity Sales (MWh)	% of Sales
Single Family	14,547	109,134	54%	1,587,572	65%
Multi-Family	8,728	18,219	9%	159,019	6%
Mobile Home	13,092	5,248	3%	68,708	3%
Limited Income	9,424	67,533	34%	636,407	26%
Total	**12,250**	**200,134**	**100%**	**2,451,707**	**100%**

Note: Minor differences with totals in Table A-1 due to calibration.

Table A-3 Single Family Market Profile, 2009, Washington

		Average Market Profiles				New Units			
End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (GWh)	Saturation	UEC (kWh)	Intensity (kWh/HH)	Compared to Average
Cooling	Central AC	36.8%	1,857	684	75	73.4%	2,154	1,581	16%
Cooling	Room AC	10.8%	683	74	8	1.4%	793	11	16%
Combined Heating/Cooling	Air Source Heat Pump	18.4%	6,091	1,122	122	15.0%	7,066	1,063	16%
Combined Heating/Cooling	Geothermal Heat Pump	0.7%	3,655	26	3	0.8%	4,239	32	16%
Space Heating	Electric Resistance	6.2%	10,449	647	71	3.0%	12,539	373	20%
Space Heating	Electric Furnace	25.0%	8,360	2,088	228	25.0%	10,031	2,505	20%
Space Heating	Supplemental	6.1%	117	7	1	6.1%	140	9	20%
Water Heating	Water Heater	55.3%	3,466	1,918	209	43.7%	4,177	1,827	21%
Interior Lighting	Screw-in	100.0%	1,452	1,452	158	100.0%	1,452	1,452	0%
Interior Lighting	Linear Fluorescent	69.2%	152	105	11	69.2%	152	105	0%
Interior Lighting	Pin-based	100.0%	60	60	7	100.0%	60	60	0%
Exterior Lighting	Screw-in	86.7%	381	330	36	86.7%	381	330	0%
Exterior Lighting	High Intensity/Flood	1.9%	146	3	0	1.9%	146	3	0%
Appliances	Clothes Washer	98.0%	126	124	13	99.8%	154	154	22%
Appliances	Clothes Dryer	92.8%	609	565	62	89.0%	692	616	14%
Appliances	Dishwasher	93.9%	246	231	25	99.9%	271	271	11%
Appliances	Refrigerator	100.0%	793	793	87	100.0%	625	625	-21%
Appliances	Freezer	69.4%	773	536	58	69.4%	708	491	-8%
Appliances	Second Refrigerator	47.3%	816	386	42	20.5%	711	146	-13%
Appliances	Stove	82.1%	383	314	34	82.1%	465	382	22%
Appliances	Microwave	98.5%	168	166	18	98.5%	173	171	3%
Electronics	Personal Computers	140.0%	279	391	43	147.0%	287	422	3%
Electronics	TVs	260.0%	359	933	102	260.0%	400	1,041	12%
Electronics	Devices and Gadgets	100.0%	60	60	7	100.0%	67	67	10%
Miscellaneous	Pool Pump	13.3%	1,500	200	22	14.0%	1,526	214	2%
Miscellaneous	Furnace Fan	30.1%	500	151	16	30.1%	614	185	23%
Miscellaneous	Miscellaneous	100.0%	1,180	1,180	129	100.0%	1,416	1,416	20%
Total				**14,547**	**1,588**			**15,549**	

Table A-4 Multi-family Market Profile, 2009, Washington

End Use	Technology	Average Market Profiles: Saturation	Average Market Profiles: UEC (kWh)	Average Market Profiles: Intensity (kWh/HH)	Average Market Profiles: Usage (GWh)	New Units: Saturation	New Units: UEC (kWh)	New Units: Intensity (kWh/HH)	New Units: Compared to Average
Cooling	Central AC	5.0%	928	46	1	24.1%	1,003	241	8%
Cooling	Room AC	25.0%	355	89	2	18.9%	384	73	8%
Combined Heating/Cooling	Air Source Heat Pump	1.0%	2,928	29	1	3.4%	3,163	108	8%
Combined Heating/Cooling	Geothermal Heat Pump	0.0%	1,757	-	-	0.5%	1,898	9	8%
Space Heating	Electric Resistance	59.0%	5,476	3,231	59	59.0%	6,023	3,554	10%
Space Heating	Electric Furnace	5.0%	4,381	219	4	5.0%	4,819	241	10%
Space Heating	Supplemental	18.0%	61	11	0	18.9%	67	13	10%
Water Heating	Water Heater	77.0%	2,142	1,650	30	71.3%	2,362	1,684	10%
Interior Lighting	Screw-in	100.0%	750	750	14	100.0%	750	750	0%
Interior Lighting	Linear Fluorescent	32.0%	76	24	0	32.0%	76	24	0%
Interior Lighting	Pin-based	3.0%	75	2	0	3.0%	75	2	0%
Exterior Lighting	Screw-in	38.5%	55	21	0	38.5%	55	21	0%
Exterior Lighting	High Intensity/Flood	0.2%	73	0	0	0.2%	73	0	0%
Appliances	Clothes Washer	32.0%	63	20	0	32.0%	70	22	11%
Appliances	Clothes Dryer	30.7%	582	179	3	30.7%	621	191	7%
Appliances	Dishwasher	64.0%	88	56	1	64.0%	93	59	5%
Appliances	Refrigerator	100.0%	677	677	12	100.0%	665	665	-2%
Appliances	Freezer	8.4%	734	62	1	8.4%	703	59	-4%
Appliances	Second Refrigerator	5.0%	687	34	1	5.0%	631	32	-8%
Appliances	Stove	96.4%	163	158	3	96.4%	181	175	11%
Appliances	Microwave	90.0%	99	89	2	90.0%	101	91	1%
Electronics	Personal Computers	63.0%	223	141	3	66.2%	226	150	1%
Electronics	TVs	165.0%	178	293	5	165.0%	188	310	6%
Electronics	Devices and Gadgets	100.0%	25	25	0	100.0%	26	26	5%
Miscellaneous	Pool Pump	0.0%	-	-	-	0.0%	-	-	0%
Miscellaneous	Furnace Fan	13.0%	38	5	0	13.0%	42	5	11%
Miscellaneous	Miscellaneous	100.0%	917	917	17	100.0%	963	963	5%
Total				**8,728**	**159**			**9,468**	

Table A-5 Mobile Home Market Profile, 2009, Washington

		Average Market Profiles				New Units			
End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (GWh)	Saturation	UEC (kWh)	Intensity (kWh/HH)	Compared to Average
Cooling	Central AC	23.2%	1,106	256	1	35.9%	1,194	428	8%
Cooling	Room AC	23.2%	407	94	0	22.0%	439	97	8%
Combined Heating/Cooling	Air Source Heat Pump	21.7%	3,488	759	4	22.8%	3,767	860	8%
Combined Heating/Cooling	Geothermal Heat Pump	0.0%	2,093	-	-	0.0%	2,260	-	8%
Space Heating	Electric Resistance	0.0%	5,888	-	-	0.0%	6,476	-	10%
Space Heating	Electric Furnace	68.1%	4,710	3,209	17	68.1%	5,181	3,530	10%
Space Heating	Supplemental	1.4%	34	0	0	1.5%	37	1	10%
Water Heating	Water Heater	96.3%	1,766	1,702	9	91.0%	1,947	1,771	10%
Interior Lighting	Screw-in	100.0%	1,307	1,307	7	100.0%	1,307	1,307	0%
Interior Lighting	Linear Fluorescent	69.2%	137	95	0	69.2%	137	95	0%
Interior Lighting	Pin-based	100.0%	54	54	0	100.0%	54	54	0%
Exterior Lighting	Screw-in	86.7%	343	297	2	86.7%	343	297	0%
Exterior Lighting	High Intensity/Flood	1.9%	131	2	0	1.9%	131	2	0%
Appliances	Clothes Washer	96.3%	128	124	1	96.3%	142	137	11%
Appliances	Clothes Dryer	98.8%	620	612	3	98.8%	662	653	7%
Appliances	Dishwasher	89.0%	250	222	1	89.0%	263	234	5%
Appliances	Refrigerator	100.0%	806	806	4	100.0%	792	792	-2%
Appliances	Freezer	59.3%	786	466	2	59.3%	753	446	-4%
Appliances	Second Refrigerator	19.5%	830	162	1	19.5%	762	149	-8%
Appliances	Stove	93.9%	344	323	2	93.9%	381	358	11%
Appliances	Microwave	82.0%	151	124	1	82.0%	154	126	2%
Electronics	Personal Computers	116.5%	262	305	2	122.3%	265	324	1%
Electronics	TVs	260.0%	359	933	5	260.0%	380	987	6%
Electronics	Devices and Gadgets	100.0%	60	60	0	100.0%	64	64	5%
Miscellaneous	Pool Pump	11.1%	1,500	167	1	11.7%	1,513	177	1%
Miscellaneous	Furnace Fan	8.3%	500	42	0	8.3%	557	47	11%
Miscellaneous	Miscellaneous	100.0%	971	971	5	100.0%	1,020	1,020	5%
Total				**13,092**	**69**			**13,955**	

Table A-6 Limited Income Market Profile, 2009, Washington

		Average Market Profiles				New Units			
End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (GWh)	Saturation	UEC (kWh)	Intensity (kWh/HH)	Compared to Average
Cooling	Central AC	22.2%	1,049	233	16	28.7%	1,133	325	8%
Cooling	Room AC	35.4%	712	252	17	18.0%	769	138	8%
Combined Heating/Cooling	Air Source Heat Pump	10.4%	2,372	247	17	10.4%	2,561	267	8%
Combined Heating/Cooling	Geothermal Heat Pump	0.0%	1,423	-	-	0.5%	1,537	8	8%
Space Heating	Electric Resistance	32.0%	5,164	1,651	112	28.8%	5,680	1,635	10%
Space Heating	Electric Furnace	19.3%	4,123	796	54	21.2%	4,536	963	10%
Space Heating	Supplemental	12.7%	63	8	1	13.4%	69	9	10%
Water Heating	Water Heater	83.9%	2,334	1,958	132	67.0%	2,574	1,725	10%
Interior Lighting	Screw-in	100.0%	728	728	49	100.0%	728	728	0%
Interior Lighting	Linear Fluorescent	69.2%	75	52	3	69.2%	75	52	0%
Interior Lighting	Pin-based	100.0%	59	59	4	100.0%	59	59	0%
Exterior Lighting	Screw-in	47.1%	106	50	3	47.1%	106	50	0%
Exterior Lighting	High Intensity/Flood	2.7%	84	2	0	2.7%	84	2	0%
Appliances	Clothes Washer	71.3%	55	39	3	71.3%	61	43	11%
Appliances	Clothes Dryer	68.6%	652	447	30	68.6%	696	477	7%
Appliances	Dishwasher	78.5%	72	56	4	78.5%	75	59	5%
Appliances	Refrigerator	100.0%	677	677	46	100.0%	665	665	-2%
Appliances	Freezer	63.4%	734	466	31	63.4%	703	446	-4%
Appliances	Second Refrigerator	23.4%	687	161	11	23.4%	631	148	-8%
Appliances	Stove	89.7%	196	176	12	89.7%	217	195	11%
Appliances	Microwave	92.6%	109	101	7	92.6%	111	102	1%
Electronics	Personal Computers	101.4%	230	233	16	106.5%	233	248	1%
Electronics	TVs	165.0%	204	337	23	165.0%	216	356	6%
Electronics	Devices and Gadgets	100.0%	30	30	2	105.0%	32	33	5%
Miscellaneous	Pool Pump	5.8%	617	36	2	5.8%	622	36	1%
Miscellaneous	Furnace Fan	25.2%	213	54	4	25.2%	238	60	11%
Miscellaneous	Miscellaneous	100.0%	575	575	39	100.0%	604	604	5%
Total				**9,424**	**636**			**9,434**	

Table A-7 Commercial Sector Market Characterization Results, Washington 2009

Avista Rate Schedule		LoadMAP Segment and Typical Building	Electricity sales (MWh)	Intensity (kWh/sq.ft.)
General Service	011, 012	Small and Medium Commercial — Retail	415,935	17.5
Large General Service	021, 022	Large Commercial — Office	1,556,929	16.7
Extra Large General Service Commercial	025C	Extra Large Commercial — University	265,686	13.9
Extra Large General Service Industrial	025I	Extra Large Industrial	613,615	40.0
Total			**2,852,165**	

Table A-8 Small/Medium Commercial Segment Market Profile, Washington, 2009

		Average Market Profiles				New Units			
End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Usage (GWh)	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Compared to Average
Cooling	Central Chiller	13.8%	2.39	0.33	8	13.8%	2.15	0.30	-10%
Cooling	RTU	63.1%	2.46	1.55	37	63.1%	2.22	1.40	-10%
Cooling	PTAC	3.3%	2.44	0.08	2	3.3%	2.20	0.07	-10%
Combined Heating/Cooling	Heat Pump	3.6%	6.19	0.22	5	3.6%	5.57	0.20	-10%
Space Heating	Electric Resistance	5.9%	6.72	0.39	9	5.9%	6.72	0.39	0%
Space Heating	Furnace	17.7%	7.05	1.25	30	17.7%	6.34	1.13	-10%
Ventilation	Ventilation	76.9%	2.09	1.61	38	76.9%	1.88	1.45	-10%
Interior Lighting	Interior Screw-in	100.0%	1.00	1.00	24	100.0%	0.90	0.90	-10%
Interior Lighting	HID	100.0%	0.68	0.68	16	100.0%	0.61	0.61	-10%
Interior Lighting	Linear Fluorescent	100.0%	3.37	3.37	80	100.0%	3.03	3.03	-10%
Exterior Lighting	Exterior Screw-in	82.6%	0.20	0.16	4	82.6%	0.18	0.15	-10%
Exterior Lighting	HID	82.6%	0.76	0.63	15	82.6%	0.68	0.56	-10%
Exterior Lighting	Linear Fluorescent	82.6%	0.16	0.13	3	82.6%	0.14	0.12	-10%
Water Heating	Water Heater	63.0%	2.00	1.26	30	63.0%	1.90	1.19	-5%
Food Preparation	Fryer	25.8%	0.16	0.04	1	25.8%	0.16	0.04	0%
Food Preparation	Oven	25.8%	0.98	0.25	6	25.8%	0.98	0.25	0%
Food Preparation	Dishwasher	25.8%	0.06	0.01	0	25.8%	0.06	0.01	0%
Food Preparation	Hot Food Container	25.8%	0.31	0.08	2	25.8%	0.31	0.08	0%
Food Preparation	Food Prep	25.8%	0.01	0.00	0	25.8%	0.01	0.00	0%
Refrigeration	Walk in Refrigeration	0.0%	-	-	-	0.0%	-	-	
Refrigeration	Glass Door Display	52.4%	0.45	0.23	6	52.4%	0.40	0.21	-10%
Refrigeration	Solid Door Refrigerator	52.4%	0.50	0.26	6	52.4%	0.45	0.24	-10%
Refrigeration	Open Display Case	52.4%	0.04	0.02	1	52.4%	0.04	0.02	-10%
Refrigeration	Vending Machine	52.4%	0.30	0.16	4	52.4%	0.30	0.16	0%
Refrigeration	Icemaker	52.4%	0.34	0.18	4	52.4%	0.34	0.18	0%
Office Equipment	Desktop Computer	99.9%	0.48	0.48	11	99.9%	0.48	0.48	0%
Office Equipment	Laptop Computer	99.9%	0.06	0.06	1	99.9%	0.06	0.06	0%
Office Equipment	Server	99.9%	0.36	0.36	9	99.9%	0.36	0.36	0%
Office Equipment	Monitor	99.9%	0.25	0.25	6	99.9%	0.25	0.25	0%
Office Equipment	Printer/copier/fax	99.9%	0.24	0.24	6	99.9%	0.24	0.24	0%
Office Equipment	POS Terminal	99.9%	0.27	0.27	7	99.9%	0.27	0.27	0%
Miscellaneous	Non-HVAC Motor	40.2%	1.22	0.49	12	40.2%	1.22	0.49	0%
Miscellaneous	Other Miscellaneous	100.0%	1.43	1.43	34	100.0%	1.43	1.43	0%
Total				**17.50**	**416**			**16.3**	

Table A-9 Large Commercial Segment Market Profile, Washington, 2009

		Average Market Profiles				New Units			
End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Usage (GWh)	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Compared to Average
Cooling	Central Chiller	24.7%	2.15	0.53	49	24.7%	1.93	0.48	-10%
Cooling	RTU	37.8%	2.52	0.95	89	37.8%	2.26	0.86	-10%
Cooling	PTAC	3.8%	2.49	0.09	9	3.8%	2.24	0.08	-10%
Combined Heating/Cooling	Heat Pump	9.1%	4.81	0.44	41	9.1%	4.33	0.40	-10%
Space Heating	Electric Resistance	5.9%	3.62	0.21	20	5.9%	3.62	0.21	0%
Space Heating	Furnace	12.7%	4.68	0.60	55	12.7%	4.21	0.54	-10%
Ventilation	Ventilation	75.1%	1.66	1.24	116	75.1%	1.49	1.12	-10%
Interior Lighting	Interior Screw-in	100.0%	0.94	0.94	88	100.0%	0.85	0.85	-10%
Interior Lighting	HID	100.0%	0.71	0.71	66	100.0%	0.64	0.64	-10%
Interior Lighting	Linear Fluorescent	100.0%	3.29	3.29	307	100.0%	2.96	2.96	-10%
Exterior Lighting	Exterior Screw-in	89.6%	0.11	0.10	9	89.6%	0.10	0.09	-10%
Exterior Lighting	HID	89.6%	0.62	0.56	52	89.6%	0.56	0.50	-10%
Exterior Lighting	Linear Fluorescent	89.6%	0.16	0.14	13	89.6%	0.14	0.13	-10%
Water Heating	Water Heater	54.2%	2.31	1.25	117	54.2%	2.20	1.19	-5%
Food Preparation	Fryer	18.4%	0.35	0.06	6	18.4%	0.35	0.06	0%
Food Preparation	Oven	18.4%	1.88	0.35	32	18.4%	1.88	0.35	0%
Food Preparation	Dishwasher	18.4%	0.19	0.03	3	18.4%	0.19	0.03	0%
Food Preparation	Hot Food Container	18.4%	0.27	0.05	5	18.4%	0.27	0.05	0%
Food Preparation	Food Prep	18.4%	0.02	0.00	0	18.4%	0.02	0.00	0%
Refrigeration	Walk in Refrigeration	39.1%	0.48	0.19	17	39.1%	0.43	0.17	-10%
Refrigeration	Glass Door Display	39.1%	0.37	0.14	13	39.1%	0.33	0.13	-10%
Refrigeration	Solid Door Refrigerator	39.1%	0.77	0.30	28	39.1%	0.69	0.27	-10%
Refrigeration	Open Display Case	39.1%	0.27	0.10	10	39.1%	0.24	0.09	-10%
Refrigeration	Vending Machine	39.1%	0.36	0.14	13	39.1%	0.36	0.14	0%
Refrigeration	Icemaker	39.1%	0.66	0.26	24	39.1%	0.66	0.26	0%
Office Equipment	Desktop Computer	98.4%	0.90	0.88	82	98.4%	0.90	0.88	0%
Office Equipment	Laptop Computer	98.4%	0.07	0.07	6	98.4%	0.07	0.07	0%
Office Equipment	Server	98.4%	0.42	0.41	38	98.4%	0.42	0.41	0%
Office Equipment	Monitor	98.4%	0.21	0.20	19	98.4%	0.21	0.20	0%
Office Equipment	Printer/copier/fax	98.4%	0.21	0.21	19	98.4%	0.21	0.21	0%
Office Equipment	POS Terminal	98.4%	0.07	0.07	6	98.4%	0.07	0.07	0%
Miscellaneous	Non-HVAC Motor	57.7%	1.40	0.81	75	57.7%	1.40	0.81	0%
Miscellaneous	Other Miscellaneous	100.0%	1.36	1.36	127	100.0%	1.36	1.36	0%
	Total			**16.70**	**1,557**			**15.6**	

Table A-10 Extra Large Commercial Segment Market Profile, Washington, 2009

End Use	Technology	Average Market Profiles: Saturation	Average Market Profiles: EUI (kWh)	Average Market Profiles: Intensity (kWh/Sqft.)	Average Market Profiles: Usage (GWh)	New Units: Saturation	New Units: EUI (kWh)	New Units: Intensity (kWh/Sqft.)	New Units: Compared to Average
Cooling	Central Chiller	52.2%	2.13	1.11	21	52.2%	1.92	1.00	-10%
Cooling	RTU	24.7%	2.22	0.55	10	24.7%	2.00	0.49	-10%
Cooling	PTAC	0.0%	2.22	-	-	0.0%	2.00	-	-10%
Combined Heating/Cooling	Heat Pump	4.4%	5.23	0.23	4	4.4%	4.70	0.21	-10%
Space Heating	Electric Resistance	15.8%	4.39	0.69	13	15.8%	4.39	0.69	0%
Space Heating	Furnace	5.6%	5.67	0.32	6	5.6%	5.11	0.29	-10%
Ventilation	Ventilation	90.2%	1.94	1.75	33	90.2%	1.74	1.57	-10%
Interior Lighting	Interior Screw-in	100.0%	1.37	1.37	26	100.0%	1.23	1.23	-10%
Interior Lighting	HID	100.0%	0.29	0.29	6	100.0%	0.26	0.26	-10%
Interior Lighting	Linear Fluorescent	100.0%	2.19	2.19	42	100.0%	1.97	1.97	-10%
Exterior Lighting	Exterior Screw-in	96.3%	0.03	0.03	1	96.3%	0.03	0.03	-10%
Exterior Lighting	HID	96.3%	0.88	0.85	16	96.3%	0.79	0.76	-10%
Exterior Lighting	Linear Fluorescent	96.3%	0.04	0.03	1	96.3%	0.03	0.03	-10%
Water Heating	Water Heater	26.3%	3.72	0.98	19	26.3%	3.53	0.93	-5%
Food Preparation	Fryer	13.8%	0.13	0.02	0	13.8%	0.13	0.02	0%
Food Preparation	Oven	13.8%	2.12	0.29	6	13.8%	2.12	0.29	0%
Food Preparation	Dishwasher	13.8%	0.08	0.01	0	13.8%	0.08	0.01	0%
Food Preparation	Hot Food Container	13.8%	0.13	0.02	0	13.8%	0.13	0.02	0%
Food Preparation	Food Prep	13.8%	0.01	0.00	0	13.8%	0.01	0.00	0%
Refrigeration	Walk in Refrigeration	26.6%	0.19	0.05	1	26.6%	0.17	0.04	-10%
Refrigeration	Glass Door Display	26.6%	0.11	0.03	1	26.6%	0.10	0.03	-10%
Refrigeration	Solid Door Refrigerator	26.6%	0.71	0.19	4	26.6%	0.64	0.17	-10%
Refrigeration	Open Display Case	26.6%	0.50	0.13	3	26.6%	0.45	0.12	-10%
Refrigeration	Vending Machine	26.6%	0.38	0.10	2	26.6%	0.38	0.10	0%
Refrigeration	Icemaker	26.6%	0.31	0.08	2	26.6%	0.31	0.08	0%
Office Equipment	Desktop Computer	100.0%	0.64	0.64	12	100.0%	0.64	0.64	0%
Office Equipment	Laptop Computer	100.0%	0.07	0.07	1	100.0%	0.07	0.07	0%
Office Equipment	Server	100.0%	0.17	0.17	3	100.0%	0.17	0.17	0%
Office Equipment	Monitor	100.0%	0.13	0.13	2	100.0%	0.13	0.13	0%
Office Equipment	Printer/copier/fax	100.0%	0.05	0.05	1	100.0%	0.05	0.05	0%
Office Equipment	POS Terminal	100.0%	0.01	0.01	0	100.0%	0.01	0.01	0%
Miscellaneous	Non-HVAC Motor	88.8%	0.82	0.73	14	88.8%	0.82	0.73	0%
Miscellaneous	Other Miscellaneous	100.0%	0.80	0.80	15	100.0%	0.80	0.80	0%
Total				**13.90**	**266**			**12.9**	

Table A-11 Extra Large Industrial Segment Market Profile, Washington, 2009

		Average Market Profiles				New Units			
End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Usage (GWh)	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Compared to Average
Cooling	Central Chiller	14.4%	7.98	1.15	18	14.4%	7.18	1.04	-10%
Cooling	RTU	17.1%	6.32	1.08	17	17.1%	5.68	0.97	-10%
Cooling	PTAC	1.1%	5.50	0.06	1	1.1%	4.95	0.05	-10%
Combined Heating/Cooling	Heat Pump	1.6%	11.13	0.18	3	1.6%	10.01	0.16	-10%
Space Heating	Electric Resistance	10.8%	8.67	0.93	14	10.8%	8.67	0.93	0%
Space Heating	Furnace	2.0%	9.10	0.18	3	2.0%	8.19	0.17	-10%
Ventilation	Ventilation	27.4%	12.31	3.37	52	27.4%	11.08	3.04	-10%
Interior Lighting	Interior Screw-in	100.0%	0.33	0.33	5	100.0%	0.30	0.30	-10%
Interior Lighting	HID	100.0%	1.05	1.05	16	100.0%	0.94	0.94	-10%
Interior Lighting	Linear Fluorescent	100.0%	1.10	1.10	17	100.0%	0.99	0.99	-10%
Exterior Lighting	Exterior Screw-in	92.5%	0.02	0.02	0	92.5%	0.02	0.02	-10%
Exterior Lighting	HID	92.5%	0.25	0.23	4	92.5%	0.23	0.21	-10%
Exterior Lighting	Linear Fluorescent	92.5%	0.01	0.01	0	92.5%	0.01	0.01	-10%
Process	Process Cooling/Refrigeration	2.4%	99.67	2.40	37	2.4%	99.67	2.40	0%
Process	Process Heating	26.2%	13.74	3.60	55	26.2%	13.74	3.60	0%
Process	Electrochemical Process	2.6%	77.43	2.00	31	2.6%	77.43	2.00	0%
Machine Drive	Less than 5 HP	90.5%	0.92	0.84	13	90.5%	0.92	0.84	0%
Machine Drive	5-24 HP	80.1%	2.26	1.81	28	80.1%	2.26	1.81	0%
Machine Drive	25-99 HP	72.4%	6.10	4.42	68	72.4%	6.10	4.42	0%
Machine Drive	100-249 HP	65.3%	3.84	2.51	38	65.3%	3.84	2.51	0%
Machine Drive	250-499 HP	23.7%	11.61	2.75	42	23.7%	11.61	2.75	0%
Machine Drive	500 and more HP	26.1%	19.50	5.08	78	26.1%	19.50	5.08	0%
Miscellaneous	Miscellaneous	100.0%	4.90	4.90	75	100.0%	4.90	4.90	0%
	Total			**40.00**	**614**			**39.1**	

Figure A–1 Residential Baseline Forecast by End Use, Washington

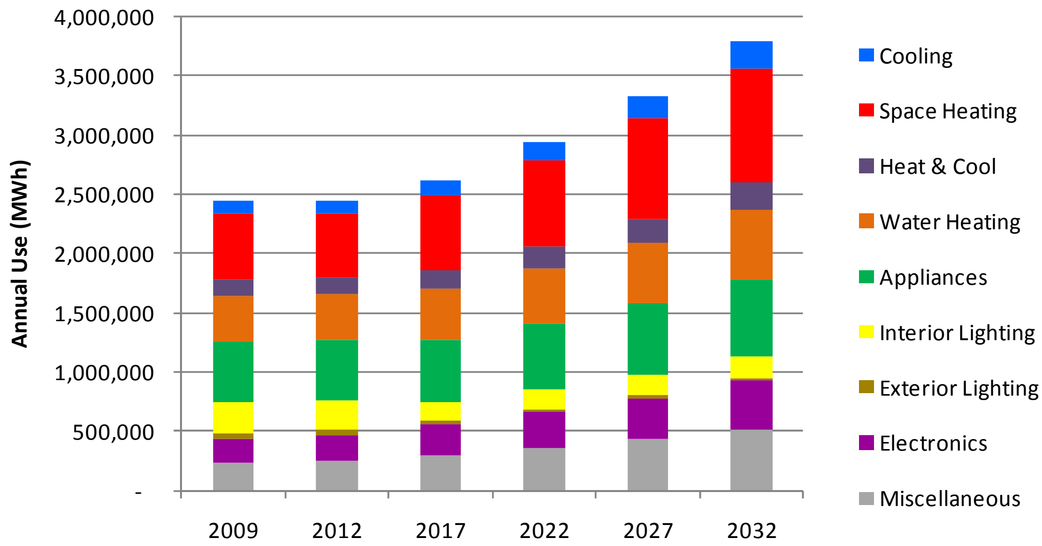

Figure A-2 C&I Baseline Electricity Forecast by End Use, Washington

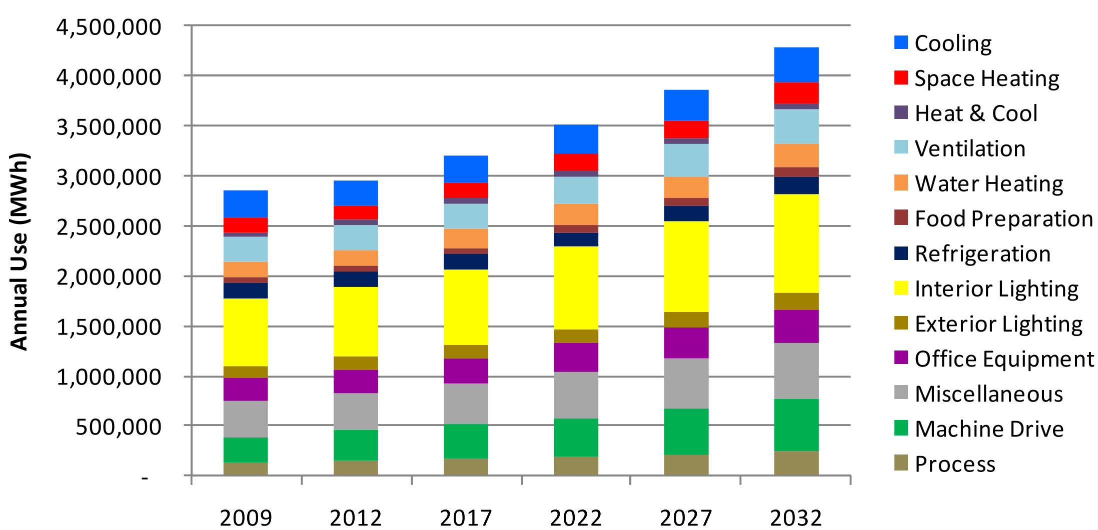

Table A-12 Baseline Forecast Summary by Sector, Washington

End Use	2009	2012	2017	2022	2027	2032	% Change ('09–'32)	Avg. Growth Rate ('09–'32)
Res. WA	2,451,707	2,448,104	2,617,630	2,947,427	3,329,882	3,792,486	54.7%	1.9%
C&I WA	2,852,165	2,955,156	3,209,083	3,509,816	3,869,176	4,280,649	50.1%	1.8%
Total	5,303,872	5,403,260	5,826,712	6,457,243	7,199,059	8,073,136	52.2%	1.8%

Figure A-3 Baseline Forecast Summary by Sector, Washington

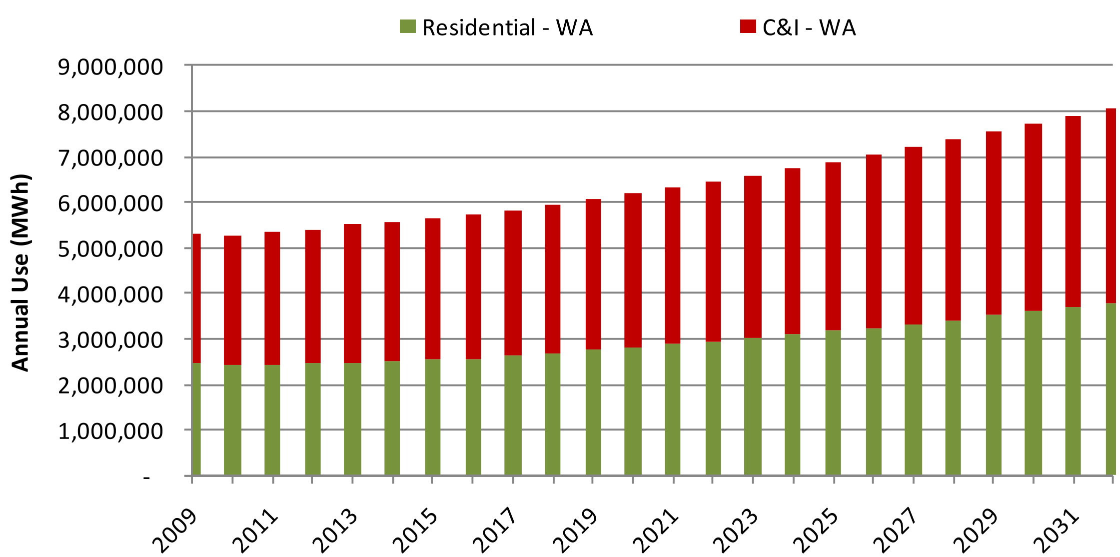

Figure A-4 Summary of Energy Efficiency Potential Savings, Washington, All Sectors

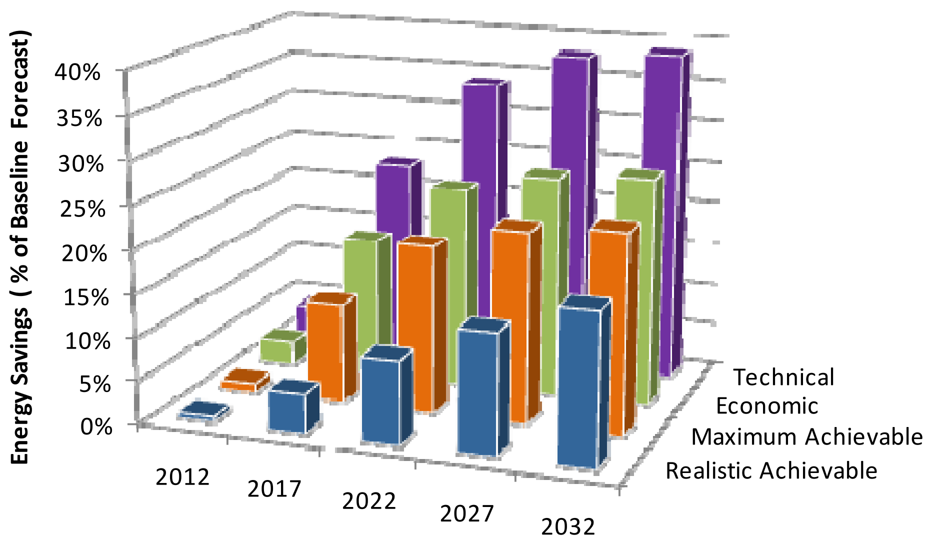

Figure A-5 Energy Efficiency Potential Forecasts, Washington, All Sectors

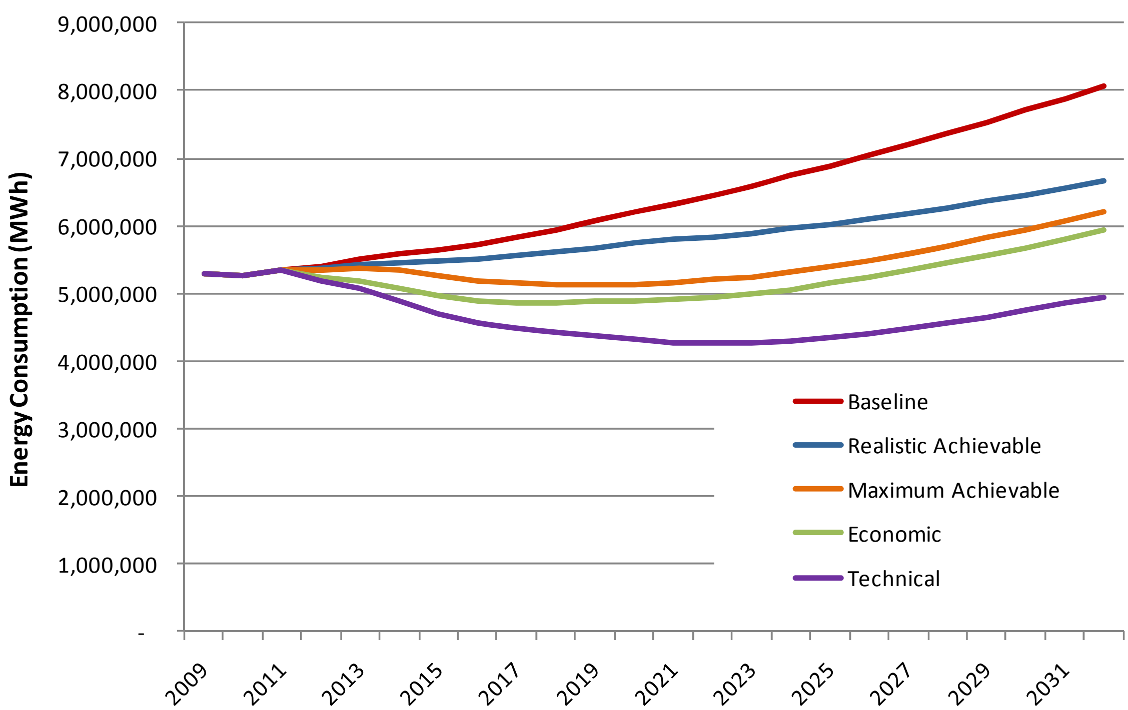

Table A-13 Summary of Energy Efficiency Potential, Washington, All Sectors

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	5,403,260	5,826,712	6,457,243	7,199,059	8,073,136
Baseline Peak Demand(MW)	1,170	1,236	1,374	1,531	1,713
Cumulative Energy Savings (MWh)					
Realistic Achievable	33,146	267,962	616,991	1,007,301	1,411,648
Maximum Achievable	57,434	679,603	1,258,467	1,598,673	1,869,605
Economic	156,759	956,924	1,517,670	1,853,199	2,143,779
Technical	212,980	1,349,814	2,191,746	2,718,118	3,118,733
Cumulative Energy Savings (% of Baseline)					
Realistic Achievable	0.6%	4.6%	9.6%	14.0%	17.5%
Maximum Achievable	1.1%	11.7%	19.5%	22.2%	23.2%
Economic	2.9%	16.4%	23.5%	25.7%	26.6%
Technical	3.9%	23.2%	33.9%	37.8%	38.6%
Peak Savings (MW)					
Realistic Achievable	10	57	126	212	298
Maximum Achievable	15	142	266	339	388
Economic	41	204	325	394	447
Technical	53	289	457	565	645
Peak Savings (% of Baseline)					
Realistic Achievable	0.8%	4.6%	9.2%	13.8%	17.4%
Maximum Achievable	1.3%	11.5%	19.3%	22.1%	22.6%
Economic	3.5%	16.5%	23.7%	25.8%	26.1%
Technical	4.6%	23.4%	33.3%	36.9%	37.6%

Table A-14 Achievable Cumulative EE Potential by Sector, Washington (MWh)

Segment	2012	2017	2022	2027	2032
Residential, WA	17,413	94,529	238,739	431,973	637,029
C&I, WA	15,733	173,433	378,252	575,328	774,619
Total	**33,146**	**267,962**	**616,991**	**1,007,301**	**1,411,648**

Figure A-6 Achievable Cumulative Potential by Sector, Washington

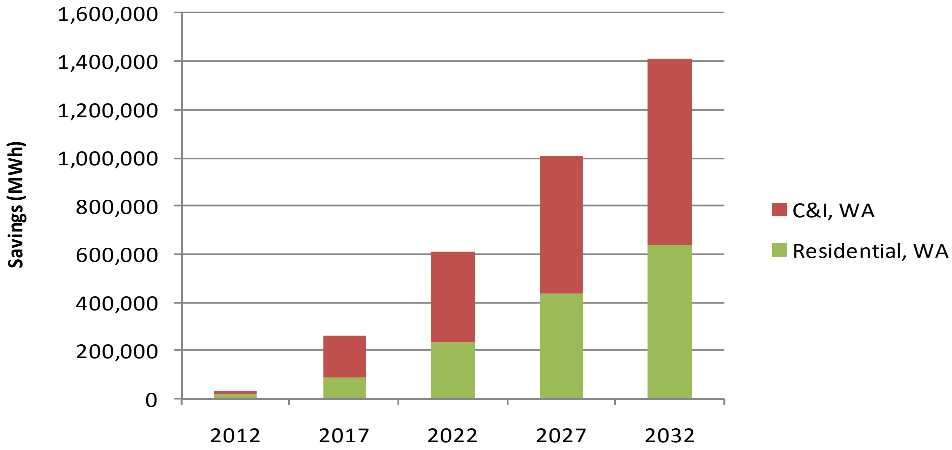

Figure A-7 Residential Energy Efficiency Potential Savings, Washington

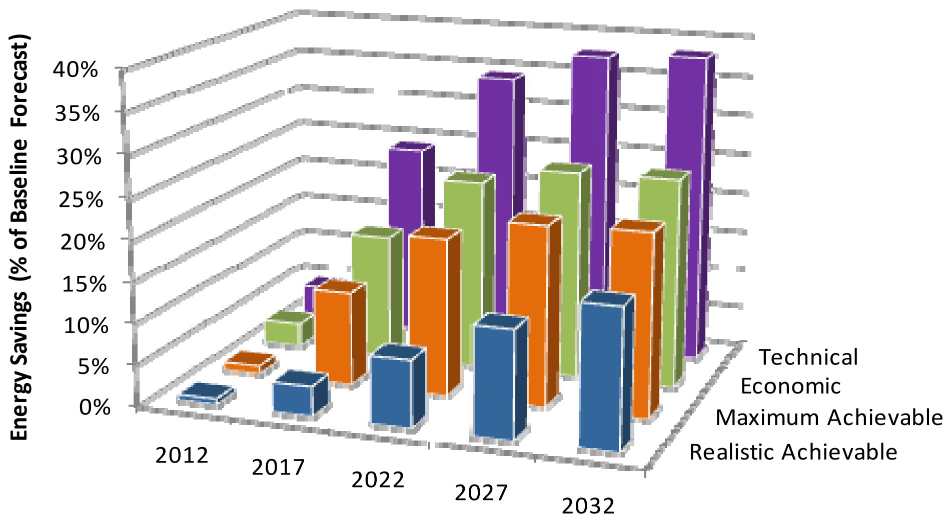

Figure A-8 Residential Energy Efficiency Potential Forecast, Washington

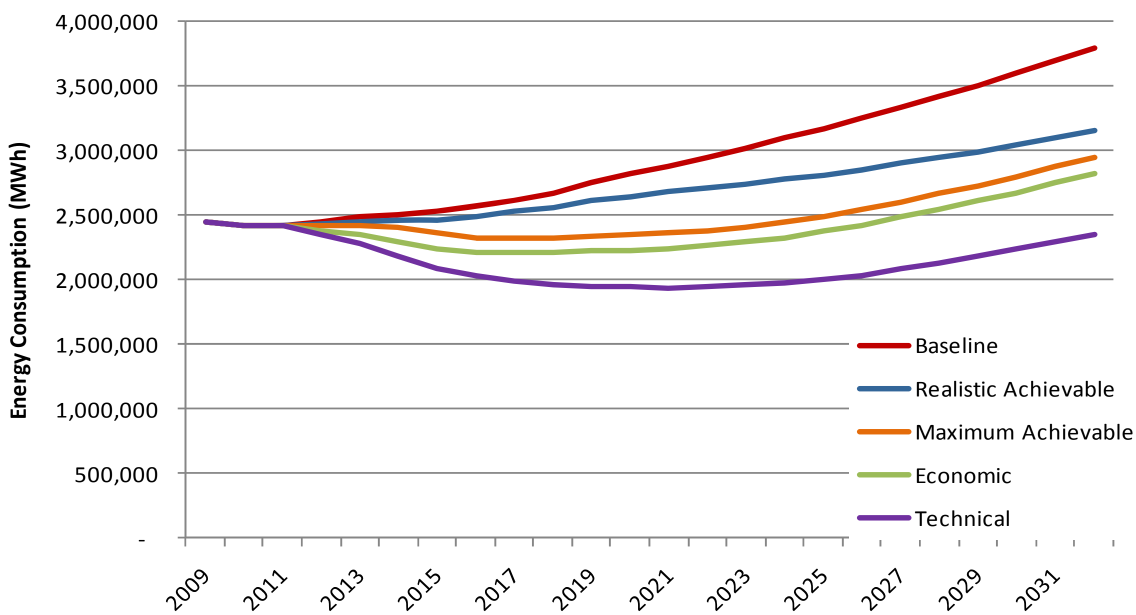

Table A-15 Energy Efficiency Potential for the Residential Sector, Washington

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	2,448,104	2,617,630	2,947,427	3,329,882	3,792,486
Baseline Peak Demand (MW)	710	736	825	925	1,041
Cumulative Energy Savings (MWh)					
Realistic achievable	17,413	94,529	238,739	431,973	637,029
Maximum achievable	24,459	298,135	567,960	730,774	843,186
Economic	70,743	404,323	687,451	847,003	970,769
Technical	103,446	626,769	1,005,455	1,250,538	1,446,982
Cumulative Energy Savings (% of Baseline)					
Realistic Achievable	0.7%	3.6%	8.1%	13.0%	16.8%
Maximum achievable	1.0%	11.4%	19.3%	21.9%	22.2%
Economic	2.9%	15.4%	23.3%	25.4%	25.6%
Technical	4.2%	23.9%	34.1%	37.6%	38.2%
Peak Savings (MW)					
Realistic Achievable	7	32	74	133	193
Maximum achievable	10	87	171	222	251
Economic	27	124	211	258	290
Technical	37	187	298	368	422
Peak Savings (% of Baseline)					
Realistic Achievable	1.0%	4.3%	9.0%	14.4%	18.5%
Maximum achievable	1.4%	11.9%	20.7%	24.0%	24.1%
Economic	3.9%	16.8%	25.5%	27.9%	27.8%
Technical	5.2%	25.4%	36.1%	39.8%	40.5%

Table A-16 Residential Baseline & Realistic Achievable Potential by Segment, WA

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)					
Single Family	1,585,536	1,691,161	1,906,692	2,156,609	2,459,834
Multi Family	160,305	175,186	199,898	227,929	260,943
Mobile Home	68,448	72,476	81,311	91,591	104,051
Limited Income	633,816	678,807	759,527	853,753	967,658
Total	2,448,104	2,617,630	2,947,427	3,329,882	3,792,486
Energy Savings, Realistic Achievable Potential (MWh)					
Single Family	12,388	64,350	164,414	291,057	426,412
Multi Family	830	4,691	12,243	24,346	36,864
Mobile Home	520	2,283	4,274	7,827	11,714
Limited Income	3,674	23,204	57,808	108,744	162,039
Total	17,413	94,529	238,739	431,973	637,029
% of Total Residential Energy Savings					
Single Family	71.1%	68.1%	68.9%	67.4%	66.9%
Multi Family	4.8%	5.0%	5.1%	5.6%	5.8%
Mobile Home	3.0%	2.4%	1.8%	1.8%	1.8%
Limited Income	21.1%	24.5%	24.2%	25.2%	25.4%

Table A-17 Residential Potential by Housing Type, 2022, Washington

Forecast	Single Family	Multi Family	Mobile Home	Limited Income	Total
Baseline Forecast (MWh)	1,906,692	199,898	81,311	759,527	2,947,427
Cumulative Energy Savings (MWh)					
Realistic Achievable	164,414	12,243	4,274	57,808	238,739
Maximum Achievable	386,645	31,832	9,576	139,906	567,960
Economic Potential	463,459	39,746	11,955	172,291	687,451
Technical Potential	639,003	61,512	28,913	276,028	1,005,455
Energy Savings % of Baseline					
Realistic Achievable	8.6%	6.1%	5.3%	7.6%	8.1%
Maximum Achievable	20.3%	15.9%	11.8%	18.4%	19.3%
Economic Potential	24.3%	19.9%	14.7%	22.7%	23.3%
Technical Potential	33.5%	30.8%	35.6%	36.3%	34.1%

