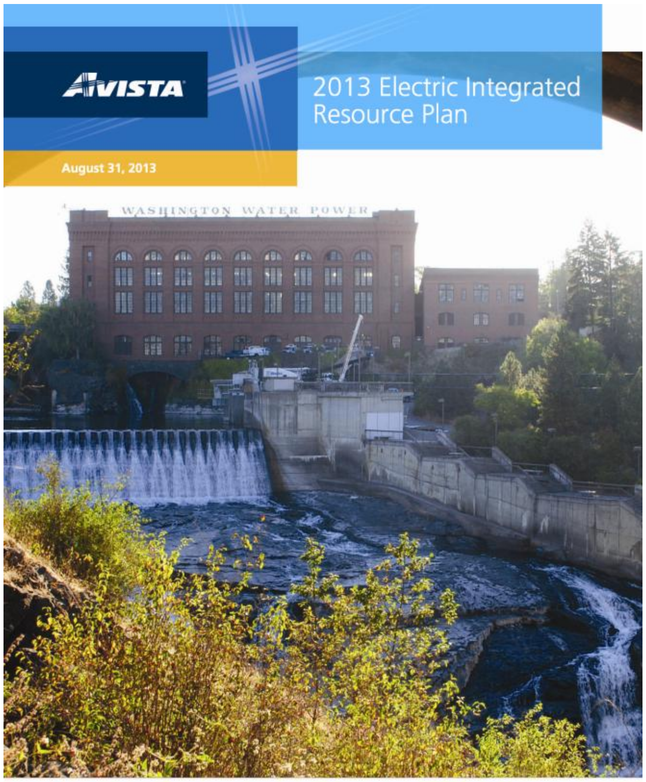
2013 Electric Integrated Resource Plan



Appendices

Table of Contents

2013 Electric Integrated Resource Plan

Appendix A – 2013 Electric IRP Technical Advisory Committee Presentations

Avista's 2013 Electric Integrated Resource Plan

Technical Advisory Committee Meeting No. 1 Agenda

Wednesday, May 23, 2012
Conference Room 130

Topic	Time	Staff
1. Introduction	8:30	Kalich
2. Powering Our Future Game	8:35	Silkworth
3. 2011 Renewable RFP	10:30	Silkworth
4. Palouse Wind Project Update	11:00	First Wind
5. Lunch	12:00	
6. 2011 IRP Acknowledgement	12:45	Kalich
7. Energy Independence Act Compliance & Forecast	1:45	Lyons/Gall
8. Work Plan	2:15	Lyons
9. Adjourn	3:00	

Powering Our Future Game

Steve Silkworth, Manager of Wholesale Marketing & Contracts

Anna Scarlett, Communications Manager

First Technical Advisory Committee Meeting

2013 Electric Integrated Resource Plan

May 23, 2012

Powering Our Future

AVISTA

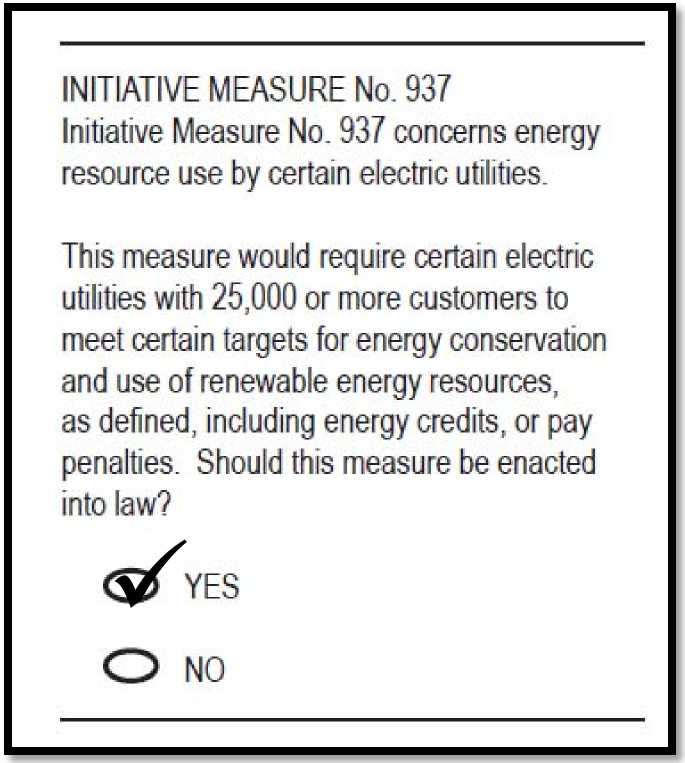
Tomorrow - 2030

You’re the power planner

Meet demand

Meet renewable portfolio standards

Wash. Renewable Portfolio Standards



INITIATIVE MEASURE No. 937

Initiative Measure No. 937 concerns energy resource use by certain electric utilities.

This measure would require certain electric utilities with 25,000 or more customers to meet certain targets for energy conservation and use of renewable energy resources, as defined, including energy credits, or pay penalties. Should this measure be enacted into law?

☑ YES

○ NO

2012 - 3% of energy delivered to Washington customers

*Dam upgrades, purchased renewable energy

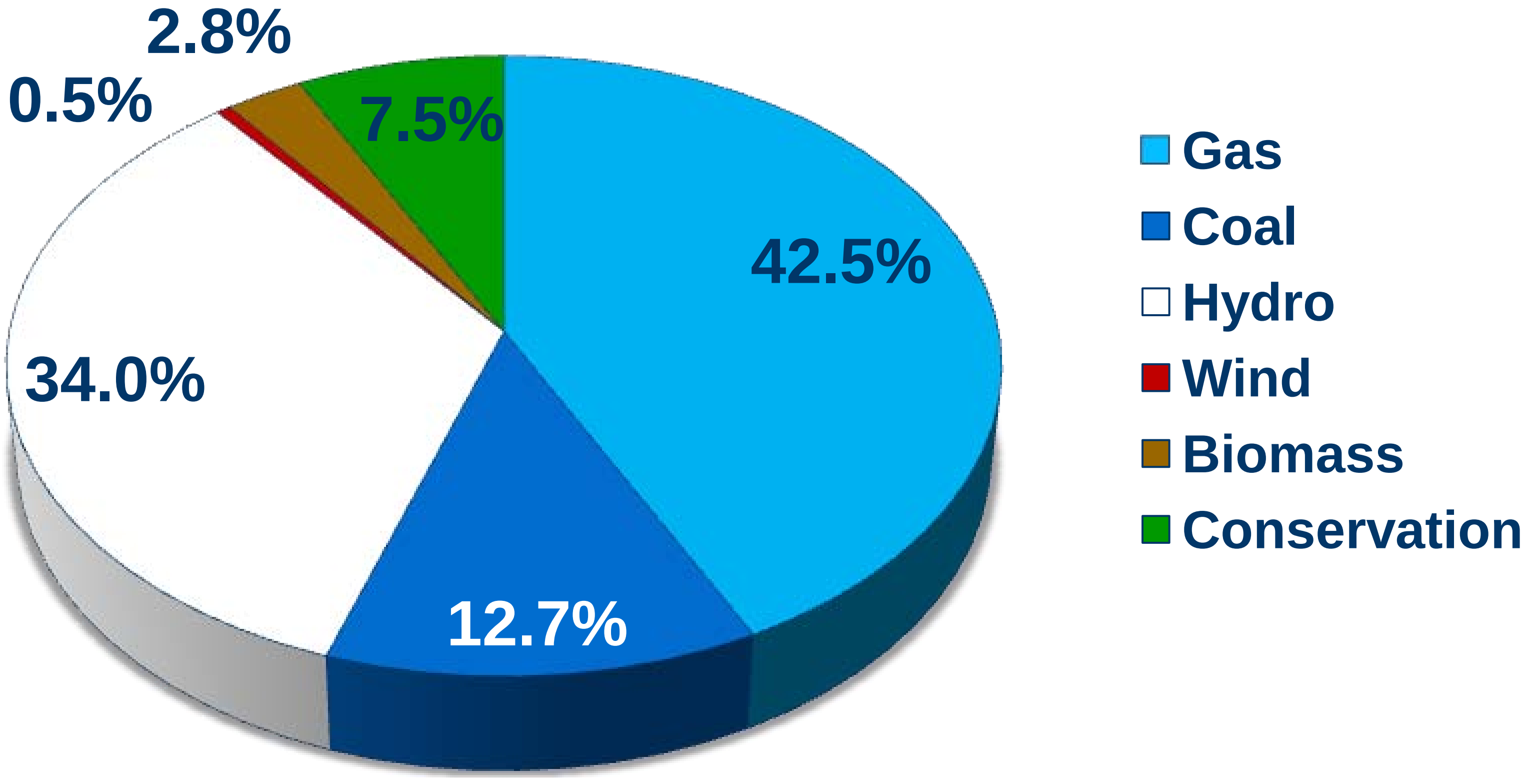
2016 - 9%

*Palouse Wind

*Kettle Falls

2020 (and beyond) - 15%

Today's Energy Generation Capability



Natural Gas

Powering Our Future

HOW DO WE MEET YOUR ENERGY NEEDS RELIABLY AND RESPONSIBLY, WHILE INTEGRATING RENEWABLE POWER?

Instructions:
Put your resource mix in the colored pie chart or circles

$ - Lowest Cost
$$$$$ - Highest Cost

Solar

Meets Washington State Renewable Portfolio Mandates – YES
Meets peak demand – NO
Cost – $$$$$

Nuclear

Meets Washington State Renewable Portfolio Mandates – NO
Meets peak demand – YES
Cost – $$$

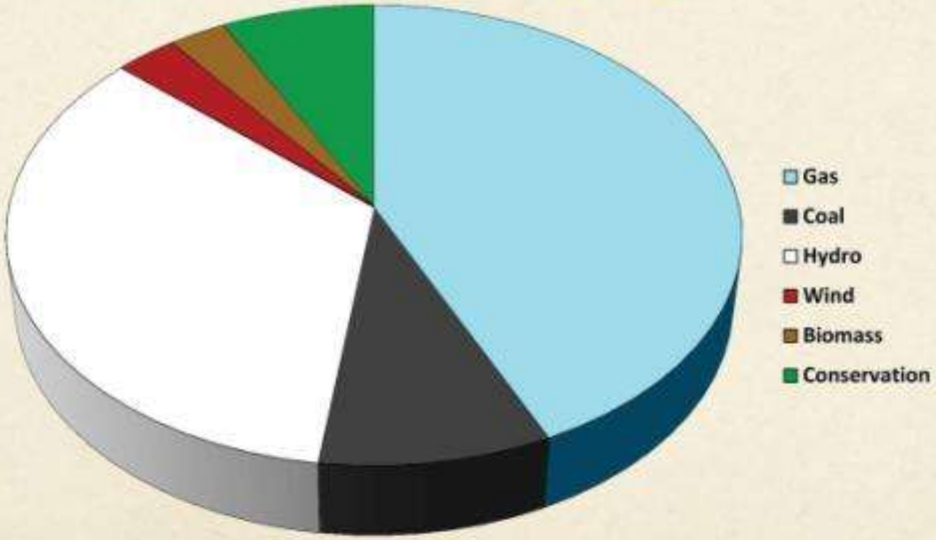
Natural gas-fired plants

Meets Washington State Renewable Portfolio Mandates – NO
Meets peak demand – YES
Cost – $

Biomass

Meets Washington State Renewable Portfolio Mandates – YES
Meets peak demand – YES
Cost – $$

Current Energy Generation Capability



Wind

Meets Washington State Renewable Portfolio Mandates – YES
Meets peak demand – NO
Cost – $$

Coal

Meets Washington State Renewable Portfolio Mandates – NO
Meets peak demand – YES
Cost – $$

Conservation

Meets Washington State Renewable Portfolio Mandates – Required, but does not count toward a renewable resource
Meets peak demand – YES, by reducing consumption
Cost – $$-$$$$

Hydroelectric

Meets Washington State Renewable Portfolio Mandates – YES
Upgrades and new hydro after 1999
Meets peak demand – YES
Cost – $$

Wind

Biomass

Conservation

Natural Gas

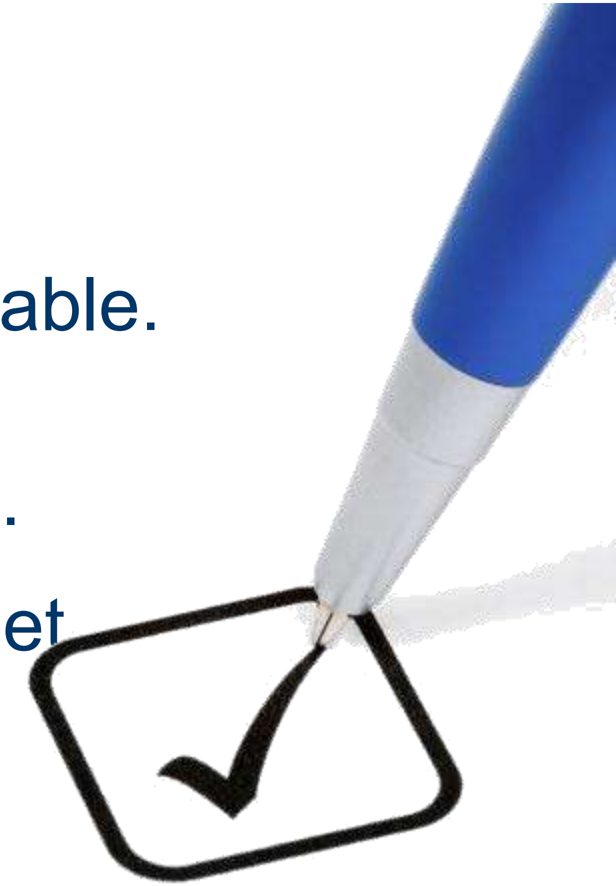
Coal

Solar

Nuclear

Hydro

1. Review the materials at your table.
2. Choose a note taker and a spokesperson from your table.
3. Write table # on your worksheet



Round 1

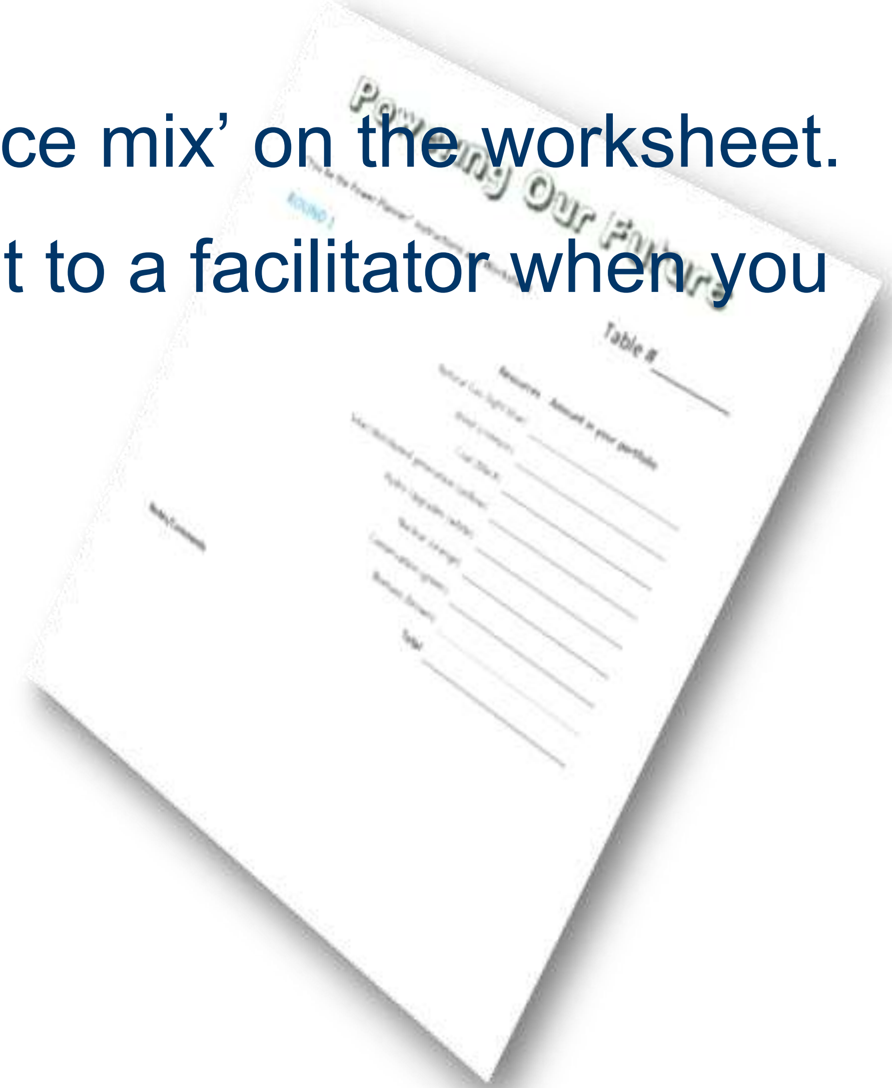
Using your blocks, choose any mix you like, placing them on the corresponding spaces on your game board.

Each block signifies 10 percent of your total new resources and you may only use a total of 10 blocks (or 100%).

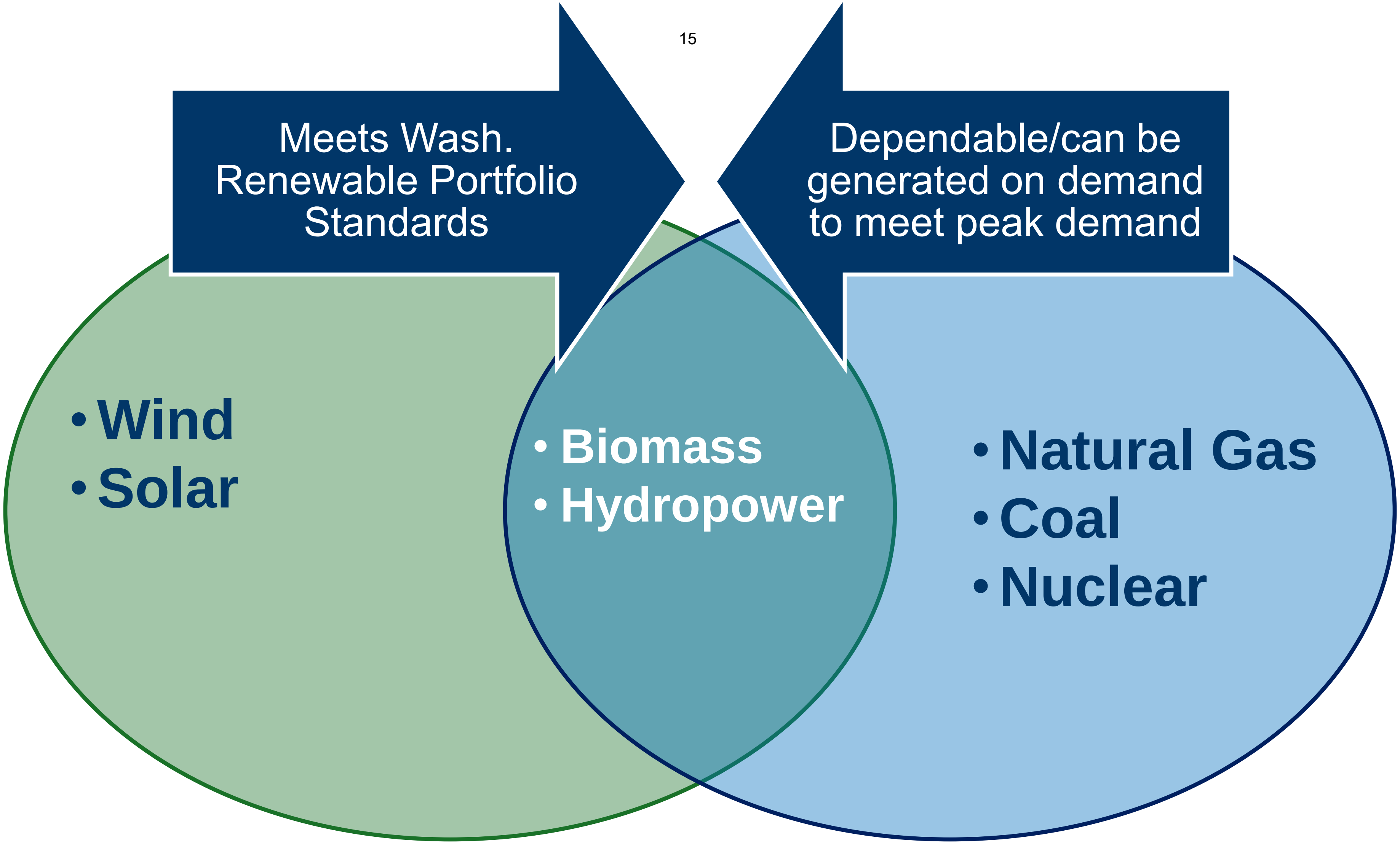
You can use any combination you like, and you can even use one resource for all your new energy if you like.

Round 1 Conclusion

1. Record your ‘resource mix’ on the worksheet.
2. Give your worksheet to a facilitator when you are finished.



Group discussion



Meets Wash. Renewable Portfolio Standards

Dependable/can be generated on demand to meet peak demand

- **Wind**
- **Solar**

- **Biomass**
- **Hydropower**

- **Natural Gas**
- **Coal**
- **Nuclear**

Conservation

Round 2

Meet electric demand.

Meet renewable portfolio requirements over the next 20 years.

Consider customers' bills, carbon emissions, and your ability to generate enough power to serve all your customers during peak demand times.

	Meets Wash.[17] Renewable Portfolio Mandates	Meets customer needs during peak demand	Relative Cost
Conservation/Energy Efficiency*		✓	$-$$$
Natural Gas		✓	$
Wind	✓		$$
Hydroelectric**	✓	✓	$$
Biomass***	✓	✓	$$$
Coal		✓	$$$
Nuclear		✓	$$$$
Solar	✓		$$$$$

* Energy efficiency programs cost more as the amount of energy that is saved increases.

** Only new hydroelectric plants and the additional energy produced with upgrades performed after 1999 qualify as renewable under Washington State Renewable Portfolio Standards.

***Only biomass plants built after 1999 qualify as renewable under Washington State Renewable Portfolio Standards.

Round 2

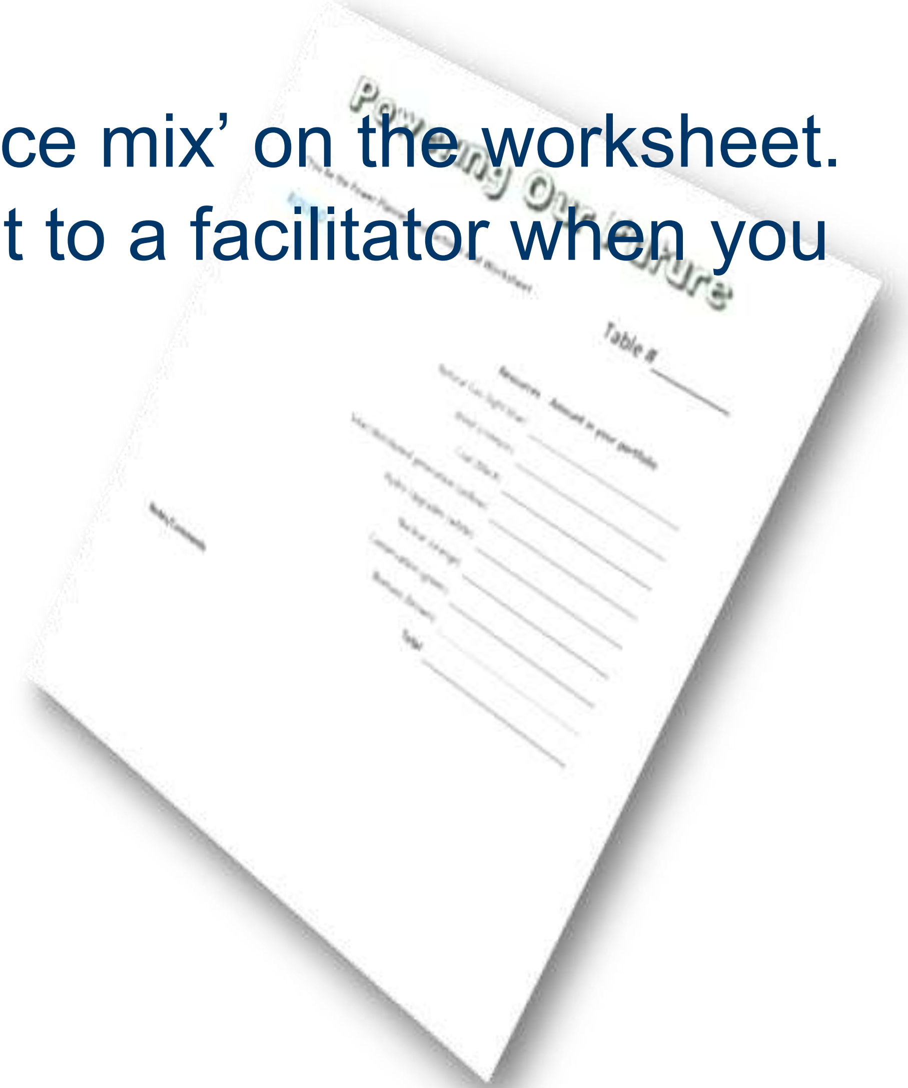
Using your blocks, choose any mix you like, placing them on the corresponding spaces on your game board.

Each block signifies 10 percent of your total new resources and you may only use a total of 10 blocks (or 100%).

Use a combination of resources that meet Renewable Portfolio Mandates and resources that are considered dependable and will meet peak demand.

Round 2 Conclusion

1. Record your ‘resource mix’ on the worksheet.
2. Give your worksheet to a facilitator when you are finished.



Powering Our Future

Table #

Resources Amount in your portfolio

Total

Group Discussion

Discussion of impact to emissions, costs, risk

Meet demand at peak times?

Conclusion

Were there any surprises?

What did you learn? What questions do you have?

2011 Renewable RFP

Steve Silkworth, Manager of Wholesale Marketing & Contracts

First Technical Advisory Committee Meeting

2013 Electric Integrated Resource Plan

May 23, 2012

Why Issue a Renewables RFP in 2011?

- 2009 IRP: identified the need for 48 aMW RECs by 2016 to meet the 9% renewable goal in Washington state
- Over supply of turbines. Turbine prices declined to 2004 levels
- ITC/PTC expires in 2012
- Washington state 75% sales tax exemption through June 2013
- Levelized costs were estimated to result in 30% to 40% lower cost than the 2009 RFP of 14 months prior
- REC demand will increase in the next few years as the 2016 tranche approaches

Renewable Resource RFP Overview

- RFP Issued: February 22, 2011
- Quantity: up to 35 aMW of I-937 qualifying renewable power including all renewable energy attributes
- Delivery Start: on or before 12/31/2012
- Term: 20+ years
- Avista requested competitive bids for projects or project output at the most favorable price available. Expected Delivered Price: $62 per MWh (20 yr) levelized

Renewable Resource RFP Overview

- Received proposals from 11 bidders with 17 options.
- Technologies submitted
    - Wind – Approximately 769 MW
    - Landfill gas – 5 MW
- Pricing was very competitive and reflected the current down-turn in the renewable energy market.
- Comparable projects proposed through the 2009 RFP (approximately 15 months prior) were now up to 30% to 40% less expensive in the 2011 solicitation.

Bid Project Locations

Received bids totaling 774 MW (769 MW wind, 5 MW landfill gas)

Montana Wind

Evaluation Criteria

1. Risk Management (30%)
   - Financing ability/experience
2. Net Price (40%)
   - Expected benefit - expected cost
3. Price Risk (10%)
   - Pricing type, O&M, generation quality, and optionality
4. Electric Factors (10%)
   - Transmission, procurement process and equipment
5. Environmental/Community (10%)
   - Permits process and location

Palouse Wind

- Approximately 105 MW
- Near Oakesdale, WA (35 miles south of Spokane)
- Interconnected directly to Avista system
- Developed by First Wind
- Commercial operation by 12/31/2012
- Vestas 1.8 MW turbines – 100M Rotors
- Net capacity factor – expected: 37.5%
- Developer will take advantage of expiring tax incentives

Palouse Wind - 2013 Avista IRP TAC Meeting

Spokane, WA – May 23, 2012

firstwind

Overview

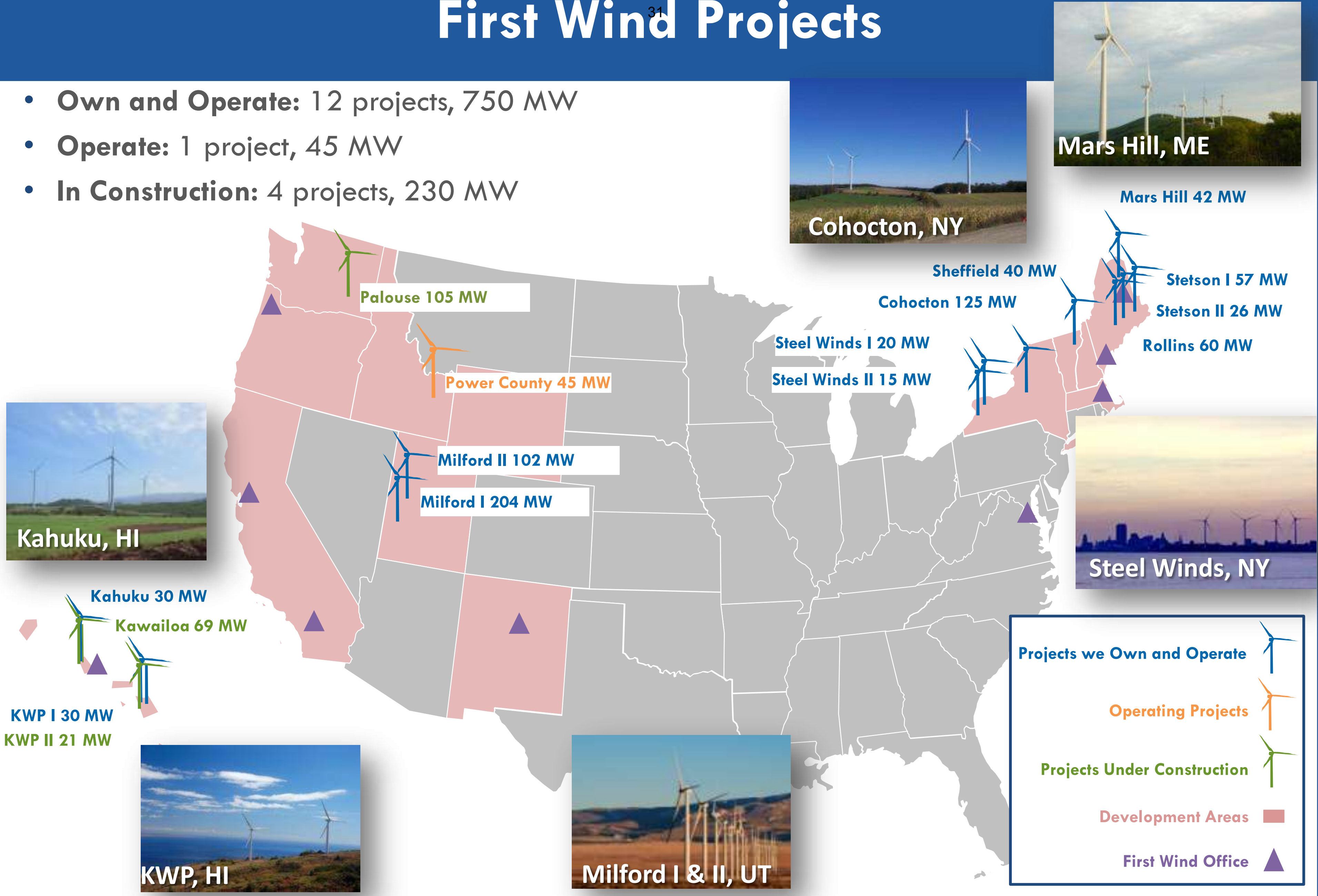
- Founded in 2002 and headquartered in **Boston** with **200+ employees** at offices and project sites around the U.S.
- Focused on **renewable energy, natural gas, energy storage and transmission development** in core markets, such as the Northeast, West and Hawaii
- Wind projects range from **15 – 205 MW**, situated on private, state and federal lands
- Vertically integrated to develop projects from **conception through operations** bringing stable, long-term contracts to utilities and customers in high-demand markets
- Successfully raised over **$6 billion** to convert development projects into operating assets

© First Wind. All Rights Reserved

Milford Wind – 306 MW in Utah

First Wind Projects

- **Own and Operate:** 12 projects, 750 MW
- **Operate:** 1 project, 45 MW
- **In Construction:** 4 projects, 230 MW



A Company of Firsts

Consistently demonstrated leadership in **Innovation**, **Environmental Stewardship**, and **Community Engagement**

Siting

- **Steel Winds** (20 MW) – Development on EPA Brownfield Site

Environmental

- **KWP** (30 MW) – Development with Habitat Conservation Plan

Power Sales

- **Stetson Phase II** (26 MW) – Unique PPA off-take with Harvard University

Transmission Engineering

- **Milford** (204+ MW) – Developed 88-mile Generator Lead

Technology

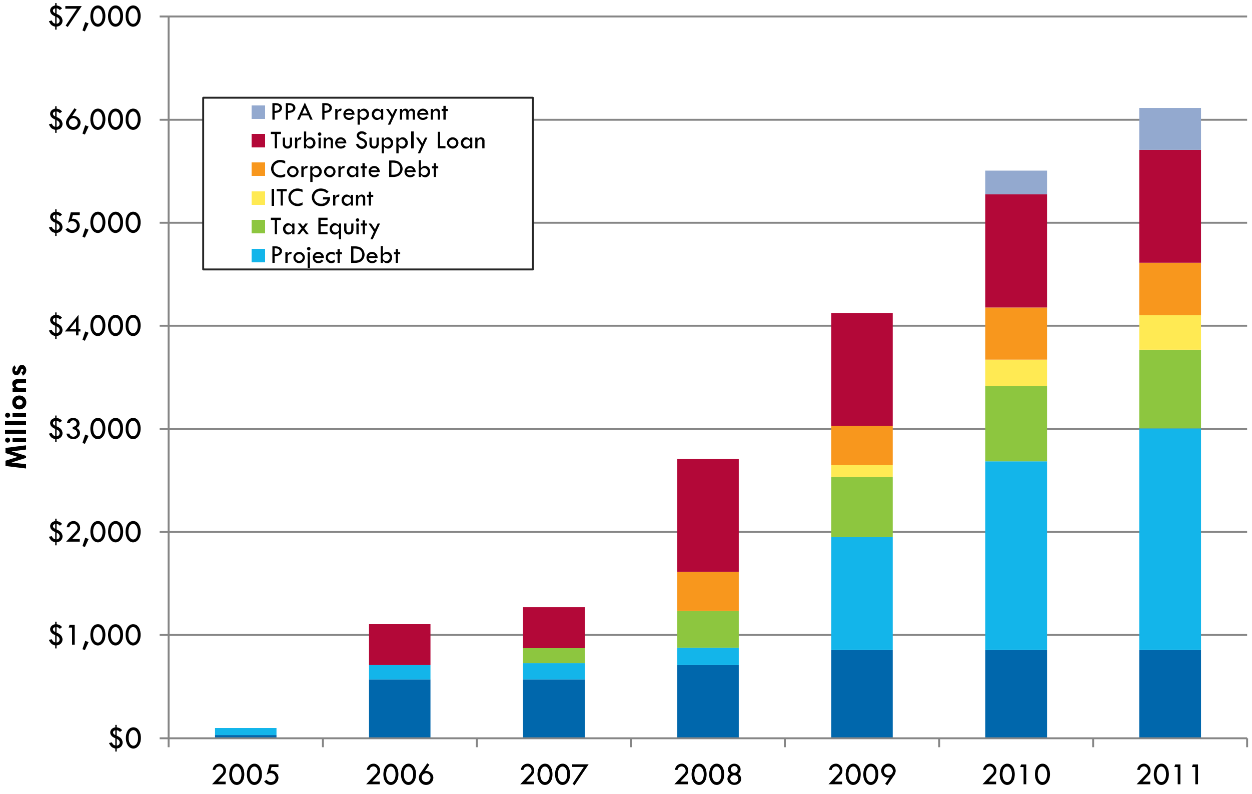
- **Kahuku** (30 MW) – Integrated 15 MW Battery Energy Storage System

Our first-in-the-state **Sheffield Wind** project required considerable environmental innovations in Vermont.

Track Record

- **Asset Conversion:** Since its founding, First Wind has raised over **$6 billion** to convert development projects into operating assets

Sources of capital by year



Select Partners

JPMorgan

KeyBank

NORD/LB

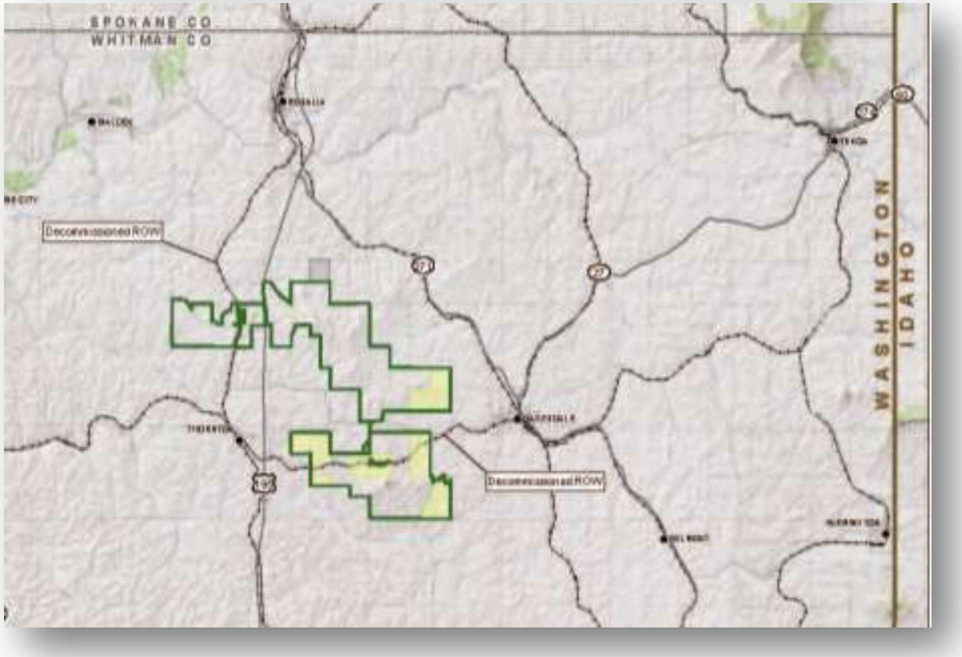
usbank

CREDIT SUISSE

Palouse Wind

Palouse Wind

- Located on ridges between State Route 195 and the town of Oakesdale in Whitman County
- Strong **winter peaking** wind resource, complimentary to regional spring hydro resource
- Utilizing 58 Vestas V100 wind turbines, with total capacity of **105 MW**
- **30-year PPA** with Avista, and interconnection to their new Benewah to Shawnee 230kV line
- **$210 million capital raise** from private sector
- Will be **largest energy facility in Whitman County**, producing renewable energy for 30,000 homes
- 40 farmers involved



Phases of Developing a Palouse Wind

2008 — 2009 — 2010 — 2011 →

Wind Resource Assessment

- *3 years of wind data from 4 tower locations*
- *Third party wind validation*

Transmission Analysis

- *Transmission*
- *Gen-tie routing*

Development

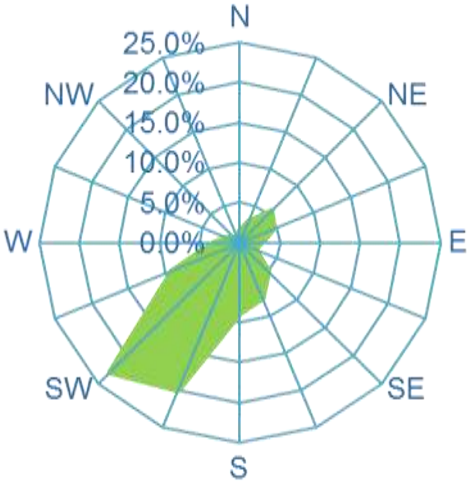
- *Site design*
- *Landowner Relations*
- *Community Involvement*

Permitting/ Public Involvement

- *Envr. Studies*
- *Public Meetings*
- *EIS and CUP Hearing*

Power Purchase Agreement

- *Avista PPA signed*
- *Interconnection Agreement*
- *Financing*



Thorough Environmental Review

- **First** EIS in Whitman County – ever
- All areas of the built and natural environment were evaluated per state law
- Over **250** Comments received during EIS process
- **164** conditions to consider during construction and operations

Important Conditions

1. County CUP Compliance Package. Preconstruction micrositing surveys
2. Habitat Mitigation. WDFW and Palouse Prairie impacts
3. Avian fatality monitoring
4. Technical Advisory Committee
5. Decommissioning Requirements

Successful Financing

- First Wind has secured **$210 Million** to finance the Palouse Wind project
- Key Bank-Joint lead arranger and administrative agent
- Norddeutsche Landesbank Girozentrale, CoBank ACB, Banco Santander served as joint lead arrangers

> “We applaud First Wind’s dedication that brings significant investment to Eastern Washington. The financing of Palouse Wind **demonstrates the solid fundamentals of the wind project that will provide an excellent source of renewable power for Washington ratepayers.”**
>
> \- *Andrew Redinger*
>
> *KeyBanc Director Utility &Renewable Energy*

KeyBank

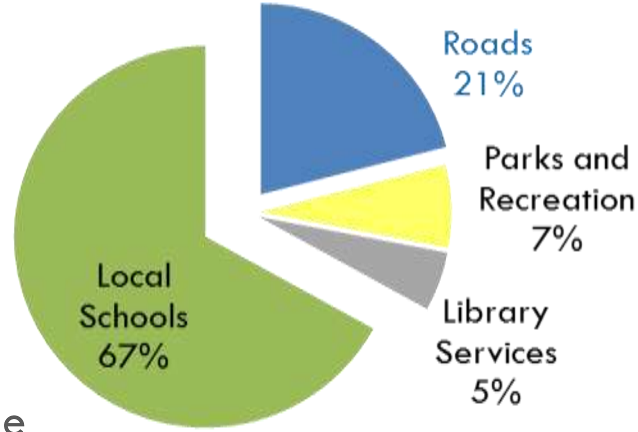
COBANK
COOPERATIVE. CONNECTED. COMMITTED.

NORD/LB
Die norddeutsche Art.

Santander

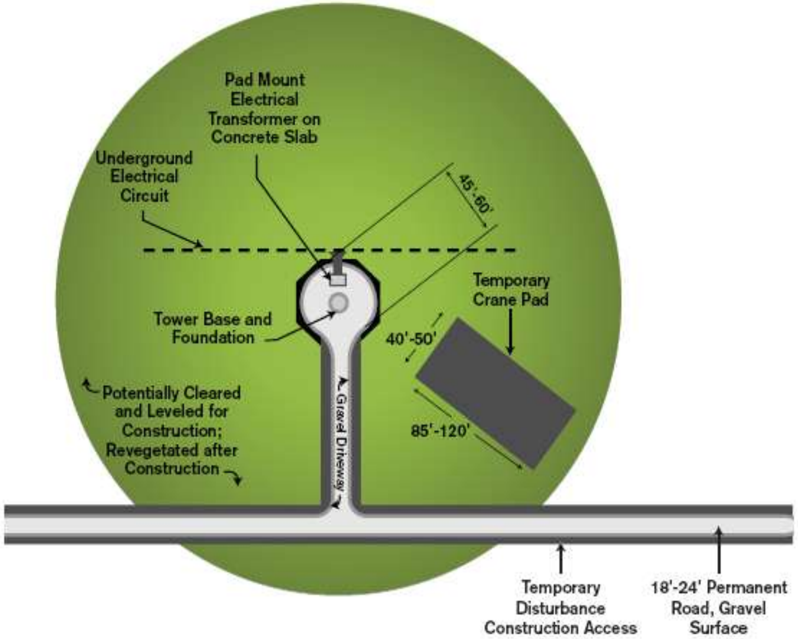
Palouse Wind represents a Major Investment in Whitman County

- Construction will support **150 - 250** jobs
- Approximately **$30 million** of spending with local businesses in Whitman County and the Inland Northwest
- **15 full-time** operations jobs, and ongoing contracting with local businesses
- Property Tax and Sales Tax Revenue
    - Over **$700,000** per year generated in tax revenue



Construction of Palouse Wind

- Construction meets the standards of County CUP conditions
- **40** permanent acres impacted, **5** acres CRP/grassland
- RMT, Inc selected as General Contractor
- Approximately **50** workers on site since October, increasing to **250** this summer
- Civil work on roads and turbine pads
- Avista switchyard construction



Inland NW Jobs

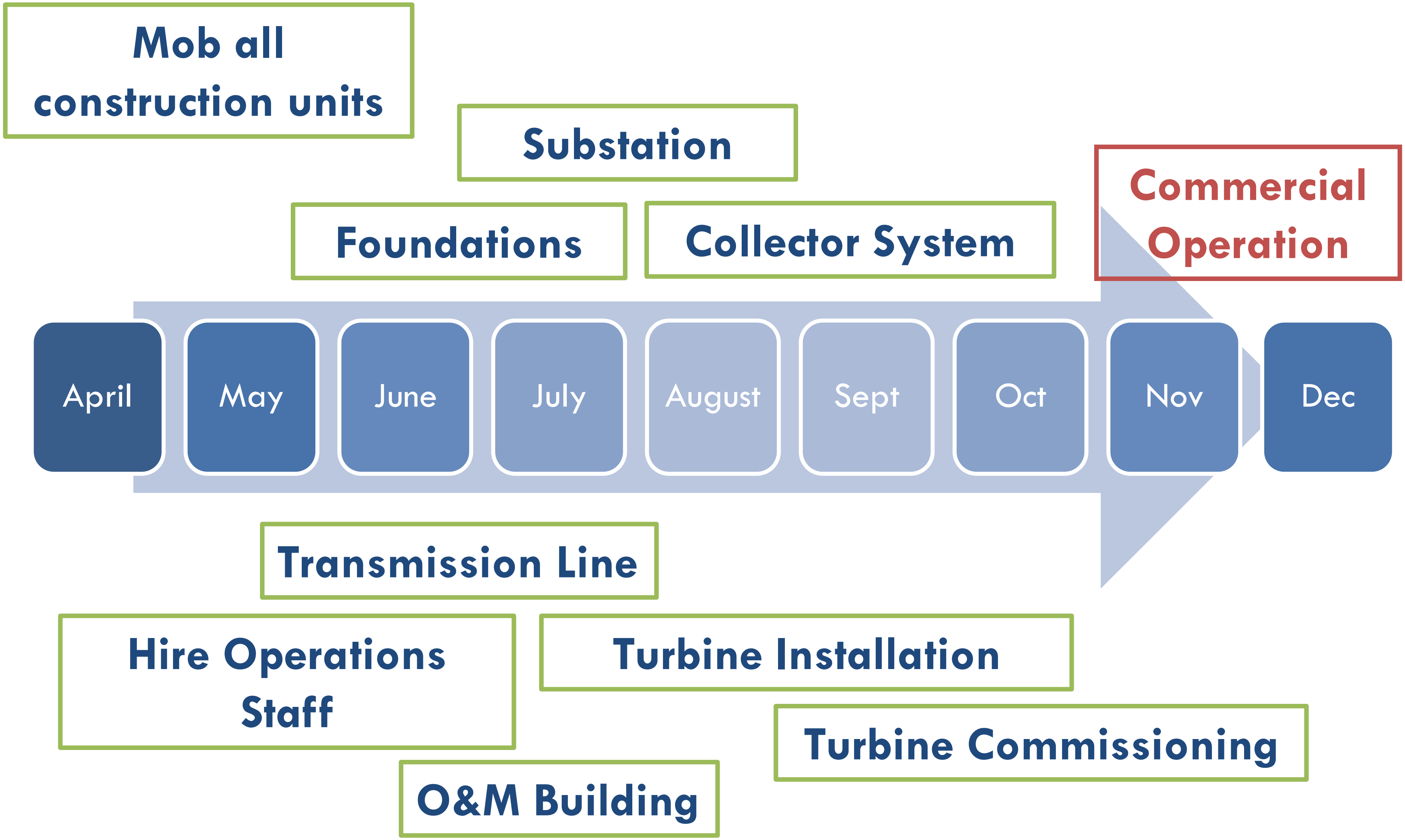
Contractors to-date include

- Busch Distributors, Oakesdale
- Pearson Fence, Colfax
- Wheatland Inn, Colfax
- Crossets Market, Oakesdale
- Brass Rail, Rosaila
- Plateau Archeology, Pullman
- Stewart Title, Pullman
- Schweitzer Engineering, Pullman
- Memorable Events, Colfax
- Goodfellow Brothers, Wenatchee
- Lydig Construction, Spokane
- Garco Construction, Spokane
- STRATA, Pullman
- Taylor Engineering, Pullman
- Atlas Sand and Gravel, Clarkston (local gravel pit)
- Landau Associates, Colfax
- Gallatin, Spokane
- Henkles & McCoy, Vancouver
- Ch2MHill, Spokane

Long Term Commitment on the Palouse

- First Wind Scholarship Program
- Palouse Empire Fair, Lentil Fest
- High School boosters
- 4H and FFA Clubs
- Fishing Kids
- Bikes for Books
- Youth sports sponsorship

What to expect in 2012



Mob all construction units

Substation

Foundations

Collector System

Commercial Operation

April

May

June

July

August

Sept

Oct

Nov

Dec

Transmission Line

Hire Operations Staff

Turbine Installation

Turbine Commissioning

O&M Building

Ben Fairbanks
Director, Business Development
p – 971.998.1411
bfairbanks@firstwind.com

firstwind
CLEAN ENERGY. MADE HERE.

2011 Electric Integrated Resource Plan Acknowledgement Review

Clint Kalich, Manager of Resource Planning and Analysis

First Technical Advisory Committee Meeting

2013 Electric Integrated Resource Plan

May 23, 2012

Acknowledgements

- Idaho Public Utilities Commission (IPUC) Case No. AVU-E-11-04, ORDER NO. 32444 acknowledged Avista’s 2011 IRP.
- Washington Utilities and Transportation Commission (UTC) Docket No. UE-101482 acknowledged Avista’s IRP on January 12, 2012.
- Acknowledgement is not a pre-approval of the Preferred Resource Strategy or the IRP itself. Future acquisitions obtain a prudence determination in general rate cases.
- IPUC encouraged Avista to make continued efforts to include more public involvement in the TAC.

Public Comments

- No public comments received in Washington jurisdiction.
- Two public comments in Idaho jurisdiction:
  - An individual commenter thought the Company should not receive any public money or rate increases for wind generation.
  - Benewah County, Idaho was concerned that the potential federal greenhouse gas policies in the IRP would lead to increased rates and negatively impact the County, and the polices were not supported by the science. They advocated for Avista to develop alternative policies to benefit the environment and the County.

Resource Needs

- IPUC believes the capacity planning assumptions are reasonable given the Company's access to and the availability of markets if resource deficits are higher than predicted.
- UTC: The 14% summer and 15% winter planning margin above operating reserves are appropriate for planning for peak loads and are consistent with other regional utilities. This is an improvement over the 2009 IRP methodology.
- UTC: Continue involvement in the NPCC Resource Adequacy Forum.
- UTC: Continue to analyze planning margin to determine the most cost-effective way to reliably meet resource adequacy needs.

Load Forecasts

- IPUC supports the inclusion of projected electric vehicle consumption.
- IPUC believes the load forecast assumptions to be reasonable.
- UTC requested a range of load forecasts in the 2009 IRP acknowledgement. 2011 IRP included a high growth case (2.33%) and a low growth case (0.93%). This is expected to continue in future IRPs.
- UTC: the Global Insights forecasts on Table 2.1, p. 2-4. GDP growth (2.7%), unemployment (5%), 1.58 million housing starts per year, and 4.75% federal funds rate may be too optimistic given the current state of the economy. Need to continue to monitor and test models under more conservative growth assumptions.

Energy Efficiency

- IPUC has concerns that the Company “…may not pursue “all” cost-effective conservation if it adheres to certain conservation-potential limitations expressed in the IRP” (maximum versus realistic achievable potential). The 2007 and draft 2012 Idaho State Energy Plans direct the IPUC to encourage utilities to pursue “all cost effective conservation.”
- UTC: Considers the Conservation Potential Assessment (CPA) done for the 2011 IRP to be sound and includes a reasonable range of forecast assumptions.
- UTC: Finds the CPA sensitivity analysis regarding changes to avoided cost “… to be useful in identifying both the potential achievable over this time horizon, but also for identifying higher costs along the supply curves.”

Renewable Portfolio Standard

- IPUC: Early acquisition of wind to meet RPS requirements ahead of need will be will be scrutinized in a future rate case, but the early acquisition allows for the use of tax incentives and lower wind costs.
- UTC: The Company needs to more clearly describe the method used to calculate REC reserve requirements and how the reserves are used for RPS compliance.
- UTC: Need to provide clear analysis of how the Company specifically (new resources, RECs or banking) plans to meet the higher RPS goals from 2016 and beyond.

Transmission & Distribution

- IPUC: Staff is encouraged by efforts to include distribution savings and supports continued involvement with regional transmission groups.
- UTC: Estimated costs for the integration of new resources are useful.
- UTC: Want to see continued cooperation with BPA on the direct interconnection of Lancaster to ensure completion of the project by the end of 2012.
- UTC: Continue to refine the analysis of feeder upgrades as they are completed and track actual loss savings in the 2013 IRP.

Generation Resource Options

- UTC would like to see a discussion and analysis of electric storage technologies for “firming intermittent generation resources or for meeting peaks in load.” This should include cost-effectiveness, commercial availability, and where this resource would fit in relation to other generating resources.
- UTC wants “… an explicit discussion of the future costs and liabilities of operating Colstrip over the 20 year planning horizon” including costs of anticipated EPA regulations because it is a significant resource and the Company’s only coal-fired asset.
- UTC: Model a scenario for the 2013 IRP without Colstrip in the Company’s resource portfolio and show “… estimates of the impact on Net Present Value (cost) of its portfolio and rates”.

Modeling Approach

- UTC: Finds the efficient frontier analysis to be informative in highlighting the tradeoff between risk and cost when choosing resources.
- UTC: Support the continued improvement of modeling for the IRP "… and urge the Company to explore its thinking and strategy with the TAC (technical advisory committee) at an early date."

Preferred Resource Strategy

- IPUC: Supports increased levels of energy efficiency. Should also include analysis and consideration of cost-effective demand response in the next IRP.
- IPUC: Tipping point analysis is beneficial to test how robust the PRS is and to point out which variables are most important to the PRS.
- UTC: Sensitivity analyses were informative.
    - High and low load growth cases (50% of expected load growth) is too improbable as a tipping point. Want to see this refined.
    - Should include "… load growth variances that result in incremental changes to the PRS, such as the delaying the acquisition of the 2018 SCCT."

Action Plan

- IPUC: The Company made progress on the 2009 IRP Action Items and the 2011 Action Items should enhance the 2013 IRP.
- UTC: 2011 Action Plan is presented well and is well grounded in the modeling and analysis.
- UTC: encourages close monitoring of actual load growth and changes in the market which may require changes to the PRS and the Action Plan.

Energy Independence Act Compliance & Forecast

John Lyons, Power Supply Analyst

James Gall, Senior Power Supply Analyst

First Technical Advisory Committee Meeting

2013 Electric Integrated Resource Plan

May 23, 2012

Energy Independence Act

- RCW 19.285 – The Energy Independence Act is also known as Initiative Measure No. 937 (I-937)
  - Requires utilities with more than 25,000 customers to obtain fifteen percent of their electricity from qualified renewable resources by 2020.
  - Also requires the acquisition of all cost-effective energy conservation.
- I-937 approved by Washington voters on November 6, 2006.

Reporting Requirements

- Annual compliance report, per WAC 480-109-040, is due on or before June 1st beginning in 2012 and must include the following:
  - Utility’s annual Washington load for the prior two years,
  - Amount of eligible renewable resources and/or renewable resource credits needed to meet annual goal by January 1 of the target year,
  - Amount and cost of each type of eligible resource used,
  - Amount and cost of any renewable energy credits acquired,
  - Type and cost of the least-cost substitute non-eligible resources available,
  - Incremental cost of eligible renewable resources and renewable energy credits, and
  - The ratio of this investment relative to the utility's total annual retail revenue requirement.

Renewable Energy Requirements

Based on a percentage of Washington state retail sales using two year rolling average

- 3% of sales by January 1, 2012
- 9% of sales by January 1, 2016
- 15% of sales by January 1, 2020

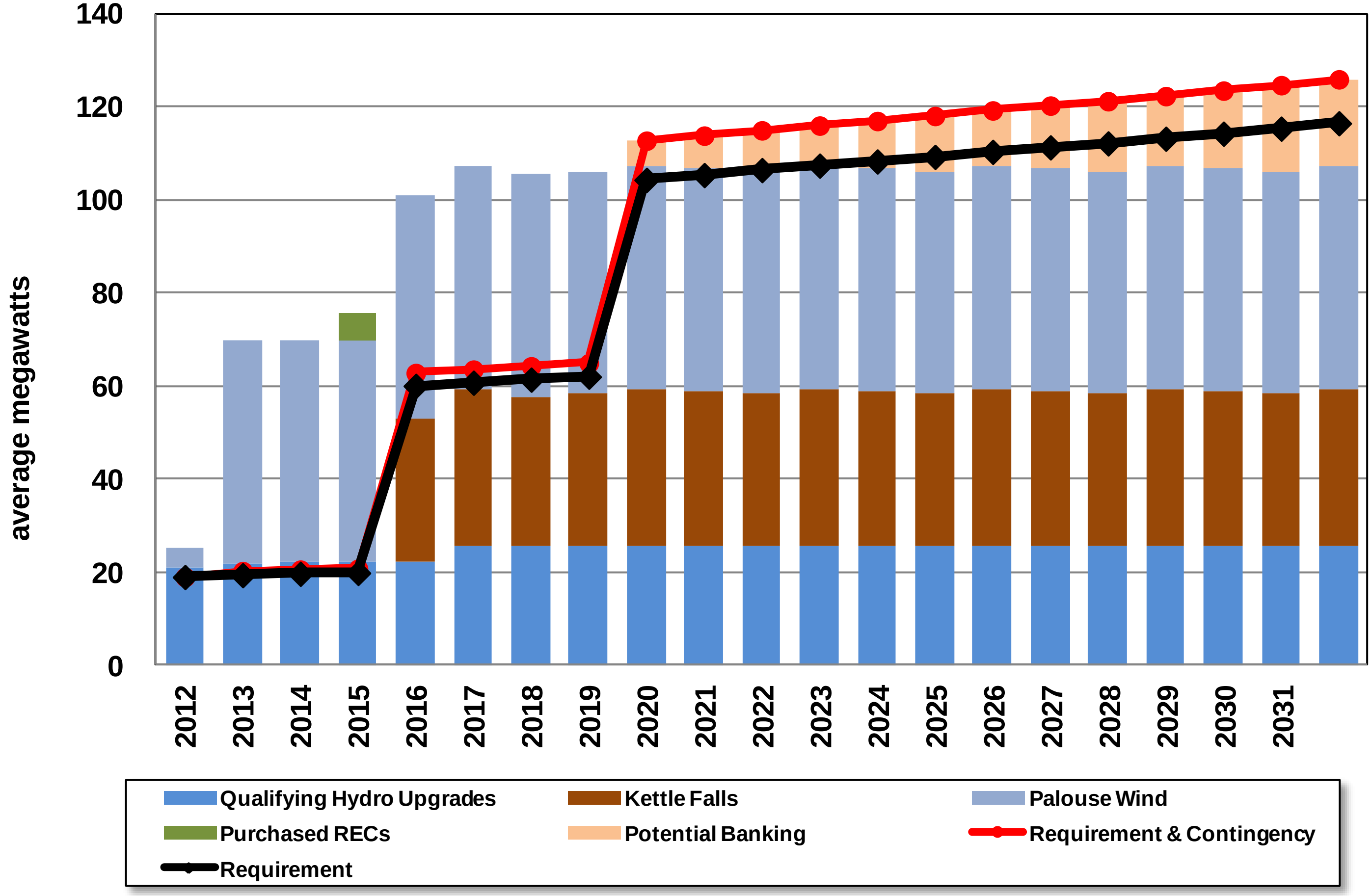
2012 Legislative Modifications

- SB 6414: Review Process for Electric Generation Project or Conservation Review
- SB 5575: Biomass Bill
  - Avista’s 50 MW Kettle Falls plant becomes a “qualified renewable resource” beginning January 1, 2016 for the Energy Independence Act

2012 Projected Compliance

	aMW
Required Renewable Energy	**18.9**
Spokane River	
Long Lake #3	1.6
Little Falls #4	0.6
Clark Fork River	
Cabinet Gorge 2-4	10.8
Noxon Rapids 1-4	5.8
Wanapum Fish Bypass	2.0
Total Hydro Upgrades	**20.8**
Palouse Wind (2012)	TBD

Long-Term Renewable Energy Requirements & Compliance Forecast



Work Plan

John Lyons, Power Supply Analyst

First Technical Advisory Committee Meeting

2013 Electric Integrated Resource Plan

May 23, 2012

Technical Advisory Committee Meetings

May 23, 2012: Powering Our Future Game, 2011 Renewable RFP, Palouse Wind Project Update, 2011 IRP Acknowledgements, Energy Independence Act Compliance & Forecast, and 2013 Work Plan.

September 2012: Two day TAC meeting. Day 1: Plant tour. Day 2: new resource assumptions, Spokane River assessment, and energy efficiency.

November 2012: Load & resource forecast, reliability planning, stochastic assumptions, and transmission cost studies.

January 2013: Environmental policy update, electric and gas price forecasts, scenario development.

March 2013: Draft Preferred Resource Strategy (PRS), energy efficiency, review of scenarios and futures, and portfolio analysis.

April 2013: Review of the final PRS and action items.

June 2013: Review of the Draft 2013 IRP.

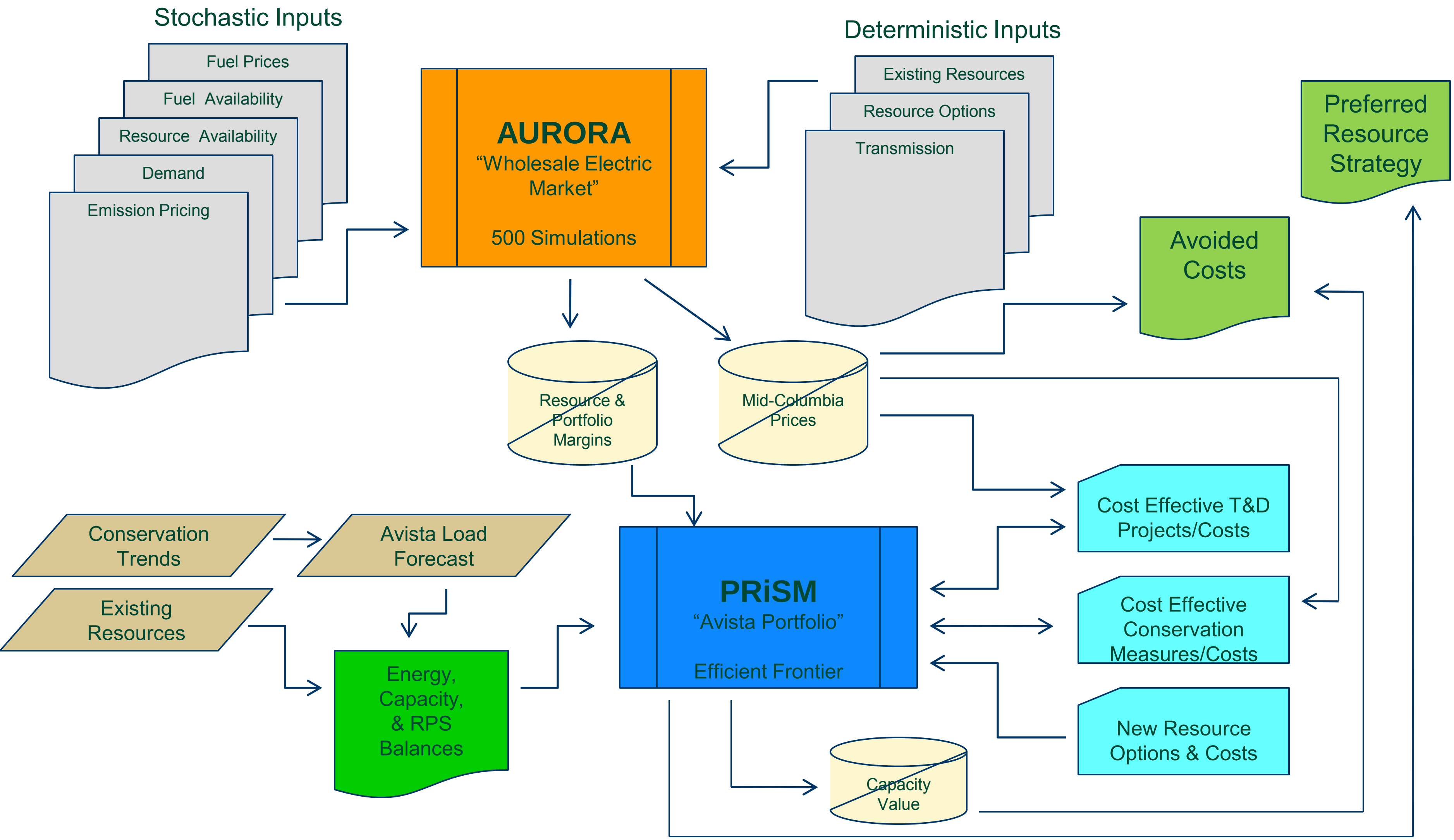
2013 Draft Electric IRP Timeline

Preferred Resource Strategy (PRS) Tasks	Target Date
Finalize load forecast	July 2012
Identify regional resource options for electric market price forecast	September 2012
Identify Avista's supply & conservation resource options	September 2012
Update AURORA^{xmp} database for electric market price forecast	October 2012
Finalize data sets/statistics variables for risk studies	October 2012
Draft transmission study due	October 2012
Energy efficiency load shapes input into AURORAxmp	October 2012
Final transmission study due	November 2012
Select natural gas price forecast	December 2012
Finalize deterministic base case	December 2012
Base case stochastic study complete	January 2013
Finalize PRiSM 3.0 model	January 2013
Develop efficient frontier and PRS	January 2013
Simulation of risk studies "futures' complete	February 2013
Simulate market scenarios in AURORA^{xmp}	February 2013
Evaluate resource strategies against market and future scenarios	March 2013
Present preliminary study and PRS to TAC	March 2013

2013 Draft Electric IRP Timeline

Writing Tasks	Target Date
File 2013 IRP Work Plan	August 2012
Prepare report and appendix outline	September 2012
Prepare text drafts	April 2013
Prepare charts and tables	April 2013
Internal drafts released at Avista	May 2013
External draft released to the TAC	June 2013
Final editing and printing	August 2013
Final IRP submission to Commissions and distribution to TAC	August 31, 2013

2013 Integrated Resource Plan Modeling Process



Stochastic Inputs

Fuel Prices

Fuel Availability

Resource Availability

Demand

Emission Pricing

AURORA
"Wholesale Electric Market"

500 Simulations

Deterministic Inputs

Existing Resources

Resource Options

Transmission

Preferred Resource Strategy

Avoided Costs

Resource & Portfolio Margins

Mid-Columbia Prices

Cost Effective T&D Projects/Costs

Conservation Trends

Avista Load Forecast

Existing Resources

PRiSM
"Avista Portfolio"

Efficient Frontier

Cost Effective Conservation Measures/Costs

Energy, Capacity, & RPS Balances

New Resource Options & Costs

Capacity Value

2013 Electric IRP Draft Outline

- Executive Summary
- Introduction and Stakeholder Involvement
- Loads and Resources
    - Economic Conditions
    - Avista Load Forecast
    - Load Forecast Scenarios
    - Avista Resources and Contracts
    - Reserve Margins
    - Resource Requirements

2013 Electric IRP Draft Outline

- Energy Efficiency and Demand Response
  - Conservation Potential Assessment
  - Overview of Energy Efficiency Potentials
  - Sensitivity of Potential to Customer and Economic Growth
  - Avoided Cost Sensitivities
  - Energy Efficiency Related Financial Impacts
  - Integrating Results into Business Planning and Operations
- Policy Considerations
  - Environmental Concerns
  - Greenhouse Gas Issues
  - State and Regional Level Policies

2013 Electric IRP Draft Outline

- Transmission & Distribution
    - Avista's Transmission System
    - Regional Transmission Issues
    - Transmission Construction Costs
    - Integration of Resources on the Avista Transmission System
    - Distribution Efficiencies
- Generation Resource Options
    - Assumptions
    - New Resources
    - Hydroelectric and Thermal Plant Upgrades

2013 Electric IRP Draft Outline

- Market Analysis
  - Assumptions and Fuel Prices
  - Market Price Forecasts
  - Scenario Analysis
- Preferred Resource Strategy
  - Resource Selection Process
  - Preferred Resource Strategy
  - Efficient Frontier Analysis
  - Avoided Costs
  - Portfolio Scenarios
- Action Items

Avista's 2013 Electric Integrated Resource Plan

Technical Advisory Committee Meeting No. 2 Agenda

Wednesday, September 5, 2012

Conference Room 328

Topic	Time	Staff
1. Introduction	8:30	Storro
2. Avista REC Planning Methods	8:35	Gall
3. Energy and Economic Forecasts	9:00	Forsyth
4. Break	10:30	
5. Shared Value Report	10:45	Wuerst
6. Lunch	11:30	
7. Generation Options	12:30	Lyons
8. Break	1:30	
9. Spokane River Assessment	1:45	Schwall
10. Adjourn	3:00	

Avista REC Planning Methods

James Gall, Senior Power Supply Analyst

Second Technical Advisory Committee Meeting

2013 Electric Integrated Resource Plan

September 5, 2012

Energy Independence Act - Refresher

- RCW 19.285 – The Energy Independence Act is also known as Initiative Measure No. 937 (I-937)
    - Requires utilities with more than 25,000 customers to obtain fifteen percent of their electricity from qualified renewable resources by 2020.
    - Also requires the acquisition of all cost-effective energy conservation.
- I-937 approved by Washington voters on November 6, 2006.

Renewable Energy Requirements - Refresher

Based on a percentage of Washington state retail sales using two year rolling average

- 3% of sales by January 1, 2012
- 9% of sales by January 1, 2016
- 15% of sales by January 1, 2020

2011 IRP Planning Margin Requirements

- In past IRP's Avista included a REC planning margin for the variability of load and generation due to weather for compliance of the EIA.
- The 2011 IRP included a planning margin of 7 to 8 aMW between 2012 and 2016 and 23+ aMW after 2016 to account for wind variability
- This planning margin was a threshold for the minimum amount of additional REC's to hold over the expected requirement.

What Has Changed Since 2011 IRP

- Load forecast is lower
- Signed 105 MW PPA for Palouse Wind
- Washington SB 5575 counts Kettle Falls as “renewable” beginning in 2016
- Hydro upgrades may use long-term average incremental energy rather than estimated actual incremental energy for compliance

What Planning Margin Do We Need Now?

- Develop risk model of REC compliance
  - Simulates future loads and qualifying wind, hydro, and biomass output
  - Accounts for actual and potential REC purchases and sales
  - Simulates 100 future outcomes
- Model allows RECs to be “Rolled” over to future years
  - Does not allow bring RECs back from future years
  - Pulling REC’s from future years is allowed but creates a short position that would be needed to be filled
- Tested several REC scenarios and the effects of policy choices

Risk Assumptions

- Load: Expected Forecast with Standard Deviation of 4.2% of Mean with a normal distribution
- Hydro: 1986 to 2011 upgrade estimated energy savings (random draw)
- Palouse: 1990 to 2010 estimates provided by First Wind (random draw)
- Kettle Falls: Expected to run 10 out of 12 months with standard deviation at 5% of mean with a normal distribution. Assumes 75% of fuel counts as renewable

REC Planning Margin Over Time

	2015 (aMW)			2020 aMW
Scenario	**Expected REC Position**	**5th Confidence Level REC Position**	**Implied Planning Margin**	**Expected 2020 REC Position (aMW)**
2009 Status Higher load forecast, no Palouse or Kettle Falls, Hydro is variable, no EWEB purchase, no Wanapum RECs	-3.1	-9.6	6.5	91.3
2009 with “Hydro Methodology 3”: Same study as above with 10 year historical hydro	-0.9	-1.9	1.0	89.0
Today’s expectations Lower load forecast, Palouse signed, Kettle Falls Counts, Hydro is flat, EWEB sold through 2014.	Long	Long	Zero	Zero

2013 IRP Implications

- REC surplus exceeds potential planning margin requirements
- No REC planning margin will be included for this IRP to meet the EIA
- Planning margins will be taken into account when selling excess RECs
- Without Kettle Falls we would have a 9.9+ aMW Planning Margin for Load/Wind Variation (assumes hydro is fixed)

Commerce REC Filing

Handout:

http://www.commerce.wa.gov/site/1001/default.aspx

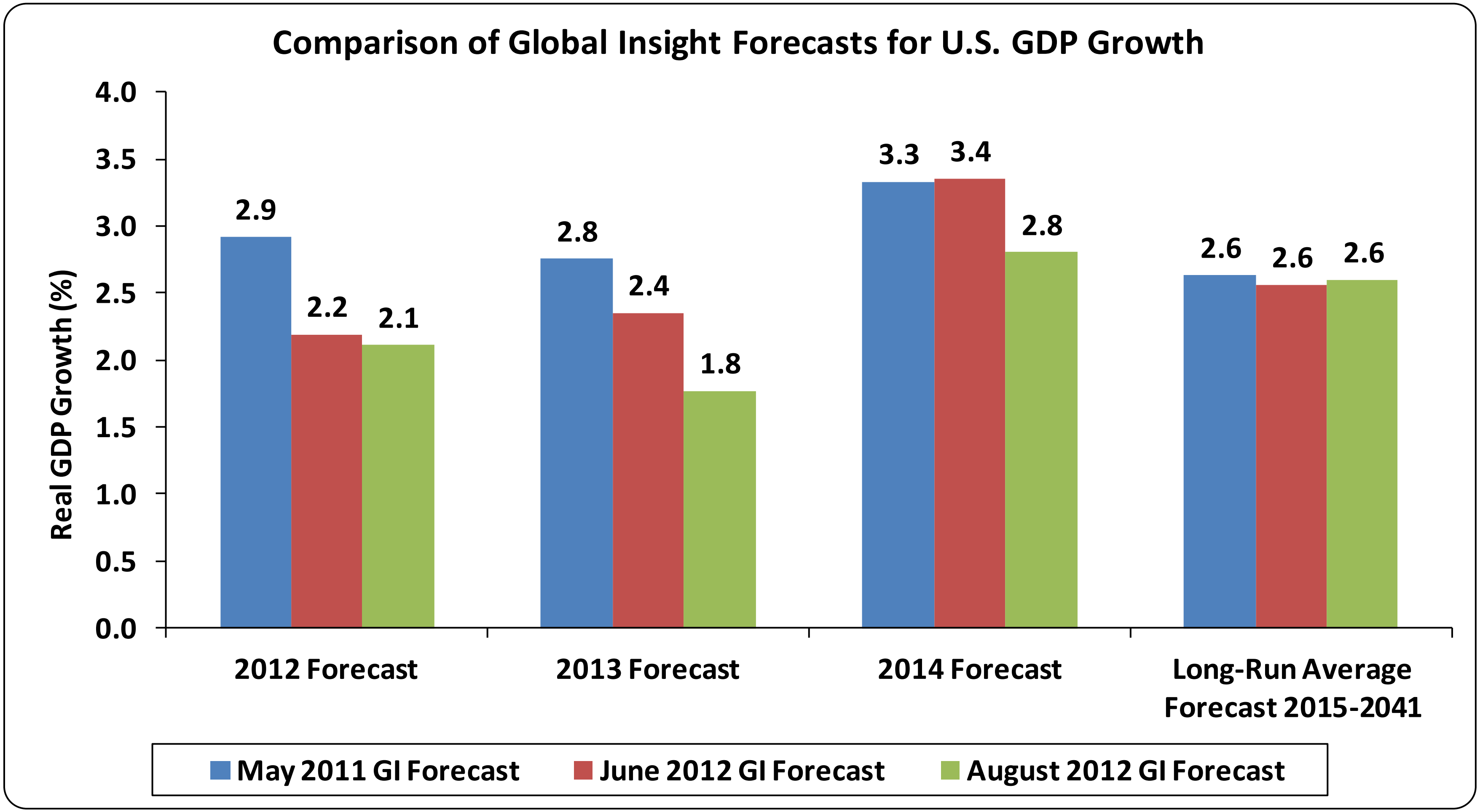
TAC Economic Outlook
September 5, 2012

Grant D. Forsyth, Ph.D.
Chief Economist
509-495-2765
Grant.Forsyth@avistacorp.com

Goals of Update

- Highlight national and regional economic conditions that impact customer and usage forecasts.
- Highlight long-run issues related long-run growth and fiscal consolidation.
- Review most recent electric load forecast.

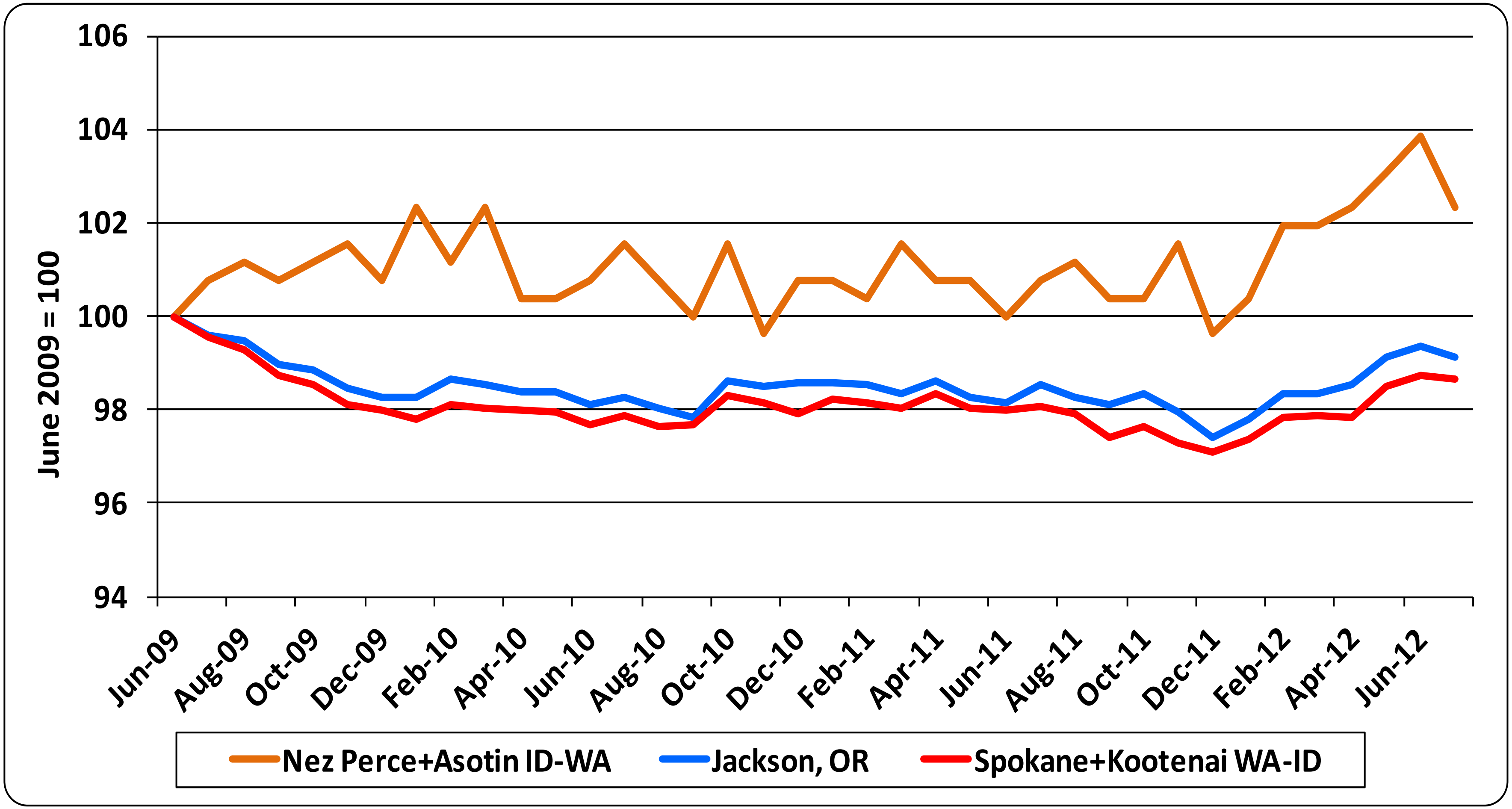
National GDP Growth and Inflation: Recent Global Insight (GI) Forecasts



- Modest growth with increasing downside risks to growth in 2012 and 2013: Europe, Asia, and Congress (aka “Fiscal Cliff”).
- Housing market appears to be stabilizing.

Data Source: BEA, Global Insight, and author’s calculations.

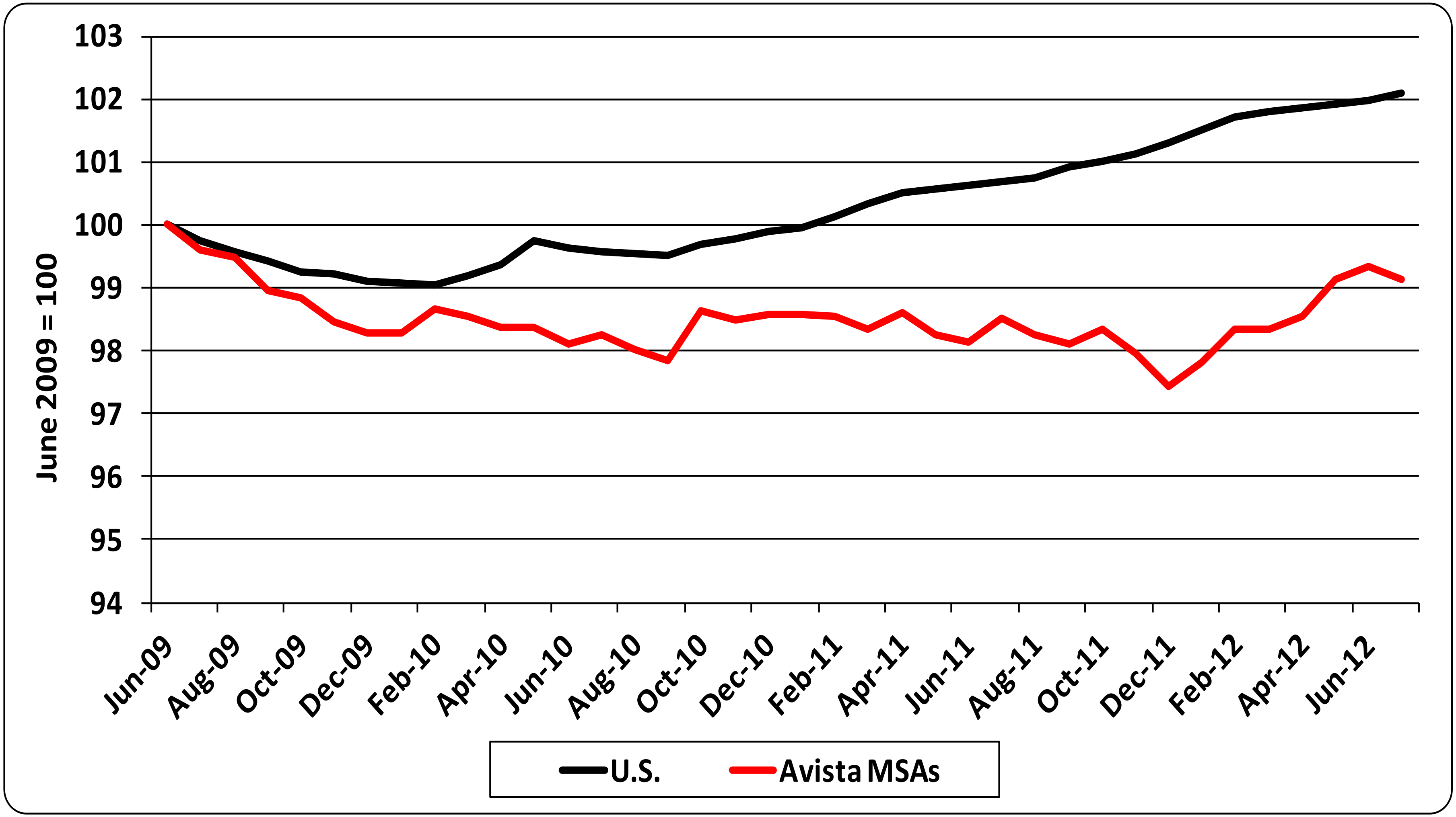
SA Employment Index in Key MSAs, June 2009-July 2012



- Employment levels similar to late 2009. Employment is growing in big metro areas.
- Holding down service area population growth and household formation.

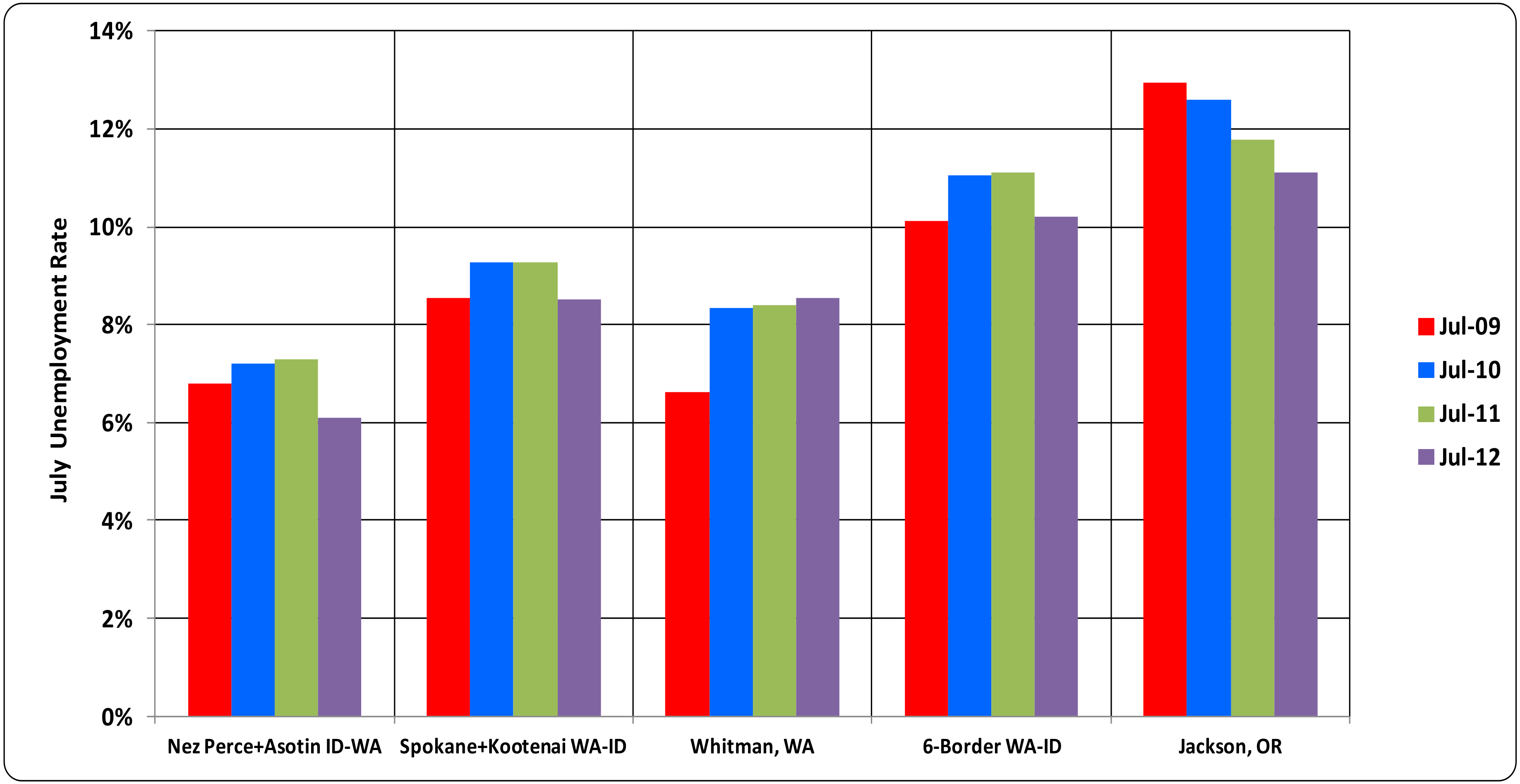
Data Source: BLS and author's calculations.

SA Employment Index for Avista's Service Area, June 2009-July 2012



Data Source: BLS and author's calculations.

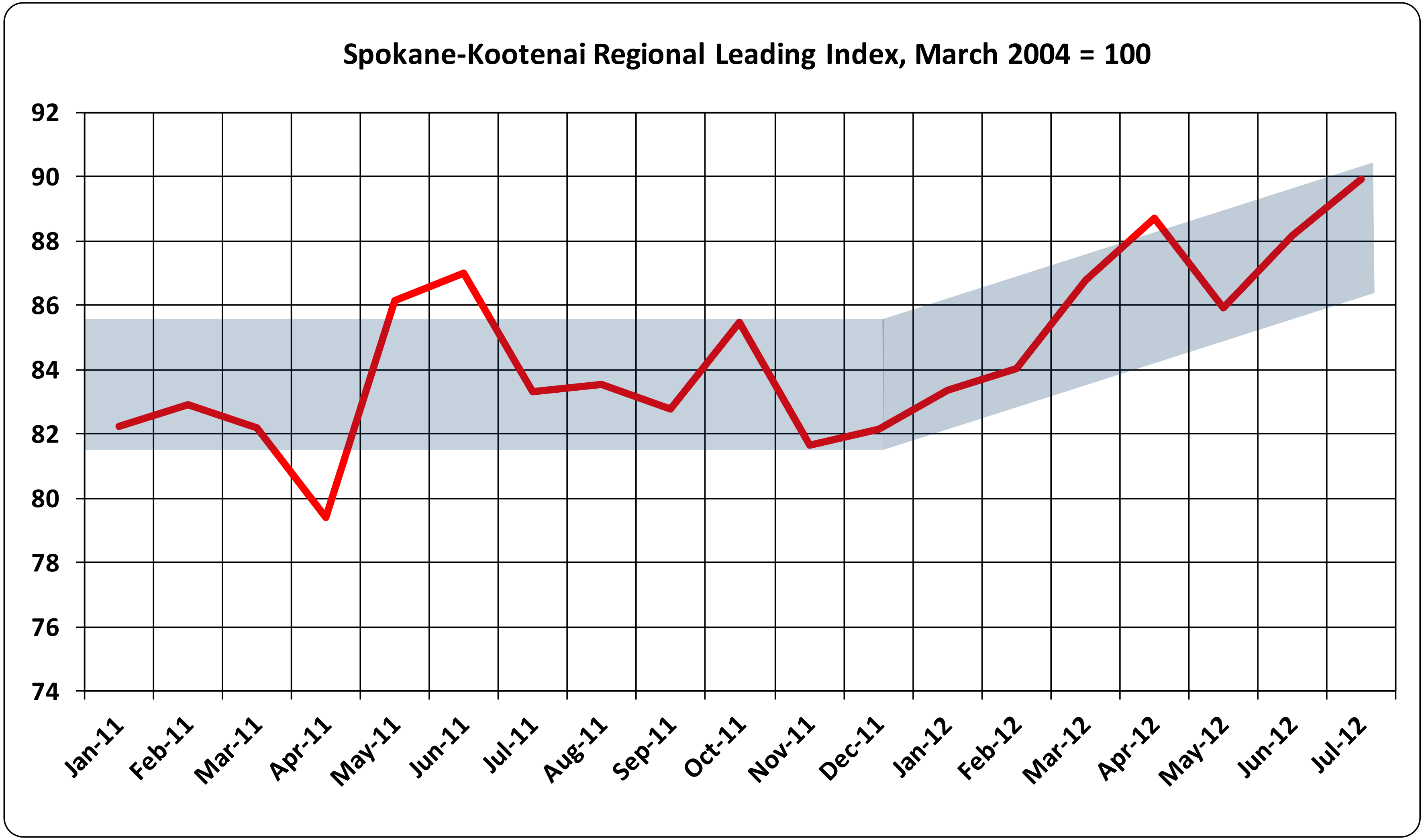
Unemployment Rate for July, 2009-2012



- Jackson, OR (Medford MSA) has fallen the most, rates still high.
- Some of the declines reflect a falling labor force from discourage workers “dropping out.”
- Expect unemployment rates to remain elevated for rest of 2012 and into 2013.

Data Source: BLS and author’s calculations.

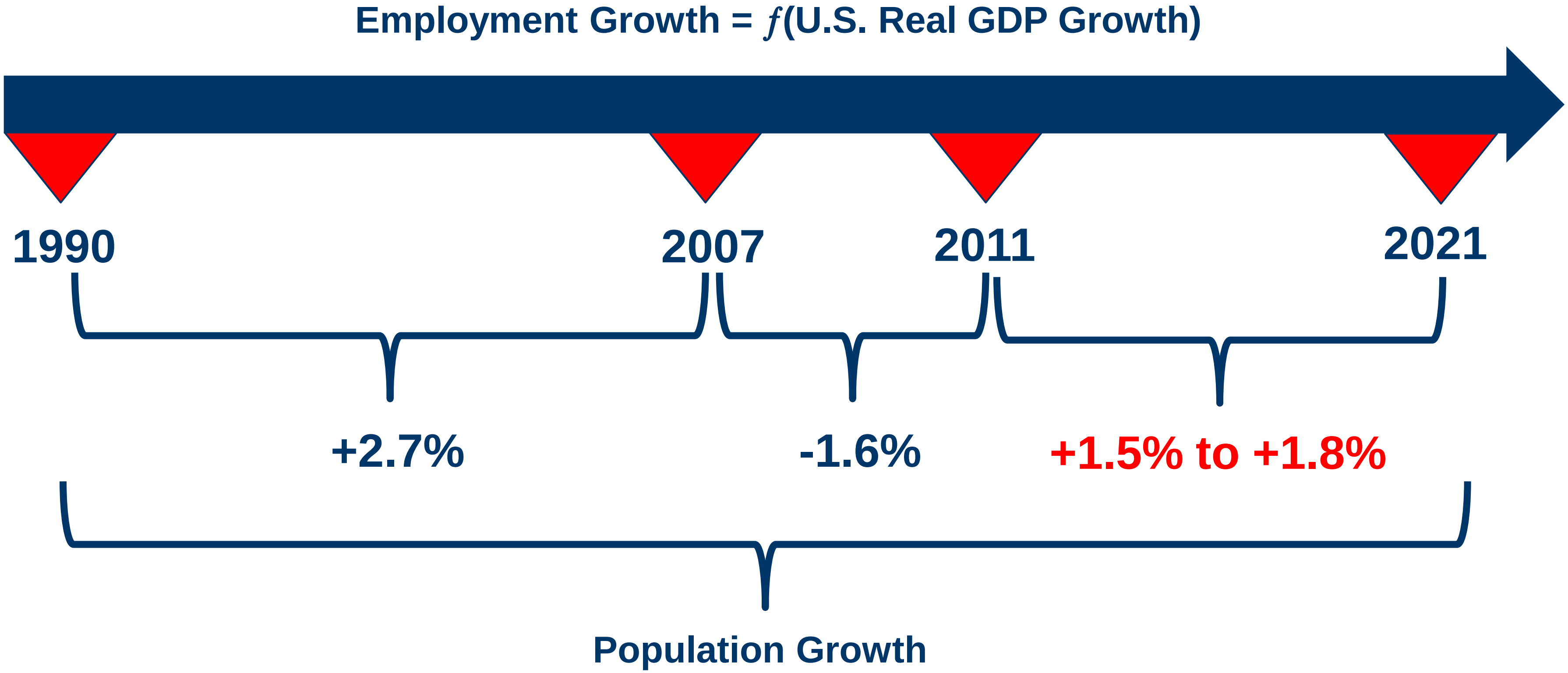
Spokane+Kootenai Leading Indicator, 2011-2012



- **Highly correlated with employment changes 12 to 15 months in advance.**
- **Signaling very slow employment growth for the rest of 2012 and through the first half of 2013.**

Data Source: Global Insight and author's calculations.

Old vs. New Long-Run: Annualized Employment and Population Growth in Spokane+Kootenai



Employment Growth = f(U.S. Real GDP Growth)

1990

2007

2011

2021

+2.7%

-1.6%

+1.5% to +1.8%

Population Growth

Regional Population Growth = f(U.S. Employ. Growth, Regional Employ. Growth)

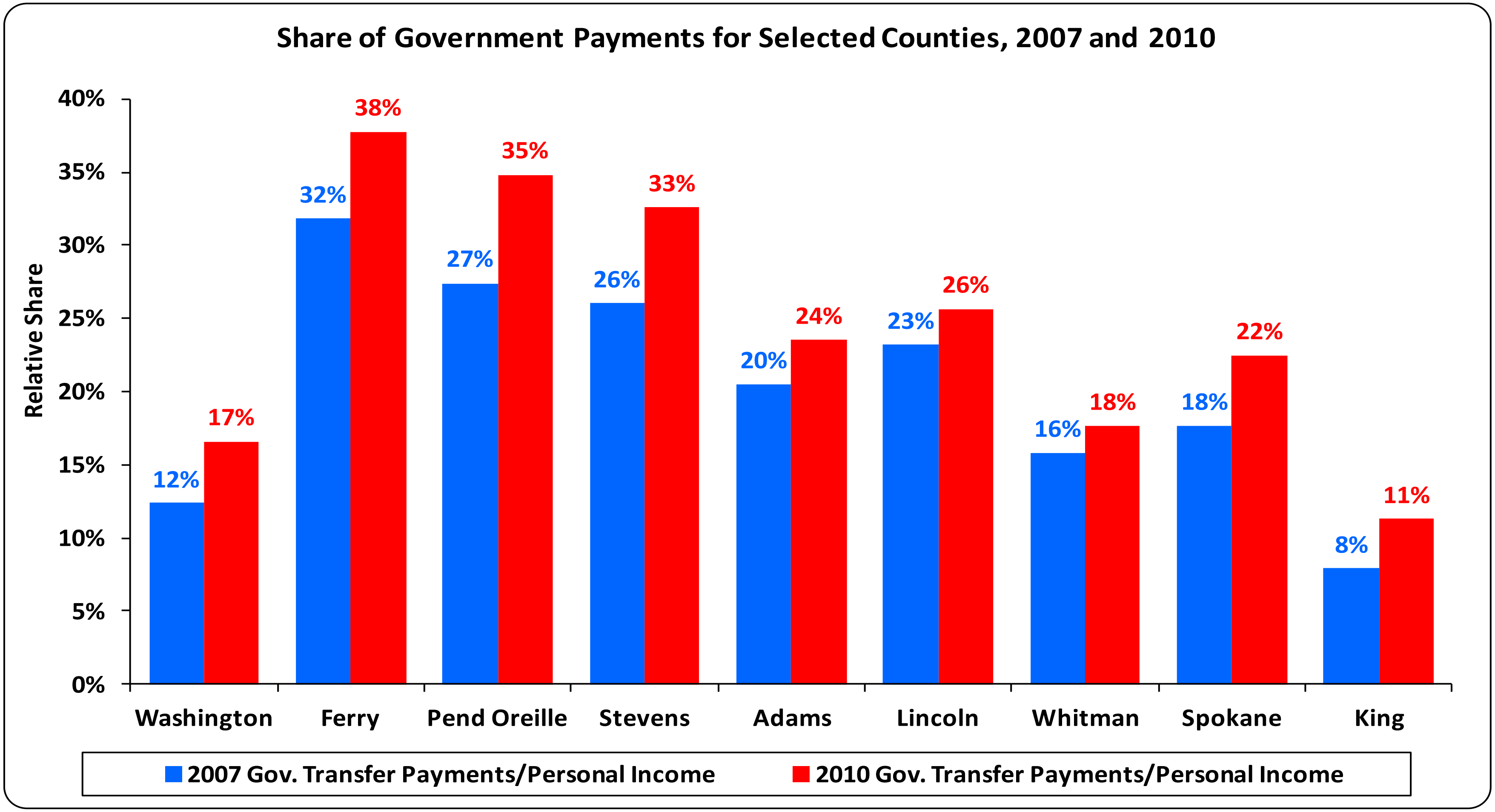
+1.1% to +1.3%

(-)

(+)

Data Source: BLS and author's calculations.

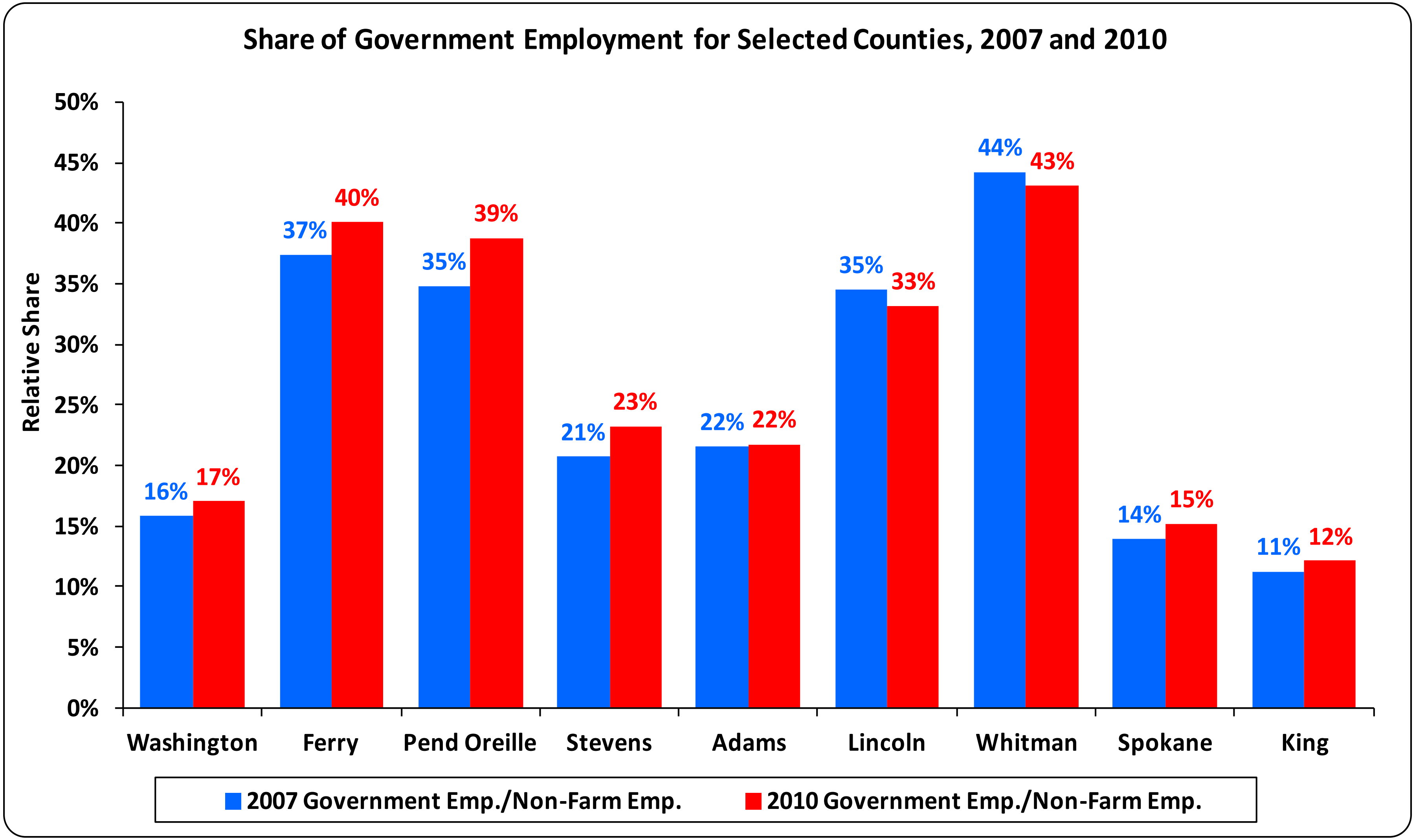
The Potential Drag of Fiscal Consolidation: Government Transfer Payments to Total Personal Income, 2007 and 2010



- **Message: Be careful what you ask for in terms of smaller government when government is an important part of your economy.**

Data Source: BEA and author’s calculations.

The Potential Drag of Fiscal Consolidation: Government Employment as a Share of Total Employment, 2007 and 2010


Share of Government Employment for Selected Counties, 2007 and 2010

Data Source: BEA and author's calculations.

Looking Forward: Other Issues Potentially Impacting Growth

- Aerospace firms have shown robust growth. This should continue given Boeing’s order book. Potential new 737 plant not in forecast.
- Air force is moving ahead with the evaluations of bases for refueling tankers. The 10 finalists will be chosen by late summer 2012. Those chosen for expansion will be announced at year-end.
- Changes in the price of natural gas.

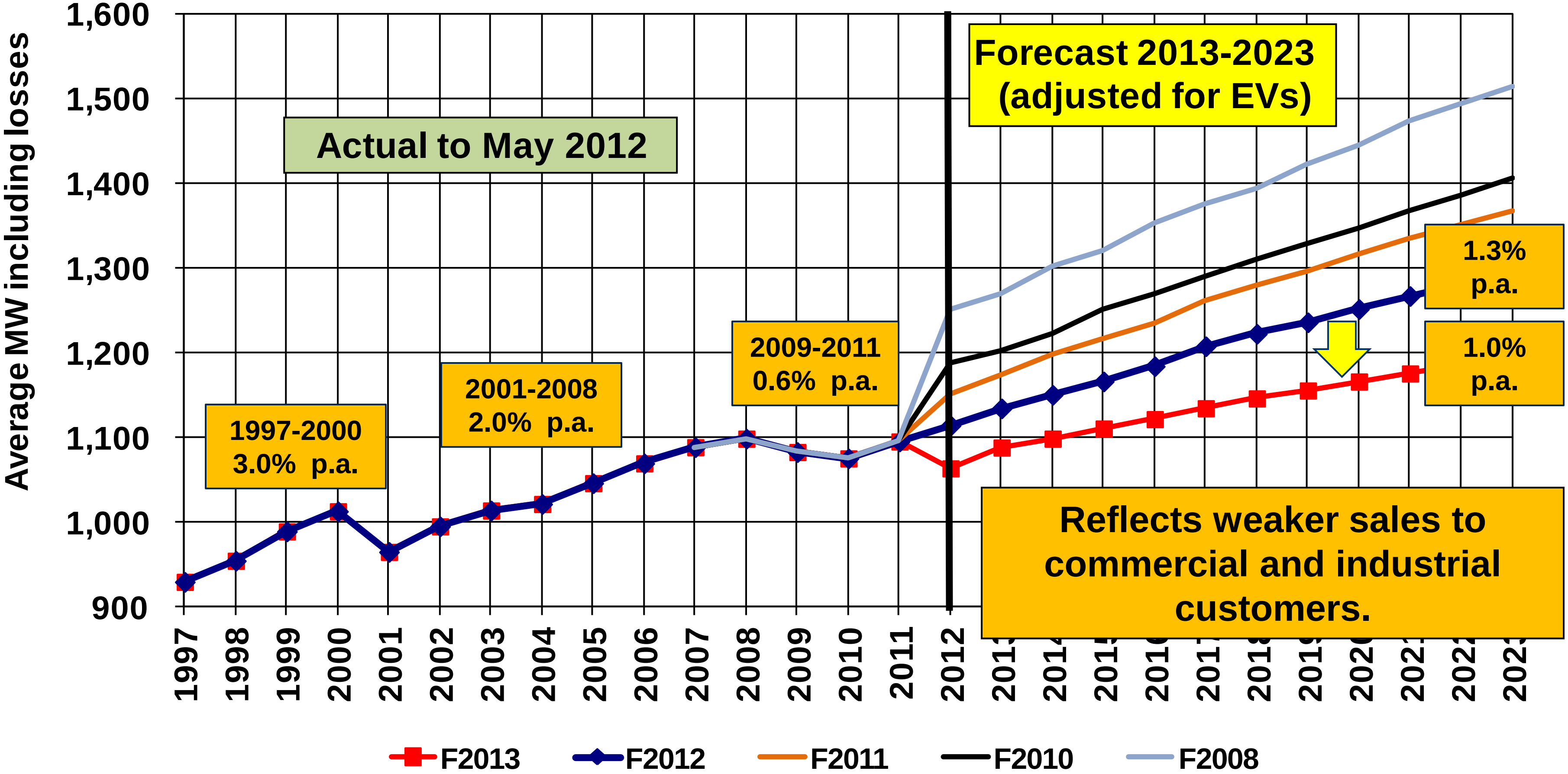
Native Load Forecast Lower

Avista Combined Native Load

Washington and Idaho

Forecast Native Load Growth Rates from 2013
5 yr = 1.04%   10 yr = 0.95%   22 yr = 1.01%

Forecast Customer Growth Rates from 2013
5 yr = 1.3% 10 yr = 1.2% 22 yr = 1.1%



Forecast 2013-2023
(adjusted for EVs)

Actual to May 2012

1997-2000
3.0% p.a.

2001-2008
2.0% p.a.

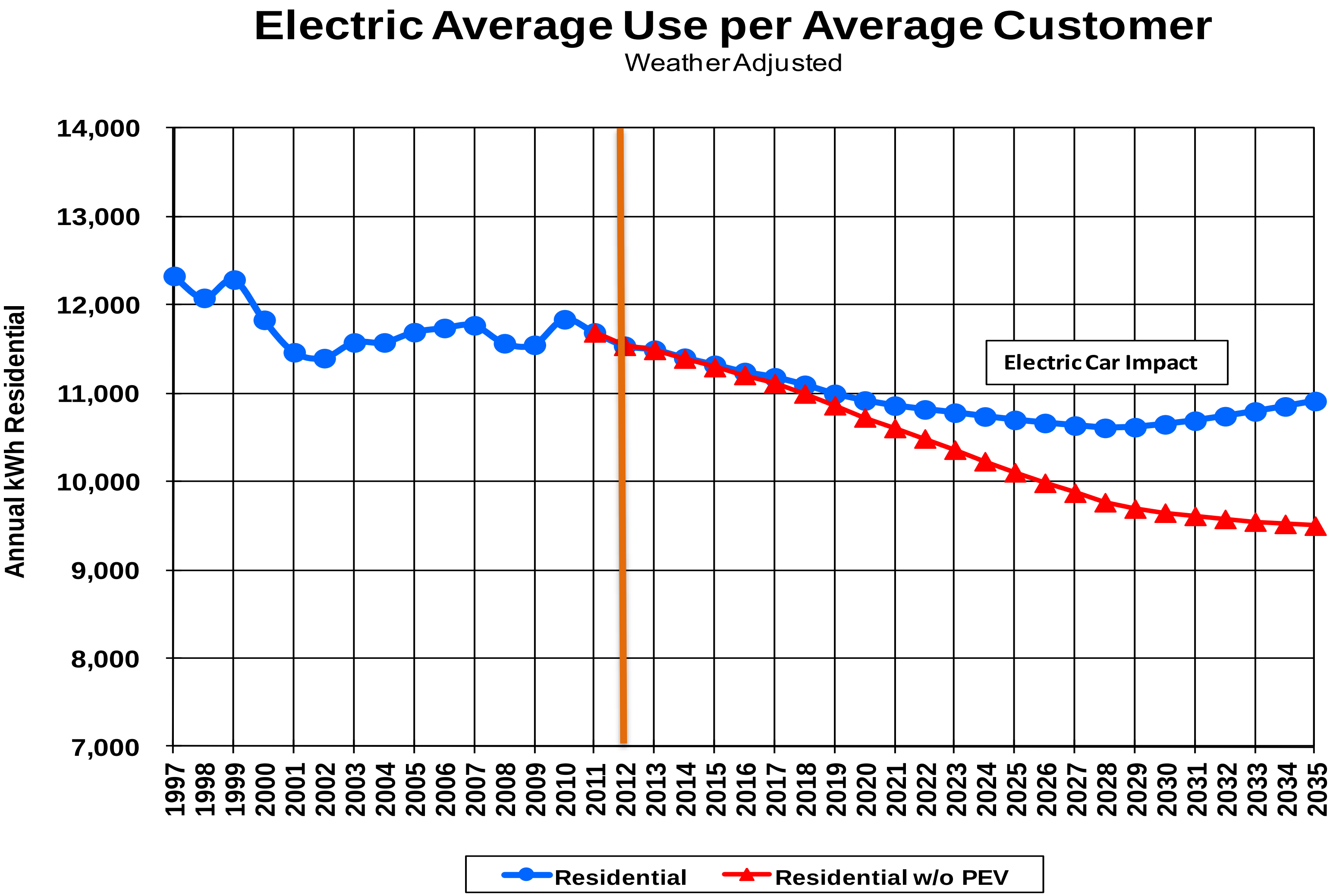
2009-2011
0.6% p.a.

1.3%
p.a.

1.0%
p.a.

Reflects weaker sales to commercial and industrial customers.

Annual Residental Use Per Customer, 1997-2035



“Together We Will Build Shared Value”

Avista’s 2012 report on our performance

Technical Advisory Committee

Sept. 5, 2012

Jessie Wuerst, Sr. Communications Manager

Cross-Company Shared Value Action Team

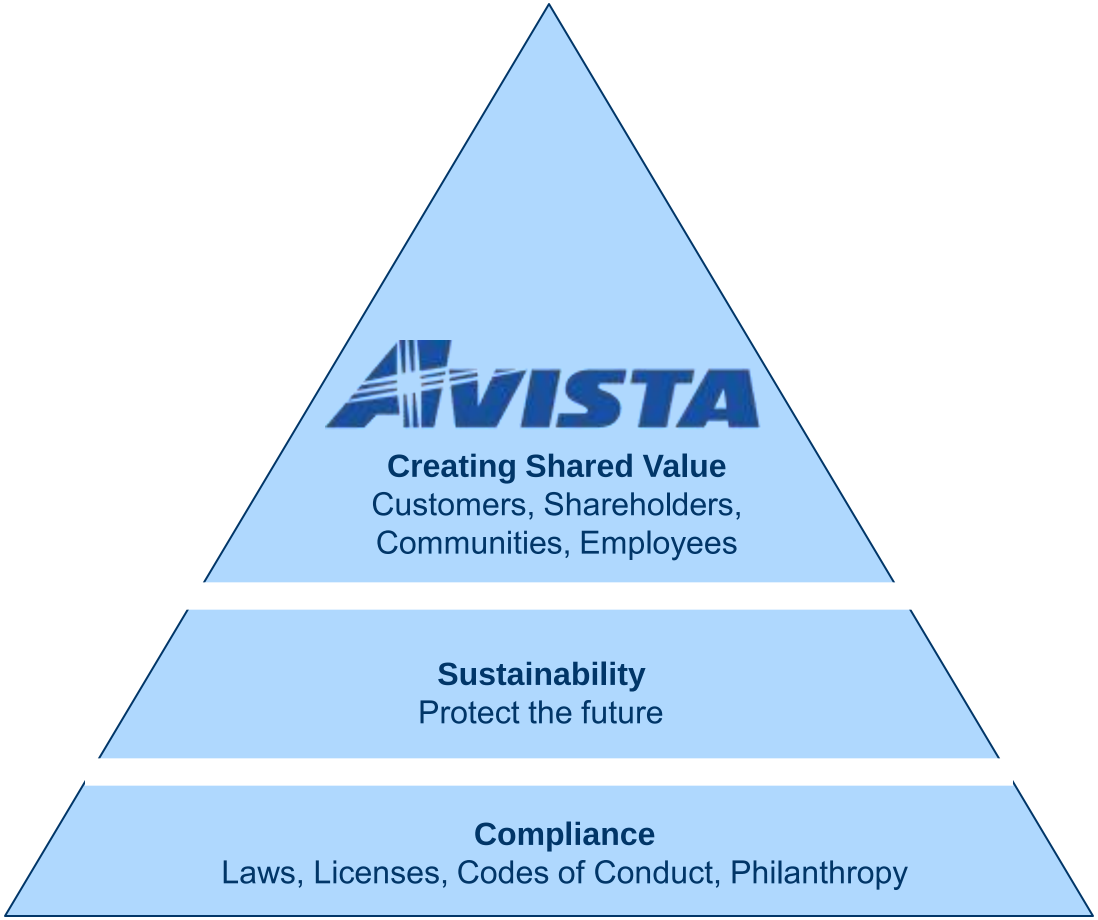
Consumer Affairs
Customer Service
Electric Operations
Energy Solutions/DSM
Environmental
Facilities
Gas Operations

Generation & Production
Health & Safety
Human Resources
Rates
Resource Planning
Supply Chain

The business case for reporting

- Increase opportunities to build understanding of Avista’s operations for all stakeholders
- Provide information that stakeholder groups want to know about
- Create opportunities for discussing partnerships with stakeholders that bring value to all
- Enhance transparency of Avista as a business to build trust and two-way communication

The “Shared Value” Pyramid



Creating Shared Value
Customers, Shareholders,
Communities, Employees

Sustainability
Protect the future

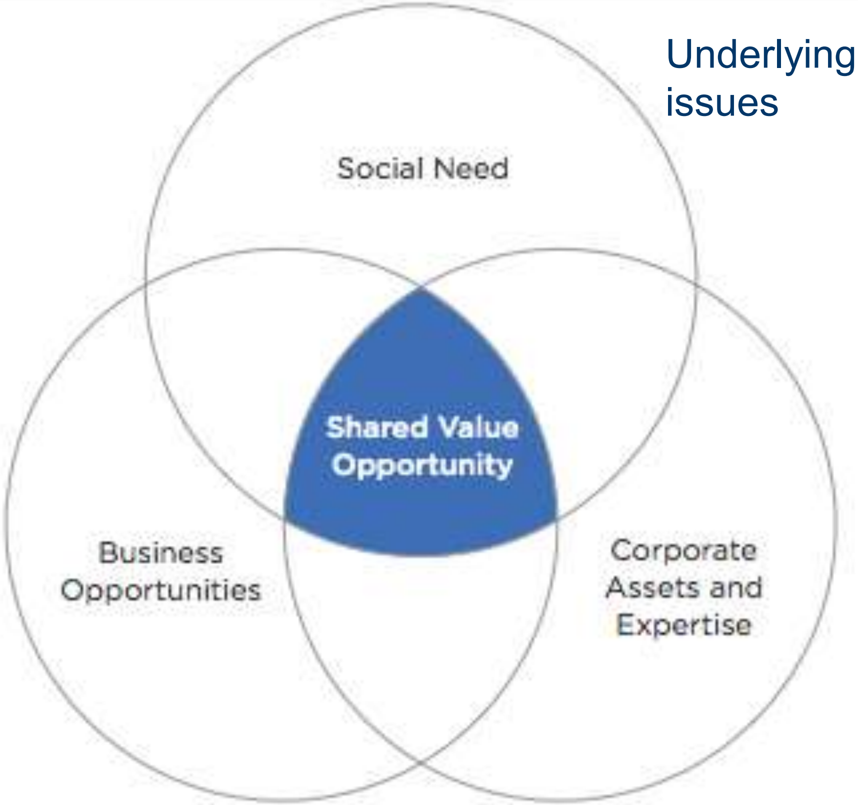
Compliance
Laws, Licenses, Codes of Conduct, Philanthropy

Shared Value – Changing Business Practices

“The principle of shared value…involves creating economic value in a way that *also* creates value for society by addressing its needs and challenges. Businesses must reconnect company success with social progress. Shared value is not social responsibility, philanthropy, or even sustainability, but a new way to achieve economic success.”

Harvard Business Review – Jan. 2011

Shared Value – An Opportunity



Underlying community/society issues

Avista strategic plans

Avista operations, programs, people

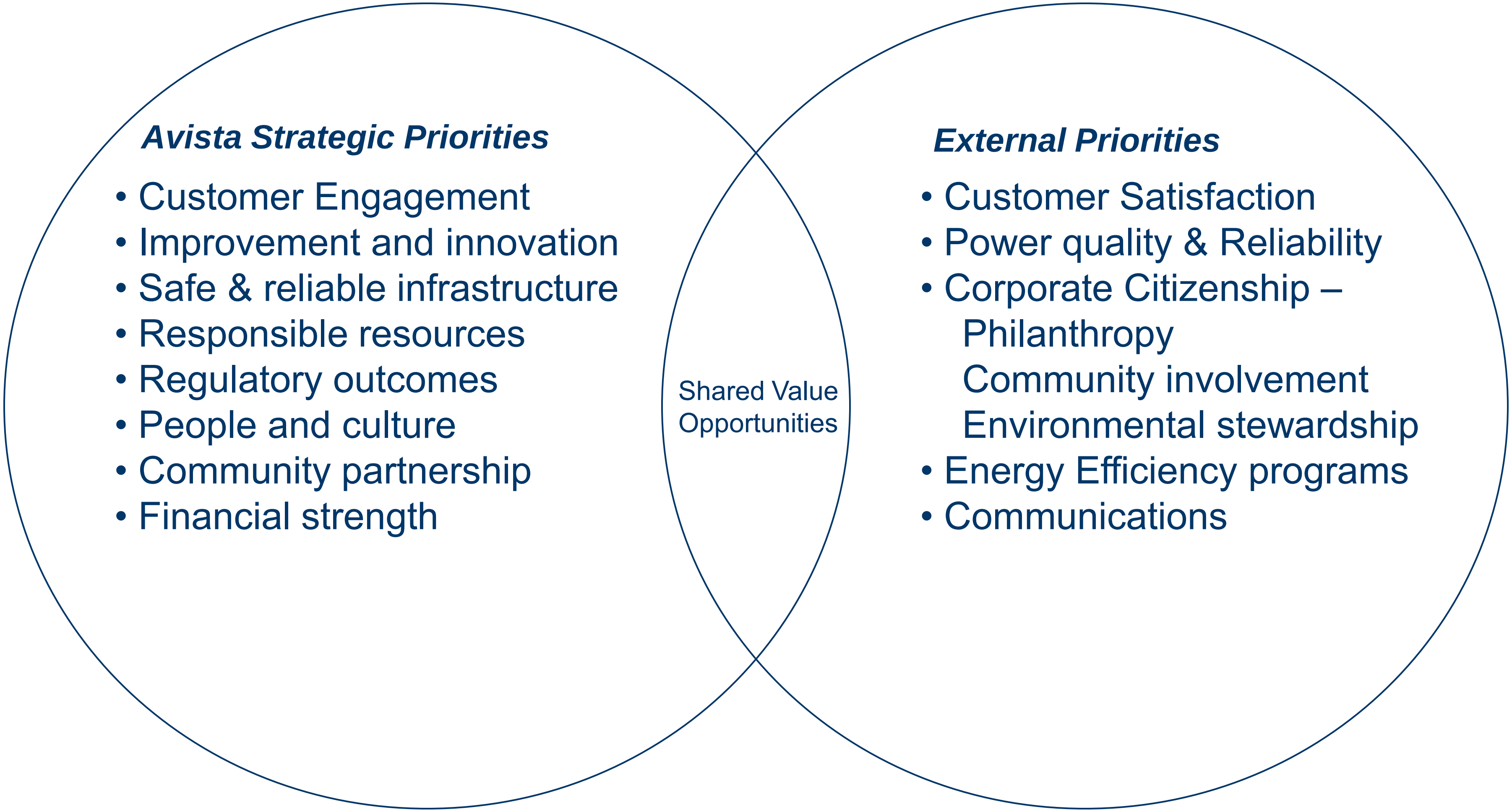
A snapshot in time of what Avista does well that grows our business and at the same time provides “social” value

Shared value opportunities are core to Avista’s vision:

“Delivering reliable energy service and the choices that matter most to you”

Shared Value reporting should focus on:

Linking business strategic priorities and what we know is of interest/concern to customers, media, investors and other stakeholders



Avista Strategic Priorities

- Customer Engagement
- Improvement and innovation
- Safe & reliable infrastructure
- Responsible resources
- Regulatory outcomes
- People and culture
- Community partnership
- Financial strength

Shared Value Opportunities

External Priorities

- Customer Satisfaction
- Power quality & Reliability
- Corporate Citizenship –
  - Philanthropy
  - Community involvement
  - Environmental stewardship
- Energy Efficiency programs
- Communications

How can we most effectively share this information with stakeholders?

Segment stakeholders, identify current points of contact with each group and insert messaging throughout the year…

Bill insert Newsletter
Social Media
Website
Community presentations (RBMs etc.)
Employees e.g. account executives

Employee communications: quarterly meetings, eview, View
Editorial board meetings
News releases

Corporate Citizenship

52,000 hours a year

Avista plugs in human energy

THE JOURNAL'S VIEW

Avista makes case for its overall impact

While it's easy to criticize Avista Corp. whenever the power goes out or each time the utility wants to hike rates, it's difficult to ignore the positive impact it has on the Inland Northwest.

Avista recently released what it's calling its "shared value report," which talks in detail about its performance as an employer and utility, as well as its activities in environmental stewardship and in community involvement.

Generally, as it's outlined in the report, a shared value opportunity is one where business opportunity, expertise, and social need come together. The concept is sort of a corporate version of a campfire Kumbaya, but the company makes an effective argument for it in the report.

As a reminder, Avista has almost 1,600 employees serving more than 358,000 customers in a service area that includes parts of Washington, Idaho, and Oregon. In 2011, it had $100 million in net income on $1.6 billion in revenue for the year.

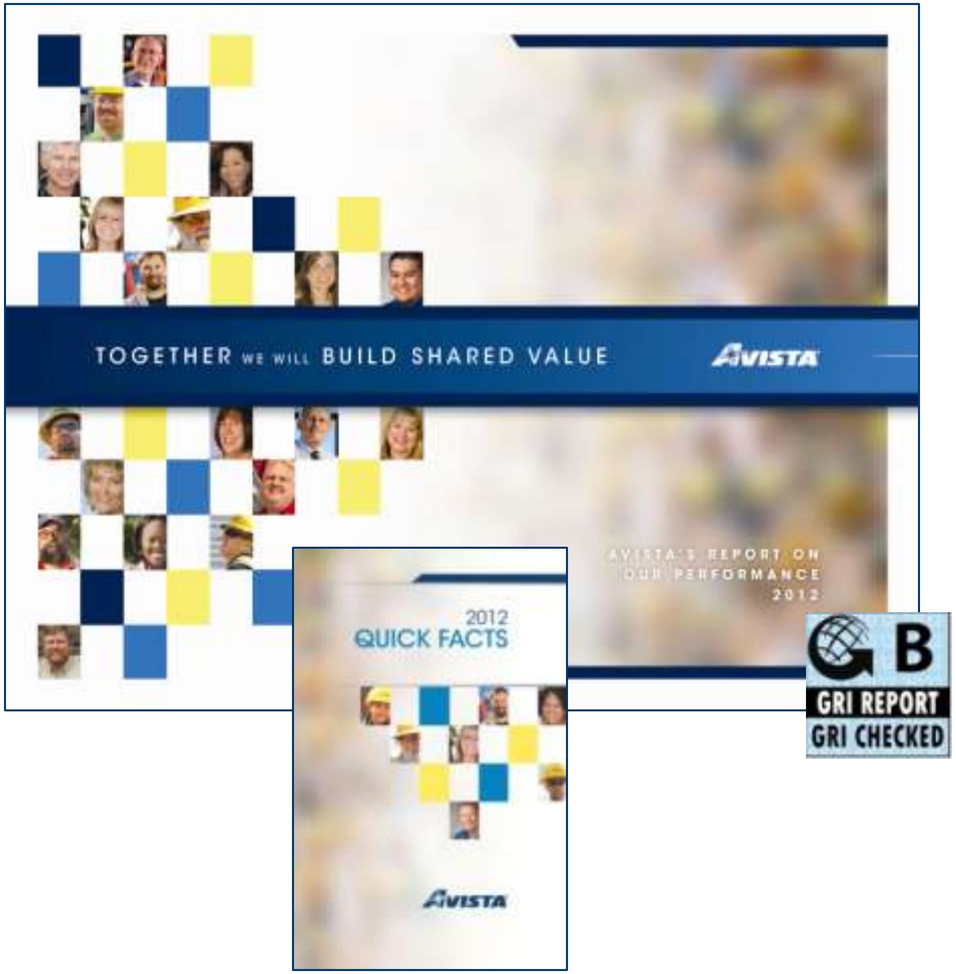
The company continues to invest tens of millions of dollars in its infrastructure on a number of fronts. Part of that, of course, is compelled by the need to meet the renewable energy generation standards laid out in Washington's Energy Independence Act, which ultimately will demand that 15 percent of each power company's electricity generation comes from renewable sources.

Avista and the Avista Foundation gave a total of $1.47 million last year, in addition to its low-income energy assistance.

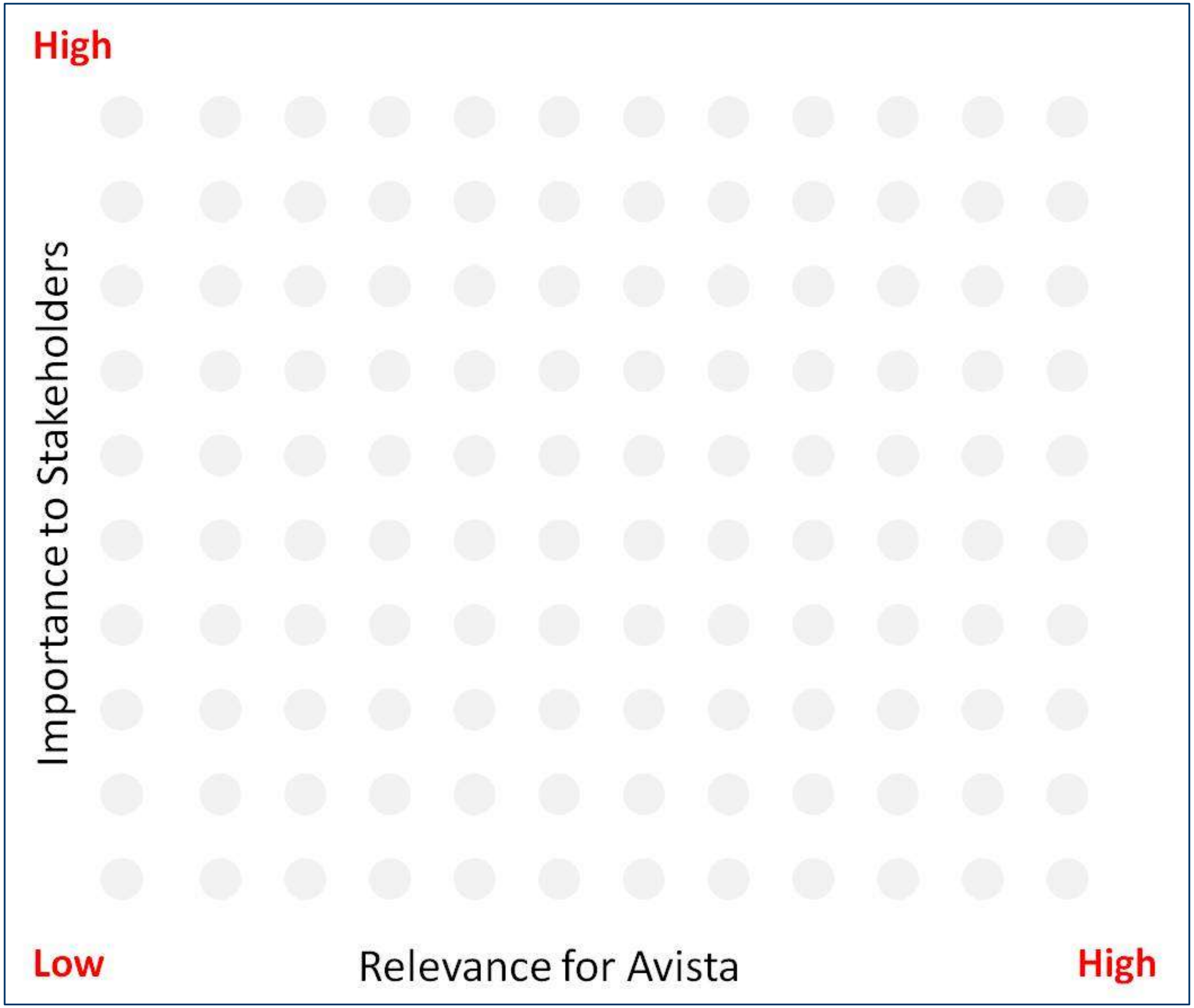
Such projects include the six-year, $75 million renovation and upgrade to the Noxon Rapids Dam in northwestern Montana, which is increasing that dam's total generating capacity by about 30 megawatts.

On a smaller monetary scale, the company is using grant money to modernize its infrastructure. Its Smart Circuits Project is a three-year initiative that accelerates the pace of improvements to its system in Spokane. Ultimately, those improvements are expected to improve reliability and re-

An integrated family of reports



Materiality Matters



Questions or Comments?

Generation Options

John Lyons, Senior Resource Policy Analyst

Second Technical Advisory Committee Meeting

2013 Electric Integrated Resource Plan

September 5, 2012

Supply Side Resource Data Sources

- Northwest Power and Conservation Council – 6th Northwest Power Plan
- Internally developed resource lists from:
  - Trade journals
  - Press releases from other companies
  - Engineering studies and other models
  - State commission announcements
  - Proposals from developers
- Consulting firms and reports
- State and federal resource studies and publications
- Data sources are used to check and refine generic resource assumptions

Natural Gas-Fired Resources

Resource Type	First Year	Size (MW)	Levelized Overnight Costs (2012 $/MWh) *	Capital Cost Excludes AFUDC (2012$)
SCCT (aero)	2015	100	$79	$1,101/kW
SCCT (frame EA)	2015	166	$81	$845/kW
SCCT (frame FA)	2015	175	$70	$728/kW
Hybrid SCCT	2015	92	$75	$1,114/kW
CCCT (air)	2017	270	$70	$1,117/kW
Reciprocating Engine	2015	113	$76	$1,060 /kW

* Prices are based on a preliminary natural gas price forecast

Other Thermal Resources

Resource Type	First Year	Size (MW)	Levelized Overnight Costs (2012 $/MWh)	Capital Cost Excludes AFUDC (2012$)
Coal (Super-critical)	2018	300	$97	$3,100/kW
Coal (IGCC)	2014	300	$127	$4,000/kW
Coal (IGCC w/sequestration)	2018	250	$170	$6,000/kW
Nuclear	2023	100*	$173	$7,000/kW
Small Scale Nuclear	2023	25	$107	$4,000/kW

* This represents a 100 MW of a 1,100 MW plant.

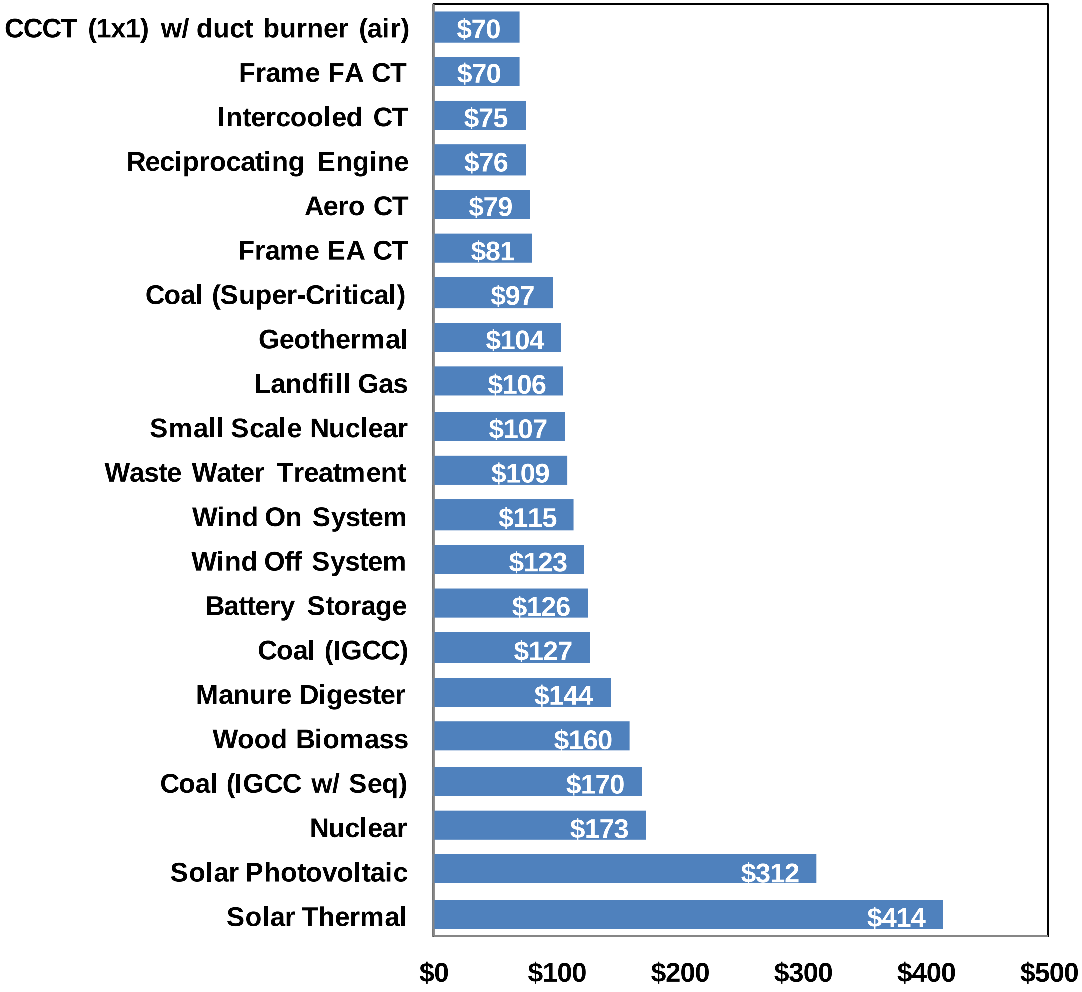
Renewable and Storage Resources

Resource Type	First Year	Size (MW)	Levelized Overnight Costs (2012 $/MWh)	Capital Cost Excludes AFUDC (Nominal 2012)
Wind (On System)	2013	100	$115	$2,140/kW
Wind (Off System)	2013	100	$123	$2,140/kW
Geothermal	2017	15	$104	$4,000/kW
Wood Biomass	2015	25	$160	$4,000/kW
Landfill Gas	2014	3.2	$106	$2,500/kW
Manure Digester	2013	0.85	$144	$4,500/kW
Waste Water Treatment	2014	0.85	$109	$4,500/kW
Solar Photovoltaic	2014	5	$312	$3,500/kW
Solar Thermal	2014	50	$414	$6,500/kW
Battery Storage	2015	5	$126	$4,000/kW

Avista Upgrade Alternatives

- Avista thermal upgrades
    - Rathdrum CT
    - Coyote Springs 2
- Avista hydroelectric upgrades
    - Spokane River Project
    - Clark Fork River Project

New Resource Options Levelized Costs ($/MWh)



Hydro Modernization Initiative

Modernize Avista’s existing fleet of hydro resources to:

- Generate incremental energy to meet load growth
- Produce RECs to meet renewable portfolio standards
- Increase plant efficiency through utilization of new technology
- Reduce risk through improved reliability and environmental mitigation

Develop long-term strategy to assess and prioritize Spokane River plant opportunities, and study Cabinet Gorge modifications to mitigate total dissolved gas issues

Clean Resources

Generation Capability and Service Territory

HYDROELECTRIC	GENERATION CAPABILITY (MW)
1 Noxon Rapids (Noxon, MT)	562.4
2 Cabinet Gorge (Clark Fork, ID)	254.6
3 Long Lake (Spokane, WA)	87.0
4 Little Falls (Spokane, WA)	34.6
5 Post Falls (Post Falls, ID)	18.0
6 Nine Mile (Spokane, WA)	17.6
7 Monroe Street (Spokane, WA)	15.0
8 Upper Falls (Spokane, WA)	10.2
Total Hydroelectric Capability	**999.4**

THERMAL	GENERATION CAPABILITY (MW)
⑨ Coyote Springs 2 (Boardman, OR)	278.3
⑩ Colstrip (Units 3 & 4) (Colstrip, MT)	222.0
⑪ Rathdrum Combustion Turbines (Rathdrum, ID)	149.0
⑫ Northeast Combustion Turbines (Spokane, WA)	61.2
⑬ Kettle Falls Biomass Plant (Kettle Falls, WA)	50.0
⑭ Boulder Park (Spokane, WA)	24.0
⑮ Kettle Falls Combustion Turbine (Kettle Falls, WA)	6.9
Total Thermal Capability	**791.4**

PURCHASED	GENERATION CAPABILITY (MW)
⑯ Lancaster (Rathdrum, ID) – Contract	275.0
Mid-Columbia Projects	**180.0**
17 Wells (Douglas PUD)	
18 Rocky Reach (Chelan PUD)	
19 Wanapum (Grant County PUD)	
20 Priest Rapids (Grant County PUD)	
㉑ Stateline Wind Farm (Touchet, WA)	35.0
Total Purchased Generation Capability	**490.0**

Value Proposition

- Improve **reliability** by replacing aging equipment
- Improve **performance** (energy and capacity) through technology advancements
- Produce **renewable energy credits** to meet RPS requirements
- Take advantage of **favorable tax treatment**
- Possible resolution of **total dissolved gas** issues

Clean Resources

Spokane River Project

- ***Spokane River was built out in the late 1800’s and early 1900’s to meet the growing demands of the Spokane region.***
- ***Undersized by today’s design standards for hydro development capturing 30% – 60% of available water***

Clean Resources

Spokane River Project

Clean Resources

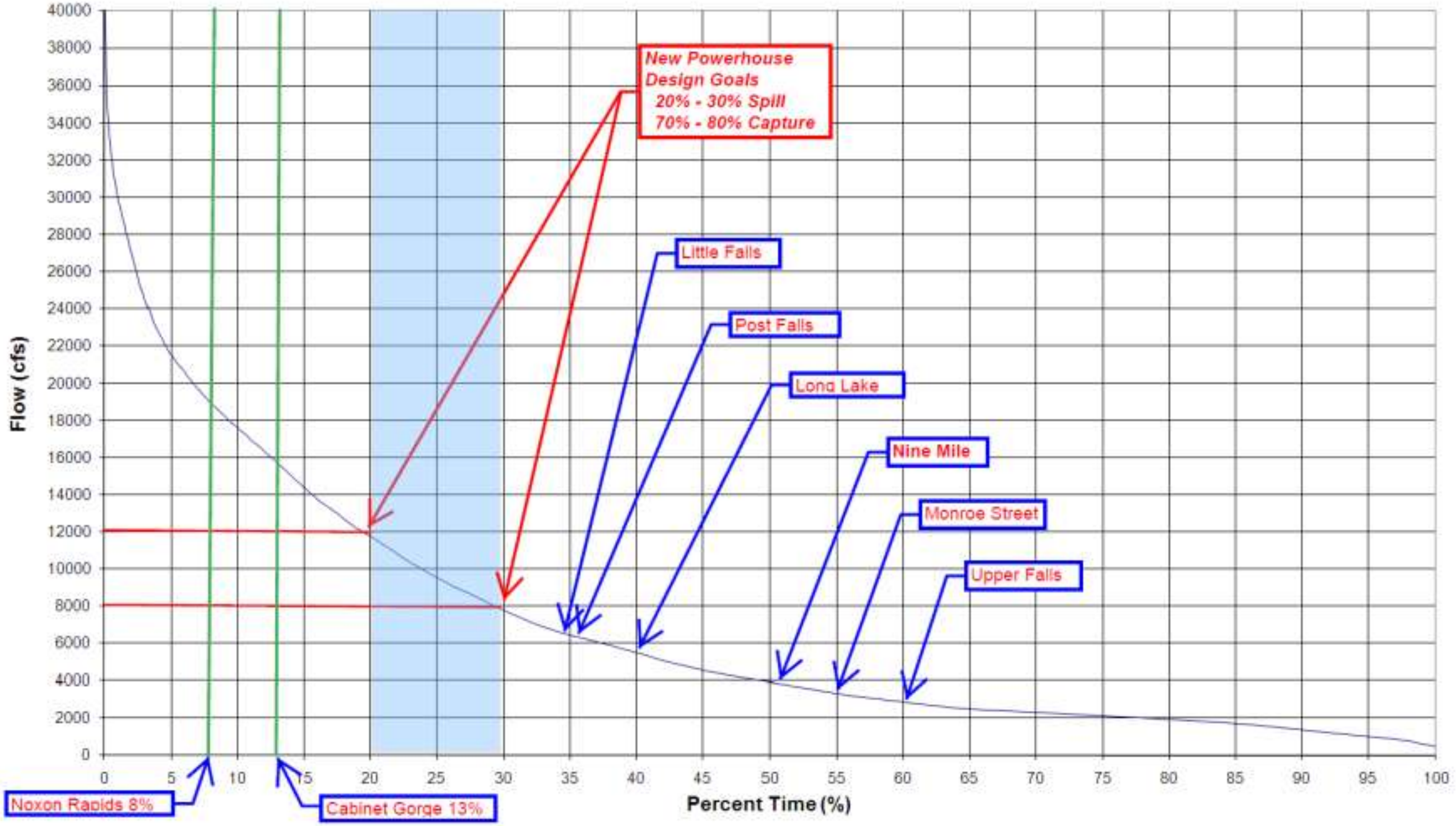
Original Monroe Street Powerhouse

Current Spokane River Project

Facility	Year Built	Generation Capability (MW)	Net Energy Output (MWh)
Post Falls	1906	14.8	90,000
Upper Falls	1922	10.0	71,000
Monroe St	1992	14.8	106,000
Nine Mile	1908	26.4	101,000
Long Lake	1915	78.0	480,000
Little Falls	1910	32.0	201,000
Total		**176.0**	**1049,000**

Clean Resources

Spokane River Project Flow Duration Curve



New Powerhouse Design Goals
20% - 30% Spill
70% - 80% Capture

Little Falls

Post Falls

Long Lake

Nine Mile

Monroe Street

Upper Falls

Noxon Rapids 8%

Cabinet Gorge 13%

Clean Resources

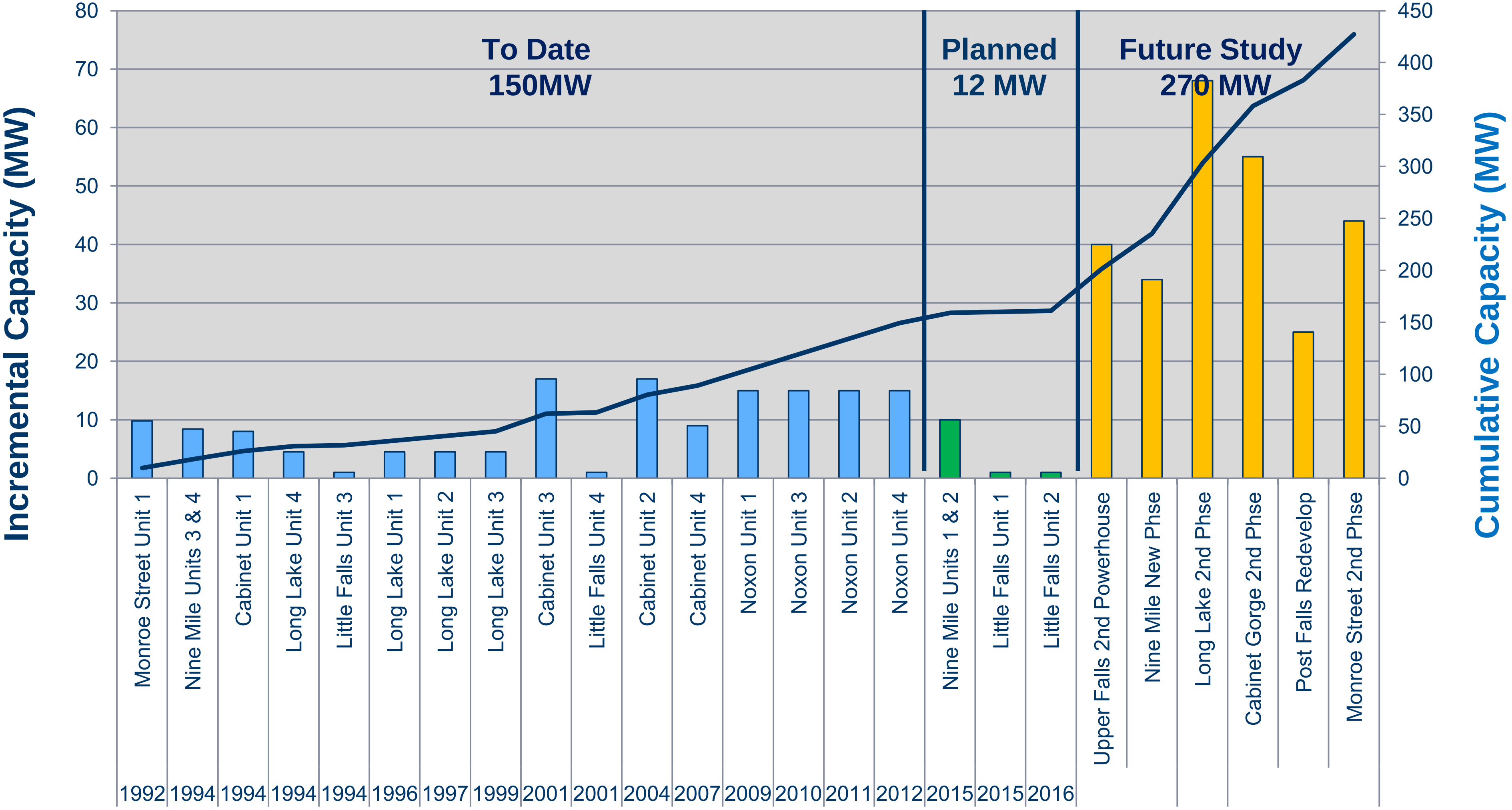
Spokane River Assessment

Goals of the Spokane River Assessment:

- ***Fully develop the Spokane River***
  - ***Capture 70% - 80%***
- ***Provide cost effective generation alternatives to meet resource needs***
- ***Increase plant efficiency and reliability***
- ***Address environmental and regulatory considerations***

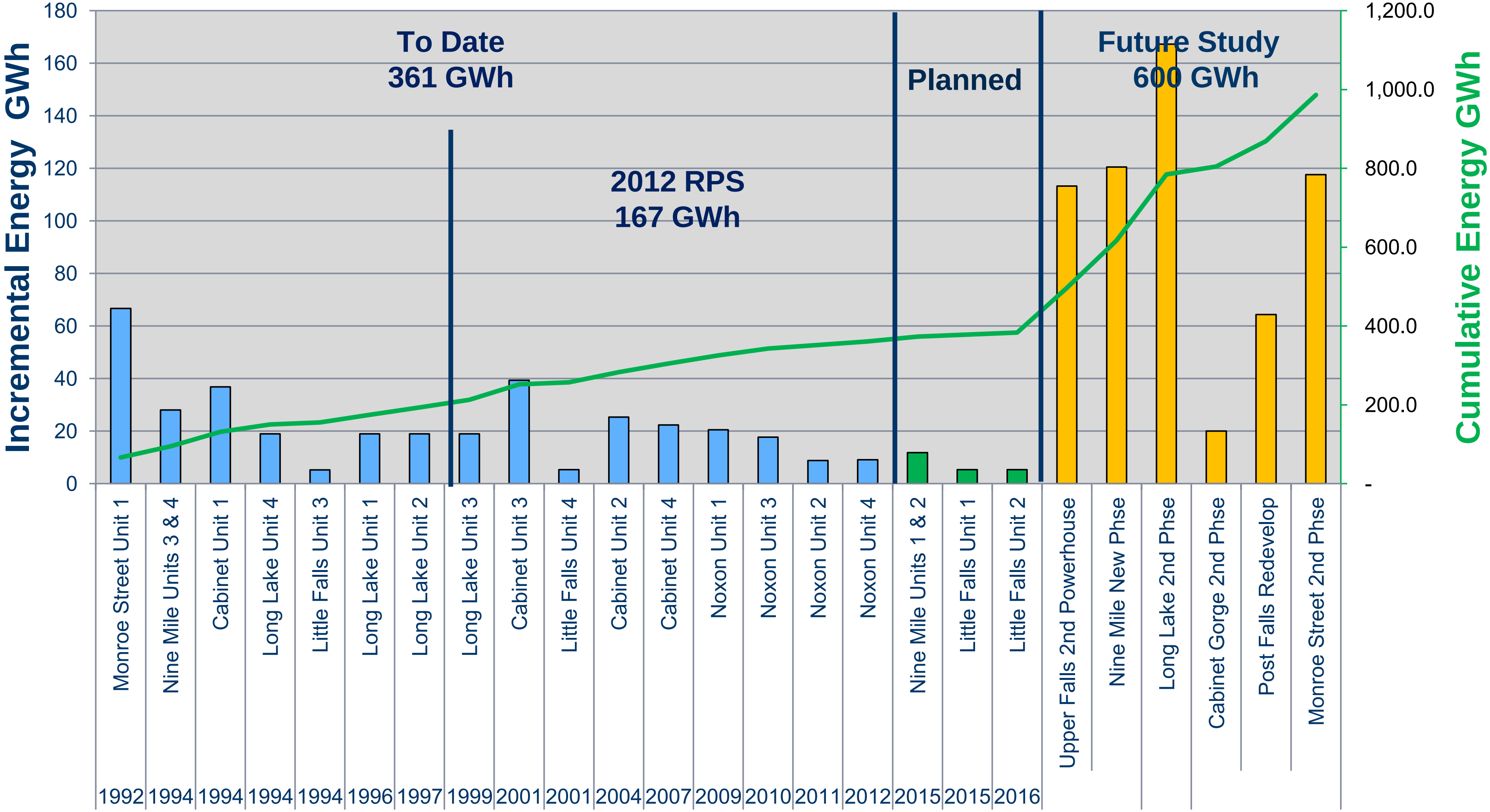
Clean Resources

A History of Hydro Upgrades



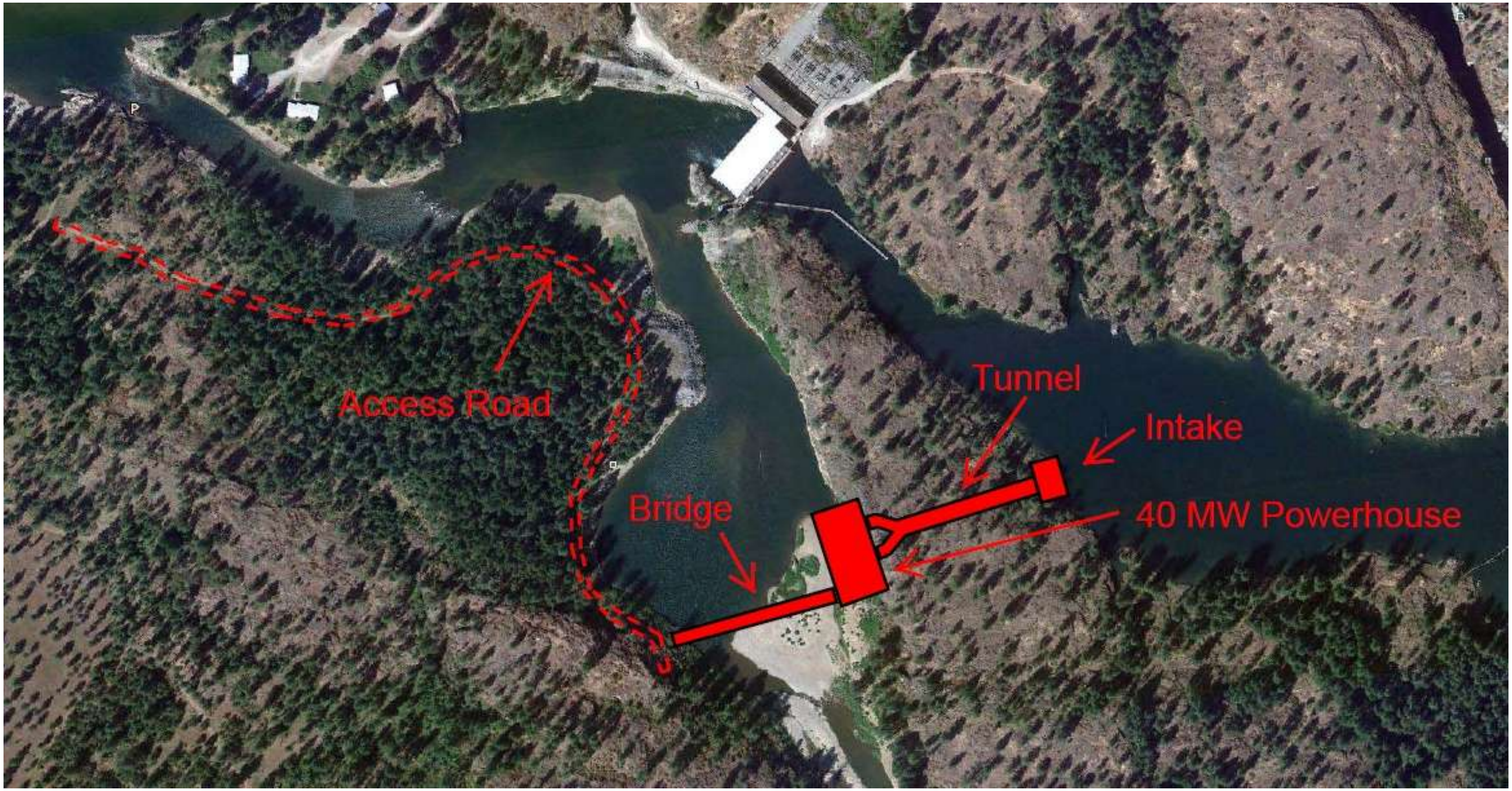
Clean Resources

A History of Hydro Upgrades



Clean Resources

Post Falls Possible Modifications



Clean Resources

New Powerhouse in the South Channel - 40 MW (2x20)

Post Falls Possible Modifications

Clean Resources

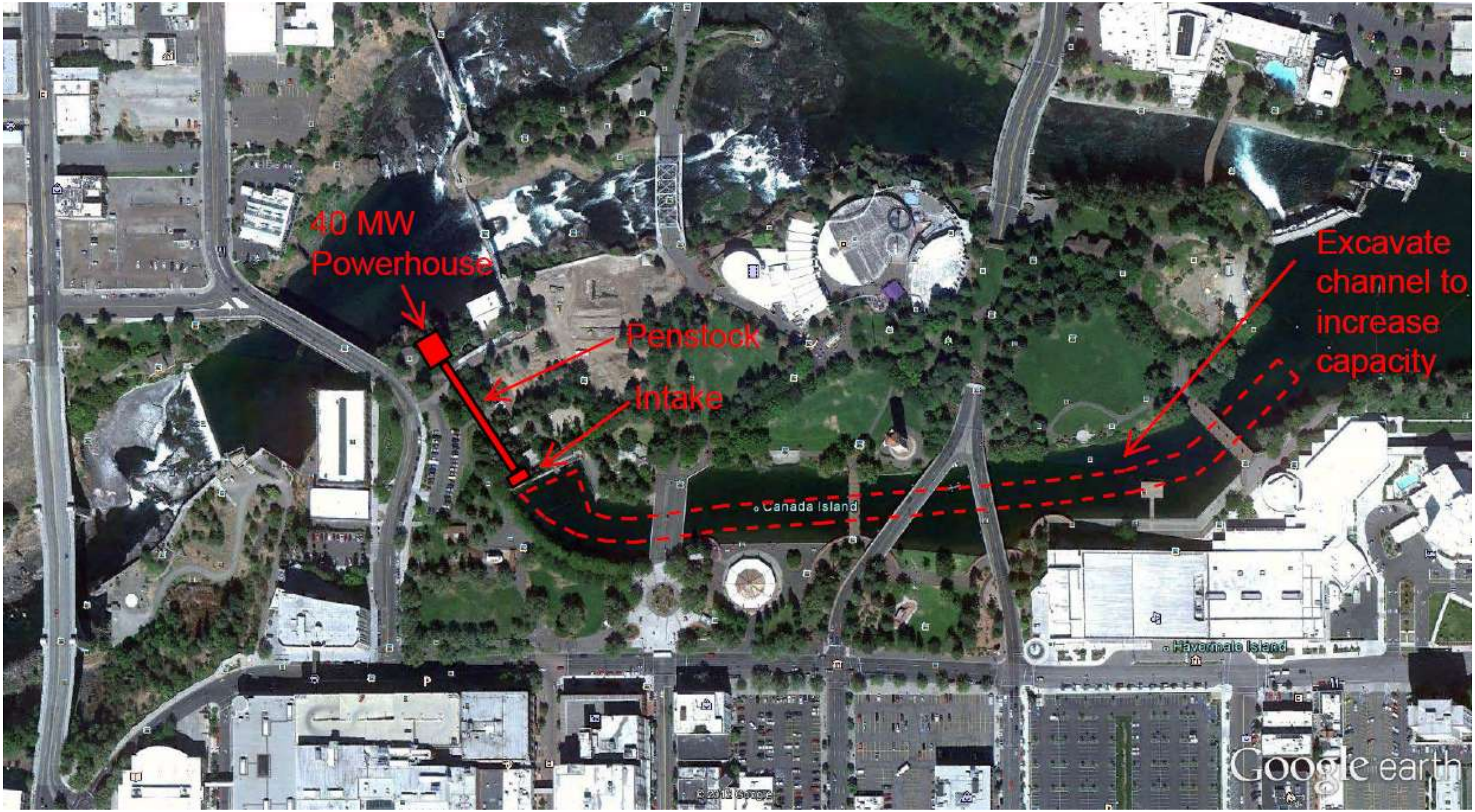
Replace Existing Powerhouse - 40 MW (5x8)

Post Falls Possible Modifications

Clean Resources

Rebuild Existing Powerhouse Turbine Generators - 33.6 MW (6x5.6)

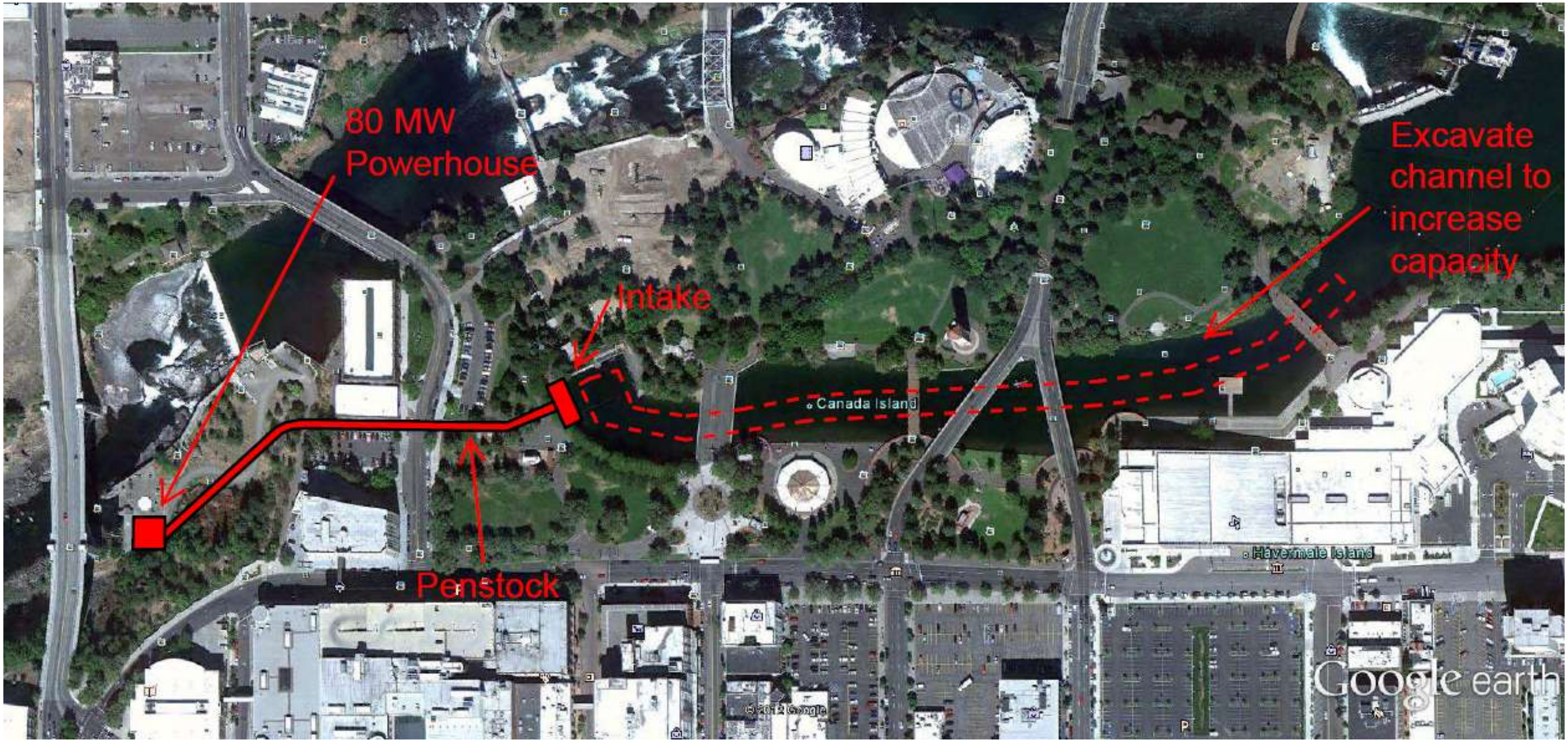
Upper Falls Possible Modifications



Clean Resources

Second Powerhouse with Channel Excavation – 40 MW

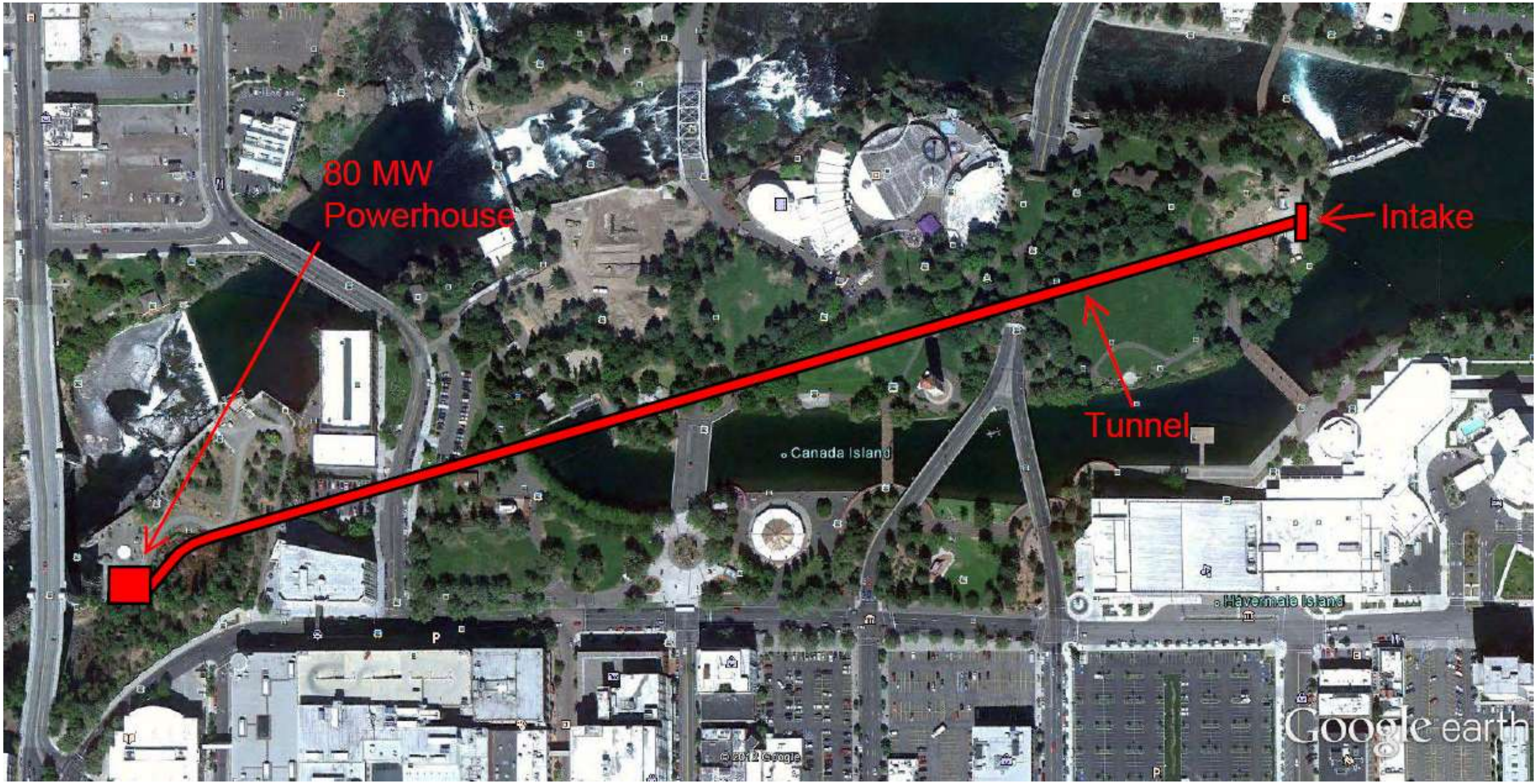
Monroe Street Possible Modifications



Clean
Resources

Second Powerhouse – with Channel Excavation 80 MW

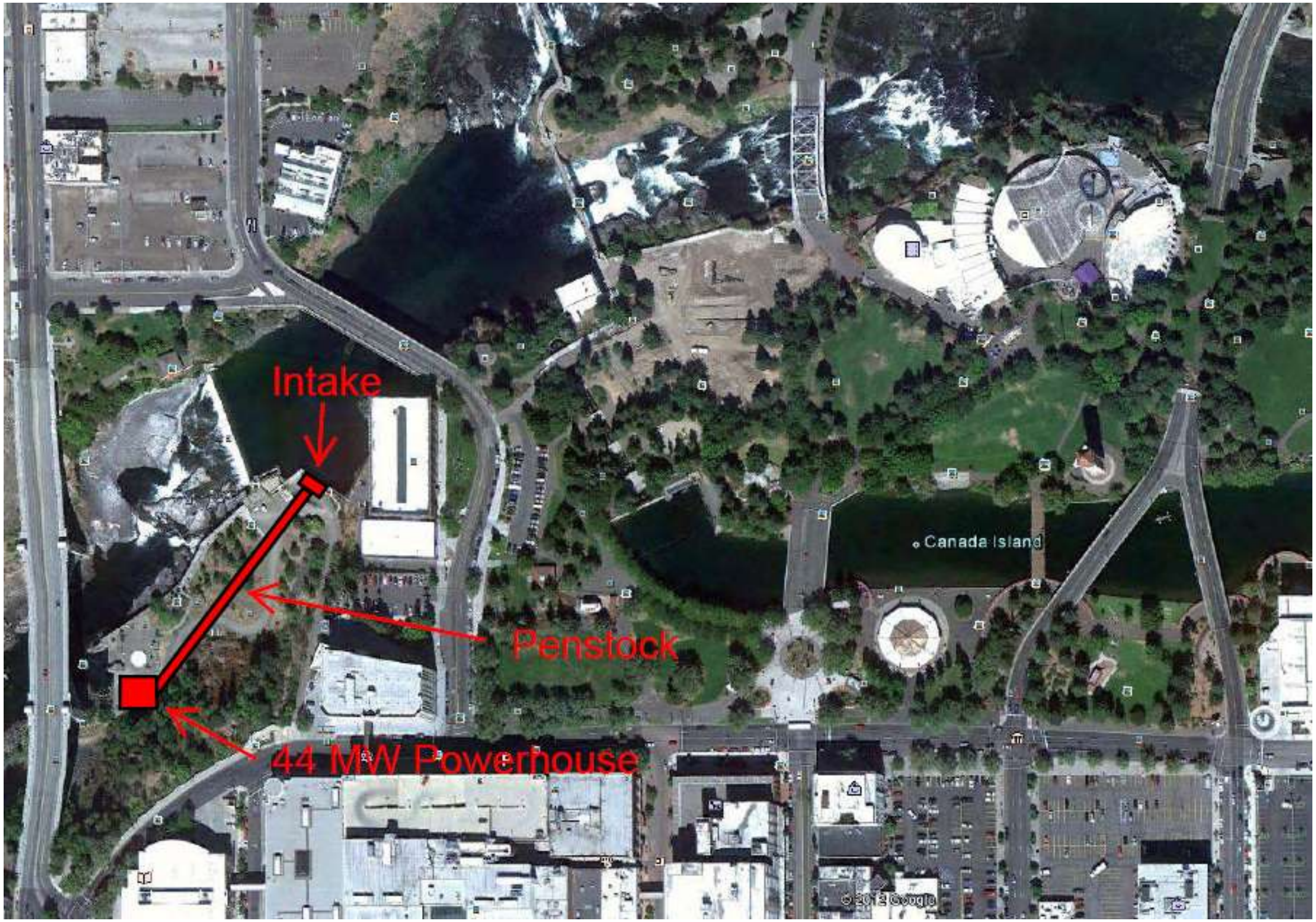
Monroe Street Possible Modifications



Clean Resources

Second Powerhouse – with Tunnel 80 MW

Monroe Street Possible Modifications



Clean Resources

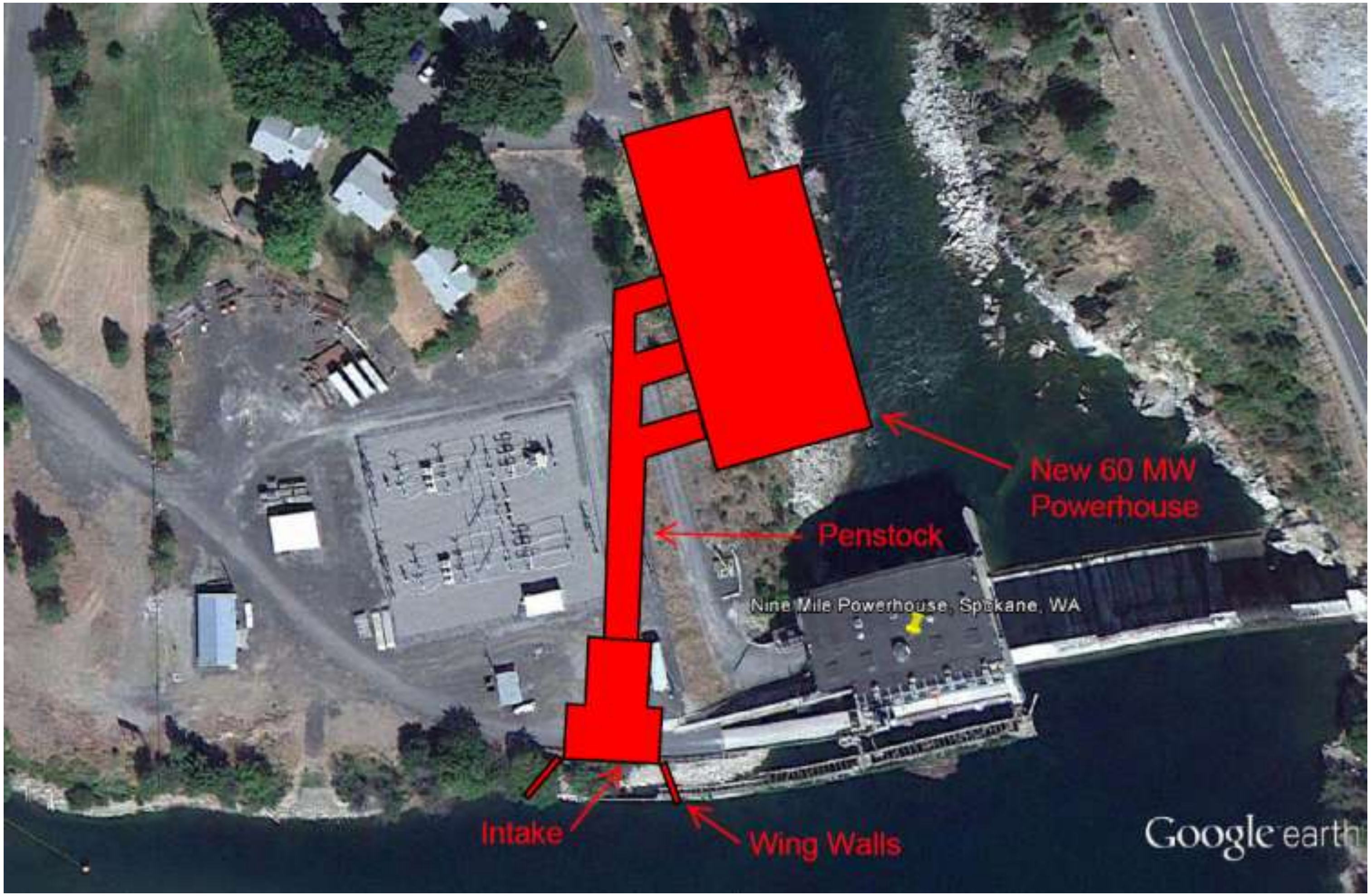
Second Powerhouse – From Monroe Street Dam 44 MW

Nine Mile Possible Modifications

Clean Resources

Existing Powerhouse Upgrade Units 1 and 2 – 32MW (4x8)

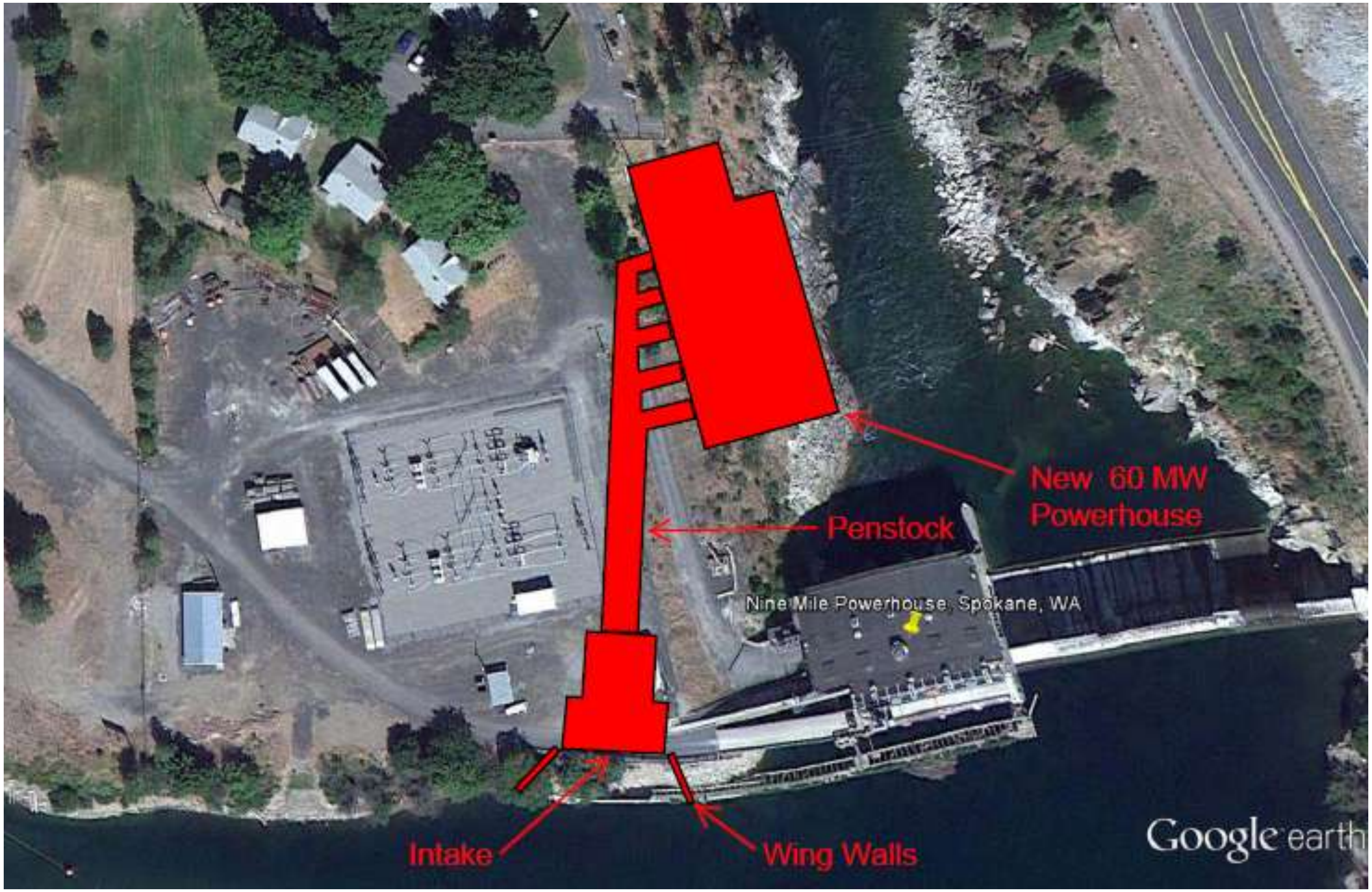
Nine Mile Possible Modifications



Clean Resources

New Powerhouse Downstream Left Bank – 60 MW (3x20)

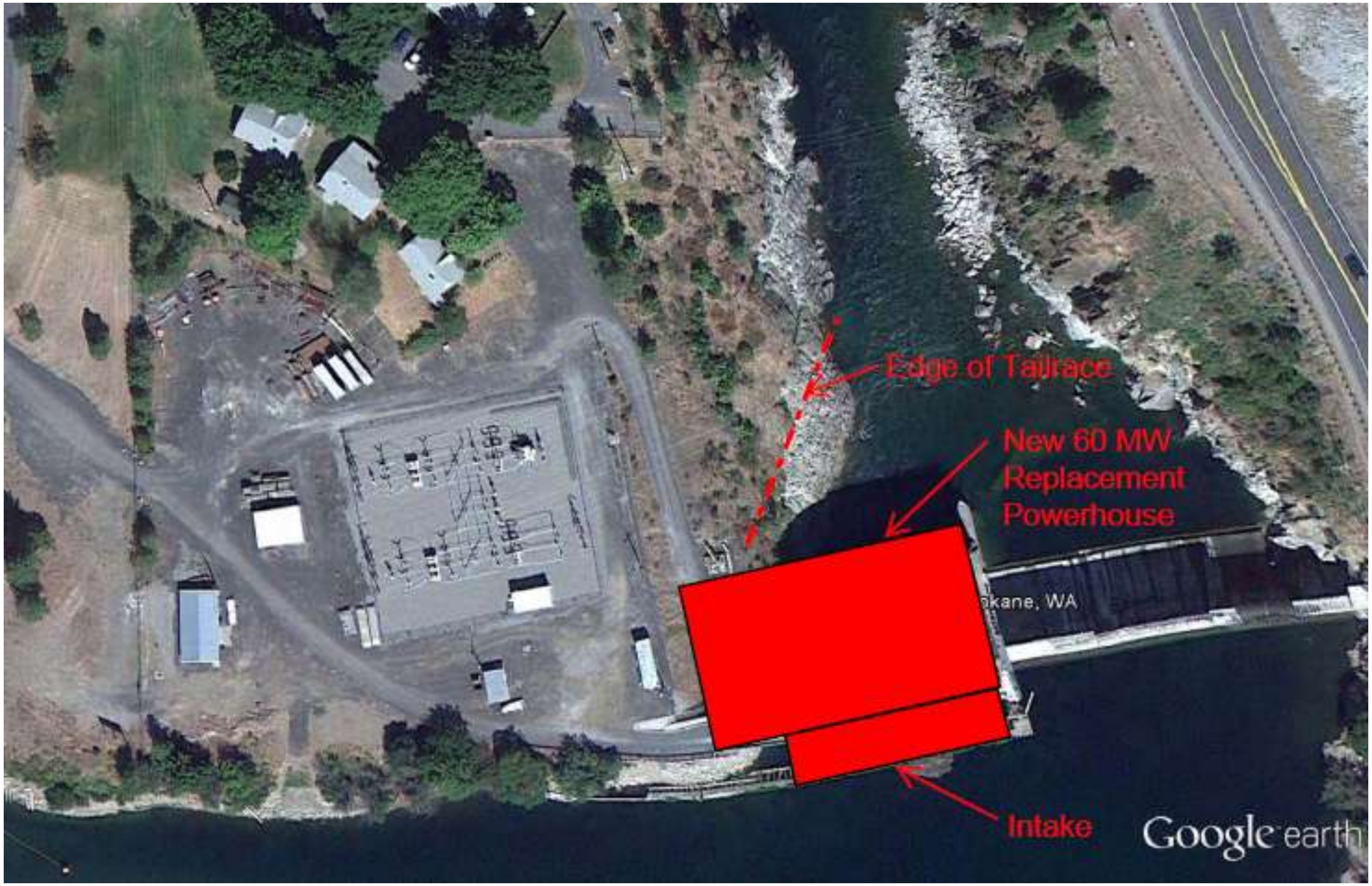
Nine Mile Possible Modifications



Clean Resources

New Powerhouse Downstream Left Bank – 60 MW (5x12)

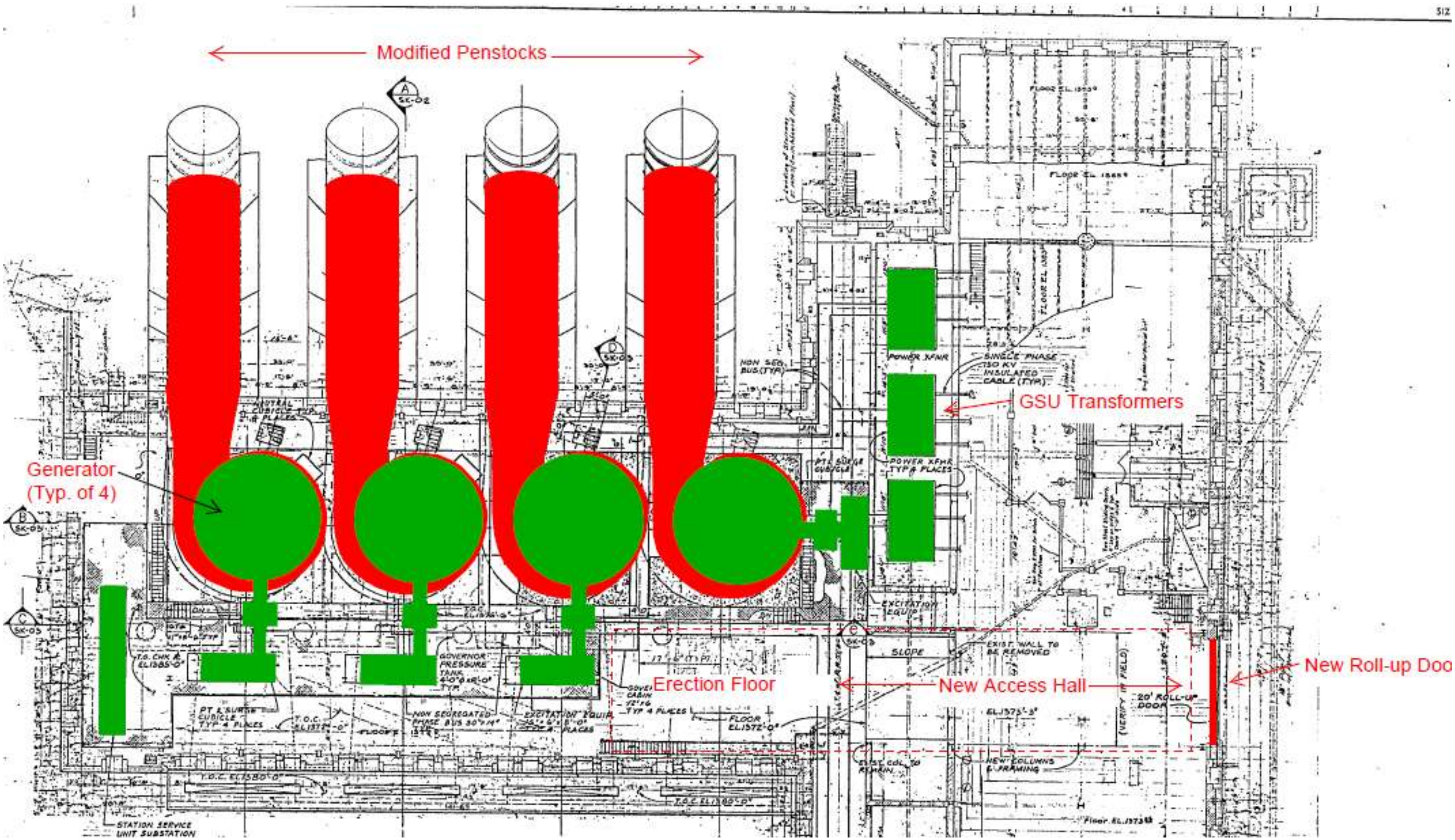
Nine Mile Possible Modifications



Clean Resources

New Powerhouse Existing Location – 60 MW (5x12)

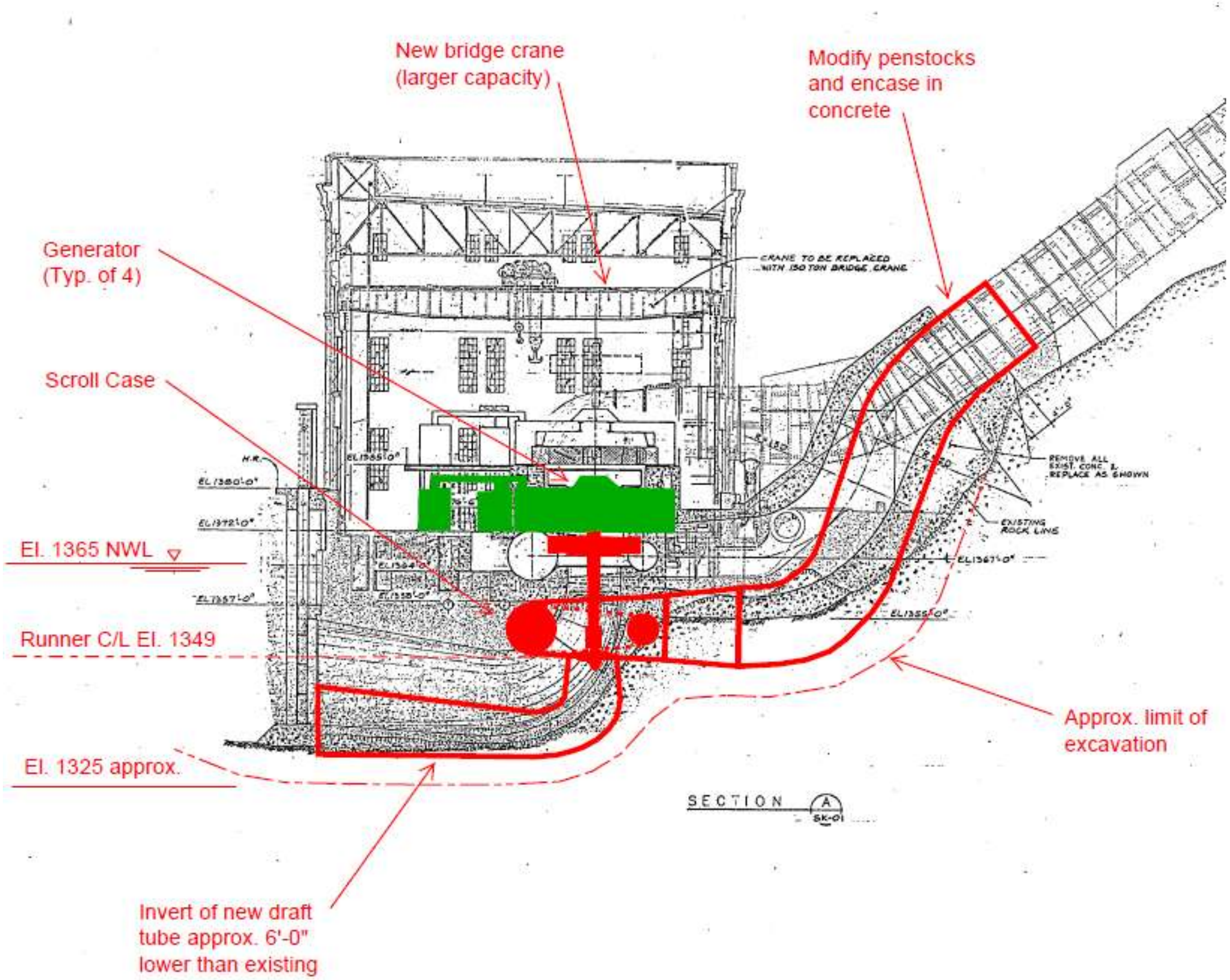
Long Lake Possible Modifications



Clean Resources

Replace Turbine Generators 120 MW (4x30)