Table A-18 Residential Cumulative Savings by End Use and Potential Type, Washington (MWh)

End Use	Case	2012	2017	2022	2027	2032
Cooling	Realistic Achievable	9	1,659	5,876	15,615	29,687
	Economic	246	15,452	28,210	40,243	54,276
	Technical	2,766	42,662	68,576	97,845	132,886
Space Heating	Realistic Achievable	216	12,242	57,209	132,448	215,198
	Economic	6,791	110,158	213,315	282,271	338,227
	Technical	9,175	144,853	273,139	365,838	453,464
Heat/Cool	Realistic Achievable	9	595	1,581	4,130	10,179
	Economic	311	8,778	10,272	12,770	18,457
	Technical	2,278	18,977	32,657	45,591	52,056
Water Heating	Realistic Achievable	469	18,949	78,476	154,418	239,950
	Economic	9,253	101,513	227,153	297,020	348,485
	Technical	24,475	195,999	366,992	463,545	517,698
Appliances	Realistic Achievable	848	8,195	17,794	28,160	39,054
	Economic	3,663	40,418	53,006	56,444	60,723
	Technical	4,768	51,790	69,442	75,057	79,777
Interior Lighting	Realistic Achievable	12,389	34,835	44,682	52,336	47,795
	Economic	36,945	71,839	81,146	74,030	56,992
	Technical	43,188	98,598	97,421	91,087	84,570
Exterior Lighting	Realistic Achievable	2,156	6,922	7,102	6,615	5,305
	Economic	6,420	14,434	11,588	8,760	6,252
	Technical	7,353	18,822	16,360	14,884	14,685
Electronics	Realistic Achievable	1,173	8,913	21,007	29,939	37,810
	Economic	5,909	30,195	44,462	50,005	57,525
	Technical	8,171	43,205	61,954	70,337	81,054
Miscellaneous	Realistic Achievable	145	2,218	5,012	8,312	12,051
	Economic	1,205	11,535	18,300	25,461	29,833
	Technical	1,273	11,864	18,916	26,354	30,793
Total	Realistic Achievable	17,413	94,529	238,739	431,973	637,029
	Economic	70,743	404,323	687,451	847,003	970,769
	Technical	103,446	626,769	1,005,455	1,250,538	1,446,982

Figure A–9 Residential Achievable Potential by End Use, Selected Years, Washington

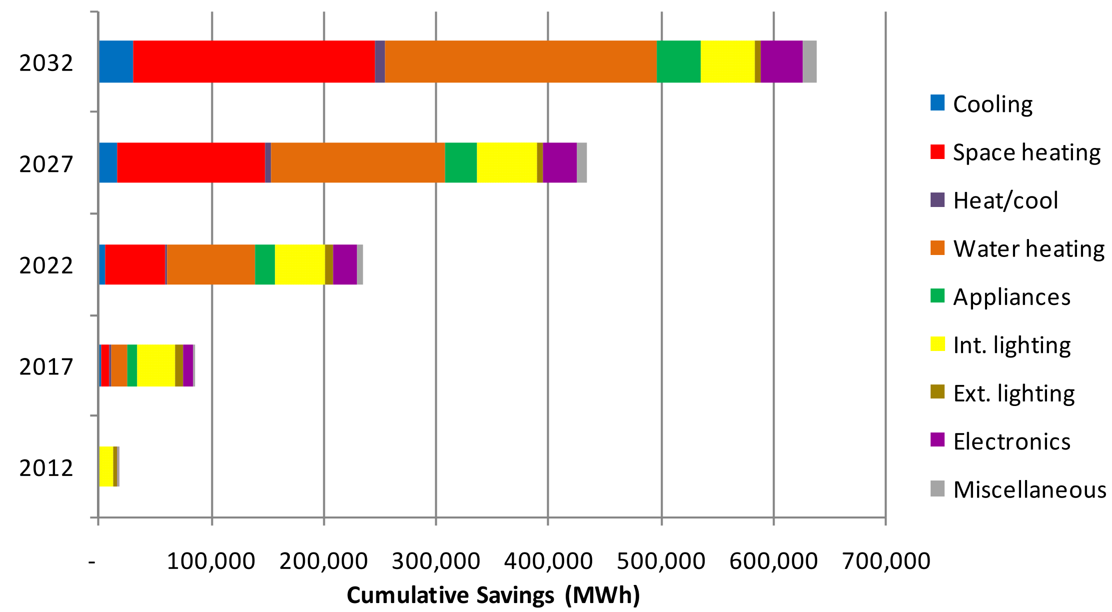

Table A-19 Residential Realistic Achievable Potential by End Use and Market Segment, 2022, WA (MWh)

	Single Family	Multi Family	Mobile Home	Limited Income	Total
Cooling	3,239	206	70	2,360	5,876
Space heating	44,225	3,196	506	9,282	57,209
Heat/cool	1,464	10	49	58	1,581
Water heating	44,891	5,834	886	26,864	78,476
Appliances	12,433	426	499	4,436	17,794
Interior lighting	31,573	1,880	1,155	10,074	44,682
Exterior lighting	5,854	99	252	896	7,102
Electronics	16,296	587	685	3,438	21,007
Miscellaneous	4,438	5	171	399	5,012
Total	**164,414**	**12,243**	**4,274**	**57,808**	**238,739**

Table A-20 Residential Cumulative Realistic Achievable Potential by End Use and Equipment Measures, Washington, Selected Years (MWh)

End Use	Technology	2012	2017	2022
Cooling	Central AC	-	100	112
Heat/Cool	Air Source Ht. Pump	-	-	-
Water Heating	Water Heater	97	726	760
Appliances	Clothes Washer	54	661	1,664
	Clothes Dryer	68	468	858
	Dishwasher	75	701	1,709
	Refrigerator	293	1,347	2,798
	Freezer	220	1,091	2,371
	Second Refrigerator	101	490	949
	Stove	14	109	245
Interior Lighting	Screw-in	11,536	28,508	34,316
	Linear Fluorescent	117	1,267	2,373
	Pin-based	735	4,932	7,438
Exterior Lighting	Screw-in	2,139	6,837	6,987
	High Intensity/Flood	17	85	115
Electronics	Personal Computers	758	6,128	10,557
	TVs	407	2,139	3,960
Miscellaneous	Pool Pump	110	1,022	2,525
	Furnace Fan	29	358	1,066
Total		16,770	56,971	80,803

Table A-21 Residential Realistic Achievable Savings for Non-equipment Measures, Washington (MWh)

Measure	2012	2017	2022
Water Heater - Convert to Gas	211	8,173	55,933
Furnace - Convert to Gas	172	5,504	35,051
Advanced New Construction Designs	1	119	2,781
Repair and Sealing - Ducting	13	1,860	5,347
Insulation - Infiltration Control	14	1,927	5,432
Water Heater - Thermostat Setback	98	5,644	9,489
Home Energy Management System	5	798	2,822
Water Heater - Hot Water Saver	4	296	3,785
Freezer - Remove Second Unit	15	2,142	4,592
Thermostat - Clock/Programmable	15	2,060	5,686
Electronics - Reduce Standby Wattage	8	646	6,490
Insulation - Foundation	1	298	1,351
Air Source Heat Pump - Maintenance	9	595	1,581
Refrigerator - Remove Second Unit	8	1,185	2,608
Water Heater - Faucet Aerators	9	685	1,639
Insulation - Ducting	1	146	836
Insulation - Wall Cavity	0	190	865
Water Heater - Tank Blanket/Insulation	34	1,803	2,812
Room AC - Removal of Second Unit	4	638	1,582
Ceiling Fan - Installation	0	63	576
Water Heater - Timer	8	934	1,676
Insulation - Ceiling	2	285	862
Water Heater - Low Flow Showerheads	6	617	1,233
Water Heater - Heat Pump	-	11	458
Central AC - Maintenance and Tune-Up	-	-	-
Insulation - Wall Sheathing	0	36	172
Pool - Pump Timer	5	838	1,421
Water Heater - Pipe Insulation	1	72	692
Whole-House Fan - Installation	-	6	166
Total	643	37,558	157,936

Figure A-10 Energy Efficiency Potential Savings, C&I Sector, Washington

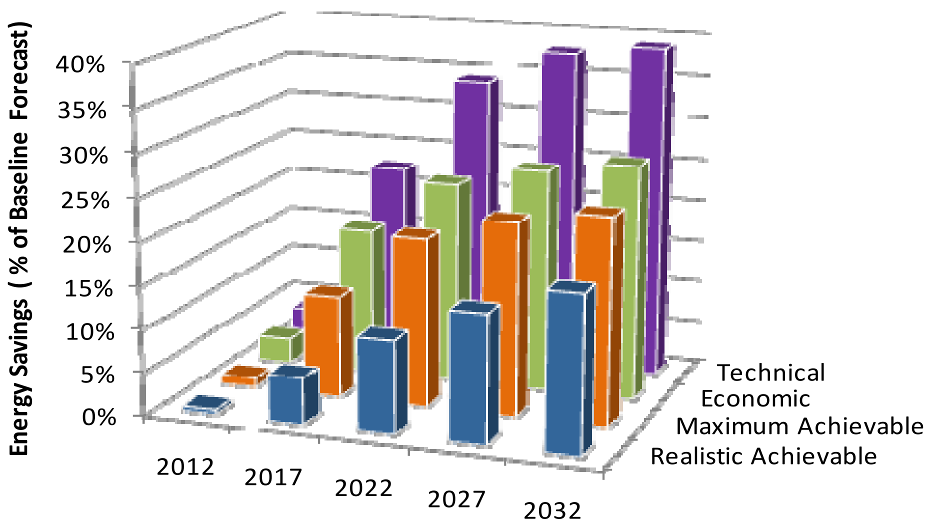

Figure A-11 Energy Efficiency Potential Forecast, C&I Sector, Washington

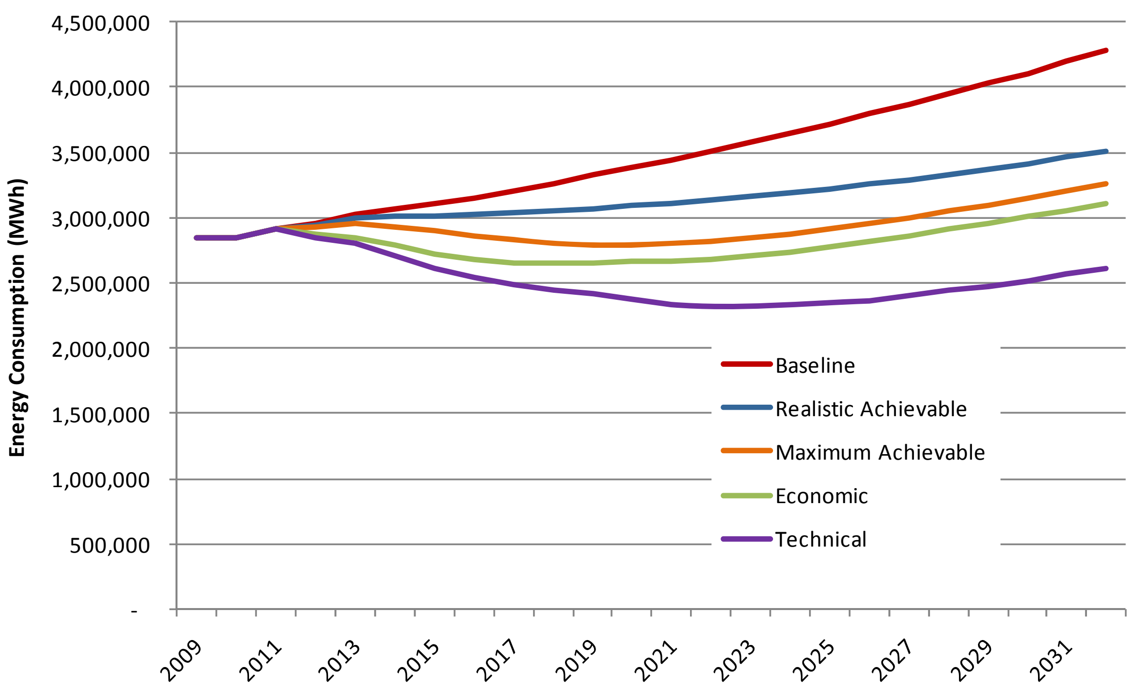

Table A-22 Energy Efficiency Potential, C&I Sector, Washington

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	2,955,156	3,209,083	3,509,816	3,869,176	4,280,649
Baseline Peak Demand(MW)	460	500	549	607	671
Cumulative Energy Savings (MWh)					
Realistic Achievable	15,733	173,433	378,252	575,328	774,619
Maximum Achievable	32,975	381,468	690,507	867,899	1,026,419
Economic	86,016	552,602	830,218	1,006,195	1,173,010
Technical	109,533	723,045	1,186,290	1,467,580	1,671,750
Cumulative Energy Savings (% of Baseline)					
Realistic Achievable	0.5%	5.4%	10.8%	14.9%	18.1%
Maximum Achievable	1.1%	11.9%	19.7%	22.4%	24.0%
Economic	2.9%	17.2%	23.7%	26.0%	27.4%
Technical	3.7%	22.5%	33.8%	37.9%	39.1%
Peak Savings (MW)					
Realistic Achievable	2	25	52	79	105
Maximum Achievable	5	55	95	117	137
Economic	13	80	114	137	157
Technical	17	102	159	197	223
Peak Savings (% of Baseline)					
Realistic Achievable	0.5%	5.1%	9.5%	13.0%	15.7%
Maximum Achievable	1.1%	11.0%	17.2%	19.4%	20.4%
Economic	2.9%	15.9%	20.8%	22.6%	23.4%
Technical	3.6%	20.4%	28.9%	32.5%	33.2%

Table A-23 C&I Sector, Baseline and Realistic Achievable Potential by Segment, Washington

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)					
Small/Med. Commercial	413,131	436,628	470,488	512,594	560,964
Large Commercial	1,558,848	1,641,938	1,770,523	1,927,937	2,109,236
Extra Large Commercial	275,848	338,184	367,338	399,653	434,542
Extra Large Industrial	707,328	792,332	901,468	1,028,993	1,175,907
Total	2,955,156	3,209,083	3,509,816	3,869,176	4,280,649
Cumulative Energy Savings, Achievable Potential (MWh)					
Small/Med. Commercial	2,551	25,567	52,366	79,356	108,891
Large Commercial	10,092	112,528	231,487	335,497	435,628
Extra Large Commercial	2,607	27,021	56,555	85,997	112,469
Extra Large Industrial	483	8,317	37,844	74,477	117,630
Total	15,733	173,433	378,252	575,328	774,619
% of Total C&I Cumulative Energy Savings					
Small/Med. Commercial	16.2%	14.7%	13.8%	13.8%	14.1%
Large Commercial	64.1%	64.9%	61.2%	58.3%	56.2%
Extra Large Commercial	16.6%	15.6%	15.0%	14.9%	14.5%
Extra Large Industrial	3.1%	4.8%	10.0%	12.9%	15.2%

Table A-24 C&I Potential by Segment, Washington, 2022

Forecast	Small/Med. Commercial	Large Commercial	Extra Large Commercial	Extra Large Industrial	Total
Baseline Forecast (MWh)	470,488	1,770,523	367,338	901,468	3,509,816
Cumulative Energy Savings (MWh)					
Realistic Achievable	52,366	231,487	56,555	37,844	378,252
Economic Potential	106,676	441,853	118,311	163,378	830,218
Technical Potential	172,714	650,066	148,095	215,416	1,186,290
Cumulative Energy Savings % of Baseline					
Realistic Achievable	11%	13%	15%	4%	11%
Economic Potential	23%	25%	32%	18%	24%
Technical Potential	37%	37%	40%	24%	34%

Table A-25 C&I Cumulative Savings by End Use and Potential Type, Washington (MWh)

End Use	Case	2012	2017	2022	2027	2032
Cooling	Realistic Achievable	127	8,672	29,166	48,498	72,425
	Economic	1,709	30,259	62,983	86,699	116,136
	Technical	4,457	60,126	124,114	157,093	189,090
Space Heating	Realistic Achievable	10	1,427	7,180	14,045	23,624
	Economic	212	7,563	19,650	28,833	42,274
	Technical	356	11,555	32,534	45,033	60,186
Heat/Cool	Realistic Achievable	31	2,494	4,572	5,575	6,982
	Economic	357	5,927	7,558	8,984	10,138
	Technical	483	6,778	9,118	11,073	12,505
Ventilation	Realistic Achievable	246	4,256	20,112	40,397	69,089
	Economic	4,017	29,775	75,187	107,501	130,189
	Technical	6,107	47,417	127,261	172,058	190,303
Water Heating	Realistic Achievable	181	4,769	10,742	16,921	23,513
	Economic	1,709	15,526	22,956	29,467	31,482
	Technical	8,806	63,741	116,091	166,541	183,186
Food Preparation	Realistic Achievable	140	1,796	5,159	9,950	14,898
	Economic	1,863	11,976	21,990	26,511	28,922
	Technical	2,173	13,179	24,316	29,162	31,947
Refrigeration	Realistic Achievable	123	1,246	4,138	7,959	11,717
	Economic	1,843	8,978	17,215	22,233	24,920
	Technical	2,183	11,986	26,785	34,794	39,418
Interior Lighting	Realistic Achievable	11,768	111,221	218,748	316,260	394,891
	Economic	50,511	299,598	396,845	456,682	523,557
	Technical	55,416	327,215	442,057	510,066	581,362
Exterior Lighting	Realistic Achievable	1,108	15,661	30,450	38,068	45,433
	Economic	4,693	44,035	50,942	53,236	56,711
	Technical	5,191	48,166	57,089	64,537	72,708
Office Equipment	Realistic Achievable	1,779	18,258	30,020	39,448	49,199
	Economic	12,800	58,446	61,458	64,159	66,791
	Technical	17,214	80,539	85,590	90,712	96,009
Machine Drive	Realistic Achievable	199	2,492	8,718	15,739	23,806
	Economic	2,252	17,069	40,392	50,946	58,527
	Technical	2,653	26,498	84,466	111,180	128,005
Process	Realistic Achievable	17	999	8,473	20,545	35,763
	Economic	3,980	22,472	50,483	66,505	77,283
	Technical	3,980	22,472	50,483	66,505	77,283
Miscellaneous	Realistic Achievable	5	142	775	1,924	3,280
	Economic	70	977	2,561	4,439	6,080
	Technical	514	3,373	6,388	8,826	9,749
Total	Realistic Achievable	15,733	173,433	378,252	575,328	774,619
	Economic	86,016	552,602	830,218	1,006,195	1,173,010
	Technical	109,533	723,045	1,186,290	1,467,580	1,671,750

Figure A-12 C&I Achievable Potential by End Use, Selected Years, Washington

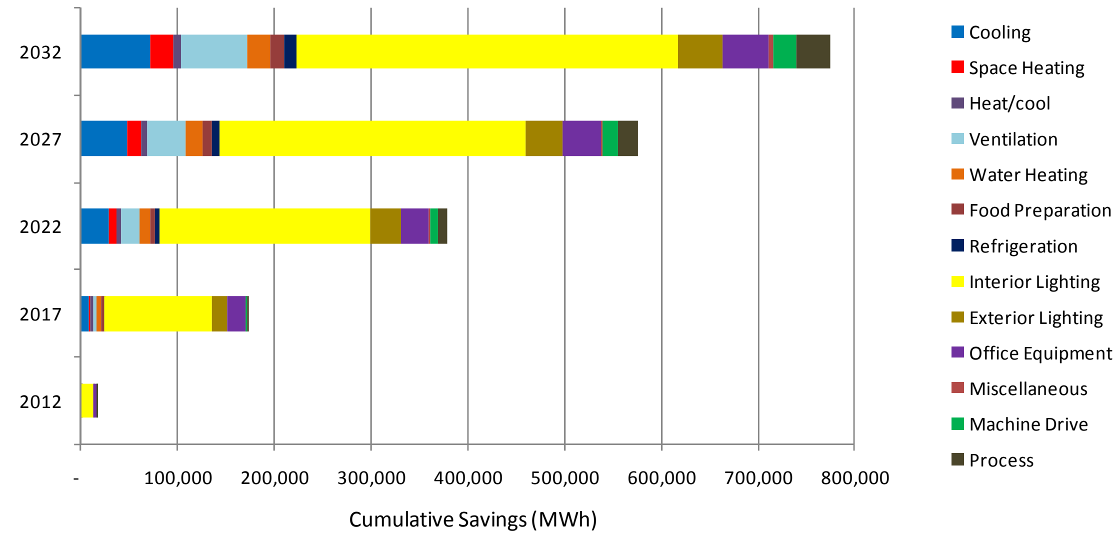

Table A-26 C&I Realistic Achievable Potential by End Use and Market Segment, 2022, Washington (MWh)

	Small/Med. Commercial	Large Commercial	Extra Large Commercial	Extra Large Industrial	Total
Cooling	1,017	17,942	4,119	6,087	29,166
Space Heating	440	4,617	1,216	906	7,180
Combined Heating/Cooling	323	3,597	464	188	4,572
Ventilation	4,268	3,818	4,496	7,530	20,112
Water Heating	1,238	3,974	5,530	-	10,742
Food Preparation	700	3,815	644	-	5,159
Refrigeration	741	3,001	396	-	4,138
Interior Lighting	33,054	149,244	30,943	5,507	218,748
Exterior Lighting	5,854	18,916	5,246	434	30,450
Office Equipment	4,529	22,130	3,362	-	30,020
Machine Drive	-	-	-	8,718	8,718
Process	-	-	-	8,473	8,473
Miscellaneous	202	432	141	-	775
Total	**52,366**	**231,487**	**56,555**	**37,844**	**378,252**

Table A-27 C&I Cumulative Achievable Potential by End Use and Equipment Measures, Washington (MWh)

End Use	Technology	2012	2017	2022
Cooling	Central Chiller	53	551	2,062
	PTAC	4	4	4
Heat/Cool	Heat Pump	14	263	795
Ventilation	Ventilation	235	3,625	13,529
Water Heater	Water Heater	160	1,908	4,354
Food Preparation	Fryer	9	101	271
	Hot Food Container	5	172	488
	Oven	127	1,495	3,996
Refrigeration	Glass Door Display	21	279	808
	Icemaker	16	216	644
	Solid Door Refrigerator	29	332	893
	Vending Machine	55	303	740
	Walk in Refrigeration	21	279	808
Interior Lighting	Interior Screw-in	6,957	45,558	69,399
	HID	1,823	16,436	32,323
	Linear Fluorescent	2,869	35,193	69,229
Exterior Lighting	Screw-in	154	2,018	3,288
	HID	864	10,866	21,367
	Linear Fluorescent	82	1,472	2,497
Office Equipment	Desktop Computer	1,056	9,794	15,665
	Laptop Computer	75	700	1,119
	Monitor	211	757	1,307
	POS Terminal	23	318	580
	Printer/copier/fax	66	1,061	1,963
	Server	342	4,823	7,781
Machine Drive	Less than 5 HP	13	92	280
	5-24 HP	28	208	649
	25-99 HP	69	518	1,616
	100-249 HP	19	146	455
	250-499 HP	21	155	484
	500 and more HP	39	292	913
Process	Electrochem. Process	2	138	1,150
	Process Cooling/Refrig.	3	185	1,538
	Process Heating	11	658	5,482
Miscellaneous	Non-HVAC Motor	4	70	339
Total		**15,460**	**140,725**	**268,060**

Table A-28 C&I Cumulative Achievable Savings for Non-equipment Measures, Washington (MWh)

Measure	2012	2017	2022
Energy Management System	25	1,553	16,501
Advanced New Construction Designs	1	70	1,070
Retrocommissioning - Lighting	37	7,653	14,120
Interior Fluorescent - High Bay Fixtures	13	787	8,430
Retrocommissioning - Comprehensive	29	6,096	10,951
Custom Measures	2	533	7,173
RTU - Maintenance	39	4,686	8,093
Fans - Variable Speed Control	5	218	2,179
Fans - Energy Efficient Motors	5	304	3,318
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	0	39	342
Interior Lighting - Occupancy Sensors	13	477	3,666
Interior Fluorescent - Delamp and Install Reflectors	12	506	3,807
Water Heater - Faucet Aerators/Low Flow Nozzles	18	2,657	5,409
Commissioning - Comprehensive	0	245	1,809
Retrocommissioning - HVAC	2	258	2,720
Heat Pump - Maintenance	17	2,231	3,777
Motors - Variable Frequency Drive	7	883	1,911
Motors - Magnetic Adjustable Speed Drives	3	146	1,535
Roofs - High Reflectivity	1	33	262
Chiller - Turbocor Compressor	2	109	1,244
Chiller - Condenser Water Temperature Reset	4	222	2,148
Chiller - VSD	1	81	859
Commissioning - Lighting	0	155	528
Thermostat - Clock/Programmable	3	458	904
Office Equipment - ENERGY STAR Power Supply	6	806	1,605
Exterior Lighting - Daylighting Controls	2	92	747
Water Heater - Heat Pump	0	54	659
Cooking - Exhaust Hoods with Sensor Control	0	8	71
Cooling - Economizer Installation	2	83	760
Insulation - Ducting	1	53	443
Exterior Lighting - Induction Lamps	0	20	290
Furnace - Convert to Gas	1	45	297
Chiller - Chilled Water Reset	1	242	437
Insulation - Wall Cavity	0	10	146
Insulation - Ceiling	0	1	17
Refrigeration - System Optimization	0	10	159
LED Exit Lighting	17	613	670
Industrial Process Improvements	0	17	205

Measure	2012	2017	2022
Refrigeration - System Controls	0	7	112
Commissioning - HVAC	-	-	16
Water Heater - Tank Blanket/Insulation	2	144	254
Pumps - Variable Speed Control	0	9	106
Miscellaneous - ENERGY STAR Water Cooler	0	40	115
Refrigeration - Strip Curtain	-	1	20
Refrigeration - Floating Head Pressure	0	6	59
Water Heater - Hot Water Saver	-	-	2
Refrigeration - Anti-Sweat Heater/Auto Door Closer	0	4	46
Refrigeration - System Maintenance	0	2	32
Water Heater - High Efficiency Circulation Pump	0	6	64
Vending Machine - Controller	0	26	44
Chiller - Chilled Water Variable-Flow System	0	4	32
Exterior Lighting - Cold Cathode Lighting	0	1	16
Laundry - High Efficiency Clothes Washer	0	6	10
Refrigeration - Night Covers	0	0	5
Total	**273**	**32,708**	**110,192**

APPENDIX | B

IDAHO MARKET PROFILES, BASELINE FORECAST, AND POTENTIAL RESULTS

This appendix contains Idaho-specific tables that summarize the study assumptions, inputs, and results for Avista's Idaho service territory only. These tables either repeat Idaho-specific information provided previously within the body of the report, or provide Idaho-specific information that corresponds to Avista system-level information in the report.

Table B–1 Electricity Use and Peak Demand by Rate Class, Idaho 2009

Sector	Rate Schedule(s)	Number of meters (customers)	2009 Electricity sales (MWh)	Peak demand (MW)
Residential	001	99,580	1,182,368	283
General Service	011, 012	19,245	322,570	61
Large General Service	021, 022	1,456	699,953	115
Extra Large General Service	025, 025P	10	266,044	40
Extra Large GS Potlatch	025P	1	892	101
Pumping	031, 032	1,312	58,885	4
Total		**121,604**	**3,422,111**	**603**

Table B–2 Residential Electricity Usage and Intensity by Segment, Idaho 2009

Idaho Segment	Intensity (kWh/Household)	Number of Customers	% of Customers	2009 Electricity Sales (MWh)	% of Sales
Single Family	13,703	59,205	59%	811,302	69%
Multi-Family	8,213	5,237	5%	43,013	4%
Mobile Home	12,320	4,774	5%	58,815	5%
Limited Income	8,868	30,363	31%	269,249	23%
Total	**11,874**	**99,580**	**100%**	**1,182,379**	**100%**

Note: Minor differences with totals in Table B–1 due to calibration.

Table B–3 Single Family Market Profile, 2009, Idaho

		Average Market Profiles				New Units			
End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (GWh)	Saturation	UEC (kWh)	Intensity (kWh/HH)	Compared to Average
Cooling	Central AC	36.8%	1,857	684	41	73.4%	2,154	1,581	16%
Cooling	Room AC	10.8%	683	74	4	1.4%	793	11	16%
Combined Heating/Cooling	Air Source Heat Pump	14.7%	6,377	940	56	13.6%	7,398	1,004	16%
Combined Heating/Cooling	Geothermal Heat Pump	0.7%	3,826	27	2	0.8%	4,439	33	16%
Space Heating	Electric Resistance	5.0%	11,494	570	34	2.5%	13,793	342	20%
Space Heating	Electric Furnace	20.0%	9,195	1,837	109	21.0%	11,035	2,315	20%
Space Heating	Supplemental	6.1%	128	8	0	6.1%	154	9	20%
Water Heating	Water Heater	44.4%	3,813	1,694	100	37.8%	4,595	1,736	21%
Interior Lighting	Screw-in	100.0%	1,394	1,394	83	100.0%	1,394	1,394	0%
Interior Lighting	Linear Fluorescent	69.2%	146	101	6	69.2%	146	101	0%
Interior Lighting	Pin-based	100.0%	58	58	3	100.0%	58	58	0%
Exterior Lighting	Screw-in	86.7%	366	317	19	86.7%	366	317	0%
Exterior Lighting	High Intensity/Flood	1.9%	140	3	0	1.9%	140	3	0%
Appliances	Clothes Washer	98.0%	126	124	7	99.8%	154	154	22%
Appliances	Clothes Dryer	92.8%	609	565	33	89.0%	692	616	14%
Appliances	Dishwasher	93.9%	246	231	14	99.9%	271	271	11%
Appliances	Refrigerator	100.0%	793	793	47	100.0%	625	625	-21%
Appliances	Freezer	69.4%	773	536	32	69.4%	708	491	-8%
Appliances	Second Refrigerator	47.3%	816	386	23	20.5%	711	146	-13%
Appliances	Stove	82.1%	383	314	19	82.1%	465	382	22%
Appliances	Microwave	98.5%	168	166	10	98.5%	173	171	3%
Electronics	Personal Computers	140.0%	279	391	23	147.0%	287	422	3%
Electronics	TVs	260.0%	359	933	55	260.0%	400	1,041	12%
Electronics	Devices and Gadgets	100.0%	60	60	4	100.0%	67	67	10%
Miscellaneous	Pool Pump	13.3%	1,500	200	12	14.0%	1,526	214	2%
Miscellaneous	Furnace Fan	30.1%	550	166	10	30.1%	675	203	23%
Miscellaneous	Miscellaneous	100.0%	1,132	1,132	67	100.0%	1,359	1,359	20%
Total				**13,703**	**811**			**15,063**	

Table B–4 Multi-family Market Profile, 2009, Idaho

		Average Market Profiles				New Units			
End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (GWh)	Saturation	UEC (kWh)	Intensity (kWh/HH)	Compared to Average
Cooling	Central AC	5.0%	845	42	0	24.1%	912	220	8%
Cooling	Room AC	25.0%	324	81	0	18.9%	350	66	8%
Combined Heating/Cooling	Air Source Heat Pump	1.0%	2,665	27	0	3.4%	2,878	98	8%
Combined Heating/Cooling	Geothermal Heat Pump	0.0%	1,599	-	-	0.5%	1,727	9	8%
Space Heating	Electric Resistance	59.0%	4,983	2,940	15	59.0%	5,481	3,234	10%
Space Heating	Electric Furnace	5.0%	3,986	199	1	5.0%	4,385	219	10%
Space Heating	Supplemental	18.0%	56	10	0	18.9%	61	12	10%
Water Heating	Water Heater	77.0%	1,936	1,491	8	71.3%	2,134	1,522	10%
Interior Lighting	Screw-in	100.0%	750	750	4	100.0%	750	750	0%
Interior Lighting	Linear Fluorescent	32.0%	76	24	0	32.0%	76	24	0%
Interior Lighting	Pin-based	3.0%	75	2	0	3.0%	75	2	0%
Exterior Lighting	Screw-in	38.5%	55	21	0	38.5%	55	21	0%
Exterior Lighting	High Intensity/Flood	0.2%	73	0	0	0.2%	73	0	0%
Appliances	Clothes Washer	32.0%	63	20	0	32.0%	70	22	11%
Appliances	Clothes Dryer	30.7%	582	179	1	30.7%	621	191	7%
Appliances	Dishwasher	64.0%	88	56	0	64.0%	93	59	5%
Appliances	Refrigerator	100.0%	677	677	4	100.0%	665	665	-2%
Appliances	Freezer	8.4%	734	62	0	8.4%	703	59	-4%
Appliances	Second Refrigerator	5.0%	687	34	0	5.0%	631	32	-8%
Appliances	Stove	96.4%	163	158	1	96.4%	181	175	11%
Appliances	Microwave	90.0%	99	89	0	90.0%	101	91	1%
Electronics	Personal Computers	63.0%	223	141	1	66.2%	226	150	1%
Electronics	TVs	165.0%	178	293	2	165.0%	188	310	6%
Electronics	Devices and Gadgets	100.0%	25	25	0	100.0%	26	26	5%
Miscellaneous	Pool Pump	0.0%	-	-	-	0.0%	-	-	0%
Miscellaneous	Furnace Fan	13.0%	38	5	0	13.0%	42	5	11%
Miscellaneous	Miscellaneous	100.0%	888	888	5	100.0%	932	932	5%
Total				**8,213**	**43**			**8,893**	

Table B–5 Mobile Home Market Profile, 2009, Idaho

		Average Market Profiles				New Units			
End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (GWh)	Saturation	UEC (kWh)	Intensity (kWh/HH)	Compared to Average
Cooling	Central AC	23.2%	962	223	1	35.9%	1,039	373	8%
Cooling	Room AC	23.2%	354	82	0	22.0%	382	84	8%
Combined Heating/Cooling	Air Source Heat Pump	21.7%	3,035	660	3	22.8%	3,277	748	8%
Combined Heating/Cooling	Geothermal Heat Pump	0.0%	1,821	-	-	0.0%	1,966	-	8%
Space Heating	Electric Resistance	0.0%	5,122	-	-	0.0%	5,634	-	10%
Space Heating	Electric Furnace	68.1%	4,098	2,792	13	68.1%	4,508	3,071	10%
Space Heating	Supplemental	1.4%	30	0	0	1.5%	33	0	10%
Water Heating	Water Heater	96.3%	1,607	1,549	7	91.0%	1,772	1,612	10%
Interior Lighting	Screw-in	100.0%	1,307	1,307	6	100.0%	1,307	1,307	0%
Interior Lighting	Linear Fluorescent	69.2%	137	95	0	69.2%	137	95	0%
Interior Lighting	Pin-based	100.0%	54	54	0	100.0%	54	54	0%
Exterior Lighting	Screw-in	86.7%	343	297	1	86.7%	343	297	0%
Exterior Lighting	High Intensity/Flood	1.9%	131	2	0	1.9%	131	2	0%
Appliances	Clothes Washer	96.3%	128	124	1	96.3%	142	137	11%
Appliances	Clothes Dryer	98.8%	620	612	3	98.8%	662	653	7%
Appliances	Dishwasher	89.0%	250	222	1	89.0%	263	234	5%
Appliances	Refrigerator	100.0%	806	806	4	100.0%	792	792	-2%
Appliances	Freezer	59.3%	786	466	2	59.3%	753	446	-4%
Appliances	Second Refrigerator	19.5%	830	162	1	19.5%	762	149	-8%
Appliances	Stove	93.9%	344	323	2	93.9%	381	358	11%
Appliances	Microwave	82.0%	151	124	1	82.0%	154	126	2%
Electronics	Personal Computers	116.5%	262	305	1	122.3%	265	324	1%
Electronics	TVs	260.0%	359	933	4	260.0%	380	987	6%
Electronics	Devices and Gadgets	100.0%	60	60	0	100.0%	64	64	5%
Miscellaneous	Pool Pump	11.1%	1,500	167	1	11.7%	1,513	177	1%
Miscellaneous	Furnace Fan	8.3%	500	42	0	8.3%	557	47	11%
Miscellaneous	Miscellaneous	100.0%	913	913	4	100.0%	959	959	5%
Total				**12,320**	**59**			**13,096**	

Table B–6 Limited Income Market Profile, 2009, Idaho

		Average Market Profiles				New Units			
End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (GWh)	Saturation	UEC (kWh)	Intensity (kWh/HH)	Compared to Average
Cooling	Central AC	22.2%	944	210	6	28.7%	1,019	293	8%
Cooling	Room AC	35.4%	641	227	7	18.0%	692	124	8%
Combined Heating/Cooling	Air Source Heat Pump	10.4%	2,134	222	7	10.4%	2,305	240	8%
Combined Heating/Cooling	Geothermal Heat Pump	0.0%	1,281	-	-	0.5%	1,383	7	8%
Space Heating	Electric Resistance	32.0%	4,647	1,486	45	28.8%	5,112	1,471	10%
Space Heating	Electric Furnace	19.3%	3,711	716	22	21.2%	4,082	867	10%
Space Heating	Supplemental	12.7%	57	7	0	13.4%	62	8	10%
Water Heating	Water Heater	83.9%	2,101	1,762	54	67.0%	2,316	1,552	10%
Interior Lighting	Screw-in	100.0%	728	728	22	100.0%	728	728	0%
Interior Lighting	Linear Fluorescent	69.2%	75	52	2	69.2%	75	52	0%
Interior Lighting	Pin-based	100.0%	59	59	2	100.0%	59	59	0%
Exterior Lighting	Screw-in	47.1%	106	50	2	47.1%	106	50	0%
Exterior Lighting	High Intensity/Flood	2.7%	84	2	0	2.7%	84	2	0%
Appliances	Clothes Washer	71.3%	55	39	1	71.3%	61	43	11%
Appliances	Clothes Dryer	68.6%	652	447	14	68.6%	696	477	7%
Appliances	Dishwasher	78.5%	72	56	2	78.5%	75	59	5%
Appliances	Refrigerator	100.0%	677	677	21	100.0%	665	665	-2%
Appliances	Freezer	63.4%	734	466	14	63.4%	703	446	-4%
Appliances	Second Refrigerator	23.4%	687	161	5	23.4%	631	148	-8%
Appliances	Stove	89.7%	196	176	5	89.7%	217	195	11%
Appliances	Microwave	92.6%	109	101	3	92.6%	111	102	1%
Electronics	Personal Computers	101.4%	230	233	7	106.5%	233	248	1%
Electronics	TVs	165.0%	204	337	10	165.0%	216	356	6%
Electronics	Devices and Gadgets	100.0%	30	30	1	105.0%	32	33	5%
Miscellaneous	Pool Pump	5.8%	617	36	1	5.8%	622	36	1%
Miscellaneous	Furnace Fan	25.2%	213	54	2	25.2%	238	60	11%
Miscellaneous	Miscellaneous	100.0%	534	534	16	100.0%	561	561	5%
Total				**8,868**	**269**			**8,884**	

Table B–7 Commercial Sector Market Characterization Results, Idaho 2009

Avista Rate Schedule		LoadMAP Segment and Typical Building	Electricity sales (MWh)	Intensity (kWh/sq.ft.)
General Service	011, 012	Small and Medium Commercial — Retail	322,570	17.5
Large General Service	021, 022	Large Commercial — Office	699,953	16.7
Extra Large General Service Commercial	025C	Extra Large Commercial — University	70,361	13.9
Extra Large General Service Industrial	025I, 025P	Extra Large Industrial	1,087,974	40.0
Total			**2,180,858**	

Table B–8 Small/Medium Commercial Segment Market Profile, Idaho, 2009

End Use	Technology	Average Market Profiles: Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Usage (GWh)	New Units: Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Compared to Average
Cooling	Central Chiller	13.8%	2.39	0.33	6	13.8%	2.15	0.30	-10%
Cooling	RTU	63.1%	2.46	1.55	29	63.1%	2.22	1.40	-10%
Cooling	PTAC	3.3%	2.44	0.08	1	3.3%	2.20	0.07	-10%
Combined Heating/Cooling	Heat Pump	3.6%	6.19	0.22	4	3.6%	5.57	0.20	-10%
Space Heating	Electric Resistance	5.9%	6.72	0.39	7	5.9%	6.72	0.39	0%
Space Heating	Furnace	17.7%	7.05	1.25	23	17.7%	6.34	1.13	-10%
Ventilation	Ventilation	76.9%	2.09	1.61	30	76.9%	1.88	1.45	-10%
Interior Lighting	Interior Screw-in	100.0%	1.00	1.00	18	100.0%	0.90	0.90	-10%
Interior Lighting	HID	100.0%	0.68	0.68	13	100.0%	0.61	0.61	-10%
Interior Lighting	Linear Fluorescent	100.0%	3.37	3.37	62	100.0%	3.03	3.03	-10%
Exterior Lighting	Exterior Screw-in	82.6%	0.20	0.16	3	82.6%	0.18	0.15	-10%
Exterior Lighting	HID	82.6%	0.76	0.63	12	82.6%	0.68	0.56	-10%
Exterior Lighting	Linear Fluorescent	82.6%	0.16	0.13	2	82.6%	0.14	0.12	-10%
Water Heating	Water Heater	63.0%	2.00	1.26	23	63.0%	1.90	1.19	-5%
Food Preparation	Fryer	25.8%	0.16	0.04	1	25.8%	0.16	0.04	0%
Food Preparation	Oven	25.8%	0.98	0.25	5	25.8%	0.98	0.25	0%
Food Preparation	Dishwasher	25.8%	0.06	0.01	0	25.8%	0.06	0.01	0%
Food Preparation	Hot Food Container	25.8%	0.31	0.08	1	25.8%	0.31	0.08	0%
Food Preparation	Food Prep	25.8%	0.01	0.00	0	25.8%	0.01	0.00	0%
Refrigeration	Walk in Refrigeration	52.4%	-	-	-	52.4%	-	-	0%
Refrigeration	Glass Door Display	52.4%	0.45	0.23	4	52.4%	0.40	0.21	-10%
Refrigeration	Solid Door Refrigerator	52.4%	0.50	0.26	5	52.4%	0.45	0.24	-10%
Refrigeration	Open Display Case	52.4%	0.04	0.02	0	52.4%	0.04	0.02	-10%
Refrigeration	Vending Machine	52.4%	0.30	0.16	3	52.4%	0.30	0.16	0%
Refrigeration	Icemaker	52.4%	0.34	0.18	3	52.4%	0.34	0.18	0%
Office Equipment	Desktop Computer	99.9%	0.48	0.48	9	99.9%	0.48	0.48	0%
Office Equipment	Laptop Computer	99.9%	0.06	0.06	1	99.9%	0.06	0.06	0%
Office Equipment	Server	99.9%	0.36	0.36	7	99.9%	0.36	0.36	0%
Office Equipment	Monitor	99.9%	0.25	0.25	5	99.9%	0.25	0.25	0%
Office Equipment	Printer/copier/fax	99.9%	0.24	0.24	4	99.9%	0.24	0.24	0%
Office Equipment	POS Terminal	99.9%	0.27	0.27	5	99.9%	0.27	0.27	0%
Miscellaneous	Non-HVAC Motor	40.2%	1.22	0.49	9	40.2%	1.22	0.49	0%
Miscellaneous	Other Miscellaneous	100.0%	1.43	1.43	26	100.0%	1.43	1.43	0%
Total				**17.50**	**323**			**16.3**	

Table B–9 Large Commercial Segment Market Profile, Idaho, 2009

		Average Market Profiles				New Units			
End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Usage (GWh)	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Compared to Average
Cooling	Central Chiller	24.7%	2.15	0.53	22	24.7%	1.93	0.48	-10%
Cooling	RTU	37.8%	2.52	0.95	40	37.8%	2.26	0.86	-10%
Cooling	PTAC	3.8%	2.49	0.09	4	3.8%	2.24	0.08	-10%
Combined Heating/Cooling	Heat Pump	9.1%	4.81	0.44	18	9.1%	4.33	0.40	-10%
Space Heating	Electric Resistance	5.9%	3.62	0.21	9	5.9%	3.62	0.21	0%
Space Heating	Furnace	12.7%	4.68	0.60	25	12.7%	4.21	0.54	-10%
Ventilation	Ventilation	75.1%	1.66	1.24	52	75.1%	1.49	1.12	-10%
Interior Lighting	Interior Screw-in	100.0%	0.94	0.94	39	100.0%	0.85	0.85	-10%
Interior Lighting	HID	100.0%	0.71	0.71	30	100.0%	0.64	0.64	-10%
Interior Lighting	Linear Fluorescent	100.0%	3.29	3.29	138	100.0%	2.96	2.96	-10%
Exterior Lighting	Exterior Screw-in	89.6%	0.11	0.10	4	89.6%	0.10	0.09	-10%
Exterior Lighting	HID	89.6%	0.62	0.56	23	89.6%	0.56	0.50	-10%
Exterior Lighting	Linear Fluorescent	89.6%	0.16	0.14	6	89.6%	0.14	0.13	-10%
Water Heating	Water Heater	54.2%	2.31	1.25	53	54.2%	2.20	1.19	-5%
Food Preparation	Fryer	18.4%	0.35	0.06	3	18.4%	0.35	0.06	0%
Food Preparation	Oven	18.4%	1.88	0.35	14	18.4%	1.88	0.35	0%
Food Preparation	Dishwasher	18.4%	0.19	0.03	1	18.4%	0.19	0.03	0%
Food Preparation	Hot Food Container	18.4%	0.27	0.05	2	18.4%	0.27	0.05	0%
Food Preparation	Food Prep	18.4%	0.02	0.00	0	18.4%	0.02	0.00	0%
Refrigeration	Walk in Refrigeration	39.1%	0.48	0.19	8	39.1%	0.43	0.17	-10%
Refrigeration	Glass Door Display	39.1%	0.37	0.14	6	39.1%	0.33	0.13	-10%
Refrigeration	Solid Door Refrigerator	39.1%	0.77	0.30	13	39.1%	0.69	0.27	-10%
Refrigeration	Open Display Case	39.1%	0.27	0.10	4	39.1%	0.24	0.09	-10%
Refrigeration	Vending Machine	39.1%	0.36	0.14	6	39.1%	0.36	0.14	0%
Refrigeration	Icemaker	39.1%	0.66	0.26	11	39.1%	0.66	0.26	0%
Office Equipment	Desktop Computer	98.4%	0.90	0.88	37	98.4%	0.90	0.88	0%
Office Equipment	Laptop Computer	98.4%	0.07	0.07	3	98.4%	0.07	0.07	0%
Office Equipment	Server	98.4%	0.42	0.41	17	98.4%	0.42	0.41	0%
Office Equipment	Monitor	98.4%	0.21	0.20	9	98.4%	0.21	0.20	0%
Office Equipment	Printer/copier/fax	98.4%	0.21	0.21	9	98.4%	0.21	0.21	0%
Office Equipment	POS Terminal	98.4%	0.07	0.07	3	98.4%	0.07	0.07	0%
Miscellaneous	Non-HVAC Motor	57.7%	1.40	0.81	34	57.7%	1.40	0.81	0%
Miscellaneous	Other Miscellaneous	100.0%	1.36	1.36	57	100.0%	1.36	1.36	0%
Total				**16.70**	**700**			**15.6**	

Table B–10 Extra Large Commercial Segment Market Profile, Idaho, 2009

		Average Market Profiles				New Units			
End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Usage (GWh)	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Compared to Average
Cooling	Central Chiller	52.2%	2.13	1.11	6	52.2%	1.92	1.00	-10%
Cooling	RTU	24.7%	2.22	0.55	3	24.7%	2.00	0.49	-10%
Cooling	PTAC	0.0%	2.22	-	-	0.0%	2.00	-	-10%
Combined Heating/Cooling	Heat Pump	4.4%	5.23	0.23	1	4.4%	4.70	0.21	-10%
Space Heating	Electric Resistance	15.8%	4.39	0.69	4	15.8%	4.39	0.69	0%
Space Heating	Furnace	5.6%	5.67	0.32	2	5.6%	5.11	0.29	-10%
Ventilation	Ventilation	90.2%	1.94	1.75	9	90.2%	1.74	1.57	-10%
Interior Lighting	Interior Screw-in	100.0%	1.37	1.37	7	100.0%	1.23	1.23	-10%
Interior Lighting	HID	100.0%	0.29	0.29	1	100.0%	0.26	0.26	-10%
Interior Lighting	Linear Fluorescent	100.0%	2.19	2.19	11	100.0%	1.97	1.97	-10%
Exterior Lighting	Exterior Screw-in	96.3%	0.03	0.03	0	96.3%	0.03	0.03	-10%
Exterior Lighting	HID	96.3%	0.88	0.85	4	96.3%	0.79	0.76	-10%
Exterior Lighting	Linear Fluorescent	96.3%	0.04	0.03	0	96.3%	0.03	0.03	-10%
Water Heating	Water Heater	26.3%	3.72	0.98	5	26.3%	3.53	0.93	-5%
Food Preparation	Fryer	13.8%	0.13	0.02	0	13.8%	0.13	0.02	0%
Food Preparation	Oven	13.8%	2.12	0.29	1	13.8%	2.12	0.29	0%
Food Preparation	Dishwasher	13.8%	0.08	0.01	0	13.8%	0.08	0.01	0%
Food Preparation	Hot Food Container	13.8%	0.13	0.02	0	13.8%	0.13	0.02	0%
Food Preparation	Food Prep	13.8%	0.01	0.00	0	13.8%	0.01	0.00	0%
Refrigeration	Walk in Refrigeration	26.6%	0.19	0.05	0	26.6%	0.17	0.04	-10%
Refrigeration	Glass Door Display	26.6%	0.11	0.03	0	26.6%	0.10	0.03	-10%
Refrigeration	Solid Door Refrigerator	26.6%	0.71	0.19	1	26.6%	0.64	0.17	-10%
Refrigeration	Open Display Case	26.6%	0.50	0.13	1	26.6%	0.45	0.12	-10%
Refrigeration	Vending Machine	26.6%	0.38	0.10	1	26.6%	0.38	0.10	0%
Refrigeration	Icemaker	26.6%	0.31	0.08	0	26.6%	0.31	0.08	0%
Office Equipment	Desktop Computer	100.0%	0.64	0.64	3	100.0%	0.64	0.64	0%
Office Equipment	Laptop Computer	100.0%	0.07	0.07	0	100.0%	0.07	0.07	0%
Office Equipment	Server	100.0%	0.17	0.17	1	100.0%	0.17	0.17	0%
Office Equipment	Monitor	100.0%	0.13	0.13	1	100.0%	0.13	0.13	0%
Office Equipment	Printer/copier/fax	100.0%	0.05	0.05	0	100.0%	0.05	0.05	0%
Office Equipment	POS Terminal	100.0%	0.01	0.01	0	100.0%	0.01	0.01	0%
Miscellaneous	Non-HVAC Motor	88.8%	0.82	0.73	4	88.8%	0.82	0.73	0%
Miscellaneous	Other Miscellaneous	100.0%	0.80	0.80	4	100.0%	0.80	0.80	0%
Total				**13.90**	**70**			**12.9**	

Table B–11 Extra Large Industrial Segment Market Profile, Idaho, 2009

End Use	Technology	Average Market Profiles: Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Usage (GWh)	New Units: Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Compared to Average
Cooling	Central Chiller	14.4%	7.98	1.15	31	14.4%	7.18	1.04	-10%
Cooling	RTU	17.1%	6.32	1.08	29	17.1%	5.68	0.97	-10%
Cooling	PTAC	1.1%	5.50	0.06	2	1.1%	4.95	0.05	-10%
Combined Heating/Cooling	Heat Pump	1.6%	11.13	0.18	5	1.6%	10.01	0.16	-10%
Space Heating	Electric Resistance	10.8%	8.67	0.93	25	10.8%	8.67	0.93	0%
Space Heating	Furnace	2.0%	9.10	0.18	5	2.0%	8.19	0.17	-10%
Ventilation	Ventilation	27.4%	12.31	3.37	92	27.4%	11.08	3.04	-10%
Interior Lighting	Interior Screw-in	100.0%	0.33	0.33	9	100.0%	0.30	0.30	-10%
Interior Lighting	HID	100.0%	1.05	1.05	28	100.0%	0.94	0.94	-10%
Interior Lighting	Linear Fluorescent	100.0%	1.10	1.10	30	100.0%	0.99	0.99	-10%
Exterior Lighting	Exterior Screw-in	92.5%	0.02	0.02	1	92.5%	0.02	0.02	-10%
Exterior Lighting	HID	92.5%	0.25	0.23	6	92.5%	0.23	0.21	-10%
Exterior Lighting	Linear Fluorescent	92.5%	0.01	0.01	0	92.5%	0.01	0.01	-10%
Process	Process Cooling/Refrigeration	2.4%	99.67	2.40	65	2.4%	99.67	2.40	0%
Process	Process Heating	26.2%	13.74	3.60	98	26.2%	13.74	3.60	0%
Process	Electrochemical Process	2.6%	77.43	2.00	54	2.6%	77.43	2.00	0%
Machine Drive	Less than 5 HP	90.5%	0.92	0.84	23	90.5%	0.92	0.84	0%
Machine Drive	5-24 HP	80.1%	2.26	1.81	49	80.1%	2.26	1.81	0%
Machine Drive	25-99 HP	72.4%	6.10	4.42	120	72.4%	6.10	4.42	0%
Machine Drive	100-249 HP	65.3%	3.84	2.51	68	65.3%	3.84	2.51	0%
Machine Drive	250-499 HP	23.7%	11.61	2.75	75	23.7%	11.61	2.75	0%
Machine Drive	500 and more HP	26.1%	19.50	5.08	138	26.1%	19.50	5.08	0%
Miscellaneous	Miscellaneous	100.0%	4.90	4.90	133	100.0%	4.90	4.90	0%
	Total			**40.00**	**1,088**			**39.1**	

Figure B–1 Residential Baseline Forecast by End Use, Idaho

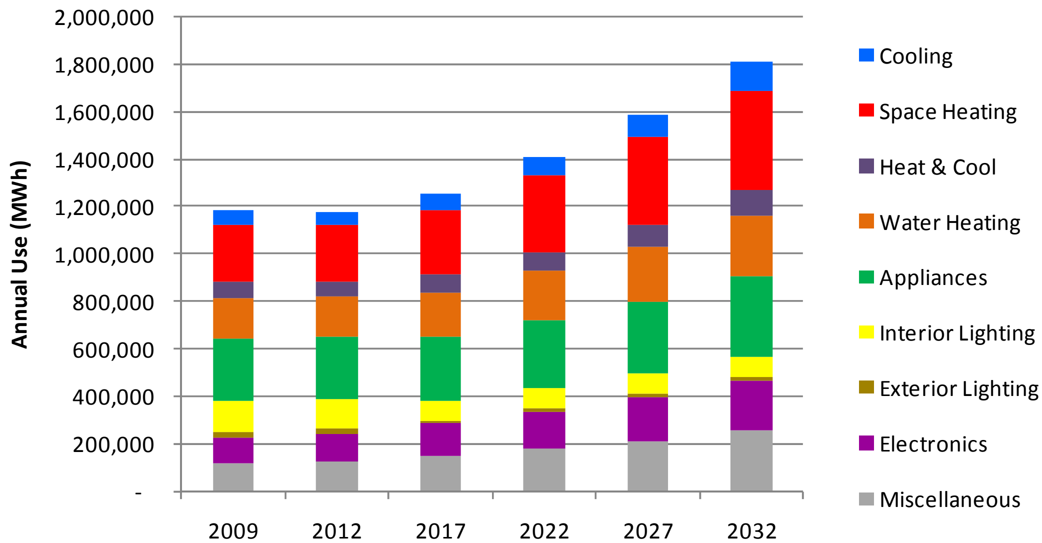

Figure B–2 C&I Baseline Electricity Forecast by End Use, Idaho

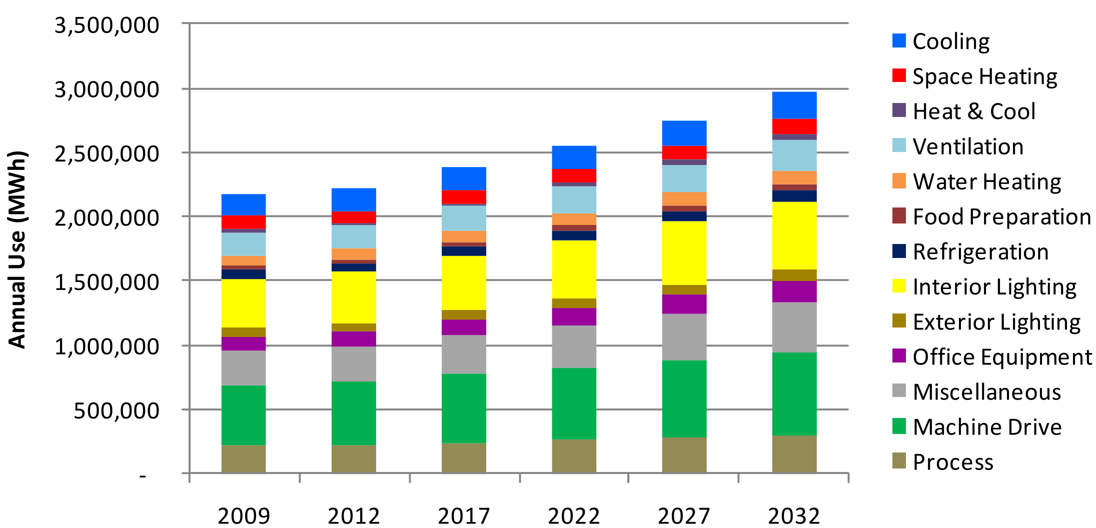

Table B-12 Baseline Forecast Summary by Sector, Idaho

End Use	2009	2012	2017	2022	2027	2032	% Change ('09–'32)	Avg. Growth Rate ('09–'32)
Res. ID	1,182,379	1,178,591	1,253,664	1,408,812	1,588,965	1,808,300	52.9%	1.8%
C&I ID	2,180,858	2,217,188	2,383,504	2,551,291	2,748,846	2,970,324	36.2%	1.3%
Total	3,363,237	3,395,780	3,637,168	3,960,104	4,337,811	4,778,624	42.1%	1.5%

Figure B–3 Baseline Forecast Summary by Sector, Idaho

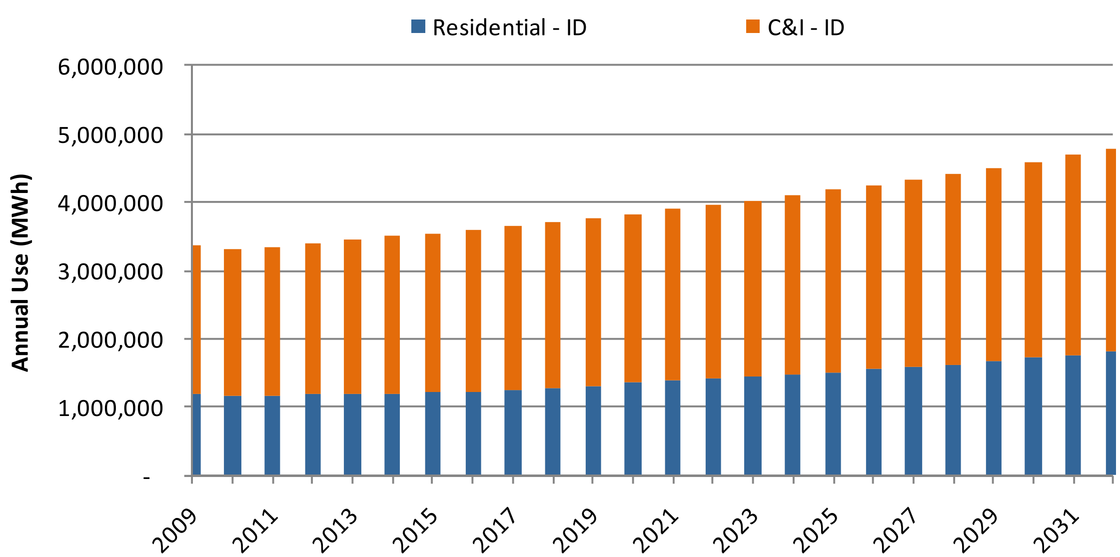

Figure B–4 Summary of Energy Efficiency Potential Savings, Idaho, All Sectors

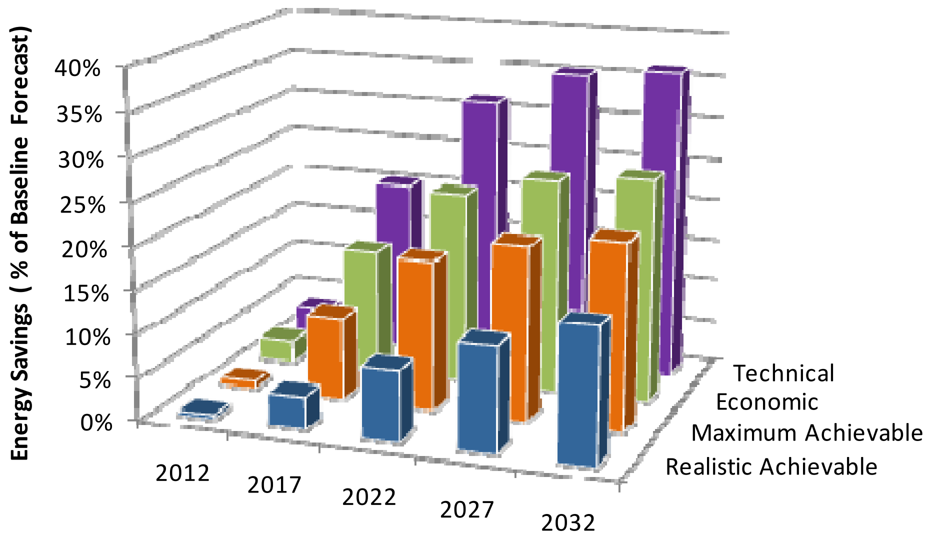

Figure B–5 Energy Efficiency Potential Forecasts, Idaho, All Sectors

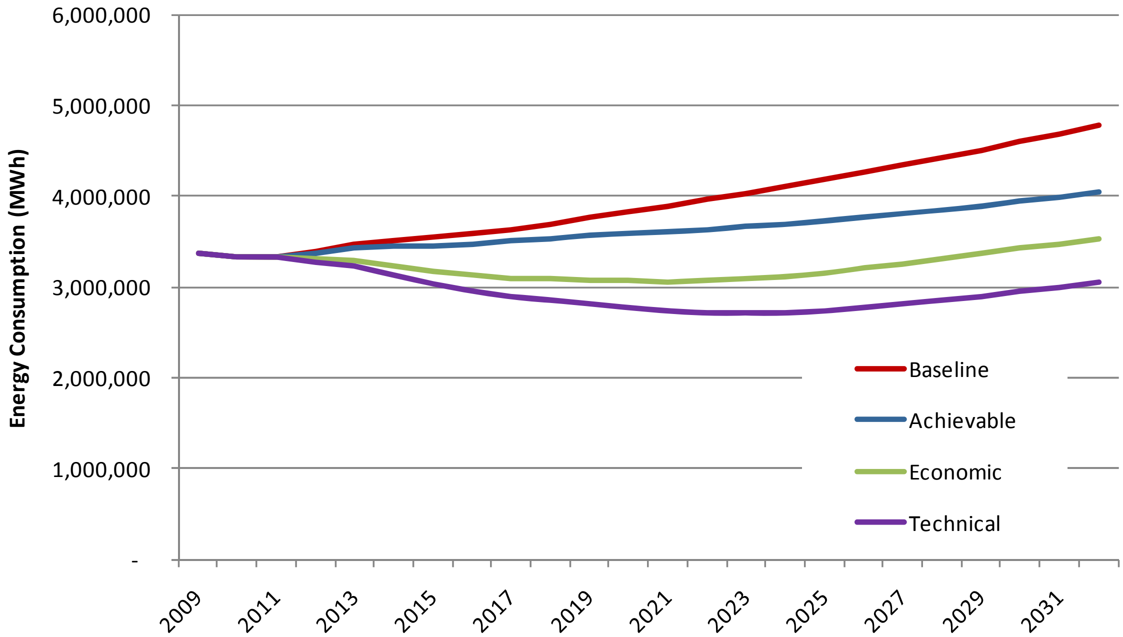

Table B–13 Summary of Energy Efficiency Potential, Idaho, All Sectors

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	3,395,780	3,637,168	3,960,104	4,337,811	4,778,624
Baseline Peak Demand(MW)	610	644	705	775	854
Cumulative Energy Savings (MWh)					
Realistic Achievable	17,115	138,024	328,192	529,056	743,485
Maximum Achievable	31,326	355,867	694,006	878,021	1,036,097
Economic	87,533	536,684	893,730	1,084,577	1,243,423
Technical	116,533	737,247	1,243,729	1,532,099	1,733,629
Cumulative Energy Savings (% of Baseline)					
Realistic Achievable	0.5%	3.8%	8.3%	12.2%	15.6%
Maximum Achievable	0.9%	9.8%	17.5%	20.2%	21.7%
Economic	2.6%	14.8%	22.6%	25.0%	26.0%
Technical	3.4%	20.3%	31.4%	35.3%	36.3%
Peak Savings (MW)					
Realistic Achievable	4	27	57	94	133
Maximum Achievable	7	65	120	153	178
Economic	19	98	154	186	213
Technical	24	133	212	262	299
Peak Savings (% of Baseline)					
Realistic Achievable	0.7%	4.1%	8.1%	12.1%	15.6%
Maximum Achievable	1.1%	10.1%	17.1%	19.7%	20.9%
Economic	3.1%	15.2%	21.9%	24.0%	24.9%
Technical	4.0%	20.6%	30.1%	33.8%	35.0%

Table B–14 Achievable Cumulative EE Potential by Sector, Idaho (MWh)

Segment	2012	2017	2022	2027	2032
Residential, Idaho	8,692	43,922	97,705	172,179	260,003
C&I, Idaho	8,423	94,102	230,487	356,878	483,482
Total	17,115	138,024	328,192	529,056	743,485

Figure B–6 Achievable Cumulative Potential by Sector, Idaho

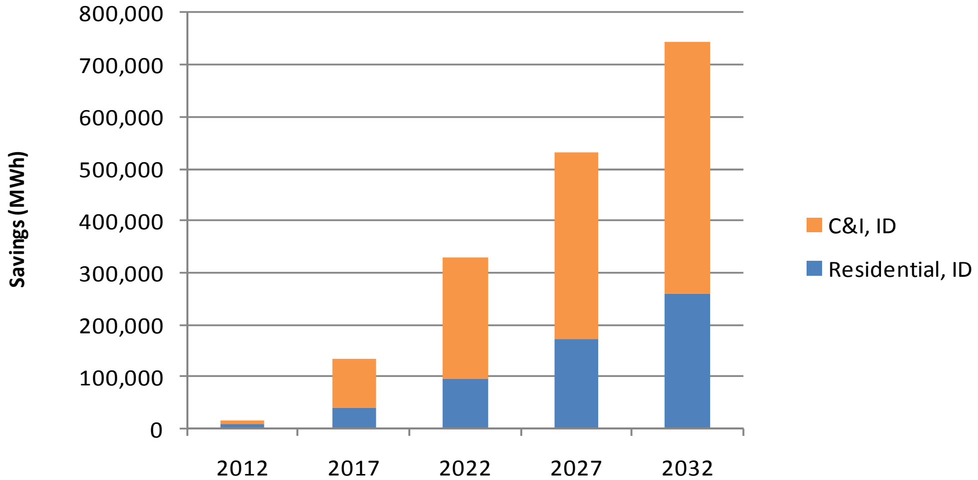

Figure B–7 Residential Energy Efficiency Potential Savings, Idaho

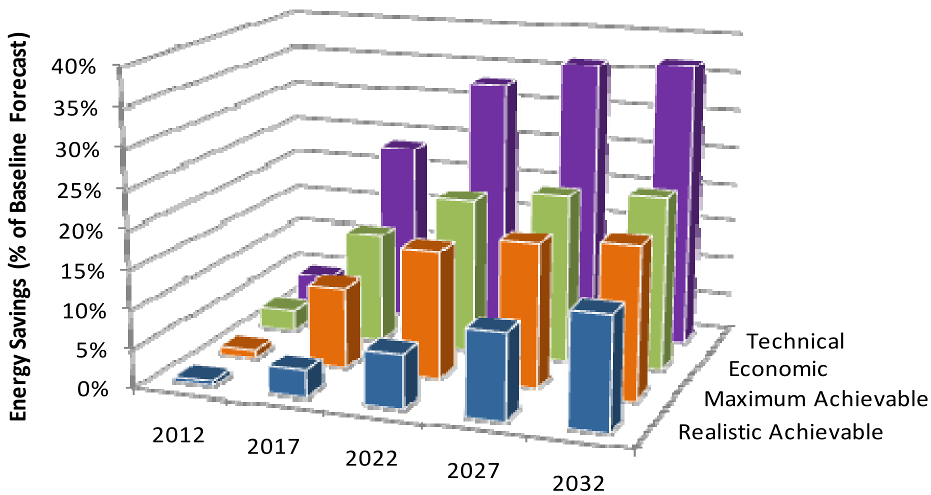

Figure B–8 Residential Energy Efficiency Potential Forecast, Idaho

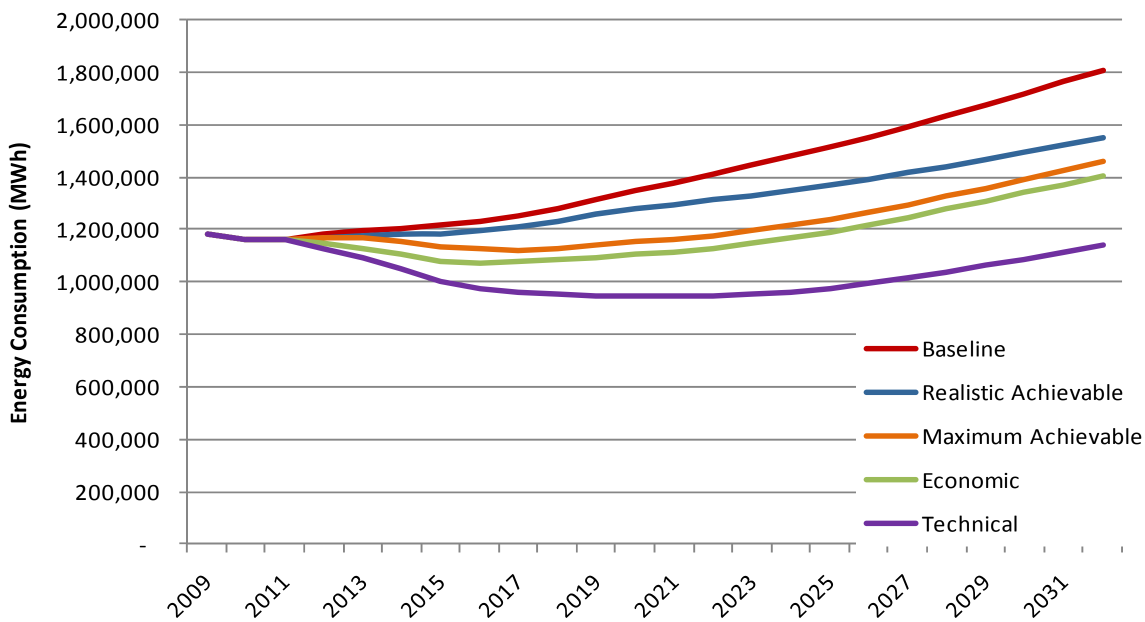

Table B–15 Energy Efficiency Potential for the Residential Sector, Idaho

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	1,178,591	1,253,664	1,408,812	1,588,965	1,808,300
Baseline Peak Demand(MW)	281	290	325	363	408
Cumulative Energy Savings (MWh)					
Realistic achievable	8,692	43,922	97,705	172,179	260,003
Maximum achievable	11,841	130,930	230,870	293,897	349,609
Economic	33,369	179,104	280,336	341,494	403,100
Technical	49,653	292,196	462,586	575,049	665,872
Cumulative Energy Savings (% of Baseline)					
Realistic achievable	0.7%	3.5%	6.9%	10.8%	14.4%
Maximum achievable	1.0%	10.4%	16.4%	18.5%	19.3%
Economic	2.8%	14.3%	19.9%	21.5%	22.3%
Technical	4.2%	23.3%	32.8%	36.2%	36.8%
Peak Savings (MW)					
Realistic achievable	3	12	26	47	70
Maximum achievable	4	32	61	79	92
Economic	11	47	75	92	106
Technical	14	69	109	135	157
Peak Savings (% of Baseline)					
Realistic achievable	1.1%	4.2%	7.9%	12.8%	17.0%
Maximum achievable	1.4%	11.2%	18.7%	21.7%	22.5%
Economic	3.8%	16.3%	23.2%	25.3%	26.1%
Technical	4.9%	23.8%	33.5%	37.2%	38.6%

Table B-16 Residential Baseline & Realistic Achievable Potential by Segment, Idaho

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)					
Single Family	809,394	860,796	969,610	1,095,955	1,250,124
Multi Family	43,239	46,927	53,367	60,656	69,266
Mobile Home	58,491	61,447	68,664	77,048	87,262
Limited Income	267,467	284,494	317,172	355,306	401,648
Total	1,178,591	1,253,664	1,408,812	1,588,965	1,808,300
Energy Savings, Realistic Achievable Potential (MWh)					
Single Family	6,394	32,068	76,498	135,426	203,716
Multi Family	236	1,141	2,100	3,891	5,937
Mobile Home	465	1,997	3,403	5,554	8,326
Limited Income	1,597	8,715	15,705	27,307	42,024
Total	8,692	43,922	97,705	172,179	260,003
% of Total Residential Energy Savings					
Single Family	73.6%	73.0%	78.3%	78.7%	78.4%
Multi Family	2.7%	2.6%	2.1%	2.3%	2.3%
Mobile Home	5.3%	4.5%	3.5%	3.2%	3.2%
Limited Income	18.4%	19.8%	16.1%	15.9%	16.2%

Table B-17 Residential Potential by Housing Type, 2022, Idaho

Forecast	Single Family	Multi Family	Mobile Home	Limited Income	Total
Baseline Forecast (MWh)	969,610	53,367	68,664	317,172	1,408,812
Cumulative Energy Savings (MWh)					
Realistic Achievable	76,498	2,100	3,403	15,705	97,705
Maximum Achievable	180,146	5,514	7,612	37,597	230,870
Economic Potential	215,829	7,112	9,445	47,950	280,336
Technical Potential	311,446	15,951	23,241	111,948	462,586
Energy Savings % of Baseline					
Realistic Achievable	7.9%	3.9%	5.0%	5.0%	6.9%
Maximum Achievable	18.6%	10.3%	11.1%	11.9%	16.4%
Economic Potential	22.3%	13.3%	13.8%	15.1%	19.9%
Technical Potential	32.1%	29.9%	33.8%	35.3%	32.8%

Table A-18 Residential Cumulative Savings by End Use and Potential Type, Oregon (MWh)

End Use	Case	2012	2017	2022	2027	2032
Cooling	Realistic Achievable	4	784	2,713	7,797	15,205
	Economic	118	7,473	13,481	20,239	27,909
	Technical	1,389	21,223	34,387	49,464	67,702
Space Heating	Realistic Achievable	90	5,124	23,932	55,063	89,268
	Economic	2,854	46,886	90,434	118,849	142,327
	Technical	3,872	62,068	117,487	158,049	196,858
Heat/Cool	Realistic Achievable	4	277	772	1,917	5,360
	Economic	136	4,094	5,019	5,928	9,460
	Technical	1,056	8,796	15,144	21,238	24,333
Water Heating	Realistic Achievable	167	6,629	23,974	46,762	77,570
	Economic	2,868	34,268	69,949	91,136	113,933
	Technical	10,553	85,265	160,064	203,679	227,582
Appliances	Realistic Achievable	434	4,216	9,065	14,393	20,002
	Economic	1,885	20,859	27,076	28,751	30,895
	Technical	2,461	26,764	35,893	38,774	41,155
Interior Lighting	Realistic Achievable	6,180	17,434	19,757	22,622	23,650
	Economic	18,432	36,002	35,080	32,028	29,190
	Technical	21,560	49,417	48,706	45,433	42,120
Exterior Lighting	Realistic Achievable	1,125	3,610	3,675	3,426	2,753
	Economic	3,350	7,531	6,023	4,553	3,242
	Technical	3,846	9,858	8,546	7,753	7,635
Electronics	Realistic Achievable	607	4,630	11,073	15,629	19,572
	Economic	3,058	15,658	23,240	26,031	29,797
	Technical	4,219	22,321	32,027	36,258	41,681
Miscellaneous	Realistic Achievable	80	1,217	2,744	4,568	6,622
	Economic	667	6,334	10,036	13,980	16,348
	Technical	697	6,484	10,331	14,400	16,807
Total	Realistic Achievable	8,692	43,922	97,705	172,179	260,003
	Economic	33,369	179,104	280,336	341,494	403,100
	Technical	49,653	292,196	462,586	575,049	665,872

Figure B–9 Residential Realistic Achievable Potential by End Use, Selected Years, Idaho

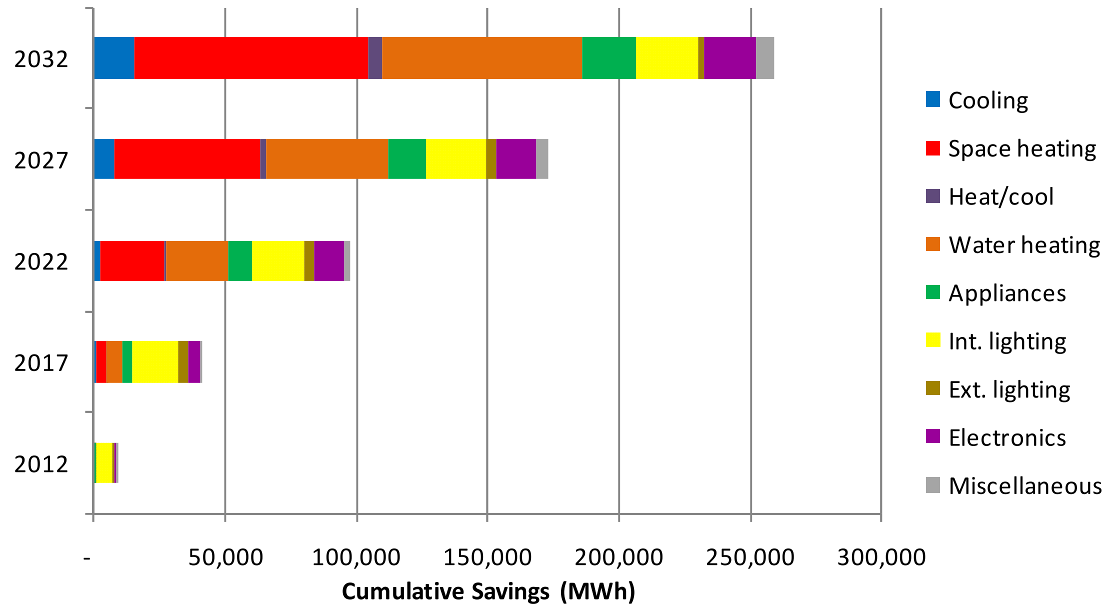

Table B-19 Residential Realistic Achievable Potential by End Use and Market Segment, 2022, Idaho (MWh)

	Single Family	Multi Family	Mobile Home	Limited Income	Total
Cooling	1,736	51	59	866	2,713
Space heating	19,066	789	402	3,676	23,932
Heat/cool	675	3	39	56	772
Water heating	20,270	422	407	2,875	23,974
Appliances	6,657	103	451	1,854	9,065
Interior lighting	13,894	535	1,047	4,281	19,757
Exterior lighting	3,020	28	227	399	3,675
Electronics	8,757	167	617	1,531	11,073
Miscellaneous	2,422	1	153	168	2,744
Total	**76,498**	**2,100**	**3,403**	**15,705**	**97,705**

Table B–20 Residential Cumulative Realistic Achievable Potential by End Use and Equipment Measures, Idaho, Selected Years (MWh)

End Use	Technology	2012	2017	2022
Cooling	Central AC	-	51	55
Heat/Cool	Air Source Ht. Pump	-	-	-
Water Heating	Water Heater	43	321	336
Appliances	Clothes Washer	29	352	888
	Clothes Dryer	35	240	440
	Dishwasher	40	373	912
	Refrigerator	146	652	1,266
	Freezer	113	560	1,221
	Second Refrigerator	53	257	475
	Stove	7	56	126
Interior Lighting	Screw-in	5,757	14,262	14,623
	Linear Fluorescent	56	639	1,202
	Pin-based	367	2,466	3,641
Exterior Lighting	Screw-in	1,117	3,567	3,619
	High Intensity/Flood	8	43	56
Electronics	Personal Computers	389	3,151	5,418
	TVs	213	1,121	2,079
Miscellaneous	Pool Pump	61	559	1,372
	Furnace Fan	16	202	602
Total		**8,450**	**28,875**	**38,332**

Table B–21 Residential Realistic Achievable Savings for Non-equipment Measures, Idaho (MWh)

Measure	2012	2017	2022
Furnace - Convert to Gas	72	2,299	14,668
Water Heater - Convert to Gas	56	2,041	13,812
Advanced New Construction Designs	0	62	1,426
Repair and Sealing - Ducting	6	853	2,417
Insulation - Infiltration Control	6	804	2,265
Water Heater - Thermostat Setback	44	2,506	4,232
Home Energy Management System	2	377	1,323
Freezer - Remove Second Unit	8	1,104	2,367
Water Heater - Hot Water Saver	2	130	1,663
Electronics - Reduce Standby Wattage	4	358	3,576
Thermostat - Clock/Programmable	6	799	2,222
Insulation - Foundation	0	141	628
Air Source Heat Pump - Maintenance	4	277	772
Refrigerator - Remove Second Unit	4	622	1,369
Water Heater - Heat Pump	-	12	334
Water Heater - Faucet Aerators	4	293	702
Insulation - Ducting	0	49	188
Water Heater - Tank Blanket/Insulation	15	794	1,238
Insulation - Wall Cavity	0	85	369
Ceiling Fan - Installation	0	24	167
Room AC - Removal of Second Unit	2	281	698
Insulation - Ceiling	1	115	339
Water Heater - Timer	0	231	801
Water Heater - Low Flow Showerheads	3	270	529
Central AC - Maintenance and Tune-Up	-	-	-
Whole-House Fan - Installation	0	21	112
Pool - Pump Timer	3	456	771
Water Heater - Pipe Insulation	0	34	326
Insulation - Wall Sheathing	0	13	58
Total	242	15,047	59,373

Figure B–10 Energy Efficiency Potential Savings, C&I Sector, Idaho

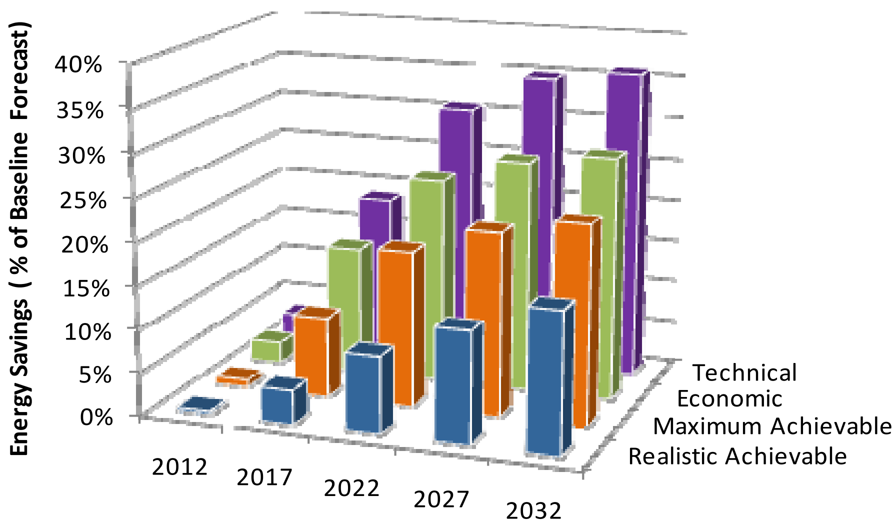

Figure B–11 Energy Efficiency Potential Forecast, C&I Sector, Idaho

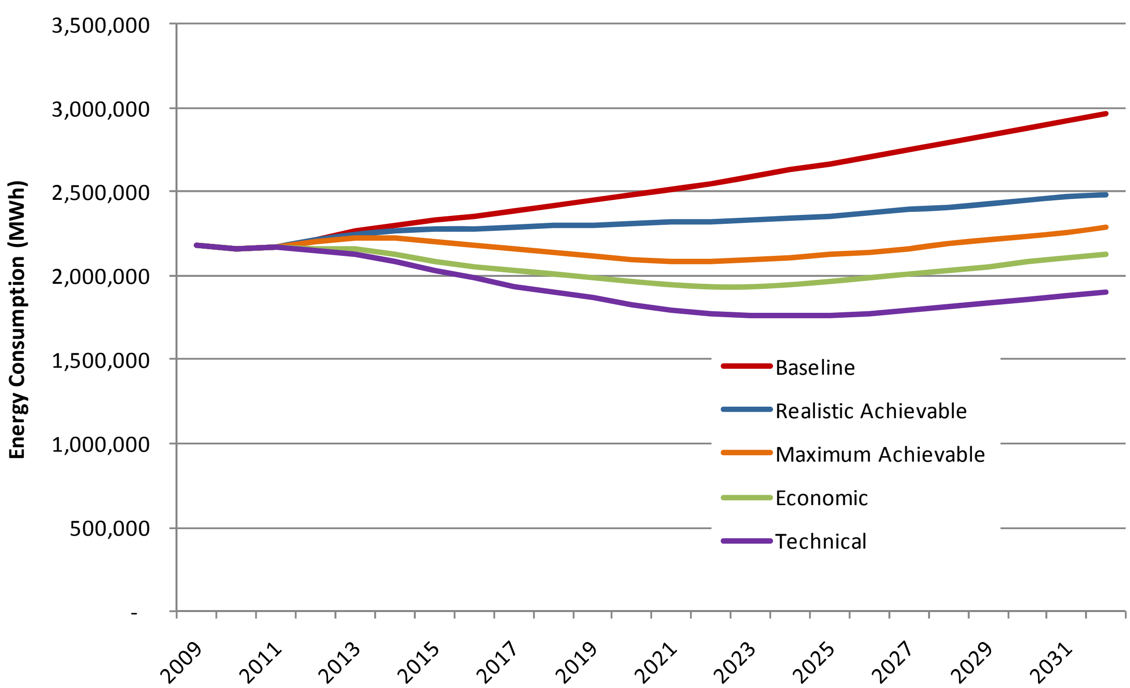

Table B–22 Energy Efficiency Potential, C&I Sector, Idaho

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	2,217,188	2,383,504	2,551,291	2,748,846	2,970,324
Baseline Peak Demand(MW)	329	354	380	411	446
Cumulative Energy Savings (MWh)					
Realistic Achievable	8,423	94,102	230,487	356,878	483,482
Maximum Achievable	19,485	224,938	463,136	584,124	686,488
Economic	54,164	357,579	613,394	743,082	840,323
Technical	66,880	445,051	781,143	957,050	1,067,757
Cumulative Energy Savings (% of Baseline)					
Realistic Achievable	0.4%	3.9%	9.0%	13.0%	16.3%
Maximum Achievable	0.9%	9.4%	18.2%	21.2%	23.1%
Economic	2.4%	15.0%	24.0%	27.0%	28.3%
Technical	3.0%	18.7%	30.6%	34.8%	35.9%
Peak Savings (MW)					
Realistic Achievable	1	14	31	48	64
Maximum Achievable	3	33	60	74	86
Economic	8	51	79	94	106
Technical	10	64	103	127	141
Peak Savings (% of Baseline)					
Realistic Achievable	0.4%	4.1%	8.3%	11.6%	14.3%
Maximum Achievable	0.9%	9.2%	15.7%	17.9%	19.4%
Economic	2.5%	14.3%	20.7%	22.9%	23.8%
Technical	3.1%	18.1%	27.2%	30.8%	31.7%

Table B–23 C&I Sector, Baseline and Realistic Achievable Potential by Segment, Idaho

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)					
Small/Med. Commercial	317,367	335,813	361,837	394,213	431,409
Large Commercial	707,532	761,508	821,587	894,850	979,118
Extra Large Commercial	72,013	83,305	90,387	98,291	106,847
Extra Large Industrial	1,120,277	1,202,878	1,277,480	1,361,492	1,452,949
Total	2,217,188	2,383,504	2,551,291	2,748,846	2,970,324
Cumulative Energy Savings, Achievable Potential (MWh)					
Small/Med. Commercial	1,962	20,807	43,865	65,456	88,728
Large Commercial	4,662	52,140	106,963	155,523	202,933
Extra Large Commercial	609	6,178	13,050	19,166	24,274
Extra Large Industrial	1,190	14,977	66,609	116,733	167,548
Total	8,423	94,102	230,487	356,878	483,482
% of Total C&I Cumulative Energy Savings					
Small/Med. Commercial	23.3%	22.1%	19.0%	18.3%	18.4%
Large Commercial	55.4%	55.4%	46.4%	43.6%	42.0%
Extra Large Commercial	7.2%	6.6%	5.7%	5.4%	5.0%
Extra Large Industrial	14.1%	15.9%	28.9%	32.7%	34.7%

Table B–24 C&I Potential by Segment, Idaho, 2022

Forecast	Small/Med. Commercial	Large Commercial	Extra Large Commercial	Extra Large Industrial	Total
Baseline Forecast (MWh)	361,837	821,587	90,387	1,277,480	2,551,291
Cumulative Energy Savings (MWh)					
Realistic Achievable	43,865	106,963	13,050	66,609	230,487
Economic Potential	87,274	204,790	25,964	295,365	613,394
Technical Potential	135,405	301,217	36,465	308,056	781,143
Cumulative Energy Savings % of Baseline					
Realistic Achievable	12%	13%	14%	5%	9%
Economic Potential	24%	25%	29%	23%	24%
Technical Potential	37%	37%	40%	24%	31%

Table B-25 C&I Cumulative Savings by End Use and Potential Type, Idaho (MWh)

End Use	Case	2012	2017	2022	2027	2032
Cooling	Realistic Achievable	78	5,923	21,250	33,605	47,275
	Economic	1,138	20,975	45,413	59,510	75,348
	Technical	2,968	36,760	76,374	95,858	113,212
Space Heating	Realistic Achievable	6	758	4,296	8,178	13,308
	Economic	133	3,983	11,757	17,084	24,436
	Technical	215	6,445	19,442	26,587	34,707
Heat/Cool	Realistic Achievable	16	1,271	2,302	2,778	3,432
	Economic	185	3,001	3,761	4,432	4,954
	Technical	260	3,540	4,747	5,741	6,445
Ventilation	Realistic Achievable	211	2,846	15,356	29,448	47,931
	Economic	3,528	26,446	69,343	93,958	107,124
	Technical	4,612	34,655	93,204	122,731	132,705
Water Heating	Realistic Achievable	25	1,545	3,227	3,742	4,068
	Economic	198	3,518	4,823	5,295	5,309
	Technical	4,444	32,290	58,774	82,998	91,291
Food Preparation	Realistic Achievable	72	868	2,449	4,745	7,111
	Economic	962	5,813	10,539	12,677	13,834
	Technical	1,043	6,341	11,660	14,033	15,375
Refrigeration	Realistic Achievable	62	631	2,054	3,943	5,850
	Economic	925	4,540	8,629	11,127	12,502
	Technical	1,091	5,996	13,223	17,139	19,437
Interior Lighting	Realistic Achievable	5,851	55,282	110,129	160,780	203,673
	Economic	27,689	162,081	212,672	243,913	279,638
	Technical	30,318	177,750	239,322	274,804	311,478
Exterior Lighting	Realistic Achievable	526	7,858	15,569	19,409	23,034
	Economic	2,403	23,137	27,251	28,628	29,938
	Technical	2,701	25,247	30,174	34,115	38,276
Office Equipment	Realistic Achievable	862	8,854	14,582	19,189	23,952
	Economic	6,253	28,449	29,883	31,230	32,556
	Technical	8,238	38,728	41,183	43,665	46,239
Machine Drive	Realistic Achievable	382	6,612	33,312	56,917	77,212
	Economic	4,308	40,409	117,995	145,338	156,337
	Technical	4,341	40,906	119,993	147,502	158,642
Process	Realistic Achievable	328	1,590	5,541	13,154	24,996
	Economic	6,410	34,803	69,990	87,646	95,276
	Technical	6,410	34,803	69,990	87,646	95,276
Miscellaneous	Realistic Achievable	2	62	419	989	1,641
	Economic	33	426	1,336	2,245	3,070
	Technical	239	1,591	3,058	4,230	4,673
Total	Realistic Achievable	8,423	94,102	230,487	356,878	483,482
	Economic	54,164	357,579	613,394	743,082	840,323
	Technical	66,880	445,051	781,143	957,050	1,067,757

Figure B-12 C&I Achievable Potential by End Use, Selected Years, Idaho

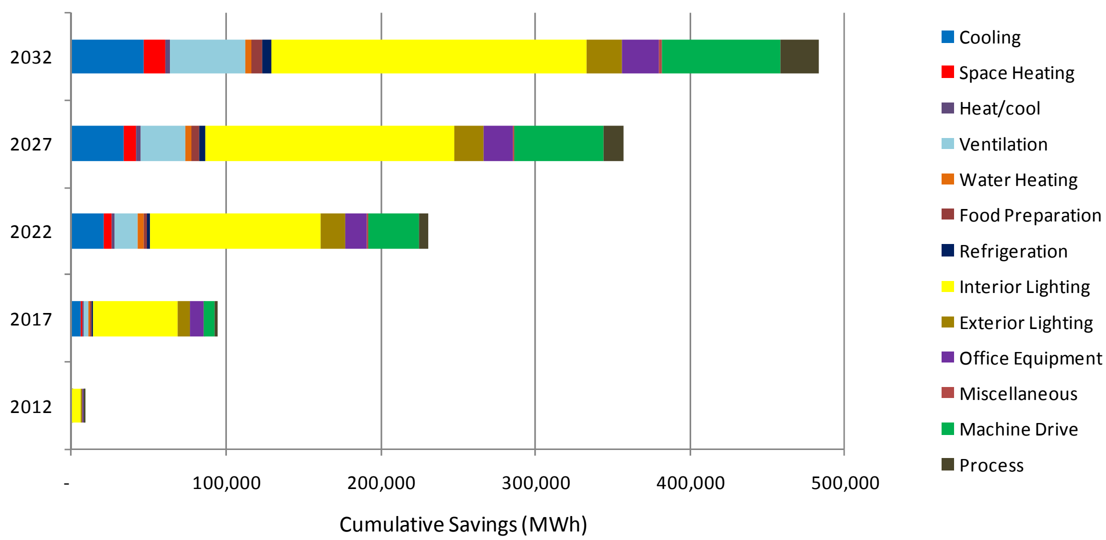

Table B-26 C&I Realistic Achievable Potential by End Use Market Segment, 2022, Idaho (MWh)

	Small/Med. Commercial	Large Commercial	Extra Large Commercial	Extra Large Industrial	Total
Cooling	2,805	8,283	1,032	9,129	21,250
Space Heating	338	2,110	305	1,544	4,296
Combined Heating/Cooling	249	1,666	119	267	2,302
Ventilation	4,489	1,846	1,131	7,890	15,356
Water Heating	952	1,851	424	-	3,227
Food Preparation	538	1,748	163	-	2,449
Refrigeration	572	1,382	100	-	2,054
Interior Lighting	25,426	68,834	7,612	8,256	110,129
Exterior Lighting	4,866	8,723	1,312	669	15,569
Office Equipment	3,482	10,274	825	-	14,582
Machine Drive	-	-	-	33,312	33,312
Process	-	-	-	5,541	5,541
Miscellaneous	146	246	26	-	419
Total	**43,865**	**106,963**	**13,050**	**66,609**	**230,487**

Table B-27 C&I Cumulative Achievable Potential by End Use and Equipment Measures, Washington (MWh)

End Use	Technology	2012	2017	2022
Cooling	Central Chiller	29	304	1,225
	PTAC	2	2	2
Heat/Cool	Heat Pump	7	128	376
Ventilation	Ventilation	196	2,023	7,393
Water Heater	Water Heater	14	111	109
Food Preparation	Fryer	4	46	121
	Hot Food Container	9	102	274
	Oven	60	708	1,884
Refrigeration	Glass Door Display	11	155	440
	Icemaker	8	108	317
	Solid Door Refrigerator	14	165	438
	Vending Machine	27	152	371
	Walk in Refriger'n	0	5	13
Interior Lighting	Interior Screw-in	3,326	21,132	32,157
	HID	1,014	9,151	18,439
	Linear Fluorescent	1,450	17,918	35,222
Exterior Lighting	Screw-in	76	1,138	1,977
	HID	403	5,269	10,440
	Linear Fluorescent	42	758	1,287
Office Equipment	Desktop Computer	490	4,569	7,322
	Laptop Computer	35	331	530
	Monitor	106	383	662
	POS Terminal	14	196	359
	Printer/copier/fax	44	564	1,025
	Server	169	2,412	3,889
Machine Drive	Less than 5 HP	21	144	383
	5-24 HP	46	324	887
	25-99 HP	114	808	2,209
	100-249 HP	32	227	622
	250-499 HP	34	242	661
	500 and more HP	64	456	1,247
Process	Electrochem. Process	46	220	719
	Process Cooling/Refrig.	62	294	961
	Process Heating	220	1,048	3,426
Miscellaneous	Non-HVAC Motor	2	25	181
Total		8,194	71,620	137,570

Table B-28 C&I Cumulative Achievable Savings for Non-equipment Measures, Idaho (MWh)

Measure	2012	2017	2022
Energy Management System	13	819	8,607
Advanced New Construction Designs	0	36	557
Retrocommissioning - Lighting	20	4,122	7,640
Interior Fluorescent - High Bay Fixtures	8	475	4,877
Pumping System - Optimization	11	507	4,907
Compressed Air - System Optimization and Improvements	11	506	4,837
Custom Measures	2	296	4,148
Fans - Variable Speed Control	7	335	3,189
Compressed Air - System Controls	7	355	3,457
RTU - Maintenance	24	3,277	6,364
Fans - Energy Efficient Motors	6	346	3,463
Retrocommissioning - Comprehensive	12	2,552	4,572
Retrocommissioning - HVAC	3	323	3,038
Motors - Variable Frequency Drive	11	1,338	2,707
Pumps - Variable Speed Control	5	241	2,289
Motors - Magnetic Adjustable Speed Drives	5	221	2,171
Compressed Air - Compressor Replacement	4	203	1,982
Pumping System - Controls	4	202	1,942
Chiller - Turbocor Compressor	3	167	1,764
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	0	22	193
Interior Lighting - Occupancy Sensors	7	249	1,949
Water Heater - Faucet Aerators/Low Flow Nozzles	9	1,306	2,692
Chiller - VSD	2	127	1,257
Interior Fluorescent - Delamp and Install Reflectors	6	222	1,622
Roofs - High Reflectivity	1	21	165
Commissioning - Comprehensive	0	123	805
Chiller - Condenser Water Temperature Reset	3	196	1,839
Heat Pump - Maintenance	9	1,143	1,925
Compressed Air - System Maintenance	13	717	1,198
Pumping System - Maintenance	-	43	606
Exterior Lighting - Daylighting Controls	2	70	562
Insulation - Ducting	1	93	778
Chiller - Chilled Water Reset	2	403	705
Thermostat - Clock/Programmable	2	304	595
Commissioning - Lighting	0	94	314
Office Equipment - ENERGY STAR Power Supply	3	399	795
Cooking - Exhaust Hoods with Sensor Control	0	6	56
Refrigeration - System Optimization	0	15	229

Measure	2012	2017	2022
Furnace - Convert to Gas	1	35	229
Water Heater - Heat Pump	0	16	211
Refrigeration - System Controls	0	10	160
Cooling - Economizer Installation	1	42	378
Exterior Lighting - Induction Lamps	0	10	140
Insulation - Ceiling	0	1	13
Industrial Process Improvements	0	11	127
LED Exit Lighting	9	319	358
Commissioning - HVAC	-	-	4
Water Heater - Tank Blanket/Insulation	2	111	195
Miscellaneous - ENERGY STAR Water Cooler	0	20	58
Refrigeration - System Maintenance	0	3	46
Refrigeration - Floating Head Pressure	0	4	46
Insulation - Wall Cavity	0	2	31
Refrigeration - Strip Curtain	-	0	14
Refrigeration - Anti-Sweat Heater/Auto Door Closer	0	3	35
Water Heater - Hot Water Saver	-	-	1
Water Heater - High Efficiency Circulation Pump	0	2	19
Vending Machine - Controller	0	13	22
Chiller - Chilled Water Variable-Flow System	0	2	19
Exterior Lighting - Cold Cathode Lighting	0	1	8
Refrigeration - Night Covers	0	0	4
Laundry - High Efficiency Clothes Washer	0	3	5
Total	**228**	**22,482**	**92,917**

APPENDIX | C

RESIDENTIAL ENERGY EFFICIENCY EQUIPMENT AND MEASURE DATA

This appendix presents detailed information for all residential energy efficiency equipment and measures that were evaluated in LoadMAP. Several sets of tables are provided.