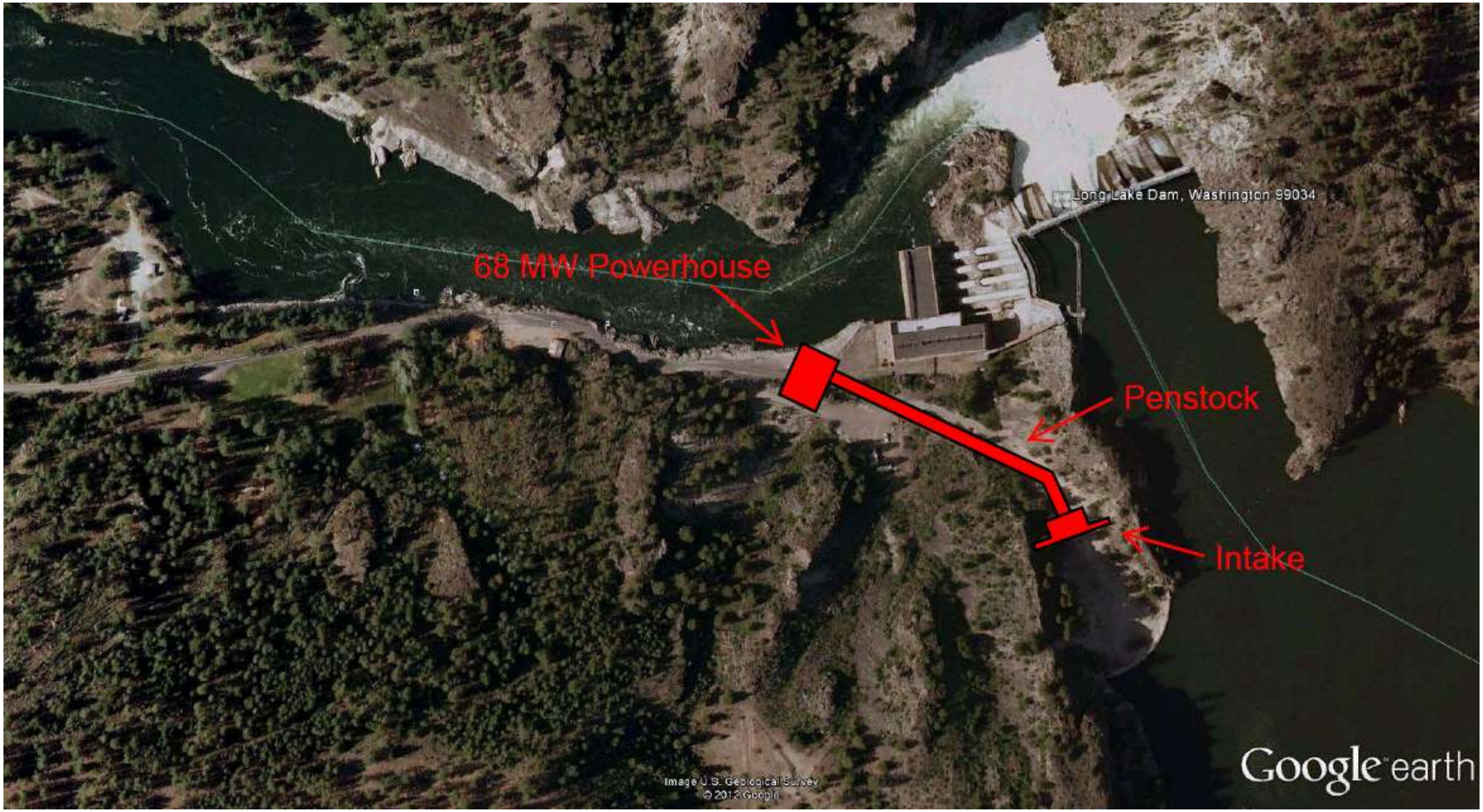
Long Lake Possible Modifications



Clean Resources

Section View - Replace Turbine Generators 120 MW (4x30)

Long Lake Possible Modifications



Clean Resources

Second Powerhouse from Saddle Dam - 68MW

Little Falls Powerhouse Rebuild

- Replace Generators
- Replace Turbines
- Replace Generator Breakers
- Replace Excitation Systems
- New Modern Control System
- New Powerhouse Crane

Clean Resources

Spokane River Project Potential

Facility	Year Built	Generation Capability (MW)	Net Energy Output (MWh)	Upgraded Capability (MW)	Upgraded Energy (MWh)
Post Falls	1906	14.8	90,000	33.6	142,500
Upper Falls	1922	10.0	71,000	50.0	184,200
Monroe St	1992	14.8	106,000	58.8	223,600
Nine Mile	1908	26.4	101,000	60.0	221,500
Long Lake	1915	78.0	480,000	146.0	619,800
Little Falls	1910	32.0	201,000	32.0	201,000
Total		**176.0**	**1049,000**	**380.4**	**1,592,600**
Percent Increase				**116%**	**52%**

Clean Resources

Clark Fork River Project

- *Clark Fork River Project was built in the 1950's and 1960's to meet the growing demands of the Spokane region.*
- *Cabinet Gorge completed in 1952*
- *Noxon Rapids completed in 1960*
  - *5th Unit was added in 1978*
- *Improvements to date include*
  - *New Turbines - efficiency upgrades*
  - *New Generators and rewinds*
  - *New Generator Step-Up Transformers*

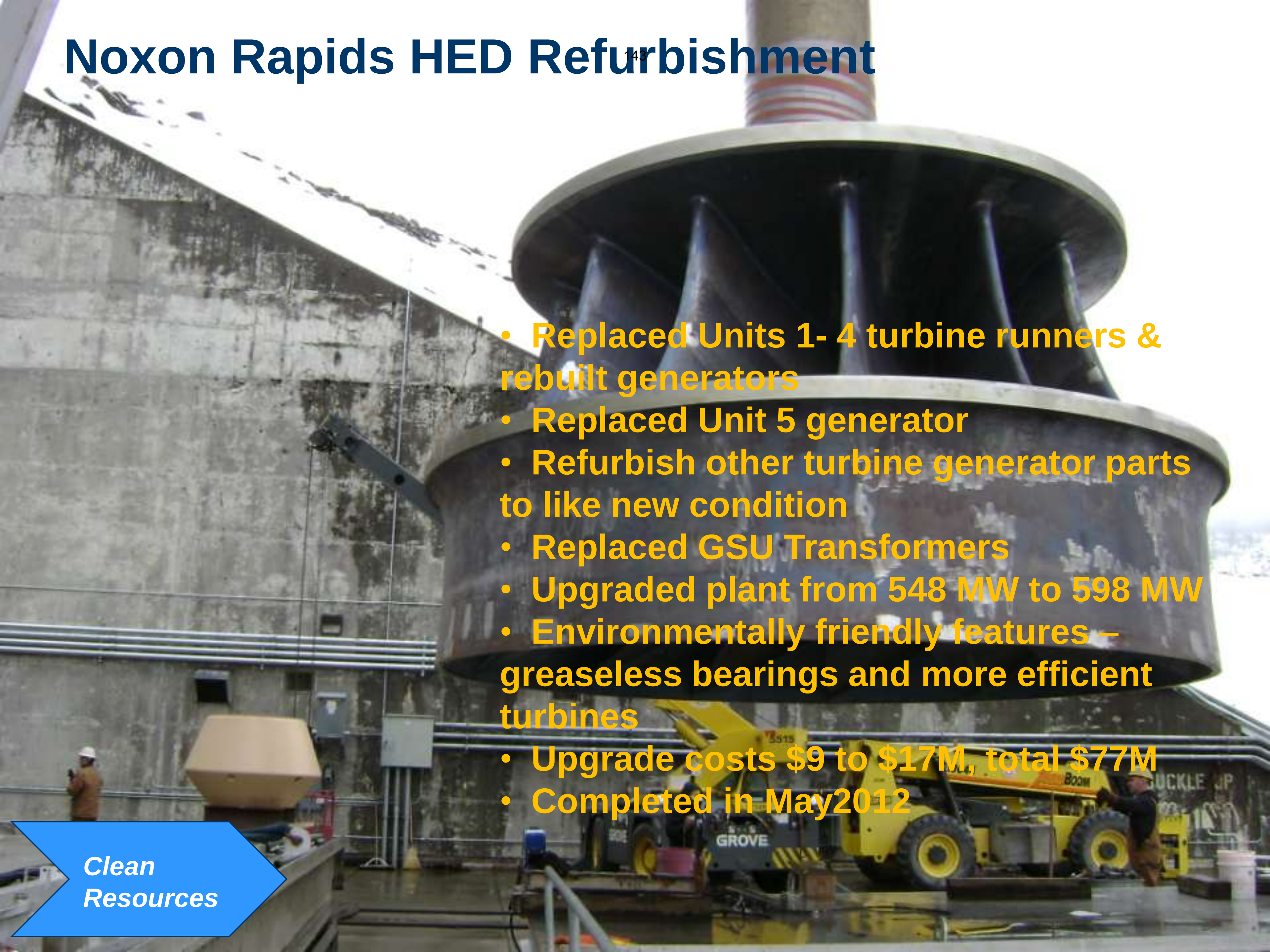
Clean Resources

Cabinet Gorge HED Refurbishment :

- Replaced 4 turbine runners & rebuilt generators
- Refurbished other turbine generator parts to like new condition
- Upgraded plant from 220 MW to 270 MW
- Environmentally friendly features – greaseless bearings and more efficient turbines
- Upgrade costs $5 to $12M, total $40M
- Complete in 2004

Clean Resources

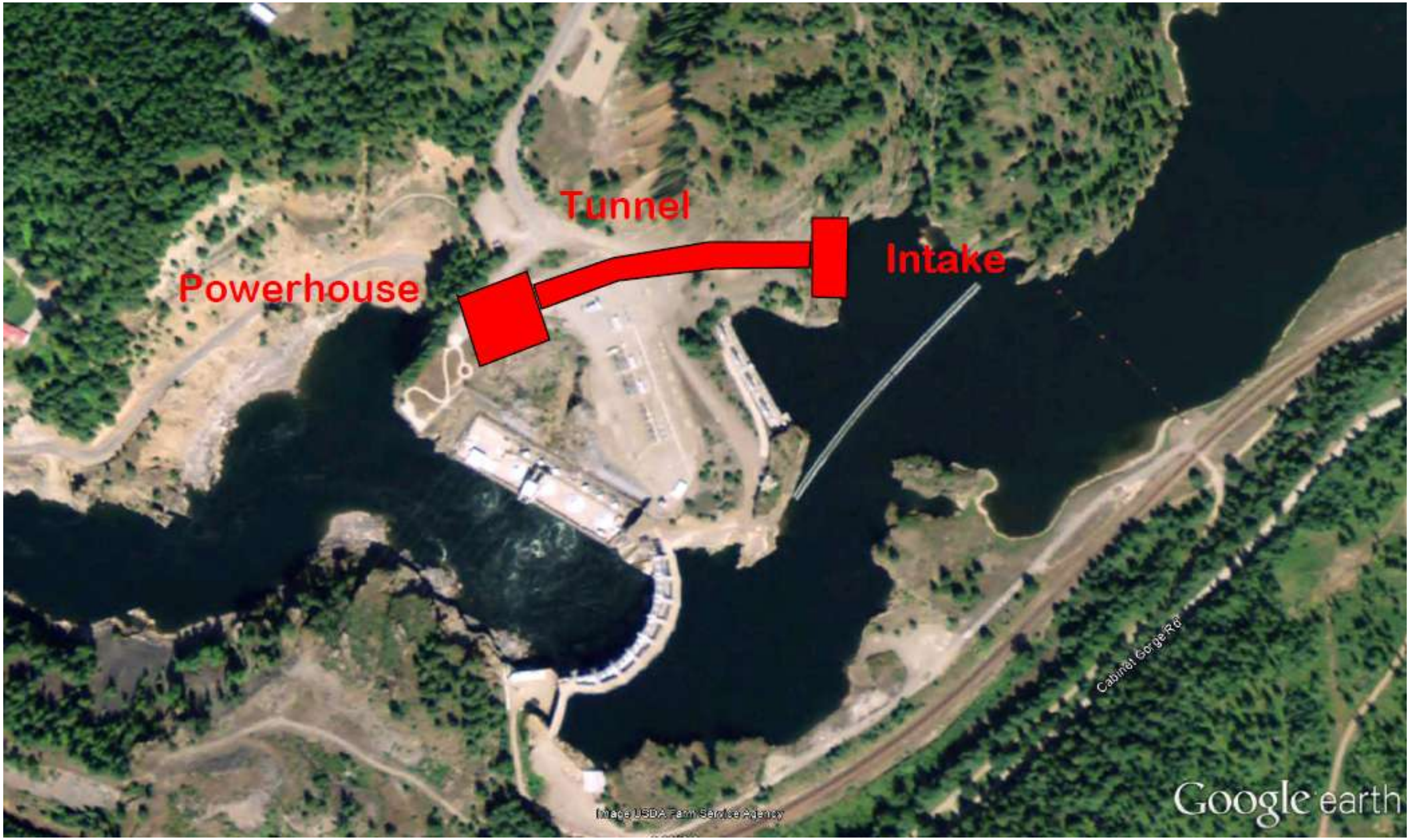
Noxon Rapids HED Refurbishment



- Replaced Units 1- 4 turbine runners & rebuilt generators
- Replaced Unit 5 generator
- Refurbish other turbine generator parts to like new condition
- Replaced GSU Transformers
- Upgraded plant from 548 MW to 598 MW
- Environmentally friendly features – greaseless bearings and more efficient turbines
- Upgrade costs $9 to $17M, total $77M
- Completed in May2012

Clean Resources

Cabinet Gorge Possible Modifications



Clean Resources

Second Powerhouse in Tunnel

Cabinet Gorge Possible Modifications

- ***Increased plant capacity will reduce Spring spillway flows, and thus reduce contributions to total dissolved gas (TDG)***
- ***Could increase plant capacity by 55 - 110 MW***
- ***Range of plant configurations under study***

Clean Resources

Avista's 2013 Electric Integrated Resource Plan

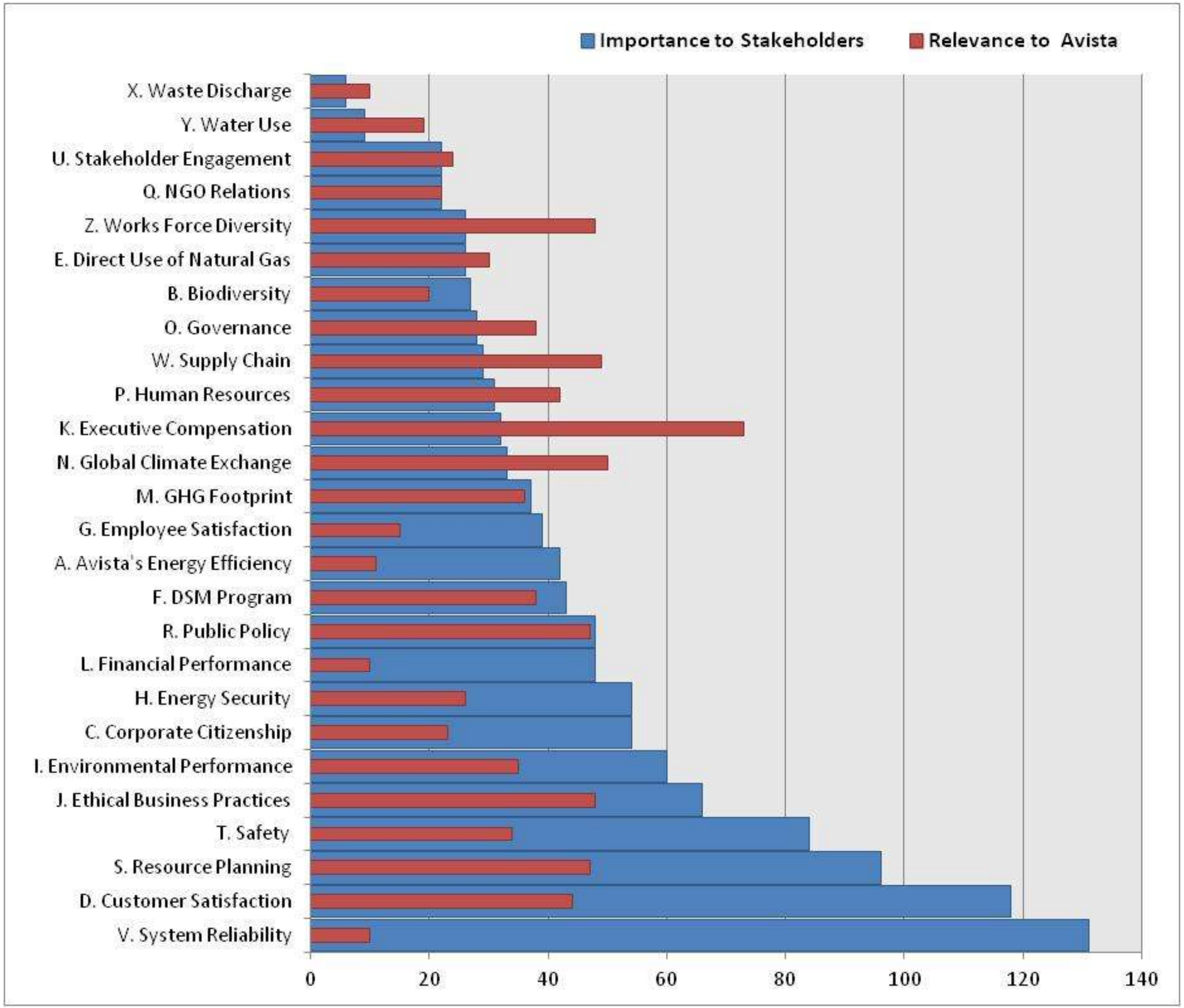
Technical Advisory Committee Meeting No. 3 Agenda

Wednesday, November 7, 2012
Conference Room 328

Topic	**Time**	**Staff**
1. Introduction	8:30	Storro
2. Modeling	8:35	Gall
3. Colstrip Discussion	9:15	Lyons
4. Energy Efficiency	10:00	Borstein
5. Lunch	11:30	
6. Peak Load Forecast	12:30	Gall/Forsyth
7. Reliability Planning	1:15	Gall
8. Break	2:00	
9. Energy Storage	2:15	Lyons
Adjourn	3:00	

Materiality Ratings

Avista’s 2013 Electric Integrated Resource Plan **Technical Advisory Committee**



Weighted score – number of responses x rated importance/relevance

September 2012

2013 IRP Modeling Approach

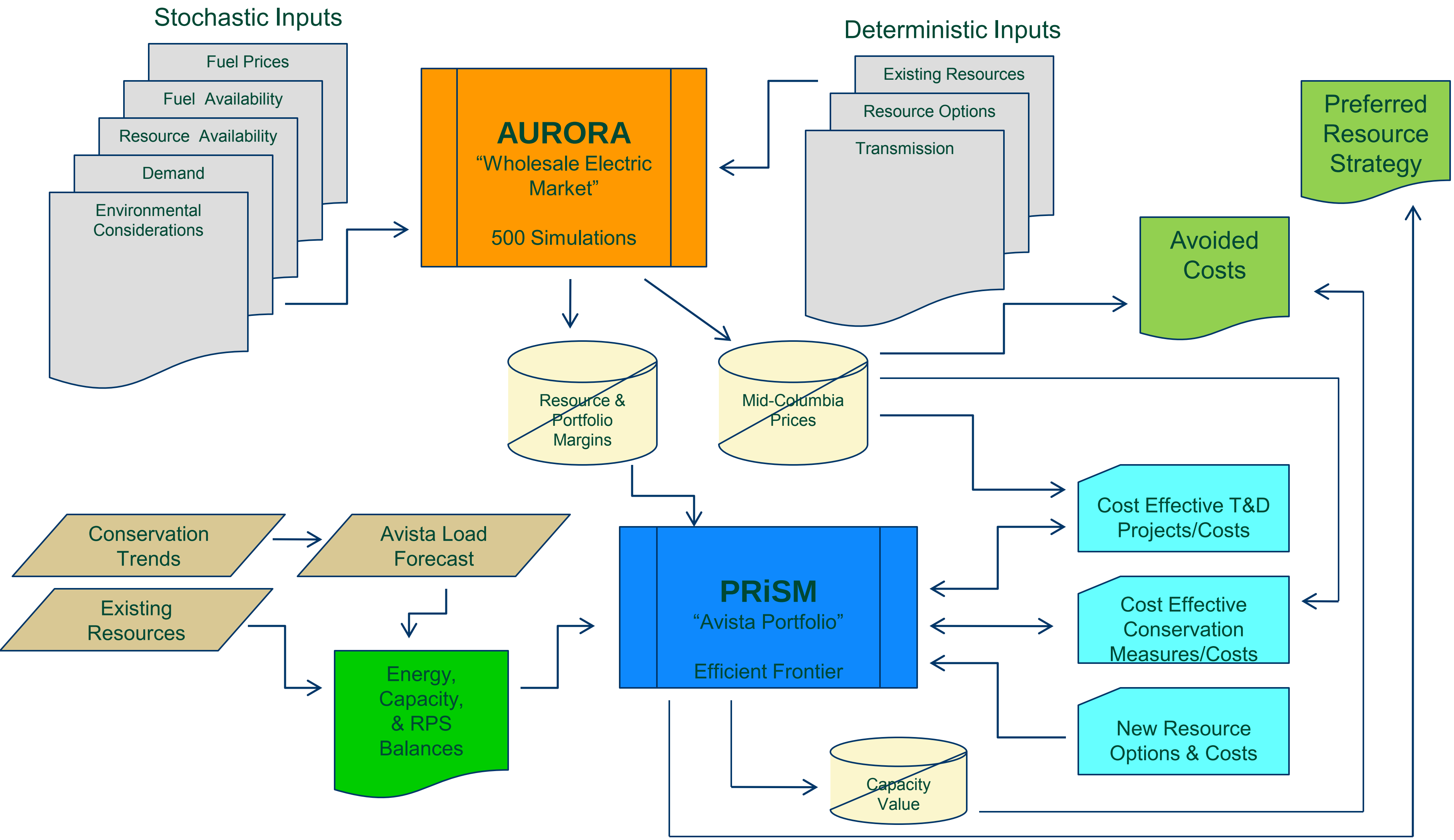
James Gall, Senior Power Supply Analyst

Third Technical Advisory Committee Meeting

2013 Electric Integrated Resource Plan

November 7, 2012

2013 IRP Modeling Process



Stochastic Inputs

Fuel Prices

Fuel Availability

Resource Availability

Demand

Environmental Considerations

AURORA
"Wholesale Electric Market"

500 Simulations

Deterministic Inputs

Existing Resources

Resource Options

Transmission

Preferred Resource Strategy

Avoided Costs

Resource & Portfolio Margins

Mid-Columbia Prices

Cost Effective T&D Projects/Costs

Conservation Trends

Avista Load Forecast

Existing Resources

Energy, Capacity, & RPS Balances

PRiSM
"Avista Portfolio"

Efficient Frontier

Cost Effective Conservation Measures/Costs

New Resource Options & Costs

Capacity Value

Electric Market Modeling

AURORAxmp® by EPIS, Inc.
COMPREHENSIVE POWER FORECASTING

- 3rd party software- EPIS, Inc.
- Electric market fundamentals- production cost model
- Simulates generation dispatch to meet load
- Outputs:
  - Market prices
  - Regional energy mix
  - Transmission usage
  - Greenhouse gas emissions
  - Power plant margins, generation levels, fuel costs
  - Avista's variable power supply costs

PRiSM- Preferred Resource Strategy Model

- Internally developed using Excel based linear program model (What's Best)
- Selects new resources to meet Avista's capacity, energy, and renewable energy requirements
- Outputs:
  - Power supply costs (variable and fixed)
  - Power supply costs variation
  - New resource selection
  - Emissions
  - Capital requirements

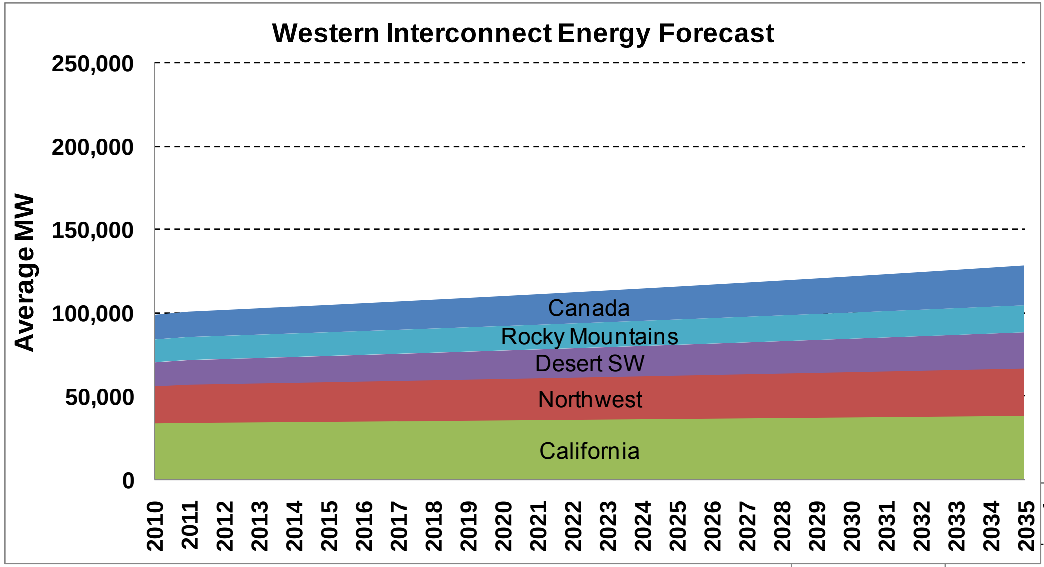
AURORA Inputs

- Regional loads
- Natural gas & coal prices
- Hydro levels
- Wind variation
- Environmental resolutions
- Resource availability
- Transmission

Regional Loads

- Forecast load growth for all regions in the Western Interconnect
- Consider both peak and energy
- Use regional published studies and public IRP's
- Stochastic modeling simulates load changes due to weather and considers regional correlation of weather patterns
- Load changes due to economic reasons are difficult to quantify and are usually picked up as IRP's are published every two years
- Peak load is becoming more difficult to quantify as "Demand Response" programs my cause data integrity issues
- Energy demand forecasts need to be net of conservation

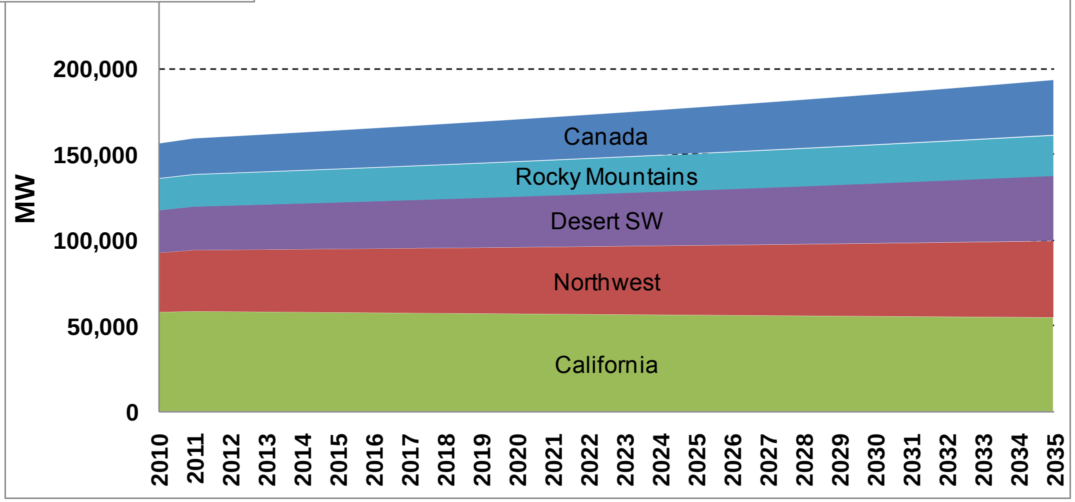
Energy & Peak Forecast (draft)



Energy	AAGR
Canada	1.91%
Rocky Mtns.	0.69%
Desert SW	1.64%
California	0.48%
Northwest	0.90%

Peak	AAGR
Canada	1.80%
Rocky Mtns.	0.98%
Desert SW	1.71%
California	-0.26%
Northwest	0.93%

Western Interconnect Peak Load Forecast



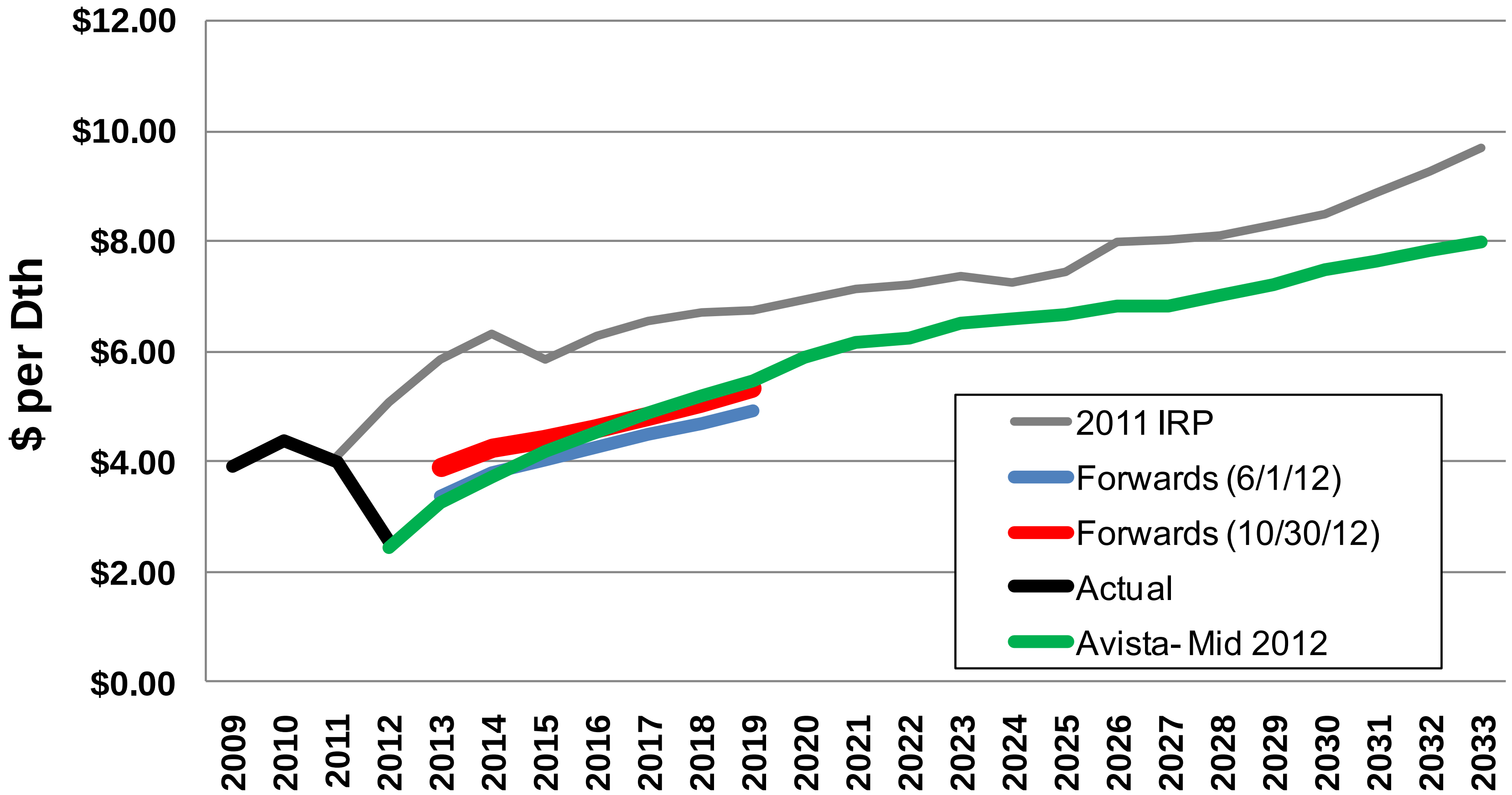
Electric Vehicles (PHEV)

- A potential change in customer load shapes could be a result of PHEV
- To address this- a load adder will be applied to reflect new demand with a majority of load added in off peak hours
- In the 2011 IRP electric vehicle demand was estimated to be 1,370 MW (off-peak) for 2020 (western interconnect)
- The load forecasts from other IRP’s typically include PHEV assumptions
- PHEV load will be pullout out of the forecast and modeled as load with an alternative load shape to reflect typical charging patterns

Natural Gas Prices

- Natural gas prices are one of the most difficult inputs to quantify
- A combination of forward prices and consultant studies will be used as the “Base Case” for this IRP. This work should be complete by December 2012
- 500 different prices using an auto regressive technique will be modeled, the mean value of the 500 simulations will be equal to the “Base Case” forecast
- A controversial input for these prices is the amount of variance within the 500 simulation.
  - Historically prices we highly volatile, recent history is more stable
  - Final variance estimates will look at current market volatility and implied variance from options contracts

Natural Gas Prices



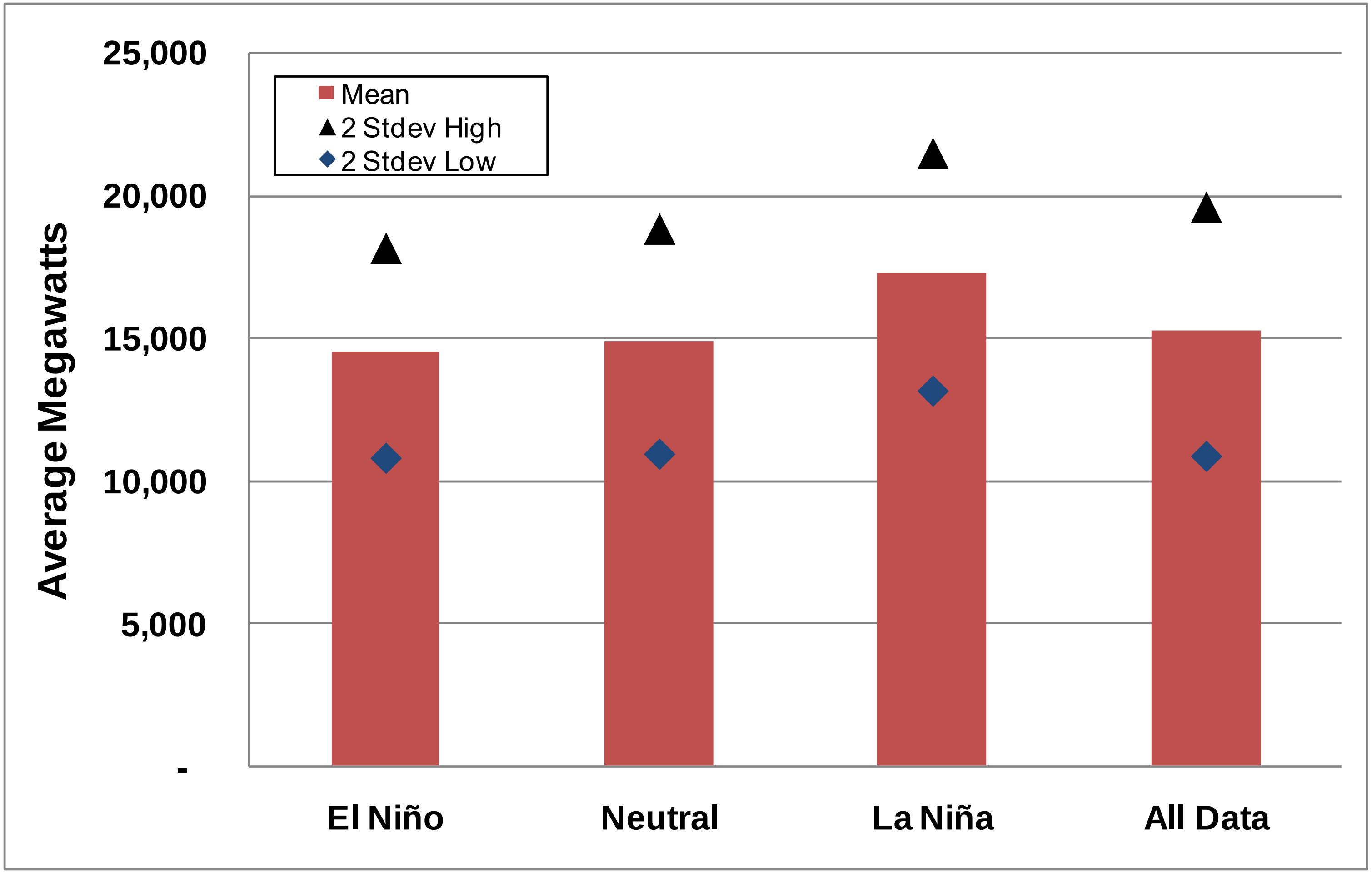
Coal Prices

- With lower natural prices and EPA regulations the demand for US based coal is lower, but potential exports may stabilize the industry
- Western US coal plants typically have long-term contracts and many are mine mouth
- Rail coal projects are subject to diesel price risk
- Prices will be based on review of coal plant publically available prices and EIA mine mouth and rail forecasts

Hydro

- 70 year average hydro conditions are used for the Northwest states, British Columbia and California provided by BPA
  - Hydro levels change monthly
  - AURORA dispatches the monthly hydro based on whether its run-of-river or storage.
- For stochastic studies the hydro levels will be randomly drawn from the 70 year record
- A new Columbia River Treaty could change regional hydro patterns, but until there is resolution, no changes will be considered

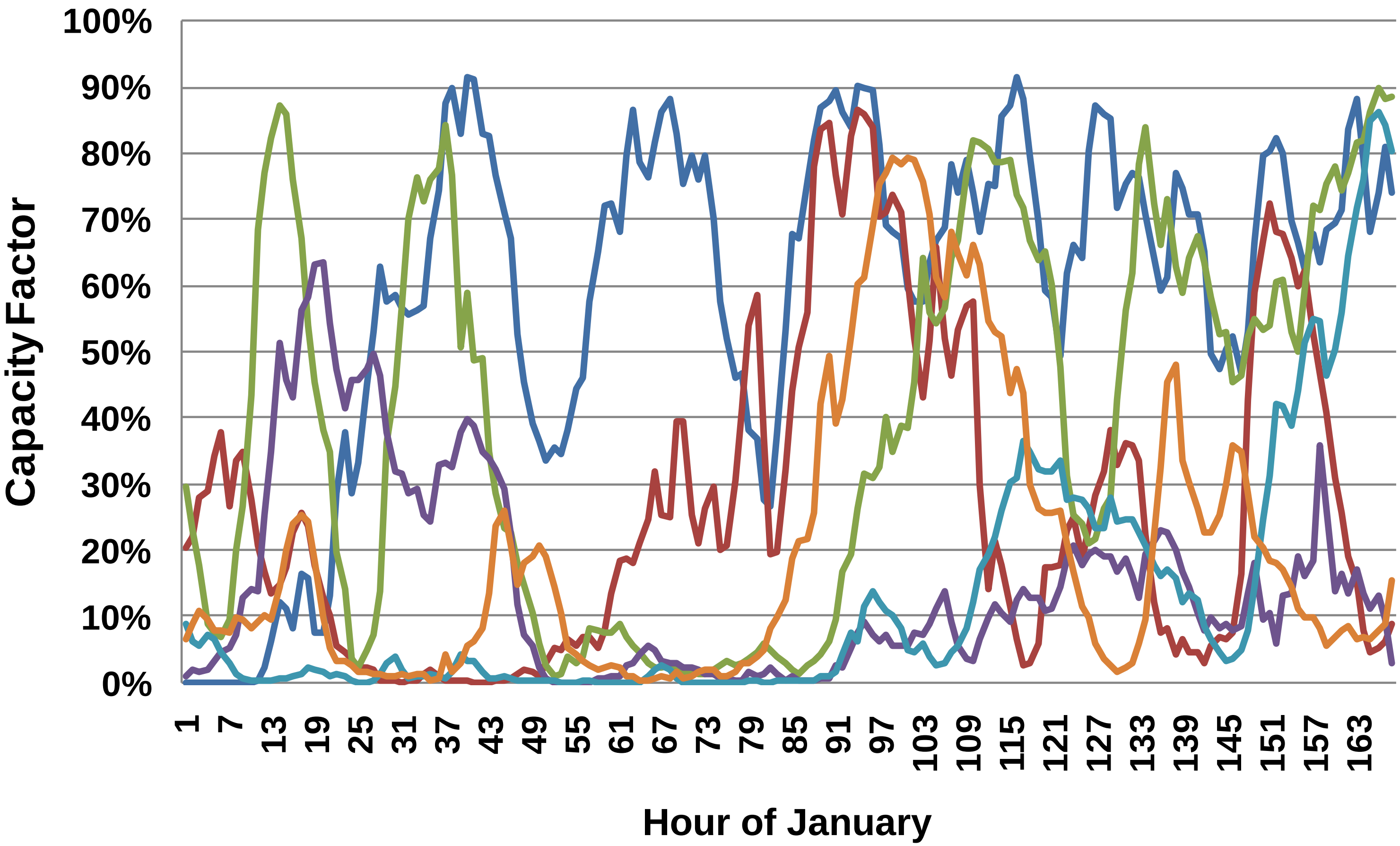
Northwest Hydro Variability



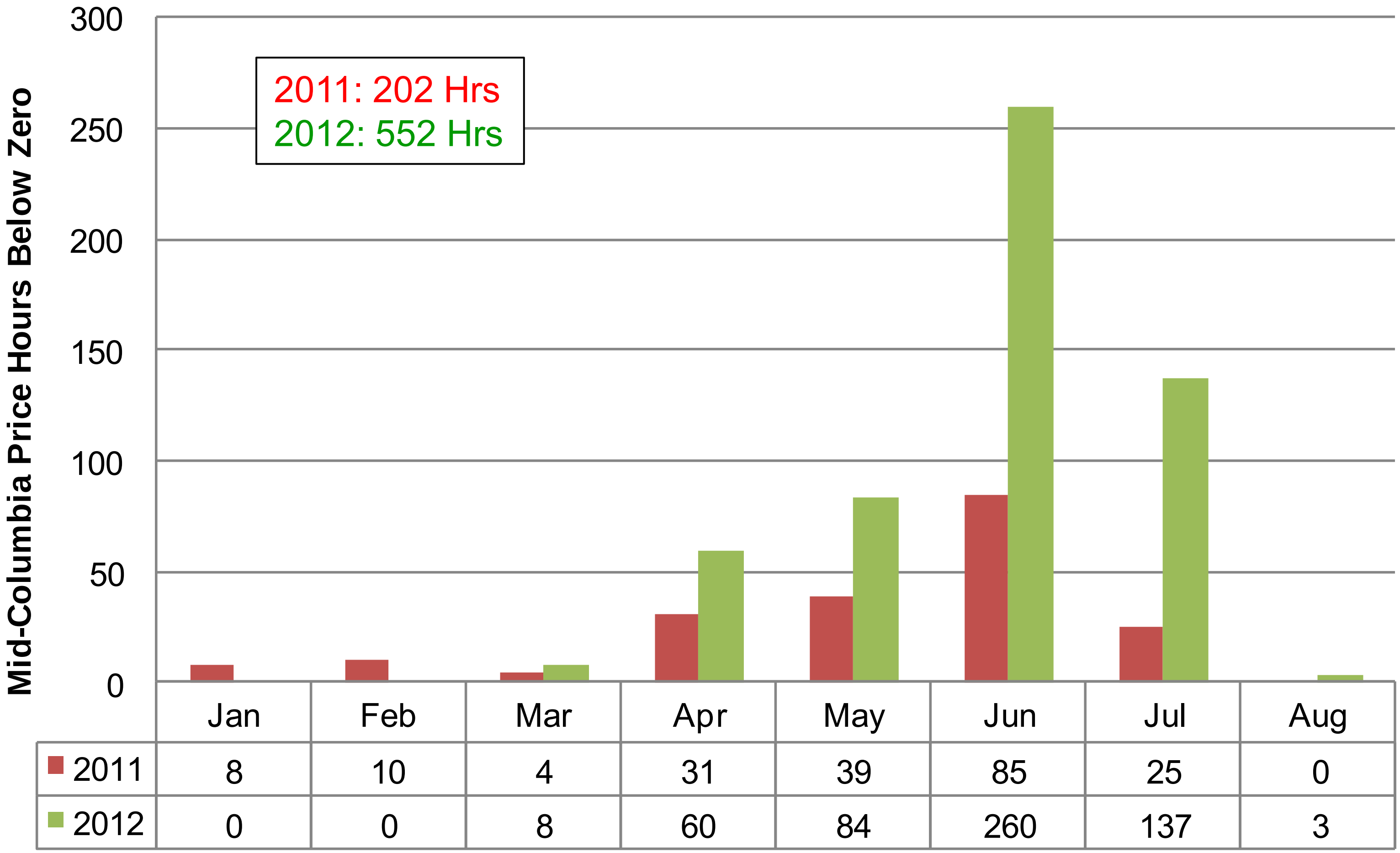
Wind

- Wind generation in the Northwest's is the fastest growing resource type
- RECs and PTC's have caused wind facilities to economically generate in oversupply periods in the Northwest- particularly in the spring months
- Wind is modeled using an autoregressive technique to simulate output in similar to reported data available from BPA, CAISO, and other publically available data sources- also considers correlation between regions
- For stochastic studies several wind curves will be drawn from to simulate variation in wind output each year
- Will pursue temperature/wind correlation for stochastic study

Wind Generation Profile (First week of January 2007-12)



Hours Mid-Columbia Prices Were Less Than $0/MWh



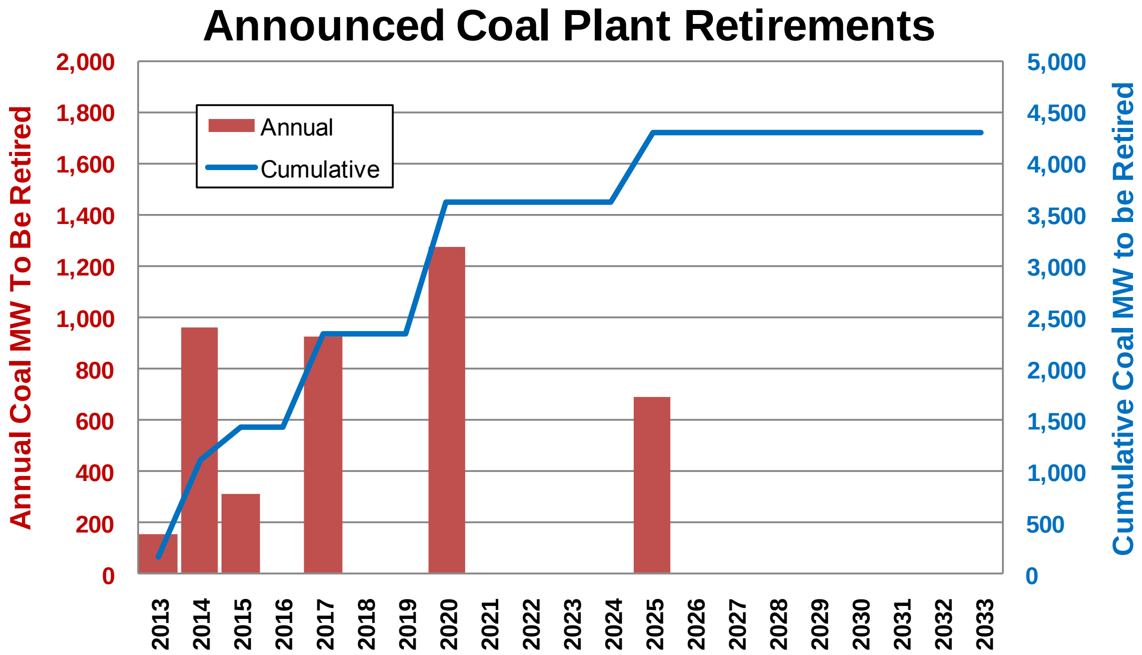
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
🟥 2011	8	10	4	31	39	85	25	0
🟩 2012	0	0	8	60	84	260	137	3

Source: Powerdex daily average prices- substantially more hours had trades with negative pricing

Greenhouse Emission Reduction Scheme

- Currently no eminent national climate change legislation
- Alternative methods for reducing greenhouse gases are more likely than a national cap-and-trade mechanism; such as early retirement of coal plants and regional greenhouse gas limits
- This IRP will model the CO_2 tax in British Columbia and an expected market clearing price for CO_2 in California
- Rather than use a cap & trade or tax method in the IRP base case the model will rather consider all announced coal plants retirements and determine future coal/natural gas plants likely to be retired due to environmental or economic reasons
- This method will show reductions to greenhouse gases in the western US without causing price shocks to the wholesale power markets

Coal Retirements

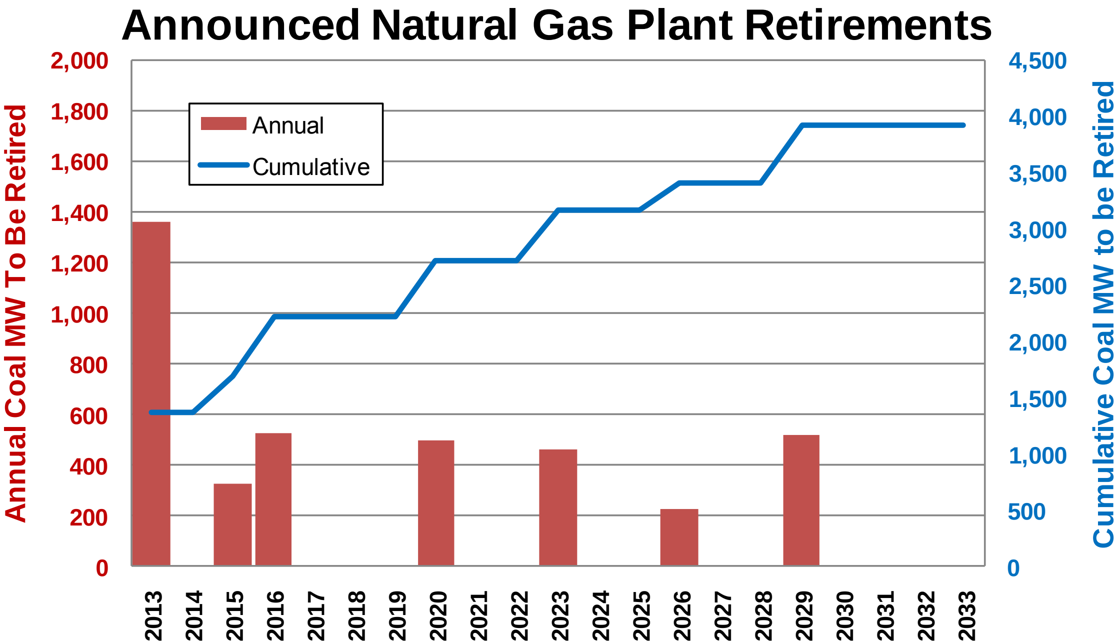


- Announced retirements of 13% of coal plant capacity in the west
- Avista will review all Western Interconnect coal plants and retire plants for modeling purposes. This method is to estimate likely EPA/State related retirements

Water Issues

- Once-through cooling
  - California plants with this cooling technology must be converted to alternative cooling methods or retired
  - For modeling purposes: older natural gas units will be retired and Nuclear plants will be considered retrofitted
    - San Onofre?
- Traditional water cooling
  - New NG resources are finding it more difficult to use water cooling- for new resources air cooling will be assumed

Once-Through Cooling Affect



- 13,500 MW of natural gas plants in California could be affected by once-through-cooling rules- nearly 4,000 MW announced retirement
- Represents 27% of California’s natural gas fleet

Western State's Renewable Portfolio Standards

- Nine western states have renewable portfolio standards (RPS)
  - A majority of qualifying projects will not be selected in AURORA due to economics, therefore renewable resources are added based likely resource types up to the RPS requirement
- Challenges are with California
  - What renewable quantity will CA allow for import- 25%?
  - How much behind the meter solar will be developed?
- Will state RPS's change- easier or more stringent?
  - Washington recently allowed legacy biomass
  - Colorado increased its requirement from 10% to 30%

Transmission Expansion

- Regional transmission expansion plans have been discussed much of the last decade- with little to show for it!

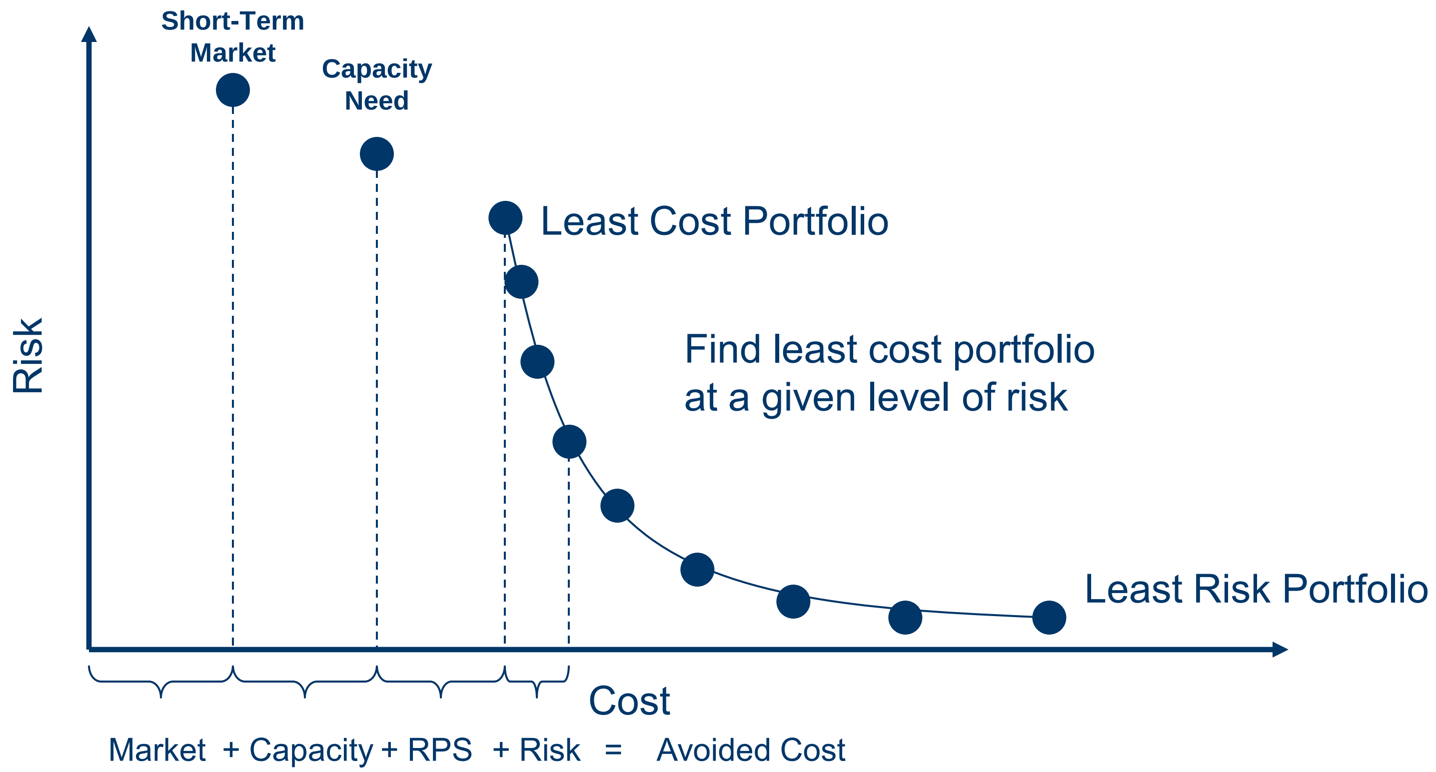
- For modeling purposes- a review of the expansion opportunities will be discussed and projects that are in advanced stages of development will be included

PRiSM

- Find optimal resource strategy to meet resource deficits over planning horizon
- Model selects its resources to reduce cost, risk, or both.
- Objective Function:
  - Minimize: Total Power Supply Cost on NPV basis (2014-2054)- Focus on first 10 years of the plan
  - Subject to:
    - Risk level
    - Capacity need +/- deviation
    - Energy need +/- deviation
    - Renewable portfolio standards
    - Resource limitations, sizes, and timing

Efficient Frontier

- Demonstrates the trade off of cost and risk
- Avoided Cost Calculation



Find least cost portfolio at a given level of risk

Market + Capacity + RPS + Risk = Avoided Cost

Colstrip Discussion

John Lyons, Senior Resource Policy Analyst

Third Technical Advisory Committee Meeting

2013 Electric Integrated Resource Plan

November 7, 2012

Future of Colstrip – Planning

- Scenarios about the future of Colstrip will be modeled in this IRP
- Washington Commission acknowledgement of the 2011 IRP:
  - “The Company should conduct a broad examination of the cost of continuing the operation of Colstrip over the 20-year planning horizon, including a range of anticipated costs associated with potential U.S. Environmental Protection Agency regulations on coal-fired generation.”
  - “The Company should model a scenario without Colstrip that includes results showing how Avista would choose to meet its load obligations without Colstrip in its portfolio, and estimates of the impact on Net Present Value (cost) of its portfolio and rates.” (Docket UE-101482)

Colstrip Ownership Information

Colstrip Basic Data			Colstrip Ownership Percentages					
Colstrip Unit #	**Size (MW)**	**Year Online**	**Avista**	**NorthWestern Energy, LLC**	**PacifiCorp**	**Portland General Electric**	**PPL Montana, LLC**	**Puget Sound Energy**
Unit #1	307	1975	0%	0%	0%	0%	50%	50%
Unit #2	307	1976	0%	0%	0%	0%	50%	50%
Unit #3	740	1984	15%	0%	10%	20%	30%	25%
Unit #4	740	1986	15%	30%	10%	20%	0%	25%
Total	2,094		11%	11%	7%	14%	25%	32%

Colstrip Units #1 – 4 use about one rail car (110 tons) of coal for every five minutes of operation – the whole project uses about 10 million tons of coal per year

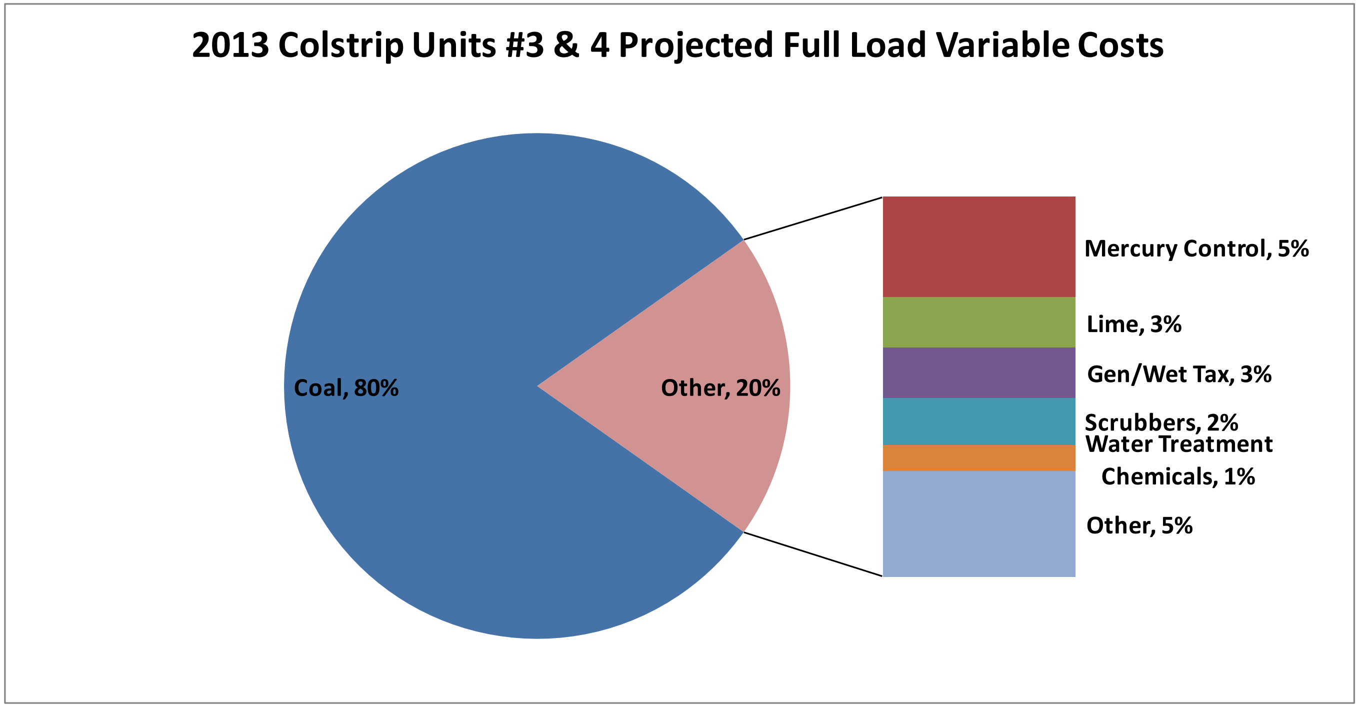
Colstrip Economic Benefits

- The plant employs 360 people and the mine has 373 employees
- $104 million in annual Montana state and local taxes (4.5% of all state revenue collections)
- 3,740 additional jobs and 7,700 more residents in Montana
- $360 million in additional personal income
- $638 million more in additional Montana output

Data from *The Economic Contribution of Colstrip Steam Electric Station Units 1-4,* November 2010.

Colstrip – Importance as a Resource

- Colstrip provides 222 MW of capacity for Avista
- 1,416,000 MWh in 2011 (162 aMW)



Other includes: full load surge pond variable costs, environmental air pollution taxes, paste plant, coal handling, coal handling dust suppression, bottom ash handling, bottom ash hauling contract and coal conditioning costs.

Colstrip Fuel Supply

- Avista’s total annual fuel use at Colstrip is approximately 980,000 tons
- Mine mouth facility
- Current fuel contract expires at the end of 2019
- Currently negotiating a fuel supply extension

Colstrip Modeling in the 2013 IRP

Base Case:

- Colstrip Units #3 – 4 kept in service through IRP modeling period
- Will comply with current and future environmental regulations

Colstrip Scenarios:

- How many scenarios are needed?
- What date or dates should be used to model a shut down of the plant?
- Other assumptions?

Avista Utilities
Conservation Potential Assessment
Approach for 2013 Update

November 7, 2012
Jan Borstein
Project Manager, Energy Analysis and Planning

ENERNOC | UtilitySOLUTIONS consulting

Outline

- CPA objectives
- Analysis approach
  - Update 2010 study
  - Changes in approach
- Project schedule

CPA Objectives

CPA objectives

Assess and analyze 20-year cost-effective conservation potential

- Meet Washington I-937 Conservation Potential Assessment requirements
  - Biennium target for 2014-2015
- Support Avista IRP development
- Provide information to support Business Plan development

Analysis Approach

ENERNOC
Utility SOLUTIONS

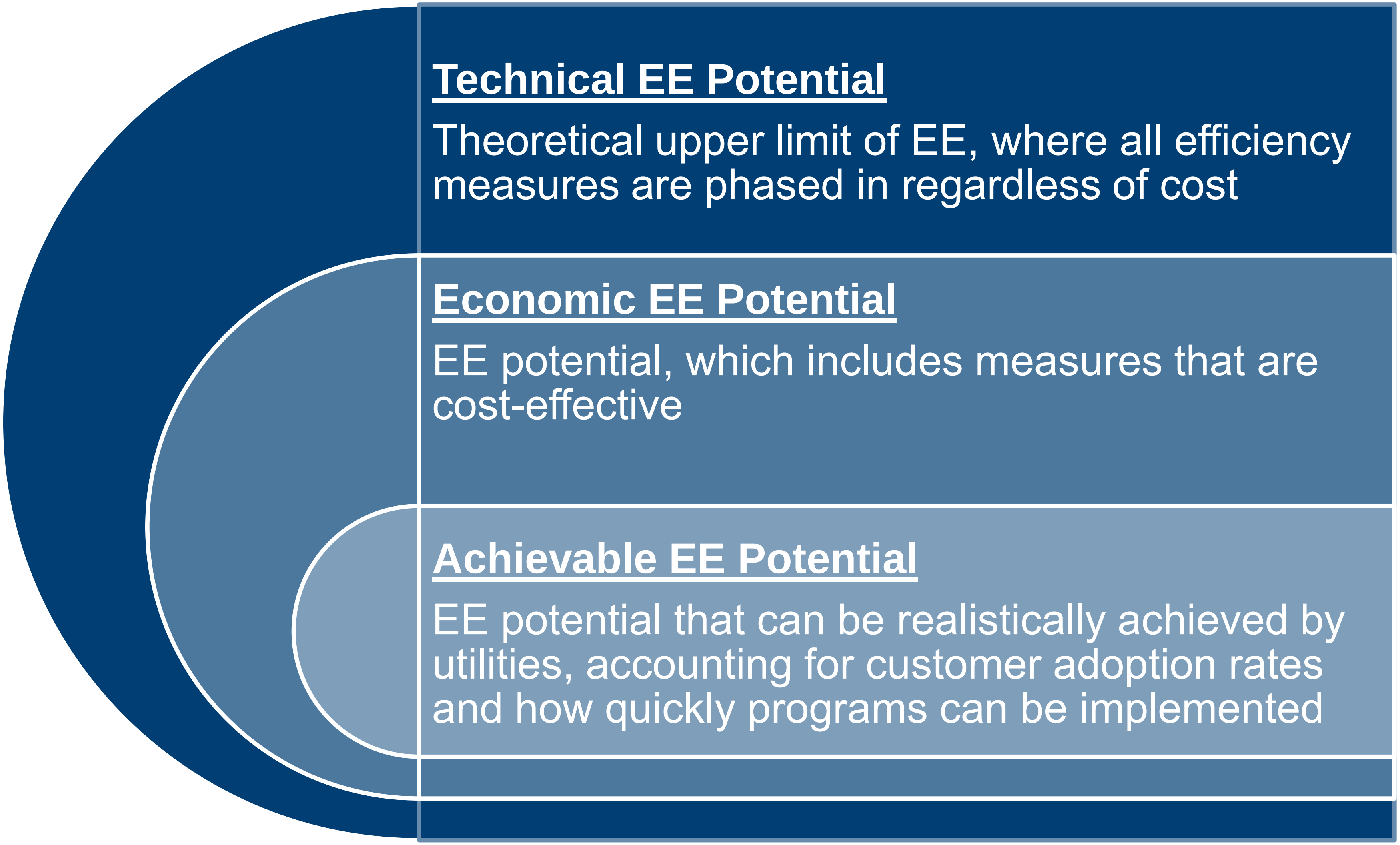
CPA considerations

The CPA approach accounts for the following factors

- Impacts of existing programs
- Impacts of codes and standards
- Technology developments and innovation
- Economic conditions
- Customer growth trends
- Energy prices

Develop three levels of potential

Potential studies identify future opportunities for EE that can be achieved through programs



Technical EE Potential

Theoretical upper limit of EE, where all efficiency measures are phased in regardless of cost

Economic EE Potential

EE potential, which includes measures that are cost-effective

Achievable EE Potential

EE potential that can be realistically achieved by utilities, accounting for customer adoption rates and how quickly programs can be implemented

Consistency with Sixth Plan

End-use model — bottom-up

- Building characteristics
- Fuel and equipment saturations
- Measure life
- Stock accounting
- Existing and new vintage
- Lost- and non-lost opportunities
- Measure saturation and applicability
- Measure savings, including contribution to peak
- Codes and standards
- Ramp rates to model market acceptance and program implementation

Consistency with Sixth Plan (cont.)

Measures

- Include nearly all in Sixth Plan
- Others also, e.g., conversion of electric water heaters and furnaces to natural gas
- Sources for measure characterization
  - Avista Technical Reference Manual (TRM)
  - RTF measure workbooks
  - EnerNOC databases, some of same sources used in Sixth Plan

Economic potential, total resource cost (TRC) test

- Considers non-energy benefits

Achievable potential – ramp rates

- Based on Council Sixth Plan ramps rates
- Modified to reflect Avista program history

ENERNOC
UtilitySOLUTIONS

Avista-specific items

End-use model

- Building characteristics, fuel shares, and equipment saturations are Avista-specific
- Calibrated to Avista 2009 sales by sector
- Update with newly available RBSA data, e.g., information on measure saturation
- Measure savings, including contribution to peak

Building codes and appliance standards updated as of 2012

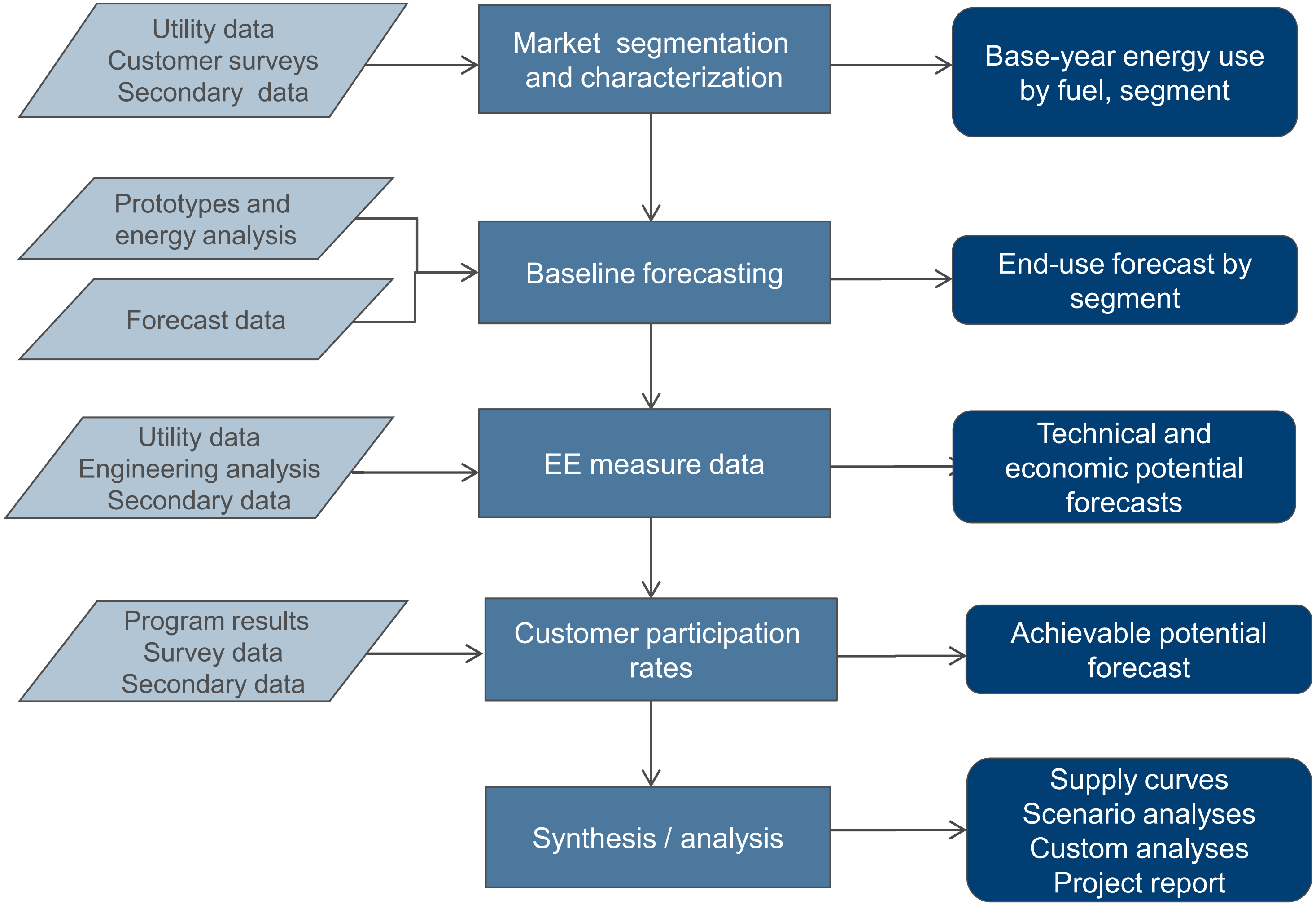
Avista-specific customer growth forecasts

Avista retail rate and avoided cost forecasts

Ramp rates adjusted to match Avista program history

ENERNOC
UtilitySOLUTIONS

Potential study analysis framework



Utility data
Customer surveys
Secondary data

Market segmentation and characterization

Base-year energy use by fuel, segment

Prototypes and energy analysis

Forecast data

Baseline forecasting

End-use forecast by segment

Utility data
Engineering analysis
Secondary data

EE measure data

Technical and economic potential forecasts

Program results
Survey data
Secondary data

Customer participation rates

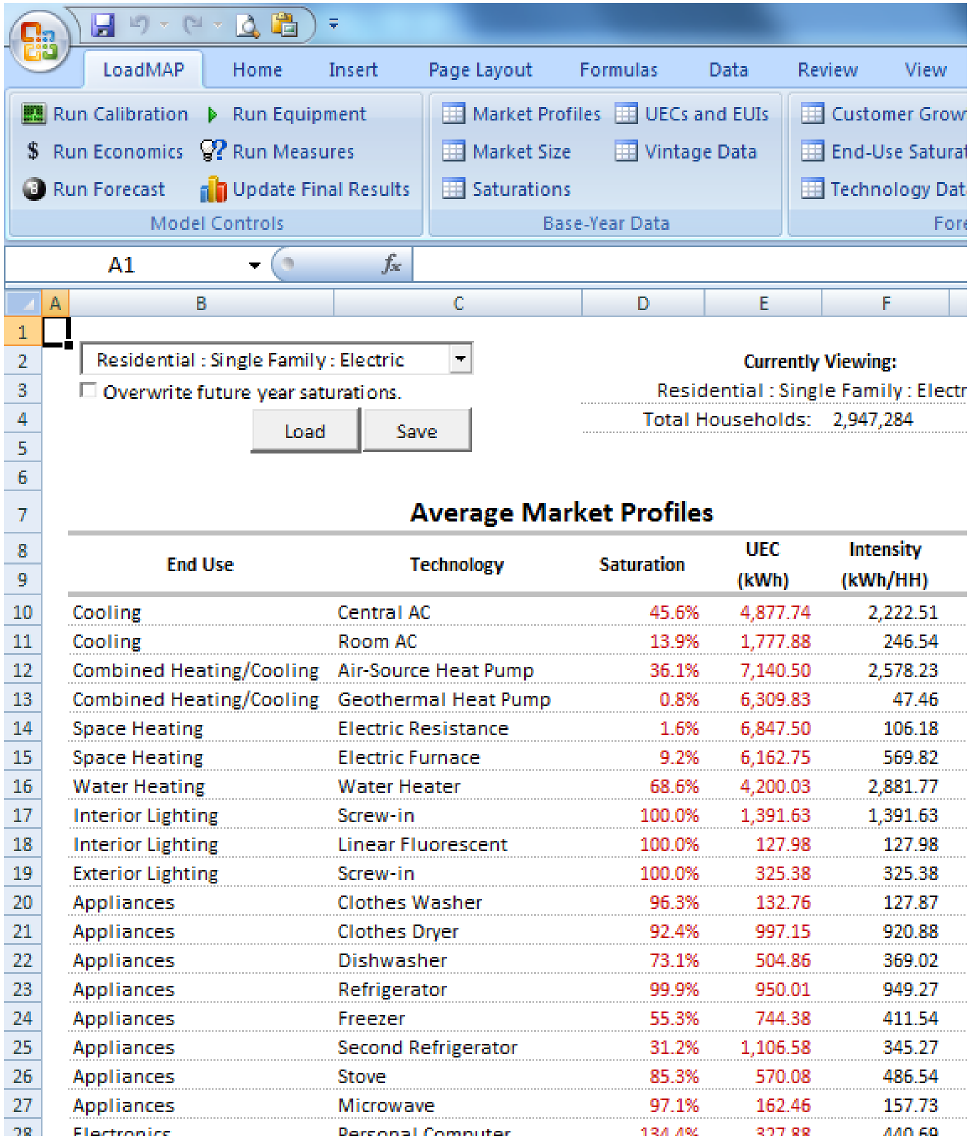
Achievable potential forecast

Synthesis / analysis

Supply curves
Scenario analyses
Custom analyses
Project report

ENERNOC
Utility SOLUTIONS

LoadMAP™ analysis tool



Residential : Single Family : Electric

☐ Overwrite future year saturations.

Currently Viewing:

Residential : Single Family : Electr

Total Households: 2,947,284

Average Market Profiles

End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)
Cooling	Central AC	45.6%	4,877.74	2,222.51
Cooling	Room AC	13.9%	1,777.88	246.54
Combined Heating/Cooling	Air-Source Heat Pump	36.1%	7,140.50	2,578.23
Combined Heating/Cooling	Geothermal Heat Pump	0.8%	6,309.83	47.46
Space Heating	Electric Resistance	1.6%	6,847.50	106.18
Space Heating	Electric Furnace	9.2%	6,162.75	569.82
Water Heating	Water Heater	68.6%	4,200.03	2,881.77
Interior Lighting	Screw-in	100.0%	1,391.63	1,391.63
Interior Lighting	Linear Fluorescent	100.0%	127.98	127.98
Exterior Lighting	Screw-in	100.0%	325.38	325.38
Appliances	Clothes Washer	96.3%	132.76	127.87
Appliances	Clothes Dryer	92.4%	997.15	920.88
Appliances	Dishwasher	73.1%	504.86	369.02
Appliances	Refrigerator	99.9%	950.01	949.27
Appliances	Freezer	55.3%	744.38	411.54
Appliances	Second Refrigerator	31.2%	1,106.58	345.27
Appliances	Stove	85.3%	570.08	486.54
Appliances	Microwave	97.1%	162.46	157.73
Electronics	Personal Computer	134.4%	327.88	440.69

- **LoadMAP stands for Load Management, Analysis and Planning**
- **LoadMAP modeling features:**
  - Embodies principles of rigorous end-use models (like REEPS and COMMEND)
  - Uses stock-accounting
  - Isolates new construction
  - Uses a simple decision logic
  - Models customized by end use
- **From user's perspective:**
  - Excel-based model
  - Easy to update assumptions
  - Enables sensitivity analysis
  - Answers what-if questions

ENERNOC
Utility SOLUTIONS

Base-year energy consumption

Base year is 2009

- At start of past study in summer 2010, 2009 was most recent year with complete sales and customer data
- 2009 was also base year for Avista load research study, which provides peak data
- We will calibrate the first few years of the forecast to sales history

ENERNOC
UtilitySOLUTIONS

Market segmentation by rate class

Used 2009 base year sales data to develop control totals

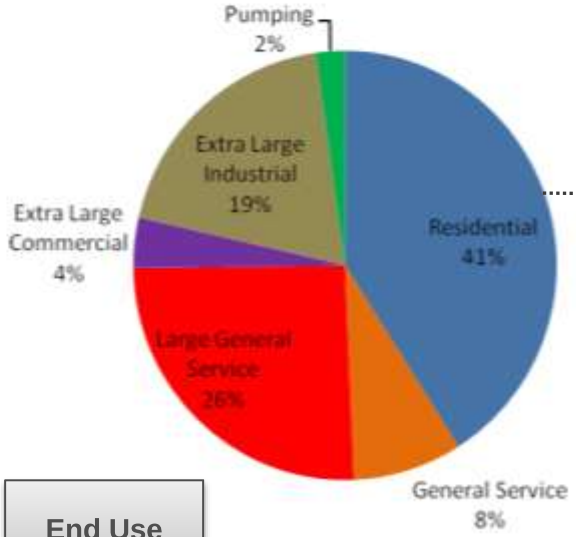
- Number of customers, annual use, and peak load by sector

Sector	Rate Schedule(s)	Number of meters (customers)	2009 Electricity sales (MWh)	Peak demand (MW)
Residential	001	299,714	3,634,086	993
General Service	011, 012	46,387	738,505	125
Large General Service	021, 022	4,808	2,256,882	347
Extra Large General Service	025, 025P	32	1,145,277	174
Extra Large GS Potlatch	025P	1	892,291	101
Pumping	031, 032	3,673	194,884	14
Total		354,615	8,861,961	1,753

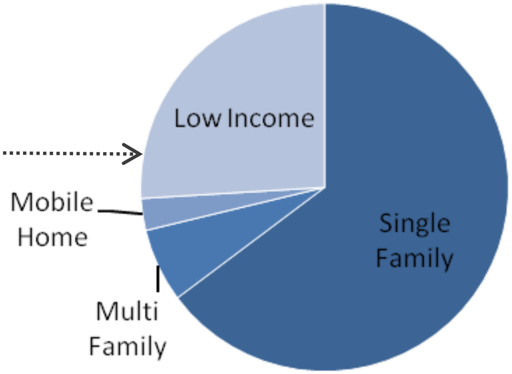
ENERNOC
UtilitySOLUTIONS

Market characterization

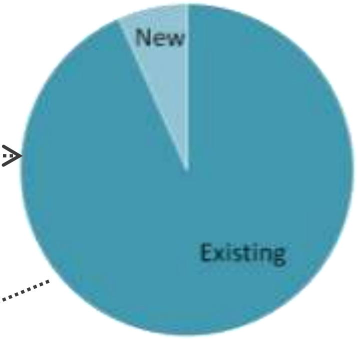
Sector



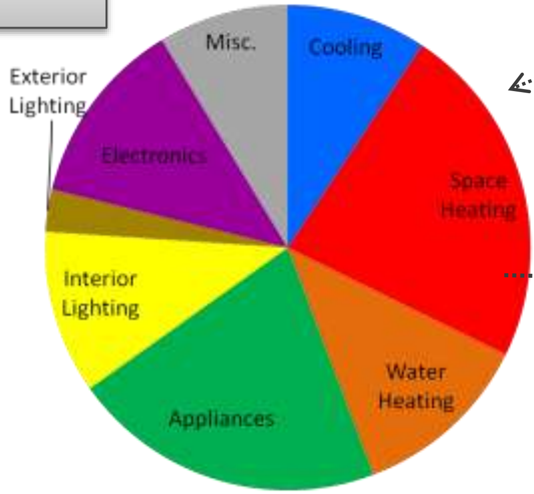
Segment



Vintage



End Use



Technology

Space heating
Air-source heat pump
Geothermal heat pump
Electric furnace
Electric resistance

Efficiency options

Air-source heat pump
SEER 13
SEER 14
SEER 15
SEER 16
Ductless Minisplit

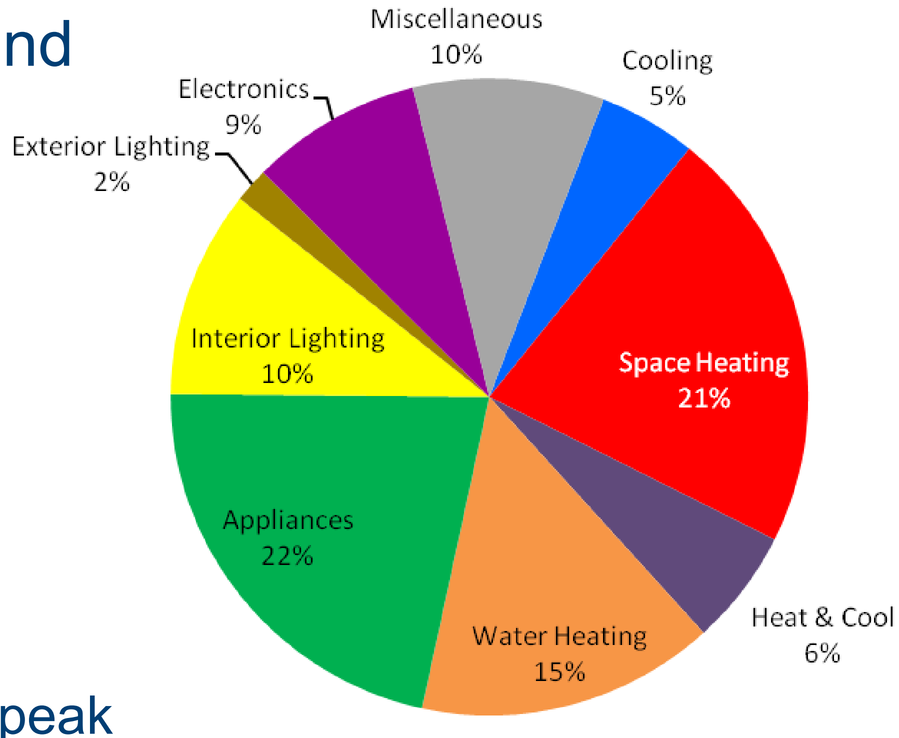
Market characterization by segment

Sector	Customers	2009 Electricity sales (GWh)
Residential	299,714	3,634,086
General Service	46,387	738,505
Large General Service	4,808	2,256,882
Extra Large GS	32	1,145,277
Extra Large GS Potlatch	1	892
Pumping	3,673	194,884
Total	354,615	8,861,961

Residential Segment	Number of Customers	Intensity (kWh/HH)	Electricity Sales (GWh)
Single family	168,339	14,250	2,398,874
Multi family	23,456	8,613	202,032
Mobile/Manufactured	10,022	12,724	127,523
Limited Income	97,896	9,251	905,656
Total	299,714	12,125	3,634,086

Energy Market Profiles

- Market profiles – a snapshot of how customers use energy by end use and technology
  - Number of customers
  - Saturations
  - Unit energy consumption (UEC) or
    energy use intensity (EUI)
  - Peak factors — fraction of annual electricity use coincident with the system peak
- Existing (average) buildings and new construction



ENERNOC Utility SOLUTIONS

Energy Market Profiles (continued)

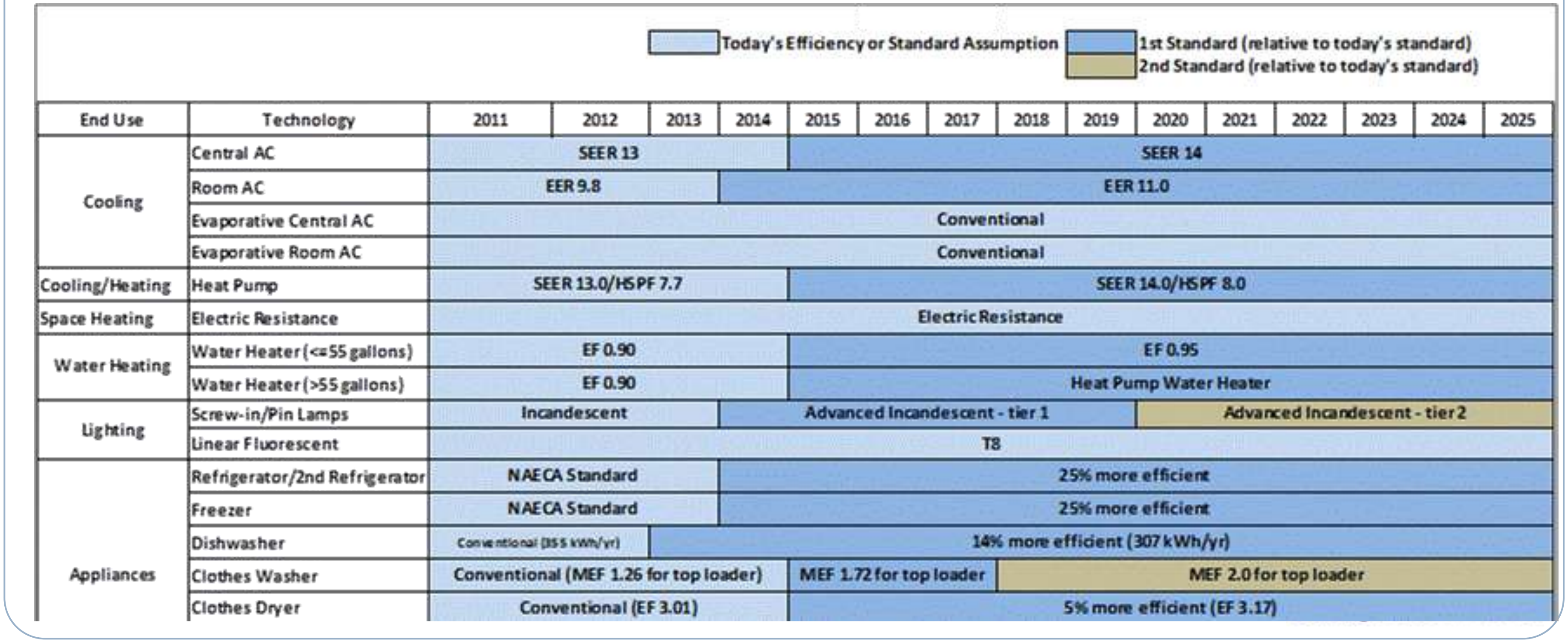
Sample for residential sector, all segments

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**

Baseline forecasting

- Model equipment choices for replacement or new construction
- Define equipment efficiency options, up to 10 per technology
- Define baseline purchase shares —begin with Annual Energy Outlook shipments data and modified for Avista service territory or local data
- Building codes and appliance standards



Today's Efficiency or Standard Assumption

1st Standard (relative to today's standard)

2nd Standard (relative to today's standard)

End Use	Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Cooling	Central AC	SEER 13				SEER 14										
	Room AC	EER 9.8			EER 11.0											
	Evaporative Central AC	Conventional														
	Evaporative Room AC	Conventional														
Cooling/Heating	Heat Pump	SEER 13.0/HSPF 7.7				SEER 14.0/HSPF 8.0										
Space Heating	Electric Resistance	Electric Resistance														
Water Heating	Water Heater (<=55 gallons)	EF 0.90				EF 0.95										
	Water Heater (>55 gallons)	EF 0.90				Heat Pump Water Heater										
Lighting	Screw-in/Pin Lamps	Incandescent			Advanced Incandescent - tier 1						Advanced Incandescent - tier 2					
	Linear Fluorescent	T8														
Appliances	Refrigerator/2nd Refrigerator	NAECA Standard			25% more efficient											
	Freezer	NAECA Standard			25% more efficient											
	Dishwasher	Conventional (355 kWh/yr)		14% more efficient (307 kWh/yr)												
	Clothes Washer	Conventional (MEF 1.26 for top loader)				MEF 1.72 for top loader			MEF 2.0 for top loader							
	Clothes Dryer	Conventional (EF 3.01)				5% more efficient (EF 3.17)										

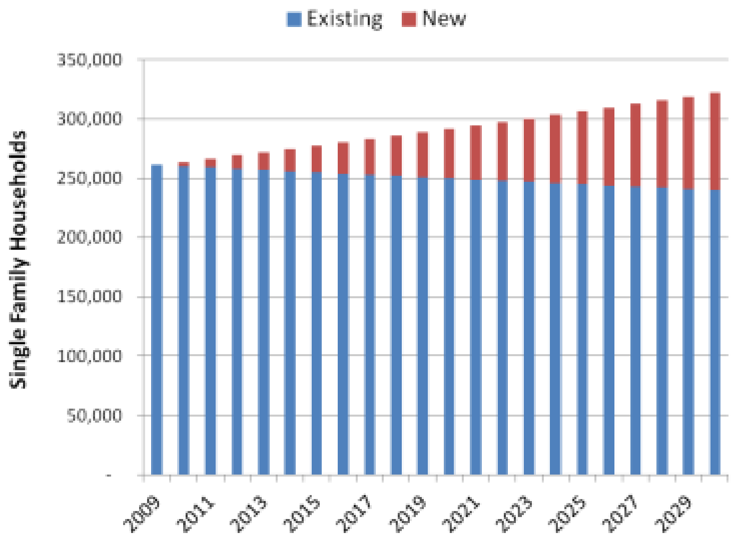
Baseline forecasting

- Air source heat pump example

Efficiency Level	Relative Energy Use	Lifetime	Standards Status	2011 Baseline Purchase Shares	2015 Baseline Purchase Shares
E1 – SEER 13	100.0%	15	Baseline until 2014	78%	0%
E2 – SEER 14 (ENERGY STAR)	91.7%	15	Baseline after 2014	0%	78%
E3 – SEER 15 (CEE Tier 2)	88.6%	15		15%	15%
E4 – SEER 16 (CEE Tier 3)	86.1%	15		7%	7%
E5– Ductless Mini-split System	75.0%	15		0%	0%

ENERNOC
UtilitySOLUTIONS

Baseline forecasting

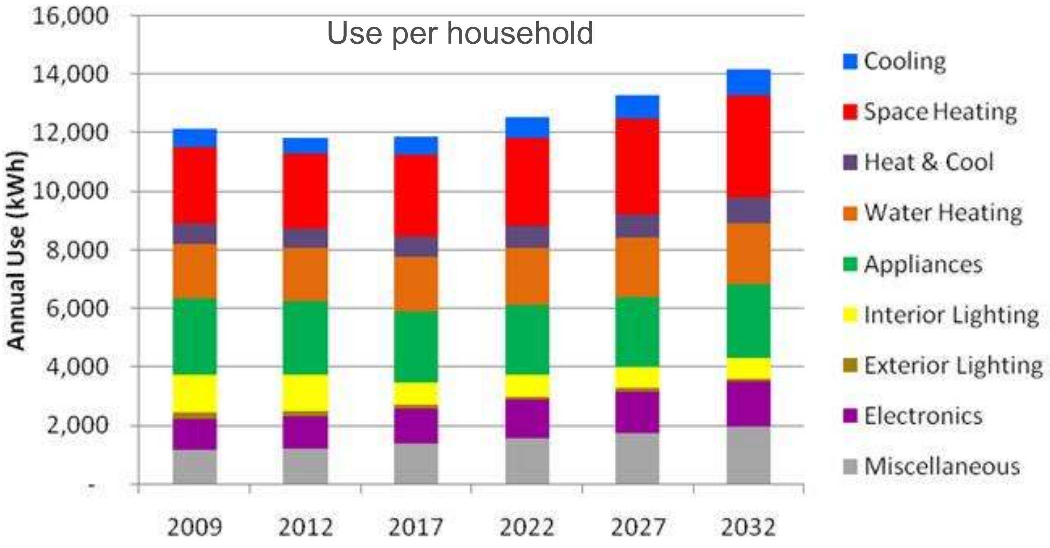


- Market size / customer growth
- Income growth
- Avista retail rates forecast
- Trends in end-use/technology saturations
- Equipment purchase decisions
- Cooling and heating degree day values
- Persons/household and physical home size
- Elasticities by end use for each variable (from client or default values based on EPRI REEPS and COMMEND models)

ENERNOC Utility SOLUTIONS

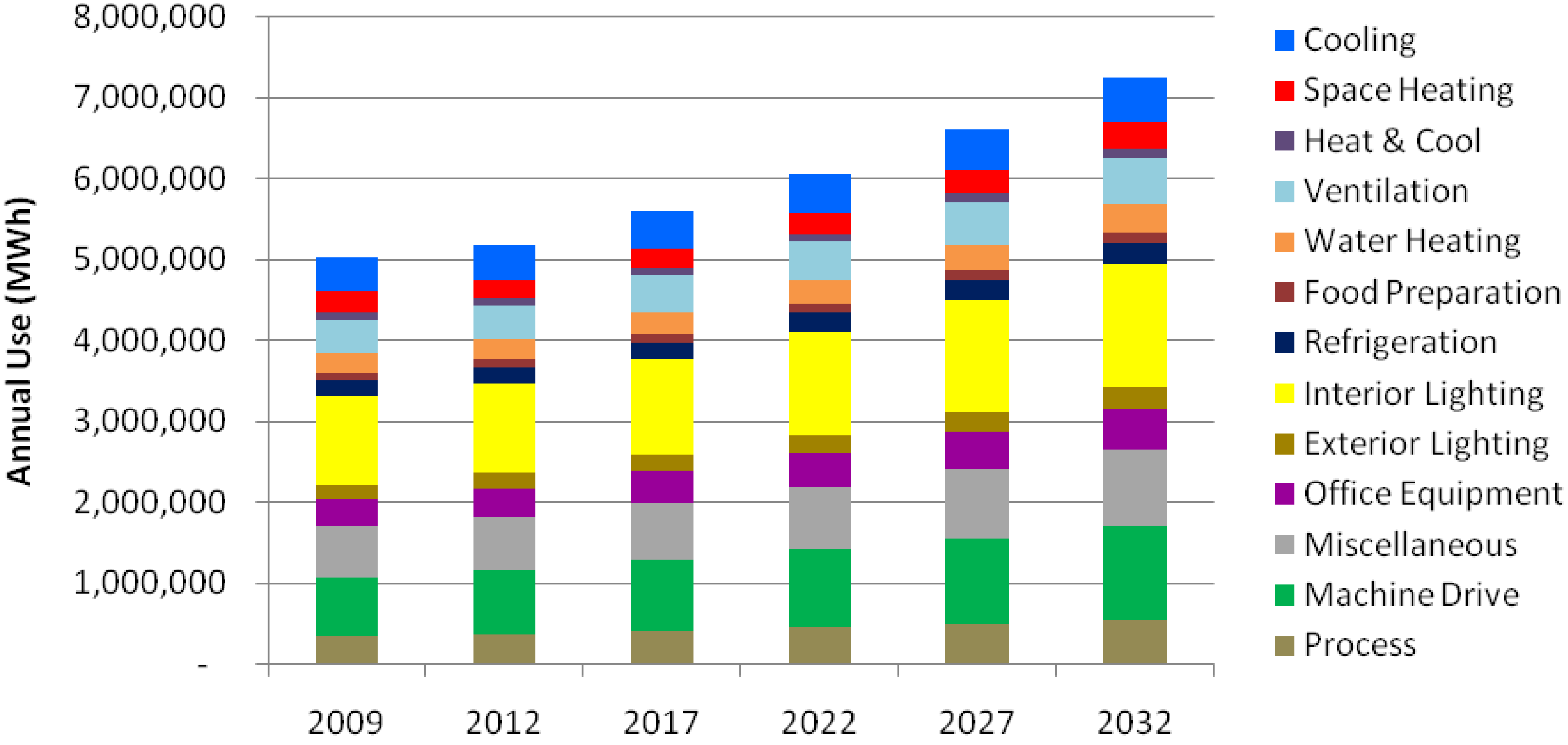
Baseline forecast – Residential

End Use	2009 (MWh)	2012 (MWh)	2017 (MWh)	2022 (MWh)	2027 (MWh)	2032 (MWh)	% Change ('09–'32)	Avg. growth rate
Cooling	180,022	164,872	197,096	239,735	293,189	357,837	99%	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	201,414	229,351	259,524	296,812	343,830	61%	2.1%
Water Heating	549,606	557,026	611,989	675,078	748,532	830,990	51%	1.8%
Appliances	790,377	776,522	796,390	837,724	899,380	996,282	26%	1.0%
Interior Lighting	383,305	375,894	335,220	397,188	465,499	543,171	42%	1.5%
Exterior Lighting	63,864	62,362	61,507	71,895	84,283	98,404	54%	1.9%
Electronics	315,599	336,232	404,126	484,986	570,101	669,577	112%	3.3%
Miscellaneous	352,599	374,582	448,055	540,785	650,016	779,045	121%	3.4%
Total	**3,634,086**	**3,632,162**	**3,989,994**	**4,558,738**	**5,217,905**	**6,002,803**	**65%**	**2.2%**



Baseline forecast – Commercial & Industrial

- Total growth of 27.1% over forecast period
- Average annual growth of 1.04%



ENERNOC Utility SOLUTIONS

Baseline forecast summary — previous CPA

Overall 48% growth in electricity use

Average annual growth rate of 1.7%

Measure identification & characterization

- Develop measure list using
  - Existing programs
  - RTF data
  - EnerNOC databases
- Characterization
  - Description
  - Costs
  - Savings
  - Applicability
  - Lifetime
- Update measure data
  - Avista TRM
  - RTF measure databases
  - BEST simulations
  - EnerNOC databases

Water heating measures
Conventional (EF 0.95)
Heat pump water heater (EF 2.3)
Solar water heater
Low-flow showerheads
Timer / Thermostat setback
Tank blanket
Drainwater heat recovery

ENERNOC UtilitySOLUTIONS

Technical potential

Technical potential

- Hypothetical case
- Most efficient option taken, regardless of cost
- Equipment is replaced at time of failure
- Other devices are phased in over time using a diffusion curve
  - Slope of curve varies according to complexity of measure and cost

Label	Water Heater Technology	Relative Energy Use	Off Market
E1	EF 0.9	100.0%	2014
E2	EF 0.95	94.0%	
E3	EF 2.3 (HPWH)	39.1%	
E4	Solar	38.2%	

ENERNOC
UtilitySOLUTIONS

Economic potential

Assumptions

- Avoided costs forecasts for energy and capacity
- T&D line losses
- Administrative cost adders

Total Resource Cost test for B/C ratio ≥ 1.0

- Most efficient cost-effective option is selected
- Screening performed for every year

Label	Water Heater Technologies	Relative Energy Use	Off Market	B/C Ratio 2012	B/C Ratio 2017
E1	EF 0.9	100.0%	2014	1.00	-
E2	EF 0.95	94.0%		1.03	1.00
E3	EF 2.3 (HPWH)	39.1%		1.05	1.08
E4	Solar	38.2%		0.68	0.70

ENERNOC Utility SOLUTIONS

Estimate achievable potential

Requires assumptions about customer acceptance, market barriers, and market maturity

Model applies series of factors to economic potential

Savings may be acquired through a variety of means

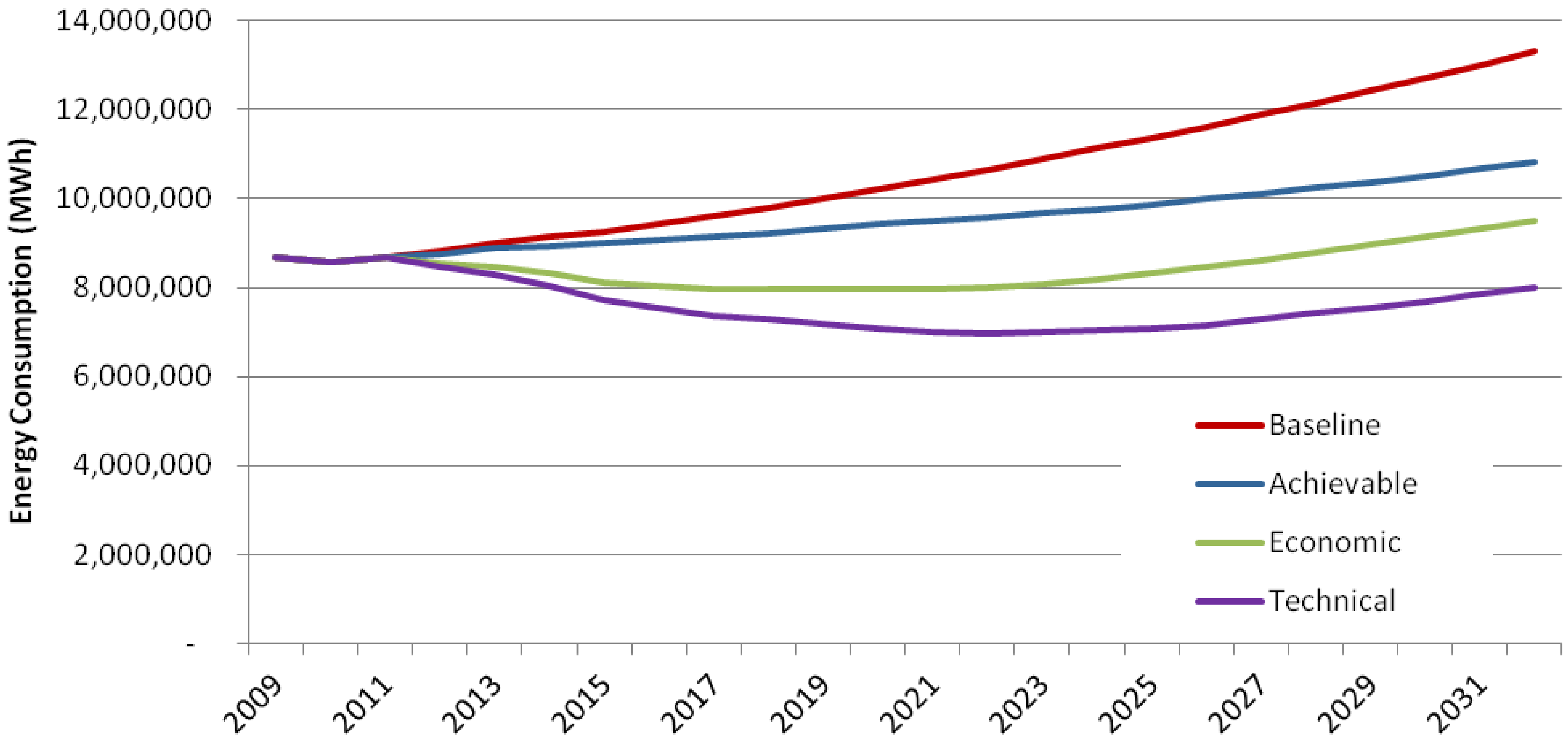
- Utility incentive programs
- Utility educational programs
- Market transformation, including NEEA

Sample potential results from previous CPA

	2012	2013	2017	2021	2022	2027	2032
Baseline Forecast (MWh)							
	8,805,759	9,000,280	9,600,889	10,425,853	10,646,717	11,876,679	13,310,674
Cumulative Energy Savings (MWh)							
Achievable	52,188	116,482	465,933	917,085	1,069,455	1,765,226	2,493,450
Economic	250,938	520,969	1,627,739	2,454,017	2,632,030	3,259,492	3,813,122
Technical	336,303	702,900	2,224,063	3,411,428	3,664,844	4,590,026	5,311,276
Cumulative Energy Savings (% of Baseline)							
Achievable	0.6%	1.3%	4.9%	8.8%	10.0%	14.9%	18.7%
Economic	2.8%	5.8%	17.0%	23.5%	24.7%	27.4%	28.6%
Technical	3.8%	7.8%	23.2%	32.7%	34.4%	38.6%	39.9%

ENERNOC
UtilitySOLUTIONS

Sample potential results (continued)

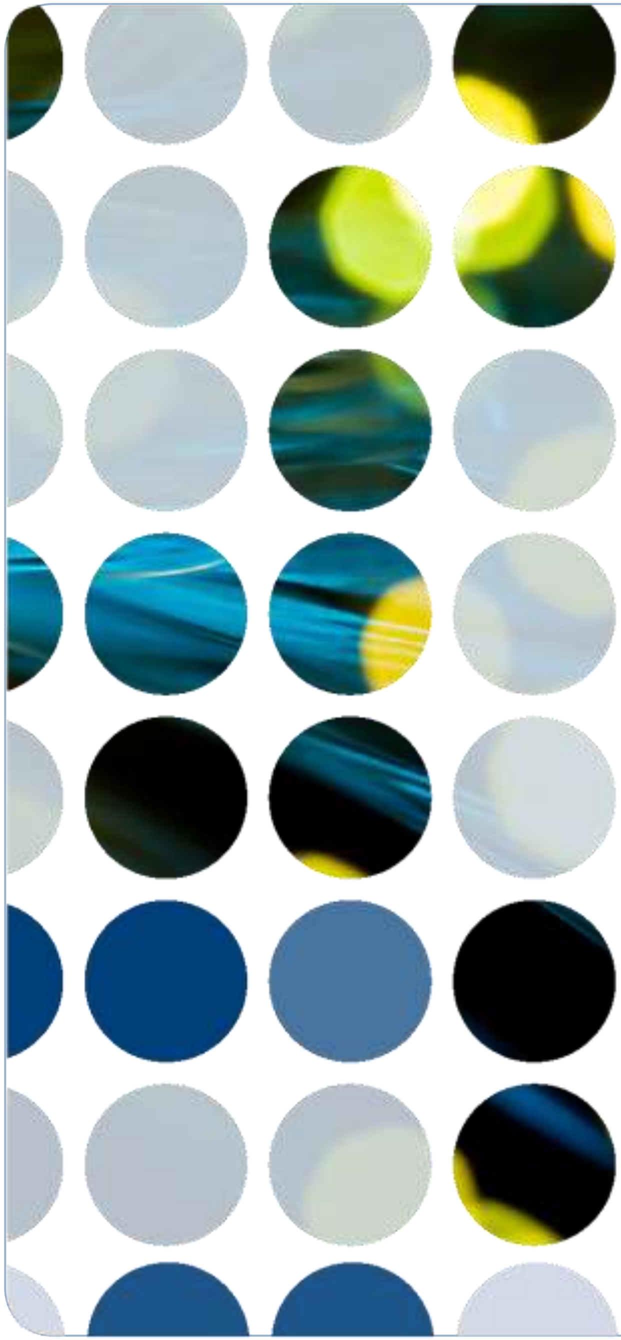


Project Schedule

Project Schedule

- Present project approach to the TAC on November 7, 2012
- Deliver preliminary results in January 2013
- Deliver final results mid-February 2013
- Present final study results to TAC and draft report in March, 2013
- Support the filing in August 2013 with a complete CPA report (including appendices)

ENERNOC
UtilitySOLUTIONS



ENERNOC

Jan Borstein
jborstein@enernoc.com
303-530-5195

Ingrid Rohmund
irohmund@enernoc.com
760-943-1532

Peak Load Forecast

James Gall, Senior Power Supply Analyst

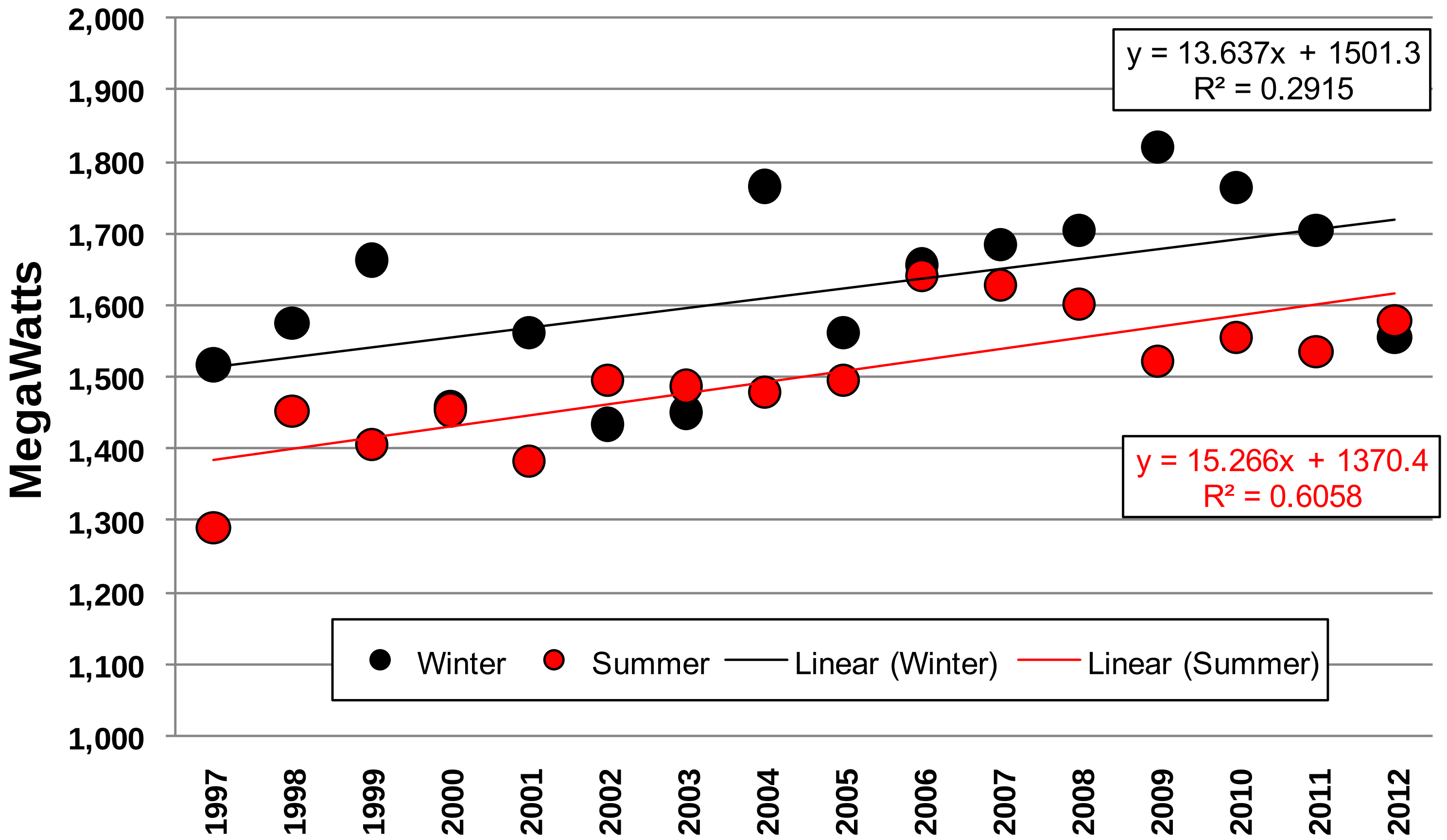
Grant Forsyth, Senior Forecaster & Economist

Third Technical Advisory Committee Meeting

2013 Electric Integrated Resource Plan

November 7, 2012

Peak Load History



Winter:
0.85% AAGR

Summer:
1.0% AAGR

Forecast Methodology

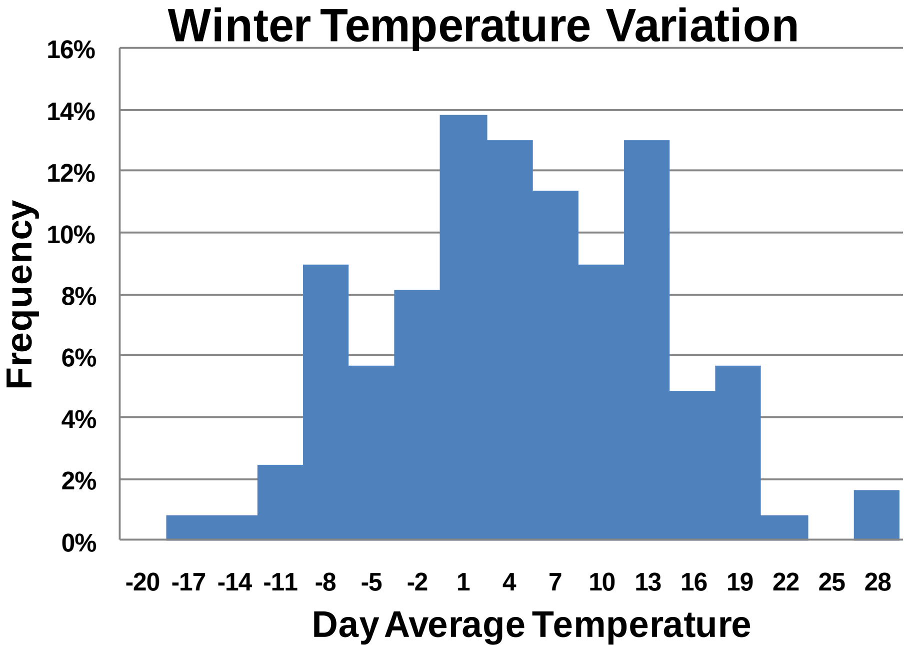
- Use multi-variable regression analysis to identify the 2011/2012 weather adjusted peak load
- Use two years of daily load data as the sample data
- Remove large industrial loads and focus on weather related load
- Variables include:
    - Heating degree days set at 55°, 45°, and 15°
    - Cooling degree days set at 65° and 70°
    - Prior day cooling degree days set at 65° for past two days
    - Summer sunlight percentage
    - NERC and school holidays
    - Number of industrial & residential customers
    - Day of week and month of year

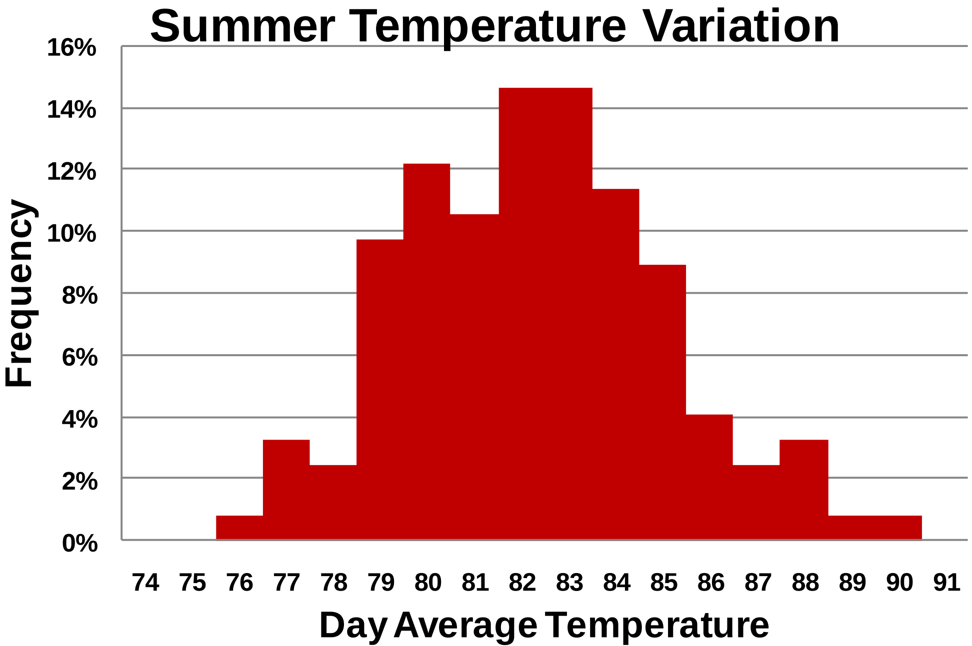
Forecast Methodology (continued)

- Peak load data was adjusted to the natural log to better estimate peak load hours
  - Resulting r^2: is 0.94
  - Standard error: 36 MW or 3.3%
  - Durbin-Watson: $1.475_{(d-1)}$, $1.973_{(d-2)}$
- Weather adjustment includes 123 years of historical Spokane temperatures and four weekday combinations
- Peak forecast is 1 in 2 peak on a weekday
- LOLP analysis will consider probability of weekend extreme temperatures and will consider it in the planning margin
- L&R will use three day average peak and single hour peak
- Peak forecast includes existing conservation programs- additional programs could further lower the forecast

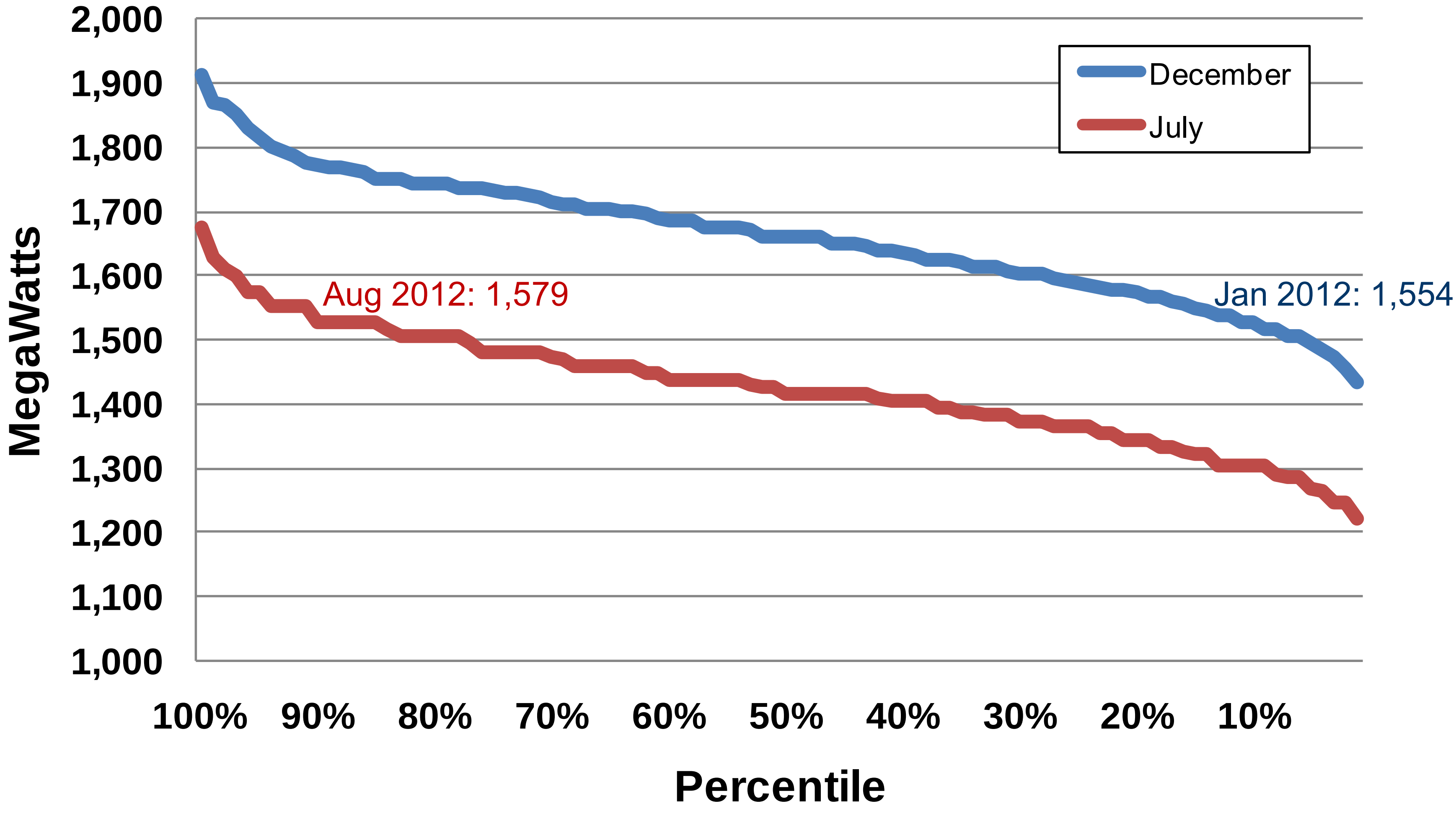
Historical Average Day Temperatures 1890-2012

	Coldest Day	Hottest Day
Extreme	-17°	90°
Average	3.9°	82.3°
Standard Deviation	8.9°	2.8°
90th Percentile	-8.8°	86°
Last Tail Event	2004: -9°	2008: 86°

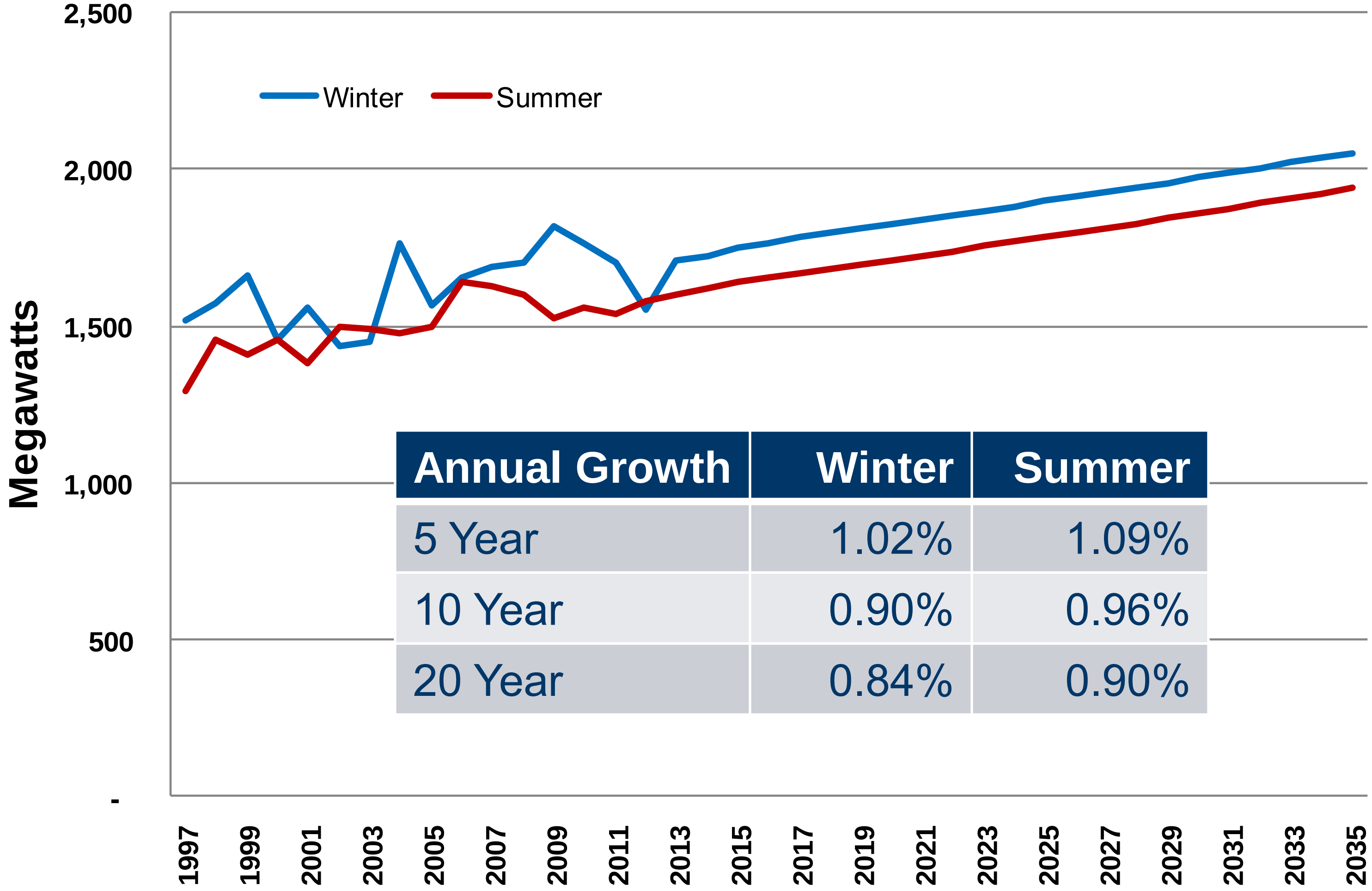




2011/2012 Weather Adjusted Peak Loads



2013 IRP Peak Load Forecast



Annual Growth	Winter	Summer
5 Year	1.02%	1.09%
10 Year	0.90%	0.96%
20 Year	0.84%	0.90%

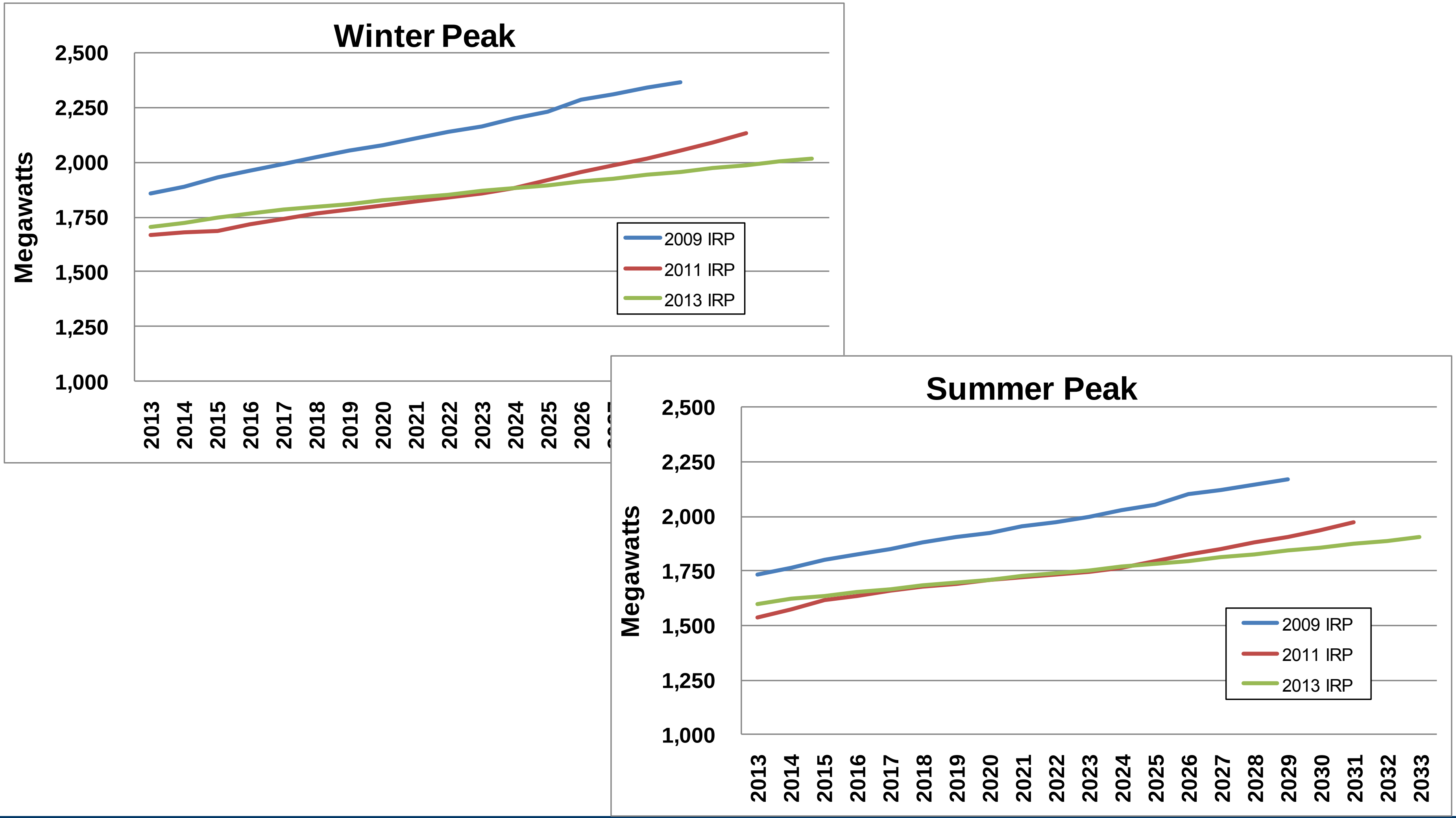
Linking Peak Load Growth to GDP Growth

- Peak loads are not constant over time. Controlling for weather and other seasonal factors, the long-run trend is towards increasing peaks
  - Monthly Peak = f(weather, non-weather seasonal factors, **economic factors**)
  - If we account for weather and non-weather seasonal factors, then changes in the peak load, we assume, are due to economic factors
- Since we cannot easily identify specific economic factors, we use GDP growth as a catch-all proxy
  - Econometric evidence suggests that Avista's load growth, excluding weather and seasonal effects, is significantly, positively correlated with GDP growth.
  - Weather and Seasonal Adjusted Peak Growth = f(GDP Growth) is a relationship estimated with historical data
  - If we have forecasts of GDP growth we can estimated what peak load growth under the assumption that the future GDP/load relationship will not be materially different than what it was in the past

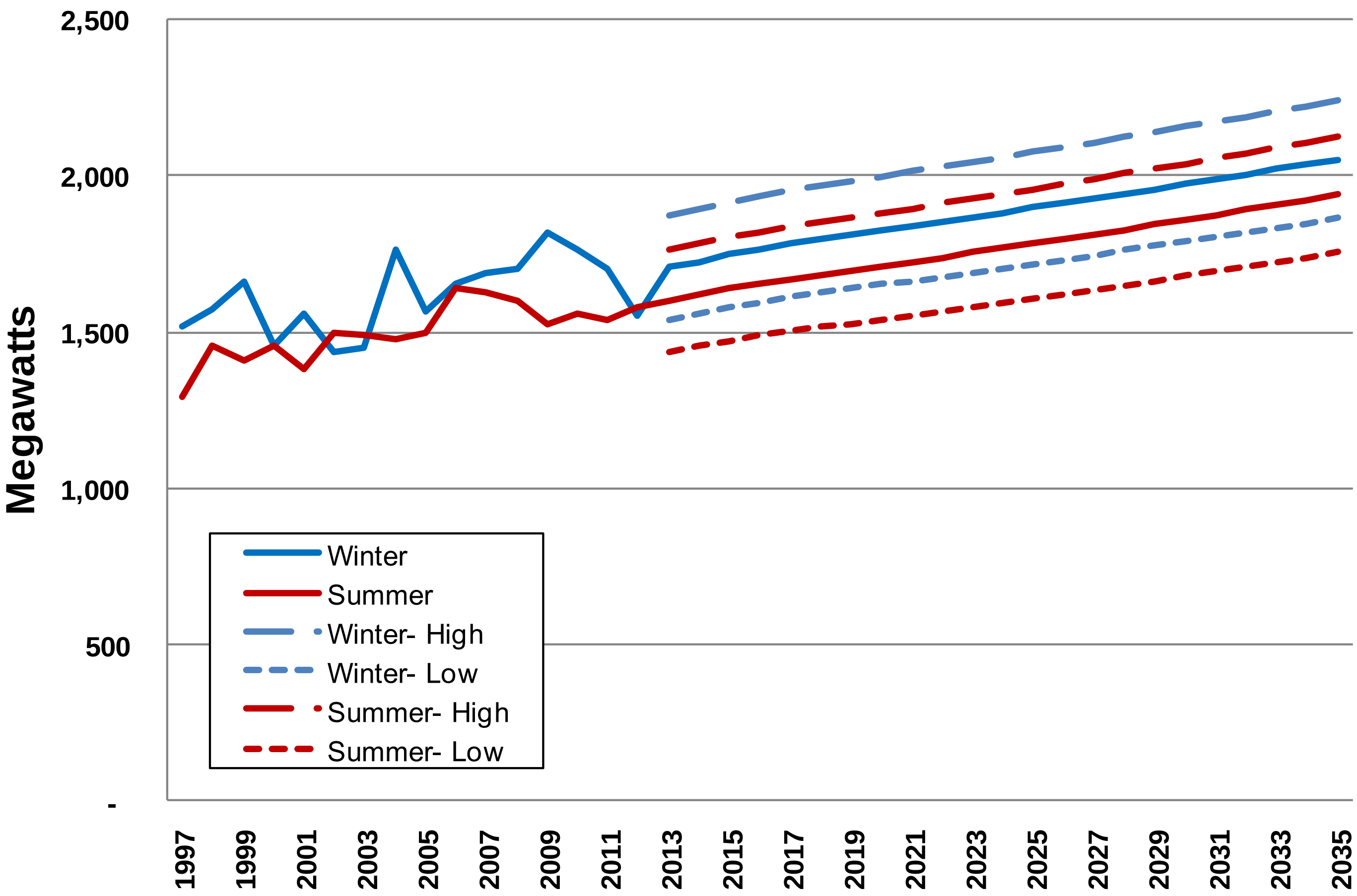
Linking Peak Load Growth to GDP Growth (Cont)

- There is growing evidence that winter peak load growth is slower than summer peak load growth
  - Could be a function of increased use of air conditioning on new and existing homes
  - Weather and Seasonal Adjusted Peak Growth = f(GDP Growth) is estimated for winter peaks and summer peaks. The estimation does produced a slightly higher growth rate for the summer peak
- Where do the forecasts for GDP growth come from?
  - 5-year forecasts are obtained by averaging GDP forecasts across multiple sources: Bloomberg survey of forecasters, The Economist poll of forecasters, WSJ survey of forecasters, Global Insight, Economy.com, and several others
  - From this set of forecasts have an average, a high, and a low forecast out five years. This gives us some sense of how the business cycle will impact peak growth
  - Beyond five years we assume a long-rung GDP growth rate of 2.5%

IRP Peak Forecast Changes



Weather Variation (1 in 20)



Reliability Planning

James Gall, Senior Power Supply Analyst

Third Technical Advisory Committee Meeting

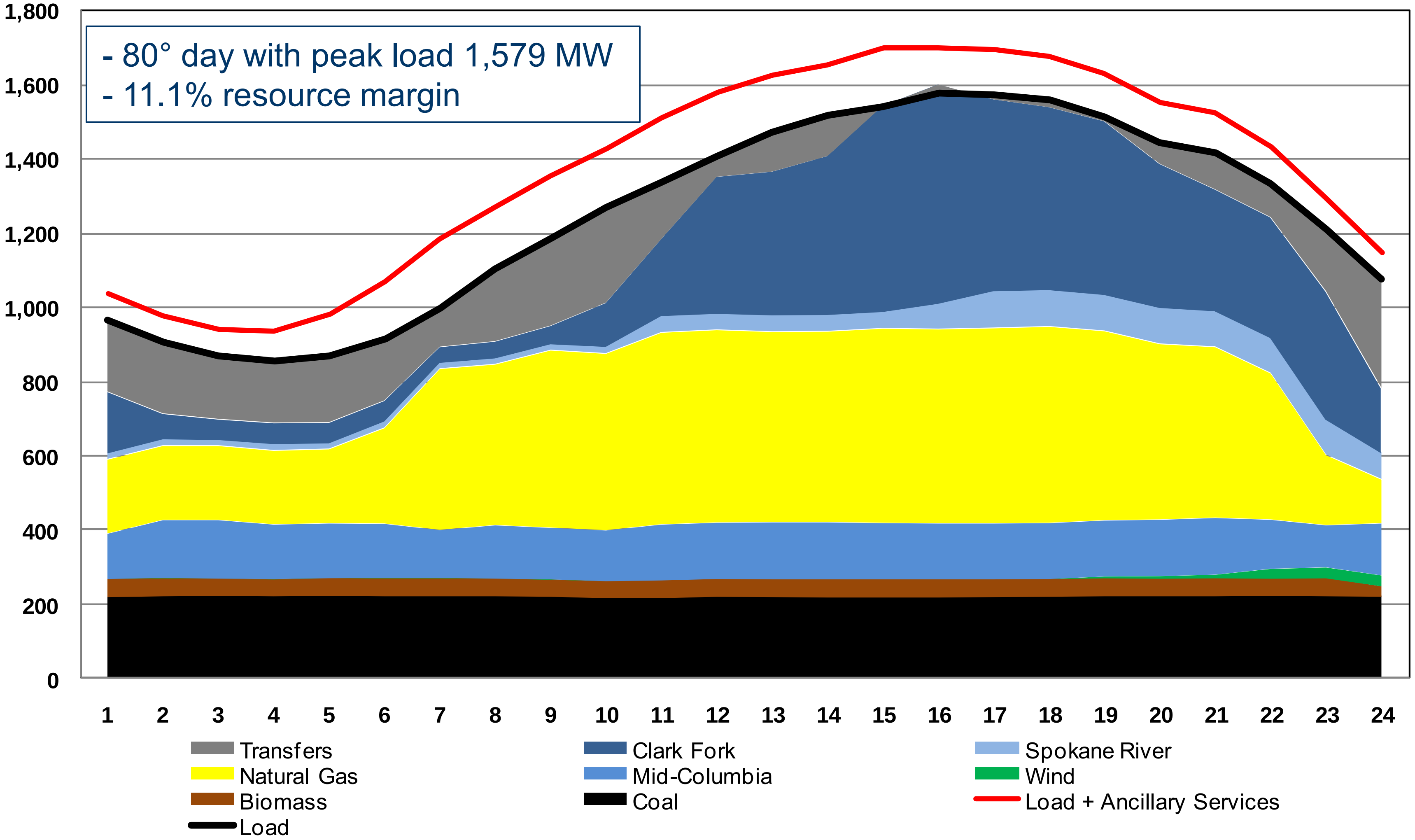
2013 Electric Integrated Resource Plan

November 7, 2012

What is Reliability Planning?

- Assessment of resource adequacy
- Estimate probability of failing to serve all load
- Used to estimate the planning margin to apply to the peak load forecast

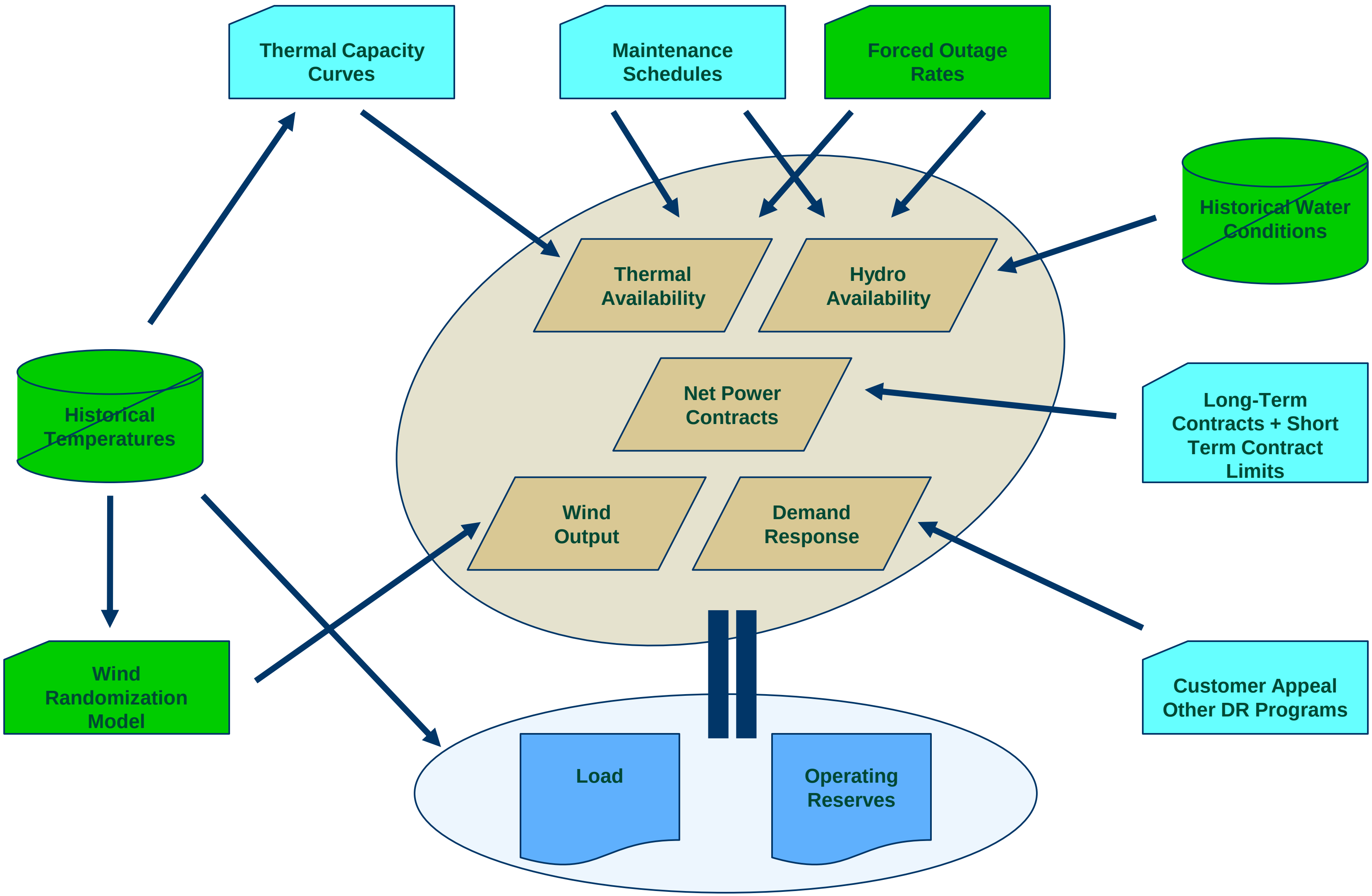
Peak Day Example- August 7, 2012


- 80° day with peak load 1,579 MW
- 11.1% resource margin

The Tool

- Excel based model with linear program to optimize resource generation to meet load and reserve requires taking into account potential market purchases and sales
- Focus on year 2020
- Simulates 1,000 future scenarios
    - Temperatures, Hydro Availability, Forced Outages, Wind Generation
- Attempts to correlate interaction between variables

Reliability Model Data Work Flow Diagram



Thermal Capacity Curves

Maintenance Schedules

Forced Outage Rates

Historical Water Conditions

Thermal Availability

Hydro Availability

Net Power Contracts

Long-Term Contracts + Short Term Contract Limits

Historical Temperatures

Wind Output

Demand Response

Wind Randomization Model

Customer Appeal Other DR Programs

Load

Operating Reserves

Loads

- Load shapes are derived from historic daily high and low temperatures
- Uses 120+ years of Spokane temperatures
- The average load and the average of the seasonal peak load of the 1,000 scenarios are designed to match the long-term energy & peak forecasts
- Two years of historical hourly loads (netted of large industrials) were used as the dependant variable of a regression analysis
- 303 independent variables were considered including: temperature, holidays, day of week, month, and hour
- Resulted in a 94% R^2 and 5.3% standard error

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

- Temperature dependency
  - Gas-fired facilities use capacity based upon location temperatures
  - Temperatures are randomly drawn and are the same as the temperatures used in the load and wind 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

- In 2020, only one wind project is expected to be on-line- The 105 MW Palouse Wind Farm
- The project is expected to be on-line by the end of 2012
- Little generation data is available at this time- only a few years of wind speed at a few locations
- To simulate wind generation a regression analysis was used to create a algorithm adjusting generation based on month, temperature, daytime vs nighttime and previous hour(s) generation.
- Method creates realistic generation profile, but due to lack of historical data- scenarios will done to understand the variability of wind during high or low 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, 7% thermal, 5% wind generation
- Regulating Margin:
  - 1.6% of average hourly load level (based on historical average of max load within hour versus average load)
- Intermediate (Wind) Resource Regulation:
  - Lesser of 10% of nameplate capacity or generation amount
- Reserves are met by excess hydro capacity (for spin & non-spin) and thermal generation not running may be used for non-spin.
- In the event a unit trips- the model will call on regional reserves for 1 hour

Contracts & Market

- Long-term contracts are included as hourly fixed power coming into the system
- Short-term system balancing transaction are allowed with limits:
  - On Peak: 500 MW
  - Off Peak: 1000 MW
  - On Peak Constrained: 0 MW
  - Off Peak Constrained: 500 MW
- Hourly market is modeled dynamically adjusting for regional temperatures and hydro conditions (future enhancement would be to include wind correlation)

Objective Function

Load Serving

- Load [SM]
+ Thermal commitment [RM]
+ Hydro commitment [LP]
+ Wind generation [SM/RM]

+/- LT Contracts

+ Demand curtailment (optional) [LP]

+/- Market transactions

>= 0 or event triggered

Operating Reserves

- Operating Reserve Requirement
- Intra-hour load regulation
- Wind regulation
+ Available thermal non-spin capability
+ Unused hydro capability (spin & non-spin)

>= 0 or event triggered

What should the penalty be for curtailing load?

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

Planning Margin Approach

- Simulate system by adding new resources and/or market reliance until the 5% LOLP threshold is met
- Estimate annual power supply costs for each case
- Management must decide on the acceptable level of market reliance given the cost of new generation
- Year 2020 is used to estimate planning margin for other years

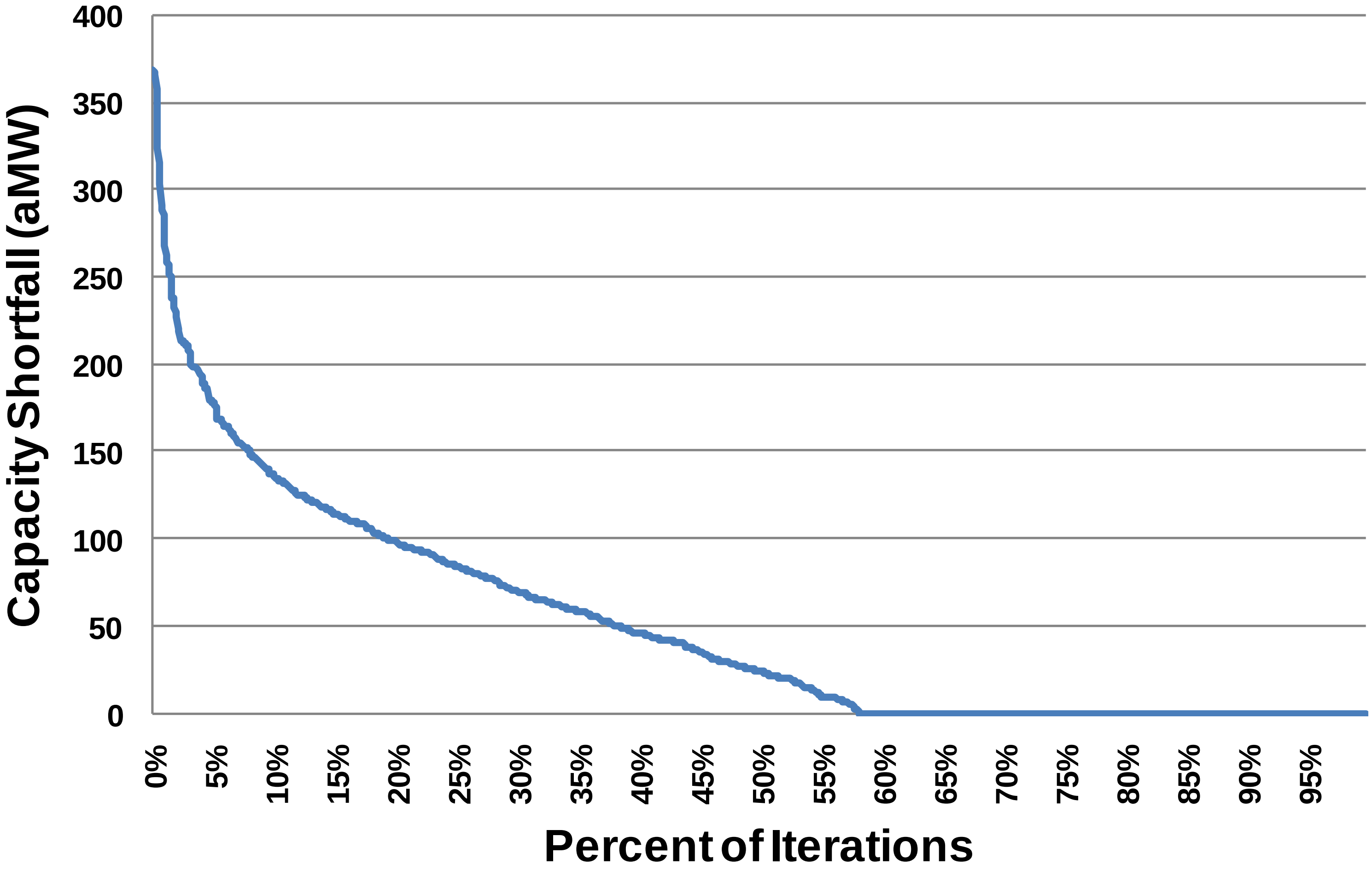
2020 Position Forecast (Draft)

3 day x 6 hour Sustained Peak

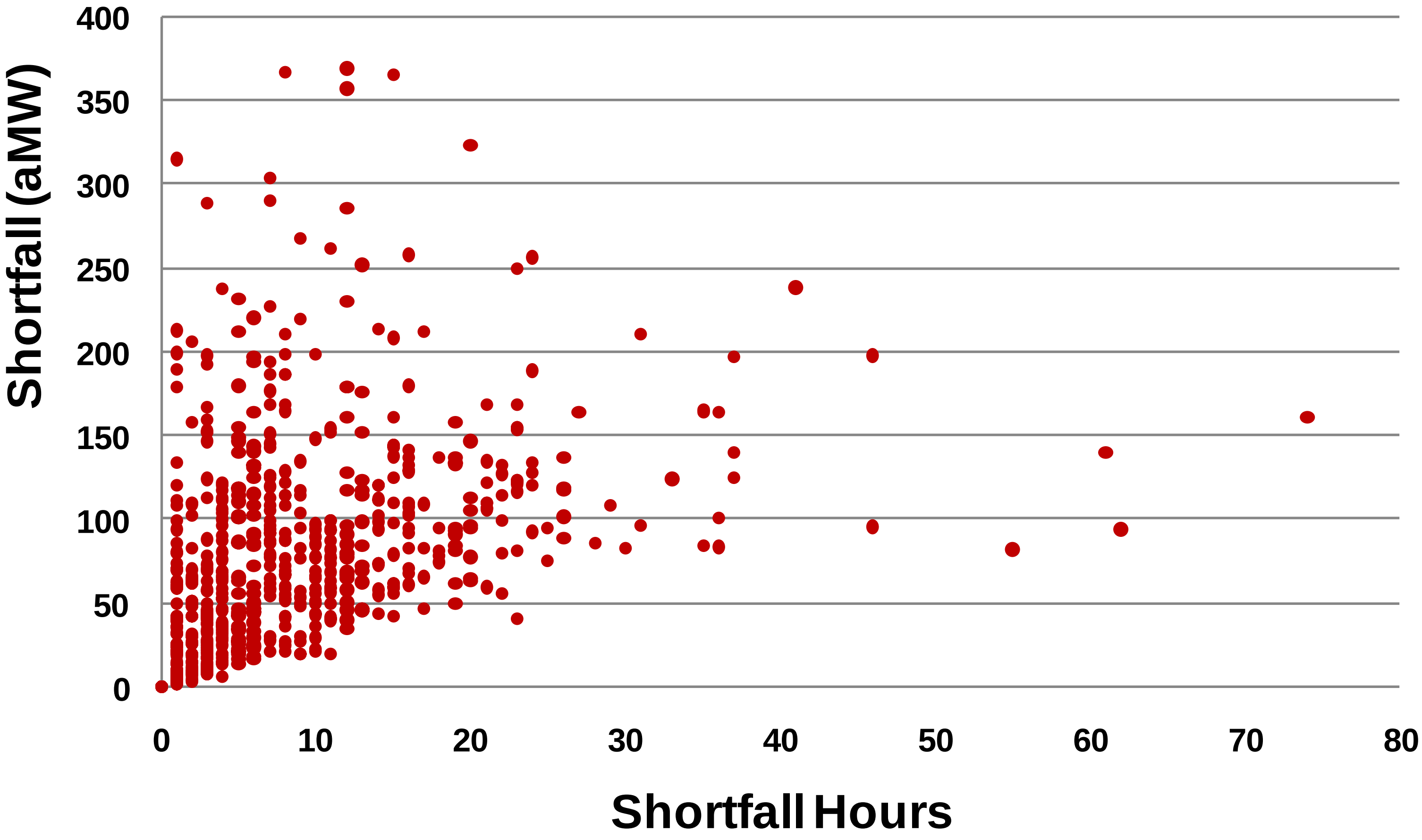
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Peak Load	-1,786	-1,639	-1,518	-1,362	-1,238	-1,369	-1,665	-1,636	-1,332	-1,418	-1,651	-1,814
Contracts Sales	-6	-6	-6	-6	-7	-7	-8	-8	-7	-6	-6	-6
Total Peak Obligation	**-1,793**	**-1,646**	**-1,524**	**-1,368**	**-1,245**	**-1,376**	**-1,673**	**-1,644**	**-1,339**	**-1,424**	**-1,657**	**-1,820**
Contract Purchases	92	94	96	96	97	95	88	85	85	87	89	92
Hydro	881	823	749	1,052	1,050	1,045	883	840	763	857	878	890
Thermal	884	881	874	755	450	499	775	780	797	865	873	882
Wind	0	0	0	0	0	0	0	0	0	0	0	0
Peaking	242	236	230	222	182	180	172	176	114	92	232	240
Total Resouarces	**2,100**	**2,034**	**1,950**	**2,125**	**1,778**	**1,818**	**1,919**	**1,881**	**1,759**	**1,901**	**2,072**	**2,105**
Position	**307**	**389**	**426**	**757**	**534**	**443**	**246**	**237**	**421**	**477**	**415**	**284**
Net Reserve Requirement	-40	-61	-153	-140	-130	-139	-30	-31	0	0	-21	-41
Position Net Reserves	**267**	**328**	**273**	**617**	**404**	**304**	**216**	**206**	**421**	**477**	**394**	**243**
Implied Planning Margin	**15%**	**20%**	**18%**	**45%**	**32%**	**22%**	**13%**	**13%**	**31%**	**33%**	**24%**	**13%**

2020 Probabilistic Capacity Requirements

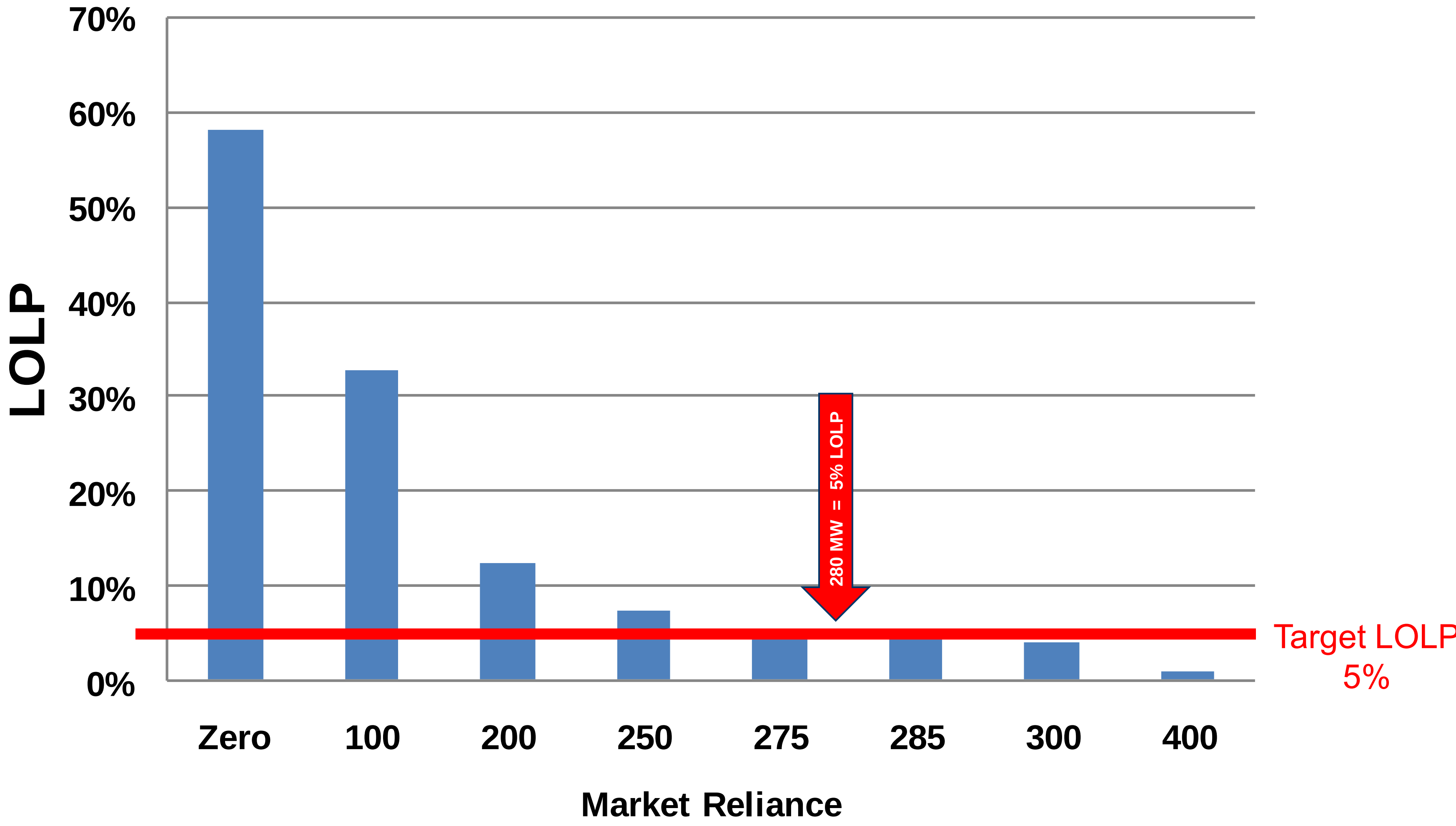
(No Additions or Market Availability)



2020 Measure of Hours and Shortfall aMW



Market Reliance Affect to LOLP in 2020



2020 LOLP Monthly Results

Market Reliance	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Zero	10%	3%	1%	0%	0%	0%	27%	23%	0%	0%	2%	10%	58.2%
100	5%	1%	0%	0%	0%	0%	14%	12%	0%	0%	1%	5%	32.9%
200	2%	0%	0%	0%	0%	0%	6%	4%	0%	0%	0%	1%	12.4%
250	1%	0%	0%	0%	0%	0%	3%	2%	0%	0%	0%	1%	7.3%
275	1%	0%	0%	0%	0%	0%	2%	2%	0%	0%	0%	1%	5.4%
285	0%	0%	0%	0%	0%	0%	2%	2%	0%	0%	0%	0%	4.6%
300	1%	0%	0%	0%	0%	0%	2%	1%	0%	0%	0%	1%	4.1%
400	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	1.0%

2020 LOLH Monthly Results

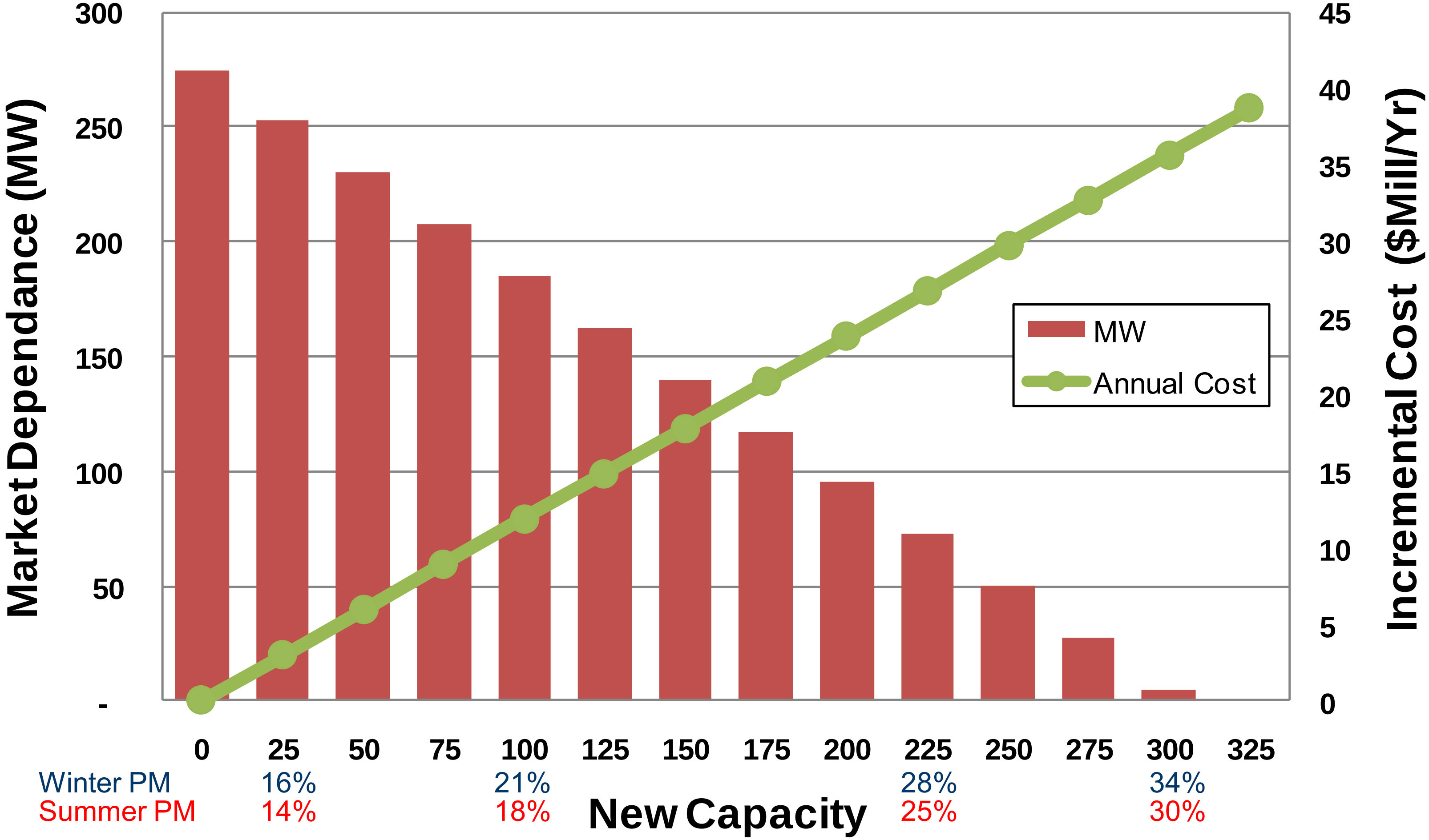
Market Reliance	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Zero	0.86	0.22	0.07	-	-	-	1.94	1.28	0.03	0.01	0.32	0.78	5.50
100	0.46	0.06	0.00	-	-	-	0.82	0.51	0.04	0.00	0.10	0.26	2.26
200	0.08	0.02	0.00	-	-	-	0.28	0.15	0.00	-	0.01	0.08	0.62
250	0.04	0.02	-	-	-	-	0.16	0.09	-	-	0.02	0.02	0.35
275	0.03	0.01	-	-	-	-	0.12	0.06	-	-	0.02	0.01	0.24
285	0.02	0.01	-	-	-	-	0.10	0.06	-	-	0.01	0.01	0.21
300	0.04	-	0.00	-	-	-	0.10	0.03	-	-	0.01	0.03	0.20

0.24 on an annual basis is considered a "reliable" system

Unit Size Affect to LOLP in 2020

Measure	Definition	Goal	300 MW Market	3- 100 MW Units	2- 150 MW Units	1- 300 MW Unit
LOLP	Probability	5%	4.1%	7.5%	8.4%	10.8%
LOLH	Hrs/Yr	0.24	0.20	0.30	0.38	0.45
EUE	aMW	N/A	16	22	30	37

Resource allocation to get to 5% LOLP goal



Energy Storage Technologies

John Lyons, Senior Resource Policy Analyst

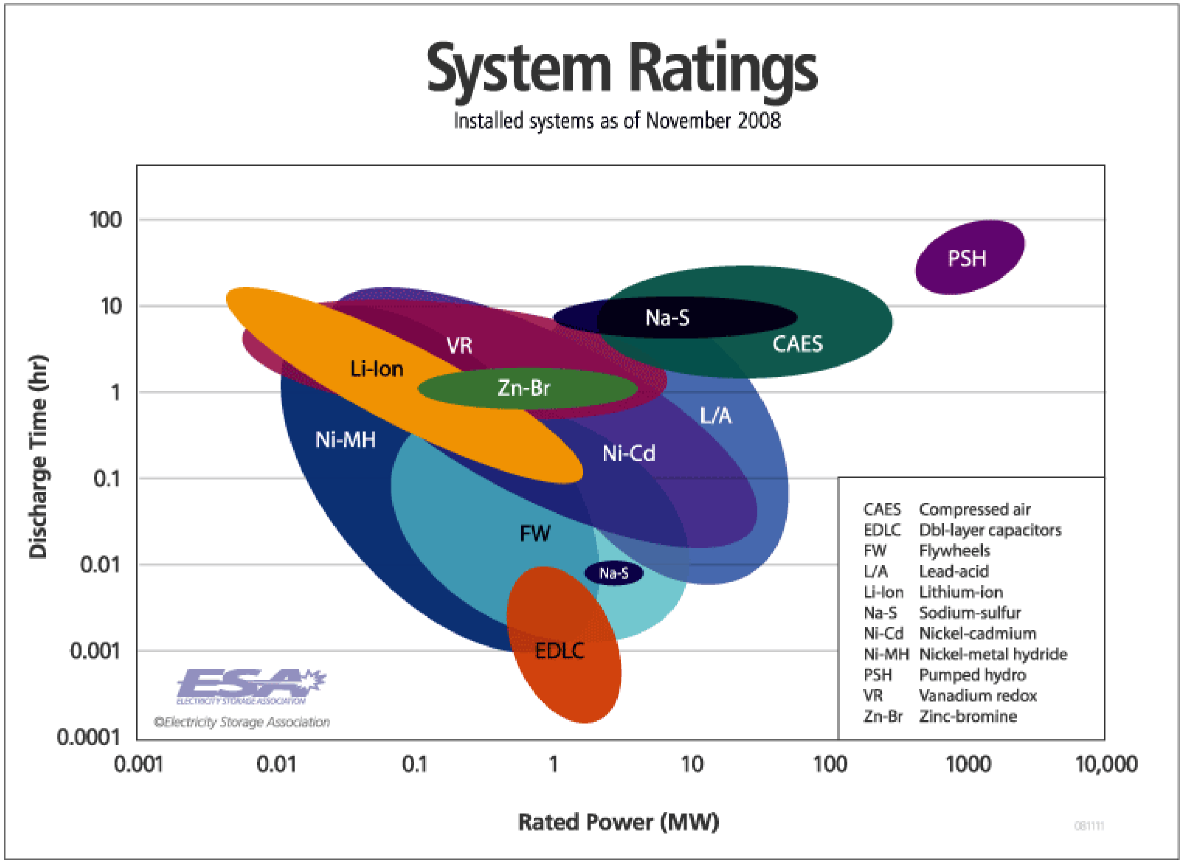
Third Technical Advisory Committee Meeting

2013 Electric Integrated Resource Plan

November 7, 2012

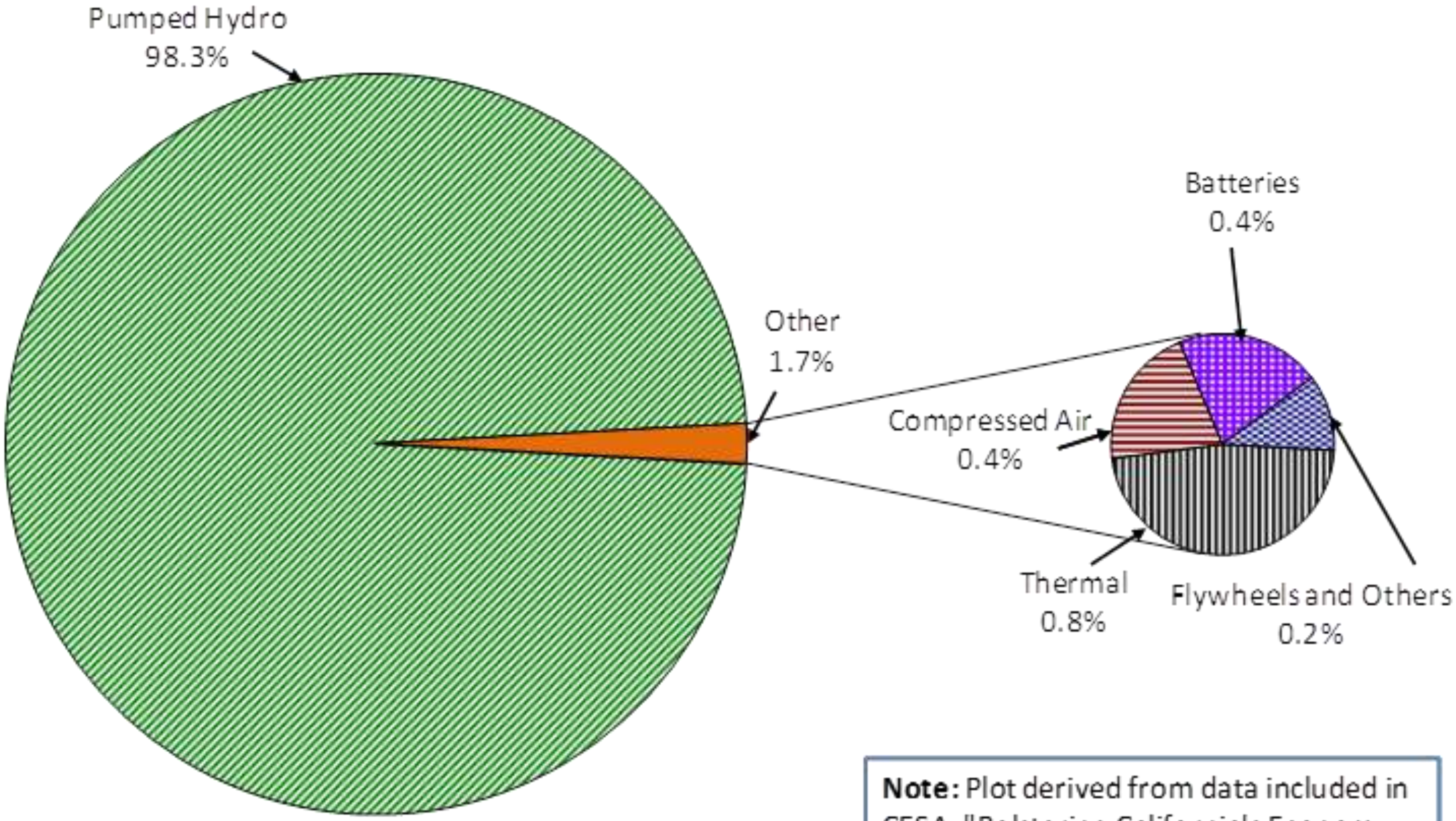
Types of Energy Storage

- Pumped Hydro
- Batteries
- Flywheel
- Compressed Air



http://www.electricitystorage.org/images/uploads/static_content/technology/technology_resources/ratings_large.gif

Current Worldwide Installed Energy Storage Capacity



Note: Plot derived from data included in CESA, "Bolstering California's Economy with AB 2514", Page 3.

Energy Storage Applications

Electric Supply

- Electric energy time-shift
- Electric supply capacity

Ancillary Services

- Load following
- Area regulation
- Electric supply reserve capacity
- Voltage support

Grid System

- Transmission support
- Transmission congestion relief
- Transmission and distribution upgrade deferral
- Substation on-site power

Eyer, J. and Corey, G. (2010) Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide. Sandia National Laboratory.

Energy Storage Applications

End User/Utility Customer

- Time-of-use energy cost management
- Demand charge management
- Electric service reliability
- Electric service power quality

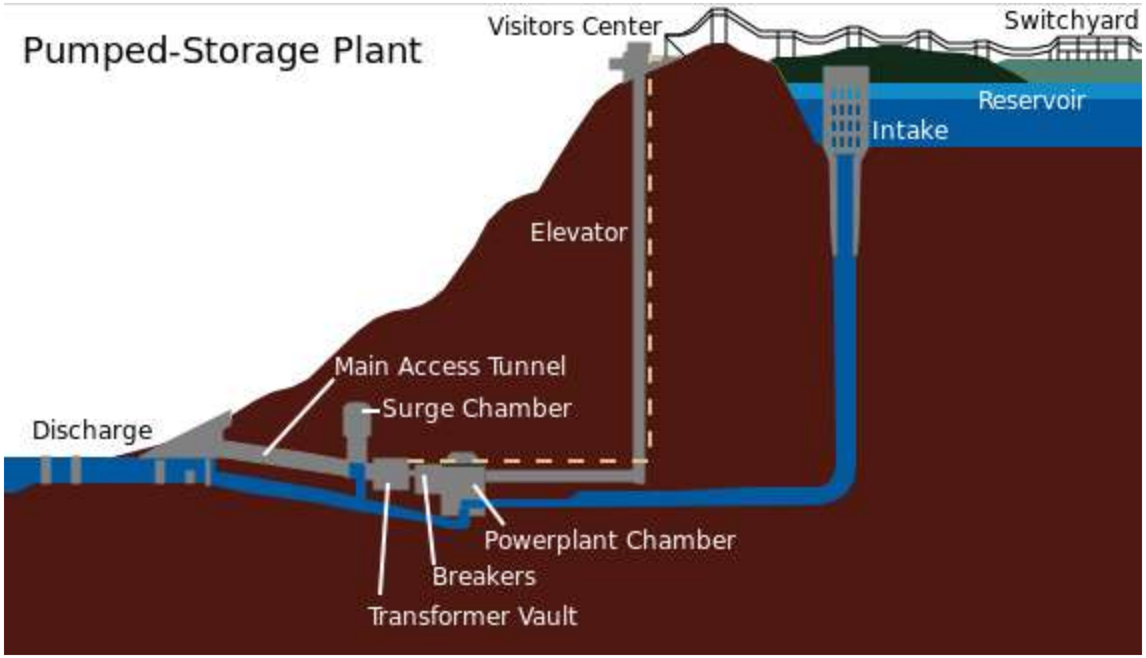
Renewables Integration

- Renewables energy time-shift
- Renewables capacity firming
- Wind generation grid integration

Eyer, J. and Corey, G. (2010) Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide. Sandia National Laboratory.

Pumped Hydro Storage

- Works by pumping water between two reservoirs with different elevations during off peak periods
- Largest share of current energy storage in the US – over 20 GW capacity with 31 GW proposed
- Tend to be long lead time resources with unique licensing and siting issues
- Avista has pumped storage potential at Long Lake and Noxon Rapids



http://en.wikipedia.org/wiki/File:Raccoon_Mountain_Pumped-Storage_Plant.svg

Batteries

- Charge off-peak, or during periods of excess variable generation, for later use
- Several different types available:
    - Litium-ion
    - Sodium-sulfur
    - Redox flow
    - Zinc bromine

Flywheels

- Converts electric energy into rotational energy, which can be called on quickly to convert back to electricity
- Uses: grid energy storage, short-term storage of excess wind generation and providing regulation services
  - Stephentown, NY – 20 MW (5 MWh over 15 minutes)

Compressed Air

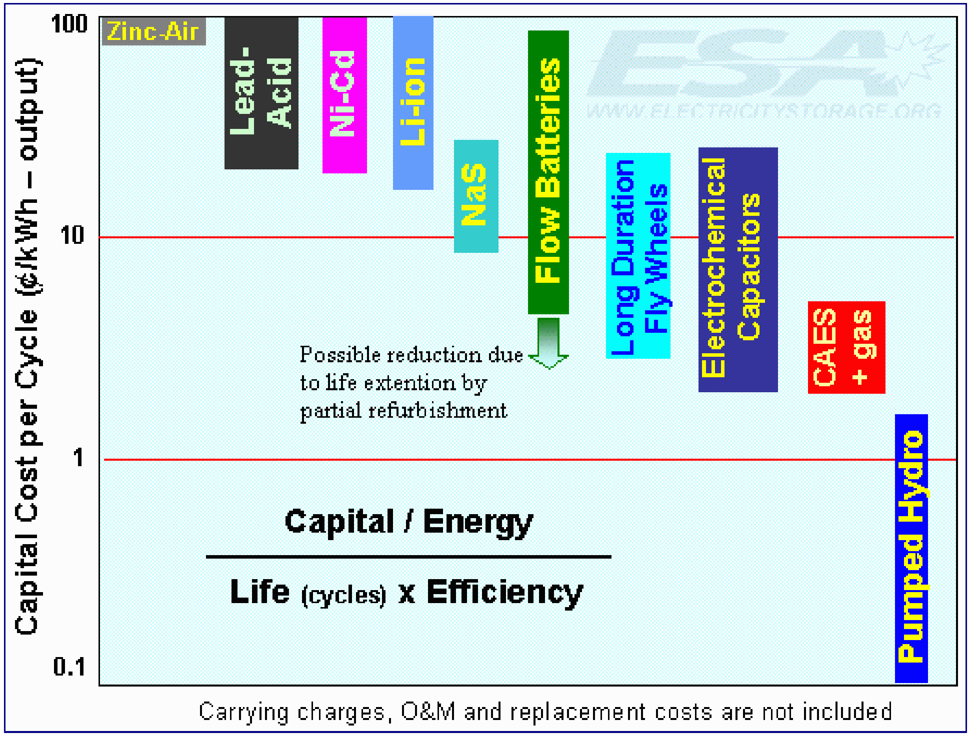
- Technology based on compressing air and pumping it into geological storage in off-peak periods for use in subsequent periods.
- Ongoing projects
  - 1978 – 290 MW Huntorf in Germany (salt dome)
  - 1991 – 110 MW McIntosh, Alabama (salt cavern)
- Scheduled projects
  - 2016 – 300 MW (10 hours) PG&E in Kern County, California
  - 2013 – 200 MW ADELE facility in Germany
  - 2016 – 317 MW Bethel Energy Center in Anderson County, Texas

Energy Storage Federal and State Policies

- No real federal policies requiring the development of energy storage
- Many federal proposals for tax benefits and proposed and actual funding of pilot projects
- Many proposals at the state level, but few implemented

Economic Issues

- High cost of installation
- Low differentials between on and off peak prices
- 2013 IRP = $4,000/kW for 5 MW in 2015



http://www.electricitystorage.org/images/uploads/static_content/technology/technology_resources/cycle_large.gif

Avista's 2013 Electric Integrated Resource Plan

Technical Advisory Committee Meeting No. 4 Agenda

Wednesday, February 6, 2013
Conference Room 428

Topic	Time	Staff
1. Introduction	8:30	
2. Natural Gas Price Forecast	8:35	Irvine
3. Electric Price Forecast	9:45	Gall
4. Break	10:45	
5. Transmission Planning	11:00	Maguire
6. Lunch	12:00	
7. Resource Needs Assessment	1:00	Kalich
8. Break	2:00	
9. Market & Portfolio Scenario Development	2:15	Lyons
10. Adjourn	3:00	

Avista Electric IRP
Natural Gas Price Forecast

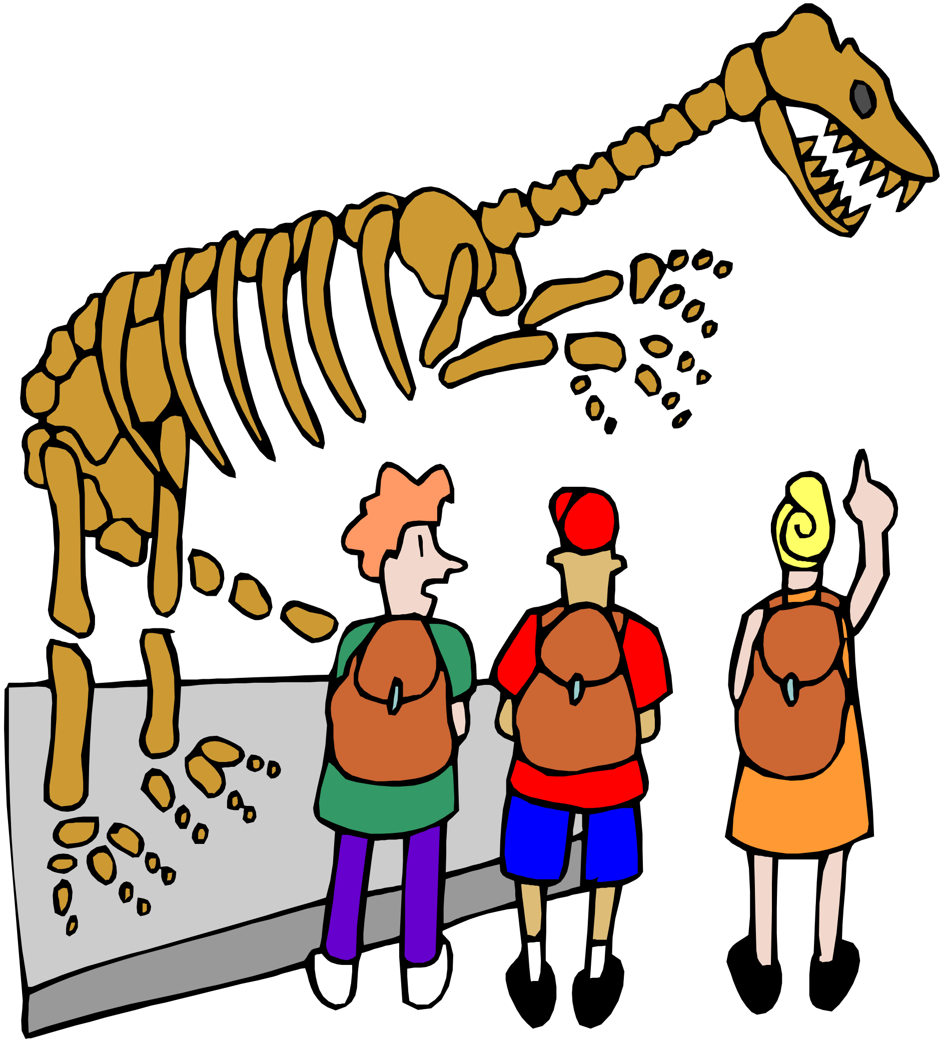
Technical Advisory Committee Meeting

February 6, 2013

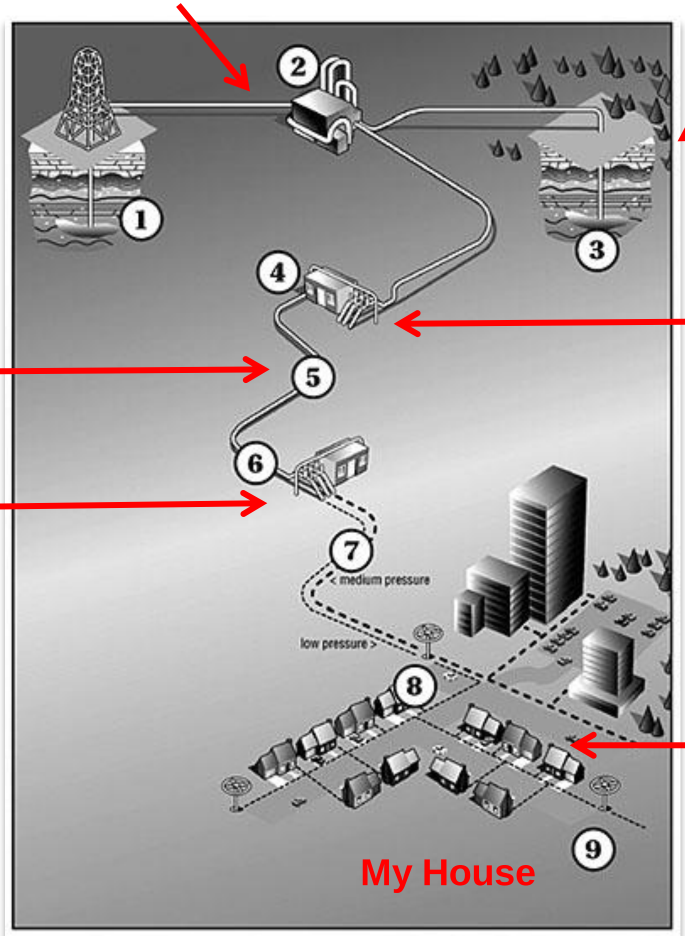
Agenda

- Natural Gas 101
- Pacific Northwest Supply and Infrastructure
- Natural Gas Price Fundamentals
  - Short Term
  - Long Term
- Fracking Facts and the Future of Shale

A Brief History ...



The Natural Gas System



Gathering System

Storage

Producer Supply

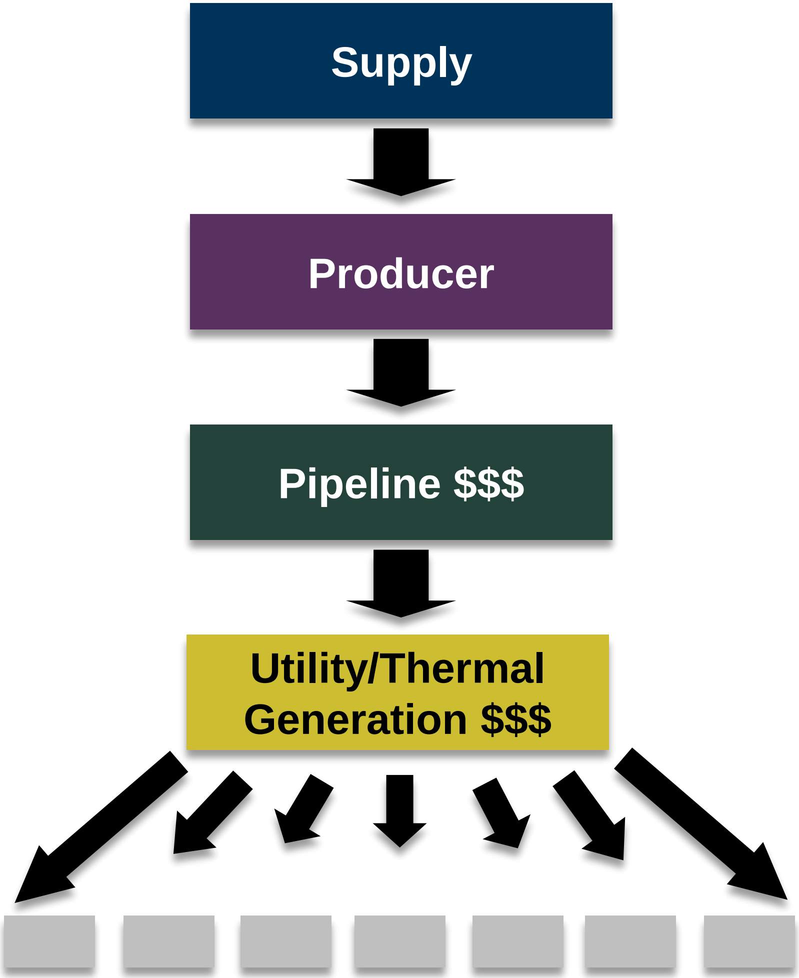
Receipt Point

Pipeline

Delivery Point/ Gate Station

Local Distribution System

Pipelines Offered a Bundled Service – “One Call, That’s All™”



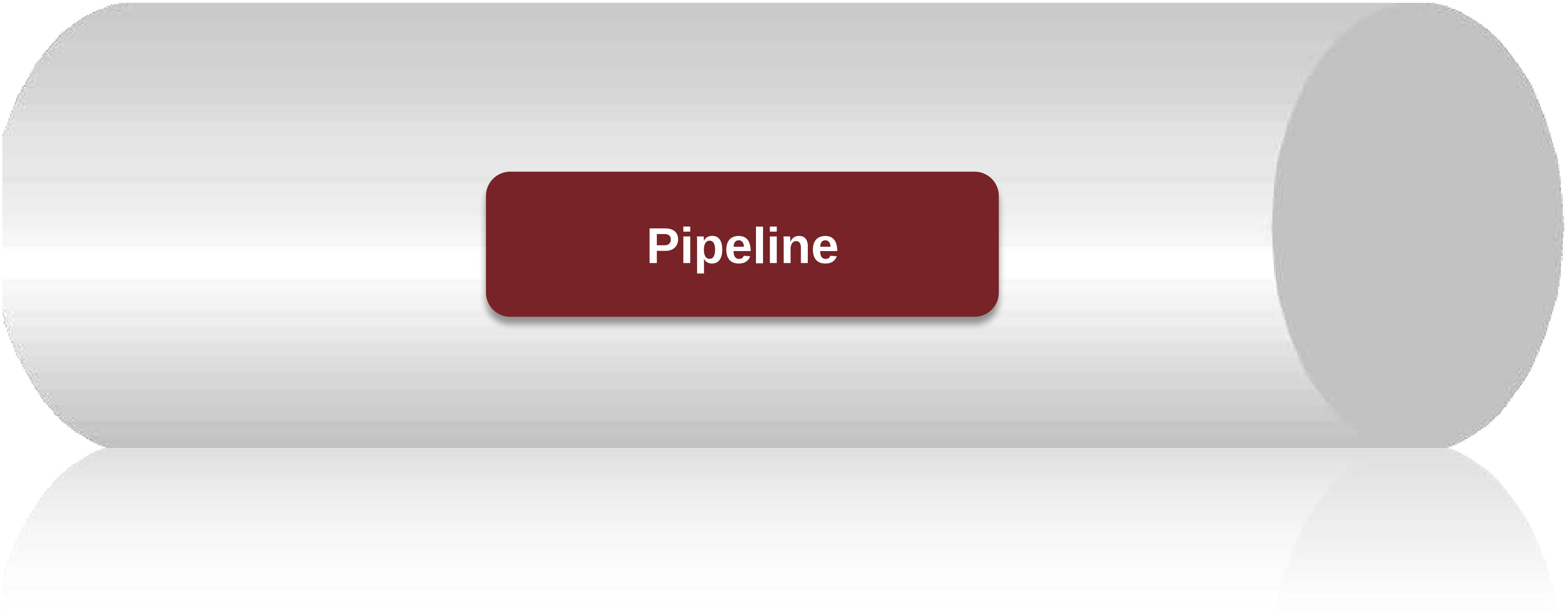
Supply

Producer

Pipeline $$$

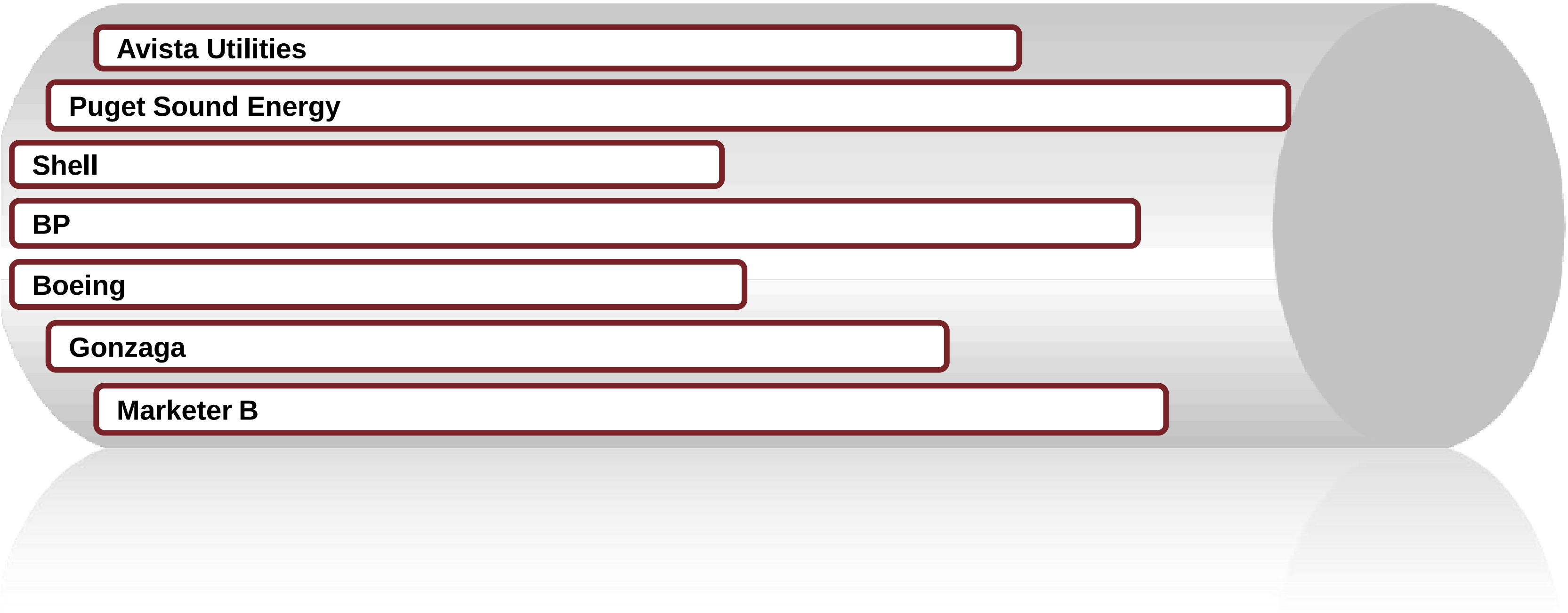
Utility/Thermal Generation $$$

FERC ORDER 436
Pushed the Pipelines Out of the Supply Business



Pipeline

Example of Contracting on a Pipeline



Avista Utilities

Puget Sound Energy

Shell

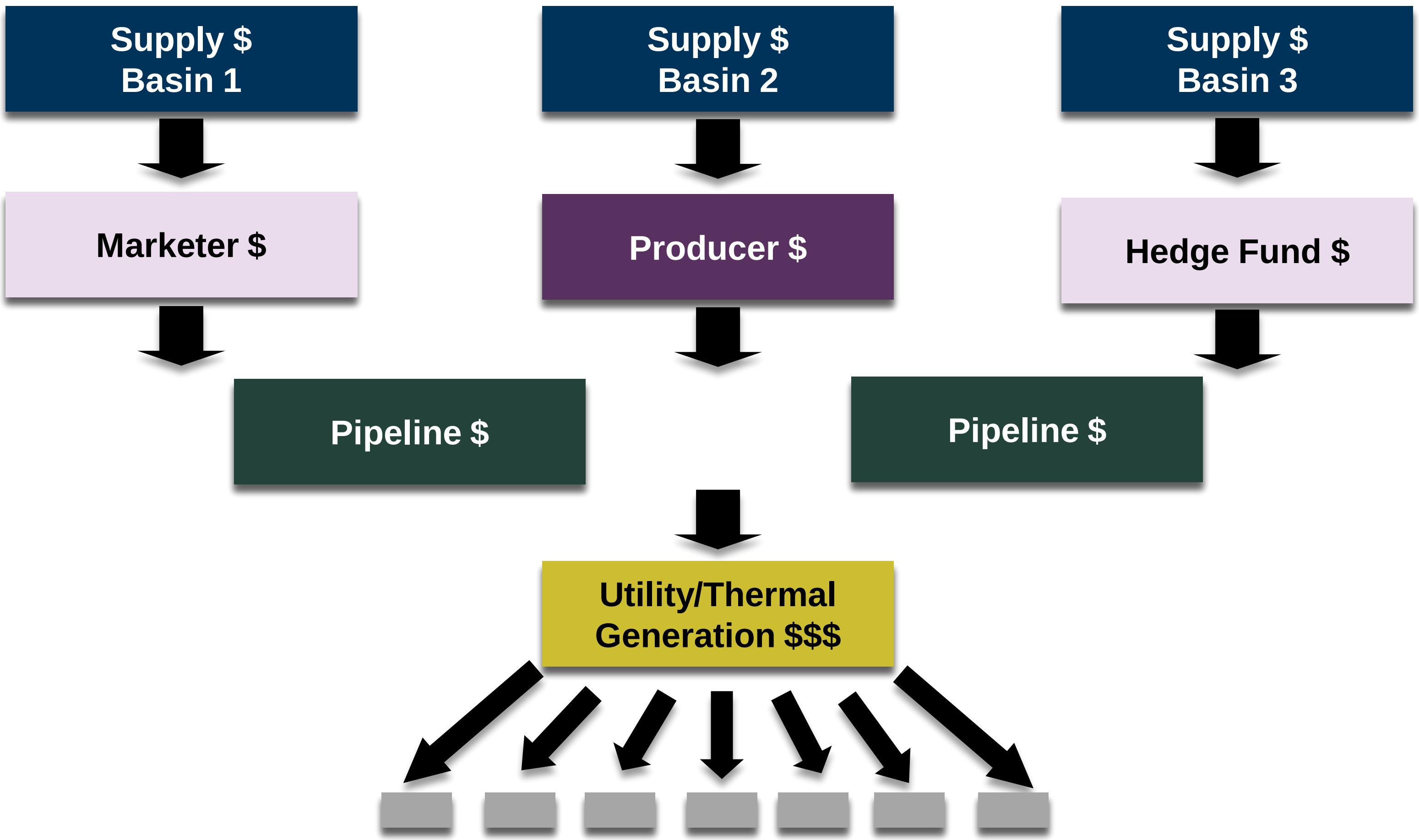
BP

Boeing

Gonzaga

Marketer B

Now Services are Unbundled – You Control the Price for Each Component



Supply $
Basin 1

Supply $
Basin 2

Supply $
Basin 3

Marketer $

Producer $

Hedge Fund $

Pipeline $

Pipeline $

Utility/Thermal Generation $$$

Natural Gas Infrastructure in the Pacific Northwest

Pacific Northwest Supply and Infrastructure

SUPPLY

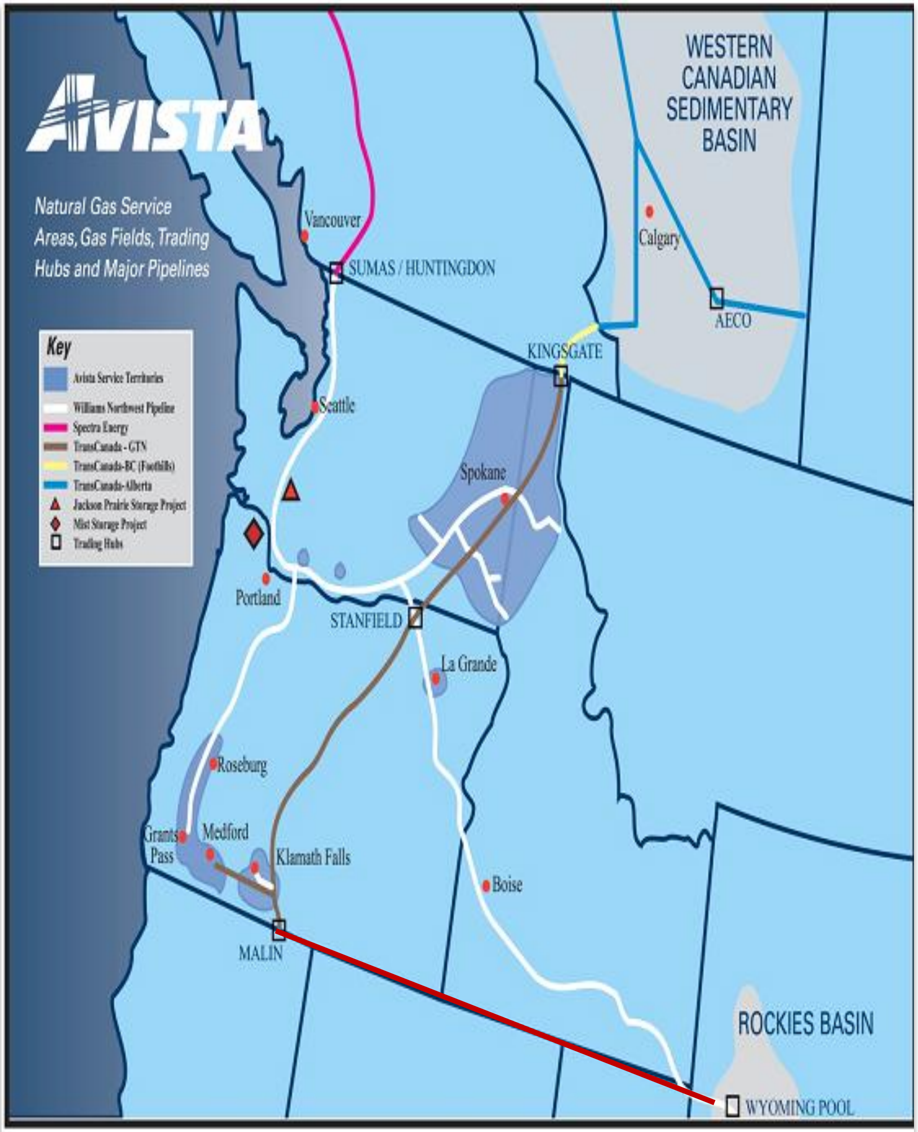
- **AECO**
  Canadian gas coming out of Alberta, Canada
- **Rockies**
  U.S. domestic gas coming from Wyoming and Colorado
- **Sumas**
  Canadian gas coming out of British Columbia, Canada
- **Malin**
  South central at the Oregon and California border
- **Stanfield**
  Intersection of two major pipelines in North Central Oregon

PIPELINES

- **Williams Northwest Pipeline**
- **TransCanada Gas Transmission Northwest**
- **TransCanada Foothills**
- **TransCanada Alberta**
- **Spectra Energy**
- **Ruby Pipeline**

STORAGE

- **Jackson Prairie Storage**
- **Mist Storage**



Types of Pipeline Contracts

Firm Transport

- Contractual rights to:
  - Receive
  - Transport
  - Deliver
- From point A to point B

Interruptible Transport

- Contractual rights to:
- Receive
- Transport
- Deliver
- From point A to Point B *AFTER FIRM TRANSPORT HAS BEEN SCHEDULED*

Seasonal Transport

- Firm service available for limited periods (Nov-Mar) or for a limited amount (TF2 on NWP)

Alternate Firm Transport

- The use of firm transport outside of the primary path
- Priority rights below firm
- Priority rights above interruptible

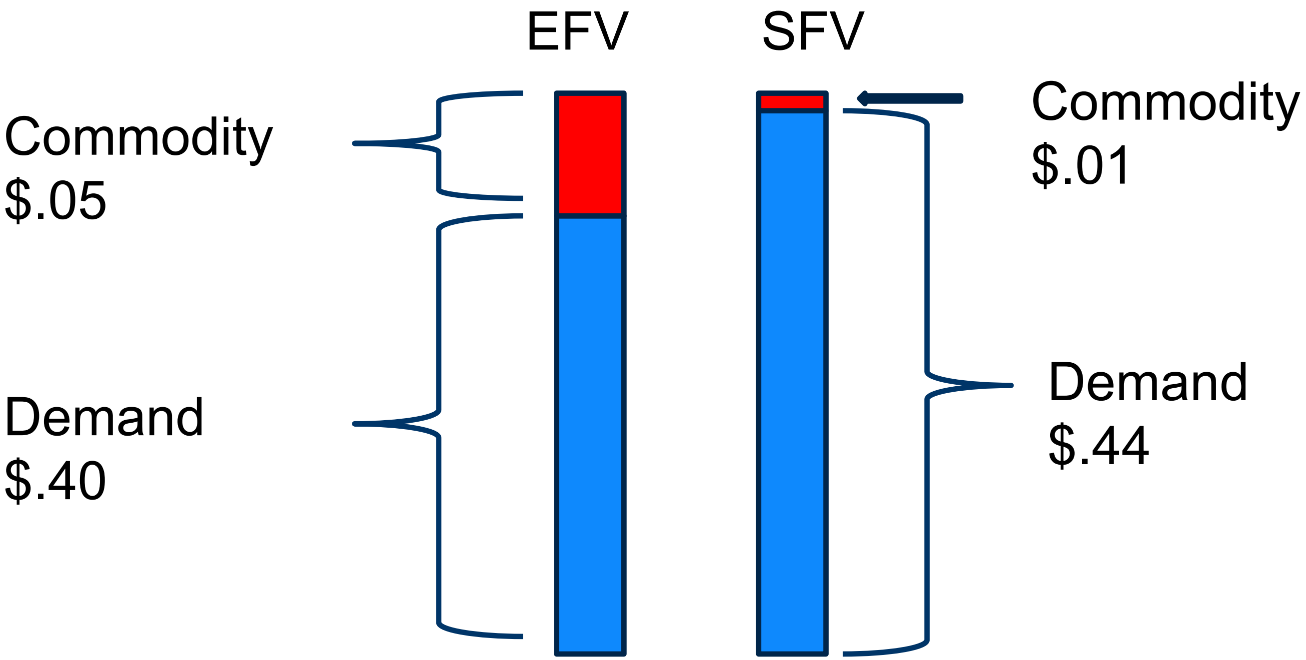
Pipeline Rate Structure

Straight Fixed Variable (SFV)	• Pipeline charges a higher demand charge and a lower variable or commodity charge
Enhanced fixed variable	• Pipeline charges a lower demand charge and a higher variable or commodity charge
Postage Stamp Rate	• Pay the same demand and variable costs regardless of how far the gas is transported
Mileage Based	• Pay a variable and demand charge based on how far the gas is transported

Straight Fixed Variable Costs vs. Enhanced Fixed Variable

🟦 Demand Charge: Paid whether transport is used or not

🟥 Commodity or variable charge: Only paid when gas is actually transported



EFV

SFV

Commodity
$.05

Demand
$.40

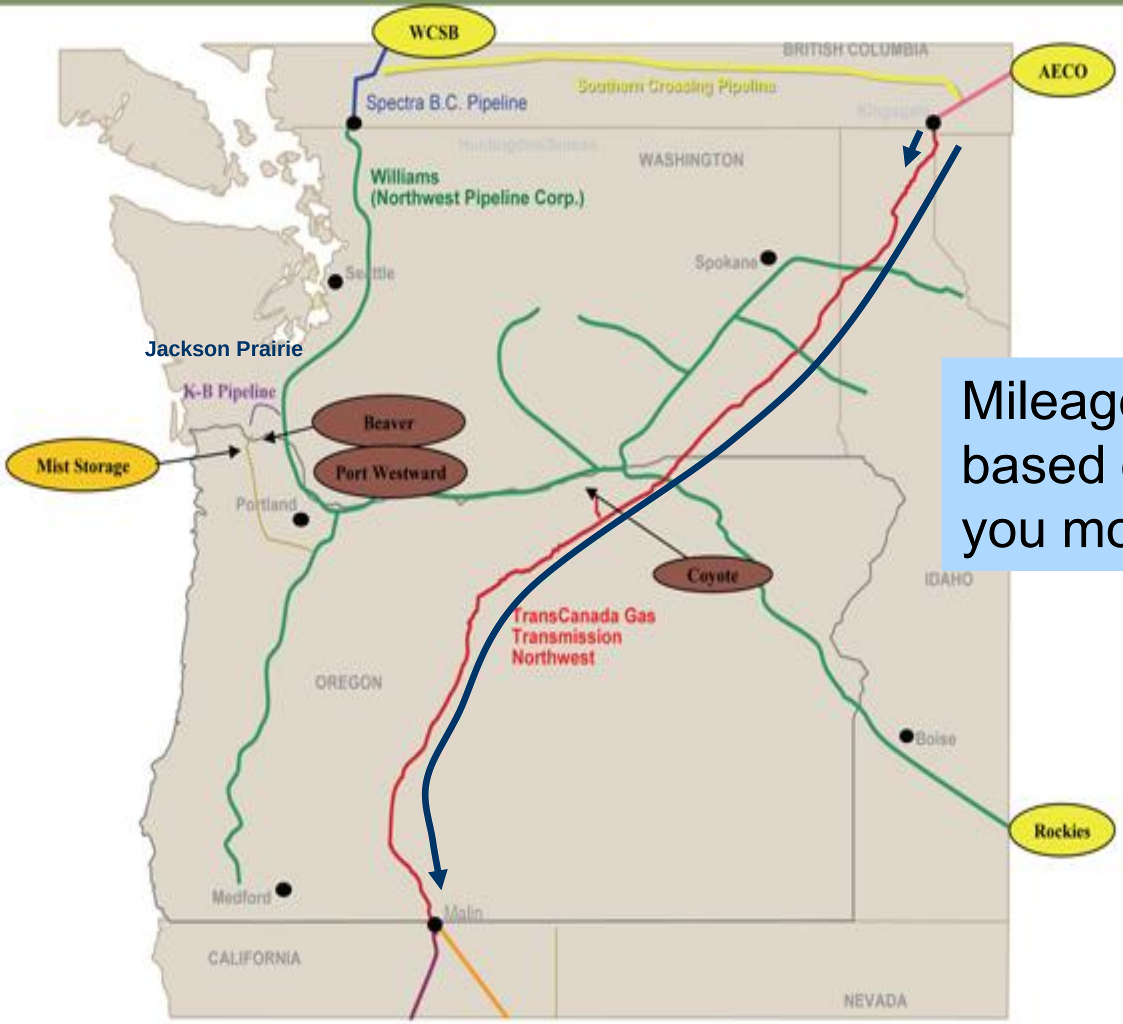
Commodity
$.01

Demand
$.44

TransCanada Gas Transmission Northwest (GTN)

- Mileage Based
- Point to Point
- Alternate firm allowed in path
- Mostly – demand based with a couple Nomination based points
  - Demand based refers to gas that will be taken off the pipeline based on the demand behind the delivery point.
  - Nomination based refers to the pipeline only delivering what was nominated (requested).
- Usually requires upstream transportation

Natural Gas Transportation

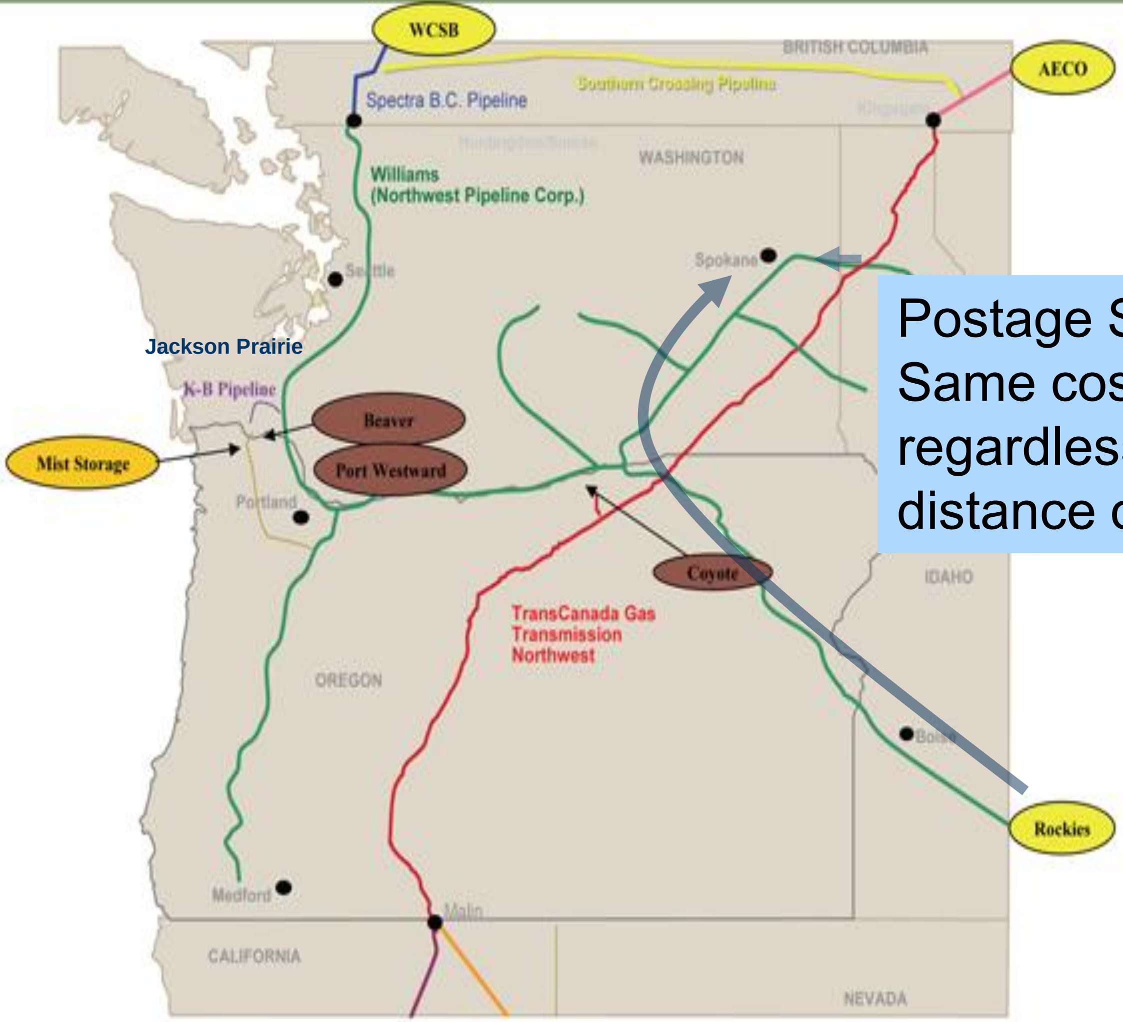


Mileage Base: Pay based on how far you move the gas

Williams Northwest Pipeline (NWP)

- Postage Stamp Based
- Point to Point
    - Delivery to ‘zones’ allowed
- Alternate firm allowed in and out of path
- Demand based delivery
    - Demand based refers to gas that will be taken off the pipeline based on the demand behind the delivery point.
    - Nomination based refers to the pipeline only delivering what was nominated (requested).
- May or may not require upstream transportation
- Enhanced fixed variable structure

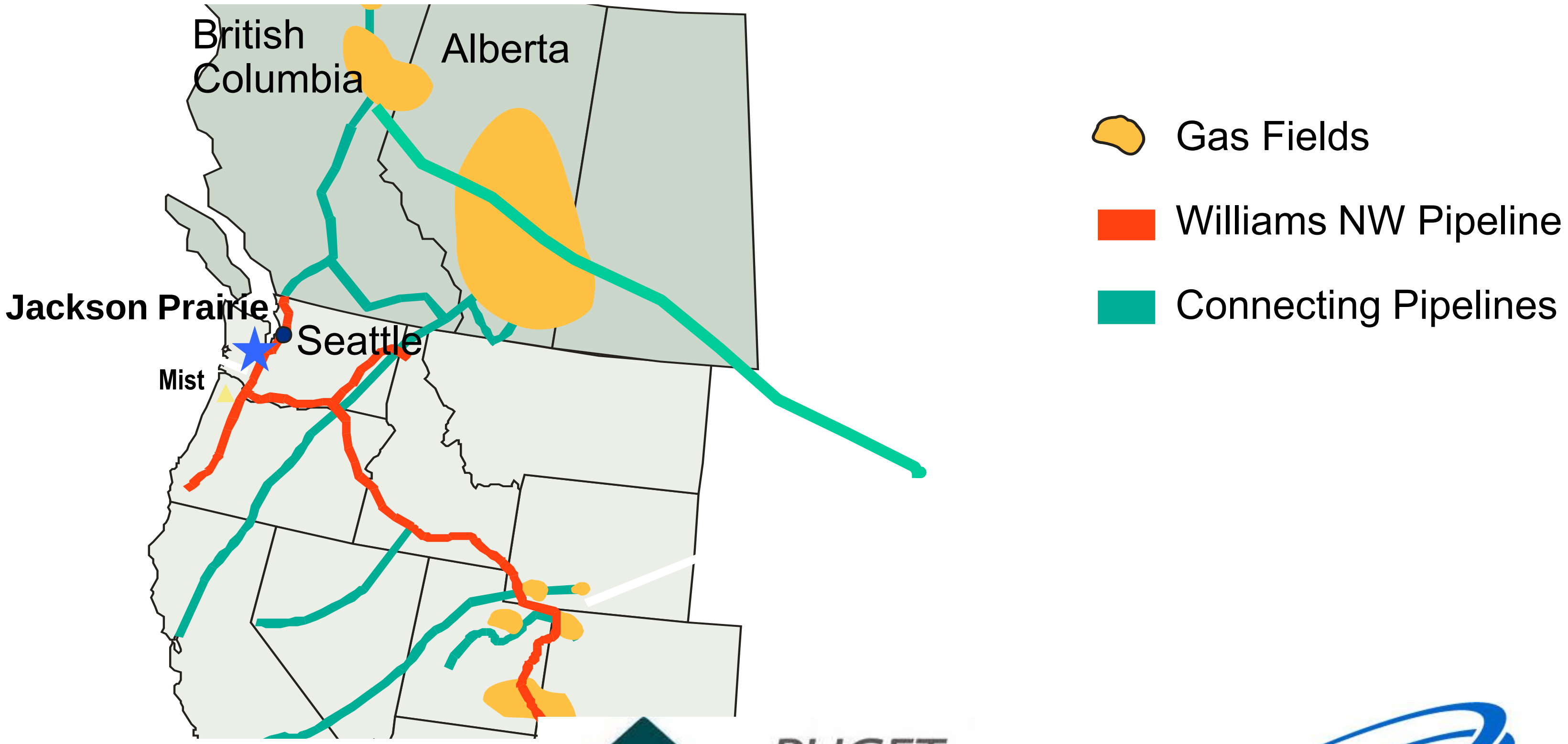
Natural Gas Transportation



Postage Stamp: Same costs regardless of distance or locations

Jackson Prairie Natural Gas Storage

Chehalis, Washington



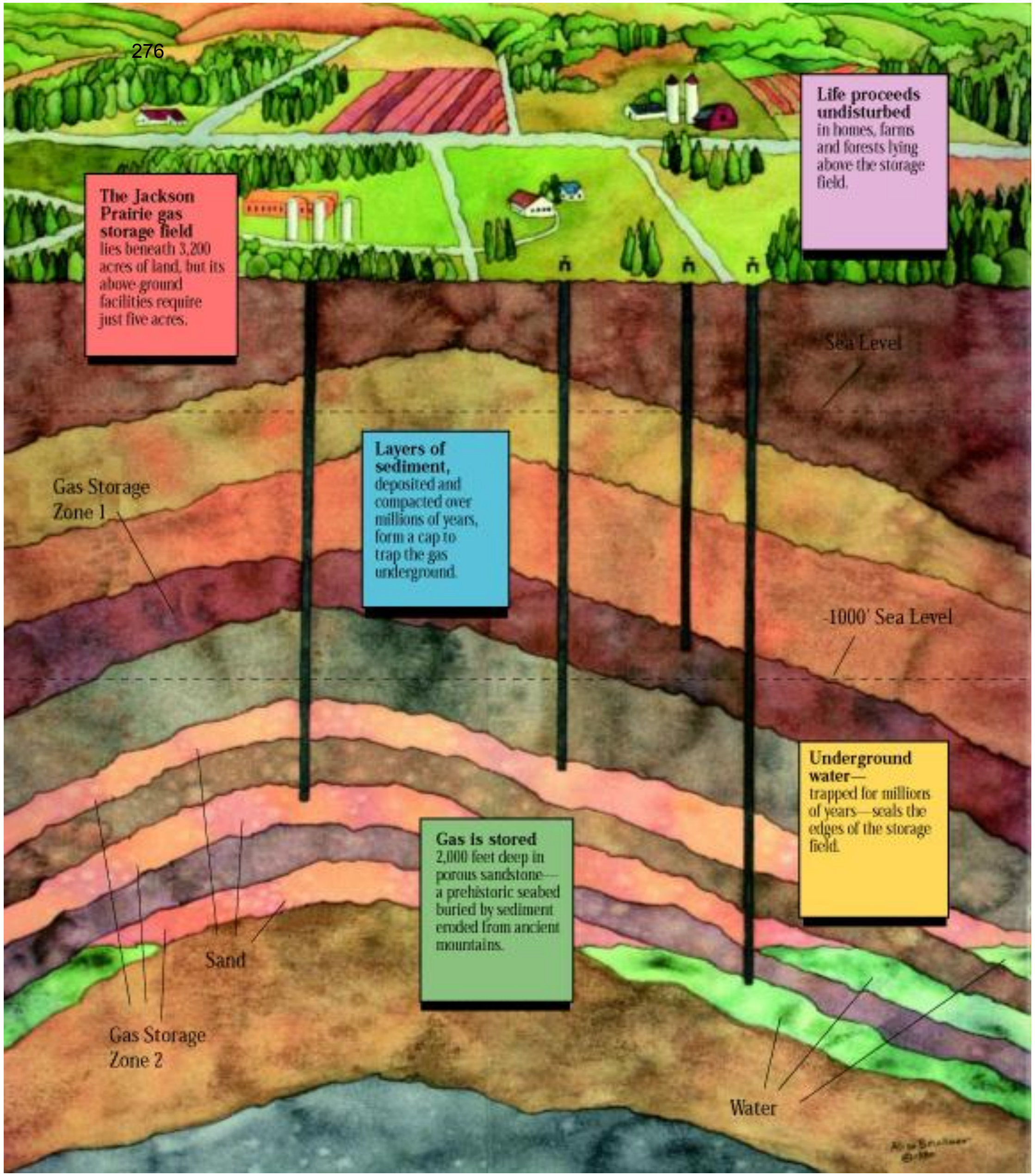
AVISTA®

PSE PUGET SOUND ENERGY

Williams®

The Facility

- Jackson Prairie is a series of deep, underground reservoirs – basically thick, porous sandstone deposits.
- The sand layers lie approximately 1,000 to 3,000 feet below the ground surface.
- Large compressors and pipelines are employed to both inject and withdraw natural gas at 54 wells spread across the 3,200 acre facility.



The Jackson Prairie gas storage field lies beneath 3,200 acres of land, but its above-ground facilities require just five acres.

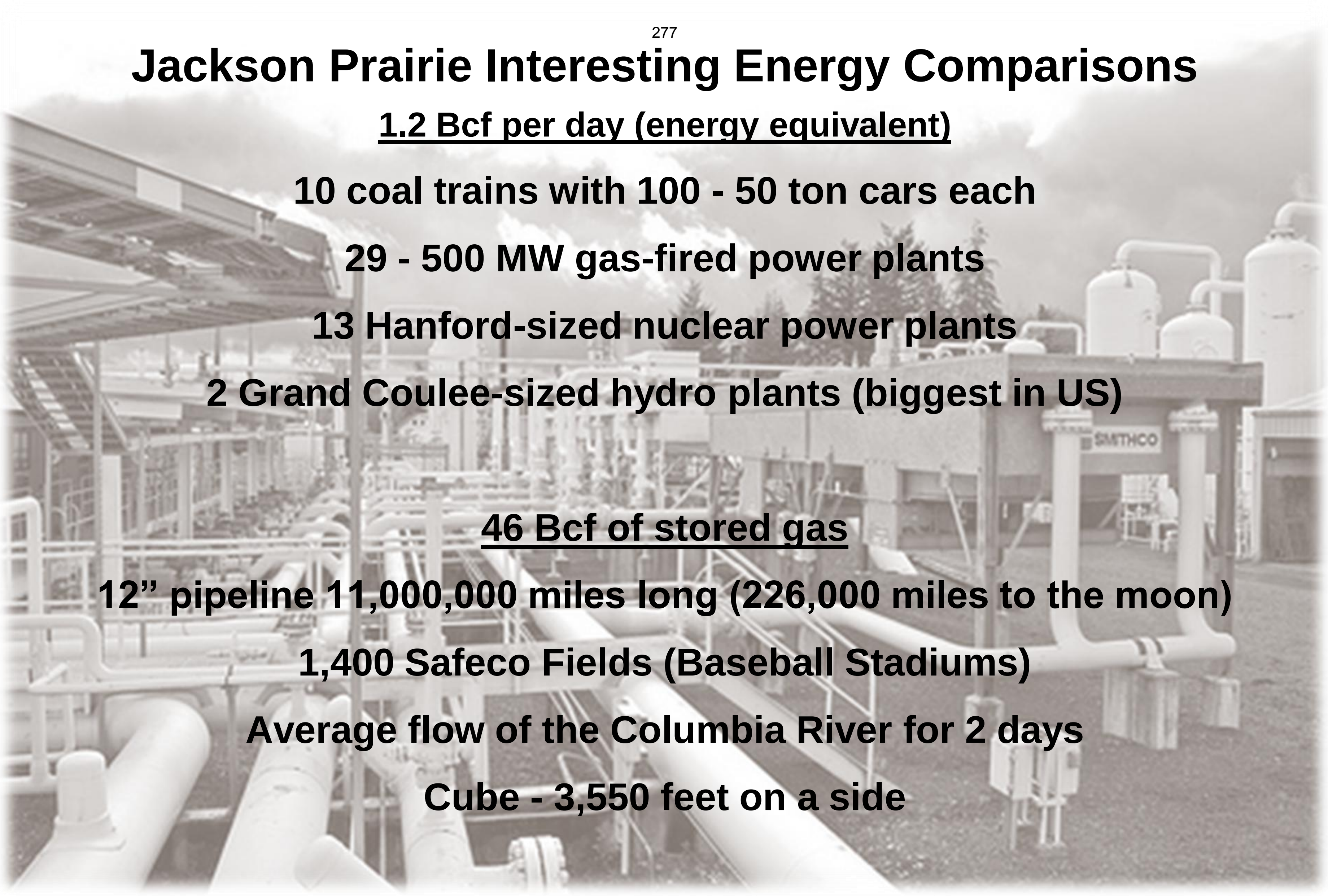
Life proceeds undisturbed in homes, farms and forests lying above the storage field.

Layers of sediment, deposited and compacted over millions of years, form a cap to trap the gas underground.

Gas is stored 2,000 feet deep in porous sandstone—a prehistoric seabed buried by sediment eroded from ancient mountains.

Underground water—trapped for millions of years—seals the edges of the storage field.

Jackson Prairie Interesting Energy Comparisons



1.2 Bcf per day (energy equivalent)

10 coal trains with 100 - 50 ton cars each

29 - 500 MW gas-fired power plants

13 Hanford-sized nuclear power plants

2 Grand Coulee-sized hydro plants (biggest in US)

46 Bcf of stored gas

12” pipeline 11,000,000 miles long (226,000 miles to the moon)

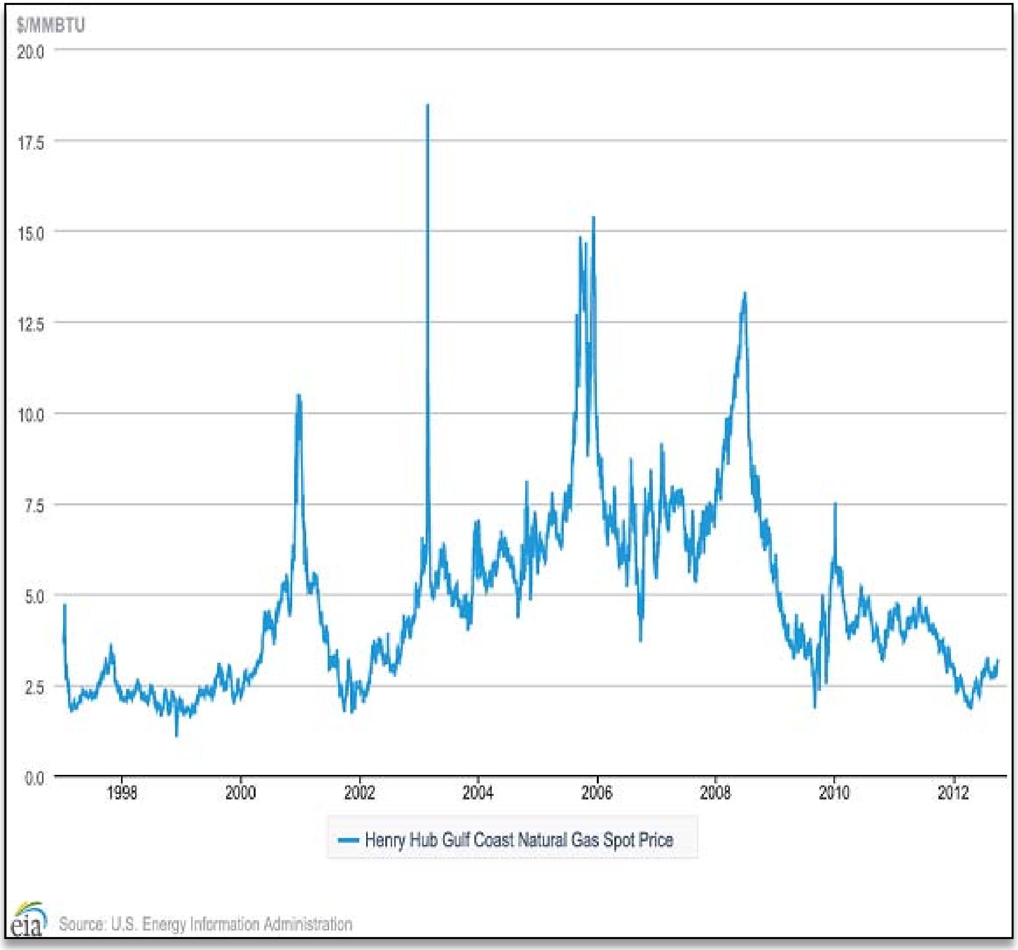
1,400 Safeco Fields (Baseball Stadiums)

Average flow of the Columbia River for 2 days

Cube - 3,550 feet on a side

Natural Gas Pricing Fundamentals

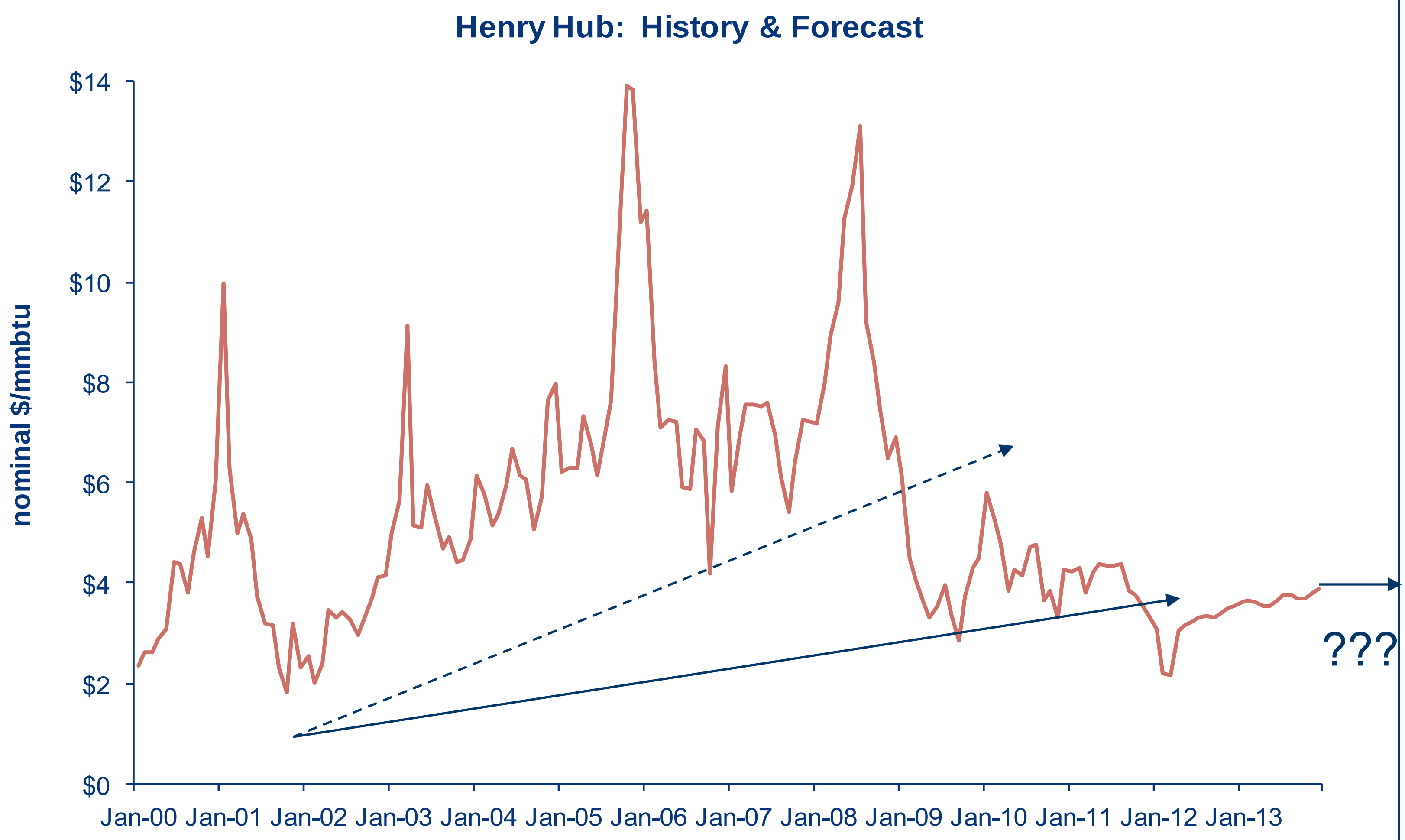
What Drives the Natural Gas Market?
Natural Gas Spot Prices (Henry Hub)



Source: U.S. Energy Information Administration

- **Supply**
  - Type: Conventional vs. Non-conventional
  - Location
  - Cost
- **Demand**
  - Residential/Commercial/Industrial
  - Power Generation
  - Natural Gas Vehicles
- **Legislation**
  - Environmental
- **Energy Correlations**
  - Oil vs. Gas
  - Coal vs. Gas
  - Natural Gas Liquids
- **Weather**
- **Storage**

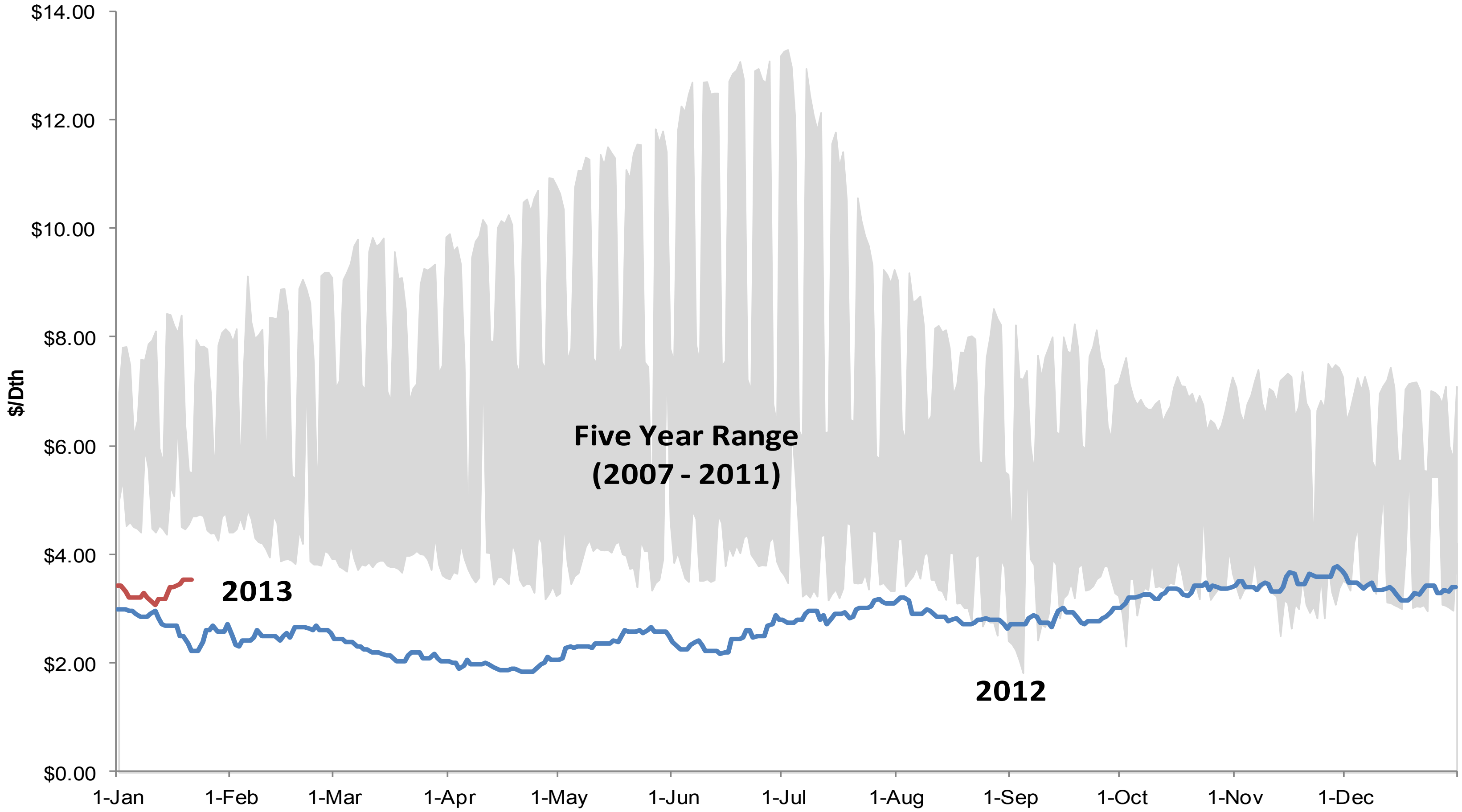
The Evolving Trend in Henry Hub Pricing



Source: Wood Mackenzie, ICE

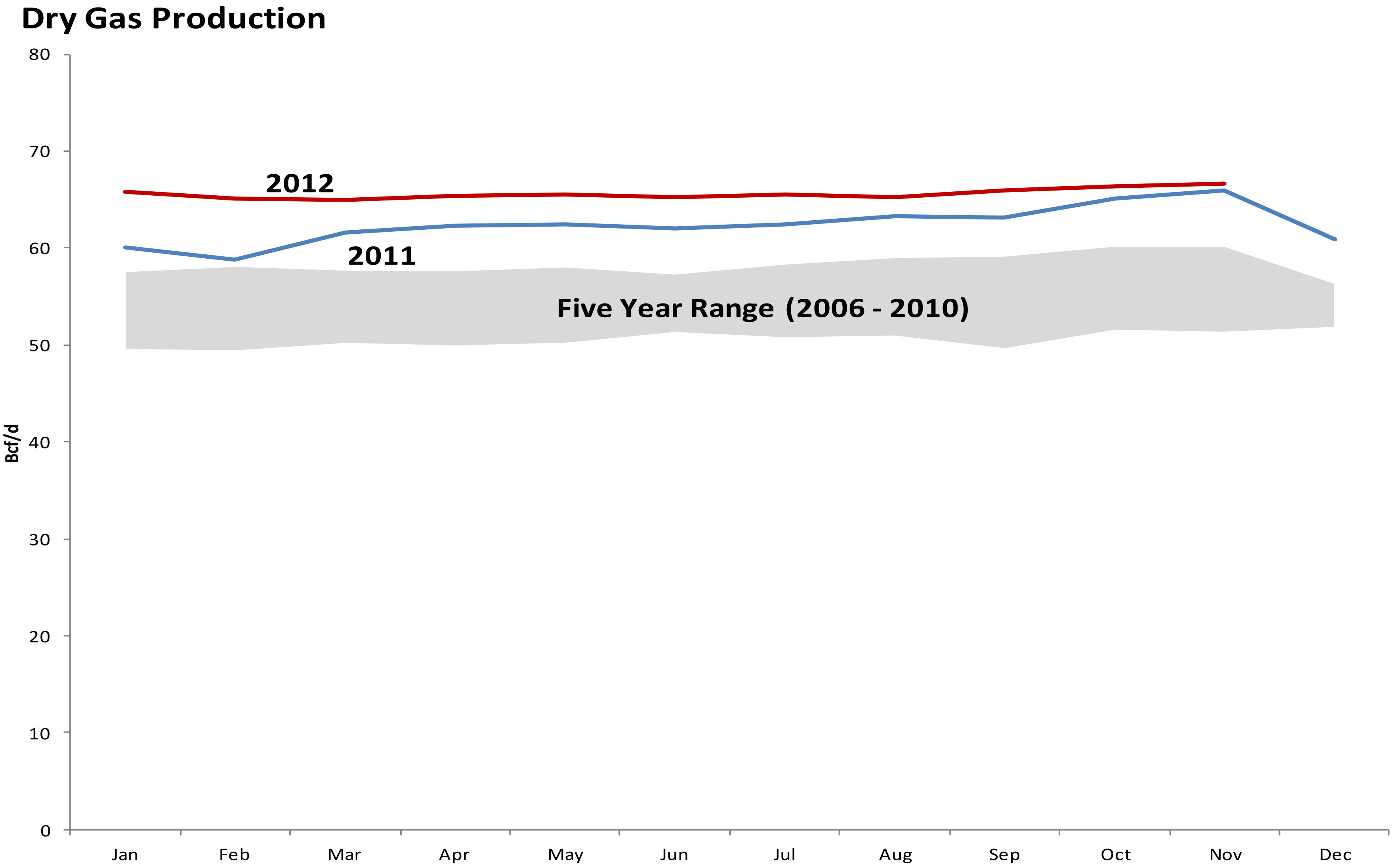
Short Term Market Perspective

Spot Henry Hub Price



Source: EIA

Short Term Market Perspective

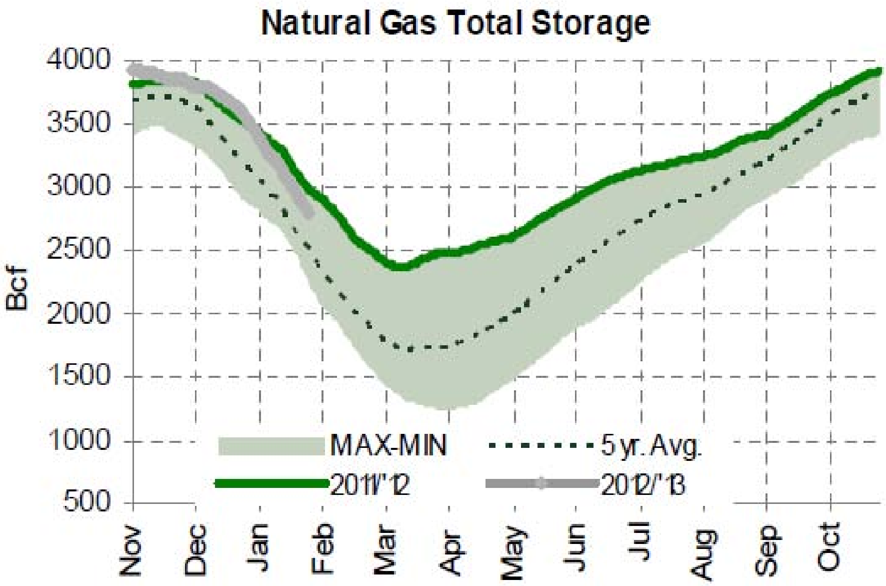


Short Term Market Perspective

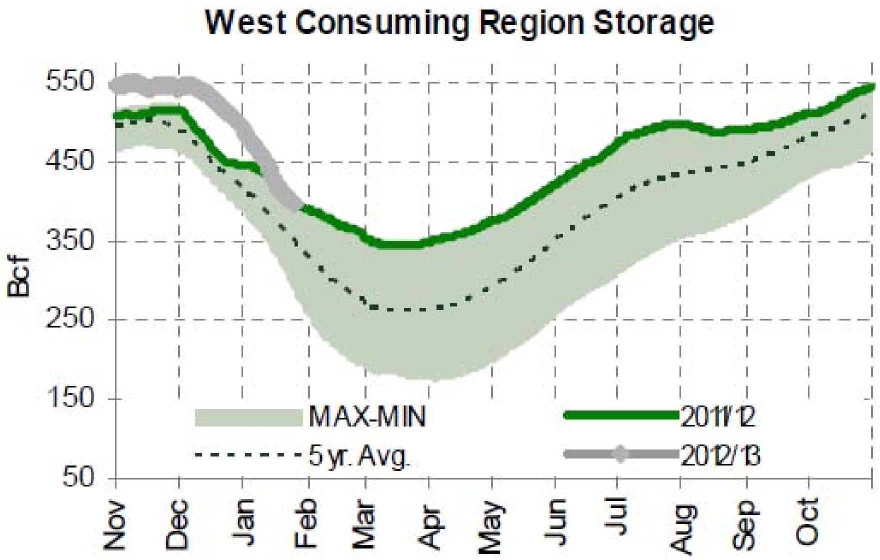
Storage (as of January 25, 2013)

Region	Total Stockpiles (Bcf)	Week-over-Week Change (Bcf)	Yearly % Change	5-Year Average % Change
Consuming East	1391	(129)	-7.27%	7.90%
Consuming West	398	(18)	-0.25%	14.00%
Producing Region	1013	(47)	-8.33%	17.80%
Total U.S.	**2802**	**(194)**	**-6.72%**	**12.20%**

Source: U.S. Energy Information Administration, Bloomberg, TD Securities



Source: EIA, TD Securities



Source: EIA, TD Securities

The Short Term Fundamentals

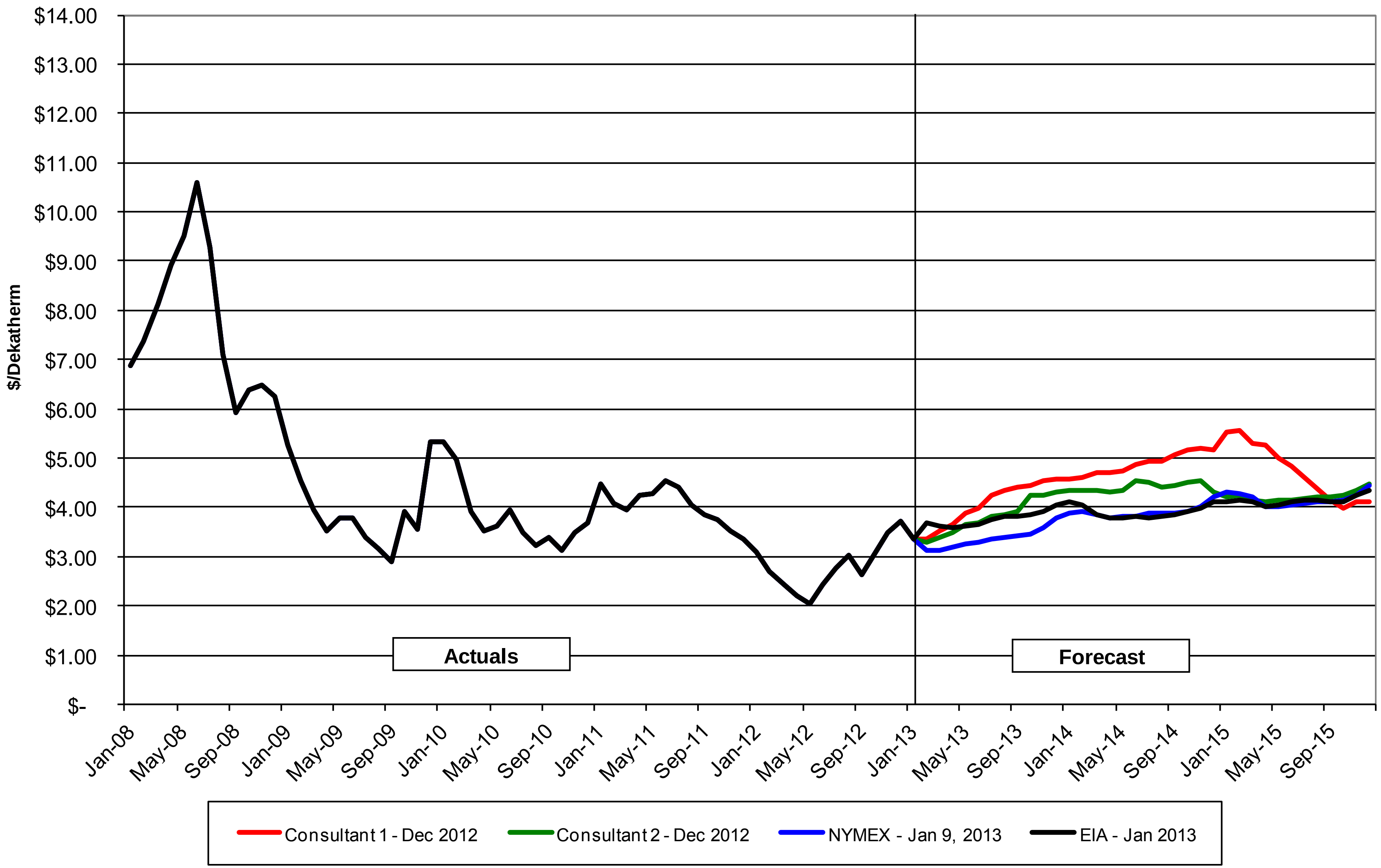
Bulls

- Weather – Normal is now bullish.
- Dwindling rig counts.
- Economic recovery.
- Coal/Nuke displacement.

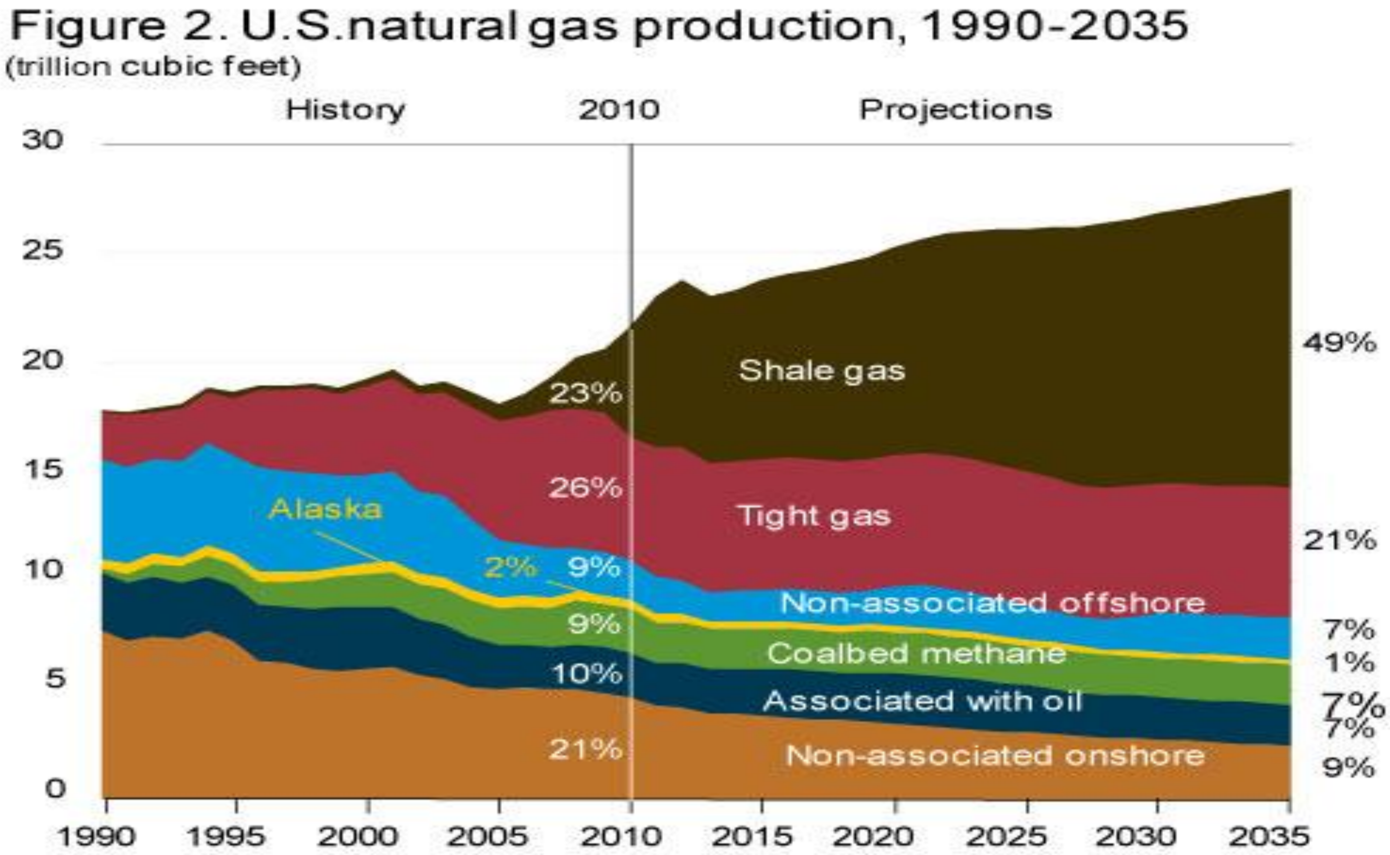
Bears

- Production is high.
- Demand is weak.
- Storage is full.
- Oh yeah, production is high.
- Did I mention, production is high.

Fundamental Forecasts vs. Actual Prices
Henry Hub

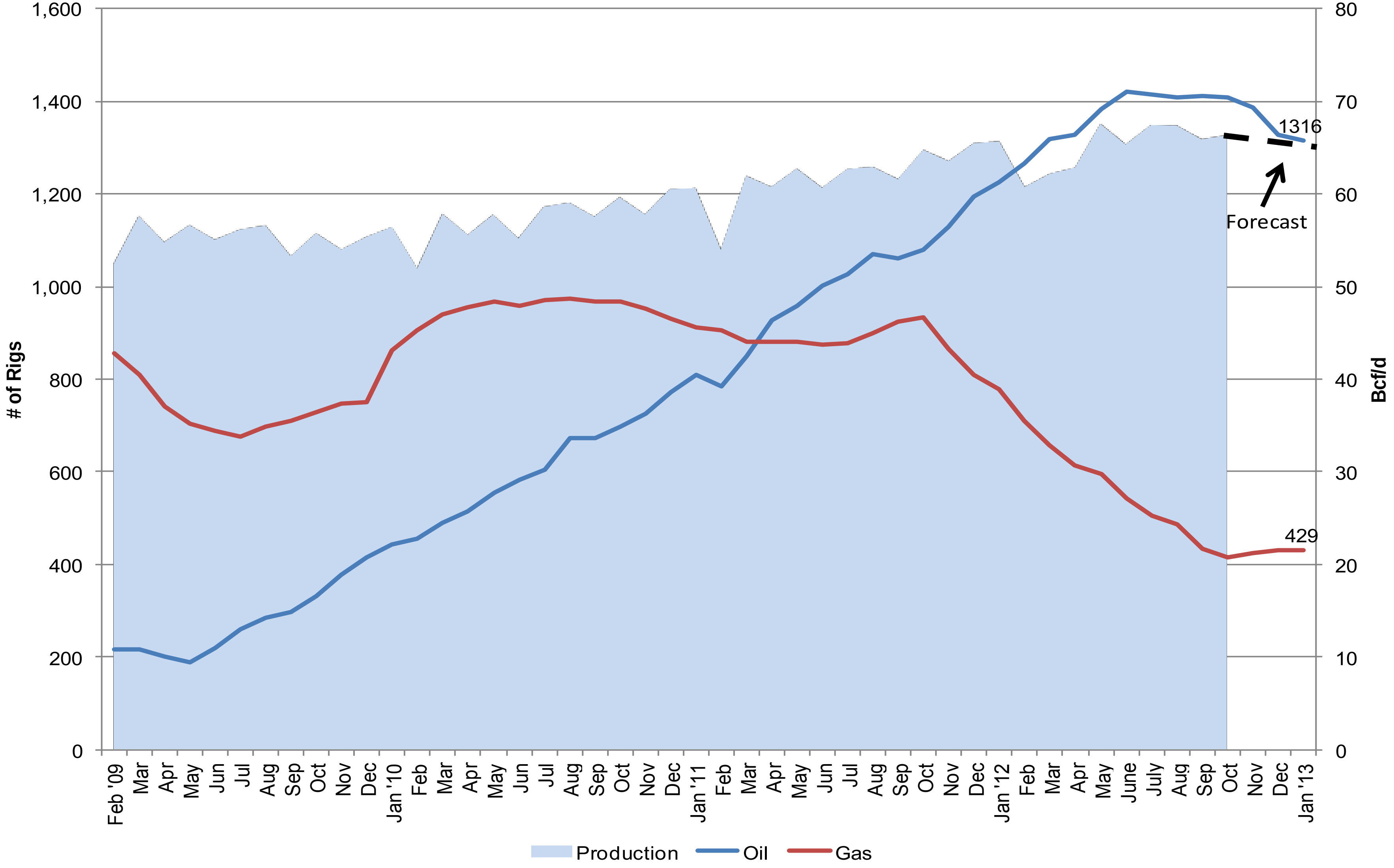


Forecasted Long Term Natural Gas Production



The Link Between Rig Counts and Production

It ain't what it used to be.



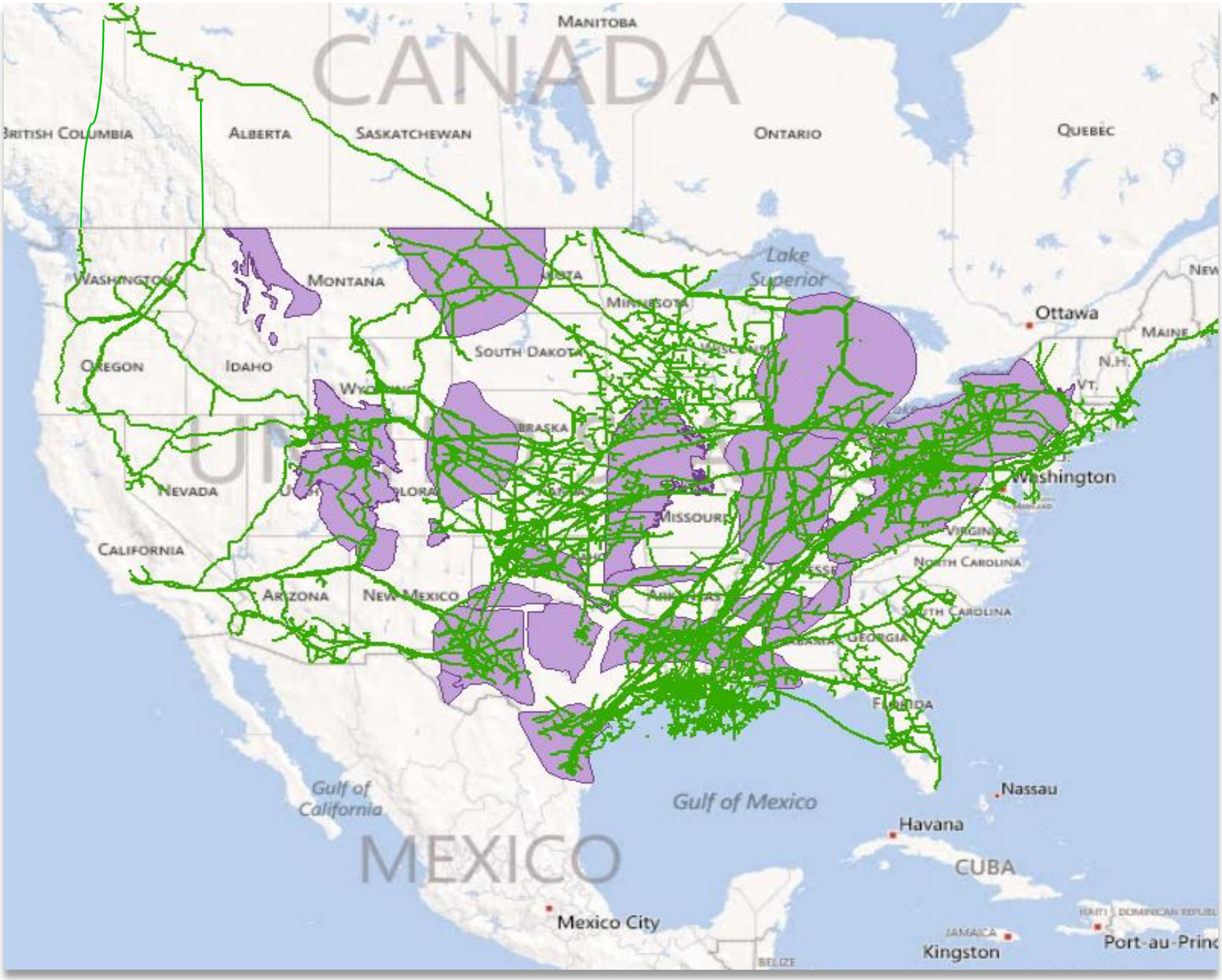
North American Pipeline Infrastructure

Shale Changed *Everything*

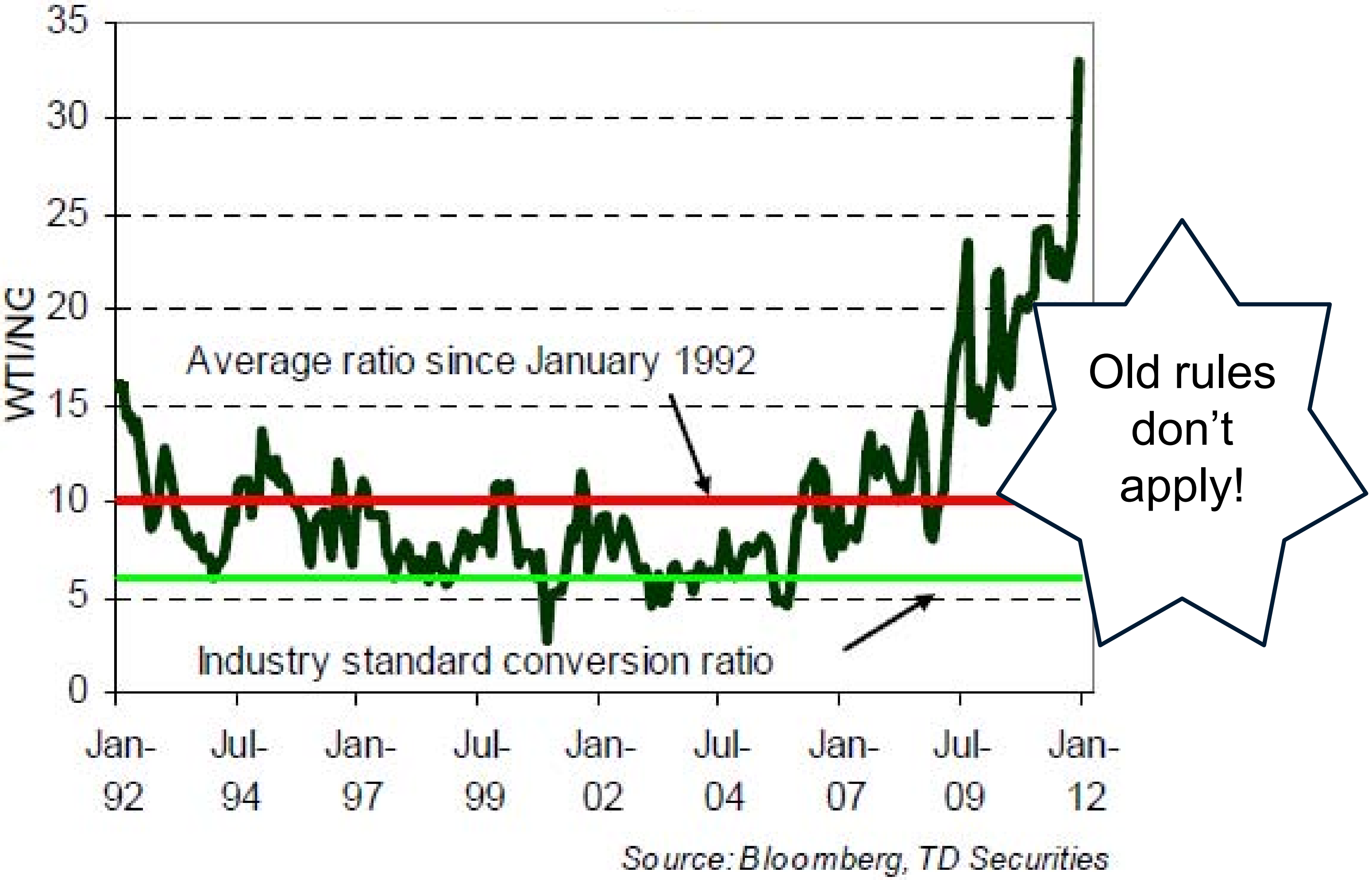
If shale were a country ... it would be the third-largest gas producer!

Source: U.S. Energy Information Administration based on data from various published studies. Canada and Mexico plays from ARI.
Updated: May 9, 2011

The Evolving Flow Dynamics



The Decoupling of Crude Oil vs. Natural Gas Prices



Source: Bloomberg, TD Securities

Old rules don't apply!

NGL’s Impact on the Cost to Produce

Natural Gas Liquids (NGL’s) include ethane, propane, normal butane, isobutane, pentane, natural gasoline, and sulphur. They are a bi-product of natural gas production and have many uses and great value.

- Ethane – is used to create etheleyne a feedstock in petrochemical production.
- Propane - used as a fuel source. Can be used in cigarette lighters, motor vehicle fuel, portable stoves and lamps, and heating fuel.
- Normal butane and Isobutane – used in refinery akylation
- Natural gasoline – used in refinery feedstock, crude dilutent, and chemical applications.
- Sulphur – used in agricultural fertilizers and industrial feedstock.

NGL’s Impact on the Cost to Produce cont.

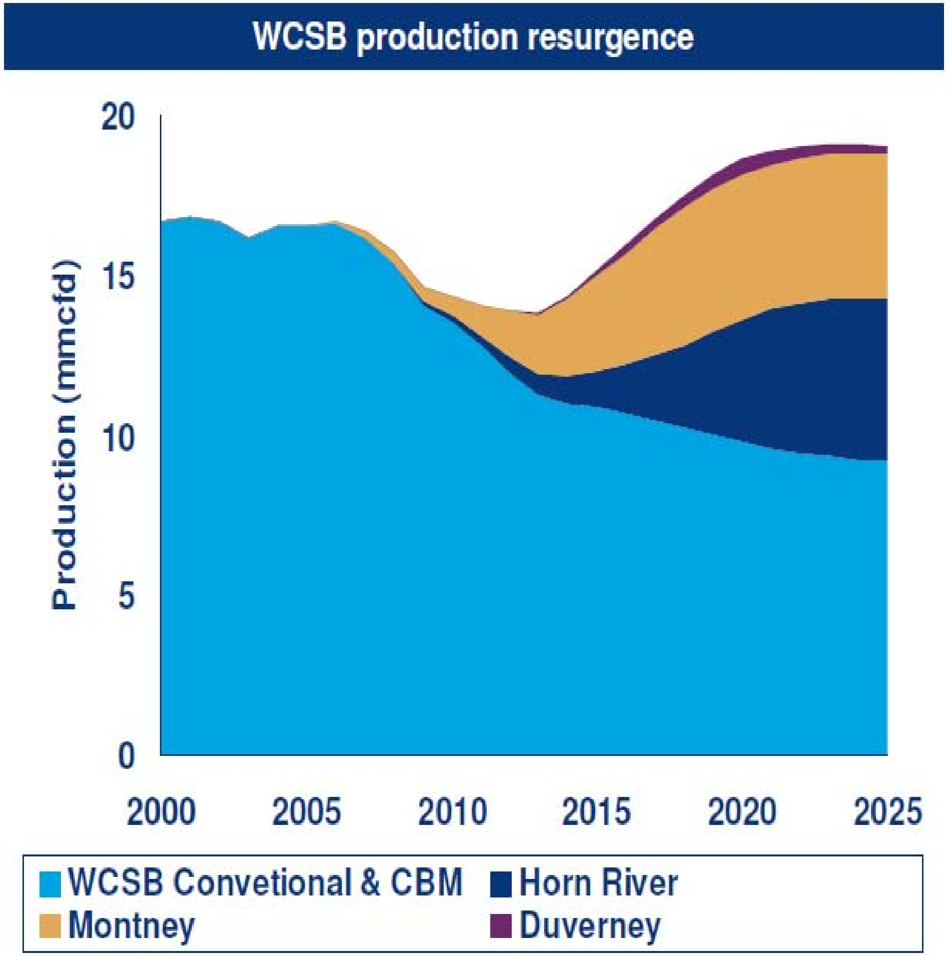
NGL’s enhance the production economics for producers. NGL’s are a main contributor to understanding why gas production companies continue to produce even with gas prices at very low levels.

The following table illustrates how the economics can improve with a credit for NGL’s.

Shale Play	Cost to Produce without NGL’s Credit	Cost to Produce including NGL’s Credit
Marcellus	$4.81	$2.83
Montney	$3.85	$0.57
Barnett	$5.39	$2.41

Note: This information is from one of our consultants. These costs are indicative of the impact. The costs can vary from play to play and company to company.

Canada Dry vs. Canada Not Dry



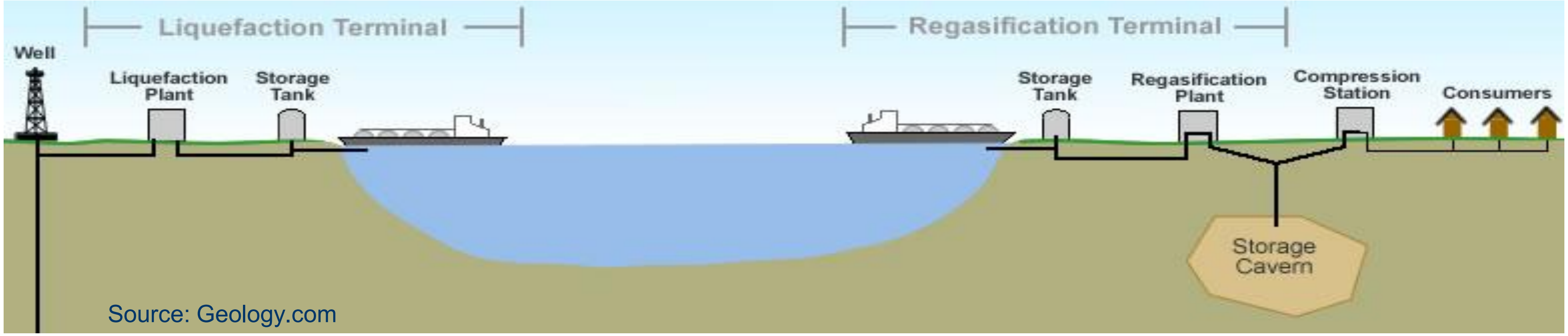
Source: Wood Mackenzie

Why won’t Canada be dry?

- Tons of JV money
- IP rates are proving to be better than anticipated.
  - Horn River IP rates have increased 150%
- Economics are pretty good too.
  - Duverney in particular is liquids rich.
- New discoveries = Liard Basin

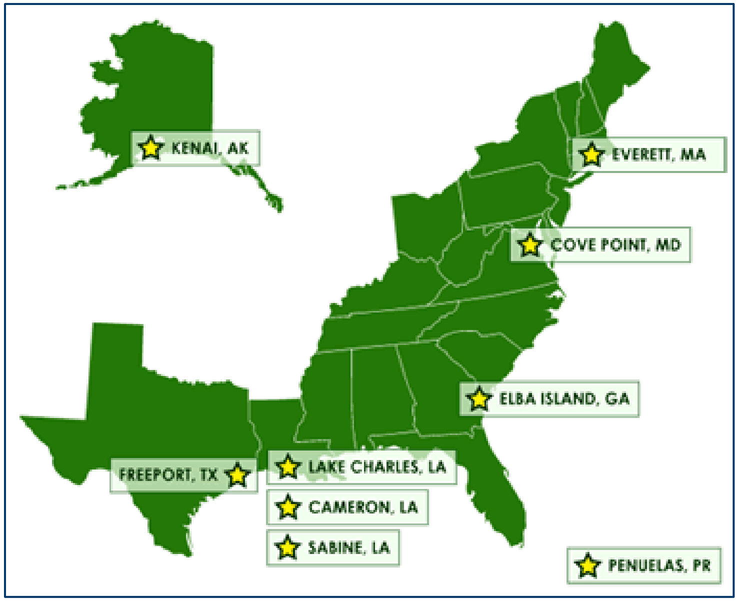
LNG Export is the New Import

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

“The Best Indicator Of Future Behavior Is Past Behavior?”

How low can you go?

- ↓ Production levels continue to remain higher than expected
- ↓ Slow economic recovery
- ↓ Moderation in weather

Seems more upside risk?

- ↑ Declining rig counts
- ↑ “Fracking” bans and/or legislation
- ↑ Any economic recovery
- ↑ Power generation
- ↑ Carbon legislation
- ↑ LNG exports

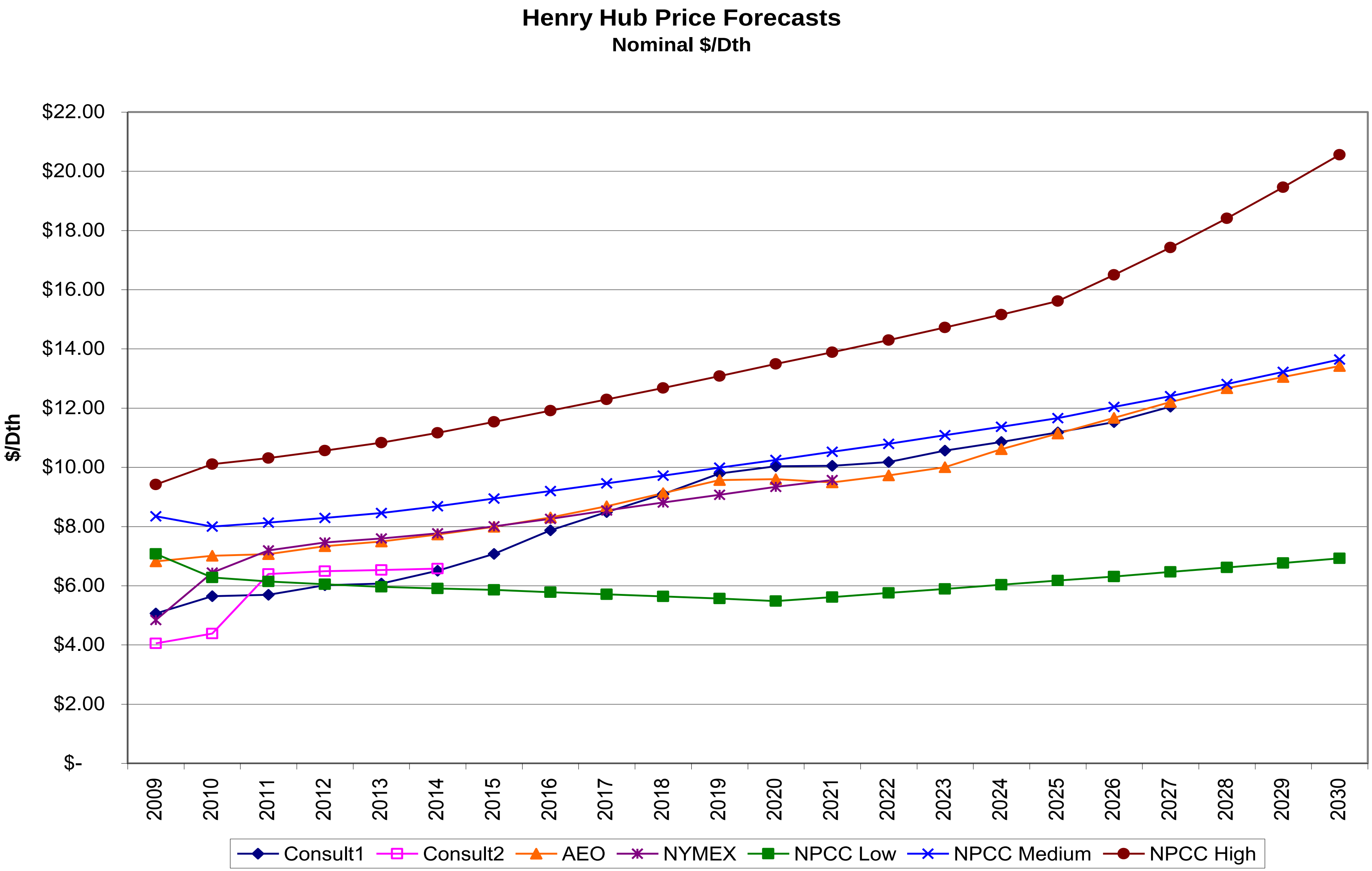
Long Term Gas Price Drivers

- Economy = Demand
  - Recession, Depression, Inflation, etc.
  - Industrial Demand
  - Demand for Power Generation
- US Natural Gas Production
- LNG Exports/Imports – Global Dynamics
- North American Storage Capacity
- Correlation (or lack thereof) with other energy products
- The Environment
  - Carbon Legislation
  - Renewable Portfolio Standards
  - The “F” Word - FRACKING

IRP Natural Gas Price Forecast Methodology

1. Two fundamental forecasts (Consultant #1 & Consultant #2)
2. Forward prices
3. Carbon legislation adder beginning in 2023 ($14/ton grows to $22/ton)
4. Year 1 forward price only
5. Year 2 75% forward price / 25% average consultant forecasts
6. Year 3 50% forward price / 50% average consultant forecasts
7. Year 4 – 6 25% forward price / 75% average consultant forecasts
8. Year 7 50% average consultant without CO2 / 50% average consultant with CO2

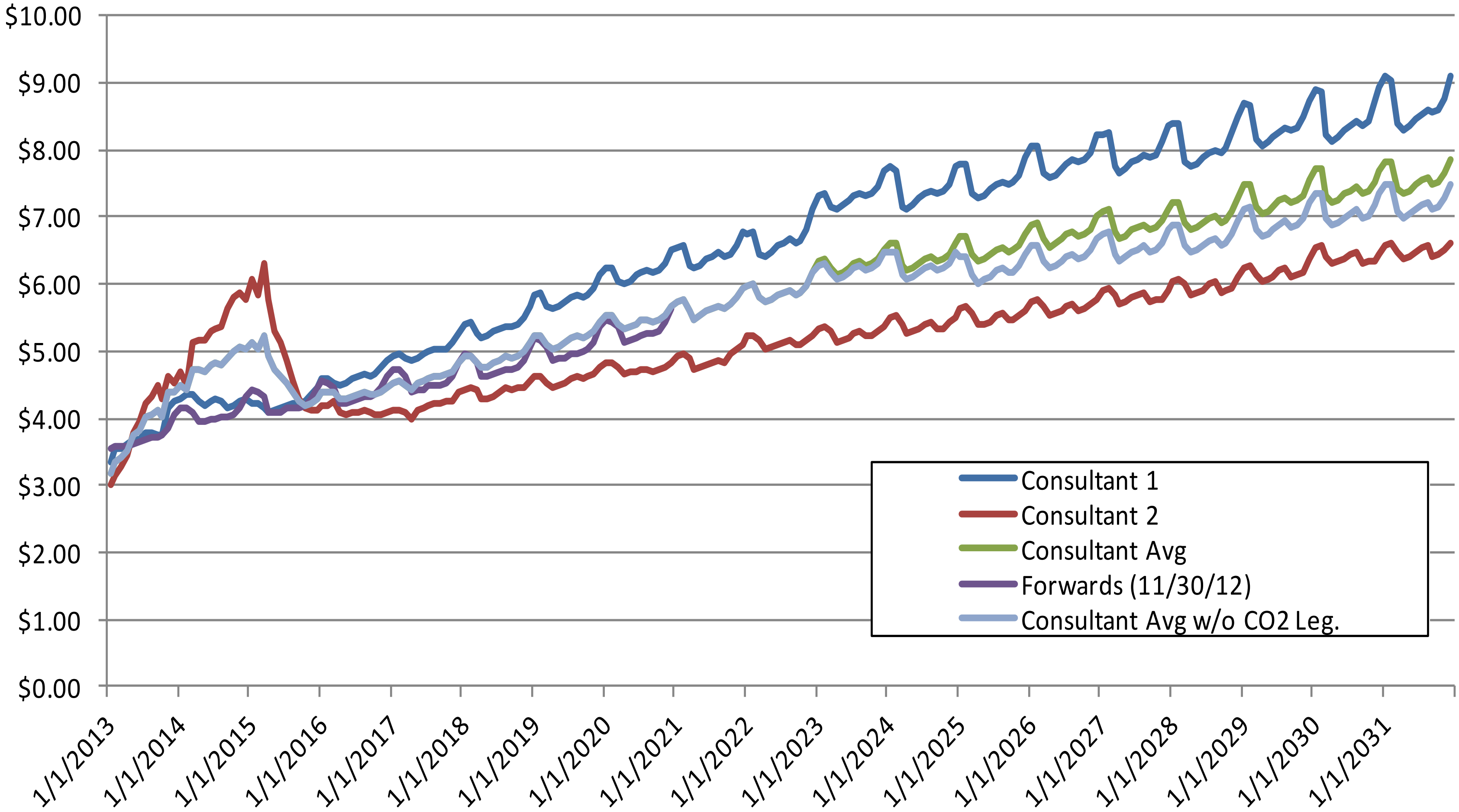
2009 IRP Forecasted Prices



Henry Hub Price Forecasts
Nominal $/Dth

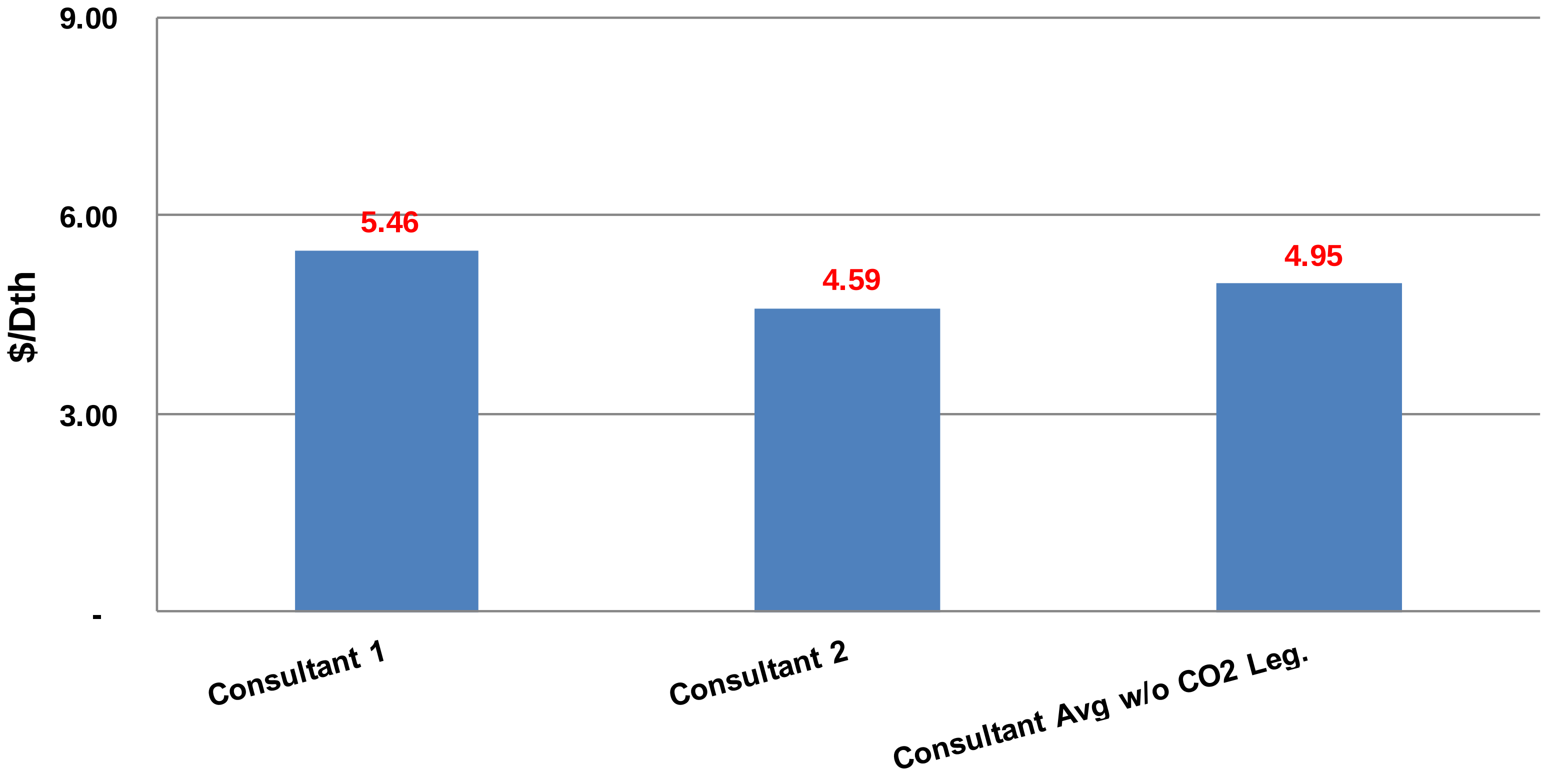
Natural Gas Price Forecasts

Nominal $/Dth



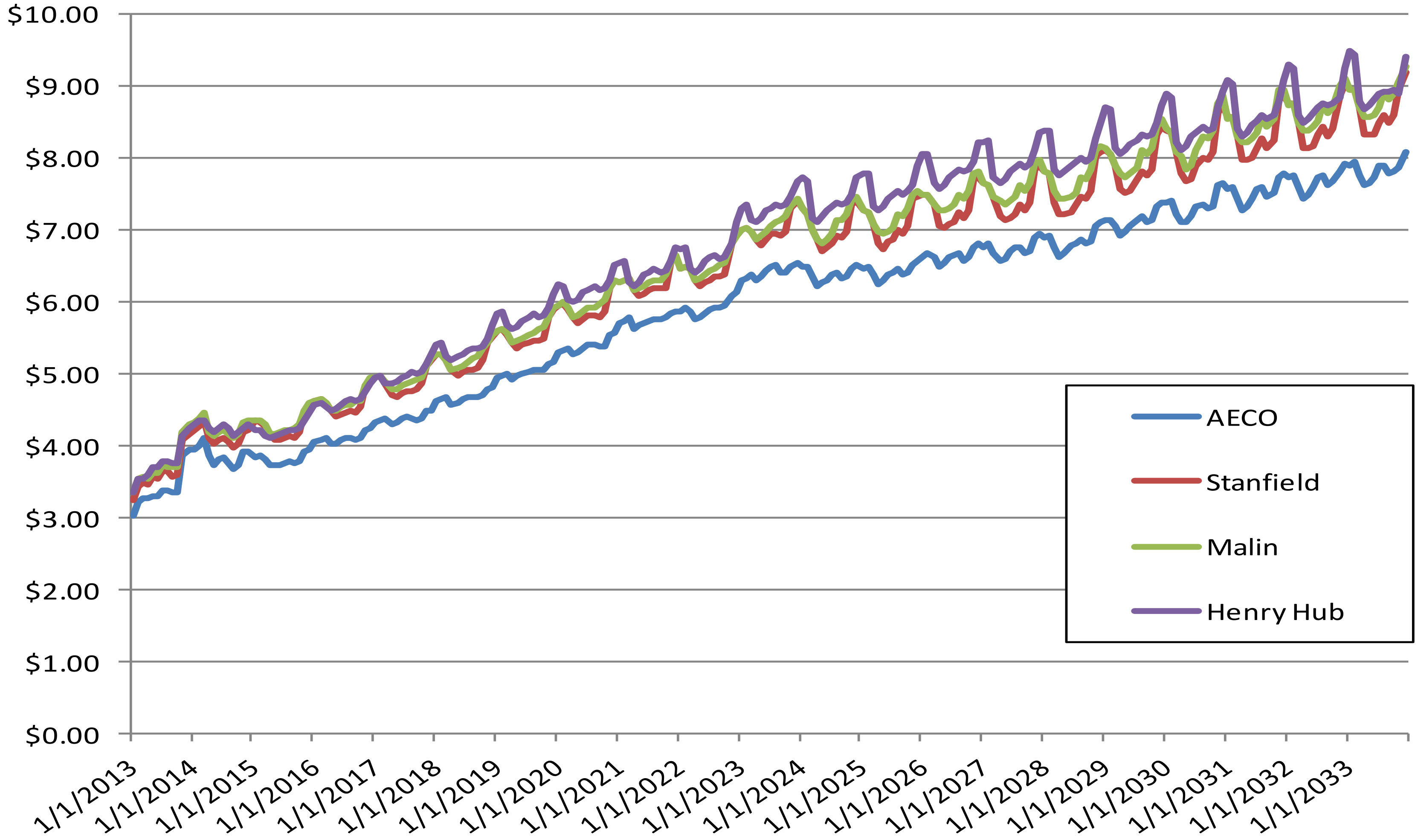
Forecasted Levelized Henry Hub Price (2013 – 2033)

Nominal $/Dth



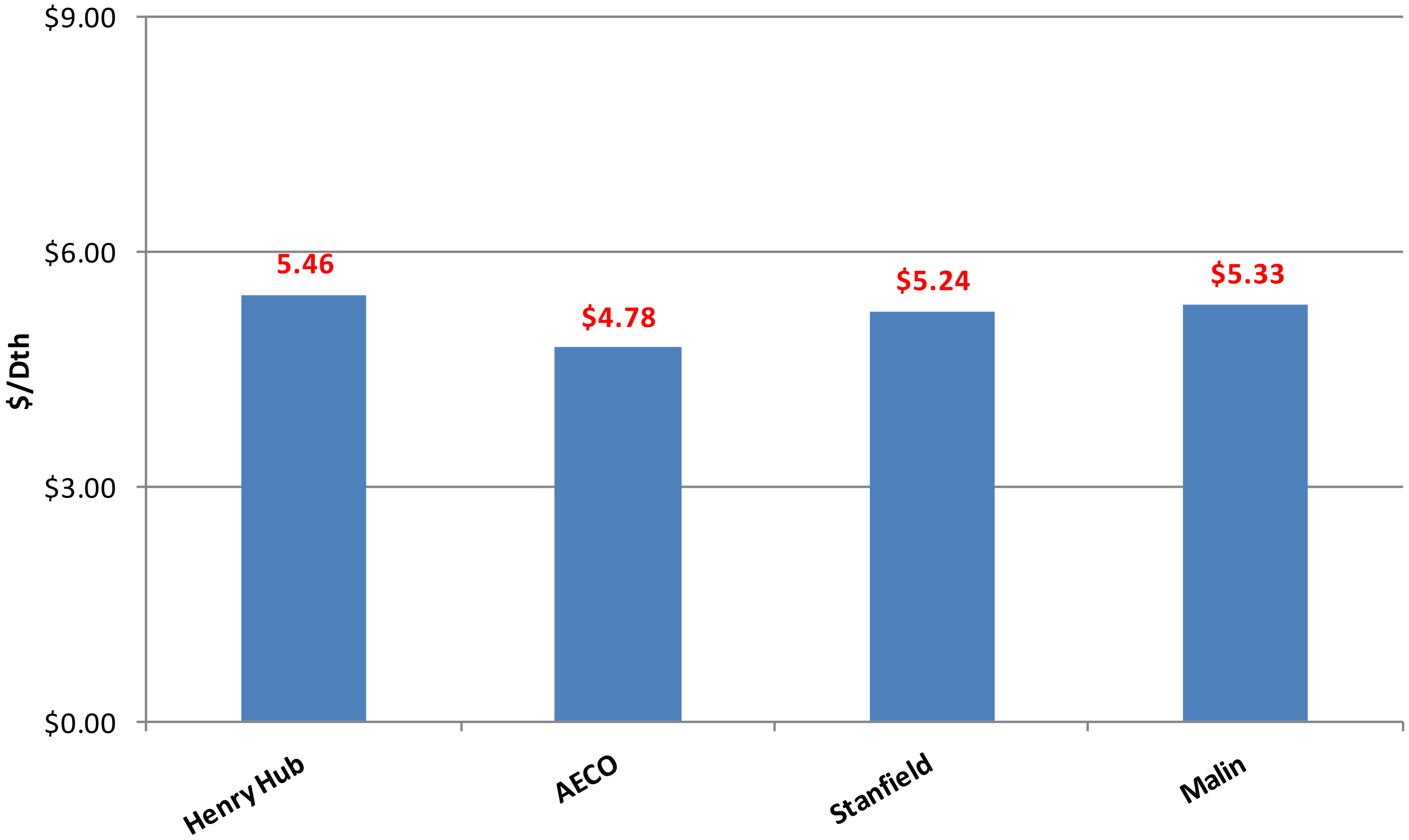
Selected Basin Forecasted Prices

Nominal $/Dth



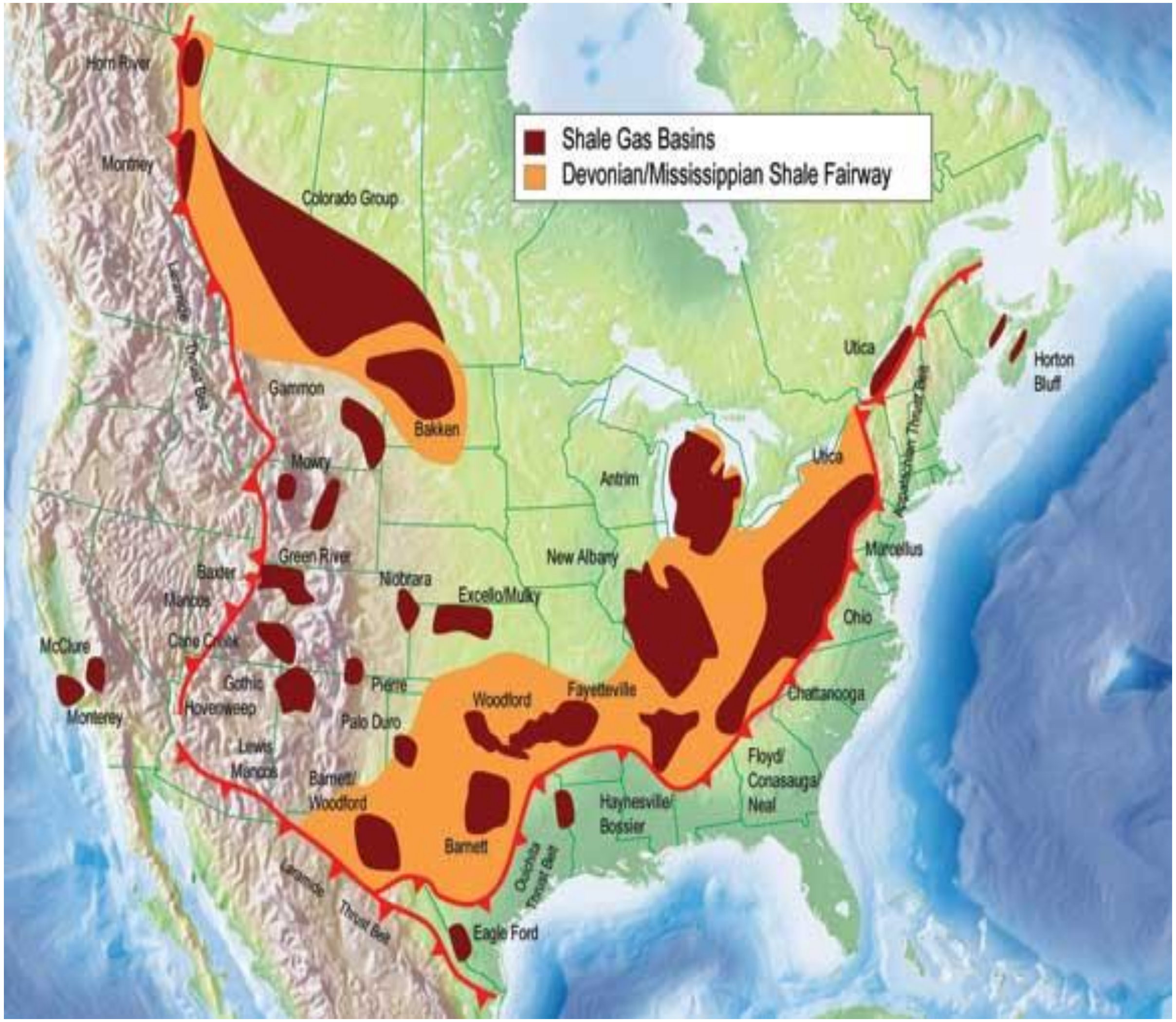
Forecasted Levelized Selected Basin Prices (2013 – 2033)

Nominal $/Dth



Fracking Facts and the Future of Shale

What is Shale Gas?



Shale gas refers to natural gas that is trapped within shale formations.

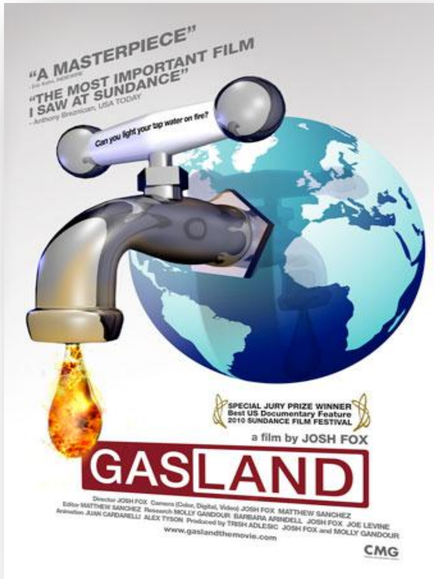
Shales are fine-grained sedimentary rocks that can be rich sources of petroleum and natural gas.

Over the past decade, the combination of horizontal drilling and hydraulic fracturing has allowed access to large volumes of shale gas that were previously uneconomical to produce.

Fracking "Facts" Make Headlines

The New York Times

Cornell University



"Insiders Sound an Alarm Amid a Natural Gas Rush" *"Shale plays are just giant Ponzi schemes"* – **New York Times**

"*Because it's releasing gases, they're not able to trap it as much, it's coming right through the ground."* *"* – **John Krasinski "The Late Show with David Letterman"**

"Fracking Shale Gas Emissions Far Worse Than Coal" – **Cornell Chronicle**

The “F” Word
What is “Fracking”?

Hydraulic fracturing (HF or “fracking”) is a process for producing oil and natural gas. A mixture of water, chemicals and a “proppant” (usually sand) is pumped into a well at extremely high pressures to fracture rock and allow natural gas to escape.

An estimated 11,000 new wells are fractured each year; and estimates show another 1,400 existing wells are re-fractured to stimulate production or to produce natural gas from a different production zone.

HF has been around for well over 60 years. This process has been used on over **one million** producing oil and gas wells.   Federal, state and other regulatory bodies have had regulations in place for over 50 years.

What Are Some Of The Issues?

Of the many allegations made in the headlines, recent press has focused its attention on the volumes, costs, and environmental impacts of shale gas production.

Issue #1: Shale resources are overestimated.

Issue #2: Shale gas is uneconomic to produce.

Issue #3: Hydraulic fracturing pollutes the air, contaminates water, and causes earthquakes.

What Are The Facts?

Issue #1: Shale resources are overestimated.

Fact: Many independent organizations, companies, and governments have examined and assessed data in order to develop estimated shale gas resource figures. All have concluded that the reserve base is much greater than previously anticipated.

A recently released MIT study states:

> *"In the US, despite their relative maturity, natural gas resources continue to grow, and the development of low-cost and abundant unconventional gas resources, particularly shale gas has a material impact on future availability and price." Ernest Moniz, MIT Professor at a hearing before the Senate Energy and Natural Resources Committee.*

eia Independent Statistics & Analysis
U.S. Energy Information Administration

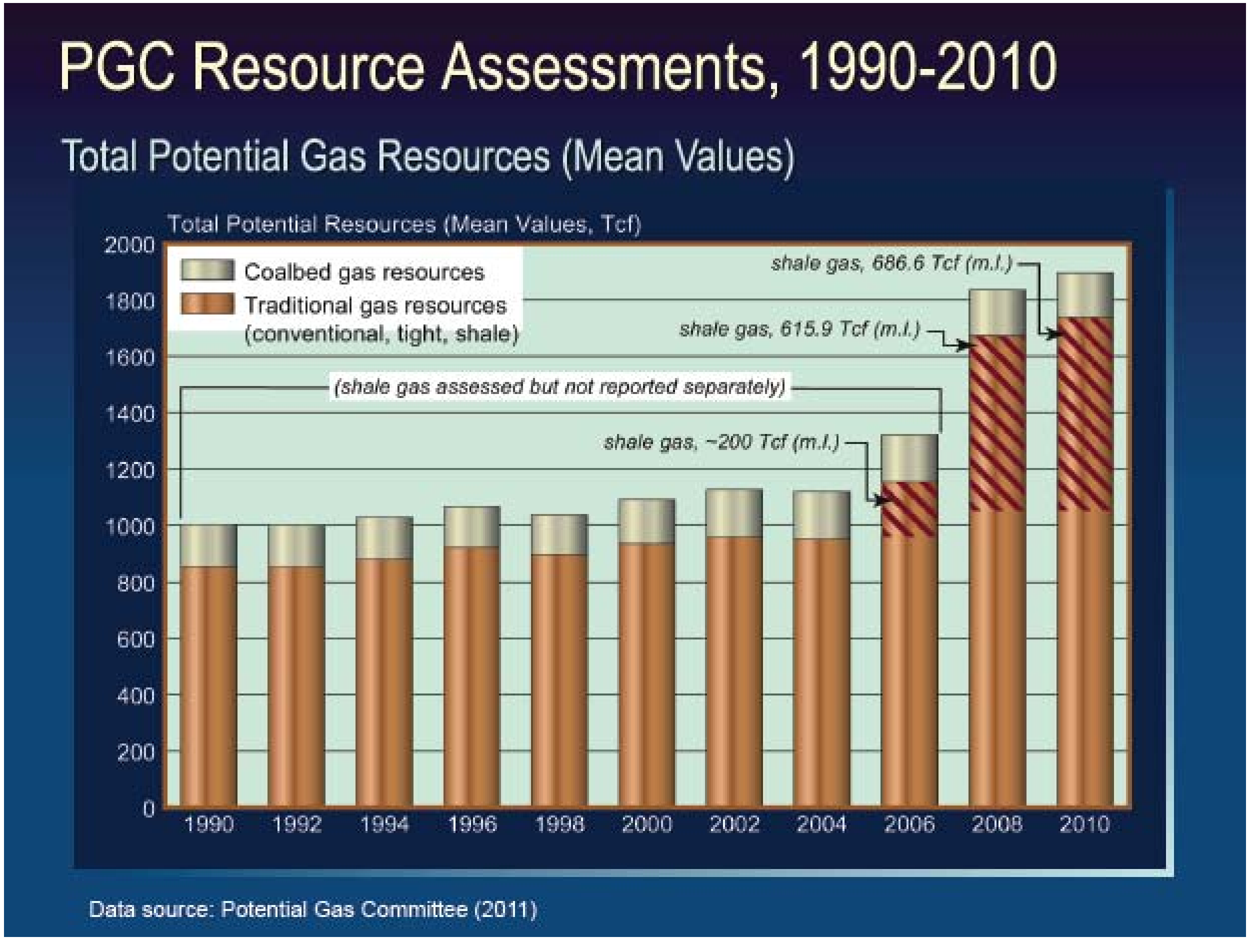
IHS CERA

National Energy Board
Office national de l'énergie

British Columbia
The Best Place on Earth
Ministry of Energy, Mines and Petroleum Resources

Wood Mackenzie

Who Estimates The Reserve Base?



Data source: Potential Gas Committee (2011)

One of the most widely used estimate is from the Potential Gas Committee.

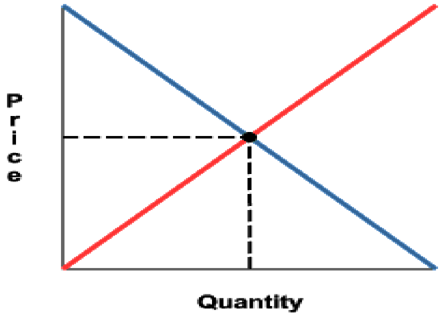
Shale had its first noticeable impact in 2006, nobody questioned it.

In 2008, as more data becomes available another adjustment is made, nobody questioned it.

Now, with even more data a modest increase in shale reserves is made, and now the questioning begins.

Who is the Potential Gas Committee? 100 Volunteer Geoscientists & Petroleum Engineers

What Are The Facts?



Issue #2: Shale gas is uneconomic to produce.

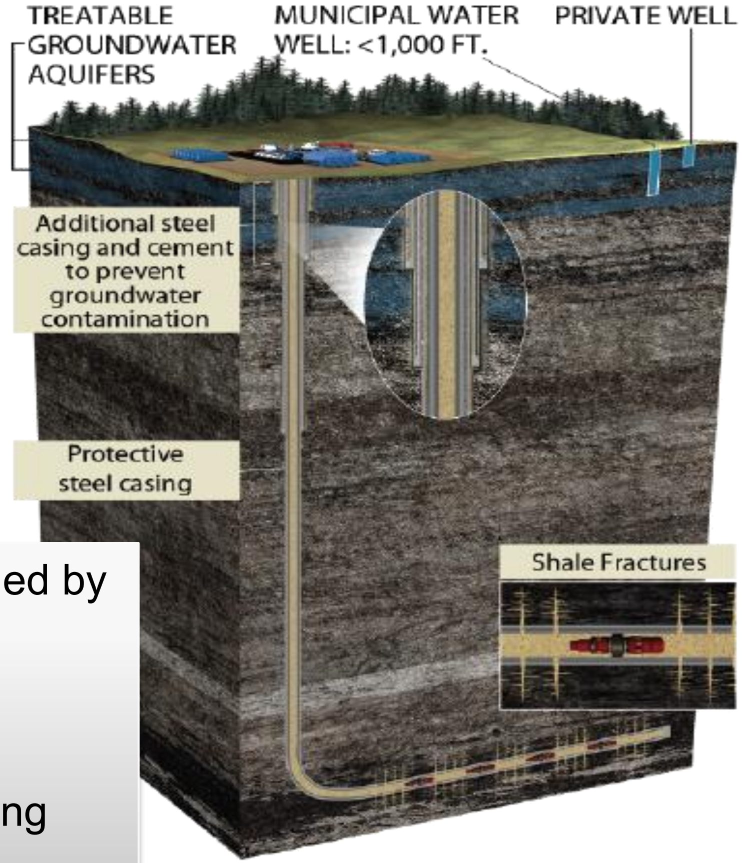
Fact: It is true that current gas prices have fallen to low levels making the economics of some wells challenging. However, there are several factors that are helping to make the economics work.

- Natural Gas Liquids – many of the shale plays are liquids rich. These liquids can be sold at prices which are linked to higher priced oil. The liquids revenue helps to offset costs.
- Drilling effectiveness – producers are showing increases in:
  - Wells per year per rig
  - Lateral length
  - 30 day average production rate.

It's only math: Costs/Volume (Costs⬇ / Volumes⬆)

What Are The Facts?

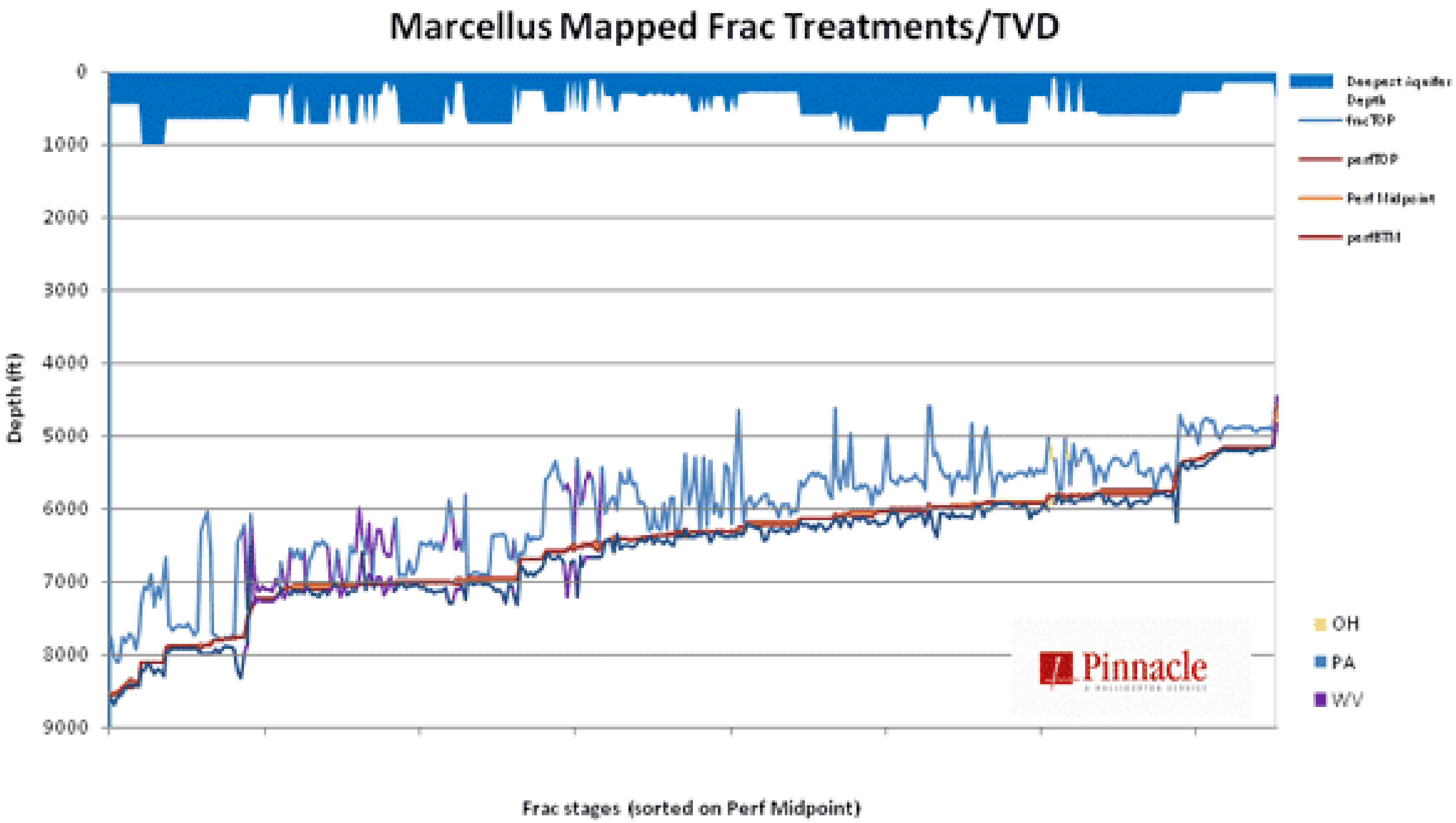
Issue #3: “Hydraulic fracturing contaminates ground water, pollutes the air, and causes earthquakes.”



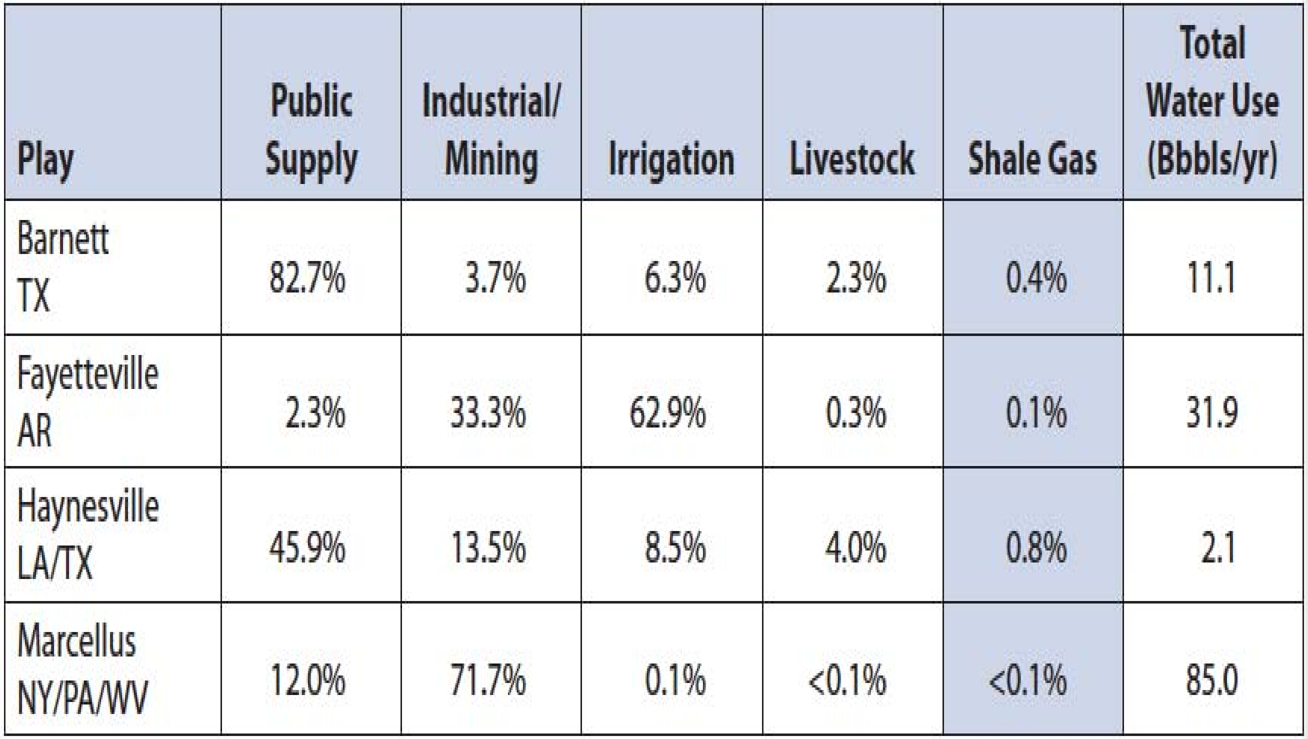
Fact: Water contamination – Contamination of water could occur in a couple of ways, one is by factures seeping gas and oil into the water table. Secondarily, much water is used in the HF process. This water is mixed with other things and could be spilled and be absorbed into the water table.

- **FracFocus.org** – Public registry created and managed by state regulators
  - Searchable public database with well-by-well information and glossary of chemicals
  - More than 10,000 wells and over 100 participating companies; several states using as tool for compliance reporting

Hydraulic Fracturing and the Water Table



How Much Water Is Used in Hydraulic Fracturing?



Play	Public Supply	Industrial/ Mining	Irrigation	Livestock	Shale Gas	Total Water Use (Bbbls/yr)
Barnett TX	82.7%	3.7%	6.3%	2.3%	0.4%	11.1
Fayetteville AR	2.3%	33.3%	62.9%	0.3%	0.1%	31.9
Haynesville LA/TX	45.9%	13.5%	8.5%	4.0%	0.8%	2.1
Marcellus NY/PA/WV	12.0%	71.7%	0.1%	<0.1%	<0.1%	85.0

How much is 5 Million gallons of water?

It is equivalent to the amount of water consumed by:

- **New York City** in about **seven (7) minutes**
- A 500 megawatt coal-fired **power plant** in **1 day**
- A **golf course** in **25 days**
- **10 acres of cotton** in a season

While these represent continuing consumption, the water used for a gas well is a one-time use.

What Are The Facts?

Issue #3 cont.: “Hydraulic fracturing contaminates ground water, pollutes the air, and causes earthquakes.”

Fact: Pollution – as with most industrial activities there the issue of pollution must be addressed. Most concerning in natural gas processing is the release of volatile organic compounds (VOC) or carcinogens and methane.

Most of the air pollutants at gas sites occurs during the completion phase of processing. The EPA just established rules that will curtail the amount of air pollution caused by gas and oil production. Companies have until 2015 to comply with the new rules, however over half of the companies currently use the required technology.

What Are The Facts?

Issue #3 cont.: “Hydraulic fracturing contaminates ground water, pollutes the air, and causes earthquakes.”

Fact: Earthquakes – It was reported that a recent study conducted by the US Geological Survey appeared to indicate increased seismic activity due to HF.

"USGS's studies do not suggest that hydraulic fracturing, commonly known as 'fracking,' causes the increased rate of earthquakes," Hayes wrote. "USGS's scientists have found, however, that at some locations the increase in seismicity coincides with the injection of wastewater in deep disposal wells.“ – DOI Deputy Secretary David Hayes

Bottom Line:

Many benefits can be realized:

- Providing jobs
- Rejuvenating the chemical, manufacturing, and steel industry
- Bridge fuel to a renewable energy future
- Reduce dependence on foreign oil

However, there are important environmental issues that will need to continue to be addressed. Industry and regulators should continue to work together to ensure safe development of this vital resource.

Electric Price Forecast

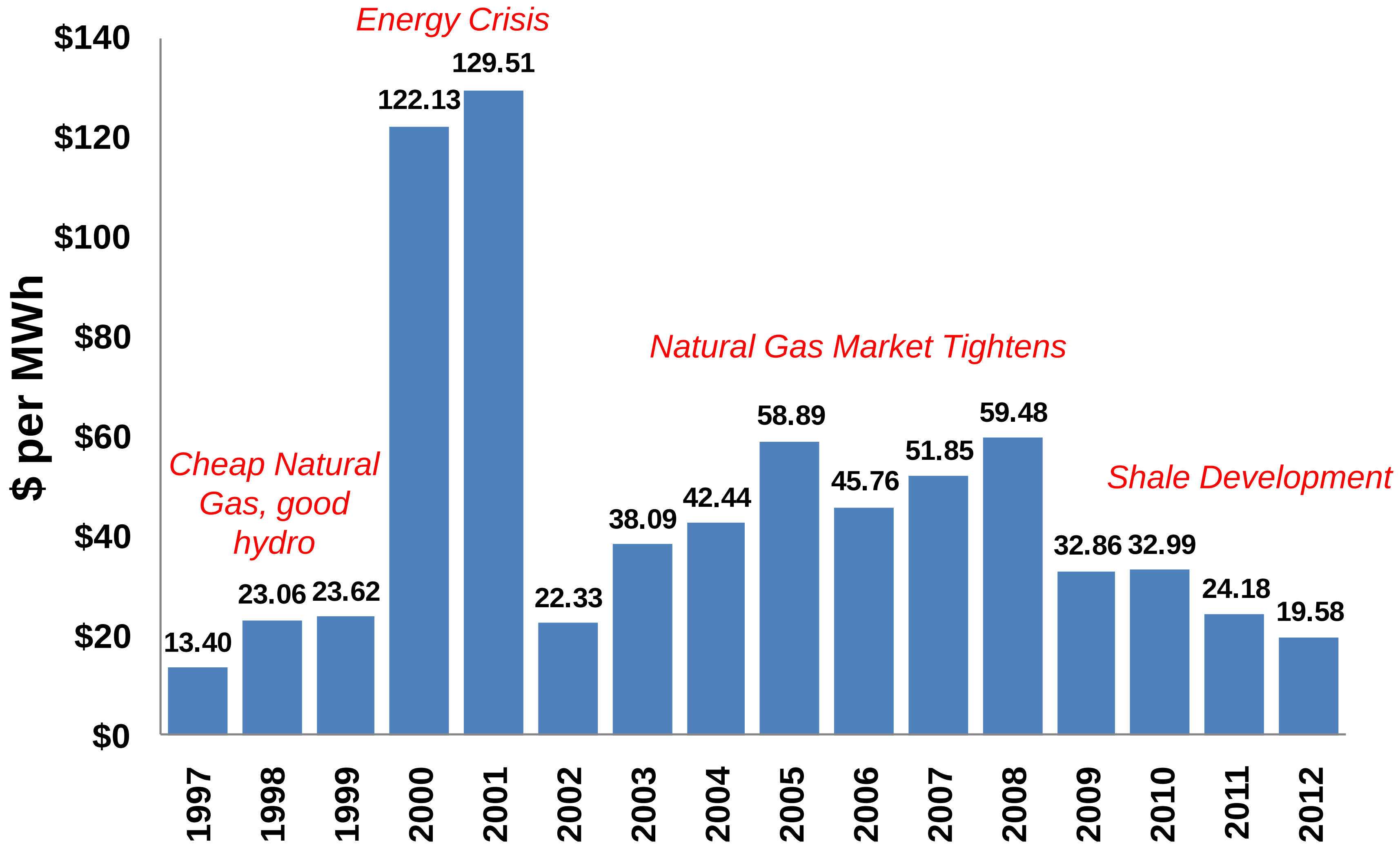
James Gall

Fourth Technical Advisory Committee Meeting

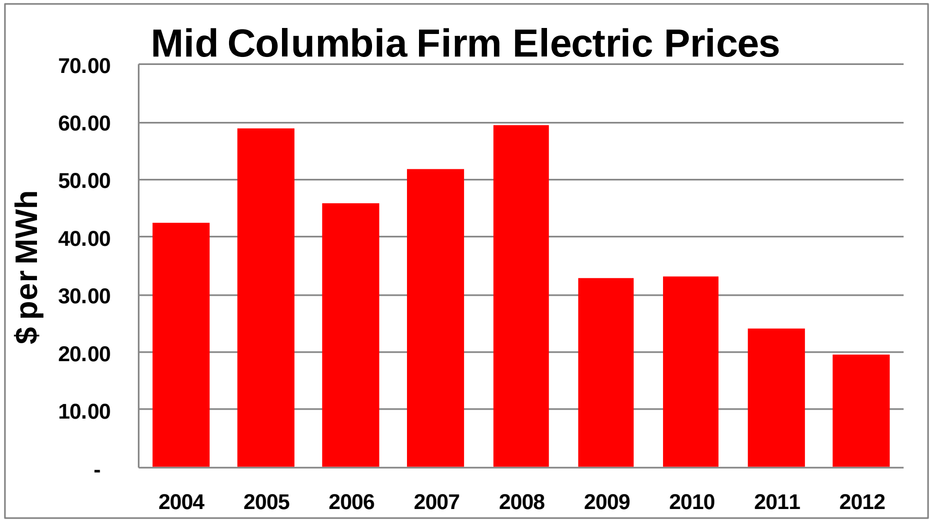
2013 Electric Integrated Resource Plan

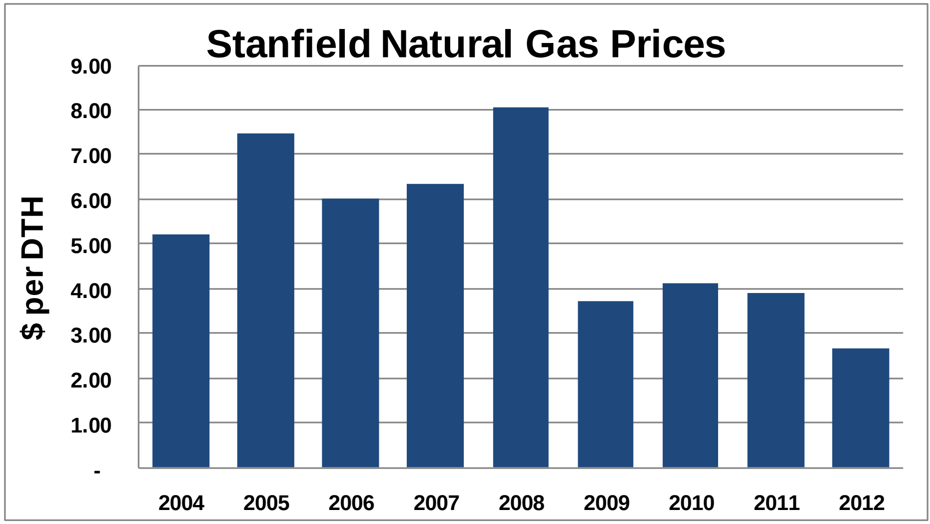
February 6, 2013

Historical Mid-Columbia Prices- *What year is it?*



Historic Mid-Columbia and Stanfield Prices





Strong tie between natural gas and electric market

Increased natural gas supply/ lower prices causing price declines at the Mid-Columbia

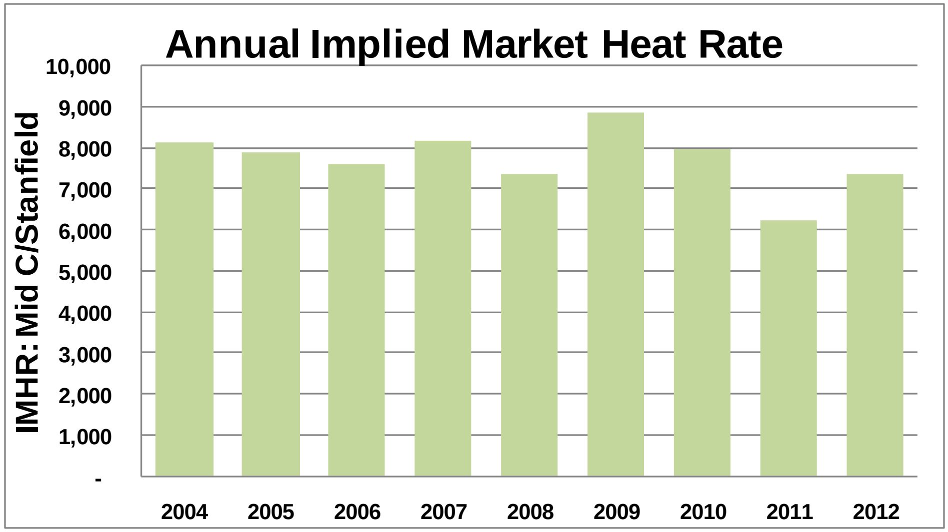
Are prices now at a new normal?

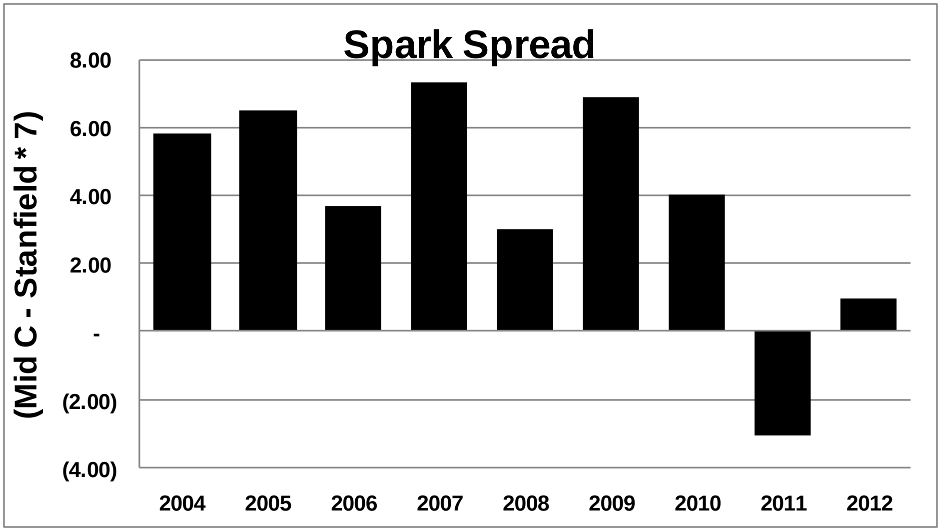
Pricing Relationships

Implied Market Heat Rate illustrates new wind supply contributing to lowering market prices

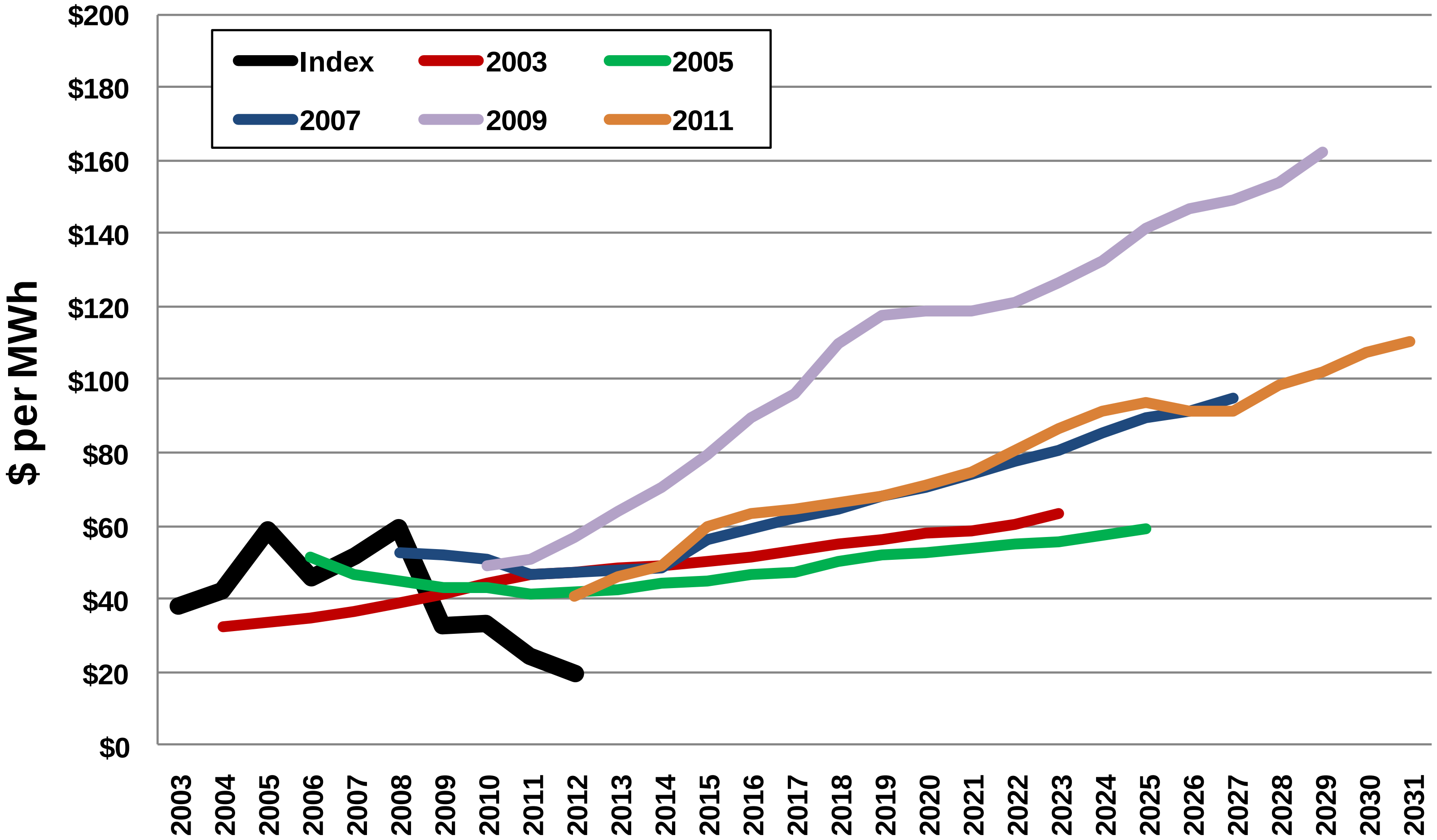
Spark Spread shows margin opportunities for Combined Cycle Resources

2011's above average hydro reduced prices further

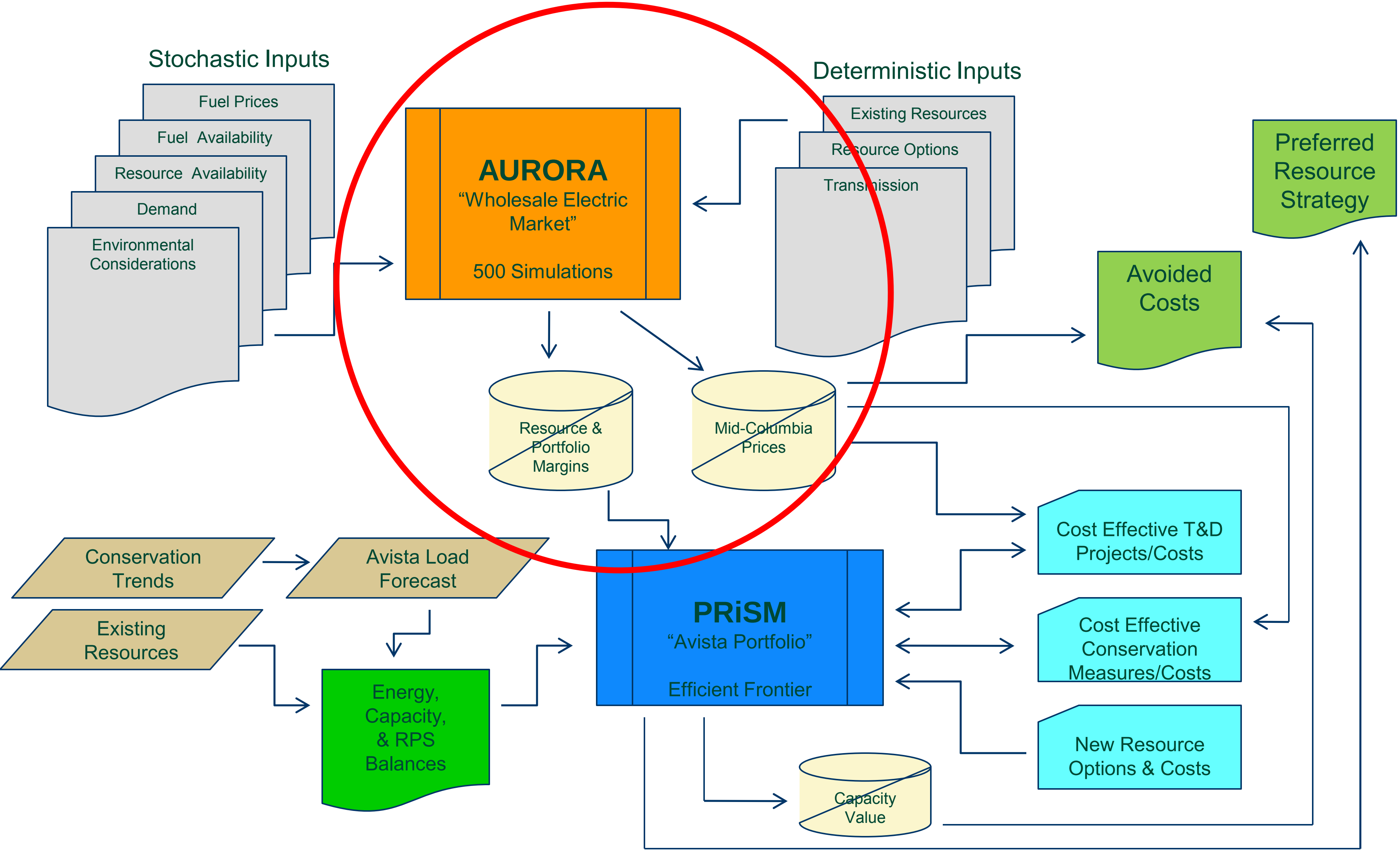




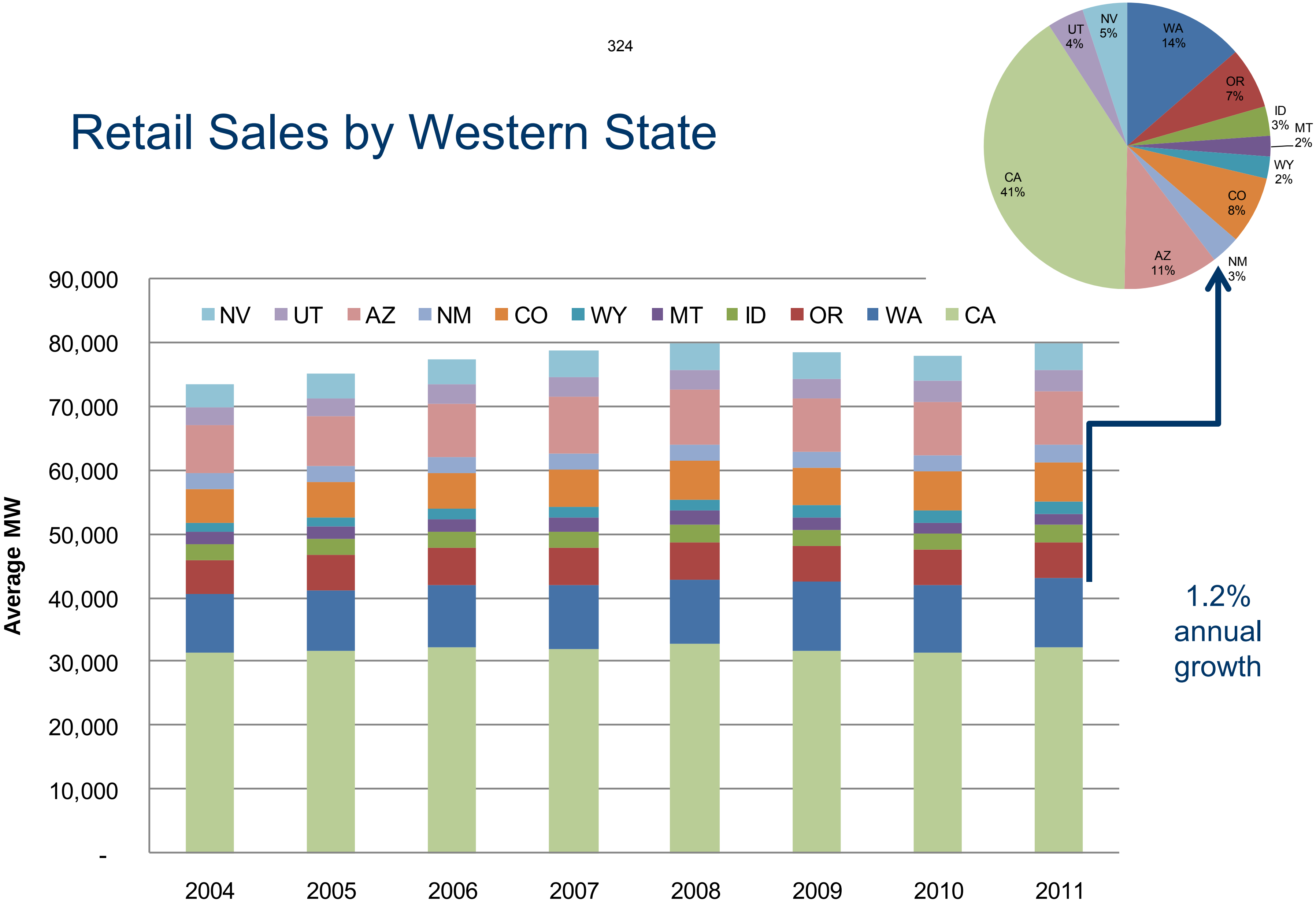
The Ghost of IRP’s Past



2013 IRP Modeling Process



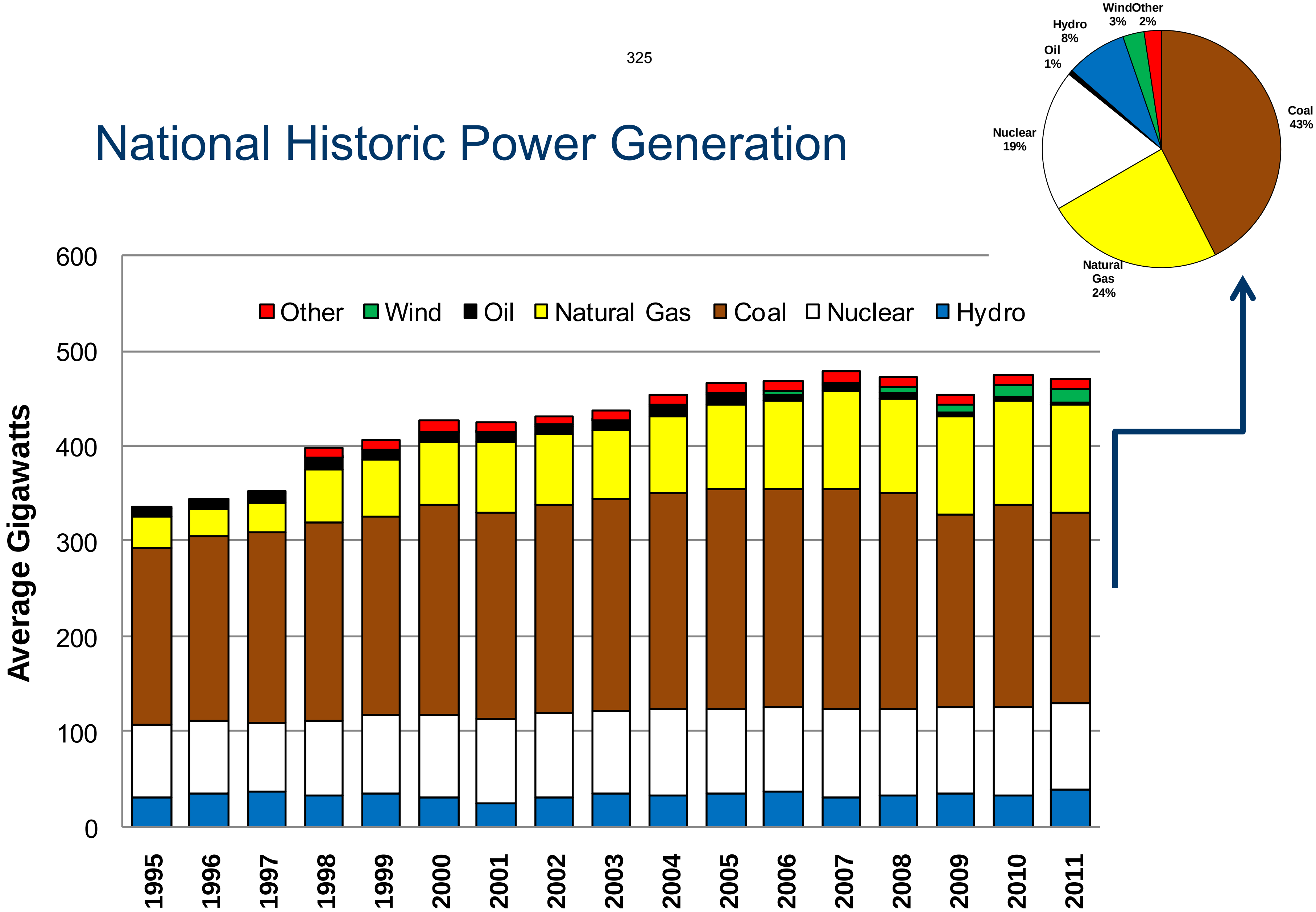
Retail Sales by Western State



1.2% annual growth

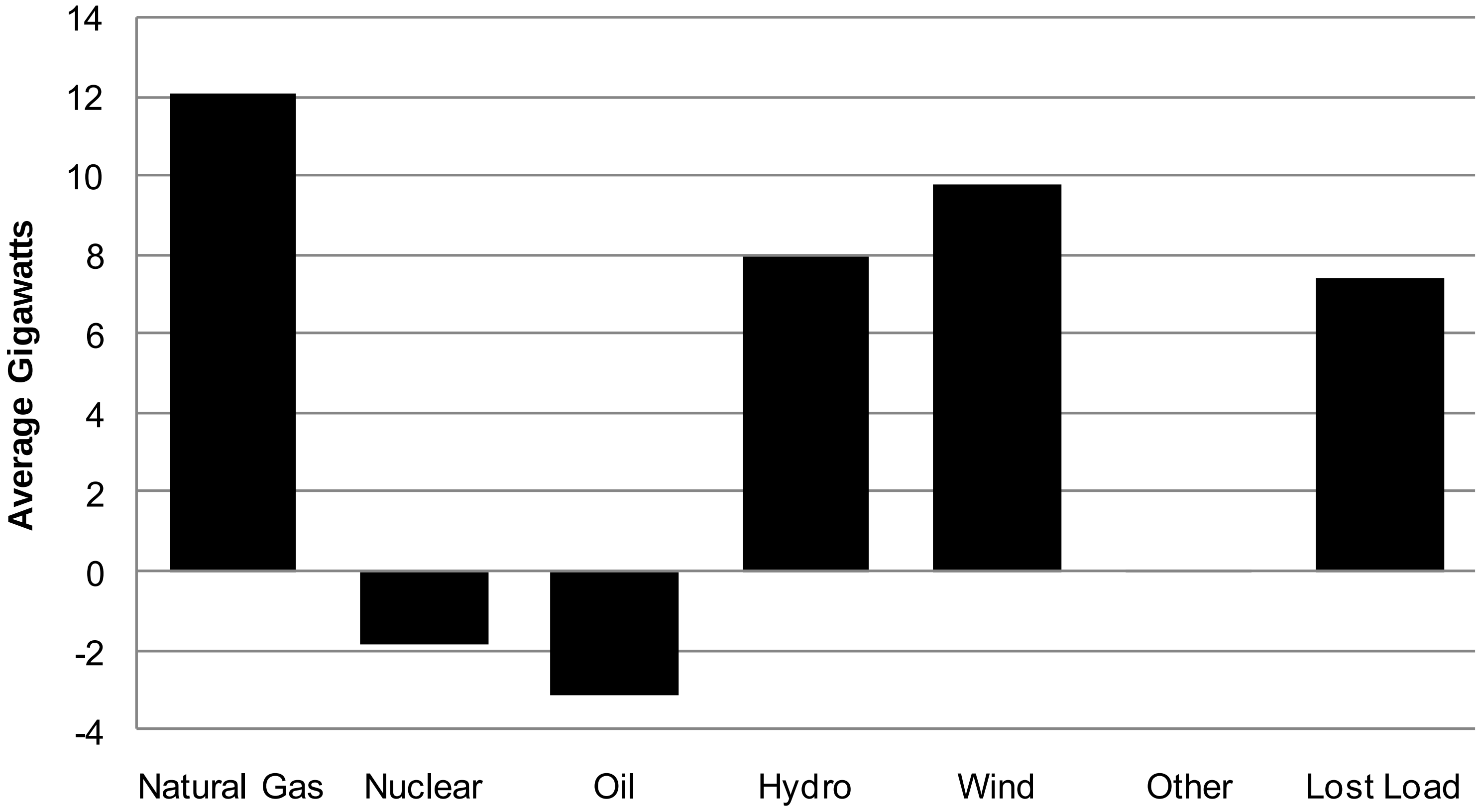
Source: SNL

National Historic Power Generation



Source: SNL

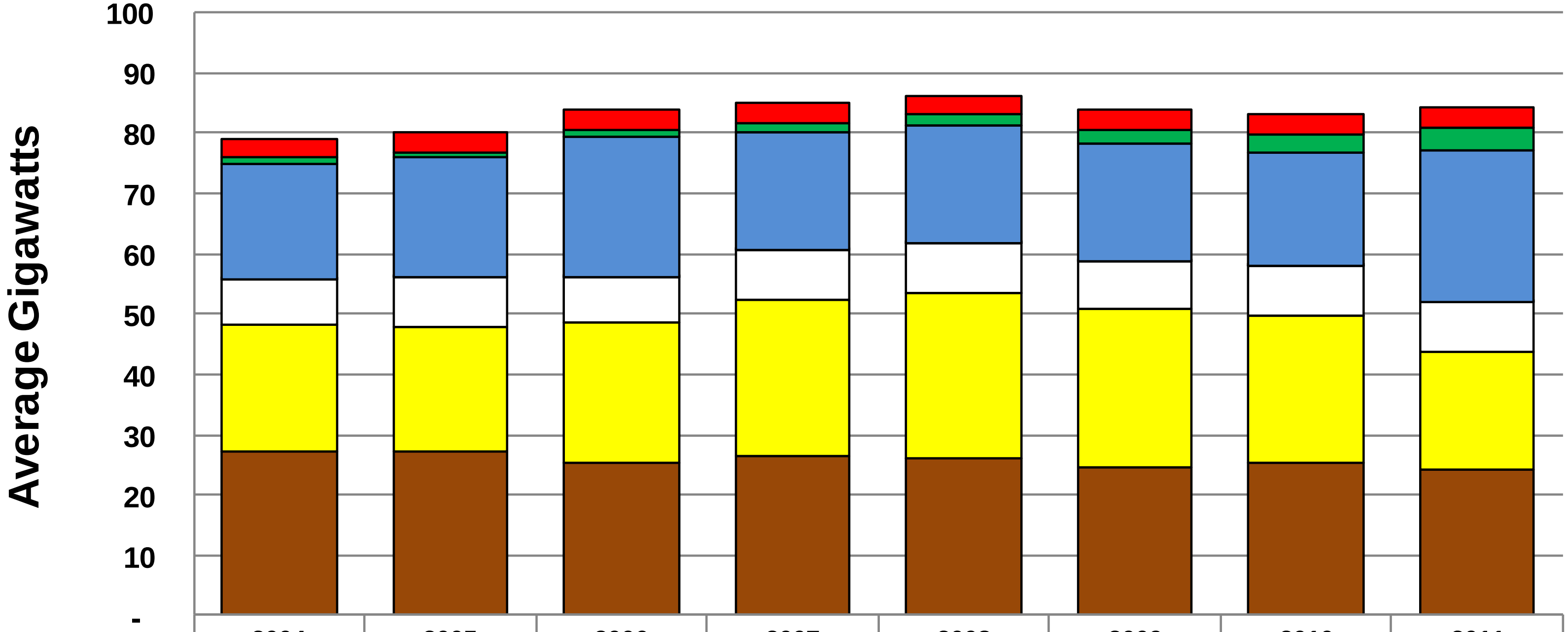
US Coal Generation Displacement



Between 2007 and 2011, Coal Generation decreased 32 aGW

Source: SNL

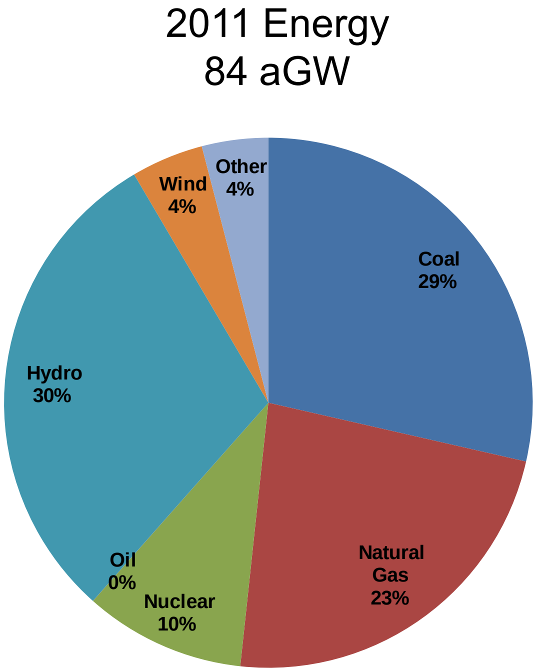
US Western Interconnect Generation by Fuel Type

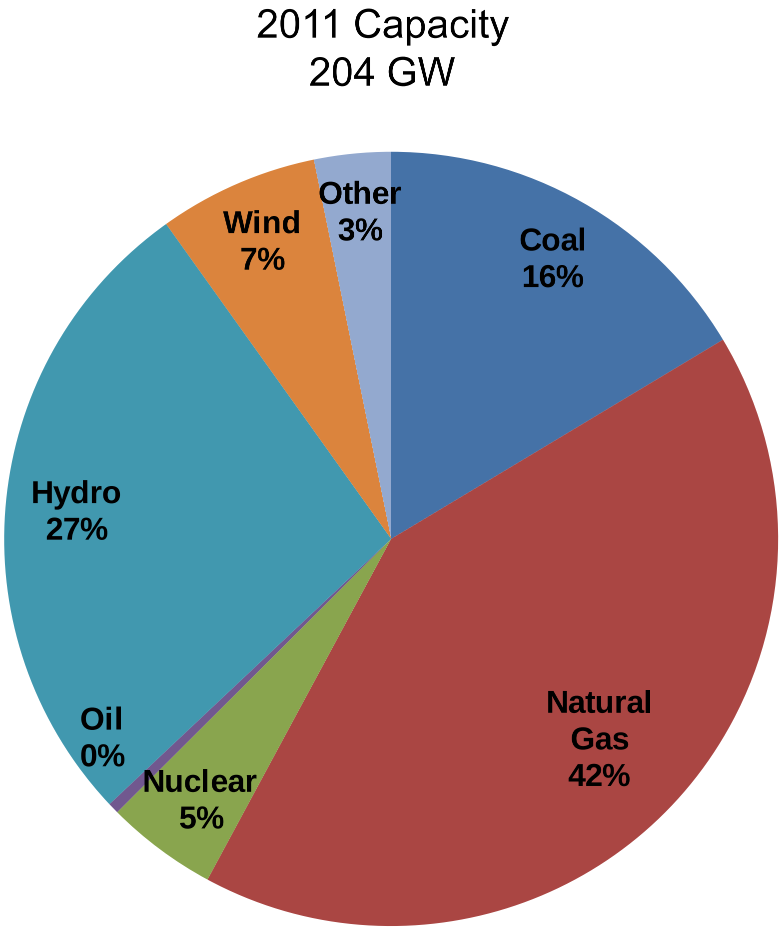


	2004	2005	2006	2007	2008	2009	2010	2011
🟥 Other	3	3	3	3	3	3	3	3
🟩 Wind	1	1	1	1	2	2	3	4
🟦 Hydro	19	20	23	20	19	19	19	25
■ Oil	0	0	0	0	0	0	0	0
□ Nuclear	8	8	7	8	8	8	8	8
🟨 Natural Gas	21	21	23	26	27	26	24	20
🟫 Coal	27	27	25	26	26	25	25	24
Total	79	80	84	85	86	84	83	84

Source: SNL

US Western Interconnect Energy Versus Capacity



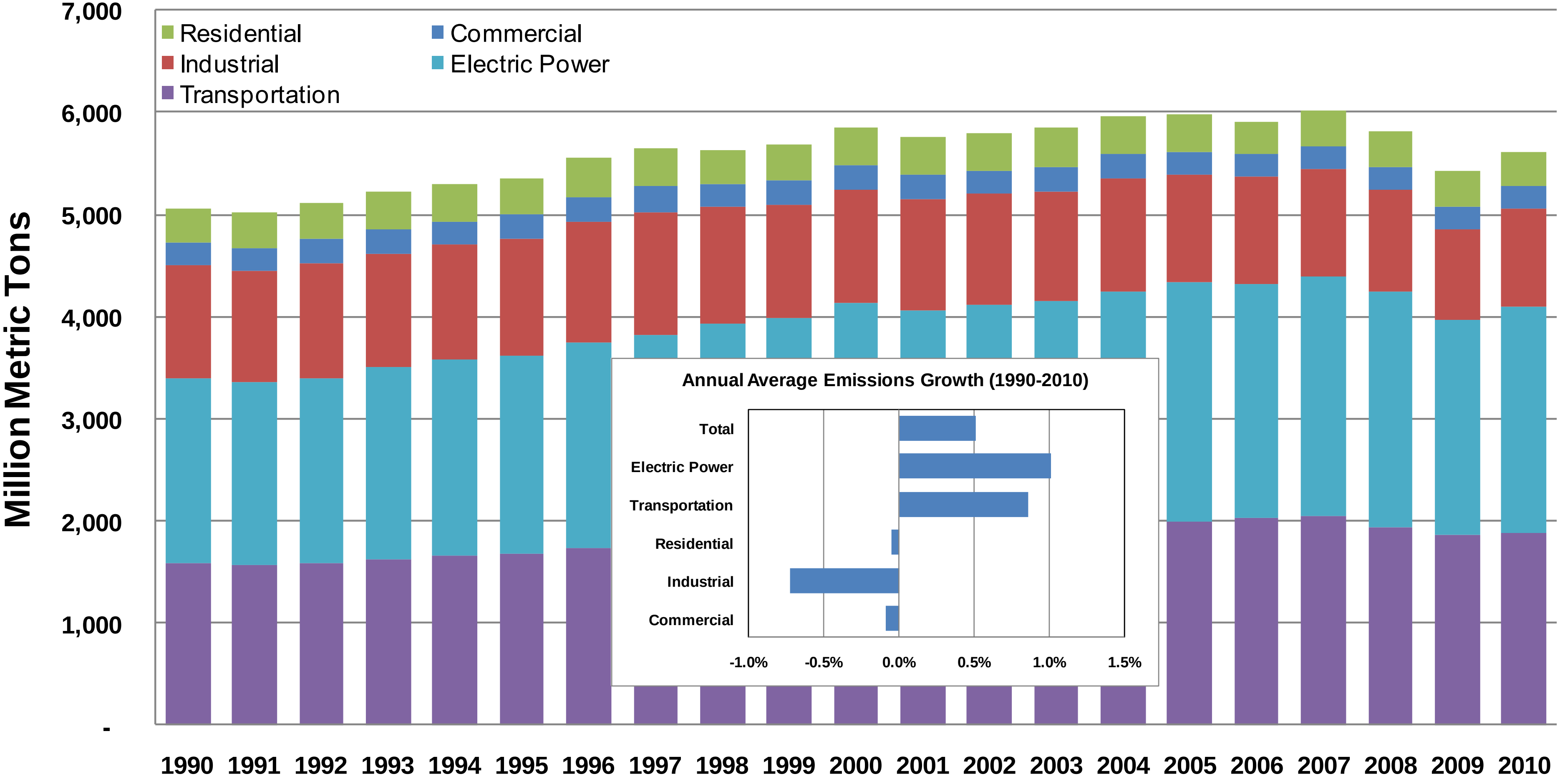


Actual coincident peak was 128.7 GW (8/25/2011)

Source: SNL

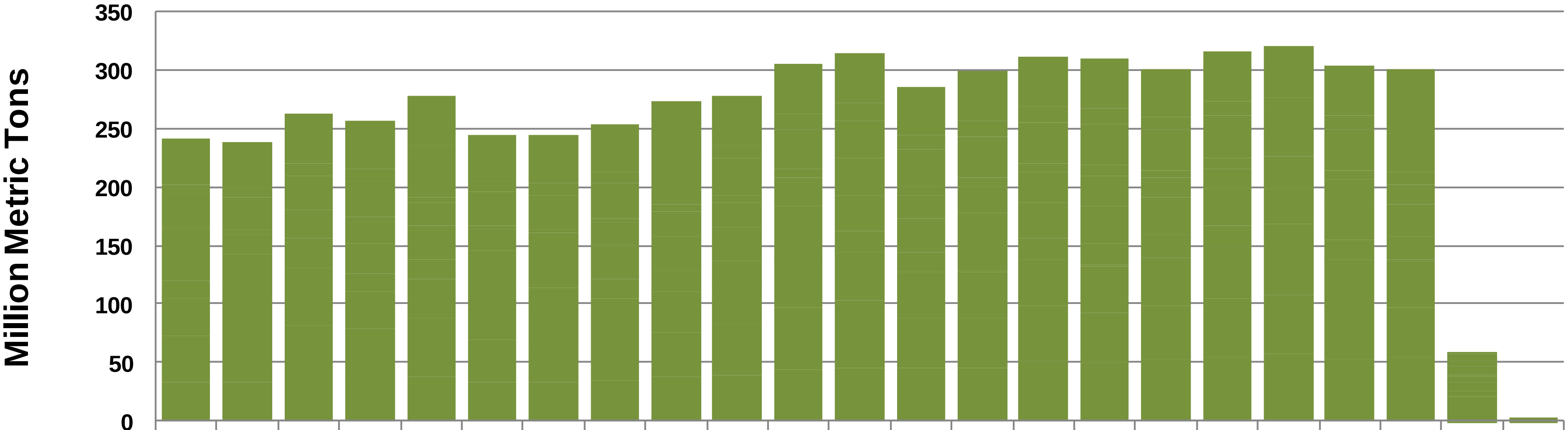
Historic US Greenhouse Gas Emissions

Electric power in 2011 is 4.6% below 2010, A total of 11% reduction since 2007



Source: EIA

Western Electric Generation Greenhouse Gas Emissions



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Delta	AAGR
🟩 WY	40	39	43	41	43	40	41	41	44	42	44	44	42	43	44	43	43	43	44	41	42	2.3	0.3%
🟩 WA	8	8	10	10	12	8	11	9	12	11	14	14	11	14	14	14	9	12	13	13	13	5.5	2.8%
🟩 UT	29	28	30	30	31	29	30	31	31	32	33	32	33	34	34	35	35	37	38	35	34	4.9	0.8%
🟩 OR	2	4	5	4	5	3	3	3	6	6	7	9	6	8	8	8	6	10	10	9	10	7.8	8.8%
🟩 NV	17	18	19	18	20	18	20	19	21	21	25	24	21	23	25	26	17	17	18	18	17	-0.1	0.0%
🟩 NM	27	23	26	27	28	27	28	29	29	30	31	30	28	30	30	32	32	31	30	32	29	1.7	0.3%
🟩 MT	16	17	18	15	18	17	14	16	18	18	17	18	16	18	19	19	19	20	20	17	20	3.7	1.1%
🟩 ID	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	1	1	0.7	41.1%
🟩 CO	31	31	32	32	33	33	34	34	35	35	39	41	40	40	40	40	41	42	41	38	39	8.1	1.2%
🟩 CA	40	38	46	42	49	37	33	36	39	43	53	58	44	43	46	42	46	50	51	48	43	3.2	0.4%
🟩 AZ	33	33	35	37	38	32	32	35	37	39	44	45	45	46	51	50	52	55	57	52	54	21.4	2.6%
TOTAL	242	238	263	256	278	245	245	253	273	278	306	315	286	299	312	310	302	316	321	303	301	59.2	1.1%

Source: EIA

Electric Market Modeling

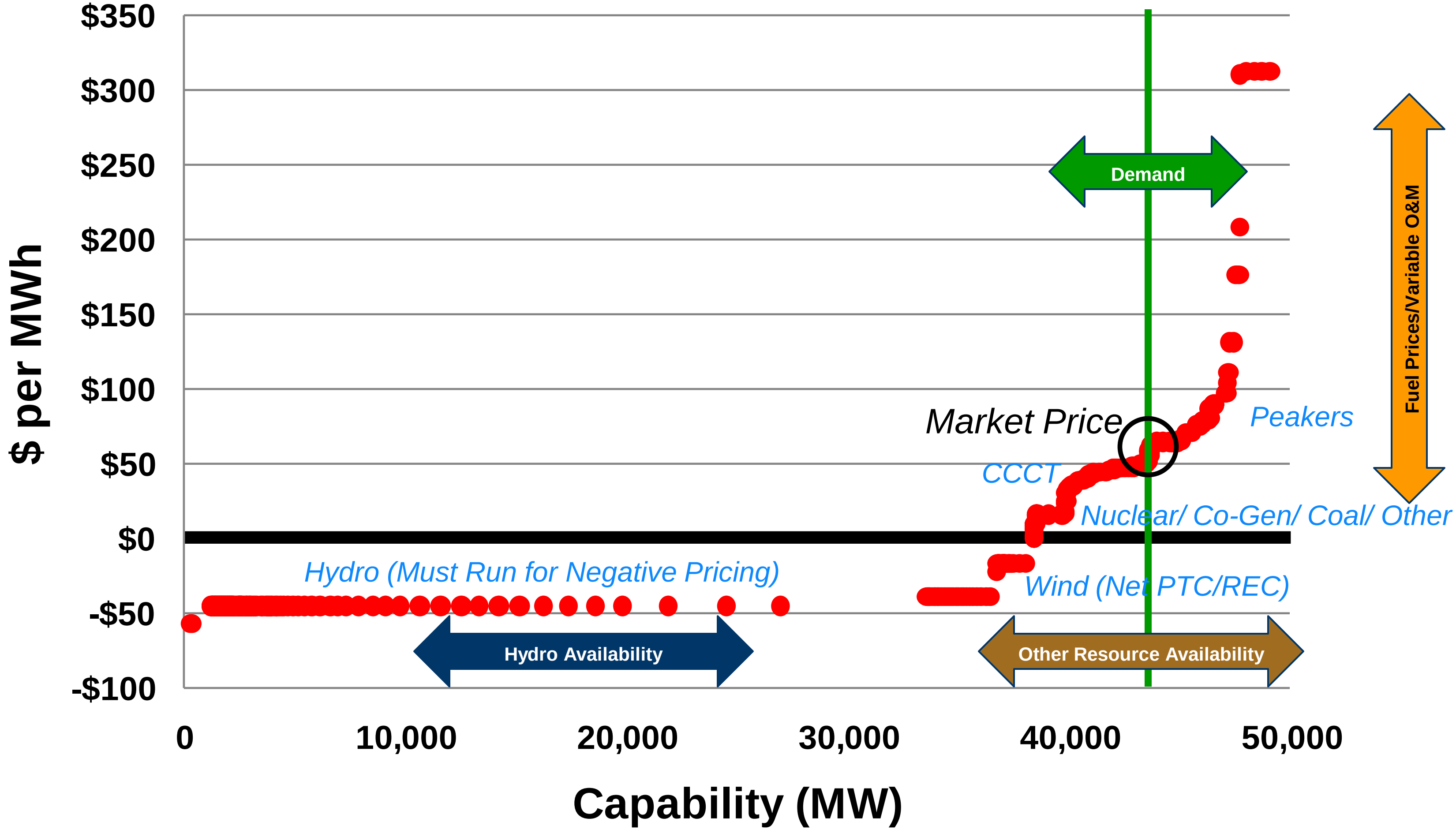
AURORAxmp® by EPIS, Inc.
COMPREHENSIVE POWER FORECASTING

- 3rd party software- EPIS, Inc.
- Electric market fundamentals- production cost model
- Simulates generation dispatch to meet load
- Outputs:
  - Market prices
  - Regional energy mix
  - Transmission usage
  - Greenhouse gas emissions
  - Power plant margins, generation levels, fuel costs
  - Avista’s variable power supply costs

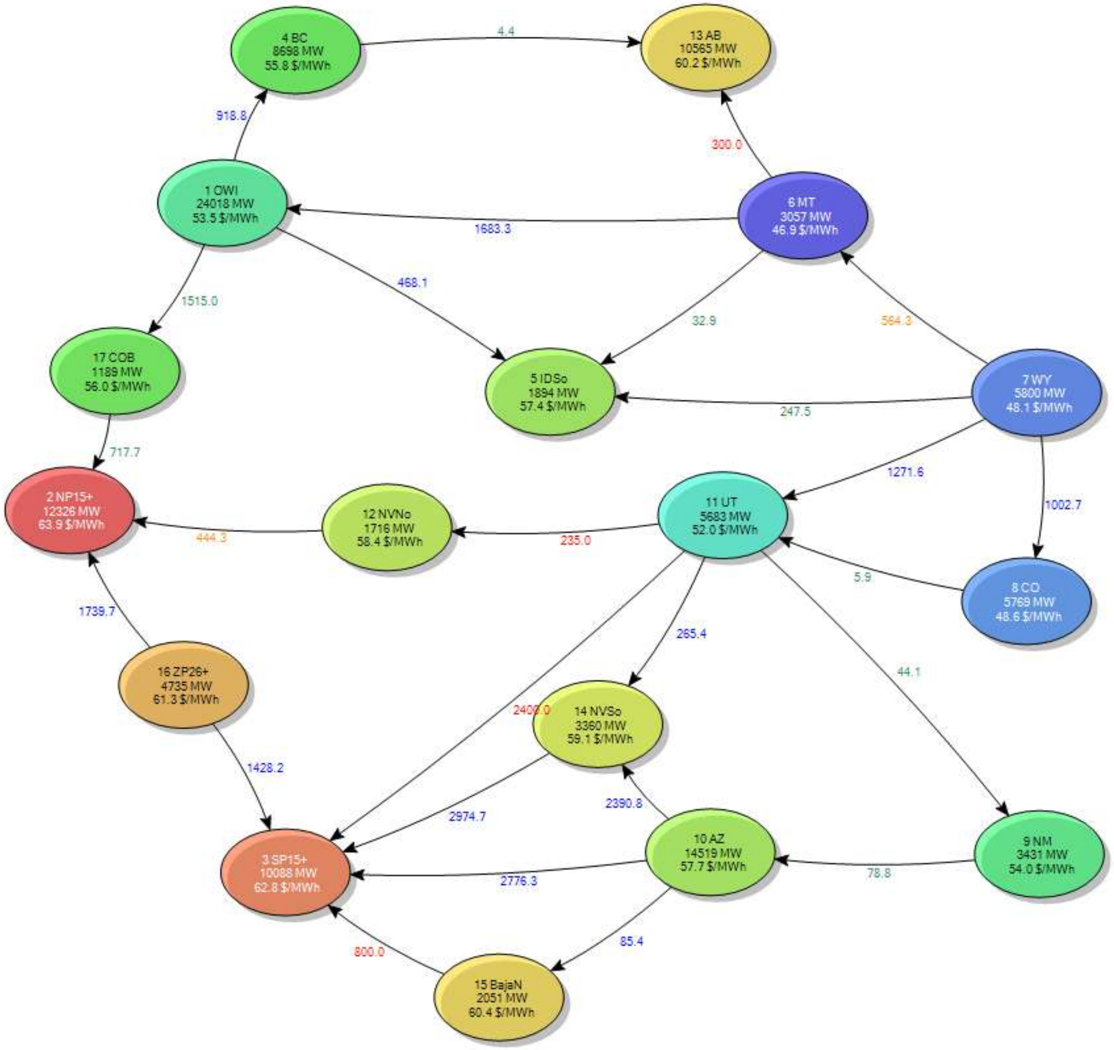
Stochastic Approach

- Simulate Western Electric market hourly for next 20 years (2014-33)
  - That is 175,248 hours for each study
- Model 500 potential outcomes
  - Variables include fuel prices, loads, wind, hydro, outages, inflation
  - Simulating 87.6 million hours
- Run time is about 5 days on 27 processors
- Why do we do this?
  - Allows for complete financial evaluation of resource alternatives
  - Without stochastic prices we cannot account for tail risk

Aurora Pricing Example- Supply/Demand Curve



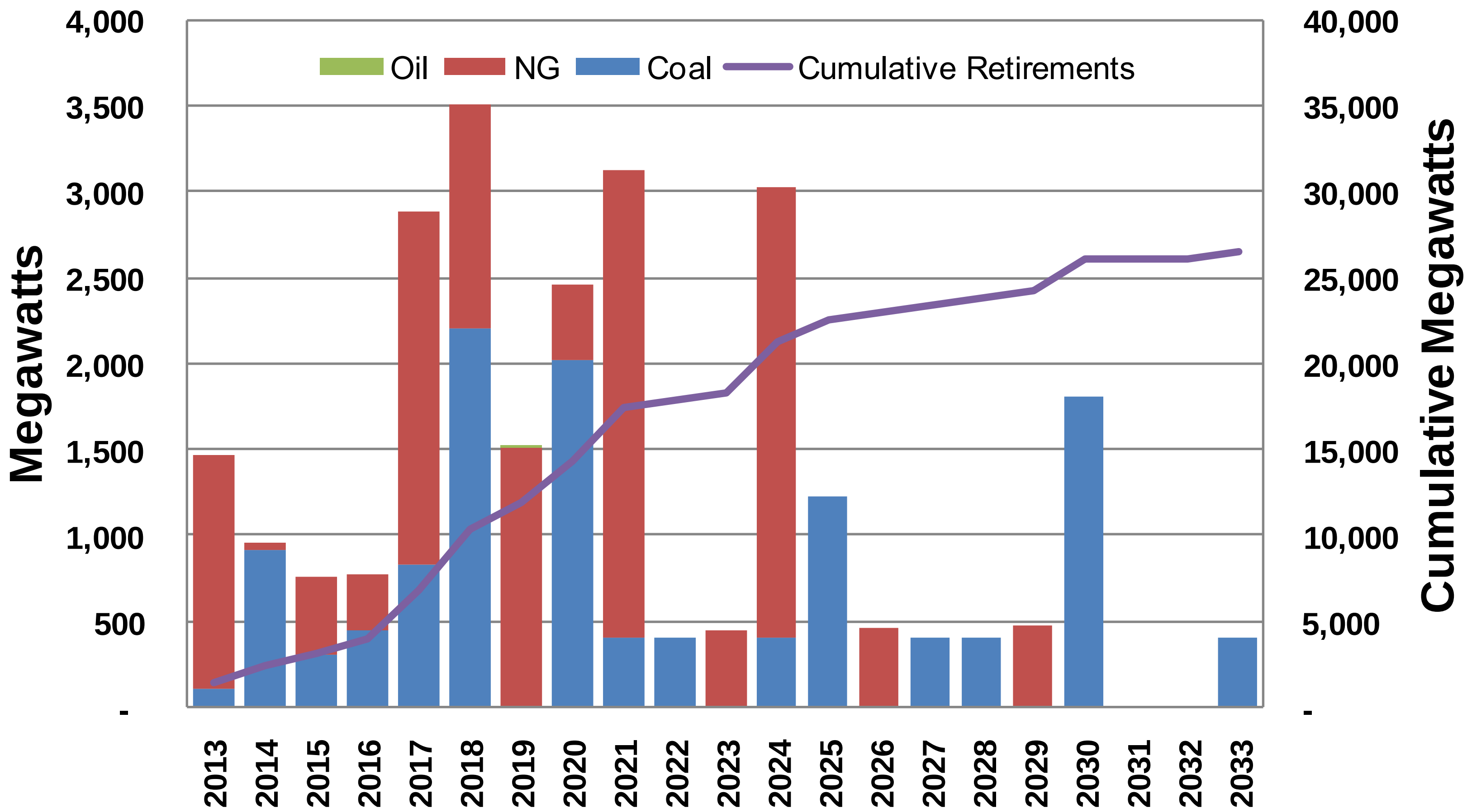
Modeled Western Interconnect Topology



Greenhouse Gas Emissions Modeling

- No national greenhouse gas tax or cap & trade is modeled
- California, Alberta, and British Columbia greenhouse gas reduction schemes are modeled
- Assumes some coal plants will retire due to EPA regulations
  - Plants were selected for retirement based on fuel costs, emission control technology and its location
- Assume certain natural gas once-through-cooling plants in California will be retired over time
- State RPS requirements met mostly by wind & solar

Forecasted Resource Retirements



Natural Gas retirements are related to lost generation from once-through-cooling technology phase out in California

New Resource Alternatives

Western Interconnect

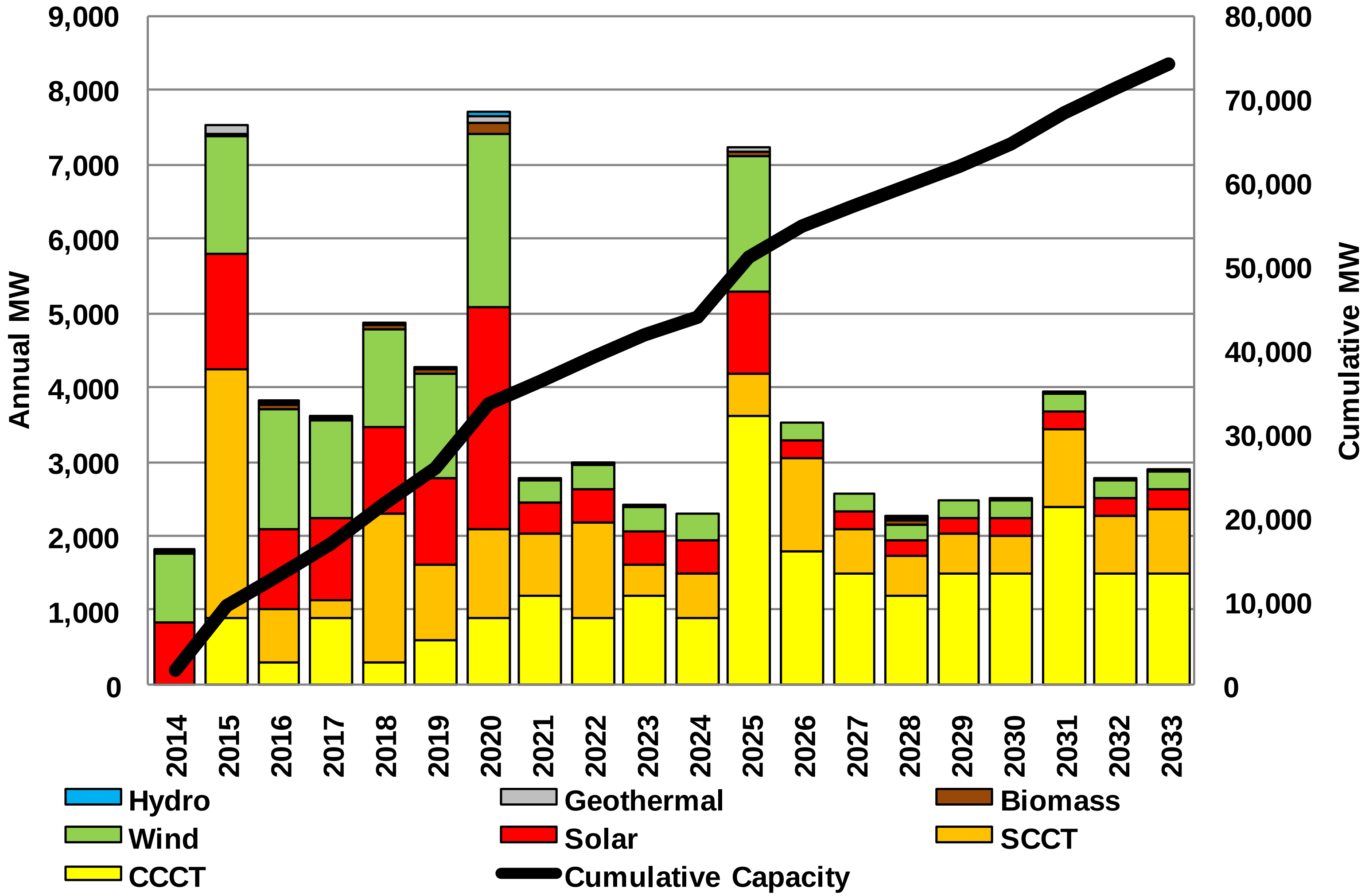
Resource alternatives to meet Renewable Portfolio Standards

- Wind
- Solar
- Biomass
- Geothermal
- Hydro Upgrades

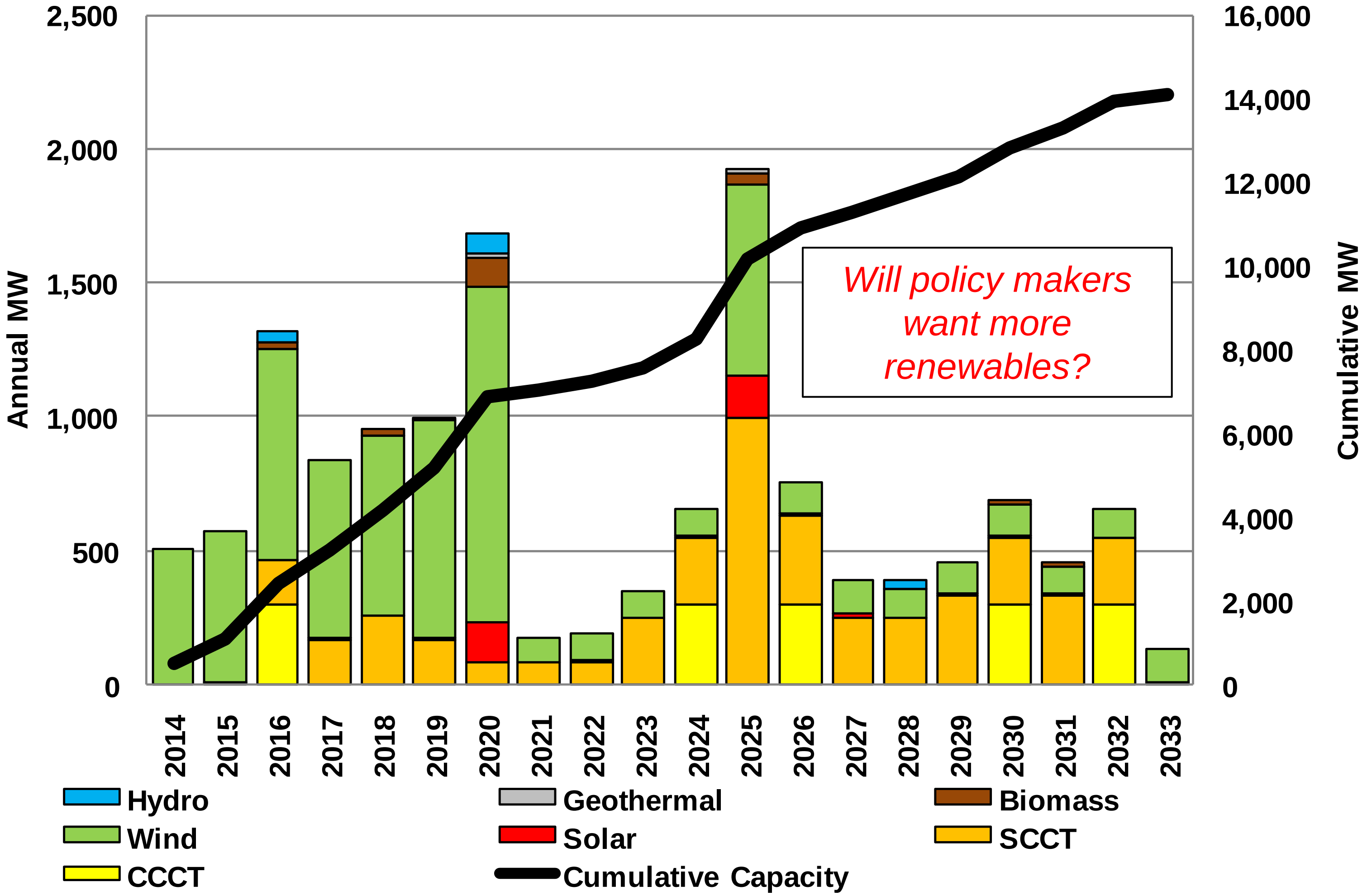
Resource alternatives to meet regional capacity requirements

- Combined Cycle
- Simple Cycle (Aero, Frame, Hybrid)
- Solar
- Wind (non RPS states)
- Nuclear
- Coal IGCC with Sequestration
- Energy Storage (not modeled)

Resource Additions (Western Interconnect)

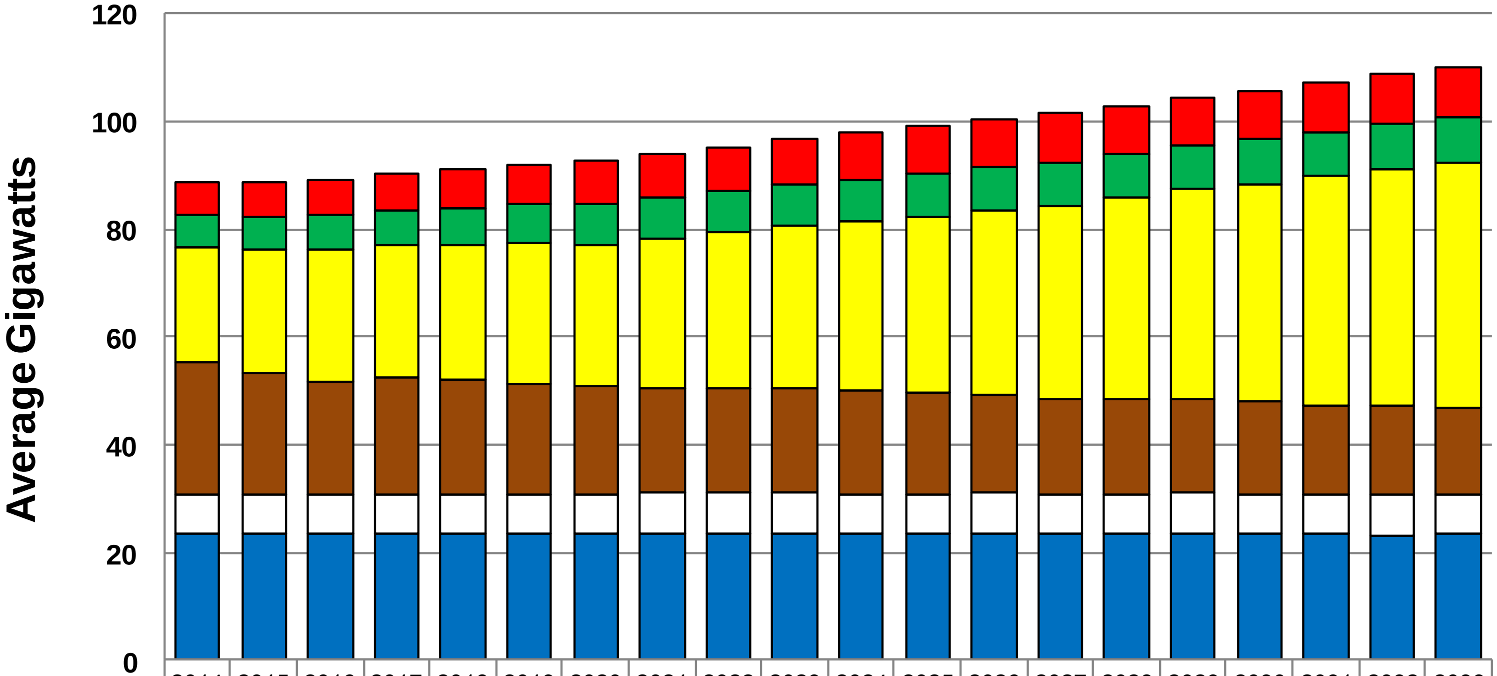


Resource Additions (Northwest)- Maintain 5% LOLP



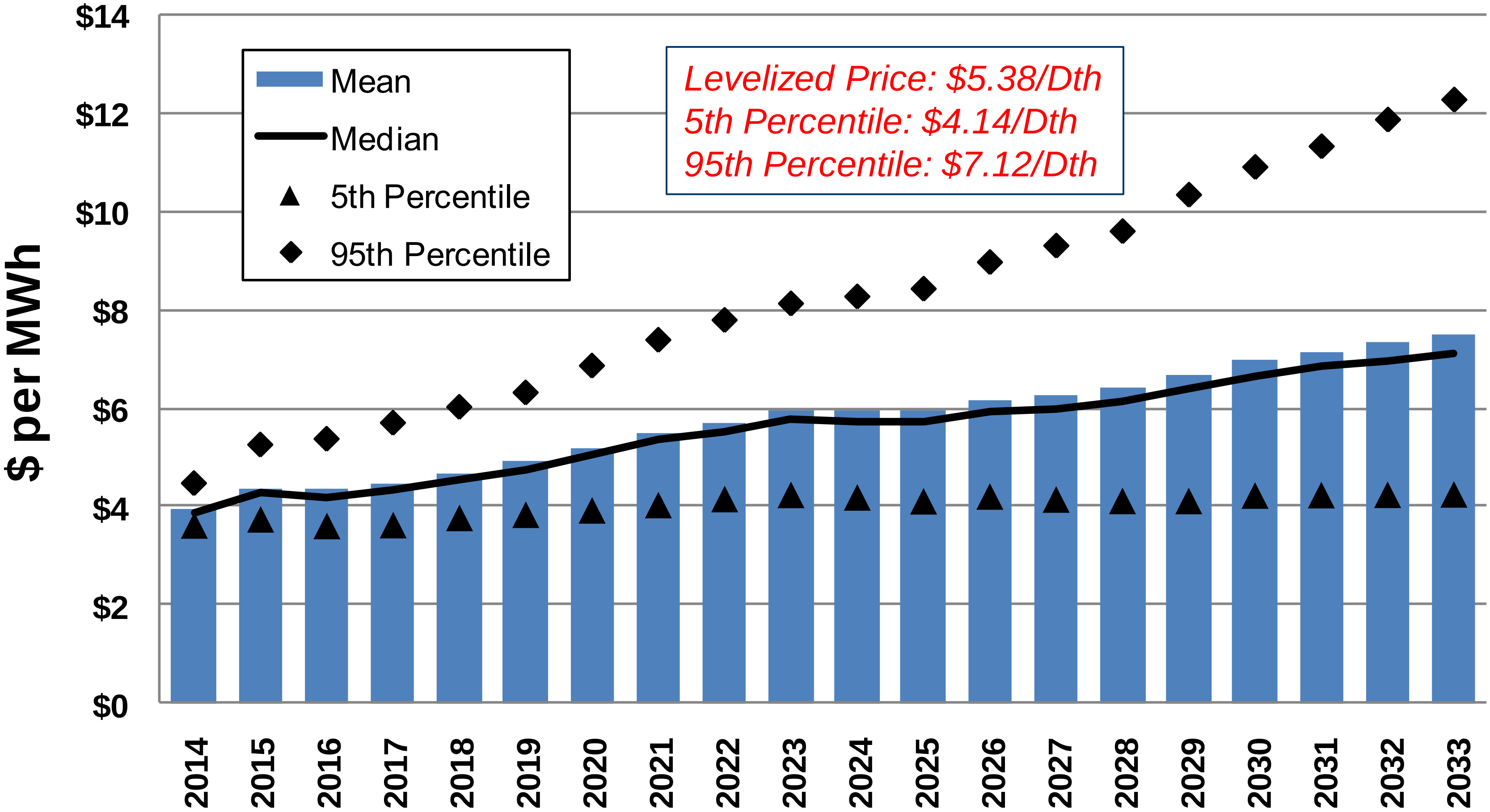
Will policy makers want more renewables?