Table C-1 provides brief descriptions for all equipment and measures that were assessed for potenital.

Tables C-2 through C-9 list the detailed unit-level data for the equipment measures for each of the housing type segments — single family, multi-family, mobile home, and limited income — and for existing and new construction, respectively. Savings are in kWh/yr/household, and incremental costs are in $/household, unless noted otherwise. The B/C ratio is zero if the measure represents the baseline technology or if the technology is not available in the first year of the forecast (2012). The B/C ratio is calculated within LoadMAP for each year of the forecast and is available once the technology or measure becomes available.

Tables C-10 through C-17 list the detailed unit-level data for the non-equipment energy efficiency measures for each of the housing type segments and for existing and new construction, respectively. Because these measures can produce energy-use savings for multiple end-use loads (e.g., insulation affects heating and cooling energy use) savings are expressed as a percentage of the end-use loads. Base saturation indicates the percentage of homes in which the measure is already installed. Applicability/Feasibility is the product of two factors that account for whether the measure is applicable to the building. Cost is expressed in $/household. The detailed measure-level tables present the results of the benefit/cost (B/C) analysis for the first year of the forecast. The B/C ratio is zero if the measure represents the baseline technology or if the measure is not available in the first year of the forecast (2012). The B/C ratio is calculated within LoadMAP for each year of the forecast and is available once the technology or measure becomes available.

Note that Tables C-2 through C-17 present information for Washington. For Idaho, savings and B/C ratios may be slightly different due to weather-related usage, differences in the states' market profiles, and different retail electricity prices. Although Idaho-specific values are not presented here, they are available within the LoadMAP files.

Table C–1 Residential Energy Efficiency Equipment/Measure Descriptions

End-Use	Equipment/ Measure	Description
Cooling	Air Conditioner — Central (CAC)	Central air conditioners consist of a refrigeration system using a direct expansion cycle. Equipment includes a compressor, an air-cooled condenser (located outdoors), an expansion valve, and an evaporator coil. A supply fan near the evaporator coil distributes supply air through air ducts to the building. Cooling efficiencies vary based on materials used, equipment size, condenser type, and system configuration. CACs may be unitary (all components housed in a factory-built assembly) or split system (an outdoor condenser section and an indoor evaporator section connected by refrigerant lines and with the compressor either indoors or outdoors). Energy efficiency is rated according to the size of the unit using the Seasonal Energy Efficiency Rating (SEER). Systems with Variable Refrigerant Flow further improve the operating efficiency. A high-efficiency option for a ductless mini-split system was also analyzed.
Cooling	Central Air Conditioner, Early Replacement	CAC systems currently on the market are significantly more efficient that older units, due to technology improvement and stricter appliance standards. This measure incents homeowners to replace an aging but still working unit with a new, higher-efficiency one.
Cooling	Central Air Conditioner Maintenance and Tune Up	An air conditioner's filters, coils, and fins require regular cleaning and maintenance for the unit to function effectively and efficiently throughout its life. Neglecting necessary maintenance leads to a steady decline in performance, requiring the AC unit to use more energy for the same cooling load.
Cooling	Air Conditioner - Room, ENERGY STAR or better	Room air conditioners are designed to cool a single room or space. They incorporate a complete air-cooled refrigeration and air-handling system in an individual package. Room air conditioners come in several forms, including window, split-type, and packaged terminal units. Energy efficiency is rated according to the size of the unit using the Energy Efficiency Rating (EER).
Cooling	Room AC — Removal of Second Unit	Homeowners may have a second room AC unit that is extremely inefficient. This measure incents homeowners to recycle the second unit and thus also eliminates associated electricity use.
Cooling	Attic Fan Attic Fan, Photovoltaic	Attic fans can reduce the need for AC by reducing heat transfer from the attic through the ceiling of the house. A well-ventilated attic can be several degrees cooler than a comparable, unventilated attic. An option for an attic fan equipped with a small solar photovoltaic generator was also modeled.
Cooling	Ceiling Fan	Ceiling fans can reduce the need for air conditioning. However, the house occupants must also select a ceiling fan with a high-efficiency motor and either shutoff the AC system or setup the thermostat temperature of the air conditioning system to realize the potential energy savings. Some ceiling fans also come with lamps. In this analysis, it is assumed that there are no lamps, and installing a ceiling fan will allow occupants to increase the thermostat cooling setpoint up by 2°F.
Cooling	Whole-House Fan	Whole-house fans can reduce the need for AC on moderate-weather days or on cool evenings. The fan facilitates a quick air change throughout the entire house. Several windows must be open to achieve the best results. The fan is mounted on the top floor of the house, usually in a hallway ceiling.

End-Use	Equipment/ Measure	Description
Space Heating	Convert to Gas	This fuel-switching measure is the replacement of an electric furnace with a gas-fired furnace. This measure will eliminate all electricity consumption and demand due to electric space heating. In this study, it is assumed that this measure can be implemented only in homes within 500 feet of a gas main.
Heat/Cool	Air Source Heat Pump	A central heat pump consists of components similar to a CAC system, but is usually designed to function both as a heat pump and an air conditioner. It consists of a refrigeration system using a direct expansion (DX) cycle. Equipment includes a compressor, an air-cooled condenser (located outdoors), an expansion valve, and an evaporator coil (located in the supply air duct near the supply fan) and a reversing valve to change the DX cycle from cooling to heating when required. The cooling and heating efficiencies vary based on the materials used, equipment size, condenser type, and system configuration. Heat pumps may be unitary (all components housed in a factory-built assembly) or a split system (an outdoor condenser section and an indoor evaporator section connected by refrigerant lines, with either outdoors or indoors. A high-efficiency option for a ductless mini-split system was also analyzed.
Heat / Cool	Geothermal Heat Pump	Geothermal heat pumps are similar to air-source heat pumps, but use the ground or groundwater instead of outside air to provide a heat source/sink. A geothermal heat pump system generally consists of three major subsystems or parts: a geothermal heat pump to move heat between the building and the fluid in the earth connection, an earth connection for transferring heat between the fluid and the earth, and a distribution subsystem for delivering heating or cooling to the building. The system may also have a desuperheater to supplement the building's water heater, or a full-demand water heater to meet all of the building's hot water needs.
Heat / Cool	Air Source Heat Pump Maintenance	A heat pump's filters, coils, and fins require regular cleaning and maintenance for the unit to function effectively and efficiently throughout its life. Neglecting necessary maintenance ensures a steady decline in performance while energy use steadily increases.
HVAC (all)	Insulation – Ducting	Air distribution ducts can be insulated to reduce heating or cooling losses. Best results can be achieved by covering the entire surface area with insulation. Several types of ducts and duct insulation are available, including flexible duct, pre-insulated duct, duct board, duct wrap, tacked, or glued rigid insulation, and waterproof hard shell materials for exterior ducts. This analysis assumes that installing duct insulation can reduce the temperature drop/gain in ducts by 50%.
HVAC (all)	Repair and Sealing – Ducting	An ideal duct system would be free of leaks. Leakage in unsealed ducts varies considerably because of differences in fabricating machinery used, methods for assembly, installation workmanship, and age of the ductwork. Air leaks from the system to the outdoors result in a direct loss proportional to the amount of leakage and the difference in enthalpy between the outdoor air and the conditioned air. This analysis assumes that over time air loss from ducts has doubled, and conducting repair and sealing of the ducts will restore leakage from ducts to the original baseline level.

End-Use	Equipment/ Measure	Description
HVAC (all)	Thermostat — Clock/Programmable	A programmable thermostat can be added to most heating/cooling systems. They are typically used during winter to lower temperatures at night and in summer to increase temperatures during the afternoon. The energy savings from this type of thermostat are identical to those of a "setback" strategy with standard thermostats, but the convenience of a programmable thermostat makes it a much more attractive option. In this analysis, the baseline is assumed to have no thermostat setback.
HVAC (all)	Doors — Storm and Thermal	Like other components of the shell, doors are subject to several types of heat loss: conduction, infiltration, and radiant losses. Similar to a storm window, a storm door creates an insulating air space between the storm and primary doors. A tight fitting storm door can also help reduce air leakage or infiltration. Thermal doors have exceptional thermal insulation properties and also are provided with weather-stripping on the doorframe to reduce air leakage.
HVAC (all)	Insulation — Infiltration Control	Lowering the air infiltration rate by caulking small leaks and weather-stripping around window frames, doorframes, power outlets, plumbing, and wall corners can provide significant energy savings. Weather-stripping doors and windows will create a tight seal and further reduce air infiltration.
HVAC (all)	Insulation —Ceiling	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation above ceilings can conserve energy by reducing the heat loss or gain into attics and/or through roofs. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose, loose-fill (blown) fiberglass, and rigid polystyrene.
HVAC (all)	Insulation — Radiant Barrier	Radiant barriers are materials installed to reduce the heat gain in buildings. Radiant barriers are made from materials that are highly reflective and have low emissivity like aluminum. The closer the emissivity is to 0 the better they will perform. Radiant barriers can be placed above the insulation or on the roof rafters.
HVAC (all)	Insulation — Foundation Insulation — Wall Cavity Insulation — Wall Sheathing	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation can conserve energy by reducing heat loss or gain from a building. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose, loose-fill (blown) fiberglass, and rigid polystyrene. Foundation, insulation, wall cavity insulation, and wall sheathing were modeled for new construction / major retrofits only.
Cooling	Roof — High Reflectivity	The color and material of a building structure surface determine the amount of solar radiation absorbed by that surface and subsequently transferred into a building. This is called solar absorptance. Using a roofing material with low solar absorptance or painting the roof a light color reduces the cooling load. This analysis assumes that implementing high reflectivity roofs will decrease the roof's absorptance of solar radiation by 45%.
Cooling	Windows — Reflective Film	Reflective films applied to the window interior help reduce solar gain into the space and thus lower cooling energy use.

End-Use	Equipment/ Measure	Description
HVAC (all)	Windows — High Efficiency / ENERGY STAR	High-efficiency windows, such as those labeled under the ENERGY STAR Program, are designed to reduce energy use and increase occupant comfort. High-efficiency windows reduce the amount of heat transfer through the glazing surface. For example, some windows have a low-E coating, a thin film of metallic oxide coating on the glass surface that allows passage of short-wave solar energy through glass and prevents long-wave energy from escaping. Another example is double-pane glass that reduces conductive and convective heat transfer. Some double-pane windows are gas-filled (usually argon) to further increase the insulating properties of the window.
Water Heating	Water Heater - Electric, High Efficiency	For electric hot water heating, the most common type is a storage heater, which incorporates an electric heating element, storage tank, outer jacket, insulation, and controls in a single unit. Efficient units are characterized by a high recovery or thermal efficiency and low standby losses (the ratio of heat lost per hour to the content of the stored water). Electric instantaneous water heaters are available, but are excluded from this study due to potentially high instantaneous demand concerns.
Water Heating	Water Heater, Heat Pump	An electric heat pump water heater (HPWH) uses a vapor-compression thermodynamic cycle similar to that found in an air-conditioner or refrigerator. Electrical work input allows a heat pump water heater to extract heat from an available source (e.g., air) and reject that heat to a higher temperature sink, in this case, the water in the water heater. Because a HPWH makes use of available ambient heat, the coefficient of performance is greater than one — typically in the range of 2 to 3. These devices are available as an alternative to conventional tank water heaters of 55 gallons or larger. By utilizing the earth as a thermal reservoir, ground source HPWH systems can reach even higher levels of efficiency. The heat pump can be integrated with a traditional water storage tank or installed remote to the storage tank.
Water Heating	Water Heating, Solar	Solar water heating systems can be used in residential buildings that have an appropriate near-south-facing roof or nearby unshaded grounds for installing a collector. Although system types vary, in general these systems use a solar absorber surface within a solar collector or an actual storage tank. Either a heat-transfer fluid or the actual potable water flows through tubes attached to the absorber and transfers heat from it. (Systems with a separate heat-transfer-fluid loop include a heat exchanger that then heats the potable water.) The heated water is stored in a separate preheat tank or a conventional water heater tank. If additional heat is needed, it is provided by a conventional water-heating system.
Water Heating	Convert to Gas	This fuel-switching measure is the replacement of an electric water heater with a gas-fired water heater. This measure will eliminate all electricity consumption and demand due to electric water heating. In this study, it is assumed that this measure can be implemented only in home within 500 feet of a gas main.
Water Heating	Faucet Aerators	Water faucet aerators are threaded screens that attach to existing faucets. They reduce the volume of water coming out of faucets while introducing air into the water stream. This measure provides energy saving by reducing hot water use, as well as water conservation for both hot and cold water.

End-Use	Equipment/ Measure	Description
Water Heating	Pipe Insulation	Insulating hot water pipes decreases energy losses from piping that distributes hot water throughout the building. I also results in quicker delivery of hot water and may allow lower the hot water set point, which saves energy. The most common insulation materials for this purpose are polyethylene and neoprene.
Water Heating	Low-Flow Showerheads	Similar to faucet aerators, low-flow showerheads reduce the consumption of hot water, which in turn decreases water heating energy use.
Water Heating	Tank Blanket	Insulating hot water tanks decreases standby energy losses from the tank. Pre-fitted insulating blankets are readily available.
Water Heating	Thermostat Setback / Timer	These measures use either a programmable thermostat or a timer to adjust the water heater setpoint at times of low usage, typically when a home is unoccupied.
Water Heating	Hot Water Saver	A hot water saver is a plumbing device that attaches to the showerhead and that pauses the flow of water until the water is hot enough for use. The water is re-started by the flip of a switch.
Interior Lighting / Exterior Lighting	Infrared Halogen Lamps	Infrared halogen lamps are designed to be a replacement for standards incandescent lamps. Also referred to as advanced incandescent lamps, these products meet the Energy Independence and Security Act (EISA) lighting standards and are phased in as the baseline technology screw-in lamp technology to reflect the timeline over which the EISA lighting standards take effect.
Interior Lighting / Exterior Lighting	Compact Fluorescent Lamps	Compact fluorescent lamps are designed to be a replacement for standard incandescent lamps and use about 25% of the energy used by standard incandescent lamps to produce the same lumen output. The can use either electronic or magnetic ballasts. Integral compact fluorescent lamps have the ballast integrated into the base of the lamp and have a standard screw-in base that permits installation into existing incandescent fixtures.
Interior Lighting / Exterior Lighting	Solid State Lighting, LEDs (Screw-in and linear)	Light-emitting diode (LED) lighting has seen recent penetration in specific applications such as traffic lights and exit signs. With the potential for extremely high efficiency, LEDs show promise to provide general-use lighting for interior spaces. Current models commercially available have efficacies comparable to CFLs. However, theoretical efficiencies are significantly higher. LED models under development are expected to provide improved efficacies.
Interior Lighting	Fluorescent, T8, Super T8, and T5 Lamps and Electronic Ballasts	T8 fluorescent lamps are smaller in diameter than standard T12 lamps, resulting in greater light output per watt. T8 lamps also operate at a lower current and wattage, which increases the efficiency of the ballast but requires the lamps to be compatible with the ballast. Fluorescent lamp fixtures can include a reflector that increases the light output from the fixture, and thus make it possible to use a fewer number of lamps in each fixture. T5 lamps further increase efficiency by reducing the lamp diameter to 5/8”.
Exterior Lighting	Metal Halide and High Pressure Sodium	These lamps technologies can provide slightly higher efficiencies than CFLs in exterior applications.
Interior Lighting	Occupancy Sensors	Occupancy sensors turn lights off when a space is unoccupied. They are appropriate for areas with intermittent use, such as bathrooms or storage areas.

End-Use	Equipment/ Measure	Description
Exterior Lighting	Photovoltaic Installation	Solar photovoltaic generation may be used to power exterior lighting and thus eliminate all or part of the electrical energy use.
Exterior Lighting	Photosensor Control	Photosensor controls turn exterior lighting on or off based on ambient lighting levels. Compared with manual operation, this can reduce the operation of exterior lighting during daylight hours.
Exterior Lighting	Timeclock Installation	Lighting timers turn exterior lighting on or off based on a preset schedule. Compared with manual operation, this can reduce the operation of exterior lighting during daylight hours.
Appliances	Refrigerator/Freezer, ENERGY STAR or better	Energy-efficient refrigerators/freezers incorporate features such as improved cabinet insulation, more efficient compressors and evaporator fans, defrost controls, mullion heaters, oversized condenser coils, and improved door seals. Further efficiency increases can be obtained by reducing the volume of refrigerated space, or adding multiple compartments to reduce losses from opening doors.
Appliances	Refrigerator/Freezer — Early Replacement	Refrigerators/freezers currently on the market are significantly more efficient that older units, due to technology improvement and stricter appliance standards. This measure incents homeowners to replace an aging but still working unit with a new, higher-efficiency one.
Appliances	Refrigerator/Freezer — Remove Second Unit	Homeowners may have a second refrigerator or freezer that is not used to full capacity and that, because of its age, is extremely inefficient. This measure incents homeowners to recycle the second unit and thus also eliminates associated electricity use.
Appliances	Dishwasher, ENERGY STAR or better	ENERGY STAR labeled dishwashers save by using both improved technology for the primary wash cycle, and by using less hot water. Construction includes more effective washing action, energy-efficient motors, and other advanced technology such as sensors that determine the length of the wash cycle and the temperature of the water necessary to clean the dishes.
Appliances	Clothes Washer, ENERGY STAR or better	ENERGY STAR labeled clothes washers use superior designs that require less water. Sensors match the hot water needs to the size and soil level of the load, preventing energy waste. Further energy and water savings can be achieved through advanced technologies such as inverter-drive or combination washer-dryer units.
Appliances	Clothes Dryer – Electric, High Efficiency	An energy-efficient clothes dryer has a moisture-sensing device to terminate the drying cycle rather than using a timer, and an energy-efficient motor is used for spinning the dryer tub. Application of a heat pump cycle for extracting the moisture from clothes leads to additional energy savings.
Appliances	Range and Oven – Electric, High Efficiency	These products have additional insulation in the oven compartment and tighter-fitting oven door gaskets and hinges to save energy. Conventional ovens must first heat up about 35 pounds of steel and a large amount of air before they heat up the food. Tests indicate that only 6% of the energy output of a typical oven is actually absorbed by the food.
Electronics	Color TVs and Home Electronics, ENERGY STAR or better	In the average home, electronic products consumed significant energy, even when they are turn off, to maintain features like clocks, remote control, and channel/station memory. ENERGY STAR labeled consumer electronics can drastically reduce consumption during standby mode, in addition to saving energy through advanced power management during normal use.

End-Use	Equipment/ Measure	Description
Electronics	Personal Computers, ENERGY STAR or better	Improved power management can significantly reduce the annual energy consumption of PCs and monitors in both standby and normal operation. ENERGY STAR and Climate Savers labeled products provide increasing level of energy efficiency.
Electronics	Reduce Standby Wattage	Representing a growing portion of home electricity consumption, plug-in electronics such as set-top boxes, DVD players, gaming systems, digital video recorders, and even battery chargers for mobile phones and laptop computers are often designed to supply a set voltage. When the units are not in use, this voltage could be dropped significantly (~1 W) and thereby generate a significant energy savings, assumed for this analysis to be between 4-5% on average. These savings are in excess of the measures already discussed for computers and televisions.
Misc.	Furnace Fans, Electronically Commutating Motor	In homes heated by a furnace, there is still substantial energy use by the fan responsible for moving the hot air throughout the ductwork. Application of an Electronically Commutating Motor (ECM) ensures that motor speed matches the heating requirements of the system and saves energy when compared to a continuously operating standard motor.
Miscellaneous	Pool Pump	High-efficiency motors and two-speed pumps provide improved energy efficiency for this load.
Miscellaneous	Pool Pump Timer	A pool pump timer allows the pump to turn off automatically, eliminating the wasted energy associated with unnecessary pumping.
Miscellaneous	Trees for Shading	Planting of shade trees, suitable to the local climate, can reduce the need for air conditioning and provide non-energy benefits as well.
Cooling / Space Heating / Interior Lighting	Home Energy Management System	A centralized home energy management system can be used to control and schedule cooling, space heating, lighting, and possibly appliances as well. Some designs also allow the homeowner to remotely control loads via the Internet.
Cooling / Space Heating	Solar Photovoltaic	Adding a solar photovoltaic (PV) system to the home can meet a portion of the home's electric load and in some cases nearly the entire load, depending on the PV system size, orientation, solar resource, and other factors. For this analysis, we assume a grid-connected system and apply the electricity savings to the home's cooling and space heating loads.
Cooling / Space Heating / Interior Lighting	Advanced New Construction Designs	Advanced new construction designs use an integrated approach to the design of new buildings to account for the interaction of building systems. Typically, designs specify the building orientation, building shell, building mechanical systems, and controls strategies with the goal of optimizing building energy efficiency and comfort. Options that may be evaluated and incorporated include passive solar strategies, increased thermal mass, natural ventilation, daylighting strategies, and shading strategies, This measure was modeled for new construction only.
Cooling / Space Heating / Interior Lighting	ENERGY STAR Homes	This measure was modeled for new construction only.
Cooling / Space Heating / Interior Lighting	Energy-Efficient Manufactured Homes	This measure was modeled for new construction only.

Table C-2 Energy Efficiency Equipment Data — Single Family, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	134	$278	15	0.41
Cooling	Central AC	SEER 15 (CEE Tier 2)	184	$556	15	0.28
Cooling	Central AC	SEER 16 (CEE Tier 3)	226	$834	15	0.23
Cooling	Central AC	Ductless Mini-Split System	405	$4,399	20	0.14
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	62	$104	10	0.33
Cooling	Room AC	EER 11	73	$282	10	0.15
Cooling	Room AC	EER 11.5	99	$626	10	0.09
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	492	$1,000	15	0.43
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	675	$2,318	15	0.26
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	829	$3,505	15	0.21
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	1,486	$5,655	20	0.45
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	516	$1,500	14	0.28
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	173	$41	15	5.79
Water Heating	Water Heater	Geothermal Heat Pump	2,269	$6,586	15	0.47
Water Heating	Water Heater	Solar	2,493	$5,653	15	0.60
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	14.44
Interior Lighting*	Screw-in	LED	40	$80	12	0.90
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.16
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.71
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.14
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Interior Lighting*	Pin-based	LED	14	$17	10	0.77
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	22.43
Exterior Lighting*	Screw-in	LED	37	$79	12	0.89
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	7.40
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	4.03
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	9.14
Exterior Lighting*	High Intensity/Flood	LED	66	$79	10	0.82
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	45	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	88	$487	10	0.16
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	98	$48	13	2.39
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	41	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	53	$1	9	31.05
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	108	$89	13	1.28
Appliances	Refrigerator	Baseline (2014)	144	$0	13	-
Appliances	Refrigerator	Energy Star (2014)	230	$89	13	-

* Savings and costs are per unit, e.g., per lamp.

Table C-2 Energy Efficiency Equipment Data — Single Family, Existing Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	114	$32	11	3.03
Appliances	Freezer	Baseline (2014)	152	$0	11	-
Appliances	Freezer	Energy Star (2014)	243	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	111	$89	13	1.31
Appliances	Second Refrigerator	Baseline (2014)	148	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	237	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	9	$2	13	7.00
Appliances	Stove	Induction (High Efficiency)	46	$1,432	13	0.05
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	108	$1	5	35.63
Electronics	Personal Computers	Climate Savers	154	$175	5	0.35
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	87	$1	11	133.21
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	138	$85	15	1.96
Miscellaneous	Pool Pump	Two-Speed Pump	551	$579	15	1.15
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	127	$1	18	281.65
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-3 Energy Efficiency Equipment Data — Multi Family, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost (/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	67	$93	15	0.62
Cooling	Central AC	SEER 15 (CEE Tier 2)	133	$185	15	0.61
Cooling	Central AC	SEER 16 (CEE Tier 3)	187	$278	15	0.57
Cooling	Central AC	Ductless Mini-Split System	245	$2,012	20	0.19
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	32	$52	10	0.35
Cooling	Room AC	EER 11	38	$141	10	0.15
Cooling	Room AC	EER 11.5	52	$313	10	0.09
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	238	$1,246	15	0.17
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	467	$2,315	15	0.18
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	659	$3,277	15	0.18
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	862	$5,022	20	0.27
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	248	$1,500	14	0.14
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	107	$41	15	3.61
Water Heating	Water Heater	Solar	1,539	$5,653	15	0.38
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	10.47
Interior Lighting*	Screw-in	LED	40	$80	12	0.65
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.16
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.71
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.14
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Interior Lighting*	Pin-based	LED	14	$17	10	0.77
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	32.52
Exterior Lighting*	Screw-in	LED	37	$79	12	1.29
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	7.40
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	4.03
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	9.14
Exterior Lighting*	High Intensity/Flood	LED	66	$79	10	0.82
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	23	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	44	$487	10	0.08
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	93	$48	13	2.28
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	15	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	19	$1	9	11.14
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	92	$89	13	1.09
Appliances	Refrigerator	Baseline (2014)	123	$0	13	-
Appliances	Refrigerator	Energy Star (2014)	196	$89	13	-

* Savings and costs are per unit, e.g., per lamp.

Table C-3 Energy Efficiency Equipment Data—Multi Family, Existing Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	108	$32	11	2.88
Appliances	Freezer	Baseline (2014)	145	$0	11	-
Appliances	Freezer	Energy Star (2014)	231	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	93	$89	13	1.11
Appliances	Second Refrigerator	Baseline (2014)	124	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	199	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	4	$2	13	2.99
Appliances	Stove	Induction (High Efficiency)	20	$1,432	13	0.02
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	86	$1	5	29.28
Electronics	Personal Computers	Climate Savers	123	$175	5	0.29
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	43	$1	11	67.65
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	-	$85	15	-
Miscellaneous	Pool Pump	Two-Speed Pump	-	$579	15	-
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	10	$1	18	21.87
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-4 Energy Efficiency Equipment Data — Mobile Home, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost (/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	80	$278	15	0.24
Cooling	Central AC	SEER 15 (CEE Tier 2)	110	$556	15	0.17
Cooling	Central AC	SEER 16 (CEE Tier 3)	134	$834	15	0.14
Cooling	Central AC	Ductless Mini-Split System	241	$4,399	20	0.08
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	37	$52	10	0.40
Cooling	Room AC	EER 11	44	$141	10	0.17
Cooling	Room AC	EER 11.5	59	$313	10	0.11
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	282	$1,246	15	0.20
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	387	$2,315	15	0.15
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	475	$3,277	15	0.13
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	852	$5,022	20	0.27
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	295	$1,500	14	0.16
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	88	$41	15	2.95
Water Heating	Water Heater	Solar	1,271	$5,653	15	0.31
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	13.00
Interior Lighting*	Screw-in	LED	40	$80	12	0.81
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.04
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.64
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.13
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Interior Lighting*	Pin-based	LED	14	$17	10	0.70
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	20.19
Exterior Lighting*	Screw-in	LED	37	$79	12	0.80
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	6.66
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	3.63
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	8.23
Exterior Lighting*	High Intensity/Flood	LED	66	$79	10	0.74
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	46	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	89	$487	10	0.16
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	99	$48	13	2.43
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	41	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	54	$1	9	31.57
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	110	$89	13	1.30
Appliances	Refrigerator	Baseline (2014)	146	$0	13	-
Appliances	Refrigerator	Energy Star (2014)	234	$89	13	-

* Savings and costs are per unit, e.g., per lamp

Table C-4 Energy Efficiency Equipment Data — Mobile Home, Existing Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	116	$32	11	3.08
Appliances	Freezer	Baseline (2014)	155	$0	11	-
Appliances	Freezer	Energy Star (2014)	248	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	113	$89	13	1.34
Appliances	Second Refrigerator	Baseline (2014)	150	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	241	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	8	$2	13	6.30
Appliances	Stove	Induction (High Efficiency)	41	$1,432	13	0.04
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	101	$1	5	33.39
Electronics	Personal Computers	Climate Savers	144	$175	5	0.33
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	87	$1	11	133.21
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	138	$85	15	1.96
Miscellaneous	Pool Pump	Two-Speed Pump	551	$579	15	1.15
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	127	$1	18	281.65
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-5 Energy Efficiency Equipment Data — Limited Income, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost (/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	76	$185	15	0.35
Cooling	Central AC	SEER 15 (CEE Tier 2)	104	$370	15	0.24
Cooling	Central AC	SEER 16 (CEE Tier 3)	127	$556	15	0.19
Cooling	Central AC	Ductless Mini-Split System	229	$2,394	20	0.15
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	65	$104	10	0.35
Cooling	Room AC	EER 11	77	$282	10	0.15
Cooling	Room AC	EER 11.5	104	$626	10	0.09
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	192	$1,246	15	0.13
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	263	$2,315	15	0.10
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	323	$3,277	15	0.09
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	579	$5,022	20	0.18
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	201	$1,500	14	0.11
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	116	$41	15	3.94
Water Heating	Water Heater	Solar	1,679	$5,653	15	0.41
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	13.85
Interior Lighting*	Screw-in	LED	40	$80	12	0.86
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.16
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.71
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.14
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Interior Lighting*	Pin-based	LED	14	$17	10	0.77
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	32.52
Exterior Lighting*	Screw-in	LED	37	$79	12	1.29
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	7.40
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	4.03
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	9.14
Exterior Lighting*	High Intensity/Flood	LED	66	$79	10	0.82
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	20	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	38	$487	10	0.07
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	104	$48	13	2.56
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	12	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	15	$1	9	9.07
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	92	$89	13	1.09
Appliances	Refrigerator	Baseline (2014)	123	$0	13	-
Appliances	Refrigerator	Energy Star (2014)	196	$89	13	-

* Savings and costs are per unit, e.g., per lamp

Table C-5 Energy Efficiency Equipment Data — Limited Income, Existing Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	108	$32	11	2.88
Appliances	Freezer	Baseline (2014)	145	$0	11	-
Appliances	Freezer	Energy Star (2014)	231	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	93	$89	13	1.11
Appliances	Second Refrigerator	Baseline (2014)	124	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	199	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	5	$2	13	3.59
Appliances	Stove	Induction (High Efficiency)	24	$1,432	13	0.02
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	89	$1	5	30.10
Electronics	Personal Computers	Climate Savers	127	$175	5	0.29
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	49	$1	11	77.80
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	57	$85	15	0.83
Miscellaneous	Pool Pump	Two-Speed Pump	226	$579	15	0.49
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	54	$1	18	123.18
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-6 Energy Efficiency Equipment Data —Single Family, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost (/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	180	$278	15	0.55
Cooling	Central AC	SEER 15 (CEE Tier 2)	240	$556	15	0.36
Cooling	Central AC	SEER 16 (CEE Tier 3)	290	$834	15	0.29
Cooling	Central AC	Ductless Mini-Split System	543	$4,399	20	0.19
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	76	$104	10	0.41
Cooling	Room AC	EER 11	90	$282	10	0.18
Cooling	Room AC	EER 11.5	122	$626	10	0.11
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	588	$1,000	15	0.51
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	783	$2,318	15	0.30
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	946	$3,505	15	0.24
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	1,775	$5,655	20	0.54
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	630	$1,500	14	0.35
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	219	$41	15	7.35
Water Heating	Water Heater	Geothermal Heat Pump	2,878	$6,586	15	0.60
Interior Lighting*	Water Heater	Solar	3,163	$5,653	15	0.77
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	14.05
Interior Lighting*	Screw-in	LED	40	$80	12	0.87
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.16
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.71
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.14
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Exterior Lighting*	Pin-based	LED	14	$17	10	0.77
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	21.82
Exterior Lighting*	Screw-in	LED	37	$79	12	0.87
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	7.40
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	4.03
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	9.14
Exterior Lighting	High Intensity/Flood	LED	66	$79	10	0.82
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	58	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	112	$487	10	0.21
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	117	$48	13	2.86
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	47	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	62	$1	9	36.25
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	102	$89	13	1.20
Appliances	Refrigerator	Baseline (2014)	135	$0	13	-

* Savings and costs are per unit, e.g., per lamp

Table C-6 Energy Efficiency Equipment Data —Single Family, New Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Refrigerator	Energy Star (2014)	217	$89	13	-
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	116	$32	11	3.08
Appliances	Freezer	Baseline (2014)	155	$0	11	-
Appliances	Freezer	Energy Star (2014)	248	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	116	$89	13	1.37
Appliances	Second Refrigerator	Baseline (2014)	154	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	247	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	11	$2	13	8.51
Appliances	Stove	Induction (High Efficiency)	56	$1,432	13	0.06
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	111	$1	5	36.63
Electronics	Personal Computers	Climate Savers	158	$175	5	0.36
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	96	$1	11	148.53
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	156	$85	15	2.22
Miscellaneous	Pool Pump	Two-Speed Pump	623	$579	15	1.30
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	155	$1	18	345.87
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-7 Energy Efficiency Equipment Data — Multi Family, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost (/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	85	$93	15	0.78
Cooling	Central AC	SEER 15 (CEE Tier 2)	166	$185	15	0.76
Cooling	Central AC	SEER 16 (CEE Tier 3)	234	$278	15	0.71
Cooling	Central AC	Ductless Mini-Split System	308	$2,012	20	0.24
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	37	$52	10	0.39
Cooling	Room AC	EER 11	43	$141	10	0.17
Cooling	Room AC	EER 11.5	59	$313	10	0.10
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	292	$1,246	15	0.21
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	571	$2,315	15	0.22
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	804	$3,277	15	0.21
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	1,058	$5,022	20	0.33
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	282	$1,500	14	0.15
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	124	$41	15	4.19
Water Heating	Water Heater	Solar	1,786	$5,653	15	0.44
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	10.18
Interior Lighting*	Screw-in	LED	40	$80	12	0.63
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.16
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.71
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.14
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Interior Lighting*	Pin-based	LED	14	$17	10	0.77
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	31.63
Exterior Lighting*	Screw-in	LED	37	$79	12	1.26
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	7.40
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	4.03
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	9.14
Exterior Lighting*	High Intensity/Flood	LED	66	$79	10	0.82
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	26	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	51	$487	10	0.09
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	105	$48	13	2.56
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	16	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	21	$1	9	12.38
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	108	$89	13	1.28
Appliances	Refrigerator	Baseline (2014)	144	$0	13	-
Appliances	Refrigerator	Energy Star (2014)	230	$89	13	-

* Savings and costs are per unit, e.g., per lamp

Table C-7 Energy Efficiency Equipment Data — Multi Family, New Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	115	$32	11	3.06
Appliances	Freezer	Baseline (2014)	154	$0	11	-
Appliances	Freezer	Energy Star (2014)	246	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	103	$89	13	1.21
Appliances	Second Refrigerator	Baseline (2014)	137	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	219	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	4	$2	13	3.31
Appliances	Stove	Induction (High Efficiency)	22	$1,432	13	0.02
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	88	$1	5	29.69
Electronics	Personal Computers	Climate Savers	125	$175	5	0.29
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	45	$1	11	71.54
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	-	$85	15	-
Miscellaneous	Pool Pump	Two-Speed Pump	-	$579	15	-
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	11	$1	18	24.36
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-8 Energy Efficiency Equipment Data — Mobile Home, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost (/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	100	$278	15	0.30
Cooling	Central AC	SEER 15 (CEE Tier 2)	133	$556	15	0.20
Cooling	Central AC	SEER 16 (CEE Tier 3)	161	$834	15	0.16
Cooling	Central AC	Ductless Mini-Split System	301	$4,399	20	0.11
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	42	$52	10	0.45
Cooling	Room AC	EER 11	50	$141	10	0.20
Cooling	Room AC	EER 11.5	67	$313	10	0.12
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	313	$1,246	15	0.22
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	417	$2,315	15	0.16
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	505	$3,277	15	0.13
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	946	$5,022	20	0.30
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	336	$1,500	14	0.18
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	102	$41	15	3.42
Water Heating	Water Heater	Solar	1,474	$5,653	15	0.36
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	12.64
Interior Lighting*	Screw-in	LED	40	$80	12	0.79
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.04
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.64
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.13
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Interior Lighting*	Pin-based	LED	14	$17	10	0.70
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	19.63
Exterior Lighting*	Screw-in	LED	37	$79	12	0.78
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	6.66
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	3.63
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	8.23
Exterior Lighting*	High Intensity/Flood	LED	66	$79	10	0.74
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	54	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	104	$487	10	0.19
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	111	$48	13	2.73
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	46	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	60	$1	9	35.11
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	129	$89	13	1.52
Appliances	Refrigerator	Baseline (2014)	172	$0	13	-
Appliances	Refrigerator	Energy Star (2014)	275	$89	13	-

* Savings and costs are per unit, e.g., per lamp

Table C-8 Energy Efficiency Equipment Data — Mobile Home, New Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	124	$32	11	3.28
Appliances	Freezer	Baseline (2014)	165	$0	11	-
Appliances	Freezer	Energy Star (2014)	263	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	124	$89	13	1.47
Appliances	Second Refrigerator	Baseline (2014)	165	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	264	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	9	$2	13	6.98
Appliances	Stove	Induction (High Efficiency)	46	$1,432	13	0.05
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	103	$1	5	33.86
Electronics	Personal Computers	Climate Savers	146	$175	5	0.33
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	91	$1	11	140.87
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	154	$85	15	2.20
Miscellaneous	Pool Pump	Two-Speed Pump	617	$579	15	1.29
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	141	$1	18	313.76
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-9 Energy Efficiency Equipment Data — Limited Income, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost (/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	95	$185	15	0.43
Cooling	Central AC	SEER 15 (CEE Tier 2)	126	$370	15	0.29
Cooling	Central AC	SEER 16 (CEE Tier 3)	152	$556	15	0.23
Cooling	Central AC	Ductless Mini-Split System	286	$2,394	20	0.18
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	74	$104	10	0.40
Cooling	Room AC	EER 11	87	$282	10	0.17
Cooling	Room AC	EER 11.5	118	$626	10	0.11
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	213	$1,246	15	0.15
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	284	$2,315	15	0.11
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	343	$3,277	15	0.09
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	643	$5,022	20	0.20
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	228	$1,500	14	0.13
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	135	$41	15	4.57
Water Heating	Water Heater	Solar	1,949	$5,653	15	0.48
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	13.47
Interior Lighting*	Screw-in	LED	40	$80	12	0.84
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.16
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.71
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.14
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Interior Lighting*	Pin-based	LED	14	$17	10	0.77
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	31.63
Exterior Lighting*	Screw-in	LED	37	$79	12	1.26
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	7.40
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	4.03
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	9.14
Exterior Lighting*	High Intensity/Flood	LED	66	$79	10	0.82
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	23	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	44	$487	10	0.08
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	117	$48	13	2.87
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	13	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	17	$1	9	10.08
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	108	$89	13	1.28
Appliances	Refrigerator	Baseline (2014)	144	$0	13	-
Appliances	Refrigerator	Energy Star (2014)	230	$89	13	-

* Savings and costs are per unit, e.g., per lamp

Table C-9 Energy Efficiency Equipment Data — Limited Income, New Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	115	$32	11	3.06
Appliances	Freezer	Baseline (2014)	154	$0	11	-
Appliances	Freezer	Energy Star (2014)	246	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	103	$89	13	1.21
Appliances	Second Refrigerator	Baseline (2014)	137	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	219	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	5	$2	13	3.98
Appliances	Stove	Induction (High Efficiency)	26	$1,432	13	0.03
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	90	$1	5	30.52
Electronics	Personal Computers	Climate Savers	129	$175	5	0.30
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	52	$1	11	82.28
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	63	$85	15	0.93
Miscellaneous	Pool Pump	Two-Speed Pump	254	$579	15	0.54
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	60	$1	18	137.23
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-10 Energy-Efficiency Measure Data—Single Family, Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Early Replacement	Cooling	10%	0%	0%	8%	$2,895	15	0.05
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	41%	100%	$125	4	0.70
Room AC - Removal of Second Unit	Cooling	100%	0%	0%	25%	$75	5	2.45
Attic Fan - Installation	Cooling	1%	0%	12%	23%	$116	18	0.08
Attic Fan - Photovoltaic - Installation	Cooling	1%	0%	13%	45%	$350	19	0.06
Ceiling Fan - Installation	Cooling	11%	0%	51%	75%	$160	15	0.81
Whole-House Fan - Installation	Cooling	9%	0%	7%	19%	$200	18	0.62
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$125	4	1.49
Insulation - Ducting	Cooling	3%	0%	15%	75%	$500	18	0.78
Insulation - Ducting	Space Heating	4%	4%	15%	75%	$500	18	0.78
Repair and Sealing - Ducting	Cooling	10%	0%	12%	50%	$500	18	2.08
Repair and Sealing - Ducting	Space Heating	15%	15%	12%	50%	$500	18	2.08
Thermostat - Clock/Programmable	Cooling	8%	0%	55%	56%	$114	11	2.89
Thermostat - Clock/Programmable	Space Heating	9%	5%	55%	56%	$114	11	2.89
Doors - Storm and Thermal	Cooling	1%	0%	38%	75%	$320	12	0.25
Doors - Storm and Thermal	Space Heating	2%	2%	38%	75%	$320	12	0.25
Insulation - Infiltration Control	Cooling	3%	0%	46%	90%	$266	12	1.72
Insulation - Infiltration Control	Space Heating	10%	10%	46%	90%	$266	12	1.72
Insulation - Ceiling	Cooling	3%	0%	68%	72%	$594	20	1.11
Insulation - Ceiling	Space Heating	10%	5%	68%	72%	$594	20	1.11
Insulation - Radiant Barrier	Cooling	5%	0%	5%	90%	$923	12	0.41
Insulation - Radiant Barrier	Space Heating	2%	1%	5%	90%	$923	12	0.41
Roofs - High Reflectivity	Cooling	6%	0%	5%	10%	$1,550	15	0.05
Windows - Reflective Film	Cooling	7%	0%	5%	45%	$267	10	0.21
Windows - High Efficiency/Energy Star	Cooling	12%	0%	83%	90%	$7,500	25	0.38
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	83%	90%	$7,500	25	0.38
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	24%	25%	$750	15	0.10
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	0%	10%	80%	$2,975	15	0.03
Exterior Lighting - Photosensor Control	Exterior Lighting	15%	0%	24%	45%	$90	8	0.21
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	10%	45%	$72	8	0.35
Water Heater - Faucet Aerators	Water Heating	4%	2%	53%	90%	$24	25	8.78
Water Heater - Pipe Insulation	Water Heating	6%	3%	17%	38%	$180	13	1.05
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	75%	80%	$96	10	4.56
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	54%	75%	$15	10	15.53
Water Heater - Thermostat Setback	Water Heating	9%	5%	17%	75%	$40	5	2.99
Water Heater - Timer	Water Heating	8%	4%	17%	40%	$194	10	1.06
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	3.28
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	1.76
Refrigerator - Early Replacement	Appliances	15%	15%	0%	20%	$1,203	13	0.08
Refrigerator - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	3.99
Freezer - Early Replacement	Appliances	15%	15%	0%	20%	$484	11	0.18
Freezer - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	3.76
Home Energy Management System	Cooling	10%	0%	20%	38%	$300	20	2.46
Home Energy Management System	Space Heating	10%	5%	20%	38%	$300	20	2.46
Home Energy Management System	Interior Lighting	10%	5%	20%	38%	$300	20	2.46
Photovoltaics	Cooling	50%	0%	0%	48%	$17,000	15	0.10
Photovoltaics	Space Heating	25%	25%	0%	48%	$17,000	15	0.10
Pool - Pump Timer	Miscellaneous	60%	0%	59%	90%	$160	15	4.92
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.43
Water Heater - Heat Pump	Water Heating	30%	15%	0%	25%	$1,500	15	0.75
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$3,675	15	1.22
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$13,769	15	0.95

Note: Costs are per household.