US Western Interconnect Resource Forecasted Output



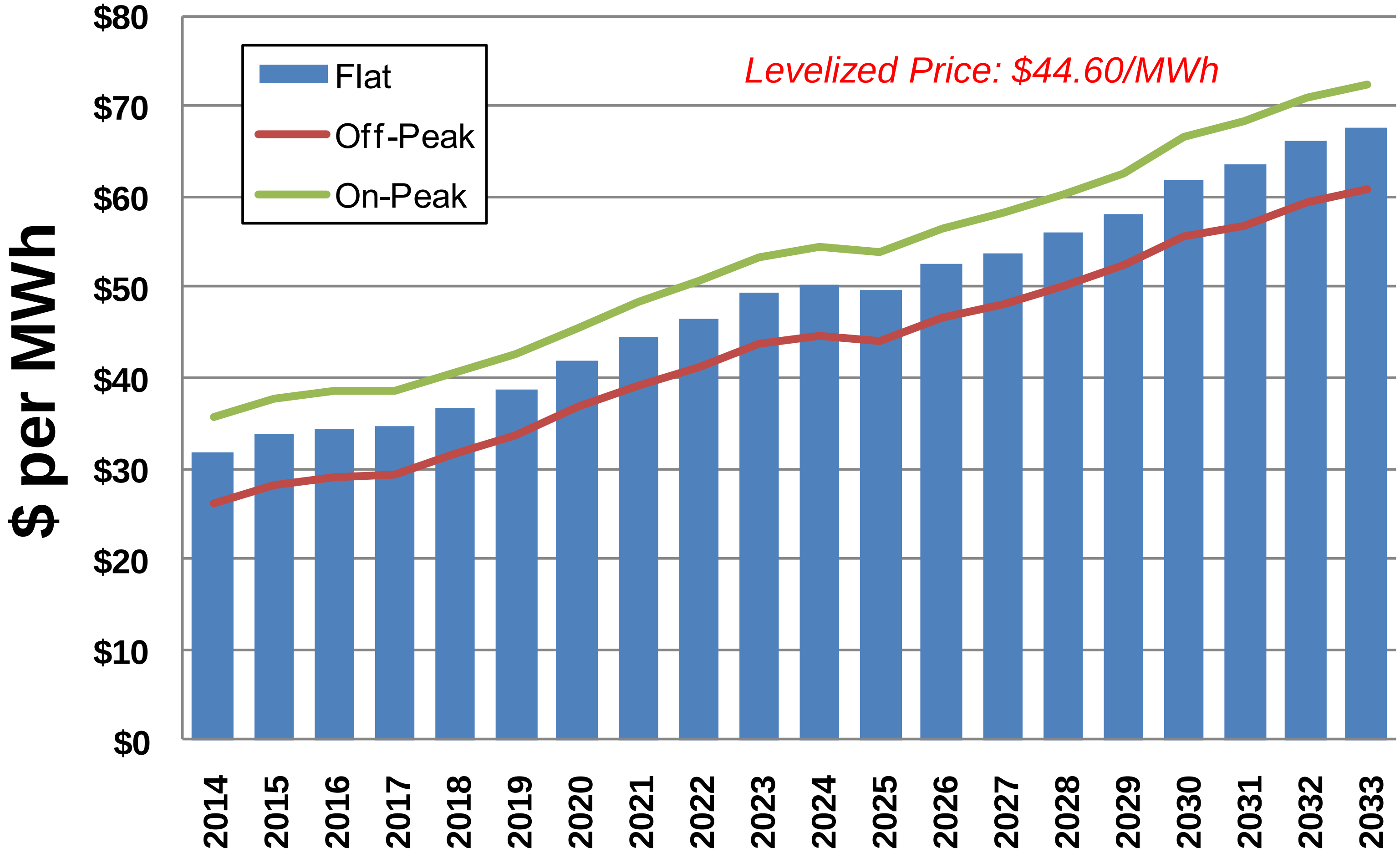
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
🟥Other	6	6	7	7	7	7	8	8	8	8	9	9	9	9	9	9	9	9	9	9
🟩Wind	6	6	6	7	7	7	7	7	8	8	8	8	8	8	8	8	8	8	8	8
■Oil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
🟨Natural Gas	21	23	24	25	25	26	26	28	29	30	32	33	34	36	37	39	40	43	44	45
🟫Coal	25	23	21	21	21	20	20	20	19	19	19	19	18	18	18	17	17	16	16	16
□Nuclear	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
🟦Hydro	23	23	24	23	23	24	23	24	24	24	23	23	24	23	23	24	23	23	23	23
Total	89	89	89	90	91	92	93	94	95	97	98	99	100	101	103	105	106	107	109	110

Stanfield Natural Gas Price Forecast

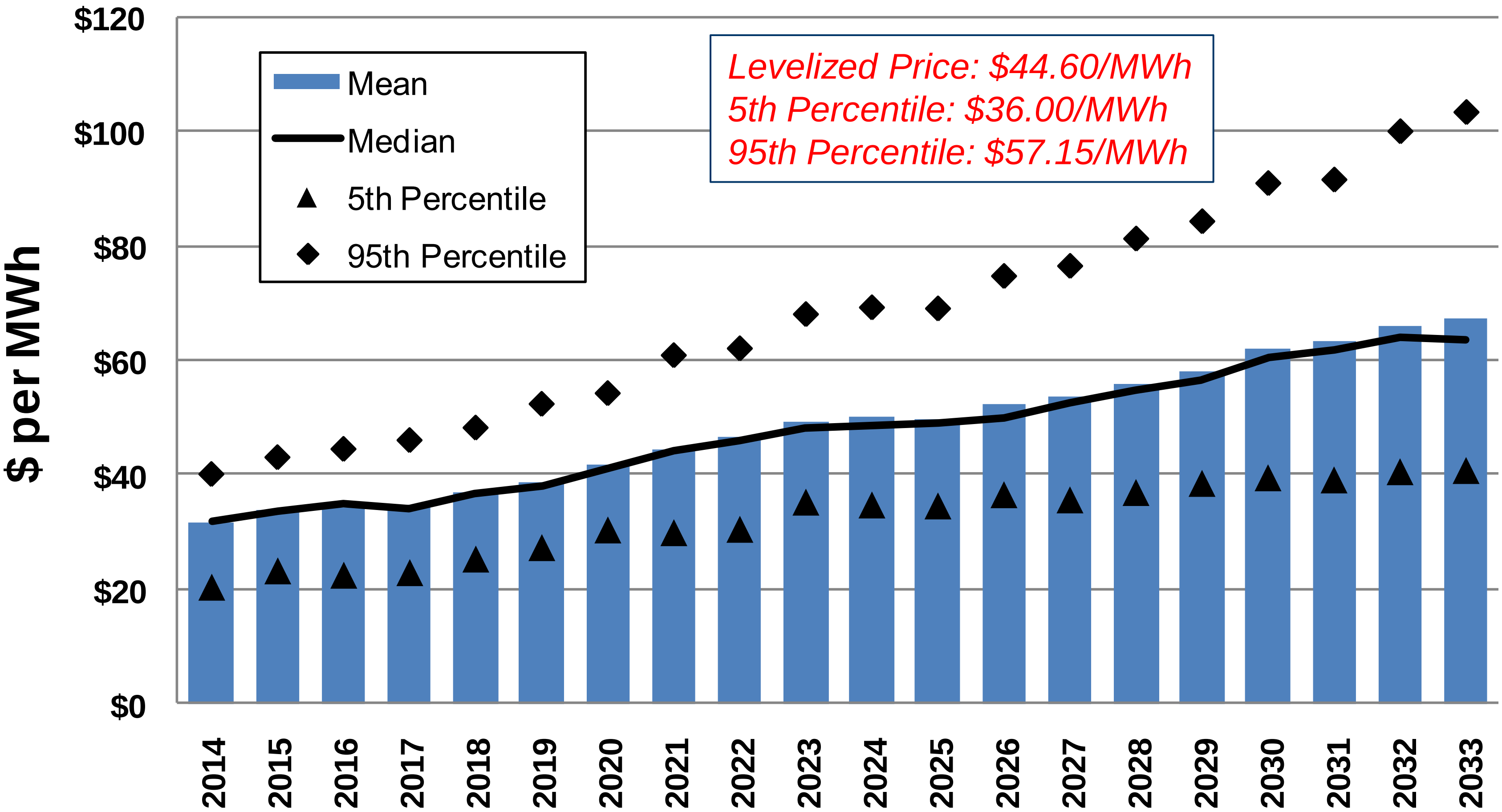


Levelized Price: $5.38/Dth
5th Percentile: $4.14/Dth
95th Percentile: $7.12/Dth

Mid-Columbia Annual Average Forecast



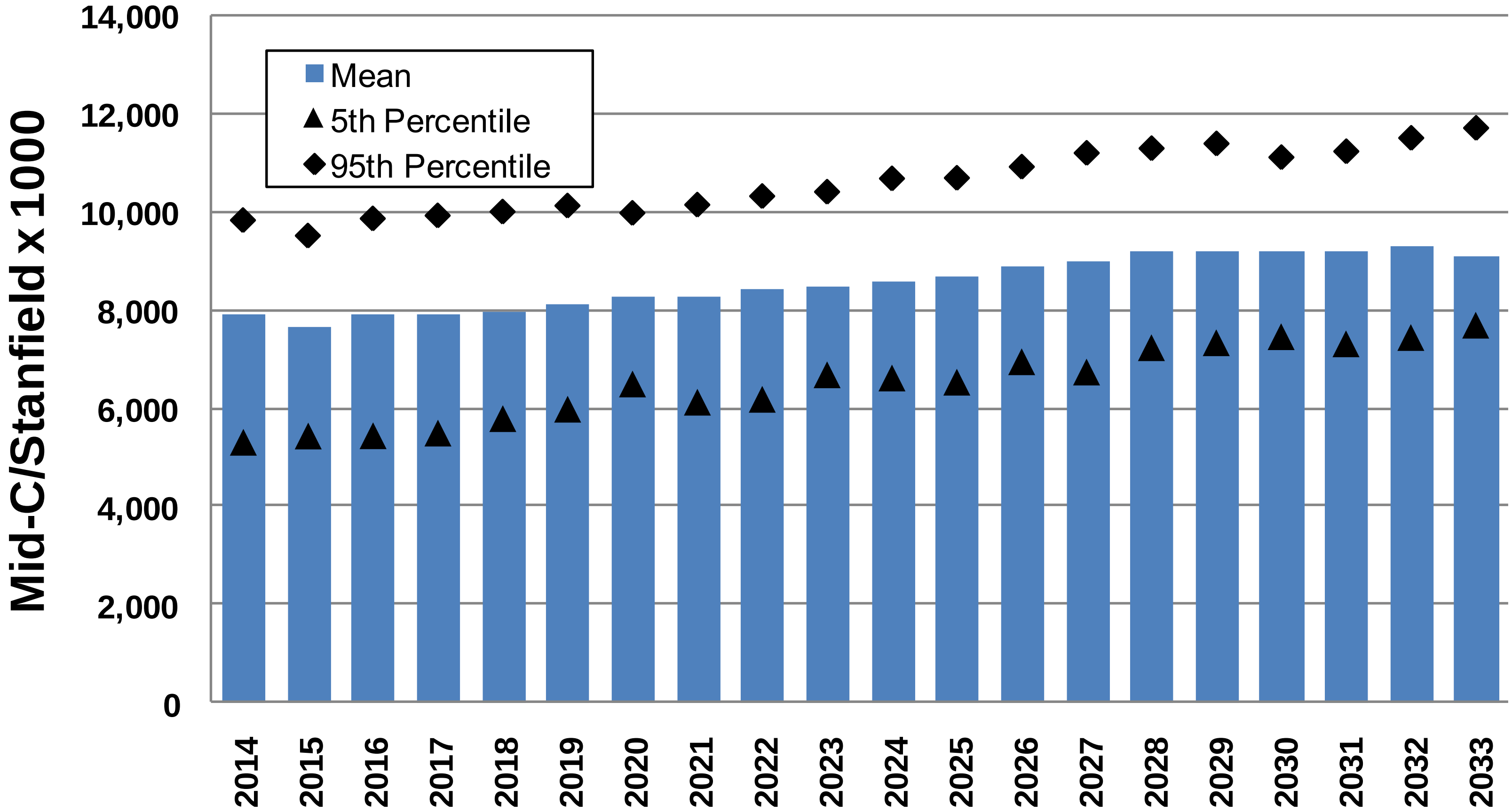
Mid-Columbia Electric Prices: Stochastic Results



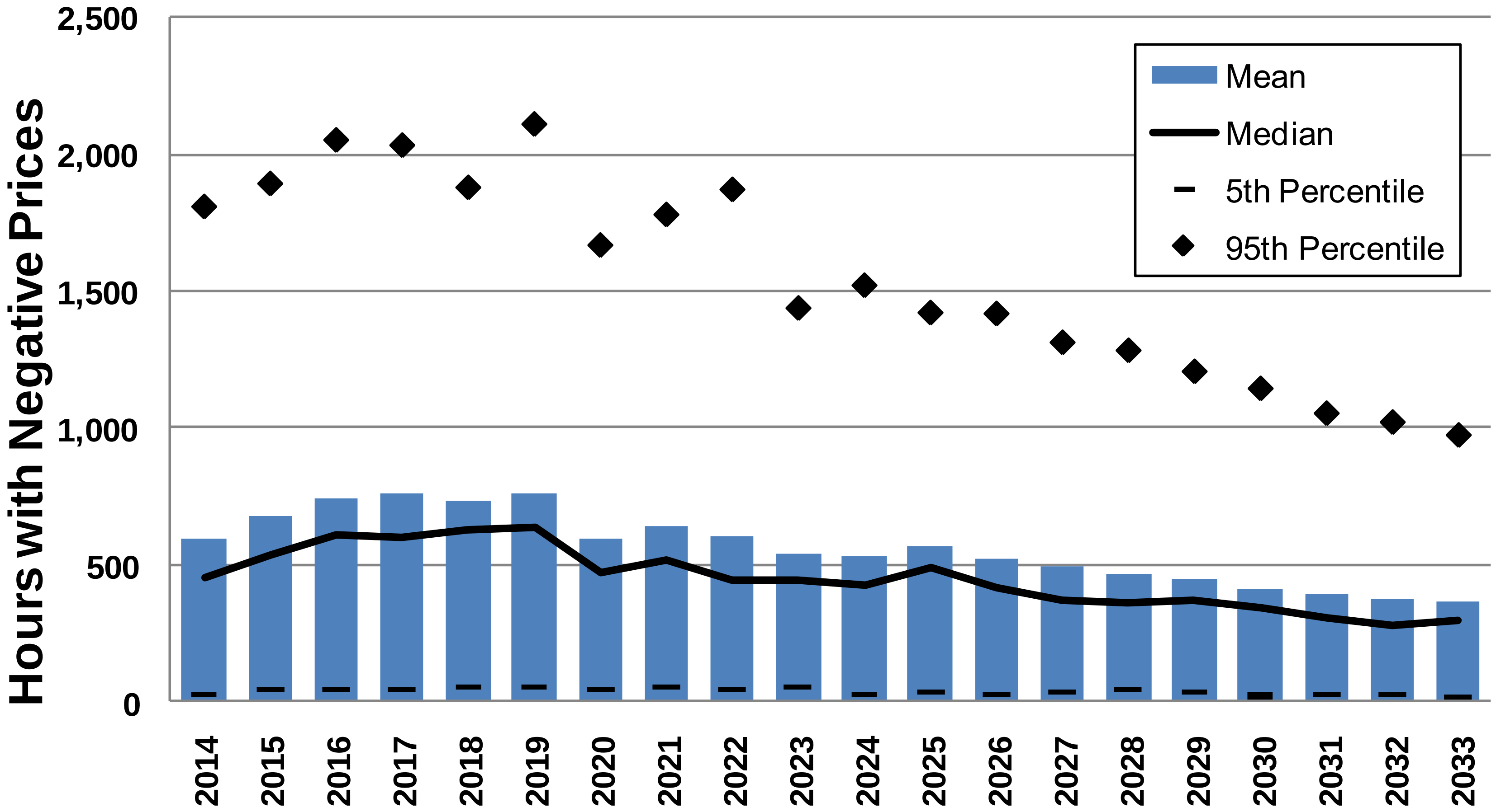
Levelized Price: $44.60/MWh
5th Percentile: $36.00/MWh
95th Percentile: $57.15/MWh

DRAFT

Implied Market Heat Rate (Mid-C / Stanfield x 1,000)

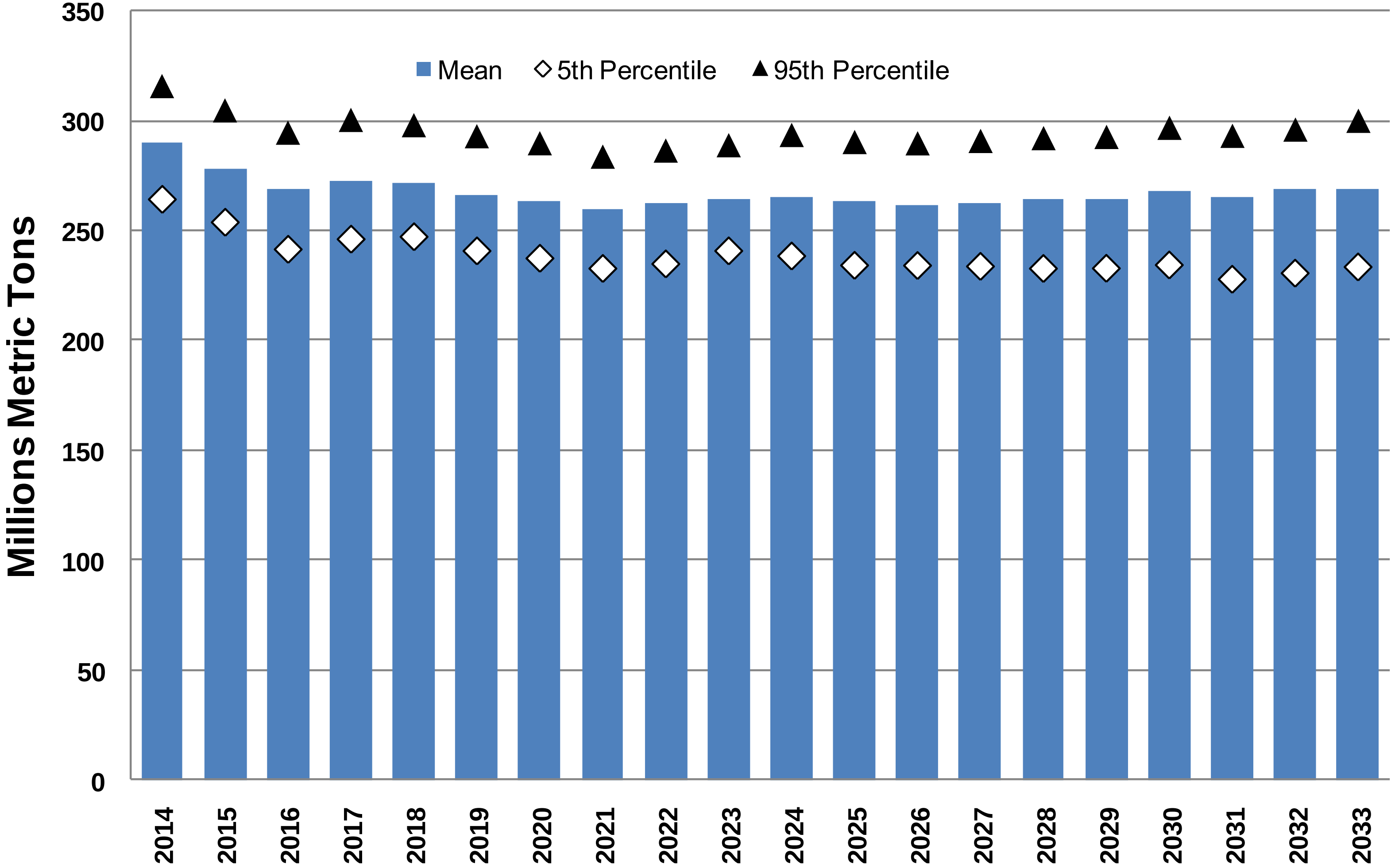


Mid-Columbia Negative Electric Pricing

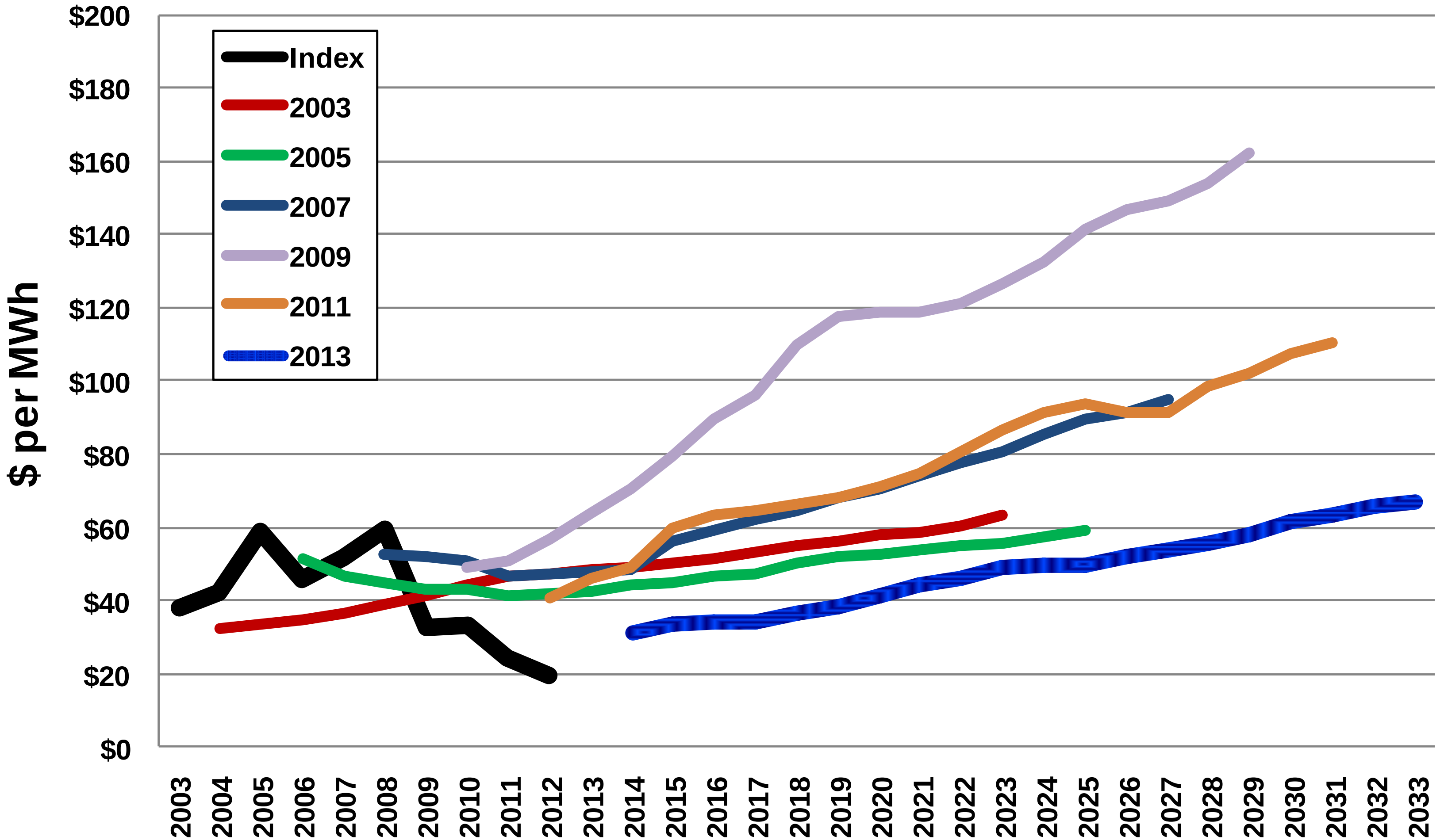


2011 had 202 hours and 2012 had 552 according to Powerdex hourly index

Western US Greenhouse Gas Emissions Forecast

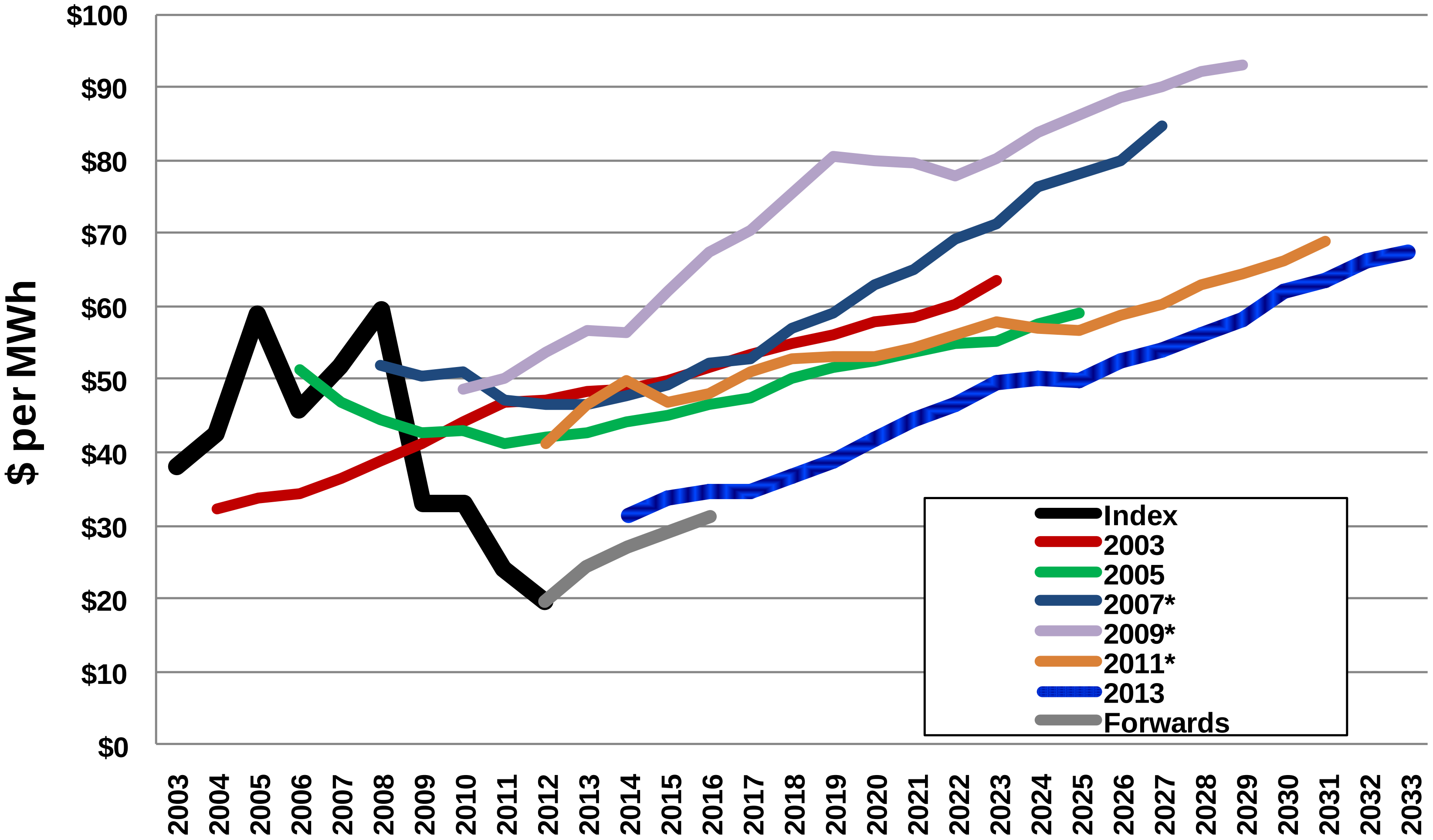


IRP Electric Price Forecast Comparison



2007-2011 IRP expected case forecasts included carbon reduction schemes increasing market prices

IRP Price Forecast Comparison (No CO_2 Pricing)



TAC PRESENTATION

New Resource Integration – Transmission

SYSTEM PLANNING

Prepared by Richard Maguire and the Avista System Planning Group

February 6, 2013

Federal Standards of Conduct

1. No non-public transmission information can be shared with the Avista Merchant Function
2. There are Avista Merchant Function personnel in attendance
3. We can’t share non-public transmission information today

Agenda

- Introduction to Avista System Planning
- Engineering of Local Generation Requests
- Recent Avista Projects
- Large Generation Interconnection Agreement (LGIA) Queue
- Integrated Resource Plan (IRP) Generation Requests
- Future Transmission Planning Initiatives

Introduction to Avista System Planning

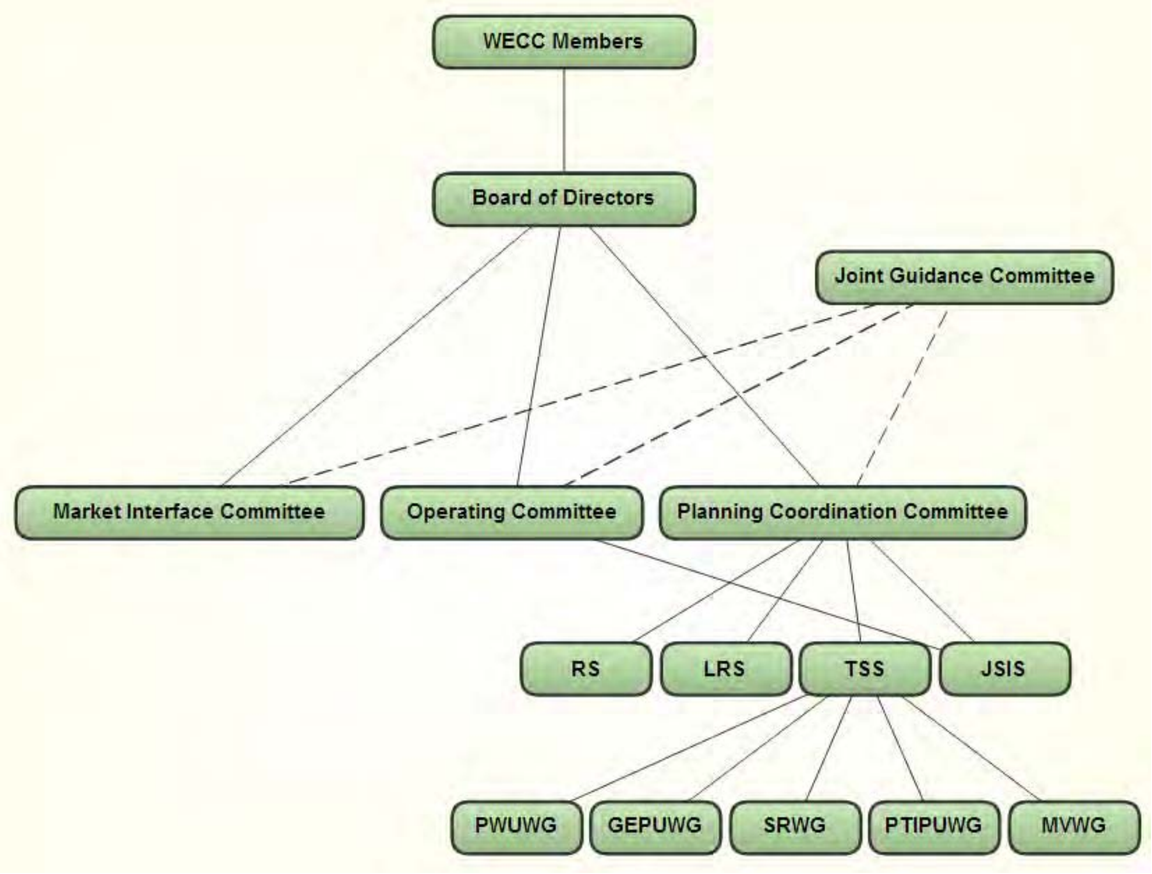
Broad Scope of What We Care About:

- Avista System Performance
- Federal, Regional, and State Compliance
- Regional Transmission System Coordination

Introduction to Avista System Planning

Regional Coordination

- WECC
- NWPP
- CG
- NTTG
- etc.



Introduction to Avista System Planning

We also spend our time:

- Developing internal standards and processes
- Engineering the transmission system
- Engineering the distribution system
- Managing Avista assets
- Projecting future loads and resources
- Engineering local generation requests

Agenda

- Introduction to Avista System Planning
- Engineering of Local Generation Requests
- Recent Avista Projects
- Large Generation Interconnection Request (LGIR) Queue
- Integrated Resource Plan (IRP) Generation Requests
- Future Transmission Planning Initiatives

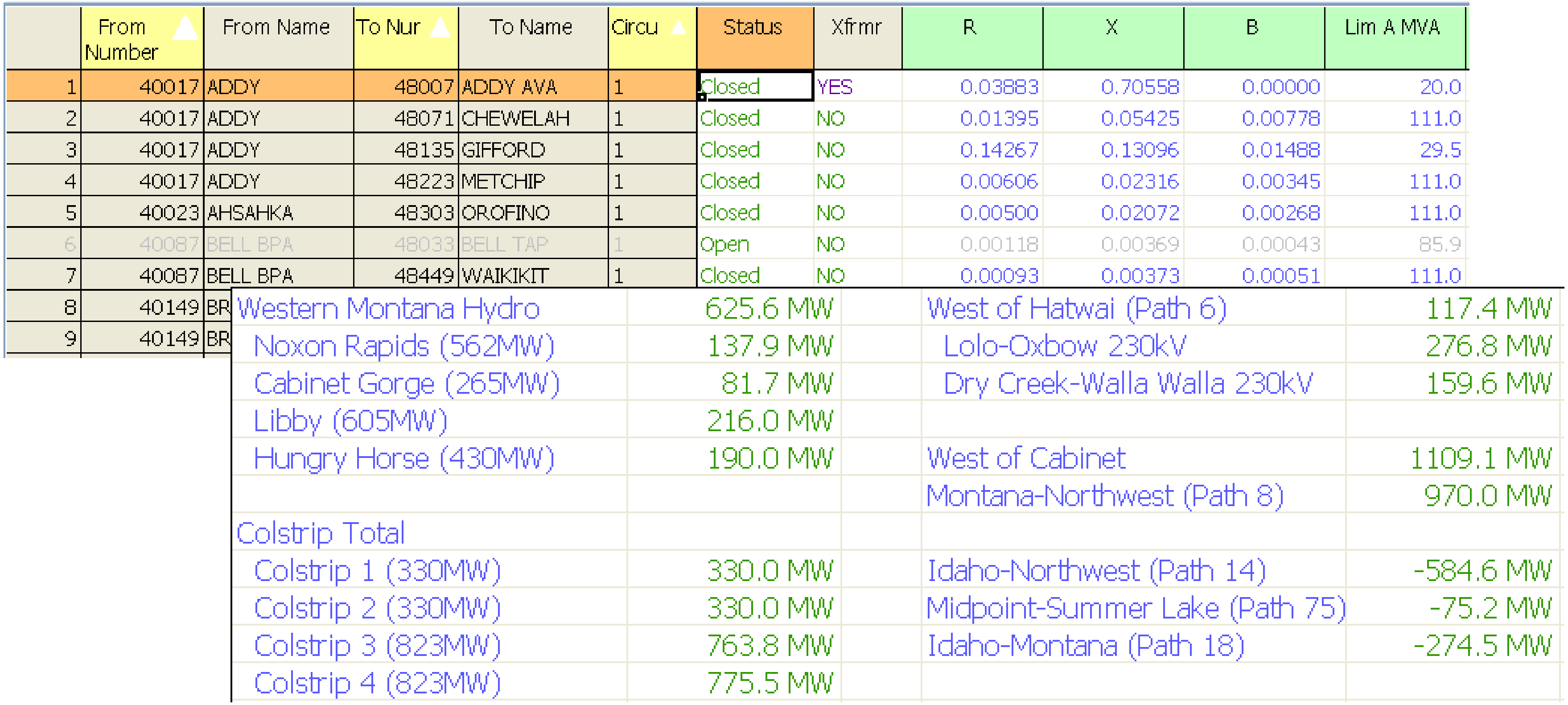
Engineering of Local Generation Requests

Typical Process for Generation Requests

- We generally get requests via two sources:
  - Internal via the IRP requests
  - External *and Internal* via LGIA requests
- We hold a scoping meeting to discuss particulars
- We outline a study plan
- We augment WECC approved cases for our studies
- We analyze the system against the standards
- We publish our findings and recommendations

Engineering of Local Generation Requests

Case Development

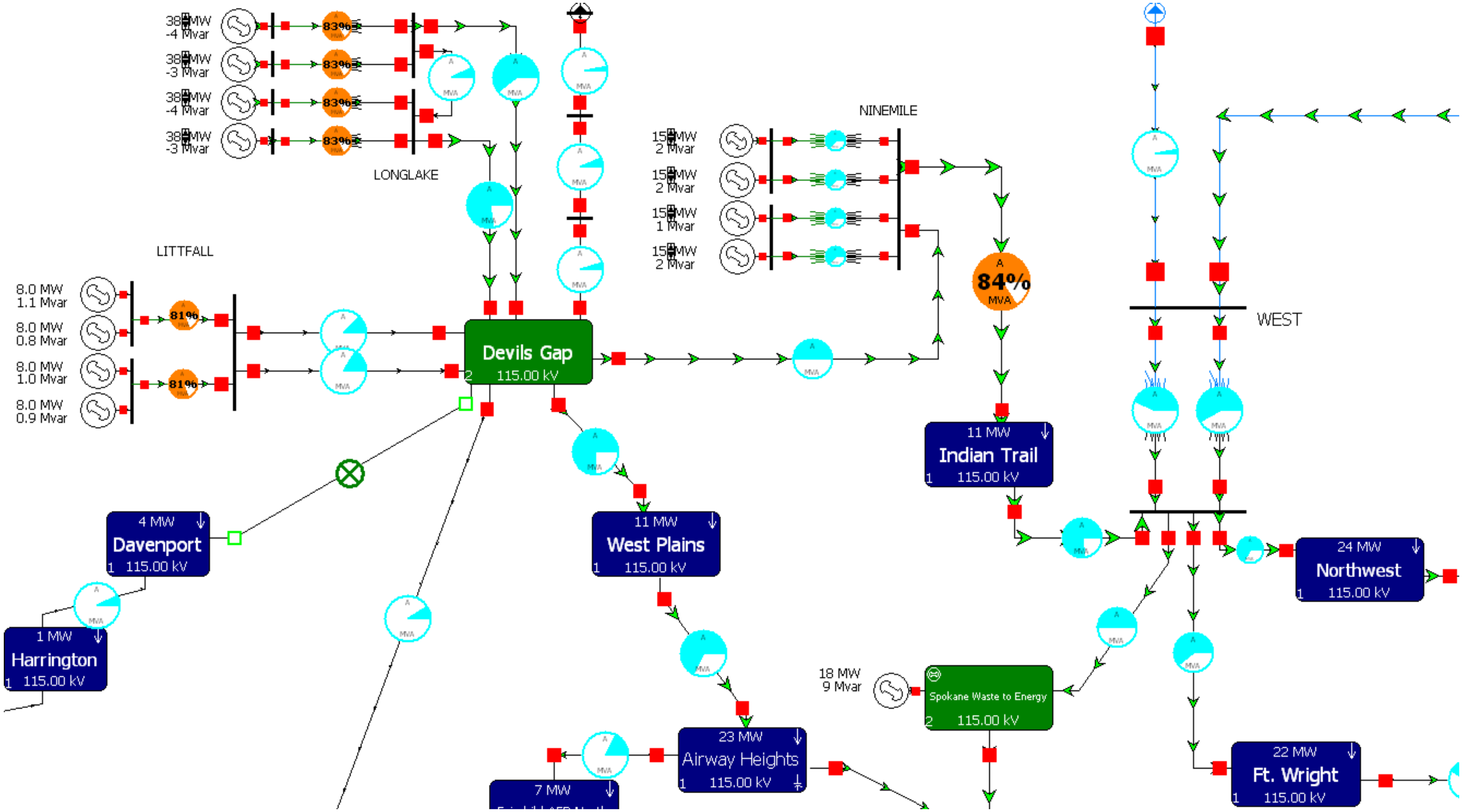


	From Number	From Name	To Nur	To Name	Circu	Status	Xfrmr	R	X	B	Lim A MVA
1	40017	ADDY	48007	ADDY AVA	1	Closed	YES	0.03883	0.70558	0.00000	20.0
2	40017	ADDY	48071	CHEWELAH	1	Closed	NO	0.01395	0.05425	0.00778	111.0
3	40017	ADDY	48135	GIFFORD	1	Closed	NO	0.14267	0.13096	0.01488	29.5
4	40017	ADDY	48223	METCHIP	1	Closed	NO	0.00606	0.02316	0.00345	111.0
5	40023	AHSAHKA	48303	OROFINO	1	Closed	NO	0.00500	0.02072	0.00268	111.0
6	40087	BELL BPA	48033	BELL TAP	1	Open	NO	0.00118	0.00369	0.00043	85.9
7	40087	BELL BPA	48449	WAIKIKIT	1	Closed	NO	0.00093	0.00373	0.00051	111.0
8	40149	BR									
9	40149	BR									

Western Montana Hydro	625.6 MW	West of Hatwai (Path 6)	117.4 MW
Noxon Rapids (562MW)	137.9 MW	Lolo-Oxbow 230kV	276.8 MW
Cabinet Gorge (265MW)	81.7 MW	Dry Creek-Walla Walla 230kV	159.6 MW
Libby (605MW)	216.0 MW		
Hungry Horse (430MW)	190.0 MW	West of Cabinet	1109.1 MW
		Montana-Northwest (Path 8)	970.0 MW
Colstrip Total			
Colstrip 1 (330MW)	330.0 MW	Idaho-Northwest (Path 14)	-584.6 MW
Colstrip 2 (330MW)	330.0 MW	Midpoint-Summer Lake (Path 75)	-75.2 MW
Colstrip 3 (823MW)	763.8 MW	Idaho-Montana (Path 18)	-274.5 MW
Colstrip 4 (823MW)	775.5 MW		

Engineering of Local Generation Requests

Case Analysis

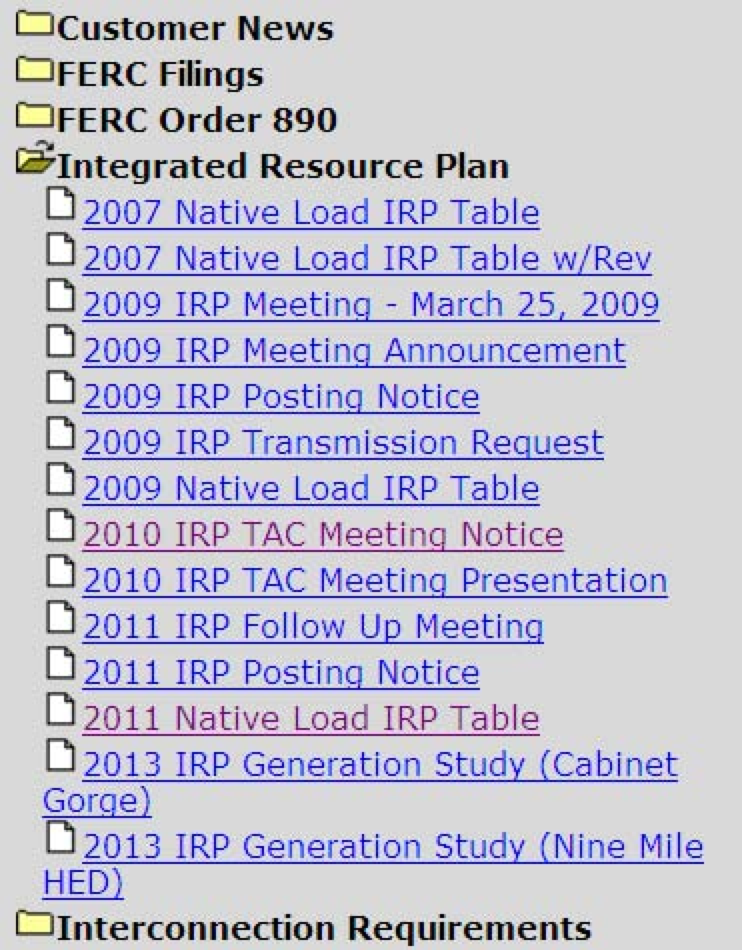


Engineering of Local Generation Requests

- 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)
  - Standards are “Request Agnostic”
- Potential Sanctions:
  - Up to $1M Per Day Per Occurrence
  - Mitigation Plan must be provided and progress demonstrated

Engineering of Local Generation Requests

Publish Results



Customer News

FERC Filings

FERC Order 890

Integrated Resource Plan

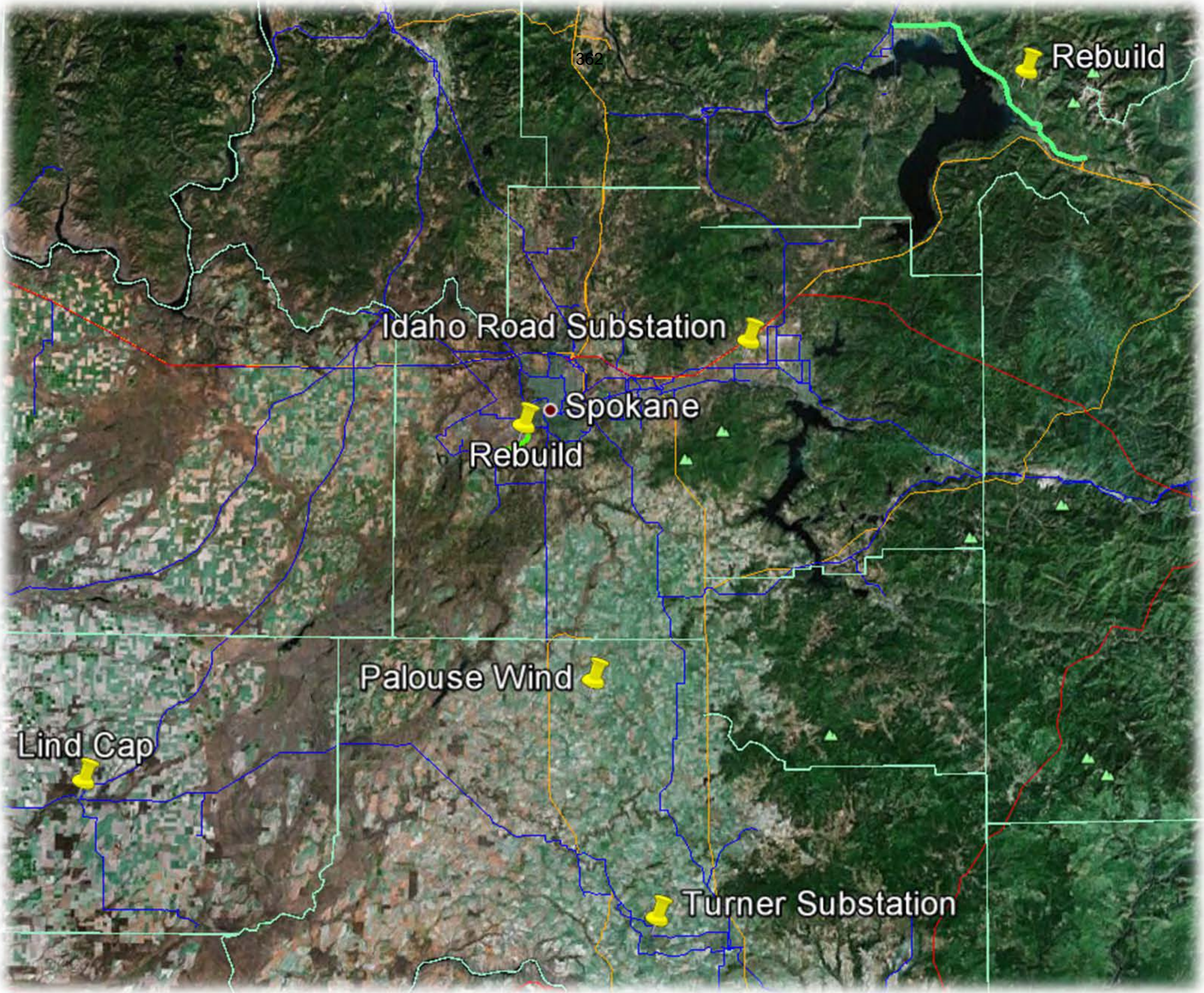
- 2007 Native Load IRP Table
- 2007 Native Load IRP Table w/Rev
- 2009 IRP Meeting - March 25, 2009
- 2009 IRP Meeting Announcement
- 2009 IRP Posting Notice
- 2009 IRP Transmission Request
- 2009 Native Load IRP Table
- 2010 IRP TAC Meeting Notice
- 2010 IRP TAC Meeting Presentation
- 2011 IRP Follow Up Meeting
- 2011 IRP Posting Notice
- 2011 Native Load IRP Table
- 2013 IRP Generation Study (Cabinet Gorge)
- 2013 IRP Generation Study (Nine Mile HED)

Interconnection Requirements

www.oasis.oati.com/avat/index.html

Agenda

- Introduction to Avista System Planning
- Engineering of Local Generation Requests
- Recent Avista Projects
- Large Generation Interconnection Request (LGIR) Queue
- Integrated Resource Plan (IRP) Generation Requests
- Future Transmission Planning Initiatives


Rebuild
Idaho Road Substation
Spokane
Rebuild
Palouse Wind
Lind Cap
Turner Substation

Recent Avista Projects

- Palouse Wind:
  - 58 turbines
  - 105 MW
  - Thornton 230 kV Substation
    - $4.35M
  - Benewah – Shawnee 230 kV Transmission Line


STATION SERVICE 2
WARNING

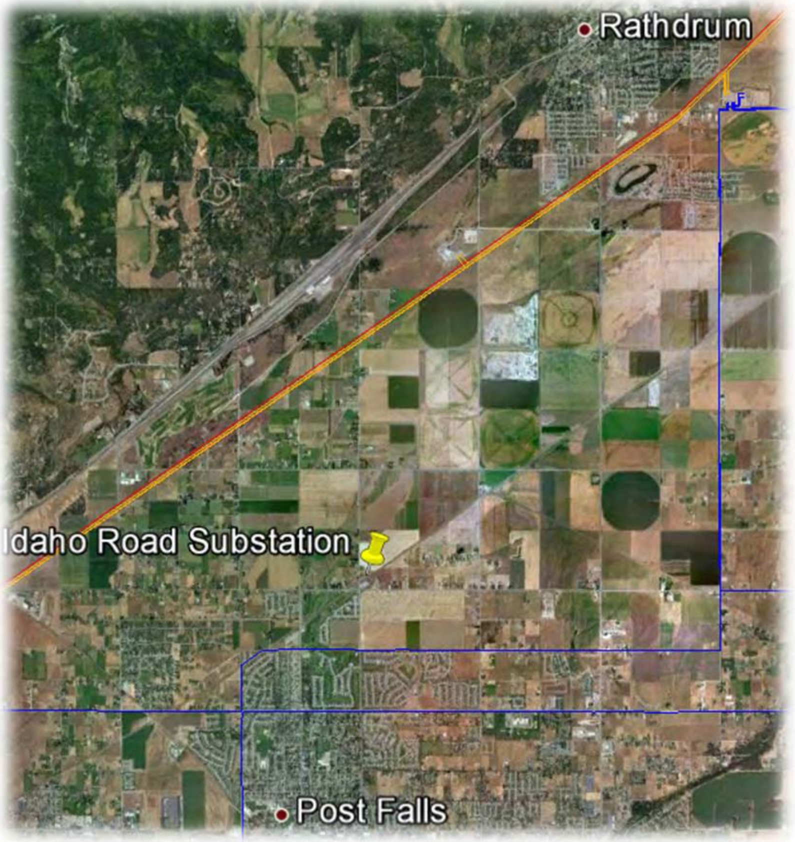
Recent Avista Projects

Lind Capacitor Bank

- ~$750K

Recent Avista Projects

Idaho Road 115 kV Substation



Recent Avista Projects

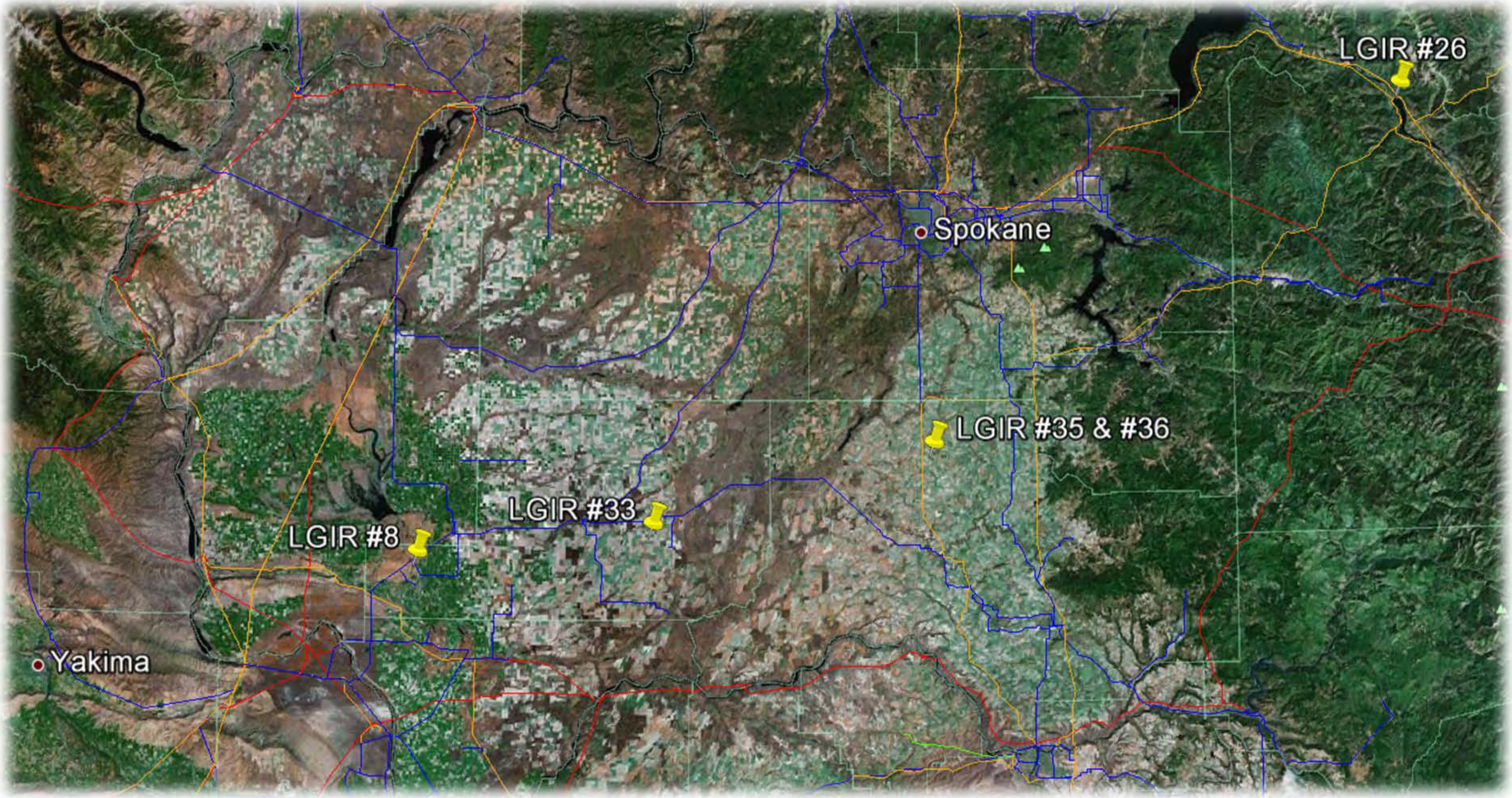
Turner 115 kV Substation

Recent Avista Projects

115 kV Transmission Lines

Agenda

- Introduction to Avista System Planning
- Engineering of Local Generation Requests
- Recent Avista Projects
- Large Generation Interconnection Request (LGIR) Queue
- Integrated Resource Plan (IRP) Generation Requests
- Future Transmission Planning Initiatives


LGIR #26
Spokane
LGIR #35 & #36
LGIR #33
LGIR #8
Yakima

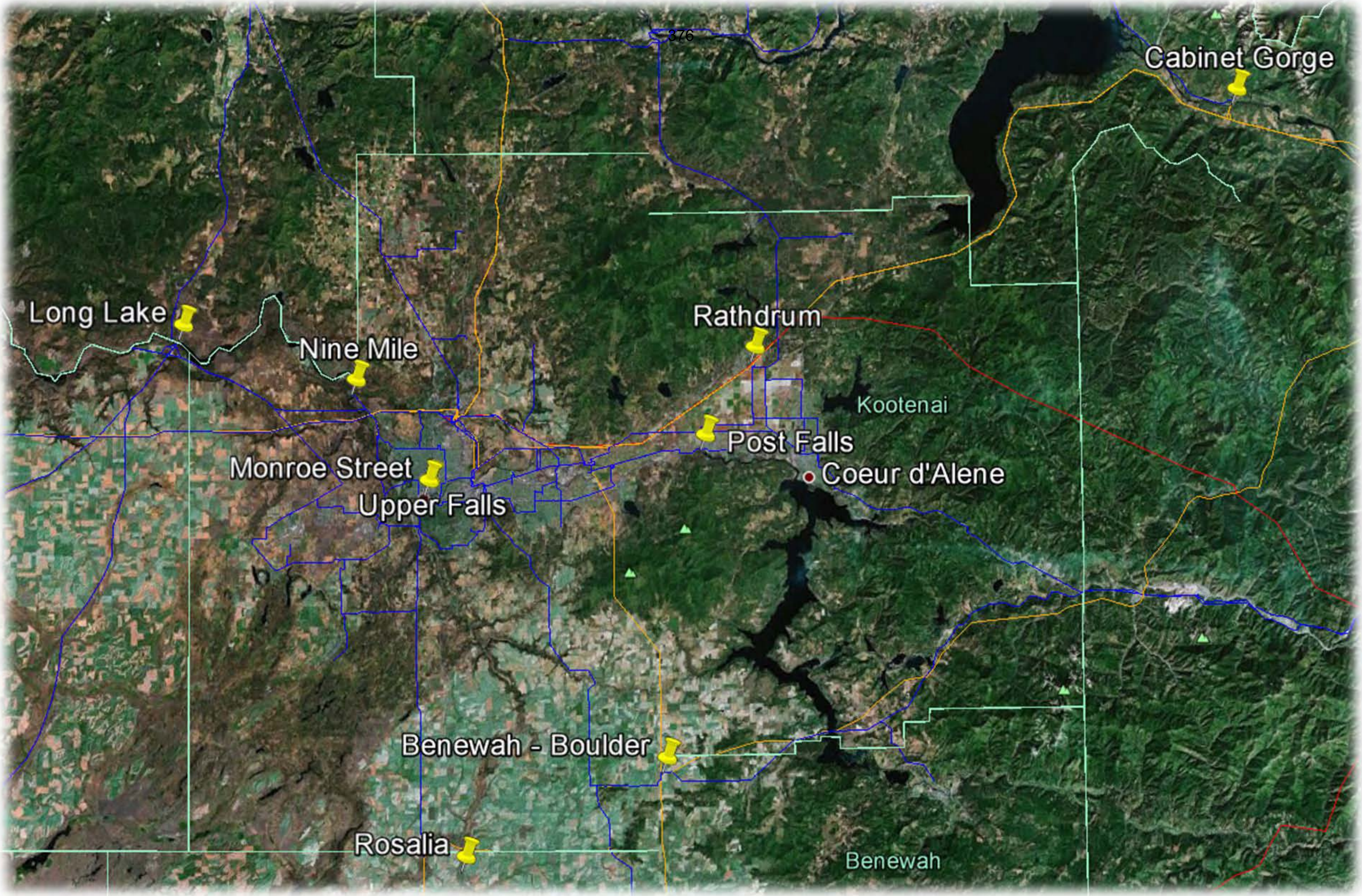
Avista Non-IRP Generation Queue

- **Project # 08**: 75 MW with Facility Study completed
    - $6.6M 230 kV switching station and tap
    - $5.6M 115 kV breaker position and reconductor
- **Project # 26**: 42MW with System Impact Study completed
- **Project # 33**: 400 MW in Feasibility Study stage
- **Project # 35**: 200 MW in System Impact Study stage
- **Project # 36**: 105 MW in Feasibility Study stage

http://www.oasis.oati.com/AVAT

Agenda

- Introduction to Avista System Planning
- Engineering of Local Generation Requests
- Recent Avista Projects
- Large Generation Interconnection Request (LGIR) Queue
- Integrated Resource Plan (IRP) Generation Requests
- Future Transmission Planning Initiatives


Cabinet Gorge
Long Lake
Rathdrum
Nine Mile
Kootenai
Post Falls
Monroe Street
Coeur d'Alene
Upper Falls
Benewah - Boulder
Rosalia
Benewah

Avista Non-IRP Generation Queue

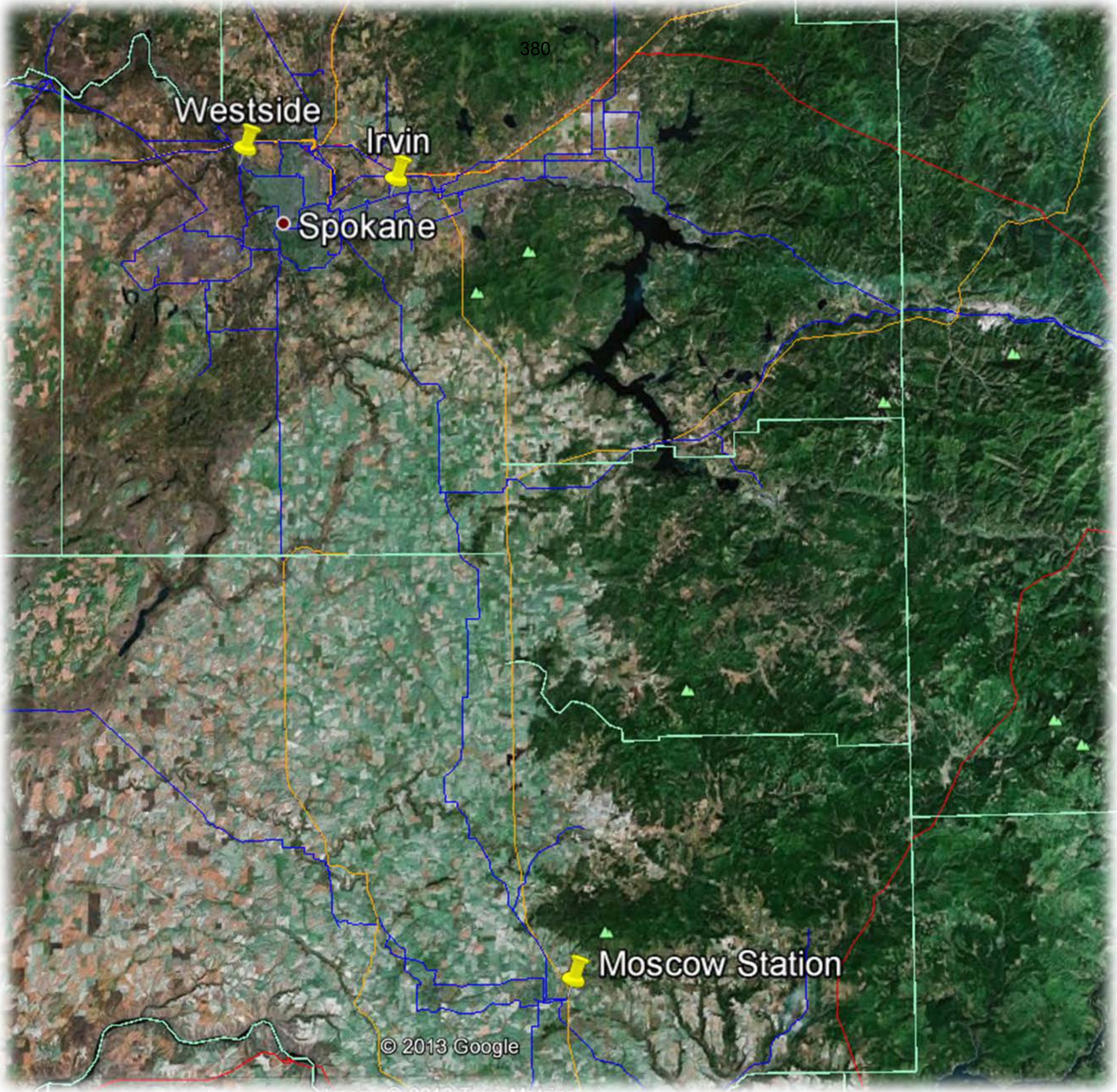
- **Nine Mile HED**: 60 MW total
- **Long Lake HED**: 68 MW additional (156 MW total)
    - Studied coincident with Nine Mile IRP request
    - $9.9M for 115 kV Transmission Line reconductoring
- **Monroe Street HED**: 80 MW additional (95 MW total)
- **Upper Falls HED**: 40 MW additional (50.26 MW total)
- **Post Falls HED**: 33.5 MW total

Avista Non-IRP Generation Queue

- **Cabinet Gorge HED:** 60 MW additional (330.5 MW total)
  - No capacity available today during Heavy Summer loading
  - Considering RAS or potential Transmission System upgrades
- **Benewah – Boulder**: 300 MW project currently under study
- **Rathdrum:** 300 MW
  - $7M for new breaker position at Rathdrum 230 kV Substation
- **Rosalia:** 200 MW
  - $4M for new breaker position at Thornton 230 kV Substation

Agenda

- Introduction to Avista System Planning
- Engineering of Local Generation Requests
- Recent Avista Projects
- Large Generation Interconnection Request (LGIR) Queue
- Integrated Resource Plan (IRP) Generation Requests
- Future Transmission Planning Initiatives


Westside
Irvin
Spokane
Moscow Station
© 2013 Google
Image © 2013 TerraMetrics

Examples of Future Construction Required to Meet NERC / WECC Reliability Standards

- Moscow Station:
  - 250 MVA transformer
  - Increases capacity to the Moscow / Pullman area and relieves loading on the Shawnee transformer
- Westside 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

Recent Avista Projects

Moscow Station Construction

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?"

Questions?

Resource Needs Assessment

Clint Kalich

Fourth Technical Advisory Committee Meeting

2013 Electric Integrated Resource Plan

February 6, 2013

Power Supply Reliability Key Terms

- Peak Demand
  - Winter and Summer single hour view to verify the utility can meet its highest expected load hour in a given year
- Sustained Peak Demand
  - Winter and summer multi-day event (3 day x 6 hour) view to verify the utility can meet its highest expected load hour in a given year
- Energy
  - On an annual basis the utility has enough energy to meet load plus contingencies (e.g., load and hydro variability)
- Operating Reserves
  - System capacity “reserved” to meet unanticipated generation outages; 5% of wind and hydro, and 7% of thermal, plants
  - Regulation to cover moment-to-moment load and generation variability
- Loss of Load Probability (LOLP)
  - Number of modeling exercises where system resources are inadequate to meet needs; 1-in-20 (5%) is deemed adequate

Historical Avista Planning Margin Targets

- 1979: 6% (single hour, hydro only); 15 to 20% with thermal units
- Somewhere in between 1979 and 1986: 13.4% to 18.7%
- 1986 to 2007: 10% + 90 MW (single hour peak)
- 2009: 15%
- 2011: Move to an 18-hour sustained peak per NPCC
    - Winter: 14% + Operating Reserves
    - Summer: 15% + Operating Reserves
    - Equivalent to NPCC 23/24% planning criteria for the Northwest

Adequacy Assessment for the 2017 Pacific Northwest Power Supply

NW
RESOURCE
ADEQUACY
FORUM

Steering Committee Meeting
October 26, 2012
Portland, Oregon

NW Adequacy Standard

- **Metric:** Loss-of-load probability (LOLP)
- **Threshold:** Maximum of 5 percent

- LOLP is the probability that extraordinary actions would have to be taken in a future year to avoid curtailment of electricity service
- Calculated assuming existing resources only and expected efficiency savings

NW RESOURCE ADEQUACY FORUM

Major Assumptions

- Existing resources (sited and licensed)
- 6th Power Plan conservation
- Market supplies
  - NW: 3,450 MW winter, 1,000 MW summer
  - SW on-peak: 1,700 MW winter, none summer
  - SW off-peak: 3,000 MW year round
- Council's medium load forecast

Major Uncertainties

- Explicitly modeled
  - Water supply
  - Temperature load variation
  - Wind
  - Forced outages
- Not modeled explicitly
  - Economic load growth
  - Uncertainty in SW market

NW RESOURCE ADEQUACY FORUM

2017 Assessment

- The expected LOLP is 6.6%
- January, February and August most critical months

- Interpretation: Relying only on existing resources and expected efficiency savings yields a power supply in 2017 whose likelihood of curtailment exceeds our agreed upon threshold

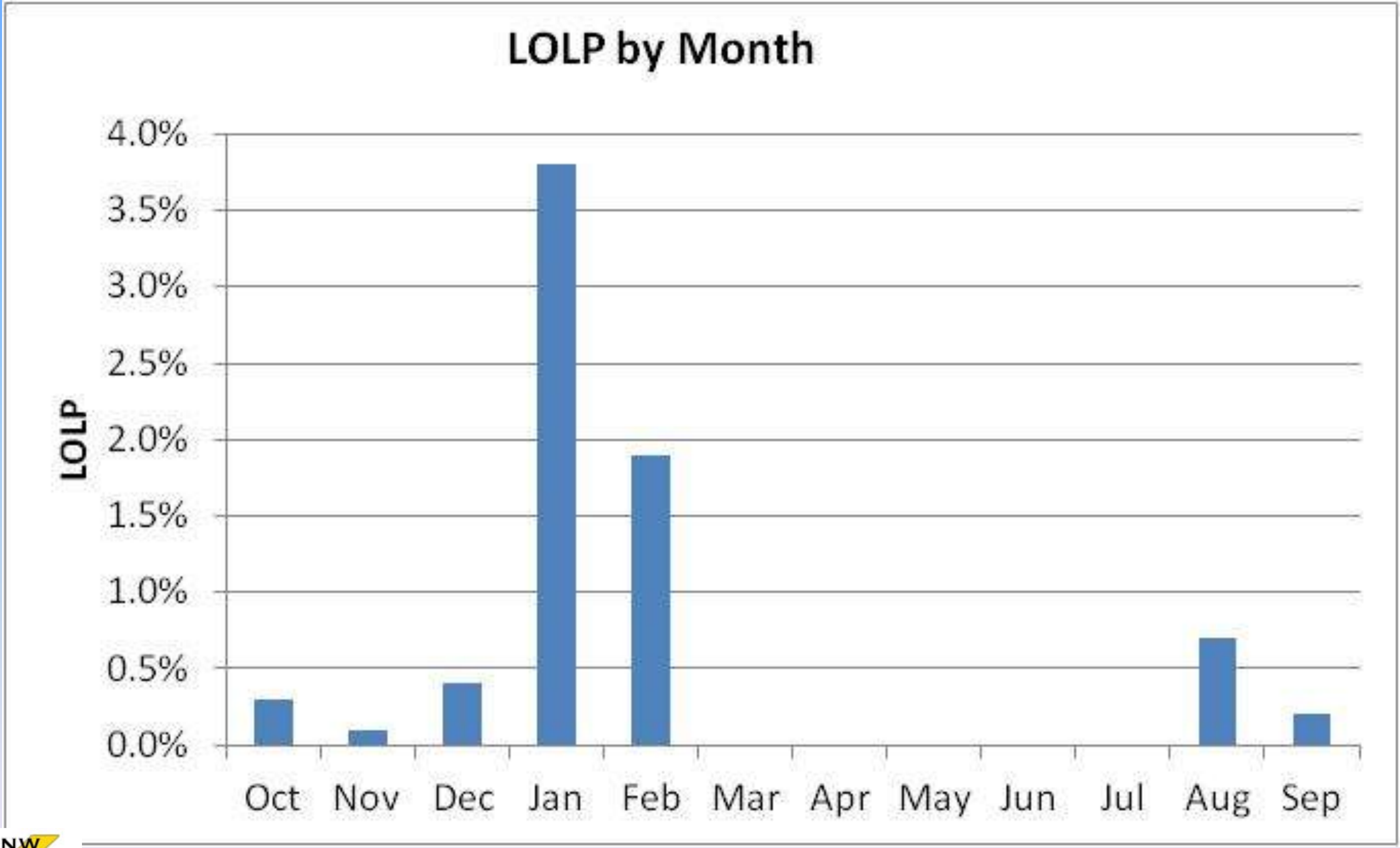
NW RESOURCE ADEQUACY FORUM

Actions to Alleviate Inadequacy

- 350 MW of new generating resource capacity drops the expected LOLP to 5%
- Equivalently, 300 average megawatts of additional energy efficiency does the same
- Demand response measures could help
- This is consistent with utility plans and the Council's resource strategy

NW RESOURCE ADEQUACY FORUM

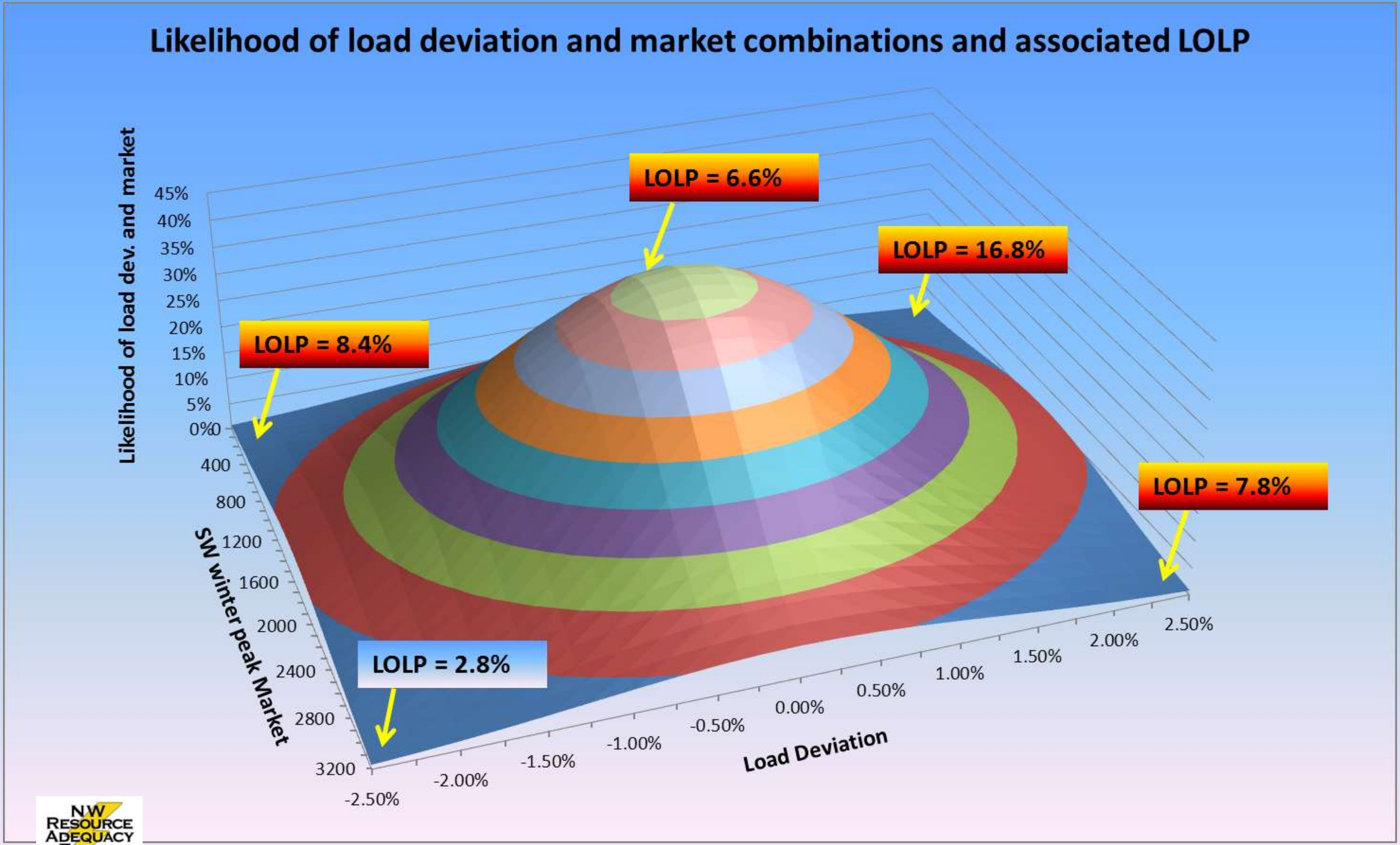
2017 Monthly LOLP



Effects of Uncertainties

Load	SW Winter Market	LOLP
Low	High	2.8%
Low	None	8.4%
High	High	7.8%
High	None	16.8%
Expected	Expected	6.6%

Illustration of LOLP Probability



Likelihood of load deviation and market combinations and associated LOLP

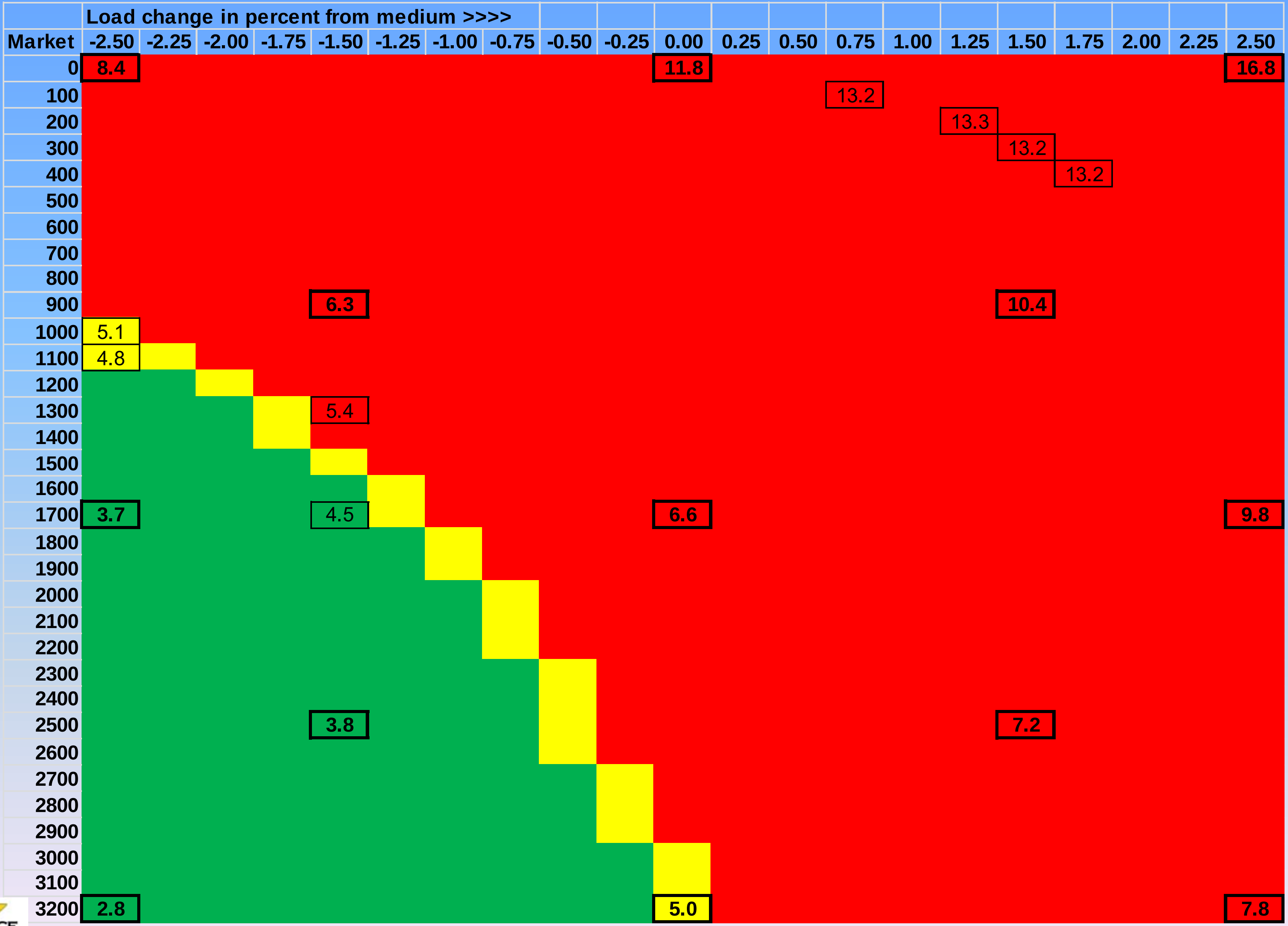
NW Resource Adequacy Forum

Effects of Adding Resources

- 350 MW of new resource moved the reference case LOLP of 6.6% down to 5.0%
- 2,850 MW of new resource moved a high LOLP of 13.3% down to 5.0%
- Sum of utility planned* resources exceeds 3,000 MW

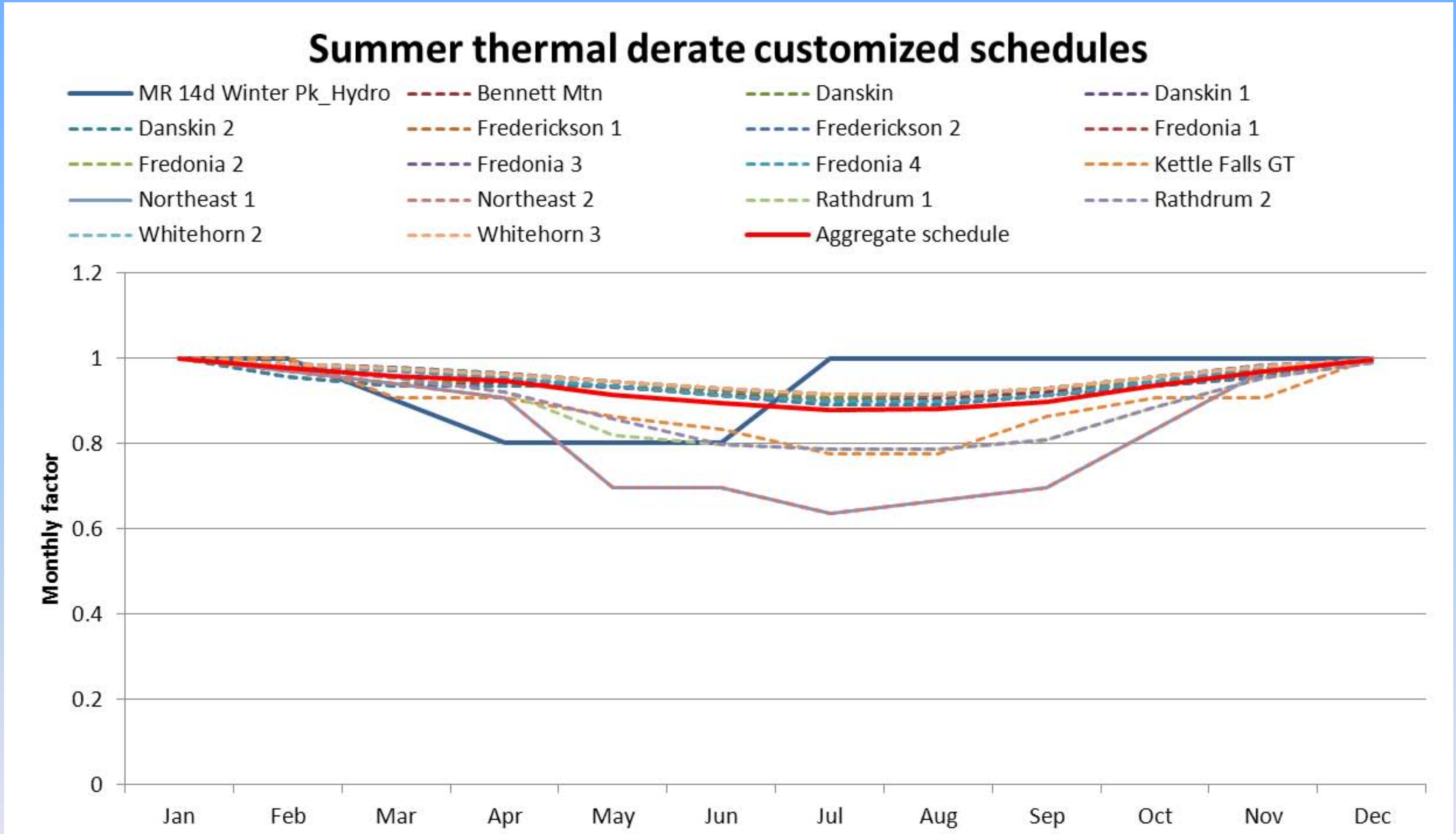
*In this context "planned" means request for proposals or RFPs.

Variation in LOLP due to Load and Market



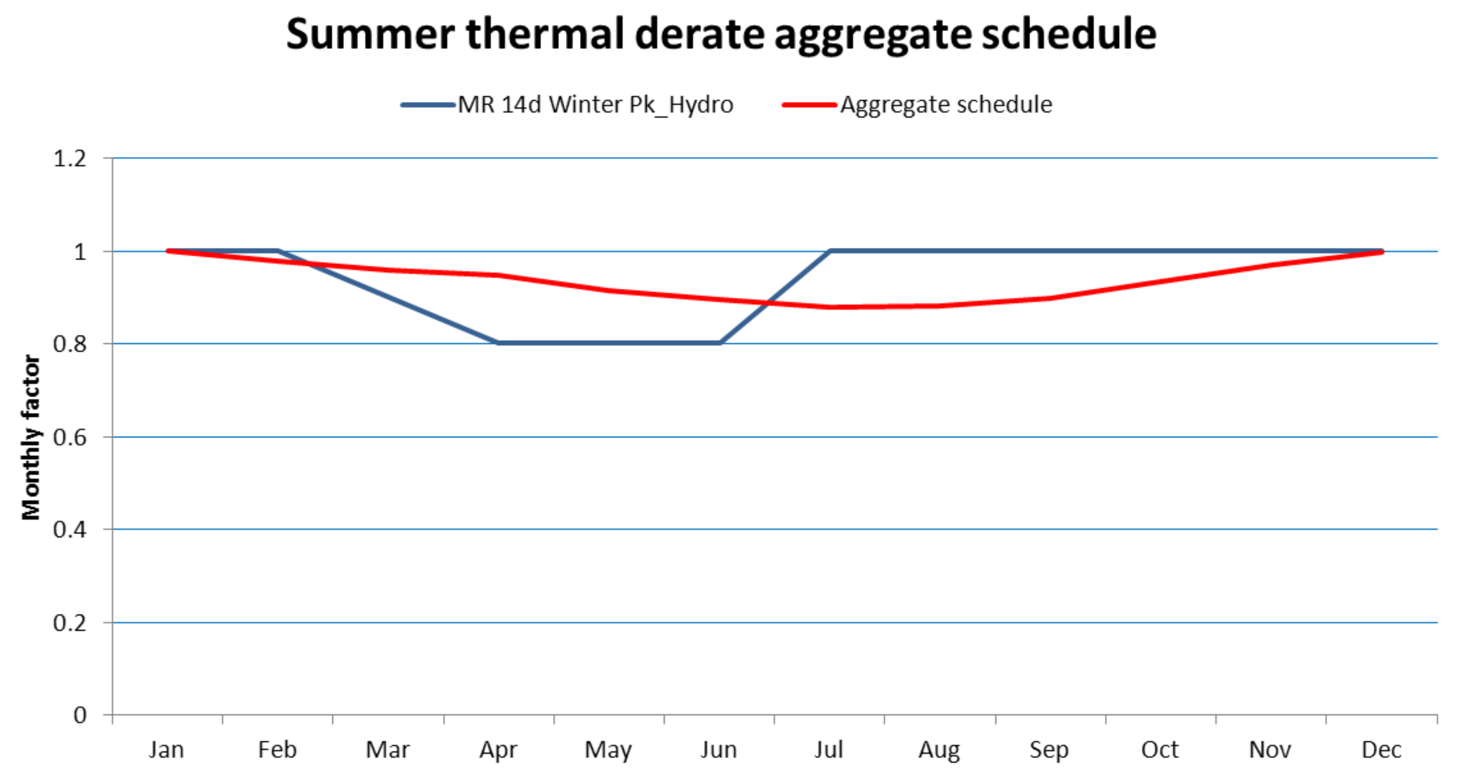
	Load change in percent from medium >>>>																				
Market	-2.50	-2.25	-2.00	-1.75	-1.50	-1.25	-1.00	-0.75	-0.50	-0.25	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50
0	8.4	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	11.8	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	16.8
100	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	13.2	🟥	🟥	🟥	🟥	🟥	🟥	🟥
200	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	13.3	🟥	🟥	🟥	🟥	🟥
300	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	13.2	🟥	🟥	🟥	🟥
400	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	13.2	🟥	🟥	🟥
500	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
600	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
700	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
800	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
900	🟥	🟥	🟥	🟥	6.3	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	10.4	🟥	🟥	🟥	🟥
1000	5.1	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
1100	4.8	🟨	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
1200	🟩	🟩	🟨	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
1300	🟩	🟩	🟩	🟨	5.4	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
1400	🟩	🟩	🟩	🟨	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
1500	🟩	🟩	🟩	🟩	🟨	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
1600	🟩	🟩	🟩	🟩	🟩	🟨	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
1700	3.7	🟩	🟩	🟩	4.5	🟨	🟥	🟥	🟥	🟥	6.6	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	9.8
1800	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
1900	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
2000	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
2100	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
2200	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
2300	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
2400	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
2500	🟩	🟩	🟩	🟩	3.8	🟩	🟩	🟩	🟨	🟥	🟥	🟥	🟥	🟥	🟥	🟥	7.2	🟥	🟥	🟥	🟥
2600	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
2700	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
2800	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
2900	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
3000	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
3100	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
3200	2.8	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	5.0	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	7.8

Thermal derate schedules



NW Resource Adequacy Forum

Thermal derate schedules



How much CT gets you to 5%

- Add a CT resource that will bring study cases with >5.0% LOLP down to 5.0%

Study Summary				LOLP Pk	LOLP E	LOLP A	EUSR	CVaRE	CVaRPk	EUE	LOLH
Study Case	**Load Dev.**	**Mkt.**	**Add CT**	**(%)**	**(%)**	**(%)**	**(%)**	**(MWh)**	**(MW)**	**(MWh**	**(Hr/sYr)**
Reference Case	0.00%	1700	350	5.0	1.5	5.0	7.3	76466	3410	3851	2.1
High Load, High Market	2.50%	3200	750	5.0	0.9	5.0	7.9	43510	2913	2197	1.4
High Load, Low Market	2.50%	0	4800	5.0	0.8	5.0	6.2	43007	2645	2162	1.4
Low Load, High Market	-2.50%	3200	NA								
Low Load, Low Market	-2.50%	0	1155	5.0	1.5	5.0	6.5	76118	2593	3829	2.4
Med-High Load, Med-High Mkt	1.50%	2500	525	5.0	1.1	5.0	8.0	58041	3165	2923	1.7
Med-High Load, Med-Low Mkt	1.50%	900	1950	5.0	1.3	5.0	6.8	61092	2866	3071	1.9
Med-Low Load, Med-High Mkt	-1.50%	2500	NA								
Med-Low Load, Med-Low Mkt	-1.50%	900	450	5.0	1.5	5.0	6.7	80421	3184	4033	2.3
Reference Load, High Market	0.00%	3200	NA								
Reference Load, Low Market	0.00%	0	2750	5.0	0.8	5.0	6.3	53995	2443	2717	1.9
High Load, Reference Market	2.50%	1700	1200	5.0	1.5	5.0	7.7	75020	3400	3778	2.1
Low Load, Reference Market	-2.50%	1700	NA								
High Case within likely region	1.25%	200	2850	5.0	1.0	5.0	6.6	56369	2587	2836	1.9

NW RESOURCE ADEQUACY FORUM

Regional Position (2016/17- Peak Hour)

	2016	**2016**	**2016**	**2017**	**2017**	**2017**	**2017**	**2017**	**2017**	**2017**	**2017**	**2017**
	10	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
1-Hr Peak												
Avg Load	**24,458**	**28,593**	**31,838**	**33,143**	**29,949**	**27,929**	**25,454**	**23,596**	**25,078**	**26,773**	**26,151**	**23,589**
Hydro	25,059	25,857	26,675	27,944	26,400	25,773	25,388	25,852	27,271	26,394	25,232	25,198
Hydro Ind.	299	299	299	299	299	299	299	299	299	299	299	299
Total Non-Hydro	**25,358**	**26,155**	**26,974**	**28,242**	**26,699**	**26,072**	**25,687**	**26,151**	**27,569**	**26,692**	**25,531**	**25,497**
Small Renewables	109	109	109	109	109	109	109	109	109	109	109	109
Nuclear	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130
Coal	4,708	4,708	4,708	4,708	4,708	4,708	4,708	4,708	4,708	4,708	4,708	4,708
CCCT	4,868	4,961	5,151	5,151	5,054	4,961	4,868	4,775	4,678	4,678	4,678	4,775
Peakers	1,751	1,784	1,853	1,853	1,817	1,784	1,751	1,717	1,682	1,682	1,682	1,717
Total Non-Hydro	**12,566**	**12,692**	**12,951**	**12,951**	**12,819**	**12,692**	**12,566**	**12,440**	**12,307**	**12,307**	**12,307**	**12,440**
Total Generation	**37,924**	**38,848**	**39,925**	**41,194**	**39,518**	**38,764**	**38,253**	**38,591**	**39,877**	**39,000**	**37,838**	**37,937**
Physicial Position	13,466	10,255	8,087	8,050	9,568	10,836	12,799	14,995	14,798	12,227	11,687	14,348
Implied Planning Margin	**55%**	**36%**	**25%**	**24%**	**32%**	**39%**	**50%**	**64%**	**59%**	**46%**	**45%**	**61%**
IPP Generation	**3,200**	**3,240**	**3,324**	**3,324**	**3,281**	**3,240**	**3,200**	**3,159**	**3,116**	**3,116**	**3,116**	**3,159**
Physicial Position w/ IPP	16,666	13,495	11,410	11,374	12,849	14,076	15,999	18,154	17,915	15,343	14,804	17,507
W/ IPP Implied Plannin Margin	**68%**	**47%**	**36%**	**34%**	**43%**	**50%**	**63%**	**77%**	**71%**	**57%**	**57%**	**74%**

Data provided by Northwest Power & Conservation Council

Regional Position (2016/17- 10 Hour Peak)

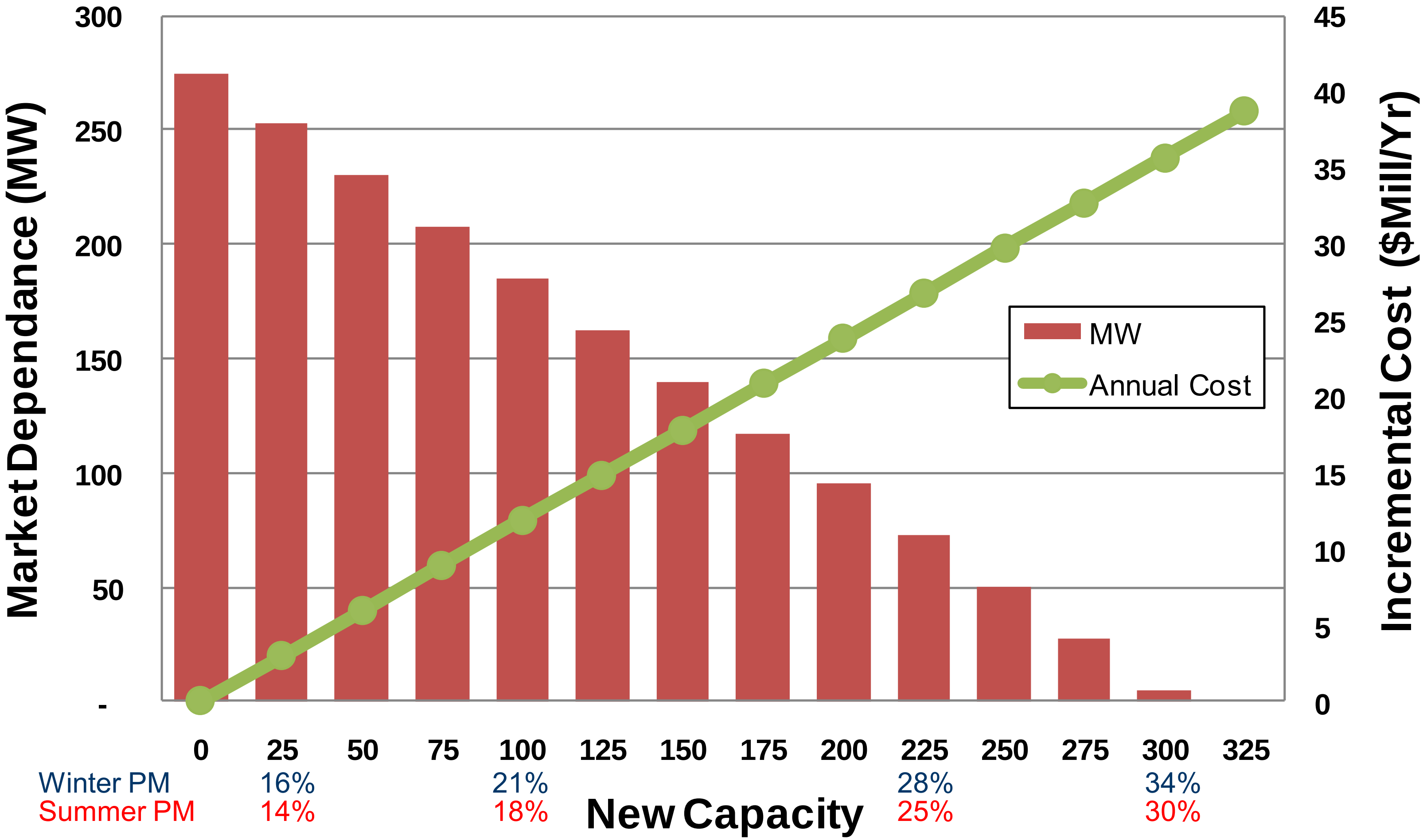
	2016	2016	2016	2017	2017	2017	2017	2017	2017	2017	2017	2017
	10	11	12	1	2	3	4	5	6	7	8	9
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
10-Hr Peak												
Avg Load	**22,991**	**26,878**	**29,928**	**31,155**	**28,152**	**26,253**	**23,926**	**22,181**	**23,574**	**25,166**	**24,582**	**22,174**
Hydro West	3,107	3,656	2,862	2,711	2,597	3,443	3,548	3,736	3,640	3,282	3,366	3,160
Hydro East	21,090	21,564	19,414	16,178	15,722	17,375	19,708	21,239	20,835	19,884	20,723	19,824
Hydro Ind.	299	299	299	299	299	299	299	299	299	299	299	299
Total Hydro	**24,496**	**25,518**	**22,574**	**19,188**	**18,617**	**21,117**	**23,554**	**25,273**	**24,774**	**23,464**	**24,387**	**23,283**
Small Renewables	109	109	109	109	109	109	109	109	109	109	109	109
Nuclear	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130
Coal	4,708	4,708	4,708	4,708	4,708	4,708	4,708	4,708	4,708	4,708	4,708	4,708
CCCT	4,868	4,961	5,151	5,151	5,054	4,961	4,868	4,775	4,678	4,678	4,678	4,775
Peakers	1,751	1,784	1,853	2,203	1,817	1,784	1,751	1,717	1,682	1,682	1,682	1,717
Total Non-Hydro	**12,566**	**12,692**	**12,951**	**13,301**	**12,819**	**12,692**	**12,566**	**12,440**	**12,307**	**12,307**	**12,307**	**12,440**
Total Generation	**37,062**	**38,211**	**35,525**	**32,489**	**31,436**	**33,809**	**36,121**	**37,713**	**37,081**	**35,771**	**36,695**	**35,723**
Physicial Position	14,072	11,333	5,598	1,334	3,283	7,556	12,194	15,533	13,507	10,605	12,113	13,549
Implied Planning Margin	**61%**	**42%**	**19%**	**4%**	**12%**	**29%**	**51%**	**70%**	**57%**	**42%**	**49%**	**61%**
IPP Generation	**3,200**	**3,240**	**3,324**	**3,324**	**3,281**	**3,240**	**3,200**	**3,159**	**3,116**	**3,116**	**3,116**	**3,159**
Physicial Position w/ IPP	17,271	14,573	8,921	4,658	6,564	10,796	15,394	18,692	16,624	13,721	15,229	16,708
W/ IPP Implied Plannin Margin	**75%**	**54%**	**30%**	**15%**	**23%**	**41%**	**64%**	**84%**	**71%**	**55%**	**62%**	**75%**

Data provided by Northwest Power & Conservation Council

Translating the Regional Position to Avista

- NPCC indicates region will be short capacity in the 2016/7 winter timeframe
  - With region in surplus, utility can rely on market in peak conditions
  - Changes in load growth or out-of-region transfers can change adequacy results
- Summer adequacy is strong for the region
  - With regional summer length- dual peaking utilities can rely on system for summer peaks
  - Future build-outs for winter peaks likely will ensure adequate regional summer capacity

Resource allocation to get Avista to 5% LOLP goal



Avista’s Peak Planning Criteria

- Winter Peak
  - 14% planning margin above load, plus operating reserves
  - If Avista is deficit prior to 2016/17, and where the NW market has been shown adequately surplus, market purchases will meet deficit needs
- Summer Peak
  - Avista operating reserves are the planning requirement, unless region’s “natural” deficit shifts to summer
  - If utility is deficit, market purchases will meet deficit needs
  - However, as with the region, building to meet winter peak generally addresses our summer need
- Both sustained- and single-hour peak positions are considered
- Wind and solar provide no winter peaking capability

January: 18 Hour Peak Position Forecast

		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
	REQUIREMENTS																				
1	Native Load	-1,596	-1,613	-1,629	-1,643	-1,656	-1,669	-1,683	-1,696	-1,710	-1,724	-1,738	-1,752	-1,766	-1,780	-1,794	-1,809	-1,824	-1,838	-1,853	-1,868
2	Firm Power Sales	-211	-158	-158	-8	-8	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6
3	**Total Requirements**	**-1,807**	**-1,771**	**-1,787**	**-1,650**	**-1,663**	**-1,675**	**-1,689**	**-1,702**	**-1,716**	**-1,730**	**-1,744**	**-1,758**	**-1,772**	**-1,786**	**-1,801**	**-1,815**	**-1,830**	**-1,844**	**-1,859**	**-1,874**
	RESOURCES																				
4	Firm Power Purchases	117	117	117	117	117	116	34	34	33	33	33	33	33	33	33	33	33	33	33	33
5	Hydro Resources	973	866	867	932	932	896	900	896	896	904	896	896	904	896	896	904	896	896	904	896
6	Base Load Thermals	895	895	895	895	895	895	895	895	895	895	895	895	895	617	617	617	617	617	617	617
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**	**2,227**	**2,121**	**2,122**	**2,187**	**2,186**	**2,149**	**2,071**	**2,068**	**2,067**	**2,074**	**2,067**	**2,067**	**2,074**	**1,788**	**1,788**	**1,796**	**1,788**	**1,788**	**1,796**	**1,788**
10	**PEAK POSITION**	**421**	**350**	**334**	**536**	**523**	**473**	**383**	**365**	**351**	**345**	**323**	**309**	**303**	**2**	**-13**	**-19**	**-42**	**-57**	**-64**	**-86**
	RESERVE PLANNING																				
11	Planning Margin	-223	-226	-228	-230	-232	-234	-236	-237	-239	-241	-243	-245	-247	-249	-251	-253	-255	-257	-259	-262
12	Total Ancillary Services Required	-186	-184	-185	-177	-179	-180	-186	-187	-189	-191	-192	-193	-194	-195	-196	-197	-197	-198	-199	-199
13	Reserve & Contingency Availability	25	9	9	17	17	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
14	Demand Response	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	**Total Reserve Planning**	**-385**	**-401**	**-405**	**-390**	**-394**	**-398**	**-405**	**-409**	**-412**	**-416**	**-419**	**-422**	**-425**	**-428**	**-431**	**-434**	**-436**	**-439**	**-442**	**-444**
16	**Peak Position w/ Contingency**	**36**	**-51**	**-70**	**146**	**129**	**76**	**-22**	**-43**	**-61**	**-71**	**-96**	**-113**	**-123**	**-426**	**-443**	**-453**	**-478**	**-495**	**-506**	**-531**
17	**Implied Planning Margin**	**25%**	**20%**	**19%**	**33%**	**32%**	**29%**	**24%**	**22%**	**21%**	**21%**	**19%**	**18%**	**18%**	**1%**	**0%**	**0%**	**-1%**	**-2%**	**-3%**	**-4%**
18	**NPCC Market Adjustment**	0	51	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	**Peak Position Net Market**	**36**	**0**	**0**	**146**	**129**	**76**	**(22)**	**(43)**	**(61)**	**(71)**	**(96)**	**(113)**	**(123)**	**(426)**	**(443)**	**(453)**	**(478)**	**(495)**	**(506)**	**(531)**

18 Hour to 1 Hour Comparison

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Winter 1 Hour	17	0	0	126	110	56	(42)	(64)	(81)	(92)	(117)	(135)	(145)	(445)	(462)	(472)	(497)	(515)	(525)	(551)
Winter 18 Hour	36	0	0	146	129	76	(22)	(43)	(61)	(71)	(96)	(113)	(123)	(426)	(443)	(453)	(478)	(495)	(506)	(531)
Delta	**19**	**0**	**0**	**19**	**19**	**20**	**20**	**20**	**20**	**21**	**21**	**22**	**22**	**18**	**19**	**19**	**19**	**19**	**20**	**20**

August: 18 Hour Peak Position Forecast

		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
	REQUIREMENTS																				
1	Native Load	-1,465	-1,482	-1,498	-1,510	-1,523	-1,536	-1,550	-1,563	-1,576	-1,590	-1,604	-1,618	-1,631	-1,646	-1,660	-1,674	-1,689	-1,703	-1,718	-1,733
2	Firm Power Sales	-212	-159	-159	-9	-9	-8	-8	-7	-7	-7	-7	-7	-7	-7	-7	-7	-7	-7	-7	-7
3	**Total Requirements**	**-1,677**	**-1,641**	**-1,657**	**-1,519**	**-1,532**	**-1,544**	**-1,557**	**-1,570**	**-1,584**	**-1,597**	**-1,611**	**-1,625**	**-1,639**	**-1,653**	**-1,667**	**-1,681**	**-1,696**	**-1,710**	**-1,725**	**-1,740**
	RESOURCES																				
4	Firm Power Purchases	29	29	29	29	29	26	26	26	26	25	25	25	25	25	25	25	25	25	25	25
5	Hydro Resources	701	707	663	631	638	583	580	622	624	622	622	624	622	622	624	622	622	624	622	622
6	Base Load Thermals	785	785	785	785	785	785	785	785	785	785	785	785	785	556	556	556	556	556	556	556
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**	**1,691**	**1,698**	**1,653**	**1,621**	**1,628**	**1,571**	**1,568**	**1,609**	**1,611**	**1,609**	**1,609**	**1,611**	**1,609**	**1,379**	**1,381**	**1,379**	**1,379**	**1,381**	**1,379**	**1,379**
10	**PEAK POSITION**	**14**	**57**	**-3**	**102**	**96**	**27**	**11**	**39**	**27**	**11**	**-2**	**-14**	**-30**	**-274**	**-286**	**-302**	**-317**	**-330**	**-346**	**-361**
	RESERVE PLANNING																				
11	Planning Margin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	Total Ancillary Services Required	-177	-176	-177	-170	-172	-173	-175	-176	-177	-179	-180	-181	-182	-166	-167	-167	-168	-169	-169	-170
13	Reserve & Contingency Availability	177	176	177	170	172	173	175	176	177	179	180	181	182	166	167	167	168	169	169	170
14	Demand Response	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	**Total Reserve Planning**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
16	**Peak Position w/ Contingency**	**14**	**57**	**-3**	**102**	**96**	**27**	**11**	**39**	**27**	**11**	**-2**	**-14**	**-30**	**-274**	**-286**	**-302**	**-317**	**-330**	**-346**	**-361**
17	**Implied Planning Margin**	**11%**	**14%**	**10%**	**18%**	**17%**	**13%**	**12%**	**14%**	**13%**	**12%**	**11%**	**10%**	**9%**	**-7%**	**-7%**	**-8%**	**-9%**	**-9%**	**-10%**	**-11%**
18	**NPCC Market Adjustment**	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	**Peak Position Net Market**	**14**	**57**	**0**	**102**	**96**	**27**	**11**	**39**	**27**	**11**	**(2)**	**(14)**	**(30)**	**(274)**	**(286)**	**(302)**	**(317)**	**(330)**	**(346)**	**(361)**

18 Hour to 1 Hour Comparison

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Summer 1 Hour	114	159	85	193	185	113	95	125	112	94	79	65	48	(191)	(204)	(221)	(236)	(249)	(267)	(282)
Summer 18 Hour	14	57	0	102	96	27	11	39	27	11	(2)	(14)	(30)	(274)	(286)	(302)	(317)	(330)	(346)	(361)
Delta	**(100)**	**(102)**	**(85)**	**(91)**	**(89)**	**(86)**	**(84)**	**(87)**	**(85)**	**(83)**	**(81)**	**(80)**	**(78)**	**(83)**	**(83)**	**(82)**	**(81)**	**(80)**	**(79)**	**(79)**

Market and Portfolio Scenario Development

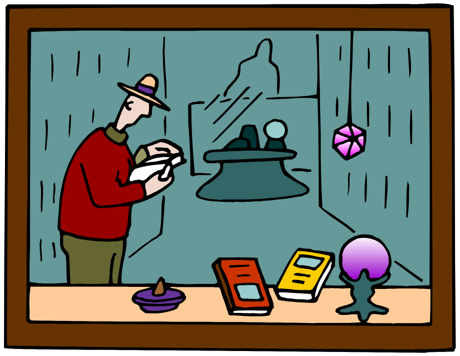
John Lyons, Senior Resource Policy Analyst

Fourth Technical Advisory Committee Meeting

2013 Electric Integrated Resource Plan

February 6, 2013

Scenarios in the 2013 IRP



Scenarios provide details about potential impacts of different critical planning assumptions that could have a major impact on resource choices, such as technological, regulatory or environmental changes.

Scenarios will be developed for:

- Avista's current load and resource portfolio
- Preferred Resource Strategy (PRS)
- Wholesale electric market
- Different resource options

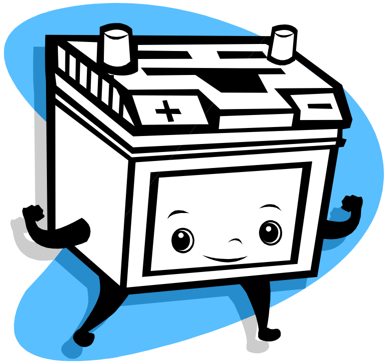
2013 IRP Scenario Types

1. Deterministic Market Scenarios: use expected input levels (natural gas prices, hydro, loads, wind, and thermal outages)
2. Stochastic Market Scenarios: use a Monte Carlo analysis
3. Portfolio Scenarios: show alternative portfolios to highlight the cost differences from the PRS

Deterministic Market Scenarios

Deterministic scenarios test the PRS across several fundamentally different futures:

- Low and High Natural Gas Prices
- Carbon Pricing
- No Coal Retirements
- High Storage Technology Penetration
- Increasing RPS



Stochastic Market Scenarios

- Expected Case: assumes average levels of hydro, loads, gas prices, wind, emissions prices and forced outages

- Carbon Pricing Scenario: various pricing trajectories similar to the 2011 IRP expected case

Portfolio Scenarios

- Market reliance only
- CO_2 credit allocations
- 2011 PRS
- Increased Washington RPS – 25% by 2025
- National renewable energy standard – 20% with and without hydro netting
- Alternative Planning Margins
- CT and CCCT tipping points
- Solar cost tipping point
- Nuclear cost tipping point
- Coal sequestration cost tipping point

Colstrip Scenarios

- 2017 Retirement Date
- 2022 Retirement Date
- Incremental Pollution Controls
- Carbon Sequestration
- Railed Coal

Avista's 2013 Electric Integrated Resource Plan

Technical Advisory Committee Meeting No. 5 Agenda

Wednesday, March 20, 2013
Conference Room 428

Topic	Time	Staff
1. Introduction	9:00	
2. Market Forecast Scenario Results and Conservation Avoided Costs	9:05	Gall
3. Conservation Results	9:30	Borstein
4. Break	11:00	
5. Demand Response	11:15	Doege
6. Lunch	12:00	
7. 2013 IRP Preferred Resource Strategy	1:00	Gall
8. Break	2:00	
9. Portfolio Scenarios	2:15	Gall
10. Adjourn	3:00	

Electric Price Forecast Scenario Analysis

James Gall

Fifth Technical Advisory Committee Meeting

2013 Electric Integrated Resource Plan

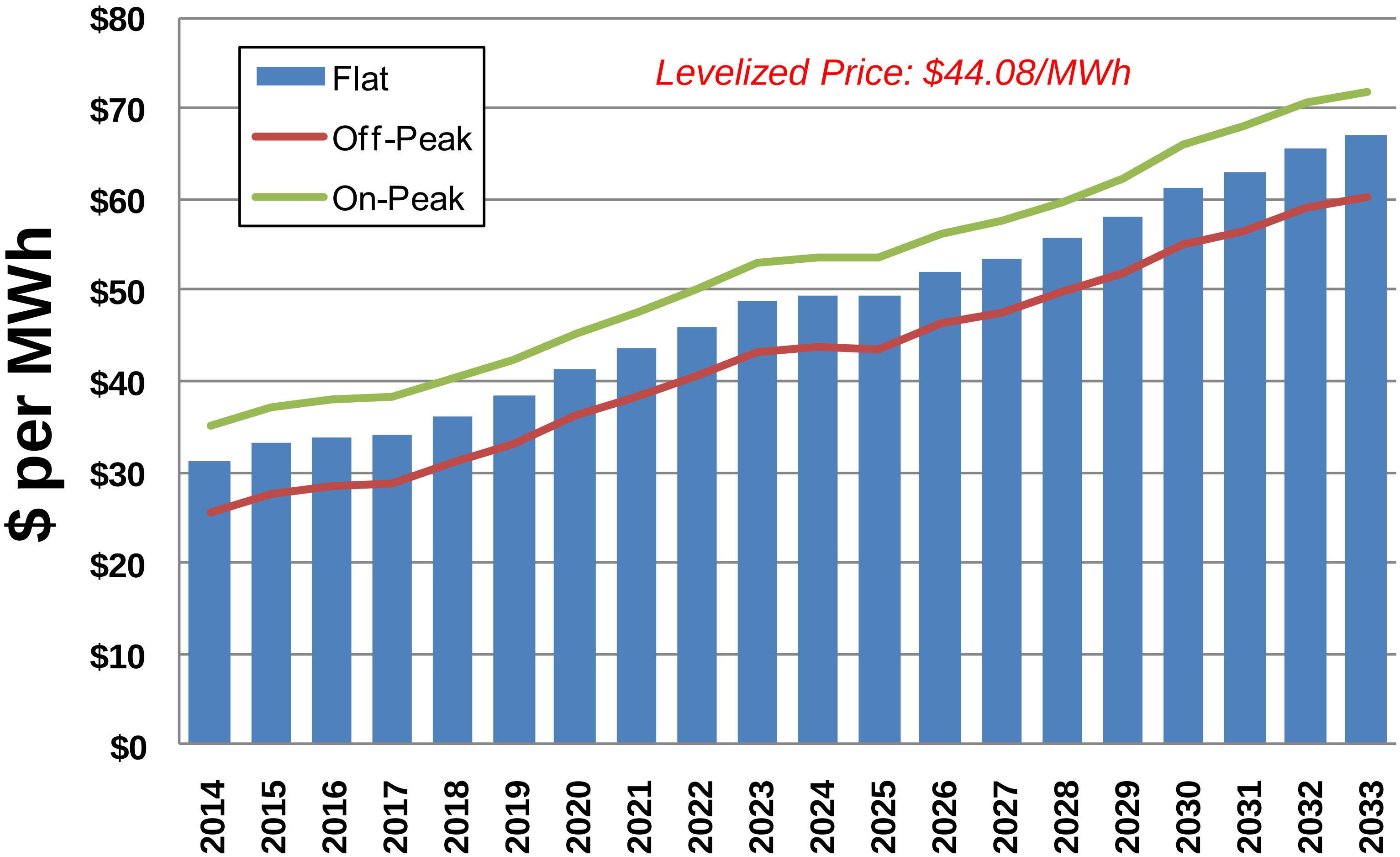
March 20, 2013

Scenario Planning

This IRP reviews two types of market scenarios to help understand how market forces can impact Avista's resource strategy

1. Deterministic studies- point forecast of future major assumptions
2. Stochastic studies- Monte-Carlo style analysis using 500 iterations for major assumptions

Expected Case Refresher

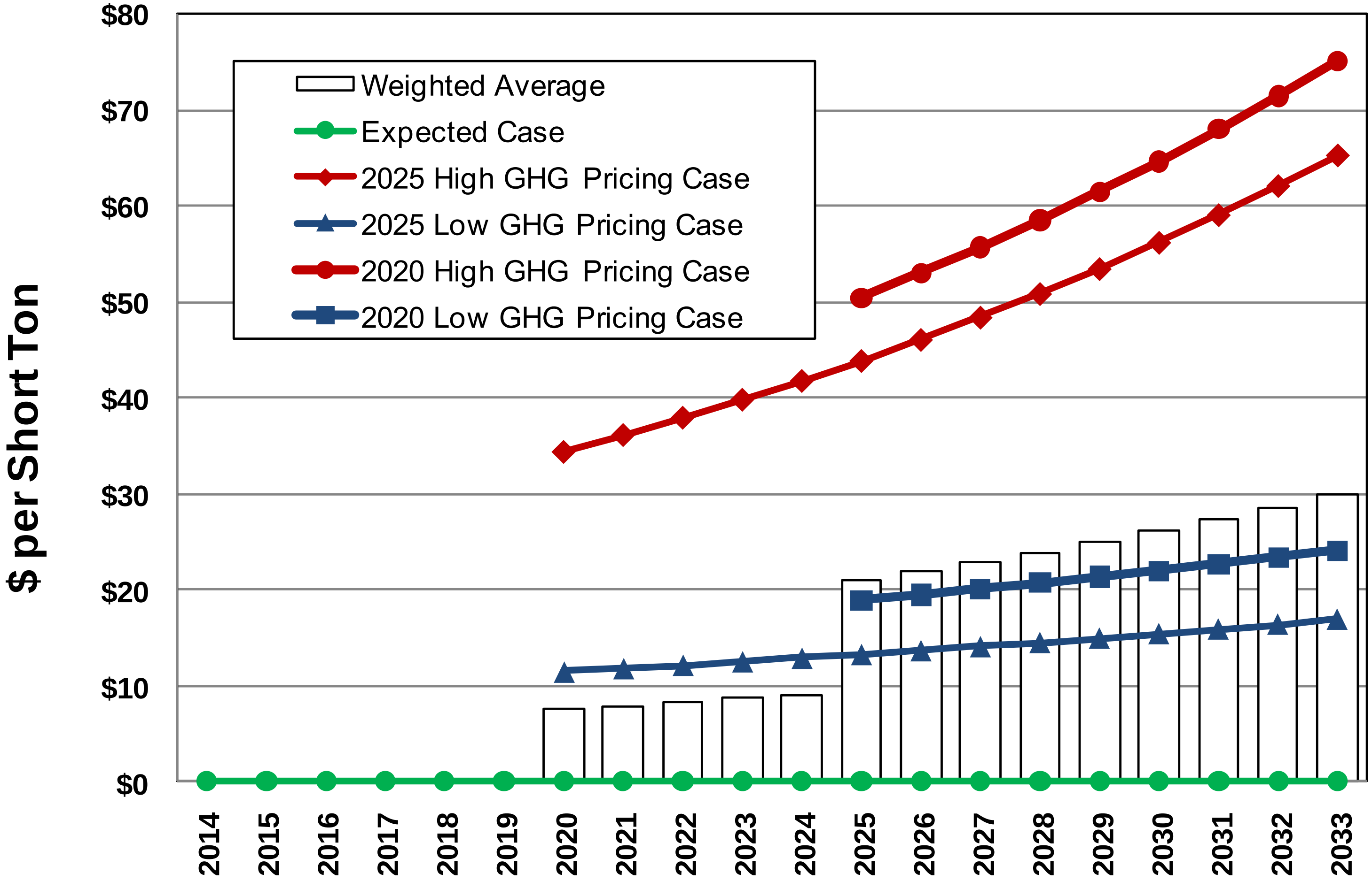


stochastic case

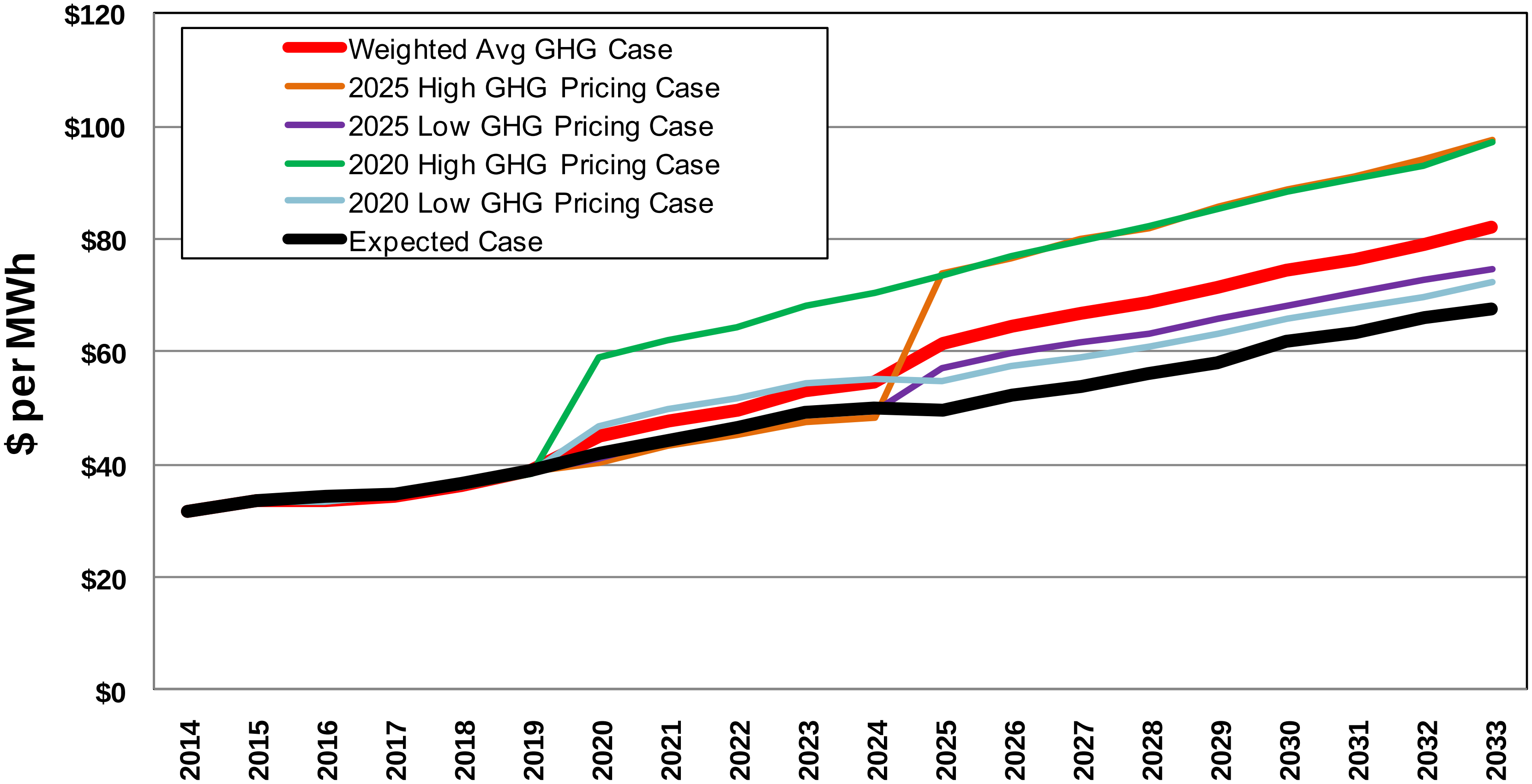
Greenhouse Gas Pricing Scenario

- Developed to understand the ramifications of national greenhouse gas reduction legislation to Avista's resource strategy
- This scenario uses 500 iterations with different potential CO_2 pricing schemes using a cap-and-trade market mechanism
- Five weighted potential pricing structures were developed to create a wide range of potential futures (2014 $)
  - Expected Case- $0/ton (33.3%)
  - 2020 High- $30/ton (16.7%), 2025 High- $40/ton (16.7%)
  - 2020 Low- $10/ton (16.7%), 2025 Low- $15/ton (16.7%)

Greenhouse Gas Pricing Scenario Price Assumptions

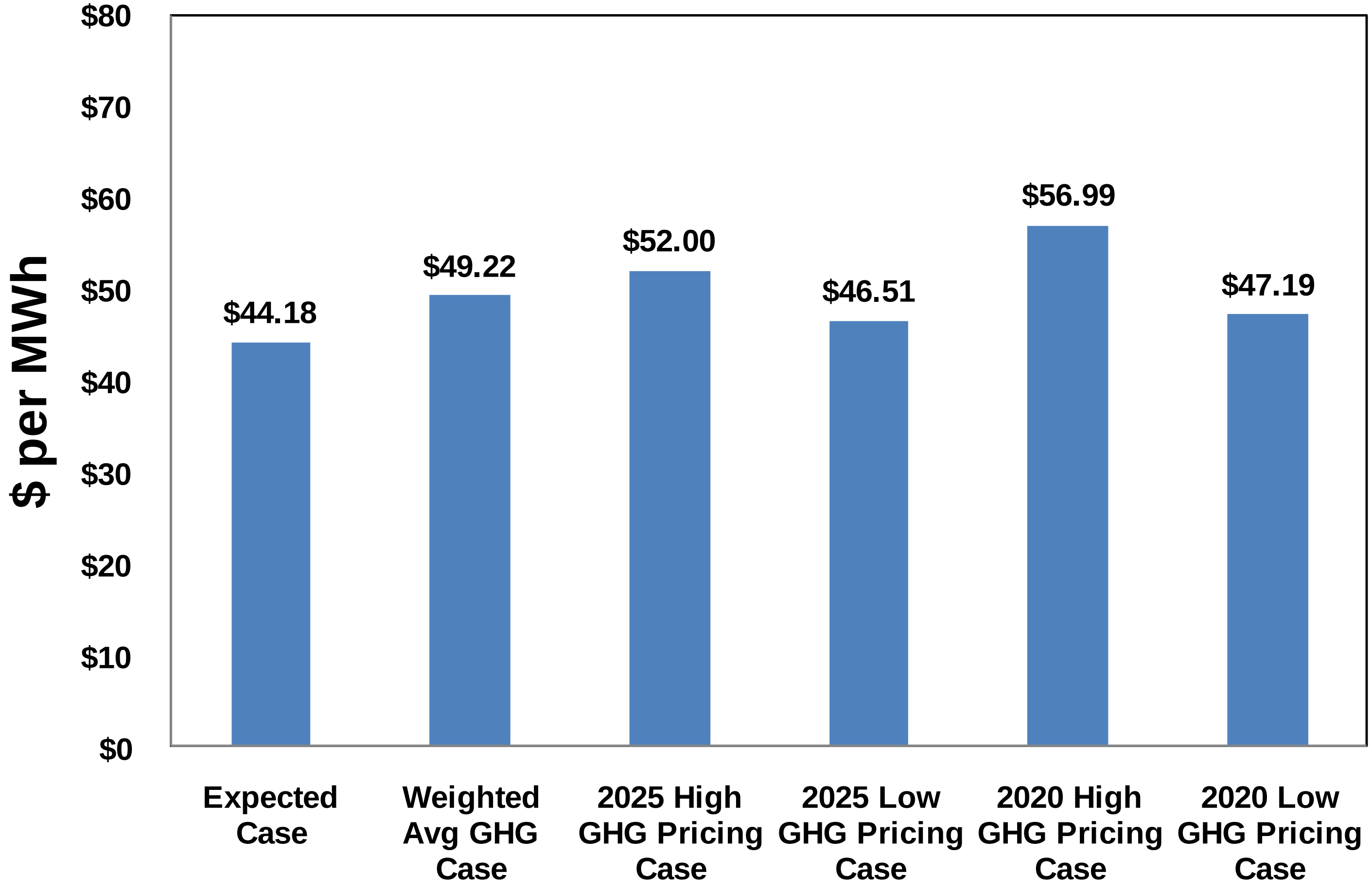


Greenhouse Gas Scenario Market Prices



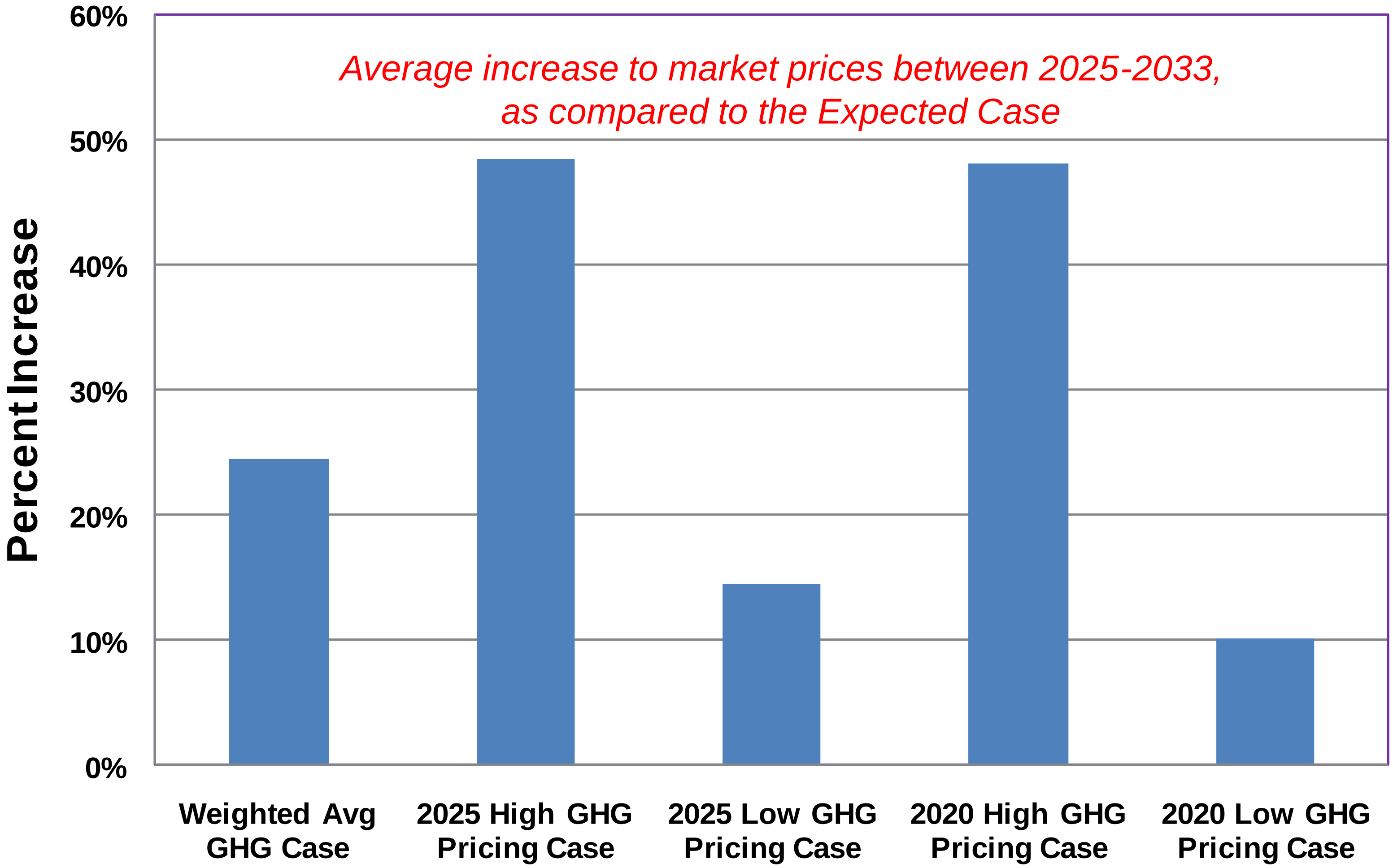
deterministic case

20-Year Levelized Greenhouse Gas Scenario Prices

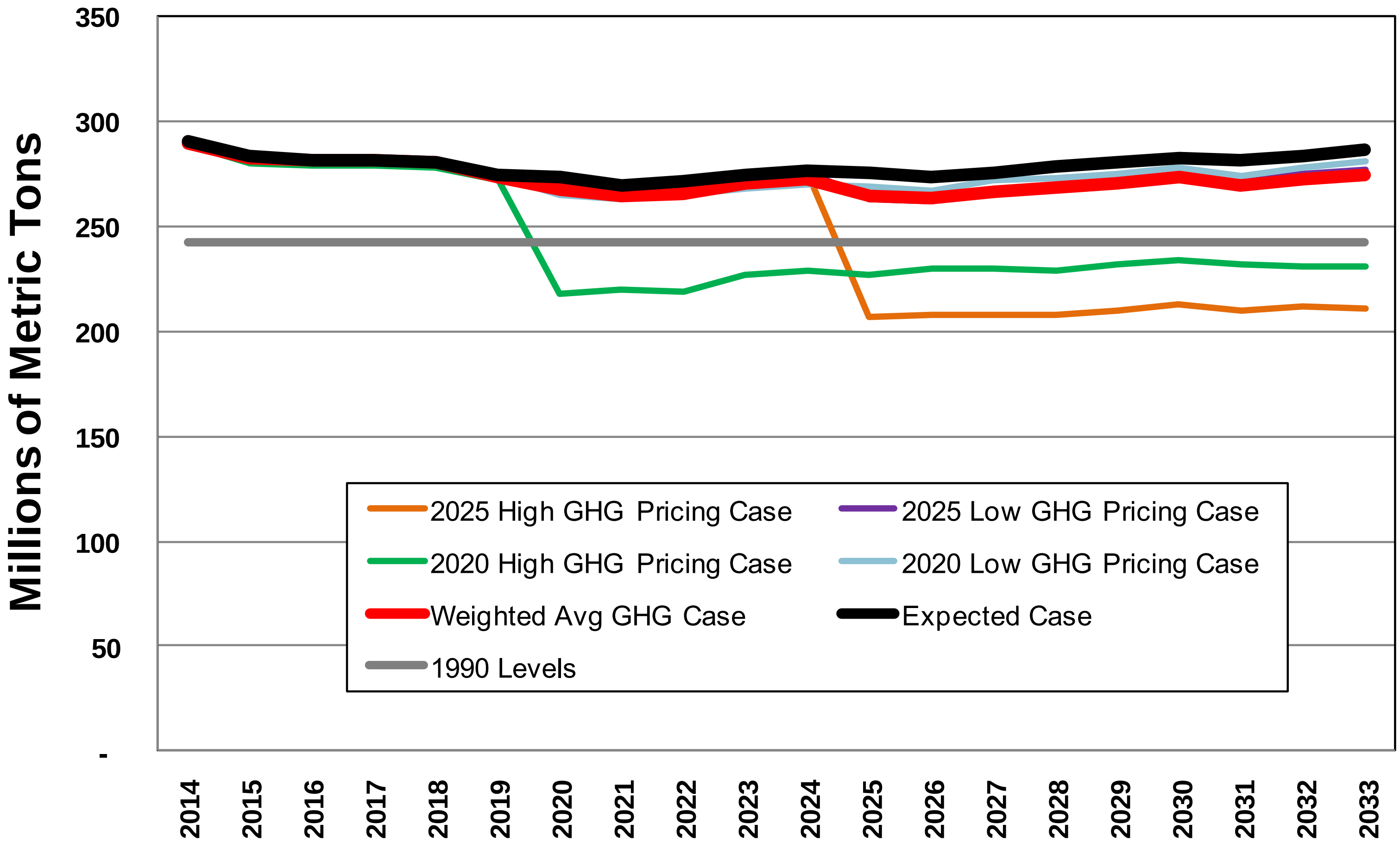


deterministic case

The Real Increase to Electric Market Prices



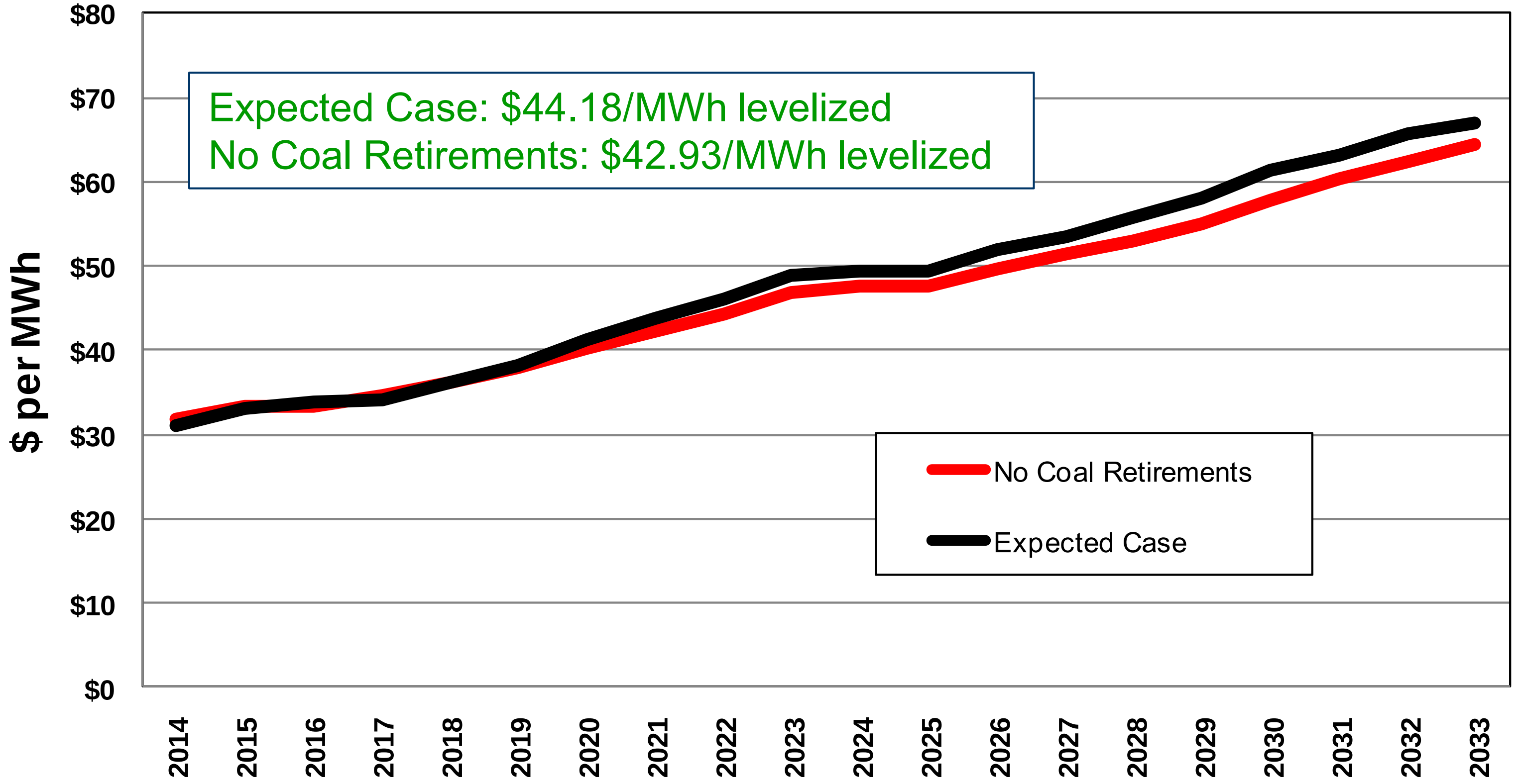
Greenhouse Gas Scenario Reductions



deterministic case

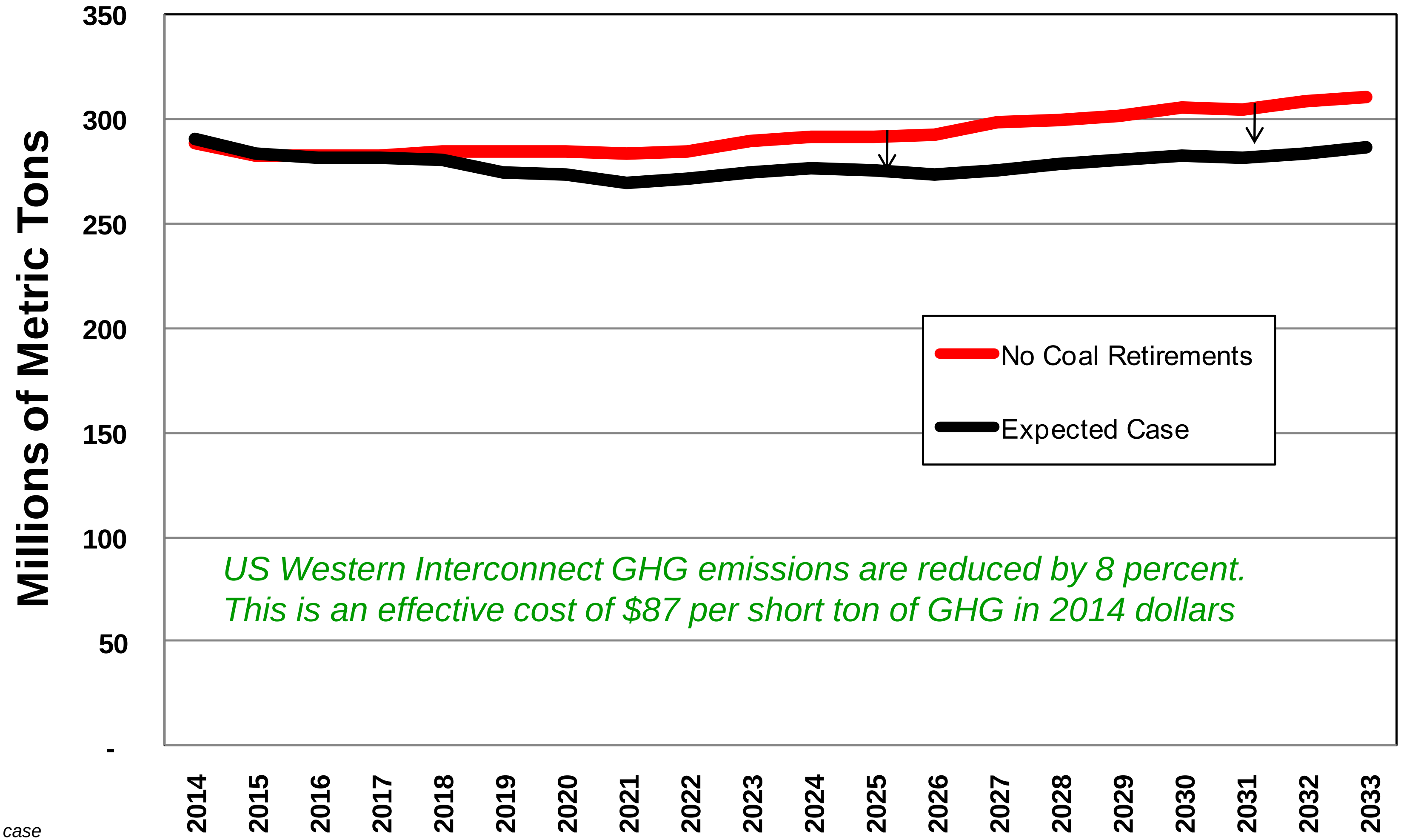
No Coal Plant Retirement Scenario

- Retains 12,000 MW of coal generation for the duration of the forecast



deterministic case

Greenhouse Gas Emissions Increase Without Coal Retirements

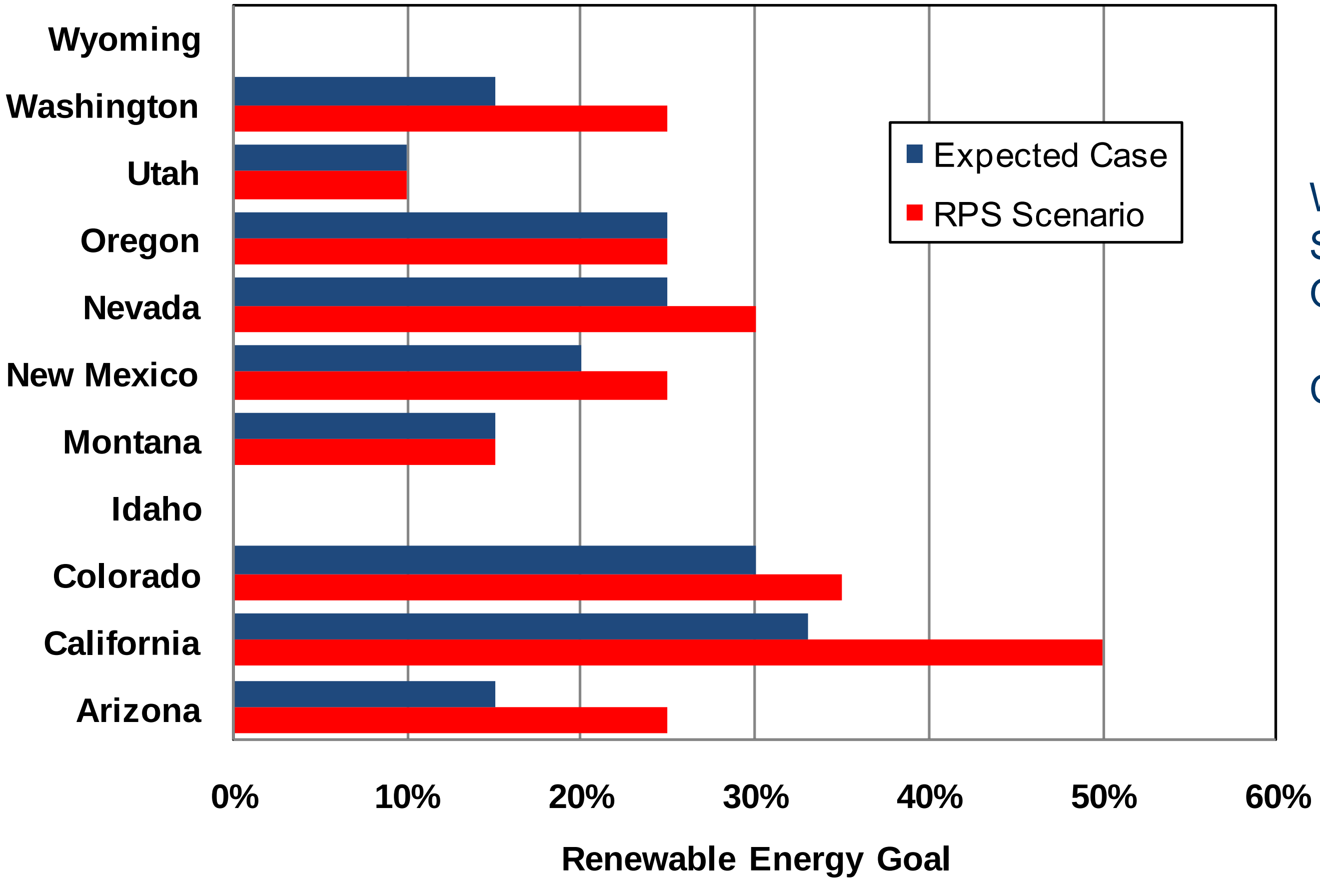


US Western Interconnect GHG emissions are reduced by 8 percent.
This is an effective cost of $87 per short ton of GHG in 2014 dollars

deterministic case

State RPS's Increased Scenario

-Assumes in beginning in 2025, states with lower RPS begin new higher standards



Adds

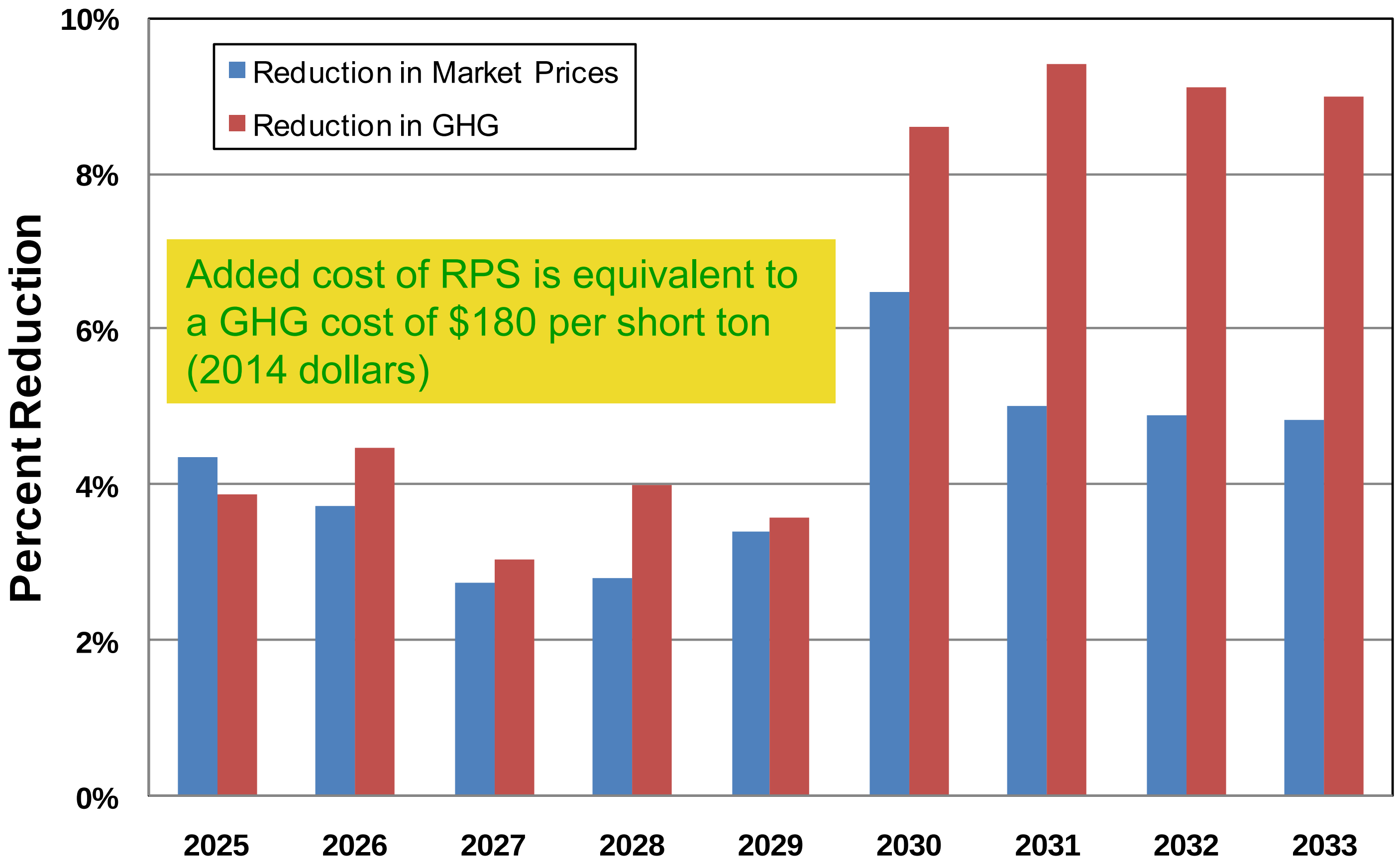
Wind: 7,000 MW

Solar: 29,000 MW

Other: 1,000 MW

Cost: $80 billion (2012$)

Changes to Market Prices and GHG Emissions



Added cost of RPS is equivalent to a GHG cost of $180 per short ton (2014 dollars)

Conservation Avoided Costs

James Gall

Fifth Technical Advisory Committee Meeting

2013 Electric Integrated Resource Plan

March 20, 2013

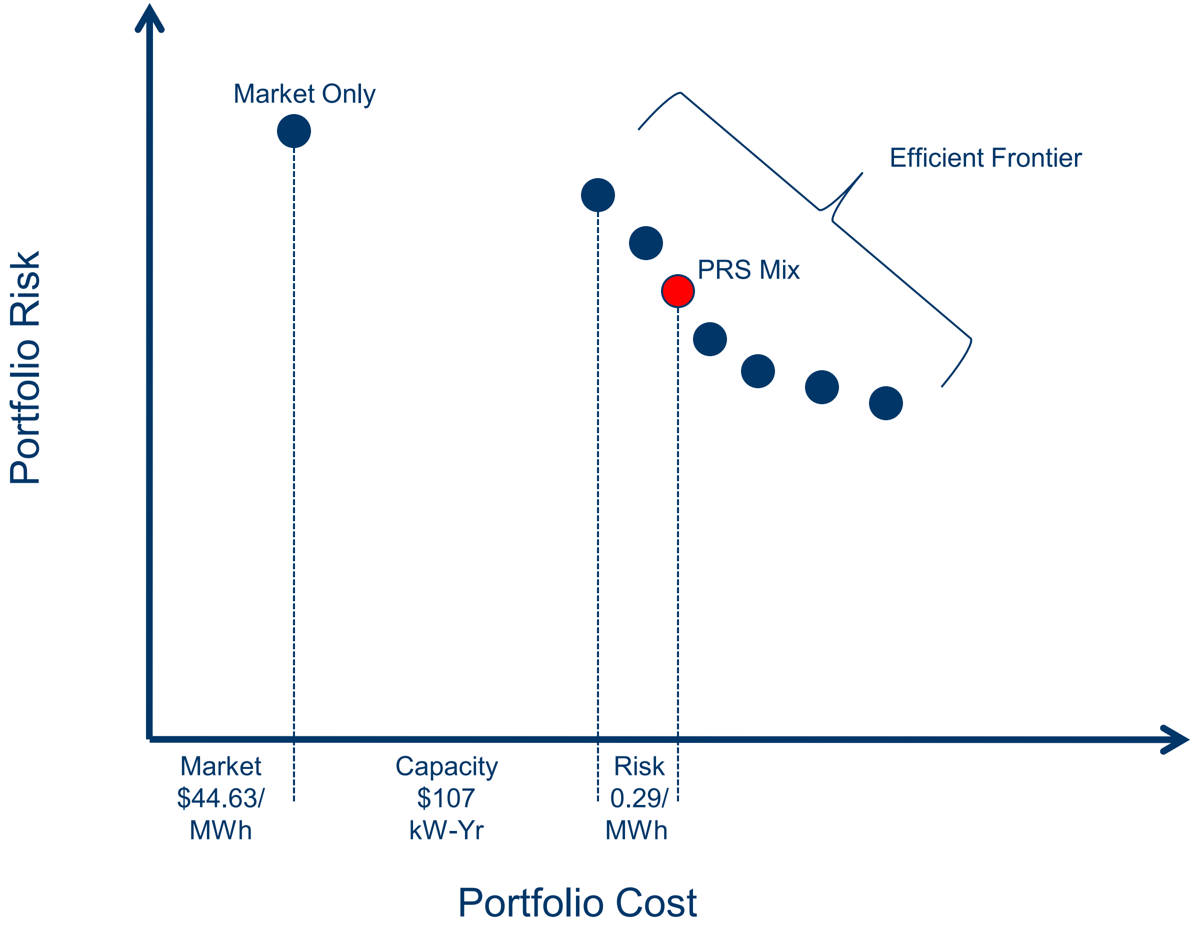
How to Value Conservation

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

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)

Efficient Frontier Approach

Assumes no additional Conservation Resources



Avoided Cost Calculation

For 1 MW Measure with Flat Delivery

Item	$/MWh
Energy Price	44.63
Capacity Savings	13.33
Risk Premium	0.29
Subtotal	**58.26**

Converts $107/kW-yr to $/MWh

Item	$/MWh
10% Preference	6.19
Distribution Capacity Savings	0.88
T&D losses	2.72
Subtotal	**9.79**

Avoided Cost:
$68.05
per
MWh

2011 IRP was $104.39/MWh

Analysis based on earlier draft of Market Prices

ENERNOC

Avista Conservation Potential Assessment – 2013 Update

Overview of Approach and Analysis Results

March 20, 2013

Agenda

- Introductions
- Study objectives
- Analysis approach
- Summary of results
- Consistency with NWPCC Methodology

Introductions

EnerNOC Team

Ingrid Rohmund

Practice Lead,
Energy Analysis
and Planning

Jan Borstein

Project Manager

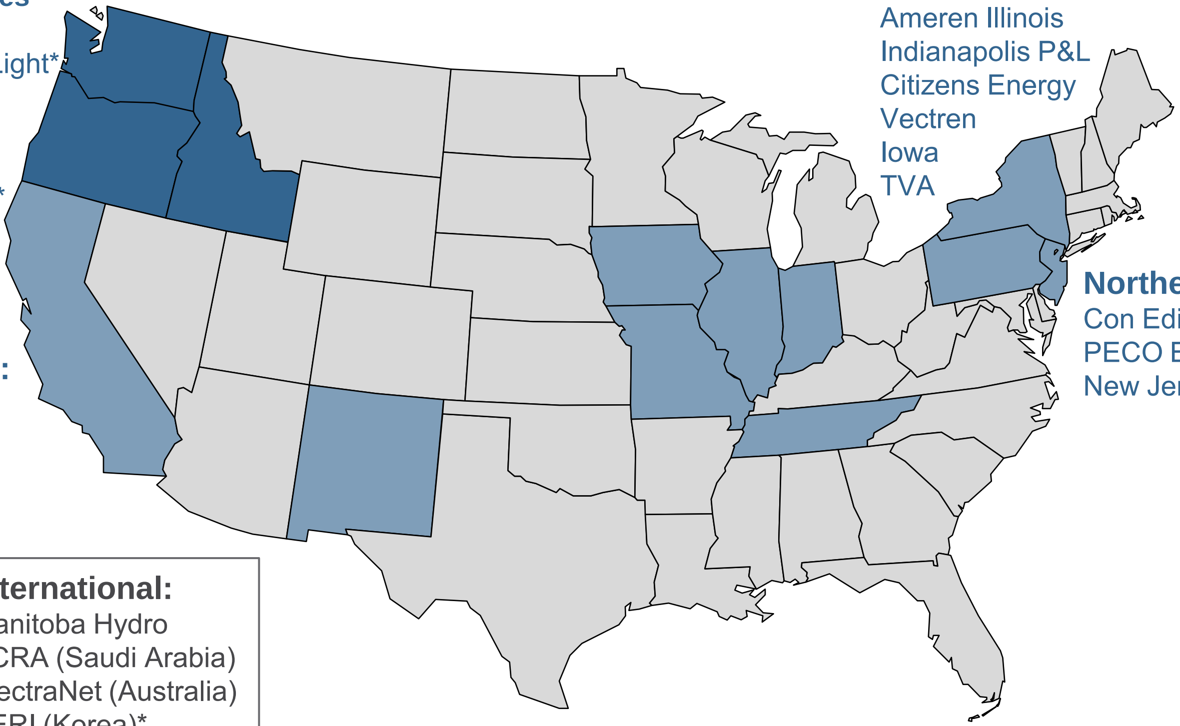
Various analysts

EnerNOC Utility Solutions Consulting

- Previously Global Energy Partners, and before that a part of EPRI
- Practice areas:
    - Energy Analysis & Planning
    - Program Evaluation and Load Analysis
    - Engineering Services
- 30 full-time consultants
    - Economists/statisticians
    - Engineers

EnerNOC experience with potential studies

National/Regional:
EPRI National DSM Study
FERC Nat'l Assessment of DR
IEE Analysis of Codes and Standards*
Midwest ISO EE and DR Assessment



Northwest:
Avista Utilities*
Idaho Power
Seattle City Light*
Portland GE*
BPA
Inland P&L*
Cowlitz PUD*
OTECC

Southwest:
LADWP
State of NM
State of HI

Midwest :
Ameren Missouri*
Ameren Illinois
Indianapolis P&L
Citizens Energy
Vectren
Iowa
TVA

Northeast:
Con Edison of NY
PECO Energy
New Jersey BPU

International:
Manitoba Hydro
ECRA (Saudi Arabia)
ElectraNet (Australia)
KERI (Korea)*

Study objectives

- Study continues Avista's process of updating estimates of conservation potential on a regular basis
- Specific objectives:
  - Provide credible and transparent estimates of conservation potential
  - Assess savings by measure or bundled measure and sector
  - Support Avista's IRP development
  - Establish 2014-2015 biennial target per requirements of Washington I-937

Analysis Approach

Study approach

Study results

Synthesize

Review Annual Business Plans
Sensitivity analysis

Achievable potential

Establish Customer Acceptance

Program results Other studies
Market acceptance rates

Technical and economic potential

Screen Measures and Options

Measure descriptions
Avoided costs

Avista program data, TRM
NWPCC/RTF workbooks

End-use projection by segment

Project the Baseline

Prototypes and energy analysis (***BEST***) Avista Forecast data
Codes and standards RTF data Secondary data

Base-year energy use by segment

Characterize the Market

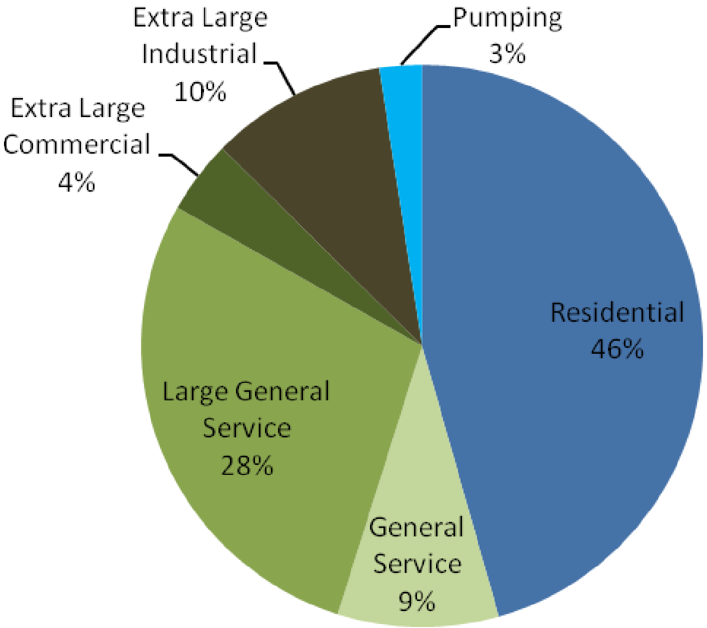
Avista billing data Program data ***Energy Market Profiles***
RBSA and other saturation surveys Secondary data Previous study results

Study objectives

Market segmentation by rate class, 2009

Sector	Rate Schedule(s)	Number of meters (customers)	2009 Electricity sales (MWh)
Residential	001	299,714	3,634,086
General Service	011, 012	46,387	738,505
Large General Service	021, 022	4,808	2,256,882
Extra Large GS – Comm.	025	12	336,047
Extra Large GS – Ind*		19	809,298
Pumping	031, 032	3,673	194,884
Total		**354,613**	**7,969,701**

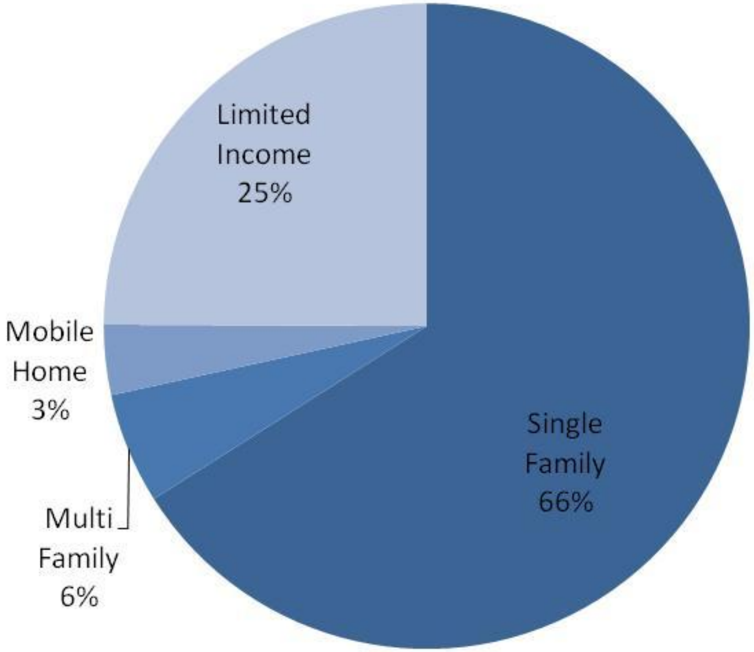
* Idaho 25P was included in previous CPA but for the 2013 study it has been analyzed separately from other large industrial customers.



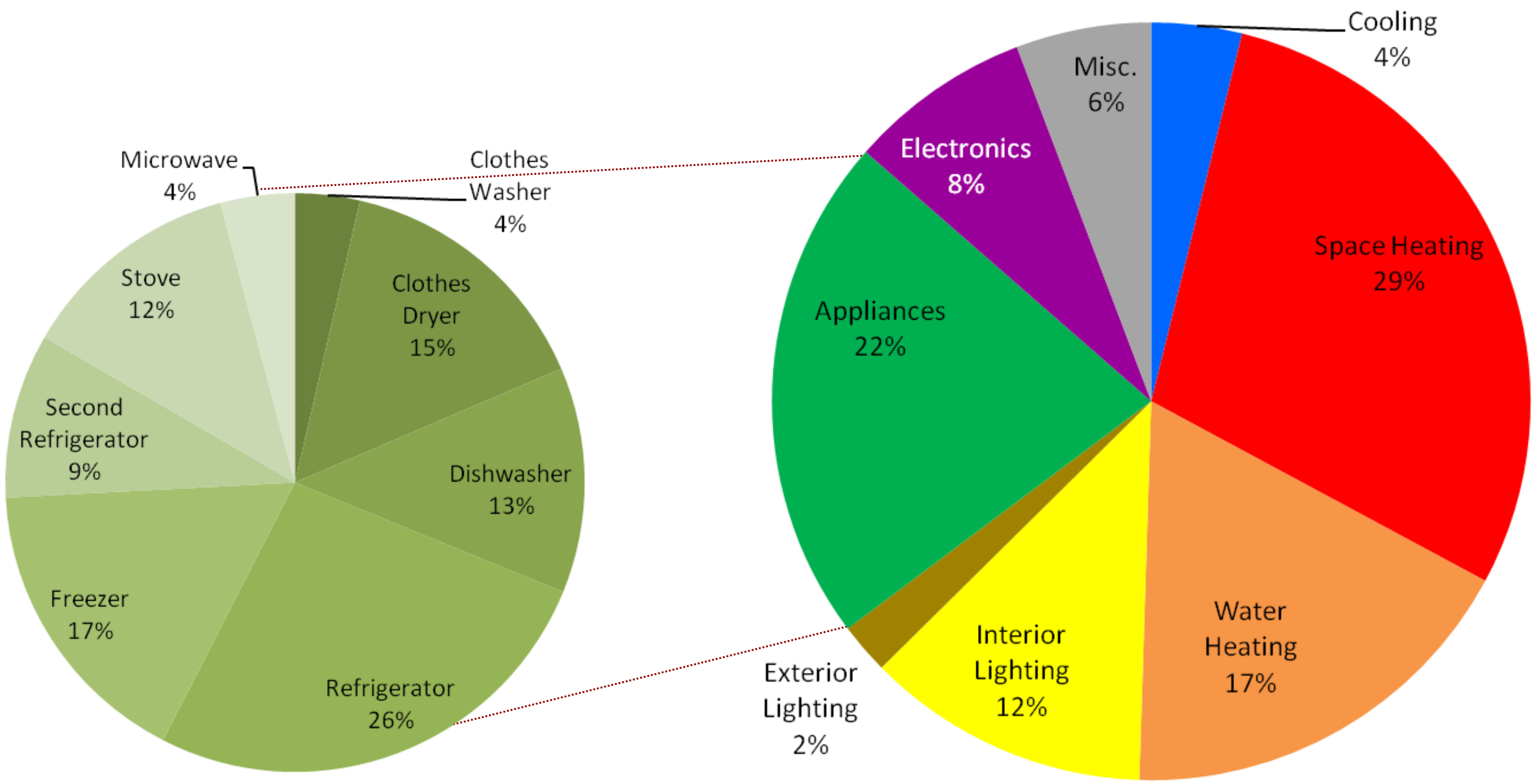
Residential market characterization, 2009

Segment	Annual Use (1000 MWh)	Number of Customers	Intensity (kWh/HH)	% of Total Usage
Single Family	2,399	168,339	14,250	66%
Multi Family	202	23,456	8,613	6%
Mobile Home	128	10,022	12,724	4%
Limited Income	906	97,896	9,251	25%
Total	**3,634**	**299,714**	**12,125**	**100%**

- Market segmentation developed using U.S. Census American Community Survey data
- Limited Income is defined as customers with annual income approximately two times the poverty level



Residential market profile, 2009



Baseline projection

- Model equipment choices for replacement or new construction
- Define baseline purchase shares —begin with Annual Energy Outlook shipments data and modify for Avista data and program history
- Incorporates building codes and appliance standards currently enacted
- In some cases, this eliminates potential future savings, as higher efficiency option becomes the baseline, least efficient option

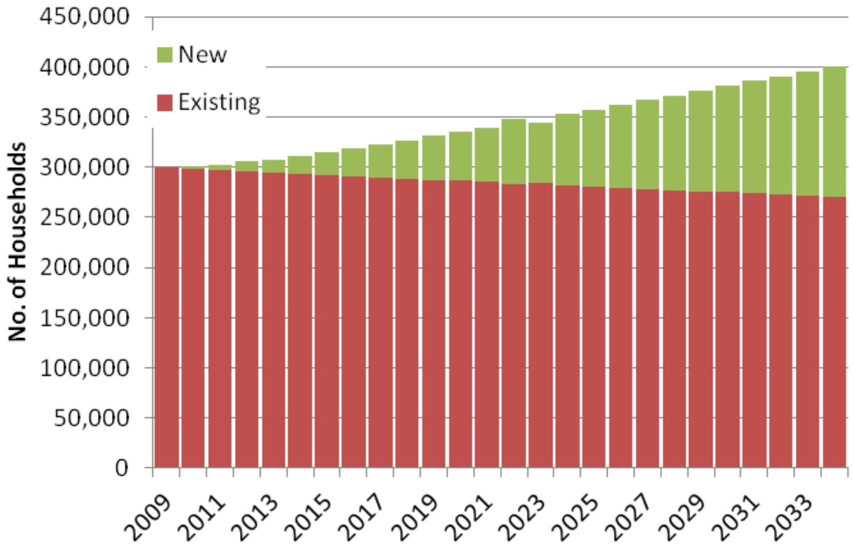
▢ Today's Efficiency or Standard Assumption

🟦 1st Standard (relative to today's standard)

🟫 2nd Standard (relative to today's standard)

End Use	Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Cooling	Central AC	SEER 13				SEER 14										
	Room AC	EER 9.8			EER 11.0											
Cooling/Heating	Heat Pump	SEER 13.0/HSPF 7.7				SEER 14.0/HSPF 8.0										
Water Heating	Water Heater (<=55	EF 0.90				EF 0.95										
	Water Heater (>55 gallons)	EF 0.90				Heat Pump Water Heater										
Lighting	Screw-in/Pin Lamps	Incandescent			Advanced Incandescent - tier 1						Advanced Incandescent - tier 2					
	Linear Fluorescent	T8														
Appliances	Refrigerator/2nd	NAECA Standard			25% more efficient											
	Freezer	NAECA Standard			25% more efficient											
	Dishwasher	Conventional (355		14% more efficient (307 kWh/yr)												
	Clothes Washer	Conventional (MEF 1.26 for top loader)				MEF 1.72 for top loader			MEF 2.0 for top loader							
	Clothes Dryer	Conventional (EF 3.01)				5% more efficient (EF 3.17)										

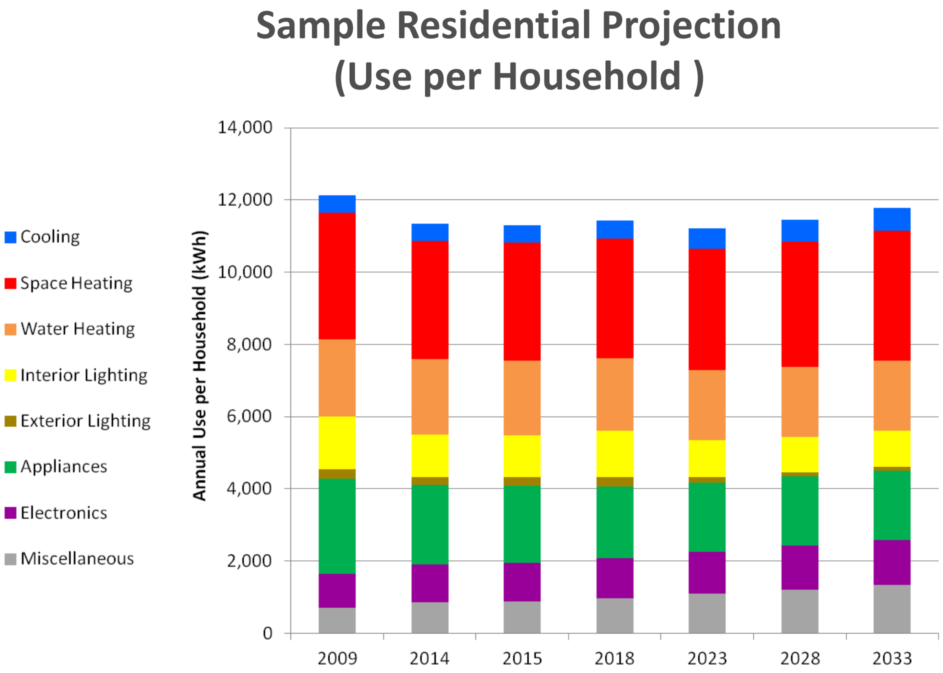
Baseline projection



- Drivers
  - Market size / customer growth
  - Income growth
  - Avista retail rates forecast
  - Trends in end-use/technology saturations
  - Equipment purchase decisions
  - Cooling and heating degree days
  - Persons/household and physical home size
  - Elasticities by end use for each forecast driver
- Calibrated model to align with 2010-2012 sales and conservation program history
  - Began with Sixth Power Plan measure ramp rates and adjusted to program achievements
  - Baseline projection aligns with sales + program achievements

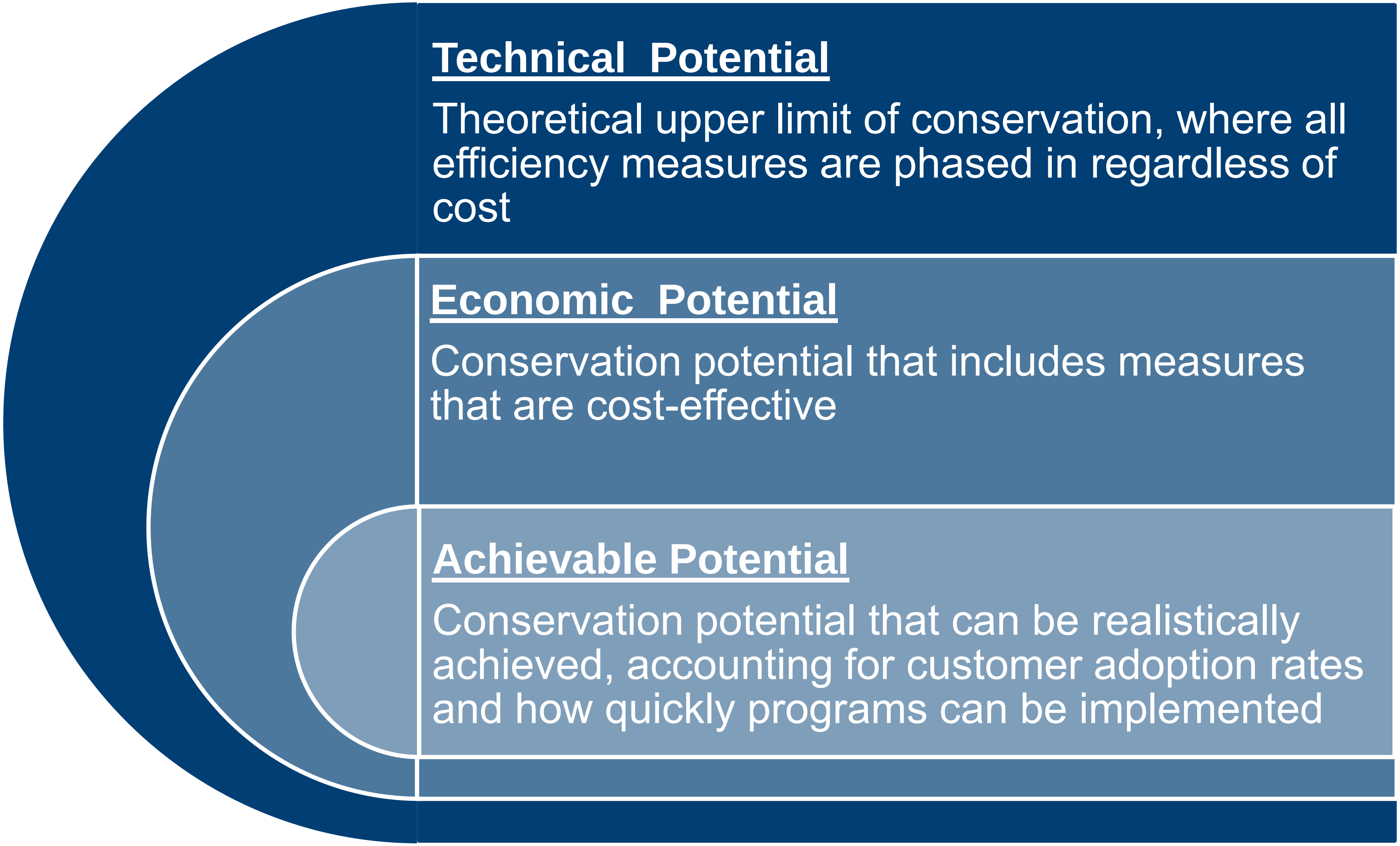
The baseline projection (absent future conservation)

- The metric against which savings are measured. It includes:
  - Current saturations of appliances, equipment, and legacy measures
  - Assumptions about customer and economic growth
  - Trends in fuel shares and appliance/equipment saturations
  - Exogenous variables including electricity prices, income, etc.



Develop three levels of potential

Potential studies identify future opportunities for EE that can be achieved through programs



Technical Potential

Theoretical upper limit of conservation, where all efficiency measures are phased in regardless of cost

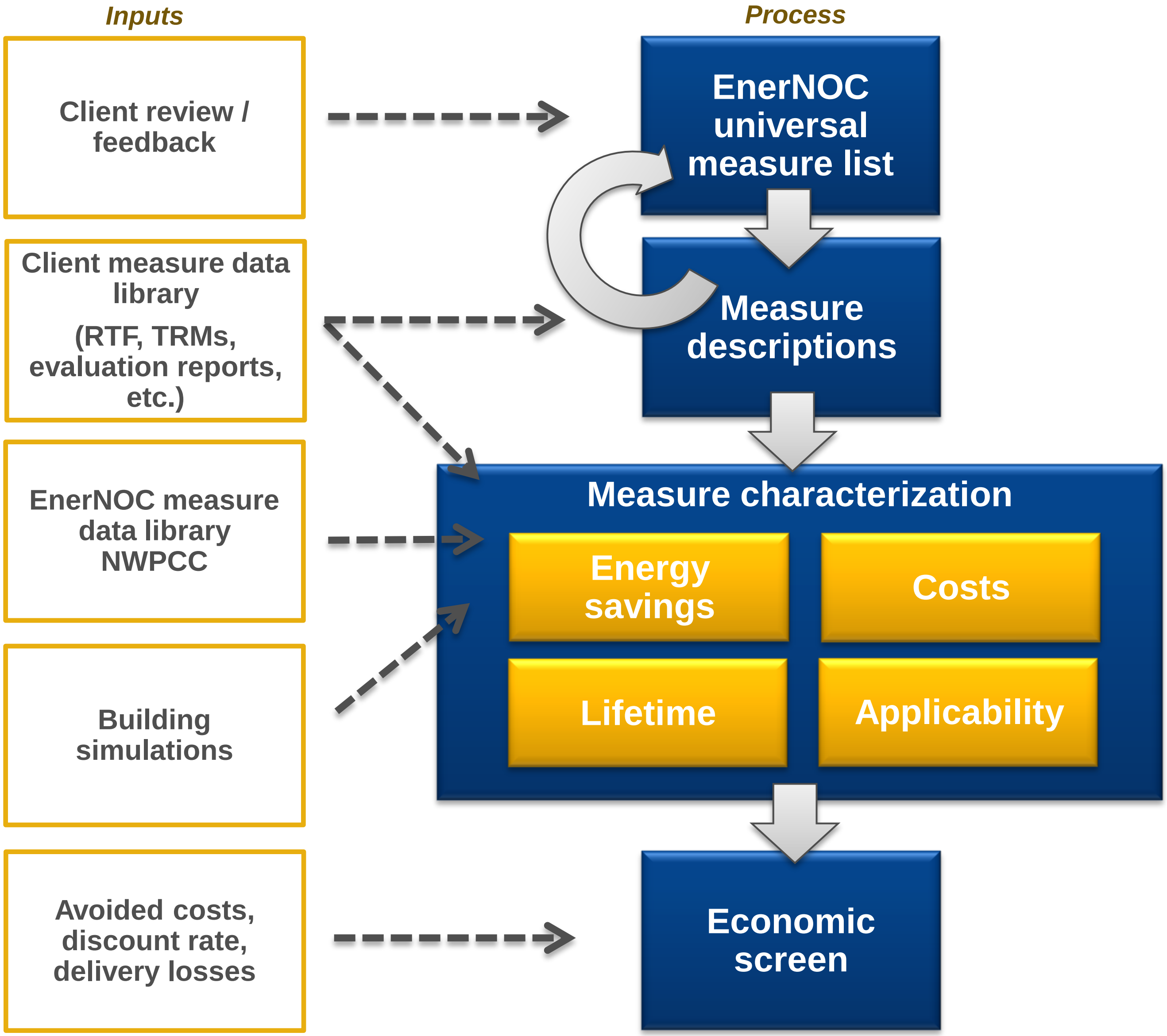
Economic Potential

Conservation potential that includes measures that are cost-effective

Achievable Potential

Conservation potential that can be realistically achieved, accounting for customer adoption rates and how quickly programs can be implemented

Conservation measure assessment approach



Inputs

Client review / feedback

Client measure data library

(RTF, TRMs, evaluation reports, etc.)

EnerNOC measure data library NWPCC

Building simulations

Avoided costs, discount rate, delivery losses

Process

EnerNOC universal measure list

Measure descriptions

Measure characterization

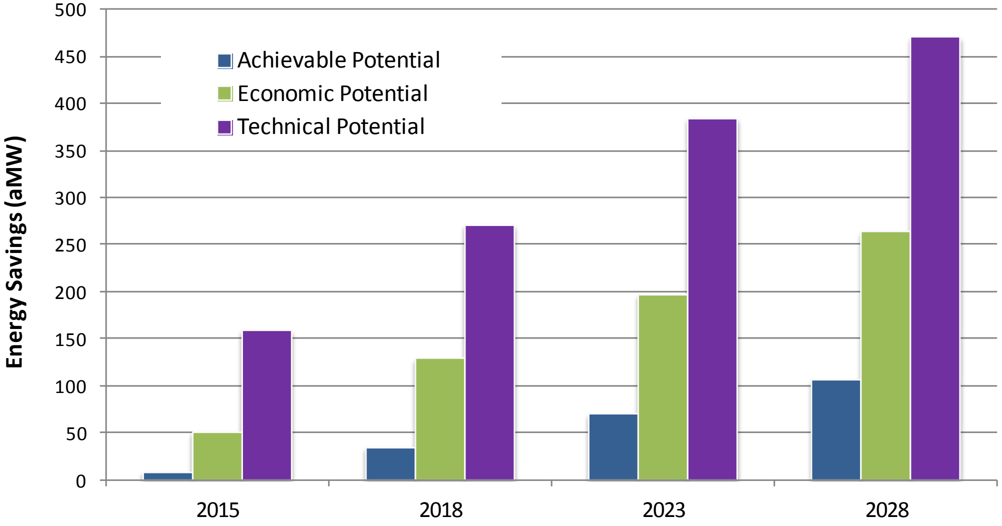
- Energy savings
- Costs
- Lifetime
- Applicability

Economic screen

Potential Results

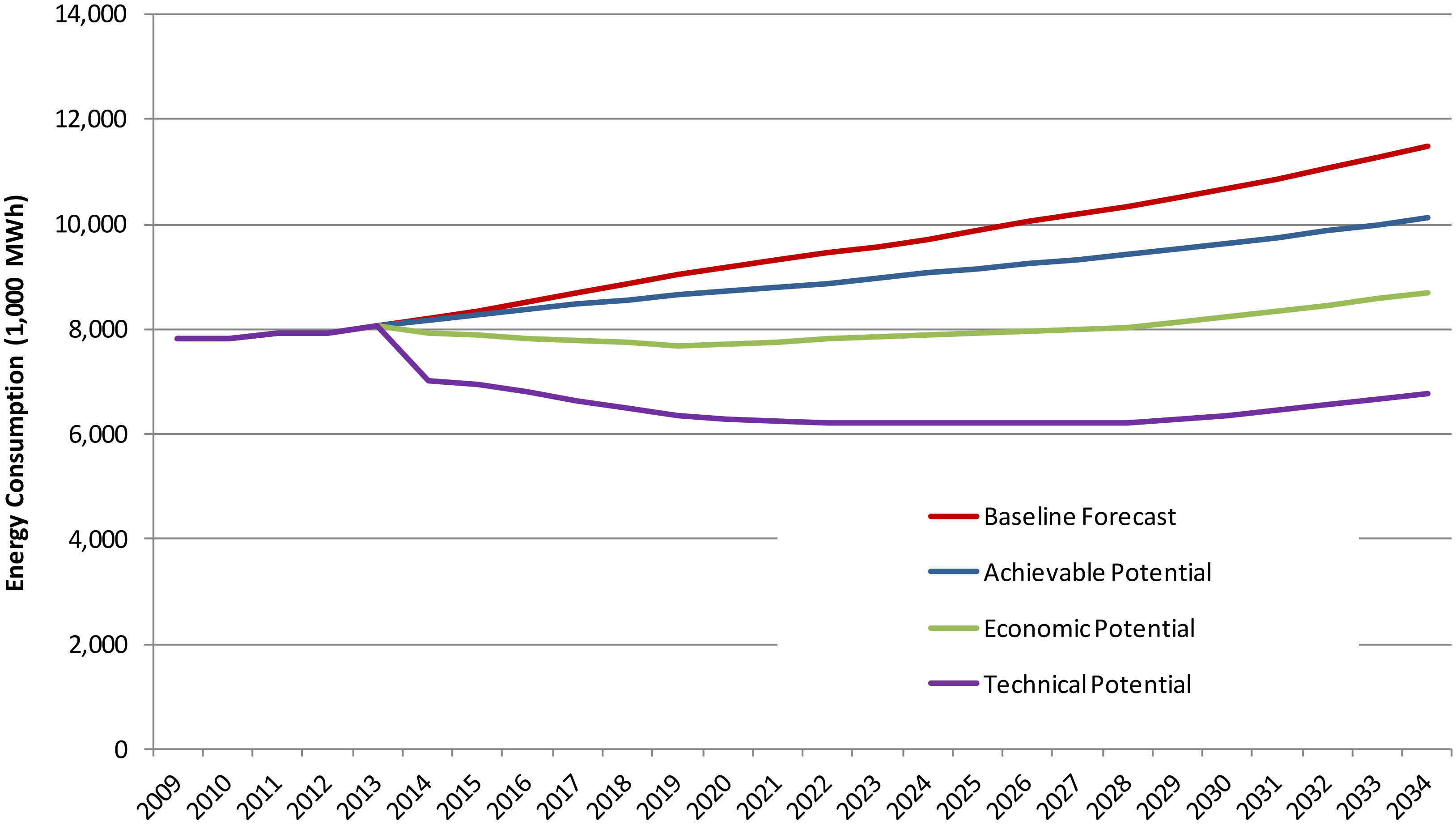
All sectors potential

- Cumulative achievable savings potential in 2014 is 4.4 aMW
- Cumulative achievable savings potential in 2015 is 8.7 aMW

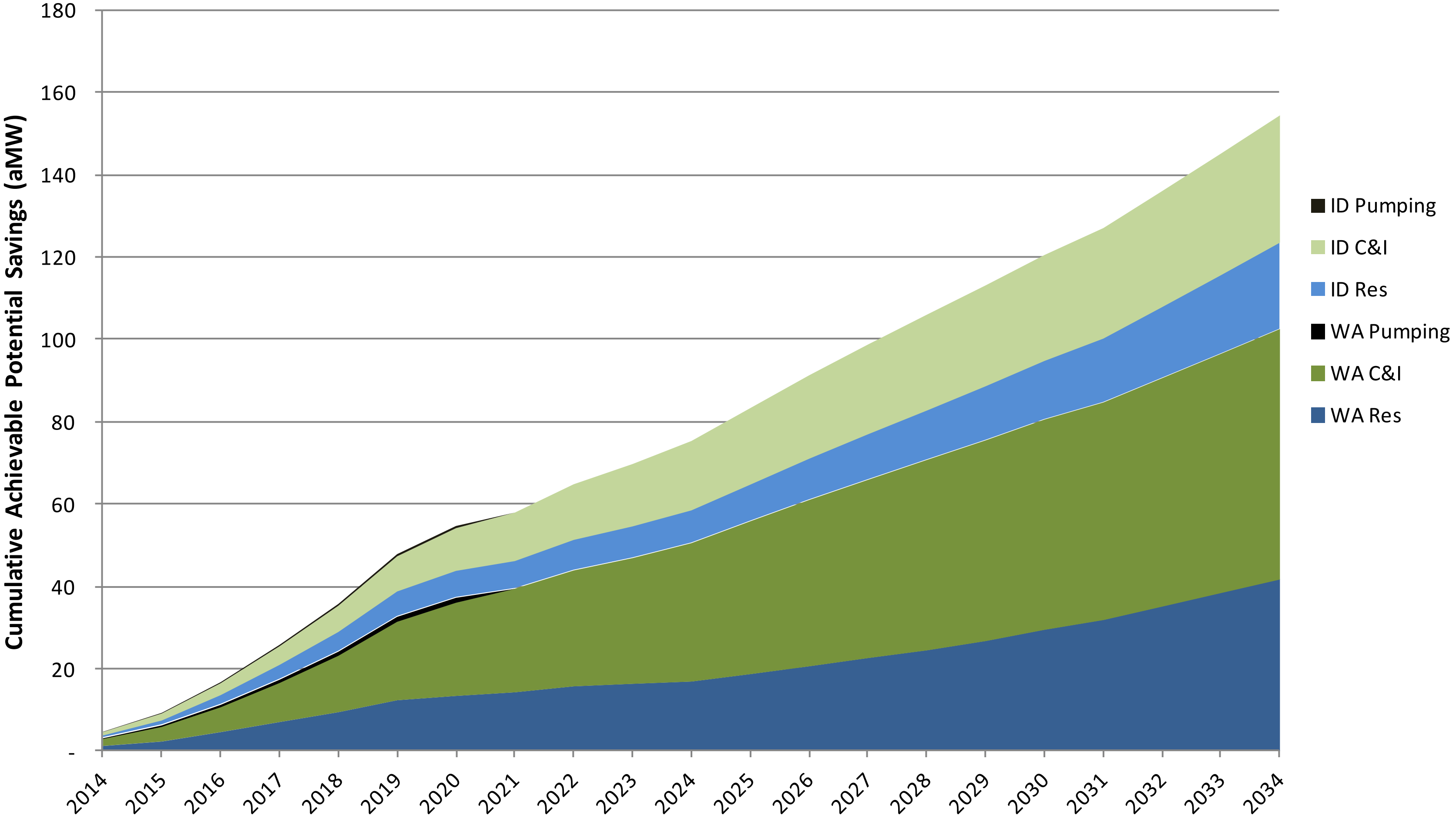


	2014	2015	2018	2023	2028	2033
Cumulative Savings (MWh)						
Achievable Potential	38,726	76,352	300,112	610,600	928,320	1,271,323
Economic Potential	272,830	446,842	1,127,376	1,723,424	2,312,719	2,675,318
Technical Potential	1,173,173	1,392,531	2,374,256	3,366,522	4,122,161	4,604,718
Cumulative Savings (aMW)						
Achievable Potential	4.4	8.7	34.3	69.7	106.0	145.1
Economic Potential	31.1	51.0	128.7	196.7	264.0	305.4
Technical Potential	133.9	159.0	271.0	384.3	470.6	525.7

All sectors potential

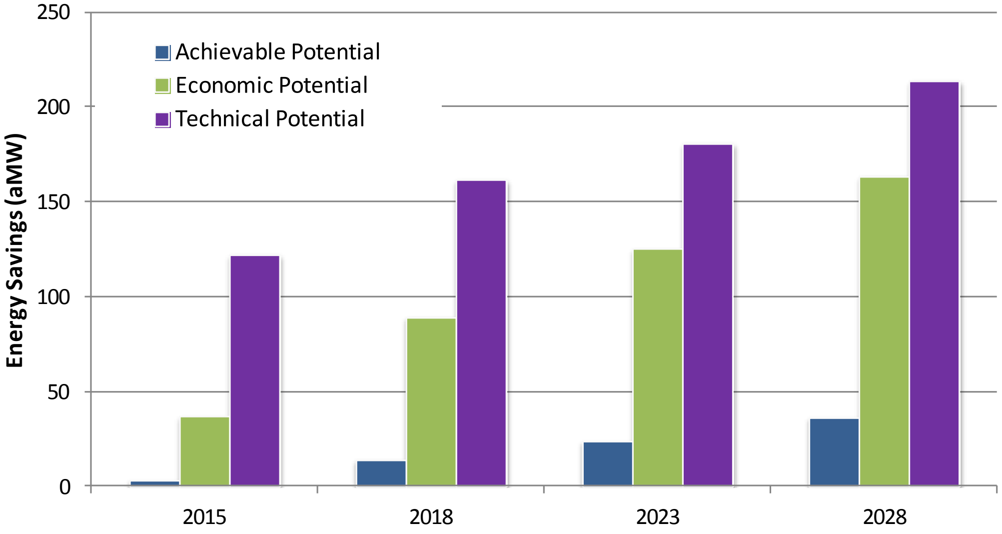


All sectors potential



Residential potential

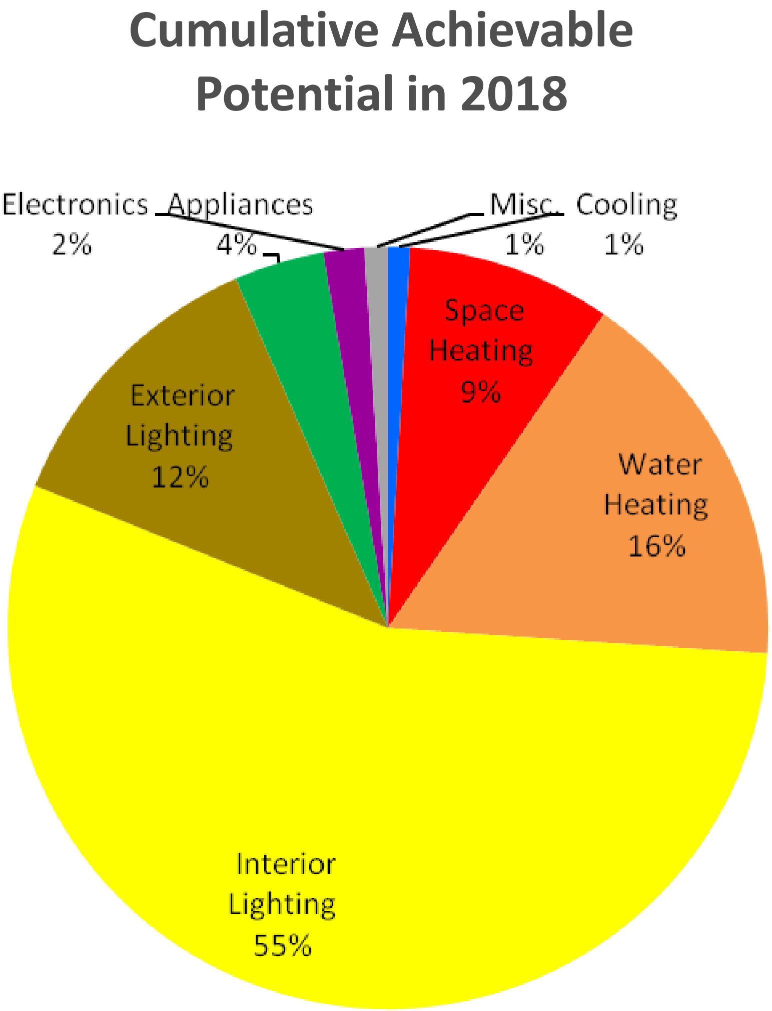
- Cumulative achievable savings potential is 1.9 aMW in 2014
- Grow to 3.4 aMW in 2015



	2014	2015	2018	2023	2028	2033
Cumulative Savings (MWh)						
Achievable Potential	16,247	30,197	124,161	202,569	319,277	503,671
Economic Potential	206,661	322,861	781,184	1,051,855	1,430,505	1,643,220
Technical Potential	987,175	1,070,490	1,415,574	1,557,797	1,870,448	2,071,698
Cumulative Savings (aMW)						
Achievable Potential	1.9	3.4	14.2	23.1	36.4	57.5
Economic Potential	23.6	36.9	89.2	120.1	163.3	187.6
Technical Potential	112.7	122.2	161.6	177.8	213.5	236.5

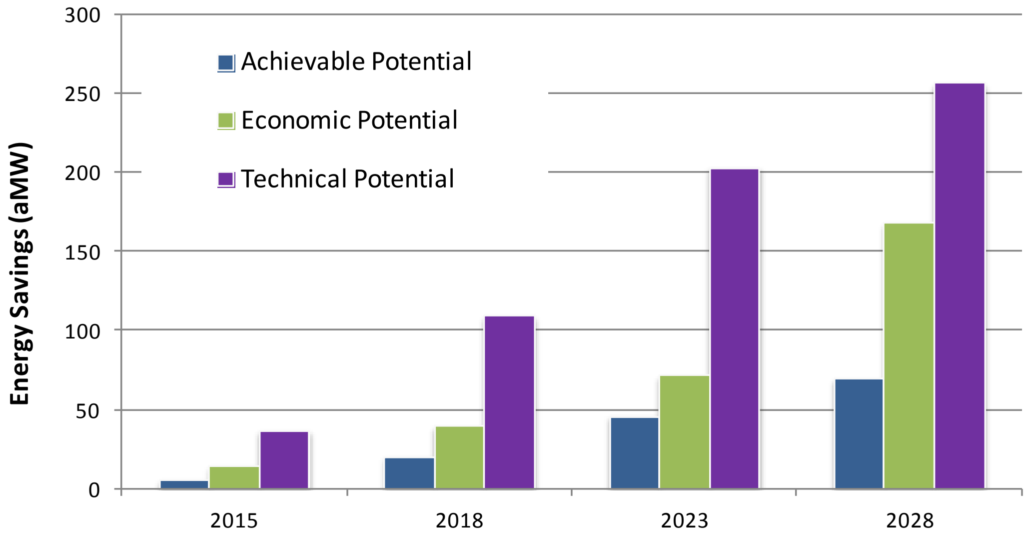
Residential achievable savings potential – top measures

- Lighting – largely CFLs (including specialty lamps), with LEDs starting to pass the cost-effectiveness test in 2015
- Space heating savings from conversion to gas and ductless heat pumps as well as new programs for duct sealing and shell/infiltration measures
- Water heating savings from conversion to gas; also low-flow fixtures, tank/pipe insulation
- Refrigerator and freezer recycling
- Programmable thermostats
- ENERGY STAR homes and new construction efficiency



Commercial & Industrial potential

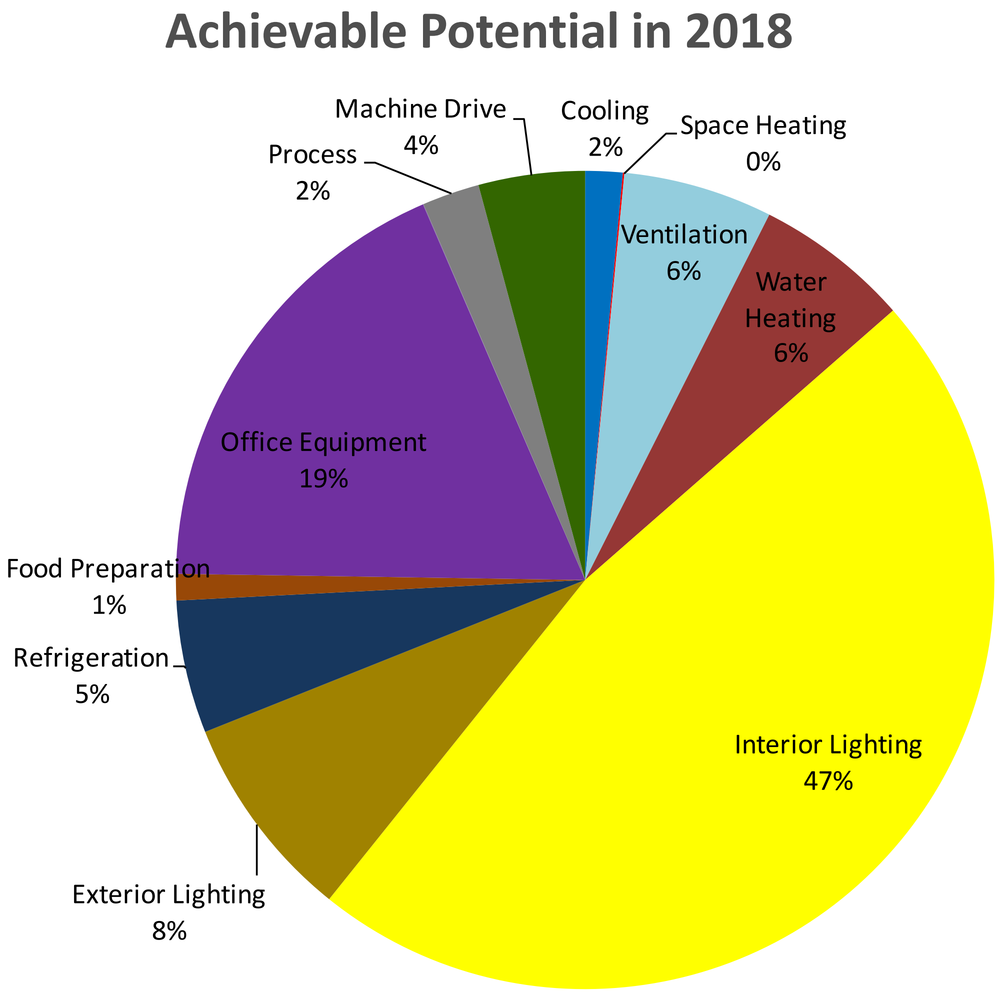
- Cumulative potential in 2015 is 5.3 aMW



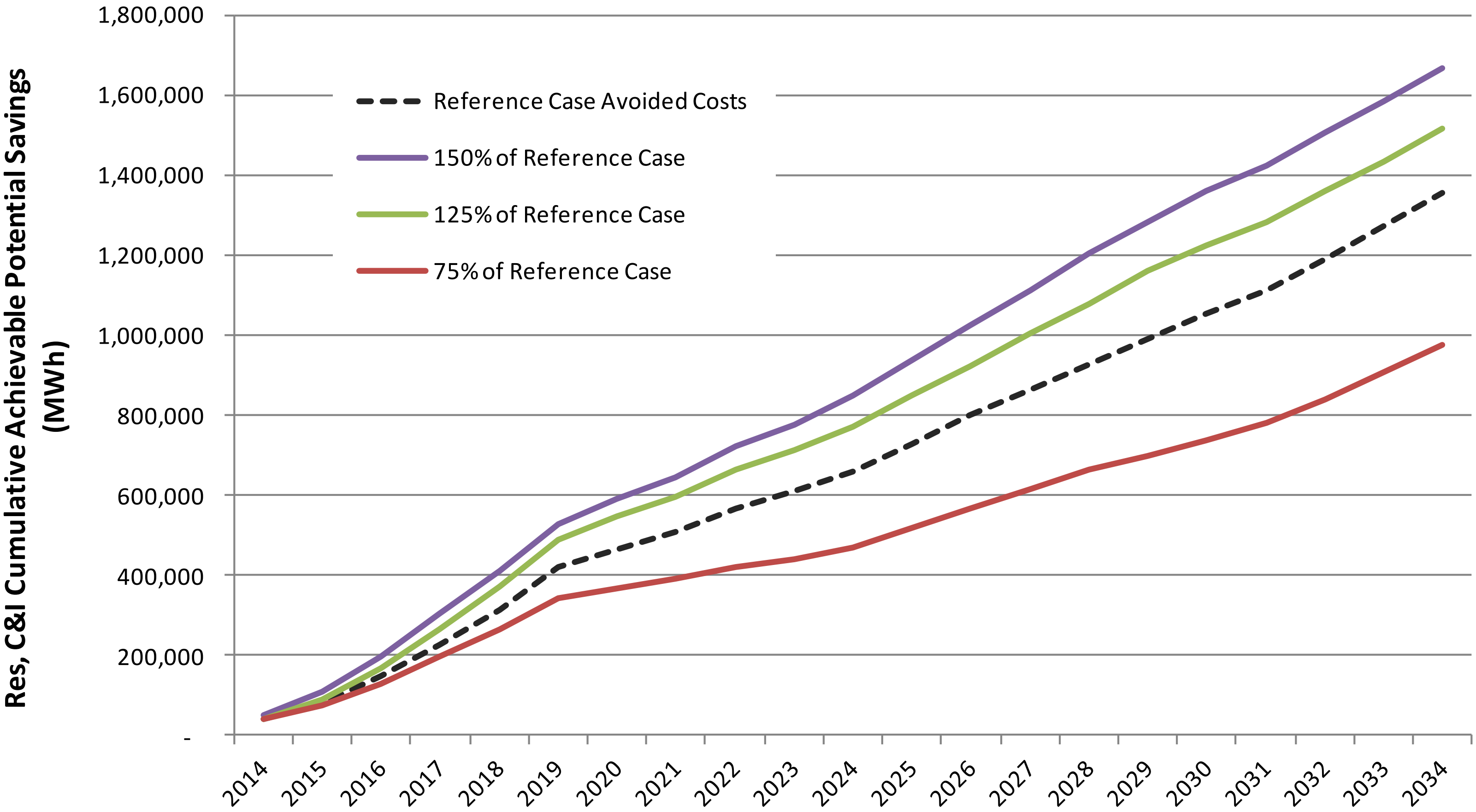
	2014	2015	2018	2023	2028	2033
Cumulative Savings (MWh)						
Achievable Potential	22,478	46,155	175,951	400,188	609,043	767,651
Economic Potential	66,170	123,981	346,193	627,462	1,474,041	1,032,097
Technical Potential	185,998	322,041	958,683	1,782,838	2,251,713	2,533,019
Cumulative Savings (aMW)						
Achievable Potential	2.6	5.3	20.1	45.7	69.5	87.6
Economic Potential	7.6	14.2	39.5	71.6	168.3	117.8
Technical Potential	21.2	36.8	109.4	203.5	257.0	289.2

C&I Conservation potential – top measures

- Lighting – mix of lamps including LEDs, various controls
- HVAC – controls, economizers, variable air volume (VAV) ventilation
- Machine drive and process – 6% from various measures for air compressors, fans, and pumps
- Also low-flow fixtures, tank/pipe insulation
- Office equipment – efficient servers, desktop computers, and printers

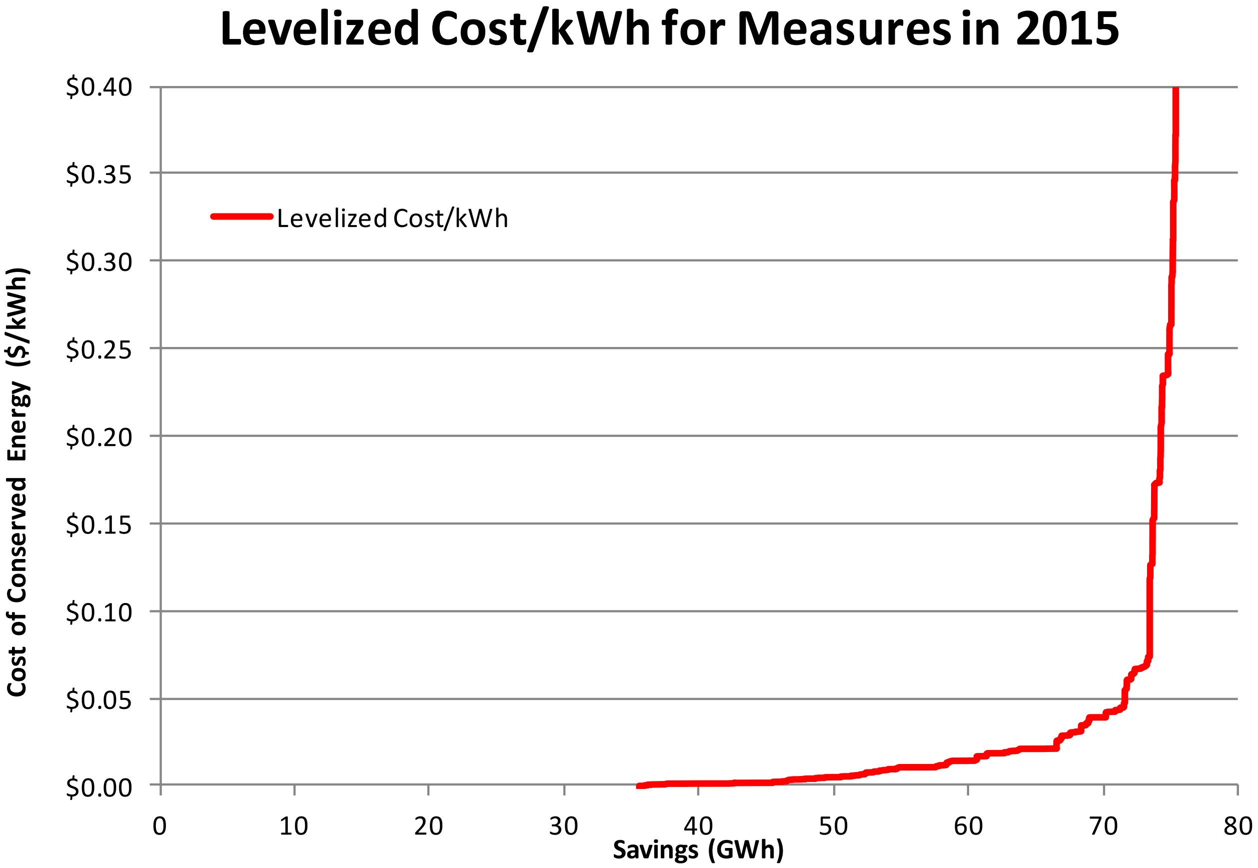


Conservation potential – sensitivity to avoided costs

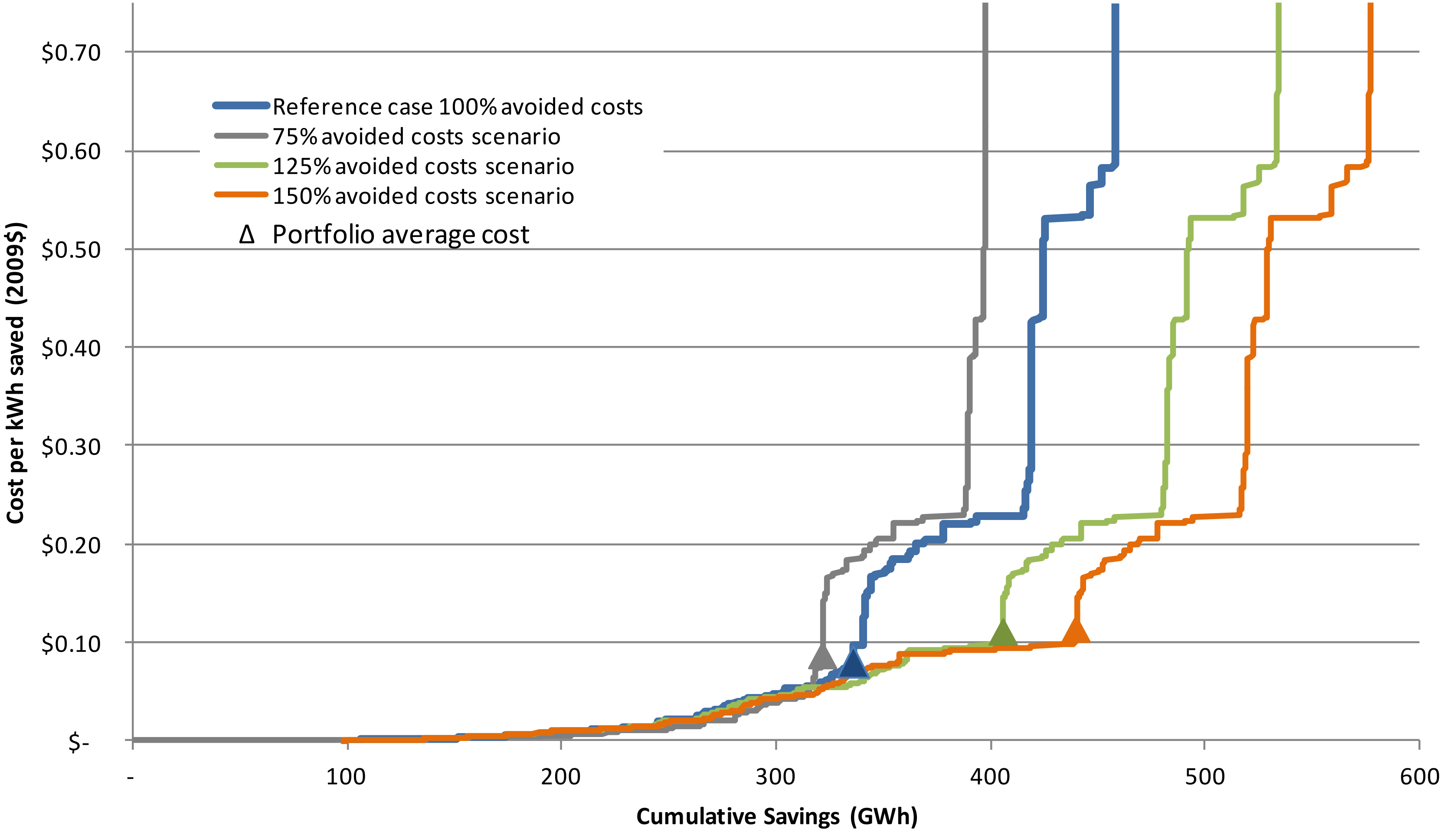


Supply curve for 2015 – cumulative savings

- Nearly 35 GWh of savings are low- or no-cost.

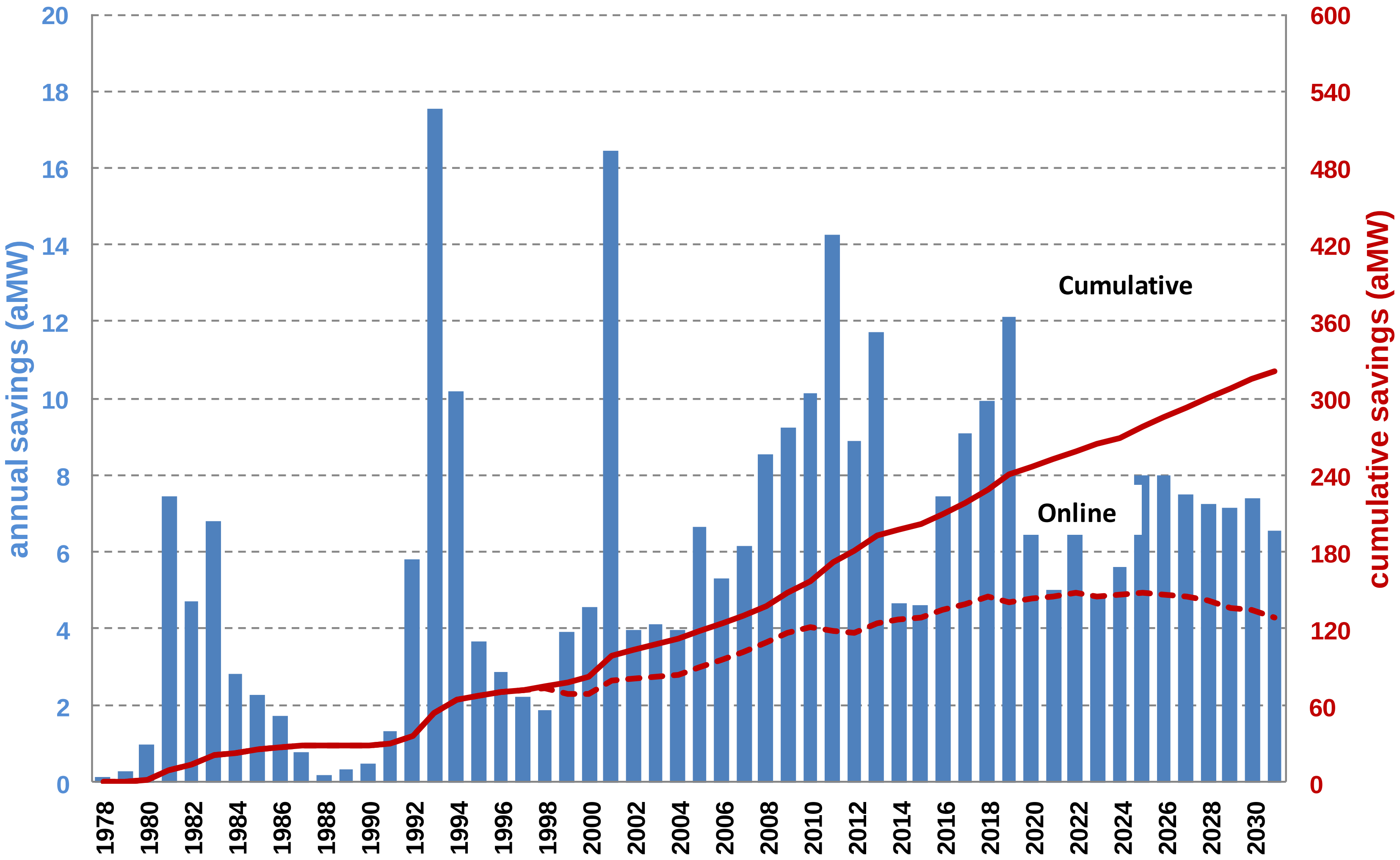


Supply curves for 2020 – avoided costs scenarios



ENERNOC

Annual and cumulative savings



ENERNOC

Consistency with the NWPCC Methodology

Initiative 937 Conservation Provisions

- Washington Initiative 937 approved by voters in 2006
- Requires that utilities estimate 10-year potentials
  - Utility Analysis Option must be consistent with the methodology of the Northwest Power and Conservation Council’s most recent Power Plan
  - Used to set a two-year biennium conservation target
  - Must be repeated every two years

Consistency with Council Methodology

- End-use model — bottom-up
  - Building characteristics
  - Fuel and equipment saturations
  - Stock accounting based on measure life
  - Codes and standards
  - Existing and new vintage
  - Lost- and non-lost opportunities
  - Measure saturation and applicability
  - Measure savings, including HVAC interactions and contribution to peak
  - Ramp rates to model market acceptance and program implementation

Consistency with Council Methodology (cont.)

- Measures
  - Include nearly all in Sixth Power Plan
  - Plus others. e.g., conversion of electric water heaters / furnaces to gas
  - Sources for measure characterization
    - RTF measure workbooks
    - Avista Technical Reference Manual (TRM)
    - EnerNOC databases, which draw upon same sources used by RTF
- Economic potential, total resource cost (TRC) test
  - Considers non-energy benefits
  - Considers HVAC interactions
  - Include 10% credit based on Conservation Act
- Achievable potential – ramp rates
  - Based on Council Sixth Power Plan ramps rates
  - Modified to reflect Avista program history

Avista-specific items

- Avista customer characteristics
  - Calibrated to Avista 2009 sales by sector
  - Average use per customer based on actual billing data
  - Equipment saturations and unit energy consumption calibrated to match usage
  - Updated with newly available NW Residential Building Stock Assessment data, e.g., information on measure saturation
- Building codes and appliance standards updated as of 2012
- Avista-specific customer growth forecasts
- Avista retail rate and avoided cost forecasts
- Ramp rates adjusted to match Avista program history

Measure reconciliation

- Develop comprehensive measure list using
  - Avista existing programs and business plan
  - RTF Unit Energy Savings workbooks
  - Sixth Power Plan
  - Previous Avista CPA
  - Recent EnerNOC studies

Water heating measures
Conventional (EF 0.95)
Heat pump water heater (EF 2.3)
Solar water heater
Low-flow showerheads
Timer / Thermostat setback
Tank blanket
Drain water heat recovery

Measure reconciliation (cont.)

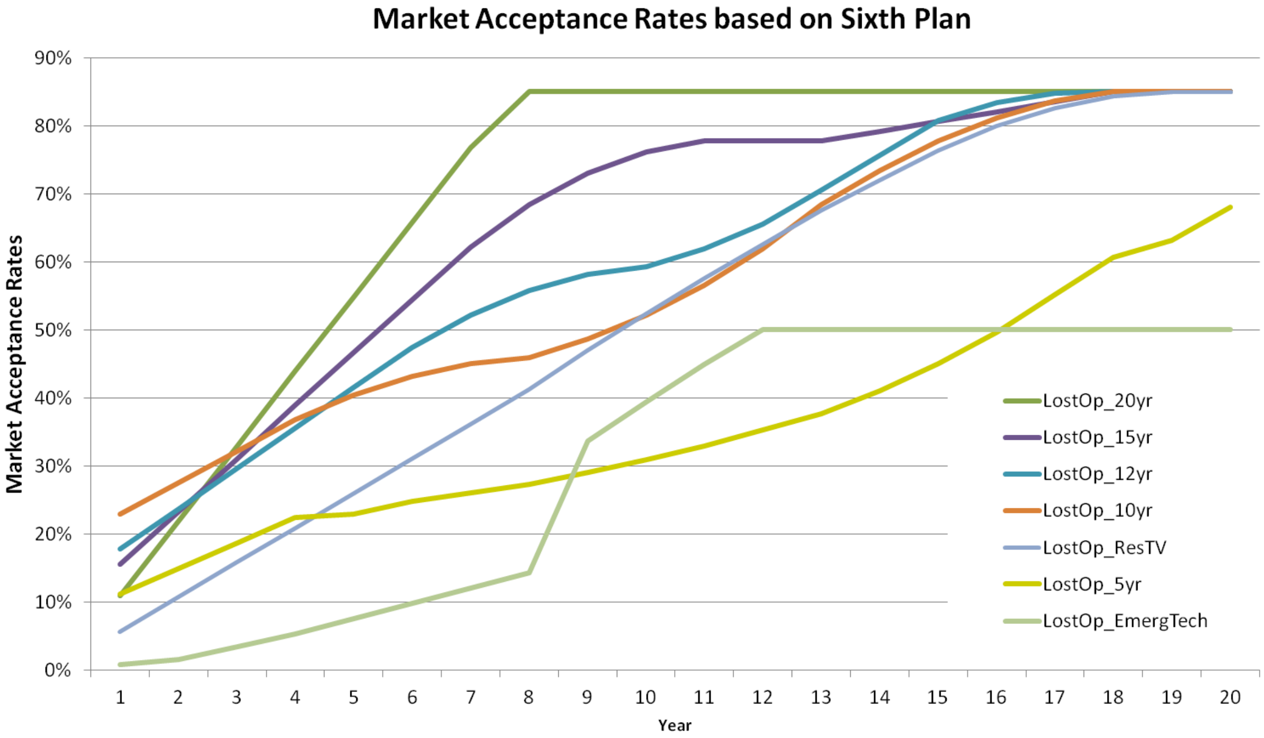
- Characterization
  - Description
  - Costs
  - Savings
  - Applicability
  - Lifetime
- Measure data sources
  - RTF UES measure databases
  - Sixth Power Plan Workbooks
  - Avista TRM
  - SEEM data
  - BEST simulations
  - EnerNOC databases

- Convert to LoadMAP format
  - Savings as % of baseline use
  - Per household, scaled to match Avista calibration
  - Per sq. ft. for C&I
  - Remove non-applicable adjustments such as storage rate

Market adoption rates for achievable potential

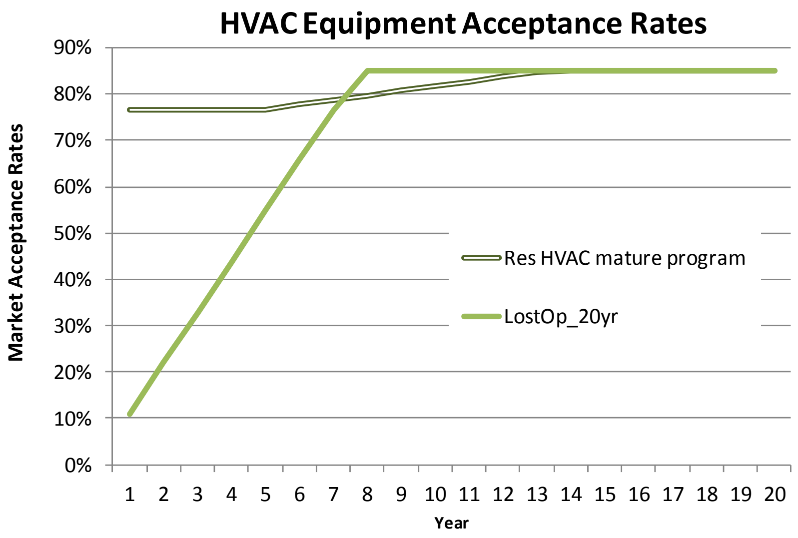
- Achievable potential requires assumptions about customer acceptance and market maturity
- Northwest Power & Conservation Council's Sixth Power Plan **Lost Opportunity** ramp rates used to develop market acceptance factors

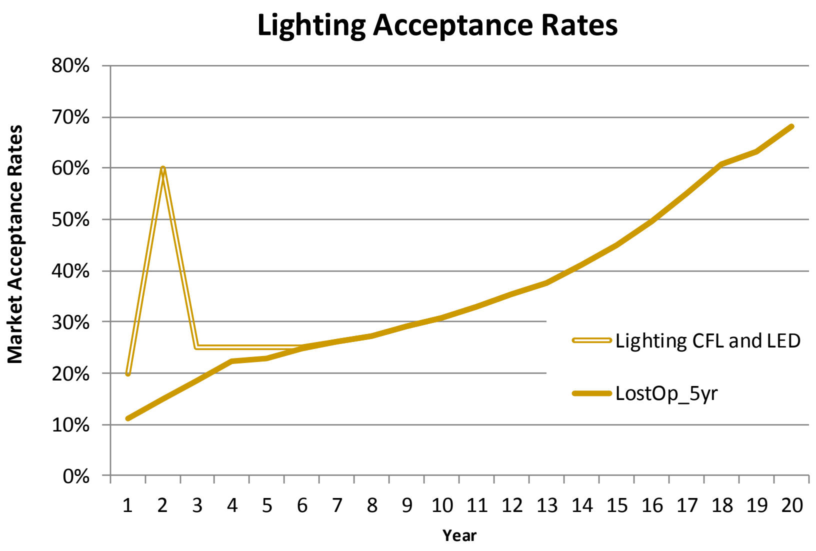
- *It is most important to focus on near-term ramp rates because studies are updated every two years*



Market adoption rates for achievable potential (cont.)

- Calibrated ramp rates to actual program achievements for Lighting and HVAC measures
- Acceptance different from Sixth Power Plan rates


HVAC Equipment Acceptance Rates


Lighting Acceptance Rates

Study schedule

- Presented project approach to the TAC on November 7, 2012
- Delivered preliminary results in late-February 2013
- Present final study results to TAC March 20, 2013
- Fine-tune analysis
- Draft report in April, 2013
- Support the filing in August 2013 with a complete CPA report

ENERNOC

Ingrid Rohmund

Practice Lead

760.943.1532

irohmund@enernoc.com

Jan Borstein

Project Manager

303.530.5195

jborstein@enernoc.com

www.enernoc.com

Demand Response

Technical Advisory Committee #5

March 20th, 2013

Leona Doege

What is Demand Response

Passive:

Pricing programs….

Time-of-Use, Critical Peak Pricing, Peak Time Rebate

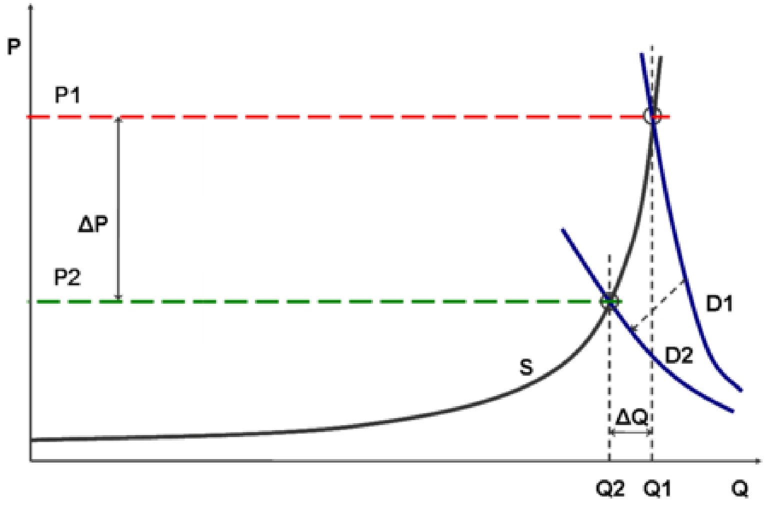
Active:

Direct Load Control

Combination programs……

Pricing program with

enabling technology



Purpose: Reduce or shift load at certain times

Passive Demand Response

Supporting Dynamic Pricing:

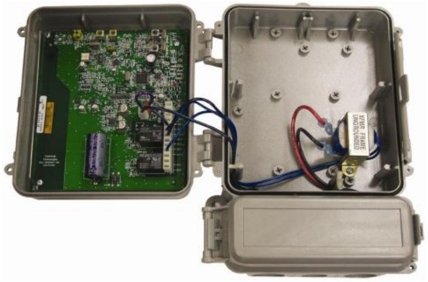
- Avista's Billing System doesn't allow for dynamic rates
- Q3 2014, New Billing System will be capable.
- Metering and its infrastructure would need

  to be upgraded in many areas.

- Merit to the inverted tail block rate structure currently used.

"Inclining block rates can reduce energy consumption by 6 percent in the near term and more over the long haul" (used in contrast to a flat rate structure, Ahmad Faroqui, "Inclining toward Energy Efficiency," Public Utilities Fortnightly, August 2008 (http://www.fortnightly.com/exclusive.cfm?o_id=94)

Direct Load Control



Mass Market:

Residential loads, electric space heat, central air-conditioning, electric water heating, pool pumps.

Commercial Programs:

Irrigation, variety of commercial/industrial

processes. Often a 3rd party aggregator is used

Avista's Direct Load Control Programs

North Idaho Pilot

- 2007-2009:
- 50 DLC Thermostats, 50 DLC Switches
- 10 Events called ranging from 2 to 4 hours each, in both the summer and winter seasons.
- Heat Pumps, Water Heaters, Electric Forced Air Furnaces, Air Conditioning

Smart Grid Demonstration Project

Smart Thermostat Pilot Program

- June 2012 – Dec 31st, 2014
- 69 Thermostats, capable of 1500
- Events are automatic ranging from 10 minutes to 24 hours, temp off-set of 2 degrees.
- Currently in testing mode, ready for real dispatch summer season 2013.
- Heat Pumps, Electric Forced Air Furnaces, Air Conditioning

Other Avista DR Activities

2001 Western Energy Crisis

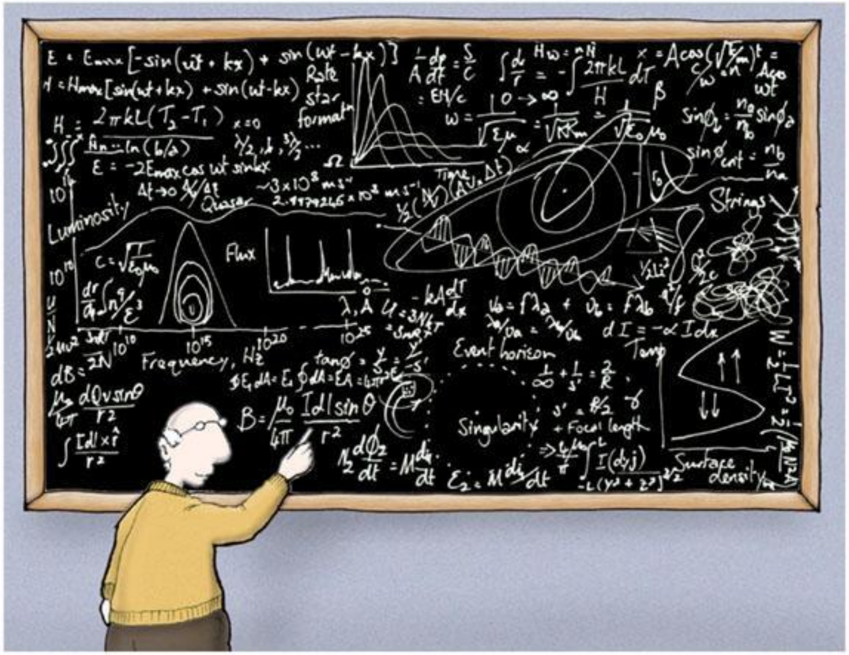
Nickel Buy Back Program

Operational issues of July 2006

Public Plea

Bi-Lateral Agreement with Industrial Customers

Knowledge Gained



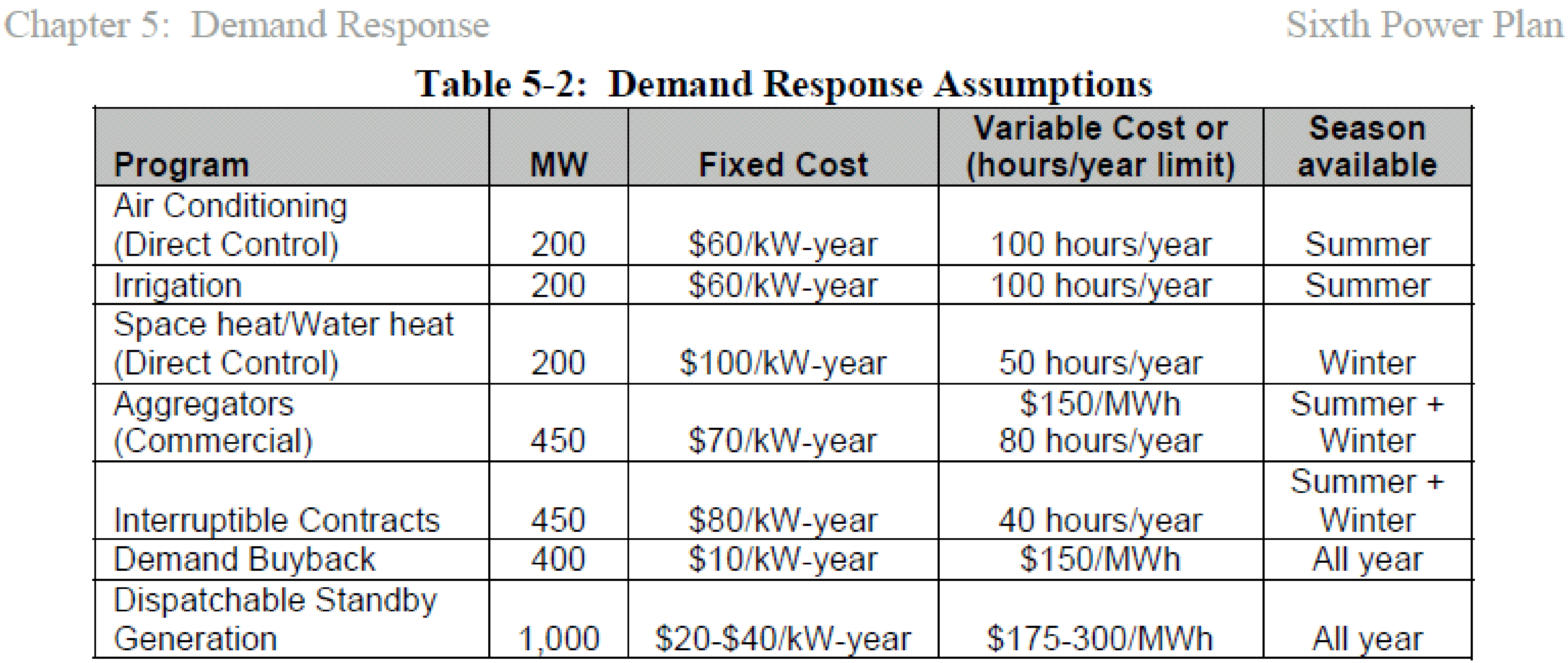
DR Works as Designed

DR Builds Customer Engagement

DLC Value lies in Capacity

High Penetration of Natural Gas in Avista service area

Demand Response Costs (Regional Estimates from NPCC)



Chapter 5: Demand Response

Sixth Power Plan

Table 5-2: Demand Response Assumptions

Program	MW	Fixed Cost	Variable Cost or (hours/year limit)	Season available
Air Conditioning (Direct Control)	200	$60/kW-year	100 hours/year	Summer
Irrigation	200	$60/kW-year	100 hours/year	Summer
Space heat/Water heat (Direct Control)	200	$100/kW-year	50 hours/year	Winter
Aggregators (Commercial)	450	$70/kW-year	$150/MWh 80 hours/year	Summer + Winter
Interruptible Contracts	450	$80/kW-year	40 hours/year	Summer + Winter
Demand Buyback	400	$10/kW-year	$150/MWh	All year
Dispatchable Standby Generation	1,000	$20-$40/kW-year	$175-300/MWh	All year

What’s Next ?

Discussion of DR Options

Q&A

Thank you for your time!

Leona Doege

DSM Program Manager

(509) 495-4289

leona.doege@avistacorp.com

Draft 2013 Preferred Resource Strategy

James Gall

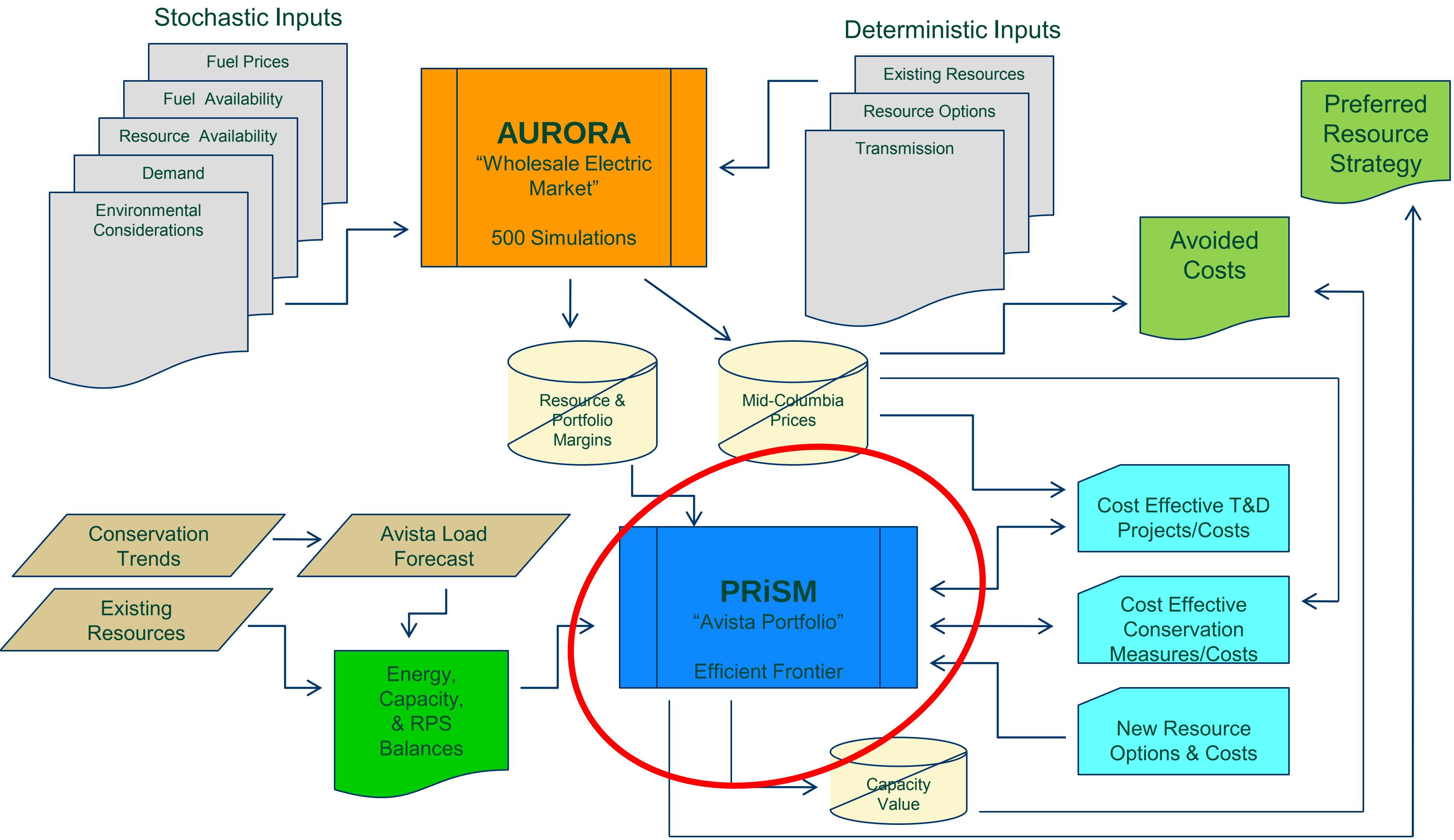
Fifth Technical Advisory Committee Meeting

2013 Electric Integrated Resource Plan

March 20, 2013

DRAFT

2013 IRP Modeling Process



AVISTA

2011 Preferred Resource Strategy

Palouse Wind

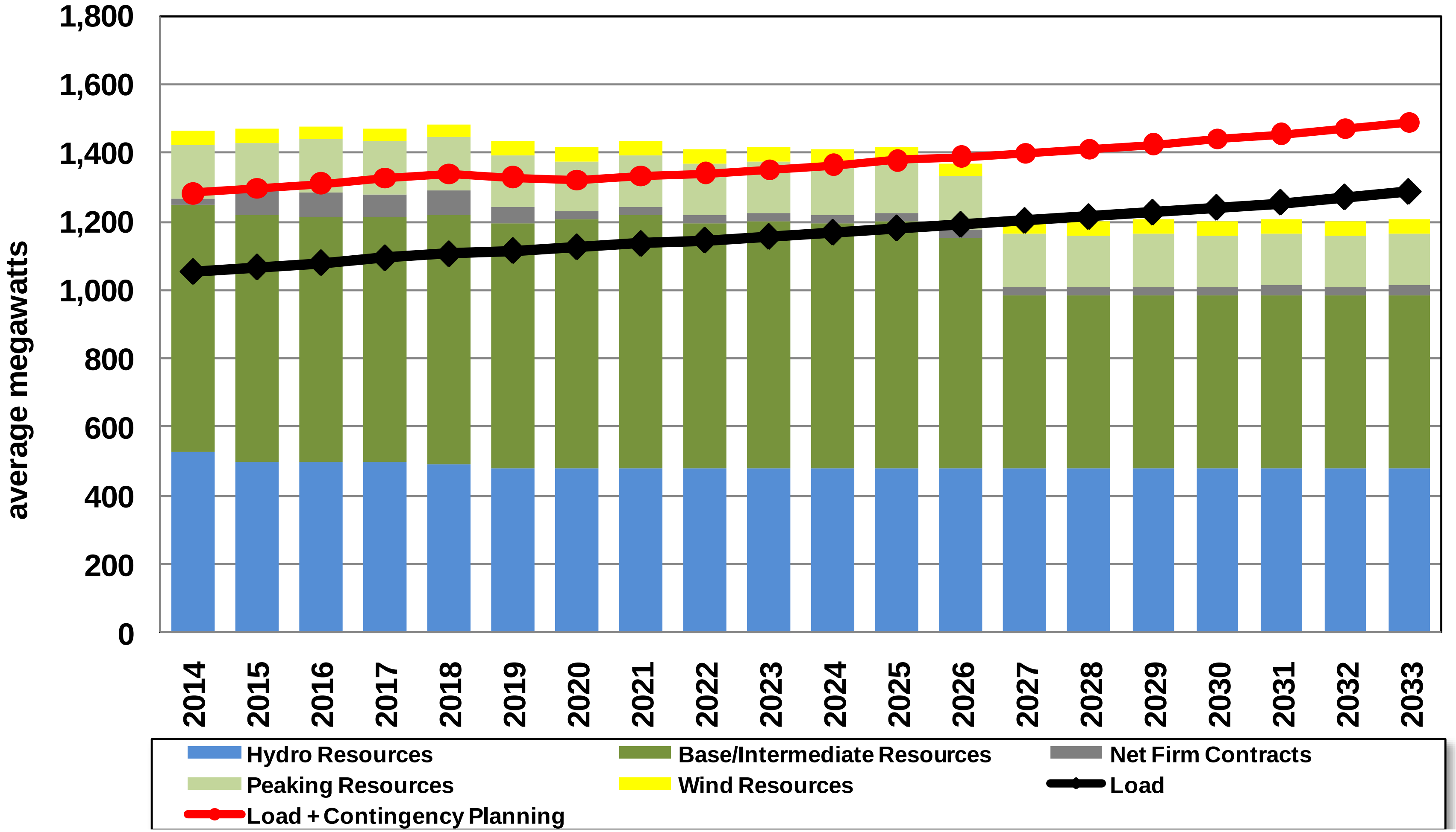
Smart Grid/Feeder Rebuilds

8.9 aMW in 2012*

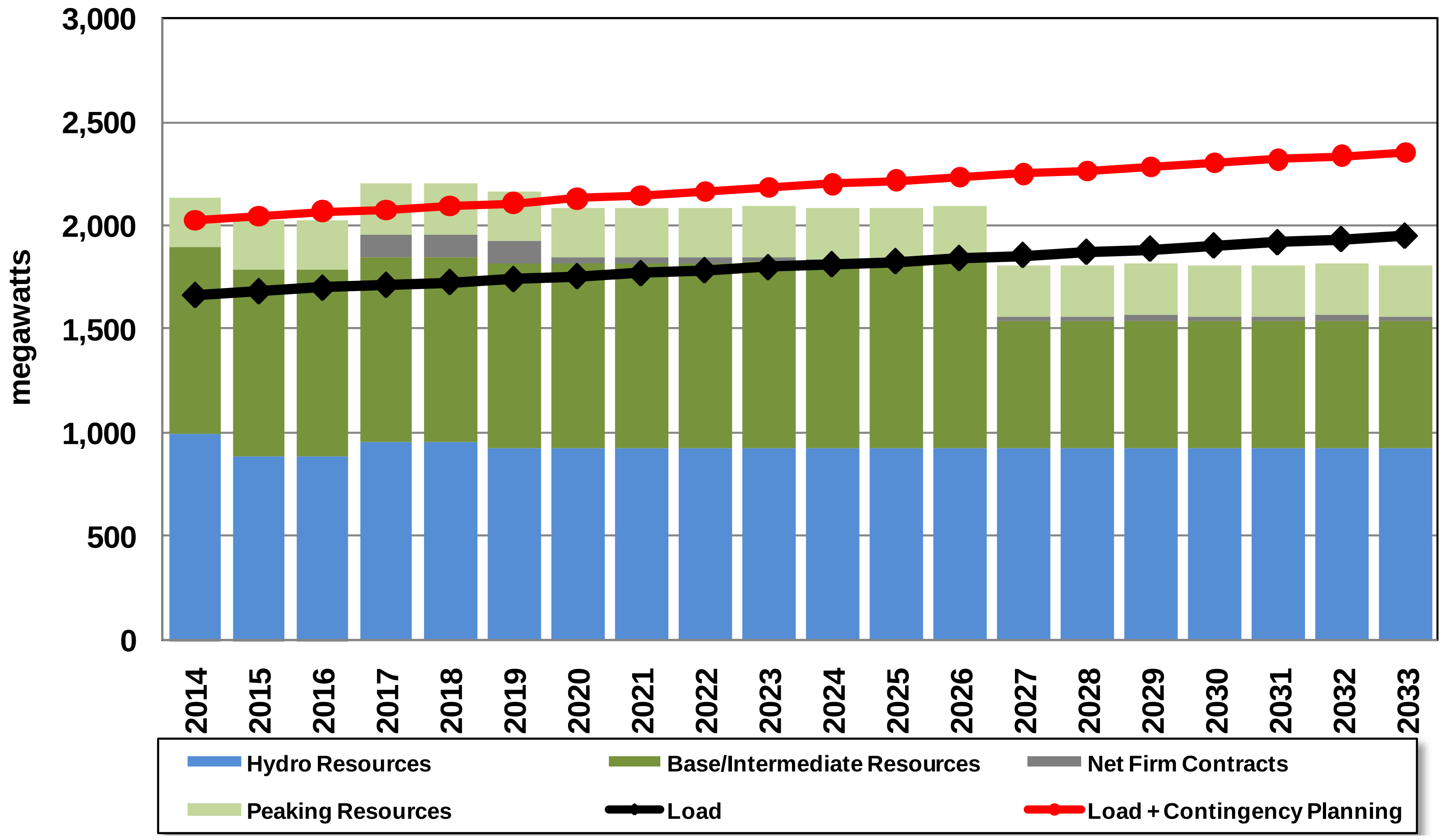
Year Ending	Resource
2012	Wind (~ 42 aMW REC)
2018	Simple Cycle CT(~ 83 MW)
2020	Simple Cycle CT (~ 83 MW)
2018-2019	Thermal Upgrades (~ 7 MW)
2018-2019	Wind (~ 43 aMW REC)
2023	Combined Cycle CT (~ 270 MW)
2026/27	Combined Cycle CT (~ 270 MW)
2029	Simple Cycle CT (~ 46 MW)
2012+	Distribution Feeder Upgrades (13 aMW by 2031)
2012+	Conservation (310 aMW by 2031)

** Early estimate to be verified by third party and does not include regional savings from NEEA*

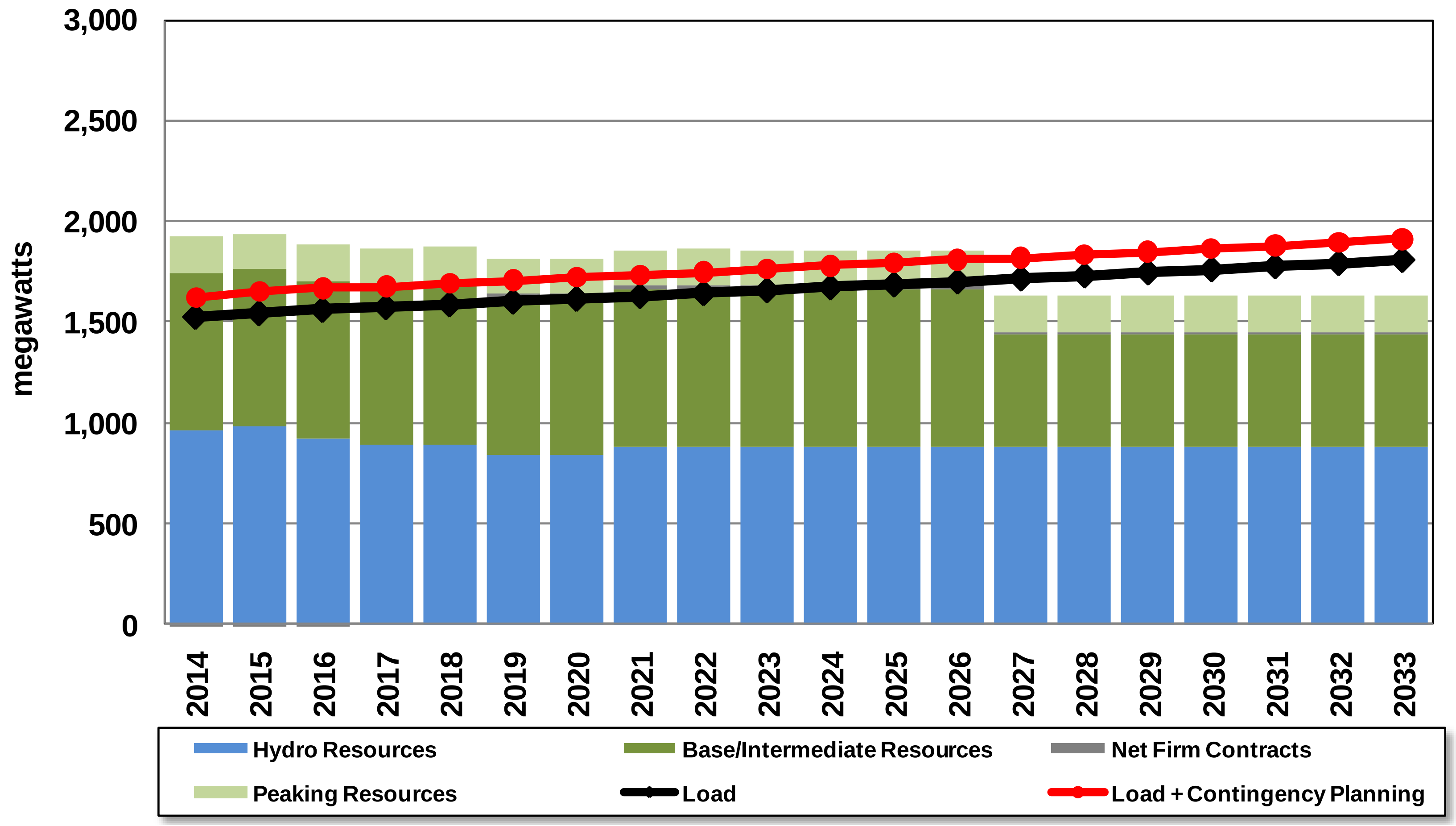
Annual Energy Position



Winter Single Hour Peak Position

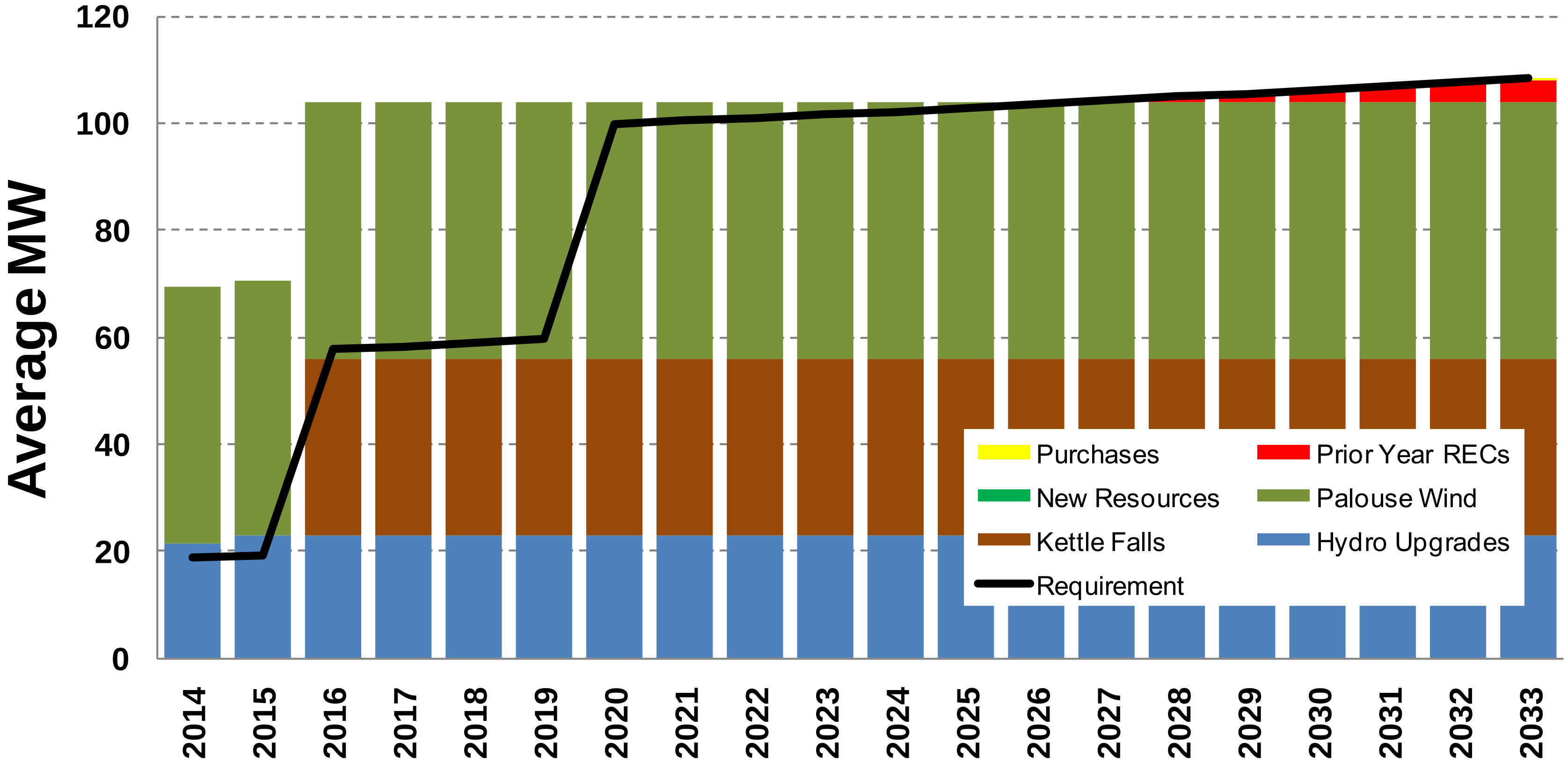


Summer Single Hour Peak Position



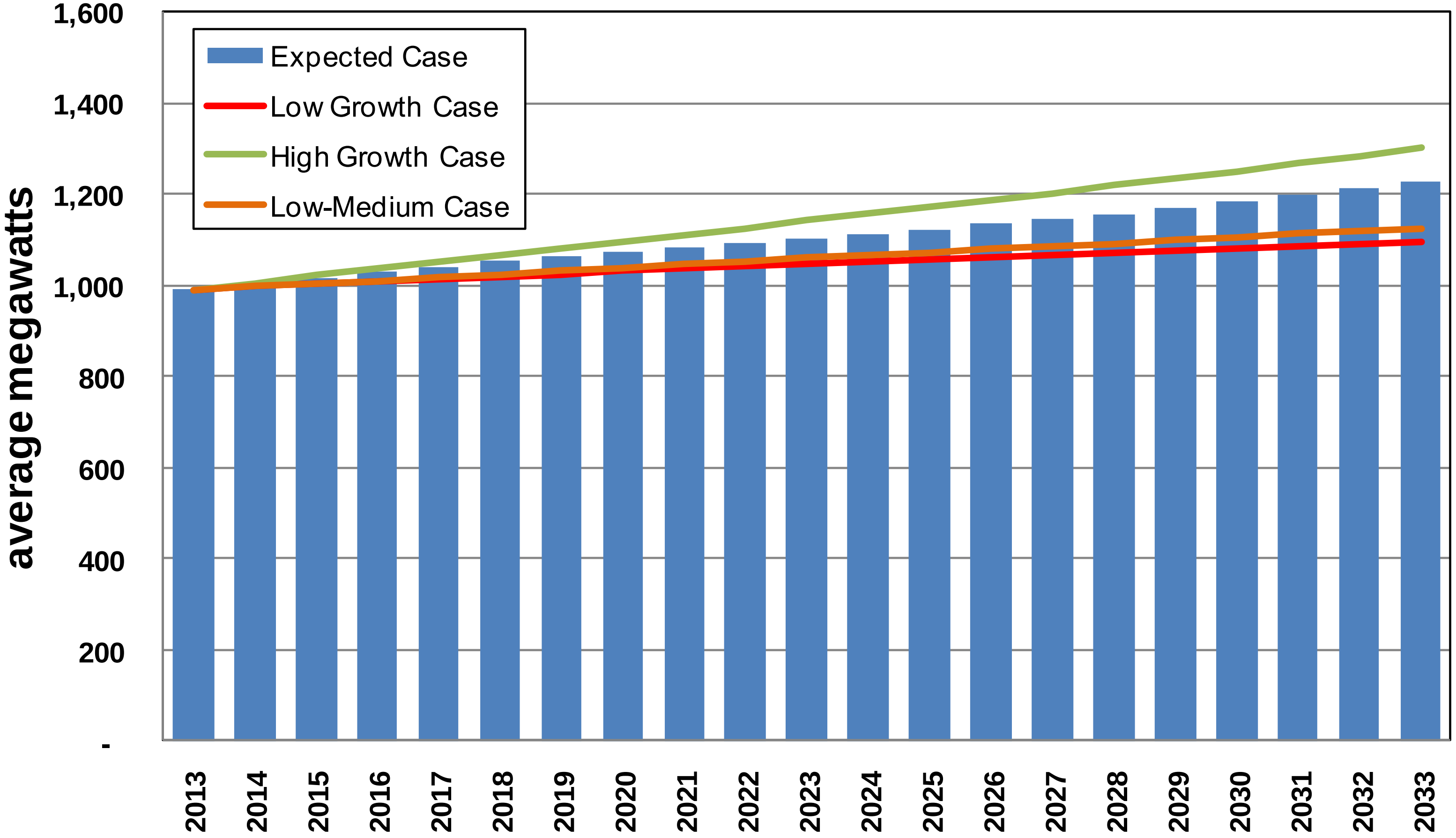
DRAFT

Washington Energy Independence Act Compliance



Assumes conservative estimate of Kettle Falls with 75 percent capacity factor

Load Forecast Scenarios



PRiSM Objective Function

- Linear program solving for the optimal resource strategy to meet resource deficits over the planning horizon.
- Model selects its resources to reduce cost, risk, or both.

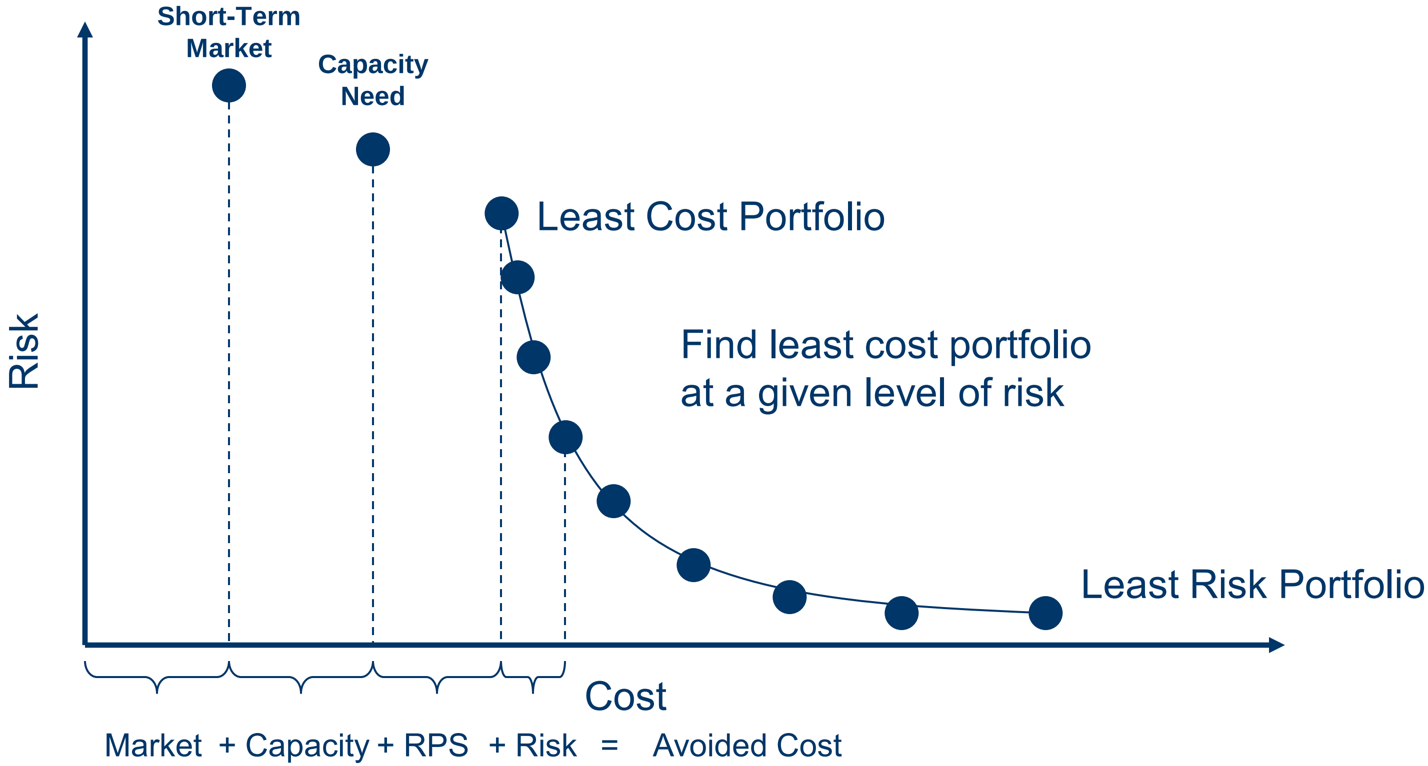
Minimize: Total Power Supply Cost on NPV basis (2014-2054 with emphasis on the first 14 years of the plan)

Subject to:

- Risk Level
- Capacity Need +/- deviation
- Energy Need +/- deviation
- Renewable Portfolio Standards
- Resource Limitations and Timing

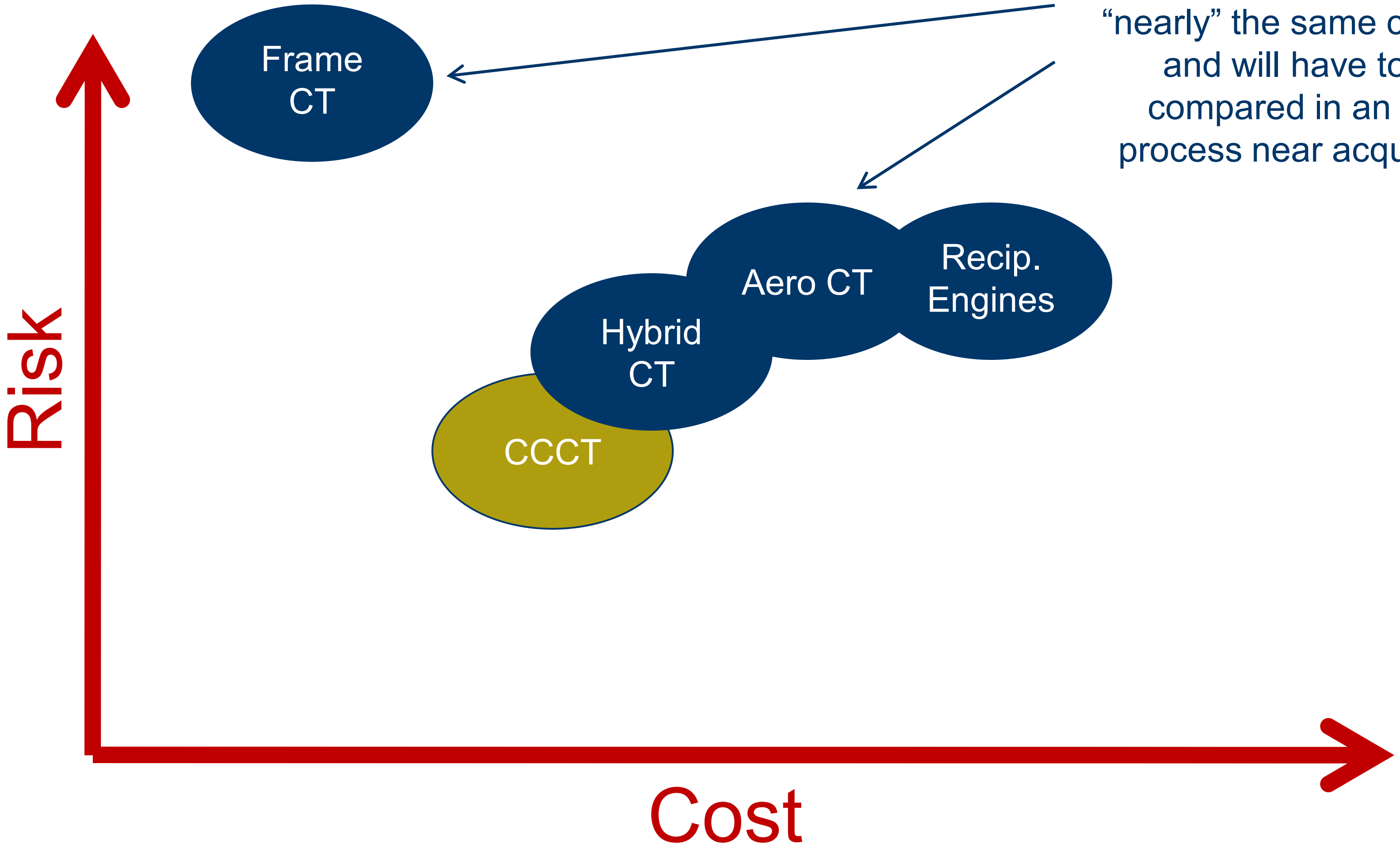
Efficient Frontier

- Demonstrates the trade off between cost and risk
- Avoided Cost Calculation



Natural Gas Turbines Cost/Risk Tradeoffs

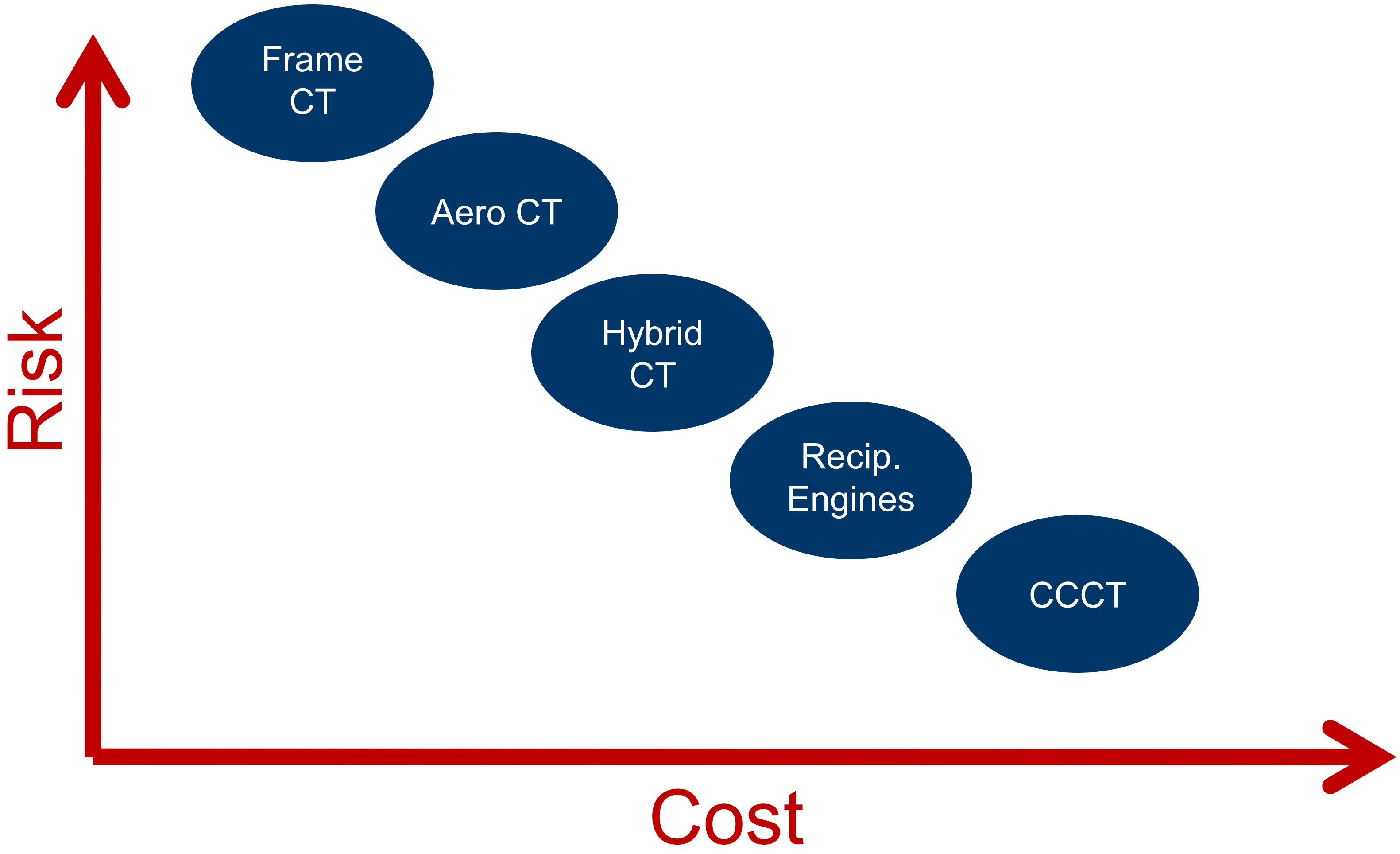
Ignoring size constraints



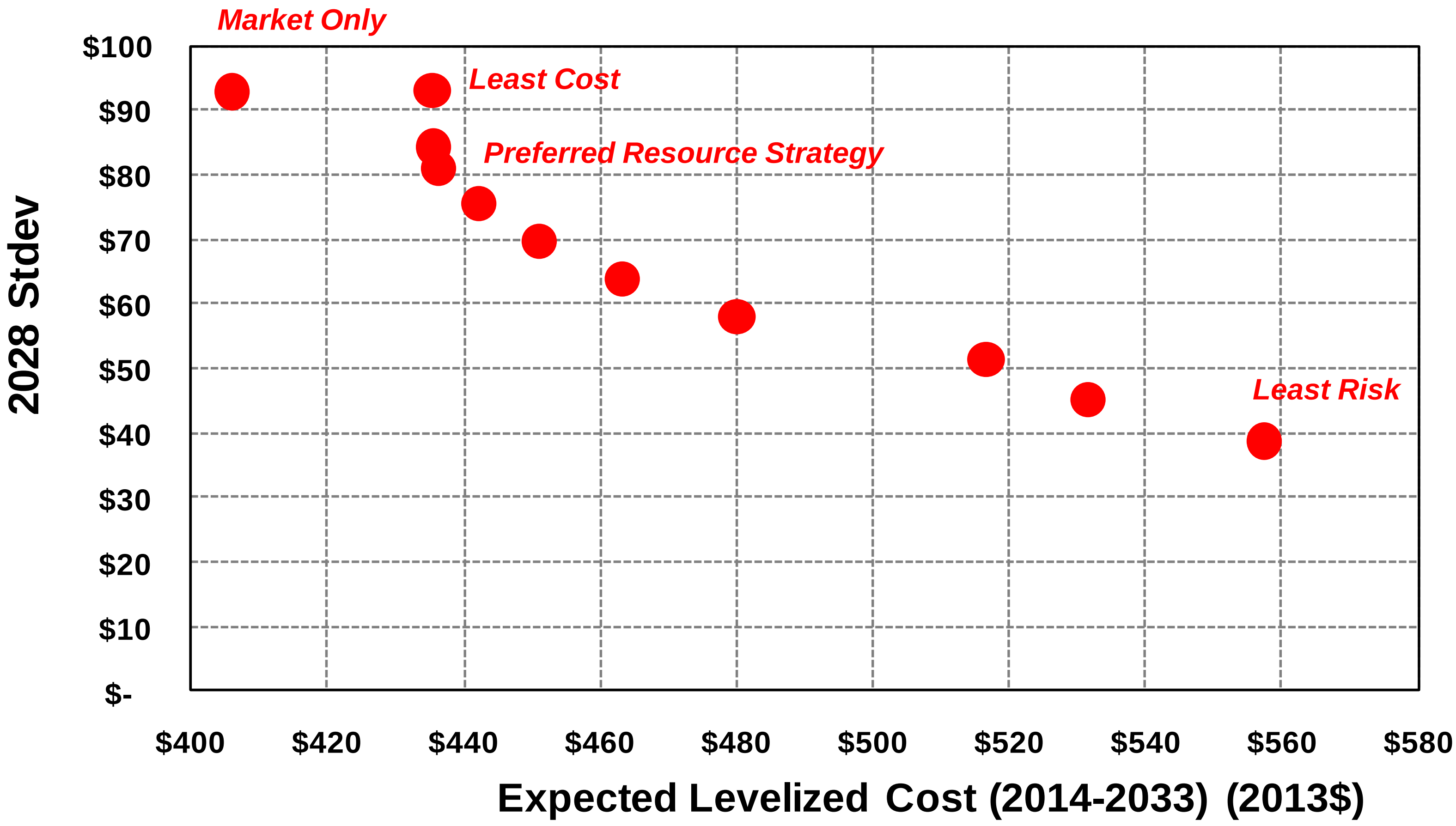
All gas peaking turbines are "nearly" the same cost/risk and will have to be compared in an RFP process near acquisition

Natural Gas Turbines Cost/Risk Tradeoffs

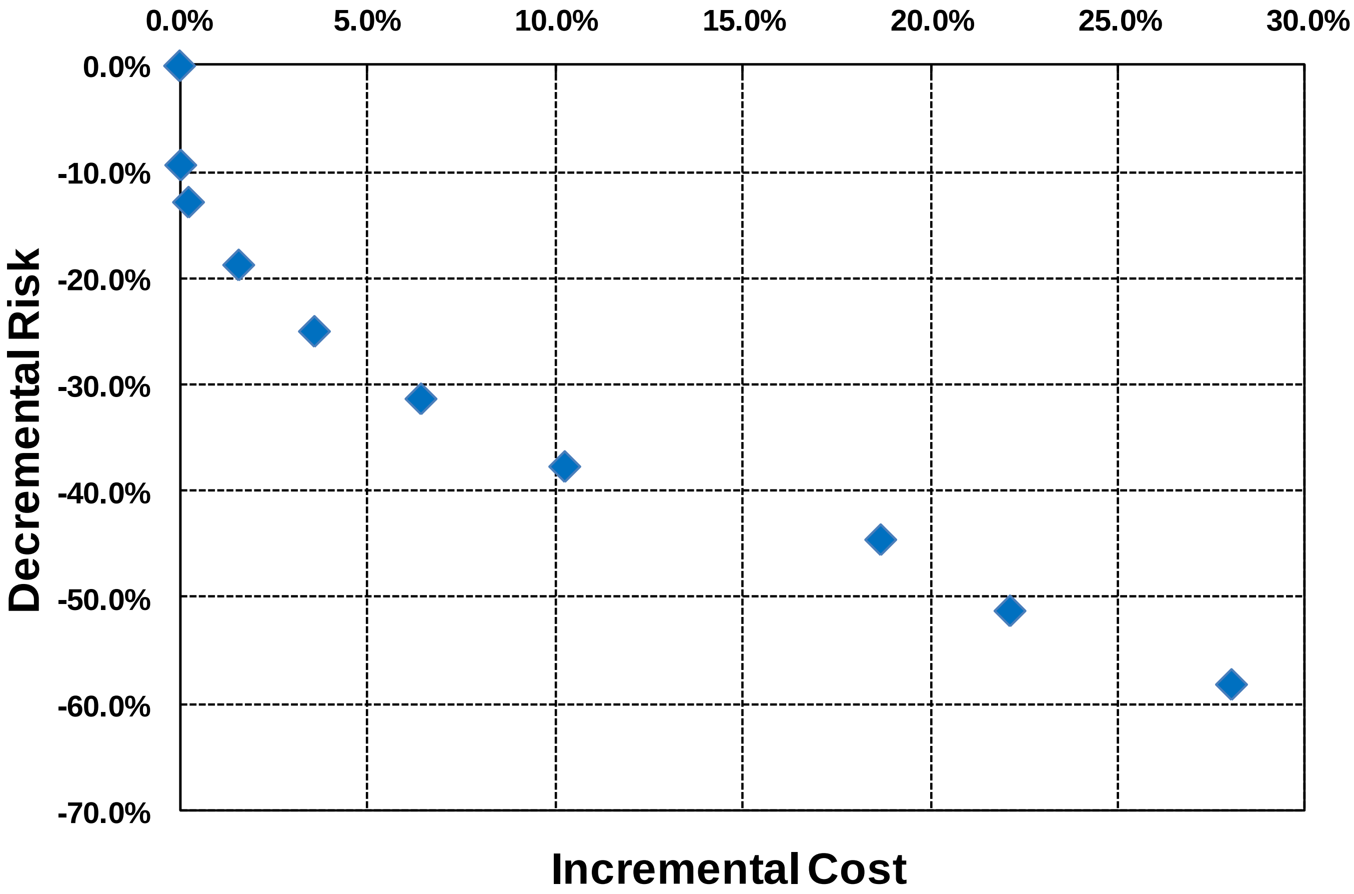
Includes size constraints



Efficient Frontier ($millions)

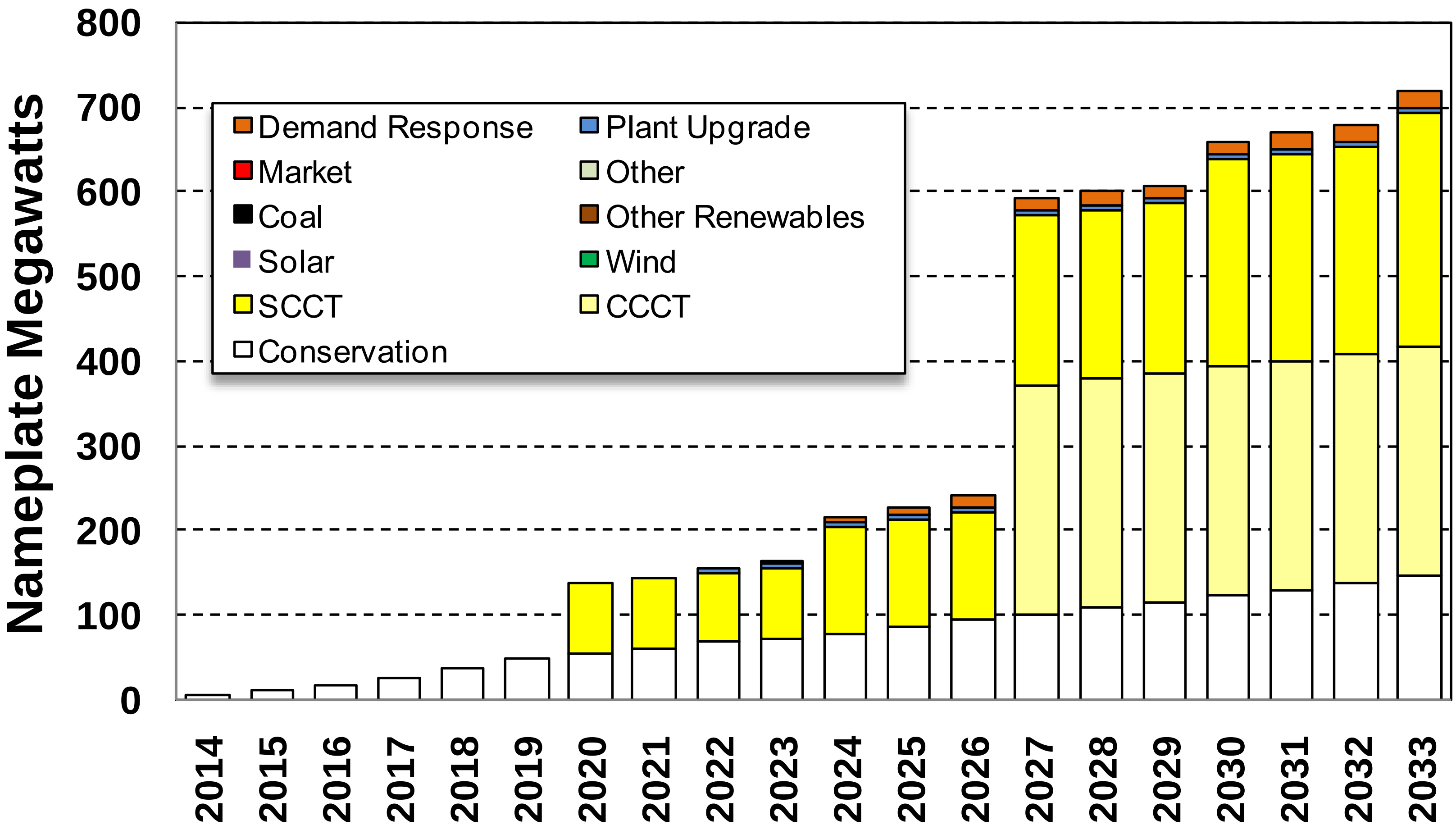


Efficient Frontier- Percent Change



DRAFT

Draft 2013 Preferred Resource Strategy

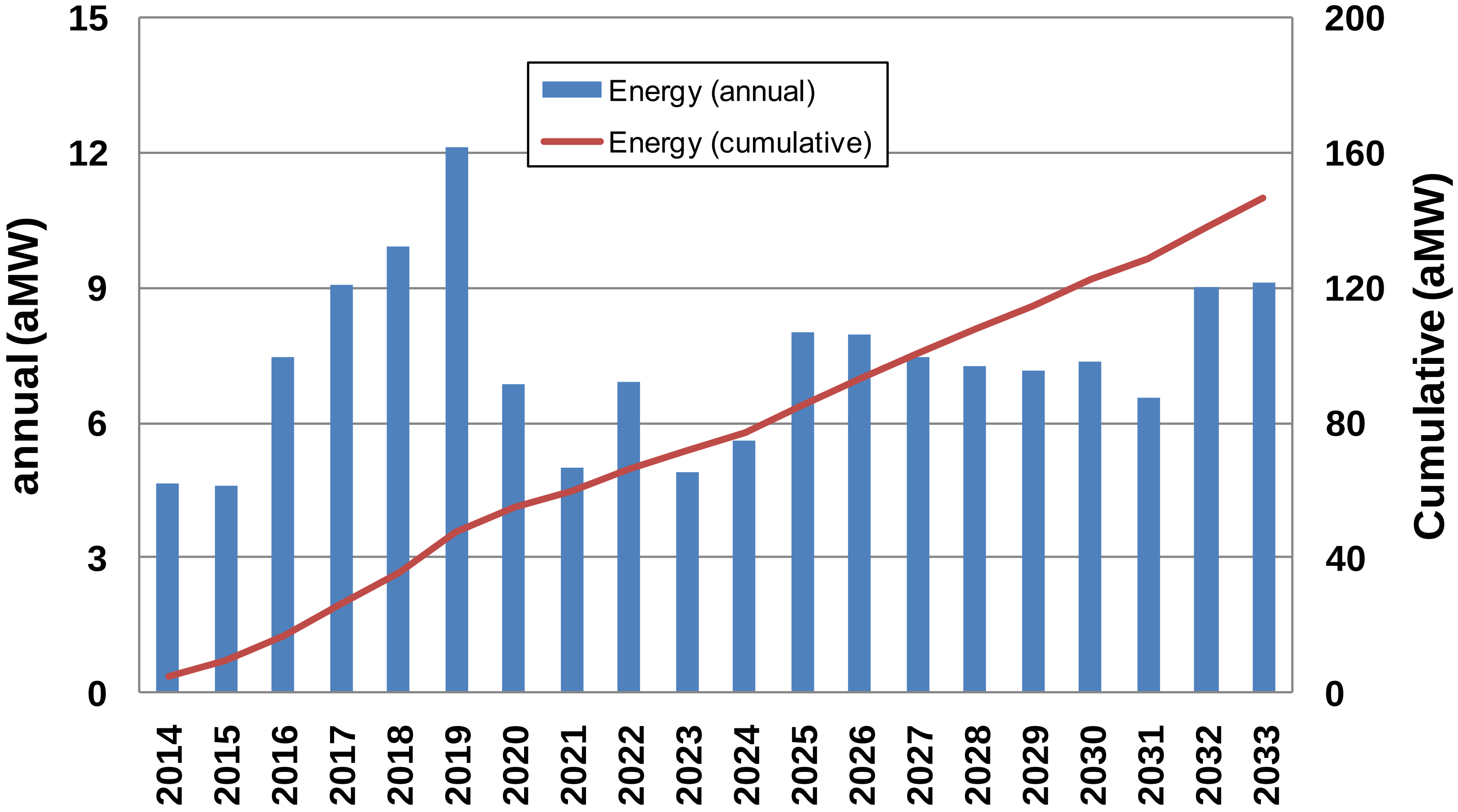


Draft 2013 Preferred Resource Strategy

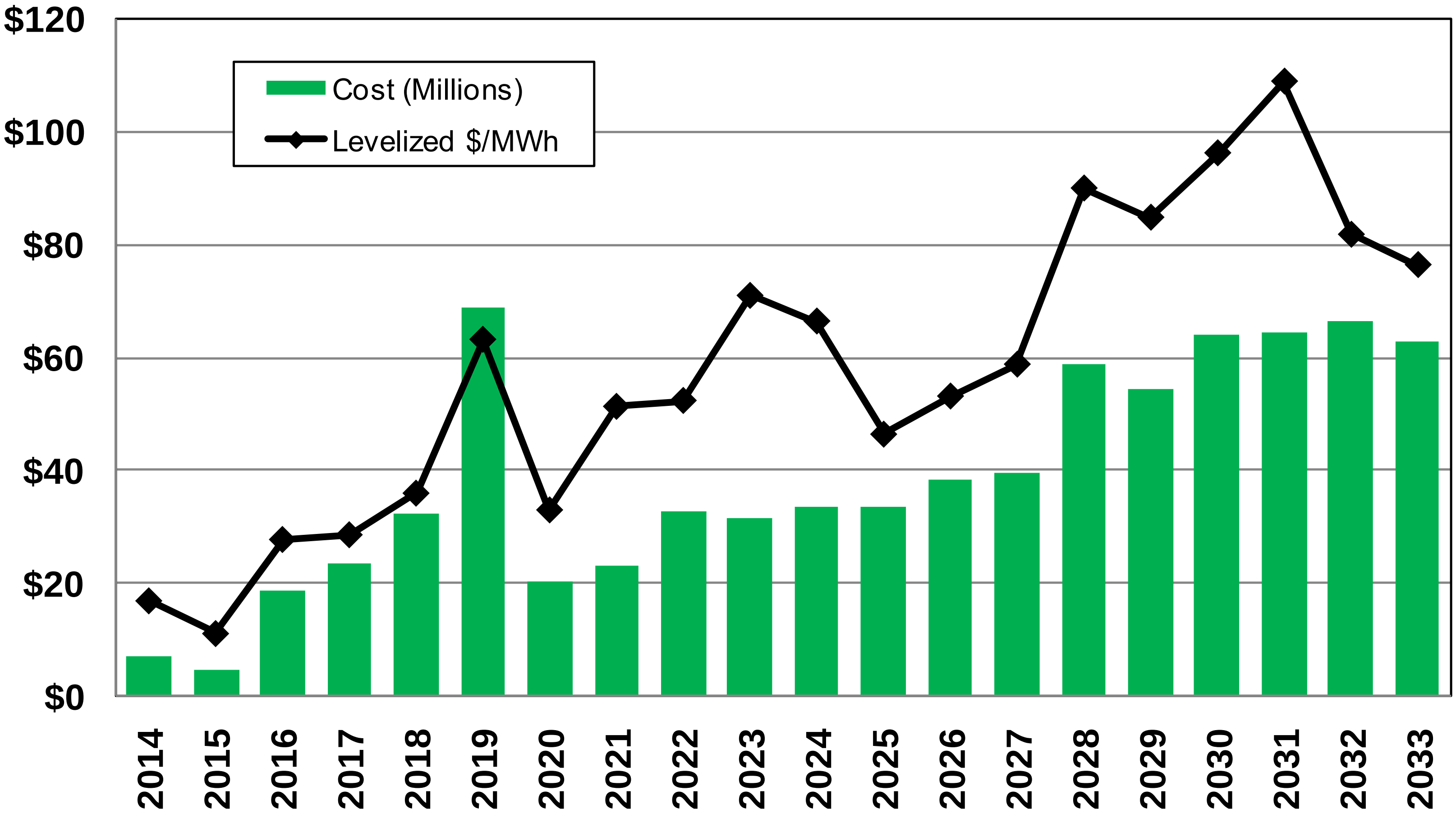
Resource	By the End of Year	Winter Peak (MW)	Energy Capability (aMW)
SCCT	2019	88	69
Rathdrum CT Upgrade	2021	2	6
SCCT	2023	46	40
SCCT	2026	78	62
CCCT	2026	281	245
SCCT	2029-32	79	69
Generation Total		**574**	**491**
Conservation	2014-33	199	147
Demand Response	2022-30	20	0
Distribution Efficiencies	2014-16	<1	<1

DRAFT

Conservation Forecast

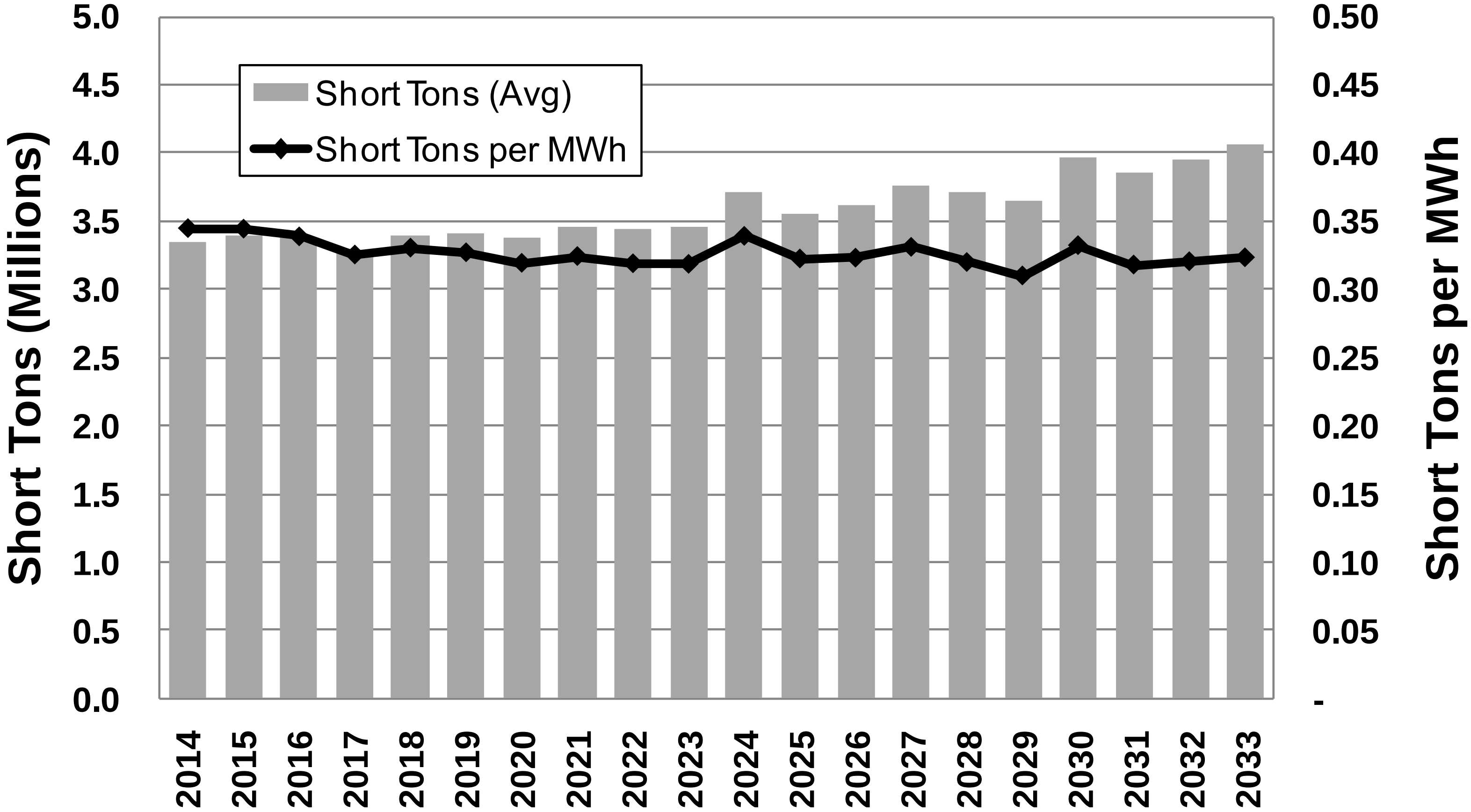


Cost of Conservation



DRAFT

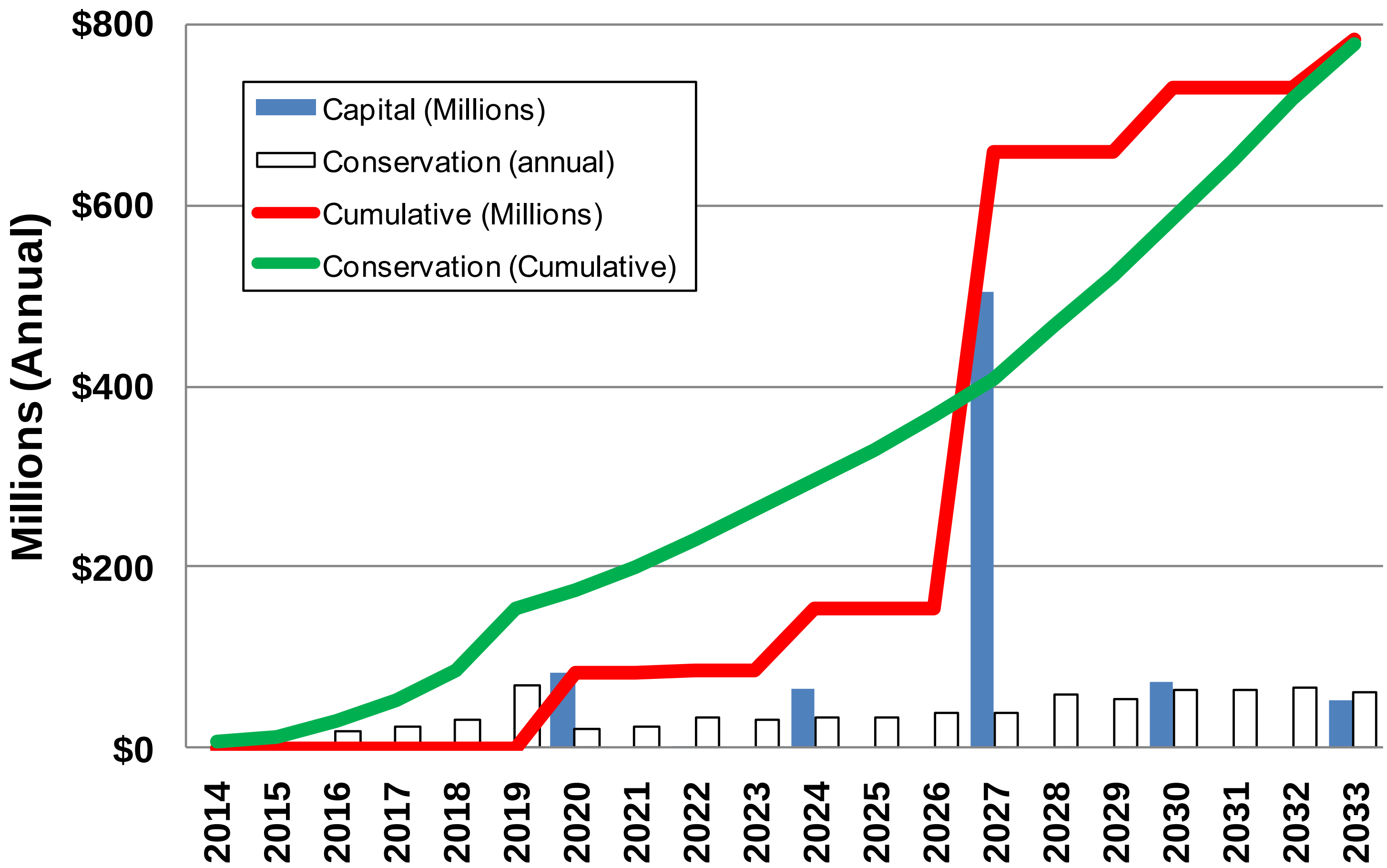
Avista Greenhouse Gas Emissions



Includes generating resources under Avista control

DRAFT

Draft 2013 PRS Capital Requirements (and Conservation Expense)

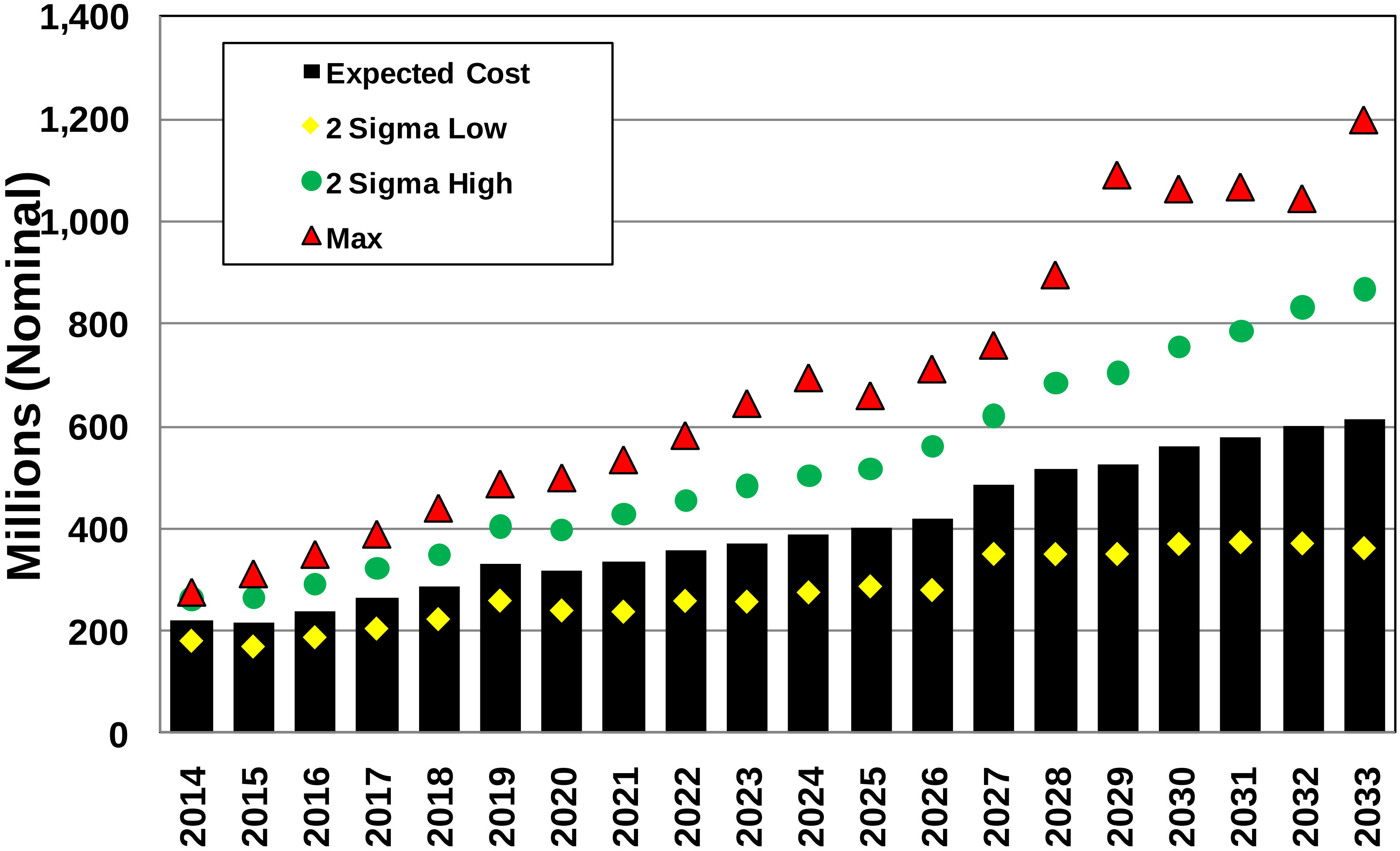


Blue bars and Red line is generation capital investment

White bars and Red line is cost effective conservation

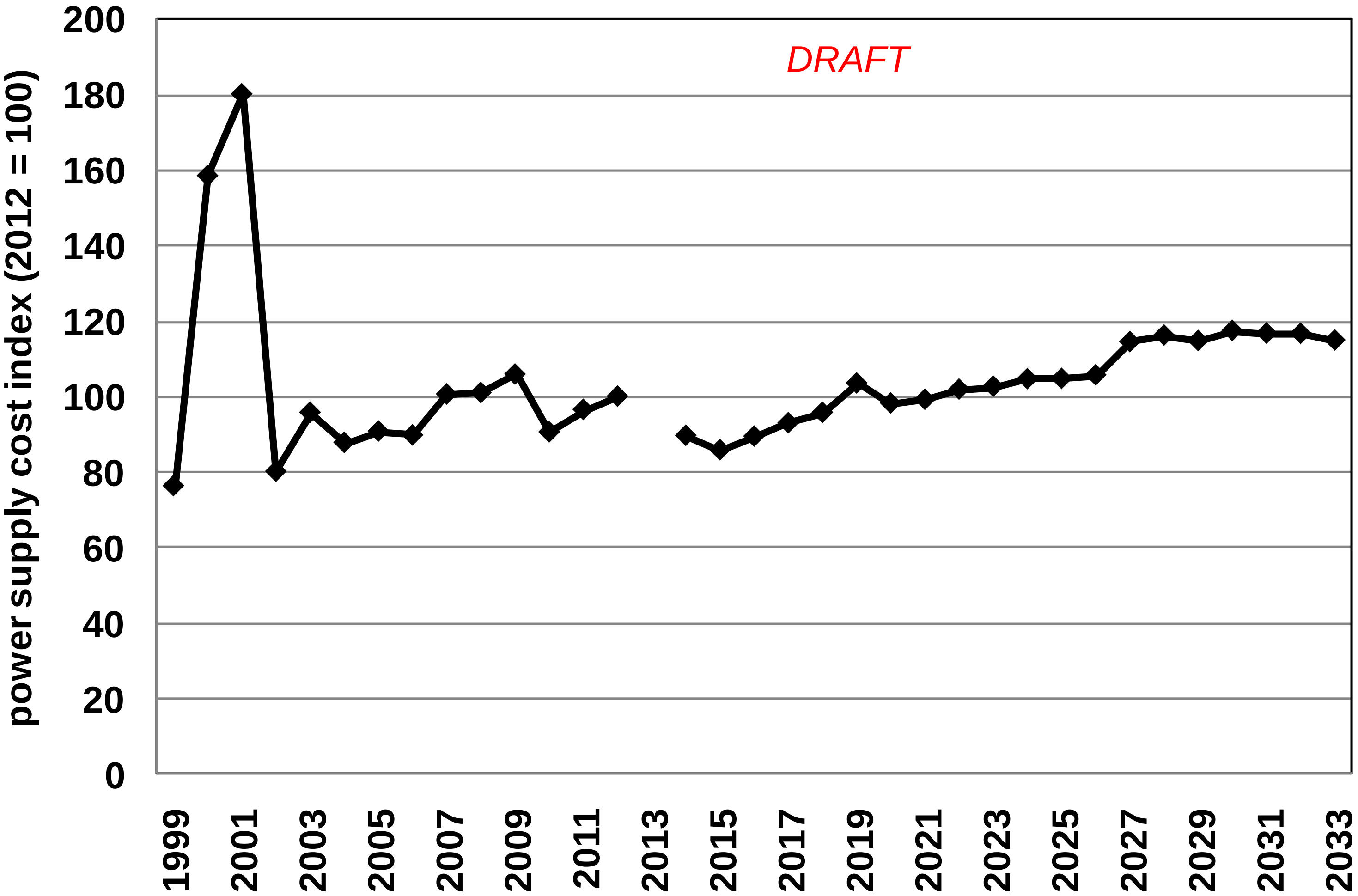
Chart illustrates comparison of generation to conservation investment

Power Supply Cost Forecast (Range)



DRAFT

Power Supply Cost Forecast Index ($/MWh)



Resource Strategy Scenarios

James Gall

Fifth Technical Advisory Committee Meeting

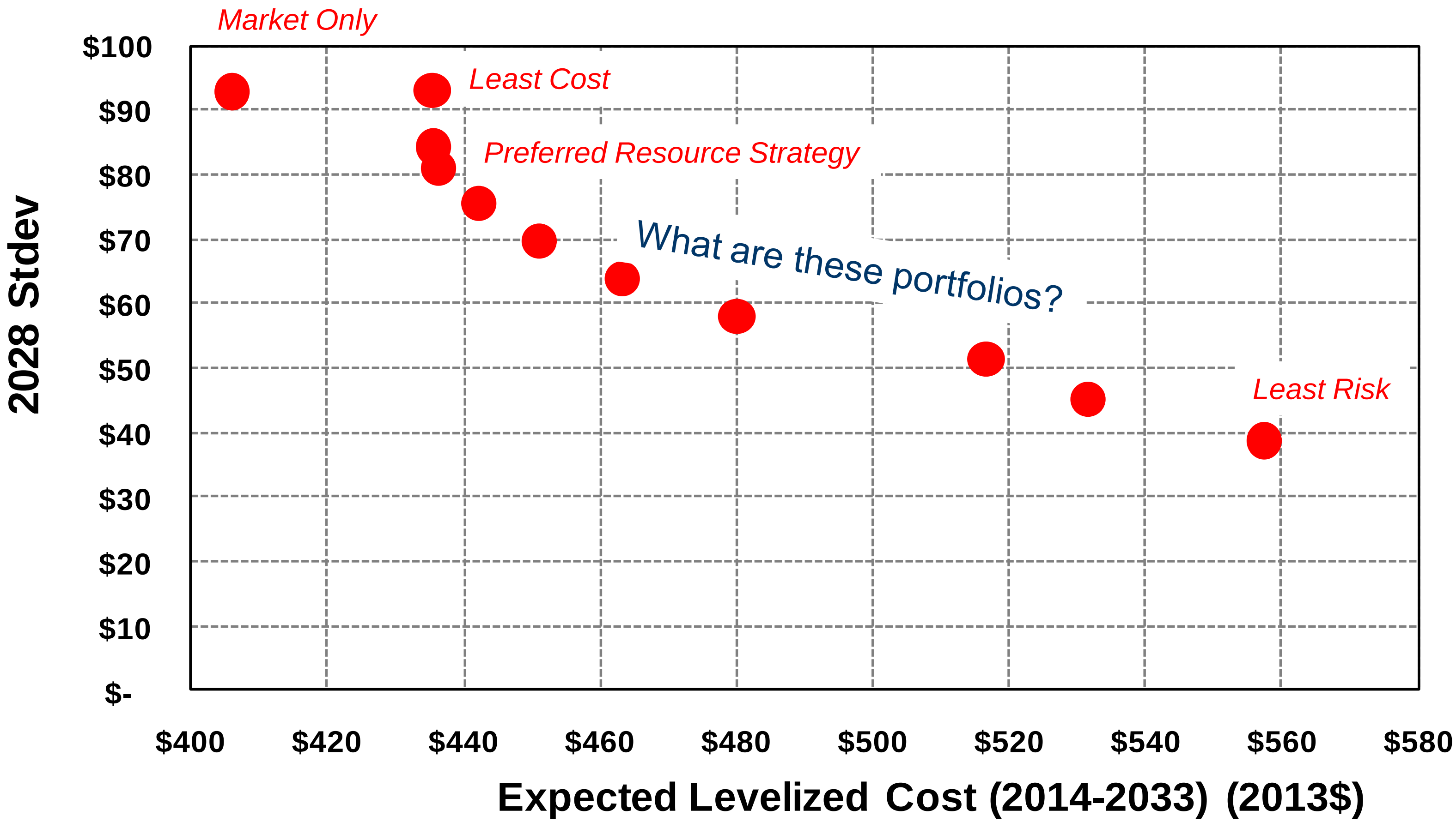
2013 Electric Integrated Resource Plan

March 20, 2013

Scenario Modeling Status Update

- Scenarios still in progress
  - Conservation
  - Stochastic carbon pricing (and other CO_2 related scenarios)
  - Colstrip scenarios
- These will be presented at the Sixth TAC meeting on June 19, 2013

Efficient Frontier ($millions)



Portfolios Along the Efficient Frontier

	Risk Level					
Nameplate (MW)	**PRS**	**High**	**Medium High**	**Medium**	**Medium Low**	**Low**
CCCT	270	-	270	540	270	270
SCCT	278	549	251	190	149	51
Wind	-	-	-	165	99	350
Solar	-	-	-	-	-	-
Other Renewables	-	-	-	-	-	50
Coal (sequestered)	-	-	-	-	250	295
Other	-	-	-	-	-	-
Market	-	-	-	-	-	-
Plant Upgrade	6	6	85	-	80	80
Demand Response	20	20	20	-	10	15
Total	**574**	**575**	**626**	**895**	**857**	**1,110**
Change in Cost (2028)		-1.0%	1.4%	21.3%	75.8%	109.6%
Change in Risk (2028)		11.0%	-3.5%	-19.4%	-35.9%	-53.1%

2011 PRS Scenario

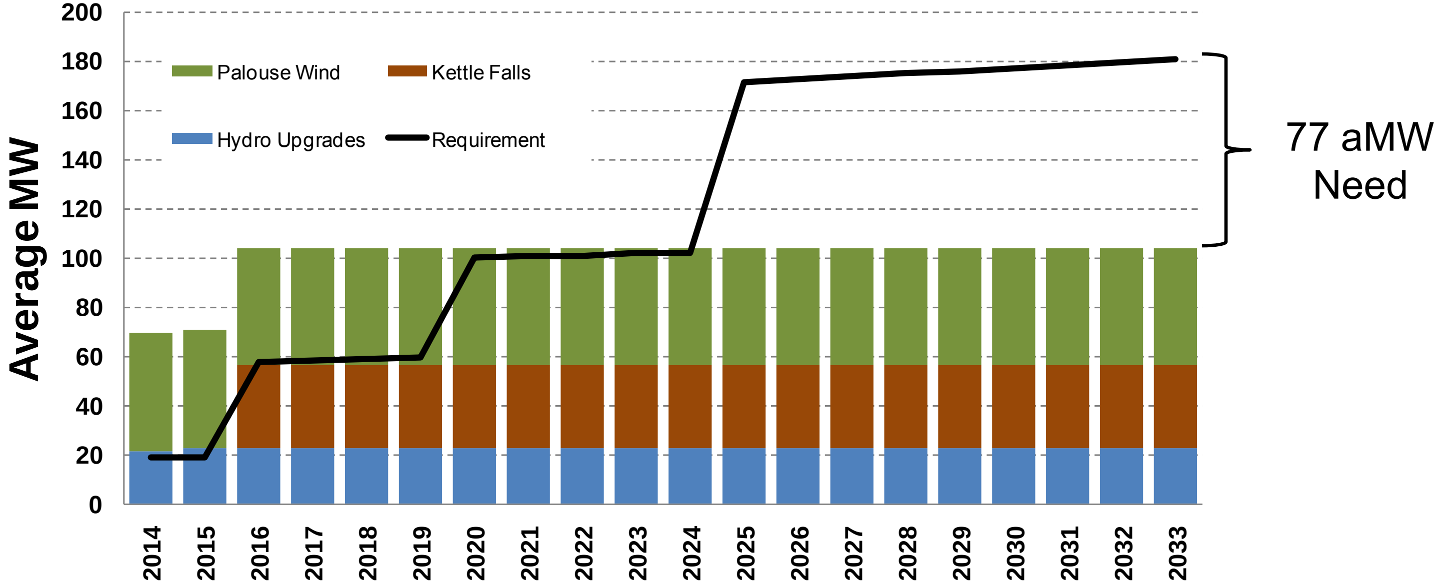
Year Ending	Resource
2012	Wind (~ 42 aMW REC)
2018	Simple Cycle CT(~ 83 MW)
2020	Simple Cycle CT (~ 83 MW)
2018-2019	Thermal Upgrades (~ 7 MW)
2018-2019	Wind (~ 43 aMW REC)
2023	Combined Cycle CT (~ 270 MW)
2026/27	Combined Cycle CT (~ 270 MW)
2029	Simple Cycle CT (~ 46 MW)
2012+	Distribution Feeder Upgrades (13 aMW by 2031)
2012+	Conservation (310 aMW by 2031)

2011 IRP PRS

- With a lower load forecast and the passage of the biomass bill in Washington, the 2011 PRS overbuilds the needs for the 2013 IRP timeframe
- The adjusted 2011 PRS portfolio is 5.7% higher NPV and lowers power supply risk by 14%- the higher cost is due to overbuilding the expected demand requirements

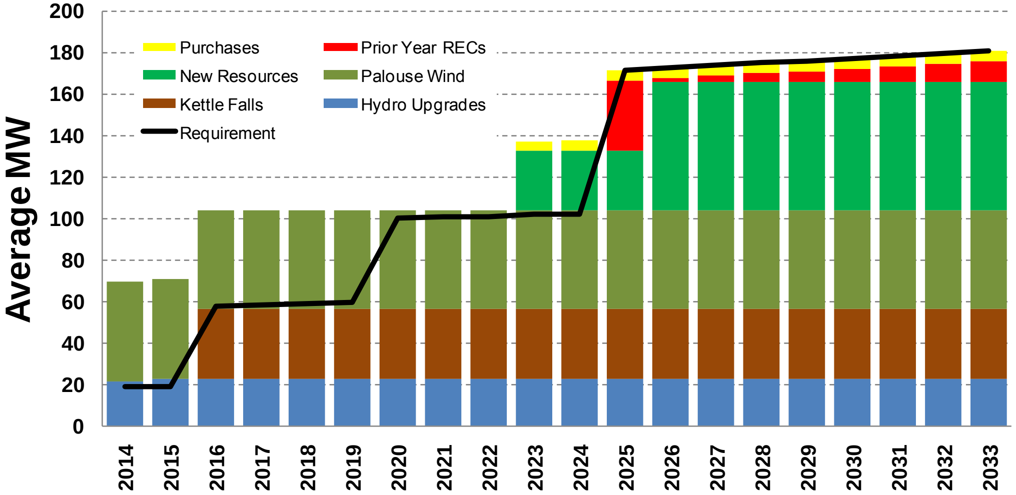
25% Washington RPS by 2025 Scenario

- The Washington Energy Independence Act (I-937) requires 15% of Washington retail sales to be from renewables by 2020
- This scenario evaluates the costs and benefits if the goal is changed to 25% by 2025



25% Washington RPS in 2025 – Scenario Results

- Hydro upgrades to Long Lake and Monroe Street (148 MW) could meet most of the incremental RPS requirement
- Assuming these resources provide winter capability and summer needs are met by market, this strategy would lower SCCT needs need by 93 MW
- The 2028 cost is 3.7% higher than PRS and risk is 1.8% lower



Hydro upgrades

National Renewable Portfolio Standard Scenario

- If the federal government passed legislation requiring renewable generation (i.e. National RPS), this scenario addresses the change in resource strategy and potential costs
- This scenario assumes 10% of load is met by renewables by 2020, then 15% by 2025, and 20% by 2030
- All Avista owned hydro generation would be netted from load to reduce the required quantity of "RECs" – any hydro upgrades would be netted against load rather than receive a REC credit
- For modeling purposes, no banking is assumed and average hydro is used for "hydro netting"

National RPS Scenario Renewable Requirements (aMW)

	2015	2020	2025	2030	2033
Average Load	1,067	1,125	1,180	1,239	1,285
Average Hydro	495	481	481	481	481
Net Load	**572**	**644**	**699**	**759**	**805**
RPS %	0%	10%	15%	20%	20%
RPS Required	**0**	**64**	**105**	**152**	**161**
Palouse Wind	40	40	40	40	40
Kettle Falls	42	43	43	42	43
Total Existing RECs	**82**	**83**	**83**	**82**	**83**
RECs Required	**0**	**0**	**22**	**69**	**78**

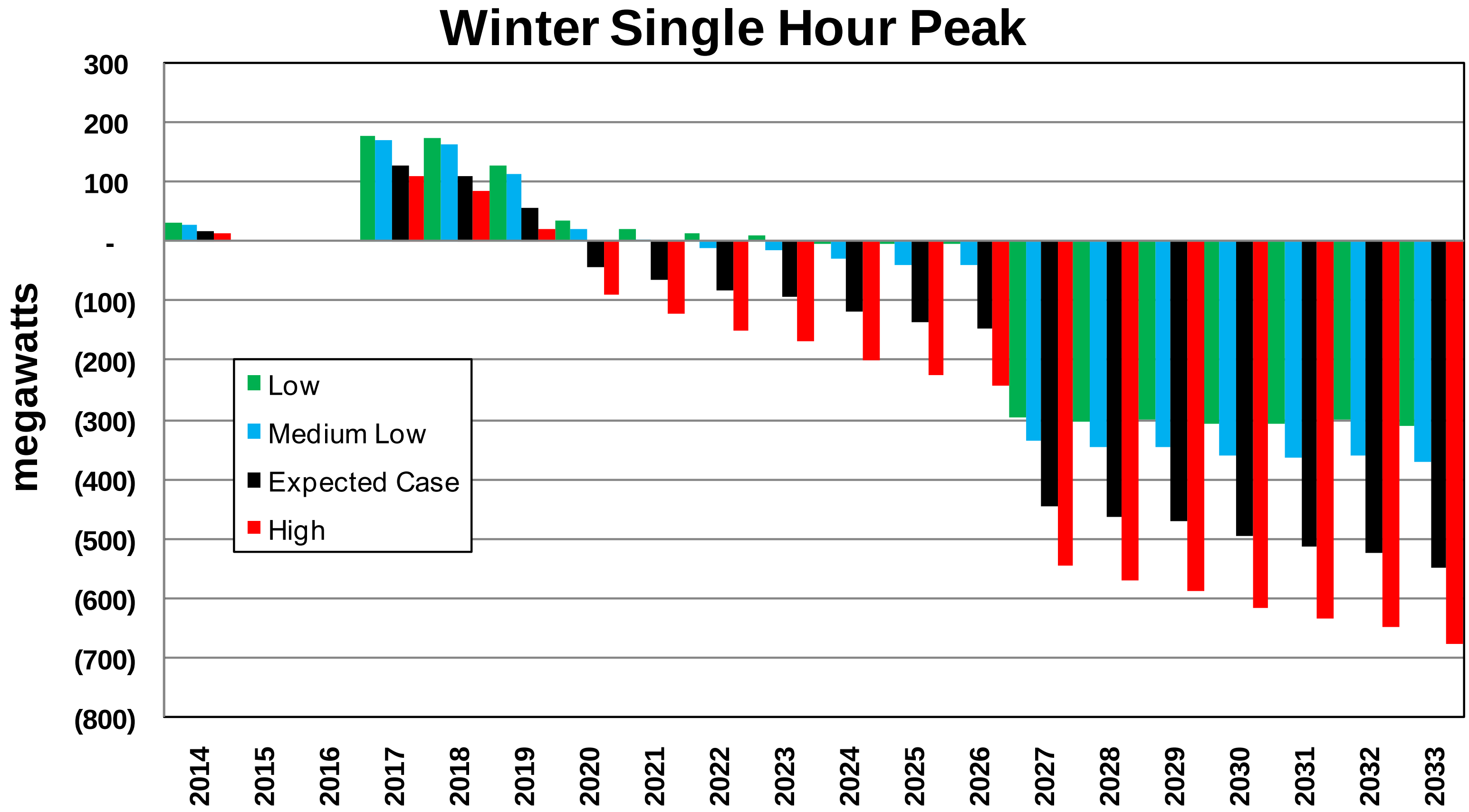
DRAFT

National RPS Scenario Portfolio Results

- Will require 230 MW of new wind capacity
- Hydro upgrades are not economic without a REC credit
- No other resources change within the Expected Case
- 20 year NPV increases 3.4% over the Expected Case
- 2028 Power Supply Costs are 4% higher and risk is 2.8% lower

DRAFT

Load Forecast Scenarios Impact to Net Position



DRAFT

Load Scenario Results

	Load Forecast			
Nameplate (MW)	**PRS**	**Low**	**Medium Low**	**High**
CCCT	270	270	270	270
SCCT	278	32	91	408
Wind	-	0	0	0
Solar	-	0	0	0
Other Renewables	-	0	0	0
Coal (seq)	-	0	0	0
Other	-	0	0	0
Market	-	0	0	0
Plant Upgrade	6	6	6	6
Demand Response	20	15	20	20
Total	**574**	**323**	**387**	**704**
Change in Cost (2028)		-5.3%	-3.7%	3.4%
Change in Risk (2028)		-0.1%	-0.5%	-0.4%

High Planning Margin Study (Less Market Dependence)

- This scenario adds more capacity resource need earlier in the study horizon and at a higher quantity, similar to a high load growth scenario
- New resources would be required by the end of 2016 rather then the end of 2019
- Requires 117 MW of additional capacity to be built (assumes met with peaking natural gas resource)
- Result 2.9% higher NPV, 2028 cost is 3.5% higher, risk level is similar to the PRS

Tipping Point Analyses

- Assumes no government incentives
- Find capital cost where resource would join a similar risk portfolio structure as the PRS
- Solar: $430 per kW ($3,500 per kW modeled)
  - Solar suffers from providing no winter peak capacity, thus competes on an energy basis only (with little energy)
- IGCC Coal w/ sequestration: $750 per kW ($6,000 per kW modeled)
- Nuclear: $2,150 per kW ($7,000 per kW modeled)
- Nuclear and Coal has high O&M cost, if those costs were lowered a higher capital cost could be afforded

Avista's 2013 Electric Integrated Resource Plan

Technical Advisory Committee Meeting No. 6 Agenda

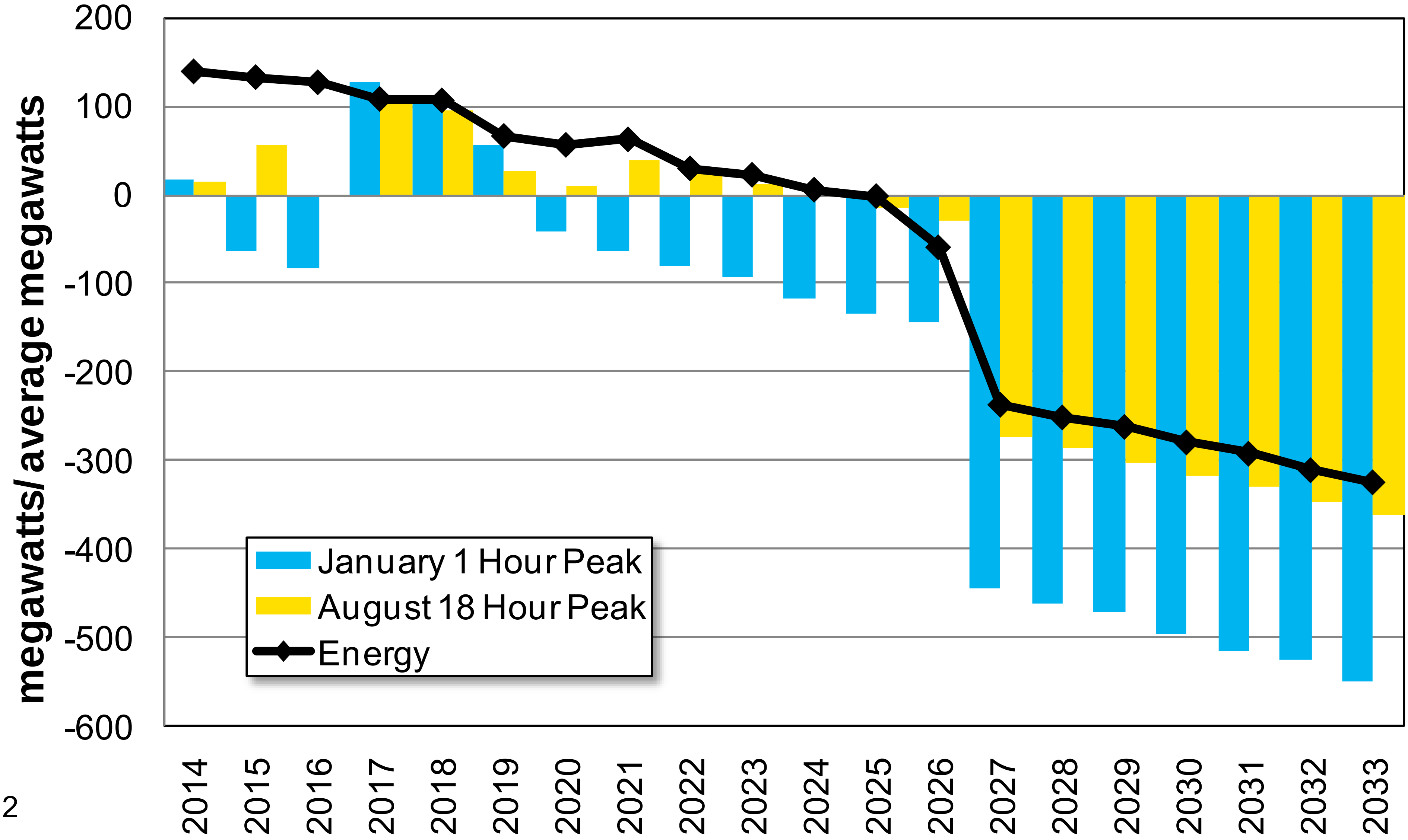
Wednesday, June 19, 2013
Conference Room 428

Topic	Time	Staff
1. Introduction	9:30	
2. 2013 Final Preferred Resource Strategy	9:35	Gall
3. Break	10:15	
4. Portfolio Scenario Analysis	10:30	Gall
5. Lunch	12:00	
6. Net Metering and Buck-a-Block	1:00	Kalich
7. Break	1:30	
8. Action Plan	1:45	Lyons
9. 2013 IRP Document Introduction	2:15	Kalich
10. Adjourn	3:00	

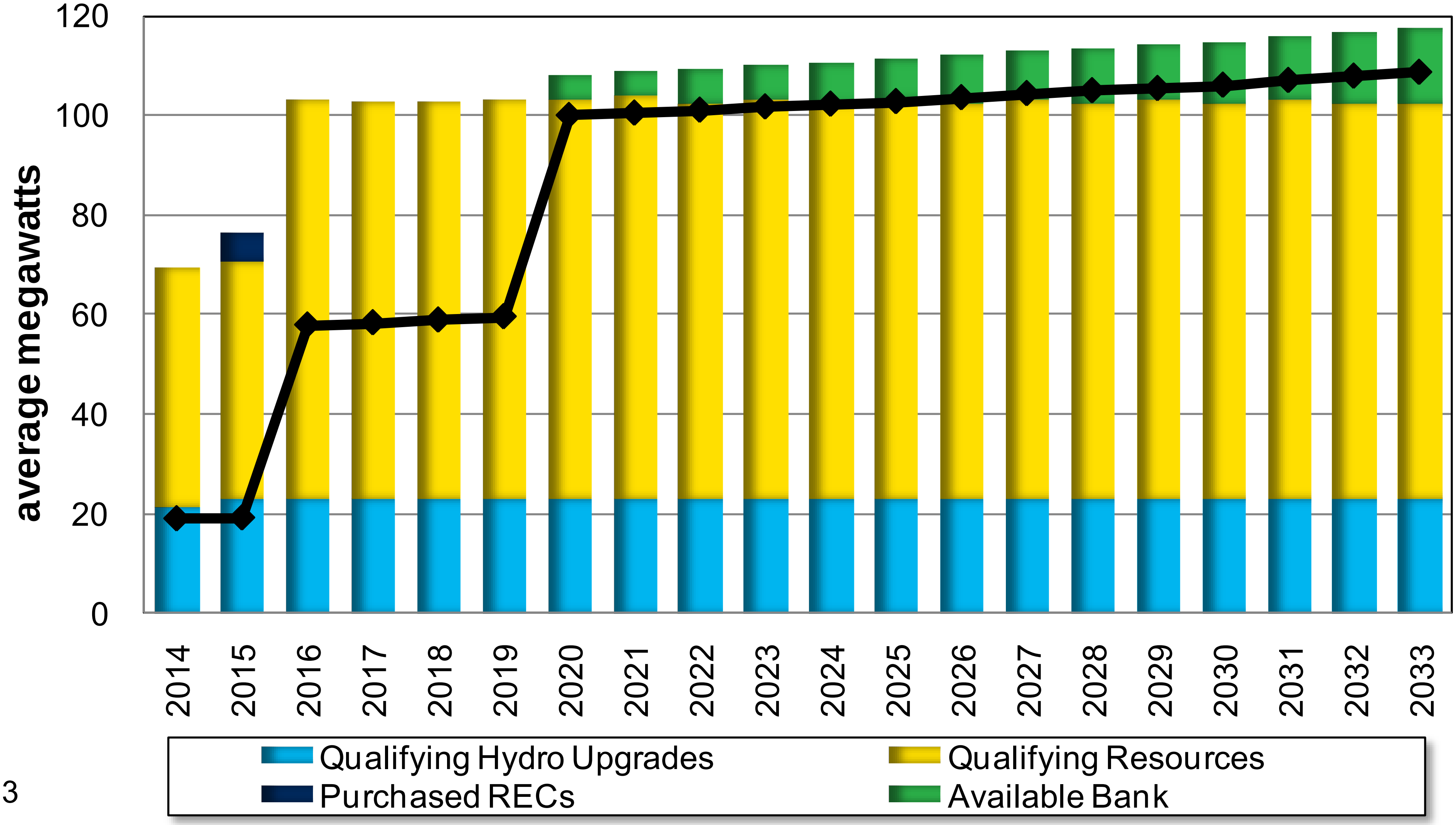
2013 Preferred Resource Strategy

James Gall, Senior Power Supply Analyst

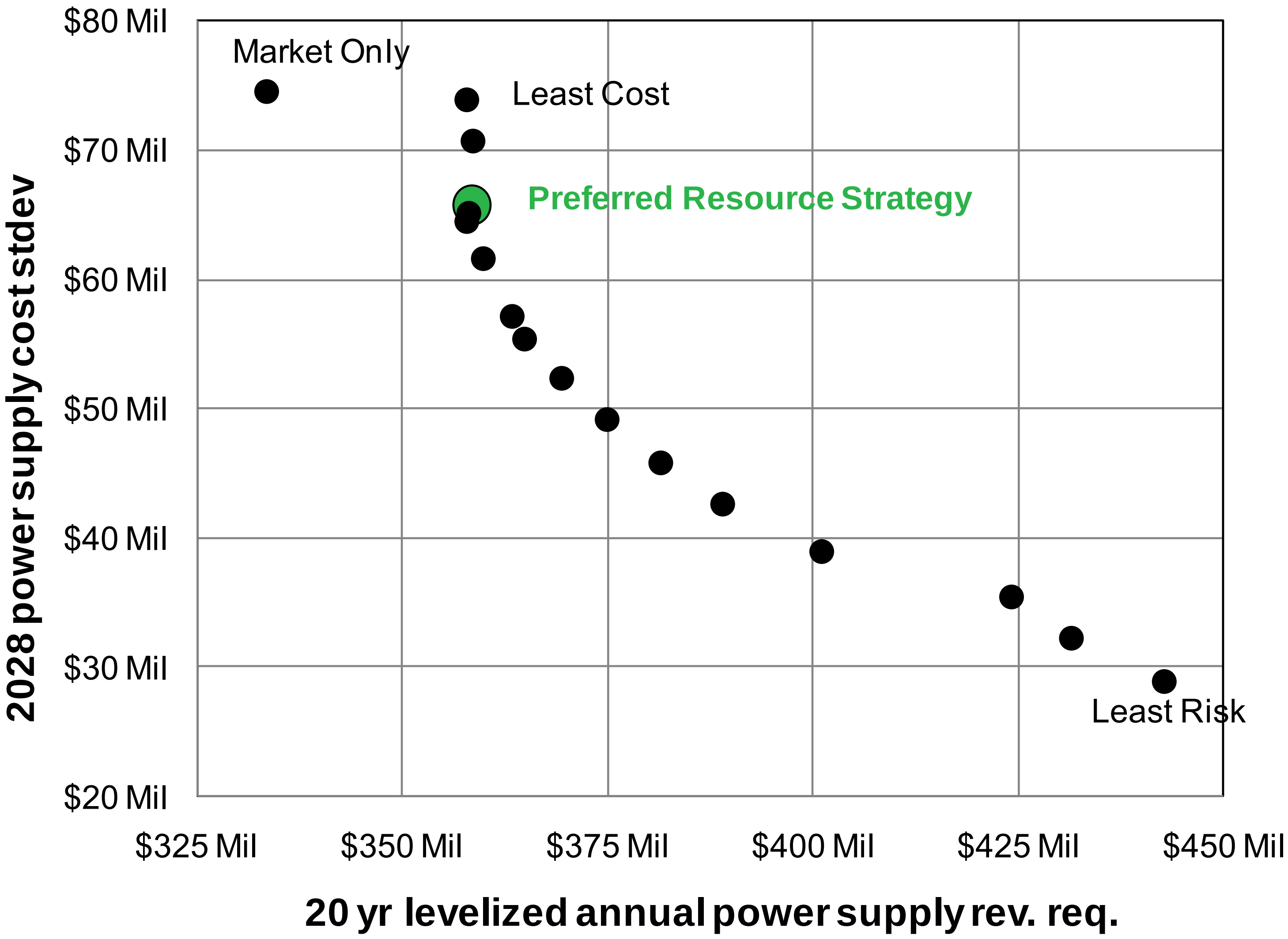
Reliability Needs



Renewable Requirements Met



Efficient Frontier Analysis



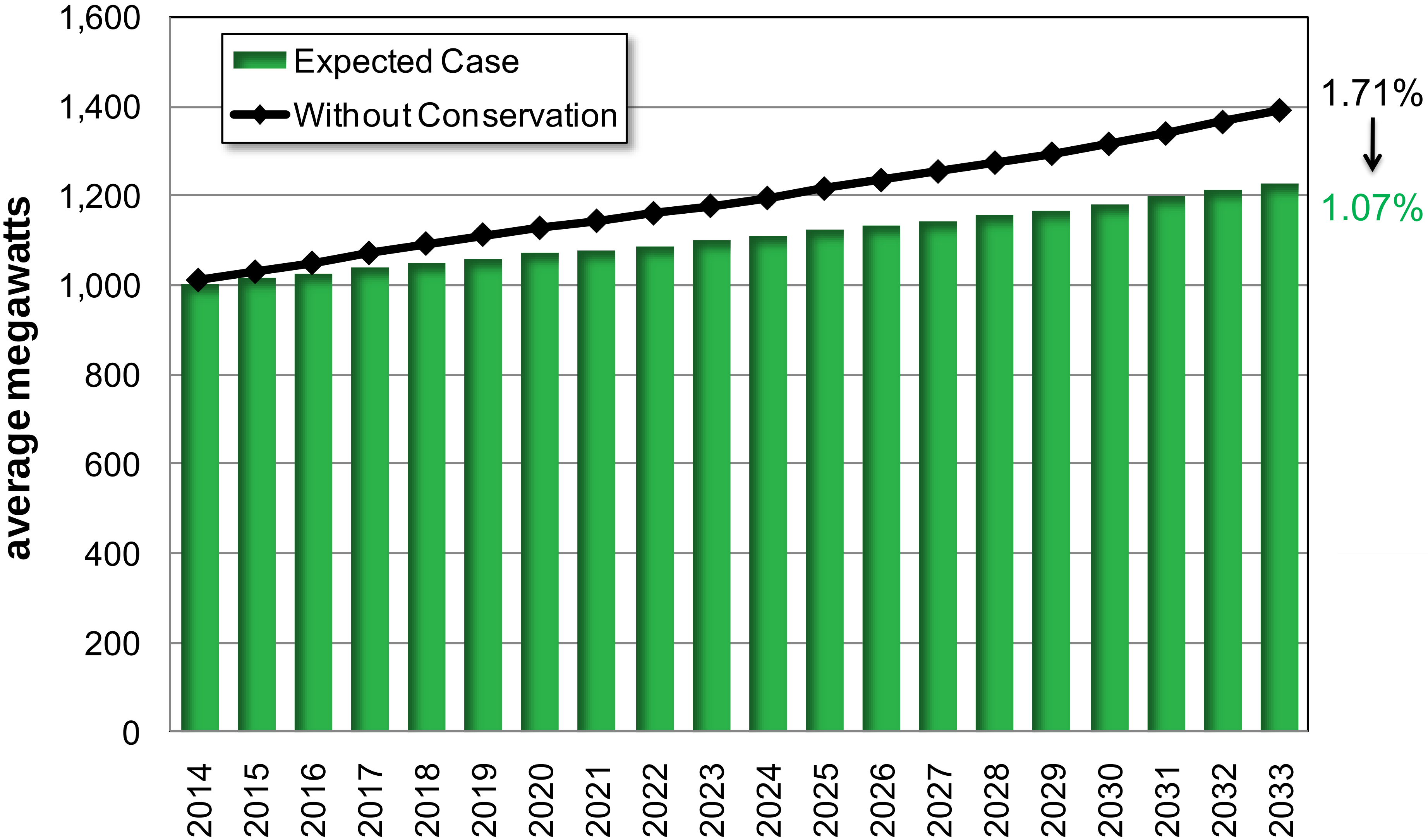
Preferred Resource Strategy

Resource	By the End of Year	Nameplate (MW)	Energy (aMW)
Simple Cycle CT	2019	83	76
Simple Cycle CT	2023	83	76
Combined Cycle CT	2026	270	248
Rathdrum CT Upgrade	2028	6	5
Simple Cycle CT	2032	50	46
Total		**492**	**453**
Efficiency Improvements	**By the End of Year**	**Peak Reduction (MW)**	**Energy (aMW)**
Energy Efficiency	2014-2033	221	164
Demand Response	2022-2027	19	0
Distribution Efficiencies	2014-2017	<1	<1
Total		**240**	**164**

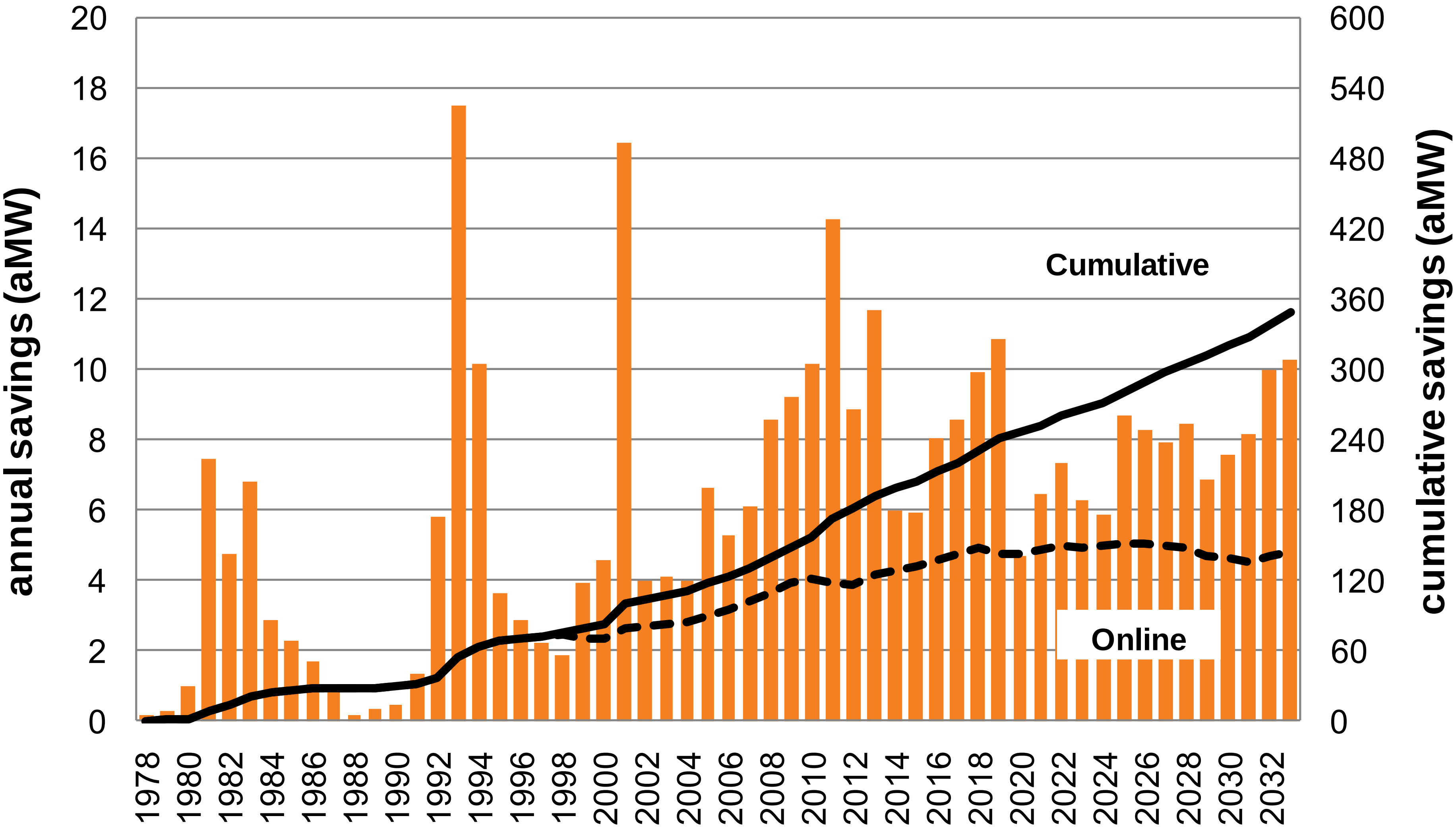
Resource Capital Requirements

Year	Investment	Year	Investment
2014	0.0	2024	91.6
2015	0.0	2025	0.0
2016	0.0	2026	0.0
2017	0.0	2027	421.7
2018	0.0	2028	97.0
2019	0.0	2029	2.4
2020	85.8	2030	0.0
2021	0.0	2031	0.0
2022	0.0	2032	0.0
2023	0.0	2033	83.6
2014-23 Total	**85.8**	**2024-33 Totals**	**696.2**

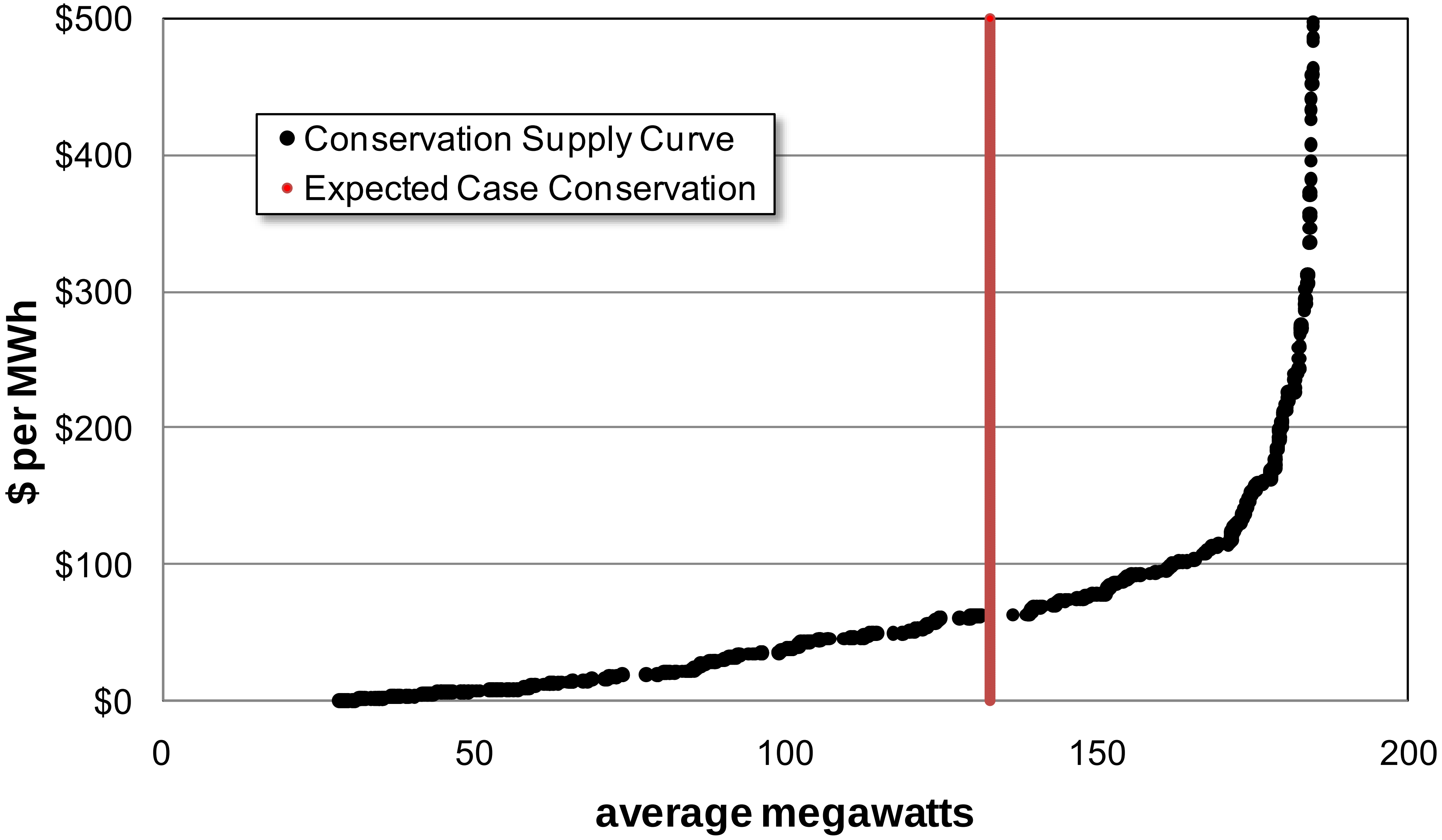
Conservation Meets 42% of Load Growth



Past and Future Conservation

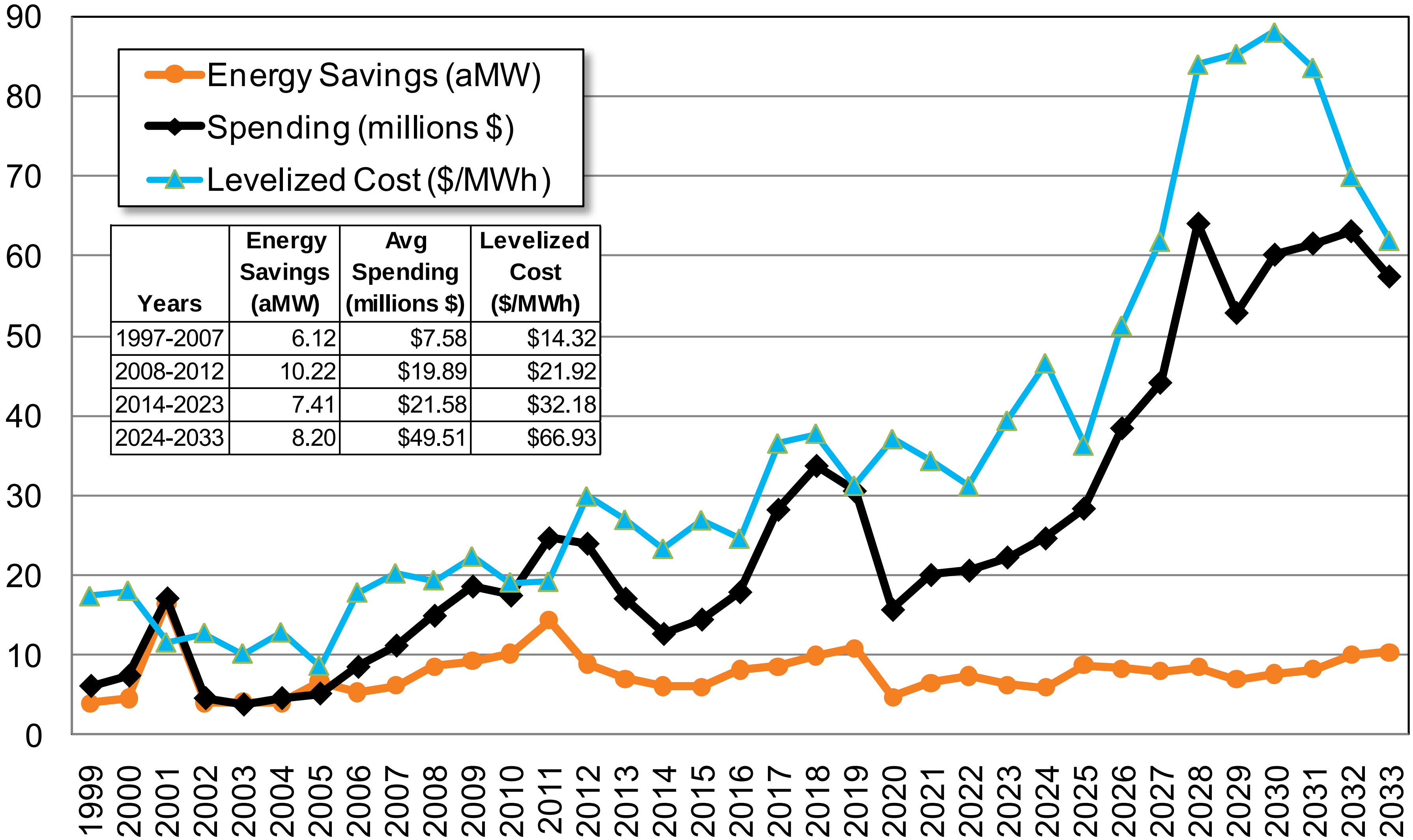


Conservation Supply Curve



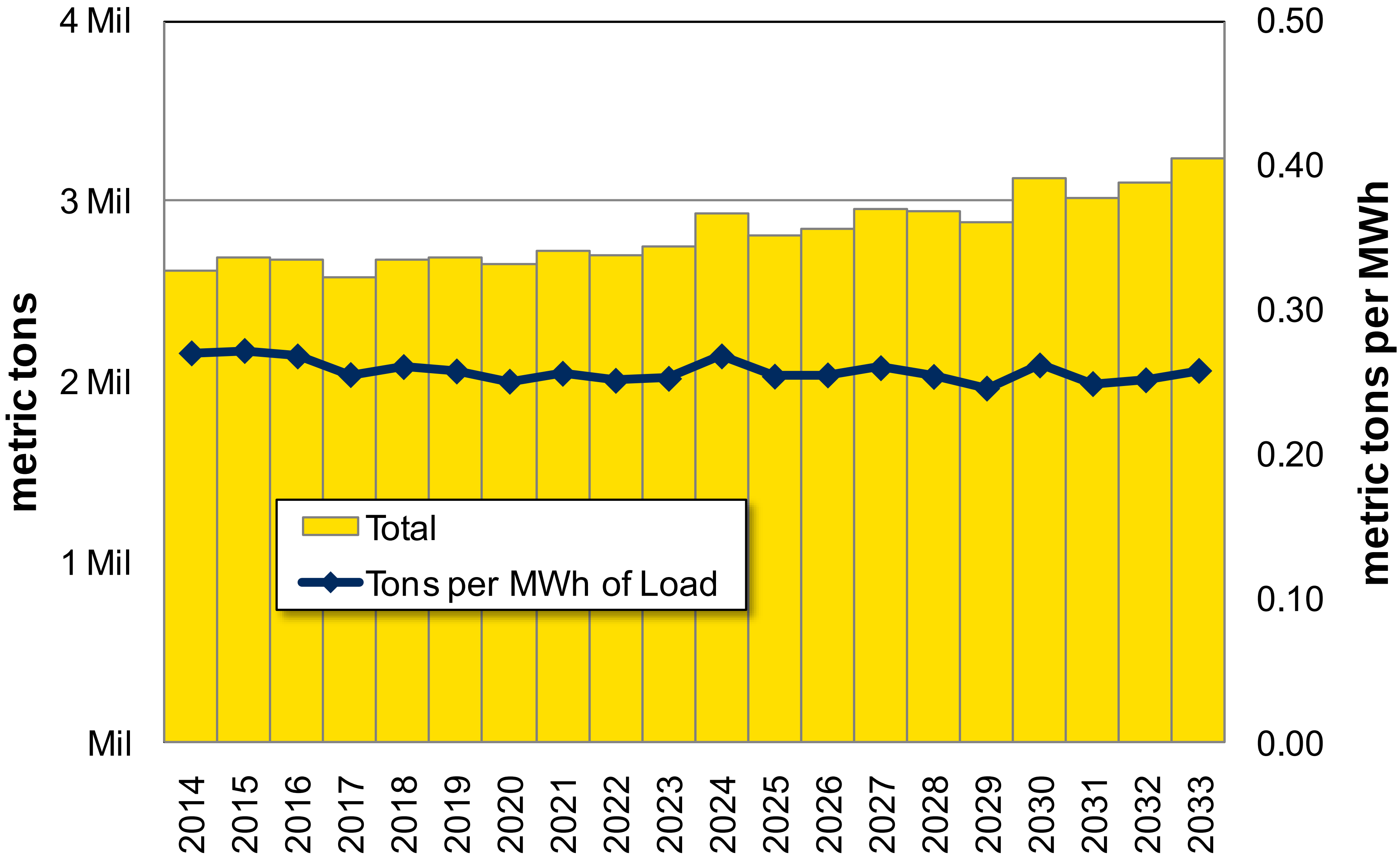
Note: excludes fuel switching and pumping programs; not grossed up for line-losses.

Cost of Conservation

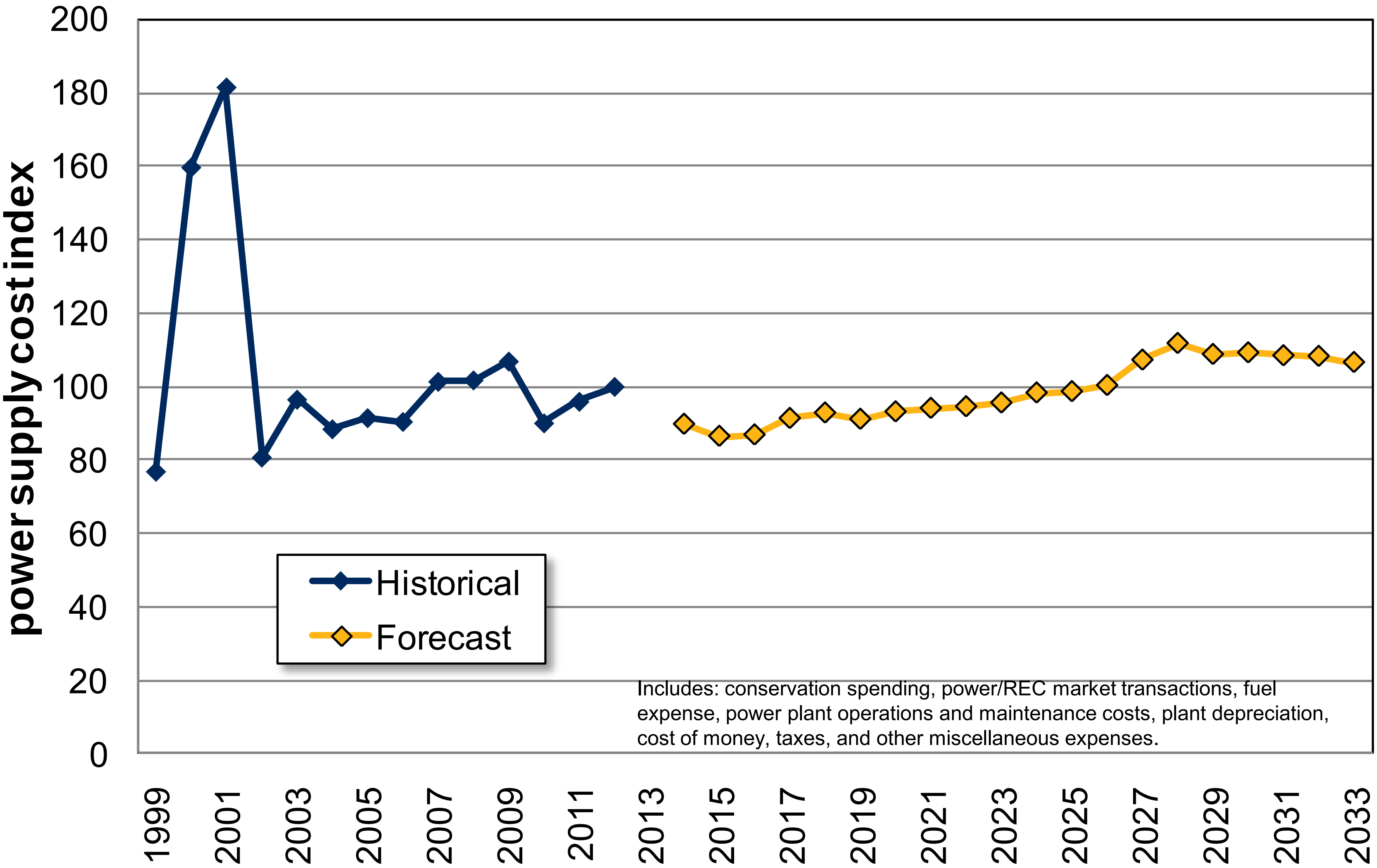


Years	Energy Savings (aMW)	Avg Spending (millions $)	Levelized Cost ($/MWh)
1997-2007	6.12	$7.58	$14.32
2008-2012	10.22	$19.89	$21.92
2014-2023	7.41	$21.58	$32.18
2024-2033	8.20	$49.51	$66.93

Greenhouse Gas Emission Forecast



Power Supply Cost Index Forecast (2012$)



Includes: conservation spending, power/REC market transactions, fuel expense, power plant operations and maintenance costs, plant depreciation, cost of money, taxes, and other miscellaneous expenses.