Table C-11 Energy-Efficiency Measure Data — Multi Family, Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Early Replacement	Cooling	10%	0%	0%	8%	$2,895	15	0.02
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	33%	100%	$100	4	0.59
Room AC - Removal of Second Unit	Cooling	100%	0%	0%	25%	$75	5	1.28
Ceiling Fan - Installation	Cooling	11%	0%	32%	75%	$80	15	0.49
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$100	4	1.05
Insulation - Ducting	Cooling	3%	0%	13%	75%	$375	18	1.16
Insulation - Ducting	Space Heating	4%	4%	13%	75%	$375	18	1.16
Repair and Sealing - Ducting	Cooling	4%	0%	12%	50%	$500	18	0.95
Repair and Sealing - Ducting	Space Heating	4%	4%	12%	50%	$500	18	0.95
Thermostat - Clock/Programmable	Cooling	8%	0%	27%	68%	$114	11	2.39
Thermostat - Clock/Programmable	Space Heating	6%	3%	27%	68%	$114	11	2.39
Doors - Storm and Thermal	Cooling	1%	0%	17%	75%	$320	12	0.35
Doors - Storm and Thermal	Space Heating	2%	2%	17%	75%	$320	12	0.35
Insulation - Infiltration Control	Cooling	1%	0%	19%	90%	$266	12	2.95
Insulation - Infiltration Control	Space Heating	13%	13%	19%	90%	$266	12	2.95
Insulation - Ceiling	Cooling	13%	0%	27%	30%	$215	20	5.67
Insulation - Ceiling	Space Heating	13%	13%	27%	30%	$215	20	5.67
Insulation - Radiant Barrier	Cooling	4%	0%	5%	90%	$923	12	0.52
Insulation - Radiant Barrier	Space Heating	4%	4%	5%	90%	$923	12	0.52
Roofs - High Reflectivity	Cooling	13%	0%	3%	10%	$1,550	15	0.03
Windows - Reflective Film	Cooling	7%	0%	5%	45%	$167	10	0.10
Windows - High Efficiency/Energy Star	Cooling	13%	0%	70%	90%	$2,500	25	0.56
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	70%	90%	$2,500	25	0.56
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	6%	10%	$256	15	0.14
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	0%	10%	50%	$2,975	15	0.00
Exterior Lighting - Photosensor Control	Exterior Lighting	20%	0%	7%	45%	$90	8	0.04
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	6%	45%	$72	8	0.05
Water Heater - Faucet Aerators	Water Heating	5%	2%	43%	90%	$24	25	6.63
Water Heater - Pipe Insulation	Water Heating	6%	3%	6%	38%	$180	13	0.65
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	71%	75%	$96	10	2.84
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	54%	75%	$15	10	9.66
Water Heater - Thermostat Setback	Water Heating	9%	5%	17%	75%	$40	5	1.86
Water Heater - Timer	Water Heating	8%	4%	5%	40%	$194	10	0.66
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	2.04
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	0.58
Refrigerator - Early Replacement	Appliances	15%	15%	0%	20%	$1,203	13	0.07
Refrigerator - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	3.36
Freezer - Early Replacement	Appliances	15%	15%	0%	20%	$484	11	0.17
Freezer - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	3.57
Home Energy Management System	Cooling	10%	0%	5%	13%	$300	20	2.46
Home Energy Management System	Space Heating	10%	5%	5%	13%	$300	20	2.46
Home Energy Management System	Interior Lighting	10%	5%	5%	13%	$300	20	2.46
Photovoltaics	Cooling	50%	0%	0%	12%	$8,500	15	0.22
Photovoltaics	Space Heating	25%	25%	0%	12%	$8,500	15	0.22
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.13
Water Heater - Heat Pump	Water Heating	30%	15%	0%	10%	$1,500	15	0.47
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$2,845	15	0.99
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$10,946	15	0.72

Note: Costs are per household.

Table C-12 Energy-Efficiency Measure Data — Mobile Home, Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Early Replacement	Cooling	10%	0%	0%	8%	$2,895	15	0.03
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	59%	100%	$100	4	0.63
Room AC - Removal of Second Unit	Cooling	100%	0%	0%	25%	$75	5	1.46
Ceiling Fan - Installation	Cooling	11%	0%	60%	75%	$80	15	0.79
Whole-House Fan - Installation	Cooling	9%	0%	5%	19%	$150	18	0.41
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$125	4	1.02
Insulation - Ducting	Cooling	3%	0%	15%	75%	$375	18	0.94
Insulation - Ducting	Space Heating	4%	4%	15%	75%	$375	18	0.94
Repair and Sealing - Ducting	Cooling	10%	0%	12%	50%	$500	18	2.08
Repair and Sealing - Ducting	Space Heating	15%	15%	12%	50%	$500	18	2.08
Thermostat - Clock/Programmable	Cooling	8%	0%	51%	56%	$114	11	2.78
Thermostat - Clock/Programmable	Space Heating	9%	5%	51%	56%	$114	11	2.78
Doors - Storm and Thermal	Cooling	1%	0%	38%	75%	$320	12	0.25
Doors - Storm and Thermal	Space Heating	2%	2%	38%	75%	$320	12	0.25
Insulation - Infiltration Control	Cooling	3%	0%	46%	90%	$266	12	1.80
Insulation - Infiltration Control	Space Heating	10%	10%	46%	90%	$266	12	1.80
Insulation - Ceiling	Cooling	3%	0%	79%	81%	$707	20	1.00
Insulation - Ceiling	Space Heating	10%	5%	79%	81%	$707	20	1.00
Insulation - Radiant Barrier	Cooling	2%	0%	5%	90%	$923	12	0.35
Insulation - Radiant Barrier	Space Heating	1%	1%	5%	90%	$923	12	0.35
Roofs - High Reflectivity	Cooling	6%	0%	5%	10%	$1,550	15	0.02
Windows - Reflective Film	Cooling	7%	0%	5%	45%	$167	10	0.16
Windows - High Efficiency/Energy Star	Cooling	12%	0%	47%	90%	$7,500	25	0.37
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	47%	90%	$7,500	25	0.37
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	67%	72%	$750	15	0.09
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	0%	10%	80%	$2,975	15	0.03
Exterior Lighting - Photosensor Control	Exterior Lighting	15%	0%	23%	45%	$90	8	0.19
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	10%	45%	$72	8	0.32
Water Heater - Faucet Aerators	Water Heating	4%	2%	79%	90%	$24	25	4.47
Water Heater - Pipe Insulation	Water Heating	6%	3%	17%	38%	$180	13	0.53
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	92%	95%	$96	10	2.32
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	54%	75%	$15	10	7.91
Water Heater - Thermostat Setback	Water Heating	9%	5%	17%	75%	$40	5	1.52
Water Heater - Timer	Water Heating	8%	4%	17%	40%	$194	10	0.54
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	1.67
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	1.65
Refrigerator - Early Replacement	Appliances	15%	15%	0%	20%	$1,203	13	0.08
Refrigerator - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	4.06
Freezer - Early Replacement	Appliances	15%	15%	0%	20%	$484	11	0.18
Freezer - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	3.82
Home Energy Management System	Cooling	10%	0%	20%	38%	$300	20	2.28
Home Energy Management System	Space Heating	10%	5%	20%	38%	$300	20	2.28
Home Energy Management System	Interior Lighting	10%	5%	20%	38%	$300	20	2.28
Photovoltaics	Cooling	50%	0%	0%	48%	$17,000	15	0.09
Photovoltaics	Space Heating	25%	25%	0%	48%	$17,000	15	0.09
Pool - Pump Timer	Miscellaneous	60%	0%	50%	90%	$160	15	4.92
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.21
Water Heater - Heat Pump	Water Heating	30%	15%	0%	10%	$1,500	15	0.38
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$2,616	15	0.88
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$11,135	15	0.62

Note: Costs are per household.

Table C-13 Energy-Efficiency Measure Data — Limited Income, Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Early Replacement	Cooling	10%	0%	0%	8%	$2,895	15	0.03
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	25%	100%	$100	4	0.61
Room AC - Removal of Second Unit	Cooling	100%	0%	0%	25%	$75	5	2.56
Attic Fan - Installation	Cooling	1%	0%	3%	23%	$116	18	0.05
Attic Fan - Photovoltaic - Installation	Cooling	1%	0%	2%	11%	$350	19	0.03
Ceiling Fan - Installation	Cooling	11%	0%	41%	75%	$80	15	0.89
Whole-House Fan - Installation	Cooling	9%	0%	5%	19%	$150	18	0.46
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$125	4	0.82
Insulation - Ducting	Cooling	3%	0%	13%	75%	$395	18	0.90
Insulation - Ducting	Space Heating	4%	4%	13%	75%	$395	18	0.90
Repair and Sealing - Ducting	Cooling	10%	0%	12%	50%	$500	18	2.07
Repair and Sealing - Ducting	Space Heating	15%	15%	12%	50%	$500	18	2.07
Thermostat - Clock/Programmable	Cooling	8%	0%	27%	68%	$114	11	2.63
Thermostat - Clock/Programmable	Space Heating	9%	5%	27%	68%	$114	11	2.63
Doors - Storm and Thermal	Cooling	1%	0%	17%	75%	$320	12	0.25
Doors - Storm and Thermal	Space Heating	2%	2%	17%	75%	$320	12	0.25
Insulation - Infiltration Control	Cooling	3%	0%	19%	90%	$266	12	1.78
Insulation - Infiltration Control	Space Heating	10%	10%	19%	90%	$266	12	1.78
Insulation - Ceiling	Cooling	3%	0%	36%	41%	$215	20	2.44
Insulation - Ceiling	Space Heating	10%	5%	36%	41%	$215	20	2.44
Insulation - Radiant Barrier	Cooling	2%	0%	5%	90%	$923	12	0.35
Insulation - Radiant Barrier	Space Heating	1%	1%	5%	90%	$923	12	0.35
Roofs - High Reflectivity	Cooling	6%	0%	3%	10%	$1,550	15	0.03
Windows - Reflective Film	Cooling	7%	0%	5%	45%	$167	10	0.18
Windows - High Efficiency/Energy Star	Cooling	12%	0%	68%	90%	$2,500	25	0.51
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	68%	90%	$2,500	25	0.51
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	8%	10%	$256	15	0.16
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	50%	10%	50%	$2,975	15	0.01
Exterior Lighting - Photosensor Control	Exterior Lighting	15%	0%	8%	45%	$90	8	0.06
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	6%	45%	$72	8	0.10
Water Heater - Faucet Aerators	Water Heating	4%	2%	46%	90%	$24	25	5.95
Water Heater - Pipe Insulation	Water Heating	6%	3%	6%	38%	$180	13	0.71
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	73%	75%	$96	10	3.09
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	54%	75%	$15	10	10.53
Water Heater - Thermostat Setback	Water Heating	9%	5%	17%	75%	$40	5	2.03
Water Heater - Timer	Water Heating	8%	4%	5%	40%	$194	10	0.72
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	2.23
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	0.77
Refrigerator - Early Replacement	Appliances	15%	15%	0%	20%	$1,203	13	0.07
Refrigerator - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	3.36
Freezer - Early Replacement	Appliances	15%	15%	0%	20%	$484	11	0.17
Freezer - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	3.57
Home Energy Management System	Cooling	10%	0%	5%	13%	$300	20	2.00
Home Energy Management System	Space Heating	10%	5%	5%	13%	$300	20	2.00
Home Energy Management System	Interior Lighting	10%	5%	5%	13%	$300	20	2.00
Photovoltaics	Cooling	50%	0%	0%	48%	$8,500	15	0.17
Photovoltaics	Space Heating	25%	25%	0%	48%	$8,500	15	0.17
Pool - Pump Timer	Miscellaneous	60%	0%	50%	90%	$160	15	2.02
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.24
Water Heater - Heat Pump	Water Heating	30%	15%	0%	20%	$1,500	15	0.51
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$2,970	15	1.03
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$10,798	15	0.69

Note: Costs are per household.

Table C-14 Energy-Efficiency Measure Data — Single Family, New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	41%	100%	$125	4	0.78
Attic Fan - Installation	Cooling	1%	0%	13%	23%	$97	18	0.15
Attic Fan - Photovoltaic - Installation	Cooling	1%	0%	4%	11%	$200	19	0.15
Ceiling Fan - Installation	Cooling	10%	0%	53%	75%	$160	15	1.09
Whole-House Fan - Installation	Cooling	9%	0%	4%	19%	$200	18	0.92
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$125	4	1.69
Insulation - Ducting	Cooling	3%	0%	50%	75%	$250	18	1.31
Insulation - Ducting	Space Heating	4%	4%	50%	75%	$250	18	1.31
Thermostat - Clock/Programmable	Cooling	8%	0%	91%	95%	$114	11	2.91
Thermostat - Clock/Programmable	Space Heating	8%	4%	91%	95%	$114	11	2.91
Doors - Storm and Thermal	Cooling	1%	0%	13%	75%	$180	12	0.45
Doors - Storm and Thermal	Space Heating	2%	2%	13%	75%	$180	12	0.45
Insulation - Ceiling	Cooling	3%	0%	68%	71%	$634	20	0.99
Insulation - Ceiling	Space Heating	8%	6%	68%	71%	$634	20	0.99
Insulation - Radiant Barrier	Cooling	2%	0%	25%	90%	$923	12	0.37
Insulation - Radiant Barrier	Space Heating	1%	1%	25%	90%	$923	12	0.37
Insulation - Foundation	Cooling	3%	0%	20%	90%	$358	20	1.35
Insulation - Foundation	Space Heating	6%	6%	20%	90%	$358	20	1.35
Insulation - Wall Cavity	Cooling	2%	0%	20%	90%	$236	20	1.15
Insulation - Wall Cavity	Space Heating	3%	3%	20%	90%	$236	20	1.15
Insulation - Wall Sheathing	Cooling	1%	0%	64%	90%	$300	20	0.89
Insulation - Wall Sheathing	Space Heating	3%	3%	64%	90%	$300	20	0.89
Roofs - High Reflectivity	Cooling	5%	0%	5%	90%	$517	15	0.17
Windows - Reflective Film	Cooling	7%	0%	2%	45%	$267	10	0.31
Windows - High Efficiency/Energy Star	Cooling	12%	0%	100%	100%	$2,200	25	0.62
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	100%	100%	$2,200	25	0.62
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	24%	27%	$500	15	0.16
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	0%	10%	80%	$2,975	15	0.04
Exterior Lighting - Photosensor Control	Exterior Lighting	13%	0%	13%	45%	$90	8	0.19
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	16%	45%	$72	8	0.36
Water Heater - Faucet Aerators	Water Heating	4%	2%	38%	90%	$24	25	11.03
Water Heater - Pipe Insulation	Water Heating	6%	3%	8%	41%	$50	13	4.71
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	90%	95%	$48	10	11.33
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$15	10	19.30
Water Heater - Thermostat Setback	Water Heating	9%	5%	5%	75%	$40	5	3.70
Water Heater - Timer	Water Heating	8%	4%	5%	40%	$194	10	1.31
Water Heater - Drainwater Heat Reocvery	Water Heating	9%	5%	1%	90%	$899	15	0.47
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	4.06
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	1.99
Home Energy Management System	Cooling	10%	0%	20%	68%	$250	20	3.16
Home Energy Management System	Space Heating	10%	5%	20%	68%	$250	20	3.16
Home Energy Management System	Interior Lighting	10%	5%	20%	68%	$250	20	3.16
Photovoltaics	Cooling	50%	0%	1%	48%	$15,800	15	0.12
Photovoltaics	Space Heating	25%	25%	1%	48%	$15,800	15	0.12
Pool - Pump Timer	Miscellaneous	60%	0%	55%	90%	$160	15	5.43
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.64
Advanced New Construction Designs	Cooling	40%	0%	2%	45%	$4,500	18	1.09
Advanced New Construction Designs	Space Heating	40%	40%	2%	45%	$4,500	18	1.09
Advanced New Construction Designs	Interior Lighting	20%	20%	2%	45%	$4,500	18	1.09
Energy Star Homes	Cooling	20%	0%	12%	75%	$5,000	18	0.75
Energy Star Homes	Space Heating	20%	20%	12%	75%	$5,000	18	0.75
Energy Star Homes	Interior Lighting	20%	20%	12%	75%	$5,000	18	0.75
Water Heater - Heat Pump	Water Heating	30%	15%	0%	25%	$1,500	15	0.94
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$3,675	15	1.53
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$13,769	15	1.14

Note: Costs are per household.

Table C-15 Energy-Efficiency Measure Data — Multi Family, New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	33%	100%	$100	4	0.62
Ceiling Fan - Installation	Cooling	10%	0%	18%	75%	$80	15	0.77
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$100	4	1.12
Insulation - Ducting	Cooling	2%	0%	50%	75%	$200	18	1.18
Insulation - Ducting	Space Heating	2%	2%	50%	75%	$200	18	1.18
Thermostat - Clock/Programmable	Cooling	8%	0%	77%	80%	$114	11	2.29
Thermostat - Clock/Programmable	Space Heating	5%	3%	77%	80%	$114	11	2.29
Doors - Storm and Thermal	Cooling	1%	0%	19%	75%	$180	12	0.66
Doors - Storm and Thermal	Space Heating	2%	2%	19%	75%	$180	12	0.66
Insulation - Ceiling	Cooling	12%	0%	27%	48%	$152	20	10.12
Insulation - Ceiling	Space Heating	16%	16%	27%	48%	$152	20	10.12
Insulation - Radiant Barrier	Cooling	2%	0%	5%	90%	$923	12	0.50
Insulation - Radiant Barrier	Space Heating	3%	3%	5%	90%	$923	12	0.50
Insulation - Wall Cavity	Cooling	2%	0%	4%	90%	$63	20	6.14
Insulation - Wall Cavity	Space Heating	4%	4%	4%	90%	$63	20	6.14
Insulation - Wall Sheathing	Cooling	1%	0%	55%	90%	$210	20	1.59
Insulation - Wall Sheathing	Space Heating	3%	3%	55%	90%	$210	20	1.59
Roofs - High Reflectivity	Cooling	8%	0%	0%	90%	$517	15	0.10
Windows - Reflective Film	Cooling	7%	0%	2%	45%	$167	10	0.17
Windows - High Efficiency/Energy Star	Cooling	13%	0%	100%	100%	$2,200	25	0.63
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	100%	100%	$2,200	25	0.63
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	6%	9%	$256	15	0.14
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	0%	10%	50%	$2,975	15	0.01
Exterior Lighting - Photosensor Control	Exterior Lighting	20%	0%	1%	45%	$90	8	0.04
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	11%	45%	$72	8	0.05
Water Heater - Faucet Aerators	Water Heating	5%	2%	11%	90%	$24	25	7.63
Water Heater - Pipe Insulation	Water Heating	6%	3%	0%	41%	$50	13	2.68
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	66%	75%	$48	10	6.45
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$15	10	10.99
Water Heater - Thermostat Setback	Water Heating	9%	5%	5%	75%	$40	5	2.11
Water Heater - Timer	Water Heating	8%	4%	5%	40%	$194	10	0.75
Water Heater - Drainwater Heat Reocvery	Water Heating	9%	5%	1%	90%	$899	15	0.27
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	2.31
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	0.63
Home Energy Management System	Cooling	10%	0%	5%	68%	$250	20	3.19
Home Energy Management System	Space Heating	10%	5%	5%	68%	$250	20	3.19
Home Energy Management System	Interior Lighting	10%	5%	5%	68%	$250	20	3.19
Photovoltaics	Cooling	50%	0%	0%	12%	$7,900	15	0.26
Photovoltaics	Space Heating	25%	25%	0%	12%	$7,900	15	0.26
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.23
Advanced New Construction Designs	Cooling	40%	0%	2%	45%	$2,500	18	1.47
Advanced New Construction Designs	Space Heating	40%	40%	2%	45%	$2,500	18	1.47
Advanced New Construction Designs	Interior Lighting	20%	20%	2%	45%	$2,500	18	1.47
Water Heater - Heat Pump	Water Heating	30%	15%	0%	10%	$1,500	15	0.53
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$2,845	15	1.13
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$10,946	15	0.84

Note: Costs are per household.

Table C-16 Energy-Efficiency Measure Data — Mobile Home, New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	59%	100%	$100	4	0.66
Ceiling Fan - Installation	Cooling	10%	0%	57%	75%	$80	15	0.95
Whole-House Fan - Installation	Cooling	9%	0%	4%	19%	$150	18	0.53
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$125	4	1.09
Insulation - Ducting	Cooling	3%	0%	50%	75%	$200	18	1.59
Insulation - Ducting	Space Heating	4%	4%	50%	75%	$200	18	1.59
Thermostat - Clock/Programmable	Cooling	8%	0%	57%	75%	$114	11	2.77
Thermostat - Clock/Programmable	Space Heating	8%	4%	57%	75%	$114	11	2.77
Doors - Storm and Thermal	Cooling	1%	0%	13%	75%	$180	12	0.49
Doors - Storm and Thermal	Space Heating	2%	2%	13%	75%	$180	12	0.49
Insulation - Ceiling	Cooling	3%	0%	79%	81%	$176	20	3.02
Insulation - Ceiling	Space Heating	8%	6%	79%	81%	$176	20	3.02
Insulation - Radiant Barrier	Cooling	2%	0%	25%	90%	$923	12	0.36
Insulation - Radiant Barrier	Space Heating	1%	1%	25%	90%	$923	12	0.36
Insulation - Wall Cavity	Cooling	2%	0%	20%	90%	$197	20	1.35
Insulation - Wall Cavity	Space Heating	3%	3%	20%	90%	$197	20	1.35
Insulation - Wall Sheathing	Cooling	1%	0%	64%	90%	$300	20	0.96
Insulation - Wall Sheathing	Space Heating	3%	3%	64%	90%	$300	20	0.96
Roofs - High Reflectivity	Cooling	5%	0%	5%	90%	$517	15	0.07
Windows - Reflective Film	Cooling	7%	0%	2%	45%	$167	10	0.21
Windows - High Efficiency/Energy Star	Cooling	12%	0%	85%	90%	$2,200	25	0.57
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	85%	90%	$2,200	25	0.57
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	67%	72%	$500	15	0.14
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	50%	10%	80%	$2,975	15	0.03
Exterior Lighting - Photosensor Control	Exterior Lighting	13%	0%	13%	45%	$90	8	0.17
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	16%	45%	$72	8	0.32
Water Heater - Faucet Aerators	Water Heating	4%	2%	57%	90%	$24	25	5.14
Water Heater - Pipe Insulation	Water Heating	6%	3%	8%	41%	$50	13	2.20
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	92%	95%	$48	10	5.28
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$15	10	9.00
Water Heater - Thermostat Setback	Water Heating	9%	5%	5%	75%	$40	5	1.72
Water Heater - Timer	Water Heating	8%	4%	5%	40%	$194	10	0.61
Water Heater - Drainwater Heat Reocvery	Water Heating	9%	5%	1%	90%	$899	15	0.22
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	1.89
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	1.79
Home Energy Management System	Cooling	10%	0%	20%	68%	$250	20	2.94
Home Energy Management System	Space Heating	10%	5%	20%	68%	$250	20	2.94
Home Energy Management System	Interior Lighting	10%	5%	20%	68%	$250	20	2.94
Photovoltaics	Cooling	50%	0%	1%	48%	$15,800	15	0.10
Photovoltaics	Space Heating	25%	25%	1%	48%	$15,800	15	0.10
Pool - Pump Timer	Miscellaneous	60%	0%	35%	90%	$160	15	5.38
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.28
Advanced New Construction Designs	Cooling	30%	0%	2%	45%	$4,500	18	0.52
Advanced New Construction Designs	Space Heating	30%	30%	2%	45%	$4,500	18	0.52
Advanced New Construction Designs	Interior Lighting	20%	20%	2%	45%	$4,500	18	0.52
Energy Efficient Manufactured Homes	Cooling	20%	0%	10%	75%	$3,500	18	0.88
Energy Efficient Manufactured Homes	Space Heating	20%	20%	10%	75%	$3,500	18	0.88
Energy Efficient Manufactured Homes	Interior Lighting	20%	20%	10%	75%	$3,500	18	0.88
Water Heater - Heat Pump	Water Heating	30%	15%	0%	10%	$1,500	15	0.44
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$2,616	15	1.00
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$11,738	15	0.69

Note: Costs are per household.

Table C-17 Energy-Efficiency Measure Data — Limited Income, New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	25%	100%	$100	4	0.65
Attic Fan - Installation	Cooling	1%	0%	15%	23%	$97	18	0.07
Attic Fan - Photovoltaic - Installation	Cooling	1%	0%	5%	11%	$200	19	0.07
Ceiling Fan - Installation	Cooling	10%	0%	33%	75%	$80	15	1.03
Whole-House Fan - Installation	Cooling	9%	0%	4%	19%	$150	18	0.58
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$125	4	0.87
Insulation - Ducting	Cooling	3%	0%	50%	75%	$210	18	1.47
Insulation - Ducting	Space Heating	4%	4%	50%	75%	$210	18	1.47
Thermostat - Clock/Programmable	Cooling	8%	0%	29%	30%	$114	11	2.54
Thermostat - Clock/Programmable	Space Heating	8%	4%	29%	30%	$114	11	2.54
Doors - Storm and Thermal	Cooling	1%	0%	19%	75%	$180	12	0.46
Doors - Storm and Thermal	Space Heating	2%	2%	19%	75%	$180	12	0.46
Insulation - Ceiling	Cooling	3%	0%	36%	48%	$152	20	3.20
Insulation - Ceiling	Space Heating	8%	6%	36%	48%	$152	20	3.20
Insulation - Radiant Barrier	Cooling	2%	0%	5%	90%	$923	12	0.36
Insulation - Radiant Barrier	Space Heating	1%	1%	5%	90%	$923	12	0.36
Insulation - Foundation	Cooling	3%	0%	4%	90%	$358	20	1.37
Insulation - Foundation	Space Heating	6%	6%	4%	90%	$358	20	1.37
Insulation - Wall Cavity	Cooling	2%	0%	4%	90%	$63	20	3.46
Insulation - Wall Cavity	Space Heating	3%	3%	4%	90%	$63	20	3.46
Insulation - Wall Sheathing	Cooling	1%	0%	59%	90%	$210	20	1.19
Insulation - Wall Sheathing	Space Heating	3%	3%	59%	90%	$210	20	1.19
Roofs - High Reflectivity	Cooling	5%	0%	0%	90%	$517	15	0.08
Windows - Reflective Film	Cooling	7%	0%	2%	45%	$167	10	0.23
Windows - High Efficiency/Energy Star	Cooling	12%	0%	78%	90%	$2,200	25	0.55
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	78%	90%	$2,200	25	0.55
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	8%	9%	$256	15	0.17
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	50%	10%	50%	$2,975	15	0.01
Exterior Lighting - Photosensor Control	Exterior Lighting	13%	0%	0%	45%	$90	8	0.06
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	11%	45%	$72	8	0.10
Water Heater - Faucet Aerators	Water Heating	4%	2%	11%	90%	$24	25	6.84
Water Heater - Pipe Insulation	Water Heating	6%	3%	0%	41%	$50	13	2.92
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	21%	75%	$48	10	7.03
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$15	10	11.97
Water Heater - Thermostat Setback	Water Heating	9%	5%	5%	75%	$40	5	2.29
Water Heater - Timer	Water Heating	8%	4%	5%	40%	$194	10	0.81
Water Heater - Drainwater Heat Reocvery	Water Heating	9%	5%	1%	90%	$899	15	0.29
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	2.52
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	0.83
Home Energy Management System	Cooling	10%	0%	5%	68%	$250	20	2.50
Home Energy Management System	Space Heating	10%	5%	5%	68%	$250	20	2.50
Home Energy Management System	Interior Lighting	10%	5%	5%	68%	$250	20	2.50
Photovoltaics	Cooling	50%	0%	0%	48%	$7,900	15	0.20
Photovoltaics	Space Heating	25%	25%	0%	48%	$7,900	15	0.20
Pool - Pump Timer	Miscellaneous	60%	0%	35%	90%	$160	15	2.21
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.30
Advanced New Construction Designs	Cooling	30%	0%	2%	45%	$2,500	18	1.25
Advanced New Construction Designs	Space Heating	30%	30%	2%	45%	$2,500	18	1.25
Advanced New Construction Designs	Interior Lighting	20%	20%	2%	45%	$2,500	18	1.25
Water Heater - Heat Pump	Water Heating	30%	15%	0%	20%	$1,500	15	0.58
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$2,970	15	1.18
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$10,798	15	0.81

Note: Costs are per household.

APPENDIX | **D**

COMMERCIAL ENERGY EFFICIENCY EQUIPMENT AND MEASURE DATA

This appendix presents detailed information for all commercial and industrial energy efficiency equipment and measures that were evaluated in LoadMAP. Several sets of tables are provided.

Table D-1 provides brief descriptions for all equipment and measures that were assessed for potenital.

Tables D-2 through D-9 list the detailed unit-level data for the equipment measures for each of the C&I segments — small/medium commercial, large commercial, extra-large commercial, and extra-large industial — and for existing and new construction, respectively. Savings are in kWh/yr/sq.ft., and incremental costs are in $/sq.ft. The B/C ratio is zero if the measure represents the baseline technology or if the technology is not available in the first year of the forecast (2012). The B/C ratio is calculated within LoadMAP for each year of the forecast and is available once the technology or measure becomes available.

Tables D-10 through D-17 list the detailed unit-level data for the non-equipment energy efficiency measures for each of the segments and for existing and new construction, respectively. Because these measures can produce energy-use savings for multiple end-use loads (e.g., insulation affects heating and cooling energy use) savings are expressed as a percentage of the end-use loads. Base saturation indicates the percentage of buildings in which the measure is already installed. Applicability/Feasibility is the product of two factors that account for whether the measure is applicable to the building. Cost is expressed in $/sq.ft. The detailed measure-level tables present the results of the benefit/cost (B/C) analysis for the first year of the forecast. The B/C ratio is zero if the measure represents the baseline technology or if the measure is not available in the first year of the forecast (2012). The B/C ratio is calculated within LoadMAP for each year of the forecast and is available once the technology or measure becomes available.

Note that Tables D-2 through D-17 present information for Washington. For Idaho, savings and B/C ratios may be slightly different due to weather-related usage, differences in the states' market profiles, and different retail electricity prices. Although Idaho-specific values are not presented here, they are available within the LoadMAP files.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Cooling	Central Cooling Systems	Commercial buildings are often cooled with a central chiller plant that creates chilled water for distribution throughout the facility. Chillers can be air source or water source, which include heat rejection via a condenser loop and cooling tower. Because of the wide variety of system types and sizes, savings and cost values for efficiency improvements in chiller systems represent an average over air- and water-cooled systems, as well as screw, reciprocating, and centrifugal technologies. Under this simplified approach, each central system is characterized by an aggregate efficiency value (inclusive of chiller, pumps, motors and condenser loop equipment), in kW/ton with a further efficiency upgrade through the application of variable refrigerant flow technology.
Cooling	Chilled Water Variable Flow System	The chilled water variable flow system is essentially a single chilled water loop with variable volume and speed. A single set of pumps operated by a VSD eliminates the need for separate distribution pumps and makes the chilled water flow throughout the entire system be variable. The use of adjustable flow limiting valves is designed to optimize water flow. Such valves provide flow limiting, shut-off and adjustment functions, automatically compensating for changes in system pressure to maximize energy efficiency.
Cooling	Packaged Cooling Systems / Rooftop Units (RTUs) and Heat Pumps	Packaged cooling systems are simple to install and maintain, and are commonly used in small and medium-sized commercial buildings. Applications range from a single supply system with air intake filters, supply fan, and cooling coil, or can become more complex with the addition of a return air duct, return air fan, and various controls to optimize performance. For packaged RTUs, varying Energy Efficiency Ratios (EER) were considered, as well as ductless or "mini-split" systems with variable refrigerant flow. For heat pumps, units with increasing EER and COP levels were evaluated, as well as a ductless mini-split system.
Cooling	Packaged Terminal Air Conditioners (PTAC)	Window (or wall) mounted room air conditioners (and heat pumps) are designed to cool (or heat) a single room or space. This type of unit incorporates a complete air-cooled refrigeration and air-handling system in an individual package. Conditioned air is discharged in response to thermostatic control to meet room requirements. Each unit has a self-contained, air-cooled direct expansion (DX) cooling system, a heat pump or other fuel-based heating system and associated controls. The energy savings increase with each incremental increase in efficiency, measured in terms of EER level.
Space Heating	Convert to Gas	This fuel-switching measure is the replacement of an electric furnace with a gas furnace. This measure eliminates all prior electricity consumption and demand due to electric space heating. In this study, it is assumed this measure can be implemented only in buildings within 500 feet of a gas main.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Cooling, Space Heating, Interior Lighting	Energy Management System	An energy management system (EMS) allows managers/owners to monitor and control the major energy-consuming systems within a commercial building. At the minimum, the EMS can be used to monitor and record energy consumption of the different end-uses in a building, and can control operation schedules of the HVAC and lighting systems. The monitoring function helps building managers/owners to identify systems that are operating inefficiently so that actions can be taken to correct the problem. The EMS can also provide preventive maintenance scheduling that will reduce the cost of operations and maintenance in the long run. The control functionality of the EMS allows the building manager/owner to operate building systems from one central location. The operation schedules set via the EMS help to prevent building systems from operating during unwanted or unoccupied periods. This analysis assumes that this measure is limited to buildings with a central HVAC system.
Cooling, Space Heating	Economizer	Economizers allow outside air (when it is cool and dry enough) to be brought into the building space to meet cooling loads instead of using mechanically cooled interior air. A dual enthalpy economizer consists of indoor and outdoor temperature and humidity sensors, dampers, motors, and motor controls. Economizers are most applicable to temperate climates and savings will be smaller in extremely hot or humid areas.
Cooling	VSD on Water Pumps	The part-load efficiency of chilled water loop pumps can be improved substantially by varying the speed of the motor drive according to the building demand for cooling. There is also a reduction in piping losses associated with this measure that has a major impact on the energy use for a building. However, pump speeds can generally only be reduced to a minimum specified rate, because chillers and the control valves may require a minimum flow rate to operate. There are two major types of variable speed drives: mechanical and electronic. An additional benefit of variable-speed drives is the ability to start and stop the motor gradually, thus extending the life of the motor and associated machinery. This analysis assumes that electronic variable speed drives are installed.
Cooling	Turbocor Compressor	Turbocor compressors use oil-free magnetic bearings to reduce friction losses and couples that with a two-stage centrifugal compressor to reduce central chiller energy consumption.
Cooling	High-Efficiency Cooling Tower Fans	High efficiency cooling tower fans utilize variable frequency drives in the cooling tower design. VFDs improve fan performance by adjusting fan speed and rotation as conditions change.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Cooling	Condenser Water Temperature Reset	Chilled water reset controls save energy by improving chiller performance through increasing the supply chilled water temperature, which allows increased suction pressure during low load periods. Raising the chilled water temperature also reduces chilled water piping losses. However, the primary savings from the chilled water reset measure results from chiller efficiency improvement. This is due partly to the smaller temperature difference between chilled water and ambient air, and partly due to the sensitivity of chiller performance to suction temperature.
Cooling	Maintenance	Filters, coils, and fins require regular cleaning and maintenance for the heat pump or roof top unit to function effectively and efficiently throughout its years of service. Neglecting necessary maintenance leads to a steady decline in performance while energy use increases. Maintenance can increase the efficiency of poorly performing equipment by as much as 10%.
Cooling	Evaporative Precooler	Evaporative precooling can improve the performance of air conditioning systems, most commonly RTUs. These systems typically use indirect evaporative cooling as a first stage to pre-cool outside air. If the evaporative system cannot meet the full cooling load, the air steam is further cooled with conventional refrigerative air conditioning technology.
Cooling	Roof- High Reflectivity (Cool Roof)	The color and material of a building structure surface will determine the amount of solar radiation absorbed by that surface and subsequently transferred into a building. This is called solar absorptance. By using a material or painting the roof with a light color (and a lower solar absorptance), the roof will absorb less solar radiation and consequently reduce the cooling load.
Cooling, Space Heating	Green Roofs	A green roof covers a section or the entire building roof with a waterproof membrane and vegetative material. Like cool roofs, green roofs can reduce solar absorptance and they can also provide insulation. They also provide non-energy benefits by absorbing rainwater and thus reducing storm water run-off, providing wildlife habitat, and reducing so-called urban heat island effects.
Cooling, Space Heating, Ventilation	HVAC Retrocommissioning	Over time, the performance of complex mechanical systems providing heating and cooling to existing commercial spaces degrades as a result of inappropriate changes to or overrides of controls, deteriorating equipment, clogged filters, changing demands and schedules, and pressure imbalances. Retrocommissioning is a comprehensive analysis of an entire system in which an engineer assesses shortcomings in system performance, and then optimizes through a process of tune-up, maintenance, and reprogramming of control or automation software. Energy efficiency programs throughout the country promote retrocommissioning as a means of greatly reducing energy consumption in existing buildings.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Cooling, Space Heating, Ventilation, Interior Lighting	Comprehensive Retrocommissioning	Comprehensive retrocommissioning covers not only HVAC and lighting, but other existing building systems as well. For example, it can improve efficiency of non-HVAC motors, vertical transport systems, and domestic hot water systems.
Cooling, Space Heating, Ventilation, Interior Lighting/Exterior Lighting	HVAC Commissioning Lighting Commissioning Comprehensive Commissioning	For new construction and major renovations, commissioning ensures that building systems are properly designed, specified, and installed to meet the design intent and provide high-efficiency performance. As the names suggests, HVAC Commissioning and Lighting Commissioning focus only on HVAC and lighting equipment and controls. Comprehensive commissioning addresses these systems but usually begins earlier in the design process, and may also address domestic hot water, non-HVAC fans, vertical transport, telecommunications, fire protection, and other building systems.
Cooling, Space Heating, Interior Lighting	Advanced New Construction Designs	Advanced new construction designs use an integrated approach to the design of new buildings to account for the interaction of building systems. Typically, architects and engineers work closely to specify the building orientation, building shell, building mechanical systems, and controls strategies with the goal of optimizing building energy efficiency and comfort. Options that may be evaluated and incorporated include passive solar strategies, increased thermal mass, daylighting strategies, and shading strategies, This measure was modeled for new construction only.
Cooling, Space Heating	Programmable Thermostat	A programmable thermostat can be added to most heating/cooling systems. They are typically used during winter to lower temperatures at night and in summer to increase temperatures during the afternoon. There are two-setting models, and well as models that allow separate programming for each day of the week. The energy savings from this type of thermostat are identical to those of a "setback" strategy with standard thermostats, but the convenience of a programmable thermostat makes it a much more attractive option. In this analysis, the baseline is assumed to have no thermostat setback.
Cooling, Space Heating	Duct Repair and Sealing	An ideal duct system would be free of leaks. Leakage in unsealed ducts varies considerably because of the differences in fabricating machinery used, the methods for assembly, installation workmanship, and age of the ductwork. Air leaks from the system to the outdoors result in a direct loss proportional to the amount of leakage and the difference in enthalpy between the outdoor air and the conditioned air. To seal ducts, a wide variety of sealing methods and products exist. Each has a relatively short shelf life, and no documented research has identified the aging characteristics of sealant applications. This analysis assumes that the baseline air loss from ducts has doubled, and conducting repair and sealing of the ducts will restore leakage from ducts to the original baseline level.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Cooling, Space Heating	Duct Insulation	Air distribution ducts can be insulated to reduce heating or cooling losses. Best results can be achieved by covering the entire surface area with insulation. Insulation material inhibits the transfer of heat through the air-supply duct. Several types of ducts and duct insulation are available, including flexible duct, pre-insulated duct, duct board, duct wrap, tacked, or glued rigid insulation, and waterproof hard shell materials for exterior ducts.
Cooling, Space Heating	Insulation – Radiant Barrier	Radiant barriers inhibit heat transfer by thermal radiation. When a radiant barrier is installed beneath the roofing material much of the heat radiated from a hot roof is reflected back to the roof limiting the amount of heat emitted downwards.
Cooling, Space Heating	High-Efficiency Windows	High-efficiency windows, such as those labeled under the ENERGY STAR Program, are designed to reduce a building's energy bill while increasing comfort for the occupants at the same time. High-efficiency windows have reducing properties that reduce the amount of heat transfer through the glazing surface. For example, some windows have a low-E coating, which is a thin film of metallic oxide coating on the glass surface that allows passage of short-wave solar energy through glass and prevents long-wave energy from escaping. Another example is double-pane glass that reduces conductive and convective heat transfer. There are also double-pane glasses that are gas-filled (usually argon) to further increase the insulating properties of the window.
Cooling, Space Heating	Ceiling and Wall Cavity Insulation	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation can conserve energy by reducing the heat loss or gain of a building. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose; loose-fill (blown) fiberglass; and rigid polystyrene.
Ventilation	Cooking – Exhaust Hoods with Sensor Controls	Improved exhaust hoods involve installing variable-speed controls on commercial kitchen hoods. These controls provide ventilation based on actual cooking loads. When grills, broilers, stoves, fryers or other kitchen appliances are not being used, the controls automatically sense the reduced load and decrease the fan speed accordingly. This results in lower energy consumption because the system is only running as needed rather than at 100% capacity at all times.
Ventilation	Variable Air Volume	A variable air volume ventilation system modulates the air flow rate as needed based on the interior conditions of the building to reduce fan load, improve dehumidification, and reduce energy usage.
Ventilation	Fans – Energy Efficient Motors	High-efficiency motors are essentially interchangeable with standard motors, but differences in construction make them more efficient. Energy-efficient motors achieve their improved efficiency by reducing the losses that occur in the conversion of electrical energy to mechanical energy. This analysis assumes that the efficiency of supply fans is increased by 5% due to installing energy-efficient motors.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Ventilation	Fans – Variable Speed Control (VSD)	The part-load efficiency of ventilation fans can be improved substantially by varying the speed of the motor drive. There are two major types of variable speed controls: mechanical and electronic. An additional benefit of variable-speed controls is the ability to start and stop the motor gradually, thus extending the life of the motor and associated machinery. This analysis assumes that electronic variable speed controls are installed.
Water Heating	High-Efficiency Water Heater Systems	Efficient electric water heaters are characterized by a high recovery or thermal efficiency (percentage of delivered electric energy which is transferred to the water) and low standby losses (the ratio of heat lost per hour to the content of the stored water). Included in the savings associated with high-efficiency electric water heaters are timers that allow temperature setpoints to change with hot water demand patterns. For example, the heating element could be shut off throughout the night, increasing the overall energy factor of the unit. In addition, tank and pipe insulation reduces standby losses and therefore reduces the demands on the water heater. This analysis considers conventional electric water heaters with efficiency greater than 96%, as well as geothermal heat pump water heaters for effective efficiency greater than one. Solar water heating was evaluated as well.
Water Heating	Convert to Gas	This fuel-switching measure is the replacement of an electric water heater with a gas-fired water heater. This measure will eliminate all prior electricity consumption and demand due to electric water heating. In this study, it is assumed that this measure can be implemented only in buildings within 500 feet of a gas main.
Water Heating	Heat Pump Water Heater	Heat pump water heaters use heat pump technology to extract heat from the ambient surroundings and transfer it to a hot water tank. These devices are available as an alternative to conventional tank water heaters of 55 gallons or larger.
Water Heating	Faucet Aerators/Low Flow Nozzles	A faucet aerator or low flow nozzle spreads the stream from a faucet helping to reduce water usage. The amount of water passing through the aerator is measured in gallons per minute (GPM) and the lower the GPM the more water the aerator conserves.
Water Heating	Pipe Insulation	Insulating hot water pipes decreases the amount of energy lost during distribution of hot water throughout the building. Insulating pipes will result in quicker delivery of hot water and allows lowering the water heating set point. There are several different types of insulation, the most common being polyethylene and neoprene.
Water Heating	High-Efficiency Circulation Pump	A high efficiency circulation pump uses an electronically commutated motor (ECM) to improve motor efficiency over a larger range of partial loads. In addition, an ECM allows for improved low RPM performance with greater torque and smaller pump dimensions.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Water Heating	Tank Blanket/Insulation	Insulation levels on domestic hot water heaters can be increased by installing a fiberglass blanket on the outside of the tank. This increase in insulation reduces standby losses and thus saves energy. Water heater insulation is available either by the blanket or by square foot of fiberglass insulation with R-values ranging from 5 to 14.
Water Heating	Thermostat Setback	Installing a setback thermostat on the water heater can lead to significant energy savings during periods when there is no one in the building.
Water Heating	Hot Water Saver	A hot water saver is a plumbing device that attaches to the showerhead and that pauses the flow of water until the water is hot enough for use. The water is re-started by the flip of a switch.
Interior Lighting, Exterior Lighting	Lamp Replacement (Interior Screw-in, HID, and Linear Fluorescent Exterior Screw-in, HID, and Linear Fluorescent)	Commercial lighting differs from the residential sector in that efficiency changes typically require more than the simple purchase and quick installation of a screw-in compact fluorescent lamp. Restrictions regarding ballasts, fixtures, and circuitry limit the potential for direct substitution of one lamp type for another. However, such replacements do exist. For example, screw-in incandescent lamps can readily be replaced with CFLs or LEDs. Also, during the buildout for a leased office space, the management could decide to replace all T12 lamps and magnetic ballasts with T8/electronic ballast configurations. This type of decision-making is modeled on a stock turnover basis because of the time between opportunities for upgrades.
Interior Lighting, Exterior Lighting	Lighting Retrocommissioning	Lighting retrocommissioning projects in existing commercial buildings do not require an event such as a tenant turnover, a major renovation, or an update to electrical circuits to drive its adoption. Rather, a decision-maker can decide at any time to perform a comprehensive audit of a facility's lighting systems, followed by an upgrade of equipment (lamps, ballasts, fixtures, reflectors), controls (occupancy sensors, daylighting controls, and central automation).
Interior Lighting	Delamping and Install Reflectors	While sometimes included in lighting retrofit projects, delamping is often performed as a separate energy efficiency measure in which a lighting engineer analyzes the lighting provided by current systems compared to the requirements of building occupants. This often leads to the removal of unnecessary lamps corresponding to an overall reduction in energy usage. .In addition, installing a reflector in each fixture can improve light distribution from the remaining lamps.
Interior Lighting, Exterior Lighting	Lighting Time Clocks and Timers	While outdoor lighting is typically required only at night, in many cases lighting remains on during daylight hours. A simple timer can set a diurnal schedule for outdoor lighting and thus reduce the operating hours by as much as 50%.
Interior Lighting	Central Lighting Controls	Central lighting control systems provide building-wide control of interior lighting to ensure that lights are properly scheduled based on expected building occupancy. Individual zones or circuits can be controlled.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Interior Lighting	Photocell Controlled T8 Dimming Ballasts	Photocells, in concert with dimming ballasts, can detect when adequate daylighting is available and dim or turn off lights to reduce electricity consumption. Usually one photocell is used to control a group of fixtures, a zone, or a circuit.
Interior Lighting	Bi-Level Fixture with Occupancy Sensor	Bi-level fixtures with occupancy sensors detect when a space is unoccupied and reduce light output to a lower level. These devices
Interior Lighting	High Bay Fixtures	Fluorescent fixtures designed for high-bay applications have several advantages over similar HID fixtures: lower energy consumption, lower lumen depreciation rates, better dimming options, faster start-up and restrike, better color rendition, more pupil lumens, and reduced glare.
Interior Lighting	Occupancy Sensor	The installation of occupancy sensors allows lights to be turned off during periods when a space is unoccupied, virtually eliminating the wasted energy due to lights being left on. There are several types of occupancy sensors in the market.
Interior Lighting	LED Exit Lighting	The lamps inside exit signs represent a significant energy end-use, since they usually operate 24 hours per day. Many old exit signs use incandescent lamps, which consume approximately 40 watts per sign. The incandescent lamps can be replaced with LED lamps that are specially designed for this specific purpose. In comparison, the LED lamps consume approximately 2-5 watts.
Interior Lighting	Task Lighting	In commercial facilities, individual work areas can use task lighting instead of brightly lighting the entire area. Significant energy savings can be realized by focusing light directly where it is needed and lowering the general lighting level. An example of task lighting is the common desk lamp. A 25W desk lamp can be installed in place of a typical lamp in a fixture.
Interior Lighting, Cooling	Hotel Guestroom Controls	Hotel guestrooms can be fitted with occupancy controls that turn off energy-using equipment when the guest is not using the room. The occupancy controls comes in several forms, but this analysis assumes the simplest kind, which is a simple switch near the room's entry where the guest can deposit their room key or card. If the key or card is present, then lights, TV, and air conditioning can receive power and operate. When the guest leaves and takes the key, all equipment shuts off.
Exterior Lighting	Daylighting Controls	Daylighting controls use a photosensor to detect ambient light and turn off exterior lights accordingly.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Exterior Lighting	Photovoltaic Lighting	Outdoor photovoltaic (PV) lighting systems use PV panels (or modules), which convert sunlight to electricity. The electricity is stored in batteries for use at night. They can be cost effective relative to installing power cables and/or step down transformers for relatively small lighting loads. The "nightly run time" listings on most "off-the-shelf" products are based on specific sunlight conditions. Systems located in places that receive less sunlight than the system is designed for will operate for fewer hours per night than expected. Nightly run times may also vary depending on how clear the sky is on any given day. Shading of the PV panel by landscape features (vegetation, buildings, etc.) will also have a large impact on battery charging and performance. Open areas with no shading, such as parking lots, are ideal places where PV lighting systems can be used.
Exterior Lighting	Cold Cathode Lighting	Cold cathode lighting does not use an external heat source to provide thermionic emission of electrons. Cold cathode lighting is typically used for exterior signage or where temperatures are likely to drop below freezing.
Exterior Lighting	Induction Lamps	Induction lamps use a contactless bulb and rely on electromagnetic fields to transfer power. This allows for the lamp to utilize more efficient materials that would otherwise react with metal electrodes. In addition, the lack of an electrode significantly extends lamp life while reducing lumen depreciation.
Office Equipment	Desktop and Laptop Computing Equipment	ENERGY STAR labeled office equipment saves energy by powering down and "going to sleep" when not in use. ENERGY STAR labeled computers automatically power down to 15 watts or less when not in use and may actually last longer than conventional products because they spend a large portion of time in a low-power sleep mode. ENERGY STAR labeled computers also generate less heat than conventional models. The ClimateSavers Initiative, made up of leading computer processor manufacturers, has stated a goal of reducing power consumption in active mode by 50% by integrating innovative power management into the chip design process.
Office Equipment	Monitors	ENERGY STAR labeled office equipment saves energy by powering down and "going to sleep" when not in use. ENERGY STAR labeled monitors automatically power down to 15 watts or less when not in use.
Office Equipment	Servers	In addition to the "sleep" mode a reductions and the efficient processors being designed by members of the ClimateSavers Initiative, servers have additional energy-saving opportunities through "virtualization" and other architecture solutions that involve optimal matching of computation tasks to hardware requirements