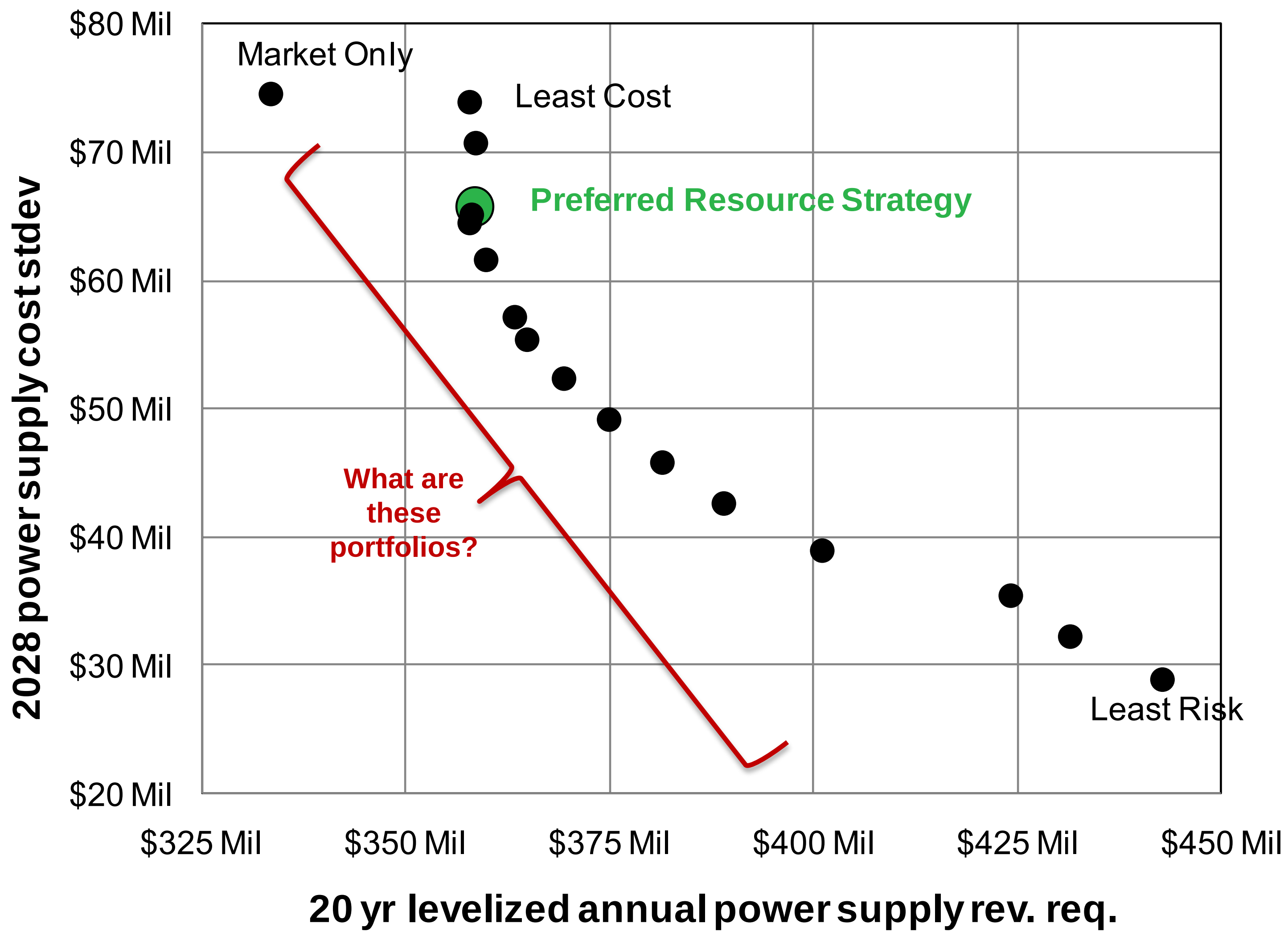
Portfolio Scenario Analysis

James Gall, Senior Power Supply Analyst

Scenarios

- Efficient Frontier Analysis
- Carbon Pricing
- Conservation
- Load Growth
- Resource & Policy Specific Portfolios
- Colstrip

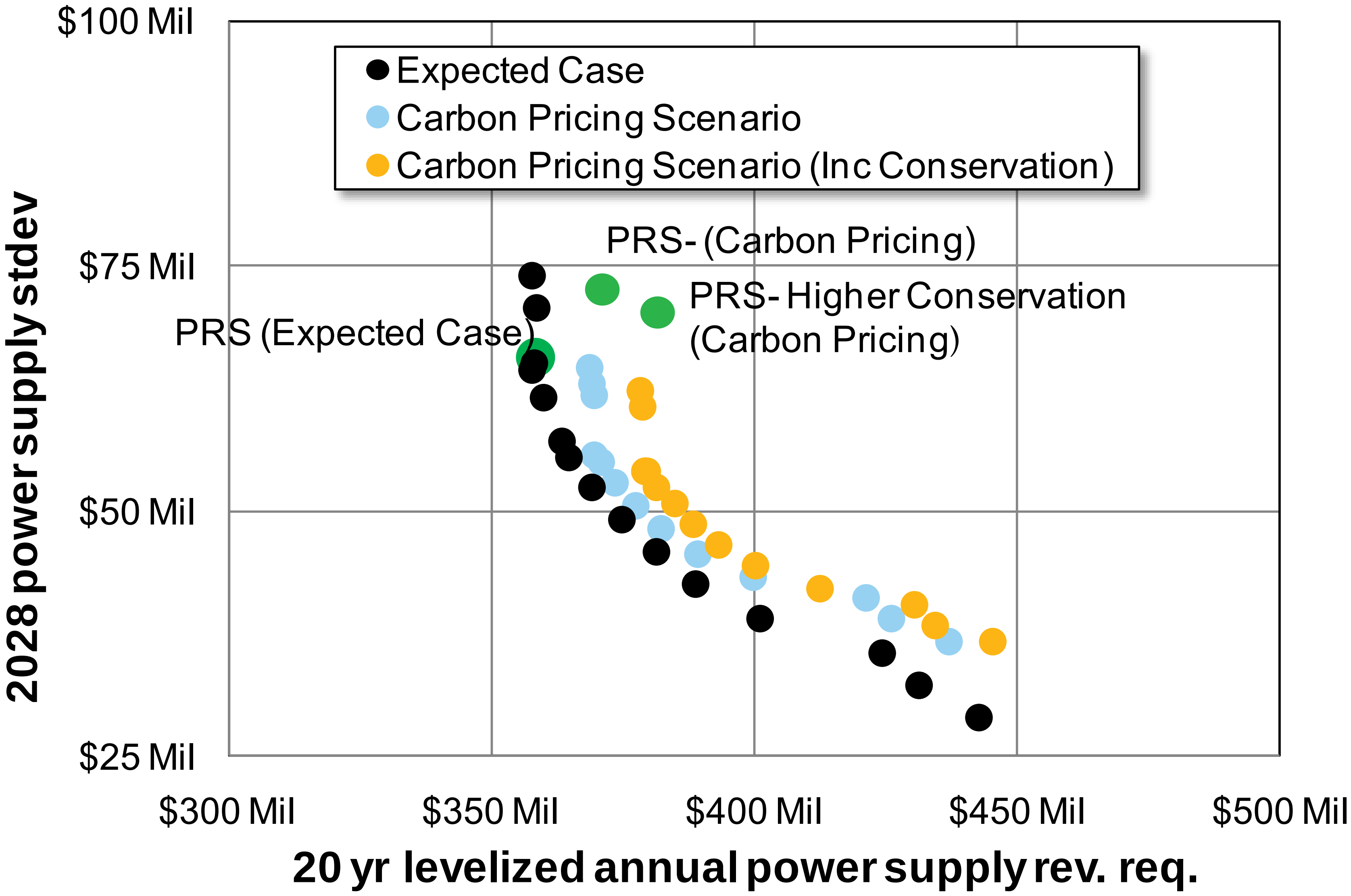
Efficient Frontier



Portfolio Mix at Alternative Risk Levels

Nameplate (MW)	PRS	High Risk	Medium High Risk	Medium Risk	Medium Low Risk	Low Risk
CCCT	270	-	270	270	540	540
SCCT	299	566	296	216	100	68
Wind	-	-	-	30	50	350
Solar	-	-	-	-	-	-
Biomass	-	-	-	-	-	50
Coal (seq)	-	-	-	-	-	-
Hydro Upgrade	-	-	-	-	-	-
Thermal Upgrade	6	6	6	85	85	80
Demand Response	19	20	20	8	12	17
Total (excluded DSM)	**594**	**592**	**592**	**609**	**788**	**1,104**
20-yr Levelized Cost (mill)	$358.4	$357.9	$357.9	$362.3	$367.0	$396.0
2028 Power Supply Stdev (mill)	$65.7	$74.0	$64.4	$60.5	$54.1	$40.2
2033 Greenhouse Gas Emissions (millions of metric tons)	3.2	2.9	3.4	3.4	3.9	3.8

Carbon Pricing Effect to Efficient Frontier



Carbon Pricing Scenario- Least Cost Strategy

Peaking Technology Switches to Higher Efficient Turbines

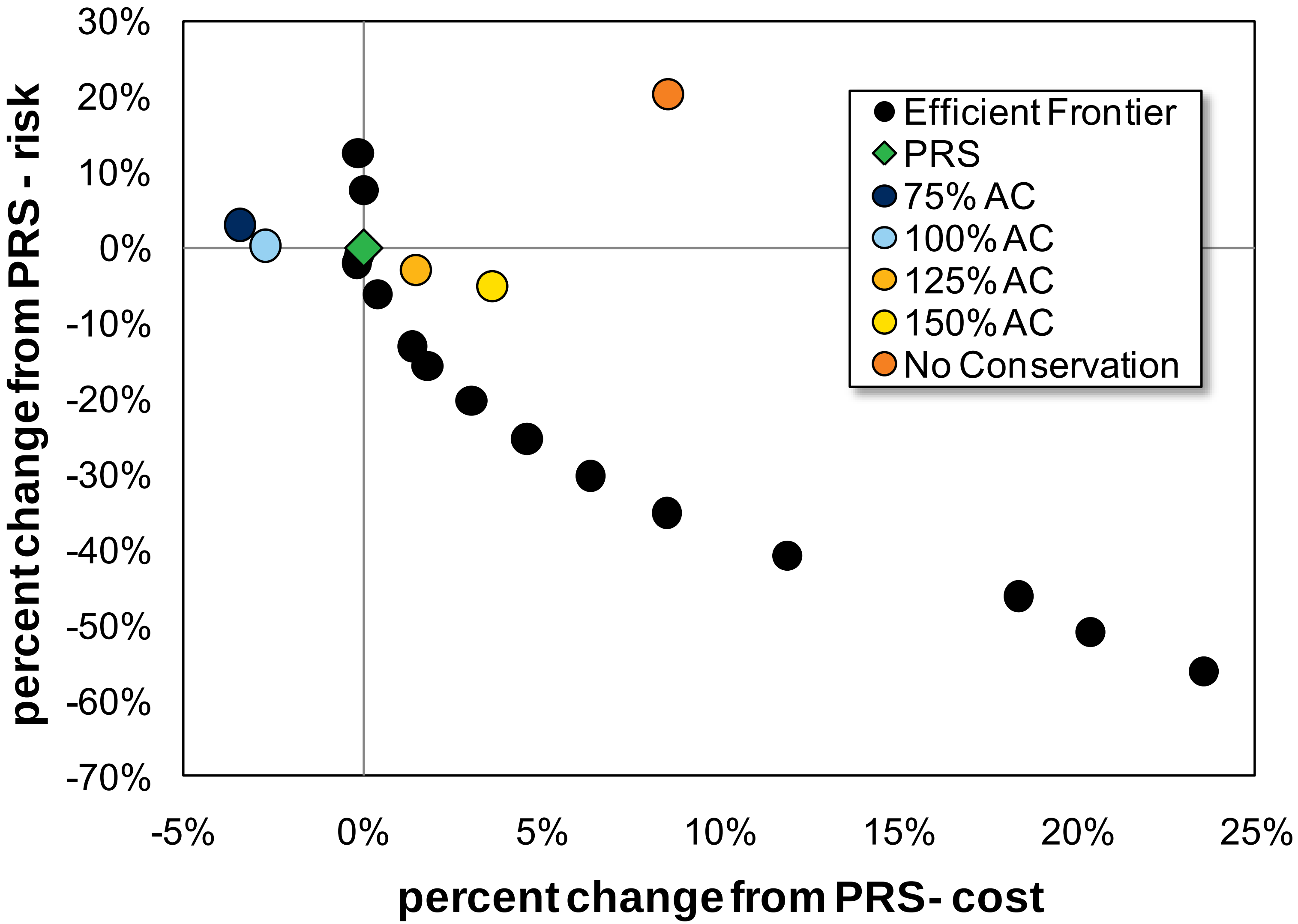
Portfolio	20-Yr Power Supply Levelized Cost	
	Expected Case	Carbon Pricing Scenario
PRS	$358.4	$367.3
PRS w/ Higher Conservation	$365.0	$377.8
Carbon Pricing Scenario- LC RS	$364.7	$374.5
Portfolio	**2028 Power Supply Cost Standard Deviation**	
	Expected Case	**Carbon Pricing Scenario**
PRS	$65.7	$72.6
PRS w/ Higher Conservation	$63.9	$70.3
Carbon Pricing Scenario- LC RS	$61.0	$63.6

Conservation Avoided Cost Scenarios

- Change cost effective point of conservation
- 20 Year Avoided Cost for Conservation is $67.91/MWh

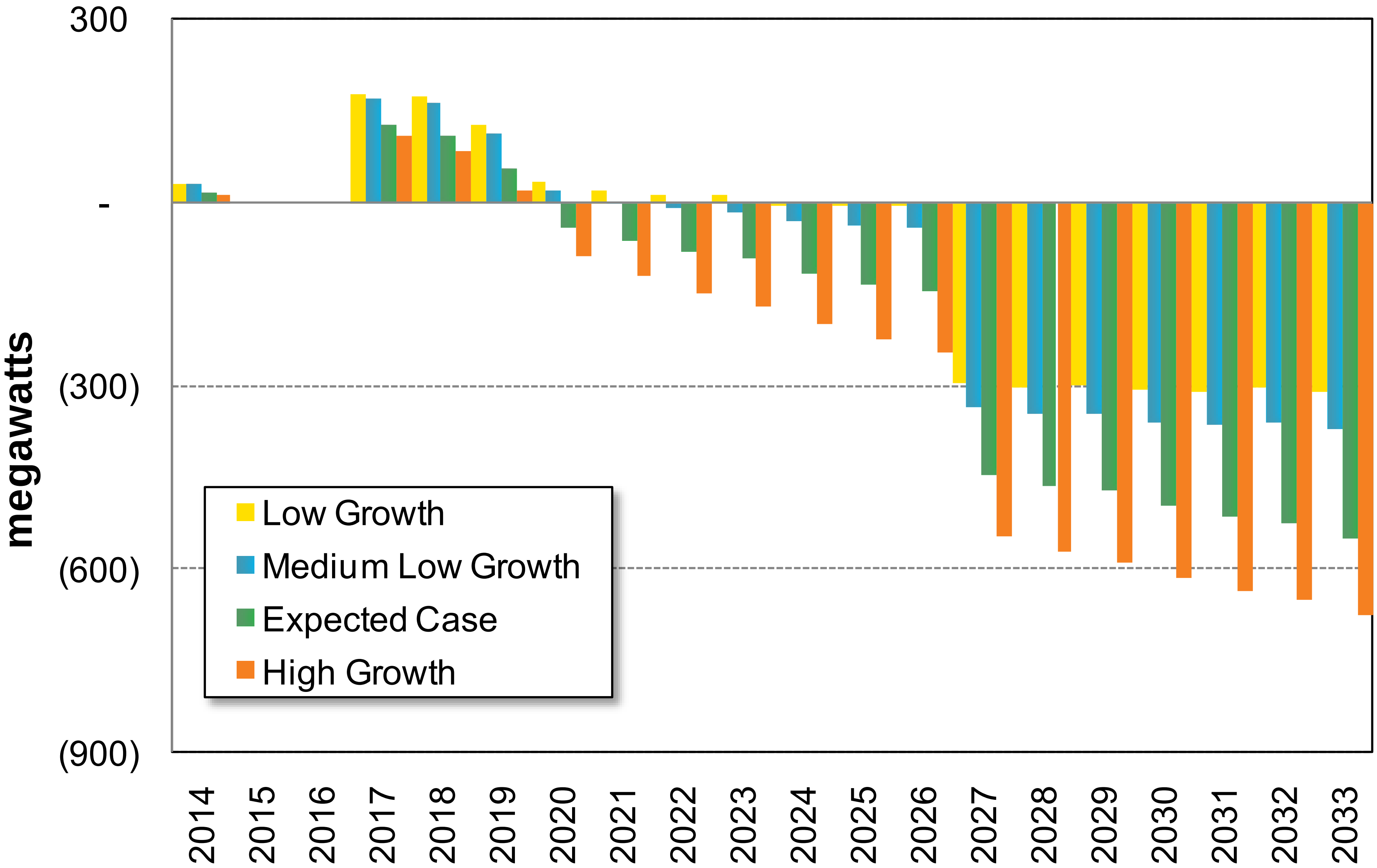
Avoided Cost Percentage	20 Year aMW	Delta aMW
75%	139	-25
100%	154	-10
Expected Case (110%)	164	0
125%	184	+20
150%	201	+37

Conservation Avoided Cost Scenarios



Load Growth Sensitivities

Winter Peak Position



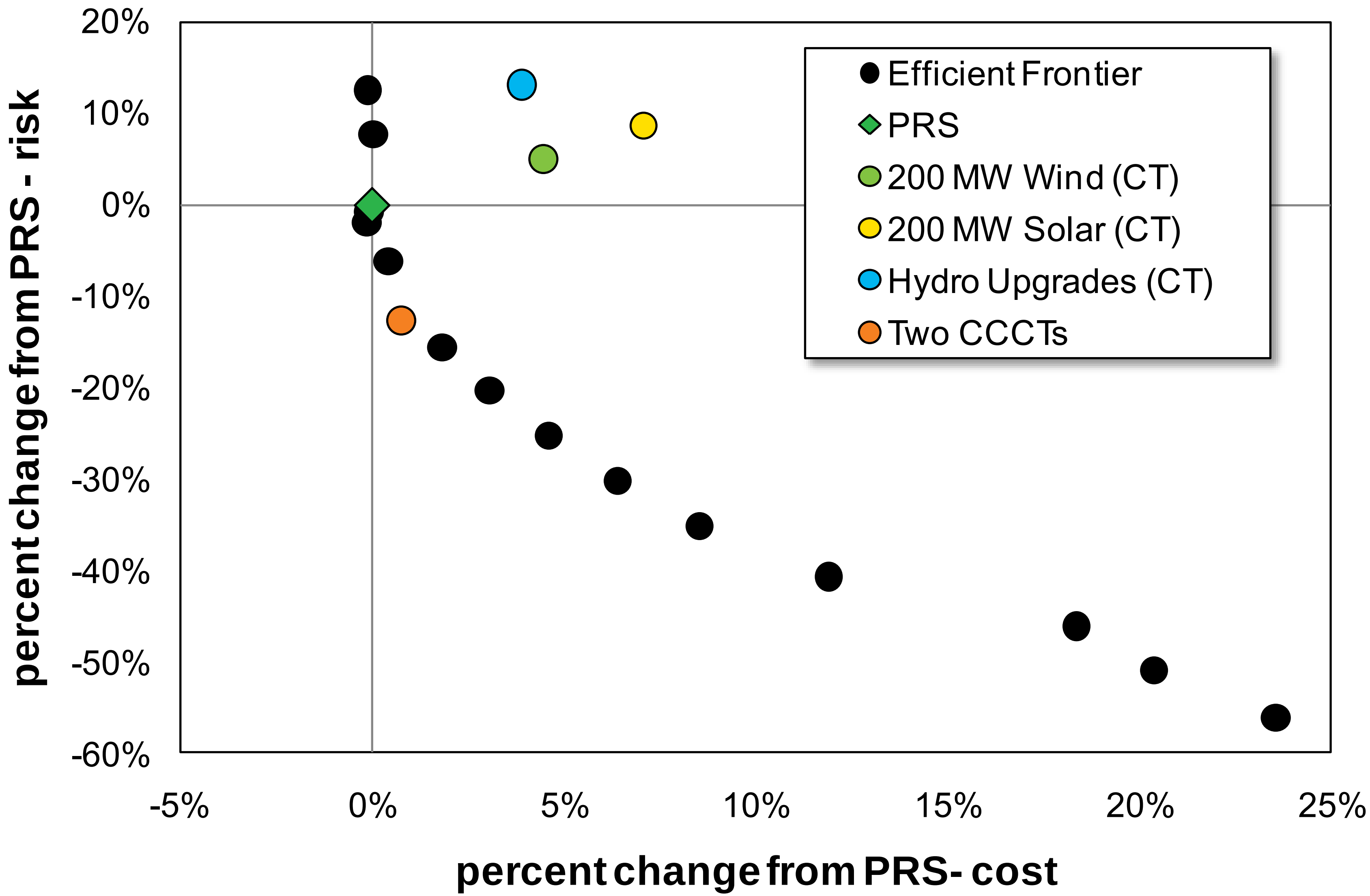
Load Growth Scenarios: Resource Selection

Year	PRS	Low Growth	Medium Low Growth	High Growth
2014				
2015				
2016				
2017				
2018				
2019	83 MW SCCT			150 MW SCCT
2020				
2021				
2022			6 MW Upgrade	92 MW SCCT
2023	83 MW SCCT		90 MW SCCT	
2024				
2025				
2026	270 MW CCCT	270 MW CCCT	270 MW CCCT	270 MW CCCT
2027		50 MW SCCT		92 MW SCCT
2028				6 MW Upgrade
2029	6 MW Upgrade			50 MW SCCT
2030				
2031				
2032				
2033	50 MW SCCT			50 MW SCCT
Demand Response (MW)	19	1	20	20
Conservation (aMW)	164	142	147	175

Resource Strategies from Policy Changes

Nameplate (MW)	PRS	Higher WA St. RPS	National RPS	Higher Capacity Margins	2011 PRS
CCCT	270	270	270	270	540
NG Peaker	299	249	296	435	187
Wind	-	-	203	-	120
Solar	-	-	-	-	-
Biomass	-	-	-	-	-
Coal (seq)	-	-	-	-	-
Hydro Upgrade	-	148	-	-	-
Thermal Upgrade	6	6	6	6	-
Demand Response	19	10	20	8	-
Total (Excluding Conservation)	**594**	**683**	**795**	**718**	**847**
20-yr Levelized Cost (millions)	$354.8	$360.3	$365.3	$364.2	$373.9
2028 Power Supply Stdev (millions)	$65.7	$64.8	$63.6	$65.8	$54.0
2033 Greenhouse Gas Emissions (millions of metric tons)	3.2	3.2	3.3	3.4	3.7

Resource Specific Portfolios



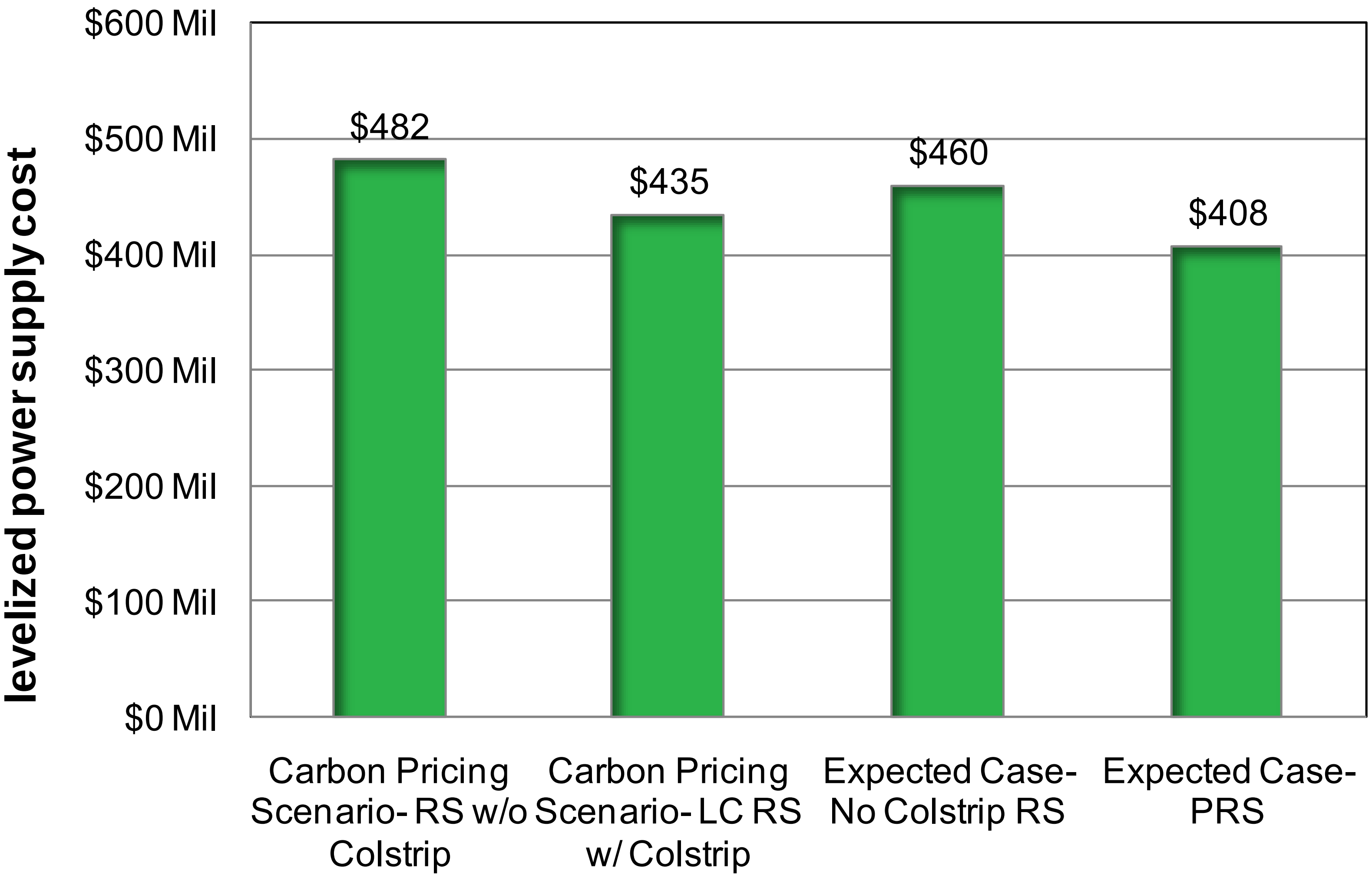
Colstrip Scenarios

- No Colstrip Resource Strategy Scenario
  - Colstrip is removed from portfolio beginning in 2018
  - No costs/benefits included due to its removal
- Regional Haze Program Scenario
  - Assumes Colstrip #3 & #4 must install SCR or shut down in 2027
  - SCR costs are expected to be $105 million (Avista share) plus $560k each year in O&M or $8.39/MWh total cost levelized

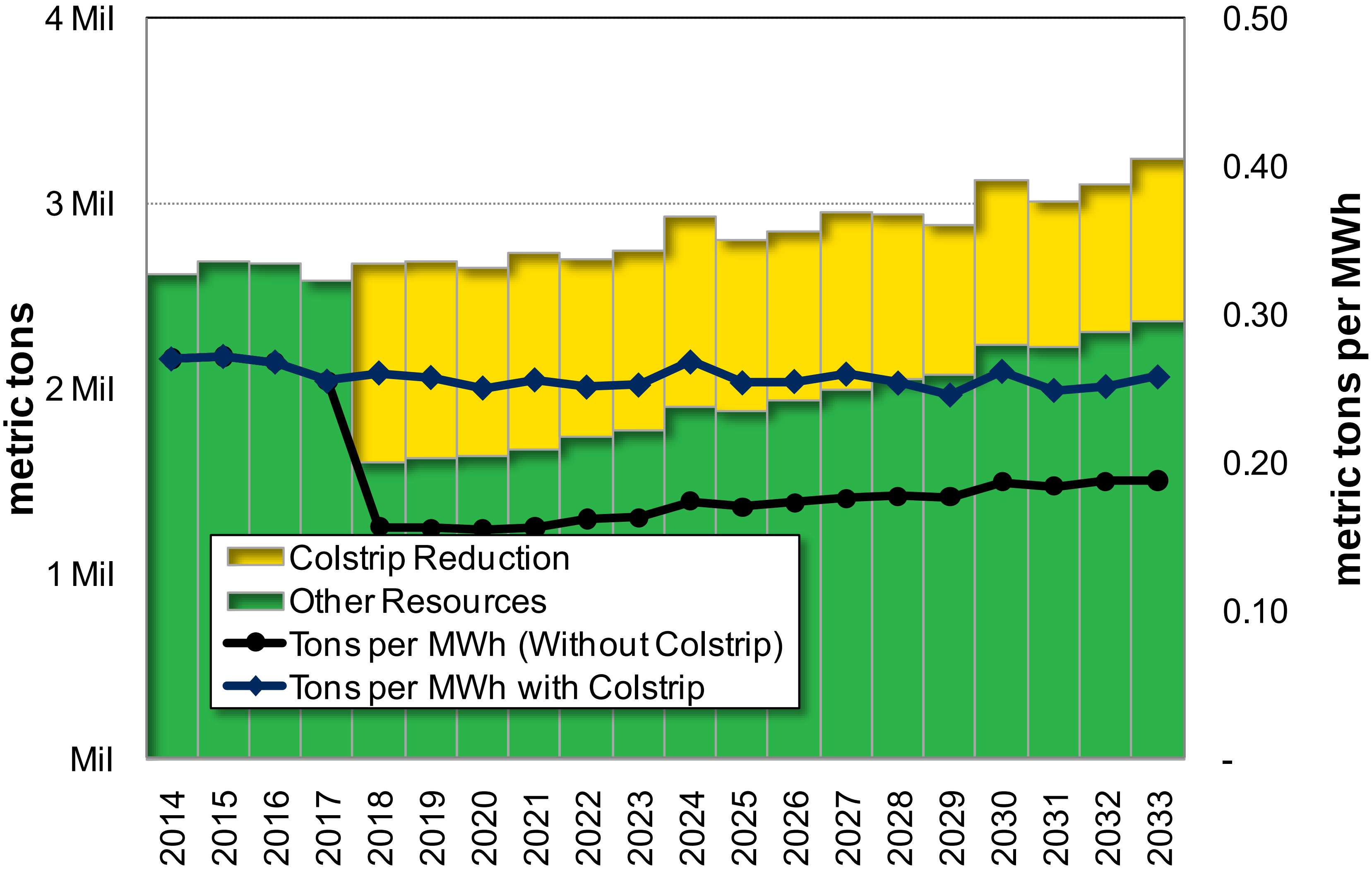
Resource Strategy Without Colstrip

Resource	By the End of Year	Nameplate (MW)	Energy (aMW)
Combined Cycle CT	2017	270	248
Simple Cycle CT	2020	50	46
Simple Cycle CT	2023	50	46
Combined Cycle CT	2026	270	248
Simple Cycle CT	2026	51	47
Simple Cycle CT	2029	55	51
Simple Cycle CT	2032	50	46
Total		**797**	**733**
Efficiency Improvements	**By the End of Year**	**Peak Reduction (MW)**	**Energy (aMW)**
Energy Efficiency	2014-2033	221	164
Demand Response	2022-2027	20	0
Distribution Efficiencies	2014-2017	<1	<1
Total		**241**	**164**

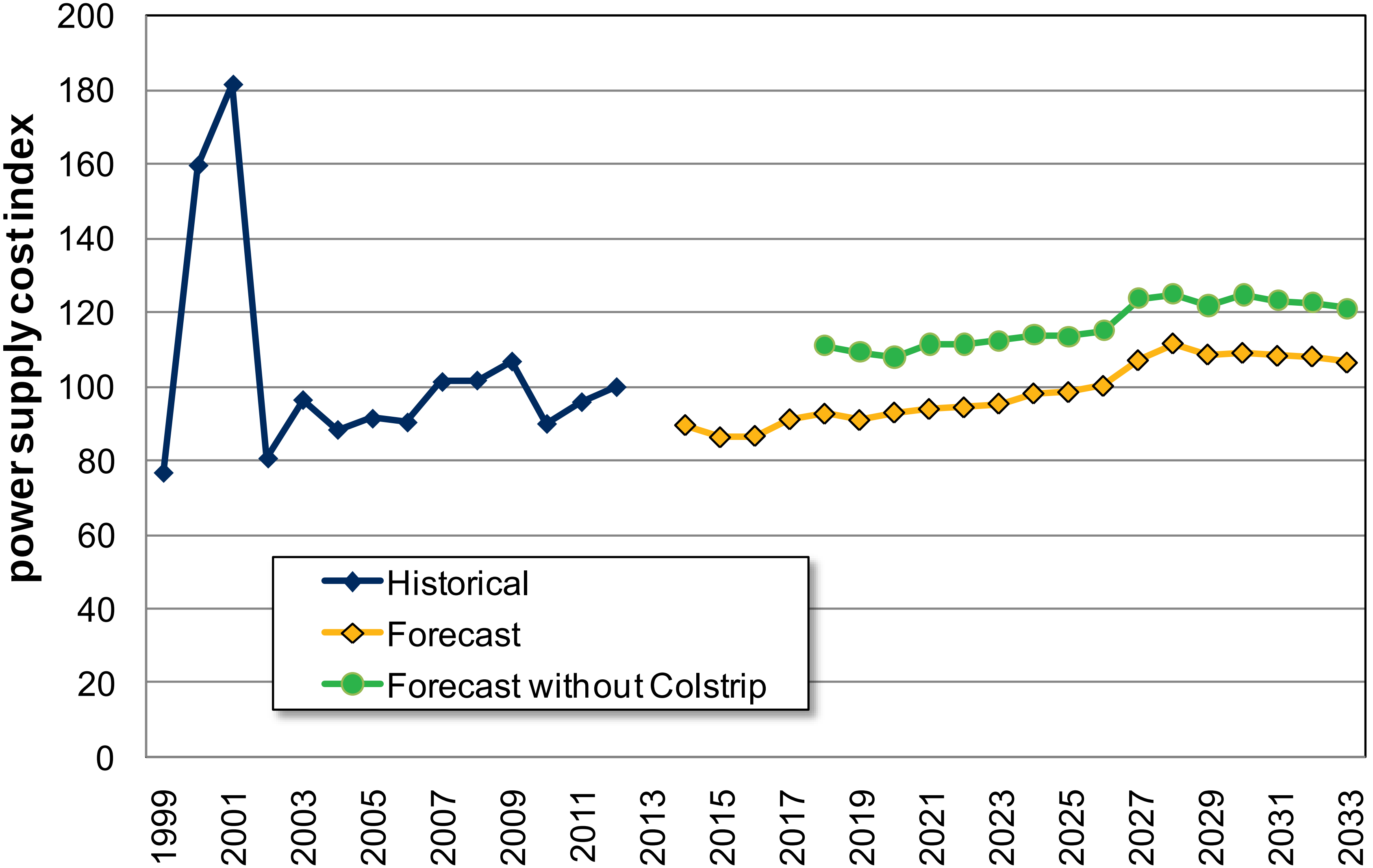
Colstrip Scenarios: Levelized Cost Comparison



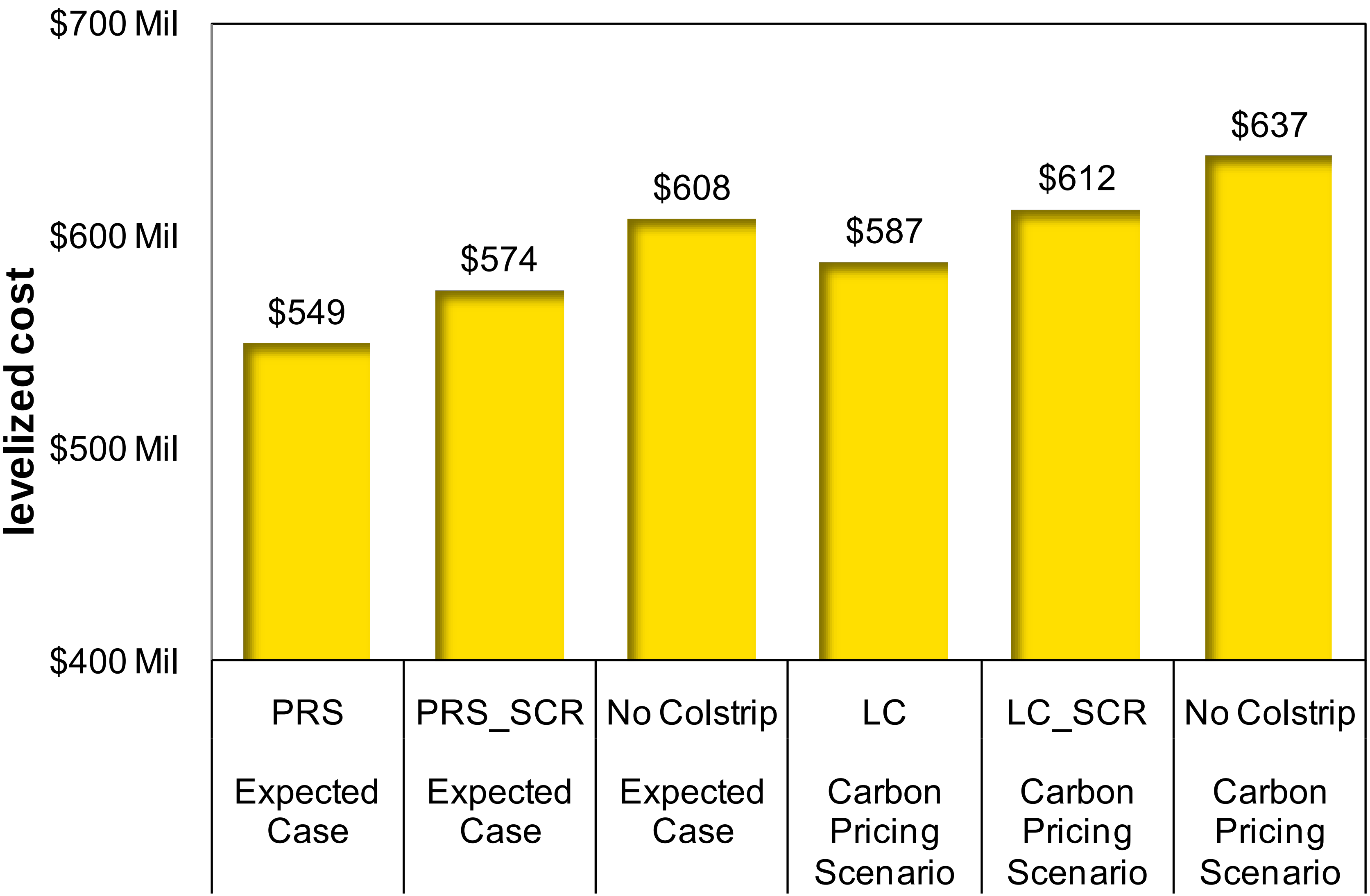
Greenhouse Gas Emissions without Colstrip



Power Supply Cost Index Comparison



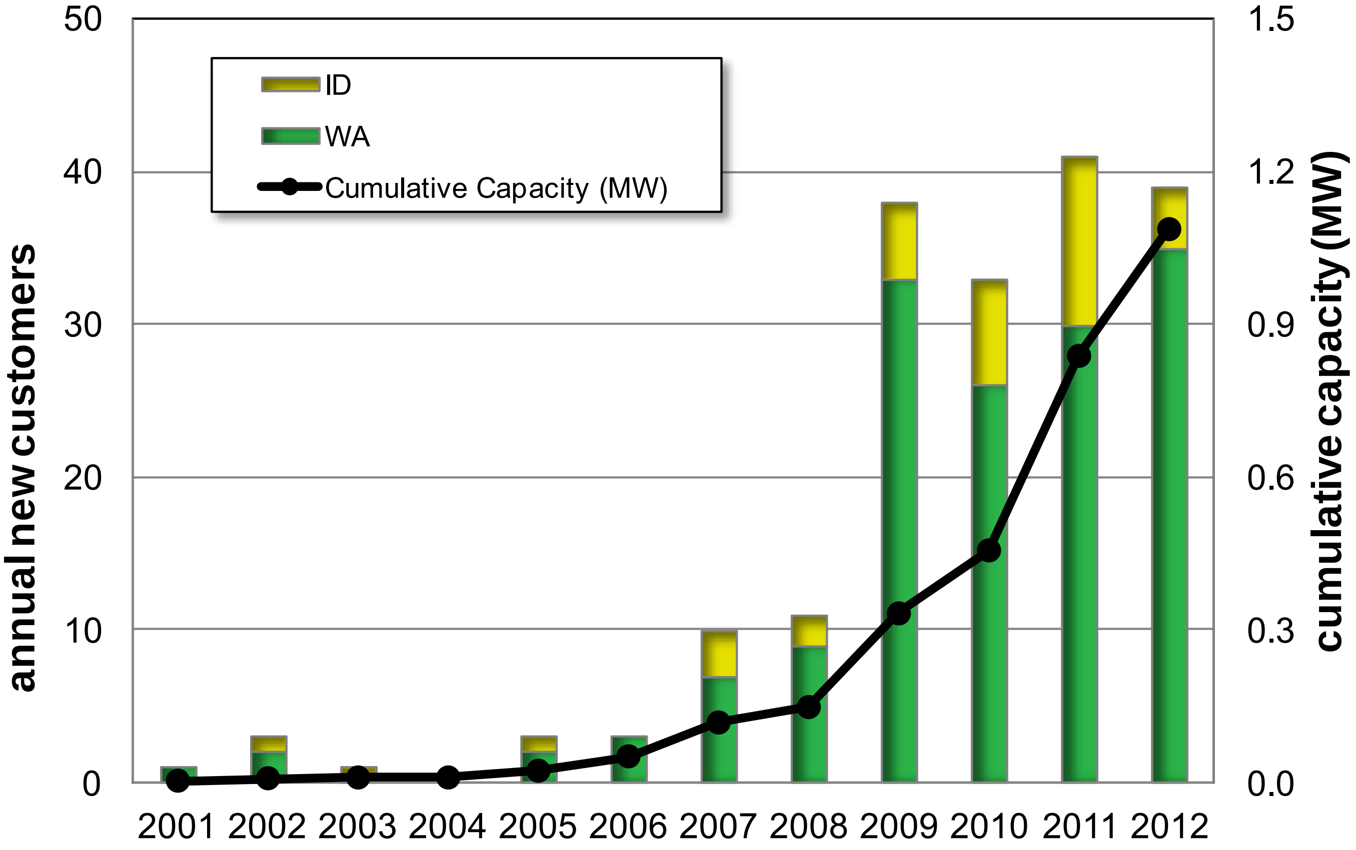
2027-33 Colstrip SCR Analysis



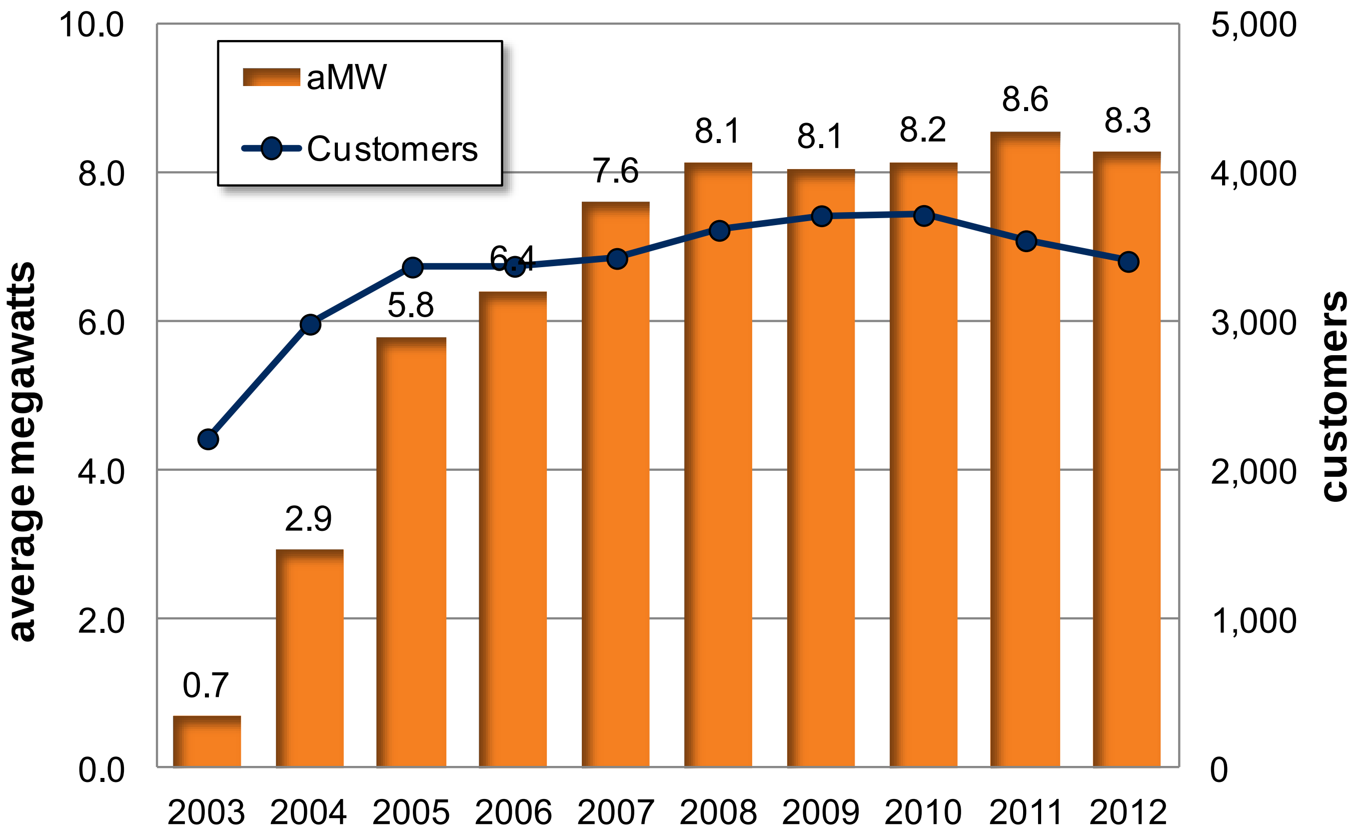
Net Metering and Buck-A-Block

Clint Kalich
Sixth Technical Advisory Committee Meeting
2013 Electric Integrated Resource Plan
June 19, 2013

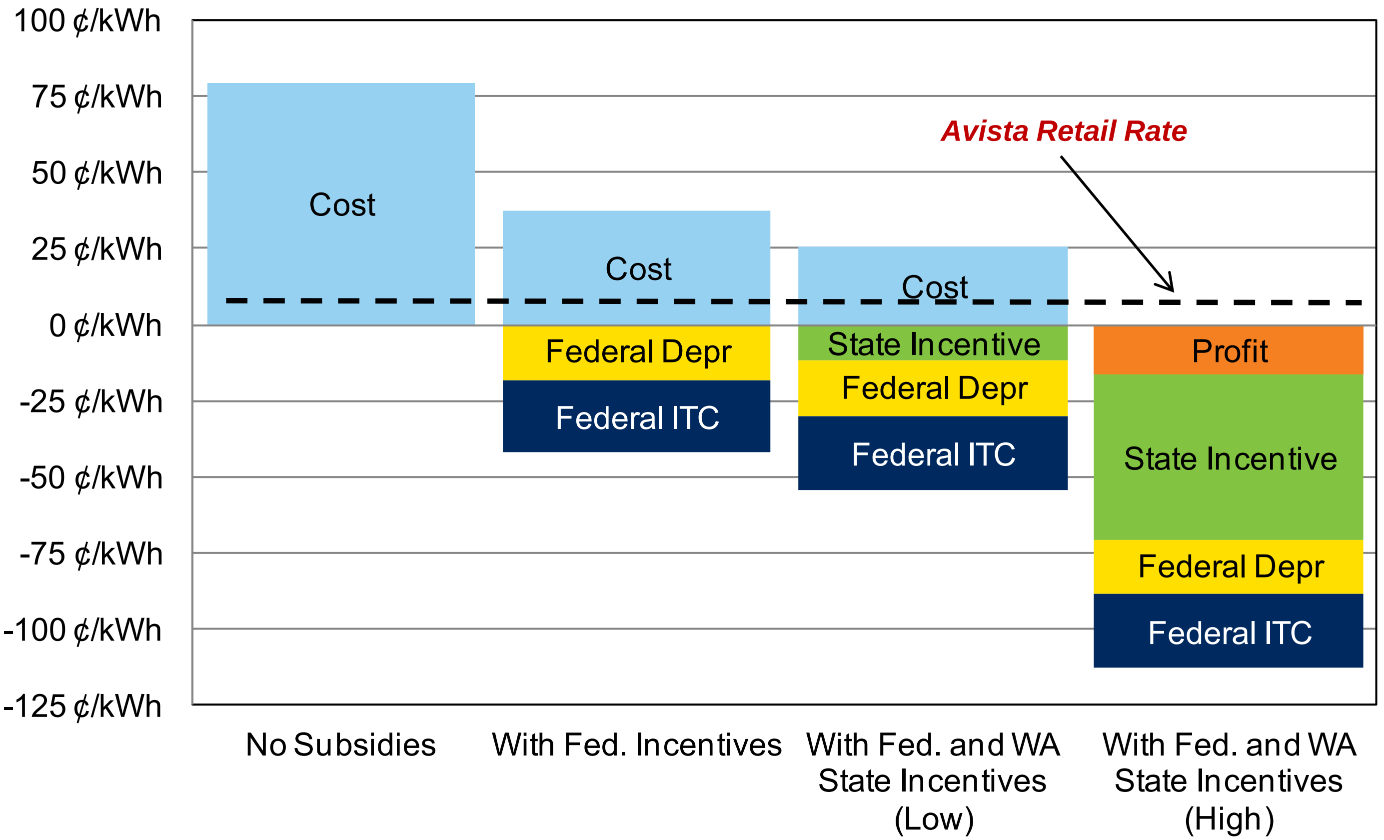
Avista's Net Metering Customers



Avista Buck-A-Block Program

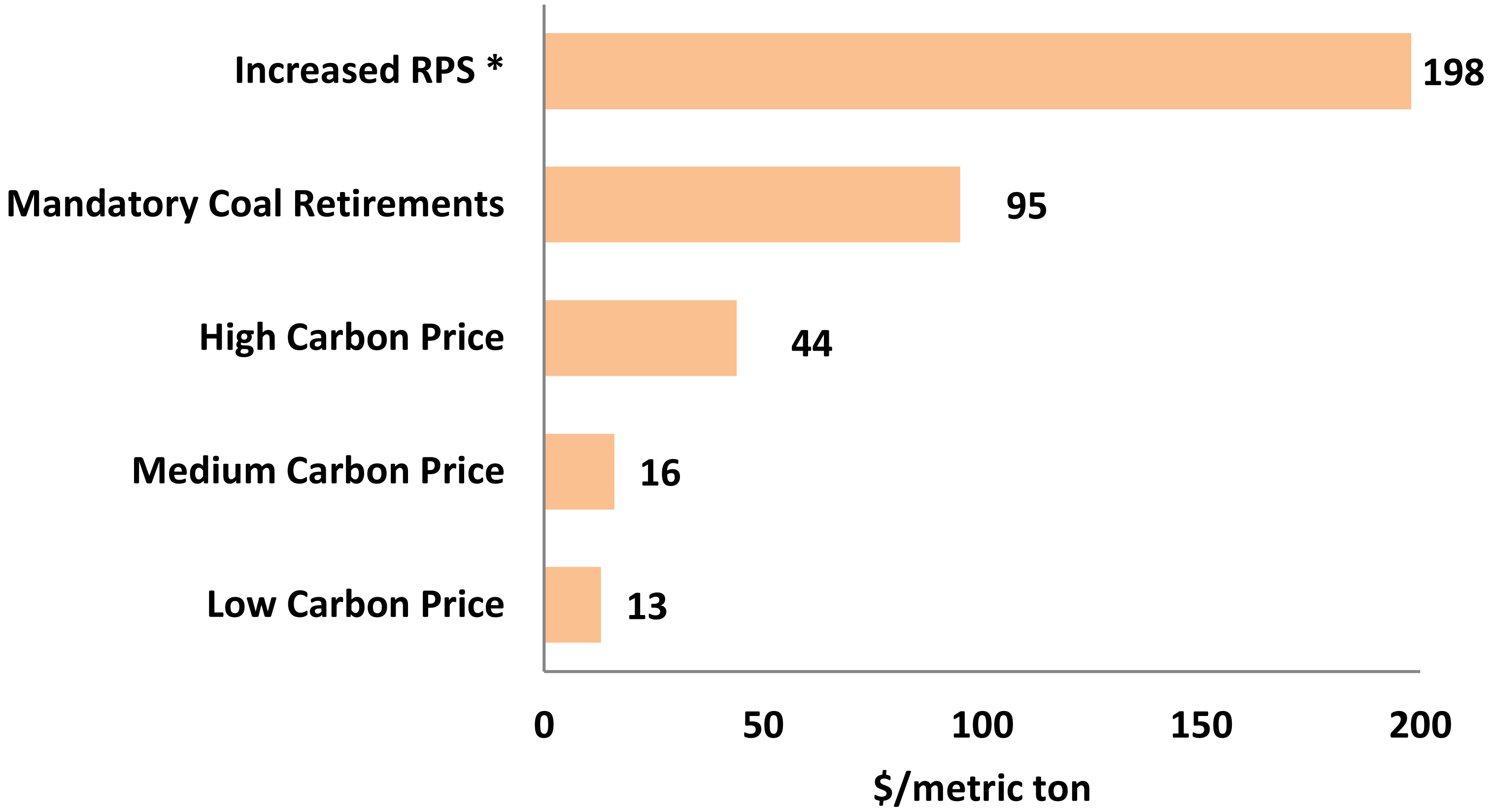


Solar Energy Subsidies



GHG Reduction Option Costs ($/Ton)

Renewable Portfolio Standards are Least Efficient, by Far



2013 IRP Action Plan

John Lyons
Sixth Technical Advisory Committee Meeting
2013 Electric Integrated Resource Plan
June 19, 2013

Generation Resource Related Analysis

- Spokane and Clark Fork River hydro upgrade options in the 2015 IRP.
- Evaluate potential locations for the natural gas-fired resource for 2019, including environmental reviews, transmission studies, and potential land acquisition.
- Continue participation in regional IRP and regional planning processes and monitor regional surplus capacity and continue to participate in regional capacity planning processes.
- Provide status update on the Little Falls and Nine Mile hydroelectric project upgrade progress.

Generation Resource Related Analysis

- Commission a demand response potential and cost assessment of commercial and industrial customers.
- Continue monitoring state and federal climate change policies and report work from Avista's Climate Change Council.
- Review and update the energy forecast methodology to better integrate economic, regional, and weather drivers of energy use.
- Develop short-term (up to 24-months) capacity position report.

Energy Efficiency

- Work with NPCC, the Washington Utilities and Transportation Commission, and others to resolve adjusted market baseline issues for setting energy efficiency target setting and acquisition claims in Washington.
- Study and quantify transmission and distribution efficiency projects as they apply to I-937 goals.
- Update processes and protocols for conservation measurement, evaluation and verification.

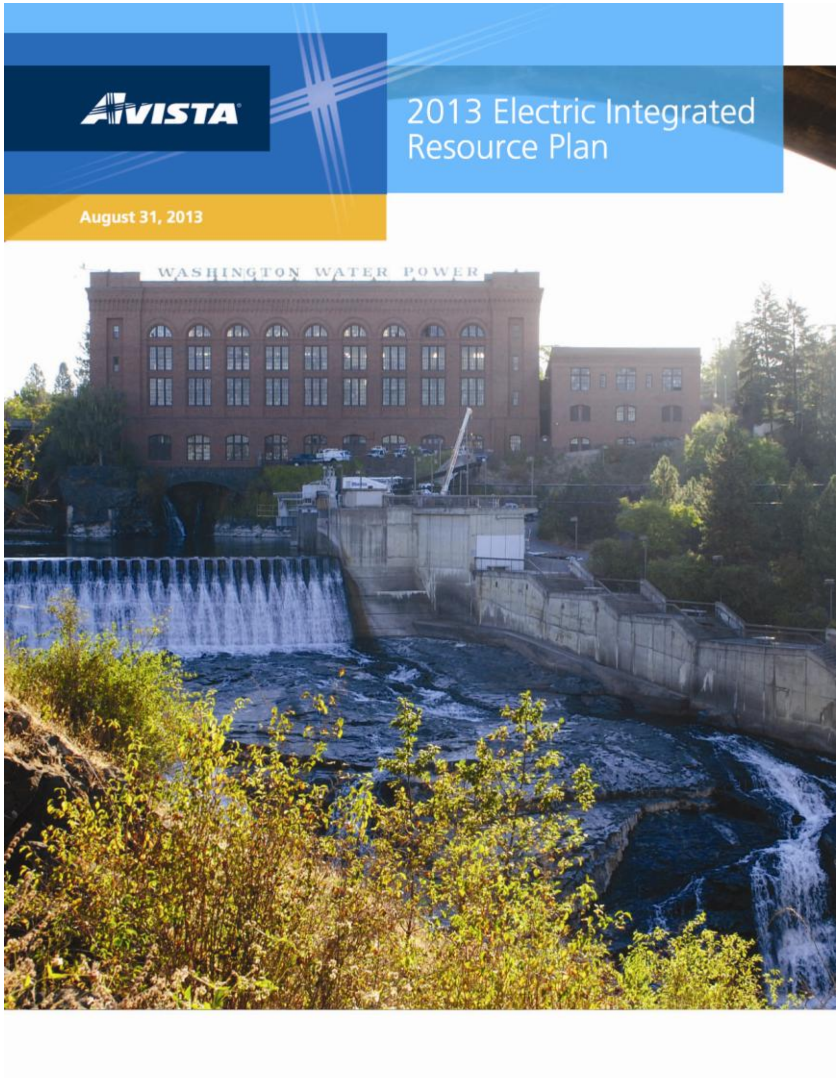
Transmission and Distribution Planning

- 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.

2013 IRP Overview

Clint Kalich
Sixth Technical Advisory Committee Meeting
2013 Electric Integrated Resource Plan
June 19, 2013

Executive Summary



2013 Electric Integrated Resource Plan

August 31, 2013

2013 IRP Chapters

- Executive Summary
- Introduction and Stakeholder Involvement
- Loads & Resources
- Energy Efficiency
- Policy Considerations
- Transmission & Distribution
- Generation Resource Options
- Market Analysis
- Preferred Resource Strategy
- Action Items

Loads & Resources

- The 2013 IRP energy forecast grows 1.0 percent per year, replacing the 1.4 percent annual growth rate from the last IRP.
- Peak load growth is slower than energy growth at, at 0.84 percent in the winter and 0.90 percent in the summer.
- Avista's first long-term capacity deficit is in 2020; the first energy deficit is in 2026.
- Palouse Wind became operational December 13, 2012.
- Kettle Falls qualifies for the Washington State Energy Independence Act beginning in 2016.
- This IRP meets all I-937 mandates over the next 20 years with a combination of qualifying hydro upgrades, Palouse Wind and Kettle Falls.

Energy Efficiency

- This IRP includes a Conservation Potential Assessment of the Company’s Idaho and Washington service territories.
- Current Company-sponsored conservation reduces retail loads by nearly 10 percent, or 115 aMW.
- Avista evaluated over 3,000 equipment options, and over 1,700 measure options covering all major end use equipment, as well as devices and actions to reduce energy consumption for this IRP.

Policy Considerations

- The 2013 IRP does not include a federal cap and trade or greenhouse gas emissions tax in its Expected Case because there is no policy development underway in a regulatory context.
- The impact of potential greenhouse gas policies are addressed through scenario analyses.
- The plan anticipates specific regulatory policies to reduce greenhouse gas emissions.

Transmission & Distribution

- Avista continues to participate in regional planning forums.
- The Spokane Valley Reinforcement Project includes both station update and conductor upgrades.
- A large upgrade project is under construction at the Moscow substation to maintain adequate load service and a Noxon substation rebuild project is in the design phase.
- Five distribution feeder rebuilds are complete since the last IRP; six additional rebuilds are planned for 2014.
- Significant generation interconnection study work at Thornton and Lind stations continues.

Generation Resource Options

- Only resources with well-defined costs and operating histories are in the PRS analysis.
- Wind, solar, and hydro upgrades represent renewable options available to the Company; future RFPs might identify competing renewable technologies.
- Renewable resource costs assume no extensions of state and federal incentives.
- This IRP models battery storage technology as a resource option for the first time in an Avista IRP.
- Upgrades to Avista’s Spokane and Clark Fork River facilities are included as resource options.

Market Analysis

- Gas and wind resources dominate new generation additions in the West.
- Shale gas continues to lower gas and electricity price forecasts.
- A growing Northwest wind fleet reduces springtime market prices below zero in many hours.
- Federal greenhouse gas policy remains uncertain, but new EPA policies point towards a regulatory model rather than a cap-and-trade system.
- Lower natural gas prices and lower loads have reduced greenhouse gas emissions from the US power industry by 11 percent since 2007.

Market Analysis continued

- The Expected Case forecasts a continuing reduction to Western Interconnect greenhouse gas emissions due to coal plant shut downs brought on by EPA regulations.
- Coal plant shut downs have similar carbon reduction results as a cap-and-trade market scheme, but have the advantage of not causing wholesale market price disruptions.

Preferred Resource Strategy

- Avista's first anticipated resource acquisition is a natural gas fired peaker by the end of 2019 to replace expiring contracts and growing loads.
- A combined cycle combustion turbine replaces the Lancaster Facility when its contract ends in 2026.
- The selection of natural gas-fired peaking units is due primarily to their smaller size better fitting Avista's modest resource deficits.
- The Preferred Resource Strategy includes demand response programs for the first time.
- Conservation offsets projected load growth by 42 percent through the 20-year IRP timeframe.

Preferred Resource Strategy continued

- Conservation spending ($711 million) exceeds new generation resource capital spending ($696 million) over the 20-year plan.
- The Colstrip coal plant remains a viable and cost-effective resource throughout the planning horizon, even under scenarios most adverse to the plant.

Remaining 2013 IRP Schedule

- June 23 TAC
- May 2013 – internal draft released at Avista
- June 2013 – external draft released to the TAC
- August 2013 – final editing and printing
- August 31, 2013 – final IRP submission to Commissions and distribution to TAC

- June 19, 2013 TAC meeting
- June 21, 2013 Management review of Internal Draft 2013 IRP complete
- June 26, 2013 distribution of Draft 2013 IRP to TAC participants
- July 24, 2013: External review by TAC complete
- August 30, 2013: 2013 IRP documents sent to the Idaho and Washington Commissions
- August 31, 2013: 2013 IRP available to public, including publication on the Company's web site

2013 Electric Integrated Resource Plan

Appendix B – 2013 Electric IRP Work Plan

Work Plan for Avista's 2013 Electric Integrated Resource Plan

For the
Washington Utilities and Transportation Commission

August 30, 2012

2013 Integrated Resource Planning Work Plan

This Work Plan is submitted in compliance with the Washington Utilities and Transportation Commission's (UTC) Integrated Resource Planning (IRP) rules (WAC 480-100-238). It outlines the process Avista will follow to develop its 2013 Electric IRP. The Company's 2013 Electric IRP will be filed with Washington and Idaho Commissions by August 31, 2013. Avista uses a public process to solicit technical expertise and feedback throughout the development of the IRP through a series of public Technical Advisory Committee (TAC) meetings. Avista held the first TAC meeting for the 2013 IRP on May 23, 2012.

The 2013 IRP process will be similar to those used to produce the previous four published plans. AURORA^{xmp} will be used for electric market price forecasting, resource valuation, and for conducting Monte-Carlo style risk analyses. AURORA^{xmp} modeling results will be used to select the Preferred Resource Strategy (PRS) using Avista's proprietary PRiSM model. This tool is used to determine how to fill future capacity and energy (physical/renewable) deficits with new resources using an efficient frontier approach to evaluate quantitative portfolio risk versus portfolio cost while accounting for environmental laws and regulations. Qualitative risks will be evaluated in separate analyses. 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 its development of the 2013 IRP. The assumptions are based on a combination of Avista's research of similar technologies, engineering studies, and the Northwest Power and Conservation Council's Sixth Power Plan. This plan will study renewable portfolio standards, energy storage, environmental costs, sustained peaking requirements and resource adequacy, energy efficiency programs, and demand response. The 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 potential 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, however input and participation will be needed in a timely manner for appropriate inclusion into the process so the plan can be submitted according to the tentative schedule outlined in this Work Plan.

Topics and meeting times may change depending on the availability of Company staff and requests for additional topics from the TAC members. The tentative timeline and agenda items for Technical Advisory Committee meetings follows:

- **TAC 1 – May 23, 2012:** Powering Our Future game, 2011 Renewable RFP, Palouse Wind Project update, 2011 IRP acknowledgement, Energy Independence Act compliance and forecast, and 2013 IRP Work Plan discussion.

- **TAC 2 (Day 1) – September 4, 2012:** Palouse Wind Project tour.

- **TAC 2 (Day 2) – September 5, 2012:** Avista renewable energy credit planning methods, energy and economic forecasts, 2012 Shared Value Report, generation options, and Spokane River Assessment.

- **TAC 3 – November 7, 2012:** Peak load forecast, reliability planning, Colstrip discussion, energy storage technologies, modeling, and energy efficiency.

- **TAC 4 – February 6, 2013:** Electric and natural gas price forecasts, transmission planning, resource needs assessment, and market and portfolio scenario development.

- **TAC 5 – March 20, 2013:** Draft PRS, review of scenarios and futures, and portfolio analysis

- **TAC 6 – June 19, 2013:** Review of final PRS and action items.

2013 Electric IRP Draft Outline

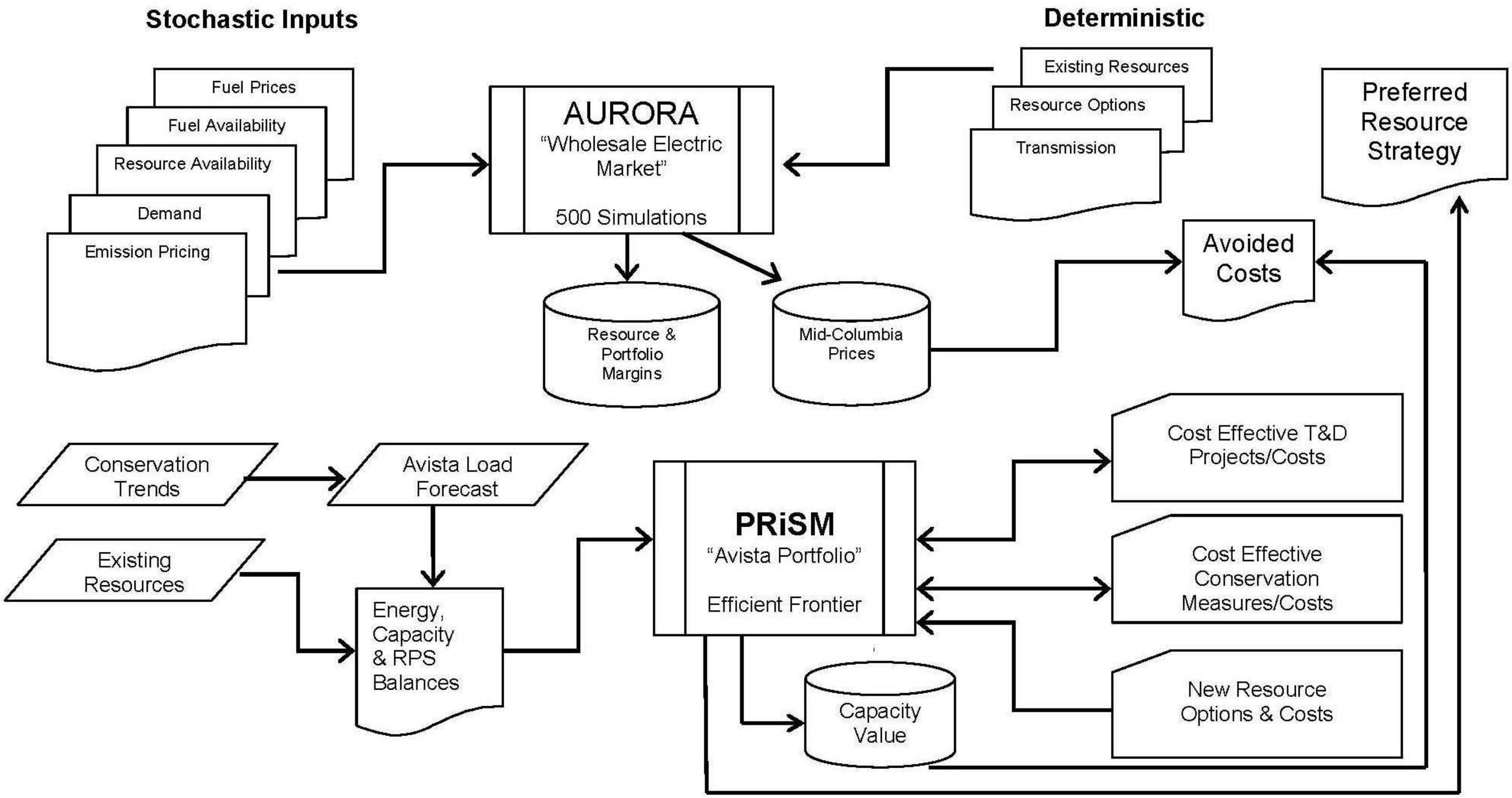
This section provides a draft outline of the major sections in the 2013 Electric IRP. This outline will be updated as IRP studies are completed and input from the Technical Advisory Committee has been received.

1. **Executive Summary**
2. **Introduction and Stakeholder Involvement**
3. **Loads and Resources**
    a. Economic Conditions
    b. Avista Energy & Peak Load Forecast
    c. Load Forecast Scenarios
    d. Avista's Resources and Contracts
    e. Reliability Planning and Reserve Margins
    f. Resource Requirements
4. **Energy Efficiency and Demand Response**
    a. Conservation Potential Assessment
    b. Demand Response Opportunities
    c. Washington State Energy Independence Act
5. **Policy Considerations**
    a. Environmental Concerns
    b. State and Federal Policies
6. **Transmission Planning**
    a. Avista's Transmission System
    b. Future Upgrades and Interconnections
    c. Transmission Construction Costs and Integration
    d. Efficiencies
7. **Generation Resource Options**
    a. New Resource Options
    b. Avista Plant Upgrades
8. **Market Analysis**
    a. Marketplace
    b. Fuel Price Forecasts
    c. Market Price Forecast
    d. Scenario Analysis
9. **Preferred Resource Strategy**
    a. Resource Selection Process
    b. Preferred Resource Strategy
    c. Efficient Frontier Analysis
    d. Avoided Costs
    e. Portfolio Scenarios
    f. Tipping Point Analysis
10. **Action Plan**
    a. 2011 Action Plan Summary
    b. 2013 Action Plan

Exhibit 1: 2013 Electric IRP Timeline

Task	Target Date
Preferred Resource Strategy (PRS)	
Finalize energy forecast	July 2012
Identify regional resource options for electric market price forecast	September 2012
Identify Avista's supply & conservation resource options	September 2012
Finalize peak load forecast	September 2012
Update AURORA^{xmp} database for electric market price forecast	October 2012
Finalize datasets/statistics variables for risk studies	October 2012
Energy efficiency load shapes input into AURORA^{xmp}	October 2012
Final transmission study due	December 2012
Select natural gas price forecast	December 2012
Finalize deterministic base case	December 2012
Base case stochastic study complete	January 2013
Finalize PRiSM model	January 2013
Develop efficient frontier and PRS	January 2013
Simulation of risk studies "futures" complete	February 2013
Simulate market scenarios in AURORA^{xmp}	February 2013
Evaluate resource strategies against market futures and scenarios	March 2013
Present preliminary study and PRS to TAC	March 2013
Writing Tasks	
File 2013 IRP work plan	August 2012
Prepare report and appendix outline	October 2012
Prepare text drafts	April 2013
Prepare charts and tables	April 2013
Internal draft released at Avista	May 2013
External draft released to the TAC	June 2013
Final editing and printing	August 2013
Final IRP submission to Commissions and distribution to TAC	August 31, 2013

Exhibit 2: 2013 Electric IRP Modeling Process



Stochastic Inputs

Fuel Prices

Fuel Availability

Resource Availability

Demand

Emission Pricing

Deterministic

Existing Resources

Resource Options

Transmission

AURORA
"Wholesale Electric Market"
500 Simulations

Resource & Portfolio Margins

Mid-Columbia Prices

Avoided Costs

Preferred Resource Strategy

Conservation Trends

Avista Load Forecast

Existing Resources

Energy, Capacity & RPS Balances

PRiSM
"Avista Portfolio"
Efficient Frontier

Capacity Value

Cost Effective T&D Projects/Costs

Cost Effective Conservation Measures/Costs

New Resource Options & Costs

2013 Electric Integrated Resource Plan

Appendix C – 2013 Electric IRP Avista Electric Conservation Potential Assessment Study

Avista Electric Conservation Potential Assessment Study

Report Number 1341

EnerNOC Utility Solutions Consulting
500 Ygnacio Valley Road
Suite 450
Walnut Creek, CA 94596
Tel: 925.482.2000
www.enernoc.com

Prepared for:
Avista Corporation

Prepared by:
EnerNOC, Inc.

Presented on:
May 30, 2013

This report was prepared by

EnerNOC Utility Solutions
500 Ygnacio Valley Blvd., Suite 450
Walnut Creek, CA 94596

Project Director: I. Rohmund
Project Manager: J. Borstein

EXECUTIVE SUMMARY

Avista Corporation (Avista) engaged EnerNOC Utility Solutions (EnerNOC) to conduct a Conservation Potential Assessment (CPA). The CPA is a 20-year conservation potential study to provide data on conservation resources for developing Avista's 2013 Integrated Resource Plan (IRP), and in accordance with Washington Initiative 937 (I-937). The study updates Avista's last CPA, which EnerNOC performed in 2011. The 2011 CPA used 2009, the first year for which complete billing data was available at the time, as the base year. This update kept 2009 as the base year for the analysis, and calibrated the model used for the assessment to align with actual sales and conservation program achievements for the years 2010–2012.

Study Objectives

The study objectives included:

- Conduct a conservation potential study for electricity for Washington and Idaho. The study accounted for:
  - Impacts of existing Avista conservation programs
  - Impacts of codes and standards
  - Technology developments and innovation
  - The economy and energy prices
- Assess and analyze cost-effective conservation potentials in accordance with the Northwest Power and Conservation Council's (NPPC) Sixth Power Plan methodology and Washington I-937 requirements.
- Obtain supply curves showing the incremental costs associated with achieving higher levels of conservation and stacking efficiency resources by cost of conserved energy.
- Analyze various market penetration rates associated with technical, economic, and achievable potential estimates.

Definitions of Potential

- **Technical potential** is defined as the theoretical upper limit of conservation potential. It assumes that customers adopt all feasible measures regardless of their cost. At the time of existing 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 for electricity in the residential sector include:
  - High-efficiency heat pumps for homes with ducts
  - Ductless mini-split heat pumps for homes without ducts
  - Heat pump water heaters
  - LED lighting

Technical potential also assumes the adoption of every other available measure, where applicable. For example, it includes installation of high-efficiency windows in all new construction opportunities and furnace maintenance in all existing buildings with furnace systems. These retrofit measures are phased in over a number of years, which is longer for higher-cost and complex measures.

- **Economic potential** represents the adoption of all ***cost-effective*** conservation measures. In this analysis, cost-effectiveness is measured by the total resource cost (TRC) test, which compares lifetime energy and capacity benefits to the incremental cost of the measure. If the benefits outweigh the costs (that is, if the TRC ratio is greater than 1.0), a given measure is considered in the economic potential. Customers are then assumed to purchase the most cost-effective option applicable to them at any decision juncture.
- **Achievable potential** takes into account market maturity, customer preferences for energy-efficient technologies, and expected program participation. Achievable potential establishes a realistic target for the conservation savings that a utility can hope to achieve through its programs. It is determined by applying a series of annual market adoption factors to the economic potential for each conservation measure. These factors represent the ramp rates at which technologies will penetrate the market. To develop these factors, the project team reviewed Avista's past conservation program achievements and program history over the last five years, as well as the Northwest Power and Conservation Council (NPCC) ramp rates used in the Sixth Plan. Details regarding the market adoption factors appear in Appendix D.

Study Approach

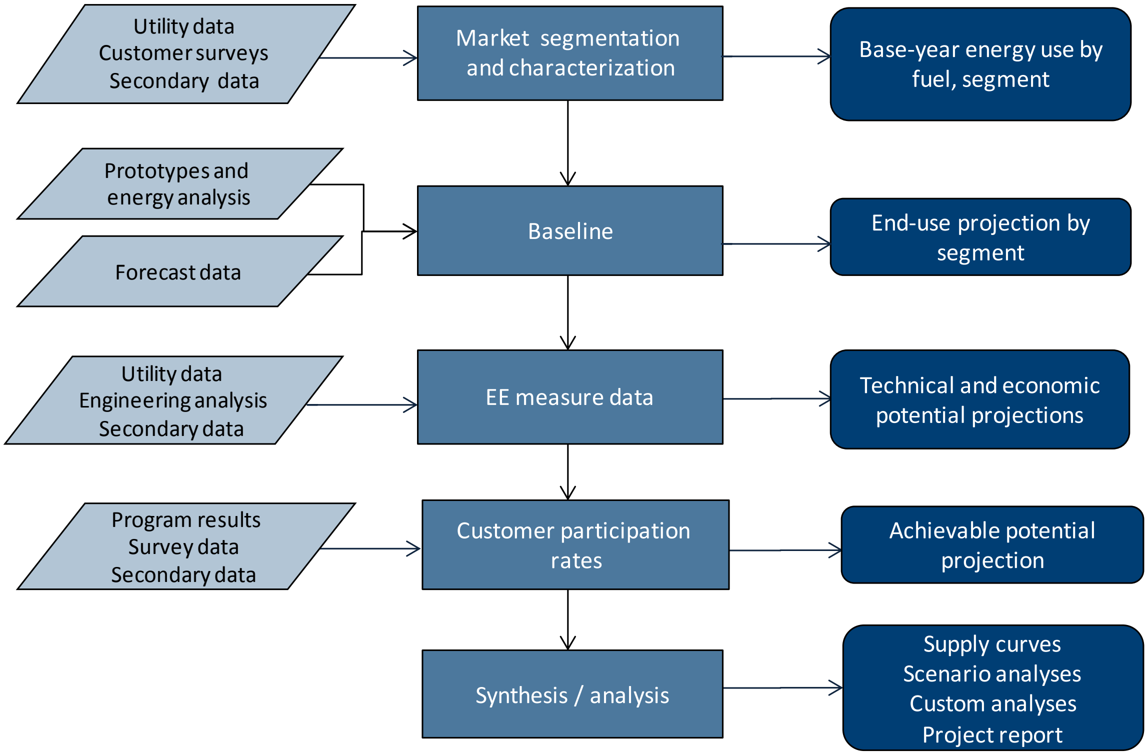
To execute this project, EnerNOC used a bottom-up analysis approach as shown in Figure ES-1. The analysis involved the following steps.

1. Held a meeting with the client project team to refine the objectives.
2. Performed a market characterization to describe sector-level electricity use for the residential and non-residential (commercial and industrial) sectors for the base year, 2009. This step drew upon the market characterization from the 2011 CPA, but updated the characterization to incorporate new information from the Northwest Energy Efficiency Alliance (NEEA) 2012 Residential Building Stock Assessment (RBSA), EnerNOC's own databases and tools, and other secondary data sources such as the American Community Survey (ACS), Northwest Power and Conservation Council (NPCC), and the Energy Information Administration (EIA).
3. Developed a baseline electricity use projection by sector, segment, and end use for 2009 through 2033. The baseline projection is the "business as usual" metric, without new utility conservation programs, against which energy savings from conservation measures are compared. The baseline projection includes the impacts of known codes and standards, as of 2012 when the study was conducted, including the Energy Independence and Security Act (EISA) lighting standards, which phase in during 2012–2014, and the 2010 appliance standards. This baseline projection 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.
4. Identified and characterized conservation measures. Measures to include and data to characterize them were drawn from the Regional Technical Forum measure workbooks, the Sixth Plan, Avista's business plan, its technical reference manual, and EnerNOC's own measure database.
5. Estimated three levels of conservation potential: *Technical, Economic, and Achievable*.

We used EnerNOC's Load Management Analysis and Planning tool (LoadMAP^{TM}) version 3.0 to develop both the baseline projection and the estimates of conservation potential. EnerNOC developed LoadMAP in 2007 and has enhanced it over time, using it for the EPRI National Potential Study and numerous utility-specific forecasting and potential studies.

Details of the approach as well as the data sources used in the study appear in Chapter 2.

Figure ES-1 Overview of Analysis Approach



Market Characterization

During 2009, Avista served 354,615 residential, commercial, industrial, and pumping customers with a combined electricity use of approximately 8,862 GWh. The study segmented these customers by state and rate class as shown in Table ES-1 and Table ES-2. 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 this study, the project team decided not to explicitly model the conservation potential for pumping customers, which represent 2% of load, but instead to use the NPCC Sixth Plan calculator to estimate pumping potential. Results of that calculation appear in Chapter 4. Potential for rate class 25P was also estimated outside of the LoadMAP framework, and thus 25P sales are not included in Table ES-2.

Table ES-1 Electricity Sales and Peak Demand by Rate Class, Washington 2009

Sector / Rate Class	Rate Schedule(s)	Number of meters (customers)	2009 Electricity Sales (GWh)	2009 Peak Demand (MW)
Residential	001	200,134	2,452	710
General Service	011, 012	27,142	416	64
Large General Service	021, 022	3,352	1,557	232
Extra Large Commercial	025C	9	266	134
Extra Large Industrial	025I	13	614	
Pumping	031, 032	2,361	136	10
Total		**233,011**	**5,440**	**1,150**

Table ES-2 Electricity Sales and Peak Demand by Rate Class, Idaho 2009

Sector / Rate Class	Rate Schedule(s)	Number of meters (customers)	2009 Electricity Sales (MWh)	2009 Peak Demand (MW)
Residential	001	99,580	1,182	283
General Service	011, 012	19,245	323	61
Large General Service	021, 022	1,456	700	115
Extra Large Commercial	025C	3	70	140
Extra Large Industrial	025I	6	196	
Pumping	031, 032	1,312	59	4
Total		**121,602**	**2,530**	**603**

Note: Excludes sales to rate class 25P.

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).

Figure ES-2 presents the residential end-use breakout in terms of intensity, kWh/household-year, by segment for Washington and Idaho combined. Space heating is the largest single use in all housing types, accounting for 29% of residential use overall. In three of the four segments, appliances are the second largest energy consumer, followed by water heating and then interior lighting. The exception is multi family housing, where water heating is the second largest end use while appliances are the third largest end use, due to a high saturation of electric water heating compared with the other segments. Across all housing types, interior and exterior lighting combined represents 14% of electricity use in 2009. Electronics, which includes personal computers, televisions, home audio, video game consoles, etc., is 8% of residential electricity usage. The miscellaneous end use includes such devices as furnace fans, pool pumps, and other plug loads (hair dryers, power tools, coffee makers, etc.).

Figure ES-2 Residential Intensity by End Use and Segment (kWh/household, 2009)

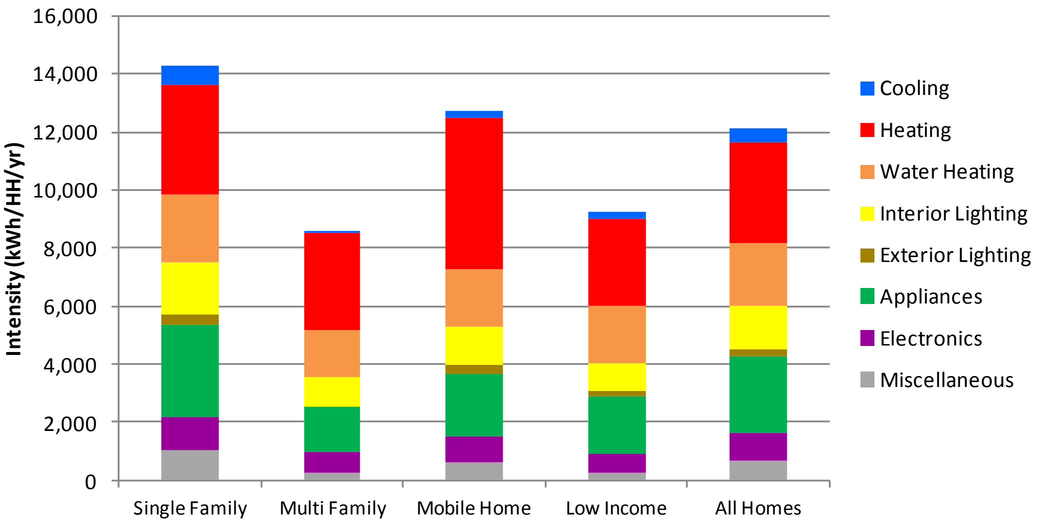
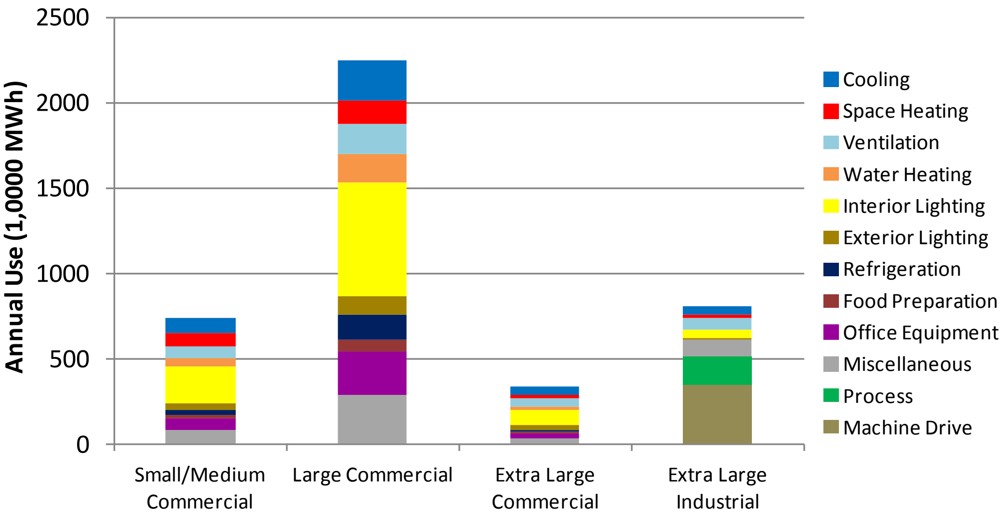


Figure 3-6 displays the breakdown of energy use by segment within the C&I sector. Lighting is the largest single energy use across all of the commercial buildings, accounting for 34% of energy use, followed by HVAC with 27% of use. For the extra large industrial customers, machine drive and process loads dominate, together accounting for 64% of energy use.

Figure ES-3 C&I Electricity Consumption by End Use and Segment (2009)



This market characterization is further detailed in Chapter 3.

Conservation Potential Results

All results below show cumulative potential, indicating how a measure installed in one year continues to provide savings in subsequent years through the end of its useful measure life. Incremental annual results appear in Appendix E. Figure ES-4 and Table ES-3 summarize the achievable potential. The C&I sector accounts for the about 55% of the savings initially, and over time its share of savings grows to around 60%.

Figure ES-4 Cumulative Achievable Potential by Sector (MWh)

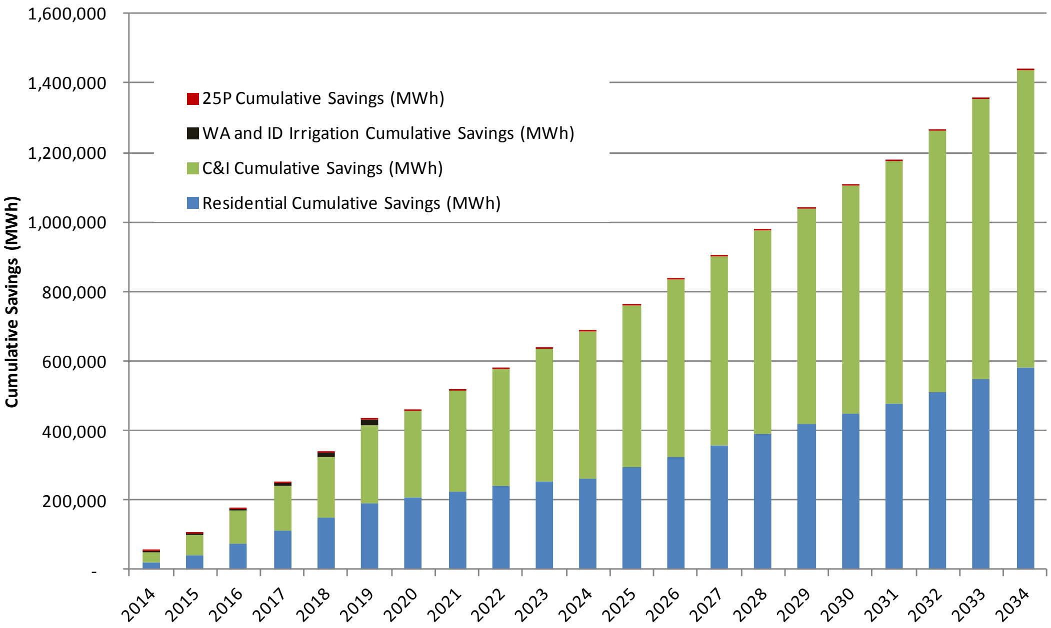


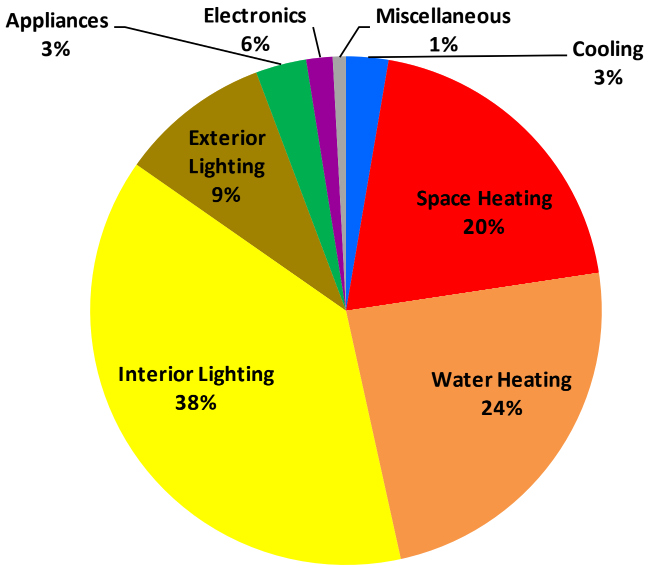
Table ES-3 Cumulative Achievable Potential by State and Sector (MWh)

	2014	2015	2018	2023	2028	2033
Washington Achievable Cumulative Savings (MWh)						
Residential	15,091	29,603	100,792	172,576	266,751	369,293
C&I	19,927	40,930	123,755	256,653	392,186	543,380
Pumping	1,402	3,237	8,742	10,535	10,535	10,535
Total	**36,420**	**73,770**	**233,289**	**439,764**	**669,472**	**923,208**
Washington Achievable Cumulative Savings (aMW)						
Residential	1.7	3.4	11.5	19.7	30.5	42.2
C&I	2.3	4.7	14.1	29.3	44.8	62.0
Pumping	0.2	0.4	1.0	1.2	1.2	1.2
Total	**4.2**	**8.4**	**26.6**	**50.2**	**76.4**	**105.4**
	2014	**2015**	**2018**	**2023**	**2028**	**2033**
Idaho Achievable Cumulative Savings (MWh)						
Residential	6,757	13,183	46,795	79,385	125,347	177,826
C&I	8,863	16,427	53,214	124,987	192,518	261,813
Pumping	618	1,426	3,852	4,642	4,642	4,642
Total	**16,238**	**31,036**	**103,861**	**209,014**	**322,507**	**444,281**
Idaho Achievable Cumulative Savings (aMW)						
Residential	0.8	1.5	5.3	9.1	14.3	20.3
C&I	1.0	1.9	6.1	14.3	22.0	29.9
Pumping	0.1	0.2	0.4	0.5	0.5	0.5
Total	**1.9**	**3.5**	**11.9**	**23.9**	**36.8**	**50.7**
	2014	**2015**	**2018**	**2023**	**2028**	**2033**
Washington and Idaho Achievable Cumulative Savings (MWh)						
Residential	21,848	42,786	147,588	251,961	392,098	547,119
C&I	28,790	57,357	176,969	381,640	584,703	805,193
Pumping	2,020	4,663	12,593	15,177	15,177	15,177
Total	**52,657**	**104,806**	**337,150**	**648,778**	**991,979**	**1,367,490**
Washington and Idaho Achievable Cumulative Savings (aMW)						
Residential	2.5	4.9	16.8	28.8	44.8	62.5
C&I	3.3	6.5	20.2	43.6	66.7	91.9
Pumping	0.2	0.5	1.4	1.7	1.7	1.7
Total	**6.0**	**12.0**	**38.5**	**74.1**	**113.2**	**156.1**

Figure ES-5 presents the residential cumulative achievable potential in 2018 by end use. We note the following:

- **Lighting**, primarily the conversion of both interior and exterior lamps to compact fluorescent lamps in the first few years, followed by LEDs for exterior lighting stating in 2015 and for interior lighting starting in 2017, represents 70,446 MWh or 47% of savings. Utility programs and other market transformation programs have made customers accepting of new lighting technologies, and thus these technologies are relatively well accepted by consumers.
- **Water heating** is the next highest source of achievable potential. As discussed above, water heating provides the largest economic potential, but the market for heat pump water heaters remains immature, and thus the uptake of this technology is limited in the near term. Although conversion to gas water heating is a mature technology and readily accepted, customers may be unable to convert at the time of replacement due to timing issues or other considerations.
- **Space heating** provides 20% of achievable potential mainly due to electric furnaces being converted to gas units, and resistance heating being displaced by ductless heat pumps.

Figure ES-5 Residential Cumulative Achievable Potential by End Use in 2018



As shown in Figure ES-6, the primary sources of C&I sector achievable savings in 2018 are as follows:

- Interior and exterior lighting, comprising lamps, fixtures, and controls, account for 64% of C&I sector achievable potential. Not only is economic potential high for lighting measures, but they are more readily accepted and implemented in the market than many other, higher cost and more complex measures.
- Office Equipment, which is the second largest portion of this sector's achievable potential (11%)
- Water heating and Ventilation each provides 6% of the total savings

Figure ES-6 ***C&I Cumulative Achievable Potential Cumulative Savings by End Use in 2018 (percentage of total)***

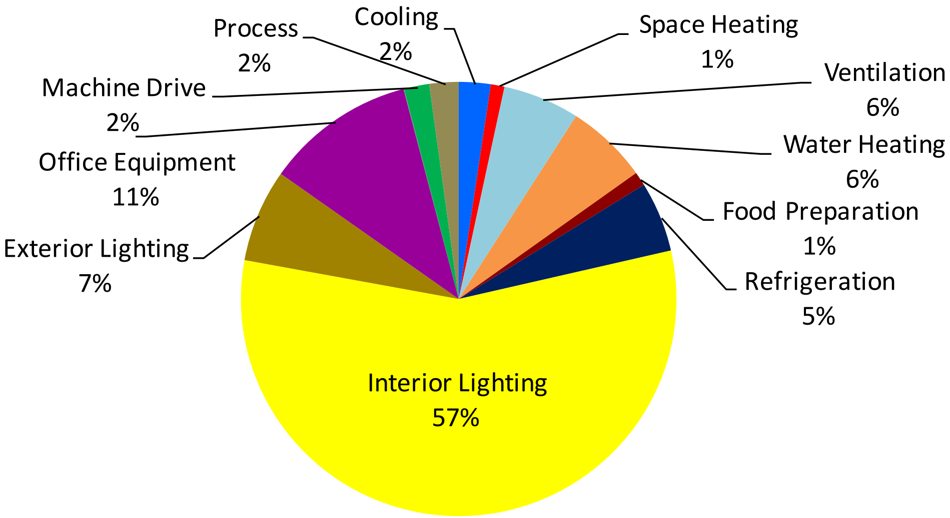


Table ES-4 summarizes the potential, by state and for the overall service territory, for selected years. For pumping and rate class 25P, only achievable potential was calculated. Economic and technical potential for these two relatively small rate classes were assumed to be equal to achievable potential. Figure ES -7 presents this information graphically.

Key findings related to cumulative conservation potentials are as follows.

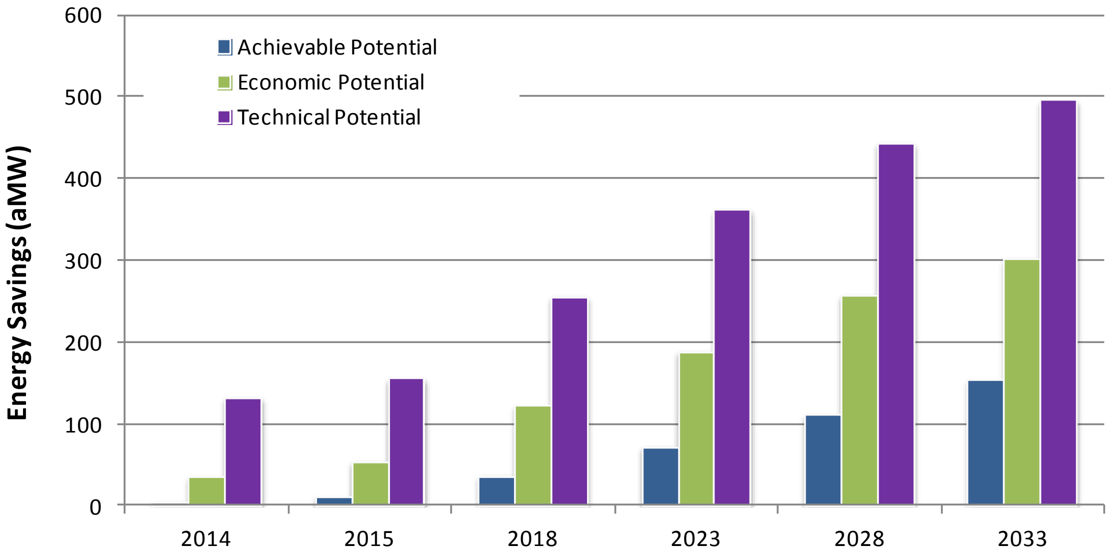
- **Achievable potential**, for the residential, commercial, and industrial sectors is 100,143 MWh or 11.4 aMW for the 2014–2015 biennium. With the addition of pumping, achievable potential is 12.0 aMW for the 2014-2015 biennium and increases to 156.1 aMW by 2033. Washington provides approximately 70% of the potential in most years. Over the 2014–2033 period, the achievable potential forecast offsets 39% of the overall growth in the residential and C&I combined baseline projections.
- **Economic potential**, which reflects the savings when all cost-effective measures are taken, is 480,967 MWh or 54.9 aMW for2014–2015. By 2033, economic potential reaches 304.5 aMW.
- **Technical potential**, which reflects the adoption of all conservation measures regardless of cost-effectiveness, is a theoretical upper bound on savings. For 2014–2015, technical potential savings are 1,372,283 MWh or 156.7 aMW. By 2033, technical potential reaches 497.2 aMW.

Table ES-4 Summary of Cumulative Conservation Potential

	2014	2015	2018	2023	2028	2033
Washington Cumulative Savings (MWh)						
Achievable Potential	36,420	73,770	233,289	439,764	669,472	923,208
Economic Potential	214,944	329,262	741,547	1,131,761	1,539,860	1,807,576
Technical Potential	794,447	941,497	1,550,783	2,212,885	2,704,067	3,024,259
Washington Cumulative Savings (aMW)						
Achievable Potential	4.2	8.4	26.6	50.2	76.4	105.4
Economic Potential	24.5	37.6	84.7	129.2	175.8	206.3
Technical Potential	90.7	107.5	177.0	252.6	308.7	345.2
Idaho Cumulative Savings (MWh)						
Achievable Potential	16,238	31,036	103,861	209,014	322,507	444,281
Economic Potential	101,779	151,705	350,121	538,404	734,193	859,791
Technical Potential	368,926	430,787	700,966	975,464	1,195,587	1,330,893
Idaho Cumulative Savings (aMW)						
Achievable Potential	1.9	3.5	11.9	23.9	36.8	50.7
Economic Potential	11.6	17.3	40.0	61.5	83.8	98.1
Technical Potential	42.1	49.2	80.0	111.4	136.5	151.9
Total Washington and Idaho Cumulative Savings (MWh)						
Achievable Potential	52,657	104,806	337,150	648,778	991,979	1,367,490
Economic Potential	316,722	480,967	1,091,669	1,670,165	2,274,053	2,667,367
Technical Potential	1,163,373	1,372,283	2,251,749	3,188,349	3,899,655	4,355,152
Total Washington and Idaho Cumulative Savings (aMW)						
Achievable Potential	6.0	12.0	38.5	74.1	113.2	156.1
Economic Potential	36.2	54.9	124.6	190.7	259.6	304.5
Technical Potential	132.8	156.7	257.0	364.0	445.2	497.2

Note: For pumping and rate class 25P, only achievable potential was calculated and thus economic and technical potential were assumed to be equal to achievable potential for these two rate classes.

Figure ES -7 Summary of Cumulative Energy Savings, Residential and C&I



Note: Excludes pumping and 25P.

Chapter 4 provides additional detail by sector and segment.

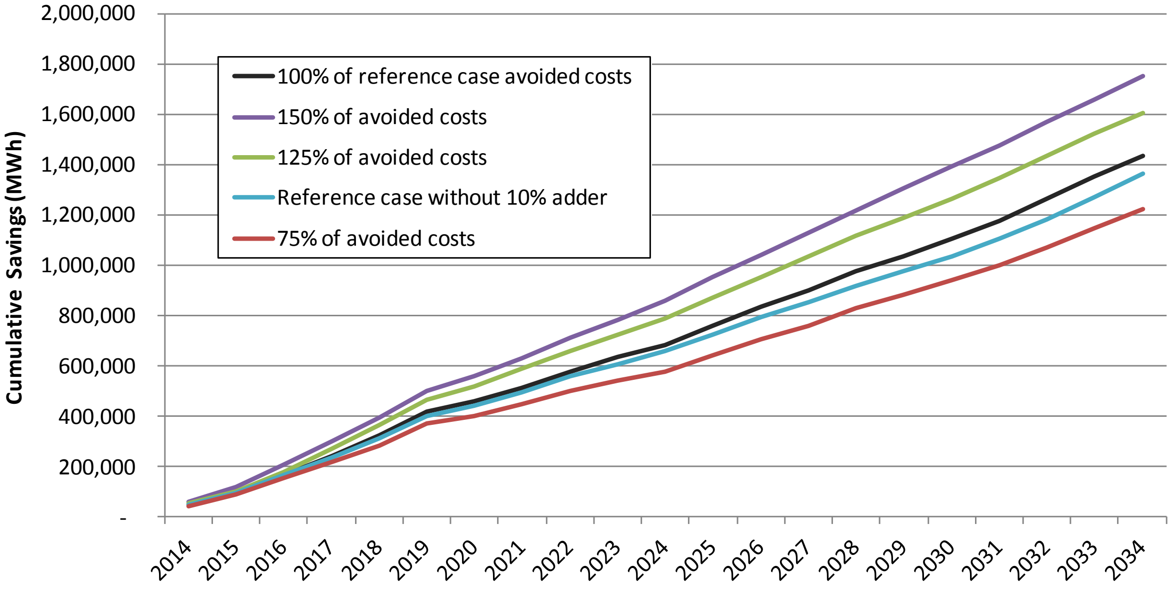
Sensitivity of Potential to Avoided Cost

Similar to the 2011 CPA, EnerNOC modeled several scenarios with varying levels of avoided costs in addition to the reference case. For this study's purposes, we have included a case where the 10% adder per NW Power and Conservation Act is removed. The other scenarios included 150%, 125%, and 75% of the avoided costs used in the reference case. Figure ES-8 and Table ES-5 show how achievable potential varies under the four scenarios.

- The reference case achievable potential reaches approximately at 1,352,291 MWh by 2033.
- Removing the 10% adder from the avoided costs decreased this achievable potential to 1,272,206 MWh, 6% reduction.
- With the 150% avoided cost case, achievable potential increased to 1,657,741 MWh (23% increase from reference) while the 125% avoided cost case and the 75% avoided cost case yielded achievable potential equal to 1,521,856 (13% increase) and 1,146,105 MWh (15% decrease) respectively.

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 achievable potential. Technical potential imposes a limit on the amount of additional conservation and each incremental unit of DSM becomes increasingly expensive.

Figure ES-8 Energy Savings, Cumulative Achievable Potential by Avoided Costs Scenario (MWh)



Note: Excludes pumping and 25P.

Table ES-5 Achievable Potential with Varying Avoided Costs

End Use	Reference Scenario	Remove 10% adder	75% of avoided costs	125% of avoided costs	150% of avoided costs
Achievable potential savings 2033 (MWh)	1,352,291	1,272,206	1,146,105	1,521,856	1,657,741
Percentage change in savings vs. 100% avoided cost Scenario		-6%	-15%	13%	23%

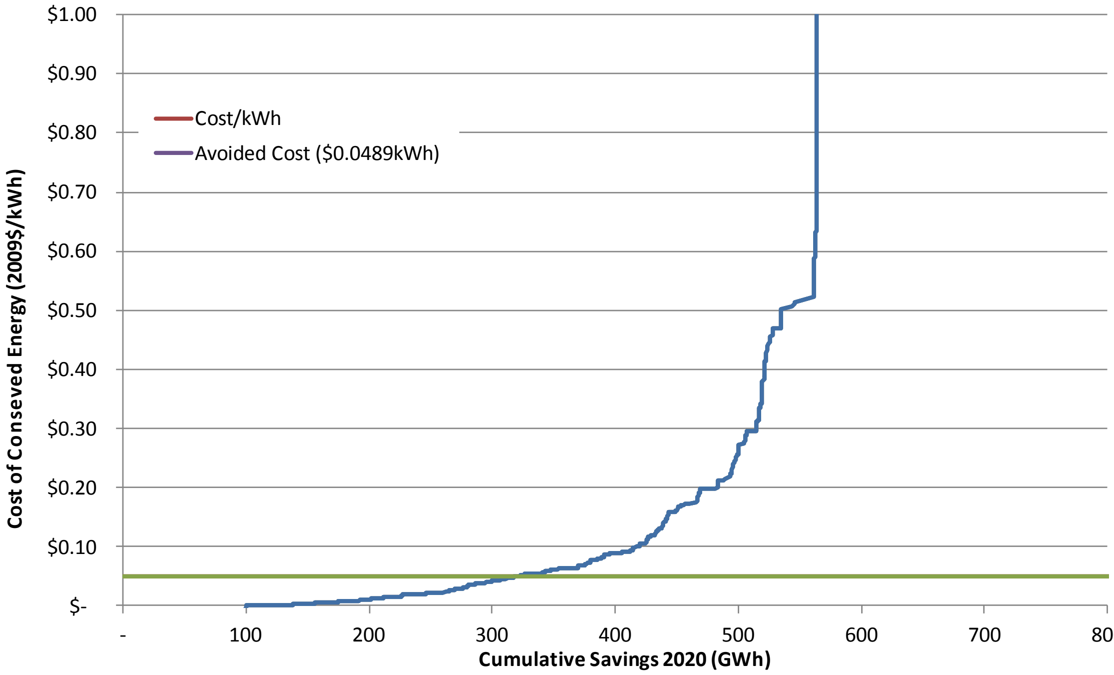
Note: Excludes pumping and 25P.

Supply Curves

The project also developed supply curves for each year to support the IRP process. At Avista’s request, the supply curves did not consider economic screening based on Avista’s avoided costs. Instead, all measures were included and the amount of savings from each measure in each year was limited by the ramp rates used for achievable potential. The supply curves do not include the savings from electricity to natural gas fuel switching, discussed above.

A sample supply curve for one year is shown in Figure ES-9. This 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 supply curve also shows that substantial savings are available at low- or no-cost.

Figure ES-9 Supply Curves for Evaluated EE Measures and Avoided Cost Scenarios



Note: Excludes pumping and 25P.

Washington Potential Excluding Conversions to Natural Gas

Avista has a history of fuel switching from electricity to natural gas and continues to target direct use as the most efficient resource option when available. The conservation potential reported above includes savings potential attributable to conversion of electric space and water heating to natural gas. However, fuel efficiency is not considered in the NPCC Sixth Plan, and thus potential due to fuel conversions is not included in Avista's conservation target consistent with Washington I-937. Washington potential consistent with the NPCC Conservation Plan methodology appears in Table ES -6. The energy efficiency target illustrated in Table ES-6, in addition to Avista's distribution efficiency target, make up the I-397 target that will be filed in Avista upcoming Biennial Conservation Plan for the 2014–2015 biennium.

Table ES -6 Washington Cumulative Potential Consistent with Conservation Plan Methodology

	2014	2015	2018	2023
Cumulative Savings (MWh)				
Residential	15,091	29,603	100,792	172,576
Commercial and Industrial	19,927	40,930	123,755	256,653
Pumping	1,402	3,237	8,742	0
Conversions to Natural Gas	(3,148)	(6,633)	(16,827)	(35,028)
Total	**33,272**	**67,137**	**216,462**	**394,200**
Cumulative Savings (aMW)				
Residential	1.72	3.38	11.51	19.70
Commercial and Industrial	2.27	4.67	14.13	29.30
Pumping	0.16	0.37	1.00	0.00
Conversions to Natural Gas	(0.36)	(0.76)	(1.92)	(4.00)
Total	**3.80**	**7.66**	**24.71**	**45.00**

Additional details on potential by sector and segment appear in Chapter 4. A second volume provides appendices with supporting information and additional results.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER | 1

INTRODUCTION

Background

Avista Corporation (Avista) engaged EnerNOC Utility Solutions (EnerNOC) to conduct a Conservation Potential Assessment (CPA). The CPA is a 20-year conservation potential study to provide data on conservation resources for developing Avista's 2013 Integrated Resource Plan (IRP), and in accordance with Washington Initiative 937 (I-937). The study updates Avista's last CPA, which EnerNOC performed in 2011. The 2011 CPA used 2009, the first year for which complete billing data was available at the time, as the base year. This update kept 2009 as the base year for the analysis, and calibrated the model used for the assessment to align with actual sales and conservation program achievements for the years 2010–2012.

Report Organization

This remainder of this report is presented in three chapters as outlined below.

- Chapter 2 — Analysis Approach and Data Development
- Chapter 3 — Market Characterization and Market Profiles
- Chapter 4 — Conservation Potential

Definition of Potential

In this study, we estimate the potential for conservation savings. The savings estimates represent gross savings developed into three types of potential: technical potential, economic potential, and achievable potential. Technical and economic potential are both theoretical limits to conservation 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. The various levels are described below.

- **Technical potential** is defined as the theoretical upper limit of conservation potential. It assumes that customers adopt all feasible measures regardless of their cost. At the time of existing 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 for electricity in the residential sector include:
    - High-efficiency heat pumps for homes with ducts
    - Ductless mini-split heat pumps for homes without ducts
    - Heat pump water heaters
    - LED lighting

Technical potential also assumes the adoption of every other available measure, where applicable. For example, it includes installation of high-efficiency windows in all new construction opportunities and furnace maintenance in all existing buildings with furnace systems. These retrofit measures are phased in over a number of years, which is longer for higher-cost and complex measures.

- **Economic potential** represents the adoption of all ***cost-effective*** conservation measures. In this analysis, cost-effectiveness is measured by the total resource cost (TRC) test, which compares lifetime energy and capacity benefits to the incremental cost of the measure. If the benefits outweigh the costs (that is, if the TRC ratio is greater than 1.0), a given measure is considered in the economic potential. Customers are then assumed to purchase the most cost-effective option applicable to them at any decision juncture.

- **Achievable potential** takes into account market maturity, customer preferences for energy-efficient technologies, and expected program participation. Achievable potential establishes a realistic target for the conservation savings that a utility can hope to achieve through its programs. It is determined by applying a series of annual market adoption factors to the economic potential for each conservation measure. These factors represent the ramp rates at which technologies will penetrate the market. To develop these factors, the project team reviewed Avista's past conservation program achievements and program history over the last five years, as well as the Northwest Power and Conservation Council (NPCC) ramp rates used in the Sixth Plan. Details regarding the market adoption factors appear in Appendix D.

Abbreviations and Acronyms

Throughout the report we use several abbreviations and acronyms. Table 1-1 shows the abbreviation or acronym, along with an explanation.

Table 1-1 Explanation of Abbreviations and Acronyms

Acronym	Explanation
ACS	American Community Survey
AEO	Annual Energy Outlook forecast developed annual by the Energy Information Administration of the DOE
B/C Ratio	Benefit to cost ratio
BEST	EnerNOC's Building Energy Simulation Tool
CAC	Central air conditioning
C&I	Commercial and industrial
CBECS	Commercial Building Energy Consumption Survey (prepared by EIA)
CBSA	NEAA Commercial Building Stock Assessment
CFL	Compact fluorescent lamp
DEEM	EnerNOC's Database of Energy Efficiency Measures
DEER	State of California Database for Energy-Efficient Resources
DSM	Demand side management
EE	Energy efficiency
EIA	Energy Information Administration
EISA	Energy Efficiency and Security Act of 2007
EPACT	Energy Policy Act of 2005
EPRI	Electric Power Research Institute
EUI	Energy-use index
HH	Household
HID	High intensity discharge lamps
HPWH	Heat pump water heater
IRP	Integrated Resource Plan
LED	Light emitting diode lamp
LoadMAP	EnerNOC's Load Management Analysis and Planning^{TM} tool
MECS	Manufacturing Energy Consumption Survey (prepared by EIA)
NEEA	Northwest Energy Efficiency Alliance
NPCC	Northwest Power and Conservation Council
RTF	Regional Technical Forum
RASS	California Residential Appliance Saturation Survey
CEUS	California Commercial End-Use Survey
REEPS	EPRI Residential End-use Energy Planning System
COMMEND	EPRI COMMercial END-use planning system
RBSA	NEAA Residential Building Stock Assessment
RECS	Residential Energy Consumption Survey (prepared by EIA)
RTU	Roof top unit
Sq. ft.	Square feet
TRM	Technical Reference Manual
TRC	Total resource cost
UEC	Unit energy consumption
UES	Unit energy savings (as defined in RTF measure workbooks)

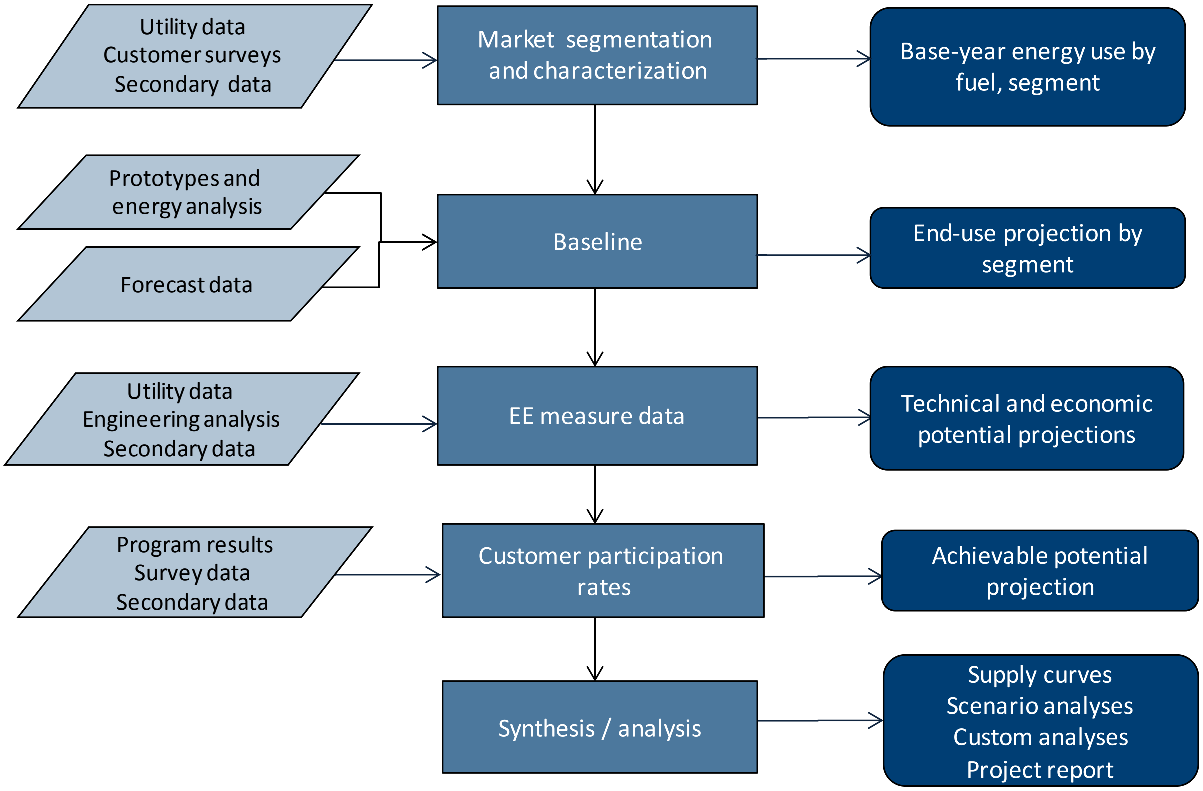
ANALYSIS APPROACH AND DATA DEVELOPMENT

This section describes the analysis approach taken for the study and the data sources used to develop the potential estimates.

Analysis Approach

To perform the conservation potential analysis, EnerNOC used a bottom-up analysis approach as shown in Figure 2-1.

Figure 2-1 Overview of Analysis Approach



The analysis involved the following steps.

1. Held a meeting with the client project team to refine the objectives of the project in detail. This resulted in a work plan for the study.
2. Performed a market characterization to describe sector-level electricity use for the residential and non-residential (commercial and industrial) sectors for the base year, 2009. This step drew upon the market characterization from the 2011 CPA, but updated the characterization to incorporate new information from the Northwest Energy Efficiency Alliance (NEEA) 2012 Residential Building Stock Assessment (RBSA), EnerNOC's own databases and tools, and other secondary data sources such as the American Community Survey (ACS), Northwest Power and Conservation Council (NPCC), and the Energy Information Administration (EIA).
3. Developed a baseline electricity use projection by sector, segment, and end use for 2009 through 2033.

4. Identified and characterized conservation measures.
5. Estimated three levels of conservation potential: measure-level conservation potential: *Technical, Economic, and Achievable*.

The analysis approach for all these steps is described in further detail throughout the remainder of this chapter.

LoadMAP Model

We used EnerNOC's Load Management Analysis and Planning tool (LoadMAP™) version 3.0 to develop both the baseline forecast and the estimates of conservation potential. EnerNOC developed LoadMAP in 2007 and has enhanced it over time, using it for the EPRI National Potential Study and numerous utility-specific forecasting and potential studies. Built in Excel, the LoadMAP framework, illustrated in Figure 2-1, is both accessible and transparent and has the following key features.

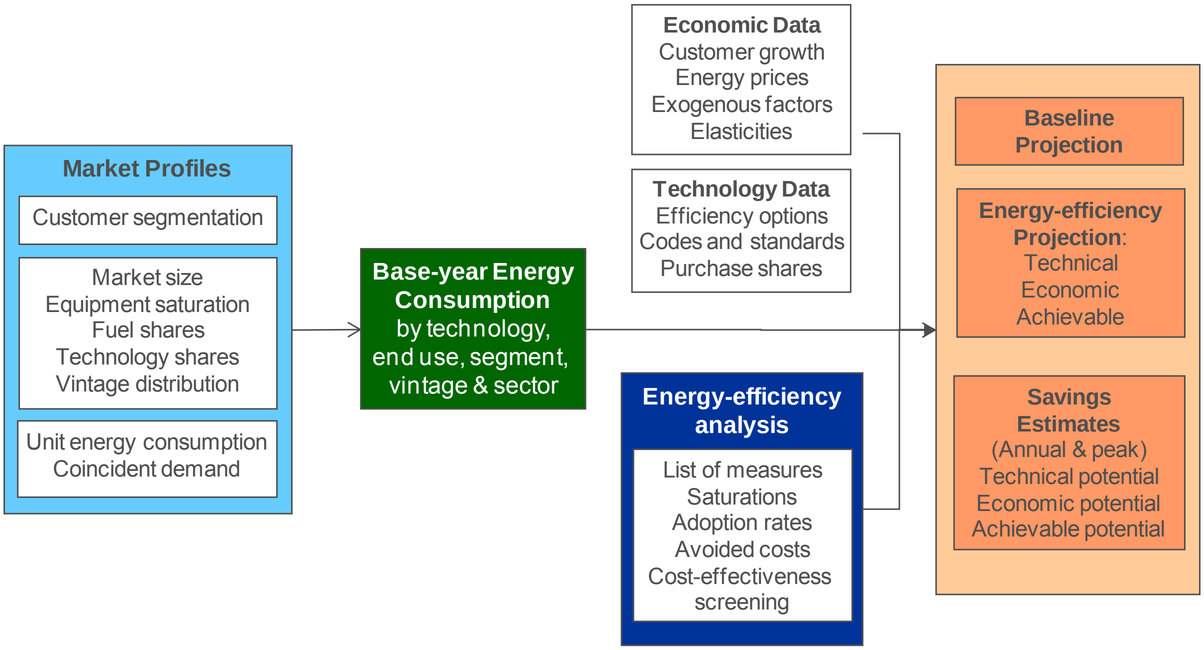
- Embodies the basic principles of rigorous end-use models (such as EPRI's REEPS and COMMEND) but in a more simplified, accessible form.
- Includes stock-accounting algorithms that treat older, less efficient appliance/equipment stock separately from newer, more efficient equipment. Equipment is replaced according to the measure life and appliance vintage distributions 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 and existing buildings separately.
- Uses a simple logic for appliance and equipment decisions. LoadMAP 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 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 below, the LoadMAP model provides projections of baseline energy use by sector, segment, end use, and technology for existing and new buildings. It also provides projections of total energy use and conservation savings associated with the three types of potential.[1]

---

[1] The model computes energy and peak-demand forecasts for each type of potential for each end use as an intermediate calculation. Annual-energy and peak-demand savings are calculated as the difference between the value in the baseline forecast and the value in the potential forecast (e.g., the technical potential forecast).

Figure 2-2 LoadMAP Analysis Framework



Market Characterization

In order to estimate the savings potential from conservation measures, it is necessary to understand how much energy is used today and what equipment is currently being used. This characterization begins with a segmentation of Avista's energy footprint to quantify energy use by sector, segment, fuel, end-use application, and the current set of technologies used. We incorporate information from the secondary research sources to advise the market characterization.

Segmentation for Modeling Purposes

The market assessment first defined the market segments (building types, end uses and other dimensions) that are relevant in the Avista service territory. The segmentation scheme for this project is presented in Table 2-1, and is the same as that used in the 2011 CPA.

Table 2-1 Overview of Segmentation Scheme for Potentials Modeling

Market Dimension	Segmentation Variable	Dimension Examples
1	Sector	Residential, commercial and industrial
2	Building type	Residential (single family, multi family, mobile home, low income) Commercial and Industrial (small/medium commercial, large commercial, extra large commercial, extra large industrial)
3	Vintage	Existing and new construction
4	Fuel	Electricity
5	End uses	Cooling, space heating, lighting, water heat, motors, etc. (as appropriate by sector)
6	Appliances/end uses and technologies	Technologies such as lamp type, air conditioning equipment, motors by application, etc.
7	Equipment efficiency levels for new purchases	Baseline and higher-efficiency options as appropriate for each technology

Following this scheme, the residential sector was segmented as described below, starting with customer segments by building type:

- Single family
- Multi family
- Mobile home
- Low income

In addition to segmentation by housing type, we identified the set of end uses and technologies that are appropriate for Avista's residential sector. These are shown in Table 2-2.

Table 2-2 Residential Electric End Uses and Technologies

End Use	Technology
Cooling	Central Air Conditioning (CAC)
Cooling	Room Air Conditioning (RAC)
Cooling/Space Heating	Air-Source Heat Pump
Cooling/Space Heating	Geothermal Heat Pump
Space Heating	Electric Resistance
Space Heating	Electric Furnace
Space Heating	Supplemental
Water Heating	Water Heater <= 55 gal
Water Heating	Water Heater > 55 gal
Interior Lighting	Screw-in Lamps
Interior Lighting	Linear Fluorescent Lamps
Interior Lighting	Specialty
Exterior Lighting	Screw-in Lamps
Appliances	Clothes Washer
Appliances	Clothes Dryer
Appliances	Dishwasher
Appliances	Refrigerator
Appliances	Freezer
Appliances	Second Refrigerator
Appliances	Stove
Appliances	Microwaves
Electronics	Personal Computers
Electronics	TVs
Electronics	Set-top Boxes/DVR
Electronics	Devices and Gadgets
Miscellaneous	Pool Pump
Miscellaneous	Furnace Fan
Miscellaneous	Miscellaneous

For the commercial and industrial sector (C&I), we segmented the market based on Avista's rate classes, using the following segments.

- Small/medium Commercial
- Large Commercial
- Extra Large Commercial
- Extra Large Industrial

The set of end uses and technologies for the C&I sector appear in Table 2-3.

Table 2-3 C&I Electric End Uses and Technologies

End Use	Technology
Cooling	Central Chiller
Cooling	Roof top AC
Cooling/Heating	Heat Pump
Space Heating	Electric Resistance
Space Heating	Electric Furnace
Ventilation	Ventilation
Water Heating	Water Heater
Interior Lighting	Screw-in
Interior Lighting	High-Bay Fixtures
Interior Lighting	Linear Fluorescent
Exterior Lighting	Exterior Screw-in
Exterior Lighting	HID
Refrigeration	Walk-in Refrigerator
Refrigeration	Reach-in Refrigerator
Refrigeration	Glass Door Display
Refrigeration	Open Display Case
Refrigeration	Icemaker
Refrigeration	Vending Machine
Food Preparation	Oven
Food Preparation	Fryer
Food Preparation	Dishwasher
Food Preparation	Hot Food Container
Office Equipment	Desktop Computer
Office Equipment	Laptop Computer
Office Equipment	Server
Office Equipment	Monitor
Office Equipment	Printer/Copier/Fax
Office Equipment	POS Terminal
Process	Process Cooling/Refrigeration
Process	Process Heating
Process	Electrochemical Process
Machine Drive	Less than 5 HP
Machine Drive	5 - 24 HP
Machine Drive	25 - 99 HP
Machine Drive	100 - 249 HP
Machine Drive	250 – 499 HP
Machine Drive	500 and more HP
Miscellaneous	Non-HVAC Motors
Miscellaneous	Miscellaneous
Miscellaneous	Other Miscellaneous

For the 2011 study, we performed a high-level market characterization of electricity sales in the 2009 base year to allocate sales to each customer segment. We used Avista billing data by rate class as well as various secondary data sources to identify the annual sales in each customer segment, as well as the market size for each segment. This information provided control totals at a sector level for calibrating the LoadMAP model to known data for the base-year and was used for this CPA update as well.

Market Profiles

The next step was to develop market profiles for each sector, customer segment, end use, and technology. A market profile includes the following elements:

- **Market size** is a representation of the number of customers in the segment. For the residential sector, it is number of households. In the commercial and industrial sector, it is floor space measured in square feet.
- **Saturations** define the fraction of homes or C&I square feet with the various technologies. (e.g., homes with electric space heating).
- **UEC (unit energy consumption) or EUI (energy-use index)** describes the amount of energy consumed in 2009 by a specific technology in buildings that have the technology. UECs are expressed in kWh/household for the residential sector, while EUIs are expressed in kWh/square foot for C&I.
- **Intensity** for the residential sector represents the average energy 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 for electricity. For the commercial and industrial sectors, intensity, computed as the product of the saturation and the EUI, represents the average use for the technology across all floor space in 2009.
- **Usage** is the annual energy use by an end use technology in the segment. It is the product of the market size and intensity and is quantified in GWh. The market assessment results and the market profiles are presented in Chapter 3.

Baseline Projection

The next step was to develop the baseline projection of annual electricity usage for 2009 through 2033 by customer segment and end use without new utility programs or naturally occurring efficiency. The end-use projection does include the relatively certain impacts of codes and standards that will unfold over the study timeframe. All such mandates that were defined as of January 2012 are included in the baseline. The baseline projection is the foundation for the analysis of savings from future conservation efforts as well as the metric against which potential savings are measured.

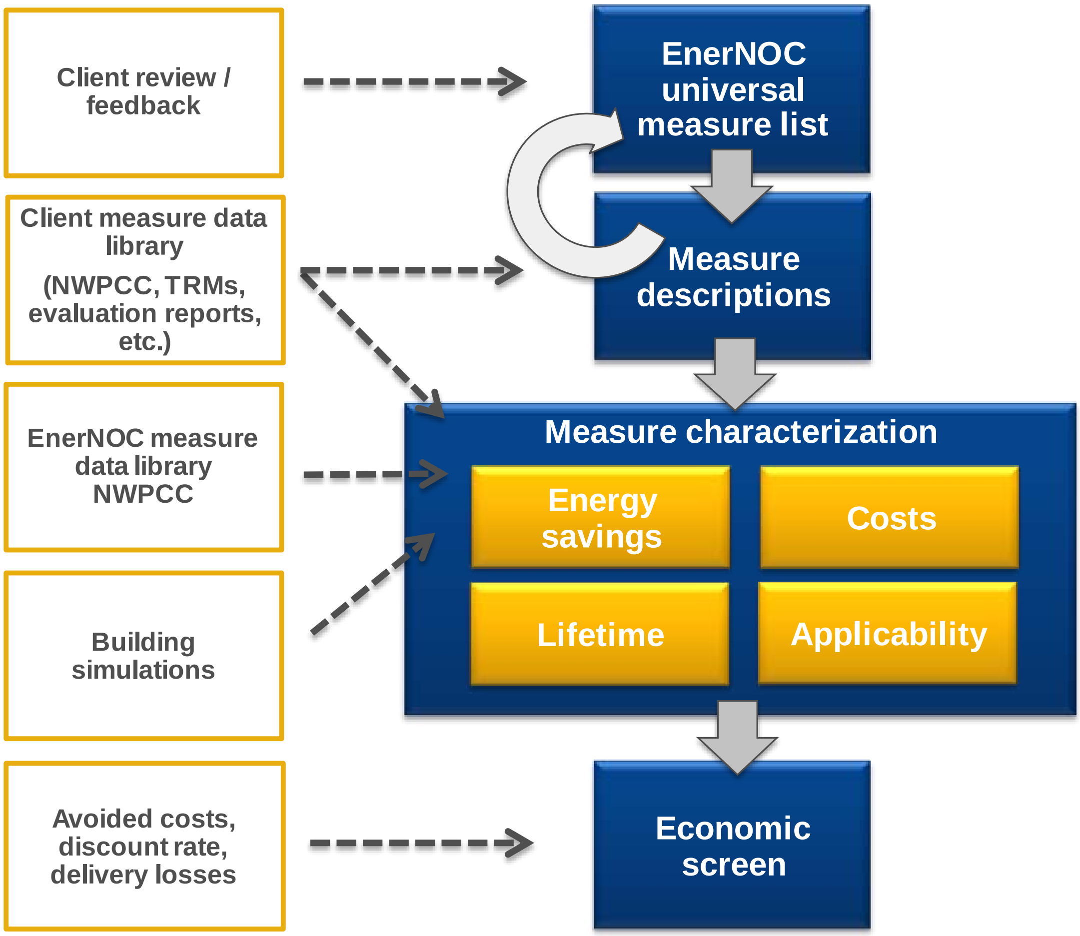
Inputs to the baseline projection include:

- Avista historic sales data and conservation program achievements for 2009 through 2012
- Current economic growth forecasts (i.e., customer growth, income growth)
- Electricity price forecasts
- Trends in fuel shares and equipment saturations
- Existing and approved changes to building codes and equipment standards

Conservation Measure Analysis

This section describes the framework used to assess the savings, costs, and other attributes of conservation measures. These characteristics form the basis for measure-level cost-effectiveness analyses as well as for determining measure-level savings. For all measures, EnerNOC assembled information to reflect equipment performance, incremental costs, and equipment lifetimes. We used this information, along with Avista's avoided costs data, in the economic screen to determine economically feasible measures. Figure 2-3 outlines the framework for measure analysis.

Figure 2-3 Approach for Measure Assessment



The framework for assessing savings, costs, and other attributes of conservation measures involves identifying the list of conservation measures to include in the analysis, determining their applicability to each market sector and segment, fully characterizing each measure, and performing cost-effectiveness screening.

The first step of the conservation measure analysis was to identify the list of all relevant conservation measures that should be considered for the Avista potential assessment. EnerNOC prepared a preliminary list of measures that compared the list of measures included in Avista's previous CPA with those in its business plan, its technical reference manual, the Sixth Plan, the RTF measure workbooks, and EnerNOC's own measure database in order to reconcile the various measure lists and provide the widest possible list of measures. This universal list of conservation measures covers all major types of end-use equipment, as well as devices and actions to reduce energy consumption. If considered today, some of these measures would not pass the economic screens initially, but may pass in future years as a result of lower projected equipment costs or higher avoided costs. After receiving feedback from Avista, we finalized the measures list.

The selected measures are categorized into two types according to the LoadMAP taxonomy: equipment measures and non-equipment measures.

- **Equipment measures** are efficient energy-consuming pieces of equipment that save energy by providing the same service with a lower energy requirement than a standard unit. An example is an ENERGY STAR refrigerator that replaces a standard efficiency refrigerator. For equipment measures, many efficiency levels may be available for a given technology, ranging 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 current federal standard SEER 13 unit and spans a broad spectrum up to a maximum efficiency of a SEER 21 unit.

- **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 to run heating and cooling systems only when people are home. Non-equipment measures can apply to more than one end use. For instance, addition of wall insulation will affect the energy use of both space heating and cooling. Non-equipment measures typically fall into one of the following categories:
  - Building shell (windows, insulation, roofing material)
  - Equipment controls (thermostat, energy management system)
  - Equipment maintenance (air conditioning and heat pump maintenance, changing setpoints)
  - Whole-building design (building orientation, 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 to reduce use of central air conditioners)
  - Commissioning and retrocommissioning

Table 2-4 summarizes the number of equipment and non-equipment measures evaluated for each segment within each sector.

Table 2-4 Number of Measures Evaluated

	Residential	C&I	Total Number of Measures
Equipment Measures Evaluated	1,536	1540	**3,076**
Non-Equipment Measures Evaluated	860	914	**1,774**
Total Measures Evaluated	**2,396**	**2454**	**4,850**

Once we assembled the list of conservation measures, the project team assessed their energy-saving characteristics. 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 and achievable potential. The residential and C&I measures are listed and described in Appendix B and Appendix C respectively.

Representative Measure Data Inputs

To provide an example of the measure data, Table 2-5 and Table 2-6 present examples of the detailed data inputs behind both equipment and non-equipment measures, respectively, for the case of heat pumps in single-family homes. Table 2-6 displays the various efficiency levels available as equipment measures, as well as the corresponding useful life, energy usage, and cost estimates. The columns labeled On Market and Off Market reflect equipment availability due to codes and standards or the entry of new products to the market.

Table 2-5 Example Equipment Measures for Air-Source Heat Pump – Single Family Home

Efficiency Level	Useful Life	Equipment Cost	Energy Usage(kWh/yr)	On Market	Off Market
SEER 13	15	$5,700	857	2009	2014
SEER 14 (Energy Star)	15	$5,767	771	2009	n/a
SEER 15 (CEE Tier 2)	15	$8,018	760	2009	n/a
SEER 16 (CEE Tier 3)	15	$9,205	737	2009	n/a

Table 2-6 lists some of the non-equipment measures applicable to space heating in an existing single-family home. All measures are evaluated for cost-effectiveness based on the lifetime benefits relative to the cost of the measure. The total savings and costs are calculated for each year of the study and depend on the base year saturation of the measure, the applicability[2] of the measure, and the savings as a percentage of the relevant energy end uses.

Table 2-6 Example Non-Equipment Measures – Single Family Home, Existing

End Use	Measure	Saturation in 2009[3]	Applicability	Lifetime (yrs)	Measure Installed Cost	Energy Savings (%)
Space Heating	Insulation - Ducting	15%	59%	18	$500	5%
Space Heating	Repair and Sealing - Ducting	12%	100%	20	$571	23%
Space Heating	Thermostat - Clock/Programmable	72%	75%	15	$249	6%
Space Heating	Doors - Storm and Thermal	38%	100%	12	$320	1%
Space Heating	Insulation - Infiltration Control	46%	100%	25	$306	9%
Space Heating	Insulation - Ceiling	76%	75%	25	$630	10%
Space Heating	Insulation - Radiant Barrier	5%	100%	12	$923	6%
Space Heating	Windows - High Efficiency/ENERGY STAR	78%	100%	25	$5,201	30%
Space Heating	Behavioral Measures	20%	50%	1	$12	1%

Screening Measures for Cost-Effectiveness

Only measures that are cost-effective are included in economic and achievable potential. Therefore, for each individual measure, LoadMAP performs an economic screen. This study uses the TRC test that compares the lifetime energy and peak demand benefits, as well as well as any non-energy benefits included in the RTF measure database, with the measure’s incremental installed cost, including material and labor. The lifetime benefits are calculated 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. The analysis uses each measure’s values for savings, costs, and lifetimes that were developed as part of the measure

---

[2] The applicability factors take into account whether the measure is applicable to a particular building type and whether it is feasible to install the measure. For instance, attic fans are not applicable to homes where there is insufficient space in the attic or there is no attic at all.

[3] Note that saturation levels reflected for the base year change over time as more measures are adopted.

characterization process described above. The analysis also accounts for transmission and distribution losses, and for program administration costs.

The LoadMAP model performs this 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 study period.

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.

If the measure passes the screen (has a B/C ratio greater than or equal to 1), the measure is included in economic potential. Otherwise, it is screened out for that year. If multiple equipment measures have B/C ratios greater than or equal to 1.0, the most efficient technology is selected by the economic screen. Table 2-7 shows the results of the economic screen for selected measures, indicating how the economic unit for a given technology may vary over time. For example, CFLs are initially the economical unit for interior screw-in lighting, but as the price of LEDs decreases, they become the economical unit for single family homes starting in 2017. For exterior lighting, due to longer hours of operation, LEDs are cost-effective starting in 2015.

Table 2-7 Economic Screen Results for Selected Single Family Equipment Measures

Technology	2014	2015	2016	2017	2018	2019
Interior Screw-in Lighting	CFL	CFL	CFL	LED	LED	LED
Exterior Screw-in Lighting	CFL	LED	LED	LED	LED	LED

Conservation Potential

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. As described in Chapter 1, three types of potentials were developed as part of this effort: Technical potential, Economic potential, and Achievable potential.

- **Technical potential** 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 selects the most efficient equipment options for each technology at the time of equipment replacement. In addition, it installs all relevant non-equipment measures for each technology to calculate savings. For example, for a central heat pump, as shown in Table 2-5, the most efficient option is a SEER 16 system. The multiple non-equipment measures shown in Table 2-6 are then applied to the energy used by the ductless mini-split system to further reduce space conditioning 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

---

[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.

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.

- **Economic potential** results from the purchase of the most efficient cost-effective option available for a given equipment or non-equipment measure as determined in the cost-effectiveness screening process described above. 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** defines the range of savings that is very likely to occur. It accounts for customers' awareness of efficiency options, any barriers to customer adoption, limits to program design, and other factors that influence the rate at which conservation measures penetrate the market.

The calculation of technical and economic potential is straightforward as described above. To develop estimates for achievable potential, we specify market adoption rates for each measure and each year. For Avista, the project team began with the ramp rates specified in the Sixth Plan conservation workbooks, but modified these to match Avista program history and service territory specifics. For specific measures, we examined historic program results for the four-year period of 2009 through 2012. We then adjusted the 2009–2013 market acceptance rates so that the achievable potential for these measures aligned with the historical results. This provided a starting point for the ramp rates in 2014. For future years, we increased the potential factors to model increasing market acceptance and program improvements. For measures not currently included in Avista programs, we relied upon the Sixth Plan ramp rates and recent EnerNOC potential studies to create market adoption rates. The market adoption rates for each measure appear in Appendix D.

Results of all the potentials analysis are presented in Chapter 4.

Data Development

This section details the data sources used in this study, followed by a discussion of how these sources were applied. In general, data were adapted to local conditions, for example, by using local sources for measure data and local weather for building simulations.

Data Sources

The data sources are organized into the following categories:

- Avista data
- NPCC and RTF data
- EnerNOC's databases and analysis tools
- Other secondary data and reports

Avista Data

Our highest priority data sources for this study were those that were specific to Avista.

- **Avista customer data:** Avista provided number of customers and total electric usage by sector from the customer billing database.
- **Avista Business Plan and program implementation and evaluation data**: Data that outlines the details of conservation programs, program goals, and achievements to date.
- **Avista Technical Resources Manual:** provides collection of UES for prescriptive programs delivered by Avista as informed by its most recent impact evaluation efforts.

Northwest Power and Conservation Council Data

- **Northwest Power and Conservation Council Sixth Plan Conservation Supply Curve Workbooks, 2010.** To develop its Power Plan, the Council used workbooks with detailed information about measures, available at http://www.nwcouncil.org/energy/powerplan/6/supplycurves/default.htm .
- **Regional Technical Forum Deemed Measures.** The NWPCC Regional Technical Forum maintains databases of deemed measure savings data, available at http://www.nwcouncil.org/energy/rtf/measures/Default.asp .
- **Regional Technical Forum Residential SEEM modeling results** http://rtf.nwcouncil.org/measures/support/Default.asp

EnerNOC Databases, Analysis Tools, and Reports

EnerNOC maintains several databases and modeling tools that we use for forecasting and potential studies.

- **EnerNOC Energy Market Profiles**: For more than 10 years, EnerNOC staff have maintained profiles of end-use consumption for the residential, commercial, and industrial sectors. These profiles include market size, fuel shares, unit consumption estimates, and annual energy use by fuel (electricity and natural gas), customer segment and end use for 10 regions in the U.S. The Energy Information Administration surveys (RECS, CBECS and MECS) as well as state-level statistics and local customer research provide the foundation for these regional profiles.
- **Building Energy Simulation Tool (BEST)**. EnerNOC's BEST is a derivative of the DOE 2.2 building simulation model, used to estimate base-year UECs and EUIs, as well as measure savings for the HVAC-related measures.
- **EnerNOC's EnergyShape™:** This database of load shapes includes the following: Residential – electric load shapes for 10 regions, 3 housing types, 13 end uses; Commercial – electric load shapes for 9 regions, 54 building types, 10 end uses; Industrial – electric load shapes, whole facility only, 19 2-digit SIC codes, as well as various 3-digit and 4-digit SIC codes
- **EnerNOC's Database of Energy Efficiency Measures (DEEM):** EnerNOC maintains an extensive database of measure data for our studies. Our database draws upon reliable sources including the California Database for Energy Efficient Resources (DEER), the EIA Technology Forecast Updates – Residential and Commercial Building Technologies – Reference Case, RS Means cost data, and Grainger Catalog Cost data**.**
- **Recent studies**. EnerNOC has conducted numerous studies of conservation potential in the last five years. We checked our input assumptions and analysis results against the results from these other studies, which include Idaho Power, and Seattle City Light. In addition, we used the information about impacts of building codes and appliance standards from a recent report for the Institute for Energy Efficiency.[5]

Other Secondary Data and Reports

Finally, a variety of secondary data sources and reports were used for this study. The main sources are identified below.

- **Residential Building Stock Assessment:** NEEA's 2011 Residential Building Stock Assessment (RBSA) provides results of a regional study of 1,404 homes, of which 27 are located within Avista's service territory. Due to the relatively low number of customers, 27, within Avista's service territory, we used the results for 113 homes in eastern Washington

---

[5] "Assessment of Electricity Savings in the U.S. Achievable through New Appliance/Equipment Efficiency Standards and Building Efficiency Codes (2010 – 2025)." Global Energy Partners, LLC for the Institute for Electric Efficiency, May 2011. http://www.edisonfoundation.net/iee/reports/IEE_CodesandStandardsAssessment_2010-2025_UPDATE.pdf

and 52 homes in northern Idaho as proxies for Avista's Washington and Idaho service territories respectively. This information allowed us to update the single family home market profiles from the 2011 CPA. At the time of the 2013 CPA, the RBSA results for mobile and multifamily homes had not yet been released. http://neea.org/docs/reports/residential-building-stock-assessment-single-family-characteristics-and-energy-use.pdf?sfvrsn=6

- **Commercial Building Stock Assessment:** NEEA's Commercial Building Stock Assessment (CBSA) provides data on regional commercial buildings. As of the most recent update in 2009, the database contains site-specific information for 2,061 buildings. http://neea.org/resource-center/regional-data-resources/commercial-building-stock-assessment
- **American Community Survey:** The US Census American Community Survey is an ongoing survey that provides data every year on household characteristics. http://www.census.gov/acs/www/
- **Residential Energy Consumption Survey (RECS).** http://www.eia.gov/consumption/residential/data/2009/
- **Annual Energy Outlook**. The Annual Energy Outlook (AEO), conducted each year by the U.S. Energy Information Administration (EIA), presents yearly projections and analysis of energy topics. For this study, we used data from the 2011 AEO.
- **California Statewide Surveys**. The Residential Appliance Saturation Survey (RASS) and the Commercial End Use Survey (CEUS) are comprehensive market research studies conducted by the California Energy Commission. These databases provide a wealth of information on appliance use in homes and businesses. RASS is based on information from almost 25,000 homes and CEUS is based on information from a stratified random sample of almost 3,000 businesses in California.
- **Electric Power Research Institute – Assessment of Achievable Potential from Energy Efficiency and Demand Response Programs in the U.S.**, also known as the EPRI National Potential Study (2009). In 2009, EPRI hired EnerNOC to conduct an assessment of the national potential for energy efficiency, with estimates derived for the four DOE regions.
- **EPRI End-Use Models (REEPS and COMMEND)**. These models provide the elasticities we apply to electricity prices, household income, home size and heating and cooling.
- **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) for the state of California. We used the DEER database to cross check the measure savings we developed using BEST and DEEM.
- **Northwest Power and Conservation Council Sixth Plan workbooks.** To develop its Power Plan, the Council maintains workbooks with detailed information about measures.
- **Other relevant regional sources.** These include reports from the Consortium for Energy Efficiency, the EPA, and the American Council for an Energy-Efficient Economy.

Data Application

We now discuss how the data sources described above were used for each step of the study.

Data Application for Market Characterization

To construct the high-level market characterization of electricity use and households/floor space for the residential, commercial, and industrial sectors, we applied the following data sources:

- Avista internal data, RECS 2009 and the American Community Survey to allocate residential customers by housing type

Data Application for Market Profiles

The specific data elements for the market profiles, together with the key data sources, are shown in Table 2-8. This CPA update began with the market profiles previously developed for the 2011 CPA, but we incorporated new residential sector data from the RBSA as described above. The C&I market profiles were largely unchanged because no significant additional data was available regarding Avista's C&I customers.

To develop the market profiles for each segment, we used the following approach:

1. Developed control totals for each segment. These include market size, segment-level annual electricity use, and annual intensity.
2. Used NEEA reports including the recently released RBSA Single Family report, 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.
3. Incorporated secondary data sources to supplement and corroborate the data from items 1 and 2 above.
4. Compared and cross-checked with regional data obtained as part of the EPRI National Potential Study and with the Energy Market Profiles Database.
5. Ensured calibration to control totals for annual electricity sales in each sector and segment.
6. Worked with Avista staff to vet the data against their knowledge and experience.

Table 2-8 Data Applied for the Market Profiles

Model Inputs	Description	Key Sources
Market size	Base-year residential dwellings and C&I floor space	Avista billing data, NEEA Reports, NPCC data
Annual intensity	Residential: Annual energy use (kWh/household) C&I: Annual energy use	Energy Market Profiles , NEEA reports, AEO, Inland Power & Light 2009 Conservation Potential Assessment, previous studies
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 dwellings that have the technology EUI: Annual electricity use per square foot/employee 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; EnerNOC's EnergyShape database

Data Application for Baseline Projection

Table 2-9 summarizes the LoadMAP model inputs requirements. These inputs are required for each segment within each sector, as well as for new construction and existing dwellings/buildings.

Table 2-9 Data Needs for the Baseline Projection and Potentials Estimation in LoadMAP

Model Inputs	Description	Key Sources
Customer growth forecasts	Forecasts of new construction in residential and C&I sectors	AEO 2011 growth forecast US BLS
Equipment purchase shares for baseline projection	For each equipment/technology, purchase shares for each efficiency level; specified separately for existing equipment replacement and new construction	Shipments data from AEO AEO 2011 regional forecast assumptions[6] Appliance/efficiency standards analysis Avista program results and evaluation reports
Electricity prices	Forecast of average energy and capacity avoided costs and retail prices	Avista projections AEO 2011
Utilization model parameters	Price elasticities, elasticities for other variables (income, weather)	EPRI's REEPS and COMMEND models AEO 2011 Avista's historical data for normal cooling & heating degree days.

In addition, we implemented assumptions for known future equipment standards as of January, 2012, as shown in the tables below.

---

[6] We developed baseline purchase decisions using the Energy Information Agency's *Annual Energy Outlook* report (2011), 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 then held values constant for the study period. This removes any effects of naturally occurring conservation or effects of future DSM programs that may be embedded in the AEO forecasts.

Table 2-10 Residential Electric Equipment Standards Applicable to Avista

Today's Efficiency or Standard Assumption
1st Standard (relative to today's standard)
2nd Standard (relative to today's standard)

End Use	Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Cooling	Central AC	SEER 13				SEER 14										
	Room AC	EER 9.8			EER 11.0											
Cooling/Heating	Heat Pump	SEER 13.0/HSPF 7.7				SEER 14.0/HSPF 8.0										
Water Heating	Water Heater (<=55 gallons)	EF 0.90				EF 0.95										
	Water Heater (>55 gallons)	EF 0.90				Heat Pump Water Heater										
Lighting	Screw-in/Pin Lamps	Incandescent			Advanced Incandescent - tier 1						Advanced Incandescent - tier 2					
	Linear Fluorescent	T8														
Appliances	Refrigerator/2nd Refrigerator	NAECA Standard			25% more efficient											
	Freezer	NAECA Standard			25% more efficient											
	Dishwasher	Conventional (355 kWh/yr)		14% more efficient (307 kWh/yr)												
	Clothes Washer	Conventional (MEF 1.26 for top loader)				MEF 1.72 for top loader			MEF 2.0 for top loader							
	Clothes Dryer	Conventional (EF 3.01)				5% more efficient (EF 3.17)										
	Range/Oven	Conventional														
	Microwave	Conventional														

Table 2-11 Commercial Electric Equipment Standards Applicable to Avista

▢ Today's Efficiency or Standard Assumption
🟦 1st Standard (relative to today's standard)
🟫 2nd Standard (relative to today's standard)

End Use	Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Cooling	Chillers	2007 ASHRAE 90.1														
	Roof Top Units	EER 11.0/11.2														
	Packaged Terminal AC/HP	EER 9.8	EER 11.0													
Lighting	Screw-in/Pin Lamps	Incandescent			Advanced Incandescent - tier 1						Advanced Incandescent - tier 2					
	Linear Fluorescent	T12	T8													
	High Intensity Discharge	Metal Halide														
Refrigeration	Walk-in Refrigerator/Freezer	EISA 2007 Standard														
	Reach-in Refrigerator	EPACT 2005 Standard														
	Glass Door Display	EPACT 2005 Standard	42% more efficient													
	Open Display Case	EPACT 2005 Standard	18% more efficient													
	Vending Machines	EPACT 2005 Standard	33% more efficient													
	Icemaker	2010 Standard														
Miscellaneous	Non-HVAC Motors	62.3% Efficiency				70% Efficiency										
	Commercial Laundry	MEF 1.26		MEF 1.6												

Table 2-12 Industrial Electric Equipment Standards Applicable to Avista

▭ Today's Efficiency or Standard Assumption

🟦 1st Standard (relative to today's standard)

🟫 2nd Standard (relative to today's standard)

End Use	Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Cooling	Chillers	2007 ASHRAE 90.1														
	Roof Top Units	EER 11.0/11.2														
	Packaged Terminal AC/HP	EER 9.8	EER 11.0													
Lighting	Screw-in/Pin Lamps	Incandescent			Advanced Incandescent - tier 1						Advanced Incandescent - tier 2					
	Linear Fluorescent	T12	T8													
	High Intensity Discharge	Metal Halide														
Machine Drive	Less than 5 HP	62.3% Efficiency				70% Efficiency										
	5-24 HP	EISA 2007 Standards														
	25-99 HP	EISA 2007 Standards														
	100-249 HP	EISA 2007 Standards														
	250-499 HP	EISA 2007 Standards														
	500 or more HP	EISA 2007 Standards														

Conservation Measure Data Application

Table 2-13 details the data sources used for measure characterization.

Table 2-13 Data Needs for the Measure Characteristics in LoadMAP

Model Inputs	Description	Key Sources
Energy Impacts	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.	Avista program results and evaluation reports BEST DEEM DEER NPCC workbooks Other secondary sources
Peak Demand Impacts	Savings during the peak demand periods are specified for each electric measure. These impacts relate to the energy savings and depend on the extent to which each measure is coincident with the system peak.	Avista program results and evaluation reports BEST EnergyShape
Costs	Equipment Measures: Includes the full cost of purchasing and installing the equipment on a per-household, per-square-foot, or per employee basis for the residential, commercial, and industrial sectors, respectively. Non-equipment measures: Existing buildings – full installed cost. New Construction - the costs may be either the full cost of the measure, or as appropriate, it may be the incremental cost of upgrading from a standard level to a higher efficiency level.	Avista program results and evaluation reports DEEM DEER NPCC workbooks RS Means Other secondary sources
Measure Lifetimes	Estimates derived from the technical data and secondary data sources that support the measure demand and energy savings analysis.	Avista program results and evaluation reports DEEM DEER NPCC workbooks Other secondary sources
Applicability	Estimate of the percentage of either dwellings in the residential sector or square feet/employment in the C&I sector where the measure is applicable and where it is technically feasible to implement.	DEEM DEER NPCC workbooks Other secondary sources
On Market and Off Market Availability	Expressed as years for equipment measures to reflect when the equipment technology is available or no longer available in the market.	EnerNOC appliance standards and building codes analysis

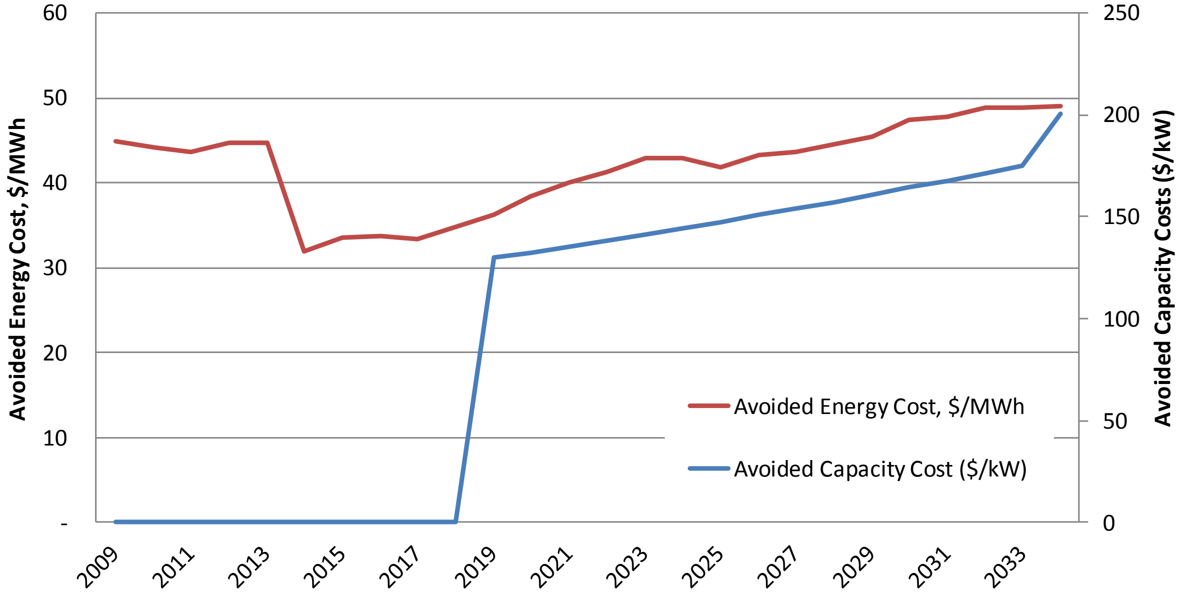
Data Application for Cost-effectiveness Screening

To perform the cost-effectiveness screening, the following information was needed:

- Preliminary avoided cost of energy and capacity provided by Avista and based on 2013 IRP planning assumptions, shown in Figure 2-4; note that Avista does not expect to incur any avoided cost for capacity until 2019.
- Line losses of 6.12%, provided by Avista
- Discount rate of 4%, provided by Avista (real)

- Program administration costs. Program administration costs can typically vary between 5–50% of total program costs. For this study, we used values of 30% that were provided by Avista, based on its program history.

Figure 2-4 Avoided Costs



Achievable Potential Estimation

To estimate potentials, two sets of parameters were required.

- **Adoption rates for non-equipment measures.** Equipment is assumed to be replaced at the end of its useful life, but for non-equipment measures, a set of factors is required to model the gradual implementation over time. Rather than installing all non-equipment measures in the first year of the forecast (instantaneous potential), they are phased in according to adoption schedules that vary based on equipment cost and measure complexity. The adoption rates for the Avista study were based on ramp rate curves specified in the NPCC Sixth Power Plan, but modified to reflect Avista's program history. These adoption rates are used within LoadMAP to generate the technical and economic potentials.
- **Market acceptance rates (MARs).** These factors are applied to Economic potential to estimate Achievable potential. These rates were developed by beginning with the Northwest Power and Conservation Council ramp rates but then adjusting those rates to reflect Avista's DSM program history.

Ramp rates and MARs are discussed in Appendix D.

CHAPTER 3

MARKET CHARACTERIZATION AND MARKET PROFILES

Avista Utilities, headquartered in Spokane, Washington, is an investor-owned utility with annual revenues of more than $1.6 billion. Avista provides electric and natural gas service to about 680,000 customers in a service territory of more than 30,000 square miles. Avista uses a mix of hydro, natural gas, coal and biomass generation. 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. This study addresses electricity conservation potential in Washington and Idaho only. This chapter characterizes the electricity use patterns of Avista's customers.

Energy Use Summary

Table 3-1 and Table 3-2 provide 2009 customer counts and weather-normalized electricity use by sector for Washington and Idaho, respectively. For this study, the NPCC Sixth Plan calculator to estimate conservation potential for pumping. Results of that calculation appear in Chapter 4. Potential for rate class 25P was also estimated outside of the LoadMAP framework, and thus 25P sales are not included in Table 3-2.

Table 3-1 Electricity Sales and Peak Demand by Rate Class, Washington 2009

Sector / Rate Class	Rate Schedule(s)	Number of meters (customers)	2009 Electricity Sales (GWh)	2009 Peak Demand (MW)
Residential	001	200,134	2,452	710
General Service	011, 012	27,142	416	64
Large General Service	021, 022	3,352	1,557	232
Extra Large Commercial	025C	9	266	134
Extra Large Industrial	025I	13	614	
Pumping	031, 032	2,361	136	10
Total		**233,011**	**5,440**	**1,150**

Table 3-2 Electricity Sales and Peak Demand by Rate Class, Idaho 2009

Sector / Rate Class	Rate Schedule(s)	Number of meters (customers)	2009 Electricity Sales (MWh)	2009 Peak Demand (MW)
Residential	001	99,580	1,182	283
General Service	011, 012	19,245	323	61
Large General Service	021, 022	1,456	700	115
Extra Large Commercial	025C	3	70	140
Extra Large Industrial	025I	6	196	
Pumping	031, 032	1,312	59	4
Total		**121,602**	**2,530**	**603**

Note: Excludes sales to rate class 25P.

After excluding pumping and 25 P, the distribution among the sectors in Washington and Idaho is similar, with the largest sector, residential, accounting for 46% of Washington sales and 48% of Idaho sales as shown in Figure 3-1 and Figure 3-2.

Figure 3-1 Electricity Sales by Rate Class, 2009

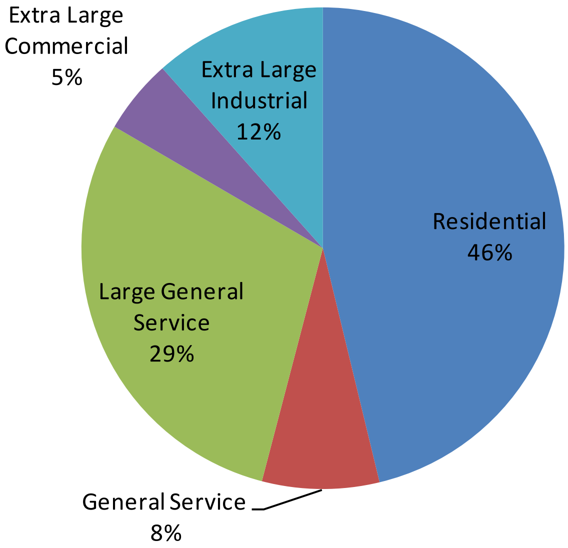
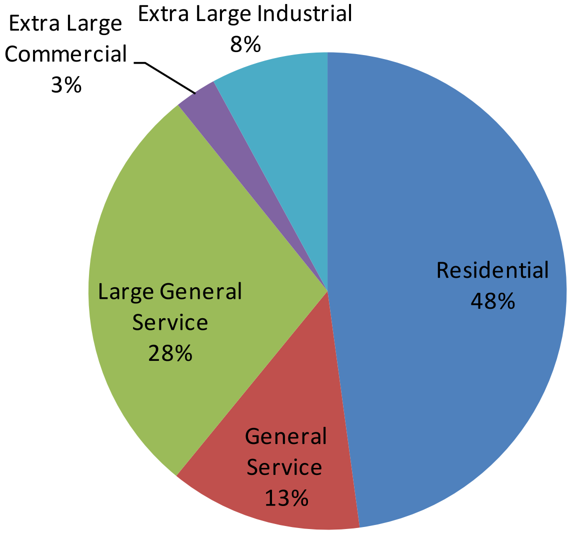


Figure 3-2 Electricity Sales by Rate Class, Idaho 2009



Note: Excludes sales to rate class 25P.

Residential Sector

The total number of households and electric sales for the service territory were obtained from Avista's financial reporting database. In 2009, there were 200,134 households in Washington and 99,580 in Idaho. We allocated these totals into the four residential segments for each segment based on housing type and level of income: Single family, multi family, mobile home, and low 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 mobile homes segment includes mobile homes and other manufactured housing. The low income segment is composed of all three of the housing types: single-family homes, multi-family homes, and mobile homes.

Table 3-3 shows how customers were allocated to segments. 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, and a 2009 Inland Power customer survey. Avista defines the low-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.

Table 3-3 Residential Sector Allocation by Segments, 2009

	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%
Low Income	67,533	34%	30,363	31%
Total	**200,134**	**100%**	**99,580**	**100%**

Next, to determine the residential whole building energy intensity (kWh/household) by segment, we drew upon data from the Energy Information Agency, the NEEA 2012 RBSA, previous NEEA residential reports, 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. The single-family segment used roughly two-thirds of the total 2009 residential sector electricity sales.

Table 3-4 Residential Electricity Usage and Intensity by Segment and State, 2009

Washington Segment	No. of Households	Intensity (kWh/HH)	% of Customers	2009 Electricity Use (GWh)	% of Sales
Single Family	109,134	14,547	54%	1,588	65%
Multi Family	18,219	8,728	9%	159	6%
Mobile Home	5,248	13,092	3%	69	3%
Low Income	67,533	9,424	34%	636	26%
Total	**200,134**	**12,250**	**100%**	**2,452**	**100%**
Idaho Segment	**No. of Households**	**Intensity (kWh/HH)**	**% of Customers**	**2009 Electricity Use (GWh)**	**% of Sales**
Single Family	59,205	13,703	59%	811	69%
Multi Family	5,237	8,213	5%	43	4%
Mobile Home	4,774	12,320	5%	59	5%
Low Income	30,363	8,868	31%	269	23%
Total	**99,580**	**11,874**	**100%**	**1,182**	**100%**

As we describe in the previous chapter, the market profiles provide the foundation upon which we develop the baseline projection. 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 data from sources including Avista TRM and Business Plan data, NEEA's RBSA and other NEEA reports, Inland Power & Light, NPCC, and AEO data.
- **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 Avista, NEEA, Inland Power & Light, NPCC, and AEO. We also used data from various utility potential studies that EnerNOC has recently completed. As needed, 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 and Table 3-6 present the average existing home market profile for all residential segments in Washington and Idaho combined. The existing-home profile represents all the housing stock in 2009. Market profiles for each of the residential segments in Washington and Idaho appear in Appendix A.

Table 3-5 Average Residential Sector Market Profile, Washington

Average Market Profiles - Washington

End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (GWh)
Cooling	Central AC	28.6%	1,150	330	66
Cooling	Room AC	20.7%	360	75	15
Cooling	Air Source Heat Pump	16.3%	735	120	24
Cooling	Geothermal Heat Pump	0.2%	730	2	0
Space Heating	Electric Resistance	20.4%	6,624	1,350	270
Space Heating	Electric Furnace	10.7%	9,173	980	196
Space Heating	Air Source Heat Pump	16.3%	7,498	1,222	245
Space Heating	Geothermal Heat Pump	0.2%	4,833	11	2
Space Heating	Supplemental	7.8%	260	20	4
Water Heating	Water Heater <= 55 Gal	66.3%	3,074	2,038	408
Water Heating	Water Heater > 55 Gal	3.1%	4,552	140	28
Interior Lighting	Screw-in	100.0%	1,060	1,060	212
Interior Lighting	Linear Fluorescent	100.0%	107	107	21
Interior Lighting	Specialty	100.0%	275	275	55
Exterior Lighting	Screw-in	100.0%	254	254	51
Appliances	Clothes Washer	82.7%	114	94	19
Appliances	Clothes Dryer	78.8%	493	389	78
Appliances	Dishwasher	85.6%	386	330	66
Appliances	Refrigerator	100.0%	694	694	139
Appliances	Freezer	56.1%	774	434	87
Appliances	Second Refrigerator	25.9%	977	253	51
Appliances	Stove	87.7%	386	338	68
Appliances	Microwave	95.6%	114	109	22
Electronics	Personal Computers	119.0%	205	244	49
Electronics	TVs	204.4%	221	452	90
Electronics	Set-top Boxes/DVR	155.2%	128	198	40
Electronics	Devices and Gadgets	100.0%	55	55	11
Miscellaneous	Pool Pump	3.6%	1,415	52	10
Miscellaneous	Furnace Fan	43.7%	577	252	50
Miscellaneous	Miscellaneous	100.0%	373	373	75
	Total			**12,250**	**2,452**

Table 3-6 Average Residential Sector Market Profile, Idaho

Average Market Profiles - Idaho

End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (GWh)
Cooling	Central AC	22.0%	945	207	21
Cooling	Room AC	19.7%	297	58	6
Cooling	Air Source Heat Pump	12.9%	609	79	8
Cooling	Geothermal Heat Pump	0.7%	657	5	0
Space Heating	Electric Resistance	20.8%	7,481	1,556	155
Space Heating	Electric Furnace	9.7%	8,401	815	81
Space Heating	Air Source Heat Pump	12.9%	7,415	959	95
Space Heating	Geothermal Heat Pump	0.7%	5,075	35	3
Space Heating	Supplemental	7.5%	258	19	2
Water Heating	Water Heater <= 55 Gal	60.8%	3,127	1,901	189
Water Heating	Water Heater > 55 Gal	3.4%	4,779	160	16
Interior Lighting	Screw-in	100.0%	1,109	1,109	110
Interior Lighting	Linear Fluorescent	100.0%	111	111	11
Interior Lighting	Specialty	100.0%	293	293	29
Exterior Lighting	Screw-in	100.0%	280	280	28
Appliances	Clothes Washer	85.8%	113	97	10
Appliances	Clothes Dryer	81.9%	490	402	40
Appliances	Dishwasher	87.0%	384	334	33
Appliances	Refrigerator	100.0%	690	690	69
Appliances	Freezer	57.8%	768	444	44
Appliances	Second Refrigerator	23.0%	954	219	22
Appliances	Stove	80.9%	379	306	31
Appliances	Microwave	96.0%	114	109	11
Electronics	Personal Computers	122.5%	204	250	25
Electronics	TVs	207.5%	219	454	45
Electronics	Set-top Boxes/DVR	146.1%	125	182	18
Electronics	Devices and Gadgets	100.0%	54	54	5
Miscellaneous	Pool Pump	5.1%	1,422	73	7
Miscellaneous	Furnace Fan	44.0%	593	261	26
Miscellaneous	Miscellaneous	100.0%	410	410	41
	Total			**11,874**	**1,182**

Table 3-7 and Figure 3-3 present the end-use shares of electricity use by housing type. Space heating is the largest single use in all housing types, accounting for 29% of residential use overall. In the single family, mobile home, and low income segments, appliances are the second largest energy consumer, followed by water heating and then interior lighting. In the case of multi-family housing, water heating is the second largest end use while appliances are the third largest end use, due to a high saturation of electric water heating compared with the other segments. Across all housing types, interior and exterior lighting combined represents 14% of electricity use in 2009. The electronics end use, which includes personal computers, televisions, home audio, video game consoles, etc., is 8% of residential electricity usage across all housing types. The miscellaneous end use includes such devices as furnace fans, pool pumps, and other plug loads (hair dryers, power tools, coffee makers, etc.).

Table 3-7 Residential Electricity Use by End Use and Segment (kWh/HH/year, 2009)

End Use	Single Family	Multi Family	Mobile Home	Low Income	Total Residential
Cooling	652	112	259	256	**467**
Space Heating	3,739	3,312	5,224	3,009	**3,517**
Water Heating	2,341	1,628	1,928	1,937	**2,139**
Interior Lighting	1,810	1,002	1,351	998	**1,466**
Exterior Lighting	370	21	276	135	**263**
Appliances	3,163	1,540	2,197	2,013	**2,628**
Electronics	1,163	726	887	630	**945**
Miscellaneous	1,013	271	602	272	**699**
Total	**14,250**	**8,613**	**12,724**	**9,251**	**12,125**

Figure 3-3 Percentage of Residential Electricity Use by End Use and Segment (2009)

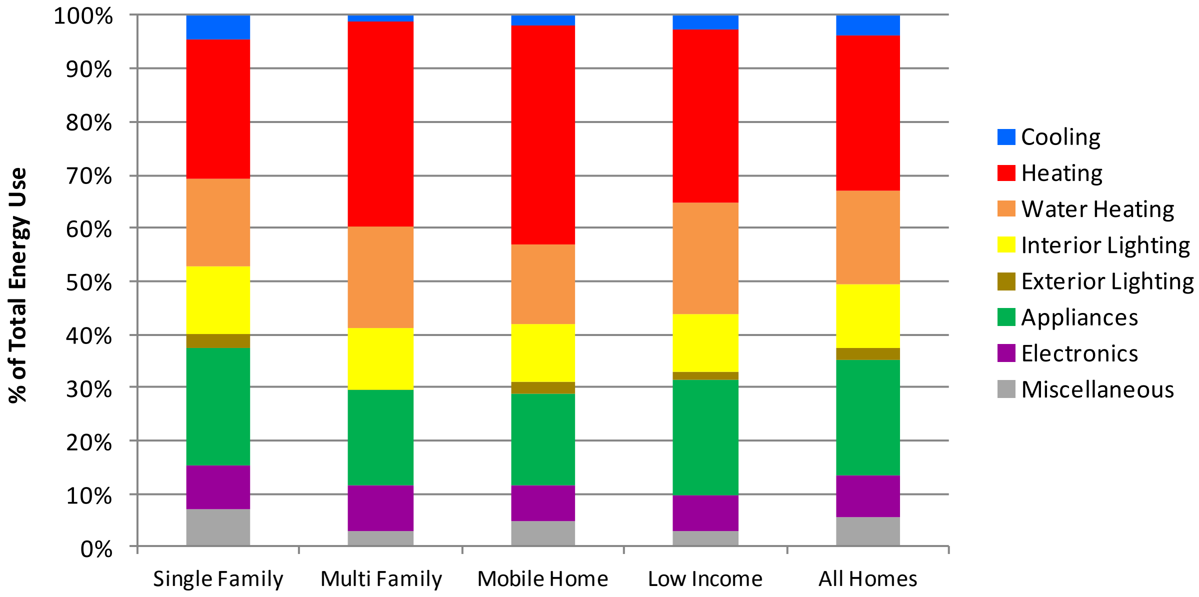
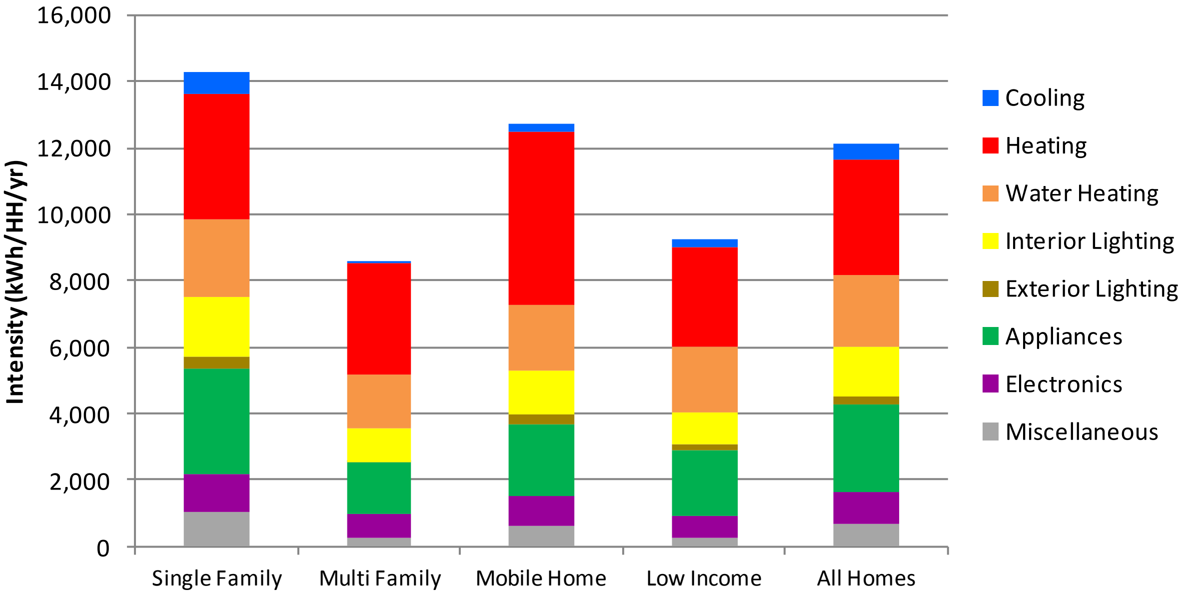


Figure 3-4 presents the end-use breakout in terms of intensity, kWh/household-year, by segment for both states combined.

Figure 3-4 Residential Intensity by End Use and Segment (kWh/household, 2009)



C&I Sector

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.

We developed the nonresidential energy use by segment using Avista 2009 billing data by rate class. Table 3-7 and Table 3-8 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. This grouping enabled better modeling of the industrial customers. Note that potential for Idaho rate class 025P was determined outside of the LoadMAP modeling framework because it was more appropriate to treat this one large customer separately as opposed to modeling it as a generic C&I customer.

Figure 3-5 shows the relative energy use of each segment as a percentage of C&I sector energy sales.

Table 3-8 Commercial and Industrial Sector Market Characterization Results, Washington 2009

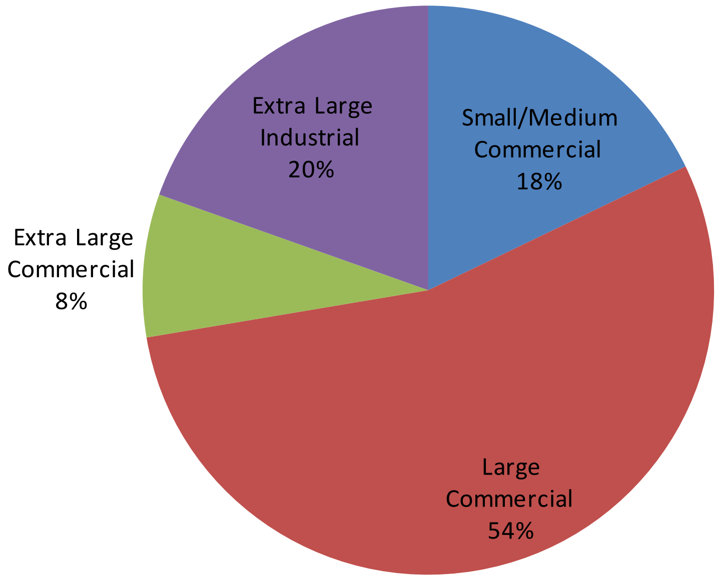
Segment	Electricity Use (GWh)	Intensity (kWh/SqFt)	Floor Space (million SqFt)
Small/Medium Commercial	416	18	24
Large Commercial	1,557	17	93
Extra Large Commercial	266	14	19
Extra Large Industrial	614	40	15
Total	**2,852**	**19**	**151**

Table 3-9 Commercial and Industrial Sector Market Characterization Results, Idaho 2009

Segment	Electricity Use (GWh)	Intensity (kWh/SqFt)	Floor Space (million SqFt)
Small/Medium Commercial	323	18	18
Large Commercial	700	17	42
Extra Large Commercial	70	14	5
Extra Large Industrial	196	40	5
Total	**1,289**	**18**	**70**

Note: Excludes sales to rate class 25P.

Figure 3-5 Commercial and Industrial Electricity Consumption by Segment 2009



We used data from NEEA reports including the 2009 CBSA, the California Commercial End Use Study (CEUS), and recently completed EnerNOC studies to estimate 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.

We then developed market profiles for each non-residential segment in each state. Table 3-10 shows an example commercial average base year market profile, in this case for the Washington Small/Medium Commercial Segment. The market profiles for each of the Washington and Idaho C&I segments are shown in Appendix A.

Table 3-10 Large Commercial Segment Market Profile, Washington, 2009

Average Market Profiles

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Usage (GWh)
Cooling	Central Chiller	24.7%	2.1	0.5	49
Cooling	RTU	37.8%	2.5	1.0	89
Cooling	Heat Pump	9.1%	3.5	0.3	30
Space Heating	Heat Pump	9.1%	2.3	0.2	20
Space Heating	Electric Resistance	5.9%	3.6	0.2	20
Space Heating	Furnace	12.7%	4.7	0.6	55
Ventilation	Ventilation	75.1%	1.7	1.2	116
Interior Lighting	Interior Screw-in	100.0%	0.9	0.9	88
Interior Lighting	High Bay Fixtures	100.0%	0.7	0.7	66
Interior Lighting	Linear Fluorescent	100.0%	3.3	3.3	307
Exterior Lighting	Exterior Screw-in	100.0%	0.1	0.1	9
Exterior Lighting	HID	100.0%	0.7	0.7	65
Water Heating	Water Heater	54.2%	2.3	1.3	117
Food Preparation	Fryer	18.4%	0.4	0.1	6
Food Preparation	Oven	18.4%	1.9	0.3	32
Food Preparation	Dishwasher	18.4%	0.2	0.0	3
Food Preparation	Hot Food Container	18.4%	0.3	0.1	5
Food Preparation	Food Prep	18.4%	0.0	0.0	0
Refrigeration	Walk in Refrigeration	39.1%	0.5	0.2	17
Refrigeration	Glass Door Display	39.1%	0.4	0.1	13
Refrigeration	Reach-in Refrigerator	39.1%	0.8	0.3	28
Refrigeration	Open Display Case	39.1%	0.3	0.1	10
Refrigeration	Vending Machine	39.1%	0.4	0.1	13
Refrigeration	Icemaker	39.1%	0.7	0.3	24
Office Equipment	Desktop Computer	98.4%	0.9	0.9	82
Office Equipment	Laptop Computer	98.4%	0.1	0.1	6
Office Equipment	Server	98.4%	0.4	0.4	38
Office Equipment	Monitor	98.4%	0.2	0.2	19
Office Equipment	Printer/copier/fax	98.4%	0.2	0.2	19
Office Equipment	POS Terminal	98.4%	0.1	0.1	6
Miscellaneous	Non-HVAC Motor	57.7%	1.4	0.8	75
Miscellaneous	Other Miscellaneous	100.0%	1.4	1.4	127
Total				**16.7**	**1,557**

Figure 3-6 displays the breakdown of energy use by end use for all C&I segments combined. This information is further detailed in Table 3-11 and Figure 3-7, which present the end-use shares of electricity use by segment.

Figure 3-6 C&I Electricity Consumption by End Use, 2009

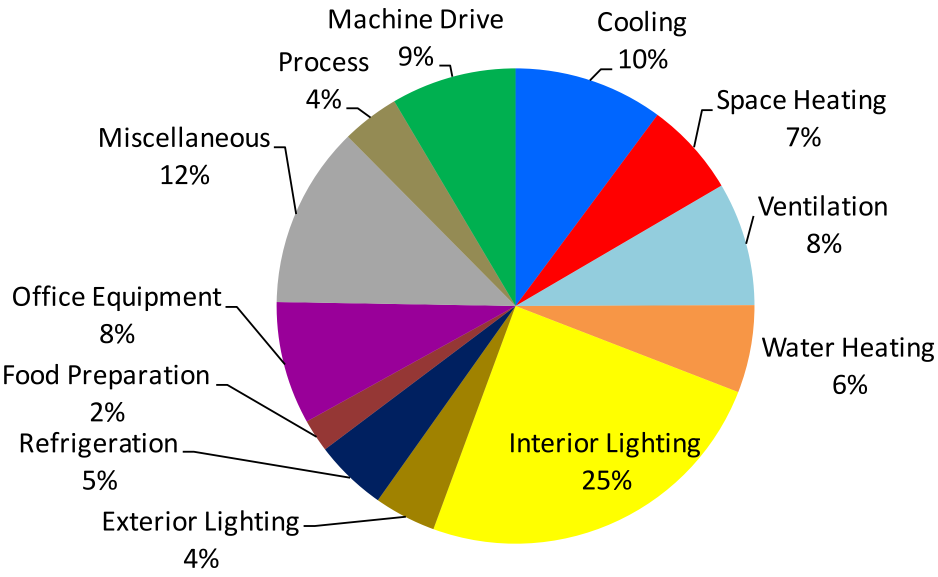
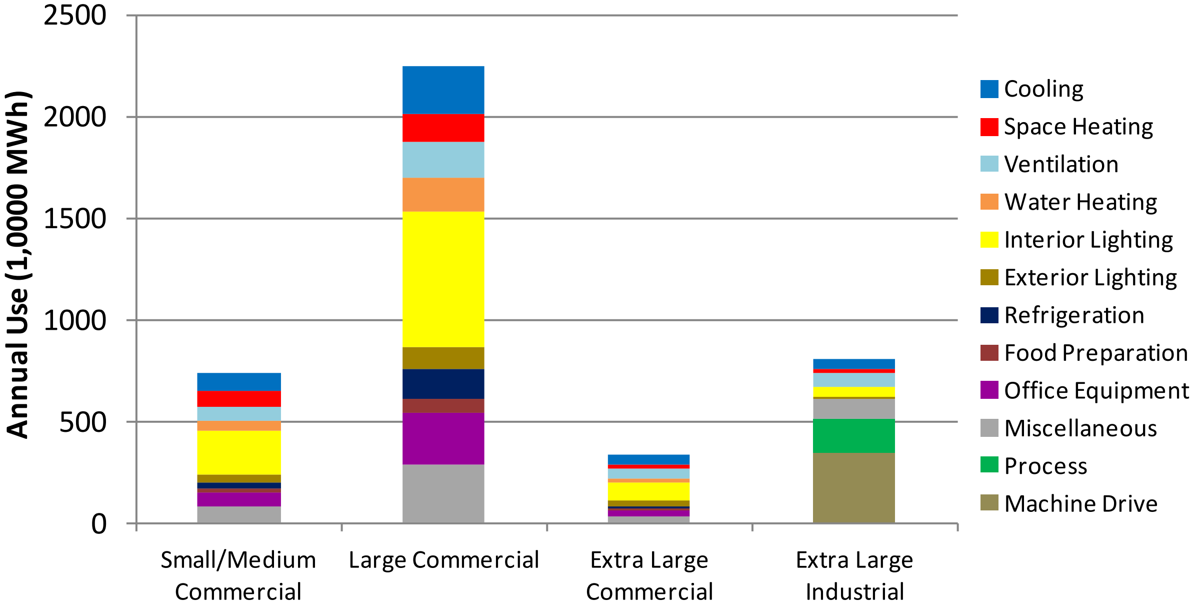


Table 3-11 C&I Electricity Consumption by End Use and Segment (GWh, 2009)

End Use	Small/Medium Commercial	Large Commercial	Extra Large Commercial	Extra Large Industrial	Total C&I
Cooling	87	244	43	48	421
Space Heating	68	168	42	68	347
Ventilation	53	169	24	-	246
Water Heating	213	668	93	50	1,024
Interior Lighting	39	108	22	5	174
Exterior Lighting	36	153	14	-	204
Refrigeration	16	68	8	-	92
Food Preparation	70	248	26	-	344
Office Equipment	81	293	37	99	510
Miscellaneous	75	138	28	25	266
Process	-	-	-	162	162
Machine Drive	-	-	-	352	352
Total	**739**	**2,257**	**336**	**809**	**4,141**

Figure 3-7 C&I Electricity Consumption by End Use and Segment (2009)



Observations include the following:

- Commercial buildings, including Small/Medium, Large, and Extra Large
  - Lighting is the largest single energy use across all of the commercial buildings, accounting for 34% of energy use.
  - Space conditioning, including space heating, cooling, and ventilation, is close behind with 27% of energy use.
  - Miscellaneous, which includes non-HVAC motors, vertical transport (e.g. elevators, escalators), medical equipment, telecommunications equipment, and various other loads, is the next largest energy use at 12%.
  - Office equipment, with 10% of use, is the fourth largest end use.
  - 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 64% of energy use.
  - HVAC and interior lighting consume 17% and 7% of energy respectively.

CHAPTER | **4**

CONSERVATION POTENTIAL

This chapter presents the results of the potential analysis, beginning with overall potential, followed by details for each sector. All results show cumulative potential, indicating how a measure installed in one year continues to provide savings in subsequent years through the end of its useful measure life. Incremental annual results appear in Appendix E.

Overall Potential

Figure 4-1 and Table 4-1 summarize the achievable potential across all sectors. The C&I sector accounts for the about 55% of the savings initially, and over time its share of savings grows to around 60%.

Figure 4-1 Cumulative Achievable Potential by Sector (MWh)

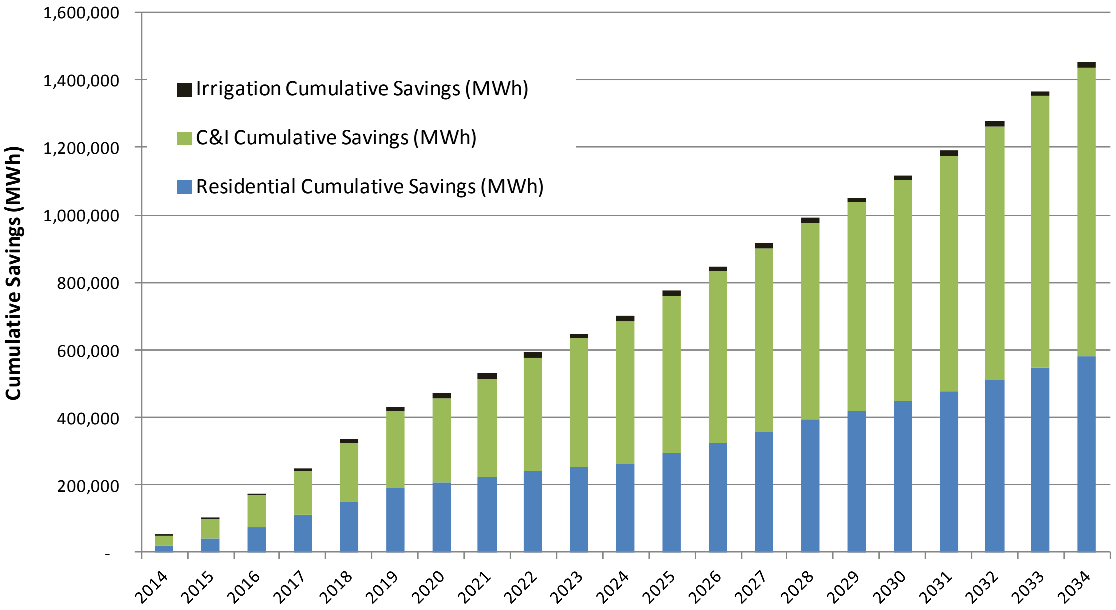


Table 4-1 Cumulative Achievable Potential by State and Sector (MWh)

	2014	2015	2018	2023	2028	2033
Washington Achievable Cumulative Savings (MWh)						
Residential	15,091	29,603	100,792	172,576	266,751	369,293
C&I	19,927	40,930	123,755	256,653	392,186	543,380
Pumping	1,402	3,237	8,742	10,535	10,535	10,535
Total	**36,420**	**73,770**	**233,289**	**439,764**	**669,472**	**923,208**
Washington Achievable Cumulative Savings (aMW)						
Residential	1.7	3.4	11.5	19.7	30.5	42.2
C&I	2.3	4.7	14.1	29.3	44.8	62.0
Pumping	0.2	0.4	1.0	1.2	1.2	1.2
Total	**4.2**	**8.4**	**26.6**	**50.2**	**76.4**	**105.4**
	2014	**2015**	**2018**	**2023**	**2028**	**2033**
Idaho Achievable Cumulative Savings (MWh)						
Residential	6,757	13,183	46,795	79,385	125,347	177,826
C&I	8,863	16,427	53,214	124,987	192,518	261,813
Pumping	618	1,426	3,852	4,642	4,642	4,642
Total	**16,238**	**31,036**	**103,861**	**209,014**	**322,507**	**444,281**
Idaho Achievable Cumulative Savings (aMW)						
Residential	0.8	1.5	5.3	9.1	14.3	20.3
C&I	1.0	1.9	6.1	14.3	22.0	29.9
Pumping	0.1	0.2	0.4	0.5	0.5	0.5
Total	**1.9**	**3.5**	**11.9**	**23.9**	**36.8**	**50.7**
	2014	**2015**	**2018**	**2023**	**2028**	**2033**
Washington and Idaho Achievable Cumulative Savings (MWh)						
Residential	21,848	42,786	147,588	251,961	392,098	547,119
C&I	28,790	57,357	176,969	381,640	584,703	805,193
Pumping	2,020	4,663	12,593	15,177	15,177	15,177
Total	**52,657**	**104,806**	**337,150**	**648,778**	**991,979**	**1,367,490**
Washington and Idaho Achievable Cumulative Savings (aMW)						
Residential	2.5	4.9	16.8	28.8	44.8	62.5
C&I	3.3	6.5	20.2	43.6	66.7	91.9
Pumping	0.2	0.5	1.4	1.7	1.7	1.7
Total	**6.0**	**12.0**	**38.5**	**74.1**	**113.2**	**156.1**

Table 4-2 summarizes the three levels of conservation potential, by state and for the overall service territory, for selected years. For rate class 25P and pumping customers, only achievable potential was assessed; economic and technical potential for these two small rate classes are assumed to be equal to achievable potential.

Table 4-2 Summary of Cumulative Conservation Potential

	2014	2015	2018	2023	2028	2033
Washington Cumulative Savings (MWh)						
Achievable Potential	36,420	73,770	233,289	439,764	669,472	923,208
Economic Potential	214,944	329,262	741,547	1,131,761	1,539,860	1,807,576
Technical Potential	794,447	941,497	1,550,783	2,212,885	2,704,067	3,024,259
Washington Cumulative Savings (aMW)						
Achievable Potential	4.2	8.4	26.6	50.2	76.4	105.4
Economic Potential	24.5	37.6	84.7	129.2	175.8	206.3
Technical Potential	90.7	107.5	177.0	252.6	308.7	345.2
Idaho Cumulative Savings (MWh)						
Achievable Potential	16,238	31,036	103,861	209,014	322,507	444,281
Economic Potential	101,779	151,705	350,121	538,404	734,193	859,791
Technical Potential	368,926	430,787	700,966	975,464	1,195,587	1,330,893
Idaho Cumulative Savings (aMW)						
Achievable Potential	1.9	3.5	11.9	23.9	36.8	50.7
Economic Potential	11.6	17.3	40.0	61.5	83.8	98.1
Technical Potential	42.1	49.2	80.0	111.4	136.5	151.9
Total Washington and Idaho Cumulative Savings (MWh)						
Achievable Potential	52,657	104,806	337,150	648,778	991,979	1,367,490
Economic Potential	316,722	480,967	1,091,669	1,670,165	2,274,053	2,667,367
Technical Potential	1,163,373	1,372,283	2,251,749	3,188,349	3,899,655	4,355,152
Total Washington and Idaho Cumulative Savings (aMW)						
Achievable Potential	6.0	12.0	38.5	74.1	113.2	156.1
Economic Potential	36.2	54.9	124.6	190.7	259.6	304.5
Technical Potential	132.8	156.7	257.0	364.0	445.2	497.2

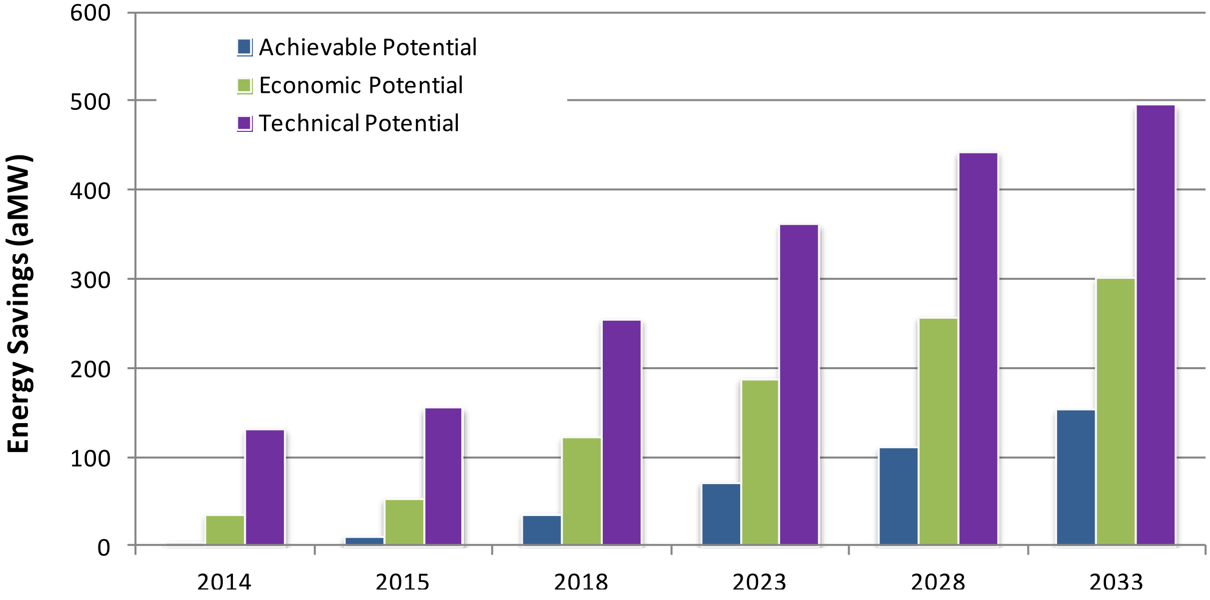
Note: For pumping and rate class 25P, only achievable potential was calculated and thus economic and technical potential were assumed to be equal to achievable potential for these two rate classes.

Key findings related to cumulative conservation potentials are as follows.

- **Achievable potential**, for the residential, commercial, and industrial sectors is 100,143 MWh or 11.4 aMW for the 2014–2015 biennium. With the addition of pumping, achievable potential is 12.0 aMW for the 2014-2015 biennium and increases to 156.1 aMW by 2033. Washington provides approximately 70% of the potential in most years. Washington provides approximately 70% of the potential in most years. Over the 2014–2033 period, the achievable potential forecast offsets 39% of the overall growth in the residential and C&I combined baseline projections.
- **Economic potential**, which reflects the savings when all cost-effective measures are taken, is 480,967 MWh or 54.9 aMW for2014-2015. By 2033, economic potential reaches 304.5 aMW.
- **Technical potential**, which reflects the adoption of all conservation measures regardless of cost-effectiveness, is a theoretical upper bound on savings. For 2014–2015, technical potential savings are 1, 372,283 MWh or 156.7 aMW. By 2033, technical potential reaches 497.2 aMW.

Error! Not a valid bookmark self-reference. presents the three levels of potential for Residential and C&I graphically.

Figure 4-2 Summary of Cumulative Energy Savings, Residential and C&I



Note: Excludes pumping and rate class 25P.

Residential Sector

Table 4-3 presents estimates for the three types of potential for the residential sector.

Table 4-3 Conservation Potential for the Residential Sector

	2014	2015	2018	2023	2028	2033
Cumulative Savings (MWh)						
Achievable Potential	21,848	42,786	147,588	251,961	392,098	547,119
Economic Potential	231,078	335,111	744,684	1,041,719	1,390,377	1,549,252
Technical Potential	963,411	1,037,905	1,338,457	1,473,324	1,727,383	1,911,746
Energy Savings (aMW)						
Achievable Potential	2.5	4.9	16.8	28.8	44.8	62.5
Economic Potential	26.4	38.3	85.0	118.9	158.7	176.9
Technical Potential	110.0	118.5	152.8	168.2	197.2	218.2

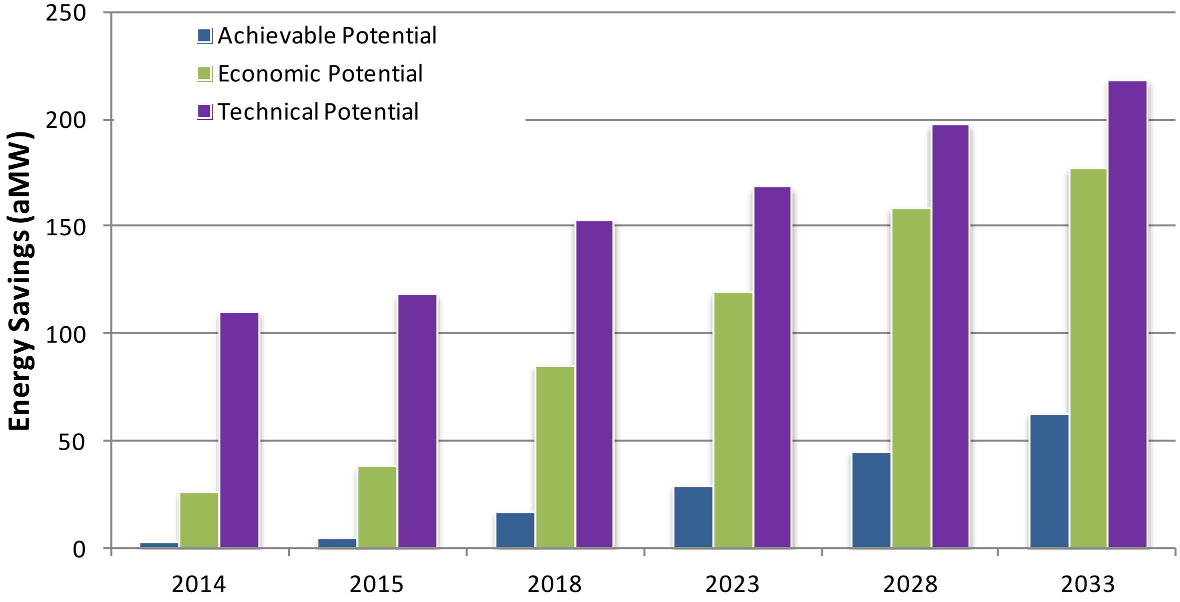
We note the following:

- **Achievable potential** for the 2014-2015 biennium is 42,786 MWh, or approximately 4.9 aMW. By 2033, the cumulative achievable projection savings are 62.5 aMW.
- **Economic potential**, which reflects the savings when all cost-effective measures are taken, is 335,111 MWh for 2014-2015. By 2033, economic potential reaches 176.9 aMW.

- **Technical potential** in the residential sector is substantial, because measures such as LED lamps, heat pump water heaters, and solar water heating could cut energy use dramatically. The 2014–2015 technical potential is 1,037,905 MWh. By 2033, technical potential reaches 218.2 aMW. The relatively wide gap between technical and economic potential reflects the fact that Avista's long-running residential conservation programs have already achieved much of the conservation that is cost-effective. In addition, avoided costs are lower than in the past CPA. As a result, additional conservation measures are becoming relatively more costly, and many do not pass the cost-effectiveness screen based on Avista's current avoided costs.

Figure 4-3 depicts the potential energy savings estimates graphically.

Figure 4-3 Residential Cumulative Savings by Potential Case



Residential Potential by End Use, Technology, and Measure Type

Table 4-4 provides estimates of savings for each end use and type of potential.

Table 4-4 Residential Cumulative Savings by End Use and Potential Type (MWh)

End Use	Potential Case	2014	2015	2018	2023	2028	2033
Cooling	Achievable	620	1,206	3,955	8,711	13,826	16,615
	Economic	1,968	2,742	8,812	14,724	19,958	23,154
	Technical	80,951	84,487	96,347	115,936	138,315	155,998
Space Heating	Achievable	3,984	8,769	29,422	72,188	126,808	178,884
	Economic	33,250	59,904	165,564	317,802	479,738	572,297
	Technical	426,183	437,898	485,931	568,938	690,804	784,960
Water Heating	Achievable	3,409	9,111	35,322	88,903	146,861	201,703
	Economic	139,048	174,837	285,037	498,268	694,979	750,037
	Technical	205,283	224,051	279,694	387,782	492,126	528,826
Interior Lighting	Achievable	9,112	15,439	56,325	50,856	61,722	77,434
	Economic	36,447	61,757	193,632	121,765	101,412	89,845
	Technical	69,443	97,468	237,734	172,522	159,744	176,303
Exterior Lighting	Achievable	3,121	5,340	14,121	7,568	1,767	4,771
	Economic	12,486	21,361	56,554	18,869	4,680	5,178
	Technical	29,639	37,425	63,855	27,506	18,316	19,975
Appliances	Achievable	1,210	1,979	4,746	11,476	15,137	22,253
	Economic	2,171	3,494	7,934	23,758	26,088	31,776
	Technical	110,903	106,754	97,381	96,098	99,364	99,247
Electronics	Achievable	269	635	2,466	8,038	16,469	27,134
	Economic	4,242	8,047	19,593	31,158	39,062	44,050
	Technical	38,001	44,875	66,641	83,650	96,504	106,895
Misc.	Achievable	122	307	1,232	4,220	9,509	18,325
	Economic	1,465	2,969	7,558	15,375	24,460	32,915
	Technical	3,009	4,947	10,872	20,892	32,212	39,542
5Total	Achievable	21,848	42,786	147,588	251,961	392,098	547,119
	Economic	231,078	335,111	744,684	1,041,719	1,390,377	1,549,252
	Technical	963,411	1,037,905	1,338,457	1,473,324	1,727,383	1,911,746

Focusing first on technical and economic potential, there are significant savings that are both possible and economic in numerous end uses:

- **Space heating** offers the highest technical potential, which would be achieved if all electric furnaces were replaced with SEER 16 air-source heat pumps (either when furnaces fail or by installing a heat pump in lieu of a furnace during new construction) and all electric resistance heat was converted to ductless mini-split systems. Note that conversion to gas is not included in the technical potential because it does not result in the least energy use at the site level.[7] On the other hand, conversion to gas furnaces is cost-effective and is thus included in the economic potential. In addition, replacing electric resistance heat with

---

[7] Based on multiplying site-level electricity use in kWh by 3.412 to convert to equivalent kBTU for comparison with natural gas use.

ductless heat pumps, selected shell measures, and thermostats also contribute to economic potential. By 2018, space heating is the third highest contributor to economic potential.

- **Water heating** offers the second-highest technical potential savings in 2014, which reflects the across-the-board installation of heat pump water heaters and solar water heating. Although solar water heating does not pass the TRC B/C screening, HPWH are found to be cost-effective for water heaters in single family homes.[8] As with furnaces, conversion to gas is not included in technical potential, but does feature in economic potential. Consequently, economic potential actually grows more rapidly than technical potential. By 2018, water heating is projected to be the largest contributor to economic potential.
- **Appliances** offer the third-highest technical potential in the near term. This reflects both the replacement of failed white-goods appliances with the highest-efficiency option and removal of second refrigerators in appliance recycling programs. However, once the new appliance standards take effect in 2015, relative savings in this category diminish and therefore many technologies no longer pass the economic screen, yielding economic potential that is relatively small.
- **Interior and Exterior Lighting** combine to provide the fourth largest source of technical potential. Initially, economic potential is substantial as well, due to CFLs and high-efficiency linear fluorescent options. By 2018, LEDs have become the cost-effective option in many segments, and thus economic potential grows substantially, making lighting the second highest source of economic potential, behind only water heating.
- **Cooling** also offer substantial technical potential savings opportunities which would be achieved if all air conditioning systems were converted to the highest efficiency units. However, standards again diminish savings relative to the base case and lower cost-effectiveness such that cooling measures are eliminated from economic potential.
- **Electronics** provides substantial technical potential as well, but most alternatives for higher efficiency are not cost effective, largely because the baseline case already incorporates relatively high efficiency equipment, as a result of successful market transformation efforts to date.

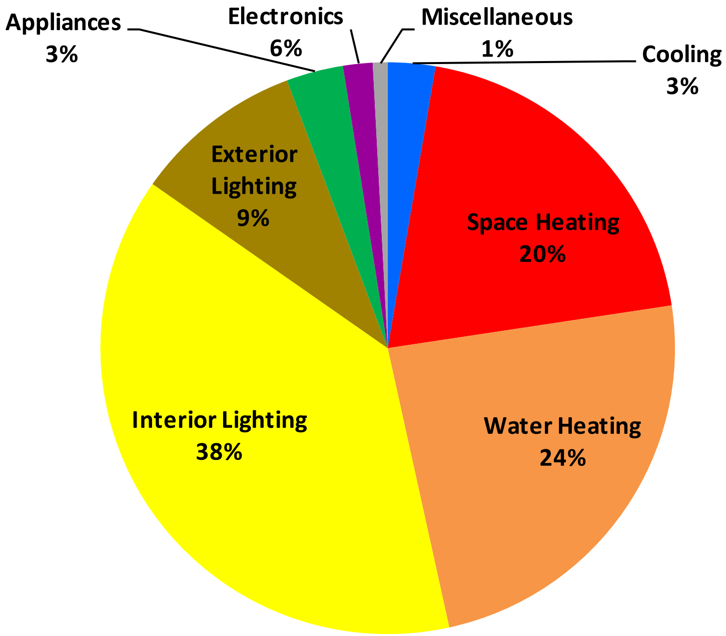
Figure 4-4 presents the residential cumulative achievable potential in 2018. This reflects the application of market acceptance rate factor to economic potential, to model how factors including market barriers, customer acceptance, and program maturity affect how quickly measures are implemented. As discussed in Chapter 2, market acceptance rates were developed based on the Sixth Plan ramp rates with adjustments to match Avista program history. We note the following:

- **Lighting**, primarily the conversion of both interior and exterior lamps to compact fluorescent lamps in the first few years, followed by LEDs starting in 2017, represents 70,446 MWh or 47% of savings. Utility programs and other market transformation programs have made customers accepting of new lighting technologies, and thus these technologies are relatively well accepted by consumers.
- **Water heating** is the next highest source of achievable potential. As discussed above, water heating provides the largest economic potential, but the market for heat pump water heaters remains immature, and thus the uptake of this technology is limited in the near term. Although conversion to gas water heating is a mature technology and readily accepted, customers may be unable to convert at the time of replacement due to timing issues or other considerations.
- **Space heating** provides 20% of achievable potential mainly due to electric furnaces being converted to gas units, and resistance heating being displaced by ductless heat pumps.

---

[8] HPWH become the baseline technology for water heaters ≥55 gallons beginning in 2016 due to a standards change, and thus the larger water heaters do not contribute to potential after 2016.

Figure 4-4 Residential Cumulative Achievable Potential by End Use in 2018



As described in Chapter 2, using our LoadMAP model, we develop separate estimates of potential for equipment and non-equipment measures. Table 4-5 presents results for equipment achievable potential at the technology level and Table 4-6 presents non-equipment measures for those measures that passed the cost-effectiveness screening. Initially, the majority of the savings come from the equipment measures, with lighting leading the way. Water heating, space heating, appliances and electronics, mainly televisions, provide savings as well. Over time, non-equipment measures, which are phased into the market more slowly but produce long-lasting savings (e.g., controls, water-saving fixtures, shell measures), produce a greater share of savings. In the non-equipment category, tank blanket installation, pipe insulation and thermostat setbacks for water heaters provide the greatest savings.

Table 4-5 Residential Cumulative Achievable Potential for Equipment Measures (MWh)

End Use	Technology	2014	2015	2018	2023	2028	2033
Cooling	Central AC	500	1,014	2,687	5,462	8,714	10,055
	Room AC	-	-	-	-	-	-
	Air Source Heat Pump	93	94	95	96	97	205
	Geothermal Heat Pump	-	-	-	-	-	-
Space Heating	Electric Resistance	348	837	3,738	13,323	31,336	52,036
	Electric Furnace	3,159	6,839	17,175	33,802	56,037	75,385
	Air Source Heat Pump	256	257	261	264	267	3,561
	Geothermal Heat Pump	-	-	-	-	-	-
Water Heating	Water Heater <= 55 Gal	1,604	3,654	11,129	38,369	82,577	136,249
	Water Heater > 55 Gal	119	166	331	810	1,387	1,944
Interior Lighting	Screw-in	6,268	9,722	39,805	18,279	7,524	15
	Linear Fluorescent	5	10	36	8	-	21
	Specialty	2,838	5,707	16,484	32,296	53,577	76,495
Exterior Lighting	Screw-in	3,121	5,340	14,121	7,568	1,767	4,771
Appliances	Clothes Washer	548	546	542	533	53	12
	Clothes Dryer	-	-	-	-	-	-
	Dishwasher	-	-	-	80	288	601
	Refrigerator	383	775	2,187	4,655	5,854	9,371
	Freezer	34	172	789	1,527	2,647	4,219
	Second Refrigerator	131	259	668	1,413	1,851	3,151
	Stove	114	227	560	1,296	2,109	2,470
	Microwave	-	-	-	-	-	-
Electronics	Personal Computers	106	260	1,111	3,079	5,678	9,692
	TVs	74	187	745	2,543	5,118	7,419
	Set-top boxes/DVR	89	188	610	2,417	5,673	10,023
	Devices and Gadgets	-	-	-	-	-	-
Miscellaneous	Pool Pump	6	15	62	241	968	2,961
	Furnace Fan	116	291	1,170	3,979	8,541	15,364
	Miscellaneous	-	-	-	-	-	-
Grand Total		19,915	36,560	114,306	172,041	282,064	426,022

Table 4-6 Residential Cumulative Achievable Savings for Non-equipment Measures (MWh), continued

Measure	2014	2015	2018	2023	2028	2033
Insulation - Ceiling	-	-	53	174	308	606
Insulation - Foundation	-	-	791	2,225	4,753	7,090
Insulation - Infiltration Control	-	-	1,692	9,543	16,408	20,226
Insulation - Wall Cavity	5	18	101	399	1,025	2,887
Refrigerator - Remove Second Unit	-	-	-	1,973	2,335	2,429
Thermostat - Clock/Programmable	243	917	6,783	14,483	18,457	18,619
Water Heater - Faucet Aerators	238	807	3,244	6,411	7,897	7,706
Water Heater - Pipe Insulation	335	1,129	4,790	9,307	11,296	10,828
Water Heater - Low Flow Showerheads	203	606	5,885	14,759	17,448	17,087
Water Heater - Tank Blanket/Insulation	575	1,909	7,317	13,150	14,736	12,937
Water Heater - Thermostat Setback	334	841	2,626	6,097	11,519	14,951
Advanced New Construction Designs	-	-	-	-	1,079	1,801
Behavioral Measures	-	-	-	1,400	2,773	3,930
Total	**1,933**	**6,226**	**33,281**	**79,920**	**110,034**	**121,098**

Residential Potential by Market Segment

Single-family homes were slightly more than half of Avista's residential customers and represented 66% of the sector's energy use in 2009. Furthermore, potential savings are generally higher in single family homes, which have larger saturations of equipment beyond the basics of space heating, water heating, and appliances. Thus, single-family homes account for the largest share of potential savings by segment, representing approximately 73% of achievable potential across the study period as indicated in Table 4-6. Table 4-7 shows the three potential cases by housing type in 2018.

Table 4-6 ***Residential Cumulative Achievable Potential by Market Segment***

	2014	2015	2018	2023	2028	2033
Achievable Savings (MWh)						
Single Family	15,922	30,820	102,461	174,454	268,519	370,353
Multi Family	765	1,551	6,307	11,114	17,841	26,271
Mobile Home	619	1,259	4,131	6,589	10,014	13,837
Low Income	4,541	9,156	34,688	59,803	95,724	136,659
Total	**21,848**	**42,786**	**147,588**	**251,961**	**392,098**	**547,119**
Achievable - % of Savings						
Single Family	73%	72%	69%	69%	68%	68%
Multi Family	4%	4%	4%	4%	5%	5%
Mobile Home	3%	3%	3%	3%	3%	3%
Low Income	21%	21%	24%	24%	24%	25%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 4-7 ***Residential Cumulative Achievable Potential by End Use and Market Segment, 2018 (MWh)***

	Single Family	Multi Family	Mobile Home	Low Income
Energy Savings (MWh)				
Achievable Potential	102,461	6,307	4,131	34,688
Economic Potential	464,782	37,980	31,907	210,015
Technical Potential	1,434,368	173,515	131,221	909,267
Energy Savings (aMW)				
Achievable Potential	4%	3%	3%	4%
Economic Potential	20%	20%	26%	24%
Technical Potential	61%	90%	106%	105%

Table 4-8 shows the savings by end use and market segment in 2018. Across all housing types, as discussed previous, lighting is the single largest opportunity, followed by water heating, and space heating. In mobile homes and low income, however, the potential for space heating is higher than for water heating, due to the higher saturation of electric heat, as well as less efficient building shells.

Table 4-8 Residential Cumulative Achievable Potential by End Use and Market Segment, 2018 (MWh)

End Use	Single Family	Multi Family	Mobile Home	Low Income	All Homes
Cooling	3,029	31	57	838	3,955
Space Heating	17,689	982	1,117	9,634	29,422
Water Heating	25,266	1,761	490	7,805	35,322
Interior Lighting	39,315	3,053	1,728	12,228	56,325
Exterior Lighting	11,190	87	488	2,355	14,121
Appliances	3,276	228	131	1,112	4,746
Electronics	1,698	142	75	550	2,466
Miscellaneous	998	23	45	167	1,232
Total	102,461	6,307	4,131	34,688	147,588

C&I Sector Potential

The baseline projection for the commercial sector grows steadily during the projection period as the region emerges from the economic downturn. As a result, opportunities for energy-efficiency savings are significant for the C&I sector.

- **Achievable potential** for the 2014-2015 biennium is 57,354 MWh, or approximately 6.5 aMW. By 2033, the cumulative achievable projection savings are 91.9 aMW. Potential for rate class 25P was separately assessed, outside the LoadMAP model, at approximately 1 MWh annually.
- **Economic potential** is 141,191 MWh for 2014-2015. By 2033, economic potential reaches 125.9 aMW.
- **Technical potential** for 2014–2015 potential is 329,713 MWh. By 2033, technical potential reaches 277.2 aMW.

Table 4-9 and Note: Excludes rate class 25P.

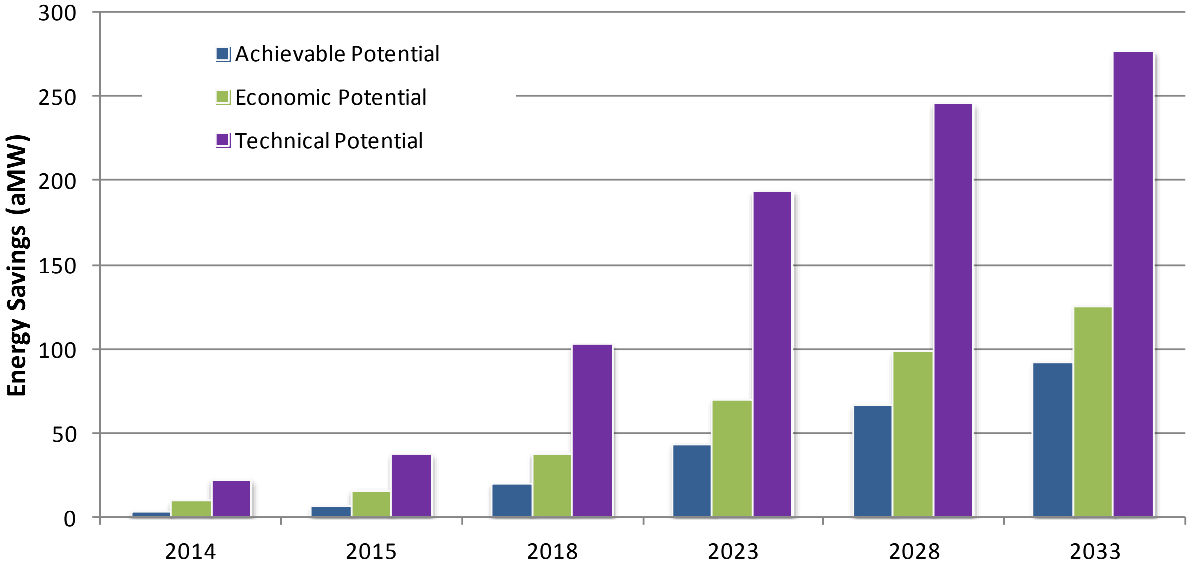
Figure 4-5 present the savings associated with each level of potential.

Table 4-9 Cumulative Conservation Potential for the C&I Sector

	2014	2015	2018	2023	2028	2033
Cumulative Savings (MWh)						
Achievable Potential	28,789	57,354	176,964	381,630	584,687	805,172
Economic Potential	83,624	141,191	334,386	613,258	868,483	1,102,916
Technical Potential	197,941	329,713	900,694	1,699,836	2,157,078	2,428,207
Cumulative Savings (aMW)						
Achievable Potential	3.3	6.5	20.2	43.6	66.7	91.9
Economic Potential	9.5	16.1	38.2	70.0	165.7	125.9
Technical Potential	22.6	37.6	102.8	194.0	246.2	277.2

Note: Excludes rate class 25P.

Figure 4-5 C&I Cumulative Savings by Potential Case



Note: Excludes rate class 25P.

C&I Potential by End Use, Technology, and Measure Type

Table 4-10 presents the commercial and industrial sector savings by end use and potential type.

Table 4-10 C&I Cumulative Potential by End Use and Potential Type (MWh)

End Use	Potential	2014	2015	2018	2023	2028	2033
Cooling	Achievable Potential	868	1,376	4,173	16,795	34,853	49,278
	Economic Potential	1,691	2,488	7,079	27,350	53,462	72,875
	Technical Potential	19,454	29,736	97,875	196,371	253,620	294,929
Space Heating	Achievable Potential	519	715	1,803	6,917	15,359	23,827
	Economic Potential	1,288	1,733	4,283	14,806	29,018	41,719
	Technical Potential	11,159	16,184	44,222	108,389	148,257	173,675
Ventilation	Achievable Potential	963	2,239	10,061	31,438	55,099	77,805
	Economic Potential	1,133	2,739	12,553	38,972	66,375	92,514
	Technical Potential	12,706	22,200	83,691	184,710	226,874	241,650
Water Heating	Achievable Potential	1,597	3,270	10,777	32,637	78,331	126,429
	Economic Potential	11,899	22,573	57,844	122,614	211,538	238,809
	Technical Potential	15,102	29,004	80,484	159,912	266,475	297,971
Interior Lighting	Achievable Potential	17,099	34,790	99,910	159,448	196,299	274,184
	Economic Potential	44,373	71,064	145,394	208,161	247,368	342,873
	Technical Potential	77,989	127,519	332,806	565,237	668,438	745,387
Exterior Lighting	Achievable Potential	1,891	3,353	12,231	33,437	48,284	52,775
	Economic Potential	7,402	11,324	33,083	53,407	58,412	60,364
	Technical Potential	12,582	17,733	42,800	75,475	84,874	93,215
Food Preparation	Achievable Potential	1,658	3,354	9,246	20,001	28,341	35,406
	Economic Potential	2,127	4,265	11,312	24,224	34,077	42,363
	Technical Potential	3,928	7,015	17,911	40,248	58,963	73,609
Refrigeration	Achievable Potential	93	343	1,833	4,922	12,431	28,158
	Economic Potential	186	603	2,490	6,123	14,718	33,143
	Technical Potential	3,663	7,396	19,377	40,458	56,695	65,200
Office Equipment	Achievable Potential	3,000	5,894	19,718	46,832	67,723	76,351
	Economic Potential	11,327	20,590	48,337	73,793	83,277	91,979
	Technical Potential	29,051	51,981	104,158	128,436	143,820	158,781
Machine Drive	Achievable Potential	4	8	40	165	300	439
	Economic Potential	8	15	73	295	512	713
	Technical Potential	188	695	2,625	6,418	10,018	11,764
Process	Achievable Potential	426	766	3,337	13,761	26,438	35,254
	Economic Potential	862	1,501	6,179	23,952	43,702	54,818
	Technical Potential	10,272	17,192	66,674	169,003	205,886	233,266
Miscellaneous	Achievable Potential	670	1,248	3,835	15,277	21,229	25,265
	Economic Potential	1,329	2,295	5,758	19,561	26,024	30,744
	Technical Potential	1,848	3,057	8,070	25,178	33,157	38,761
Total	**Achievable Potential**	28,789	57,354	176,964	381,630	584,687	805,172
	Economic Potential	83,624	141,191	334,386	613,258	868,483	1,102,916
	Technical Potential	197,941	329,713	900,694	1,699,836	2,157,078	2,428,207

Note: Excludes rate class 25P.

The end uses with the highest technical and economic potential are:

- **Interior lighting**, as a result of LED lighting that is now commercially available, has the highest technical potential at 332,806 MWh in 2018. LEDs are found to be cost-effective in all applications beginning in either 2014 or 2015, as a result of longer hours of operation in commercial buildings. In addition, super T8s for linear fluorescent systems, T5s for high-bay fixtures, and control systems also contribute to lighting economic potential. Therefore, economic potential is highest for lighting as well, at 145,394 MWh in 2018, which is roughly 44% of the lighting technical potential and 43% of total economic potential in 2018.
- **HVAC end uses** collectively comprise 25% of technical potential or 225,778 MWh. However, relatively few measures pass the economic screen, so that economic potential is only 23,915 MWh, or about one tenth of the technical potential.
- **Office equipment** has significant technical potential of 101,158 MWh in 2018, and economic potential of 48,337 MWh
- **Water heating** technical potential comes next, with 80,484 MWh, and because measures such as HPWH and water saving devices are cost-effective, economic potential is 57,844 MWh.

Table 4-11 and Table 4-12 present achievable potential savings for equipment measures and non-equipment measures, respectively. Table 4-12 presents only measures that passed the cost-effectiveness test.

Table 4-11 C&I Cumulative Achievable Savings for Equipment Measures (MWh)

End Use	Technology	2014	2015	2018	2023	2028	2033
Cooling	Central Chiller	350	670	2,231	6,803	12,639	17,307
	RTU	-	-	-	-	-	-
	Heat Pump	-	-	-	-	-	-
Space Heating	Heat Pump	-	-	-	-	-	-
	Electric Resistance	-	-	-	-	-	-
	Furnace	-	-	-	-	-	-
Ventilation	Ventilation	963	2,072	8,768	26,596	49,646	72,087
Water Heating	Water Heater	1,311	2,844	9,464	26,736	64,973	107,400
Interior Lighting	Linear Fluorescent	93	141	5,268	29,001	44,645	68,240
	Interior Screw-in	10,160	19,861	42,656	29,637	12,498	42,051
	High Bay Fixtures	6,482	14,295	48,666	77,212	85,244	94,133
Exterior Lighting	HID	1,140	2,519	8,105	27,952	41,884	47,529
	Exterior Screw-in	678	708	3,507	2,823	2,075	-
Refrigeration	Reach-in Refrigerator	409	839	2,364	5,026	7,600	10,224
	Glass Door Display	462	946	2,614	5,502	8,266	10,964
	Open Display Case	-	-	-	-	-	-
	Icemaker	291	589	1,595	3,648	4,865	5,399
	Vending Machine	452	921	2,520	5,382	6,822	7,744
	Walk in Refrigerator	-	-	-	-	-	-
Food Preparation	Oven	-	137	944	2,673	8,844	23,982
	Fryer	93	207	670	1,532	2,303	2,660
	Dishwasher	-	-	-	-	-	-
	Hot Food Container	-	-	220	717	1,284	1,516
	Other Food Prep	-	-	-	-	-	-
Office Equipment	Desktop Computers	1,381	2,607	6,968	13,526	20,092	22,514
	Server	1,095	2,340	7,192	16,419	23,871	26,404
	Monitor	121	229	1,979	4,709	6,994	7,837
	Printer/copier/fax	-	-	395	3,452	5,311	6,242
	POS Terminal	-	-	381	956	1,425	1,613
	Laptop Computer	96	182	487	945	1,403	1,573
Miscellaneous	Non-HVAC Motor						
	Other Miscellaneous	-	-	-	-	-	-
Process	Process Cooling/Refrigeration	301	574	1,810	8,290	11,076	12,927
	Process Heating	-	-	-	-	-	-
	Electrochemical Process	293	558	1,614	5,791	8,190	9,645
Machine Drive	Less than 5 HP	3	27	122	241	640	851
	5-24 HP	7	14	41	160	212	247
	25-99 HP	19	36	104	405	537	623
	100-249 HP	11	20	59	230	305	353
	250-499 HP	3	6	32	287	343	392
	500 and more HP	6	12	60	543	649	742
Grand Total		**26,202**	**53,316**	**160,683**	**306,133**	**433,342**	**601,609**

Note: Excludes rate class 25P.

Table 4-12 C&I Cumulative Achievable Savings for Non-equipment Measures (MWh)

Measure	2014	2015	2018	2023	2028	2033
Energy Management System	1,142	1,525	3,673	15,912	39,422	63,759
Exterior Lighting - Daylighting Controls	0	0	5	58	271	482
Interior Lighting - Occupancy Sensors	0	0	9	58	113	160
Thermostat - Clock/Programmable	213	296	754	2,471	4,822	6,948
Heat Pump - Maintenance	41	69	277	918	1,387	1,634
Water Heater - Faucet Aerators/Low Flow Nozzles	-	-	-	-	-	411
Water Heater - High Efficiency Circulation Pump	285	425	1,313	5,900	13,358	18,617
Retrocommissioning - Lighting	-	-	1,689	17,461	38,207	43,900
Air-Cooled Chiller - Cond. Water Temperature Reset	0	0	87	761	1,218	1,689
Chiller - Chilled Water Reset	-	-	-	-	17	63
Chiller - Chilled Water Variable-Flow System	0	0	3	16	40	64
Chiller - High Efficiency Cooling Tower Fans	0	0	6	37	69	103
Cooling - Economizer Installation	-	-	168	1,916	4,085	4,999
Fans - Energy Efficient Motors	-	161	720	2,249	2,533	2,293
Interior Lighting - Time Clocks and Timers	-	-	-	21	92	140
Refrigeration - Strip Curtain	43	59	149	415	710	920
LED Exit Lighting	4	20	483	599	771	748
Refrigeration - High Efficiency Case Lighting	-	1	5	29	78	153
Exterior Lighting - Cold Cathode Lighting	72	125	507	1,442	1,703	1,989
Laundry - High Efficiency Clothes Washer	4	7	35	115	157	192
Interior Lighting - Skylights	-	-	7	108	279	469
Office Equipment - Smart Power Strips	305	536	2,316	6,826	8,626	10,168
Ventilation - Demand Control Ventilation	0	5	571	2,576	2,875	3,349
Strategic Energy Management	5	7	62	434	1,163	1,968
Refrigeration - System Controls	28	38	85	192	297	350
Refrigeration - System Maintenance	28	44	169	482	665	829
Refrigeration - System Optimization	17	29	116	252	285	298
Motors - Variable Frequency Drive	6	13	197	1,167	2,159	3,207
Motors - Magnetic Adjustable Speed Drives	222	380	1,489	3,821	4,690	5,921
Compressed Air - System Optimization and Improvements	7	14	196	2,992	9,116	11,744
Compressed Air - Compressor Replacement	100	172	655	2,485	5,571	8,169

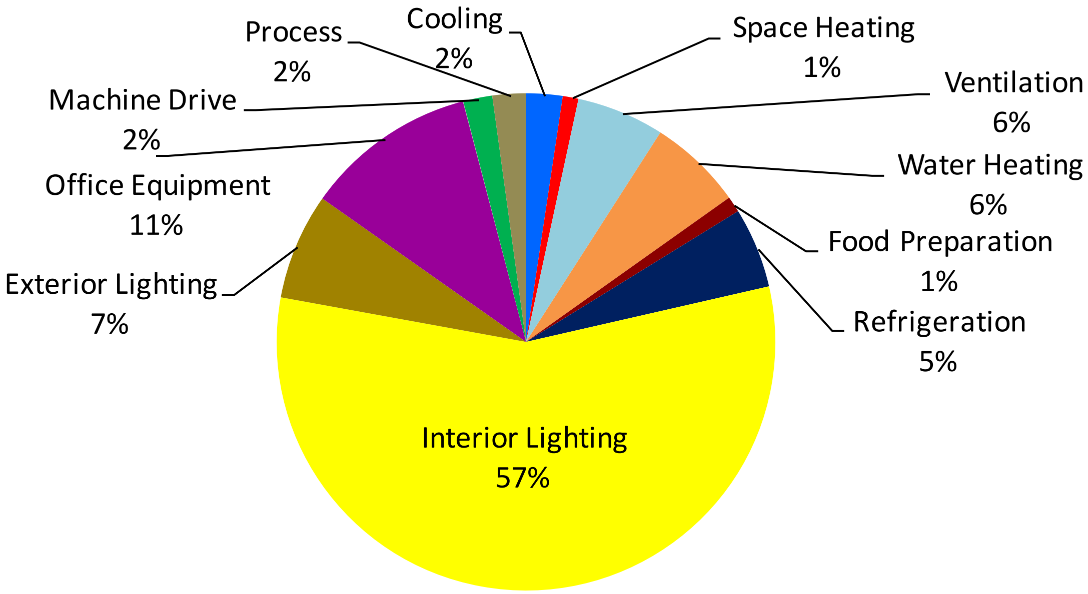
Measure	2014	2015	2018	2023	2028	2033
Fan System - Controls	3	6	27	89	126	160
Fan System - Optimization	17	29	113	291	350	382
Fan System - Maintenance	0	0	1	8	14	20
Pumping System - Controls	21	37	228	975	1,610	2,275
Pumping System - Maintenance	0	1	13	67	117	169
Total	**2,566**	**4,001**	**16,130**	**74,436**	**150,049**	**202,076**

Note: Excludes rate class 25P.

As shown in Figure 4-6, the primary sources of C&I sector achievable savings in 2018 are as follows:

- Interior and exterior lighting, comprising lamps, fixtures, and controls, account for 64% of C&I sector achievable potential. Not only is economic potential high for lighting measures, but they are more readily accepted and implemented in the market than many other, higher cost and more complex measures.
- Office Equipment, which is the second largest portion of this sector's achievable potential (11%)
- Water heating and Ventilation each provides 6% of the total savings

Figure 4-6 C&I Cumulative Achievable Potential Cumulative Savings by End Use in 2018 (percentage of total)



Note: Excludes rate class 25P.

C&I Potential by Market Segment

Table 4-13 shows potential estimates by segment in 2018. The large commercial segment has the largest achievable conservation potential of 201,247 MWh, roughly 58% of the overall commercial achievable potential. The small/medium segment follows with a large gap at 64,655 MWh.

Table 4-13 C&I Cumulative Potential by Market Segment, 2018

	Energy Savings (MWh)		
	Achievable Potential	Economic Potential	Technical Potential
Small/Med. Commercial	34,044	64,655	174,575
Large Commercial	101,745	201,247	529,133
Extra Large Commercial	16,950	31,634	79,582
Extra Large Industrial	24,224	36,850	117,403
Total	**176,964**	**334,386**	**900,694**

Note: Excludes rate class 25P.

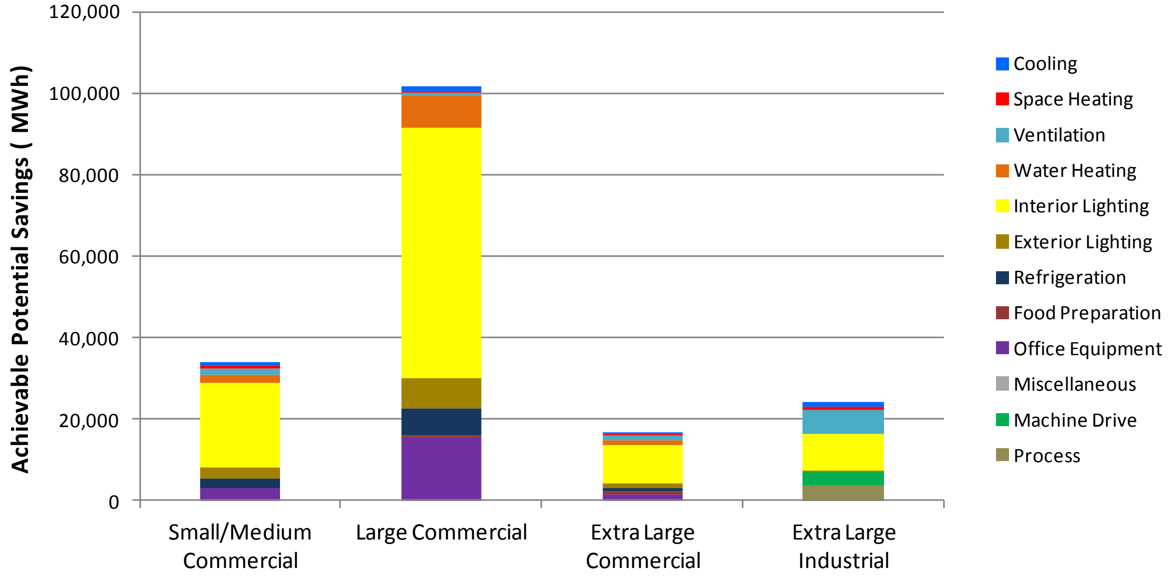
Figure 4-7 presents the achievable potential in 2018 by end use and building type. Lighting measures are key measure across all buildings.

Table 4-14 C&I Cumulative Achievable Savings in 2018 by End Use and Rate Class(MWh)

End Use	Small/Medium Commercial	Large Commercial	Extra Large Commercial	Extra Large Industrial	Total
Cooling	835	1,305	665	1,368	4,173
Space Heating	717	163	296	627	1,803
Ventilation	1,740	1,124	1,165	6,031	10,061
Water Heating	1,990	7,772	1,016	-	10,777
Interior Lighting	20,429	61,213	9,566	8,702	99,910
Exterior Lighting	2,967	7,669	1,276	318	12,231
Refrigeration	2,211	6,457	578	-	9,246
Food Preparation	220	639	975	-	1,833
Office Equipment	2,928	15,379	1,411	-	19,718
Miscellaneous	8	24	2	5	40
Process	-	-	-	3,835	3,835
Machine Drive	-	-	-	3,337	3,337
Total	**34,044**	**101,745**	**16,950**	**24,224**	**176,964**

Note: Excludes rate class 25P.

Figure 4-7 C&I Cumulative Achievable Savings in 2018 by End Use and Building Type



Note: Excludes rate class 25P.

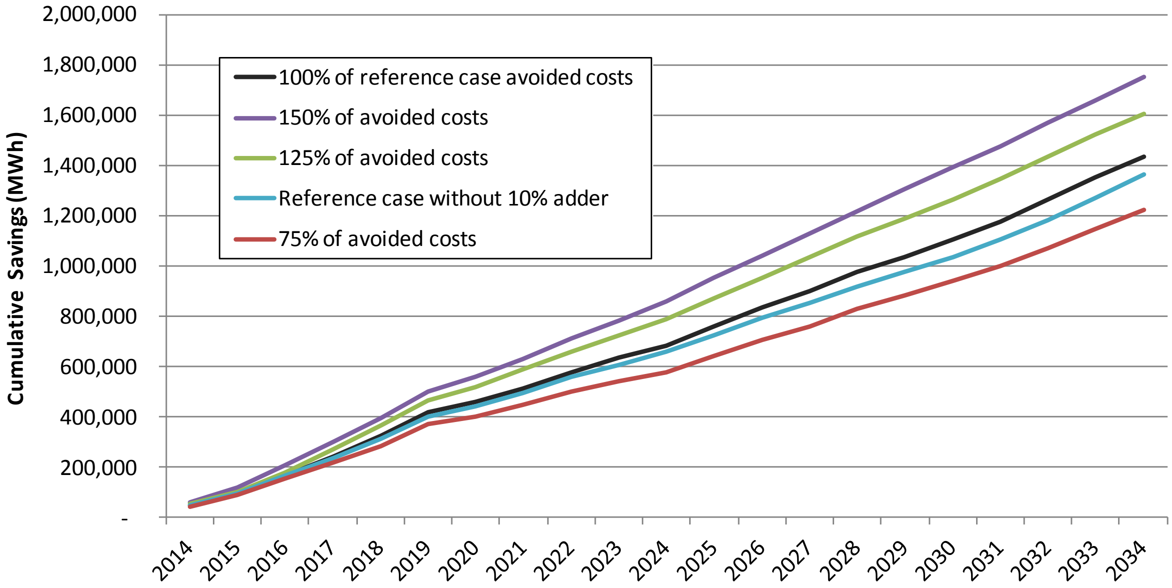
Sensitivity of Potential to Avoided Cost

Similar to the 2011 CPA, EnerNOC modeled several scenarios with varying levels of avoided costs in addition to the reference case. For this study's purposes, we have included a case where the 10% adder per NW Power and Conservation Act is removed. The other scenarios included 150%, 125%, and 75% of the avoided costs used in the reference case. Figure 4-8 and Table 4-15 show how achievable potential varies under the four scenarios.

- The reference case achievable potential reaches approximately at 1,352,291 MWh by 2033.
- Removing the 10% adder from the avoided costs decreased this achievable potential to 1,272,206 MWh, 6% reduction.
- With the 150% avoided cost case, achievable potential increased to 1,657,741 MWh while the 125% avoided cost case and the 75% avoided cost case yielded achievable potential equal to 1,521,856 and 1,146,105 MWh respectively.

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 achievable potential. Technical potential imposes a limit on the amount of additional conservation and each incremental unit of DSM becomes increasingly expensive.

Figure 4-8 Energy Savings, Cumulative Achievable Potential by Avoided Costs Scenario (MWh)



Note: Excludes pumping and rate class 25P.

Table 4-15 Achievable Potential with Varying Avoided Costs

End Use	Reference Scenario	Remove 10% adder	75% of avoided costs	125% of avoided costs	150% of avoided costs
Achievable potential savings 2033 (MWh)	1,352,291	1,272,206	1,146,105	1,521,856	1,657,741
Percentage change in savings vs. 100% avoided cost Scenario		-6%	-15%	13%	23%

Note: Excludes pumping and rate class 25P.

Electricity to Natural Gas Fuel Switching

While fuel efficiency is not considered in the NPCC Sixth Plan, Avista has a history of fuel switching from electricity to natural gas and continues to target direct use as the most efficient resource option when available. The conservation potential modeled above includes savings potential attributable to conversion of electric space and water heating to natural gas. Table 4-16 displays savings potential from converting electric furnaces and water heaters to natural gas.

Within LoadMAP, we modeled savings for these measures in the residential sector only, but because we calibrated the level of expected conversions to Avista's recent program history that includes small commercial building conversions as well, this potential may reflect a small percentage of commercial section conversions. Because conversions remove most of the electricity use from two of the largest residential end uses (water and space heating), it accounts for 8.3% of combined residential, commercial and industrial savings by 2033. For water heating, about one-fifth of the savings from gas conversions occurs in new construction. For furnaces, new construction accounts for roughly 27% of the total.

Table 4-16 Cumulative Achievable Potential from Conversion to Natural Gas (MWh)

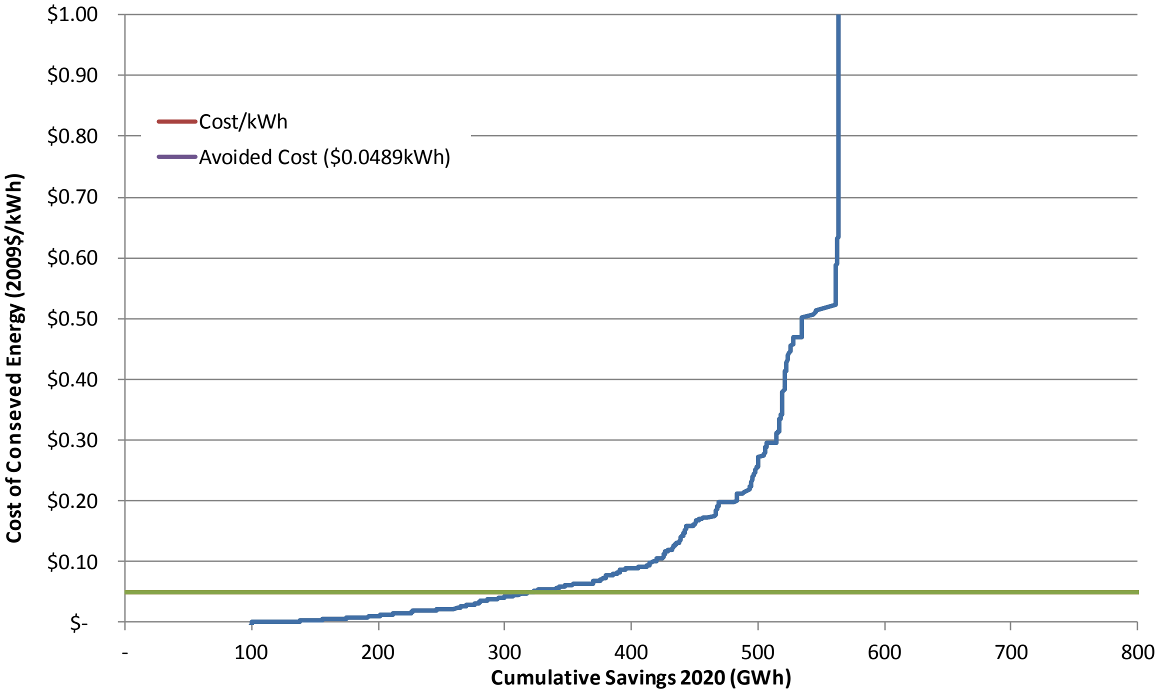
	2014	2015	2018	2023	2028	2033
Washington Cumulative Savings (MWh)						
Furnace Conversions	2,322	5,047	12,715	25,105	41,493	55,787
Water Heating Conversions	825	1,586	4,112	9,924	14,362	20,221
Total Conversions	3,148	6,633	16,827	35,028	55,855	76,009
Idaho Cumulative Savings (MWh)						
Furnace Conversions	837	1,792	4,460	8,698	14,544	19,598
Water Heating Conversions	47	121	602	4,264	10,085	16,451
Total Conversions	884	1,913	5,062	12,961	24,629	36,049
Total Washington and Idaho Cumulative Savings (MWh)						
Furnace Conversions	3,159	6,839	17,175	33,802	56,037	75,385
Water Heating Conversions	873	1,707	4,714	14,187	24,447	36,673
Total Conversions	4,032	8,546	21,889	47,990	80,484	112,058

Supply Curves

The project also developed supply curves for each year to support the IRP process. At Avista's request, the supply curves did not consider economic screening based on Avista's avoided costs. Instead, all measures were included and the amount of savings from each measure in each year was limited by the ramp rates used for achievable potential. The supply curves do not include the savings from electricity to natural gas fuel switching, discussed above.

A sample supply curve for one year is shown in Figure 4-9. This 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 supply curve also shows that substantial savings are available at low- or no-cost.

Figure 4-9 Supply Curves for Evaluated EE Measures and Avoided Cost Scenarios



Note: Excludes pumping and rate class 25P.

Pumping Potential

Table 4-18 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 2.4% of total electricity sales and 0.8% of peak demand (see Table 3-1 and Table 3-2). Because pumping represents a relatively small percentage of Avista's total sales, the project team decided to estimate achievable potential for pumping based on the Sixth Plan calculator agriculture sector, option 3.[9]

Table 4-17 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			**2.4%**	**0.8%**

The Sixth Plan Calculator estimates agricultural conservation targets based on 2007 sales. It provides annual conservation targets through 2019. Table 4-18 displays incremental annual savings potential for 2014–2019.

---

[9] Available on the NWPCC website at http://www.nwcouncil.org/energy/powerplan/6/assessmentmethodology/.

Table 4-18 Sixth Plan Calculator Agriculture Incremental Annual Potential, 2014–2019 (MWh)

Segment	2014	2015	2016	2017	2018	2019
Pumping, Washington	1,402	1,835	1,856	1,835	1,814	1,794
Pumping, Idaho	618	809	818	809	799	790
Pumping, Total	**2,020**	**2,643**	**2,673**	**2,643**	**2,614**	**2,584**

Washington Potential Excluding Conversions to Natural Gas

Based on the modeling described above, Washington potential consistent with the NPCC Conservation Plan methodology is as shown in Table 4-19.

Table 4-19 Washington Cumulative Potential Consistent with Conservation Plan Methodology

	2014	2015	2018	2023
Cumulative Savings (MWh)				
Residential	15,091	29,603	100,792	172,576
Commercial and Industrial	19,927	40,930	123,755	256,653
Pumping	1,402	3,237	8,742	0
Conversions to Natural Gas	(3,148)	(6,633)	(16,827)	(35,028)
Total	**33,272**	**67,137**	**216,462**	**394,200**
Cumulative Savings (aMW)				
Residential	1.72	3.38	11.51	19.70
Commercial and Industrial	2.27	4.67	14.13	29.30
Pumping	0.16	0.37	1.00	0.00
Conversions to Natural Gas	(0.36)	(0.76)	(1.92)	(4.00)
Total	**3.80**	**7.66**	**24.71**	**45.00**

About EnerNOC

EnerNOC's Utility Solutions Consulting team is part of EnerNOC's Utility Solutions, which provides a comprehensive suite of demand-side management (DSM) services to utilities and grid operators worldwide. Hundreds of utilities have leveraged our technology, our people, and our proven processes to make their energy efficiency (EE) and demand response (DR) initiatives a success. Utilities trust EnerNOC to work with them at every stage of the DSM program lifecycle – assessing market potential, designing effective programs, implementing those programs, and measuring program results.

EnerNOC's Utility Solutions deliver value to our utility clients through two separate practice areas – Implementation and Consulting.

- Our Implementation team leverages EnerNOC's deep "behind-the-meter expertise" and world-class technology platform to help utilities create and manage DR and EE programs that deliver reliable and cost-effective energy savings. We focus exclusively on the commercial and industrial (C&I) customer segments, with a track record of successful partnerships that spans more than a decade. Through a focus on high quality, measurable savings, EnerNOC has successfully delivered hundreds of thousands of MWh of energy efficiency for our utility clients, and we have thousands of MW of demand response capacity under management.
- The Consulting team provides expertise and analysis to support a broad range of utility DSM activities, including: potential assessments; end-use forecasts; integrated resource planning; EE, DR, and smart grid pilot and program design and administration; load research; technology assessments and demonstrations; evaluation, measurement and verification; and regulatory support.

The team has decades of combined experience in the utility DSM industry. The staff is comprised of professional electrical, mechanical, chemical, civil, industrial, and environmental engineers as well as economists, business planners, project managers, market researchers, load research professionals, and statisticians. Utilities view EnerNOC's experts as trusted advisors, and we work together collaboratively to make any DSM initiative a success.

Avista Electric Conservation Potential Assessment Study

Appendices

Report Number 1341

EnerNOC Utility Solutions Consulting
500 Ygnacio Valley Road
Suite 450
Walnut Creek, CA 94596
Tel: 925.482.2000
www.enernoc.com

Prepared for:	*Prepared by:*	*Presented on*:
Avista Corporation	EnerNOC, Inc.	May 30, 2013

This report was prepared by

EnerNOC Utility Solutions Consulting
500 Ygnacio Valley Blvd., Suite 450
Walnut Creek, CA 94596

Project Director: I. Rohmund
Project Manager: J. Borstein

CONTENTS

LIST OF TABLES

MARKET PROFILES

Market profiles describe electricity use by sector, segment, end use and technology in the base year of the study (2009). The market profiles are given for average buildings and new vintages.

As explained in Chapter 2 of the Avista Conservation Potential Assessment (CPA) report , a market profile includes the following elements:

- **Market size** is a representation of the number of customers in the segment. For the residential sector, it is number of households. In the commercial and industrial sector, it is floor space measured in square feet.
- **Saturations** define the fraction of buildings with the specific technologies. (e.g., homes with electric space heating).
- **UEC (unit energy consumption) or EUI (energy-use index)** describes the amount of energy consumed in the base year by a specific technology in buildings that have the technology. We use UECs expressed in kWh/household for the residential sector, and EUIs expressed in kWh/square foot for the commercial and industrial sectors.
- **Intensity** for the residential sector represents the average energy use for the technology across all households in the base year. It is computed as the product of the saturation and the UEC and is defined as kWh/household for electricity. For the commercial and industrial sector, intensity, computed as the product of the saturation and the EUI, represents the average use for the technology across all floor space.
- **Usage** is the annual energy use by a technology/end use in the segment. It is the product of the market size and intensity and is quantified in GWh for electricity.

This appendix presents the following market profiles:

- Residential market profiles by housing type and state (Table A-1 through Table A-8)
- C&I by rate class and state (Table A-9 through Table A-16)

Table A-1 Single Family Electric Market Profile, Washington 2009

		Average Market Profile				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%	1,393	513	56	66.1%	1,601	1,058	15.0%
Cooling	Room AC	10.8%	512	55	6	8.7%	589	51	15.0%
Cooling	Air Source Heat Pump	22.2%	833	185	20	23.3%	958	223	15.0%
Cooling	Geothermal Heat Pump	0.4%	730	3	0	0.4%	840	4	15.0%
Cooling	Ductless HP	0.0%	456	-	-	0.0%	524	-	15.0%
Space Heating	Electric Resistance	7.7%	10,302	792	86	3.8%	11,847	455	15.0%
Space Heating	Electric Furnace	9.8%	11,757	1,157	126	8.9%	13,521	1,198	15.0%
Space Heating	Supplemental	3.3%	117	4	0	3.3%	134	4	15.0%
Space Heating	Air Source Heat Pump	22.2%	8,561	1,903	208	22.2%	9,845	2,188	15.0%
Space Heating	Geothermal Heat Pump	0.4%	4,833	20	2	0.4%	5,558	23	15.0%
Space Heating	Ductless HP	0.0%	4,000	-	-	0.0%	4,600	-	15.0%
Water Heating	Water Heater <= 55 Gal	53.2%	4,031	2,143	234	48.6%	3,684	1,790	-8.6%
Water Heating	Water Heater > 55 Gal	5.6%	4,552	257	28	5.2%	4,157	214	-8.7%
Interior Lighting	Screw-in	100.0%	1,295	1,295	141	100.0%	1,425	1,425	10.0%
Interior Lighting	Linear Fluorescent	100.0%	128	128	14	100.0%	141	141	10.0%
Interior Lighting	Specialty	100.0%	356	356	39	100.0%	409	409	15.0%
Exterior Lighting	Screw-in	100.0%	363	363	40	100.0%	400	400	10.0%
Appliances	Clothes Washer	98.0%	126	124	13	99.8%	95	94	-25.0%
Appliances	Clothes Dryer	92.8%	549	509	56	97.4%	466	454	-15.0%
Appliances	Dishwasher	93.9%	434	407	44	98.6%	369	364	-15.0%
Appliances	Refrigerator	100.0%	793	793	87	100.0%	539	539	-32.0%
Appliances	Freezer	59.9%	881	528	58	69.4%	554	384	-37.1%
Appliances	Second Refrigerator	31.3%	1,083	339	37	31.3%	693	217	-36.0%
Appliances	Stove	85.1%	443	377	41	82.1%	443	364	0.0%
Appliances	Microwave	98.5%	130	128	14	98.5%	134	132	3.0%
Electronics	Personal Computers	140.0%	227	317	35	154.0%	227	349	0.0%
Electronics	TVs	234.0%	240	562	61	245.7%	240	590	0.0%
Electronics	Set-top boxes/DVR	171.7%	136	234	26	188.8%	136	257	0.0%
Electronics	Devices and Gadgets	100.0%	60	60	7	105.0%	67	70	10.0%
Miscellaneous	Pool Pump	5.0%	1,500	75	8	5.3%	1,526	80	1.7%
Miscellaneous	Furnace Fan	59.4%	622	370	40	62.4%	622	388	0.0%
Miscellaneous	Miscellaneous	100.0%	549	549	60	100.0%	604	604	10.0%
Total				14,547	1,588			14,471	-0.5%

Table A-2 Multi Family Electric Market Profile, Washington 2009

		Average Market Profile				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%	464	23	0	15.0%	534	80	15.0%
Cooling	Room AC	25.0%	355	89	2	18.9%	409	77	15.0%
Cooling	Air Source Heat Pump	1.0%	429	4	0	1.1%	493	5	15.0%
Cooling	Geothermal Heat Pump	0.0%	444	-	-	0.2%	511	1	15.0%
Cooling	Ductless HP	0.0%	229	-	-	0.0%	263	-	15.0%
Space Heating	Electric Resistance	59.0%	5,180	3,056	56	47.2%	5,957	2,812	15.0%
Space Heating	Electric Furnace	5.0%	5,162	258	5	6.0%	5,936	356	15.0%
Space Heating	Supplemental	18.0%	61	11	0	18.0%	70	13	15.0%
Space Heating	Air Source Heat Pump	1.0%	3,220	32	1	1.0%	3,703	37	15.0%
Space Heating	Geothermal Heat Pump	0.0%	2,898	-	-	0.0%	3,333	-	15.0%
Space Heating	Ductless HP	0.0%	2,011	-	-	0.0%	2,313	-	15.0%
Water Heating	Water Heater <= 55 Gal	77.0%	2,142	1,650	30	75.0%	1,958	1,469	-8.6%
Water Heating	Water Heater > 55 Gal	0.0%	3,142	-	-	0.0%	2,870	-	-8.7%
Interior Lighting	Screw-in	100.0%	784	784	14	100.0%	863	863	10.0%
Interior Lighting	Linear Fluorescent	100.0%	89	89	2	100.0%	98	98	10.0%
Interior Lighting	Specialty	100.0%	143	143	3	100.0%	164	164	15.0%
Exterior Lighting	Screw-in	100.0%	21	21	0	100.0%	23	23	10.0%
Appliances	Clothes Washer	32.0%	101	32	1	48.0%	76	36	-25.0%
Appliances	Clothes Dryer	30.7%	439	135	2	46.1%	373	172	-15.0%
Appliances	Dishwasher	64.0%	347	222	4	96.0%	295	283	-15.0%
Appliances	Refrigerator	100.0%	634	634	12	100.0%	431	431	-32.0%
Appliances	Freezer	8.4%	705	59	1	8.9%	443	39	-37.1%
Appliances	Second Refrigerator	5.0%	866	43	1	5.0%	554	28	-36.0%
Appliances	Stove	96.4%	354	342	6	96.4%	354	342	0.0%
Appliances	Microwave	90.0%	104	94	2	90.0%	107	96	3.0%
Electronics	Personal Computers	63.0%	181	114	2	69.3%	181	126	0.0%
Electronics	TVs	165.0%	216	357	7	173.3%	216	375	0.0%
Electronics	Set-top boxes/DVR	154.5%	136	211	4	170.0%	136	232	0.0%
Electronics	Devices and Gadgets	100.0%	54	54	1	105.0%	60	63	10.0%
Miscellaneous	Pool Pump	0.0%	1,500	-	-	0.0%	1,526	-	1.7%
Miscellaneous	Furnace Fan	13.0%	498	65	1	13.7%	498	68	0.0%
Miscellaneous	Miscellaneous	100.0%	206	206	4	100.0%	226	226	10.0%
Total				8,728	159			8,514	-2.5%

Table A-3 Mobile Home Electric Market Profile, Washington 2009

		Average Market Profile				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%	553	128	1	39.4%	594	234	7.5%
Cooling	Room AC	23.2%	305	71	0	22.0%	328	72	7.5%
Cooling	Air Source Heat Pump	21.7%	361	79	0	22.8%	388	89	7.5%
Cooling	Geothermal Heat Pump	0.0%	325	-	-	0.0%	349	-	7.5%
Cooling	Ductless HP	0.0%	302	-	-	0.0%	324	-	7.5%
Space Heating	Electric Resistance	1.2%	6,823	81	0	1.1%	7,335	83	7.5%
Space Heating	Electric Furnace	57.6%	7,321	4,214	22	57.6%	7,870	4,530	7.5%
Space Heating	Supplemental	1.4%	3,780	54	0	1.5%	4,064	61	7.5%
Space Heating	Air Source Heat Pump	21.7%	4,667	1,015	5	22.8%	5,017	1,146	7.5%
Space Heating	Geothermal Heat Pump	0.0%	4,200	-	-	0.2%	4,515	9	7.5%
Space Heating	Ductless HP	0.0%	2,649	-	-	0.0%	2,848	-	7.5%
Water Heating	Water Heater <= 55 Gal	75.6%	2,620	1,980	10	75.6%	2,508	1,895	-4.3%
Water Heating	Water Heater > 55 Gal	0.0%	2,959	-	-	0.0%	2,831	-	-4.3%
Interior Lighting	Screw-in	100.0%	1,010	1,010	5	100.0%	1,061	1,061	5.0%
Interior Lighting	Linear Fluorescent	100.0%	100	100	1	100.0%	105	105	5.0%
Interior Lighting	Specialty	100.0%	278	278	1	100.0%	298	298	7.5%
Exterior Lighting	Screw-in	100.0%	283	283	1	100.0%	298	298	5.0%
Appliances	Clothes Washer	86.7%	98	85	0	86.7%	86	75	-12.5%
Appliances	Clothes Dryer	88.9%	428	380	2	88.9%	396	352	-7.5%
Appliances	Dishwasher	80.1%	338	271	1	84.1%	313	263	-7.5%
Appliances	Refrigerator	100.0%	618	618	3	100.0%	520	520	-16.0%
Appliances	Freezer	53.3%	687	366	2	53.3%	559	298	-18.6%
Appliances	Second Refrigerator	17.6%	845	148	1	17.6%	693	122	-18.0%
Appliances	Stove	84.5%	345	292	2	84.5%	345	292	0.0%
Appliances	Microwave	93.6%	101	95	0	93.6%	103	96	1.5%
Electronics	Personal Computers	104.8%	193	202	1	110.1%	193	212	0.0%
Electronics	TVs	234.0%	204	478	3	234.0%	204	478	0.0%
Electronics	Set-top boxes/DVR	154.5%	116	179	1	170.0%	116	197	0.0%
Electronics	Devices and Gadgets	100.0%	51	51	0	100.0%	54	54	5.0%
Miscellaneous	Pool Pump	5.6%	1,125	63	0	5.8%	1,135	66	0.8%
Miscellaneous	Furnace Fan	63.3%	467	296	2	63.3%	467	296	0.0%
Miscellaneous	Miscellaneous	100.0%	274	274	1	100.0%	288	288	5.0%
Total				13,092	69			13,488	3.0%

Table A-4 Low Income Electric Market Profile, Washington 2009

		Average Market Profile				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%	591	131	9	28.7%	635	182	7.5%
Cooling	Room AC	35.4%	289	102	7	18.0%	311	56	7.5%
Cooling	Air Source Heat Pump	10.4%	467	49	3	10.4%	502	52	7.5%
Cooling	Geothermal Heat Pump	0.0%	437	-	-	0.5%	470	2	7.5%
Cooling	Ductless HP	0.0%	262	-	-	0.0%	281	-	7.5%
Space Heating	Electric Resistance	32.0%	5,914	1,891	128	28.8%	6,358	1,830	7.5%
Space Heating	Electric Furnace	9.9%	6,413	637	43	8.9%	6,894	614	7.5%
Space Heating	Supplemental	12.7%	364	46	3	13.4%	392	52	7.5%
Space Heating	Air Source Heat Pump	10.4%	4,401	459	31	10.4%	4,731	493	7.5%
Space Heating	Geothermal Heat Pump	0.0%	3,042	-	-	0.0%	3,270	-	7.5%
Space Heating	Ductless HP	0.0%	2,296	-	-	0.0%	2,468	-	7.5%
Water Heating	Water Heater <= 55 Gal	83.9%	2,357	1,977	133	83.9%	2,255	1,892	-4.3%
Water Heating	Water Heater > 55 Gal	0.0%	2,950	-	-	0.0%	2,822	-	-4.3%
Interior Lighting	Screw-in	100.0%	758	758	51	100.0%	796	796	5.0%
Interior Lighting	Linear Fluorescent	100.0%	79	79	5	100.0%	83	83	5.0%
Interior Lighting	Specialty	100.0%	181	181	12	100.0%	195	195	7.5%
Exterior Lighting	Screw-in	100.0%	138	138	9	100.0%	145	145	5.0%
Appliances	Clothes Washer	71.3%	89	63	4	78.4%	78	61	-12.5%
Appliances	Clothes Dryer	68.6%	385	264	18	75.4%	356	269	-7.5%
Appliances	Dishwasher	78.5%	305	239	16	86.3%	282	243	-7.5%
Appliances	Refrigerator	100.0%	557	557	38	100.0%	468	468	-16.0%
Appliances	Freezer	63.0%	619	390	26	63.0%	504	317	-18.6%
Appliances	Second Refrigerator	23.4%	761	178	12	23.4%	624	146	-18.0%
Appliances	Stove	89.7%	311	279	19	89.7%	311	279	0.0%
Appliances	Microwave	92.6%	91	85	6	92.6%	93	86	1.5%
Electronics	Personal Computers	101.4%	160	163	11	106.5%	160	171	0.0%
Electronics	TVs	165.0%	180	297	20	165.0%	180	297	0.0%
Electronics	Set-top boxes/DVR	128.8%	107	138	9	141.6%	107	152	0.0%
Electronics	Devices and Gadgets	100.0%	45	45	3	105.0%	48	50	5.0%
Miscellaneous	Pool Pump	2.3%	1,170	27	2	2.3%	1,180	27	0.8%
Miscellaneous	Furnace Fan	25.2%	436	110	7	25.2%	436	110	0.0%
Miscellaneous	Miscellaneous	100.0%	140	140	9	100.0%	147	147	5.0%
Total				9,424	636			9,215	-2.2%

Table A-5 Single Family Electric Market Profile, Idaho 2009

		Average Market Profile				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%	1,253	291	17	66.1%	1,441	952	15.0%
Cooling	Room AC	10.8%	461	50	3	8.7%	530	46	15.0%
Cooling	Air Source Heat Pump	14.6%	750	109	6	15.3%	862	132	15.0%
Cooling	Geothermal Heat Pump	1.2%	657	8	0	0.8%	756	6	15.0%
Cooling	Ductless HP	0.0%	478	-	-	0.0%	550	-	15.0%
Space Heating	Electric Resistance	13.3%	10,817	1,436	85	6.6%	12,440	825	15.0%
Space Heating	Electric Furnace	5.5%	12,345	679	40	4.9%	14,197	702	15.0%
Space Heating	Supplemental	4.4%	111	5	0	4.4%	128	6	15.0%
Space Heating	Air Source Heat Pump	14.6%	8,989	1,310	78	14.6%	10,338	1,506	15.0%
Space Heating	Geothermal Heat Pump	1.2%	5,075	58	3	1.2%	5,836	67	15.0%
Space Heating	Ductless HP	0.0%	4,200	-	-	0.0%	4,830	-	15.0%
Water Heating	Water Heater <= 55 Gal	46.4%	4,233	1,962	116	42.4%	3,869	1,639	-8.6%
Water Heating	Water Heater > 55 Gal	5.6%	4,779	270	16	5.2%	4,365	225	-8.7%
Interior Lighting	Screw-in	100.0%	1,360	1,360	81	100.0%	1,496	1,496	10.0%
Interior Lighting	Linear Fluorescent	100.0%	134	134	8	100.0%	148	148	10.0%
Interior Lighting	Specialty	100.0%	374	374	22	100.0%	430	430	15.0%
Exterior Lighting	Screw-in	100.0%	381	381	23	100.0%	420	420	10.0%
Appliances	Clothes Washer	98.0%	126	124	7	99.8%	95	94	-25.0%
Appliances	Clothes Dryer	92.8%	549	509	30	97.4%	466	454	-15.0%
Appliances	Dishwasher	93.9%	434	407	24	98.6%	369	364	-15.0%
Appliances	Refrigerator	100.0%	793	793	47	100.0%	539	539	-32.0%
Appliances	Freezer	59.8%	881	527	31	69.4%	554	384	-37.1%
Appliances	Second Refrigerator	24.8%	1,083	269	16	24.8%	693	172	-36.0%
Appliances	Stove	74.8%	443	331	20	82.1%	487	400	10.0%
Appliances	Microwave	98.5%	130	128	8	98.5%	134	132	3.0%
Electronics	Personal Computers	140.0%	227	317	19	154.0%	227	349	0.0%
Electronics	TVs	231.0%	240	555	33	242.6%	240	583	0.0%
Electronics	Set-top boxes/DVR	153.5%	136	209	12	168.9%	136	230	0.0%
Electronics	Devices and Gadgets	100.0%	60	60	4	105.0%	67	70	10.0%
Miscellaneous	Pool Pump	7.0%	1,500	105	6	7.4%	1,526	112	1.7%
Miscellaneous	Furnace Fan	54.9%	654	359	21	57.7%	654	377	0.0%
Miscellaneous	Miscellaneous	100.0%	584	584	35	100.0%	642	642	10.0%
Total			1,253	13,703	811			13,502	-1.5%

Table A-6 Multi Family Electric Market Profile, Idaho 2009

		Average Market Profile				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%	395	20	0	15.0%	454	68	15.0%
Cooling	Room AC	25.0%	302	75	0	18.9%	347	66	15.0%
Cooling	Air Source Heat Pump	1.0%	365	4	0	1.1%	419	4	15.0%
Cooling	Geothermal Heat Pump	0.0%	377	-	-	0.2%	434	1	15.0%
Cooling	Ductless HP	0.0%	215	-	-	0.0%	248	-	15.0%
Space Heating	Electric Resistance	59.0%	4,869	2,873	15	47.2%	5,599	2,643	15.0%
Space Heating	Electric Furnace	5.0%	4,852	243	1	6.0%	5,580	335	15.0%
Space Heating	Supplemental	18.0%	58	10	0	18.0%	66	12	15.0%
Space Heating	Air Source Heat Pump	1.0%	3,027	30	0	1.0%	3,481	35	15.0%
Space Heating	Geothermal Heat Pump	0.0%	2,724	-	-	0.0%	3,133	-	15.0%
Space Heating	Ductless HP	0.0%	1,890	-	-	0.0%	2,174	-	15.0%
Water Heating	Water Heater <= 55 Gal	77.0%	2,014	1,551	8	75.0%	1,841	1,380	-8.6%
Water Heating	Water Heater > 55 Gal	0.0%	2,954	-	-	0.0%	2,698	-	-8.7%
Interior Lighting	Screw-in	100.0%	737	737	4	100.0%	811	811	10.0%
Interior Lighting	Linear Fluorescent	100.0%	84	84	0	100.0%	92	92	10.0%
Interior Lighting	Specialty	100.0%	134	134	1	100.0%	154	154	15.0%
Exterior Lighting	Screw-in	100.0%	20	20	0	100.0%	22	22	10.0%
Appliances	Clothes Washer	32.0%	95	30	0	48.0%	71	34	-25.0%
Appliances	Clothes Dryer	30.7%	412	127	1	46.1%	351	161	-15.0%
Appliances	Dishwasher	64.0%	326	209	1	96.0%	277	266	-15.0%
Appliances	Refrigerator	100.0%	596	596	3	100.0%	405	405	-32.0%
Appliances	Freezer	8.4%	662	56	0	8.9%	416	37	-37.1%
Appliances	Second Refrigerator	5.0%	814	41	0	5.0%	521	26	-36.0%
Appliances	Stove	96.4%	333	321	2	96.4%	333	321	0.0%
Appliances	Microwave	90.0%	98	88	0	90.0%	101	91	3.0%
Electronics	Personal Computers	63.0%	170	107	1	69.3%	170	118	0.0%
Electronics	TVs	165.0%	203	335	2	173.3%	203	352	0.0%
Electronics	Set-top boxes/DVR	154.5%	128	198	1	170.0%	128	218	0.0%
Electronics	Devices and Gadgets	100.0%	51	51	0	105.0%	56	59	10.0%
Miscellaneous	Pool Pump	0.0%	1,410	-	-	0.0%	1,434	-	1.7%
Miscellaneous	Furnace Fan	13.0%	468	61	0	13.7%	468	64	0.0%
Miscellaneous	Miscellaneous	100.0%	213	213	1	100.0%	234	234	10.0%
Total				8,213	43			8,010	-2.5%

Table A-7 Mobile Home Electric Market Profile, Idaho 2009

		Average Market Profile				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%	475	110	1	39.4%	511	201	7.5%
Cooling	Room AC	23.2%	262	61	0	22.0%	282	62	7.5%
Cooling	Air Source Heat Pump	21.7%	311	68	0	22.8%	334	76	7.5%
Cooling	Geothermal Heat Pump	0.0%	280	-	-	0.0%	300	-	7.5%
Cooling	Ductless HP	0.0%	285	-	-	0.0%	307	-	7.5%
Space Heating	Electric Resistance	1.2%	6,448	77	0	1.1%	6,931	78	7.5%
Space Heating	Electric Furnace	57.6%	6,918	3,982	19	57.6%	7,437	4,281	7.5%
Space Heating	Supplemental	1.4%	3,572	51	0	1.5%	3,840	58	7.5%
Space Heating	Air Source Heat Pump	21.7%	4,410	959	5	22.8%	4,741	1,083	7.5%
Space Heating	Geothermal Heat Pump	0.0%	3,969	-	-	0.0%	4,267	-	7.5%
Space Heating	Ductless HP	0.0%	2,503	-	-	0.0%	2,691	-	7.5%
Water Heating	Water Heater <= 55 Gal	75.6%	2,476	1,871	9	75.6%	2,370	1,791	-4.3%
Water Heating	Water Heater > 55 Gal	0.0%	2,796	-	-	0.0%	2,675	-	-4.3%
Interior Lighting	Screw-in	100.0%	955	955	5	100.0%	1,003	1,003	5.0%
Interior Lighting	Linear Fluorescent	100.0%	94	94	0	100.0%	99	99	5.0%
Interior Lighting	Specialty	100.0%	262	262	1	100.0%	282	282	7.5%
Exterior Lighting	Screw-in	100.0%	268	268	1	100.0%	281	281	5.0%
Appliances	Clothes Washer	86.7%	93	81	0	86.7%	81	71	-12.5%
Appliances	Clothes Dryer	88.9%	404	359	2	88.9%	374	332	-7.5%
Appliances	Dishwasher	80.1%	320	256	1	84.1%	296	249	-7.5%
Appliances	Refrigerator	100.0%	584	584	3	100.0%	491	491	-16.0%
Appliances	Freezer	53.3%	649	346	2	53.3%	529	282	-18.6%
Appliances	Second Refrigerator	17.6%	798	140	1	17.6%	655	115	-18.0%
Appliances	Stove	84.5%	326	276	1	84.5%	326	276	0.0%
Appliances	Microwave	93.6%	96	90	0	93.6%	97	91	1.5%
Electronics	Personal Computers	104.8%	182	191	1	110.1%	182	200	0.0%
Electronics	TVs	234.0%	193	452	2	234.0%	193	452	0.0%
Electronics	Set-top boxes/DVR	154.5%	110	169	1	170.0%	110	186	0.0%
Electronics	Devices and Gadgets	100.0%	49	49	0	100.0%	51	51	5.0%
Miscellaneous	Pool Pump	5.6%	1,063	59	0	5.8%	1,072	63	0.8%
Miscellaneous	Furnace Fan	63.3%	441	279	1	63.3%	441	279	0.0%
Miscellaneous	Miscellaneous	100.0%	230	230	1	100.0%	242	242	5.0%
Total				12,320	59			12,674	2.9%

Table A-8 Low income Electric Market Profile, Idaho 2009

Average Market Profile						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%	414	92	3	28.7%	445	128	7.5%
Cooling	Room AC	35.4%	202	72	2	18.0%	218	39	7.5%
Cooling	Air Source Heat Pump	10.4%	327	34	1	10.4%	351	37	7.5%
Cooling	Geothermal Heat Pump	0.0%	306	-	-	0.5%	329	2	7.5%
Cooling	Ductless HP	0.0%	249	-	-	0.0%	267	-	7.5%
Space Heating	Electric Resistance	32.0%	5,619	1,797	55	28.8%	6,040	1,738	7.5%
Space Heating	Electric Furnace	11.2%	6,092	680	21	10.0%	6,549	655	7.5%
Space Heating	Supplemental	12.7%	346	44	1	13.4%	372	50	7.5%
Space Heating	Air Source Heat Pump	10.4%	4,181	436	13	10.4%	4,494	468	7.5%
Space Heating	Geothermal Heat Pump	0.0%	2,890	-	-	0.0%	3,107	-	7.5%
Space Heating	Ductless HP	0.0%	2,181	-	-	0.0%	2,345	-	7.5%
Water Heating	Water Heater <= 55 Gal	83.9%	2,203	1,848	56	83.9%	2,109	1,769	-4.3%
Water Heating	Water Heater > 55 Gal	0.0%	2,758	-	-	0.0%	2,639	-	-4.3%
Interior Lighting	Screw-in	100.0%	709	709	22	100.0%	745	745	5.0%
Interior Lighting	Linear Fluorescent	100.0%	74	74	2	100.0%	78	78	5.0%
Interior Lighting	Specialty	100.0%	169	169	5	100.0%	182	182	7.5%
Exterior Lighting	Screw-in	100.0%	129	129	4	100.0%	136	136	5.0%
Appliances	Clothes Washer	71.3%	83	59	2	78.4%	72	57	-12.5%
Appliances	Clothes Dryer	68.6%	360	247	7	75.4%	333	251	-7.5%
Appliances	Dishwasher	78.5%	285	224	7	86.3%	263	227	-7.5%
Appliances	Refrigerator	100.0%	521	521	16	100.0%	437	437	-16.0%
Appliances	Freezer	63.0%	578	364	11	63.0%	471	297	-18.6%
Appliances	Second Refrigerator	23.4%	711	167	5	23.4%	583	137	-18.0%
Appliances	Stove	89.7%	291	261	8	89.7%	291	261	0.0%
Appliances	Microwave	92.6%	85	79	2	92.6%	87	80	1.5%
Electronics	Personal Computers	101.4%	150	152	5	106.5%	150	160	0.0%
Electronics	TVs	165.0%	168	277	8	165.0%	168	277	0.0%
Electronics	Set-top boxes/DVR	128.8%	100	129	4	141.6%	100	142	0.0%
Electronics	Devices and Gadgets	100.0%	42	42	1	105.0%	44	47	5.0%
Miscellaneous	Pool Pump	2.3%	1,094	25	1	2.3%	1,103	25	0.8%
Miscellaneous	Furnace Fan	25.2%	407	103	3	25.2%	407	103	0.0%
Miscellaneous	Miscellaneous	100.0%	133	133	4	100.0%	140	140	5.0%
Total				8,868	269			8,666	-2.3%

Table A-9 Small/Medium Commercial Electric Market Profile, Washington 2009

		Average Market Profile				New Units			
End Use	**Technology**	**Saturation**	**UEC (kWh)**	**Intensity (kWh/HH)**	**Usage (GWh)**	**Saturation**	**UEC (kWh)**	**Intensity (kWh/HH)**	**Compared to Average**
Cooling	Central Chiller	13.8%	2	0	8	13.8%	2	0	-13.6%
Cooling	RTU	63.1%	2	2	37	63.1%	2	1	-15.9%
Cooling	Heat Pump	3.6%	5	0	4	3.6%	4	0	-15.9%
Space Heating	Electric Resistance	5.9%	7	0	9	5.9%	6	0	-5.0%
Space Heating	Furnace	17.7%	7	1	30	17.7%	7	1	-5.0%
Space Heating	Heat Pump	3.6%	4	0	3	3.6%	3	0	-6.8%
Ventilation	Ventilation	76.9%	2	2	38	76.9%	2	1	-14.8%
Interior Lighting	Interior Screw-in	100.0%	1	1	24	100.0%	1	1	-1.2%
Interior Lighting	High Bay Fixtures	100.0%	1	1	16	100.0%	1	1	-20.0%
Interior Lighting	Linear Fluorescent	100.0%	3	3	80	100.0%	3	3	-12.7%
Exterior Lighting	Exterior Screw-in	100.0%	0	0	4	100.0%	0	0	-26.0%
Exterior Lighting	HID	100.0%	1	1	18	100.0%	1	1	-26.4%
Water Heating	Water Heater	63.0%	2	1	30	63.0%	2	1	-6.0%
Food Preparation	Fryer	25.8%	0	0	1	30.8%	0	0	-0.6%
Food Preparation	Oven	25.8%	1	0	6	35.8%	1	0	-1.2%
Food Preparation	Dishwasher	25.8%	0	0	0	35.8%	0	0	-24.1%
Food Preparation	Hot Food Container	25.8%	0	0	2	35.8%	0	0	-20.0%
Food Preparation	Food Prep	25.8%	0	0	0	35.8%	0	0	-20.0%
Refrigeration	Walk in Refrigeration	52.4%	-	-	-	62.4%	-	-	0.0%
Refrigeration	Glass Door Display	52.4%	0	0	6	57.4%	0	0	-8.8%
Refrigeration	Reach-in Refrigerator	52.4%	1	0	6	57.4%	0	0	-30.0%
Refrigeration	Open Display Case	52.4%	0	0	1	57.4%	0	0	-8.4%
Refrigeration	Vending Machine	52.4%	0	0	4	57.4%	0	0	-12.8%
Refrigeration	Icemaker	52.4%	0	0	4	57.4%	0	0	-11.9%
Office Equipment	Desktop Computer	99.9%	0	0	11	104.9%	0	1	-0.7%
Office Equipment	Laptop Computer	99.9%	0	0	1	104.9%	0	0	-0.7%
Office Equipment	Server	99.9%	0	0	9	104.9%	0	0	-4.7%
Office Equipment	Monitor	99.9%	0	0	6	104.9%	0	0	-2.8%
Office Equipment	Printer/copier/fax	99.9%	0	0	6	104.9%	0	0	-6.1%
Office Equipment	POS Terminal	99.9%	0	0	7	104.9%	0	0	-15.6%
Miscellaneous	Non-HVAC Motor	40.2%	1	0	12	40.2%	1	1	5.1%
Miscellaneous	Other Miscellaneous	100.0%	1	1	34	100.0%	2	2	20.0%
Total				18	416			16	-6.9%

Table A-10 Large Commercial Electric Market Profile, Washington 2009

Average Market Profile						New Units			
End Use	**Technology**	**Saturation**	**UEC (kWh)**	**Intensity (kWh/HH)**	**Usage (GWh)**	**Saturation**	**UEC (kWh)**	**Intensity (kWh/HH)**	**Compared to Average**
Cooling	Central Chiller	24.7%	2	1	49	24.7%	2	0	-16.9%
Cooling	RTU	37.8%	3	1	89	37.8%	2	1	-17.4%
Cooling	Heat Pump	9.1%	4	0	30	9.1%	3	0	-16.9%
Space Heating	Electric Resistance	5.9%	4	0	20	5.9%	3	0	-12.6%
Space Heating	Furnace	12.7%	5	1	55	12.7%	4	1	-12.6%
Space Heating	Heat Pump	9.1%	2	0	20	9.1%	2	0	-3.5%
Ventilation	Ventilation	75.1%	2	1	116	75.1%	1	1	-14.8%
Interior Lighting	Interior Screw-in	100.0%	1	1	88	100.0%	1	1	-1.4%
Interior Lighting	High Bay Fixtures	100.0%	1	1	66	100.0%	1	1	-20.0%
Interior Lighting	Linear Fluorescent	100.0%	3	3	307	100.0%	3	3	-13.6%
Exterior Lighting	Exterior Screw-in	100.0%	0	0	9	100.0%	0	0	-18.1%
Exterior Lighting	HID	100.0%	1	1	65	100.0%	1	1	-26.4%
Water Heating	Water Heater	54.2%	2	1	117	54.2%	2	1	-4.0%
Food Preparation	Fryer	18.4%	0	0	6	23.4%	0	0	-0.6%
Food Preparation	Oven	18.4%	2	0	32	28.4%	2	1	-1.2%
Food Preparation	Dishwasher	18.4%	0	0	3	28.4%	0	0	-24.1%
Food Preparation	Hot Food Container	18.4%	0	0	5	28.4%	0	0	-39.9%
Food Preparation	Food Prep	18.4%	0	0	0	28.4%	0	0	-20.0%
Refrigeration	Walk in Refrigeration	39.1%	0	0	17	49.1%	0	0	-30.0%
Refrigeration	Glass Door Display	39.1%	0	0	13	44.1%	0	0	-9.7%
Refrigeration	Reach-in Refrigerator	39.1%	1	0	28	44.1%	1	0	-30.0%
Refrigeration	Open Display Case	39.1%	0	0	10	44.1%	0	0	-9.3%
Refrigeration	Vending Machine	39.1%	0	0	13	44.1%	0	0	-12.8%
Refrigeration	Icemaker	39.1%	1	0	24	44.1%	1	0	-12.2%
Office Equipment	Desktop Computer	98.4%	1	1	82	103.4%	1	1	-0.7%
Office Equipment	Laptop Computer	98.4%	0	0	6	103.4%	0	0	-0.7%
Office Equipment	Server	98.4%	0	0	38	103.4%	0	0	-4.7%
Office Equipment	Monitor	98.4%	0	0	19	103.4%	0	0	-2.8%
Office Equipment	Printer/copier/fax	98.4%	0	0	19	103.4%	0	0	-6.1%
Office Equipment	POS Terminal	98.4%	0	0	6	103.4%	0	0	-15.6%
Miscellaneous	Non-HVAC Motor	57.7%	1	1	75	57.7%	1	1	5.1%
Miscellaneous	Other Miscellaneous	100.0%	1	1	127	100.0%	2	2	10.0%
Total				17	1,557			16	-6.8%

Table A-11 Extra Large Commercial Electric Market Profile, Washington 2009

		Average Market Profile				New Units			
End Use	**Technology**	**Saturation**	**UEC (kWh)**	**Intensity (kWh/HH)**	**Usage (GWh)**	**Saturation**	**UEC (kWh)**	**Intensity (kWh/HH)**	**Compared to Average**
Cooling	Central Chiller	52.2%	2	1	21	52.2%	2	1	-14.7%
Cooling	RTU	24.7%	2	1	10	24.7%	2	0	-16.7%
Cooling	Heat Pump	4.4%	2	0	2	4.4%	2	0	-26.2%
Space Heating	Electric Resistance	15.8%	4	1	13	15.8%	4	1	-13.1%
Space Heating	Furnace	5.6%	6	0	6	5.6%	5	0	-13.1%
Space Heating	Heat Pump	90.2%	2	2	33	90.2%	2	2	-12.1%
Ventilation	Ventilation	100.0%	1	1	26	100.0%	1	1	-2.7%
Interior Lighting	Interior Screw-in	100.0%	0	0	6	100.0%	0	0	-20.0%
Interior Lighting	High Bay Fixtures	100.0%	2	2	42	100.0%	2	2	-8.3%
Interior Lighting	Linear Fluorescent	100.0%	0	0	1	100.0%	0	0	-51.9%
Exterior Lighting	Exterior Screw-in	100.0%	1	1	17	100.0%	1	1	-26.4%
Exterior Lighting	HID	26.3%	4	1	19	26.3%	4	1	-2.0%
Water Heating	Water Heater	13.8%	0	0	0	18.8%	0	0	-0.6%
Food Preparation	Fryer	13.8%	2	0	6	23.8%	2	0	-1.2%
Food Preparation	Oven	13.8%	0	0	0	23.8%	0	0	-24.1%
Food Preparation	Dishwasher	13.8%	0	0	0	23.8%	0	0	-39.9%
Food Preparation	Hot Food Container	13.8%	0	0	0	23.8%	0	0	0.0%
Food Preparation	Food Prep	26.6%	0	0	1	36.6%	0	0	-30.0%
Refrigeration	Walk in Refrigeration	26.6%	0	0	1	31.6%	0	0	-9.7%
Refrigeration	Glass Door Display	26.6%	1	0	4	31.6%	0	0	-30.0%
Refrigeration	Reach-in Refrigerator	26.6%	0	0	3	31.6%	0	0	-9.3%
Refrigeration	Open Display Case	26.6%	0	0	2	31.6%	0	0	-27.9%
Refrigeration	Vending Machine	26.6%	0	0	2	31.6%	0	0	-11.4%
Refrigeration	Icemaker	100.0%	1	1	12	105.0%	1	1	-0.7%
Office Equipment	Desktop Computer	100.0%	0	0	1	105.0%	0	0	-0.7%
Office Equipment	Laptop Computer	100.0%	0	0	3	105.0%	0	0	-4.7%
Office Equipment	Server	100.0%	0	0	2	105.0%	0	0	-2.8%
Office Equipment	Monitor	100.0%	0	0	1	105.0%	0	0	-6.1%
Office Equipment	Printer/copier/fax	100.0%	0	0	0	105.0%	0	0	-15.6%
Office Equipment	POS Terminal	88.8%	1	1	14	88.8%	1	1	5.1%
Miscellaneous	Non-HVAC Motor	100.0%	1	1	15	100.0%	1	1	10.0%
Miscellaneous	Other Miscellaneous	4.4%	3	0	3	4.4%	3	0	-3.1%
Total				14	266			13	-6.0%

Table A-12 Extra Large Industrial Electric Market Profile, Washington 2009

		Average Market Profile				New Units			
End Use	**Technology**	**Saturation**	**UEC (kWh)**	**Intensity (kWh/HH)**	**Usage (GWh)**	**Saturation**	**UEC (kWh)**	**Intensity (kWh/HH)**	**Compared to Average**
Cooling	Central Chiller	14.4%	8	1	18	14.4%	7	1	-11.7%
Cooling	RTU	17.1%	6	1	17	17.1%	6	1	-12.3%
Cooling	Heat Pump	2.7%	5	0	2	2.7%	4	0	-20.9%
Space Heating	Electric Resistance	10.8%	9	1	14	10.8%	8	1	-5.0%
Space Heating	Furnace	2.0%	9	0	3	2.0%	9	0	0.0%
Space Heating	Heat Pump	2.7%	4	0	2	2.7%	4	0	-4.9%
Ventilation	Ventilation	27.4%	12	3	52	27.4%	10	3	-15.0%
Interior Lighting	Interior Screw-in	100.0%	0	0	5	100.0%	0	0	-5.0%
Interior Lighting	High Bay Fixtures	100.0%	1	1	16	100.0%	1	1	-12.7%
Interior Lighting	Linear Fluorescent	100.0%	1	1	17	100.0%	1	1	-26.0%
Exterior Lighting	Exterior Screw-in	100.0%	0	0	0	100.0%	0	0	-26.4%
Exterior Lighting	HID	100.0%	0	0	4	100.0%	0	0	-26.4%
Process	Process Cooling/Refrigeration	2.4%	100	2	37	2.5%	100	3	0.0%
Process	Process Heating	26.2%	14	4	55	27.5%	14	4	0.0%
Process	Electrochemical Process	2.6%	77	2	31	2.7%	77	2	0.0%
Machine Drive	Less than 5 HP	90.5%	1	1	13	95.0%	1	1	0.0%
Machine Drive	5-24 HP	80.1%	2	2	28	84.1%	2	2	0.0%
Machine Drive	25-99 HP	72.4%	6	4	68	76.0%	6	5	0.0%
Machine Drive	100-249 HP	65.3%	4	3	38	68.6%	4	3	0.0%
Machine Drive	250-499 HP	23.7%	12	3	42	24.9%	12	3	0.0%
Machine Drive	500 and more HP	26.1%	20	5	78	27.4%	20	5	0.0%
Miscellaneous	Miscellaneous	100.0%	5	5	75	103.0%	5	5	0.0%
Total				40	614			40	0.2%

Table A-13 Small/Medium Commercial Electric Market Profile, Idaho 2009

		Average Market Profile				New Units			
End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (GWh)	Saturation	UEC (kWh)	Intensity (kWh/HH)	Compared to Average
Cooling	Central Chiller	13.8%	2	0	6	13.8%	2	0	-13.6%
Cooling	RTU	63.1%	2	2	29	63.1%	2	1	-15.9%
Cooling	Heat Pump	3.6%	5	0	3	3.6%	4	0	-15.9%
Space Heating	Electric Resistance	5.9%	7	0	7	5.9%	6	0	-5.0%
Space Heating	Furnace	17.7%	7	1	23	17.7%	7	1	-5.0%
Space Heating	Heat Pump	3.6%	4	0	2	3.6%	3	0	-6.8%
Ventilation	Ventilation	76.9%	2	2	30	76.9%	2	1	-14.8%
Interior Lighting	Interior Screw-in	100.0%	1	1	18	100.0%	1	1	-1.2%
Interior Lighting	High Bay Fixtures	100.0%	1	1	13	100.0%	1	1	-20.0%
Interior Lighting	Linear Fluorescent	100.0%	3	3	62	100.0%	3	3	-12.7%
Exterior Lighting	Exterior Screw-in	100.0%	0	0	4	100.0%	0	0	-26.0%
Exterior Lighting	HID	100.0%	1	1	13	100.0%	1	1	-26.4%
Water Heating	Water Heater	63.0%	2	1	23	63.0%	2	1	-6.0%
Food Preparation	Fryer	25.8%	0	0	1	30.8%	0	0	-0.6%
Food Preparation	Oven	25.8%	1	0	5	35.8%	1	0	-1.2%
Food Preparation	Dishwasher	25.8%	0	0	0	35.8%	0	0	-24.1%
Food Preparation	Hot Food Container	25.8%	0	0	1	35.8%	0	0	-20.0%
Food Preparation	Food Prep	25.8%	0	0	0	35.8%	0	0	-20.0%
Refrigeration	Walk in Refrigeration	52.4%	-	-	-	62.4%	-	-	0.0%
Refrigeration	Glass Door Display	52.4%	0	0	4	57.4%	0	0	-8.8%
Refrigeration	Reach-in Refrigerator	52.4%	1	0	5	57.4%	0	0	-30.0%
Refrigeration	Open Display Case	52.4%	0	0	0	57.4%	0	0	-8.4%
Refrigeration	Vending Machine	52.4%	0	0	3	57.4%	0	0	-12.8%
Refrigeration	Icemaker	52.4%	0	0	3	57.4%	0	0	-11.9%
Office Equipment	Desktop Computer	99.9%	0	0	9	104.9%	0	1	-0.7%
Office Equipment	Laptop Computer	99.9%	0	0	1	104.9%	0	0	-0.7%
Office Equipment	Server	99.9%	0	0	7	104.9%	0	0	-4.7%
Office Equipment	Monitor	99.9%	0	0	5	104.9%	0	0	-2.8%
Office Equipment	Printer/copier/fax	99.9%	0	0	4	104.9%	0	0	-6.1%
Office Equipment	POS Terminal	99.9%	0	0	5	104.9%	0	0	-15.6%
Miscellaneous	Non-HVAC Motor	40.2%	1	0	9	40.2%	1	1	5.1%
Miscellaneous	Other Miscellaneous	100.0%	1	1	26	100.0%	2	2	20.0%
Total				18	323			16	-6.9%

Table A-14 Large Commercial Electric Market Profile, Idaho 2009

		Average Market Profile				New Units			
End Use	**Technology**	**Saturation**	**UEC (kWh)**	**Intensity (kWh/HH)**	**Usage (GWh)**	**Saturation**	**UEC (kWh)**	**Intensity (kWh/HH)**	**Compared to Average**
Cooling	Central Chiller	24.7%	2	1	22	24.7%	2	0	-16.9%
Cooling	RTU	37.8%	3	1	40	37.8%	2	1	-17.4%
Cooling	Heat Pump	9.1%	4	0	14	9.1%	3	0	-16.9%
Space Heating	Electric Resistance	5.9%	4	0	9	5.9%	3	0	-12.6%
Space Heating	Furnace	12.7%	5	1	25	12.7%	4	1	-12.6%
Space Heating	Heat Pump	9.1%	2	0	9	9.1%	2	0	-3.5%
Ventilation	Ventilation	75.1%	2	1	52	75.1%	1	1	-14.8%
Interior Lighting	Interior Screw-in	100.0%	1	1	39	100.0%	1	1	-1.4%
Interior Lighting	High Bay Fixtures	100.0%	1	1	30	100.0%	1	1	-20.0%
Interior Lighting	Linear Fluorescent	100.0%	3	3	138	100.0%	3	3	-13.6%
Exterior Lighting	Exterior Screw-in	100.0%	0	0	4	100.0%	0	0	-18.1%
Exterior Lighting	HID	100.0%	1	1	29	100.0%	1	1	-26.4%
Water Heating	Water Heater	54.2%	2	1	53	54.2%	2	1	-4.0%
Food Preparation	Fryer	18.4%	0	0	3	23.4%	0	0	-0.6%
Food Preparation	Oven	18.4%	2	0	14	28.4%	2	1	-1.2%
Food Preparation	Dishwasher	18.4%	0	0	1	28.4%	0	0	-24.1%
Food Preparation	Hot Food Container	18.4%	0	0	2	28.4%	0	0	-39.9%
Food Preparation	Food Prep	18.4%	0	0	0	28.4%	0	0	-20.0%
Refrigeration	Walk in Refrigeration	39.1%	0	0	8	49.1%	0	0	-30.0%
Refrigeration	Glass Door Display	39.1%	0	0	6	44.1%	0	0	-9.7%
Refrigeration	Reach-in Refrigerator	39.1%	1	0	13	44.1%	1	0	-30.0%
Refrigeration	Open Display Case	39.1%	0	0	4	44.1%	0	0	-9.3%
Refrigeration	Vending Machine	39.1%	0	0	6	44.1%	0	0	-12.8%
Refrigeration	Icemaker	39.1%	1	0	11	44.1%	1	0	-12.2%
Office Equipment	Desktop Computer	98.4%	1	1	37	103.4%	1	1	-0.7%
Office Equipment	Laptop Computer	98.4%	0	0	3	103.4%	0	0	-0.7%
Office Equipment	Server	98.4%	0	0	17	103.4%	0	0	-4.7%
Office Equipment	Monitor	98.4%	0	0	9	103.4%	0	0	-2.8%
Office Equipment	Printer/copier/fax	98.4%	0	0	9	103.4%	0	0	-6.1%
Office Equipment	POS Terminal	98.4%	0	0	3	103.4%	0	0	-15.6%
Miscellaneous	Non-HVAC Motor	57.7%	1	1	34	57.7%	1	1	5.1%
Miscellaneous	Other Miscellaneous	100.0%	1	1	57	100.0%	2	2	10.0%
Total				17	700			16	-6.8%

Table A-15 Extra Large Commercial Electric Market Profile, Idaho 2009

		Average Market Profile				New Units			
End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (GWh)	Saturation	UEC (kWh)	Intensity (kWh/HH)	Compared to Average
Cooling	Central Chiller	52.2%	2	1	6	52.2%	2	1	-14.7%
Cooling	RTU	24.7%	2	1	3	24.7%	2	0	-16.7%
Cooling	Heat Pump	4.4%	2	0	0	4.4%	2	0	-26.2%
Space Heating	Electric Resistance	15.8%	4	1	4	15.8%	4	1	-13.1%
Space Heating	Furnace	5.6%	6	0	2	5.6%	5	0	-13.1%
Space Heating	Heat Pump	90.2%	2	2	9	90.2%	2	2	-12.1%
Ventilation	Ventilation	100.0%	1	1	7	100.0%	1	1	-2.7%
Interior Lighting	Interior Screw-in	100.0%	0	0	1	100.0%	0	0	-20.0%
Interior Lighting	High Bay Fixtures	100.0%	2	2	11	100.0%	2	2	-8.3%
Interior Lighting	Linear Fluorescent	100.0%	0	0	0	100.0%	0	0	-51.9%
Exterior Lighting	Exterior Screw-in	100.0%	1	1	4	100.0%	1	1	-26.4%
Exterior Lighting	HID	26.3%	4	1	5	26.3%	4	1	-2.0%
Water Heating	Water Heater	13.8%	0	0	0	23.8%	0	0	-0.6%
Food Preparation	Fryer	13.8%	2	0	1	23.8%	2	0	-1.2%
Food Preparation	Oven	13.8%	0	0	0	23.8%	0	0	-24.1%
Food Preparation	Dishwasher	13.8%	0	0	0	23.8%	0	0	-39.9%
Food Preparation	Hot Food Container	13.8%	0	0	0	23.8%	0	0	0.0%
Food Preparation	Food Prep	26.6%	0	0	0	31.6%	0	0	-30.0%
Refrigeration	Walk in Refrigeration	26.6%	0	0	0	31.6%	0	0	-9.7%
Refrigeration	Glass Door Display	26.6%	1	0	1	31.6%	0	0	-30.0%
Refrigeration	Reach-in Refrigerator	26.6%	0	0	1	31.6%	0	0	-9.3%
Refrigeration	Open Display Case	26.6%	0	0	1	31.6%	0	0	-27.9%
Refrigeration	Vending Machine	26.6%	0	0	0	31.6%	0	0	-11.4%
Refrigeration	Icemaker	100.0%	1	1	3	105.0%	1	1	-0.7%
Office Equipment	Desktop Computer	100.0%	0	0	0	105.0%	0	0	-0.7%
Office Equipment	Laptop Computer	100.0%	0	0	1	105.0%	0	0	-4.7%
Office Equipment	Server	100.0%	0	0	1	105.0%	0	0	-2.8%
Office Equipment	Monitor	100.0%	0	0	0	105.0%	0	0	-6.1%
Office Equipment	Printer/copier/fax	100.0%	0	0	0	100.0%	0	0	-15.6%
Office Equipment	POS Terminal	88.8%	1	1	4	88.8%	1	1	5.1%
Miscellaneous	Non-HVAC Motor	100.0%	1	1	4	100.0%	1	1	10.0%
Miscellaneous	Other Miscellaneous	4.4%	3	0	1	4.4%	3	0	-3.1%
Total				14	70			13	-6.0%

Table A-16 Extra Large Industrial Electric Market Profile, Idaho 2009

Average Market Profile						New Units			
End Use	**Technology**	**Saturation**	**UEC (kWh)**	**Intensity (kWh/HH)**	**Usage (GWh)**	**Saturation**	**UEC (kWh)**	**Intensity (kWh/HH)**	**Compared to Average**
Cooling	Central Chiller	14.4%	8	1	6	14.4%	7	1	-11.7%
Cooling	RTU	17.1%	6	1	5	17.1%	6	1	-12.3%
Cooling	Heat Pump	2.7%	4	0	0	2.7%	3	0	-20.9%
Space Heating	Electric Resistance	10.8%	9	1	5	10.8%	8	1	-5.0%
Space Heating	Furnace	2.0%	9	0	1	2.0%	9	0	0.0%
Space Heating	Heat Pump	27.4%	12	3	17	27.4%	10	3	-15.0%
Ventilation	Ventilation	100.0%	0	0	2	100.0%	0	0	-5.0%
Interior Lighting	Interior Screw-in	100.0%	1	1	5	100.0%	1	1	-12.7%
Interior Lighting	High Bay Fixtures	100.0%	1	1	5	100.0%	1	1	-26.0%
Interior Lighting	Linear Fluorescent	100.0%	0	0	0	100.0%	0	0	-26.4%
Exterior Lighting	Exterior Screw-in	100.0%	0	0	1	100.0%	0	0	-26.4%
Exterior Lighting	HID	2.4%	100	2	12	2.5%	100	3	0.0%
Process	Process Cooling/Refrigeration	26.2%	14	4	18	27.5%	14	4	0.0%
Process	Process Heating	2.6%	77	2	10	2.7%	77	2	0.0%
Process	Electrochemical Process	90.5%	1	1	4	95.0%	1	1	0.0%
Machine Drive	Less than 5 HP	80.1%	2	2	9	84.1%	2	2	0.0%
Machine Drive	5-24 HP	72.4%	6	4	22	76.0%	6	5	0.0%
Machine Drive	25-99 HP	65.3%	4	3	12	68.6%	4	3	0.0%
Machine Drive	100-249 HP	23.7%	12	3	13	24.9%	12	3	0.0%
Machine Drive	250-499 HP	26.1%	20	5	25	27.4%	20	5	0.0%
Machine Drive	500 and more HP	100.0%	5	5	24	103.0%	5	5	0.0%
Miscellaneous	Miscellaneous	2.7%	5	0	1	2.7%	5	0	-4.9%
Total				40	196			40	0.2%

APPENDIX | B

RESIDENTIAL ENERGY EFFICIENCY EQUIPMENT AND MEASURE DATA

This appendix presents detailed information for all energy-efficiency measures (*equipment* and *non-equipment* measures per the LoadMAP taxonomy) that were evaluated as part of this study. Several sets of tables are provided.

Measure Descriptions

Table B-1 and Table B-2 provide brief descriptions for all equipment and non-equipment measures that were assessed for potential.

Equipment Measure Data

Table B-3 through Table B-18 list the detailed unit-level data of Washington and Idaho for the equipment measures for each of the housing type segments — Single Family, Multi Family, Mobile Home, and Low income for existing and new construction, respectively. Savings are in annual kWh per household, and incremental costs are in $/household ($/HH), unless noted otherwise. The BC ratio shown in the tables are for the first year of the potential analysis (2014), although the B/C ratio is calculated within LoadMAP for each year of the forecast. The B/C ratio in the tables is 1.00 if the measure represents the baseline technology, and zero if the technology is not available in 2014. The final data item in these tables is the levelized cost of conserved energy, which is defined as the cost of the measure divided by the cumulative amount of energy savings accrued over the measure's lifetime ($/kWh).

Non-Equipment Measure Data

Table B-19 through Table B-34 list the detailed unit-level data of Washington and Idaho 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 net percentage of all the relevant, combined end-use loads. Base saturation indicates the percentage of homes in which the measure is already installed. Applicability is a factor 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 potential analysis (2014) although the B/C ratio is calculated within LoadMAP for each year of the forecast. These tables also contain the levelized cost of conserved energy, which is defined as the cost of the measure divided by the cumulative amount of energy savings accrued over the measure's lifetime, given in terms of $/kWh.

Table B-1 Residential Energy Efficiency Equipment Measure Descriptions

End Use	Technology	Measure Description
Cooling	Central AC	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). Ductless systems with Variable Refrigerant Flow further improve the operating efficiency.
Cooling	Room AC	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/ Space Heating	Ductless Heat Pump	Ductless heat pumps systems are similar to convential air-source heat pumps in that they use electricity to transfer heat between outdoor and indoor air via a vapor compression cycle. They can thus provide both heating and colling. However, they are mounted though a wall and thus can be retrofitted in homes that use electric zonal baseboard, wall, or ceiling units and as a result do not have ducts. They may also be suitable in new construction, where one or more systems can be installed.
Cooling/ Space Heating	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 is also analyzed.
Cooling/ Space Heating	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.

End Use	Technology	Measure Description
Space Heating	Electric Resistance	Resistive heating elements are used to convert electricity directly to heat. Conductive fins surrounding the element or another mechanism is used to deliver the heat directly to the surrounding room or area. These are typically either baseboard or wall-mounted units.
Space Heating	Electric Furnace	Furnaces heat air and distribute the heated air through the building using ducts. Efficiency improvements can include: exhaust fan controls, electronic ignition (no pilot light), compact size and lighter weight to reduce cycling losses, smaller-diameter flue pipe, and sealed combustion. Very high efficiency units, or condensing units, condense the water vapor produced in the combustion process and also use the heat from this condensation.
Water Heating	Water Heater	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). A further efficiency gain is available through a heat pump water heater (HPWH), which uses a vapor-compression thermodynamic cycle similar to that found in an air-conditioner or refrigerator 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. Electric instantaneous water heaters are available, but are excluded from this study due to potentially high instantaneous demand concerns. For natural gas hot water heating, the most common type is a storage heater, which incorporates a burner, 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). A further efficiency gain is available in condensing units, which condense the water vapor produced in the combustion process and also use the heat from this condensation.
Interior Lighting	Screw-in	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. 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. They 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. 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	Linear Fluorescent	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

End Use	Technology	Measure Description
		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”. 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	Specialty Lighting	Bulbs that the DOE does not consider conventional and are not covered by federal efficiency standards. These include: appliance bulbs, heavy-duty bulbs, dimmable bulbs, three-way bulbs, G shape (globe) lamps, candelabra base, and others.
Exterior Lighting	Screw-in	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. 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. They 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. 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.
Appliances	Refrigerator	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	Second Refrigerator	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	Freezer	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.

End Use	Technology	Measure Description
Appliances	Clothes Washer	High efficiency 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. MEF is the official energy efficiency metric used to compare relative efficiencies of different clothes washers. MEF considers the energy used to run the washer, heat the water, and run the dryer. The higher the MEF, the more efficient the clothes washer.
Appliances	Clothes Dryer	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	Dishwasher	High efficiency 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	Stove	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. Higher efficiency options include convection ovens, halogen burners, and induction burners.
Appliances	Microwave	No high efficiency option is modeled.
Electronics	Personal Computers	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	TVs	In the average home, TVs consume significant energy, even when they are turned 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.
Electronics	Devices and Gadgets	High efficiency electronics can use efficient components and employ sleep/powersave modes.
Electronics	Set-top Boxes/DVR	High efficiency electronics can use efficient components and employ sleep/powersave modes.
Miscellaneous	Pool Pump	High-efficiency motors and two-speed pumps provide improved energy efficiency for this load.
Miscellaneous	Furnace Fan	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	Miscellaneous	Improvement of miscellaneous electricity uses.

Table B-2 Residential Energy Efficiency Non-Equipment Measure Descriptions

End Use	Measure	Description
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.
Cooling	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)	Insulation - Foundation	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 is modeled for new construction / major retrofits only.
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 - 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 - Wall Cavity	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. Wall insulation is modeled for new construction / major retrofits only.
HVAC (All)	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. Wall sheathing is modeled for new construction / major retrofits only.
Cooling	Ducting - Repair and Sealing	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.
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

End Use	Measure	Description
		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.
HVAC (All)	Windows - Install Reflective Film	Reflective films applied to the window interior help reduce solar gain into the space and thus lower cooling energy use.
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)	Roofs - High Reflectivity	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 living roof or a roofing material with a light color (and a lower solar absorptance), the roof will absorb less solar radiation and consequently reduce the cooling load. Living roofs also reduce stormwater runoff.
HVAC (All)	Attic Fan - Installation	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 is also modeled.
HVAC (All)	Attic Fan - Photovoltaic - Installation	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 is also modeled.
HVAC (All)	Whole-House Fan - Installation	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.
HVAC (All)	Ceiling Fan - Installation	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.
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)	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	Central AC - 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 AC - 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

End Use	Measure	Description
		performance, requiring the AC unit to use more energy for the same cooling load.
Cooling / Space Heating	Central 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.
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.
Water Heating	Water Heater - Drainwater Heat Recovery	Drainwater Heat Recovery is a system in which drain water is used to preheat cold water entering the water heater. While these systems themselves are relatively inexpensive, upgrading an existing system could be unreasonable because of demolition costs. Thus they are modeled for new vintage only.
Water Heating	Water Heater - 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.
Water Heating	Water Heater - 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	Water Heater - Pipe Insulation	Insulating hot water pipes decreases energy losses from piping that distributes hot water throughout the building. It also results in quicker delivery of hot water and may allow the lowering of the hot water set point, which saves energy. The most common insulation materials for this purpose are polyethylene and neoprene.
Water Heating	Water Heater - 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	Water Heater - Desuperheater	A desuperheater can be added to an existing geothermal heat pump system (typically installed with the primary function of space heating and cooling) in order to draw off a portion of the geothermal heat for water heating purposes. The system can either supplement the building's water heater, or be a full-demand water heater that meets all of the building's hot water needs.
Water Heating	Water Heater - Solar System	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	Tank Blanket Insulation	Many water heaters have a high factory-set temperature, at 140 degrees F or higher, but most users operate comfortably with the thermostat at 120 degrees F. Reducing the water heater temperature by as little as 10 degrees can save between 3-5% in energy costs.
Water Heating	Thermostat Setback	Many water heaters have a high factory-set temperature, at 140 degrees F or higher, but most users operate comfortably with the thermostat at 125 degrees F. Reducing the water heater temperature by as little as 10 degrees can save between 3-5% in energy costs.
Interior Lighting	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.
Exterior Lighting	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

End Use	Measure	Description
		exterior lighting during daylight hours.
Exterior Lighting	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	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 - 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 - 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	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	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.
Electronics	Reduce Standby Wattage - Smart Power Strips	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.
Miscellaneous	Pool Pump - Timer	A pool pump timer allows the pump to turn off automatically, eliminating the wasted energy associated with unnecessary pumping.
Miscellaneous	Behavioral Measures	The behavioral measure models the wide range of options for providing homeowners with ongoing information on their energy use, for example via a web portal. These tools are based on the premise that homeowners will reduce energy use if they better understand how they use energy and the associated costs. The level of assumed savings is based on isolated behavioral effects and excludes the technology effects of all other measures listed here.

Table B-3 Energy Efficiency Equipment Data, Electric—Single Family, Existing Vintage, Washington

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central AC	SEER 13	-	$0.00	15	-	$0.00
Cooling	Central AC	SEER 14 (Energy Star)	116.70	$277.86	15	1.40	$0.21
Cooling	Central AC	SEER 15 (CEE Tier 2)	160.13	$555.71	15	0.95	$0.30
Cooling	Central AC	SEER 16 (CEE Tier 3)	196.50	$833.57	15	0.90	$0.37
Cooling	Central AC	Ductless Mini-Split System	352.42	$4,399.48	20	0.64	$0.88
Cooling	Room AC	EER 9.8	-	$0.00	10	1.00	$0.00
Cooling	Room AC	EER 10.8 (Energy Star)	46.56	$104.04	10	0.84	$0.26
Cooling	Room AC	EER 11	54.94	$282.26	10	0.64	$0.61
Cooling	Room AC	EER 11.5	74.37	$625.50	10	0.44	$1.00
Cooling	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	85.84	$0.00	15	1.30	$0.00
Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	97.34	$0.00	15	0.89	$0.00
Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	119.45	$0.00	15	0.83	$0.00
Cooling	Air Source Heat Pump	Ductless Mini-Split System	214.24	$0.00	20	0.83	$0.00
Cooling	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Cooling	Geothermal Heat Pump	High Efficiency	104.84	$0.00	15	0.91	$0.00
Cooling	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Electric Resistance	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Ductless Mini-Split System	3,605.70	$156.87	20	1.34	$0.00
Space Heating	Electric Furnace	3400 BTU/KW	-	$0.00	15	1.00	$0.00
Space Heating	Supplemental	Supplemental	-	$0.00	5	1.00	$0.00
Space Heating	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Space Heating	Air Source Heat Pump	SEER 14 (Energy Star)	126.61	$67.05	15	1.30	$0.05
Space Heating	Air Source Heat Pump	SEER 15 (CEE Tier 2)	998.92	$2,318.20	15	0.89	$0.20
Space Heating	Air Source Heat Pump	SEER 16 (CEE Tier 3)	1,225.79	$3,504.51	15	0.83	$0.25
Space Heating	Air Source Heat Pump	Ductless Mini-Split System	2,198.46	$5,655.04	20	0.83	$0.18
Space Heating	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Space Heating	Geothermal Heat Pump	High Efficiency	693.85	$1,500.00	15	0.91	$0.19
Space Heating	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	High Efficiency (EF=0.95)	207.44	$77.11	15	1.03	$0.03
Water Heating	Water Heater <= 55 Gal	EF 2.3 (HP)	1,999.65	$1,761.86	15	0.91	$0.08
Water Heating	Water Heater <= 55 Gal	Solar	2,791.58	$6,214.86	15	0.47	$0.19
Water Heating	Water Heater > 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater >	High Efficiency	264.15	$97.23	15	1.03	$0.03

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
	55 Gal	(EF=0.95)					
Water Heating	Water Heater > 55 Gal	EF 2.3 (HP)	2,000.81	$1,691.15	15	0.93	$0.07
Water Heating	Water Heater > 55 Gal	Solar	3,154.00	$6,144.15	15	0.52	$0.17
Interior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Interior Lighting	Screw-in	Infrared Halogen	269.42	$188.19	5	1.00	$0.15
Interior Lighting	Screw-in	CFL	855.57	$33.82	6	2.54	$0.01
Interior Lighting	Screw-in	LED	1,169.35	$1,937.55	12	-	$0.17
Interior Lighting	Screw-in	LED	1,169.35	$1,937.55	12	-	$0.17
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	11.21	-$3.65	6	1.14	-$0.06
Interior Lighting	Linear Fluorescent	Super T8	33.57	$29.17	6	0.70	$0.16
Interior Lighting	Linear Fluorescent	T5	34.89	$49.41	6	0.55	$0.26
Interior Lighting	Linear Fluorescent	LED	36.60	$433.68	10	0.19	$1.40
Interior Lighting	Specialty	Halogen	-	$0.00	4	1.00	$0.00
Interior Lighting	Specialty	CFL	263.66	$1.92	7	1.91	$0.00
Interior Lighting	Specialty	LED	277.40	$522.52	12	0.29	$0.19
Exterior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Exterior Lighting	Screw-in	Infrared Halogen	92.90	$51.30	5	1.00	$0.12
Exterior Lighting	Screw-in	CFL	315.29	-$1.24	3	4.38	$0.00
Exterior Lighting	Screw-in	LED	365.98	$757.28	12	-	$0.21
Exterior Lighting	Screw-in	LED	365.98	$757.28	12	-	$0.21
Appliances	Clothes Washer	Baseline	-	$0.00	14	-	$0.00
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	51.92	$69.81	14	-	$0.12
Appliances	Clothes Washer	Horizontal Axis	71.68	$150.80	14	1.00	$0.19
Appliances	Clothes Dryer	Baseline	-	$0.00	13	-	$0.00
Appliances	Clothes Dryer	Moisture Detection	76.97	$48.40	13	1.00	$0.06
Appliances	Dishwasher	Baseline	-	$0.00	15	1.00	$0.00
Appliances	Dishwasher	Energy Star	64.27	$460.95	9	-	$0.93
Appliances	Dishwasher	Energy Star (2011)	8.42	$5.61	15	1.00	$0.06
Appliances	Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Refrigerator	Energy Star	55.03	$20.67	20	-	$0.03
Appliances	Refrigerator	Baseline (2014)	100.80	$0.00	13	1.00	$0.00
Appliances	Refrigerator	Energy Star (2014)	161.28	$88.71	13	1.02	$0.05
Appliances	Freezer	Baseline	-	$0.00	22	-	$0.00
Appliances	Freezer	Energy Star	44.98	$3.98	22	-	$0.01
Appliances	Freezer	Baseline (2014)	104.39	-$145.00	11	1.00	-$0.15
Appliances	Freezer	Energy Star (2014)	167.03	-$112.83	11	1.00	-$0.07
Appliances	Second Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Second Refrigerator	Energy Star	75.16	$20.67	20	-	$0.02
Appliances	Second Refrigerator	Baseline (2014)	137.68	$0.00	13	1.00	$0.00

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Appliances	Second Refrigerator	Energy Star (2014)	220.29	$88.71	13	1.01	$0.04
Appliances	Stove	Baseline	-	$0.00	13	1.00	$0.00
Appliances	Stove	Convection Oven	10.67	$1.86	13	1.00	$0.02
Appliances	Stove	Induction (High Efficiency)	53.33	$1,432.20	13	0.39	$2.59
Appliances	Microwave	Baseline	-	$0.00	9	1.00	$0.00
Electronics	Personal Computers	Baseline	-	$0.00	5	1.00	$0.00
Electronics	Personal Computers	Energy Star	89.47	$1.20	5	1.01	$0.00
Electronics	Personal Computers	Climate Savers	127.82	$175.49	5	0.85	$0.30
Electronics	TVs	Baseline	-	$0.00	11	1.00	$0.00
Electronics	TVs	Energy Star	52.12	$0.56	10	0.95	$0.00
Electronics	Set-top boxes/DVR	Baseline	-	$0.00	11	1.00	$0.00
Electronics	Set-top boxes/DVR	Energy Star	31.55	$0.56	11	1.01	$0.00
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0.00	5	1.00	$0.00
Miscellaneous	Pool Pump	Baseline Pump	-	$0.00	15	1.00	$0.00
Miscellaneous	Pool Pump	High Efficiency Pump	137.76	$85.00	15	1.00	$0.05
Miscellaneous	Pool Pump	Two-Speed Pump	551.02	$579.00	15	0.83	$0.09
Miscellaneous	Furnace Fan	Baseline	-	$0.00	18	1.00	$0.00
Miscellaneous	Furnace Fan	Furnace Fan with ECM	157.58	$0.64	18	1.28	$0.00
Miscellaneous	Miscellaneous	Miscellaneous	-	$0.00	5	1.00	$0.00

Table B-4 Energy Efficiency Equipment Data, Electric—Single Family, New Vintage, Washington

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central AC	SEER 13	-	$0.00	15	-	$0.00
Cooling	Central AC	SEER 14 (Energy Star)	148.36	$277.86	15	1.40	$0.16
Cooling	Central AC	SEER 15 (CEE Tier 2)	197.61	$555.71	15	0.95	$0.24
Cooling	Central AC	SEER 16 (CEE Tier 3)	238.95	$833.57	15	0.90	$0.30
Cooling	Central AC	Ductless Mini-Split System	448.12	$4,399.48	20	0.65	$0.69
Cooling	Room AC	EER 9.8	-	$0.00	10	1.00	$0.00
Cooling	Room AC	EER 10.8 (Energy Star)	57.89	$104.04	10	0.85	$0.21
Cooling	Room AC	EER 11	68.22	$282.26	10	0.65	$0.49
Cooling	Room AC	EER 11.5	92.51	$625.50	10	0.45	$0.80
Cooling	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	109.44	$67.05	15	1.30	$0.05
Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	120.45	$2,318.20	15	0.91	$1.66
Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	145.65	$3,504.51	15	0.85	$2.08
Cooling	Air Source Heat Pump	Ductless Mini-Split System	273.14	$5,655.04	20	0.87	$1.46
Cooling	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Cooling	Geothermal Heat Pump	High Efficiency	124.81	$1,500.00	15	0.92	$1.04
Cooling	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Electric Resistance	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Ductless Mini-Split System	4,146.56	$156.87	20	1.35	$0.00
Space Heating	Electric Furnace	3400 BTU/KW	-	$0.00	15	1.00	$0.00
Space Heating	Supplemental	Supplemental	-	$0.00	5	1.00	$0.00
Space Heating	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Space Heating	Air Source Heat Pump	SEER 14 (Energy Star)	161.42	$67.05	15	1.30	$0.04
Space Heating	Air Source Heat Pump	SEER 15 (CEE Tier 2)	1,236.03	$2,318.20	15	0.91	$0.16
Space Heating	Air Source Heat Pump	SEER 16 (CEE Tier 3)	1,494.65	$3,504.51	15	0.85	$0.20
Space Heating	Air Source Heat Pump	Ductless Mini-Split System	2,802.94	$5,655.04	20	0.87	$0.14
Space Heating	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Space Heating	Geothermal Heat Pump	High Efficiency	826.07	$1,500.00	15	0.92	$0.16
Space Heating	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	High Efficiency (EF=0.95)	207.44	$77.11	15	1.03	$0.03
Water Heating	Water Heater <= 55 Gal	EF 2.3 (HP)	1,999.65	$1,761.86	15	0.91	$0.08
Water Heating	Water Heater <= 55 Gal	Solar	2,791.58	$6,214.86	15	0.47	$0.19
Water Heating	Water Heater > 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater >	High Efficiency	264.15	$97.23	15	1.03	$0.03

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
	55 Gal	(EF=0.95)					
Water Heating	Water Heater > 55 Gal	EF 2.3 (HP)	2,000.81	$1,691.15	15	0.93	$0.07
Water Heating	Water Heater > 55 Gal	Solar	3,154.00	$6,144.15	15	0.52	$0.17
Interior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Interior Lighting	Screw-in	Infrared Halogen	307.59	$188.19	5	1.00	$0.13
Interior Lighting	Screw-in	CFL	976.77	$33.82	6	2.46	$0.01
Interior Lighting	Screw-in	LED	1,334.99	$1,937.55	12	-	$0.15
Interior Lighting	Screw-in	LED	1,334.99	$1,937.55	12	-	$0.15
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	13.19	-$3.65	6	1.13	-$0.05
Interior Lighting	Linear Fluorescent	Super T8	39.53	$29.17	6	0.73	$0.14
Interior Lighting	Linear Fluorescent	T5	41.09	$49.41	6	0.58	$0.22
Interior Lighting	Linear Fluorescent	LED	43.10	$433.68	10	0.21	$1.19
Interior Lighting	Specialty	Halogen	-	$0.00	4	1.00	$0.00
Interior Lighting	Specialty	CFL	303.20	-$6.90	7	2.33	$0.00
Interior Lighting	Specialty	LED	319.01	$163.55	12	0.76	$0.05
Exterior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Exterior Lighting	Screw-in	Infrared Halogen	168.10	$20.17	5	1.00	$0.03
Exterior Lighting	Screw-in	CFL	473.06	$0.00	3	4.21	$0.00
Exterior Lighting	Screw-in	LED	599.29	$88.71	12	-	$0.02
Exterior Lighting	Screw-in	LED	599.29	$88.71	12	-	$0.02
Appliances	Clothes Washer	Baseline	-	$0.00	14	-	$0.00
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	100.07	$3.98	14	-	$0.00
Appliances	Clothes Washer	Horizontal Axis	183.40	-$145.00	14	1.00	-$0.07
Appliances	Clothes Dryer	Baseline	-	$0.00	13	-	$0.00
Appliances	Clothes Dryer	Moisture Detection	76.97	$48.40	13	1.00	$0.06
Appliances	Dishwasher	Baseline	-	$0.00	15	1.00	$0.00
Appliances	Dishwasher	Energy Star	64.52	$460.95	9	-	$0.92
Appliances	Dishwasher	Energy Star (2011)	8.45	$5.61	15	1.00	$0.06
Appliances	Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Refrigerator	Energy Star	62.37	$20.17	20	-	$0.02
Appliances	Refrigerator	Baseline (2014)	114.24	$0.00	13	1.00	$0.00
Appliances	Refrigerator	Energy Star (2014)	182.79	$88.71	13	1.02	$0.05
Appliances	Freezer	Baseline	-	$0.00	22	-	$0.00
Appliances	Freezer	Energy Star	48.14	$3.98	22	-	$0.01
Appliances	Freezer	Baseline (2014)	111.72	-$145.00	11	1.00	-$0.14
Appliances	Freezer	Energy Star (2014)	178.76	-$112.83	11	1.01	-$0.07
Appliances	Second Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Second Refrigerator	Energy Star	80.17	$20.67	20	-	$0.02
Appliances	Second Refrigerator	Baseline (2014)	146.86	$0.00	13	1.00	$0.00

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Appliances	Second Refrigerator	Energy Star (2014)	234.98	$88.71	13	1.01	$0.04
Appliances	Stove	Baseline	-	$0.00	13	1.00	$0.00
Appliances	Stove	Convection Oven	10.66	$1.86	13	1.00	$0.02
Appliances	Stove	Induction (High Efficiency)	53.32	$1,432.20	13	0.39	$2.59
Appliances	Microwave	Baseline	-	$0.00	9	1.00	$0.00
Electronics	Personal Computers	Baseline	-	$0.00	5	1.00	$0.00
Electronics	Personal Computers	Energy Star	87.57	$1.20	5	1.01	$0.00
Electronics	Personal Computers	Climate Savers	125.09	$175.49	5	0.85	$0.30
Electronics	TVs	Baseline	-	$0.00	11	1.00	$0.00
Electronics	TVs	Energy Star	57.91	$0.56	11	1.02	$0.00
Electronics	Set-top boxes/DVR	Baseline	-	$0.00	11	1.00	$0.00
Electronics	Set-top boxes/DVR	Energy Star	31.55	$0.56	11	1.01	$0.00
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0.00	5	1.00	$0.00
Miscellaneous	Pool Pump	Baseline Pump	-	$0.00	15	1.00	$0.00
Miscellaneous	Pool Pump	High Efficiency Pump	155.66	$85.00	15	1.01	$0.05
Miscellaneous	Pool Pump	Two-Speed Pump	622.65	$579.00	15	0.88	$0.08
Miscellaneous	Furnace Fan	Baseline	-	$0.00	18	1.00	$0.00
Miscellaneous	Furnace Fan	Furnace Fan with ECM	157.58	$0.64	18	1.28	$0.00
Miscellaneous	Miscellaneous	Miscellaneous	-	$0.00	5	1.00	$0.00

Table B-5 Energy Efficiency Equipment Data, Electric—Single Family, Existing Vintage, Idaho

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central AC	SEER 13	-	$0.00	15	-	$0.00
Cooling	Central AC	SEER 14 (Energy Star)	105.03	$277.86	15	1.40	$0.23
Cooling	Central AC	SEER 15 (CEE Tier 2)	144.12	$555.71	15	0.94	$0.33
Cooling	Central AC	SEER 16 (CEE Tier 3)	176.85	$833.57	15	0.89	$0.41
Cooling	Central AC	Ductless Mini-Split System	317.18	$4,399.48	20	0.64	$0.98
Cooling	Room AC	EER 9.8	-	$0.00	10	1.00	$0.00
Cooling	Room AC	EER 10.8 (Energy Star)	41.90	$104.04	10	0.83	$0.29
Cooling	Room AC	EER 11	49.45	$282.26	10	0.63	$0.68
Cooling	Room AC	EER 11.5	66.94	$625.50	10	0.43	$1.11
Cooling	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	77.25	$0.00	15	1.30	$0.00
Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	87.61	$0.00	15	0.89	$0.00
Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	107.51	$0.00	15	0.84	$0.00
Cooling	Air Source Heat Pump	Ductless Mini-Split System	192.81	$0.00	20	0.85	$0.00
Cooling	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Cooling	Geothermal Heat Pump	High Efficiency	94.35	$0.00	15	0.91	$0.00
Cooling	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Electric Resistance	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Ductless Mini-Split System	3,785.99	$156.87	20	1.35	$0.00
Space Heating	Electric Furnace	3400 BTU/KW	-	$0.00	15	1.00	$0.00
Space Heating	Supplemental	Supplemental	-	$0.00	5	1.00	$0.00
Space Heating	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Space Heating	Air Source Heat Pump	SEER 14 (Energy Star)	132.94	$67.05	15	1.30	$0.04
Space Heating	Air Source Heat Pump	SEER 15 (CEE Tier 2)	1,048.86	$2,318.20	15	0.89	$0.19
Space Heating	Air Source Heat Pump	SEER 16 (CEE Tier 3)	1,287.08	$3,504.51	15	0.84	$0.24
Space Heating	Air Source Heat Pump	Ductless Mini-Split System	2,308.39	$5,655.04	20	0.85	$0.17
Space Heating	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Space Heating	Geothermal Heat Pump	High Efficiency	728.55	$1,500.00	15	0.91	$0.18
Space Heating	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	High Efficiency (EF=0.95)	217.82	$77.11	15	1.03	$0.03
Water Heating	Water Heater <= 55 Gal	EF 2.3 (HP)	2,099.63	$1,761.86	15	0.87	$0.07
Water Heating	Water Heater <= 55 Gal	Solar	2,931.16	$6,214.86	15	0.44	$0.18
Water Heating	Water Heater > 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater > 55 Gal	High Efficiency (EF=0.95)	277.36	$97.23	15	1.03	$0.03
Water Heating	Water Heater >	EF 2.3 (HP)	2,100.85	$1,691.15	15	0.90	$0.07

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
	55 Gal						
Water Heating	Water Heater > 55 Gal	Solar	1,877.26	$6,144.15	15	0.43	$0.28
Interior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Interior Lighting	Screw-in	Infrared Halogen	282.89	$188.19	5	1.00	$0.14
Interior Lighting	Screw-in	CFL	898.35	$33.82	6	2.59	$0.01
Interior Lighting	Screw-in	LED	1,227.82	$1,937.55	12	-	$0.16
Interior Lighting	Screw-in	LED	1,227.82	$1,937.55	12	-	$0.16
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	11.77	-$3.50	6	1.14	-$0.05
Interior Lighting	Linear Fluorescent	Super T8	35.25	$28.01	6	0.71	$0.15
Interior Lighting	Linear Fluorescent	T5	36.64	$47.43	6	0.56	$0.24
Interior Lighting	Linear Fluorescent	LED	38.43	$416.33	10	0.20	$1.28
Interior Lighting	Specialty	Halogen	-	$0.00	4	1.00	$0.00
Interior Lighting	Specialty	CFL	276.84	$1.92	7	1.93	$0.00
Interior Lighting	Specialty	LED	291.27	$522.52	12	0.30	$0.18
Exterior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Exterior Lighting	Screw-in	Infrared Halogen	97.55	$49.25	5	1.00	$0.11
Exterior Lighting	Screw-in	CFL	331.06	-$1.19	3	4.38	$0.00
Exterior Lighting	Screw-in	LED	384.28	$726.99	12	-	$0.19
Exterior Lighting	Screw-in	LED	384.28	$726.99	12	-	$0.19
Appliances	Clothes Washer	Baseline	-	$0.00	14	-	$0.00
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	51.92	$69.81	14	-	$0.12
Appliances	Clothes Washer	Horizontal Axis	71.68	$150.80	14	1.00	$0.19
Appliances	Clothes Dryer	Baseline	-	$0.00	13	-	$0.00
Appliances	Clothes Dryer	Moisture Detection	76.97	$48.40	13	1.00	$0.06
Appliances	Dishwasher	Baseline	-	$0.00	15	1.00	$0.00
Appliances	Dishwasher	Energy Star	64.27	$460.95	9	-	$0.93
Appliances	Dishwasher	Energy Star (2011)	8.42	$5.61	15	1.00	$0.06
Appliances	Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Refrigerator	Energy Star	55.03	$20.17	20	-	$0.03
Appliances	Refrigerator	Baseline (2014)	100.80	$0.00	13	1.00	$0.00
Appliances	Refrigerator	Energy Star (2014)	161.28	$88.71	13	1.01	$0.05
Appliances	Freezer	Baseline	-	$0.00	22	-	$0.00
Appliances	Freezer	Energy Star	44.98	$3.98	22	-	$0.01
Appliances	Freezer	Baseline (2014)	104.39	-$145.00	11	1.00	-$0.15
Appliances	Freezer	Energy Star (2014)	167.03	-$112.83	11	1.00	-$0.07
Appliances	Second Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Second Refrigerator	Energy Star	75.16	$20.67	20	-	$0.02
Appliances	Second Refrigerator	Baseline (2014)	137.68	$0.00	13	1.00	$0.00
Appliances	Second Refrigerator	Energy Star (2014)	220.29	$88.71	13	1.01	$0.04

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Appliances	Stove	Baseline	-	$0.00	13	1.00	$0.00
Appliances	Stove	Convection Oven	10.67	$1.86	13	1.00	$0.02
Appliances	Stove	Induction (High Efficiency)	53.33	$1,432.20	13	0.38	$2.59
Appliances	Microwave	Baseline	-	$0.00	9	1.00	$0.00
Electronics	Personal Computers	Baseline	-	$0.00	5	1.00	$0.00
Electronics	Personal Computers	Energy Star	89.47	$1.20	5	1.01	$0.00
Electronics	Personal Computers	Climate Savers	127.82	$175.49	5	0.85	$0.30
Electronics	TVs	Baseline	-	$0.00	11	1.00	$0.00
Electronics	TVs	Energy Star	52.12	$0.56	11	1.02	$0.00
Electronics	Set-top boxes/DVR	Baseline	-	$0.00	11	1.00	$0.00
Electronics	Set-top boxes/DVR	Energy Star	31.55	$0.56	11	1.01	$0.00
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0.00	5	1.00	$0.00
Miscellaneous	Pool Pump	Baseline Pump	-	$0.00	15	1.00	$0.00
Miscellaneous	Pool Pump	High Efficiency Pump	137.76	$85.00	15	1.00	$0.05
Miscellaneous	Pool Pump	Two-Speed Pump	551.02	$579.00	15	0.83	$0.09
Miscellaneous	Furnace Fan	Baseline	-	$0.00	18	1.00	$0.00
Miscellaneous	Furnace Fan	Furnace Fan with ECM	165.46	$0.64	18	1.29	$0.00
Miscellaneous	Miscellaneous	Miscellaneous	-	$0.00	5	1.00	$0.00

Table B-6 Energy Efficiency Equipment Data, Electric—Single Family, New Vintage, Idaho

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central AC	SEER 13	-	$0.00	15	-	$0.00
Cooling	Central AC	SEER 14 (Energy Star)	133.52	$277.86	15	1.40	$0.18
Cooling	Central AC	SEER 15 (CEE Tier 2)	177.85	$555.71	15	0.95	$0.27
Cooling	Central AC	SEER 16 (CEE Tier 3)	215.06	$833.57	15	0.90	$0.34
Cooling	Central AC	Ductless Mini-Split System	403.30	$4,399.48	20	0.64	$0.77
Cooling	Room AC	EER 9.8	-	$0.00	10	1.00	$0.00
Cooling	Room AC	EER 10.8 (Energy Star)	52.10	$104.04	10	0.84	$0.24
Cooling	Room AC	EER 11	61.40	$282.26	10	0.64	$0.55
Cooling	Room AC	EER 11.5	83.26	$625.50	10	0.44	$0.89
Cooling	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	98.49	$67.05	15	1.30	$0.06
Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	108.40	$2,318.20	15	0.92	$1.85
Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	131.09	$3,504.51	15	0.87	$2.31
Cooling	Air Source Heat Pump	Ductless Mini-Split System	245.83	$5,655.04	20	0.88	$1.63
Cooling	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Cooling	Geothermal Heat Pump	High Efficiency	112.33	$1,500.00	15	0.92	$1.15
Cooling	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Electric Resistance	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Ductless Mini-Split System	4,353.88	$156.87	20	1.37	$0.00
Space Heating	Electric Furnace	3400 BTU/KW	-	$0.00	15	1.00	$0.00
Space Heating	Supplemental	Supplemental	-	$0.00	5	1.00	$0.00
Space Heating	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Space Heating	Air Source Heat Pump	SEER 14 (Energy Star)	169.49	$67.05	15	1.30	$0.03
Space Heating	Air Source Heat Pump	SEER 15 (CEE Tier 2)	1,297.83	$2,318.20	15	0.92	$0.15
Space Heating	Air Source Heat Pump	SEER 16 (CEE Tier 3)	1,569.38	$3,504.51	15	0.87	$0.19
Space Heating	Air Source Heat Pump	Ductless Mini-Split System	2,943.09	$5,655.04	20	0.88	$0.14
Space Heating	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Space Heating	Geothermal Heat Pump	High Efficiency	867.38	$1,500.00	15	0.92	$0.15
Space Heating	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	High Efficiency (EF=0.95)	217.82	$77.11	15	1.03	$0.03
Water Heating	Water Heater <= 55 Gal	EF 2.3 (HP)	2,099.63	$1,761.86	15	0.87	$0.07
Water Heating	Water Heater <= 55 Gal	Solar	2,931.16	$6,214.86	15	0.44	$0.18
Water Heating	Water Heater > 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater > 55 Gal	High Efficiency (EF=0.95)	277.36	$97.23	15	1.03	$0.03
Water Heating	Water Heater >	EF 2.3 (HP)	2,100.85	$1,691.15	15	0.90	$0.07

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
	55 Gal						
Water Heating	Water Heater > 55 Gal	Solar	1,877.26	$6,144.15	15	0.43	$0.28
Interior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Interior Lighting	Screw-in	Infrared Halogen	322.96	$188.19	5	1.00	$0.13
Interior Lighting	Screw-in	CFL	1,025.61	$33.82	6	2.51	$0.01
Interior Lighting	Screw-in	LED	1,401.74	$1,937.55	12	-	$0.14
Interior Lighting	Screw-in	LED	1,401.74	$1,937.55	12	-	$0.14
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	13.85	-$3.50	6	1.13	-$0.05
Interior Lighting	Linear Fluorescent	Super T8	41.50	$28.01	6	0.74	$0.12
Interior Lighting	Linear Fluorescent	T5	43.14	$47.43	6	0.59	$0.20
Interior Lighting	Linear Fluorescent	LED	45.26	$416.33	10	0.21	$1.09
Interior Lighting	Specialty	Halogen	-	$0.00	4	1.00	$0.00
Interior Lighting	Specialty	CFL	318.36	-$6.40	7	2.32	$0.00
Interior Lighting	Specialty	LED	334.96	$164.04	12	0.77	$0.05
Exterior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Exterior Lighting	Screw-in	Infrared Halogen	173.38	$20.17	5	1.00	$0.03
Exterior Lighting	Screw-in	CFL	491.00	$0.00	3	4.30	$0.00
Exterior Lighting	Screw-in	LED	620.11	$88.71	12	-	$0.01
Exterior Lighting	Screw-in	LED	620.11	$88.71	12	-	$0.01
Appliances	Clothes Washer	Baseline	-	$0.00	14	-	$0.00
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	100.07	$3.98	14	-	$0.00
Appliances	Clothes Washer	Horizontal Axis	183.40	-$145.00	14	1.00	-$0.07
Appliances	Clothes Dryer	Baseline	-	$0.00	13	-	$0.00
Appliances	Clothes Dryer	Moisture Detection	76.97	$48.40	13	1.00	$0.06
Appliances	Dishwasher	Baseline	-	$0.00	15	1.00	$0.00
Appliances	Dishwasher	Energy Star	64.52	$460.95	9	-	$0.92
Appliances	Dishwasher	Energy Star (2011)	8.45	$5.61	15	1.00	$0.06
Appliances	Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Refrigerator	Energy Star	62.37	$20.17	20	-	$0.02
Appliances	Refrigerator	Baseline (2014)	114.24	$0.00	13	1.00	$0.00
Appliances	Refrigerator	Energy Star (2014)	182.79	$88.71	13	1.02	$0.05
Appliances	Freezer	Baseline	-	$0.00	22	-	$0.00
Appliances	Freezer	Energy Star	48.14	$3.98	22	-	$0.01
Appliances	Freezer	Baseline (2014)	111.72	-$145.00	11	1.00	-$0.14
Appliances	Freezer	Energy Star (2014)	178.76	-$112.83	11	1.00	-$0.07
Appliances	Second Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Second Refrigerator	Energy Star	80.17	$20.67	20	-	$0.02
Appliances	Second Refrigerator	Baseline (2014)	146.86	$0.00	13	1.00	$0.00
Appliances	Second Refrigerator	Energy Star (2014)	234.98	$88.71	13	1.01	$0.04

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Appliances	Stove	Baseline	-	$0.00	13	1.00	$0.00
Appliances	Stove	Convection Oven	11.73	$1.86	13	1.00	$0.02
Appliances	Stove	Induction (High Efficiency)	58.65	$1,432.20	13	0.38	$2.35
Appliances	Microwave	Baseline	-	$0.00	9	1.00	$0.00
Electronics	Personal Computers	Baseline	-	$0.00	5	1.00	$0.00
Electronics	Personal Computers	Energy Star	87.57	$1.20	5	1.01	$0.00
Electronics	Personal Computers	Climate Savers	125.09	$175.49	5	0.85	$0.30
Electronics	TVs	Baseline	-	$0.00	11	1.00	$0.00
Electronics	TVs	Energy Star	57.91	$0.56	11	1.02	$0.00
Electronics	Set-top boxes/DVR	Baseline	-	$0.00	11	1.00	$0.00
Electronics	Set-top boxes/DVR	Energy Star	31.55	$0.56	11	1.01	$0.00
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0.00	5	1.00	$0.00
Miscellaneous	Pool Pump	Baseline Pump	-	$0.00	15	1.00	$0.00
Miscellaneous	Pool Pump	High Efficiency Pump	155.66	$85.00	15	1.01	$0.05
Miscellaneous	Pool Pump	Two-Speed Pump	622.65	$579.00	15	0.87	$0.08
Miscellaneous	Furnace Fan	Baseline	-	$0.00	18	1.00	$0.00
Miscellaneous	Furnace Fan	Furnace Fan with ECM	165.46	$0.64	18	1.29	$0.00
Miscellaneous	Miscellaneous	Miscellaneous	-	$0.00	5	1.00	$0.00

Table B-7 Energy Efficiency Equipment Data, Electric—Multi Family, Existing Vintage, Washington

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central AC	SEER 13	-	$0.00	15	-	$0.00
Cooling	Central AC	SEER 14 (Energy Star)	41.57	$92.62	15	1.40	$0.19
Cooling	Central AC	SEER 15 (CEE Tier 2)	81.72	$185.24	15	0.96	$0.20
Cooling	Central AC	SEER 16 (CEE Tier 3)	115.28	$277.86	15	0.93	$0.21
Cooling	Central AC	Ductless Mini-Split System	150.88	$2,012.28	20	0.62	$0.94
Cooling	Room AC	EER 9.8	-	$0.00	10	1.00	$0.00
Cooling	Room AC	EER 10.8 (Energy Star)	32.61	$52.02	10	0.86	$0.19
Cooling	Room AC	EER 11	38.42	$141.13	10	0.66	$0.44
Cooling	Room AC	EER 11.5	52.05	$312.75	10	0.46	$0.71
Cooling	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	44.14	$1,245.78	15	1.30	$2.44
Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	71.87	$2,315.13	15	0.92	$2.79
Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	101.38	$3,277.48	15	0.85	$2.80
Cooling	Air Source Heat Pump	Ductless Mini-Split System	132.69	$5,022.03	20	0.85	$2.68
Cooling	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Cooling	Geothermal Heat Pump	High Efficiency	63.75	$1,500.00	15	0.89	$2.03
Cooling	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Electric Resistance	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Ductless Mini-Split System	1,812.94	$156.87	20	1.27	$0.01
Space Heating	Electric Furnace	3400 BTU/KW	-	$0.00	15	1.00	$0.00
Space Heating	Supplemental	Supplemental	-	$0.00	5	1.00	$0.00
Space Heating	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Space Heating	Air Source Heat Pump	SEER 14 (Energy Star)	172.19	$1,245.78	15	1.30	$0.63
Space Heating	Air Source Heat Pump	SEER 15 (CEE Tier 2)	538.74	$2,315.13	15	0.92	$0.37
Space Heating	Air Source Heat Pump	SEER 16 (CEE Tier 3)	760.01	$3,277.48	15	0.85	$0.37
Space Heating	Air Source Heat Pump	Ductless Mini-Split System	994.66	$5,022.03	20	0.85	$0.36
Space Heating	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Space Heating	Geothermal Heat Pump	High Efficiency	416.01	$1,500.00	15	0.89	$0.31
Space Heating	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	High Efficiency (EF=0.95)	110.09	$77.11	15	1.01	$0.06
Water Heating	Water Heater <= 55 Gal	EF 2.3 (HP)	1,061.19	$1,761.86	15	0.64	$0.14
Water Heating	Water Heater <= 55 Gal	Solar	1,202.35	$6,214.86	15	0.27	$0.45
Water Heating	Water Heater > 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater >	High Efficiency	182.05	$97.23	15	1.02	$0.05

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
	55 Gal	(EF=0.95)					
Water Heating	Water Heater > 55 Gal	EF 2.3 (HP)	1,378.92	$1,691.15	15	0.78	$0.11
Water Heating	Water Heater > 55 Gal	Solar	1,231.85	$6,144.15	15	0.35	$0.43
Interior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Interior Lighting	Screw-in	Infrared Halogen	163.13	$134.14	5	1.00	$0.18
Interior Lighting	Screw-in	CFL	518.03	$12.45	6	2.94	$0.00
Interior Lighting	Screw-in	LED	708.02	$1,161.45	12	-	$0.17
Interior Lighting	Screw-in	LED	708.02	$1,161.45	12	-	$0.17
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	7.79	-$1.83	6	1.13	-$0.04
Interior Lighting	Linear Fluorescent	Super T8	23.35	$14.59	6	0.76	$0.11
Interior Lighting	Linear Fluorescent	T5	24.27	$24.70	6	0.61	$0.19
Interior Lighting	Linear Fluorescent	LED	25.46	$216.84	10	0.23	$1.01
Interior Lighting	Specialty	Halogen	-	$0.00	4	1.00	$0.00
Interior Lighting	Specialty	CFL	105.71	$0.77	7	1.91	$0.00
Interior Lighting	Specialty	LED	111.22	$209.01	12	0.29	$0.19
Exterior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Exterior Lighting	Screw-in	Infrared Halogen	5.39	$5.08	5	1.00	$0.20
Exterior Lighting	Screw-in	CFL	18.28	-$0.32	3	5.74	-$0.01
Exterior Lighting	Screw-in	LED	21.22	$1,167.57	12	-	$5.64
Exterior Lighting	Screw-in	LED	21.22	$1,167.57	12	-	$5.64
Appliances	Clothes Washer	Baseline	-	$0.00	14	-	$0.00
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	41.54	$69.81	14	-	$0.15
Appliances	Clothes Washer	Horizontal Axis	57.34	$150.80	14	1.00	$0.24
Appliances	Clothes Dryer	Baseline	-	$0.00	13	-	$0.00
Appliances	Clothes Dryer	Moisture Detection	61.35	$48.40	13	1.00	$0.08
Appliances	Dishwasher	Baseline	-	$0.00	15	1.00	$0.00
Appliances	Dishwasher	Energy Star	51.42	$460.95	15	-	$0.78
Appliances	Dishwasher	Energy Star (2011)	6.74	$5.61	15	1.00	$0.07
Appliances	Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Refrigerator	Energy Star	44.02	$20.17	20	-	$0.03
Appliances	Refrigerator	Baseline (2014)	80.64	$0.00	13	1.00	$0.00
Appliances	Refrigerator	Energy Star (2014)	129.03	$88.71	13	1.01	$0.07
Appliances	Freezer	Baseline	-	$0.00	22	-	$0.00
Appliances	Freezer	Energy Star	35.99	$3.98	22	-	$0.01
Appliances	Freezer	Baseline (2014)	83.52	-$145.00	11	1.00	-$0.19
Appliances	Freezer	Energy Star (2014)	133.62	-$112.83	11	0.99	-$0.09
Appliances	Second Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Second Refrigerator	Energy Star	60.13	$20.67	20	-	$0.02
Appliances	Second Refrigerator	Baseline (2014)	110.14	$0.00	13	1.00	$0.00

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Appliances	Second Refrigerator	Energy Star (2014)	176.23	$88.71	13	1.01	$0.05
Appliances	Stove	Baseline	-	$0.00	13	1.00	$0.00
Appliances	Stove	Convection Oven	8.53	$1.86	13	1.00	$0.02
Appliances	Stove	Induction (High Efficiency)	42.66	$1,432.20	13	0.38	$3.23
Appliances	Microwave	Baseline	-	$0.00	9	1.00	$0.00
Electronics	Personal Computers	Baseline	-	$0.00	5	1.00	$0.00
Electronics	Personal Computers	Energy Star	71.58	$1.20	5	1.01	$0.00
Electronics	Personal Computers	Climate Savers	102.26	$175.49	5	0.85	$0.37
Electronics	TVs	Baseline	-	$0.00	11	1.00	$0.00
Electronics	TVs	Energy Star	46.91	$0.56	11	1.02	$0.00
Electronics	Set-top boxes/DVR	Baseline	-	$0.00	11	1.00	$0.00
Electronics	Set-top boxes/DVR	Energy Star	31.55	$0.56	11	1.01	$0.00
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0.00	5	1.00	$0.00
Miscellaneous	Pool Pump	Baseline Pump	-	$0.00	15	1.00	$0.00
Miscellaneous	Pool Pump	High Efficiency Pump	137.76	$85.00	15	1.00	$0.05
Miscellaneous	Pool Pump	Two-Speed Pump	551.02	$579.00	15	0.83	$0.09
Miscellaneous	Furnace Fan	Baseline	-	$0.00	18	1.00	$0.00
Miscellaneous	Furnace Fan	Furnace Fan with ECM	126.06	$0.00	18	1.27	$0.00
Miscellaneous	Miscellaneous	Miscellaneous	-	$0.00	5	1.00	$0.00

Table B-8 Energy EfficiencyEquipment Data, Electric—Multi Family, New Vintage, Washington

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central AC	SEER 13	-	$0.00	15	-	$0.00
Cooling	Central AC	SEER 14 (Energy Star)	53.20	$92.62	15	1.40	$0.15
Cooling	Central AC	SEER 15 (CEE Tier 2)	103.85	$185.24	15	0.97	$0.15
Cooling	Central AC	SEER 16 (CEE Tier 3)	146.35	$277.86	15	0.93	$0.16
Cooling	Central AC	Ductless Mini-Split System	192.62	$2,012.28	20	0.63	$0.74
Cooling	Room AC	EER 9.8	-	$0.00	10	1.00	$0.00
Cooling	Room AC	EER 10.8 (Energy Star)	40.50	$52.02	10	0.87	$0.15
Cooling	Room AC	EER 11	47.72	$141.13	10	0.69	$0.35
Cooling	Room AC	EER 11.5	64.71	$312.75	10	0.49	$0.57
Cooling	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	56.37	$1,245.78	15	1.30	$1.91
Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	91.36	$2,315.13	15	0.94	$2.19
Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	128.74	$3,277.48	15	0.88	$2.20
Cooling	Air Source Heat Pump	Ductless Mini-Split System	169.45	$5,022.03	20	0.87	$2.10
Cooling	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Cooling	Geothermal Heat Pump	High Efficiency	75.90	$1,500.00	15	0.90	$1.71
Cooling	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Electric Resistance	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Ductless Mini-Split System	2,084.88	$156.87	20	1.29	$0.01
Space Heating	Electric Furnace	3400 BTU/KW	-	$0.00	15	1.00	$0.00
Space Heating	Supplemental	Supplemental	-	$0.00	5	1.00	$0.00
Space Heating	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Space Heating	Air Source Heat Pump	SEER 14 (Energy Star)	219.90	$1,245.78	15	1.30	$0.49
Space Heating	Air Source Heat Pump	SEER 15 (CEE Tier 2)	684.88	$2,315.13	15	0.94	$0.29
Space Heating	Air Source Heat Pump	SEER 16 (CEE Tier 3)	965.10	$3,277.48	15	0.88	$0.29
Space Heating	Air Source Heat Pump	Ductless Mini-Split System	1,270.27	$5,022.03	20	0.87	$0.28
Space Heating	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Space Heating	Geothermal Heat Pump	High Efficiency	495.28	$1,500.00	15	0.90	$0.26
Space Heating	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	High Efficiency (EF=0.95)	110.09	$77.11	15	1.01	$0.06
Water Heating	Water Heater <= 55 Gal	EF 2.3 (HP)	1,061.19	$1,761.86	15	0.64	$0.14
Water Heating	Water Heater <= 55 Gal	Solar	1,202.35	$6,214.86	15	0.27	$0.45
Water Heating	Water Heater > 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater > 55 Gal	High Efficiency (EF=0.95)	182.05	$97.23	15	1.02	$0.05
Water Heating	Water Heater >	EF 2.3 (HP)	1,378.92	$1,691.15	15	0.78	$0.11

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
	55 Gal						
Water Heating	Water Heater > 55 Gal	Solar	1,231.85	$6,144.15	15	0.35	$0.43
Interior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Interior Lighting	Screw-in	Infrared Halogen	186.22	$134.14	5	1.00	$0.16
Interior Lighting	Screw-in	CFL	591.38	$12.45	6	2.81	$0.00
Interior Lighting	Screw-in	LED	808.26	$1,381.00	12	-	$0.18
Interior Lighting	Screw-in	LED	808.26	$1,381.00	12	-	$0.18
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	9.18	-$1.83	6	1.13	-$0.04
Interior Lighting	Linear Fluorescent	Super T8	27.49	$14.59	6	0.80	$0.10
Interior Lighting	Linear Fluorescent	T5	28.58	$24.70	6	0.65	$0.16
Interior Lighting	Linear Fluorescent	LED	29.98	$216.84	10	0.24	$0.86
Interior Lighting	Specialty	Halogen	-	$0.00	4	1.00	$0.00
Interior Lighting	Specialty	CFL	121.57	-$13.05	7	3.30	-$0.02
Interior Lighting	Specialty	LED	127.91	$62.12	12	1.02	$0.05
Exterior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Exterior Lighting	Screw-in	Infrared Halogen	6.13	$5.08	5	1.00	$0.18
Exterior Lighting	Screw-in	CFL	20.80	-$0.32	3	5.55	-$0.01
Exterior Lighting	Screw-in	LED	24.14	$75.05	12	-	$0.32
Exterior Lighting	Screw-in	LED	24.14	$75.05	12	-	$0.32
Appliances	Clothes Washer	Baseline	-	$0.00	14	-	$0.00
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	41.54	$69.81	14	-	$0.15
Appliances	Clothes Washer	Horizontal Axis	57.34	$150.80	14	1.00	$0.24
Appliances	Clothes Dryer	Baseline	-	$0.00	13	-	$0.00
Appliances	Clothes Dryer	Moisture Detection	61.35	$48.40	13	1.00	$0.08
Appliances	Dishwasher	Baseline	-	$0.00	15	1.00	$0.00
Appliances	Dishwasher	Energy Star	51.61	$460.95	9	-	$1.15
Appliances	Dishwasher	Energy Star (2011)	6.76	$5.61	15	1.00	$0.07
Appliances	Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Refrigerator	Energy Star	49.89	$20.17	20	-	$0.03
Appliances	Refrigerator	Baseline (2014)	91.39	$0.00	13	1.00	$0.00
Appliances	Refrigerator	Energy Star (2014)	146.23	$88.71	13	1.01	$0.06
Appliances	Freezer	Baseline	-	$0.00	22	-	$0.00
Appliances	Freezer	Energy Star	38.51	$3.98	22	-	$0.01
Appliances	Freezer	Baseline (2014)	89.38	-$145.00	11	1.00	-$0.18
Appliances	Freezer	Energy Star (2014)	143.01	-$112.83	11	1.00	-$0.09
Appliances	Second Refrigerator	Baseline	-	$0.00	13	-	$0.00
Appliances	Second Refrigerator	Energy Star	64.14	$20.67	20	-	$0.02
Appliances	Second Refrigerator	Baseline (2014)	117.49	$0.00	13	1.00	$0.00
Appliances	Second Refrigerator	Energy Star (2014)	187.98	$88.71	13	1.01	$0.05

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Appliances	Stove	Baseline	-	$0.00	13	1.00	$0.00
Appliances	Stove	Convection Oven	8.53	$1.86	13	1.00	$0.02
Appliances	Stove	Induction (High Efficiency)	42.66	$1,432.20	13	0.38	$3.23
Appliances	Microwave	Baseline	-	$0.00	9	1.00	$0.00
Electronics	Personal Computers	Baseline	-	$0.00	5	1.00	$0.00
Electronics	Personal Computers	Energy Star	70.05	$1.20	5	1.01	$0.00
Electronics	Personal Computers	Climate Savers	100.08	$175.49	5	0.85	$0.38
Electronics	TVs	Baseline	-	$0.00	11	1.00	$0.00
Electronics	TVs	Energy Star	52.12	$0.56	11	1.02	$0.00
Electronics	Set-top boxes/DVR	Baseline	-	$0.00	11	1.00	$0.00
Electronics	Set-top boxes/DVR	Energy Star	31.55	$0.56	11	1.01	$0.00
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0.00	5	1.00	$0.00
Miscellaneous	Pool Pump	Baseline Pump	-	$0.00	15	1.00	$0.00
Miscellaneous	Pool Pump	High Efficiency Pump	155.66	$85.00	15	1.01	$0.05
Miscellaneous	Pool Pump	Two-Speed Pump	622.65	$579.00	15	0.88	$0.08
Miscellaneous	Furnace Fan	Baseline	-	$0.00	18	1.00	$0.00
Miscellaneous	Furnace Fan	Furnace Fan with ECM	126.06	$0.64	18	1.27	$0.00
Miscellaneous	Miscellaneous	Miscellaneous	-	$0.00	5	1.00	$0.00

Table B-9 Energy Efficiency Equipment Data, Electric—Multi Family, Existing Vintage, Idaho

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central AC	SEER 13	-	$0.00	15	-	$0.00
Cooling	Central AC	SEER 14 (Energy Star)	35.49	$92.62	15	1.40	$0.23
Cooling	Central AC	SEER 15 (CEE Tier 2)	69.76	$185.24	15	0.96	$0.23
Cooling	Central AC	SEER 16 (CEE Tier 3)	98.42	$277.86	15	0.92	$0.24
Cooling	Central AC	Ductless Mini-Split System	128.81	$2,012.28	20	0.62	$1.11
Cooling	Room AC	EER 9.8	-	$0.00	10	1.00	$0.00
Cooling	Room AC	EER 10.8 (Energy Star)	27.73	$52.02	10	0.84	$0.22
Cooling	Room AC	EER 11	32.67	$141.13	10	0.65	$0.51
Cooling	Room AC	EER 11.5	44.26	$312.75	10	0.45	$0.84
Cooling	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	37.52	$1,245.78	15	1.30	$2.87
Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	61.09	$2,315.13	15	0.92	$3.28
Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	86.18	$3,277.48	15	0.85	$3.29
Cooling	Air Source Heat Pump	Ductless Mini-Split System	112.78	$5,022.03	20	0.84	$3.15
Cooling	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Cooling	Geothermal Heat Pump	High Efficiency	54.19	$1,500.00	15	0.87	$2.39
Cooling	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Electric Resistance	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Ductless Mini-Split System	1,704.17	$156.87	20	1.27	$0.01
Space Heating	Electric Furnace	3400 BTU/KW	-	$0.00	15	1.00	$0.00
Space Heating	Supplemental	Supplemental	-	$0.00	5	1.00	$0.00
Space Heating	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Space Heating	Air Source Heat Pump	SEER 14 (Energy Star)	161.86	$1,245.78	15	1.30	$0.67
Space Heating	Air Source Heat Pump	SEER 15 (CEE Tier 2)	506.41	$2,315.13	15	0.92	$0.40
Space Heating	Air Source Heat Pump	SEER 16 (CEE Tier 3)	714.41	$3,277.48	15	0.85	$0.40
Space Heating	Air Source Heat Pump	Ductless Mini-Split System	934.98	$5,022.03	20	0.84	$0.38
Space Heating	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Space Heating	Geothermal Heat Pump	High Efficiency	391.05	$1,500.00	15	0.87	$0.33
Space Heating	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	High Efficiency (EF=0.95)	103.48	$77.11	15	1.00	$0.06
Water Heating	Water Heater <= 55 Gal	EF 2.3 (HP)	997.52	$1,761.86	15	0.57	$0.15
Water Heating	Water Heater <= 55 Gal	Solar	1,130.20	$6,214.86	15	0.24	$0.48
Water Heating	Water Heater > 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater > 55 Gal	High Efficiency (EF=0.95)	171.13	$97.23	15	1.01	$0.05
Water Heating	Water Heater >	EF 2.3 (HP)	1,296.19	$1,691.15	15	0.71	$0.11

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
	55 Gal						
Water Heating	Water Heater > 55 Gal	Solar	1,158.24	$6,144.15	15	0.31	$0.46
Interior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Interior Lighting	Screw-in	Infrared Halogen	153.34	$134.14	5	1.00	$0.19
Interior Lighting	Screw-in	CFL	486.95	$12.45	6	3.12	$0.00
Interior Lighting	Screw-in	LED	665.53	$1,161.45	12	-	$0.18
Interior Lighting	Screw-in	LED	665.53	$1,161.45	12	-	$0.18
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	7.33	-$1.83	6	1.13	-$0.05
Interior Lighting	Linear Fluorescent	Super T8	21.95	$14.59	6	0.75	$0.12
Interior Lighting	Linear Fluorescent	T5	22.81	$24.70	6	0.60	$0.20
Interior Lighting	Linear Fluorescent	LED	23.93	$216.84	10	0.22	$1.07
Interior Lighting	Specialty	Halogen	-	$0.00	4	1.00	$0.00
Interior Lighting	Specialty	CFL	99.37	$0.77	7	1.91	$0.00
Interior Lighting	Specialty	LED	104.55	$209.01	12	0.28	$0.20
Exterior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Exterior Lighting	Screw-in	Infrared Halogen	5.06	$5.08	5	1.00	$0.22
Exterior Lighting	Screw-in	CFL	17.18	-$0.32	3	5.89	-$0.01
Exterior Lighting	Screw-in	LED	19.94	$1,167.57	12	-	$6.00
Exterior Lighting	Screw-in	LED	19.94	$1,167.57	12	-	$6.00
Appliances	Clothes Washer	Baseline	-	$0.00	14	-	$0.00
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	39.05	$69.81	14	-	$0.16
Appliances	Clothes Washer	Horizontal Axis	53.90	$150.80	14	1.00	$0.25
Appliances	Clothes Dryer	Baseline	-	$0.00	13	-	$0.00
Appliances	Clothes Dryer	Moisture Detection	57.67	$48.40	13	1.00	$0.08
Appliances	Dishwasher	Baseline	-	$0.00	15	1.00	$0.00
Appliances	Dishwasher	Energy Star	48.33	$460.95	9	-	$1.23
Appliances	Dishwasher	Energy Star (2011)	6.33	$5.61	15	0.99	$0.08
Appliances	Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Refrigerator	Energy Star	41.38	$20.17	20	-	$0.03
Appliances	Refrigerator	Baseline (2014)	75.80	$0.00	13	1.00	$0.00
Appliances	Refrigerator	Energy Star (2014)	121.28	$88.71	13	1.01	$0.07
Appliances	Freezer	Baseline	-	$0.00	22	-	$0.00
Appliances	Freezer	Energy Star	33.83	$3.98	22	-	$0.01
Appliances	Freezer	Baseline (2014)	78.50	-$145.00	11	1.00	-$0.20
Appliances	Freezer	Energy Star (2014)	125.61	-$112.83	11	0.99	-$0.10
Appliances	Second Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Second Refrigerator	Energy Star	56.52	$20.67	20	-	$0.03
Appliances	Second Refrigerator	Baseline (2014)	103.54	$0.00	13	1.00	$0.00
Appliances	Second Refrigerator	Energy Star (2014)	165.66	$88.71	13	1.00	$0.05

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Appliances	Stove	Baseline	-	$0.00	13	1.00	$0.00
Appliances	Stove	Convection Oven	8.02	$1.86	13	1.00	$0.02
Appliances	Stove	Induction (High Efficiency)	40.10	$1,432.20	13	0.37	$3.44
Appliances	Microwave	Baseline	-	$0.00	9	1.00	$0.00
Electronics	Personal Computers	Baseline	-	$0.00	5	1.00	$0.00
Electronics	Personal Computers	Energy Star	67.28	$1.20	5	1.01	$0.00
Electronics	Personal Computers	Climate Savers	96.12	$175.49	5	0.85	$0.39
Electronics	TVs	Baseline	-	$0.00	11	1.00	$0.00
Electronics	TVs	Energy Star	44.09	$0.56	11	1.02	$0.00
Electronics	Set-top boxes/DVR	Baseline	-	$0.00	11	1.00	$0.00
Electronics	Set-top boxes/DVR	Energy Star	29.65	$0.56	11	1.01	$0.00
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0.00	5	1.00	$0.00
Miscellaneous	Pool Pump	Baseline Pump	-	$0.00	15	1.00	$0.00
Miscellaneous	Pool Pump	High Efficiency Pump	129.49	$85.00	15	1.00	$0.06
Miscellaneous	Pool Pump	Two-Speed Pump	517.96	$579.00	15	0.81	$0.10
Miscellaneous	Furnace Fan	Baseline	-	$0.00	18	1.00	$0.00
Miscellaneous	Furnace Fan	Furnace Fan with ECM	118.50	$0.00	18	1.27	$0.00
Miscellaneous	Miscellaneous	Miscellaneous	-	$0.00	5	1.00	$0.00

Table B-10 Energy Efficiency Equipment Data, Electric—Multi Family, New Vintage, Idaho

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central AC	SEER 13	-	$0.00	15	-	$0.00
Cooling	Central AC	SEER 14 (Energy Star)	45.42	$92.62	15	1.40	$0.18
Cooling	Central AC	SEER 15 (CEE Tier 2)	88.66	$185.24	15	0.96	$0.18
Cooling	Central AC	SEER 16 (CEE Tier 3)	124.94	$277.86	15	0.93	$0.19
Cooling	Central AC	Ductless Mini-Split System	164.44	$2,012.28	20	0.63	$0.87
Cooling	Room AC	EER 9.8	-	$0.00	10	1.00	$0.00
Cooling	Room AC	EER 10.8 (Energy Star)	34.44	$52.02	10	0.86	$0.18
Cooling	Room AC	EER 11	40.58	$141.13	10	0.67	$0.41
Cooling	Room AC	EER 11.5	55.03	$312.75	10	0.47	$0.67
Cooling	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	47.92	$1,245.78	15	1.30	$2.25
Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	77.66	$2,315.13	15	0.93	$2.58
Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	109.43	$3,277.48	15	0.87	$2.59
Cooling	Air Source Heat Pump	Ductless Mini-Split System	144.03	$5,022.03	20	0.86	$2.47
Cooling	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Cooling	Geothermal Heat Pump	High Efficiency	64.51	$1,500.00	15	0.87	$2.01
Cooling	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Electric Resistance	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Ductless Mini-Split System	1,959.79	$156.87	20	1.29	$0.01
Space Heating	Electric Furnace	3400 BTU/KW	-	$0.00	15	1.00	$0.00
Space Heating	Supplemental	Supplemental	-	$0.00	5	1.00	$0.00
Space Heating	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Space Heating	Air Source Heat Pump	SEER 14 (Energy Star)	206.71	$1,245.78	15	1.30	$0.52
Space Heating	Air Source Heat Pump	SEER 15 (CEE Tier 2)	643.79	$2,315.13	15	0.93	$0.31
Space Heating	Air Source Heat Pump	SEER 16 (CEE Tier 3)	907.19	$3,277.48	15	0.87	$0.31
Space Heating	Air Source Heat Pump	Ductless Mini-Split System	1,194.05	$5,022.03	20	0.86	$0.30
Space Heating	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Space Heating	Geothermal Heat Pump	High Efficiency	465.56	$1,500.00	15	0.87	$0.28
Space Heating	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	High Efficiency (EF=0.95)	103.48	$77.11	15	1.00	$0.06
Water Heating	Water Heater <= 55 Gal	EF 2.3 (HP)	997.52	$1,761.86	15	0.57	$0.15
Water Heating	Water Heater <= 55 Gal	Solar	1,130.20	$6,214.86	15	0.24	$0.48
Water Heating	Water Heater > 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater > 55 Gal	High Efficiency (EF=0.95)	171.13	$97.23	15	1.01	$0.05
Water Heating	Water Heater >	EF 2.3 (HP)	1,296.19	$1,691.15	15	0.71	$0.11

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
	55 Gal						
Water Heating	Water Heater > 55 Gal	Solar	1,158.24	$6,144.15	15	0.31	$0.46
Interior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Interior Lighting	Screw-in	Infrared Halogen	175.05	$134.14	5	1.00	$0.17
Interior Lighting	Screw-in	CFL	555.89	$12.45	6	2.98	$0.00
Interior Lighting	Screw-in	LED	759.76	$1,381.00	12	-	$0.19
Interior Lighting	Screw-in	LED	759.76	$1,381.00	12	-	$0.19
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	8.63	-$1.83	6	1.13	-$0.04
Interior Lighting	Linear Fluorescent	Super T8	25.84	$14.59	6	0.78	$0.10
Interior Lighting	Linear Fluorescent	T5	26.86	$24.70	6	0.63	$0.17
Interior Lighting	Linear Fluorescent	LED	28.18	$216.84	10	0.23	$0.91
Interior Lighting	Specialty	Halogen	-	$0.00	4	1.00	$0.00
Interior Lighting	Specialty	CFL	114.28	-$13.07	7	3.40	-$0.02
Interior Lighting	Specialty	LED	120.23	$61.68	12	1.01	$0.05
Exterior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Exterior Lighting	Screw-in	Infrared Halogen	5.76	$5.08	5	1.00	$0.19
Exterior Lighting	Screw-in	CFL	19.55	-$0.34	3	5.79	-$0.01
Exterior Lighting	Screw-in	LED	22.70	$75.05	12	-	$0.34
Exterior Lighting	Screw-in	LED	22.70	$75.05	12	-	$0.34
Appliances	Clothes Washer	Baseline	-	$0.00	14	-	$0.00
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	39.05	$69.81	14	-	$0.16
Appliances	Clothes Washer	Horizontal Axis	53.90	$150.80	14	1.00	$0.25
Appliances	Clothes Dryer	Baseline	-	$0.00	13	-	$0.00
Appliances	Clothes Dryer	Moisture Detection	57.67	$48.40	13	1.00	$0.08
Appliances	Dishwasher	Baseline	-	$0.00	15	1.00	$0.00
Appliances	Dishwasher	Energy Star	48.52	$460.95	9	-	$1.23
Appliances	Dishwasher	Energy Star (2011)	6.36	$5.61	15	0.99	$0.08
Appliances	Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Refrigerator	Energy Star	46.90	$20.17	20	-	$0.03
Appliances	Refrigerator	Baseline (2014)	85.91	$0.00	13	1.00	$0.00
Appliances	Refrigerator	Energy Star (2014)	137.46	$88.71	13	1.01	$0.06
Appliances	Freezer	Baseline	-	$0.00	22	-	$0.00
Appliances	Freezer	Energy Star	36.20	$3.98	22	-	$0.01
Appliances	Freezer	Baseline (2014)	84.02	-$145.00	11	1.00	-$0.19
Appliances	Freezer	Energy Star (2014)	134.43	-$112.83	11	0.99	-$0.09
Appliances	Second Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Second Refrigerator	Energy Star	60.29	$20.67	20	-	$0.02
Appliances	Second Refrigerator	Baseline (2014)	110.44	$0.00	13	1.00	$0.00
Appliances	Second Refrigerator	Energy Star (2014)	176.70	$88.71	13	1.00	$0.05

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Appliances	Stove	Baseline	-	$0.00	13	1.00	$0.00
Appliances	Stove	Convection Oven	8.02	$1.86	13	1.00	$0.02
Appliances	Stove	Induction (High Efficiency)	40.10	$1,432.20	13	0.37	$3.44
Appliances	Microwave	Baseline	-	$0.00	9	1.00	$0.00
Electronics	Personal Computers	Baseline	-	$0.00	5	1.00	$0.00
Electronics	Personal Computers	Energy Star	65.85	$1.20	5	1.01	$0.00
Electronics	Personal Computers	Climate Savers	94.07	$175.49	5	0.85	$0.40
Electronics	TVs	Baseline	-	$0.00	11	1.00	$0.00
Electronics	TVs	Energy Star	48.99	$0.56	11	1.02	$0.00
Electronics	Set-top boxes/DVR	Baseline	-	$0.00	11	1.00	$0.00
Electronics	Set-top boxes/DVR	Energy Star	29.65	$0.56	11	1.01	$0.00
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0.00	5	1.00	$0.00
Miscellaneous	Pool Pump	Baseline Pump	-	$0.00	15	1.00	$0.00
Miscellaneous	Pool Pump	High Efficiency Pump	146.32	$85.00	15	1.01	$0.05
Miscellaneous	Pool Pump	Two-Speed Pump	585.29	$579.00	15	0.85	$0.09
Miscellaneous	Furnace Fan	Baseline	-	$0.00	18	1.00	$0.00
Miscellaneous	Furnace Fan	Furnace Fan with ECM	118.50	$0.64	18	1.27	$0.00
Miscellaneous	Miscellaneous	Miscellaneous	-	$0.00	5	1.00	$0.00

Table B-11 Energy Efficiency Equipment Data, Electric—Mobile Home, Existing Vintage, Washington

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central AC	SEER 13	-	$0.00	15	-	$0.00
Cooling	Central AC	SEER 14 (Energy Star)	46.32	$277.86	20	1.40	$0.42
Cooling	Central AC	SEER 15 (CEE Tier 2)	63.55	$555.71	15	0.78	$0.76
Cooling	Central AC	SEER 16 (CEE Tier 3)	77.99	$833.57	15	0.73	$0.92
Cooling	Central AC	Ductless Mini-Split System	139.87	$4,399.48	20	0.51	$2.23
Cooling	Room AC	EER 9.8	-	$0.00	10	1.00	$0.00
Cooling	Room AC	EER 10.8 (Energy Star)	27.99	$52.02	10	0.85	$0.22
Cooling	Room AC	EER 11	33.03	$141.13	10	0.65	$0.51
Cooling	Room AC	EER 11.5	44.72	$312.75	10	0.45	$0.83
Cooling	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	43.49	$1,720.87	15	1.30	$3.42
Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	40.94	$2,315.13	15	0.96	$4.89
Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	50.24	$3,277.48	15	0.88	$5.64
Cooling	Air Source Heat Pump	Ductless Mini-Split System	90.11	$5,022.03	20	0.89	$3.94
Cooling	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Cooling	Geothermal Heat Pump	High Efficiency	46.66	$1,500.00	15	0.90	$2.78
Cooling	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Electric Resistance	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Ductless Mini-Split System	2,388.11	$156.87	20	1.28	$0.00
Space Heating	Electric Furnace	3400 BTU/KW	-	$0.00	15	1.00	$0.00
Space Heating	Supplemental	Supplemental	-	$0.00	5	1.00	$0.00
Space Heating	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Space Heating	Air Source Heat Pump	SEER 14 (Energy Star)	239.45	$1,720.87	15	1.30	$0.62
Space Heating	Air Source Heat Pump	SEER 15 (CEE Tier 2)	528.37	$2,315.13	15	0.96	$0.38
Space Heating	Air Source Heat Pump	SEER 16 (CEE Tier 3)	648.37	$3,277.48	15	0.88	$0.44
Space Heating	Air Source Heat Pump	Ductless Mini-Split System	1,162.86	$5,022.03	20	0.89	$0.31
Space Heating	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Space Heating	Geothermal Heat Pump	High Efficiency	813.13	$188.19	15	0.90	$0.02
Space Heating	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	High Efficiency (EF=0.95)	134.84	$77.11	15	1.01	$0.05
Water Heating	Water Heater <= 55 Gal	EF 2.3 (HP)	1,299.77	$1,761.86	15	0.72	$0.12
Water Heating	Water Heater <= 55 Gal	Solar	1,472.84	$6,214.86	15	0.32	$0.36
Water Heating	Water Heater > 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater >	High Efficiency	171.70	$97.23	15	1.02	$0.05

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
	55 Gal	(EF=0.95)					
Water Heating	Water Heater > 55 Gal	EF 2.3 (HP)	1,300.53	$1,691.15	15	0.76	$0.11
Water Heating	Water Heater > 55 Gal	Solar	1,162.12	$6,144.15	15	0.34	$0.46
Interior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Interior Lighting	Screw-in	Infrared Halogen	210.16	$188.19	5	1.00	$0.19
Interior Lighting	Screw-in	CFL	667.39	$28.57	6	2.81	$0.01
Interior Lighting	Screw-in	LED	912.15	$1,353.42	12	-	$0.15
Interior Lighting	Screw-in	LED	912.15	$1,353.42	12	-	$0.15
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	8.74	-$3.65	6	1.14	-$0.08
Interior Lighting	Linear Fluorescent	Super T8	26.18	$29.17	6	0.65	$0.20
Interior Lighting	Linear Fluorescent	T5	27.22	$49.41	6	0.51	$0.33
Interior Lighting	Linear Fluorescent	LED	28.55	$433.68	10	0.17	$1.80
Interior Lighting	Specialty	Halogen	-	$0.00	4	1.00	$0.00
Interior Lighting	Specialty	CFL	205.65	$1.34	7	1.92	$0.00
Interior Lighting	Specialty	LED	216.37	$365.76	12	0.31	$0.17
Exterior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Exterior Lighting	Screw-in	Infrared Halogen	72.47	$51.30	5	1.00	$0.15
Exterior Lighting	Screw-in	CFL	245.95	-$1.81	3	4.75	$0.00
Exterior Lighting	Screw-in	LED	285.49	$1,356.06	12	-	$0.49
Exterior Lighting	Screw-in	LED	285.49	$1,356.06	12	-	$0.49
Appliances	Clothes Washer	Baseline	-	$0.00	14	-	$0.00
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	40.50	$69.81	14	-	$0.16
Appliances	Clothes Washer	Horizontal Axis	55.91	$150.80	14	1.00	$0.25
Appliances	Clothes Dryer	Baseline	-	$0.00	13	-	$0.00
Appliances	Clothes Dryer	Moisture Detection	60.29	$48.40	13	1.00	$0.08
Appliances	Dishwasher	Baseline	-	$0.00	15	1.00	$0.00
Appliances	Dishwasher	Energy Star	50.13	$460.95	9	-	$1.19
Appliances	Dishwasher	Energy Star (2011)	6.57	$5.61	15	1.00	$0.07
Appliances	Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Refrigerator	Energy Star	42.92	$20.17	20	-	$0.03
Appliances	Refrigerator	Baseline (2014)	78.63	$0.00	13	1.00	$0.00
Appliances	Refrigerator	Energy Star (2014)	125.80	$88.71	13	1.01	$0.07
Appliances	Freezer	Baseline	-	$0.00	22	-	$0.00
Appliances	Freezer	Energy Star	35.09	$3.98	22	-	$0.01
Appliances	Freezer	Baseline (2014)	81.43	-$145.00	11	1.00	-$0.20
Appliances	Freezer	Energy Star (2014)	130.28	-$112.83	11	0.99	-$0.10
Appliances	Second Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Second Refrigerator	Energy Star	58.63	$20.67	20	-	$0.02
Appliances	Second Refrigerator	Baseline (2014)	107.39	$0.00	13	1.00	$0.00

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Appliances	Second Refrigerator	Energy Star (2014)	171.83	$88.71	13	1.01	$0.05
Appliances	Stove	Baseline	-	$0.00	13	1.00	$0.00
Appliances	Stove	Convection Oven	8.32	$1.86	13	1.00	$0.02
Appliances	Stove	Induction (High Efficiency)	41.60	$1,432.20	13	0.37	$3.32
Appliances	Microwave	Baseline	-	$0.00	9	1.00	$0.00
Electronics	Personal Computers	Baseline	-	$0.00	5	1.00	$0.00
Electronics	Personal Computers	Energy Star	76.05	$1.20	5	1.01	$0.00
Electronics	Personal Computers	Climate Savers	108.65	$175.49	5	0.85	$0.35
Electronics	TVs	Baseline	-	$0.00	11	1.00	$0.00
Electronics	TVs	Energy Star	44.30	$0.56	11	1.02	$0.00
Electronics	Set-top boxes/DVR	Baseline	-	$0.00	11	1.00	$0.00
Electronics	Set-top boxes/DVR	Energy Star	26.81	$0.56	11	1.01	$0.00
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0.00	5	1.00	$0.00
Miscellaneous	Pool Pump	Baseline Pump	-	$0.00	15	1.00	$0.00
Miscellaneous	Pool Pump	High Efficiency Pump	103.32	$85.00	15	0.98	$0.07
Miscellaneous	Pool Pump	Two-Speed Pump	413.27	$579.00	15	0.74	$0.12
Miscellaneous	Furnace Fan	Baseline	-	$0.00	18	1.00	$0.00
Miscellaneous	Furnace Fan	Furnace Fan with ECM	118.18	$0.64	18	1.27	$0.00
Miscellaneous	Miscellaneous	Miscellaneous	-	$0.00	5	1.00	$0.00

Table B-12 Energy Efficiency Equipment Data, Electric—Mobile Home, New Vintage, Washington

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central AC	SEER 13	-	$0.00	15	-	$0.00
Cooling	Central AC	SEER 14 (Energy Star)	55.05	$277.86	15	1.40	$0.44
Cooling	Central AC	SEER 15 (CEE Tier 2)	73.33	$555.71	15	0.94	$0.66
Cooling	Central AC	SEER 16 (CEE Tier 3)	88.67	$833.57	15	0.89	$0.81
Cooling	Central AC	Ductless Mini-Split System	166.28	$4,399.48	20	0.62	$1.87
Cooling	Room AC	EER 9.8	-	$0.00	10	1.00	$0.00
Cooling	Room AC	EER 10.8 (Energy Star)	32.54	$52.02	10	0.86	$0.19
Cooling	Room AC	EER 11	38.34	$141.13	10	0.66	$0.44
Cooling	Room AC	EER 11.5	51.99	$312.75	10	0.46	$0.71
Cooling	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	51.74	$1,720.87	15	1.30	$2.88
Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	47.26	$2,315.13	15	0.97	$4.24
Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	57.15	$3,277.48	15	0.89	$4.96
Cooling	Air Source Heat Pump	Ductless Mini-Split System	107.18	$5,022.03	20	0.90	$3.32
Cooling	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Cooling	Geothermal Heat Pump	High Efficiency	51.93	$1,500.00	15	0.91	$2.50
Cooling	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Electric Resistance	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Ductless Mini-Split System	2,567.22	$156.87	20	1.29	$0.00
Space Heating	Electric Furnace	3400 BTU/KW	-	$0.00	15	1.00	$0.00
Space Heating	Supplemental	Supplemental	-	$0.00	5	1.00	$0.00
Space Heating	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Space Heating	Air Source Heat Pump	SEER 14 (Energy Star)	284.83	$1,720.87	15	1.30	$0.52
Space Heating	Air Source Heat Pump	SEER 15 (CEE Tier 2)	609.96	$2,315.13	15	0.97	$0.33
Space Heating	Air Source Heat Pump	SEER 16 (CEE Tier 3)	737.59	$3,277.48	15	0.89	$0.38
Space Heating	Air Source Heat Pump	Ductless Mini-Split System	1,383.21	$5,022.03	20	0.90	$0.26
Space Heating	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Space Heating	Geothermal Heat Pump	High Efficiency	671.05	$1,500.00	15	0.91	$0.19
Space Heating	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	High Efficiency (EF=0.95)	141.18	$77.11	15	1.02	$0.05
Water Heating	Water Heater <= 55 Gal	EF 2.3 (HP)	1,360.93	$1,761.86	15	0.73	$0.11
Water Heating	Water Heater <= 55 Gal	Solar	1,542.14	$6,214.86	15	0.33	$0.35
Water Heating	Water Heater > 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater >	High Efficiency	179.84	$97.23	15	1.02	$0.05

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
	55 Gal	(EF=0.95)					
Water Heating	Water Heater > 55 Gal	EF 2.3 (HP)	1,362.23	$1,691.15	15	0.77	$0.11
Water Heating	Water Heater > 55 Gal	Solar	1,217.25	$6,144.15	15	0.35	$0.44
Interior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Interior Lighting	Screw-in	Infrared Halogen	229.01	$188.19	5	1.00	$0.18
Interior Lighting	Screw-in	CFL	727.25	$28.57	6	2.74	$0.01
Interior Lighting	Screw-in	LED	993.96	$1,937.55	12	-	$0.20
Interior Lighting	Screw-in	LED	993.96	$1,937.55	12	-	$0.20
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	9.82	-$3.65	6	1.14	-$0.07
Interior Lighting	Linear Fluorescent	Super T8	29.43	$29.17	6	0.67	$0.18
Interior Lighting	Linear Fluorescent	T5	30.59	$49.41	6	0.53	$0.30
Interior Lighting	Linear Fluorescent	LED	32.09	$433.68	10	0.18	$1.60
Interior Lighting	Specialty	Halogen	-	$0.00	4	1.00	$0.00
Interior Lighting	Specialty	CFL	221.07	-$7.66	7	2.45	-$0.01
Interior Lighting	Specialty	LED	232.60	$134.50	12	0.74	$0.06
Exterior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Exterior Lighting	Screw-in	Infrared Halogen	78.72	$51.30	5	1.00	$0.14
Exterior Lighting	Screw-in	CFL	267.15	-$2.04	3	4.76	$0.00
Exterior Lighting	Screw-in	LED	310.10	$757.28	12	-	$0.25
Exterior Lighting	Screw-in	LED	310.10	$757.28	12	-	$0.25
Appliances	Clothes Washer	Baseline	-	$0.00	14	-	$0.00
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	47.25	$69.81	14	-	$0.13
Appliances	Clothes Washer	Horizontal Axis	65.23	$150.80	14	1.00	$0.21
Appliances	Clothes Dryer	Baseline	-	$0.00	13	-	$0.00
Appliances	Clothes Dryer	Moisture Detection	65.61	$48.40	13	1.00	$0.07
Appliances	Dishwasher	Baseline	-	$0.00	15	1.00	$0.00
Appliances	Dishwasher	Energy Star	54.76	$460.95	9	-	$1.09
Appliances	Dishwasher	Energy Star (2011)	7.17	$5.61	15	1.00	$0.07
Appliances	Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Refrigerator	Energy Star	60.09	$20.17	20	-	$0.02
Appliances	Refrigerator	Baseline (2014)	110.08	$0.00	13	1.00	$0.00
Appliances	Refrigerator	Energy Star (2014)	176.12	$88.71	13	1.02	$0.05
Appliances	Freezer	Baseline	-	$0.00	22	-	$0.00
Appliances	Freezer	Energy Star	48.64	$3.98	22	-	$0.01
Appliances	Freezer	Baseline (2014)	112.87	-$145.00	11	1.00	-$0.14
Appliances	Freezer	Energy Star (2014)	180.59	-$112.83	11	1.01	-$0.07
Appliances	Second Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Second Refrigerator	Energy Star	80.12	$20.67	20	-	$0.02
Appliances	Second Refrigerator	Baseline (2014)	146.77	$0.00	13	1.00	$0.00

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Appliances	Second Refrigerator	Energy Star (2014)	234.83	$88.71	13	1.01	$0.04
Appliances	Stove	Baseline	-	$0.00	13	1.00	$0.00
Appliances	Stove	Convection Oven	35.13	$0.56	13	1.00	$0.00
Appliances	Stove	Induction (High Efficiency)	41.59	$0.00	13	0.37	$0.00
Appliances	Microwave	Baseline	-	$0.00	9	1.00	$0.00
Electronics	Personal Computers	Baseline	-	$0.00	5	1.00	$0.00
Electronics	Personal Computers	Energy Star	74.43	$1.20	5	1.01	$0.00
Electronics	Personal Computers	Climate Savers	106.33	$175.49	5	0.85	$0.36
Electronics	TVs	Baseline	-	$0.00	11	1.00	$0.00
Electronics	TVs	Energy Star	49.22	$0.56	11	1.02	$0.00
Electronics	Set-top boxes/DVR	Baseline	-	$0.00	11	1.00	$0.00
Electronics	Set-top boxes/DVR	Energy Star	26.81	$0.56	11	1.01	$0.00
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0.00	5	1.00	$0.00
Miscellaneous	Pool Pump	Baseline Pump	-	$0.00	15	1.00	$0.00
Miscellaneous	Pool Pump	High Efficiency Pump	115.77	$85.00	15	0.99	$0.06
Miscellaneous	Pool Pump	Two-Speed Pump	463.09	$579.00	15	0.78	$0.11
Miscellaneous	Furnace Fan	Baseline	-	$0.00	18	1.00	$0.00
Miscellaneous	Furnace Fan	Furnace Fan with ECM	118.18	$0.64	18	1.27	$0.00
Miscellaneous	Miscellaneous	Miscellaneous	-	$0.00	5	1.00	$0.00

Table B-13 Energy Efficiency Equipment Data, Electric—Mobile Home, Existing Vintage, Idaho

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central AC	SEER 13	-	$0.00	15	-	$0.00
Cooling	Central AC	SEER 14 (Energy Star)	39.83	$277.86	15	1.40	$0.60
Cooling	Central AC	SEER 15 (CEE Tier 2)	54.66	$555.71	15	0.94	$0.88
Cooling	Central AC	SEER 16 (CEE Tier 3)	67.07	$833.57	15	0.89	$1.07
Cooling	Central AC	Ductless Mini-Split System	120.29	$4,399.48	20	0.62	$2.59
Cooling	Room AC	EER 9.8	-	$0.00	10	1.00	$0.00
Cooling	Room AC	EER 10.8 (Energy Star)	24.07	$52.02	10	0.84	$0.26
Cooling	Room AC	EER 11	28.41	$141.13	10	0.64	$0.59
Cooling	Room AC	EER 11.5	38.46	$312.75	10	0.44	$0.96
Cooling	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	37.41	$1,720.87	15	1.30	$3.98
Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	35.21	$2,315.13	15	0.96	$5.69
Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	43.21	$3,277.48	15	0.88	$6.56
Cooling	Air Source Heat Pump	Ductless Mini-Split System	77.49	$5,022.03	20	0.88	$4.59
Cooling	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Cooling	Geothermal Heat Pump	High Efficiency	40.13	$1,500.00	15	0.89	$3.23
Cooling	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Electric Resistance	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Ductless Mini-Split System	2,256.76	$156.87	20	1.27	$0.00
Space Heating	Electric Furnace	3400 BTU/KW	-	$0.00	15	1.00	$0.00
Space Heating	Supplemental	Supplemental	-	$0.00	5	1.00	$0.00
Space Heating	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Space Heating	Air Source Heat Pump	SEER 14 (Energy Star)	226.28	$1,720.87	15	1.30	$0.66
Space Heating	Air Source Heat Pump	SEER 15 (CEE Tier 2)	499.31	$2,315.13	15	0.96	$0.40
Space Heating	Air Source Heat Pump	SEER 16 (CEE Tier 3)	612.71	$3,277.48	15	0.88	$0.46
Space Heating	Air Source Heat Pump	Ductless Mini-Split System	1,098.90	$5,022.03	20	0.88	$0.32
Space Heating	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Space Heating	Geothermal Heat Pump	High Efficiency	768.40	$188.19	15	0.89	$0.02
Space Heating	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	High Efficiency (EF=0.95)	127.42	$77.11	15	1.01	$0.05
Water Heating	Water Heater <= 55 Gal	EF 2.3 (HP)	1,228.29	$1,761.86	15	0.64	$0.12
Water Heating	Water Heater <= 55 Gal	Solar	1,391.83	$6,214.86	15	0.27	$0.39
Water Heating	Water Heater > 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater > 55 Gal	High Efficiency (EF=0.95)	162.25	$97.23	15	1.01	$0.05
Water Heating	Water Heater >	EF 2.3 (HP)	1,229.00	$1,691.15	15	0.68	$0.12

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
	55 Gal						
Water Heating	Water Heater > 55 Gal	Solar	1,098.20	$6,144.15	15	0.30	$0.48
Interior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Interior Lighting	Screw-in	Infrared Halogen	198.60	$188.19	5	1.00	$0.20
Interior Lighting	Screw-in	CFL	630.68	$28.57	6	2.95	$0.01
Interior Lighting	Screw-in	LED	861.98	$1,353.42	12	-	$0.16
Interior Lighting	Screw-in	LED	861.98	$1,353.42	12	-	$0.16
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	8.26	-$3.50	6	1.14	-$0.08
Interior Lighting	Linear Fluorescent	Super T8	24.74	$28.01	6	0.65	$0.21
Interior Lighting	Linear Fluorescent	T5	25.72	$47.43	6	0.50	$0.34
Interior Lighting	Linear Fluorescent	LED	26.98	$416.33	10	0.17	$1.83
Interior Lighting	Specialty	Halogen	-	$0.00	4	1.00	$0.00
Interior Lighting	Specialty	CFL	194.34	$1.34	7	1.93	$0.00
Interior Lighting	Specialty	LED	204.47	$365.76	12	0.30	$0.18
Exterior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Exterior Lighting	Screw-in	Infrared Halogen	68.48	$49.25	5	1.00	$0.16
Exterior Lighting	Screw-in	CFL	232.42	-$1.53	3	4.76	$0.00
Exterior Lighting	Screw-in	LED	269.78	$1,356.33	12	-	$0.52
Exterior Lighting	Screw-in	LED	269.78	$1,356.33	12	-	$0.52
Appliances	Clothes Washer	Baseline	-	$0.00	14	-	$0.00
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	38.27	$69.81	14	-	$0.17
Appliances	Clothes Washer	Horizontal Axis	52.83	$150.80	14	1.00	$0.26
Appliances	Clothes Dryer	Baseline	-	$0.00	13	-	$0.00
Appliances	Clothes Dryer	Moisture Detection	56.98	$48.40	13	1.00	$0.08
Appliances	Dishwasher	Baseline	-	$0.00	15	1.00	$0.00
Appliances	Dishwasher	Energy Star	47.38	$460.95	9	-	$1.26
Appliances	Dishwasher	Energy Star (2011)	6.21	$5.61	15	0.99	$0.08
Appliances	Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Refrigerator	Energy Star	40.56	$20.17	20	-	$0.04
Appliances	Refrigerator	Baseline (2014)	74.30	$0.00	13	1.00	$0.00
Appliances	Refrigerator	Energy Star (2014)	118.88	$88.71	13	1.01	$0.07
Appliances	Freezer	Baseline	-	$0.00	22	-	$0.00
Appliances	Freezer	Energy Star	33.16	$3.98	22	-	$0.01
Appliances	Freezer	Baseline (2014)	76.95	-$145.00	11	1.00	-$0.21
Appliances	Freezer	Energy Star (2014)	123.12	-$112.83	11	0.99	-$0.10
Appliances	Second Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Second Refrigerator	Energy Star	55.40	$20.67	20	-	$0.03
Appliances	Second Refrigerator	Baseline (2014)	101.48	$0.00	13	1.00	$0.00
Appliances	Second Refrigerator	Energy Star (2014)	162.38	$88.71	13	1.00	$0.05

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Appliances	Stove	Baseline	-	$0.00	13	1.00	$0.00
Appliances	Stove	Convection Oven	7.86	$1.86	13	1.00	$0.02
Appliances	Stove	Induction (High Efficiency)	39.31	$1,432.20	13	0.37	$3.51
Appliances	Microwave	Baseline	-	$0.00	9	1.00	$0.00
Electronics	Personal Computers	Baseline	-	$0.00	5	1.00	$0.00
Electronics	Personal Computers	Energy Star	71.87	$1.20	5	1.01	$0.00
Electronics	Personal Computers	Climate Savers	102.67	$175.49	5	0.85	$0.37
Electronics	TVs	Baseline	-	$0.00	11	1.00	$0.00
Electronics	TVs	Energy Star	41.87	$0.56	11	1.02	$0.00
Electronics	Set-top boxes/DVR	Baseline	-	$0.00	11	1.00	$0.00
Electronics	Set-top boxes/DVR	Energy Star	25.34	$0.56	11	1.01	$0.00
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0.00	5	1.00	$0.00
Miscellaneous	Pool Pump	Baseline Pump	-	$0.00	15	1.00	$0.00
Miscellaneous	Pool Pump	High Efficiency Pump	97.63	$85.00	15	0.97	$0.08
Miscellaneous	Pool Pump	Two-Speed Pump	390.54	$579.00	15	0.71	$0.13
Miscellaneous	Furnace Fan	Baseline	-	$0.00	18	1.00	$0.00
Miscellaneous	Furnace Fan	Furnace Fan with ECM	111.68	$0.64	18	1.26	$0.00
Miscellaneous	Miscellaneous	Miscellaneous	-	$0.00	5	1.00	$0.00

Table B-14 Energy Efficiency Equipment Data, Electric—Mobile Home, New Vintage, Idaho

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central AC	SEER 13	-	$0.00	15	-	$0.00
Cooling	Central AC	SEER 14 (Energy Star)	47.34	$277.86	15	1.40	$0.51
Cooling	Central AC	SEER 15 (CEE Tier 2)	63.06	$555.71	15	0.94	$0.76
Cooling	Central AC	SEER 16 (CEE Tier 3)	76.25	$833.57	15	0.89	$0.95
Cooling	Central AC	Ductless Mini-Split System	143.00	$4,399.48	20	0.62	$2.18
Cooling	Room AC	EER 9.8	-	$0.00	10	1.00	$0.00
Cooling	Room AC	EER 10.8 (Energy Star)	27.98	$52.02	10	0.85	$0.22
Cooling	Room AC	EER 11	32.97	$141.13	10	0.65	$0.51
Cooling	Room AC	EER 11.5	44.72	$312.75	10	0.45	$0.83
Cooling	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	44.49	$1,720.87	15	1.30	$3.34
Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	40.65	$2,315.13	15	0.97	$4.93
Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	49.15	$3,277.48	15	0.89	$5.77
Cooling	Air Source Heat Pump	Ductless Mini-Split System	92.17	$5,022.03	20	0.90	$3.85
Cooling	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Cooling	Geothermal Heat Pump	High Efficiency	44.66	$1,500.00	15	0.90	$2.90
Cooling	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Electric Resistance	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Ductless Mini-Split System	2,426.02	$156.87	20	1.29	$0.00
Space Heating	Electric Furnace	3400 BTU/KW	-	$0.00	15	1.00	$0.00
Space Heating	Supplemental	Supplemental	-	$0.00	5	1.00	$0.00
Space Heating	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Space Heating	Air Source Heat Pump	SEER 14 (Energy Star)	269.16	$1,720.87	15	1.30	$0.55
Space Heating	Air Source Heat Pump	SEER 15 (CEE Tier 2)	576.42	$2,315.13	15	0.97	$0.35
Space Heating	Air Source Heat Pump	SEER 16 (CEE Tier 3)	697.02	$3,277.48	15	0.89	$0.41
Space Heating	Air Source Heat Pump	Ductless Mini-Split System	1,307.13	$5,022.03	20	0.90	$0.27
Space Heating	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Space Heating	Geothermal Heat Pump	High Efficiency	634.14	$1,500.00	15	0.90	$0.20
Space Heating	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	High Efficiency (EF=0.95)	133.42	$77.11	15	1.01	$0.05
Water Heating	Water Heater <= 55 Gal	EF 2.3 (HP)	1,286.08	$1,761.86	15	0.66	$0.12
Water Heating	Water Heater <= 55 Gal	Solar	1,457.32	$6,214.86	15	0.29	$0.37
Water Heating	Water Heater > 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater > 55 Gal	High Efficiency (EF=0.95)	169.95	$97.23	15	1.01	$0.05
Water Heating	Water Heater >	EF 2.3 (HP)	1,287.31	$1,691.15	15	0.71	$0.11