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Office Equipment	Printers/Copiers/ Fax/ POS Terminals	ENERGY STAR labeled office equipment saves energy by powering down and "going to sleep" when not in use. ENERGY STAR labeled copiers are equipped with a feature that allows them to automatically turn off after a period of inactivity, reducing a copier's annual electricity costs by over 60%. High-speed copiers that include a duplexing unit that is set to automatically make double-sided copies can reduce paper costs and help to save trees.
Office Equipment	ENERGY STAR Power Supply	Power supplies with an efficient ac-dc or ac-ac conversion process can obtain the ENERGY STAR label. These devices can be used to power computers, phones, and other office equipment.
Refrigeration	Walk-in Refrigeration Systems	Standard compressors typically operate at approximately 65% efficiency. High-efficiency models are available that can improve compressor efficiency by 15%.
Refrigeration	Glass Door and Solid Door Refrigeration Units (Reach-in /Open Display Case/Vending Machine) Door Gasket Replacement High Efficiency Case Lighting	In addition to walk-in, "cold-storage" refrigeration, a significant amount of energy in the commercial sector can be attributed to "reach-in" units. These stand-alone appliances can range from a residential-style refrigerator/freezer unit in an office kitchen or the breakroom of a retail store to the refrigerated display cases in some grocery or convenience stores. As in the case of residential units, these refrigerators can be designed to perform at higher efficiency through a combination of compressor equipment upgrades, default temperature settings, and defrost patterns. Other measures for these units are replacing aging door gaskets that no longer adequately seal the case, and replacing inefficient display lights with CFL or LED systems to reduce internal heat gains in the cases.
Refrigeration	Open Display Case	Glass doors can be used to enclose multi-deck display cases for refrigerated items in supermarkets. In addition, more efficient units are designed to perform at higher efficiency through a combination of compressor equipment upgrades, default temperature settings, and defrost patterns.
Refrigeration	Anti-Sweat Heater/ Auto Door Closer Controls	Anti-sweat heaters are used in virtually all low-temperature display cases and many medium-temperature cases to control humidity and prevent the condensation of water vapor on the sides and doors and on the products contained in the cases. Typically, these heaters stay on all the time, even though they only need to be on about half the time. Anti-sweat heater controls can come in the form of humidity sensors or time clocks.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Refrigeration	Floating Head Pressure Controls	Floating head pressure control allows the pressure in the condenser to "float" with ambient temperatures. This method reduces refrigeration compression ratios, improves system efficiency and extends the compressor life. The greatest savings with a floating head pressure approach occurs when the ambient temperatures are low, such as in the winter season. Floating head pressure control is most practical for new installations. However, retrofits installation can be completed with some existing refrigeration systems. Installing floating head pressure control increases the capacity of the compressor when temperatures are low, which may lead to short cycling.
Refrigeration	Bare Suction Lines	Insulating bare suction lines reduces heat
Refrigeration	Night Covers	Night covers can be used on open refrigeration cases when a facility is closed or few customers are in the store.
Refrigeration	Strip Curtain	Strip curtains at the entrances to large walk-in coolers or freezers, such as those used in supermarkets, reduce air transfer between the refrigerated space and the surrounding space.
Refrigeration	Icemakers	In certain building types (restaurant, hotel), the production of ice is a significant usage of electricity. By optimizing the timing of ice production and the type of output to the specific application, icemakers are assumed to deliver electricity savings.
Refrigeration	Vending Machine - Controller	Cold beverage vending machines usually operate 24 hours a day regardless of whether the surrounding area is occupied or not. The result is that the vending machine consumes energy unnecessarily, because it will operate all night to keep the beverage cold even when there would be no customer until the next morning. A vending machine controller can reduce energy consumption without compromising the temperature of the vended product. The controller uses an infrared sensor to monitor the surrounding area's occupancy and will power down the vending machine when the area is unoccupied. It will also monitor the room's temperature and will re -power the machine at one to three hour intervals independent of occupancy to ensure that the product stays cold.
Food Service	Kitchen Equipment	Commercial cooking and food preparation equipment represent a significant contribution to energy consumption in restaurants and other food service applications. By replacing old units with efficient ones, this energy consumption can be greatly reduced. These measures include fryers, commercial ovens, dishwashers, hot food containers and miscellaneous other food preparation equipment. Savings range between 15 and 65%, depending on the specific unit being replaced.
Cooling, Space Heating, Interior Lighting, Food Preparation, Refrigeration	Custom Measures	Custom measures were included in the CPA analysis to serve as a "catch all" for measures for which costs and savings are not easily quantified and that could be part of a program such as Avista's existing Site-Specific incentive program. Costs and energy savings were assumed such that the measures passed the economic screen.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Miscellaneous	Non-HVAC motor	Because the Small/Medium Commercial and Large Commercial segments include some industrial customers, the CPA analysis included equipment upgrades for non-HVAC motors. This equipment measure also incorporates improvements for vertical transport. Premium efficiency motors reduce the amount of lost energy going into heat rather than power. Since less heat is generated, less energy is needed to cool the motor with a fan. Therefore, the initial cost of energy efficient motors is generally higher than for standard motors. However their life-cycle costs can make them far more economical because of savings they generate in operating expense. Premium efficiency motors can provide savings of 0.5% to 3% over standard motors. The savings results from the fact that energy efficient motors run cooler than their standard counterparts, resulting in an increase in the life of the motor insulation and bearing. In general, an efficient motor is a more reliable motor because there are fewer winding failures, longer periods between needed maintenance, and fewer forced outages. For example, using copper instead of aluminum in the windings, and increasing conductor cross-sectional area, lowers a motor's I2R losses.
Miscellaneous	Pumps – Variable Speed Control	The part-load efficiency of chilled and hot water loop pumps can be improved substantially by varying the speed of the motor drive according to the building demand for heating or cooling. There is also a reduction in piping losses associated with this measure that has a major impact on the heating loads and energy use for a building. However, pump speeds can generally only be reduced to a minimum specified rate, because chillers, boilers, and the control valves may require a minimum flow rate to operate. There are two major types of variable speed controls: mechanical and electronic. An additional benefit of variable-speed drives is the ability to start and stop the motor gradually, thus extending the life of the motor and associated machinery. This analysis assumes that electronic variable speed controls are installed.
Miscellaneous	Laundry – High Efficiency Clothes Washer	High efficiency clothes washers use designs that require less water. These machines use sensors to match the hot water needs to the load, preventing energy waste. There are two designs: top-loading and front-loading. Further energy and water savings can be achieved through advanced technologies such as inverter-drive or combination washer-dryer units.
Miscellaneous	ENERGY STAR Water Cooler	An ENERGY STAR water cooler has more insulation and improved chilling mechanisms, resulting in about half the energy use of a standard cooler.
Miscellaneous	Industrial Process Improvements	Because the Avista C&I sector segmentation was based on Avista's rate classes, the commercial building segments include a small percentage or industrial business types. This measure was included to account for energy efficiency potential that could be achieved through various process improvements at these customers.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Machine Drive.	Motors, Premium Efficiency	Premium efficiency motors reduce the amount of lost energy going into heat rather than power. Since less heat is generated, less energy is needed to cool the motor with a fan. Therefore, the initial cost of energy efficient motors is generally higher than for standard motors. However their life-cycle costs can make them far more economical because of savings they generate in operating expense. Premium efficiency motors can provide savings of 0.5% to 3% over standard motors. The savings results from the fact that energy efficient motors run cooler than their standard counterparts, resulting in an increase in the life of the motor insulation and bearing. In general, an efficient motor is a more reliable motor because there are fewer winding failures, longer periods between needed maintenance, and fewer forced outages. For example, using copper instead of aluminum in the windings, and increasing conductor cross-sectional area, lowers a motor's I2R losses. This analysis assumes 75% loading factor (for peak efficiency) for 1800 rpm motor. Hours of operation vary depending on horsepower size. In addition, improved drives and controls are assumed to be implemented along with the motors, resulting in savings as high as 10% of annual energy consumption
Machine Drive	Motors – Variable Frequency Drive	In addition to energy savings, VFDs increase motor and system life and provide a greater degree of control over the motor system. Especially for motor systems handling fluids, VFDs can efficiently respond to changing operating conditions.
Machine Drive	Magnetic Adjustable Speed Drive	To allow for adjustable speed operation, this technology uses magnetic induction to couple a drive to its load. Varying the magnetic slip within the coupling controls the speed of the output shaft. Magnetic drives perform best at the upper end of the speed range due to the energy consumed by the slip. Unlike traditional ASDs, magnetically coupled ASDs create no power distortion on the electrical system. However, magnetically coupled ASD efficiency is best when power needs are greatest. VFDs may show greater efficiency when the average load speed is below 90% of the motor speed, however this occurs when power demands are reduced.
Machine Drive	Compressed Air – System Controls, Optimization and Improvements, Maintenance	Controls for compressed air systems can shift load from two partially loaded compressors to one compressor in order to maximize compression efficiency and may also involve the addition of VFDs. Improvements include installing high-efficiency motors. Maintenance includes fixing air leaks and replacing air filters.
Machine Drive	Fan Systems – Controls, Optimization and Maintenance	Certain practices require a consistent flow rate, such as indoor air quality and clean room ventilation. To achieve this, fan flow controls can be used to maintain precise volume flow control ensuring a constant air delivery even on fluctuating pressure conditions. This is done through programmable circuitry to electronically control fan motor speed. Motors can be configured to accept a signal from a controller that would vary the flow rate in direct proportion to the signal.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Machine Drive	Pumping Systems – Controls, Optimization and Maintenance	Pumping systems optimization includes installing VFDs, correctly resizing the motors, and installing timers and automated on-off controls. Maintenance includes repairing diaphragms and fixing piping leaks.
Process	Process Cooling/Refrigeration	Because of the customized nature of industrial cooling and refrigeration applications, a variety of opportunities are summarized as a general improvement in cooling and cold storage equipment. Costs and savings were developed using average values for this group of measures from the Sixth Plan industrial supply curve workbooks.
Process	Process Heating	Because of the customized nature of industrial heating applications, a variety of opportunities are summarized as a general improvement in process heating equipment, such as arc furnaces. Costs and savings were developed using average values for this group of measures from the Sixth Plan industrial supply curve workbooks.
Process	Electrochemical Process	Because of the customized nature of industrial electrochemical applications, a variety of opportunities are summarized as a general improvement in equipment and processes. Costs and savings were developed using average values for this group of measures from the Sixth Plan industrial supply curve workbooks.
Process	Refrigeration – System Controls, Maintenance, and Optimization	Because refrigeration equipment performance degrades over time and control settings are frequently overridden, these measures account for savings that can be achieved through system maintenance and controls optimization.

Table D-2 Energy Efficiency Equipment Data — Small/Medium Comm., Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	-
Cooling	Central Chiller	1.3 kw/ton, COP 2.7	0.29	$0.39	20	-
Cooling	Central Chiller	1.26 kw/ton, COP 2.8	0.35	$0.50	20	0.51
Cooling	Central Chiller	1.0 kw/ton, COP 3.5	0.73	$0.62	20	1.90
Cooling	Central Chiller	0.97 kw/ton, COP 3.6	0.77	$0.74	20	1.39
Cooling	Central Chiller	Variable Refrigerant Flow	1.01	$11.57	20	0.07
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.22	$0.18	16	-
Cooling	RTU	EER 11.2	0.43	$0.35	16	-
Cooling	RTU	EER 12.0	0.57	$0.58	16	0.49
Cooling	RTU	Ductless VRF	0.69	$5.12	16	0.05
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.09	$0.08	14	0.86
Cooling	PTAC	EER 10.8	0.21	$0.16	14	1.00
Cooling	PTAC	EER 11	0.25	$0.43	14	0.43
Cooling	PTAC	EER 11.5	0.33	$0.96	14	0.27
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	0.57	$0.39	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	0.90	$1.18	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	1.20	$1.57	15	0.98
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	1.31	$1.96	15	0.68
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	1.46	$11.50	20	0.10
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	1.30	$1.22	15	1.07
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.23	$0.09	4	-
Interior Lighting	Interior Screw-in	CFL	0.94	$0.03	7	16.50
Interior Lighting	Interior Screw-in	LED	1.04	$1.18	12	0.84
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.30	($0.07)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.30	($0.03)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.91	$0.25	6	1.73
Interior Lighting	Linear Fluorescent	T5	0.95	$0.43	6	1.06
Interior Lighting	Linear Fluorescent	LED	0.99	$3.74	15	0.33
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.14	$0.05	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.60	$0.02	7	17.60
Exterior Lighting	Exterior Screw-in	Metal Halides	0.60	$0.05	4	3.16
Exterior Lighting	Exterior Screw-in	LED	0.66	$0.64	12	0.90
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.22	($0.13)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.24	$0.55	9	0.37
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.01	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.04	$0.02	6	1.12
Exterior Lighting	Linear Fluorescent	T5	0.04	$0.03	6	0.69
Exterior Lighting	Linear Fluorescent	LED	0.05	$0.24	15	0.22
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.10	$0.02	15	5.23
Water Heating	Water Heater	Geothermal Heat Pump	1.33	$3.53	15	0.43
Water Heating	Water Heater	Solar	1.46	$3.03	15	0.55
Food Preparation	Fryer	Standard	-	$0.00	12	-
Food Preparation	Fryer	Efficient	0.03	$0.04	12	0.80
Food Preparation	Oven	Standard	-	$0.00	12	-

Note: Costs and savings are per sq. ft.

Table D-2 Energy Efficiency Equipment Data — Small/Med. Comm., Existing Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Food Preparation	Oven	Efficient	0.39	$0.36	12	1.02
Food Preparation	Dishwasher	Standard	-	$0.00	12	-
Food Preparation	Dishwasher	Efficient	0.02	$0.05	12	0.36
Food Preparation	Hot Food Container	Standard	-	$0.00	12	-
Food Preparation	Hot Food Container	Efficient	0.40	$0.16	12	2.29
Food Preparation	Food Prep	Standard	-	$0.00	12	-
Food Preparation	Food Prep	Efficient	0.00	$0.03	12	0.07
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	-
Refrigeration	Walk in Refrigeration	Efficient	-	$0.09	18	-
Refrigeration	Glass Door Display	Standard	-	$0.00	18	-
Refrigeration	Glass Door Display	Efficient	0.16	$0.00	18	56.08
Refrigeration	Solid Door Refrigerator	Standard	-	$0.00	18	-
Refrigeration	Solid Door Refrigerator	Efficient	0.19	$0.02	18	9.87
Refrigeration	Open Display Case	Standard	-	$0.00	18	-
Refrigeration	Open Display Case	Efficient	0.00	$0.00	18	0.24
Refrigeration	Vending Machine	Base	-	$0.00	10	-
Refrigeration	Vending Machine	Base (2012)	0.11	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency	0.13	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency (2012)	0.20	$0.00	10	46.48
Refrigeration	Icemaker	Standard	-	$0.00	12	-
Refrigeration	Icemaker	Efficient	0.05	$0.00	12	12.76
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	-
Office Equipment	Desktop Computer	Energy Star	0.19	$0.00	4	23.04
Office Equipment	Desktop Computer	Climate Savers	0.27	$0.36	4	0.23
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	-
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	7.34
Office Equipment	Laptop Computer	Climate Savers	0.03	$0.12	4	0.08
Office Equipment	Server	Standard	-	$0.00	3	-
Office Equipment	Server	Energy Star	0.12	$0.01	3	2.14
Office Equipment	Monitor	Standard	-	$0.00	4	-
Office Equipment	Monitor	Energy Star	0.22	$0.00	4	19.68
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	-
Office Equipment	Printer/copier/fax	Energy Star	0.09	$0.04	6	0.98
Office Equipment	POS Terminal	Standard	-	$0.00	4	-
Office Equipment	POS Terminal	Energy Star	0.03	$0.00	4	2.96
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.00	15	-
Miscellaneous	Non-HVAC Motor	High Efficiency	0.05	$0.06	15	0.95
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.06	$0.06	15	-
Miscellaneous	Non-HVAC Motor	Premium	0.07	$0.11	15	0.72
Miscellaneous	Non-HVAC Motor	Premium (2015)	0.08	$0.11	15	-
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-3 Energy Efficiency Equipment Data — Large Commercial, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	-
Cooling	Central Chiller	1.3 kw/ton, COP 2.7	0.30	$0.26	20	-
Cooling	Central Chiller	1.26 kw/ton, COP 2.8	0.36	$0.33	20	0.83
Cooling	Central Chiller	1.0 kw/ton, COP 3.5	0.75	$0.41	20	3.11
Cooling	Central Chiller	0.97 kw/ton, COP 3.6	0.79	$0.49	20	2.28
Cooling	Central Chiller	Variable Refrigerant Flow	1.04	$7.63	20	0.11
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.22	$0.13	16	-
Cooling	RTU	EER 11.2	0.45	$0.25	16	-
Cooling	RTU	EER 12.0	0.59	$0.41	16	0.75
Cooling	RTU	Ductless VRF	0.72	$3.67	16	0.07
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.09	$0.09	14	0.86
Cooling	PTAC	EER 10.8	0.21	$0.17	14	1.00
Cooling	PTAC	EER 11	0.25	$0.46	14	0.43
Cooling	PTAC	EER 11.5	0.34	$1.03	14	0.27
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	0.46	$0.18	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	0.73	$0.55	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	0.97	$0.73	15	1.85
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	1.07	$0.91	15	1.28
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	1.19	$5.35	20	0.19
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	1.03	$1.22	15	0.86
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.19	$0.08	4	-
Interior Lighting	Interior Screw-in	CFL	0.78	$0.03	7	14.13
Interior Lighting	Interior Screw-in	LED	0.87	$1.11	12	0.72
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.31	($0.08)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.30	($0.03)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.89	$0.25	6	1.66
Interior Lighting	Linear Fluorescent	T5	0.92	$0.42	6	1.02
Interior Lighting	Linear Fluorescent	LED	0.97	$3.67	15	0.32
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.08	$0.01	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.34	$0.01	7	34.02
Exterior Lighting	Exterior Screw-in	Metal Halides	0.34	$0.02	4	6.10
Exterior Lighting	Exterior Screw-in	LED	0.38	$0.19	12	1.73
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.19	($0.11)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.20	$0.45	9	0.37
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.01	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.04	$0.02	6	1.18
Exterior Lighting	Linear Fluorescent	T5	0.04	$0.03	6	0.72
Exterior Lighting	Linear Fluorescent	LED	0.05	$0.24	15	0.23
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.12	$0.02	15	5.71
Water Heating	Water Heater	Geothermal Heat Pump	1.54	$3.53	15	0.46
Water Heating	Water Heater	Solar	1.69	$3.03	15	0.60
Food Preparation	Fryer	Standard	-	$0.00	12	-
Food Preparation	Fryer	Efficient	0.07	$0.02	12	3.52
Food Preparation	Oven	Standard	-	$0.00	12	-

Note: Costs and savings are per sq. ft.

Table D-3 Energy Efficiency Equipment Data — Large Commercial, Existing Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Food Preparation	Oven	Efficient	0.75	$0.46	12	1.43
Food Preparation	Dishwasher	Standard	-	$0.00	12	-
Food Preparation	Dishwasher	Efficient	0.07	$0.10	12	0.58
Food Preparation	Hot Food Container	Standard	-	$0.00	12	-
Food Preparation	Hot Food Container	Efficient	0.35	$0.30	12	0.99
Food Preparation	Food Prep	Standard	-	$0.00	12	-
Food Preparation	Food Prep	Efficient	0.01	$0.03	12	0.24
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	-
Refrigeration	Walk in Refrigeration	Efficient	0.15	$1.26	18	0.13
Refrigeration	Glass Door Display	Standard	-	$0.00	18	-
Refrigeration	Glass Door Display	Efficient	0.13	$0.01	18	24.96
Refrigeration	Solid Door Refrigerator	Standard	-	$0.00	18	-
Refrigeration	Solid Door Refrigerator	Efficient	0.30	$0.08	18	4.39
Refrigeration	Open Display Case	Standard	-	$0.00	18	-
Refrigeration	Open Display Case	Efficient	0.00	$0.04	18	0.16
Refrigeration	Vending Machine	Base	-	$0.00	10	-
Refrigeration	Vending Machine	Base (2012)	0.13	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency	0.15	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency (2012)	0.23	$0.00	10	20.70
Refrigeration	Icemaker	Standard	-	$0.00	12	-
Refrigeration	Icemaker	Efficient	0.11	$0.02	12	5.62
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	-
Office Equipment	Desktop Computer	Energy Star	0.35	$0.00	4	47.46
Office Equipment	Desktop Computer	Climate Savers	0.50	$0.32	4	0.46
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	-
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	15.12
Office Equipment	Laptop Computer	Climate Savers	0.04	$0.06	4	0.17
Office Equipment	Server	Standard	-	$0.00	3	-
Office Equipment	Server	Energy Star	0.13	$0.01	3	4.41
Office Equipment	Monitor	Standard	-	$0.00	4	-
Office Equipment	Monitor	Energy Star	0.19	$0.01	4	9.14
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	-
Office Equipment	Printer/copier/fax	Energy Star	0.08	$0.02	6	2.02
Office Equipment	POS Terminal	Standard	-	$0.00	4	-
Office Equipment	POS Terminal	Energy Star	0.01	$0.00	4	2.94
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.00	15	-
Miscellaneous	Non-HVAC Motor	High Efficiency	0.06	$0.06	15	0.92
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.06	$0.06	15	-
Miscellaneous	Non-HVAC Motor	Premium	0.08	$0.13	15	0.69
Miscellaneous	Non-HVAC Motor	Premium (2015)	0.09	$0.13	15	-
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-4 Energy Efficiency Equipment Data — Extra Large Commercial, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	-
Cooling	Central Chiller	0.60 kw/ton, COP 5.9	0.43	$0.09	20	-
Cooling	Central Chiller	0.58 kw/ton, COP 6.1	0.49	$0.18	20	0.66
Cooling	Central Chiller	0.55 kw/Ton, COP 6.4	0.57	$0.25	20	0.91
Cooling	Central Chiller	0.51 kw/ton, COP 6.9	0.69	$0.44	20	0.78
Cooling	Central Chiller	0.50 kw/Ton, COP 7.0	0.72	$0.53	20	0.69
Cooling	Central Chiller	0.48 kw/ton, COP 7.3	0.77	$0.62	20	0.68
Cooling	Central Chiller	Variable Refrigerant Flow	1.00	$10.92	20	0.05
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.20	$0.24	16	-
Cooling	RTU	EER 11.2	0.41	$0.45	16	-
Cooling	RTU	EER 12.0	0.53	$0.75	16	0.37
Cooling	RTU	Ductless VRF	0.65	$6.64	16	0.03
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.08	$0.06	14	1.09
Cooling	PTAC	EER 10.8	0.19	$0.12	14	1.28
Cooling	PTAC	EER 11	0.22	$0.32	14	0.55
Cooling	PTAC	EER 11.5	0.30	$0.71	14	0.34
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	0.50	$0.24	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	0.79	$0.73	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	1.06	$0.97	15	1.34
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	1.16	$1.21	15	0.93
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	1.29	$7.10	20	0.14
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	1.21	$1.22	15	1.01
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.30	$0.14	4	-
Interior Lighting	Interior Screw-in	CFL	1.25	$0.06	7	13.22
Interior Lighting	Interior Screw-in	LED	1.38	$1.90	12	0.67
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.13	($0.05)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.20	($0.03)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.59	$0.21	6	1.31
Interior Lighting	Linear Fluorescent	T5	0.61	$0.35	6	0.80
Interior Lighting	Linear Fluorescent	LED	0.64	$3.08	15	0.25
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.02	$0.00	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.10	$0.00	7	37.00
Exterior Lighting	Exterior Screw-in	Metal Halides	0.10	$0.00	4	6.64
Exterior Lighting	Exterior Screw-in	LED	0.11	$0.05	12	1.89
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.26	($0.16)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.28	$0.64	9	0.37
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.00	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.01	$0.00	6	1.12
Exterior Lighting	Linear Fluorescent	T5	0.01	$0.01	6	0.69
Exterior Lighting	Linear Fluorescent	LED	0.01	$0.06	15	0.22
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.19	$0.02	15	9.79
Water Heating	Water Heater	Geothermal Heat Pump	2.47	$3.53	15	0.80
Water Heating	Water Heater	Solar	2.72	$3.03	15	1.02
Food Preparation	Fryer	Standard	-	$0.00	12	-

Note: Costs and savings are per sq. ft.

Table D-4 Energy Efficiency Equipment Data — Extra Large Commercial, Existing Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Food Preparation	Fryer	Efficient	0.03	$0.00	12	6.02
Food Preparation	Oven	Standard	-	$0.00	12	-
Food Preparation	Oven	Efficient	0.85	$0.38	12	2.11
Food Preparation	Dishwasher	Standard	-	$0.00	12	-
Food Preparation	Dishwasher	Efficient	0.03	$0.04	12	0.57
Food Preparation	Hot Food Container	Standard	-	$0.00	12	-
Food Preparation	Hot Food Container	Efficient	0.17	$0.22	12	0.73
Food Preparation	Food Prep	Standard	-	$0.00	12	-
Food Preparation	Food Prep	Efficient	0.00	$0.03	12	0.15
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	-
Refrigeration	Walk in Refrigeration	Efficient	0.06	$0.05	18	1.42
Refrigeration	Glass Door Display	Standard	-	$0.00	18	-
Refrigeration	Glass Door Display	Efficient	0.04	$0.00	18	78.11
Refrigeration	Solid Door Refrigerator	Standard	-	$0.00	18	-
Refrigeration	Solid Door Refrigerator	Efficient	0.27	$0.02	18	12.81
Refrigeration	Open Display Case	Standard	-	$0.00	18	-
Refrigeration	Open Display Case	Efficient	0.01	$0.03	18	0.34
Refrigeration	Vending Machine	Base	-	$0.00	10	-
Refrigeration	Vending Machine	Base (2012)	0.13	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency	0.16	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency (2012)	0.24	$0.00	10	68.21
Refrigeration	Icemaker	Standard	-	$0.00	12	-
Refrigeration	Icemaker	Efficient	0.05	$0.00	12	17.60
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	-
Office Equipment	Desktop Computer	Energy Star	0.25	$0.00	4	32.37
Office Equipment	Desktop Computer	Climate Savers	0.35	$0.33	4	0.32
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	-
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	10.31
Office Equipment	Laptop Computer	Climate Savers	0.04	$0.10	4	0.12
Office Equipment	Server	Standard	-	$0.00	3	-
Office Equipment	Server	Energy Star	0.06	$0.00	3	3.01
Office Equipment	Monitor	Standard	-	$0.00	4	-
Office Equipment	Monitor	Energy Star	0.11	$0.01	4	6.80
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	-
Office Equipment	Printer/copier/fax	Energy Star	0.02	$0.01	6	1.38
Office Equipment	POS Terminal	Standard	-	$0.00	4	-
Office Equipment	POS Terminal	Energy Star	0.00	$0.00	4	2.01
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.00	15	-
Miscellaneous	Non-HVAC Motor	High Efficiency	0.03	$0.03	15	1.02
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.04	$0.03	15	-
Miscellaneous	Non-HVAC Motor	Premium	0.05	$0.07	15	0.76
Miscellaneous	Non-HVAC Motor	Premium (2015)	0.05	$0.07	15	-
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-5 Energy Efficiency Equipment Data — Extra Large Industrial, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	-
Cooling	Central Chiller	0.60 kw/ton, COP 5.9	1.61	$0.33	20	-
Cooling	Central Chiller	0.58 kw/ton, COP 6.1	1.82	$0.66	20	0.68
Cooling	Central Chiller	0.55 kw/Ton, COP 6.4	2.15	$0.93	20	0.94
Cooling	Central Chiller	0.51 kw/ton, COP 6.9	2.58	$1.59	20	0.80
Cooling	Central Chiller	0.50 kw/Ton, COP 7.0	2.68	$1.92	20	0.71
Cooling	Central Chiller	0.48 kw/ton, COP 7.3	2.90	$2.25	20	0.70
Cooling	Central Chiller	Variable Refrigerant Flow	3.74	$39.62	20	0.06
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.56	$0.39	16	-
Cooling	RTU	EER 11.2	1.12	$0.73	16	-
Cooling	RTU	EER 12.0	1.47	$1.22	16	0.62
Cooling	RTU	Ductless VRF	1.79	$10.83	16	0.06
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.20	$0.06	14	2.79
Cooling	PTAC	EER 10.8	0.47	$0.11	14	3.27
Cooling	PTAC	EER 11	0.55	$0.31	14	1.41
Cooling	PTAC	EER 11.5	0.75	$0.69	14	0.87
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	1.07	$0.92	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	1.69	$2.75	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	2.25	$3.66	15	0.75
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	2.47	$4.58	15	0.52
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	2.74	$26.86	20	0.08
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	7.66	$1.22	15	6.38
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.09	$0.04	4	-
Interior Lighting	Interior Screw-in	CFL	0.38	$0.02	7	14.80
Interior Lighting	Interior Screw-in	LED	0.42	$0.52	12	0.75
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.46	($0.14)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.10	($0.01)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.31	$0.08	6	1.73
Interior Lighting	Linear Fluorescent	T5	0.32	$0.14	6	1.06
Interior Lighting	Linear Fluorescent	LED	0.33	$1.21	15	0.33
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.01	$0.00	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.02	$0.00	7	15.02
Exterior Lighting	Exterior Screw-in	Metal Halides	0.02	$0.00	4	2.69
Exterior Lighting	Exterior Screw-in	LED	0.03	$0.03	12	0.77
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.07	($0.04)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.08	$0.18	9	0.37
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.00	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.00	$0.00	6	1.16
Exterior Lighting	Linear Fluorescent	T5	0.00	$0.00	6	0.71
Exterior Lighting	Linear Fluorescent	LED	0.00	$0.01	15	0.22
Process	Process Cooling/Refrigera	Standard	-	$0.00	10	-
Process	Process Cooling/Refrigera	Efficient	18.88	$5.59	10	2.49
Process	Process Heating	Standard	-	$0.00	10	-
Process	Process Heating	Efficient	6.18	$0.57	10	7.97
Process	Electrochemical Process	Standard	-	$0.00	10	-

Note: Costs and savings are per sq. ft.

Table D-5 Energy Efficiency Equipment Data — Extra Large Industrial, Existing Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Process	Electrochemical Process	Efficient	13.16	$2.64	10	3.67
Machine Drive	Less than 5 HP	Standard	-	$0.00	10	-
Machine Drive	Less than 5 HP	High Efficiency	0.05	$0.02	10	2.08
Machine Drive	Less than 5 HP	Standard (2015)	0.07	$0.00	10	-
Machine Drive	Less than 5 HP	Premium	0.07	$0.03	10	1.66
Machine Drive	Less than 5 HP	High Efficiency (2015)	0.11	$0.02	10	-
Machine Drive	Less than 5 HP	Premium (2015)	0.14	$0.03	10	-
Machine Drive	5-24 HP	Standard	-	$0.00	10	-
Machine Drive	5-24 HP	High	0.11	$0.02	10	5.09
Machine Drive	5-24 HP	Premium	0.18	$0.03	10	4.07
Machine Drive	25-99 HP	Standard	-	$0.00	10	-
Machine Drive	25-99 HP	High	0.31	$0.02	10	13.72
Machine Drive	25-99 HP	Premium	0.49	$0.03	10	10.97
Machine Drive	100-249 HP	Standard	-	$0.00	10	-
Machine Drive	100-249 HP	High	0.12	$0.02	10	5.17
Machine Drive	100-249 HP	Premium	0.15	$0.03	10	3.44
Machine Drive	250-499 HP	Standard	-	$0.00	10	-
Machine Drive	250-499 HP	High	0.35	$0.02	10	15.66
Machine Drive	250-499 HP	Premium	0.47	$0.03	10	10.44
Machine Drive	500 and more HP	Standard	-	$0.00	10	-
Machine Drive	500 and more HP	High	0.59	$0.02	10	26.28
Machine Drive	500 and more HP	Premium	0.78	$0.03	10	17.52
Miscellaneous	Miscellaneous	Miscellaneous	-	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-6 Energy Efficiency Equipment Data — Small/Medium Commercial, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	-
Cooling	Central Chiller	1.3 kw/ton, COP 2.7	0.29	$0.39	20	-
Cooling	Central Chiller	1.26 kw/ton, COP 2.8	0.35	$0.50	20	0.51
Cooling	Central Chiller	1.0 kw/ton, COP 3.5	0.73	$0.62	20	1.90
Cooling	Central Chiller	0.97 kw/ton, COP 3.6	0.77	$0.74	20	1.39
Cooling	Central Chiller	Variable Refrigerant Flow	1.01	$11.57	20	0.07
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.22	$0.18	16	-
Cooling	RTU	EER 11.2	0.43	$0.35	16	-
Cooling	RTU	EER 12.0	0.57	$0.58	16	0.49
Cooling	RTU	Ductless VRF	0.69	$5.12	16	0.05
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.09	$0.08	14	0.86
Cooling	PTAC	EER 10.8	0.21	$0.16	14	1.00
Cooling	PTAC	EER 11	0.25	$0.43	14	0.43
Cooling	PTAC	EER 11.5	0.33	$0.96	14	0.27
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	0.57	$0.39	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	0.90	$1.18	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	1.20	$1.57	15	0.98
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	1.31	$1.96	15	0.68
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	1.46	$11.50	20	0.10
Combined Heating/Cooling	Heat Pump	Geothermal Heat Pump	1.75	$20.69	20	-
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	1.64	$1.22	15	1.35
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.20	$0.09	4	-
Interior Lighting	Interior Screw-in	CFL	0.85	$0.03	7	14.85
Interior Lighting	Interior Screw-in	LED	0.93	$1.18	12	0.76
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.27	($0.07)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.27	($0.03)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.82	$0.25	6	1.56
Interior Lighting	Linear Fluorescent	T5	0.85	$0.43	6	0.95
Interior Lighting	Linear Fluorescent	LED	0.89	$3.74	15	0.30
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.13	$0.05	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.54	$0.02	7	15.84
Exterior Lighting	Exterior Screw-in	Metal Halides	0.54	$0.05	4	2.84
Exterior Lighting	Exterior Screw-in	LED	0.60	$0.64	12	0.81
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.20	($0.13)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.22	$0.55	9	0.33
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.01	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.04	$0.02	6	1.01
Exterior Lighting	Linear Fluorescent	T5	0.04	$0.03	6	0.62
Exterior Lighting	Linear Fluorescent	LED	0.04	$0.24	15	0.20
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.10	$0.02	15	5.23
Water Heating	Water Heater	Geothermal Heat Pump	1.33	$3.53	15	0.43
Water Heating	Water Heater	Solar	1.46	$3.03	15	0.55
Food Preparation	Fryer	Standard	-	$0.00	12	-
Food Preparation	Fryer	Efficient	0.03	$0.04	12	0.80

Note: Costs and savings are per sq. ft.

Table D-6 Energy Efficiency Equipment Data — Small/Medium Commercial, New Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Food Preparation	Oven	Standard	-	$0.00	12	-
Food Preparation	Oven	Efficient	0.39	$0.36	12	1.02
Food Preparation	Dishwasher	Standard	-	$0.00	12	-
Food Preparation	Dishwasher	Efficient	0.02	$0.05	12	0.36
Food Preparation	Hot Food Container	Standard	-	$0.00	12	-
Food Preparation	Hot Food Container	Efficient	0.40	$0.16	12	2.29
Food Preparation	Food Prep	Standard	-	$0.00	12	-
Food Preparation	Food Prep	Efficient	0.00	$0.03	12	0.07
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	-
Refrigeration	Walk in Refrigeration	Efficient	-	$0.09	18	-
Refrigeration	Glass Door Display	Standard	-	$0.00	18	-
Refrigeration	Glass Door Display	Efficient	0.16	$0.00	18	56.08
Refrigeration	Solid Door Refrigerator	Standard	-	$0.00	18	-
Refrigeration	Solid Door Refrigerator	Efficient	0.19	$0.02	18	9.87
Refrigeration	Open Display Case	Standard	-	$0.00	18	-
Refrigeration	Open Display Case	Efficient	0.00	$0.00	18	0.24
Refrigeration	Vending Machine	Base	-	$0.00	10	-
Refrigeration	Vending Machine	Base (2012)	0.11	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency	0.13	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency (2012)	0.20	$0.00	10	46.48
Refrigeration	Icemaker	Standard	-	$0.00	12	-
Refrigeration	Icemaker	Efficient	0.05	$0.00	12	12.76
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	-
Office Equipment	Desktop Computer	Energy Star	0.19	$0.00	4	23.04
Office Equipment	Desktop Computer	Climate Savers	0.27	$0.36	4	0.23
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	-
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	7.34
Office Equipment	Laptop Computer	Climate Savers	0.03	$0.12	4	0.08
Office Equipment	Server	Standard	-	$0.00	3	-
Office Equipment	Server	Energy Star	0.12	$0.01	3	2.14
Office Equipment	Monitor	Standard	-	$0.00	4	-
Office Equipment	Monitor	Energy Star	0.22	$0.00	4	19.68
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	-
Office Equipment	Printer/copier/fax	Energy Star	0.09	$0.04	6	0.98
Office Equipment	POS Terminal	Standard	-	$0.00	4	-
Office Equipment	POS Terminal	Energy Star	0.03	$0.00	4	2.96
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.00	15	-
Miscellaneous	Non-HVAC Motor	High Efficiency	0.05	$0.06	15	0.95
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.06	$0.06	15	-
Miscellaneous	Non-HVAC Motor	Premium	0.07	$0.11	15	0.72
Miscellaneous	Non-HVAC Motor	Premium (2015)	0.08	$0.11	15	-
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-7 Energy Efficiency Equipment Data — Large Commercial, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	-
Cooling	Central Chiller	1.3 kw/ton, COP 2.7	0.32	$0.24	20	-
Cooling	Central Chiller	1.26 kw/ton, COP 2.8	0.39	$0.31	20	0.97
Cooling	Central Chiller	1.0 kw/ton, COP 3.5	0.80	$0.38	20	3.62
Cooling	Central Chiller	0.97 kw/ton, COP 3.6	0.85	$0.45	20	2.66
Cooling	Central Chiller	Variable Refrigerant Flow	1.12	$7.06	20	0.12
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.22	$0.13	16	-
Cooling	RTU	EER 11.2	0.45	$0.25	16	-
Cooling	RTU	EER 12.0	0.59	$0.41	16	0.75
Cooling	RTU	Ductless VRF	0.72	$3.67	16	0.07
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.09	$0.09	14	0.86
Cooling	PTAC	EER 10.8	0.21	$0.17	14	1.00
Cooling	PTAC	EER 11	0.25	$0.46	14	0.43
Cooling	PTAC	EER 11.5	0.34	$1.03	14	0.27
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	0.46	$0.18	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	0.73	$0.55	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	0.97	$0.73	15	1.85
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	1.07	$0.91	15	1.28
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	1.19	$5.35	20	0.19
Combined Heating/Cooling	Heat Pump	Geothermal Heat Pump	1.42	$9.62	20	-
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	1.30	$1.22	15	1.09
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.17	$0.08	4	-
Interior Lighting	Interior Screw-in	CFL	0.71	$0.03	7	12.72
Interior Lighting	Interior Screw-in	LED	0.78	$1.11	12	0.65
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.28	($0.08)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.27	($0.03)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.80	$0.25	6	1.49
Interior Lighting	Linear Fluorescent	T5	0.83	$0.42	6	0.92
Interior Lighting	Linear Fluorescent	LED	0.87	$3.67	15	0.29
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.07	$0.01	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.31	$0.01	7	30.62
Exterior Lighting	Exterior Screw-in	Metal Halides	0.31	$0.02	4	5.49
Exterior Lighting	Exterior Screw-in	LED	0.34	$0.19	12	1.56
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.17	($0.11)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.18	$0.45	9	0.34
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.01	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.04	$0.02	6	1.06
Exterior Lighting	Linear Fluorescent	T5	0.04	$0.03	6	0.65
Exterior Lighting	Linear Fluorescent	LED	0.04	$0.24	15	0.20
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.12	$0.02	15	5.71
Water Heating	Water Heater	Geothermal Heat Pump	1.54	$3.53	15	0.46
Water Heating	Water Heater	Solar	1.69	$3.03	15	0.60
Food Preparation	Fryer	Standard	-	$0.00	12	-
Food Preparation	Fryer	Efficient	0.07	$0.02	12	3.52

Note: Costs and savings are per sq. ft.

Table D-7 Energy Efficiency Equipment Data — Large Commercial, New Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Food Preparation	Oven	Standard	-	$0.00	12	-
Food Preparation	Oven	Efficient	0.75	$0.46	12	1.43
Food Preparation	Dishwasher	Standard	-	$0.00	12	-
Food Preparation	Dishwasher	Efficient	0.07	$0.10	12	0.58
Food Preparation	Hot Food Container	Standard	-	$0.00	12	-
Food Preparation	Hot Food Container	Efficient	0.35	$0.30	12	0.99
Food Preparation	Food Prep	Standard	-	$0.00	12	-
Food Preparation	Food Prep	Efficient	0.01	$0.03	12	0.24
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	-
Refrigeration	Walk in Refrigeration	Efficient	0.15	$1.26	18	0.13
Refrigeration	Glass Door Display	Standard	-	$0.00	18	-
Refrigeration	Glass Door Display	Efficient	0.13	$0.01	18	24.96
Refrigeration	Solid Door Refrigerator	Standard	-	$0.00	18	-
Refrigeration	Solid Door Refrigerator	Efficient	0.30	$0.08	18	4.39
Refrigeration	Open Display Case	Standard	-	$0.00	18	-
Refrigeration	Open Display Case	Efficient	0.00	$0.04	18	0.16
Refrigeration	Vending Machine	Base	-	$0.00	10	-
Refrigeration	Vending Machine	Base (2012)	0.13	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency	0.15	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency (2012)	0.23	$0.00	10	20.70
Refrigeration	Icemaker	Standard	-	$0.00	12	-
Refrigeration	Icemaker	Efficient	0.11	$0.02	12	5.62
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	-
Office Equipment	Desktop Computer	Energy Star	0.35	$0.00	4	47.46
Office Equipment	Desktop Computer	Climate Savers	0.50	$0.32	4	0.46
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	-
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	15.12
Office Equipment	Laptop Computer	Climate Savers	0.04	$0.06	4	0.17
Office Equipment	Server	Standard	-	$0.00	3	-
Office Equipment	Server	Energy Star	0.13	$0.01	3	4.41
Office Equipment	Monitor	Standard	-	$0.00	4	-
Office Equipment	Monitor	Energy Star	0.19	$0.01	4	9.14
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	-
Office Equipment	Printer/copier/fax	Energy Star	0.08	$0.02	6	2.02
Office Equipment	POS Terminal	Standard	-	$0.00	4	-
Office Equipment	POS Terminal	Energy Star	0.01	$0.00	4	2.94
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.00	15	-
Miscellaneous	Non-HVAC Motor	High Efficiency	0.06	$0.06	15	0.92
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.06	$0.06	15	-
Miscellaneous	Non-HVAC Motor	Premium	0.08	$0.13	15	0.69
Miscellaneous	Non-HVAC Motor	Premium (2015)	0.09	$0.13	15	-
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-8 Energy Efficiency Equipment Data — Extra Large Commercial, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	-
Cooling	Central Chiller	0.60 kw/ton, COP 5.9	0.43	$0.09	20	-
Cooling	Central Chiller	0.58 kw/ton, COP 6.1	0.49	$0.18	20	0.66
Cooling	Central Chiller	0.55 kw/Ton, COP 6.4	0.57	$0.25	20	0.91
Cooling	Central Chiller	0.51 kw/ton, COP 6.9	0.69	$0.44	20	0.78
Cooling	Central Chiller	0.50 kw/Ton, COP 7.0	0.72	$0.53	20	0.69
Cooling	Central Chiller	0.48 kw/ton, COP 7.3	0.77	$0.62	20	0.68
Cooling	Central Chiller	Variable Refrigerant Flow	1.00	$10.92	20	0.05
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.20	$0.24	16	-
Cooling	RTU	EER 11.2	0.41	$0.44	16	-
Cooling	RTU	EER 12.0	0.53	$0.73	16	0.37
Cooling	RTU	Ductless VRF	0.65	$6.51	16	0.04
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.08	$0.06	14	1.09
Cooling	PTAC	EER 10.8	0.19	$0.12	14	1.28
Cooling	PTAC	EER 11	0.22	$0.32	14	0.55
Cooling	PTAC	EER 11.5	0.30	$0.71	14	0.34
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	0.50	$0.24	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	0.79	$0.73	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	1.06	$0.97	15	1.34
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	1.16	$1.21	15	0.93
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	1.29	$7.10	20	0.14
Combined Heating/Cooling	Heat Pump	Geothermal Heat Pump	1.55	$12.77	20	-
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	1.52	$1.22	15	1.27
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.27	$0.14	4	-
Interior Lighting	Interior Screw-in	CFL	1.13	$0.06	7	11.90
Interior Lighting	Interior Screw-in	LED	1.24	$1.90	12	0.61
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.11	($0.05)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.18	($0.03)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.53	$0.21	6	1.18
Interior Lighting	Linear Fluorescent	T5	0.55	$0.35	6	0.72
Interior Lighting	Linear Fluorescent	LED	0.58	$3.08	15	0.23
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.02	$0.00	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.09	$0.00	7	33.30
Exterior Lighting	Exterior Screw-in	Metal Halides	0.09	$0.00	4	5.97
Exterior Lighting	Exterior Screw-in	LED	0.10	$0.05	12	1.70
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.24	($0.16)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.25	$0.64	9	0.33
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.00	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.01	$0.00	6	1.01
Exterior Lighting	Linear Fluorescent	T5	0.01	$0.01	6	0.62
Exterior Lighting	Linear Fluorescent	LED	0.01	$0.06	15	0.19
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.19	$0.02	15	9.79
Water Heating	Water Heater	Geothermal Heat Pump	2.47	$3.53	15	0.80
Water Heating	Water Heater	Solar	2.72	$3.03	15	1.02

Note: Costs and savings are per sq. ft.

Table D-9 Energy Efficiency Equipment Data — Extra Large Commercial, New Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Food Preparation	Fryer	Standard	-	$0.00	12	-
Food Preparation	Fryer	Efficient	0.03	$0.00	12	6.02
Food Preparation	Oven	Standard	-	$0.00	12	-
Food Preparation	Oven	Efficient	0.85	$0.38	12	2.11
Food Preparation	Dishwasher	Standard	-	$0.00	12	-
Food Preparation	Dishwasher	Efficient	0.03	$0.04	12	0.57
Food Preparation	Hot Food Container	Standard	-	$0.00	12	-
Food Preparation	Hot Food Container	Efficient	0.17	$0.22	12	0.73
Food Preparation	Food Prep	Standard	-	$0.00	12	-
Food Preparation	Food Prep	Efficient	0.00	$0.03	12	0.15
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	-
Refrigeration	Walk in Refrigeration	Efficient	0.06	$0.05	18	1.42
Refrigeration	Glass Door Display	Standard	-	$0.00	18	-
Refrigeration	Glass Door Display	Efficient	0.04	$0.00	18	78.11
Refrigeration	Solid Door Refrigerator	Standard	-	$0.00	18	-
Refrigeration	Solid Door Refrigerator	Efficient	0.27	$0.02	18	13.75
Refrigeration	Open Display Case	Standard	-	$0.00	18	-
Refrigeration	Open Display Case	Efficient	0.01	$0.03	18	0.34
Refrigeration	Vending Machine	Base	-	$0.00	10	-
Refrigeration	Vending Machine	Base (2012)	0.13	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency	0.16	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency (2012)	0.24	$0.00	10	68.21
Refrigeration	Icemaker	Standard	-	$0.00	12	-
Refrigeration	Icemaker	Efficient	0.05	$0.00	12	17.60
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	-
Office Equipment	Desktop Computer	Energy Star	0.25	$0.00	4	32.37
Office Equipment	Desktop Computer	Climate Savers	0.35	$0.33	4	0.32
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	-
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	10.31
Office Equipment	Laptop Computer	Climate Savers	0.04	$0.10	4	0.12
Office Equipment	Server	Standard	-	$0.00	3	-
Office Equipment	Server	Energy Star	0.06	$0.00	3	3.01
Office Equipment	Monitor	Standard	-	$0.00	4	-
Office Equipment	Monitor	Energy Star	0.11	$0.01	4	6.80
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	-
Office Equipment	Printer/copier/fax	Energy Star	0.02	$0.01	6	1.38
Office Equipment	POS Terminal	Standard	-	$0.00	4	-
Office Equipment	POS Terminal	Energy Star	0.00	$0.00	4	2.01
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.00	15	-
Miscellaneous	Non-HVAC Motor	High Efficiency	0.03	$0.03	15	1.02
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.04	$0.03	15	-
Miscellaneous	Non-HVAC Motor	Premium	0.05	$0.07	15	0.76
Miscellaneous	Non-HVAC Motor	Premium (2015)	0.05	$0.07	15	-
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-9 Energy Efficiency Equipment Data — Extra Large Industrial, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	-
Cooling	Central Chiller	0.60 kw/ton, COP 5.9	1.61	$0.33	20	-
Cooling	Central Chiller	0.58 kw/ton, COP 6.1	1.82	$0.66	20	0.68
Cooling	Central Chiller	0.55 kw/Ton, COP 6.4	2.15	$0.93	20	0.94
Cooling	Central Chiller	0.51 kw/ton, COP 6.9	2.58	$1.59	20	0.80
Cooling	Central Chiller	0.50 kw/Ton, COP 7.0	2.68	$1.92	20	0.71
Cooling	Central Chiller	0.48 kw/ton, COP 7.3	2.90	$2.25	20	0.70
Cooling	Central Chiller	Variable Refrigerant Flow	3.74	$39.62	20	0.06
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.56	$0.39	16	-
Cooling	RTU	EER 11.2	1.12	$0.74	16	-
Cooling	RTU	EER 12.0	1.47	$1.23	16	0.62
Cooling	RTU	Ductless VRF	1.79	$10.88	16	0.06
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.20	$0.06	14	2.79
Cooling	PTAC	EER 10.8	0.47	$0.11	14	3.27
Cooling	PTAC	EER 11	0.55	$0.31	14	1.41
Cooling	PTAC	EER 11.5	0.75	$0.69	14	0.87
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	1.07	$0.92	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	1.69	$2.75	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	2.25	$3.66	15	0.75
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	2.47	$4.58	15	0.52
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	2.74	$26.86	20	0.08
Combined Heating/Cooling	Heat Pump	Geothermal Heat Pump	3.29	$48.32	20	-
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	9.66	$1.22	15	8.05
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.08	$0.04	4	-
Interior Lighting	Interior Screw-in	CFL	0.34	$0.02	7	13.32
Interior Lighting	Interior Screw-in	LED	0.38	$0.52	12	0.68
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.41	($0.14)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.09	($0.01)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.28	$0.08	6	1.56
Interior Lighting	Linear Fluorescent	T5	0.29	$0.14	6	0.96
Interior Lighting	Linear Fluorescent	LED	0.30	$1.21	15	0.30
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.01	$0.00	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.02	$0.00	7	13.52
Exterior Lighting	Exterior Screw-in	Metal Halides	0.02	$0.00	4	2.42
Exterior Lighting	Exterior Screw-in	LED	0.02	$0.03	12	0.69
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.07	($0.04)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.07	$0.18	9	0.33
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.00	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.00	$0.00	6	1.05
Exterior Lighting	Linear Fluorescent	T5	0.00	$0.00	6	0.64
Exterior Lighting	Linear Fluorescent	LED	0.00	$0.01	15	0.20
Process	Process Cooling/Refrigera	Standard	-	$0.00	10	-
Process	Process Cooling/Refrigera	Efficient	18.88	$5.59	10	2.49
Process	Process Heating	Standard	-	$0.00	10	-
Process	Process Heating	Efficient	6.18	$0.57	10	7.97

Note: Costs and savings are per sq. ft.

Table D-9 Energy Efficiency Equipment Data — Extra Large Industrial, New Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Process	Electrochemical Process	Standard	-	$0.00	10	-
Process	Electrochemical Process	Efficient	13.16	$2.64	10	3.67
Machine Drive	Less than 5 HP	Standard	-	$0.00	10	-
Machine Drive	Less than 5 HP	High Efficiency	0.05	$0.02	10	2.08
Machine Drive	Less than 5 HP	Standard (2015)	0.07	$0.00	10	-
Machine Drive	Less than 5 HP	Premium	0.07	$0.03	10	1.66
Machine Drive	Less than 5 HP	High Efficiency (2015)	0.11	$0.02	10	-
Machine Drive	Less than 5 HP	Premium (2015)	0.14	$0.03	10	-
Machine Drive	5-24 HP	Standard	-	$0.00	10	-
Machine Drive	5-24 HP	High	0.11	$0.02	10	5.09
Machine Drive	5-24 HP	Premium	0.18	$0.03	10	4.07
Machine Drive	25-99 HP	Standard	-	$0.00	10	-
Machine Drive	25-99 HP	High	0.31	$0.02	10	13.72
Machine Drive	25-99 HP	Premium	0.49	$0.03	10	10.97
Machine Drive	100-249 HP	Standard	-	$0.00	10	-
Machine Drive	100-249 HP	High	0.12	$0.02	10	5.17
Machine Drive	100-249 HP	Premium	0.15	$0.03	10	3.44
Machine Drive	250-499 HP	Standard	-	$0.00	10	-
Machine Drive	250-499 HP	High	0.35	$0.02	10	15.66
Machine Drive	250-499 HP	Premium	0.47	$0.03	10	10.44
Machine Drive	500 and more HP	Standard	-	$0.00	10	-
Machine Drive	500 and more HP	High	0.59	$0.02	10	26.28
Machine Drive	500 and more HP	Premium	0.78	$0.03	10	17.52
Miscellaneous	Miscellaneous	Miscellaneous	-	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-10 Energy Efficiency Measure Data — Small/Med. Comm., Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
RTU - Maintenance	Cooling	14%	0%	14%	90%	$0.08	4	0.75
RTU - Evaporative Precooler	Cooling	10%	0%	0%	0%	$0.88	15	0.20
Chiller - Chilled Water Reset	Cooling	14%	0%	0%	0%	$0.86	4	0.08
Chiller - Chilled Water Variable-Flow System	Cooling	5%	0%	0%	0%	$0.86	10	0.07
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	0%	$0.90	20	0.70
Chiller - VSD	Cooling	27%	0%	0%	0%	$1.17	20	0.48
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	0%	0%	$0.04	10	0.01
Chiller - Condenser Water Temprature Reset	Cooling	10%	0%	0%	0%	$0.87	14	0.18
Cooling - Economizer Installation	Cooling	6%	0%	45%	49%	$0.15	15	0.71
Heat Pump - Maintenance	Combined Heating/Cooling	7%	7%	10%	95%	$0.03	4	5.00
Insulation - Ducting	Cooling	6%	0%	9%	50%	$0.41	20	0.71
Insulation - Ducting	Space Heating	3%	1%	9%	50%	$0.41	20	0.71
Repair and Sealing - Ducting	Cooling	2%	0%	5%	25%	$0.38	15	0.45
Repair and Sealing - Ducting	Space Heating	2%	1%	5%	25%	$0.38	15	0.45
Energy Management System	Cooling	6%	0%	24%	75%	$0.35	14	0.72
Energy Management System	Space Heating	5%	3%	24%	75%	$0.35	14	0.72
Energy Management System	Interior Lighting	2%	1%	24%	75%	$0.35	14	0.72
Cooking - Exhaust Hoods with Sensor Control	Ventilation	25%	13%	1%	15%	$0.04	10	7.36
Fans - Energy Efficient Motors	Ventilation	5%	5%	11%	90%	$0.05	10	1.38
Fans - Variable Speed Control	Ventilation	15%	5%	8%	90%	$0.20	10	0.89
Retrocommissioning - HVAC	Cooling	9%	0%	15%	90%	$0.60	4	0.50
Retrocommissioning - HVAC	Space Heating	9%	6%	15%	90%	$0.60	4	0.50
Retrocommissioning - HVAC	Ventilation	9%	6%	15%	90%	$0.60	4	0.50
Pumps - Variable Speed Control	Miscellaneous	1%	0%	0%	34%	$0.44	10	1.01
Thermostat - Clock/Programmable	Cooling	5%	0%	34%	50%	$0.13	11	1.12
Thermostat - Clock/Programmable	Space Heating	5%	1%	34%	50%	$0.13	11	1.12
Insulation - Ceiling	Cooling	2%	0%	10%	18%	$0.64	20	0.70
Insulation - Ceiling	Space Heating	17%	4%	10%	18%	$0.64	20	0.70
Insulation - Radiant Barrier	Cooling	3%	0%	7%	13%	$0.26	20	0.81
Insulation - Radiant Barrier	Space Heating	5%	2%	7%	13%	$0.26	20	0.81
Roofs - High Reflectivity	Cooling	15%	0%	2%	95%	$0.18	15	1.47
Windows - High Efficiency	Cooling	5%	0%	61%	75%	$0.44	20	0.63
Windows - High Efficiency	Space Heating	3%	2%	61%	75%	$0.44	20	0.63
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	81%	90%	$0.65	8	0.34
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	Interior Lighting	25%	13%	1%	45%	$0.50	8	0.90
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	2%	50%	$0.11	8	1.36
Interior Fluorescent - Delamp and Install Reflectors	Interior Lighting	20%	10%	18%	25%	$0.50	11	0.97
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	Interior Lighting	10%	5%	10%	23%	$0.50	8	0.36
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	23%	$0.70	11	1.73
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	7%	45%	$0.20	8	1.11
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.26
Interior Screw-in - Task Lighting	Interior Lighting	7%	4%	25%	75%	$0.24	5	0.09
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	9%	56%	$0.20	8	0.56
Water Heater - Faucet Aerators/Low Flow Nozzles	Water Heating	4%	1%	8%	90%	$0.01	9	4.28
Water Heater - Pipe Insulation	Water Heating	6%	3%	46%	50%	$0.28	15	0.37
Water Heater - High Efficiency Circulation Pump	Water Heating	5%	4%	0%	0%	$0.11	10	0.64
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	40%	50%	$0.02	10	5.87
Water Heater - Thermostat Setback	Water Heating	4%	2%	5%	75%	$0.11	10	0.47
Water Heater - Hot Water Saver	Water Heating	5%	1%	0%	0%	$0.02	5	1.56
Refrigeration - Anti-Sweat Heater/Auto Door Closer	Refrigeration	5%	3%	0%	75%	$0.20	16	1.10
Refrigeration - Floating Head Pressure	Refrigeration	7%	4%	18%	38%	$0.35	16	1.25
Refrigeration - Door Gasket Replacement	Refrigeration	4%	2%	5%	75%	$0.10	8	0.10
Insulation - Bare Suction Lines	Refrigeration	3%	2%	5%	75%	$0.10	8	0.21
Refrigeration - Night Covers	Refrigeration	6%	3%	5%	75%	$0.05	8	1.02
Refrigeration - Strip Curtain	Refrigeration	4%	2%	5%	56%	$0.02	8	0.00
Retrocommissioning - Comprehensive	Cooling	12%	0%	40%	90%	$0.70	4	0.71
Retrocommissioning - Comprehensive	Space Heating	12%	9%	40%	90%	$0.70	4	0.71
Retrocommissioning - Comprehensive	Interior Lighting	12%	9%	40%	90%	$0.70	4	0.71
Office Equipment - Energy Star Power Supply	Office Equipment	1%	1%	10%	95%	$0.00	7	61.20
Vending Machine - Controller	Refrigeration	15%	11%	2%	10%	$0.27	10	1.09
LED Exit Lighting	Interior Lighting	2%	2%	9%	86%	$0.00	10	12.75
Retrocommissioning - Lighting	Interior Lighting	9%	6%	5%	90%	$0.10	5	1.59
Retrocommissioning - Lighting	Exterior Lighting	9%	6%	5%	90%	$0.10	5	1.59
Refrigeration - High Efficiency Case Lighting	Refrigeration	4%	2%	5%	75%	$0.20	8	0.00
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	1.37
Exterior Lighting - Induction Lamps	Exterior Lighting	3%	3%	5%	56%	$0.00	5	8.10
Laundry - High Efficiency Clothes Washer	Miscellaneous	0%	0%	5%	10%	$0.00	10	36.95
Interior Lighting - Hotel Guestroom Controls	Interior Lighting	10%	5%	0%	0%	$0.14	8	0.33
Miscellaneous - Energy Star Water Cooler	Miscellaneous	0%	0%	5%	95%	$0.00	8	1.95
Industrial Process Improvements	Miscellaneous	10%	8%	0%	23%	$0.52	10	1.16
Custom Measures	Cooling	10%	0%	10%	45%	$1.50	15	0.59
Custom Measures	Space Heating	10%	8%	10%	45%	$1.50	15	0.59
Custom Measures	Interior Lighting	10%	6%	10%	45%	$1.50	15	0.59
Custom Measures	Food Preparation	10%	7%	10%	45%	$1.50	15	0.59
Custom Measures	Refrigeration	10%	5%	10%	45%	$1.50	15	0.59
Water Heater - Heat Pump	Water Heating	30%	15%	0%	19%	$0.80	15	0.69
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$4.00	15	0.54
Furnace - Convert to Gas	Space Heating	100%	100%	0%	47%	$8.04	15	1.08

Note: Costs are per sq. ft.

Table D-11 Energy Efficiency Measure Data — Large Commercial, Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
RTU - Maintenance	Cooling	14%	0%	27%	90%	$0.06	4	1.30
RTU - Evaporative Precooler	Cooling	10%	0%	0%	0%	$0.88	15	0.21
Chiller - Chilled Water Reset	Cooling	19%	0%	15%	75%	$0.18	4	0.50
Chiller - Chilled Water Variable-Flow System	Cooling	5%	0%	30%	34%	$0.18	10	0.31
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	66%	$0.90	20	0.64
Chiller - VSD	Cooling	32%	0%	15%	66%	$1.17	20	0.52
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	15%	41%	$0.04	10	0.01
Chiller - Condenser Water Temprature Reset	Cooling	9%	0%	5%	75%	$0.18	14	0.76
Cooling - Economizer Installation	Cooling	11%	0%	44%	49%	$0.15	15	1.29
Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	10%	95%	$0.06	4	3.04
Insulation - Ducting	Cooling	3%	0%	8%	50%	$0.41	20	0.52
Insulation - Ducting	Space Heating	3%	1%	8%	50%	$0.41	20	0.52
Repair and Sealing - Ducting	Cooling	2%	0%	5%	25%	$0.38	15	0.43
Repair and Sealing - Ducting	Space Heating	2%	1%	5%	25%	$0.38	15	0.43
Energy Management System	Cooling	23%	0%	37%	90%	$0.35	14	2.63
Energy Management System	Space Heating	18%	12%	37%	90%	$0.35	14	2.63
Energy Management System	Interior Lighting	9%	6%	37%	90%	$0.35	14	2.63
Cooking - Exhaust Hoods with Sensor Control	Ventilation	13%	7%	1%	11%	$0.04	10	2.97
Fans - Energy Efficient Motors	Ventilation	5%	5%	11%	90%	$0.05	10	1.11
Fans - Variable Speed Control	Ventilation	15%	5%	2%	90%	$0.20	10	0.71
Retrocommissioning - HVAC	Cooling	12%	0%	15%	90%	$0.30	4	0.72
Retrocommissioning - HVAC	Space Heating	12%	9%	15%	90%	$0.30	4	0.72
Retrocommissioning - HVAC	Ventilation	9%	6%	15%	90%	$0.30	4	0.72
Pumps - Variable Speed Control	Miscellaneous	1%	0%	0%	34%	$0.13	10	1.05
Thermostat - Clock/Programmable	Cooling	5%	0%	33%	50%	$0.13	11	1.02
Thermostat - Clock/Programmable	Space Heating	5%	1%	33%	50%	$0.13	11	1.02
Insulation - Ceiling	Cooling	1%	0%	9%	30%	$0.85	20	0.45
Insulation - Ceiling	Space Heating	12%	3%	9%	30%	$0.85	20	0.45
Insulation - Radiant Barrier	Cooling	2%	0%	7%	13%	$0.26	20	0.64
Insulation - Radiant Barrier	Space Heating	5%	2%	7%	13%	$0.26	20	0.64
Roofs - High Reflectivity	Cooling	5%	0%	2%	75%	$0.08	15	1.08
Windows - High Efficiency	Cooling	12%	0%	72%	75%	$0.88	20	0.74
Windows - High Efficiency	Space Heating	11%	8%	72%	75%	$0.88	20	0.74
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	86%	90%	$0.65	8	0.34
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	Interior Lighting	25%	13%	1%	45%	$0.45	8	0.96
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	2%	13%	$0.29	8	0.42
Interior Fluorescent - Delamp and Install Reflectors	Interior Lighting	30%	15%	17%	38%	$0.50	11	1.40
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	Interior Lighting	10%	5%	10%	23%	$0.40	8	0.43
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	23%	$0.63	11	1.85
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	13%	45%	$0.20	8	1.10
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.21
Interior Screw-in - Task Lighting	Interior Lighting	10%	5%	10%	75%	$0.24	5	0.13
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	9%	56%	$0.20	8	0.55
Water Heater - Faucet Aerators/Low Flow Nozzles	Water Heating	4%	1%	3%	90%	$0.03	9	1.62
Water Heater - Pipe Insulation	Water Heating	6%	3%	0%	0%	$0.28	15	0.42
Water Heater - High Efficiency Circulation Pump	Water Heating	5%	4%	0%	23%	$0.11	10	0.70
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$0.04	10	3.28
Water Heater - Thermostat Setback	Water Heating	4%	2%	0%	0%	$0.11	10	0.52
Water Heater - Hot Water Saver	Water Heating	5%	1%	0%	3%	$0.04	5	0.88
Refrigeration - Anti-Sweat Heater/Auto Door Closer	Refrigeration	5%	3%	0%	75%	$0.20	16	0.58
Refrigeration - Floating Head Pressure	Refrigeration	7%	4%	38%	45%	$0.35	16	0.95
Refrigeration - Door Gasket Replacement	Refrigeration	4%	2%	5%	75%	$0.10	8	0.65
Insulation - Bare Suction Lines	Refrigeration	3%	2%	5%	75%	$0.10	8	0.37
Refrigeration - Night Covers	Refrigeration	6%	3%	5%	75%	$0.05	8	0.65
Refrigeration - Strip Curtain	Refrigeration	4%	2%	5%	56%	$0.02	8	0.96
Retrocommissioning - Comprehensive	Cooling	12%	0%	40%	90%	$0.35	4	1.06
Retrocommissioning - Comprehensive	Space Heating	12%	9%	40%	90%	$0.35	4	1.06
Retrocommissioning - Comprehensive	Interior Lighting	12%	9%	40%	90%	$0.35	4	1.06
Office Equipment - Energy Star Power Supply	Office Equipment	1%	1%	10%	95%	$0.00	7	68.11
Vending Machine - Controller	Refrigeration	15%	11%	2%	10%	$0.27	10	1.11
LED Exit Lighting	Interior Lighting	2%	2%	9%	86%	$0.00	10	12.29
Retrocommissioning - Lighting	Interior Lighting	9%	6%	5%	90%	$0.05	5	3.07
Retrocommissioning - Lighting	Exterior Lighting	9%	6%	5%	90%	$0.05	5	3.07
Refrigeration - High Efficiency Case Lighting	Refrigeration	4%	2%	5%	75%	$0.20	8	0.52
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	1.14
Exterior Lighting - Induction Lamps	Exterior Lighting	3%	3%	5%	56%	$0.00	5	6.50
Laundry - High Efficiency Clothes Washer	Miscellaneous	0%	0%	5%	10%	$0.00	10	33.94
Interior Lighting - Hotel Guestroom Controls	Interior Lighting	10%	5%	1%	2%	$0.14	8	0.32
Miscellaneous - Energy Star Water Cooler	Miscellaneous	0%	0%	5%	95%	$0.00	8	1.78
Industrial Process Improvements	Miscellaneous	10%	8%	0%	5%	$0.52	10	1.18
Custom Measures	Cooling	10%	0%	10%	45%	$0.90	15	0.99
Custom Measures	Space Heating	10%	8%	10%	45%	$0.90	15	0.99
Custom Measures	Interior Lighting	10%	8%	10%	45%	$0.90	15	0.99
Custom Measures	Food Preparation	10%	8%	10%	45%	$0.90	15	0.99
Custom Measures	Refrigeration	10%	8%	10%	45%	$0.90	15	0.99
Water Heater - Heat Pump	Water Heating	30%	15%	0%	28%	$0.80	15	0.77
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	0%	$4.00	15	0.59
Furnace - Convert to Gas	Space Heating	100%	100%	0%	0%	$6.00	15	1.04

Note: Costs are per sq. ft.

Table D-12 Energy Efficiency Measure Data — Extra Large Comm., Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
RTU - Maintenance	Cooling	14%	0%	47%	90%	$0.06	4	1.15
RTU - Evaporative Precooler	Cooling	10%	0%	0%	0%	$0.88	15	0.19
Chiller - Chilled Water Reset	Cooling	15%	0%	30%	75%	$0.09	4	0.79
Chiller - Chilled Water Variable-Flow System	Cooling	8%	0%	30%	34%	$0.09	10	1.00
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	75%	$0.90	20	0.66
Chiller - VSD	Cooling	28%	0%	3%	75%	$1.17	20	0.47
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	25%	37%	$0.04	10	0.01
Chiller - Condenser Water Temprature Reset	Cooling	9%	0%	0%	75%	$0.09	14	1.49
Cooling - Economizer Installation	Cooling	11%	0%	73%	81%	$0.15	15	1.20
Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	5%	95%	$0.06	4	2.91
Insulation - Ducting	Cooling	8%	0%	2%	50%	$0.41	20	0.77
Insulation - Ducting	Space Heating	3%	1%	2%	50%	$0.41	20	0.77
Repair and Sealing - Ducting	Cooling	5%	0%	5%	25%	$0.38	15	0.65
Repair and Sealing - Ducting	Space Heating	5%	3%	5%	25%	$0.38	15	0.65
Energy Management System	Cooling	12%	0%	80%	90%	$0.35	14	1.21
Energy Management System	Space Heating	9%	6%	80%	90%	$0.35	14	1.21
Energy Management System	Interior Lighting	5%	3%	80%	90%	$0.35	14	1.21
Cooking - Exhaust Hoods with Sensor Control	Ventilation	13%	7%	1%	8%	$0.04	10	3.46
Fans - Energy Efficient Motors	Ventilation	5%	5%	11%	90%	$0.05	10	1.30
Fans - Variable Speed Control	Ventilation	15%	5%	2%	90%	$0.20	10	0.83
Retrocommissioning - HVAC	Cooling	12%	0%	15%	90%	$0.20	4	1.00
Retrocommissioning - HVAC	Space Heating	12%	9%	15%	90%	$0.20	4	1.00
Retrocommissioning - HVAC	Ventilation	9%	6%	15%	90%	$0.20	4	1.00
Pumps - Variable Speed Control	Miscellaneous	1%	0%	1%	34%	$0.44	10	1.01
Thermostat - Clock/Programmable	Cooling	3%	0%	25%	50%	$0.13	11	0.69
Thermostat - Clock/Programmable	Space Heating	3%	1%	25%	50%	$0.13	11	0.69
Insulation - Ceiling	Cooling	1%	0%	2%	9%	$0.85	20	0.48
Insulation - Ceiling	Space Heating	12%	3%	2%	9%	$0.85	20	0.48
Insulation - Radiant Barrier	Cooling	1%	0%	2%	13%	$0.26	20	0.57
Insulation - Radiant Barrier	Space Heating	4%	2%	2%	13%	$0.26	20	0.57
Roofs - High Reflectivity	Cooling	10%	0%	0%	95%	$0.18	15	0.90
Windows - High Efficiency	Cooling	6%	0%	95%	100%	$2.10	20	0.37
Windows - High Efficiency	Space Heating	2%	2%	95%	100%	$2.10	20	0.37
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	78%	90%	$0.65	8	0.26
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	Interior Lighting	25%	13%	3%	45%	$0.40	8	0.72
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	2%	10%	$0.29	8	0.45
Interior Fluorescent - Delamp and Install Reflectors	Interior Lighting	30%	15%	3%	25%	$0.50	11	0.93
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	Interior Lighting	10%	5%	10%	23%	$0.20	8	0.57
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	23%	$0.56	11	1.38
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	42%	45%	$0.20	8	0.84
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.23
Interior Screw-in - Task Lighting	Interior Lighting	10%	5%	5%	75%	$0.24	5	0.18
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	12%	56%	$0.20	8	0.42
Water Heater - Faucet Aerators/Low Flow Nozzles	Water Heating	4%	1%	2%	90%	$0.03	9	2.66
Water Heater - Pipe Insulation	Water Heating	6%	3%	0%	0%	$0.28	15	0.70
Water Heater - High Efficiency Circulation Pump	Water Heating	5%	4%	0%	23%	$0.11	10	1.19
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$0.04	10	5.48
Water Heater - Thermostat Setback	Water Heating	4%	0%	0%	0%	$0.11	10	0.72
Water Heater - Hot Water Saver	Water Heating	5%	1%	0%	0%	$0.04	5	1.45
Refrigeration - Anti-Sweat Heater/Auto Door Closer	Refrigeration	5%	3%	10%	75%	$0.20	16	0.02
Refrigeration - Floating Head Pressure	Refrigeration	7%	4%	10%	38%	$0.35	16	0.34
Refrigeration - Door Gasket Replacement	Refrigeration	4%	2%	5%	75%	$0.10	8	0.13
Insulation - Bare Suction Lines	Refrigeration	3%	2%	5%	75%	$0.10	8	0.28
Refrigeration - Night Covers	Refrigeration	6%	3%	5%	75%	$0.05	8	0.29
Refrigeration - Strip Curtain	Refrigeration	4%	2%	5%	56%	$0.02	8	0.18
Retrocommissioning - Comprehensive	Cooling	12%	0%	40%	90%	$0.25	4	1.21
Retrocommissioning - Comprehensive	Space Heating	12%	9%	40%	90%	$0.25	4	1.21
Retrocommissioning - Comprehensive	Interior Lighting	12%	9%	40%	90%	$0.25	4	1.21
Office Equipment - Energy Star Power Supply	Office Equipment	1%	1%	10%	95%	$0.00	7	39.11
Vending Machine - Controller	Refrigeration	15%	11%	2%	10%	$0.27	10	1.12
LED Exit Lighting	Interior Lighting	2%	2%	9%	86%	$0.00	10	18.34
Retrocommissioning - Lighting	Interior Lighting	9%	6%	5%	90%	$0.05	5	2.54
Retrocommissioning - Lighting	Exterior Lighting	9%	6%	5%	90%	$0.05	5	2.54
Refrigeration - High Efficiency Case Lighting	Refrigeration	4%	2%	5%	75%	$0.20	8	0.04
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	1.61
Exterior Lighting - Induction Lamps	Exterior Lighting	3%	3%	5%	56%	$0.00	5	6.95
Laundry - High Efficiency Clothes Washer	Miscellaneous	0%	0%	5%	10%	$0.00	10	20.31
Interior Lighting - Hotel Guestroom Controls	Interior Lighting	10%	5%	0%	0%	$0.14	8	0.47
Miscellaneous - Energy Star Water Cooler	Miscellaneous	0%	0%	5%	95%	$0.00	8	1.07
Industrial Process Improvements	Miscellaneous	10%	8%	0%	0%	$0.52	10	1.11
Custom Measures	Cooling	10%	0%	10%	45%	$0.67	15	1.09
Custom Measures	Space Heating	10%	8%	10%	45%	$0.67	15	1.09
Custom Measures	Interior Lighting	10%	8%	10%	45%	$0.67	15	1.09
Custom Measures	Food Preparation	10%	8%	10%	45%	$0.67	15	1.09
Custom Measures	Refrigeration	10%	8%	10%	45%	$0.67	15	1.09
Water Heater - Heat Pump	Water Heating	30%	15%	0%	41%	$0.80	15	1.28
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	0%	$4.00	15	1.00
Furnace - Convert to Gas	Space Heating	100%	100%	0%	0%	$4.00	15	1.66

Note: Costs are per sq. ft.

Table D-13 Energy Efficiency Measure Data — Extra Large Industrial, Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Refrigeration - System Controls	Process	11%	8%	5%	34%	$0.40	10	18.09
Refrigeration - System Maintenance	Process	3%	2%	5%	34%	$0.00	10	2,067.93
Refrigeration - System Optimization	Process	15%	11%	5%	34%	$0.80	10	12.92
Motors - Variable Frequency Drive	Machine Drive	13%	9%	25%	38%	$0.10	10	3.38
Motors - Magnetic Adjustable Speed Drives	Machine Drive	13%	9%	25%	38%	$0.10	10	3.38
Compressed Air - System Controls	Machine Drive	9%	7%	5%	34%	$0.40	10	0.59
Compressed Air - System Optimization and Improvements	Machine Drive	13%	9%	5%	34%	$0.80	10	0.42
Compressed Air - System Maintenance	Machine Drive	3%	2%	5%	34%	$0.20	10	0.34
Compressed Air - Compressor Replacement	Machine Drive	5%	4%	5%	34%	$0.20	10	0.68
Fan System - Controls	Machine Drive	4%	3%	10%	38%	$0.35	10	0.11
Fan System - Controls	Machine Drive	4%	3%	10%	38%	$0.35	10	0.11
Fan System - Optimization	Machine Drive	6%	5%	10%	38%	$0.70	10	0.08
Fan System - Optimization	Machine Drive	6%	5%	10%	38%	$0.70	10	0.08
Fan System - Maintenance	Machine Drive	1%	1%	10%	38%	$0.15	10	0.07
Fan System - Maintenance	Machine Drive	1%	1%	10%	38%	$0.15	10	0.07
Pumping System - Controls	Machine Drive	5%	4%	5%	34%	$0.38	12	0.43
Pumping System - Optimization	Machine Drive	13%	9%	5%	34%	$0.75	12	0.54
Pumping System - Maintenance	Machine Drive	2%	1%	5%	34%	$0.19	10	0.27
RTU - Maintenance	Cooling	14%	0%	22%	90%	$0.06	4	3.18
Chiller - Chilled Water Reset	Cooling	14%	0%	30%	75%	$0.09	4	2.69
Chiller - Chilled Water Variable-Flow System	Cooling	5%	0%	30%	34%	$0.20	10	1.05
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	67%	$0.90	20	2.48
Chiller - VSD	Cooling	26%	0%	15%	67%	$1.17	20	1.68
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	25%	50%	$0.04	10	0.03
Chiller - Condenser Water Temprature Reset	Cooling	10%	0%	0%	75%	$0.20	14	2.72
Cooling - Economizer Installation	Cooling	6%	0%	29%	34%	$0.15	15	2.02
Heat Pump - Maintenance	Combined Heating/Cooling	7%	7%	2%	95%	$0.03	4	8.67
Insulation - Ducting	Space Heating	6%	6%	12%	50%	$0.41	20	1.01
Insulation - Ducting	Cooling	3%	0%	12%	50%	$0.41	20	1.01
Repair and Sealing - Ducting	Cooling	2%	0%	5%	25%	$0.38	15	0.63
Repair and Sealing - Ducting	Space Heating	2%	1%	5%	25%	$0.38	15	0.63
Energy Management System	Cooling	6%	0%	11%	90%	$0.35	14	1.09
Energy Management System	Space Heating	5%	3%	11%	90%	$0.35	14	1.09
Energy Management System	Interior Lighting	2%	1%	11%	90%	$0.35	14	1.09
Fans - Energy Efficient Motors	Ventilation	5%	5%	2%	90%	$0.14	10	2.94
Fans - Variable Speed Control	Ventilation	15%	5%	3%	90%	$0.20	10	5.29
Retrocommissioning - HVAC	Cooling	12%	0%	1%	70%	$0.25	4	1.54
Retrocommissioning - HVAC	Space Heating	12%	9%	1%	70%	$0.25	4	1.54
Retrocommissioning - HVAC	Ventilation	9%	6%	1%	70%	$0.25	4	1.54
Pumps - Variable Speed Control	Machine Drive	5%	4%	0%	34%	$0.44	10	0.31
Thermostat - Clock/Programmable	Cooling	5%	0%	59%	70%	$0.13	11	2.11
Thermostat - Clock/Programmable	Space Heating	5%	1%	59%	70%	$0.13	11	2.11
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	84%	90%	$0.65	8	0.17
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	2%	27%	$0.08	8	0.46
Interior Fluorescent - Delamp and Install Reflectors	Interior Lighting	20%	10%	17%	38%	$0.50	11	0.31
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	38%	$0.20	11	1.95
LED Exit Lighting	Interior Lighting	2%	2%	9%	86%	$0.00	10	4.00
Retrocommissioning - Lighting	Interior Lighting	9%	6%	9%	70%	$0.05	5	1.44
Retrocommissioning - Lighting	Exterior Lighting	9%	6%	9%	70%	$0.05	5	1.44
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	15%	45%	$0.20	8	0.55
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.07
Interior Screw-in - Task Lighting	Interior Lighting	7%	4%	10%	75%	$0.24	5	0.03
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	2%	56%	$0.20	8	0.27
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	0.46
Custom Measures	Cooling	10%	0%	10%	45%	$1.60	15	1.63
Custom Measures	Space Heating	10%	8%	10%	45%	$1.60	15	1.63
Custom Measures	Interior Lighting	10%	8%	10%	45%	$1.60	15	1.63
Custom Measures	Machine Drive	10%	8%	10%	45%	$1.60	15	1.63
Furnace - Convert to Gas	Space Heating	100%	100%	0%	0%	$4.00	15	2.67

Note: Costs are per sq. ft.

Table D-14 Energy Efficiency Measure Data — Small/Medium Comm., New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
RTU - Maintenance	Cooling	14%	0%	14%	90%	$0.08	4	0.82
RTU - Evaporative Precooler	Cooling	10%	0%	0%	0%	$0.88	15	0.18
Chiller - Chilled Water Reset	Cooling	11%	0%	0%	0%	$0.86	4	0.06
Chiller - Chilled Water Variable-Flow System	Cooling	4%	0%	0%	0%	$0.86	10	0.05
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	0%	$0.90	20	0.63
Chiller - VSD	Cooling	26%	0%	0%	0%	$1.17	20	0.42
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	0%	0%	$0.04	10	0.01
Chiller - Condenser Water Temprature Reset	Cooling	8%	0%	0%	0%	$0.87	14	0.13
Cooling - Economizer Installation	Cooling	6%	0%	45%	49%	$0.15	15	0.65
Heat Pump - Maintenance	Combined Heating/Cooling	7%	7%	10%	95%	$0.03	4	4.32
Insulation - Ducting	Cooling	5%	0%	9%	50%	$0.41	20	0.64
Insulation - Ducting	Space Heating	3%	1%	9%	50%	$0.41	20	0.64
Energy Management System	Cooling	5%	0%	24%	75%	$0.35	14	0.55
Energy Management System	Space Heating	2%	1%	24%	75%	$0.35	14	0.55
Energy Management System	Interior Lighting	2%	1%	24%	75%	$0.35	14	0.55
Cooking - Exhaust Hoods with Sensor Control	Ventilation	25%	13%	1%	15%	$0.04	10	7.04
Fans - Energy Efficient Motors	Ventilation	5%	5%	11%	90%	$0.05	10	1.32
Fans - Variable Speed Control	Ventilation	15%	5%	8%	90%	$0.20	10	0.85
Commissioning - HVAC	Cooling	5%	0%	40%	75%	$0.90	25	0.33
Commissioning - HVAC	Space Heating	5%	4%	40%	75%	$0.90	25	0.33
Commissioning - HVAC	Ventilation	5%	4%	40%	75%	$0.90	25	0.33
Pumps - Variable Speed Control	Miscellaneous	1%	0%	5%	34%	$0.44	10	1.01
Thermostat - Clock/Programmable	Cooling	5%	0%	34%	50%	$0.13	11	1.06
Thermostat - Clock/Programmable	Space Heating	5%	1%	34%	50%	$0.13	11	1.06
Insulation - Ceiling	Cooling	1%	0%	10%	81%	$0.16	20	1.60
Insulation - Ceiling	Space Heating	15%	4%	10%	81%	$0.16	20	1.60
Insulation - Radiant Barrier	Cooling	2%	0%	7%	13%	$0.26	20	0.76
Insulation - Radiant Barrier	Space Heating	6%	2%	7%	13%	$0.26	20	0.76
Roofs - High Reflectivity	Cooling	7%	0%	5%	95%	$0.09	15	1.25
Windows - High Efficiency	Cooling	5%	0%	61%	75%	$0.35	20	0.69
Windows - High Efficiency	Space Heating	3%	2%	61%	75%	$0.35	20	0.69
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	81%	90%	$0.65	8	0.31
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	Interior Lighting	25%	13%	1%	45%	$0.38	8	1.07
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	10%	75%	$0.09	8	1.50
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	Interior Lighting	10%	5%	10%	23%	$0.50	8	0.32
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	23%	$0.70	11	1.56
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	7%	45%	$0.20	8	1.00
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.24
Interior Screw-in - Task Lighting	Interior Lighting	7%	4%	25%	75%	$0.24	5	0.08
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	9%	56%	$0.20	8	0.50
Water Heater - Faucet Aerators/Low Flow Nozzles	Water Heating	4%	1%	8%	90%	$0.01	9	4.22
Water Heater - Pipe Insulation	Water Heating	4%	2%	46%	50%	$0.28	15	0.24
Water Heater - High Efficiency Circulation Pump	Water Heating	5%	4%	0%	0%	$0.11	10	0.63
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	40%	50%	$0.02	10	5.80
Water Heater - Thermostat Setback	Water Heating	4%	0%	10%	75%	$0.11	10	0.38
Water Heater - Hot Water Saver	Water Heating	5%	1%	0%	0%	$0.02	5	1.53
Refrigeration - Anti-Sweat Heater/Auto Door Closer	Refrigeration	5%	3%	0%	75%	$0.20	16	1.09
Refrigeration - Floating Head Pressure	Refrigeration	7%	4%	18%	38%	$0.35	16	1.24
Refrigeration - Door Gasket Replacement	Refrigeration	4%	2%	5%	75%	$0.10	8	0.09
Insulation - Bare Suction Lines	Refrigeration	3%	2%	5%	75%	$0.10	8	0.20
Refrigeration - Night Covers	Refrigeration	6%	3%	5%	75%	$0.05	8	1.02
Refrigeration - Strip Curtain	Refrigeration	4%	2%	5%	56%	$0.02	8	0.00
Commissioning - Comprehensive	Cooling	10%	0%	40%	75%	$1.25	25	0.83
Commissioning - Comprehensive	Space Heating	10%	7%	40%	75%	$1.25	25	0.83
Commissioning - Comprehensive	Interior Lighting	10%	7%	40%	75%	$1.25	25	0.83
Office Equipment - Energy Star Power Supply	Office Equipment	1%	1%	10%	95%	$0.00	7	61.07
Vending Machine - Controller	Refrigeration	15%	11%	2%	10%	$0.27	10	1.08
LED Exit Lighting	Interior Lighting	2%	2%	85%	86%	$0.00	10	11.83
Commissioning - Lighting	Interior Lighting	5%	4%	30%	75%	$0.20	25	1.54
Commissioning - Lighting	Exterior Lighting	5%	4%	30%	75%	$0.20	25	1.54
Refrigeration - High Efficiency Case Lighting	Refrigeration	4%	2%	5%	75%	$0.20	8	0.00
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	1.23
Exterior Lighting - Induction Lamps	Exterior Lighting	3%	3%	5%	56%	$0.00	5	7.30
Laundry - High Efficiency Clothes Washer	Miscellaneous	0%	0%	5%	10%	$0.00	10	36.95
Interior Lighting - Hotel Guestroom Controls	Interior Lighting	10%	5%	0%	0%	$0.14	8	0.30
Miscellaneous - Energy Star Water Cooler	Miscellaneous	0%	0%	5%	95%	$0.00	8	1.95
Advanced New Construction Designs	Cooling	40%	0%	5%	75%	$2.00	35	2.01
Advanced New Construction Designs	Space Heating	40%	30%	5%	75%	$2.00	35	2.01
Advanced New Construction Designs	Interior Lighting	25%	19%	5%	75%	$2.00	35	2.01
Insulation - Wall Cavity	Cooling	1%	0%	10%	68%	$0.34	20	0.72
Insulation - Wall Cavity	Space Heating	10%	2%	10%	68%	$0.34	20	0.72
Roofs - Green	Cooling	7%	0%	2%	11%	$1.00	30	0.26
Roofs - Green	Space Heating	4%	3%	2%	11%	$1.00	30	0.26
Industrial Process Improvements	Miscellaneous	10%	8%	0%	23%	$0.52	10	1.16
Custom Measures	Cooling	8%	0%	10%	45%	$1.50	15	0.45
Custom Measures	Space Heating	8%	6%	10%	45%	$1.50	15	0.45
Custom Measures	Interior Lighting	8%	6%	10%	45%	$1.50	15	0.45
Custom Measures	Food Preparation	8%	6%	10%	45%	$1.50	15	0.45
Custom Measures	Refrigeration	8%	6%	10%	45%	$1.50	15	0.45
Water Heater - Heat Pump	Water Heating	30%	15%	0%	19%	$0.80	15	0.68
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$4.00	15	0.53
Furnace - Convert to Gas	Space Heating	100%	100%	0%	47%	$8.04	15	1.01

Note: Costs are per sq. ft.

Table D-15 Energy Efficiency Measure Data — Large Commercial, New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
RTU - Maintenance	Cooling	14%	0%	27%	90%	$0.06	4	1.13
RTU - Evaporative Precooler	Cooling	10%	0%	0%	0%	$0.88	15	0.19
Chiller - Chilled Water Reset	Cooling	18%	0%	30%	75%	$0.18	4	0.42
Chiller - Chilled Water Variable-Flow System	Cooling	5%	0%	30%	34%	$0.18	10	0.28
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	66%	$0.90	20	0.61
Chiller - VSD	Cooling	32%	0%	15%	66%	$1.17	20	0.50
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	15%	41%	$0.04	10	0.01
Chiller - Condenser Water Temprature Reset	Cooling	8%	0%	25%	75%	$0.18	14	0.63
Cooling - Economizer Installation	Cooling	11%	0%	44%	49%	$0.15	15	1.19
Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	10%	95%	$0.06	4	2.72
Insulation - Ducting	Cooling	4%	0%	8%	50%	$0.41	20	0.56
Insulation - Ducting	Space Heating	3%	1%	8%	50%	$0.41	20	0.56
Energy Management System	Cooling	21%	0%	48%	90%	$0.35	14	2.10
Energy Management System	Space Heating	8%	5%	48%	90%	$0.35	14	2.10
Energy Management System	Interior Lighting	9%	6%	48%	90%	$0.35	14	2.10
Cooking - Exhaust Hoods with Sensor Control	Ventilation	13%	7%	1%	11%	$0.04	10	2.84
Fans - Energy Efficient Motors	Ventilation	5%	5%	11%	90%	$0.05	10	1.07
Fans - Variable Speed Control	Ventilation	15%	5%	2%	90%	$0.20	10	0.68
Commissioning - HVAC	Cooling	5%	0%	50%	75%	$0.85	25	0.30
Commissioning - HVAC	Space Heating	5%	4%	50%	75%	$0.85	25	0.30
Commissioning - HVAC	Ventilation	5%	4%	50%	75%	$0.85	25	0.30
Pumps - Variable Speed Control	Miscellaneous	1%	0%	5%	34%	$0.13	10	1.05
Thermostat - Clock/Programmable	Cooling	5%	0%	33%	50%	$0.13	11	0.97
Thermostat - Clock/Programmable	Space Heating	5%	1%	33%	50%	$0.13	11	0.97
Insulation - Ceiling	Cooling	1%	0%	75%	81%	$0.35	20	0.60
Insulation - Ceiling	Space Heating	10%	3%	75%	81%	$0.35	20	0.60
Insulation - Radiant Barrier	Cooling	1%	0%	7%	13%	$0.26	20	0.56
Insulation - Radiant Barrier	Space Heating	5%	2%	7%	13%	$0.26	20	0.56
Roofs - High Reflectivity	Cooling	4%	0%	5%	95%	$0.05	15	1.28
Windows - High Efficiency	Cooling	12%	0%	72%	75%	$0.88	20	0.72
Windows - High Efficiency	Space Heating	11%	8%	72%	75%	$0.88	20	0.72
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	86%	90%	$0.65	8	0.30
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	Interior Lighting	25%	13%	1%	45%	$0.34	8	1.14
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	10%	19%	$0.19	8	0.57
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	Interior Lighting	10%	5%	10%	23%	$0.40	8	0.39
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	23%	$0.63	11	1.66
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	13%	45%	$0.20	8	0.99
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.19
Interior Screw-in - Task Lighting	Interior Lighting	10%	5%	10%	75%	$0.24	5	0.11
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	9%	56%	$0.20	8	0.49
Water Heater - Faucet Aerators/Low Flow Nozzles	Water Heating	4%	1%	3%	90%	$0.03	9	1.60
Water Heater - Pipe Insulation	Water Heating	4%	2%	0%	0%	$0.28	15	0.27
Water Heater - High Efficiency Circulation Pump	Water Heating	5%	4%	0%	23%	$0.11	10	0.69
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$0.04	10	3.23
Water Heater - Thermostat Setback	Water Heating	4%	0%	0%	0%	$0.11	10	0.44
Water Heater - Hot Water Saver	Water Heating	5%	1%	0%	3%	$0.04	5	0.87
Refrigeration - Anti-Sweat Heater/Auto Door Closer	Refrigeration	5%	3%	0%	75%	$0.20	16	0.58
Refrigeration - Floating Head Pressure	Refrigeration	7%	4%	38%	45%	$0.35	16	0.94
Refrigeration - Door Gasket Replacement	Refrigeration	4%	2%	5%	75%	$0.10	8	0.63
Insulation - Bare Suction Lines	Refrigeration	3%	2%	5%	75%	$0.10	8	0.35
Refrigeration - Night Covers	Refrigeration	6%	3%	5%	75%	$0.05	8	0.65
Refrigeration - Strip Curtain	Refrigeration	4%	2%	5%	56%	$0.02	8	0.94
Commissioning - Comprehensive	Cooling	10%	0%	40%	75%	$1.00	25	0.96
Commissioning - Comprehensive	Space Heating	10%	7%	40%	75%	$1.00	25	0.96
Commissioning - Comprehensive	Interior Lighting	10%	7%	40%	75%	$1.00	25	0.96
Office Equipment - Energy Star Power Supply	Office Equipment	1%	1%	10%	95%	$0.00	7	67.83
Vending Machine - Controller	Refrigeration	15%	11%	2%	10%	$0.27	10	1.09
LED Exit Lighting	Interior Lighting	2%	2%	85%	86%	$0.00	10	11.13
Commissioning - Lighting	Interior Lighting	5%	4%	60%	75%	$0.15	25	1.99
Commissioning - Lighting	Exterior Lighting	5%	4%	60%	75%	$0.15	25	1.99
Refrigeration - High Efficiency Case Lighting	Refrigeration	4%	2%	5%	75%	$0.20	8	0.52
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	1.03
Exterior Lighting - Induction Lamps	Exterior Lighting	3%	3%	5%	56%	$0.00	5	5.86
Laundry - High Efficiency Clothes Washer	Miscellaneous	0%	0%	5%	10%	$0.00	10	33.94
Interior Lighting - Hotel Guestroom Controls	Interior Lighting	10%	5%	1%	2%	$0.14	8	0.29
Miscellaneous - Energy Star Water Cooler	Miscellaneous	0%	0%	5%	95%	$0.00	8	1.78
Advanced New Construction Designs	Cooling	40%	0%	5%	75%	$2.00	35	1.84
Advanced New Construction Designs	Space Heating	40%	30%	5%	75%	$2.00	35	1.84
Advanced New Construction Designs	Interior Lighting	25%	19%	5%	75%	$2.00	35	1.84
Insulation - Wall Cavity	Cooling	1%	0%	9%	68%	$0.78	20	0.43
Insulation - Wall Cavity	Space Heating	10%	2%	9%	68%	$0.78	20	0.43
Roofs - Green	Cooling	4%	0%	2%	13%	$1.00	15	0.08
Roofs - Green	Space Heating	2%	2%	2%	13%	$1.00	15	0.08
Industrial Process Improvements	Miscellaneous	10%	8%	0%	5%	$0.52	10	1.18
Custom Measures	Cooling	8%	0%	10%	45%	$0.90	15	0.73
Custom Measures	Space Heating	8%	6%	10%	45%	$0.90	15	0.73
Custom Measures	Interior Lighting	8%	6%	10%	45%	$0.90	15	0.73
Custom Measures	Food Preparation	8%	6%	10%	45%	$0.90	15	0.73
Custom Measures	Refrigeration	8%	6%	10%	45%	$0.90	15	0.73
Water Heater - Heat Pump	Water Heating	30%	15%	0%	28%	$0.80	15	0.76
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	0%	$4.00	15	0.58
Furnace - Convert to Gas	Space Heating	100%	100%	0%	0%	$6.00	15	0.98

Note: Costs are per sq. ft.

Table D-16 Energy Efficiency Measure Data — Extra Large Commercial, New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
RTU - Maintenance	Cooling	14%	0%	47%	90%	$0.06	4	1.02
RTU - Evaporative Precooler	Cooling	10%	0%	0%	0%	$0.88	15	0.17
Chiller - Chilled Water Reset	Cooling	12%	0%	60%	75%	$0.09	4	0.61
Chiller - Chilled Water Variable-Flow System	Cooling	8%	0%	30%	34%	$0.09	10	0.95
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	75%	$0.90	20	0.64
Chiller - VSD	Cooling	28%	0%	3%	75%	$1.17	20	0.45
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	25%	37%	$0.04	10	0.01
Chiller - Condenser Water Temprature Reset	Cooling	8%	0%	25%	75%	$0.09	14	1.28
Cooling - Economizer Installation	Cooling	11%	0%	73%	81%	$0.15	15	1.14
Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	5%	95%	$0.06	4	2.61
Insulation - Ducting	Cooling	7%	0%	2%	50%	$0.41	20	0.71
Insulation - Ducting	Space Heating	3%	1%	2%	50%	$0.41	20	0.71
Energy Management System	Cooling	11%	0%	80%	90%	$0.35	14	0.94
Energy Management System	Space Heating	4%	2%	80%	90%	$0.35	14	0.94
Energy Management System	Interior Lighting	5%	3%	80%	90%	$0.35	14	0.94
Cooking - Exhaust Hoods with Sensor Control	Ventilation	13%	7%	1%	8%	$0.04	10	3.31
Fans - Energy Efficient Motors	Ventilation	5%	5%	11%	90%	$0.05	10	1.24
Fans - Variable Speed Control	Ventilation	15%	5%	2%	90%	$0.20	10	0.80
Commissioning - HVAC	Cooling	5%	0%	50%	75%	$0.70	25	0.42
Commissioning - HVAC	Space Heating	5%	4%	50%	75%	$0.70	25	0.42
Commissioning - HVAC	Ventilation	5%	4%	50%	75%	$0.70	25	0.42
Pumps - Variable Speed Control	Miscellaneous	1%	0%	1%	34%	$0.44	10	1.01
Thermostat - Clock/Programmable	Cooling	3%	0%	25%	50%	$0.13	11	0.67
Thermostat - Clock/Programmable	Space Heating	3%	1%	25%	50%	$0.13	11	0.67
Insulation - Ceiling	Cooling	1%	0%	2%	81%	$0.35	20	0.68
Insulation - Ceiling	Space Heating	10%	3%	2%	81%	$0.35	20	0.68
Insulation - Radiant Barrier	Cooling	1%	0%	2%	13%	$0.26	20	0.47
Insulation - Radiant Barrier	Space Heating	2%	1%	2%	13%	$0.26	20	0.47
Roofs - High Reflectivity	Cooling	10%	0%	5%	95%	$0.18	15	0.85
Windows - High Efficiency	Cooling	6%	0%	95%	100%	$1.69	20	0.38
Windows - High Efficiency	Space Heating	2%	2%	95%	100%	$1.69	20	0.38
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	78%	90%	$0.65	8	0.23
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	Interior Lighting	25%	13%	3%	45%	$0.30	8	0.86
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	10%	15%	$0.19	8	0.61
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	Interior Lighting	10%	5%	10%	23%	$0.20	8	0.52
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	23%	$0.56	11	1.24
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	42%	45%	$0.20	8	0.76
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.20
Interior Screw-in - Task Lighting	Interior Lighting	10%	5%	25%	75%	$0.24	5	0.16
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	12%	56%	$0.20	8	0.38
Water Heater - Faucet Aerators/Low Flow Nozzles	Water Heating	4%	1%	2%	90%	$0.03	9	2.63
Water Heater - Pipe Insulation	Water Heating	6%	3%	0%	0%	$0.28	15	0.69
Water Heater - High Efficiency Circulation Pump	Water Heating	5%	4%	0%	23%	$0.11	10	1.18
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$0.04	10	5.43
Water Heater - Thermostat Setback	Water Heating	4%	0%	0%	0%	$0.11	10	0.71
Water Heater - Hot Water Saver	Water Heating	5%	1%	0%	0%	$0.04	5	1.43
Refrigeration - Anti-Sweat Heater/Auto Door Closer	Refrigeration	5%	3%	10%	75%	$0.20	16	0.02
Refrigeration - Floating Head Pressure	Refrigeration	7%	4%	10%	38%	$0.35	16	0.32
Refrigeration - Door Gasket Replacement	Refrigeration	4%	2%	5%	75%	$0.10	8	0.12
Insulation - Bare Suction Lines	Refrigeration	3%	2%	5%	75%	$0.10	8	0.26
Refrigeration - Night Covers	Refrigeration	6%	3%	5%	75%	$0.05	8	0.27
Refrigeration - Strip Curtain	Refrigeration	4%	2%	5%	56%	$0.02	8	0.17
Commissioning - Comprehensive	Cooling	10%	0%	40%	75%	$0.80	25	1.05
Commissioning - Comprehensive	Space Heating	10%	7%	40%	75%	$0.80	25	1.05
Commissioning - Comprehensive	Interior Lighting	10%	7%	40%	75%	$0.80	25	1.05
Office Equipment - Energy Star Power Supply	Office Equipment	1%	1%	10%	95%	$0.00	7	38.86
Vending Machine - Controller	Refrigeration	15%	11%	2%	10%	$0.27	10	1.10
LED Exit Lighting	Interior Lighting	2%	2%	85%	86%	$0.00	10	16.52
Commissioning - Lighting	Interior Lighting	5%	4%	60%	75%	$0.10	25	2.47
Commissioning - Lighting	Exterior Lighting	5%	4%	60%	75%	$0.10	25	2.47
Refrigeration - High Efficiency Case Lighting	Refrigeration	4%	2%	5%	75%	$0.20	8	0.04
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	1.45
Exterior Lighting - Induction Lamps	Exterior Lighting	3%	3%	5%	56%	$0.00	5	6.26
Laundry - High Efficiency Clothes Washer	Miscellaneous	0%	0%	5%	10%	$0.00	10	20.31
Interior Lighting - Hotel Guestroom Controls	Interior Lighting	10%	5%	0%	0%	$0.14	8	0.42
Miscellaneous - Energy Star Water Cooler	Miscellaneous	0%	0%	5%	95%	$0.00	8	1.07
Advanced New Construction Designs	Cooling	40%	0%	5%	75%	$2.00	35	1.67
Advanced New Construction Designs	Space Heating	40%	30%	5%	75%	$2.00	35	1.67
Advanced New Construction Designs	Interior Lighting	25%	19%	5%	75%	$2.00	35	1.67
Insulation - Wall Cavity	Cooling	1%	0%	2%	68%	$0.09	20	1.73
Insulation - Wall Cavity	Space Heating	10%	2%	2%	68%	$0.09	20	1.73
Roofs - Green	Cooling	10%	0%	2%	13%	$1.00	15	0.20
Roofs - Green	Space Heating	5%	3%	2%	13%	$1.00	15	0.20
Industrial Process Improvements	Miscellaneous	10%	8%	0%	0%	$0.52	10	1.11
Custom Measures	Cooling	8%	0%	10%	45%	$0.67	15	0.81
Custom Measures	Space Heating	8%	6%	10%	45%	$0.67	15	0.81
Custom Measures	Interior Lighting	8%	6%	10%	45%	$0.67	15	0.81
Custom Measures	Food Preparation	8%	6%	10%	45%	$0.67	15	0.81
Custom Measures	Refrigeration	8%	6%	10%	45%	$0.67	15	0.81
Water Heater - Heat Pump	Water Heating	30%	15%	0%	41%	$0.80	15	1.27
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	0%	$4.00	15	1.00
Furnace - Convert to Gas	Space Heating	100%	100%	0%	0%	$4.00	15	1.57

Note: Costs are per sq. ft.

Table D-17 Energy Efficiency Measure Data — Extra Large Industrial, New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Refrigeration - System Controls	Process	11%	8%	5%	34%	$0.40	10	18.09
Refrigeration - System Maintenance	Process	3%	2%	5%	34%	$0.00	10	2,067.93
Refrigeration - System Optimization	Process	15%	11%	5%	34%	$0.80	10	12.92
Motors - Variable Frequency Drive	Machine Drive	13%	9%	25%	38%	$0.10	10	3.38
Motors - Magnetic Adjustable Speed Drives	Machine Drive	13%	9%	25%	38%	$0.10	10	3.38
Compressed Air - System Controls	Machine Drive	9%	7%	5%	34%	$0.40	10	0.59
Compressed Air - System Optimization and Improvements	Machine Drive	13%	9%	5%	34%	$0.80	10	0.42
Compressed Air - System Maintenance	Machine Drive	3%	2%	5%	34%	$0.20	10	0.34
Compressed Air - Compressor Replacement	Machine Drive	5%	4%	5%	34%	$0.20	10	0.68
Fan System - Controls	Machine Drive	4%	3%	10%	38%	$0.35	10	0.11
Fan System - Controls	Machine Drive	4%	3%	10%	38%	$0.35	10	0.11
Fan System - Optimization	Machine Drive	6%	5%	10%	38%	$0.70	10	0.08
Fan System - Optimization	Machine Drive	6%	5%	10%	38%	$0.70	10	0.08
Fan System - Maintenance	Machine Drive	1%	1%	10%	38%	$0.15	10	0.07
Fan System - Maintenance	Machine Drive	1%	1%	10%	38%	$0.15	10	0.07
Pumping System - Controls	Machine Drive	5%	4%	5%	34%	$0.38	12	0.42
Pumping System - Optimization	Machine Drive	13%	9%	5%	34%	$0.75	12	0.54
Pumping System - Maintenance	Machine Drive	2%	1%	5%	34%	$0.19	10	0.27
RTU - Maintenance	Cooling	14%	0%	22%	90%	$0.06	4	2.82
Chiller - Chilled Water Reset	Cooling	14%	0%	60%	75%	$0.09	4	2.53
Chiller - Chilled Water Variable-Flow System	Cooling	4%	0%	30%	34%	$0.20	10	0.80
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	67%	$0.90	20	2.40
Chiller - VSD	Cooling	27%	0%	25%	67%	$1.17	20	1.63
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	25%	50%	$0.04	10	0.04
Chiller - Condenser Water Temprature Reset	Cooling	10%	0%	5%	75%	$0.20	14	2.60
Cooling - Economizer Installation	Cooling	6%	0%	29%	34%	$0.15	15	1.92
Heat Pump - Maintenance	Combined Heating/Cooling	7%	7%	2%	95%	$0.03	4	7.76
Insulation - Ducting	Space Heating	5%	5%	12%	50%	$0.41	20	0.95
Insulation - Ducting	Cooling	3%	0%	12%	50%	$0.41	20	0.95
Energy Management System	Cooling	5%	0%	11%	90%	$0.35	14	0.88
Energy Management System	Space Heating	2%	1%	11%	90%	$0.35	14	0.88
Energy Management System	Interior Lighting	2%	1%	11%	90%	$0.35	14	0.88
Fans - Energy Efficient Motors	Ventilation	5%	5%	2%	90%	$0.14	10	2.81
Fans - Variable Speed Control	Ventilation	15%	5%	3%	90%	$0.34	10	2.97
Commissioning - HVAC	Cooling	5%	0%	60%	75%	$0.70	25	0.92
Commissioning - HVAC	Space Heating	5%	4%	60%	75%	$0.70	25	0.92
Commissioning - HVAC	Ventilation	5%	4%	60%	75%	$0.70	25	0.92
Pumps - Variable Speed Control	Machine Drive	5%	4%	0%	34%	$0.44	10	0.31
Thermostat - Clock/Programmable	Cooling	5%	0%	59%	70%	$0.13	11	2.02
Thermostat - Clock/Programmable	Space Heating	5%	1%	59%	70%	$0.13	11	2.02
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	84%	90%	$0.65	8	0.15
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	10%	40%	$0.08	8	0.42
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	38%	$0.20	11	1.76
LED Exit Lighting	Interior Lighting	2%	2%	85%	86%	$0.00	10	3.72
Commissioning - Lighting	Interior Lighting	5%	4%	60%	75%	$0.10	25	1.41
Commissioning - Lighting	Exterior Lighting	5%	4%	60%	75%	$0.10	25	1.41
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	15%	45%	$0.20	8	0.50
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.06
Interior Screw-in - Task Lighting	Interior Lighting	7%	4%	10%	75%	$0.24	5	0.03
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	2%	56%	$0.20	8	0.25
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	0.41
Advanced New Construction Designs	Cooling	40%	0%	5%	75%	$2.00	35	2.67
Advanced New Construction Designs	Space Heating	40%	30%	5%	75%	$2.00	35	2.67
Advanced New Construction Designs	Interior Lighting	25%	19%	5%	75%	$2.00	35	2.67
Custom Measures	Cooling	8%	0%	10%	45%	$1.60	15	1.28
Custom Measures	Space Heating	8%	6%	10%	45%	$1.60	15	1.28
Custom Measures	Interior Lighting	8%	6%	10%	45%	$1.60	15	1.28
Custom Measures	Machine Drive	8%	6%	10%	45%	$1.60	15	1.28
Furnace - Convert to Gas	Space Heating	100%	100%	0%	0%	$4.00	15	2.51

Note: Costs are per sq. ft.

APPENDIX | E

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ABOUT GLOBAL

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Global Energy Partners
An EnerNOC Company
500 Ygnacio Valley Road, Suite 450
Walnut Creek, CA 94596

P: 925.482.2000
F: 925.284.3147
E: gephq@gepllc.com

2011 Electric Integrated Resource Plan

Appendix E – North Idaho Transmission Study

Interoffice Memorandum
System Planning

MEMO: **SP-2011-08 Rev A**
DATE: **August 11, 2011**
TO: **James Gall, IRP Group**
FROM: **Reuben Arts**
SUBJECT: **500 MW of New Generation in the Rathdrum Area**

Introduction

Based on initial 2011 IRP analysis 200 MW of new capacity is required in 2019-2020 and an additional 300 MW of capacity in the 2022-2024 time period. North Idaho is one of several potential locations this capacity could be added, but requires further detail to understand its potential.

Problem Statement

The IRP group is specifically interested in the cost for both the point of integration (POI) station and associated system upgrades, to integrate the new generation with the following options:

1. Cabinet-Rathdrum 230 kV transmission line (assume 5 miles from Rathdrum)
2. Rathdrum-Boulder 230 kV transmission line (assume Lancaster looped in, and assume the generation is half way between Lancaster and Rathdrum)
3. Rathdrum-Beacon 230 kV transmission line (assume 1-2 miles from Rathdrum)
4. Double Tap, Rathdrum-Boulder and Rathdrum-Beacon 230 kV transmission lines (again assume Lancaster is looped in and that the new generation will tap between Lancaster and Rathdrum)
5. Mixed location. 300 MW at the least cost option (between 1 and 4) and an additional 200 MW on the Cabinet-Rathdrum 230 kV transmission line.
6. Other Transmission Alternatives

Power Flow Analysis

The case that was used to highlight the impacts of an additional 500 MW in the Rathdrum area was the WECC approved and Avista modified light summer high flow case (AVA-11ls1ae-12BA1251-WOH4277). The West of Hatwai path typically experiences high flows during light Avista load hours. High West of Hatwai flows tend to coincide with high Western Montana Hydro generation, high Boundary generation, high flows on Montana to Northwest, and light loads in Eastern Washington, North Idaho, and Montana. Existing Clark Fork RAS is in place, and assumed armed, since the Western Montana Hydro (WMH) complex is greater than 1450 MW. Since the New Project would require significant Avista system transmission changes, and RAS changes, the results are listed as though RAS were not armed. This does affect the results of some contingencies, but ultimately does not change the conclusions of this memo.

Option 1

Perhaps one of the worst performing arrangements is option 1.This option immediately requires another line, or a line reconductor, from the 500 MW project back to Rathdrum. In order to stay within N-0 thermal limits the project can only be 175 MW without any system upgrades. In a high flow, N-0 scenario, the line segment from the project back to Rathdrum loads to around 163%, which is roughly 272 MW overloaded. There are a handful of N-1 and N-2 contingencies that cause significant thermal violations, the worst N-1 being the loss of the 230 kV transmission line from the new project to Rathdrum. See Figure 1

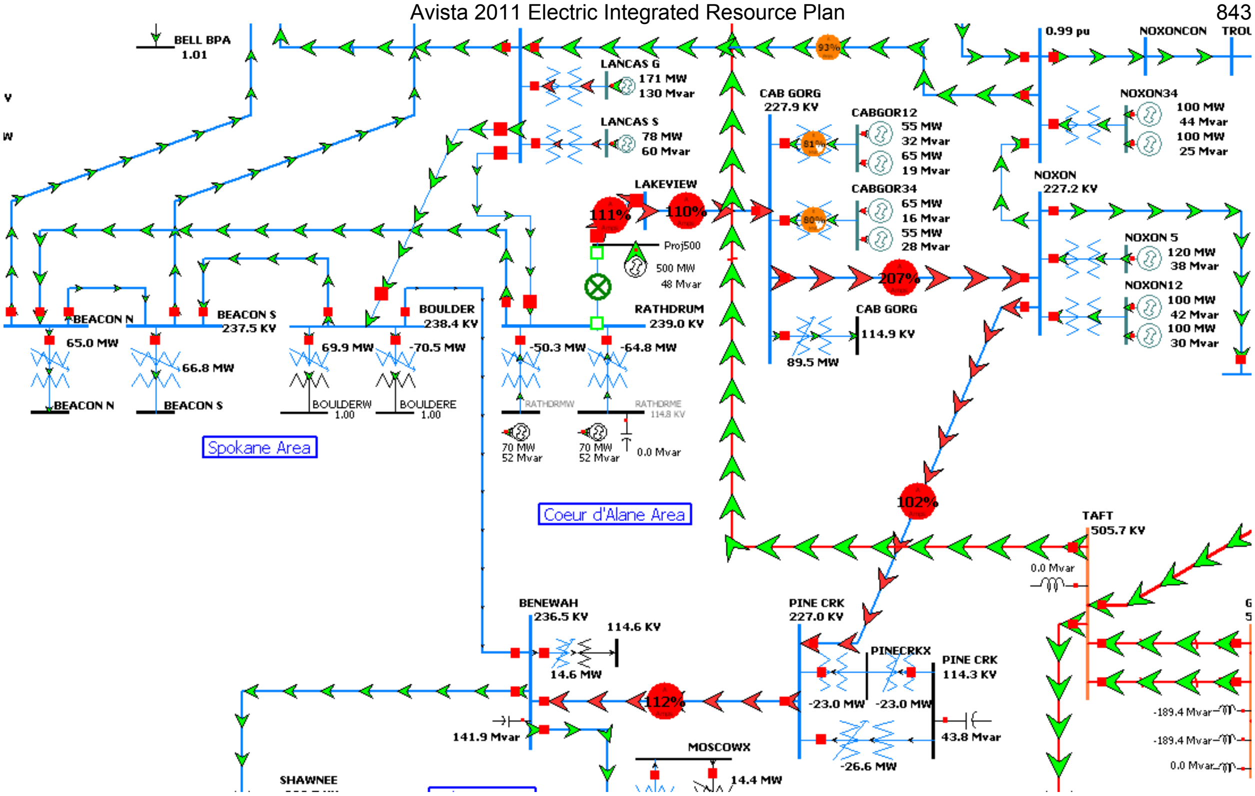

Figure 1 – N-1 Contingency

In addition to this worst case outage there are two N-2 scenarios that cause fairly significant problems as well. The Beacon-Rathdrum and Boulder-Lancaster-Rathdrum 230 kV transmission lines share a common structure for the majority of the line lengths. Losing both lines to the west of Lancaster causes the Bell S3-Lancaster 230 kV transmission line to overload. Losing both lines to the east of Lancaster, causes nearly the same scenario as shown in Figure 1.

To alleviate these overloads three new 230 kV transmission lines, would need to be built. First the Rathdrum-New Project 230 kV transmission line must be reconductored at a cost of roughly $2.25M. Second, A 230 kV transmission line, with new right-of-way, must be built from the New Project to Lancaster. The estimated distance for this line is roughly 5 miles. The estimated loaded cost for this line, including a new line position at Lancaster and at the New Project, is roughly $9M. Finally, another 230 kV transmission line, again with new right-of-way, is required from Lancaster to Boulder. This line length is estimate at roughly 15 miles. The estimated loaded cost of the new line, including new line positions, is roughly $17M. New right-of-way in this area will be difficult to obtain, which would have the potential of more than doubling costs.

RAS may be a viable solution. If at all possible RAS should be a last resort. Unlike improving our transmission system, RAS does not provide operational flexibility and in some cases can compound the impacts of future generation needs. However, it does represent the cheapest solution and is therefore listed as solution 1.

Option 1	N-0 Max. Output	Facility Requirement[1]	Total[2] ($000)
Solution 1	500 MW	Reconductor 230 kV transmission line from new station to Rathdrum, New 230 kV DB-DB Station and RAS[3]	13,250
Solution 2	500 MW	Reconductor from Rathdrum-New Project. New line from Lancaster to New Project. New line from Lancaster to Boulder, New 230 kV DB-DB Station	36,250

Option 2

This option would tap the Rathdrum-Boulder, or what soon will be the Rathdrum-Lancaster-Boulder, 230 kV transmission line. This options has no N-0 issues at the full requested 500 MW. There are a handful of N-1 and N-2 contingencies that cause significant thermal violations, the worst being the loss of the Lancaster-Boulder & Rathdrum-Beacon 230 kV transmission lines. These lines share a common structure and therefore represent a credible N-2 scenario. This outage causes the Lancaster-Bell S3 230 kV transmission line to load to 189%, or roughly 450 MW above its thermal limit. See Figure 2.

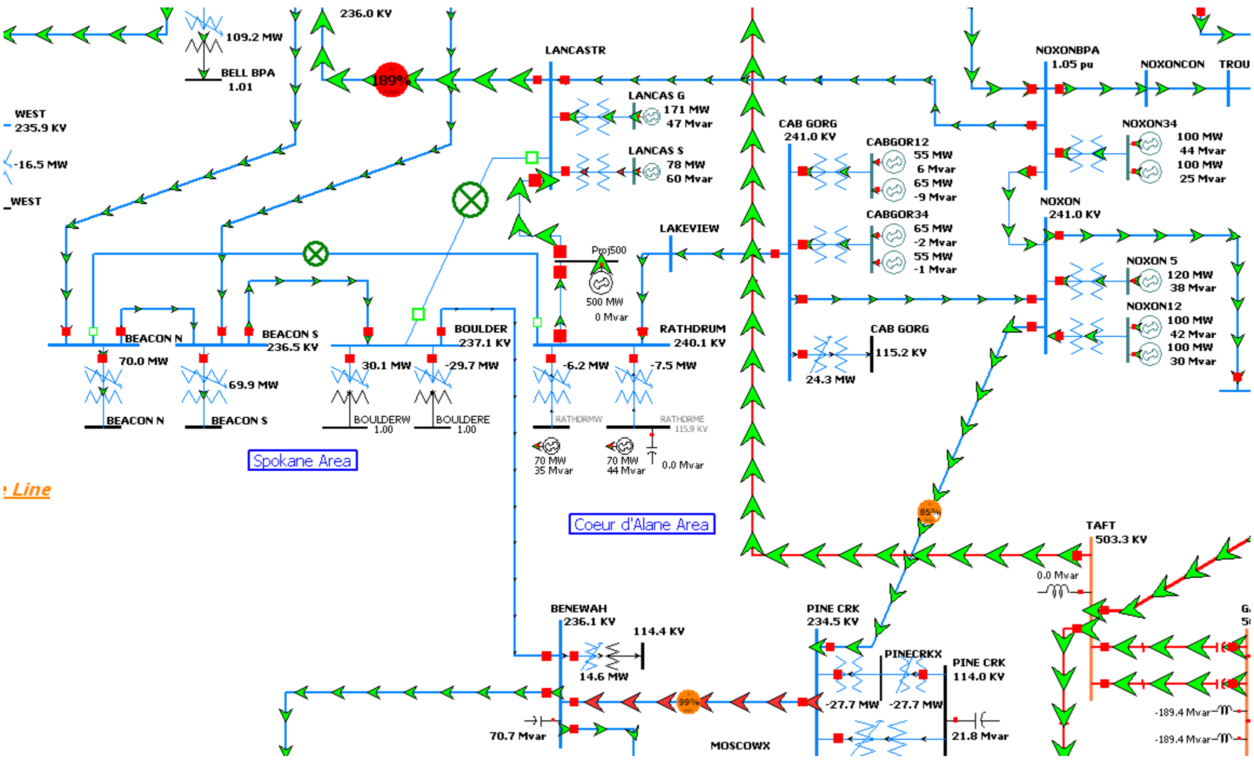

Figure 2 - N-2 Contingency

To alleviate these overloads two new 230 kV transmission lines, would need to be built. A 230 kV transmission line, with new right-of-way, must be built from the New Project to Lancaster. The estimated distance for this line is roughly 3 miles. The estimated loaded cost for this line, including a new line position at Lancaster and at the New Project, is roughly $8M. Another 230 kV transmission line, again with new right-of-way, is required from Lancaster to Boulder. This line length is estimate at roughly 15 miles. The estimated loaded cost of the new line, including new line positions, is roughly $17M. New right-of-way in this area will be difficult to obtain, which would have the potential of more than doubling costs.

[1] Cost estimates do not include costs of the radial line to the POI, the generator or generator station if applicable.
[2] Total is for network and direct assigned costs, are in 2011 dollars, and is +/- 50%.
[3] The RAS portion is a worst case scenario where another fiber loop is required. $3M allocated for RAS.

RAS may be a viable solution. If at all possible RAS should be a last resort. Unlike improving our transmission system, RAS does not provide operational flexibility and in some cases can compound the impacts of future generation needs. However, it does represent the cheapest solution and is therefore listed as solution 1.

Option 2	N-0 Max. Output	Facility Requirement[4]	Total[5] ($000)
Solution 1	500 MW	New 230 kV DB-DB Station and RAS[6]	11,000
Solution 2	500 MW	New line from Lancaster to New Project. New line from Lancaster to Boulder, New 230 kV DB-DB Station	33,000

Option 3

This option taps the Rathdrum-Beacon 230 kV transmission line. Again, this options has no N-0 issues at the full requested 500 MW. There are a handful of N-1 and N-2 contingencies that cause significant thermal violations, the worst being the loss of the Beacon-New Project & Rathdrum-Lancaster 230 kV transmission lines. These lines share a common structure and therefore represent a credible N-2 scenario. This outage forces the entire proposed 500 MW toward Cabinet and Noxon. This causes overloads on the Cabinet-Noxon and Pine Creek-Benewah 230 kV transmission lines. See Figure 3.

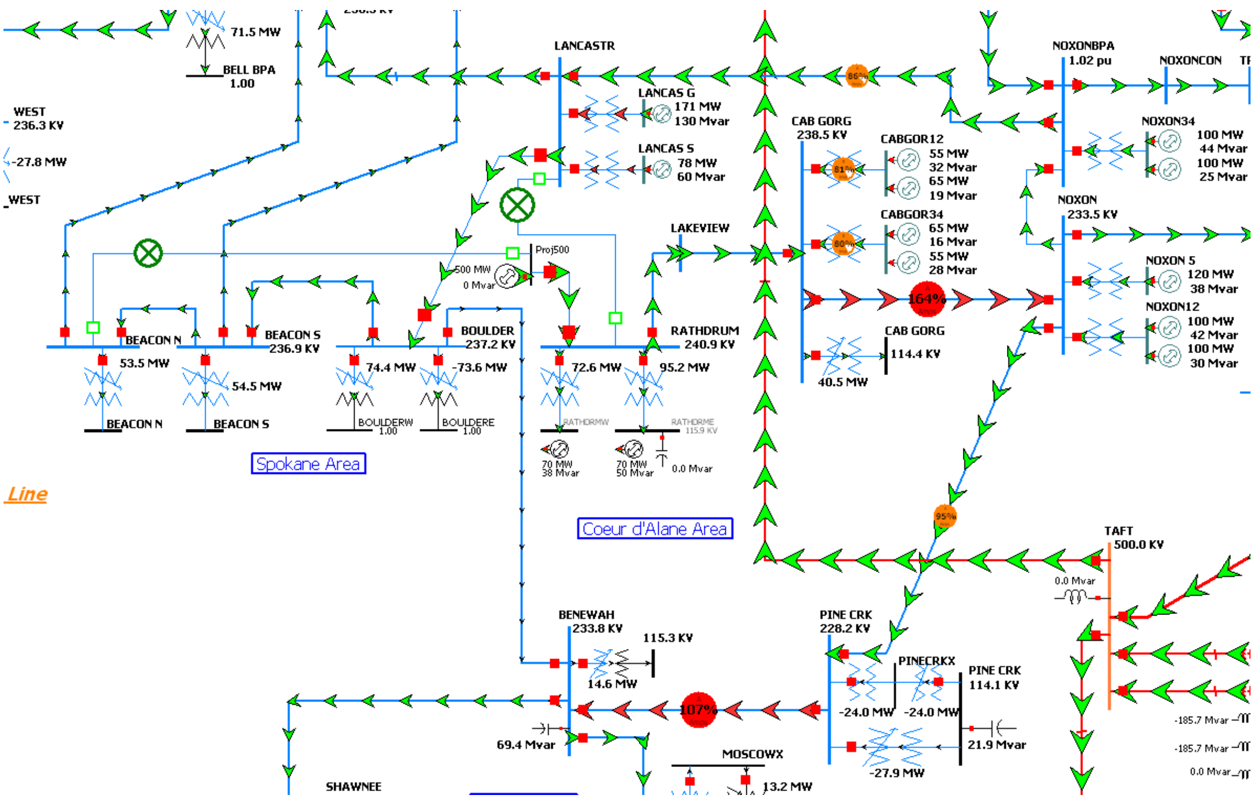

Figure 3 - N-2 Contingency

[4] Cost estimates do not include costs of the radial line to the POI, the generator or generator station if applicable.
[5] Total is for network and direct assigned costs, are in 2011 dollars, and is +/- 50%.
[6] The RAS portion is a worst case scenario where another fiber loop is required. $3M allocated for RAS.

To alleviate these overloads two new 230 kV transmission lines, would need to be built. A 230 kV transmission line, with new right-of-way, must be built from the New Project to Lancaster. The estimated distance for this line is roughly 3 miles. The estimated loaded cost for this line, including a new line position at Lancaster and at the New Project, is roughly $8M. Another 230 kV transmission line, again with new right-of-way, is required from Lancaster to Boulder. This line length is estimate at roughly 15 miles. The estimated loaded cost of the new line, including new line positions, is roughly $17M. New right-of-way in this area will be difficult to obtain, which would have the potential of more than doubling costs.

RAS may be a viable solution. If at all possible RAS should be a last resort. Unlike improving our transmission system, RAS does not provide operational flexibility and in some cases can compound the impacts of future generation needs. However, it does represent the cheapest solution and is therefore listed as solution 1.

Option 3	N-0 Max. Output	Facility Requirement[7]	Total[8] ($000)
Solution 1	500 MW	New 230 kV DB-DB Station and RAS[9]	11,000
Solution 2	500 MW	New line from Lancaster to New Project. New line from Lancaster to Boulder, New 230 kV DB-DB Station	33,000

Option 4

This option taps the Rathdrum-Beacon & Rathdrum-Lancaster 230 kV transmission lines. This options has no N-0 issues at the full requested 500 MW. There are a handful of N-1 and N-2 contingencies that cause significant thermal violations, the worst being the loss of the Beacon-New Project & Lancaster-New Project 230 kV transmission lines. These lines share a common structure and therefore represent a credible N-2 scenario. This outage forces the entire proposed 500 MW toward Cabinet and Noxon. This causes overloads on the Cabinet-Noxon and Pine Creek-Benewah 230 kV transmission lines. (Very similar to Figure 3 on the previous page).

To alleviate these overloads two new 230 kV transmission lines, would need to be built. A 230 kV transmission line, with new right-of-way, must be built from the New Project to Lancaster. The estimated distance for this line is roughly 3 miles. The estimated loaded cost for this line, including a new line position at Lancaster and at the New Project, is roughly $8M. Another 230 kV transmission line, again with new right-of-way, is required from Lancaster to Boulder. This line length is estimate at roughly 15 miles. The estimated loaded cost of the new line, including new line positions, is roughly $17M. New right-of-way in this area will be difficult to obtain, which would have the potential of more than doubling costs.

RAS may be a viable solution. If at all possible RAS should be a last resort. Unlike improving our transmission system, RAS does not provide operational flexibility and in some cases can compound the impacts of future generation needs. However, it does represent the cheapest solution and is therefore listed as solution 1.

Option 4	N-0 Max. Output	Facility Requirement	Total ($000)
Solution 1	500 MW	New 230 kV DB-DB Station and RAS	15,000
Solution 2	500 MW	New line from Lancaster to New Project. New line from Lancaster to Boulder, New 230 kV DB-DB Station	37,000

[7] Cost estimates do not include costs of the radial line to the POI, the generator or generator station if applicable.
[8] Total is for network and direct assigned costs, are in 2011 dollars, and is +/- 50%.
[9] The RAS portion is a worst case scenario where another fiber loop is required. $3M allocated for RAS.

Option 5

This option taps the Rathdrum-Beacon & Rathdrum-Cabinet 230 kV transmission lines. A new switching station is required for each tap. A 300 MW generating station would be on the Beacon-Rathdrum 230 kV transmission line and 200 MW would be on the Rathdrum-Cabinet 230 kV transmission line. This option has no N-0 issues at the full requested 500 MW. There are a handful of N-1 and N-2 contingencies that cause significant thermal violations, the worst being the loss of the Beacon-New Project & Lancaster-Rathdrum 230 kV transmission lines. These lines share a common structure and therefore represent a credible N-2 scenario. This outage forces the entire proposed 500 MW toward Cabinet and Noxon. This causes overloads on the Cabinet-Noxon and Pine Creek-Benewah 230 kV transmission lines. (Very similar to what was shown in Figure 3).

To alleviate these overloads three new 230 kV transmission lines, would need to be built. A 230 kV transmission line, with new right-of-way, must be built from the New Project (300MW piece) to Lancaster. The estimated distance for this line is roughly 5 miles. The estimated loaded cost for this line, including a new line position at Lancaster and at the New Project, is roughly $9M. Another 230 kV transmission line, again with new right-of-way, is required from Lancaster to Boulder. This line length is estimate at roughly 15 miles. The estimated loaded cost of the new line, including new line positions, is roughly $17M. Finally, for the loss of the Rathdrum-New Project (200MW piece) 230 kV transmission line, causes the Cabinet-Noxon 230 kV transmission line to load to 117%. To alleviate this overload a new line, with new right-of-way must be built back to Rathdrum. The estimated loaded cost of this 5 mile line, along with associated line positions, is $9M. New right-of-way in this area will be difficult to obtain, which would have the potential of more than doubling costs.

RAS may be a viable solution. If at all possible RAS should be a last resort. Unlike improving our transmission system, RAS does not provide operational flexibility and in some cases can compound the impacts of future generation needs. However, it does represent the cheapest solution and is therefore listed as solution 1.

Option 5	N-0 Max. Output	Facility Requirement[10]	Total[11] ($000)
Solution 1	500 MW	Two New 230 kV DB-DB Stations and RAS[12]	22,000
Solution 2	500 MW	Two New 230 kV DB-DB Stations, New line from Lancaster to New Project (300MW). New line from Lancaster to Boulder, New line from New Project (200MW) to Rathdrum	51,000

Option 6 – Other Transmission Alternatives

In addition to the five options listed, there are a few more options that may seem to be intuitive interconnection points. These integration options are:

a. Lancaster 230 kV (BPA) switching station
b. Rathdrum 230/115/13.2 kV substation
c. Cabinet-Rathdrum & Noxon-Lancaster 230 kV transmission lines
d. Bell-Taft 500 kV transmission line

Option 6a - Connecting to the Lancaster 230 kV switching station would save Avista the cost of a new switching station. It would also negate the need for a new transmission line, with associated right-of-way, from the new project to Lancaster. The estimated savings, adding the previously quoted loaded costs, less

[10] Cost estimates do not include costs of the radial line to the POI, the generator or generator station if applicable.
[11] Total is for network and direct assigned costs, are in 2011 dollars, and is +/- 50%.
[12] The RAS portion is a worst case scenario where another fiber loop is required. $3M allocated for RAS.

the added cost of connecting to Lancaster, is $13M[13]. This does not take into account any fees associated with connecting to BPA. This option assumes there is room in the Lancaster substation to accept the new line position. If Lancaster substation cannot accommodate the new line position, the cost savings to interconnect at Lancaster may be negligible or non-existent.

This option would still have all the contingency issues and associated upgrades similar to Option 2.

Option 6b - Connecting to the Rathdrum substation saves the cost of building another switching station. All contingency results are nearly identical to connecting the project to option 2 or option 3. The estimated savings of this option is $4M[14]. This option assumes there is room in the Rathdrum substation to accept the new line position. If Rathdrum substation cannot accommodate the new line position, the cost savings to interconnect at Rathdrum may be negligible or non-existent.

Option 6c – Tapping the Cabinet-Rathdrum & Noxon-Lancaster 230 kV transmission lines does improve the network performance, in comparison to tapping only the Cabinet-Rathdrum 230 kV transmission line. However, this option still requires all the same network upgrades that option 1 requires since it is still possible to have an N-2 situation where the generation of the New Project, Noxon and Cabinet is separated from the Coeur d'Alene/Spokane load. (See Figure 1). This option is listed for completeness.

Option 6d - Connecting solely to the Bell-Taft 500 kV transmission line cannot be done without RAS and possibly some network upgrades on BPA's system. In addition to the network upgrades that would likely be required on BPA's system, Avista would also be financially liable to pay wheeling fees from the new project across BPA's lines to Avista's load. If the project is connected to both BPA's Bell-Taft 500 kV transmission line and Avista's Rathdrum area 230 kV system, effectively avoiding wheeling charges, both RAS and significant network upgrades will be required. Due to the cost of a new 500 kV substation, associated RAS and the potentially large cost of network upgrades on BPA's 500 kV system, this option is not recommended.

Conclusion

Of the formally identified options, options 2 and 3 represent the least cost and best performing options. Of the other transmission alternatives, the Lancaster switching station, followed by the Rathdrum substation, interconnection options represent the least cost and best performing alternative options. The following favorable options are:

- Option 2: $11-33M (RAS only vs System Upgrades)[15]
- Option 3: $11-33M (RAS only vs System Upgrades)[15]
- Lancaster Alternative Option: $7-20M (RAS only vs System Upgrades)
- Rathdrum Alternative Option: $7-33M (RAS only vs System Upgrades)

[13] Assumes a network upgrade solution would be pursued, instead of a RAS only solution.
[14] This $4M savings would be for either a RAS only or a network upgrade solution.
[15] If the new project is interconnected to the west of Lancaster, the Lancaster-New Project 230 kV transmission line is not needed. Hence the network upgrade cost would be reduced by $8M.

2011 Electric Integrated Resource Plan

Appendix F – 2011 Electric IRP New Resource Table for Transmission

2011 Avista IRP
New Resource Table For Transmission

Resource	Resource Location	POR or Local Area	POD	Start	Stop	Capacity MW	Year Total
Noxon 4 (incremental)	Noxon, MT	Noxon, MT	AVA System	4/1/2012	Indefinite	14.0	
Wind	Oaksdale, WA	Thorton	AVA System	8/1/2012	Indefinite	102.0	116.0
Lancaster CCCT	Rathdrum, ID	Bell/Westside	AVA System	1/1/2013	10/31/2026	125.0	
Lancaster CCCT	Rathdrum, ID	Mid-C	AVA System	1/1/2013	10/31/2026	150.0	275.0
Coyote Springs 2	Boardman, OR	Coyote Springs 2	AVA System	5/1/2018	Indefinite	16.0	16.0
SCCT	TBD	TBD	AVA System	1/1/2019	Indefinite	86.3	86.3
Wind	Reardan, WA	Reardan	AVA System	1/1/2020	Indefinite	60.0	60.0
Wind	Reardan, WA	Reardan	AVA System	1/1/2021	Indefinite	60.0	
SCCT	TBD	TBD	AVA System	1/1/2021	Indefinite	86.3	146.3
CCCT	TBD	TBD	AVA System	1/1/2024	Indefinite	280.8	280.8
CCCT	TBD	TBD	AVA System	11/1/2026	Indefinite	280.8	280.8
SCCT	TBD	TBD	AVA System	1/1/2030	Indefinite	47.8	47.8
					Total	1309	1309

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