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
	55 Gal						
Water Heating	Water Heater > 55 Gal	Solar	1,150.30	$6,144.15	15	0.31	$0.46
Interior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Interior Lighting	Screw-in	Infrared Halogen	216.42	$188.19	5	1.00	$0.19
Interior Lighting	Screw-in	CFL	687.25	$28.57	6	2.88	$0.01
Interior Lighting	Screw-in	LED	939.30	$1,937.55	12	-	$0.21
Interior Lighting	Screw-in	LED	939.30	$1,937.55	12	-	$0.21
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	9.28	-$3.50	6	1.14	-$0.07
Interior Lighting	Linear Fluorescent	Super T8	27.81	$28.01	6	0.67	$0.18
Interior Lighting	Linear Fluorescent	T5	28.91	$47.43	6	0.52	$0.30
Interior Lighting	Linear Fluorescent	LED	30.33	$416.33	10	0.18	$1.63
Interior Lighting	Specialty	Halogen	-	$0.00	4	1.00	$0.00
Interior Lighting	Specialty	CFL	208.91	-$7.12	7	2.46	-$0.01
Interior Lighting	Specialty	LED	219.80	$140.97	12	0.70	$0.07
Exterior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Exterior Lighting	Screw-in	Infrared Halogen	74.39	$49.25	5	1.00	$0.14
Exterior Lighting	Screw-in	CFL	252.46	-$1.76	3	4.76	$0.00
Exterior Lighting	Screw-in	LED	293.05	$726.99	12	-	$0.25
Exterior Lighting	Screw-in	LED	293.05	$726.99	12	-	$0.25
Appliances	Clothes Washer	Baseline	-	$0.00	14	-	$0.00
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	44.65	$69.81	14	-	$0.14
Appliances	Clothes Washer	Horizontal Axis	61.64	$150.80	14	1.00	$0.22
Appliances	Clothes Dryer	Baseline	-	$0.00	13	-	$0.00
Appliances	Clothes Dryer	Moisture Detection	62.00	$48.40	13	1.00	$0.08
Appliances	Dishwasher	Baseline	-	$0.00	15	1.00	$0.00
Appliances	Dishwasher	Energy Star	51.75	$460.95	9	-	$1.15
Appliances	Dishwasher	Energy Star (2011)	6.78	$5.61	15	0.99	$0.07
Appliances	Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Refrigerator	Energy Star	56.79	$20.17	20	-	$0.03
Appliances	Refrigerator	Baseline (2014)	104.02	$0.00	13	1.00	$0.00
Appliances	Refrigerator	Energy Star (2014)	166.43	$88.71	13	1.02	$0.05
Appliances	Freezer	Baseline	-	$0.00	22	-	$0.00
Appliances	Freezer	Energy Star	45.96	$3.98	22	-	$0.01
Appliances	Freezer	Baseline (2014)	106.66	-$145.00	11	1.00	-$0.15
Appliances	Freezer	Energy Star (2014)	170.66	-$112.83	11	1.00	-$0.07
Appliances	Second Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Second Refrigerator	Energy Star	75.71	$20.67	20	-	$0.02
Appliances	Second Refrigerator	Baseline (2014)	138.70	$0.00	13	1.00	$0.00
Appliances	Second Refrigerator	Energy Star (2014)	221.91	$88.71	13	1.01	$0.04

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Appliances	Stove	Baseline	-	$0.00	13	1.00	$0.00
Appliances	Stove	Convection Oven	33.20	$0.56	13	1.00	$0.00
Appliances	Stove	Induction (High Efficiency)	39.30	$0.00	13	0.36	$0.00
Appliances	Microwave	Baseline	-	$0.00	9	1.00	$0.00
Electronics	Personal Computers	Baseline	-	$0.00	5	1.00	$0.00
Electronics	Personal Computers	Energy Star	70.34	$1.20	5	1.01	$0.00
Electronics	Personal Computers	Climate Savers	100.48	$175.49	5	0.85	$0.38
Electronics	TVs	Baseline	-	$0.00	11	1.00	$0.00
Electronics	TVs	Energy Star	46.52	$0.56	11	1.02	$0.00
Electronics	Set-top boxes/DVR	Baseline	-	$0.00	11	1.00	$0.00
Electronics	Set-top boxes/DVR	Energy Star	25.34	$0.56	11	1.01	$0.00
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0.00	5	1.00	$0.00
Miscellaneous	Pool Pump	Baseline Pump	-	$0.00	15	1.00	$0.00
Miscellaneous	Pool Pump	High Efficiency Pump	109.40	$85.00	15	0.99	$0.07
Miscellaneous	Pool Pump	Two-Speed Pump	437.62	$579.00	15	0.76	$0.11
Miscellaneous	Furnace Fan	Baseline	-	$0.00	18	1.00	$0.00
Miscellaneous	Furnace Fan	Furnace Fan with ECM	111.68	$0.64	18	1.27	$0.00
Miscellaneous	Miscellaneous	Miscellaneous	-	$0.00	5	1.00	$0.00

Table B-15 Energy Efficiency Equipment Data, Electric—Low income, Existing Vintage, Washington

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central AC	SEER 13	-	$0.00	15	-	$0.00
Cooling	Central AC	SEER 14 (Energy Star)	49.41	$185.24	15	1.40	$0.32
Cooling	Central AC	SEER 15 (CEE Tier 2)	67.79	$370.47	15	0.93	$0.47
Cooling	Central AC	SEER 16 (CEE Tier 3)	83.19	$555.71	15	0.87	$0.58
Cooling	Central AC	Ductless Mini-Split System	149.20	$2,394.23	20	0.64	$1.14
Cooling	Room AC	EER 9.8	-	$0.00	10	1.00	$0.00
Cooling	Room AC	EER 10.8 (Energy Star)	26.53	$104.04	10	0.81	$0.46
Cooling	Room AC	EER 11	31.30	$282.26	10	0.60	$1.07
Cooling	Room AC	EER 11.5	42.38	$625.50	10	0.40	$1.75
Cooling	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	37.76	$1,245.78	15	1.30	$2.85
Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	51.80	$2,315.13	15	0.91	$3.86
Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	63.57	$3,277.48	15	0.84	$4.46
Cooling	Air Source Heat Pump	Ductless Mini-Split System	114.01	$5,022.03	20	0.84	$3.12
Cooling	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Cooling	Geothermal Heat Pump	High Efficiency	62.78	$1,500.00	15	0.89	$2.07
Cooling	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Electric Resistance	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Ductless Mini-Split System	2,070.05	$156.87	20	1.29	$0.01
Space Heating	Electric Furnace	3400 BTU/KW	-	$0.00	15	1.00	$0.00
Space Heating	Supplemental	Supplemental	-	$0.00	5	1.00	$0.00
Space Heating	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Space Heating	Air Source Heat Pump	SEER 14 (Energy Star)	355.79	$1,245.78	15	1.30	$0.30
Space Heating	Air Source Heat Pump	SEER 15 (CEE Tier 2)	488.18	$2,315.13	15	0.91	$0.41
Space Heating	Air Source Heat Pump	SEER 16 (CEE Tier 3)	599.06	$3,277.48	15	0.84	$0.47
Space Heating	Air Source Heat Pump	Ductless Mini-Split System	1,074.41	$5,022.03	20	0.84	$0.33
Space Heating	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Space Heating	Geothermal Heat Pump	High Efficiency	436.67	$1,500.00	15	0.89	$0.30
Space Heating	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	High Efficiency (EF=0.95)	121.27	$77.11	15	1.01	$0.05
Water Heating	Water Heater <= 55 Gal	EF 2.3 (HP)	1,168.96	$1,761.86	15	0.67	$0.13
Water Heating	Water Heater <= 55 Gal	Solar	1,324.61	$6,214.86	15	0.29	$0.41
Water Heating	Water Heater > 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater >	High Efficiency	171.20	$97.23	15	1.02	$0.05

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
	55 Gal	(EF=0.95)					
Water Heating	Water Heater > 55 Gal	EF 2.3 (HP)	1,296.77	$1,691.15	15	0.76	$0.11
Water Heating	Water Heater > 55 Gal	Solar	1,158.76	$6,144.15	15	0.34	$0.46
Interior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Interior Lighting	Screw-in	Infrared Halogen	157.77	$98.38	5	1.00	$0.13
Interior Lighting	Screw-in	CFL	501.00	$17.84	6	2.46	$0.01
Interior Lighting	Screw-in	LED	684.74	$1,012.85	12	-	$0.15
Interior Lighting	Screw-in	LED	684.74	$1,012.85	12	-	$0.15
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	6.94	-$1.79	6	1.13	-$0.05
Interior Lighting	Linear Fluorescent	Super T8	20.79	$14.30	6	0.74	$0.13
Interior Lighting	Linear Fluorescent	T5	21.61	$24.22	6	0.59	$0.21
Interior Lighting	Linear Fluorescent	LED	22.67	$212.60	10	0.21	$1.11
Interior Lighting	Specialty	Halogen	-	$0.00	4	1.00	$0.00
Interior Lighting	Specialty	CFL	134.16	$0.96	7	1.91	$0.00
Interior Lighting	Specialty	LED	141.16	$261.26	12	0.29	$0.19
Exterior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Exterior Lighting	Screw-in	Infrared Halogen	35.33	$9.82	5	1.00	$0.06
Exterior Lighting	Screw-in	CFL	119.89	-$0.47	3	4.15	$0.00
Exterior Lighting	Screw-in	LED	139.17	$1,016.52	12	-	$0.75
Exterior Lighting	Screw-in	LED	139.17	$1,016.52	12	-	$0.75
Appliances	Clothes Washer	Baseline	-	$0.00	14	-	$0.00
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	36.47	$69.81	14	-	$0.17
Appliances	Clothes Washer	Horizontal Axis	50.35	$150.80	14	1.00	$0.27
Appliances	Clothes Dryer	Baseline	-	$0.00	13	-	$0.00
Appliances	Clothes Dryer	Moisture Detection	53.87	$48.40	13	1.00	$0.09
Appliances	Dishwasher	Baseline	-	$0.00	15	1.00	$0.00
Appliances	Dishwasher	Energy Star	45.15	$460.95	9	-	$1.32
Appliances	Dishwasher	Energy Star (2011)	5.91	$5.61	15	0.99	$0.08
Appliances	Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Refrigerator	Energy Star	38.65	$20.17	20	-	$0.04
Appliances	Refrigerator	Baseline (2014)	70.80	$0.00	13	1.00	$0.00
Appliances	Refrigerator	Energy Star (2014)	113.29	$88.71	13	1.01	$0.08
Appliances	Freezer	Baseline	-	$0.00	22	-	$0.00
Appliances	Freezer	Energy Star	31.60	$3.98	22	-	$0.01
Appliances	Freezer	Baseline (2014)	73.33	-$145.00	11	1.00	-$0.22
Appliances	Freezer	Energy Star (2014)	117.32	-$112.83	11	0.99	-$0.11
Appliances	Second Refrigerator	Baseline	-	$0.00	13	-	$0.00
Appliances	Second Refrigerator	Energy Star	52.79	$20.67	20	-	$0.03
Appliances	Second Refrigerator	Baseline (2014)	96.71	$0.00	13	1.00	$0.00

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Appliances	Second Refrigerator	Energy Star (2014)	154.73	$88.71	13	1.00	$0.06
Appliances	Stove	Baseline	-	$0.00	13	1.00	$0.00
Appliances	Stove	Convection Oven	7.49	$1.86	13	1.00	$0.02
Appliances	Stove	Induction (High Efficiency)	37.46	$1,432.20	13	0.37	$3.68
Appliances	Microwave	Baseline	-	$0.00	9	1.00	$0.00
Electronics	Personal Computers	Baseline	-	$0.00	5	1.00	$0.00
Electronics	Personal Computers	Energy Star	63.35	$1.20	5	1.01	$0.00
Electronics	Personal Computers	Climate Savers	90.50	$175.49	5	0.85	$0.42
Electronics	TVs	Baseline	-	$0.00	11	1.00	$0.00
Electronics	TVs	Energy Star	38.99	$0.56	11	1.02	$0.00
Electronics	Set-top boxes/DVR	Baseline	-	$0.00	11	1.00	$0.00
Electronics	Set-top boxes/DVR	Energy Star	24.86	$0.56	11	1.01	$0.00
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0.00	5	1.00	$0.00
Miscellaneous	Pool Pump	Baseline Pump	-	$0.00	15	1.00	$0.00
Miscellaneous	Pool Pump	High Efficiency Pump	107.45	$85.00	15	0.99	$0.07
Miscellaneous	Pool Pump	Two-Speed Pump	429.80	$579.00	15	0.75	$0.12
Miscellaneous	Furnace Fan	Baseline	-	$0.00	18	1.00	$0.00
Miscellaneous	Furnace Fan	Furnace Fan with ECM	110.30	$0.64	18	1.27	$0.00
Miscellaneous	Miscellaneous	Miscellaneous	-	$0.00	5	1.00	$0.00

Table B-16 Energy Efficiency Equipment Data, Electric—Low Income, New Vintage, Washington

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central AC	SEER 13	-	$0.00	15	-	$0.00
Cooling	Central AC	SEER 14 (Energy Star)	58.73	$185.24	15	1.40	$0.27
Cooling	Central AC	SEER 15 (CEE Tier 2)	78.22	$370.47	15	0.93	$0.41
Cooling	Central AC	SEER 16 (CEE Tier 3)	94.59	$555.71	15	0.87	$0.51
Cooling	Central AC	Ductless Mini-Split System	177.38	$2,394.23	20	0.65	$0.95
Cooling	Room AC	EER 9.8	-	$0.00	10	1.00	$0.00
Cooling	Room AC	EER 10.8 (Energy Star)	30.83	$104.04	10	0.82	$0.40
Cooling	Room AC	EER 11	36.33	$282.26	10	0.61	$0.92
Cooling	Room AC	EER 11.5	49.27	$625.50	10	0.41	$1.50
Cooling	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	44.94	$0.00	15	1.30	$0.00
Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	59.86	$0.00	15	0.91	$0.00
Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	72.38	$0.00	15	0.85	$0.00
Cooling	Air Source Heat Pump	Ductless Mini-Split System	135.74	$0.00	20	0.86	$0.00
Cooling	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Cooling	Geothermal Heat Pump	High Efficiency	69.87	$0.00	15	0.89	$0.00
Cooling	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Electric Resistance	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Ductless Mini-Split System	2,225.30	$156.87	20	1.30	$0.00
Space Heating	Electric Furnace	3400 BTU/KW	-	$0.00	15	1.00	$0.00
Space Heating	Supplemental	Supplemental	-	$0.00	5	1.00	$0.00
Space Heating	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Space Heating	Air Source Heat Pump	SEER 14 (Energy Star)	423.49	$1,245.78	15	1.30	$0.25
Space Heating	Air Source Heat Pump	SEER 15 (CEE Tier 2)	564.08	$2,315.13	15	0.91	$0.35
Space Heating	Air Source Heat Pump	SEER 16 (CEE Tier 3)	682.10	$3,277.48	15	0.85	$0.42
Space Heating	Air Source Heat Pump	Ductless Mini-Split System	1,279.15	$5,022.03	20	0.86	$0.28
Space Heating	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Space Heating	Geothermal Heat Pump	High Efficiency	485.98	$1,500.00	15	0.89	$0.27
Space Heating	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	High Efficiency (EF=0.95)	126.97	$77.11	15	1.01	$0.05
Water Heating	Water Heater <= 55 Gal	EF 2.3 (HP)	1,223.96	$1,761.86	15	0.69	$0.12
Water Heating	Water Heater <= 55 Gal	Solar	1,386.93	$6,214.86	15	0.30	$0.39
Water Heating	Water Heater > 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater >	High Efficiency	179.32	$97.23	15	1.02	$0.05

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
	55 Gal	(EF=0.95)					
Water Heating	Water Heater > 55 Gal	EF 2.3 (HP)	1,358.29	$1,691.15	15	0.77	$0.11
Water Heating	Water Heater > 55 Gal	Solar	1,213.73	$6,144.15	15	0.35	$0.44
Interior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Interior Lighting	Screw-in	Infrared Halogen	171.92	$98.38	5	1.00	$0.12
Interior Lighting	Screw-in	CFL	545.94	$17.84	6	2.41	$0.01
Interior Lighting	Screw-in	LED	746.16	$1,012.85	12	-	$0.14
Interior Lighting	Screw-in	LED	746.16	$1,012.85	12	-	$0.14
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	7.80	-$1.79	6	1.13	-$0.04
Interior Lighting	Linear Fluorescent	Super T8	23.37	$14.30	6	0.77	$0.11
Interior Lighting	Linear Fluorescent	T5	24.29	$24.22	6	0.62	$0.18
Interior Lighting	Linear Fluorescent	LED	25.48	$212.60	10	0.23	$0.99
Interior Lighting	Specialty	Halogen	-	$0.00	4	1.00	$0.00
Interior Lighting	Specialty	CFL	144.22	-$9.74	7	2.86	-$0.01
Interior Lighting	Specialty	LED	151.74	$67.71	12	0.95	$0.05
Exterior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Exterior Lighting	Screw-in	Infrared Halogen	38.38	$9.82	5	1.00	$0.06
Exterior Lighting	Screw-in	CFL	130.23	-$0.51	3	4.13	$0.00
Exterior Lighting	Screw-in	LED	151.17	$144.92	12	-	$0.10
Exterior Lighting	Screw-in	LED	151.17	$144.92	12	-	$0.10
Appliances	Clothes Washer	Baseline	-	$0.00	14	-	$0.00
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	42.55	$69.81	14	-	$0.15
Appliances	Clothes Washer	Horizontal Axis	58.74	$150.80	14	1.00	$0.23
Appliances	Clothes Dryer	Baseline	-	$0.00	13	-	$0.00
Appliances	Clothes Dryer	Moisture Detection	58.62	$48.40	13	1.00	$0.08
Appliances	Dishwasher	Baseline	-	$0.00	15	1.00	$0.00
Appliances	Dishwasher	Energy Star	49.31	$460.95	9	-	$1.21
Appliances	Dishwasher	Energy Star (2011)	6.46	$5.61	15	0.99	$0.08
Appliances	Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Refrigerator	Energy Star	54.11	$20.17	20	-	$0.03
Appliances	Refrigerator	Baseline (2014)	99.12	$0.00	13	1.00	$0.00
Appliances	Refrigerator	Energy Star (2014)	158.60	$88.71	13	1.02	$0.05
Appliances	Freezer	Baseline	-	$0.00	22	-	$0.00
Appliances	Freezer	Energy Star	43.80	$3.98	22	-	$0.01
Appliances	Freezer	Baseline (2014)	101.64	-$145.00	11	1.00	-$0.16
Appliances	Freezer	Energy Star (2014)	162.63	-$112.83	11	1.00	-$0.08
Appliances	Second Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Second Refrigerator	Energy Star	72.15	$20.67	20	-	$0.02
Appliances	Second Refrigerator	Baseline (2014)	132.17	$0.00	13	1.00	$0.00

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Appliances	Second Refrigerator	Energy Star (2014)	211.47	$88.71	13	1.01	$0.04
Appliances	Stove	Baseline	-	$0.00	13	1.00	$0.00
Appliances	Stove	Convection Oven	7.49	$1.86	13	1.00	$0.02
Appliances	Stove	Induction (High Efficiency)	37.45	$1,432.20	13	0.37	$3.68
Appliances	Microwave	Baseline	-	$0.00	9	1.00	$0.00
Electronics	Personal Computers	Baseline	-	$0.00	5	1.00	$0.00
Electronics	Personal Computers	Energy Star	62.00	$1.20	5	1.01	$0.00
Electronics	Personal Computers	Climate Savers	88.57	$175.49	5	0.85	$0.43
Electronics	TVs	Baseline	-	$0.00	11	1.00	$0.00
Electronics	TVs	Energy Star	43.32	$0.56	11	1.02	$0.00
Electronics	Set-top boxes/DVR	Baseline	-	$0.00	11	1.00	$0.00
Electronics	Set-top boxes/DVR	Energy Star	24.86	$0.56	11	1.01	$0.00
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0.00	5	1.00	$0.00
Miscellaneous	Pool Pump	Baseline Pump	-	$0.00	15	1.00	$0.00
Miscellaneous	Pool Pump	High Efficiency Pump	120.40	$85.00	15	0.99	$0.06
Miscellaneous	Pool Pump	Two-Speed Pump	481.61	$579.00	15	0.79	$0.10
Miscellaneous	Furnace Fan	Baseline	-	$0.00	18	1.00	$0.00
Miscellaneous	Furnace Fan	Furnace Fan with ECM	110.30	$0.64	18	1.27	$0.00
Miscellaneous	Miscellaneous	Miscellaneous	-	$0.00	5	1.00	$0.00

Table B-17 Energy Efficiency Equipment Data, Electric—Low Income, Existing Vintage, Idaho

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central AC	SEER 13	-	$0.00	15	-	$0.00
Cooling	Central AC	SEER 14 (Energy Star)	34.58	$185.24	15	1.40	$0.46
Cooling	Central AC	SEER 15 (CEE Tier 2)	47.45	$370.47	15	0.93	$0.68
Cooling	Central AC	SEER 16 (CEE Tier 3)	58.23	$555.71	15	0.87	$0.83
Cooling	Central AC	Ductless Mini-Split System	104.44	$2,394.23	20	0.63	$1.62
Cooling	Room AC	EER 9.8	-	$0.00	10	1.00	$0.00
Cooling	Room AC	EER 10.8 (Energy Star)	18.57	$104.04	10	0.80	$0.66
Cooling	Room AC	EER 11	21.91	$282.26	10	0.59	$1.53
Cooling	Room AC	EER 11.5	29.66	$625.50	10	0.39	$2.50
Cooling	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	26.43	$1,245.78	15	1.30	$4.08
Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	36.26	$2,315.13	15	0.91	$5.52
Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	44.50	$3,277.48	15	0.83	$6.37
Cooling	Air Source Heat Pump	Ductless Mini-Split System	79.81	$5,022.03	20	0.84	$4.45
Cooling	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Cooling	Geothermal Heat Pump	High Efficiency	43.95	$1,500.00	15	0.87	$2.95
Cooling	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Electric Resistance	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Ductless Mini-Split System	1,966.55	$156.87	20	1.29	$0.01
Space Heating	Electric Furnace	3400 BTU/KW	-	$0.00	15	1.00	$0.00
Space Heating	Supplemental	Supplemental	-	$0.00	5	1.00	$0.00
Space Heating	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Space Heating	Air Source Heat Pump	SEER 14 (Energy Star)	338.00	$1,245.78	15	1.30	$0.32
Space Heating	Air Source Heat Pump	SEER 15 (CEE Tier 2)	463.77	$2,315.13	15	0.91	$0.43
Space Heating	Air Source Heat Pump	SEER 16 (CEE Tier 3)	569.10	$3,277.48	15	0.83	$0.50
Space Heating	Air Source Heat Pump	Ductless Mini-Split System	1,020.69	$5,022.03	20	0.84	$0.35
Space Heating	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Space Heating	Geothermal Heat Pump	High Efficiency	414.84	$1,500.00	15	0.87	$0.31
Space Heating	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	High Efficiency (EF=0.95)	113.39	$77.11	15	1.00	$0.06
Water Heating	Water Heater <= 55 Gal	EF 2.3 (HP)	1,092.98	$1,761.86	15	0.60	$0.14
Water Heating	Water Heater <= 55 Gal	Solar	1,238.51	$6,214.86	15	0.26	$0.43
Water Heating	Water Heater > 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater > 55 Gal	High Efficiency (EF=0.95)	160.07	$97.23	15	1.01	$0.05
Water Heating	Water Heater >	EF 2.3 (HP)	1,212.48	$1,691.15	15	0.68	$0.12

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
	55 Gal						
Water Heating	Water Heater > 55 Gal	Solar	1,083.44	$6,144.15	15	0.30	$0.49
Interior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Interior Lighting	Screw-in	Infrared Halogen	147.51	$98.38	5	1.00	$0.14
Interior Lighting	Screw-in	CFL	468.44	$17.84	6	2.59	$0.01
Interior Lighting	Screw-in	LED	640.24	$1,012.85	12	-	$0.16
Interior Lighting	Screw-in	LED	640.24	$1,012.85	12	-	$0.16
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	6.49	-$1.79	6	1.13	-$0.05
Interior Lighting	Linear Fluorescent	Super T8	19.44	$14.30	6	0.73	$0.13
Interior Lighting	Linear Fluorescent	T5	20.21	$24.22	6	0.57	$0.22
Interior Lighting	Linear Fluorescent	LED	21.20	$212.60	10	0.21	$1.19
Interior Lighting	Specialty	Halogen	-	$0.00	4	1.00	$0.00
Interior Lighting	Specialty	CFL	125.44	$0.96	7	1.91	$0.00
Interior Lighting	Specialty	LED	131.98	$261.26	12	0.28	$0.20
Exterior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Exterior Lighting	Screw-in	Infrared Halogen	33.03	$9.82	5	1.00	$0.06
Exterior Lighting	Screw-in	CFL	112.10	-$0.47	3	4.28	$0.00
Exterior Lighting	Screw-in	LED	130.12	$1,016.52	12	-	$0.80
Exterior Lighting	Screw-in	LED	130.12	$1,016.52	12	-	$0.80
Appliances	Clothes Washer	Baseline	-	$0.00	14	-	$0.00
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	34.10	$69.81	14	-	$0.19
Appliances	Clothes Washer	Horizontal Axis	47.07	$150.80	14	1.00	$0.29
Appliances	Clothes Dryer	Baseline	-	$0.00	13	-	$0.00
Appliances	Clothes Dryer	Moisture Detection	50.36	$48.40	13	1.00	$0.09
Appliances	Dishwasher	Baseline	-	$0.00	15	1.00	$0.00
Appliances	Dishwasher	Energy Star	42.21	$460.95	9	-	$1.41
Appliances	Dishwasher	Energy Star (2011)	5.53	$5.61	15	0.99	$0.09
Appliances	Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Refrigerator	Energy Star	36.14	$20.17	20	-	$0.04
Appliances	Refrigerator	Baseline (2014)	66.20	$0.00	13	1.00	$0.00
Appliances	Refrigerator	Energy Star (2014)	105.92	$88.71	13	1.00	$0.08
Appliances	Freezer	Baseline	-	$0.00	22	-	$0.00
Appliances	Freezer	Energy Star	29.54	$3.98	22	-	$0.01
Appliances	Freezer	Baseline (2014)	68.56	-$145.00	11	1.00	-$0.23
Appliances	Freezer	Energy Star (2014)	109.70	-$112.83	11	0.98	-$0.11
Appliances	Second Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Second Refrigerator	Energy Star	49.36	$20.67	20	-	$0.03
Appliances	Second Refrigerator	Baseline (2014)	90.42	$0.00	13	1.00	$0.00
Appliances	Second Refrigerator	Energy Star (2014)	144.67	$88.71	13	1.00	$0.06

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Appliances	Stove	Baseline	-	$0.00	13	1.00	$0.00
Appliances	Stove	Convection Oven	7.00	$1.86	13	1.00	$0.03
Appliances	Stove	Induction (High Efficiency)	35.02	$1,432.20	13	0.36	$3.94
Appliances	Microwave	Baseline	-	$0.00	9	1.00	$0.00
Electronics	Personal Computers	Baseline	-	$0.00	5	1.00	$0.00
Electronics	Personal Computers	Energy Star	59.23	$1.20	5	1.01	$0.00
Electronics	Personal Computers	Climate Savers	84.61	$175.49	5	0.85	$0.45
Electronics	TVs	Baseline	-	$0.00	11	1.00	$0.00
Electronics	TVs	Energy Star	36.45	$0.56	11	1.01	$0.00
Electronics	Set-top boxes/DVR	Baseline	-	$0.00	11	1.00	$0.00
Electronics	Set-top boxes/DVR	Energy Star	23.24	$0.56	11	1.01	$0.00
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0.00	5	1.00	$0.00
Miscellaneous	Pool Pump	Baseline Pump	-	$0.00	15	1.00	$0.00
Miscellaneous	Pool Pump	High Efficiency Pump	100.46	$85.00	15	0.98	$0.07
Miscellaneous	Pool Pump	Two-Speed Pump	401.86	$579.00	15	0.73	$0.12
Miscellaneous	Furnace Fan	Baseline	-	$0.00	18	1.00	$0.00
Miscellaneous	Furnace Fan	Furnace Fan with ECM	103.13	$0.64	18	1.26	$0.00
Miscellaneous	Miscellaneous	Miscellaneous	-	$0.00	5	1.00	$0.00

Table B-18 Energy Efficiency Equipment Data, Electric—Low income, New Vintage, Idaho

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central AC	SEER 13	-	$0.00	15	-	$0.00
Cooling	Central AC	SEER 14 (Energy Star)	41.11	$185.24	15	1.40	$0.39
Cooling	Central AC	SEER 15 (CEE Tier 2)	54.76	$370.47	15	0.93	$0.59
Cooling	Central AC	SEER 16 (CEE Tier 3)	66.21	$555.71	15	0.87	$0.73
Cooling	Central AC	Ductless Mini-Split System	124.17	$2,394.23	20	0.64	$1.36
Cooling	Room AC	EER 9.8	-	$0.00	10	1.00	$0.00
Cooling	Room AC	EER 10.8 (Energy Star)	21.58	$104.04	10	0.80	$0.57
Cooling	Room AC	EER 11	25.43	$282.26	10	0.59	$1.32
Cooling	Room AC	EER 11.5	34.49	$625.50	10	0.39	$2.15
Cooling	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	31.46	$0.00	15	1.30	$0.00
Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	41.90	$0.00	15	0.91	$0.00
Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	50.67	$0.00	15	0.85	$0.00
Cooling	Air Source Heat Pump	Ductless Mini-Split System	95.02	$0.00	20	0.85	$0.00
Cooling	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Cooling	Geothermal Heat Pump	High Efficiency	48.91	$0.00	15	0.87	$0.00
Cooling	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Electric Resistance	-	$0.00	20	1.00	$0.00
Space Heating	Electric Resistance	Ductless Mini-Split System	2,114.04	$156.87	20	1.30	$0.01
Space Heating	Electric Furnace	3400 BTU/KW	-	$0.00	15	1.00	$0.00
Space Heating	Supplemental	Supplemental	-	$0.00	5	1.00	$0.00
Space Heating	Air Source Heat Pump	SEER 13	-	$0.00	15	-	$0.00
Space Heating	Air Source Heat Pump	SEER 14 (Energy Star)	402.32	$1,245.78	15	1.30	$0.27
Space Heating	Air Source Heat Pump	SEER 15 (CEE Tier 2)	535.87	$2,315.13	15	0.91	$0.37
Space Heating	Air Source Heat Pump	SEER 16 (CEE Tier 3)	647.99	$3,277.48	15	0.85	$0.44
Space Heating	Air Source Heat Pump	Ductless Mini-Split System	1,215.19	$5,022.03	20	0.85	$0.29
Space Heating	Geothermal Heat Pump	Standard	-	$0.00	15	1.00	$0.00
Space Heating	Geothermal Heat Pump	High Efficiency	461.68	$1,500.00	15	0.87	$0.28
Space Heating	Ductless HP	Ductless Mini-Split System	-	$0.00	20	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater <= 55 Gal	High Efficiency (EF=0.95)	118.72	$77.11	15	1.00	$0.06
Water Heating	Water Heater <= 55 Gal	EF 2.3 (HP)	1,144.40	$1,761.86	15	0.62	$0.13
Water Heating	Water Heater <= 55 Gal	Solar	1,296.78	$6,214.86	15	0.26	$0.41
Water Heating	Water Heater > 55 Gal	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater > 55 Gal	High Efficiency (EF=0.95)	167.67	$97.23	15	1.01	$0.05

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Water Heating	Water Heater > 55 Gal	EF 2.3 (HP)	1,270.00	$1,691.15	15	0.70	$0.12
Water Heating	Water Heater > 55 Gal	Solar	1,134.84	$6,144.15	15	0.31	$0.47
Interior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Interior Lighting	Screw-in	Infrared Halogen	160.74	$98.38	5	1.00	$0.13
Interior Lighting	Screw-in	CFL	510.45	$17.84	6	2.54	$0.01
Interior Lighting	Screw-in	LED	697.66	$1,012.85	12	-	$0.15
Interior Lighting	Screw-in	LED	697.66	$1,012.85	12	-	$0.15
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	7.29	-$1.79	6	1.13	-$0.05
Interior Lighting	Linear Fluorescent	Super T8	21.85	$14.30	6	0.75	$0.12
Interior Lighting	Linear Fluorescent	T5	22.71	$24.22	6	0.60	$0.20
Interior Lighting	Linear Fluorescent	LED	23.82	$212.60	10	0.22	$1.06
Interior Lighting	Specialty	Halogen	-	$0.00	4	1.00	$0.00
Interior Lighting	Specialty	CFL	134.85	-$9.64	7	2.92	-$0.01
Interior Lighting	Specialty	LED	141.88	$71.04	12	0.91	$0.05
Exterior Lighting	Screw-in	Incandescent	-	$0.00	4	-	$0.00
Exterior Lighting	Screw-in	Infrared Halogen	35.88	$9.82	5	1.00	$0.06
Exterior Lighting	Screw-in	CFL	121.77	-$0.51	3	4.25	$0.00
Exterior Lighting	Screw-in	LED	141.35	$144.92	12	-	$0.11
Exterior Lighting	Screw-in	LED	141.35	$144.92	12	-	$0.11
Appliances	Clothes Washer	Baseline	-	$0.00	14	-	$0.00
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	39.78	$69.81	14	-	$0.16
Appliances	Clothes Washer	Horizontal Axis	54.92	$150.80	14	1.00	$0.25
Appliances	Clothes Dryer	Baseline	-	$0.00	13	-	$0.00
Appliances	Clothes Dryer	Moisture Detection	54.81	$48.40	13	1.00	$0.09
Appliances	Dishwasher	Baseline	-	$0.00	15	1.00	$0.00
Appliances	Dishwasher	Energy Star	46.11	$460.95	9	-	$1.29
Appliances	Dishwasher	Energy Star (2011)	6.04	$5.61	15	0.99	$0.08
Appliances	Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Refrigerator	Energy Star	50.60	$20.17	20	-	$0.03
Appliances	Refrigerator	Baseline (2014)	92.68	$0.00	13	1.00	$0.00
Appliances	Refrigerator	Energy Star (2014)	148.29	$88.71	13	1.01	$0.06
Appliances	Freezer	Baseline	-	$0.00	22	-	$0.00
Appliances	Freezer	Energy Star	40.95	$3.98	22	-	$0.01
Appliances	Freezer	Baseline (2014)	95.04	-$145.00	11	1.00	-$0.17
Appliances	Freezer	Energy Star (2014)	152.06	-$112.83	11	1.00	-$0.08
Appliances	Second Refrigerator	Baseline	-	$0.00	20	-	$0.00
Appliances	Second Refrigerator	Energy Star	67.46	$20.67	20	-	$0.02
Appliances	Second Refrigerator	Baseline (2014)	123.58	$0.00	13	1.00	$0.00
Appliances	Second	Energy Star (2014)	197.72	$88.71	13	1.01	$0.04

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
	Refrigerator						
Appliances	Stove	Baseline	-	$0.00	13	1.00	$0.00
Appliances	Stove	Convection Oven	7.00	$1.86	13	1.00	$0.03
Appliances	Stove	Induction (High Efficiency)	35.02	$1,432.20	13	0.36	$3.94
Appliances	Microwave	Baseline	-	$0.00	9	1.00	$0.00
Electronics	Personal Computers	Baseline	-	$0.00	5	1.00	$0.00
Electronics	Personal Computers	Energy Star	57.97	$1.20	5	1.01	$0.00
Electronics	Personal Computers	Climate Savers	82.81	$175.49	5	0.85	$0.46
Electronics	TVs	Baseline	-	$0.00	11	1.00	$0.00
Electronics	TVs	Energy Star	40.50	$0.56	11	1.02	$0.00
Electronics	Set-top boxes/DVR	Baseline	-	$0.00	11	1.00	$0.00
Electronics	Set-top boxes/DVR	Energy Star	23.24	$0.56	11	1.01	$0.00
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0.00	5	1.00	$0.00
Miscellaneous	Pool Pump	Baseline Pump	-	$0.00	15	1.00	$0.00
Miscellaneous	Pool Pump	High Efficiency Pump	112.58	$85.00	15	0.99	$0.07
Miscellaneous	Pool Pump	Two-Speed Pump	450.31	$579.00	15	0.77	$0.11
Miscellaneous	Furnace Fan	Baseline	-	$0.00	18	1.00	$0.00
Miscellaneous	Furnace Fan	Furnace Fan with ECM	103.13	$0.64	18	1.26	$0.00
Miscellaneous	Miscellaneous	Miscellaneous	-	$0.00	5	1.00	$0.00

Table B-19 Energy Efficiency Non-Equipment Data, Electric—Single Family, Existing Vintage, Washington

Measure	Base Saturation	Applicability	Lifetime (Years)	Cost ($/HH)	Savings (kWh)	BC Ratio	Levelized Cost ($/kWh)
Central AC - Early Replacement	0.0%	80.0%	15	$2,895.00	139.3	0.00	$2.133
Central AC - Maintenance and Tune-Up	41.0%	100.0%	4	$125.00	137.4	0.06	$0.251
Room AC - Removal of Second Unit	0.0%	100.0%	5	$75.00	512.4	0.42	$0.033
Attic Fan - Installation	12.0%	50.0%	18	$115.80	6.2	0.00	$1.736
Attic Fan - Photovoltaic - Installation	13.0%	100.0%	19	$350.00	6.2	0.00	$5.107
Ceiling Fan - Installation	51.0%	100.0%	15	$160.00	108.8	0.06	$0.151
Whole-House Fan - Installation	6.9%	25.0%	18	$200.00	174.6	0.08	$0.106
Air Source Heat Pump - Maintenance	37.8%	100.0%	4	$125.00	926.7	0.42	$0.037
Insulation - Ducting	15.0%	59.4%	18	$500.00	483.1	0.09	$0.096
Repair and Sealing - Ducting	12.3%	100.0%	20	$571.38	2,111.0	0.35	$0.024
Thermostat - Clock/Programmable	71.8%	75.0%	15	$249.47	587.7	0.49	$0.044
Doors - Storm and Thermal	38.0%	100.0%	12	$320.00	116.9	0.05	$0.322
Insulation - Infiltration Control	46.0%	100.0%	25	$306.11	876.6	0.48	$0.028
Insulation - Ceiling	76.4%	75.0%	25	$630.45	991.9	0.18	$0.051
Insulation - Radiant Barrier	5.0%	100.0%	12	$922.68	571.9	0.09	$0.190
Roofs - High Reflectivity	5.0%	100.0%	15	$1,549.61	82.7	0.00	$1.923
Windows - Reflective Film	5.0%	50.0%	10	$266.67	369.6	0.12	$0.096
Windows - High Efficiency/Energy Star	77.6%	100.0%	25	$5,200.97	4,270.5	0.11	$0.098
Interior Lighting - Occupancy Sensor	23.5%	50.0%	15	$750.00	444.7	0.05	$0.173
Exterior Lighting - Photovoltaic Installation	10.0%	100.0%	15	$2,975.00	53.8	0.00	$5.679
Exterior Lighting - Photosensor Control	23.5%	100.0%	8	$90.00	36.3	0.03	$0.388
Exterior Lighting - Timeclock Installation	10.0%	100.0%	8	$72.00	36.3	0.04	$0.310
Water Heater - Faucet Aerators	53.2%	100.0%	25	$24.00	275.8	1.23	$0.007
Water Heater - Pipe Insulation	17.0%	100.0%	13	$15.00	242.9	1.94	$0.007
Water Heater - Low Flow Showerheads	75.5%	100.0%	10	$25.48	354.0	1.87	$0.010
Water Heater - Tank Blanket/Insulation	54.0%	100.0%	10	$15.00	781.1	4.19	$0.003
Water Heater - Thermostat Setback	17.0%	100.0%	5	$40.00	781.1	1.23	$0.012
Electronics - Reduce Standby Wattage	5.0%	100.0%	8	$20.00	117.4	0.47	$0.027
Refrigerator - Early Replacement	10.0%	85.0%	7	$109.00	319.9	0.16	$0.059
Refrigerator - Remove Second Unit	17.3%	85.0%	7	$109.00	437.0	0.83	$0.043
Freezer - Early Replacement	10.0%	85.0%	5	$109.00	355.4	0.14	$0.070
Freezer - Remove Second Unit	17.3%	85.0%	5	$109.00	384.9	0.75	$0.065
Behavioral Measures	20.0%	50.0%	1	$12.00	125.0	0.20	$0.096
Pool - Pump Timer	58.8%	100.0%	15	$160.00	194.3	0.12	$0.085
Insulation - Foundation	25.9%	39.0%	25	$750.53	521.1	0.19	$0.116
Insulation - Wall Cavity	88.4%	100.0%	25	$1,415.87	2,186.1	0.17	$0.052
Insulation - Wall Sheathing	64.4%	100.0%	20	$300.00	276.9	0.14	$0.096
Water Heater - Solar System	5.0%	25.0%	20	$6,500.00	6,437.3	0.11	$0.089

Table B-20 Energy Efficiency Non-Equipment Data, Electric—Single Family, New Vintage, Washington

Measure	Base Saturation	Applicability	Lifetime (Years)	Cost ($/HH)	Savings (kWh)	BC Ratio	Levelized Cost ($/kWh)
Central AC - Maintenance and Tune-Up	41.0%	100.0%	4	$125.00	158.0	0.07	$0.218
Attic Fan - Installation	12.6%	50.0%	18	$96.50	8.7	0.01	$1.027
Attic Fan - Photovoltaic - Installation	4.0%	25.0%	19	$200.00	8.7	0.00	$2.072
Ceiling Fan - Installation	52.6%	100.0%	15	$160.00	174.2	0.10	$0.094
Whole-House Fan - Installation	4.0%	25.0%	18	$200.00	239.6	0.12	$0.078
Air Source Heat Pump - Maintenance	37.8%	100.0%	4	$125.00	1,065.7	0.53	$0.032
Insulation - Ducting	50.0%	59.4%	18	$250.00	553.3	0.22	$0.042
Thermostat - Clock/Programmable	90.6%	95.0%	15	$249.47	608.2	0.41	$0.042
Doors - Storm and Thermal	13.0%	100.0%	12	$180.00	203.5	0.16	$0.104
Insulation - Ceiling	81.8%	75.0%	20	$634.00	549.5	0.13	$0.102
Insulation - Radiant Barrier	25.0%	100.0%	12	$922.68	193.4	0.03	$0.561
Roofs - High Reflectivity	5.0%	100.0%	15	$516.54	129.8	0.02	$0.408
Windows - Reflective Film	2.0%	50.0%	10	$266.67	338.0	0.11	$0.105
Windows - High Efficiency/Energy Star	95.5%	100.0%	25	$2,200.00	3,037.6	0.22	$0.058
Interior Lighting - Occupancy Sensor	23.5%	30.0%	15	$500.00	493.6	0.10	$0.104
Exterior Lighting - Photovoltaic Installation	10.0%	100.0%	15	$2,975.00	60.1	0.00	$5.076
Exterior Lighting - Photosensor Control	13.2%	100.0%	8	$90.00	40.0	0.05	$0.352
Exterior Lighting - Timeclock Installation	16.0%	100.0%	8	$72.00	40.0	0.06	$0.282
Water Heater - Faucet Aerators	38.3%	100.0%	25	$24.00	251.6	1.13	$0.008
Water Heater - Pipe Insulation	8.0%	100.0%	13	$15.00	221.9	1.78	$0.008
Water Heater - Low Flow Showerheads	89.8%	100.0%	10	$25.48	354.0	1.81	$0.010
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	10	$15.00	713.6	3.82	$0.003
Water Heater - Thermostat Setback	5.0%	100.0%	5	$40.00	713.6	1.13	$0.013
Electronics - Reduce Standby Wattage	5.0%	100.0%	8	$20.00	126.7	0.53	$0.025
Behavioral Measures	20.0%	75.0%	1	$12.00	142.7	0.24	$0.084
Pool - Pump Timer	55.0%	100.0%	15	$160.00	200.1	0.14	$0.082
Insulation - Foundation	54.8%	63.6%	20	$358.00	744.7	0.49	$0.042
Insulation - Wall Cavity	91.1%	100.0%	25	$236.00	558.7	0.38	$0.034
Insulation - Wall Sheathing	64.4%	100.0%	20	$300.00	315.7	0.17	$0.084
Water Heater - Drainwater Heat Reocvery	1.0%	100.0%	25	$899.00	1,176.3	0.14	$0.061

Table B-21 Energy Efficiency Non-Equipment Data, Electric—Single Family, Existing Vintage, Idaho

Measure	Base Saturation	Applicability	Lifetime (Years)	Cost ($/HH)	Savings (kWh)	BC Ratio	Levelized Cost ($/kWh)
Central AC - Early Replacement	0.0%	80.0%	15	$2,895.00	139.3	0.00	$2.133
Central AC - Maintenance and Tune-Up	41.0%	100.0%	4	$125.00	137.4	0.06	$0.251
Room AC - Removal of Second Unit	0.0%	100.0%	5	$75.00	512.4	0.42	$0.033
Attic Fan - Installation	12.0%	50.0%	18	$115.80	6.2	0.00	$1.736
Attic Fan - Photovoltaic - Installation	13.0%	100.0%	19	$350.00	6.2	0.00	$5.107
Ceiling Fan - Installation	51.0%	100.0%	15	$160.00	108.8	0.06	$0.151
Whole-House Fan - Installation	6.9%	25.0%	18	$200.00	174.6	0.08	$0.106
Air Source Heat Pump - Maintenance	37.8%	100.0%	4	$125.00	926.7	0.42	$0.037
Insulation - Ducting	15.0%	59.4%	18	$500.00	483.1	0.09	$0.096
Repair and Sealing - Ducting	12.3%	100.0%	20	$571.38	2,111.0	0.35	$0.024
Thermostat - Clock/Programmable	71.8%	75.0%	15	$249.47	587.7	0.49	$0.044
Doors - Storm and Thermal	38.0%	100.0%	12	$320.00	116.9	0.05	$0.322
Insulation - Infiltration Control	46.0%	100.0%	25	$306.11	876.6	0.48	$0.028
Insulation - Ceiling	76.4%	75.0%	25	$630.45	991.9	0.18	$0.051
Insulation - Radiant Barrier	5.0%	100.0%	12	$922.68	571.9	0.09	$0.190
Roofs - High Reflectivity	5.0%	100.0%	15	$1,549.61	82.7	0.00	$1.923
Windows - Reflective Film	5.0%	50.0%	10	$266.67	369.6	0.12	$0.096
Windows - High Efficiency/Energy Star	77.6%	100.0%	25	$5,200.97	4,270.5	0.11	$0.098
Interior Lighting - Occupancy Sensor	23.5%	50.0%	15	$750.00	444.7	0.05	$0.173
Exterior Lighting - Photovoltaic Installation	10.0%	100.0%	15	$2,975.00	53.8	0.00	$5.679
Exterior Lighting - Photosensor Control	23.5%	100.0%	8	$90.00	36.3	0.03	$0.388
Exterior Lighting - Timeclock Installation	10.0%	100.0%	8	$72.00	36.3	0.04	$0.310
Water Heater - Faucet Aerators	53.2%	100.0%	25	$24.00	275.8	1.23	$0.007
Water Heater - Pipe Insulation	17.0%	100.0%	13	$15.00	242.9	1.94	$0.007
Water Heater - Low Flow Showerheads	75.5%	100.0%	10	$25.48	354.0	1.87	$0.010
Water Heater - Tank Blanket/Insulation	54.0%	100.0%	10	$15.00	781.1	4.19	$0.003
Water Heater - Thermostat Setback	17.0%	100.0%	5	$40.00	781.1	1.23	$0.012
Electronics - Reduce Standby Wattage	5.0%	100.0%	8	$20.00	117.4	0.47	$0.027
Refrigerator - Early Replacement	10.0%	85.0%	7	$109.00	319.9	0.16	$0.059
Refrigerator - Remove Second Unit	17.3%	85.0%	7	$109.00	437.0	0.83	$0.043
Freezer - Early Replacement	10.0%	85.0%	5	$109.00	355.4	0.14	$0.070
Freezer - Remove Second Unit	17.3%	85.0%	5	$109.00	384.9	0.75	$0.065
Behavioral Measures	20.0%	50.0%	1	$12.00	125.0	0.20	$0.096
Pool - Pump Timer	58.8%	100.0%	15	$160.00	194.3	0.12	$0.085
Insulation - Foundation	25.9%	39.0%	25	$750.53	521.1	0.19	$0.116
Insulation - Wall Cavity	88.4%	100.0%	25	$1,415.87	2,186.1	0.17	$0.052
Insulation - Wall Sheathing	64.4%	100.0%	20	$300.00	276.9	0.14	$0.096
Water Heater - Solar System	5.0%	25.0%	20	$6,500.00	6,437.3	0.11	$0.089

Table B-22 Energy Efficiency Non-Equipment Data, Electric—Single Family, New Vintage, Idaho

Measure	Base Saturation	Applicability	Lifetime (Years)	Cost ($/HH)	Savings (kWh)	BC Ratio	Levelized Cost ($/kWh)
Central AC - Maintenance and Tune-Up	41.0%	100.0%	4	$125.00	158.0	0.07	$0.218
Attic Fan - Installation	12.6%	50.0%	18	$96.50	8.7	0.01	$1.027
Attic Fan - Photovoltaic - Installation	4.0%	25.0%	19	$200.00	8.7	0.00	$2.072
Ceiling Fan - Installation	52.6%	100.0%	15	$160.00	174.2	0.10	$0.094
Whole-House Fan - Installation	4.0%	25.0%	18	$200.00	239.6	0.12	$0.078
Air Source Heat Pump - Maintenance	37.8%	100.0%	4	$125.00	1,065.7	0.53	$0.032
Insulation - Ducting	50.0%	59.4%	18	$250.00	553.3	0.22	$0.042
Thermostat - Clock/Programmable	90.6%	95.0%	15	$249.47	608.2	0.41	$0.042
Doors - Storm and Thermal	13.0%	100.0%	12	$180.00	203.5	0.16	$0.104
Insulation - Ceiling	81.8%	75.0%	20	$634.00	549.5	0.13	$0.102
Insulation - Radiant Barrier	25.0%	100.0%	12	$922.68	193.4	0.03	$0.561
Roofs - High Reflectivity	5.0%	100.0%	15	$516.54	129.8	0.02	$0.408
Windows - Reflective Film	2.0%	50.0%	10	$266.67	338.0	0.11	$0.105
Windows - High Efficiency/Energy Star	95.5%	100.0%	25	$2,200.00	3,037.6	0.22	$0.058
Interior Lighting - Occupancy Sensor	23.5%	30.0%	15	$500.00	493.6	0.10	$0.104
Exterior Lighting - Photovoltaic Installation	10.0%	100.0%	15	$2,975.00	60.1	0.00	$5.076
Exterior Lighting - Photosensor Control	13.2%	100.0%	8	$90.00	40.0	0.05	$0.352
Exterior Lighting - Timeclock Installation	16.0%	100.0%	8	$72.00	40.0	0.06	$0.282
Water Heater - Faucet Aerators	38.3%	100.0%	25	$24.00	251.6	1.13	$0.008
Water Heater - Pipe Insulation	8.0%	100.0%	13	$15.00	221.9	1.78	$0.008
Water Heater - Low Flow Showerheads	89.8%	100.0%	10	$25.48	354.0	1.81	$0.010
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	10	$15.00	713.6	3.82	$0.003
Water Heater - Thermostat Setback	5.0%	100.0%	5	$40.00	713.6	1.13	$0.013
Electronics - Reduce Standby Wattage	5.0%	100.0%	8	$20.00	126.7	0.53	$0.025
Behavioral Measures	20.0%	75.0%	1	$12.00	142.7	0.24	$0.084
Pool - Pump Timer	55.0%	100.0%	15	$160.00	200.1	0.14	$0.082
Insulation - Foundation	54.8%	63.6%	20	$358.00	744.7	0.49	$0.042
Insulation - Wall Cavity	91.1%	100.0%	25	$236.00	558.7	0.38	$0.034
Insulation - Wall Sheathing	64.4%	100.0%	20	$300.00	315.7	0.17	$0.084
Water Heater - Drainwater Heat Reocvery	1.0%	100.0%	25	$899.00	1,176.3	0.14	$0.061

Table B-23 Energy Efficiency Non-Equipment Data, Electric—Multi Family, Existing Vintage, Washington

Measure	Base Saturation	Applicability	Lifetime (Years)	Cost ($/HH)	Savings (kWh)	BC Ratio	Levelized Cost ($/kWh)
Central AC - Early Replacement	0.0%	80.0%	15	$2,895.00	46.4	0.00	$6.400
Central AC - Maintenance and Tune-Up	32.8%	100.0%	4	$100.00	45.8	0.03	$0.602
Room AC - Removal of Second Unit	0.0%	100.0%	5	$75.00	355.3	0.29	$0.048
Ceiling Fan - Installation	32.4%	100.0%	15	$80.00	37.9	0.04	$0.216
Air Source Heat Pump - Maintenance	25.0%	100.0%	4	$100.00	360.1	0.21	$0.077
Insulation - Ducting	13.0%	13.0%	18	$375.00	7.0	0.00	$4.945
Repair and Sealing - Ducting	11.8%	100.0%	18	$500.00	720.5	0.13	$0.064
Thermostat - Clock/Programmable	27.0%	75.0%	15	$114.42	315.1	0.35	$0.037
Doors - Storm and Thermal	17.0%	100.0%	12	$320.00	-	-	$0.000
Insulation - Infiltration Control	19.0%	100.0%	12	$266.00	283.6	0.17	$0.110
Insulation - Ceiling	30.0%	40.0%	20	$215.00	277.6	0.17	$0.068
Insulation - Radiant Barrier	5.0%	100.0%	12	$922.68	433.3	0.06	$0.251
Roofs - High Reflectivity	3.0%	100.0%	15	$1,549.61	39.3	0.00	$4.045
Windows - Reflective Film	5.0%	50.0%	10	$166.67	112.4	0.06	$0.197
Windows - High Efficiency/Energy Star	70.4%	100.0%	25	$2,500.00	1,020.7	0.05	$0.196
Interior Lighting - Occupancy Sensor	5.6%	20.0%	15	$256.00	253.9	0.08	$0.103
Exterior Lighting - Photovoltaic Installation	10.0%	100.0%	15	$2,975.00	5.5	0.00	$55.926
Exterior Lighting - Photosensor Control	7.1%	100.0%	8	$90.00	2.1	0.00	$6.688
Exterior Lighting - Timeclock Installation	6.0%	100.0%	8	$72.00	2.1	0.00	$5.350
Water Heater - Faucet Aerators	43.2%	100.0%	25	$24.00	237.5	1.05	$0.008
Water Heater - Pipe Insulation	6.0%	100.0%	13	$15.00	149.6	0.90	$0.011
Water Heater - Low Flow Showerheads	71.6%	100.0%	10	$25.48	282.0	1.11	$0.012
Water Heater - Tank Blanket/Insulation	54.0%	100.0%	10	$15.00	480.9	2.25	$0.004
Water Heater - Thermostat Setback	17.0%	100.0%	5	$40.00	480.9	0.67	$0.019
Electronics - Reduce Standby Wattage	5.0%	100.0%	8	$20.00	73.6	0.31	$0.043
Refrigerator - Early Replacement	10.0%	85.0%	7	$109.00	255.9	0.13	$0.074
Refrigerator - Remove Second Unit	17.3%	85.0%	7	$109.00	437.0	0.83	$0.043
Freezer - Early Replacement	10.0%	85.0%	5	$109.00	307.9	0.12	$0.081
Freezer - Remove Second Unit	17.3%	85.0%	5	$109.00	384.9	0.75	$0.065
Behavioral Measures	5.0%	25.0%	1	$12.00	65.5	0.10	$0.183
Insulation - Wall Cavity	80.0%	100.0%	25	$707.94	522.3	0.09	$0.109
Insulation - Wall Sheathing	55.1%	100.0%	20	$210.00	356.6	0.22	$0.052

Table B-24 Energy Efficiency Non-Equipment Data, Electric—Multi Family, New Vintage, Washington

Measure	Base Saturation	Applicability	Lifetime (Years)	Cost ($/HH)	Savings (kWh)	BC Ratio	Levelized Cost ($/kWh)
Central AC - Maintenance and Tune-Up	32.8%	100.0%	4	$100.00	52.7	0.03	$0.524
Ceiling Fan - Installation	17.6%	100.0%	15	$80.00	59.7	0.07	$0.138
Air Source Heat Pump - Maintenance	25.0%	100.0%	4	$100.00	414.1	0.27	$0.067
Insulation - Ducting	13.0%	13.0%	18	$200.00	7.3	0.00	$2.531
Thermostat - Clock/Programmable	77.0%	80.0%	15	$114.42	364.1	0.36	$0.032
Doors - Storm and Thermal	19.0%	100.0%	12	$180.00	-	-	$0.000
Insulation - Ceiling	30.7%	50.0%	20	$152.00	430.5	0.37	$0.031
Insulation - Radiant Barrier	5.0%	100.0%	12	$922.68	160.5	0.02	$0.677
Roofs - High Reflectivity	0.0%	100.0%	15	$516.54	35.4	0.01	$1.498
Windows - Reflective Film	2.0%	50.0%	10	$166.67	129.5	0.07	$0.171
Windows - High Efficiency/Energy Star	89.2%	100.0%	25	$2,200.00	2,298.8	0.14	$0.077
Interior Lighting - Occupancy Sensor	5.6%	10.0%	15	$256.00	281.1	0.11	$0.093
Exterior Lighting - Photovoltaic Installation	10.0%	100.0%	15	$2,975.00	6.3	0.00	$48.646
Exterior Lighting - Photosensor Control	0.7%	100.0%	8	$90.00	2.3	0.00	$6.080
Exterior Lighting - Timeclock Installation	11.0%	100.0%	8	$72.00	2.3	0.01	$4.864
Water Heater - Faucet Aerators	11.0%	100.0%	25	$24.00	217.0	1.04	$0.009
Water Heater - Pipe Insulation	0.0%	100.0%	13	$15.00	136.6	1.11	$0.012
Water Heater - Low Flow Showerheads	66.2%	100.0%	10	$25.48	282.0	1.42	$0.012
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	10	$15.00	439.3	2.67	$0.005
Water Heater - Thermostat Setback	5.0%	100.0%	5	$40.00	439.3	0.76	$0.021
Electronics - Reduce Standby Wattage	5.0%	100.0%	8	$20.00	79.5	0.35	$0.039
Behavioral Measures	5.0%	75.0%	1	$12.00	75.1	0.13	$0.160
Insulation - Wall Cavity	91.1%	100.0%	25	$62.50	478.4	1.03	$0.010
Insulation - Wall Sheathing	55.1%	100.0%	20	$210.00	410.2	0.26	$0.045
Water Heater - Drainwater Heat Reocvery	1.0%	100.0%	25	$899.00	724.2	0.09	$0.100

Table B-25 Energy Efficiency Non-Equipment Data, Electric—Multi Family, Existing Vintage, Idaho

Measure	Base Saturation	Applicability	Lifetime (Years)	Cost ($/HH)	Savings (kWh)	BC Ratio	Levelized Cost ($/kWh)
Central AC - Early Replacement	0.0%	80.0%	15	$2,895.00	46.4	0.00	$6.400
Central AC - Maintenance and Tune-Up	32.8%	100.0%	4	$100.00	45.8	0.03	$0.602
Room AC - Removal of Second Unit	0.0%	100.0%	5	$75.00	355.3	0.29	$0.048
Ceiling Fan - Installation	32.4%	100.0%	15	$80.00	37.9	0.04	$0.216
Air Source Heat Pump - Maintenance	25.0%	100.0%	4	$100.00	360.1	0.21	$0.077
Insulation - Ducting	13.0%	13.0%	18	$375.00	7.0	0.00	$4.945
Repair and Sealing - Ducting	11.8%	100.0%	18	$500.00	720.5	0.13	$0.064
Thermostat - Clock/Programmable	27.0%	75.0%	15	$114.42	315.1	0.35	$0.037
Doors - Storm and Thermal	17.0%	100.0%	12	$320.00	-	-	$0.000
Insulation - Infiltration Control	19.0%	100.0%	12	$266.00	283.6	0.17	$0.110
Insulation - Ceiling	30.0%	40.0%	20	$215.00	277.6	0.17	$0.068
Insulation - Radiant Barrier	5.0%	100.0%	12	$922.68	433.3	0.06	$0.251
Roofs - High Reflectivity	3.0%	100.0%	15	$1,549.61	39.3	0.00	$4.045
Windows - Reflective Film	5.0%	50.0%	10	$166.67	112.4	0.06	$0.197
Windows - High Efficiency/Energy Star	70.4%	100.0%	25	$2,500.00	1,020.7	0.05	$0.196
Interior Lighting - Occupancy Sensor	5.6%	20.0%	15	$256.00	253.9	0.08	$0.103
Exterior Lighting - Photovoltaic Installation	10.0%	100.0%	15	$2,975.00	5.5	0.00	$55.926
Exterior Lighting - Photosensor Control	7.1%	100.0%	8	$90.00	2.1	0.00	$6.688
Exterior Lighting - Timeclock Installation	6.0%	100.0%	8	$72.00	2.1	0.00	$5.350
Water Heater - Faucet Aerators	43.2%	100.0%	25	$24.00	237.5	1.05	$0.008
Water Heater - Pipe Insulation	6.0%	100.0%	13	$15.00	149.6	0.90	$0.011
Water Heater - Low Flow Showerheads	71.6%	100.0%	10	$25.48	282.0	1.11	$0.012
Water Heater - Tank Blanket/Insulation	54.0%	100.0%	10	$15.00	480.9	2.25	$0.004
Water Heater - Thermostat Setback	17.0%	100.0%	5	$40.00	480.9	0.67	$0.019
Electronics - Reduce Standby Wattage	5.0%	100.0%	8	$20.00	73.6	0.31	$0.043
Refrigerator - Early Replacement	10.0%	85.0%	7	$109.00	255.9	0.13	$0.074
Refrigerator - Remove Second Unit	17.3%	85.0%	7	$109.00	437.0	0.83	$0.043
Freezer - Early Replacement	10.0%	85.0%	5	$109.00	307.9	0.12	$0.081
Freezer - Remove Second Unit	17.3%	85.0%	5	$109.00	384.9	0.75	$0.065
Behavioral Measures	5.0%	25.0%	1	$12.00	65.5	0.10	$0.183
Insulation - Wall Cavity	80.0%	100.0%	25	$707.94	522.3	0.09	$0.109
Insulation - Wall Sheathing	55.1%	100.0%	20	$210.00	356.6	0.22	$0.052

Table B-26 Energy Efficiency Non-Equipment Data, Electric—Multi Family, New Vintage, Idaho

Measure	Base Saturation	Applicability	Lifetime (Years)	Cost ($/HH)	Savings (kWh)	BC Ratio	Levelized Cost ($/kWh)
Central AC - Maintenance and Tune-Up	32.8%	100.0%	4	$100.00	52.7	0.03	$0.524
Ceiling Fan - Installation	17.6%	100.0%	15	$80.00	59.7	0.07	$0.138
Air Source Heat Pump - Maintenance	25.0%	100.0%	4	$100.00	414.1	0.27	$0.067
Insulation - Ducting	13.0%	13.0%	18	$200.00	7.3	0.00	$2.531
Thermostat - Clock/Programmable	77.0%	80.0%	15	$114.42	364.1	0.36	$0.032
Doors - Storm and Thermal	19.0%	100.0%	12	$180.00	-	-	$0.000
Insulation - Ceiling	30.7%	50.0%	20	$152.00	430.5	0.37	$0.031
Insulation - Radiant Barrier	5.0%	100.0%	12	$922.68	160.5	0.02	$0.677
Roofs - High Reflectivity	0.0%	100.0%	15	$516.54	35.4	0.01	$1.498
Windows - Reflective Film	2.0%	50.0%	10	$166.67	129.5	0.07	$0.171
Windows - High Efficiency/Energy Star	89.2%	100.0%	25	$2,200.00	2,298.8	0.14	$0.077
Interior Lighting - Occupancy Sensor	5.6%	10.0%	15	$256.00	281.1	0.11	$0.093
Exterior Lighting - Photovoltaic Installation	10.0%	100.0%	15	$2,975.00	6.3	0.00	$48.646
Exterior Lighting - Photosensor Control	0.7%	100.0%	8	$90.00	2.3	0.00	$6.080
Exterior Lighting - Timeclock Installation	11.0%	100.0%	8	$72.00	2.3	0.01	$4.864
Water Heater - Faucet Aerators	11.0%	100.0%	25	$24.00	217.0	1.04	$0.009
Water Heater - Pipe Insulation	0.0%	100.0%	13	$15.00	136.6	1.11	$0.012
Water Heater - Low Flow Showerheads	66.2%	100.0%	10	$25.48	282.0	1.42	$0.012
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	10	$15.00	439.3	2.67	$0.005
Water Heater - Thermostat Setback	5.0%	100.0%	5	$40.00	439.3	0.76	$0.021
Electronics - Reduce Standby Wattage	5.0%	100.0%	8	$20.00	79.5	0.35	$0.039
Behavioral Measures	5.0%	75.0%	1	$12.00	75.1	0.13	$0.160
Insulation - Wall Cavity	91.1%	100.0%	25	$62.50	478.4	1.03	$0.010
Insulation - Wall Sheathing	55.1%	100.0%	20	$210.00	410.2	0.26	$0.045
Water Heater - Drainwater Heat Reocvery	1.0%	100.0%	25	$899.00	724.2	0.09	$0.100

Table B-27 Energy Efficiency Non-Equipment Data, Electric—Mobile Home, Existing Vintage, Washington

Measure	Base Saturation	Applicability	Lifetime (Years)	Cost ($/HH)	Savings (kWh)	BC Ratio	Levelized Cost ($/kWh)
Central AC - Early Replacement	0.0%	80.0%	15	$2,895.00	55.3	0.00	$5.373
Central AC - Maintenance and Tune-Up	58.9%	100.0%	4	$100.00	54.5	0.03	$0.506
Room AC - Removal of Second Unit	0.0%	100.0%	5	$75.00	305.2	0.25	$0.056
Ceiling Fan - Installation	60.0%	100.0%	15	$80.00	41.2	0.05	$0.199
Whole-House Fan - Installation	5.2%	25.0%	18	$150.00	66.1	0.04	$0.211
Air Source Heat Pump - Maintenance	25.0%	100.0%	4	$125.00	496.0	0.22	$0.070
Insulation - Ducting	15.0%	65.0%	18	$375.00	320.3	0.08	$0.109
Repair and Sealing - Ducting	12.3%	100.0%	18	$398.09	2,477.4	0.59	$0.015
Thermostat - Clock/Programmable	51.0%	75.0%	15	$114.42	513.2	0.94	$0.023
Doors - Storm and Thermal	38.0%	100.0%	12	$320.00	79.1	0.04	$0.476
Insulation - Infiltration Control	46.0%	100.0%	25	$208.70	364.9	0.42	$0.046
Insulation - Ceiling	46.2%	85.0%	25	$276.18	355.8	0.18	$0.062
Insulation - Radiant Barrier	5.0%	100.0%	12	$922.68	387.5	0.07	$0.280
Roofs - High Reflectivity	5.0%	100.0%	15	$1,549.61	31.3	0.00	$5.080
Windows - Reflective Film	5.0%	50.0%	10	$166.67	139.9	0.07	$0.159
Windows - High Efficiency/Energy Star	52.4%	100.0%	25	$3,171.89	4,053.4	0.16	$0.063
Interior Lighting - Occupancy Sensor	66.6%	80.0%	15	$750.00	346.9	0.04	$0.222
Exterior Lighting - Photovoltaic Installation	10.0%	100.0%	15	$2,975.00	41.9	0.00	$7.281
Exterior Lighting - Photosensor Control	23.4%	100.0%	8	$90.00	28.3	0.02	$0.497
Exterior Lighting - Timeclock Installation	10.0%	100.0%	8	$72.00	28.3	0.03	$0.398
Water Heater - Faucet Aerators	78.9%	100.0%	25	$24.00	179.3	1.02	$0.011
Water Heater - Pipe Insulation	17.0%	100.0%	13	$15.00	157.9	1.14	$0.011
Water Heater - Low Flow Showerheads	92.1%	100.0%	10	$25.48	816.8	2.74	$0.004
Water Heater - Tank Blanket/Insulation	54.0%	100.0%	10	$15.00	507.7	2.43	$0.004
Water Heater - Thermostat Setback	17.0%	100.0%	5	$40.00	507.7	0.72	$0.018
Electronics - Reduce Standby Wattage	5.0%	100.0%	8	$20.00	91.0	0.37	$0.034
Refrigerator - Early Replacement	10.0%	85.0%	7	$109.00	249.5	0.12	$0.076
Refrigerator - Remove Second Unit	17.3%	85.0%	7	$109.00	437.0	0.83	$0.043
Freezer - Early Replacement	10.0%	85.0%	5	$109.00	300.2	0.12	$0.083
Freezer - Remove Second Unit	17.3%	85.0%	5	$109.00	384.9	0.75	$0.065
Behavioral Measures	20.0%	50.0%	1	$12.00	84.5	0.14	$0.142
Pool - Pump Timer	50.0%	100.0%	15	$160.00	145.7	0.09	$0.113
Insulation - Wall Cavity	81.8%	100.0%	25	$707.94	1,004.5	0.17	$0.057
Insulation - Wall Sheathing	64.4%	100.0%	20	$300.00	187.2	0.11	$0.141

Table B-28 Energy Efficiency Non-Equipment Data, Electric—Mobile Home, New Vintage, Washington

Measure	Base Saturation	Applicability	Lifetime (Years)	Cost ($/HH)	Savings (kWh)	BC Ratio	Levelized Cost ($/kWh)
Central AC - Maintenance and Tune-Up	58.9%	100.0%	4	$100.00	58.6	0.03	$0.471
Ceiling Fan - Installation	57.0%	100.0%	15	$80.00	60.2	0.07	$0.136
Whole-House Fan - Installation	4.0%	25.0%	18	$150.00	82.8	0.05	$0.168
Air Source Heat Pump - Maintenance	25.0%	100.0%	4	$125.00	533.2	0.26	$0.065
Insulation - Ducting	55.0%	65.0%	18	$200.00	344.0	0.17	$0.054
Thermostat - Clock/Programmable	57.0%	75.0%	15	$114.42	552.4	0.77	$0.021
Doors - Storm and Thermal	13.0%	100.0%	12	$180.00	126.6	0.11	$0.167
Insulation - Ceiling	46.2%	85.0%	20	$176.00	341.1	0.32	$0.046
Insulation - Radiant Barrier	25.0%	100.0%	12	$922.68	115.6	0.02	$0.939
Roofs - High Reflectivity	5.0%	100.0%	15	$516.54	44.8	0.01	$1.183
Windows - Reflective Film	2.0%	50.0%	10	$166.67	116.7	0.06	$0.190
Windows - High Efficiency/Energy Star	95.5%	100.0%	25	$2,200.00	1,916.5	0.15	$0.092
Interior Lighting - Occupancy Sensor	66.6%	80.0%	15	$500.00	366.0	0.08	$0.140
Exterior Lighting - Photovoltaic Installation	10.0%	100.0%	15	$2,975.00	44.8	0.00	$6.818
Exterior Lighting - Photosensor Control	13.2%	100.0%	8	$90.00	29.8	0.04	$0.473
Exterior Lighting - Timeclock Installation	16.0%	100.0%	8	$72.00	29.8	0.05	$0.379
Water Heater - Faucet Aerators	56.6%	100.0%	25	$24.00	171.3	1.01	$0.011
Water Heater - Pipe Insulation	8.0%	100.0%	13	$15.00	151.1	1.43	$0.011
Water Heater - Low Flow Showerheads	92.1%	100.0%	10	$25.48	781.8	3.37	$0.004
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	10	$15.00	485.8	2.95	$0.004
Water Heater - Thermostat Setback	5.0%	100.0%	5	$40.00	485.8	0.84	$0.019
Electronics - Reduce Standby Wattage	5.0%	100.0%	8	$20.00	94.1	0.40	$0.033
Behavioral Measures	20.0%	75.0%	1	$12.00	90.5	0.15	$0.133
Pool - Pump Timer	35.0%	100.0%	15	$160.00	148.8	0.10	$0.110
Insulation - Wall Cavity	64.5%	100.0%	25	$197.06	356.6	0.31	$0.044
Insulation - Wall Sheathing	64.4%	100.0%	20	$300.00	200.7	0.11	$0.132
Water Heater - Drainwater Heat Reocvery	1.0%	100.0%	25	$899.00	800.7	0.11	$0.090

Table B-29 Energy Efficiency Non-Equipment Data, Electric—Mobile Home, Existing Vintage, Idaho

Measure	Base Saturation	Applicability	Lifetime (Years)	Cost ($/HH)	Savings (kWh)	BC Ratio	Levelized Cost ($/kWh)
Central AC - Early Replacement	0.0%	80.0%	15	$2,895.00	55.3	0.00	$5.373
Central AC - Maintenance and Tune-Up	58.9%	100.0%	4	$100.00	54.5	0.03	$0.506
Room AC - Removal of Second Unit	0.0%	100.0%	5	$75.00	305.2	0.25	$0.056
Ceiling Fan - Installation	60.0%	100.0%	15	$80.00	41.2	0.05	$0.199
Whole-House Fan - Installation	5.2%	25.0%	18	$150.00	66.1	0.04	$0.211
Air Source Heat Pump - Maintenance	25.0%	100.0%	4	$125.00	496.0	0.22	$0.070
Insulation - Ducting	15.0%	65.0%	18	$375.00	320.3	0.08	$0.109
Repair and Sealing - Ducting	12.3%	100.0%	18	$398.09	2,477.4	0.59	$0.015
Thermostat - Clock/Programmable	51.0%	75.0%	15	$114.42	513.2	0.94	$0.023
Doors - Storm and Thermal	38.0%	100.0%	12	$320.00	79.1	0.04	$0.476
Insulation - Infiltration Control	46.0%	100.0%	25	$208.70	364.9	0.42	$0.046
Insulation - Ceiling	46.2%	85.0%	25	$276.18	355.8	0.18	$0.062
Insulation - Radiant Barrier	5.0%	100.0%	12	$922.68	387.5	0.07	$0.280
Roofs - High Reflectivity	5.0%	100.0%	15	$1,549.61	31.3	0.00	$5.080
Windows - Reflective Film	5.0%	50.0%	10	$166.67	139.9	0.07	$0.159
Windows - High Efficiency/Energy Star	52.4%	100.0%	25	$3,171.89	4,053.4	0.16	$0.063
Interior Lighting - Occupancy Sensor	66.6%	80.0%	15	$750.00	346.9	0.04	$0.222
Exterior Lighting - Photovoltaic Installation	10.0%	100.0%	15	$2,975.00	41.9	0.00	$7.281
Exterior Lighting - Photosensor Control	23.4%	100.0%	8	$90.00	28.3	0.02	$0.497
Exterior Lighting - Timeclock Installation	10.0%	100.0%	8	$72.00	28.3	0.03	$0.398
Water Heater - Faucet Aerators	78.9%	100.0%	25	$24.00	179.3	1.02	$0.011
Water Heater - Pipe Insulation	17.0%	100.0%	13	$15.00	157.9	1.14	$0.011
Water Heater - Low Flow Showerheads	92.1%	100.0%	10	$25.48	816.8	2.74	$0.004
Water Heater - Tank Blanket/Insulation	54.0%	100.0%	10	$15.00	507.7	2.43	$0.004
Water Heater - Thermostat Setback	17.0%	100.0%	5	$40.00	507.7	0.72	$0.018
Electronics - Reduce Standby Wattage	5.0%	100.0%	8	$20.00	91.0	0.37	$0.034
Refrigerator - Early Replacement	10.0%	85.0%	7	$109.00	249.5	0.12	$0.076
Refrigerator - Remove Second Unit	17.3%	85.0%	7	$109.00	437.0	0.83	$0.043
Freezer - Early Replacement	10.0%	85.0%	5	$109.00	300.2	0.12	$0.083
Freezer - Remove Second Unit	17.3%	85.0%	5	$109.00	384.9	0.75	$0.065
Behavioral Measures	20.0%	50.0%	1	$12.00	84.5	0.14	$0.142
Pool - Pump Timer	50.0%	100.0%	15	$160.00	145.7	0.09	$0.113
Insulation - Wall Cavity	81.8%	100.0%	25	$707.94	1,004.5	0.17	$0.057
Insulation - Wall Sheathing	64.4%	100.0%	20	$300.00	187.2	0.11	$0.141

Table B-30 Energy Efficiency Non-Equipment Data, Electric—Mobile Home, New Vintage, Idaho

Measure	Base Saturation	Applicability	Lifetime (Years)	Cost ($/HH)	Savings (kWh)	BC Ratio	Levelized Cost ($/kWh)
Central AC - Maintenance and Tune-Up	58.9%	100.0%	4	$100.00	58.6	0.03	$0.471
Ceiling Fan - Installation	57.0%	100.0%	15	$80.00	60.2	0.07	$0.136
Whole-House Fan - Installation	4.0%	25.0%	18	$150.00	82.8	0.05	$0.168
Air Source Heat Pump - Maintenance	25.0%	100.0%	4	$125.00	533.2	0.26	$0.065
Insulation - Ducting	55.0%	65.0%	18	$200.00	344.0	0.17	$0.054
Thermostat - Clock/Programmable	57.0%	75.0%	15	$114.42	552.4	0.77	$0.021
Doors - Storm and Thermal	13.0%	100.0%	12	$180.00	126.6	0.11	$0.167
Insulation - Ceiling	46.2%	85.0%	20	$176.00	341.1	0.32	$0.046
Insulation - Radiant Barrier	25.0%	100.0%	12	$922.68	115.6	0.02	$0.939
Roofs - High Reflectivity	5.0%	100.0%	15	$516.54	44.8	0.01	$1.183
Windows - Reflective Film	2.0%	50.0%	10	$166.67	116.7	0.06	$0.190
Windows - High Efficiency/Energy Star	95.5%	100.0%	25	$2,200.00	1,916.5	0.15	$0.092
Interior Lighting - Occupancy Sensor	66.6%	80.0%	15	$500.00	366.0	0.08	$0.140
Exterior Lighting - Photovoltaic Installation	10.0%	100.0%	15	$2,975.00	44.8	0.00	$6.818
Exterior Lighting - Photosensor Control	13.2%	100.0%	8	$90.00	29.8	0.04	$0.473
Exterior Lighting - Timeclock Installation	16.0%	100.0%	8	$72.00	29.8	0.05	$0.379
Water Heater - Faucet Aerators	56.6%	100.0%	25	$24.00	171.3	1.01	$0.011
Water Heater - Pipe Insulation	8.0%	100.0%	13	$15.00	151.1	1.43	$0.011
Water Heater - Low Flow Showerheads	92.1%	100.0%	10	$25.48	781.8	3.37	$0.004
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	10	$15.00	485.8	2.95	$0.004
Water Heater - Thermostat Setback	5.0%	100.0%	5	$40.00	485.8	0.84	$0.019
Electronics - Reduce Standby Wattage	5.0%	100.0%	8	$20.00	94.1	0.40	$0.033
Behavioral Measures	20.0%	75.0%	1	$12.00	90.5	0.15	$0.133
Pool - Pump Timer	35.0%	100.0%	15	$160.00	148.8	0.10	$0.110
Insulation - Wall Cavity	64.5%	100.0%	25	$197.06	356.6	0.31	$0.044
Insulation - Wall Sheathing	64.4%	100.0%	20	$300.00	200.7	0.11	$0.132
Water Heater - Drainwater Heat Reocvery	1.0%	100.0%	25	$899.00	800.7	0.11	$0.090

Table B-31 Energy Efficiency Non-Equipment Data, Electric—Low income, Existing Vintage, Washington

Measure	Base Saturation	Applicability	Lifetime (Years)	Cost ($/HH)	Savings (kWh)	BC Ratio	Levelized Cost ($/kWh)
Central AC - Early Replacement	0.0%	80.0%	15	$2,895.00	59.1	0.00	$5.026
Central AC - Maintenance and Tune-Up	24.6%	100.0%	4	$100.00	58.3	0.43	$0.473
Room AC - Removal of Second Unit	0.0%	100.0%	5	$75.00	289.2	0.24	$0.059
Attic Fan - Installation	2.9%	50.0%	18	$115.80	2.4	0.00	$4.502
Attic Fan - Photovoltaic - Installation	2.0%	25.0%	19	$350.00	2.4	0.00	$13.244
Ceiling Fan - Installation	40.8%	100.0%	15	$80.00	42.0	0.05	$0.196
Whole-House Fan - Installation	5.3%	25.0%	18	$150.00	67.3	0.04	$0.207
Air Source Heat Pump - Maintenance	25.0%	100.0%	4	$125.00	480.2	0.62	$0.072
Insulation - Ducting	13.0%	25.0%	18	$395.00	279.5	0.37	$0.131
Repair and Sealing - Ducting	11.8%	100.0%	18	$500.00	837.0	0.46	$0.056
Thermostat - Clock/Programmable	35.9%	75.0%	15	$114.42	450.0	1.19	$0.026
Doors - Storm and Thermal	17.0%	100.0%	12	$320.00	68.7	0.04	$0.548
Insulation - Infiltration Control	19.0%	100.0%	12	$266.00	522.9	0.64	$0.060
Insulation - Ceiling	39.3%	55.0%	20	$215.00	170.6	0.45	$0.111
Insulation - Radiant Barrier	5.0%	100.0%	12	$922.68	336.6	0.36	$0.323
Roofs - High Reflectivity	3.0%	100.0%	15	$1,549.61	31.9	0.00	$4.987
Windows - Reflective Film	5.0%	50.0%	10	$166.67	142.5	0.07	$0.156
Windows - High Efficiency/Energy Star	71.3%	100.0%	25	$2,500.00	1,226.3	0.40	$0.163
Interior Lighting - Occupancy Sensor	8.2%	20.0%	15	$256.00	254.7	0.09	$0.103
Exterior Lighting - Photovoltaic Installation	10.0%	100.0%	15	$2,975.00	20.4	0.00	$14.935
Exterior Lighting - Photosensor Control	8.4%	100.0%	8	$90.00	13.8	0.01	$1.020
Exterior Lighting - Timeclock Installation	6.0%	100.0%	8	$72.00	13.8	0.02	$0.816
Water Heater - Faucet Aerators	45.5%	100.0%	25	$24.00	170.6	1.00	$0.011
Water Heater - Pipe Insulation	6.0%	100.0%	13	$15.00	150.2	1.22	$0.011
Water Heater - Low Flow Showerheads	73.8%	100.0%	10	$25.48	777.0	2.77	$0.004
Water Heater - Tank Blanket/Insulation	54.0%	100.0%	10	$15.00	482.9	2.29	$0.004
Water Heater - Thermostat Setback	17.0%	100.0%	5	$40.00	482.9	0.68	$0.019
Electronics - Reduce Standby Wattage	5.0%	100.0%	8	$20.00	64.3	0.27	$0.049
Refrigerator - Early Replacement	10.0%	85.0%	7	$109.00	224.7	0.11	$0.084
Refrigerator - Remove Second Unit	17.3%	85.0%	7	$109.00	437.0	0.83	$0.043
Freezer - Early Replacement	10.0%	85.0%	5	$109.00	270.4	0.10	$0.092
Freezer - Remove Second Unit	17.3%	85.0%	5	$109.00	384.9	0.75	$0.065
Behavioral Measures	5.0%	25.0%	1	$12.00	71.9	0.11	$0.167
Pool - Pump Timer	50.0%	100.0%	15	$160.00	151.5	0.10	$0.108
Insulation - Foundation	13.0%	40.0%	20	$358.00	361.5	0.63	$0.087
Insulation - Wall Cavity	44.2%	100.0%	25	$1,415.87	870.1	0.38	$0.130
Insulation - Wall Sheathing	58.8%	100.0%	20	$210.00	162.6	0.44	$0.114

Table B-32 Energy Efficiency Non-Equipment Data, Electric—Low income, New Vintage, Washington

Measure	Base Saturation	Applicability	Lifetime (Years)	Cost ($/HH)	Savings (kWh)	BC Ratio	Levelized Cost ($/kWh)
Central AC - Maintenance and Tune-Up	24.6%	100.0%	4	$100.00	62.7	0.44	$0.440
Attic Fan - Installation	15.0%	50.0%	18	$96.50	3.3	0.00	$2.739
Attic Fan - Photovoltaic - Installation	5.0%	25.0%	19	$200.00	3.3	0.00	$5.524
Ceiling Fan - Installation	33.0%	100.0%	15	$80.00	65.4	0.08	$0.126
Whole-House Fan - Installation	4.0%	25.0%	18	$150.00	89.9	0.06	$0.155
Air Source Heat Pump - Maintenance	37.8%	100.0%	4	$125.00	516.2	0.65	$0.067
Insulation - Ducting	25.0%	25.0%	18	$210.00	303.0	0.44	$0.064
Thermostat - Clock/Programmable	45.3%	75.0%	15	$114.42	490.0	1.05	$0.024
Doors - Storm and Thermal	19.0%	100.0%	12	$180.00	111.5	0.10	$0.190
Insulation - Ceiling	39.0%	50.0%	20	$152.00	300.6	0.67	$0.045
Insulation - Radiant Barrier	5.0%	100.0%	12	$922.68	103.0	0.32	$1.054
Roofs - High Reflectivity	0.0%	100.0%	15	$516.54	48.7	0.01	$1.089
Windows - Reflective Film	2.0%	50.0%	10	$166.67	126.8	0.07	$0.175
Windows - High Efficiency/Energy Star	80.2%	100.0%	25	$2,200.00	1,681.0	0.44	$0.105
Interior Lighting - Occupancy Sensor	8.2%	10.0%	15	$256.00	268.5	0.12	$0.098
Exterior Lighting - Photovoltaic Installation	10.0%	100.0%	15	$2,975.00	21.8	0.00	$13.986
Exterior Lighting - Photosensor Control	0.0%	100.0%	8	$90.00	14.5	0.02	$0.971
Exterior Lighting - Timeclock Installation	11.0%	100.0%	8	$72.00	14.5	0.02	$0.777
Water Heater - Faucet Aerators	10.6%	100.0%	25	$24.00	162.9	1.04	$0.012
Water Heater - Pipe Insulation	0.0%	100.0%	13	$15.00	143.7	1.56	$0.012
Water Heater - Low Flow Showerheads	66.2%	100.0%	10	$25.48	743.6	3.45	$0.005
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	10	$15.00	462.1	2.80	$0.004
Water Heater - Thermostat Setback	5.0%	100.0%	5	$40.00	462.1	0.80	$0.020
Electronics - Reduce Standby Wattage	5.0%	100.0%	8	$20.00	66.9	0.29	$0.047
Behavioral Measures	5.0%	75.0%	1	$12.00	77.7	0.13	$0.154
Pool - Pump Timer	35.0%	100.0%	15	$160.00	154.7	0.11	$0.106
Insulation - Foundation	27.4%	40.0%	20	$358.00	395.1	0.65	$0.080
Insulation - Wall Cavity	45.6%	100.0%	25	$62.50	311.7	1.25	$0.016
Insulation - Wall Sheathing	58.8%	100.0%	20	$210.00	175.7	0.46	$0.105
Water Heater - Drainwater Heat Reocvery	1.0%	100.0%	25	$899.00	761.6	0.12	$0.095

Table B-33 Energy Efficiency Non-Equipment Data, Electric—Low income, Existing Vintage, Idaho

Measure	Base Saturation	Applicability	Lifetime (Years)	Cost ($/HH)	Savings (kWh)	BC Ratio	Levelized Cost ($/kWh)
Central AC - Early Replacement	0.0%	80.0%	15	$2,895.00	59.1	0.00	$5.026
Central AC - Maintenance and Tune-Up	24.6%	100.0%	4	$100.00	58.3	0.43	$0.473
Room AC - Removal of Second Unit	0.0%	100.0%	5	$75.00	289.2	0.24	$0.059
Attic Fan - Installation	2.9%	50.0%	18	$115.80	2.4	0.00	$4.502
Attic Fan - Photovoltaic - Installation	2.0%	25.0%	19	$350.00	2.4	0.00	$13.244
Ceiling Fan - Installation	40.8%	100.0%	15	$80.00	42.0	0.05	$0.196
Whole-House Fan - Installation	5.3%	25.0%	18	$150.00	67.3	0.04	$0.207
Air Source Heat Pump - Maintenance	25.0%	100.0%	4	$125.00	480.2	0.62	$0.072
Insulation - Ducting	13.0%	25.0%	18	$395.00	279.5	0.37	$0.131
Repair and Sealing - Ducting	11.8%	100.0%	18	$500.00	837.0	0.46	$0.056
Thermostat - Clock/Programmable	35.9%	75.0%	15	$114.42	450.0	1.19	$0.026
Doors - Storm and Thermal	17.0%	100.0%	12	$320.00	68.7	0.04	$0.548
Insulation - Infiltration Control	19.0%	100.0%	12	$266.00	522.9	0.64	$0.060
Insulation - Ceiling	39.3%	55.0%	20	$215.00	170.6	0.45	$0.111
Insulation - Radiant Barrier	5.0%	100.0%	12	$922.68	336.6	0.36	$0.323
Roofs - High Reflectivity	3.0%	100.0%	15	$1,549.61	31.9	0.00	$4.987
Windows - Reflective Film	5.0%	50.0%	10	$166.67	142.5	0.07	$0.156
Windows - High Efficiency/Energy Star	71.3%	100.0%	25	$2,500.00	1,226.3	0.40	$0.163
Interior Lighting - Occupancy Sensor	8.2%	20.0%	15	$256.00	254.7	0.09	$0.103
Exterior Lighting - Photovoltaic Installation	10.0%	100.0%	15	$2,975.00	20.4	0.00	$14.935
Exterior Lighting - Photosensor Control	8.4%	100.0%	8	$90.00	13.8	0.01	$1.020
Exterior Lighting - Timeclock Installation	6.0%	100.0%	8	$72.00	13.8	0.02	$0.816
Water Heater - Faucet Aerators	45.5%	100.0%	25	$24.00	170.6	1.00	$0.011
Water Heater - Pipe Insulation	6.0%	100.0%	13	$15.00	150.2	1.22	$0.011
Water Heater - Low Flow Showerheads	73.8%	100.0%	10	$25.48	777.0	2.77	$0.004
Water Heater - Tank Blanket/Insulation	54.0%	100.0%	10	$15.00	482.9	2.29	$0.004
Water Heater - Thermostat Setback	17.0%	100.0%	5	$40.00	482.9	0.68	$0.019
Electronics - Reduce Standby Wattage	5.0%	100.0%	8	$20.00	64.3	0.27	$0.049
Refrigerator - Early Replacement	10.0%	85.0%	7	$109.00	224.7	0.11	$0.084
Refrigerator - Remove Second Unit	17.3%	85.0%	7	$109.00	437.0	0.83	$0.043

Table B-34 Energy Efficiency Non-Equipment Data, Electric—Low income, New Vintage, Idaho

Measure	Base Saturation	Applicability	Lifetime (Years)	Cost ($/HH)	Savings (kWh)	BC Ratio	Levelized Cost ($/kWh)
Central AC - Maintenance and Tune-Up	24.6%	100.0%	4	$100.00	62.7	0.44	$0.440
Attic Fan - Installation	15.0%	50.0%	18	$96.50	3.3	0.00	$2.739
Attic Fan - Photovoltaic - Installation	5.0%	25.0%	19	$200.00	3.3	0.00	$5.524
Ceiling Fan - Installation	33.0%	100.0%	15	$80.00	65.4	0.08	$0.126
Whole-House Fan - Installation	4.0%	25.0%	18	$150.00	89.9	0.06	$0.155
Air Source Heat Pump - Maintenance	37.8%	100.0%	4	$125.00	516.2	0.65	$0.067
Insulation - Ducting	25.0%	25.0%	18	$210.00	303.0	0.44	$0.064
Thermostat - Clock/Programmable	45.3%	75.0%	15	$114.42	490.0	1.05	$0.024
Doors - Storm and Thermal	19.0%	100.0%	12	$180.00	111.5	0.10	$0.190
Insulation - Ceiling	39.0%	50.0%	20	$152.00	300.6	0.67	$0.045
Insulation - Radiant Barrier	5.0%	100.0%	12	$922.68	103.0	0.32	$1.054
Roofs - High Reflectivity	0.0%	100.0%	15	$516.54	48.7	0.01	$1.089
Windows - Reflective Film	2.0%	50.0%	10	$166.67	126.8	0.07	$0.175
Windows - High Efficiency/Energy Star	80.2%	100.0%	25	$2,200.00	1,681.0	0.44	$0.105
Interior Lighting - Occupancy Sensor	8.2%	10.0%	15	$256.00	268.5	0.12	$0.098
Exterior Lighting - Photovoltaic Installation	10.0%	100.0%	15	$2,975.00	21.8	0.00	$13.986
Exterior Lighting - Photosensor Control	0.0%	100.0%	8	$90.00	14.5	0.02	$0.971
Exterior Lighting - Timeclock Installation	11.0%	100.0%	8	$72.00	14.5	0.02	$0.777
Water Heater - Faucet Aerators	10.6%	100.0%	25	$24.00	162.9	1.04	$0.012
Water Heater - Pipe Insulation	0.0%	100.0%	13	$15.00	143.7	1.56	$0.012
Water Heater - Low Flow Showerheads	66.2%	100.0%	10	$25.48	743.6	3.45	$0.005
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	10	$15.00	462.1	2.80	$0.004
Water Heater - Thermostat Setback	5.0%	100.0%	5	$40.00	462.1	0.80	$0.020
Electronics - Reduce Standby Wattage	5.0%	100.0%	8	$20.00	66.9	0.29	$0.047
Behavioral Measures	5.0%	75.0%	1	$12.00	77.7	0.13	$0.154
Pool - Pump Timer	35.0%	100.0%	15	$160.00	154.7	0.11	$0.106
Insulation - Foundation	27.4%	40.0%	20	$358.00	395.1	0.65	$0.080
Insulation - Wall Cavity	45.6%	100.0%	25	$62.50	311.7	1.25	$0.016
Insulation - Wall Sheathing	58.8%	100.0%	20	$210.00	175.7	0.46	$0.105
Water Heater - Drainwater Heat Reocvery	1.0%	100.0%	25	$899.00	761.6	0.12	$0.095

APPENDIX | **C**

C&I ENERGY EFFICIENCY EQUIPMENT AND MEASURE DATA

This appendix presents detailed information for all commercial energy-efficiency measures (*equipment* and *non-equipment* measures per the LoadMAP taxonomy) that were evaluated in this study.

Table C-1 and Table C-2 provide brief narrative descriptions for all equipment and non-equipment measures that were assessed for potential.

Table C-3 through Table C-18 list the detailed unit-level data (including economic screen results) for commercial equipment measures in existing and new buildings. The column headings and units are the same as described for the corresponding residential sector tables above.

Table C-19 through Table C-34 list the detailed unit-level data (including economic screen results) for commercial non-equipment measures in existing and new construction. The column headings and units are the same as described for the corresponding residential sector tables above.

Table C-1 C&I Energy Efficiency Equipment Measure Descriptions

End Use	Technology	Measure Description
Cooling	Air-Cooled Chiller	A central chiller plant creates chilled water for distribution throughout the facility. Because of the wide variety of system types and sizes, savings and cost values for efficiency improvements represent an average over screw, reciprocating, and centrifugal technologies. Under this simplified approach, each central system is characterized by an aggregate efficiency value (inclusive of chiller, pumps, and motors), in kW/ton with a further efficiency upgrade through the application of variable refrigerant flow technology.
Cooling	Water-Cooled Chiller	A central chiller plant creates chilled water for distribution throughout the facility. Water source chillers 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 represent an average over 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	Roof Top AC	Packaged cooling systems, such as rooftop units (RTUs), 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) are modeled, as well as a ductless mini-split system.
Cooling / Space Heating	Air-Source Heat Pump	For heat pumps, units with increasing EER and COP levels are evaluated, as well as a ductless mini-split system.
Cooling / Space Heating	Geothermal Heat Pump	For heat pumps, units with increasing EER and COP levels are evaluated.
Space Heating	Electric Furnace	Resistive heating elements are used to convert electricity directly to heat. The heat is then delivered by a supply fan and duct system to the regions that require heating.
Space Heating	Electric Resistance	Resistive heating elements are used to convert electricity directly to heat. Conductive fins surrounding the element or another mechanism is used to deliver the heat directly to the surrounding room or area. These are typically either baseboard or wall-mounted units.
Ventilation	Ventilation	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.
Water Heating	Water Heater	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 and heat pump water heaters.
Interior Lighting	Screw-in	This measure evaluates higher-efficiency alternatives for screw-in interior lamps including halogen, CFL, and LED.
Interior Lighting	High-Bay Fixtures	With the exception of screw-in lighting, commercial and industrial lighting efficiency changes typically require more than the simple purchase and installation of an alternative lamp Restrictions regarding ballasts, fixtures, and circuitry limit the potential for direct substitution of one lamp type for another. Also, during the buildout for a leased office space, management could decide

End Use	Technology	Measure Description
		to replace all lamps, ballasts, and fixtures with different configurations. This type of decision-making is modeled on a stock turnover basis because of the time between opportunities for upgrades. For High-Bay fixtures, alternatives include mercury vapor, metal halides, T5 fluorescent high output, and high-pressure sodium.
Interior Lighting	Linear Fluorescent	With the exception of screw-in lighting, commercial and industrial lighting efficiency changes typically require more than the simple purchase and installation of an alternative lamp. Restrictions regarding ballasts, fixtures, and circuitry limit the potential for direct substitution of one lamp type for another. Also, during the buildout for a leased office space, management could decide to replace all lamps, ballasts, and fixtures with different configurations. This type of decision-making is modeled on a stock turnover basis because of the time between opportunities for upgrades. For linear fluorescent fixtures, alternatives include T12, T8, Super T8, T5, and LED.
Exterior Lighting	Screw-in	This measure evaluates higher-efficiency alternatives for screw-in interior lamps including halogen, CFL, and LED.
Exterior Lighting	HID	Alternatives modeled include metal halides, T8 and T5 high output, high pressure sodium, and LEDs
Exterior Lighting	Linear Fluorescent	For linear fluorescent fixtures, alternatives include T12, T8, Super T8, T5, and LED.
Refrigeration	Walk-in Refrigerator	These refrigerators can be designed to perform at higher efficiency through a combination of compressor equipment upgrades, default temperature settings, and defrost patterns. Standard refrigeration compressors typically operate at approximately 65% efficiency. High-efficiency models are available that can improve compressor efficiency by 15%. Analysis assumes unit with: 140 square feet, Cooling capacity of 26,230 BTU/hr.
Refrigeration	Reach-in Refrigerator	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 larger reach-in units in foodservice applications. 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. Analysis assumes unit with: 48 cubic feet, Cooling capacity of 3000 BTU/hr.
Refrigeration	Glass Door Display, Open Display Case	These refrigerators can be designed to perform at higher efficiency through a combination of compressor equipment upgrades, default temperature settings, and defrost patterns. Standard refrigeration compressors typically operate at approximately 65% efficiency. High-efficiency models are available that can improve compressor efficiency by 15%. Analysis assumes unit with: Cooling capacity of 20,000 BTU/hr
Refrigeration	Icemaker	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	High-efficiency vending machines incorporate more efficient compressors and lighting.
Food Preparation	Ovens,Fryers, Hot Food Containers, Dishwashers	This set of measures includes high-efficiency fryers, ovens, dishwashers, and hot food containers. Less common equipment, such as broilers and steamers, and assumed to be modeled with the other more common equipment types.
Office Equipment	Desktop Computer, Laptop, Monitors	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.
Office Equipment	Server	In addition to the "sleep" mode a reductions, servers have additional energy-saving opportunities through "virtualization" and other architecture solutions that involve optimal matching of computation tasks to hardware requirements

End Use	Technology	Measure Description
Office Equipment	Printer/Copier/Fax	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.
Office Equipment	POS Terminal	Point-of-sale terminals in retail and supermarket facilities are always on. Efficient models incorporate a high-efficiency power supply to reduce energy use.
Miscellaneous	Non-HVAC Motors	Includes motors for a variety of non-HVAC uses including vertical transportation. 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	Miscellaneous	Improvement of miscellaneous electricity uses

Table C-2 Commercial and Industrial Energy Efficiency Non-Equipment Measure Descriptions

End Use	Measure	Description
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 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.
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. 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.
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 - Wall Cavity	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.
HVAC (All)	Ducting - Repair and Sealing	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.
HVAC (All)	Windows - High Efficiency	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.
HVAC (All)	Roof - High Reflectivity	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 living roof or a roofing material with a light color (and a lower solar absorptance), the roof will absorb less solar radiation and consequently reduce the cooling load. Living roofs also reduce stormwater runoff.
HVAC (All)	Roofs - Green	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	Chiller - Condenser Water Temperature Reset	Resetting the condenser water temperature to the lowest possible setting allows the cooling tower to generate cooler water whenever possible and decreases the temperature lift between the condenser and the evaporator.

End Use	Measure	Description
		This will generally increase chiller part-load efficiency, though it may require increased tower fan energy use.
Cooling	Chiller - 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	Chiller - VSD on Fans	Variable speed drives, which reduce chiller energy use under part load, are modeled for both air-cooled and water-cooled chillers.
Cooling	Chiller - Chilled Water 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	Chiller - Chilled Water Variable-Flow System	The part-load efficiency of chilled water loops can be improved substantially by varying the flow speed of the delivered water with the building demand for cooling.
Cooling	Chiller - High Efficiency Cooling Tower Fans	High-efficiency cooling fans utilize efficient components and variable frequency drives that improve fan performance by adjusting fan speed and rotation as conditions change.
Cooling	RTU - 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	RTU - Maintenance	Regular cleaning and maintenance enables a 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 / Space Heating	Heat Pump - Maintenance	Regular cleaning and maintenance enables a heat pump 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%.
Ventilation	Ventilation - Demand Control Ventilation	Also known as CO2 Controlled, this measure uses carbon dioxide (CO2) levels to indicate the level of occupancy in a space. Sensors monitor CO2 levels so that air handling controls can adjust the amount of outside air intake. Ventilation rates are thereby controlled based on occupancy, rather than a fixed rate, thus saving HVAC energy use.
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.
Water Heating	Water Heater - 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	Water Heater - High Efficiency Circulation	A high efficiency circulation pump uses an electronically commutated motor (ECM) to improve motor efficiency over a larger range of partial loads. In

End Use	Measure	Description
	Pump	addition, an ECM allows for improved low RPM performance with greater torque and smaller pump dimensions.
Water Heating	Water Heater - 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	Water Heater - Tank Blanket/Insulation	Insulation levels on 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.
Interior Lighting	Interior Lighting – Central Lighting Controls	Daylighting controls use a photosensor to detect ambient light and adjust or turn off electric lights accordingly.
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	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	Interior Lighting - Occupancy Sensors	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	Interior Lighting - Timeclocks and Timers	In many cases lighting remains on at night and during weekends. A simple timer can set a schedule for turning lights off to reduce operating hours.
Interior Lighting	Interior Screw-in - Task Lighting	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	Interior Lighting – 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.
Interior Lighting	Interior Lighting - Skylights	Addition of transparent windows/fixtures in the roof to allow daylight to enter and reduce the need for powered lighting. Applies to new construction only.
Interior Lighting	Interior Fluorescent - Bi-Level Fixture	Bi-level fixtures have the ability to reduce light output to a lower level, given a control strategy that is based on a timer, occupancy sensor, motion sensor, or manual switch.
Interior Lighting	Interior Fluorescent – 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.
Exterior	Exterior Lighting -	Daylighting controls use a photosensor to detect ambient light and adjust or

End Use	Measure	Description
Lighting	Daylighting Controls	turn off electric lights accordingly.
Exterior Lighting	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	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.
Food Preparation	Cooking Exhaust hood with sensor control	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.
Refrigeration	Refrigerator - Anti-Sweat Heater/ Auto Door Closer	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.
Refrigeration	Refrigerator - Door Gasket Replacement	This measure involves replacing aging door gaskets that no longer adequately seal reach-in refrigerators or glass door display cases.
Refrigeration	Refrigerator - Floating Head Pressure	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	Refrigerator - 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 (All)	Insulation - Bare suction lines	Suction lines deliver refrigerant fluid from to the inlet or suction side of a compressor. Insulating these lines prevents ambient air from heating the fluid in the line, and thus improves efficiency.
Refrigeration	Refrigerator - High Efficiency Case Lighting	High-efficiency case lightin, usually with LEDs, reduces waste heat from lighting that must be removed from refrigeratied display cases.
Refrigeration	Refrigerator – Night Covers	Night covers can be used on open refrigeration cases when a facility is closed or few customers are in the store.
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.
Office Equipment	Office Equipment – Smart Power Strips	These power strips encorporate motion sensing to power down office equipment when not in use.

End Use	Measure	Description
Micellaneous	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.
Micellaneous	Micellaneous – ENERGY STAR Washer Cooler	An ENERGY STAR water cooler has more insulation and improved chilling mechanisms, resulting in about half the energy use of a standard cooler.
Micellaneous	Pumps - Variable Speed Control	The part-load efficiency of drive systems can be improved by varying the speed of the motor drive. An additional benefit of variable-speed controls is the ability to start and stop the motor and process gradually, thus extending the life of the motor and associated machinery.
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	Motors – Magnetic Adjustable Speed Drives	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 Imrovements, 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 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	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.
Machine Drive	Motors - Synchronous Belts	Synchronous belts offer higher efficiency compared with standard belts due to reduced slipping, as well as less maintenance and retensioning.
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.
HVAC (All)	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

End Use	Measure	Description
		systems from operating during unwanted or unoccupied periods. This analysis assumes that this measure is limited to buildings with a central HVAC system.
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. 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.
HVAC (All)	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. Designs may specify the building orientation, building shell, proper sizing of equipment and 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, energy recovery ventilation, daylighting strategies, and shading strategies. This measure is modeled for new vintage only.
HVAC, Lighting	Commissioning - HVAC, Lighting, Comprehensive	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.
HVAC, Lighting	Retrocommissioning - HVAC, Lighting	In existing buildings, the retrocommissioning process identifies low-cost or no cost measures, including controls adjustments, to improve building performance and reduce operating costs. Retrocommissioning addresses HVAC, lighting, DHW, and other major building systems.
All	Transformer	All electric power passes through one or more transformers on its way to service equipment, lighting, and other loads. Currently available materials and designs can considerably reduce both load and no-load losses. The new NEMA TP-1 standard is used as the reference definition for energy -efficient products. Tier-1 represents TP-1 dry-type transformers while Tier-2 reflects a switch to liquid immersed TP-1 products. More efficient transformers with attractive payback periods are estimated to save 40 to 50 percent of the energy lost by a "typical" transformer, which translates into a one to three percent reduction in electric bills for commercial and industrial customers.
All	Strategic Energy Management	Strategic Energy Management is a systematic approach to integrating energy management into an organization’s business practices and creating lasting energy management processes that produce reliable energy savings.

Table C-3 Energy Efficiency Equipment Data, Electric—Small/Medium Commercial, Existing Vintage, Washington

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	-	$0.00
Cooling	Central Chiller	1.3 kw/ton, COP 2.7	0.31	$0.39	20	1.10	$0.09
Cooling	Central Chiller	1.26 kw/ton, COP 2.8	0.38	$0.50	20	0.96	$0.09
Cooling	Central Chiller	1.0 kw/ton, COP 3.5	0.79	$0.62	20	0.99	$0.06
Cooling	Central Chiller	0.97 kw/ton, COP 3.6	0.83	$0.74	20	0.95	$0.06
Cooling	Central Chiller	Variable Refrigerant Flow	1.09	$11.57	20	0.18	$0.75
Cooling	RTU	EER 9.2	-	$0.00	16	-	$0.00
Cooling	RTU	EER 10.1	0.21	$0.18	16	-	$0.07
Cooling	RTU	EER 11.2	0.42	$0.35	16	1.00	$0.07
Cooling	RTU	EER 12.0	0.55	$0.58	16	0.91	$0.09
Cooling	RTU	Ductless VRF	0.68	$5.12	16	0.28	$0.62
Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-	$0.00
Cooling	Heat Pump	EER 10.3, COP 3.2	0.42	$0.39	15	-	$0.08
Cooling	Heat Pump	EER 11.0, COP 3.3	0.66	$1.18	15	1.00	$0.15
Cooling	Heat Pump	EER 11.7, COP 3.4	0.88	$1.57	15	0.97	$0.15
Cooling	Heat Pump	EER 12, COP 3.4	0.97	$1.96	15	0.93	$0.18
Cooling	Heat Pump	Ductless Mini-Split System	1.07	$11.50	20	0.52	$0.76
Space Heating	Electric Resistance	Standard	-	$0.00	25	1.00	$0.00
Space Heating	Furnace	Standard	-	$0.00	18	1.00	$0.00
Ventilation	Ventilation	Constant Volume	-	$0.00	15	1.00	$0.00
Ventilation	Ventilation	Variable Air Volume	1.37	$1.22	15	0.92	$0.08
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	1	-	$0.00
Interior Lighting	Interior Screw-in	Infrared Halogen	0.47	$0.09	1	1.00	$0.18
Interior Lighting	Interior Screw-in	CFL	1.96	$0.03	4	5.64	$0.00
Interior Lighting	Interior Screw-in	LED	2.17	$1.18	12	-	$0.06
Interior Lighting	High Bay Fixtures	Metal Halides	-	$0.00	6	1.00	$0.00
Interior Lighting	High Bay Fixtures	High Pressure Sodium	0.25	-$0.07	9	2.04	-$0.04
Interior Lighting	High Bay Fixtures	T8	0.25	-$0.15	6	4.03	-$0.11
Interior Lighting	High Bay Fixtures	T5	0.32	-$0.15	6	4.81	-$0.08
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	0.34	-$0.03	6	1.11	-$0.02
Interior Lighting	Linear Fluorescent	Super T8	1.03	$0.25	6	0.94	$0.04
Interior Lighting	Linear Fluorescent	T5	1.07	$0.43	6	0.81	$0.07
Interior Lighting	Linear Fluorescent	LED	1.12	$3.74	15	-	$0.29
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	1	-	$0.00
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.09	$0.05	1	1.00	$0.50
Exterior Lighting	Exterior Screw-in	CFL	0.38	$0.02	4	6.92	$0.01
Exterior Lighting	Exterior Screw-in	Metal Halides	0.39	$0.05	4	3.30	$0.04
Exterior Lighting	Exterior Screw-in	LED	0.43	$0.64	12	-	$0.15
Exterior	HID	Metal Halides	-	$0.00	6	1.00	$0.00

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Lighting							
Exterior Lighting	HID	High Pressure Sodium	0.17	-$0.13	9	2.08	-$0.10
Exterior Lighting	HID	Low Pressure Sodium	0.18	$0.55	9	0.57	$0.40
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.11	$0.02	15	1.02	$0.02
Water Heating	Water Heater	EF 2.0	1.07	-$0.48	15	2.84	-$0.04
Water Heating	Water Heater	EF 2.3	1.20	-$0.47	15	3.25	-$0.03
Water Heating	Water Heater	EF 2.4	1.24	-$0.47	15	3.38	-$0.03
Water Heating	Water Heater	Geothermal Heat Pump	1.42	$3.53	15	0.38	$0.21
Water Heating	Water Heater	Solar	1.56	$3.03	15	0.44	$0.17
Food Preparation	Fryer	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Fryer	Efficient	0.03	$0.04	12	0.87	$0.12
Food Preparation	Oven	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Oven	Efficient	0.39	$0.36	12	0.92	$0.10
Food Preparation	Dishwasher	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Dishwasher	Efficient	0.02	$0.05	12	0.87	$0.28
Food Preparation	Hot Food Container	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Hot Food Container	Efficient	0.32	$0.16	12	0.96	$0.05
Food Preparation	Food Prep	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Food Prep	Efficient	0.00	$0.03	12	0.88	$1.40
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Walk in Refrigeration	Efficient	-	$0.09	18	0.90	$0.00
Refrigeration	Glass Door Display	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Glass Door Display	Efficient	0.16	$0.00	18	1.36	$0.00
Refrigeration	Reach-in Refrigerator	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Reach-in Refrigerator	Efficient	0.15	$0.02	18	1.15	$0.01
Refrigeration	Open Display Case	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Open Display Case	Efficient	0.00	$0.00	18	0.92	$0.33
Refrigeration	Vending Machine	Base	-	$0.00	10	-	$0.00
Refrigeration	Vending Machine	Base (2012)	0.09	$0.00	10	1.00	$0.00
Refrigeration	Vending Machine	High Efficiency	0.11	$0.00	10	-	$0.00
Refrigeration	Vending Machine	High Efficiency (2012)	0.17	$0.00	10	1.18	$0.00
Refrigeration	Icemaker	Standard	-	$0.00	12	1.00	$0.00
Refrigeration	Icemaker	Efficient	0.05	$0.00	12	1.11	$0.01
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	1.00	$0.00
Office Equipment	Desktop Computer	Energy Star	0.21	$0.00	4	1.01	$0.00
Office Equipment	Desktop Computer	Climate Savers	0.30	$0.36	4	0.85	$0.32
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	1.00	$0.00
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	1.00	$0.01
Office Equipment	Laptop Computer	Climate Savers	0.04	$0.12	4	0.84	$0.87
Office	Server	Standard	-	$0.00	3	1.00	$0.00

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Equipment							
Office Equipment	Server	Energy Star	0.11	$0.01	3	0.99	$0.04
Office Equipment	Monitor	Standard	-	$0.00	4	1.00	$0.00
Office Equipment	Monitor	Energy Star	0.06	$0.00	4	1.03	$0.01
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	1.00	$0.00
Office Equipment	Printer/copier/fax	Energy Star	0.08	$0.04	6	0.95	$0.09
Office Equipment	POS Terminal	Standard	-	$0.00	4	1.00	$0.00
Office Equipment	POS Terminal	Energy Star	0.02	$0.00	4	1.00	$0.03
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-	$0.00
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.06	15	-	$0.71
Miscellaneous	Non-HVAC Motor	High Efficiency	0.01	$0.00	15	1.00	$0.00
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.06	$0.06	15	0.98	$0.08
Miscellaneous	Non-HVAC Motor	Premium	-	$0.00	0	-	$0.00
Miscellaneous	Non-HVAC Motor	Premium (2015)	-	$0.00	0	-	$0.00
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-	$0.00
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	1.00	$0.00

Table C-4 Energy Efficiency Equipment Data, Electric—Small/Medium Commercial, New Vintage, Washington

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	-	$0.00
Cooling	Central Chiller	1.3 kw/ton, COP 2.7	0.28	$0.39	20	1.10	$0.10
Cooling	Central Chiller	1.26 kw/ton, COP 2.8	0.34	$0.50	20	0.96	$0.11
Cooling	Central Chiller	1.0 kw/ton, COP 3.5	0.70	$0.62	20	0.98	$0.06
Cooling	Central Chiller	0.97 kw/ton, COP 3.6	0.74	$0.74	20	0.94	$0.07
Cooling	Central Chiller	Variable Refrigerant Flow	0.97	$11.57	20	0.18	$0.84
Cooling	RTU	EER 9.2	-	$0.00	16	-	$0.00
Cooling	RTU	EER 10.1	0.20	$0.18	16	-	$0.08
Cooling	RTU	EER 11.2	0.41	$0.35	16	1.00	$0.07
Cooling	RTU	EER 12.0	0.53	$0.58	16	0.91	$0.09
Cooling	RTU	Ductless VRF	0.65	$5.12	16	0.28	$0.65
Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-	$0.00
Cooling	Heat Pump	EER 10.3, COP 3.2	0.40	$0.39	15	-	$0.08
Cooling	Heat Pump	EER 11.0, COP 3.3	0.63	$1.18	15	1.00	$0.16
Cooling	Heat Pump	EER 11.7, COP 3.4	0.84	$1.57	15	0.97	$0.16
Cooling	Heat Pump	EER 12, COP 3.4	0.93	$1.96	15	0.93	$0.18
Cooling	Heat Pump	Ductless Mini-Split System	1.03	$11.50	20	0.52	$0.79
Space Heating	Electric Resistance	Standard	-	$0.00	25	1.00	$0.00
Space Heating	Furnace	Standard	-	$0.00	18	1.00	$0.00
Ventilation	Ventilation	Constant Volume	-	$0.00	15	1.00	$0.00
Ventilation	Ventilation	Variable Air Volume	1.89	$1.22	15	1.01	$0.06
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	1	-	$0.00
Interior Lighting	Interior Screw-in	Infrared Halogen	0.65	$0.09	1	1.00	$0.13
Interior Lighting	Interior Screw-in	CFL	2.67	$0.03	4	5.27	$0.00
Interior Lighting	Interior Screw-in	LED	2.96	$1.18	12	-	$0.04
Interior Lighting	High Bay Fixtures	Metal Halides	-	$0.00	6	1.00	$0.00
Interior Lighting	High Bay Fixtures	High Pressure Sodium	0.24	-$0.07	9	2.06	-$0.04
Interior Lighting	High Bay Fixtures	T8	0.24	-$0.15	6	4.16	-$0.11
Interior Lighting	High Bay Fixtures	T5	0.30	-$0.15	6	4.95	-$0.09
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	0.32	-$0.03	6	1.11	-$0.02
Interior Lighting	Linear Fluorescent	Super T8	0.96	$0.25	6	0.93	$0.05
Interior Lighting	Linear Fluorescent	T5	1.00	$0.43	6	0.79	$0.08
Interior Lighting	Linear Fluorescent	LED	1.05	$3.74	15	-	$0.31
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	1	-	$0.00
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.08	$0.05	1	1.00	$0.60
Exterior Lighting	Exterior Screw-in	CFL	0.32	$0.02	4	7.11	$0.02
Exterior Lighting	Exterior Screw-in	Metal Halides	0.32	$0.05	4	3.29	$0.04
Exterior Lighting	Exterior Screw-in	LED	0.36	$0.64	12	-	$0.18
Exterior	HID	Metal Halides	-	$0.00	6	1.00	$0.00

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Lighting							
Exterior Lighting	HID	High Pressure Sodium	0.17	-$0.13	9	2.08	-$0.10
Exterior Lighting	HID	Low Pressure Sodium	0.18	$0.55	9	0.57	$0.40
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.11	$0.02	15	1.02	$0.02
Water Heating	Water Heater	EF 2.0	1.05	-$0.48	15	2.86	-$0.04
Water Heating	Water Heater	EF 2.3	1.18	-$0.47	15	3.27	-$0.03
Water Heating	Water Heater	EF 2.4	1.22	-$0.47	15	3.40	-$0.03
Water Heating	Water Heater	Geothermal Heat Pump	1.39	$3.53	15	0.38	$0.22
Water Heating	Water Heater	Solar	1.53	$3.03	15	0.43	$0.17
Food Preparation	Fryer	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Fryer	Efficient	0.03	$0.04	12	0.87	$0.12
Food Preparation	Oven	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Oven	Efficient	0.39	$0.36	12	0.92	$0.10
Food Preparation	Dishwasher	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Dishwasher	Efficient	0.02	$0.05	12	0.87	$0.28
Food Preparation	Hot Food Container	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Hot Food Container	Efficient	0.32	$0.16	12	0.96	$0.05
Food Preparation	Food Prep	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Food Prep	Efficient	0.00	$0.03	12	0.87	$1.73
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Walk in Refrigeration	Efficient	-	$0.09	18	0.90	$0.00
Refrigeration	Glass Door Display	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Glass Door Display	Efficient	0.16	$0.00	18	1.36	$0.00
Refrigeration	Reach-in Refrigerator	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Reach-in Refrigerator	Efficient	0.15	$0.02	18	1.15	$0.01
Refrigeration	Open Display Case	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Open Display Case	Efficient	0.00	$0.00	18	0.91	$0.35
Refrigeration	Vending Machine	Base	-	$0.00	10	-	$0.00
Refrigeration	Vending Machine	Base (2012)	0.09	$0.00	10	1.00	$0.00
Refrigeration	Vending Machine	High Efficiency	0.11	$0.00	10	-	$0.00
Refrigeration	Vending Machine	High Efficiency (2012)	0.17	$0.00	10	1.18	$0.00
Refrigeration	Icemaker	Standard	-	$0.00	12	1.00	$0.00
Refrigeration	Icemaker	Efficient	0.05	$0.00	12	1.11	$0.01
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	1.00	$0.00
Office Equipment	Desktop Computer	Energy Star	0.21	$0.00	4	1.01	$0.00
Office Equipment	Desktop Computer	Climate Savers	0.30	$0.36	4	0.85	$0.32
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	1.00	$0.00
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	1.00	$0.01

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Office Equipment	Laptop Computer	Climate Savers	0.04	$0.12	4	0.84	$0.87
Office Equipment	Server	Standard	-	$0.00	3	1.00	$0.00
Office Equipment	Server	Energy Star	0.11	$0.01	3	0.99	$0.04
Office Equipment	Monitor	Standard	-	$0.00	4	1.00	$0.00
Office Equipment	Monitor	Energy Star	0.06	$0.00	4	1.03	$0.01
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	1.00	$0.00
Office Equipment	Printer/copier/fax	Energy Star	0.08	$0.04	6	0.95	$0.09
Office Equipment	POS Terminal	Standard	-	$0.00	4	1.00	$0.00
Office Equipment	POS Terminal	Energy Star	0.02	$0.00	4	1.00	$0.03
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-	$0.00
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.06	15	-	$0.71
Miscellaneous	Non-HVAC Motor	High Efficiency	0.01	$0.00	15	1.00	$0.00
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.06	$0.06	15	0.98	$0.08
Miscellaneous	Non-HVAC Motor	Premium	-	$0.00	0	-	$0.00
Miscellaneous	Non-HVAC Motor	Premium (2015)	-	$0.00	0	-	$0.00
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-	$0.00
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	1.00	$0.00

Table C-5 Energy Efficiency Equipment Data, Small/Medium Commercial, Existing Vintage, Idaho

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	-	$0.00
Cooling	Central Chiller	1.3 kw/ton, COP 2.7	0.31	$0.39	20	1.10	$0.09
Cooling	Central Chiller	1.26 kw/ton, COP 2.8	0.38	$0.50	20	0.96	$0.09
Cooling	Central Chiller	1.0 kw/ton, COP 3.5	0.79	$0.62	20	0.99	$0.06
Cooling	Central Chiller	0.97 kw/ton, COP 3.6	0.83	$0.74	20	0.95	$0.06
Cooling	Central Chiller	Variable Refrigerant Flow	1.09	$11.57	20	0.18	$0.75
Cooling	RTU	EER 9.2	-	$0.00	16	-	$0.00
Cooling	RTU	EER 10.1	0.21	$0.18	16	-	$0.07
Cooling	RTU	EER 11.2	0.42	$0.35	16	1.00	$0.07
Cooling	RTU	EER 12.0	0.55	$0.58	16	0.91	$0.09
Cooling	RTU	Ductless VRF	0.68	$5.12	16	0.28	$0.62
Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-	$0.00
Cooling	Heat Pump	EER 10.3, COP 3.2	0.42	$0.39	15	-	$0.08
Cooling	Heat Pump	EER 11.0, COP 3.3	0.66	$1.18	15	1.00	$0.15
Cooling	Heat Pump	EER 11.7, COP 3.4	0.88	$1.57	15	0.97	$0.15
Cooling	Heat Pump	EER 12, COP 3.4	0.97	$1.96	15	0.93	$0.18
Cooling	Heat Pump	Ductless Mini-Split System	1.07	$11.50	20	0.51	$0.76
Space Heating	Electric Resistance	Standard	-	$0.00	25	1.00	$0.00
Space Heating	Furnace	Standard	-	$0.00	18	1.00	$0.00
Ventilation	Ventilation	Constant Volume	-	$0.00	15	1.00	$0.00
Ventilation	Ventilation	Variable Air Volume	1.37	$1.22	15	0.93	$0.08
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	1	-	$0.00
Interior Lighting	Interior Screw-in	Infrared Halogen	0.47	$0.09	1	1.00	$0.18
Interior Lighting	Interior Screw-in	CFL	1.96	$0.03	4	5.64	$0.00
Interior Lighting	Interior Screw-in	LED	2.17	$1.18	12	-	$0.06
Interior Lighting	High Bay Fixtures	Metal Halides	-	$0.00	6	1.00	$0.00
Interior Lighting	High Bay Fixtures	High Pressure Sodium	0.25	-$0.07	9	2.01	-$0.04
Interior Lighting	High Bay Fixtures	T8	0.25	-$0.15	6	3.95	-$0.11
Interior Lighting	High Bay Fixtures	T5	0.32	-$0.15	6	4.72	-$0.08
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	0.34	-$0.03	6	1.11	-$0.02
Interior Lighting	Linear Fluorescent	Super T8	1.03	$0.25	6	0.95	$0.04
Interior Lighting	Linear Fluorescent	T5	1.07	$0.43	6	0.82	$0.07
Interior Lighting	Linear Fluorescent	LED	1.12	$3.74	15	-	$0.29
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	1	-	$0.00
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.13	$0.05	1	1.00	$0.37
Exterior Lighting	Exterior Screw-in	CFL	0.52	$0.02	4	6.55	$0.01
Exterior Lighting	Exterior Screw-in	Metal Halides	0.52	$0.05	4	3.32	$0.03
Exterior Lighting	Exterior Screw-in	LED	0.58	$0.64	12	-	$0.11
Exterior	HID	Metal Halides	-	$0.00	6	1.00	$0.00

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Lighting							
Exterior Lighting	HID	High Pressure Sodium	0.15	-$0.13	9	2.09	-$0.11
Exterior Lighting	HID	Low Pressure Sodium	0.16	$0.55	9	0.57	$0.43
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.11	$0.02	15	1.03	$0.02
Water Heating	Water Heater	EF 2.0	1.07	-$0.48	15	2.79	-$0.04
Water Heating	Water Heater	EF 2.3	1.20	-$0.47	15	3.19	-$0.03
Water Heating	Water Heater	EF 2.4	1.24	-$0.47	15	3.32	-$0.03
Water Heating	Water Heater	Geothermal Heat Pump	1.42	$3.53	15	0.40	$0.21
Water Heating	Water Heater	Solar	1.56	$3.03	15	0.46	$0.17
Food Preparation	Fryer	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Fryer	Efficient	0.03	$0.04	12	0.88	$0.12
Food Preparation	Oven	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Oven	Efficient	0.39	$0.36	12	0.93	$0.10
Food Preparation	Dishwasher	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Dishwasher	Efficient	0.02	$0.05	12	0.87	$0.28
Food Preparation	Hot Food Container	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Hot Food Container	Efficient	0.32	$0.16	12	0.98	$0.05
Food Preparation	Food Prep	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Food Prep	Efficient	0.00	$0.03	12	0.87	$1.73
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Walk in Refrigeration	Efficient	-	$0.09	18	0.90	$0.00
Refrigeration	Glass Door Display	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Glass Door Display	Efficient	0.16	$0.00	18	1.37	$0.00
Refrigeration	Reach-in Refrigerator	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Reach-in Refrigerator	Efficient	0.15	$0.02	18	1.16	$0.01
Refrigeration	Open Display Case	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Open Display Case	Efficient	0.00	$0.00	18	0.92	$0.33
Refrigeration	Vending Machine	Base	-	$0.00	10	-	$0.00
Refrigeration	Vending Machine	Base (2012)	0.09	$0.00	10	1.00	$0.00
Refrigeration	Vending Machine	High Efficiency	0.11	$0.00	10	-	$0.00
Refrigeration	Vending Machine	High Efficiency (2012)	0.17	$0.00	10	1.19	$0.00
Refrigeration	Icemaker	Standard	-	$0.00	12	1.00	$0.00
Refrigeration	Icemaker	Efficient	0.05	$0.00	12	1.11	$0.01
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	1.00	$0.00
Office Equipment	Desktop Computer	Energy Star	0.21	$0.00	4	1.01	$0.00
Office Equipment	Desktop Computer	Climate Savers	0.30	$0.36	4	0.85	$0.32
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	1.00	$0.00
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	1.00	$0.01

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Office Equipment	Laptop Computer	Climate Savers	0.04	$0.12	4	0.84	$0.87
Office Equipment	Server	Standard	-	$0.00	3	1.00	$0.00
Office Equipment	Server	Energy Star	0.11	$0.01	3	0.99	$0.04
Office Equipment	Monitor	Standard	-	$0.00	4	1.00	$0.00
Office Equipment	Monitor	Energy Star	0.06	$0.00	4	1.03	$0.01
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	1.00	$0.00
Office Equipment	Printer/copier/fax	Energy Star	0.08	$0.04	6	0.95	$0.09
Office Equipment	POS Terminal	Standard	-	$0.00	4	1.00	$0.00
Office Equipment	POS Terminal	Energy Star	0.02	$0.00	4	1.00	$0.03
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-	$0.00
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.06	15	-	$0.71
Miscellaneous	Non-HVAC Motor	High Efficiency	0.01	$0.00	15	1.00	$0.00
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.06	$0.06	15	0.98	$0.08
Miscellaneous	Non-HVAC Motor	Premium	-	$0.00	0	-	$0.00
Miscellaneous	Non-HVAC Motor	Premium (2015)	-	$0.00	0	-	$0.00
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-	$0.00
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	1.00	$0.00

Table C-6 Energy Efficiency Equipment Data, Electric— Small/Medium Commercial, New Vintage, Idaho

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	-	$0.00
Cooling	Central Chiller	1.3 kw/ton, COP 2.7	0.28	$0.39	20	1.10	$0.10
Cooling	Central Chiller	1.26 kw/ton, COP 2.8	0.34	$0.50	20	0.96	$0.11
Cooling	Central Chiller	1.0 kw/ton, COP 3.5	0.70	$0.62	20	0.98	$0.06
Cooling	Central Chiller	0.97 kw/ton, COP 3.6	0.74	$0.74	20	0.94	$0.07
Cooling	Central Chiller	Variable Refrigerant Flow	0.97	$11.57	20	0.18	$0.84
Cooling	RTU	EER 9.2	-	$0.00	16	-	$0.00
Cooling	RTU	EER 10.1	0.20	$0.18	16	-	$0.08
Cooling	RTU	EER 11.2	0.41	$0.35	16	1.00	$0.07
Cooling	RTU	EER 12.0	0.53	$0.58	16	0.91	$0.09
Cooling	RTU	Ductless VRF	0.65	$5.12	16	0.28	$0.65
Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-	$0.00
Cooling	Heat Pump	EER 10.3, COP 3.2	0.40	$0.39	15	-	$0.08
Cooling	Heat Pump	EER 11.0, COP 3.3	0.63	$1.18	15	1.00	$0.16
Cooling	Heat Pump	EER 11.7, COP 3.4	0.84	$1.57	15	0.97	$0.16
Cooling	Heat Pump	EER 12, COP 3.4	0.93	$1.96	15	0.93	$0.18
Cooling	Heat Pump	Ductless Mini-Split System	1.03	$11.50	20	0.51	$0.79
Space Heating	Electric Resistance	Standard	-	$0.00	25	1.00	$0.00
Space Heating	Furnace	Standard	-	$0.00	18	1.00	$0.00
Ventilation	Ventilation	Constant Volume	-	$0.00	15	1.00	$0.00
Ventilation	Ventilation	Variable Air Volume	1.89	$1.22	15	1.02	$0.06
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	1	-	$0.00
Interior Lighting	Interior Screw-in	Infrared Halogen	0.65	$0.09	1	1.00	$0.13
Interior Lighting	Interior Screw-in	CFL	2.67	$0.03	4	5.28	$0.00
Interior Lighting	Interior Screw-in	LED	2.96	$1.18	12	-	$0.04
Interior Lighting	High Bay Fixtures	Metal Halides	-	$0.00	6	1.00	$0.00
Interior Lighting	High Bay Fixtures	High Pressure Sodium	0.24	-$0.07	9	2.03	-$0.04
Interior Lighting	High Bay Fixtures	T8	0.24	-$0.15	6	4.08	-$0.11
Interior Lighting	High Bay Fixtures	T5	0.30	-$0.15	6	4.86	-$0.09
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	0.32	-$0.03	6	1.11	-$0.02
Interior Lighting	Linear Fluorescent	Super T8	0.96	$0.25	6	0.94	$0.05
Interior Lighting	Linear Fluorescent	T5	1.00	$0.43	6	0.80	$0.08
Interior Lighting	Linear Fluorescent	LED	1.05	$3.74	15	-	$0.31
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	1	-	$0.00
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.11	$0.05	1	1.00	$0.44
Exterior Lighting	Exterior Screw-in	CFL	0.44	$0.02	4	6.76	$0.01
Exterior Lighting	Exterior Screw-in	Metal Halides	0.44	$0.05	4	3.31	$0.03
Exterior Lighting	Exterior Screw-in	LED	0.48	$0.64	12	-	$0.14
Exterior	HID	Metal Halides	-	$0.00	6	1.00	$0.00

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Lighting							
Exterior Lighting	HID	High Pressure Sodium	0.15	-$0.13	9	2.09	-$0.11
Exterior Lighting	HID	Low Pressure Sodium	0.16	$0.55	9	0.57	$0.43
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.11	$0.02	15	1.03	$0.02
Water Heating	Water Heater	EF 2.0	1.05	-$0.48	15	2.80	-$0.04
Water Heating	Water Heater	EF 2.3	1.18	-$0.47	15	3.20	-$0.03
Water Heating	Water Heater	EF 2.4	1.22	-$0.47	15	3.33	-$0.03
Water Heating	Water Heater	Geothermal Heat Pump	1.39	$3.53	15	0.39	$0.22
Water Heating	Water Heater	Solar	1.53	$3.03	15	0.45	$0.17
Food Preparation	Fryer	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Fryer	Efficient	0.03	$0.04	12	0.88	$0.12
Food Preparation	Oven	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Oven	Efficient	0.39	$0.36	12	0.93	$0.10
Food Preparation	Dishwasher	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Dishwasher	Efficient	0.02	$0.05	12	0.87	$0.28
Food Preparation	Hot Food Container	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Hot Food Container	Efficient	0.32	$0.16	12	0.98	$0.05
Food Preparation	Food Prep	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Food Prep	Efficient	0.00	$0.03	12	0.87	$1.73
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Walk in Refrigeration	Efficient	-	$0.09	18	0.90	$0.00
Refrigeration	Glass Door Display	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Glass Door Display	Efficient	0.16	$0.00	18	1.37	$0.00
Refrigeration	Reach-in Refrigerator	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Reach-in Refrigerator	Efficient	0.15	$0.02	18	1.16	$0.01
Refrigeration	Open Display Case	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Open Display Case	Efficient	0.00	$0.00	18	0.92	$0.35
Refrigeration	Vending Machine	Base	-	$0.00	10	-	$0.00
Refrigeration	Vending Machine	Base (2012)	0.09	$0.00	10	1.00	$0.00
Refrigeration	Vending Machine	High Efficiency	0.11	$0.00	10	-	$0.00
Refrigeration	Vending Machine	High Efficiency (2012)	0.17	$0.00	10	1.19	$0.00
Refrigeration	Icemaker	Standard	-	$0.00	12	1.00	$0.00
Refrigeration	Icemaker	Efficient	0.05	$0.00	12	1.11	$0.01
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	1.00	$0.00
Office Equipment	Desktop Computer	Energy Star	0.21	$0.00	4	1.01	$0.00
Office Equipment	Desktop Computer	Climate Savers	0.30	$0.36	4	0.85	$0.32
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	1.00	$0.00
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	1.00	$0.01

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Office Equipment	Laptop Computer	Climate Savers	0.04	$0.12	4	0.84	$0.87
Office Equipment	Server	Standard	-	$0.00	3	1.00	$0.00
Office Equipment	Server	Energy Star	0.11	$0.01	3	0.99	$0.04
Office Equipment	Monitor	Standard	-	$0.00	4	1.00	$0.00
Office Equipment	Monitor	Energy Star	0.06	$0.00	4	1.03	$0.01
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	1.00	$0.00
Office Equipment	Printer/copier/fax	Energy Star	0.08	$0.04	6	0.95	$0.09
Office Equipment	POS Terminal	Standard	-	$0.00	4	1.00	$0.00
Office Equipment	POS Terminal	Energy Star	0.02	$0.00	4	1.00	$0.03
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-	$0.00
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.06	15	-	$0.71
Miscellaneous	Non-HVAC Motor	High Efficiency	0.01	$0.00	15	1.00	$0.00
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.06	$0.06	15	0.98	$0.08
Miscellaneous	Non-HVAC Motor	Premium	-	$0.00	0	-	$0.00
Miscellaneous	Non-HVAC Motor	Premium (2015)	-	$0.00	0	-	$0.00
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-	$0.00
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	1.00	$0.00

Table C-7 Energy Efficiency Equipment Data, Electric—Large Commercial, Existing Vintage, Washington

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	-	$0.00
Cooling	Central Chiller	1.3 kw/ton, COP 2.7	0.29	$0.26	20	1.10	$0.06
Cooling	Central Chiller	1.26 kw/ton, COP 2.8	0.34	$0.33	20	0.97	$0.07
Cooling	Central Chiller	1.0 kw/ton, COP 3.5	0.71	$0.41	20	1.02	$0.04
Cooling	Central Chiller	0.97 kw/ton, COP 3.6	0.76	$0.49	20	0.99	$0.05
Cooling	Central Chiller	Variable Refrigerant Flow	0.99	$7.63	20	0.21	$0.54
Cooling	RTU	EER 9.2	-	$0.00	16	-	$0.00
Cooling	RTU	EER 10.1	0.22	$0.13	16	-	$0.05
Cooling	RTU	EER 11.2	0.44	$0.25	16	1.00	$0.05
Cooling	RTU	EER 12.0	0.57	$0.41	16	0.93	$0.06
Cooling	RTU	Ductless VRF	0.70	$3.67	16	0.32	$0.43
Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-	$0.00
Cooling	Heat Pump	EER 10.3, COP 3.2	0.29	$0.18	15	-	$0.06
Cooling	Heat Pump	EER 11.0, COP 3.3	0.45	$0.55	15	1.00	$0.10
Cooling	Heat Pump	EER 11.7, COP 3.4	0.61	$0.73	15	0.98	$0.10
Cooling	Heat Pump	EER 12, COP 3.4	0.66	$0.91	15	0.95	$0.12
Cooling	Heat Pump	Ductless Mini-Split System	0.74	$5.35	20	0.56	$0.51
Space Heating	Electric Resistance	Standard	-	$0.00	25	1.00	$0.00
Space Heating	Furnace	Standard	-	$0.00	18	1.00	$0.00
Ventilation	Ventilation	Constant Volume	-	$0.00	15	1.00	$0.00
Ventilation	Ventilation	Variable Air Volume	1.39	$1.22	15	0.91	$0.08
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	1	-	$0.00
Interior Lighting	Interior Screw-in	Infrared Halogen	0.49	$0.08	1	1.00	$0.16
Interior Lighting	Interior Screw-in	CFL	2.03	$0.03	4	5.52	$0.00
Interior Lighting	Interior Screw-in	LED	2.24	$1.11	12	-	$0.05
Interior Lighting	High Bay Fixtures	Metal Halides	-	$0.00	6	1.00	$0.00
Interior Lighting	High Bay Fixtures	High Pressure Sodium	0.24	-$0.08	9	2.10	-$0.04
Interior Lighting	High Bay Fixtures	T8	0.24	-$0.16	6	4.40	-$0.12
Interior Lighting	High Bay Fixtures	T5	0.31	-$0.16	6	5.23	-$0.10
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	0.34	-$0.03	6	1.11	-$0.02
Interior Lighting	Linear Fluorescent	Super T8	1.03	$0.25	6	0.94	$0.04
Interior Lighting	Linear Fluorescent	T5	1.07	$0.42	6	0.81	$0.07
Interior Lighting	Linear Fluorescent	LED	1.12	$3.67	15	-	$0.28
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	1	-	$0.00
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.05	$0.01	1	1.00	$0.26
Exterior Lighting	Exterior Screw-in	CFL	0.22	$0.01	4	6.10	$0.01
Exterior Lighting	Exterior Screw-in	Metal Halides	0.22	$0.02	4	3.35	$0.02
Exterior Lighting	Exterior Screw-in	LED	0.24	$0.19	12	-	$0.08
Exterior	HID	Metal Halides	-	$0.00	6	1.00	$0.00

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Lighting							
Exterior Lighting	HID	High Pressure Sodium	0.15	-$0.11	9	2.03	-$0.09
Exterior Lighting	HID	Low Pressure Sodium	0.16	$0.45	9	0.58	$0.36
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.13	$0.02	15	1.03	$0.01
Water Heating	Water Heater	EF 2.0	1.26	-$0.48	15	2.78	-$0.03
Water Heating	Water Heater	EF 2.3	1.42	-$0.47	15	3.18	-$0.03
Water Heating	Water Heater	EF 2.4	1.46	-$0.47	15	3.30	-$0.03
Water Heating	Water Heater	Geothermal Heat Pump	1.67	$3.53	15	0.40	$0.18
Water Heating	Water Heater	Solar	1.84	$3.03	15	0.46	$0.14
Food Preparation	Fryer	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Fryer	Efficient	0.07	$0.02	12	1.07	$0.03
Food Preparation	Oven	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Oven	Efficient	0.74	$0.46	12	0.95	$0.06
Food Preparation	Dishwasher	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Dishwasher	Efficient	0.06	$0.10	12	0.89	$0.16
Food Preparation	Hot Food Container	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Hot Food Container	Efficient	0.21	$0.30	12	0.70	$0.15
Food Preparation	Food Prep	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Food Prep	Efficient	0.01	$0.03	12	0.88	$0.46
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Walk in Refrigeration	Efficient	0.11	$1.26	18	0.88	$0.87
Refrigeration	Glass Door Display	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Glass Door Display	Efficient	0.13	$0.01	18	1.25	$0.00
Refrigeration	Reach-in Refrigerator	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Reach-in Refrigerator	Efficient	0.16	$0.08	18	1.01	$0.04
Refrigeration	Open Display Case	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Open Display Case	Efficient	0.00	$0.04	18	0.88	$0.55
Refrigeration	Vending Machine	Base	-	$0.00	10	-	$0.00
Refrigeration	Vending Machine	Base (2012)	0.11	$0.00	10	1.00	$0.00
Refrigeration	Vending Machine	High Efficiency	0.13	$0.00	10	-	$0.00
Refrigeration	Vending Machine	High Efficiency (2012)	0.20	$0.00	10	1.09	$0.00
Refrigeration	Icemaker	Standard	-	$0.00	12	1.00	$0.00
Refrigeration	Icemaker	Efficient	0.10	$0.02	12	1.06	$0.02
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	1.00	$0.00
Office Equipment	Desktop Computer	Energy Star	0.39	$0.00	4	1.02	$0.00
Office Equipment	Desktop Computer	Climate Savers	0.55	$0.32	4	0.87	$0.15
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	1.00	$0.00
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	1.01	$0.00

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Office Equipment	Laptop Computer	Climate Savers	0.04	$0.06	4	0.85	$0.42
Office Equipment	Server	Standard	-	$0.00	3	1.00	$0.00
Office Equipment	Server	Energy Star	0.13	$0.01	3	1.02	$0.02
Office Equipment	Monitor	Standard	-	$0.00	4	1.00	$0.00
Office Equipment	Monitor	Energy Star	0.05	$0.01	4	1.00	$0.03
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	1.00	$0.00
Office Equipment	Printer/copier/fax	Energy Star	0.07	$0.02	6	0.98	$0.04
Office Equipment	POS Terminal	Standard	-	$0.00	4	1.00	$0.00
Office Equipment	POS Terminal	Energy Star	0.01	$0.00	4	1.00	$0.03
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-	$0.00
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.06	15	-	$0.63
Miscellaneous	Non-HVAC Motor	High Efficiency	0.01	$0.00	15	1.00	$0.00
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.07	$0.06	15	0.98	$0.07
Miscellaneous	Non-HVAC Motor	Premium	-	$0.00	0	-	$0.00
Miscellaneous	Non-HVAC Motor	Premium (2015)	-	$0.00	0	-	$0.00
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-	$0.00
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	1.00	$0.00

Table C-8 Energy Efficiency Equipment Data, Electric— Large Commercial, New Vintage, Washington

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	-	$0.00
Cooling	Central Chiller	1.3 kw/ton, COP 2.7	0.26	$0.24	20	1.10	$0.07
Cooling	Central Chiller	1.26 kw/ton, COP 2.8	0.31	$0.31	20	0.97	$0.07
Cooling	Central Chiller	1.0 kw/ton, COP 3.5	0.64	$0.38	20	1.02	$0.04
Cooling	Central Chiller	0.97 kw/ton, COP 3.6	0.68	$0.45	20	0.99	$0.05
Cooling	Central Chiller	Variable Refrigerant Flow	0.89	$7.06	20	0.21	$0.56
Cooling	RTU	EER 9.2	-	$0.00	16	-	$0.00
Cooling	RTU	EER 10.1	0.21	$0.13	16	-	$0.05
Cooling	RTU	EER 11.2	0.41	$0.25	16	1.00	$0.05
Cooling	RTU	EER 12.0	0.54	$0.41	16	0.93	$0.06
Cooling	RTU	Ductless VRF	0.66	$3.67	16	0.32	$0.46
Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-	$0.00
Cooling	Heat Pump	EER 10.3, COP 3.2	0.31	$0.18	15	-	$0.05
Cooling	Heat Pump	EER 11.0, COP 3.3	0.50	$0.55	15	1.00	$0.10
Cooling	Heat Pump	EER 11.7, COP 3.4	0.66	$0.73	15	0.98	$0.10
Cooling	Heat Pump	EER 12, COP 3.4	0.73	$0.91	15	0.96	$0.11
Cooling	Heat Pump	Ductless Mini-Split System	0.81	$5.35	20	0.57	$0.47
Space Heating	Electric Resistance	Standard	-	$0.00	25	1.00	$0.00
Space Heating	Furnace	Standard	-	$0.00	18	1.00	$0.00
Ventilation	Ventilation	Constant Volume	-	$0.00	15	1.00	$0.00
Ventilation	Ventilation	Variable Air Volume	1.79	$1.22	15	0.99	$0.06
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	1	-	$0.00
Interior Lighting	Interior Screw-in	Infrared Halogen	0.61	$0.08	1	1.00	$0.13
Interior Lighting	Interior Screw-in	CFL	2.52	$0.03	4	5.27	$0.00
Interior Lighting	Interior Screw-in	LED	2.78	$1.11	12	-	$0.04
Interior Lighting	High Bay Fixtures	Metal Halides	-	$0.00	6	1.00	$0.00
Interior Lighting	High Bay Fixtures	High Pressure Sodium	0.25	-$0.08	9	2.09	-$0.04
Interior Lighting	High Bay Fixtures	T8	0.25	-$0.16	6	4.36	-$0.12
Interior Lighting	High Bay Fixtures	T5	0.31	-$0.16	6	5.19	-$0.09
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	0.31	-$0.03	6	1.11	-$0.02
Interior Lighting	Linear Fluorescent	Super T8	0.93	$0.25	6	0.92	$0.05
Interior Lighting	Linear Fluorescent	T5	0.97	$0.42	6	0.78	$0.08
Interior Lighting	Linear Fluorescent	LED	1.02	$3.67	15	-	$0.31
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	1	-	$0.00
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.05	$0.01	1	1.00	$0.26
Exterior Lighting	Exterior Screw-in	CFL	0.22	$0.01	4	6.10	$0.01
Exterior Lighting	Exterior Screw-in	Metal Halides	0.22	$0.02	4	3.35	$0.02
Exterior Lighting	Exterior Screw-in	LED	0.24	$0.19	12	-	$0.08
Exterior	HID	Metal Halides	-	$0.00	6	1.00	$0.00

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Lighting							
Exterior Lighting	HID	High Pressure Sodium	0.15	-$0.11	9	2.03	-$0.09
Exterior Lighting	HID	Low Pressure Sodium	0.16	$0.45	9	0.58	$0.36
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.12	$0.02	15	1.03	$0.02
Water Heating	Water Heater	EF 2.0	1.21	-$0.48	15	2.81	-$0.03
Water Heating	Water Heater	EF 2.3	1.35	-$0.47	15	3.21	-$0.03
Water Heating	Water Heater	EF 2.4	1.39	-$0.47	15	3.34	-$0.03
Water Heating	Water Heater	Geothermal Heat Pump	1.60	$3.53	15	0.39	$0.19
Water Heating	Water Heater	Solar	1.76	$3.03	15	0.45	$0.15
Food Preparation	Fryer	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Fryer	Efficient	0.07	$0.02	12	1.07	$0.03
Food Preparation	Oven	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Oven	Efficient	0.74	$0.46	12	0.95	$0.06
Food Preparation	Dishwasher	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Dishwasher	Efficient	0.06	$0.10	12	0.89	$0.16
Food Preparation	Hot Food Container	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Hot Food Container	Efficient	0.21	$0.30	12	0.70	$0.15
Food Preparation	Food Prep	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Food Prep	Efficient	0.01	$0.03	12	0.88	$0.46
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Walk in Refrigeration	Efficient	0.11	$1.26	18	0.88	$0.88
Refrigeration	Glass Door Display	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Glass Door Display	Efficient	0.13	$0.01	18	1.25	$0.00
Refrigeration	Reach-in Refrigerator	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Reach-in Refrigerator	Efficient	0.23	$0.08	18	1.05	$0.03
Refrigeration	Open Display Case	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Open Display Case	Efficient	0.00	$0.04	18	0.88	$0.55
Refrigeration	Vending Machine	Base	-	$0.00	10	-	$0.00
Refrigeration	Vending Machine	Base (2012)	0.11	$0.00	10	1.00	$0.00
Refrigeration	Vending Machine	High Efficiency	0.13	$0.00	10	-	$0.00
Refrigeration	Vending Machine	High Efficiency (2012)	0.20	$0.00	10	1.09	$0.00
Refrigeration	Icemaker	Standard	-	$0.00	12	1.00	$0.00
Refrigeration	Icemaker	Efficient	0.09	$0.02	12	1.06	$0.02
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	1.00	$0.00
Office Equipment	Desktop Computer	Energy Star	0.39	$0.00	4	1.02	$0.00
Office Equipment	Desktop Computer	Climate Savers	0.55	$0.32	4	0.87	$0.15
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	1.00	$0.00
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	1.01	$0.00

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Office Equipment	Laptop Computer	Climate Savers	0.04	$0.06	4	0.85	$0.42
Office Equipment	Server	Standard	-	$0.00	3	1.00	$0.00
Office Equipment	Server	Energy Star	0.13	$0.01	3	1.02	$0.02
Office Equipment	Monitor	Standard	-	$0.00	4	1.00	$0.00
Office Equipment	Monitor	Energy Star	0.05	$0.01	4	1.00	$0.03
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	1.00	$0.00
Office Equipment	Printer/copier/fax	Energy Star	0.07	$0.02	6	0.98	$0.04
Office Equipment	POS Terminal	Standard	-	$0.00	4	1.00	$0.00
Office Equipment	POS Terminal	Energy Star	0.01	$0.00	4	1.00	$0.03
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-	$0.00
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.06	15	-	$0.63
Miscellaneous	Non-HVAC Motor	High Efficiency	0.01	$0.00	15	1.00	$0.00
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.07	$0.06	15	0.98	$0.07
Miscellaneous	Non-HVAC Motor	Premium	-	$0.00	0	-	$0.00
Miscellaneous	Non-HVAC Motor	Premium (2015)	-	$0.00	0	-	$0.00
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-	$0.00
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	1.00	$0.00

Table C-9 Energy Efficiency Equipment Data, Electric—Large Commercial, Existing Vintage, Idaho

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	-	$0.00
Cooling	Central Chiller	1.3 kw/ton, COP 2.7	0.29	$0.26	20	1.10	$0.06
Cooling	Central Chiller	1.26 kw/ton, COP 2.8	0.34	$0.33	20	0.97	$0.07
Cooling	Central Chiller	1.0 kw/ton, COP 3.5	0.71	$0.41	20	1.02	$0.04
Cooling	Central Chiller	0.97 kw/ton, COP 3.6	0.76	$0.49	20	0.99	$0.05
Cooling	Central Chiller	Variable Refrigerant Flow	0.99	$7.63	20	0.21	$0.54
Cooling	RTU	EER 9.2	-	$0.00	16	-	$0.00
Cooling	RTU	EER 10.1	0.22	$0.13	16	-	$0.05
Cooling	RTU	EER 11.2	0.44	$0.25	16	1.00	$0.05
Cooling	RTU	EER 12.0	0.57	$0.41	16	0.93	$0.06
Cooling	RTU	Ductless VRF	0.70	$3.67	16	0.32	$0.43
Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-	$0.00
Cooling	Heat Pump	EER 10.3, COP 3.2	0.29	$0.18	15	-	$0.06
Cooling	Heat Pump	EER 11.0, COP 3.3	0.45	$0.55	15	1.00	$0.10
Cooling	Heat Pump	EER 11.7, COP 3.4	0.61	$0.73	15	0.98	$0.10
Cooling	Heat Pump	EER 12, COP 3.4	0.66	$0.91	15	0.95	$0.12
Cooling	Heat Pump	Ductless Mini-Split System	0.74	$5.35	20	0.56	$0.51
Space Heating	Electric Resistance	Standard	-	$0.00	25	1.00	$0.00
Space Heating	Furnace	Standard	-	$0.00	18	1.00	$0.00
Ventilation	Ventilation	Constant Volume	-	$0.00	15	1.00	$0.00
Ventilation	Ventilation	Variable Air Volume	1.39	$1.22	15	0.92	$0.08
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	1	-	$0.00
Interior Lighting	Interior Screw-in	Infrared Halogen	0.49	$0.08	1	1.00	$0.16
Interior Lighting	Interior Screw-in	CFL	2.03	$0.03	4	5.53	$0.00
Interior Lighting	Interior Screw-in	LED	2.24	$1.11	12	-	$0.05
Interior Lighting	High Bay Fixtures	Metal Halides	-	$0.00	6	1.00	$0.00
Interior Lighting	High Bay Fixtures	High Pressure Sodium	0.24	-$0.08	9	2.09	-$0.04
Interior Lighting	High Bay Fixtures	T8	0.24	-$0.16	6	4.37	-$0.12
Interior Lighting	High Bay Fixtures	T5	0.31	-$0.16	6	5.20	-$0.10
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	0.34	-$0.03	6	1.11	-$0.02
Interior Lighting	Linear Fluorescent	Super T8	1.03	$0.25	6	0.95	$0.04
Interior Lighting	Linear Fluorescent	T5	1.07	$0.42	6	0.81	$0.07
Interior Lighting	Linear Fluorescent	LED	1.12	$3.67	15	-	$0.28
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	1	-	$0.00
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.05	$0.01	1	1.00	$0.26
Exterior Lighting	Exterior Screw-in	CFL	0.22	$0.01	4	6.10	$0.01
Exterior Lighting	Exterior Screw-in	Metal Halides	0.22	$0.02	4	3.35	$0.02
Exterior Lighting	Exterior Screw-in	LED	0.24	$0.19	12	-	$0.08
Exterior	HID	Metal Halides	-	$0.00	6	1.00	$0.00

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Lighting							
Exterior Lighting	HID	High Pressure Sodium	0.15	-$0.11	9	2.02	-$0.09
Exterior Lighting	HID	Low Pressure Sodium	0.16	$0.45	9	0.58	$0.36
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.13	$0.02	15	1.03	$0.01
Water Heating	Water Heater	EF 2.0	1.26	-$0.48	15	2.76	-$0.03
Water Heating	Water Heater	EF 2.3	1.42	-$0.47	15	3.16	-$0.03
Water Heating	Water Heater	EF 2.4	1.46	-$0.47	15	3.29	-$0.03
Water Heating	Water Heater	Geothermal Heat Pump	1.67	$3.53	15	0.41	$0.18
Water Heating	Water Heater	Solar	1.84	$3.03	15	0.47	$0.14
Food Preparation	Fryer	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Fryer	Efficient	0.07	$0.02	12	1.07	$0.03
Food Preparation	Oven	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Oven	Efficient	0.74	$0.46	12	0.96	$0.06
Food Preparation	Dishwasher	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Dishwasher	Efficient	0.06	$0.10	12	0.89	$0.16
Food Preparation	Hot Food Container	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Hot Food Container	Efficient	0.21	$0.30	12	0.70	$0.15
Food Preparation	Food Prep	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Food Prep	Efficient	0.01	$0.03	12	0.88	$0.46
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Walk in Refrigeration	Efficient	0.11	$1.26	18	0.88	$0.87
Refrigeration	Glass Door Display	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Glass Door Display	Efficient	0.13	$0.01	18	1.26	$0.00
Refrigeration	Reach-in Refrigerator	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Reach-in Refrigerator	Efficient	0.16	$0.08	18	1.02	$0.04
Refrigeration	Open Display Case	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Open Display Case	Efficient	0.00	$0.04	18	0.88	$0.55
Refrigeration	Vending Machine	Base	-	$0.00	10	-	$0.00
Refrigeration	Vending Machine	Base (2012)	0.11	$0.00	10	1.00	$0.00
Refrigeration	Vending Machine	High Efficiency	0.13	$0.00	10	-	$0.00
Refrigeration	Vending Machine	High Efficiency (2012)	0.20	$0.00	10	1.09	$0.00
Refrigeration	Icemaker	Standard	-	$0.00	12	1.00	$0.00
Refrigeration	Icemaker	Efficient	0.10	$0.02	12	1.06	$0.02
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	1.00	$0.00
Office Equipment	Desktop Computer	Energy Star	0.39	$0.00	4	1.02	$0.00
Office Equipment	Desktop Computer	Climate Savers	0.55	$0.32	4	0.87	$0.15
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	1.00	$0.00
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	1.01	$0.00

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Office Equipment	Laptop Computer	Climate Savers	0.04	$0.06	4	0.85	$0.42
Office Equipment	Server	Standard	-	$0.00	3	1.00	$0.00
Office Equipment	Server	Energy Star	0.13	$0.01	3	1.01	$0.02
Office Equipment	Monitor	Standard	-	$0.00	4	1.00	$0.00
Office Equipment	Monitor	Energy Star	0.05	$0.01	4	1.00	$0.03
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	1.00	$0.00
Office Equipment	Printer/copier/fax	Energy Star	0.07	$0.02	6	0.98	$0.04
Office Equipment	POS Terminal	Standard	-	$0.00	4	1.00	$0.00
Office Equipment	POS Terminal	Energy Star	0.01	$0.00	4	1.00	$0.03
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-	$0.00
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.06	15	-	$0.63
Miscellaneous	Non-HVAC Motor	High Efficiency	0.01	$0.00	15	1.00	$0.00
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.07	$0.06	15	0.98	$0.07
Miscellaneous	Non-HVAC Motor	Premium	-	$0.00	0	-	$0.00
Miscellaneous	Non-HVAC Motor	Premium (2015)	-	$0.00	0	-	$0.00
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-	$0.00
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	1.00	$0.00

Table C-10 Energy Efficiency Equipment Data, Electric— Large Commercial, New Vintage, Idaho

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	-	$0.00
Cooling	Central Chiller	1.3 kw/ton, COP 2.7	0.26	$0.24	20	1.10	$0.07
Cooling	Central Chiller	1.26 kw/ton, COP 2.8	0.31	$0.31	20	0.97	$0.07
Cooling	Central Chiller	1.0 kw/ton, COP 3.5	0.64	$0.38	20	1.02	$0.04
Cooling	Central Chiller	0.97 kw/ton, COP 3.6	0.68	$0.45	20	0.99	$0.05
Cooling	Central Chiller	Variable Refrigerant Flow	0.89	$7.06	20	0.21	$0.56
Cooling	RTU	EER 9.2	-	$0.00	16	-	$0.00
Cooling	RTU	EER 10.1	0.21	$0.13	16	-	$0.05
Cooling	RTU	EER 11.2	0.41	$0.25	16	1.00	$0.05
Cooling	RTU	EER 12.0	0.54	$0.41	16	0.93	$0.06
Cooling	RTU	Ductless VRF	0.66	$3.67	16	0.32	$0.46
Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-	$0.00
Cooling	Heat Pump	EER 10.3, COP 3.2	0.31	$0.18	15	-	$0.05
Cooling	Heat Pump	EER 11.0, COP 3.3	0.50	$0.55	15	1.00	$0.10
Cooling	Heat Pump	EER 11.7, COP 3.4	0.66	$0.73	15	0.98	$0.10
Cooling	Heat Pump	EER 12, COP 3.4	0.73	$0.91	15	0.95	$0.11
Cooling	Heat Pump	Ductless Mini-Split System	0.81	$5.35	20	0.57	$0.47
Space Heating	Electric Resistance	Standard	-	$0.00	25	1.00	$0.00
Space Heating	Furnace	Standard	-	$0.00	18	1.00	$0.00
Ventilation	Ventilation	Constant Volume	-	$0.00	15	1.00	$0.00
Ventilation	Ventilation	Variable Air Volume	1.79	$1.22	15	1.00	$0.06
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	1	-	$0.00
Interior Lighting	Interior Screw-in	Infrared Halogen	0.61	$0.08	1	1.00	$0.13
Interior Lighting	Interior Screw-in	CFL	2.52	$0.03	4	5.28	$0.00
Interior Lighting	Interior Screw-in	LED	2.78	$1.11	12	-	$0.04
Interior Lighting	High Bay Fixtures	Metal Halides	-	$0.00	6	1.00	$0.00
Interior Lighting	High Bay Fixtures	High Pressure Sodium	0.25	-$0.08	9	2.08	-$0.04
Interior Lighting	High Bay Fixtures	T8	0.25	-$0.16	6	4.34	-$0.12
Interior Lighting	High Bay Fixtures	T5	0.31	-$0.16	6	5.16	-$0.09
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	0.31	-$0.03	6	1.11	-$0.02
Interior Lighting	Linear Fluorescent	Super T8	0.93	$0.25	6	0.92	$0.05
Interior Lighting	Linear Fluorescent	T5	0.97	$0.42	6	0.79	$0.08
Interior Lighting	Linear Fluorescent	LED	1.02	$3.67	15	-	$0.31
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	1	-	$0.00
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.05	$0.01	1	1.00	$0.26
Exterior Lighting	Exterior Screw-in	CFL	0.22	$0.01	4	6.10	$0.01
Exterior Lighting	Exterior Screw-in	Metal Halides	0.22	$0.02	4	3.35	$0.02
Exterior Lighting	Exterior Screw-in	LED	0.24	$0.19	12	-	$0.08
Exterior	HID	Metal Halides	-	$0.00	6	1.00	$0.00

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Lighting							
Exterior Lighting	HID	High Pressure Sodium	0.15	-$0.11	9	2.02	-$0.09
Exterior Lighting	HID	Low Pressure Sodium	0.16	$0.45	9	0.58	$0.36
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.12	$0.02	15	1.03	$0.02
Water Heating	Water Heater	EF 2.0	1.21	-$0.48	15	2.79	-$0.03
Water Heating	Water Heater	EF 2.3	1.35	-$0.47	15	3.19	-$0.03
Water Heating	Water Heater	EF 2.4	1.39	-$0.47	15	3.32	-$0.03
Water Heating	Water Heater	Geothermal Heat Pump	1.60	$3.53	15	0.40	$0.19
Water Heating	Water Heater	Solar	1.76	$3.03	15	0.46	$0.15
Food Preparation	Fryer	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Fryer	Efficient	0.07	$0.02	12	1.07	$0.03
Food Preparation	Oven	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Oven	Efficient	0.74	$0.46	12	0.96	$0.06
Food Preparation	Dishwasher	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Dishwasher	Efficient	0.06	$0.10	12	0.89	$0.16
Food Preparation	Hot Food Container	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Hot Food Container	Efficient	0.21	$0.30	12	0.70	$0.15
Food Preparation	Food Prep	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Food Prep	Efficient	0.01	$0.03	12	0.88	$0.46
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Walk in Refrigeration	Efficient	0.11	$1.26	18	0.88	$0.88
Refrigeration	Glass Door Display	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Glass Door Display	Efficient	0.13	$0.01	18	1.26	$0.00
Refrigeration	Reach-in Refrigerator	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Reach-in Refrigerator	Efficient	0.23	$0.08	18	1.05	$0.03
Refrigeration	Open Display Case	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Open Display Case	Efficient	0.00	$0.04	18	0.88	$0.55
Refrigeration	Vending Machine	Base	-	$0.00	10	-	$0.00
Refrigeration	Vending Machine	Base (2012)	0.11	$0.00	10	1.00	$0.00
Refrigeration	Vending Machine	High Efficiency	0.13	$0.00	10	-	$0.00
Refrigeration	Vending Machine	High Efficiency (2012)	0.20	$0.00	10	1.09	$0.00
Refrigeration	Icemaker	Standard	-	$0.00	12	1.00	$0.00
Refrigeration	Icemaker	Efficient	0.09	$0.02	12	1.06	$0.02
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	1.00	$0.00
Office Equipment	Desktop Computer	Energy Star	0.39	$0.00	4	1.02	$0.00
Office Equipment	Desktop Computer	Climate Savers	0.55	$0.32	4	0.87	$0.15
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	1.00	$0.00
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	1.01	$0.00

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Office Equipment	Laptop Computer	Climate Savers	0.04	$0.06	4	0.85	$0.42
Office Equipment	Server	Standard	-	$0.00	3	1.00	$0.00
Office Equipment	Server	Energy Star	0.13	$0.01	3	1.01	$0.02
Office Equipment	Monitor	Standard	-	$0.00	4	1.00	$0.00
Office Equipment	Monitor	Energy Star	0.05	$0.01	4	1.00	$0.03
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	1.00	$0.00
Office Equipment	Printer/copier/fax	Energy Star	0.07	$0.02	6	0.98	$0.04
Office Equipment	POS Terminal	Standard	-	$0.00	4	1.00	$0.00
Office Equipment	POS Terminal	Energy Star	0.01	$0.00	4	1.00	$0.03
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-	$0.00
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.06	15	-	$0.63
Miscellaneous	Non-HVAC Motor	High Efficiency	0.01	$0.00	15	1.00	$0.00
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.07	$0.06	15	0.98	$0.07
Miscellaneous	Non-HVAC Motor	Premium	-	$0.00	0	-	$0.00
Miscellaneous	Non-HVAC Motor	Premium (2015)	-	$0.00	0	-	$0.00
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-	$0.00
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	1.00	$0.00

Table C-11 Energy Efficiency Equipment Data, Electric—Extra Large Commercial, Existing Vintage, Washington

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central Chiller	Variable Refrigerant Flow	1.08	$10.92	20	0.15	$0.71
Cooling	RTU	EER 9.2	-	$0.00	16	-	$0.00
Cooling	RTU	EER 10.1	0.20	$0.24	16	-	$0.10
Cooling	RTU	EER 11.2	0.40	$0.45	16	1.00	$0.09
Cooling	RTU	EER 12.0	0.52	$0.75	16	0.89	$0.12
Cooling	RTU	Ductless VRF	0.63	$6.64	16	0.26	$0.87
Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-	$0.00
Cooling	Heat Pump	EER 10.3, COP 3.2	0.20	$0.24	15	-	$0.11
Cooling	Heat Pump	EER 11.0, COP 3.3	0.31	$0.73	15	1.00	$0.20
Cooling	Heat Pump	EER 11.7, COP 3.4	0.42	$0.97	15	0.97	$0.20
Cooling	Heat Pump	EER 12, COP 3.4	0.46	$1.21	15	0.94	$0.23
Cooling	Heat Pump	Ductless Mini-Split System	0.51	$7.10	20	0.54	$0.99
Space Heating	Electric Resistance	Standard	-	$0.00	25	1.00	$0.00
Space Heating	Furnace	Standard	-	$0.00	18	1.00	$0.00
Ventilation	Ventilation	Constant Volume	-	$0.00	15	1.00	$0.00
Ventilation	Ventilation	Variable Air Volume	2.10	$1.22	15	1.04	$0.05
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	1	-	$0.00
Interior Lighting	Interior Screw-in	Infrared Halogen	0.79	$0.14	1	1.00	$0.18
Interior Lighting	Interior Screw-in	CFL	3.25	$0.06	4	5.60	$0.00
Interior Lighting	Interior Screw-in	LED	3.59	$1.90	12	-	$0.05
Interior Lighting	High Bay Fixtures	Metal Halides	-	$0.00	6	1.00	$0.00
Interior Lighting	High Bay Fixtures	High Pressure Sodium	0.10	-$0.05	9	2.23	-$0.07
Interior Lighting	High Bay Fixtures	T8	0.10	-$0.11	6	5.65	-$0.19
Interior Lighting	High Bay Fixtures	T5	0.13	-$0.10	6	6.21	-$0.15
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	0.23	-$0.03	6	1.12	-$0.02
Interior Lighting	Linear Fluorescent	Super T8	0.69	$0.21	6	0.89	$0.06
Interior Lighting	Linear Fluorescent	T5	0.71	$0.35	6	0.75	$0.09
Interior Lighting	Linear Fluorescent	LED	0.75	$3.08	15	-	$0.36
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	1	-	$0.00
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.02	$0.00	1	1.00	$0.22
Exterior Lighting	Exterior Screw-in	CFL	0.07	$0.00	4	5.89	$0.01
Exterior Lighting	Exterior Screw-in	Metal Halides	0.07	$0.00	4	3.36	$0.02
Exterior Lighting	Exterior Screw-in	LED	0.07	$0.05	12	-	$0.07
Exterior Lighting	HID	Metal Halides	-	$0.00	6	1.00	$0.00
Exterior Lighting	HID	High Pressure Sodium	0.19	-$0.16	9	2.08	-$0.10
Exterior Lighting	HID	Low Pressure Sodium	0.21	$0.64	9	0.57	$0.40

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.20	$0.02	15	1.04	$0.01
Water Heating	Water Heater	EF 2.0	1.95	-$0.48	15	2.49	-$0.02
Water Heating	Water Heater	EF 2.3	2.19	-$0.47	15	2.86	-$0.02
Water Heating	Water Heater	EF 2.4	2.26	-$0.47	15	2.98	-$0.02
Water Heating	Water Heater	Geothermal Heat Pump	2.59	$3.53	15	0.56	$0.12
Water Heating	Water Heater	Solar	2.84	$3.03	15	0.65	$0.09
Food Preparation	Fryer	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Fryer	Efficient	0.03	$0.00	12	1.13	$0.02
Food Preparation	Oven	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Oven	Efficient	0.84	$0.38	12	1.00	$0.05
Food Preparation	Dishwasher	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Dishwasher	Efficient	0.03	$0.04	12	0.89	$0.18
Food Preparation	Hot Food Container	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Hot Food Container	Efficient	0.10	$0.22	12	0.66	$0.22
Food Preparation	Food Prep	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Food Prep	Efficient	0.00	$0.03	12	0.88	$0.77
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Walk in Refrigeration	Efficient	0.04	$0.05	18	0.95	$0.08
Refrigeration	Glass Door Display	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Glass Door Display	Efficient	0.04	$0.00	18	1.39	$0.00
Refrigeration	Reach-in Refrigerator	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Reach-in Refrigerator	Efficient	0.21	$0.02	18	1.19	$0.01
Refrigeration	Open Display Case	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Open Display Case	Efficient	0.01	$0.03	18	0.93	$0.25
Refrigeration	Vending Machine	Base	-	$0.00	10	-	$0.00
Refrigeration	Vending Machine	Base (2012)	0.12	$0.00	10	1.00	$0.00
Refrigeration	Vending Machine	High Efficiency	0.14	$0.00	10	-	$0.00
Refrigeration	Vending Machine	High Efficiency (2012)	0.21	$0.00	10	1.24	$0.00
Refrigeration	Icemaker	Standard	-	$0.00	12	1.00	$0.00
Refrigeration	Icemaker	Efficient	0.04	$0.00	12	1.12	$0.01
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	1.00	$0.00
Office Equipment	Desktop Computer	Energy Star	0.28	$0.00	4	1.02	$0.00
Office Equipment	Desktop Computer	Climate Savers	0.39	$0.33	4	0.86	$0.22
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	1.00	$0.00
Office Equipment	Laptop Computer	Energy Star	0.03	$0.00	4	1.00	$0.01
Office Equipment	Laptop Computer	Climate Savers	0.04	$0.10	4	0.84	$0.61
Office Equipment	Server	Standard	-	$0.00	3	1.00	$0.00
Office	Server	Energy Star	0.05	$0.00	3	1.00	$0.03

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Equipment							
Office Equipment	Monitor	Standard	-	$0.00	4	1.00	$0.00
Office Equipment	Monitor	Energy Star	0.03	$0.01	4	0.99	$0.04
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	1.00	$0.00
Office Equipment	Printer/copier/fax	Energy Star	0.02	$0.01	6	0.96	$0.06
Office Equipment	POS Terminal	Standard	-	$0.00	4	1.00	$0.00
Office Equipment	POS Terminal	Energy Star	0.00	$0.00	4	0.99	$0.05
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-	$0.00
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.00	$0.06	15	-	$1.06
Miscellaneous	Non-HVAC Motor	High Efficiency	0.01	$0.00	15	1.00	$0.00
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.04	$0.06	15	0.97	$0.12
Miscellaneous	Non-HVAC Motor	Premium	-	$0.00	0	-	$0.00
Miscellaneous	Non-HVAC Motor	Premium (2015)	-	$0.00	0	-	$0.00
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-	$0.00
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	1.00	$0.00

Table C-12 Energy Efficiency Equipment Data, Electric— Extra Large Commercial, New Vintage, Washington

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central Chiller	Variable Refrigerant Flow	1.01	$10.92	20	0.15	$0.77
Cooling	RTU	EER 9.2	-	$0.00	16	-	$0.00
Cooling	RTU	EER 10.1	0.19	$0.24	16	-	$0.10
Cooling	RTU	EER 11.2	0.38	$0.44	16	1.00	$0.10
Cooling	RTU	EER 12.0	0.49	$0.73	16	0.89	$0.12
Cooling	RTU	Ductless VRF	0.60	$6.51	16	0.26	$0.90
Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-	$0.00
Cooling	Heat Pump	EER 10.3, COP 3.2	0.17	$0.24	15	-	$0.12
Cooling	Heat Pump	EER 11.0, COP 3.3	0.28	$0.73	15	1.00	$0.23
Cooling	Heat Pump	EER 11.7, COP 3.4	0.37	$0.97	15	0.97	$0.23
Cooling	Heat Pump	EER 12, COP 3.4	0.41	$1.21	15	0.94	$0.26
Cooling	Heat Pump	Ductless Mini-Split System	0.45	$7.10	20	0.54	$1.12
Space Heating	Electric Resistance	Standard	-	$0.00	25	1.00	$0.00
Space Heating	Furnace	Standard	-	$0.00	18	1.00	$0.00
Ventilation	Ventilation	Constant Volume	-	$0.00	15	1.00	$0.00
Ventilation	Ventilation	Variable Air Volume	2.23	$1.22	15	1.06	$0.05
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	1	-	$0.00
Interior Lighting	Interior Screw-in	Infrared Halogen	0.87	$0.14	1	1.00	$0.16
Interior Lighting	Interior Screw-in	CFL	3.61	$0.06	4	5.48	$0.00
Interior Lighting	Interior Screw-in	LED	3.99	$1.90	12	-	$0.05
Interior Lighting	High Bay Fixtures	Metal Halides	-	$0.00	6	1.00	$0.00
Interior Lighting	High Bay Fixtures	High Pressure Sodium	0.10	-$0.05	9	2.23	-$0.07
Interior Lighting	High Bay Fixtures	T8	0.10	-$0.11	6	5.65	-$0.19
Interior Lighting	High Bay Fixtures	T5	0.13	-$0.10	6	6.21	-$0.15
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	0.22	-$0.03	6	1.12	-$0.02
Interior Lighting	Linear Fluorescent	Super T8	0.66	$0.21	6	0.88	$0.06
Interior Lighting	Linear Fluorescent	T5	0.68	$0.35	6	0.74	$0.09
Interior Lighting	Linear Fluorescent	LED	0.72	$3.08	15	-	$0.37
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	1	-	$0.00
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.01	$0.00	1	1.00	$0.38
Exterior Lighting	Exterior Screw-in	CFL	0.04	$0.00	4	6.57	$0.01
Exterior Lighting	Exterior Screw-in	Metal Halides	0.04	$0.00	4	3.32	$0.03
Exterior Lighting	Exterior Screw-in	LED	0.04	$0.05	12	-	$0.12
Exterior Lighting	HID	Metal Halides	-	$0.00	6	1.00	$0.00
Exterior Lighting	HID	High Pressure Sodium	0.19	-$0.16	9	2.08	-$0.10
Exterior Lighting	HID	Low Pressure Sodium	0.21	$0.64	9	0.57	$0.40

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.20	$0.02	15	1.04	$0.01
Water Heating	Water Heater	EF 2.0	1.98	-$0.48	15	2.49	-$0.02
Water Heating	Water Heater	EF 2.3	2.22	-$0.47	15	2.85	-$0.02
Water Heating	Water Heater	EF 2.4	2.29	-$0.47	15	2.97	-$0.02
Water Heating	Water Heater	Geothermal Heat Pump	2.62	$3.53	15	0.57	$0.12
Water Heating	Water Heater	Solar	2.88	$3.03	15	0.66	$0.09
Food Preparation	Fryer	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Fryer	Efficient	0.03	$0.00	12	1.13	$0.02
Food Preparation	Oven	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Oven	Efficient	0.84	$0.38	12	1.00	$0.05
Food Preparation	Dishwasher	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Dishwasher	Efficient	0.03	$0.04	12	0.89	$0.18
Food Preparation	Hot Food Container	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Hot Food Container	Efficient	0.10	$0.22	12	0.66	$0.22
Food Preparation	Food Prep	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Food Prep	Efficient	0.00	$0.03	12	0.88	$0.62
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Walk in Refrigeration	Efficient	0.04	$0.05	18	0.95	$0.08
Refrigeration	Glass Door Display	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Glass Door Display	Efficient	0.04	$0.00	18	1.39	$0.00
Refrigeration	Reach-in Refrigerator	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Reach-in Refrigerator	Efficient	0.21	$0.02	18	1.20	$0.01
Refrigeration	Open Display Case	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Open Display Case	Efficient	0.01	$0.03	18	0.93	$0.25
Refrigeration	Vending Machine	Base	-	$0.00	10	-	$0.00
Refrigeration	Vending Machine	Base (2012)	0.10	$0.00	10	1.00	$0.00
Refrigeration	Vending Machine	High Efficiency	0.12	$0.00	10	-	$0.00
Refrigeration	Vending Machine	High Efficiency (2012)	0.18	$0.00	10	1.21	$0.00
Refrigeration	Icemaker	Standard	-	$0.00	12	1.00	$0.00
Refrigeration	Icemaker	Efficient	0.04	$0.00	12	1.12	$0.01
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	1.00	$0.00
Office Equipment	Desktop Computer	Energy Star	0.28	$0.00	4	1.02	$0.00
Office Equipment	Desktop Computer	Climate Savers	0.39	$0.33	4	0.86	$0.22
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	1.00	$0.00
Office Equipment	Laptop Computer	Energy Star	0.03	$0.00	4	1.00	$0.01
Office Equipment	Laptop Computer	Climate Savers	0.04	$0.10	4	0.84	$0.61
Office Equipment	Server	Standard	-	$0.00	3	1.00	$0.00
Office	Server	Energy Star	0.05	$0.00	3	1.00	$0.03

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Equipment							
Office Equipment	Monitor	Standard	-	$0.00	4	1.00	$0.00
Office Equipment	Monitor	Energy Star	0.03	$0.01	4	0.99	$0.04
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	1.00	$0.00
Office Equipment	Printer/copier/fax	Energy Star	0.02	$0.01	6	0.96	$0.06
Office Equipment	POS Terminal	Standard	-	$0.00	4	1.00	$0.00
Office Equipment	POS Terminal	Energy Star	0.00	$0.00	4	0.99	$0.05
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-	$0.00
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.00	$0.06	15	-	$1.06
Miscellaneous	Non-HVAC Motor	High Efficiency	0.01	$0.00	15	1.00	$0.00
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.04	$0.06	15	0.97	$0.12
Miscellaneous	Non-HVAC Motor	Premium	-	$0.00	0	-	$0.00
Miscellaneous	Non-HVAC Motor	Premium (2015)	-	$0.00	0	-	$0.00
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-	$0.00
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	1.00	$0.00

Table C-13 Energy Efficiency Equipment Data, Electric—Extra Large Commercial, Existing Vintage, Idaho

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central Chiller	Variable Refrigerant Flow	1.08	$10.92	20	0.16	$0.71
Cooling	RTU	EER 9.2	-	$0.00	16	-	$0.00
Cooling	RTU	EER 10.1	0.20	$0.24	16	-	$0.10
Cooling	RTU	EER 11.2	0.40	$0.45	16	1.00	$0.09
Cooling	RTU	EER 12.0	0.52	$0.75	16	0.89	$0.12
Cooling	RTU	Ductless VRF	0.63	$6.64	16	0.26	$0.87
Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-	$0.00
Cooling	Heat Pump	EER 10.3, COP 3.2	0.20	$0.24	15	-	$0.11
Cooling	Heat Pump	EER 11.0, COP 3.3	0.31	$0.73	15	1.00	$0.20
Cooling	Heat Pump	EER 11.7, COP 3.4	0.42	$0.97	15	0.97	$0.20
Cooling	Heat Pump	EER 12, COP 3.4	0.46	$1.21	15	0.94	$0.23
Cooling	Heat Pump	Ductless Mini-Split System	0.51	$7.10	20	0.53	$0.99
Space Heating	Electric Resistance	Standard	-	$0.00	25	1.00	$0.00
Space Heating	Furnace	Standard	-	$0.00	18	1.00	$0.00
Ventilation	Ventilation	Constant Volume	-	$0.00	15	1.00	$0.00
Ventilation	Ventilation	Variable Air Volume	2.10	$1.22	15	1.02	$0.05
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	1	-	$0.00
Interior Lighting	Interior Screw-in	Infrared Halogen	0.79	$0.14	1	1.00	$0.18
Interior Lighting	Interior Screw-in	CFL	3.25	$0.06	4	5.61	$0.00
Interior Lighting	Interior Screw-in	LED	3.59	$1.90	12	-	$0.05
Interior Lighting	High Bay Fixtures	Metal Halides	-	$0.00	6	1.00	$0.00
Interior Lighting	High Bay Fixtures	High Pressure Sodium	0.10	-$0.05	9	2.26	-$0.07
Interior Lighting	High Bay Fixtures	T8	0.10	-$0.11	6	5.77	-$0.19
Interior Lighting	High Bay Fixtures	T5	0.13	-$0.10	6	6.31	-$0.15
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	0.23	-$0.03	6	1.12	-$0.02
Interior Lighting	Linear Fluorescent	Super T8	0.69	$0.21	6	0.88	$0.06
Interior Lighting	Linear Fluorescent	T5	0.71	$0.35	6	0.74	$0.09
Interior Lighting	Linear Fluorescent	LED	0.75	$3.08	15	-	$0.36
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	1	-	$0.00
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.02	$0.00	1	1.00	$0.22
Exterior Lighting	Exterior Screw-in	CFL	0.07	$0.00	4	5.90	$0.01
Exterior Lighting	Exterior Screw-in	Metal Halides	0.07	$0.00	4	3.36	$0.02
Exterior Lighting	Exterior Screw-in	LED	0.07	$0.05	12	-	$0.07
Exterior Lighting	HID	Metal Halides	-	$0.00	6	1.00	$0.00
Exterior Lighting	HID	High Pressure Sodium	0.19	-$0.16	9	2.09	-$0.10
Exterior Lighting	HID	Low Pressure Sodium	0.21	$0.64	9	0.57	$0.40

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.20	$0.02	15	1.03	$0.01
Water Heating	Water Heater	EF 2.0	1.95	-$0.48	15	2.55	-$0.02
Water Heating	Water Heater	EF 2.3	2.19	-$0.47	15	2.92	-$0.02
Water Heating	Water Heater	EF 2.4	2.26	-$0.47	15	3.04	-$0.02
Water Heating	Water Heater	Geothermal Heat Pump	2.59	$3.53	15	0.52	$0.12
Water Heating	Water Heater	Solar	2.84	$3.03	15	0.60	$0.09
Food Preparation	Fryer	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Fryer	Efficient	0.03	$0.00	12	1.11	$0.02
Food Preparation	Oven	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Oven	Efficient	0.84	$0.38	12	0.99	$0.05
Food Preparation	Dishwasher	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Dishwasher	Efficient	0.03	$0.04	12	0.88	$0.18
Food Preparation	Hot Food Container	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Hot Food Container	Efficient	0.10	$0.22	12	0.65	$0.22
Food Preparation	Food Prep	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Food Prep	Efficient	0.00	$0.03	12	0.88	$0.77
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Walk in Refrigeration	Efficient	0.04	$0.05	18	0.95	$0.08
Refrigeration	Glass Door Display	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Glass Door Display	Efficient	0.04	$0.00	18	1.39	$0.00
Refrigeration	Reach-in Refrigerator	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Reach-in Refrigerator	Efficient	0.21	$0.02	18	1.18	$0.01
Refrigeration	Open Display Case	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Open Display Case	Efficient	0.01	$0.03	18	0.93	$0.25
Refrigeration	Vending Machine	Base	-	$0.00	10	-	$0.00
Refrigeration	Vending Machine	Base (2012)	0.12	$0.00	10	1.00	$0.00
Refrigeration	Vending Machine	High Efficiency	0.14	$0.00	10	-	$0.00
Refrigeration	Vending Machine	High Efficiency (2012)	0.21	$0.00	10	1.23	$0.00
Refrigeration	Icemaker	Standard	-	$0.00	12	1.00	$0.00
Refrigeration	Icemaker	Efficient	0.04	$0.00	12	1.12	$0.01
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	1.00	$0.00
Office Equipment	Desktop Computer	Energy Star	0.28	$0.00	4	1.02	$0.00
Office Equipment	Desktop Computer	Climate Savers	0.39	$0.33	4	0.86	$0.22
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	1.00	$0.00
Office Equipment	Laptop Computer	Energy Star	0.03	$0.00	4	1.00	$0.01
Office Equipment	Laptop Computer	Climate Savers	0.04	$0.10	4	0.84	$0.61
Office Equipment	Server	Standard	-	$0.00	3	1.00	$0.00
Office	Server	Energy Star	0.05	$0.00	3	1.00	$0.03

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Equipment							
Office Equipment	Monitor	Standard	-	$0.00	4	1.00	$0.00
Office Equipment	Monitor	Energy Star	0.03	$0.01	4	0.99	$0.04
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	1.00	$0.00
Office Equipment	Printer/copier/fax	Energy Star	0.02	$0.01	6	0.96	$0.06
Office Equipment	POS Terminal	Standard	-	$0.00	4	1.00	$0.00
Office Equipment	POS Terminal	Energy Star	0.00	$0.00	4	0.99	$0.05
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-	$0.00
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.00	$0.06	15	-	$1.06
Miscellaneous	Non-HVAC Motor	High Efficiency	0.01	$0.00	15	1.00	$0.00
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.04	$0.06	15	0.97	$0.12
Miscellaneous	Non-HVAC Motor	Premium	-	$0.00	0	-	$0.00
Miscellaneous	Non-HVAC Motor	Premium (2015)	-	$0.00	0	-	$0.00
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-	$0.00
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	1.00	$0.00

Table C-14 Energy Efficiency Equipment Data, Electric— Extra Large Commercial, New Vintage, Idaho

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central Chiller	Variable Refrigerant Flow	1.01	$10.92	20	0.15	$0.77
Cooling	RTU	EER 9.2	-	$0.00	16	-	$0.00
Cooling	RTU	EER 10.1	0.19	$0.24	16	-	$0.10
Cooling	RTU	EER 11.2	0.38	$0.44	16	1.00	$0.10
Cooling	RTU	EER 12.0	0.49	$0.73	16	0.89	$0.12
Cooling	RTU	Ductless VRF	0.60	$6.51	16	0.26	$0.90
Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-	$0.00
Cooling	Heat Pump	EER 10.3, COP 3.2	0.17	$0.24	15	-	$0.12
Cooling	Heat Pump	EER 11.0, COP 3.3	0.28	$0.73	15	1.00	$0.23
Cooling	Heat Pump	EER 11.7, COP 3.4	0.37	$0.97	15	0.97	$0.23
Cooling	Heat Pump	EER 12, COP 3.4	0.41	$1.21	15	0.94	$0.26
Cooling	Heat Pump	Ductless Mini-Split System	0.45	$7.10	20	0.53	$1.12
Space Heating	Electric Resistance	Standard	-	$0.00	25	1.00	$0.00
Space Heating	Furnace	Standard	-	$0.00	18	1.00	$0.00
Ventilation	Ventilation	Constant Volume	-	$0.00	15	1.00	$0.00
Ventilation	Ventilation	Variable Air Volume	2.23	$1.22	15	1.05	$0.05
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	1	-	$0.00
Interior Lighting	Interior Screw-in	Infrared Halogen	0.87	$0.14	1	1.00	$0.16
Interior Lighting	Interior Screw-in	CFL	3.61	$0.06	4	5.48	$0.00
Interior Lighting	Interior Screw-in	LED	3.99	$1.90	12	-	$0.05
Interior Lighting	High Bay Fixtures	Metal Halides	-	$0.00	6	1.00	$0.00
Interior Lighting	High Bay Fixtures	High Pressure Sodium	0.10	-$0.05	9	2.26	-$0.07
Interior Lighting	High Bay Fixtures	T8	0.10	-$0.11	6	5.77	-$0.19
Interior Lighting	High Bay Fixtures	T5	0.13	-$0.10	6	6.31	-$0.15
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	0.22	-$0.03	6	1.12	-$0.02
Interior Lighting	Linear Fluorescent	Super T8	0.66	$0.21	6	0.87	$0.06
Interior Lighting	Linear Fluorescent	T5	0.68	$0.35	6	0.73	$0.09
Interior Lighting	Linear Fluorescent	LED	0.72	$3.08	15	-	$0.37
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	1	-	$0.00
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.01	$0.00	1	1.00	$0.38
Exterior Lighting	Exterior Screw-in	CFL	0.04	$0.00	4	6.58	$0.01
Exterior Lighting	Exterior Screw-in	Metal Halides	0.04	$0.00	4	3.32	$0.03
Exterior Lighting	Exterior Screw-in	LED	0.04	$0.05	12	-	$0.12
Exterior Lighting	HID	Metal Halides	-	$0.00	6	1.00	$0.00
Exterior Lighting	HID	High Pressure Sodium	0.19	-$0.16	9	2.09	-$0.10
Exterior Lighting	HID	Low Pressure Sodium	0.21	$0.64	9	0.57	$0.40

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	1.00	$0.00
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.20	$0.02	15	1.03	$0.01
Water Heating	Water Heater	EF 2.0	1.98	-$0.48	15	2.54	-$0.02
Water Heating	Water Heater	EF 2.3	2.22	-$0.47	15	2.92	-$0.02
Water Heating	Water Heater	EF 2.4	2.29	-$0.47	15	3.04	-$0.02
Water Heating	Water Heater	Geothermal Heat Pump	2.62	$3.53	15	0.52	$0.12
Water Heating	Water Heater	Solar	2.88	$3.03	15	0.60	$0.09
Food Preparation	Fryer	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Fryer	Efficient	0.03	$0.00	12	1.11	$0.02
Food Preparation	Oven	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Oven	Efficient	0.84	$0.38	12	0.99	$0.05
Food Preparation	Dishwasher	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Dishwasher	Efficient	0.03	$0.04	12	0.88	$0.18
Food Preparation	Hot Food Container	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Hot Food Container	Efficient	0.10	$0.22	12	0.65	$0.22
Food Preparation	Food Prep	Standard	-	$0.00	12	1.00	$0.00
Food Preparation	Food Prep	Efficient	0.00	$0.03	12	0.88	$0.62
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Walk in Refrigeration	Efficient	0.04	$0.05	18	0.95	$0.08
Refrigeration	Glass Door Display	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Glass Door Display	Efficient	0.04	$0.00	18	1.39	$0.00
Refrigeration	Reach-in Refrigerator	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Reach-in Refrigerator	Efficient	0.21	$0.02	18	1.19	$0.01
Refrigeration	Open Display Case	Standard	-	$0.00	18	1.00	$0.00
Refrigeration	Open Display Case	Efficient	0.01	$0.03	18	0.93	$0.25
Refrigeration	Vending Machine	Base	-	$0.00	10	-	$0.00
Refrigeration	Vending Machine	Base (2012)	0.10	$0.00	10	1.00	$0.00
Refrigeration	Vending Machine	High Efficiency	0.12	$0.00	10	-	$0.00
Refrigeration	Vending Machine	High Efficiency (2012)	0.18	$0.00	10	1.20	$0.00
Refrigeration	Icemaker	Standard	-	$0.00	12	1.00	$0.00
Refrigeration	Icemaker	Efficient	0.04	$0.00	12	1.12	$0.01
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	1.00	$0.00
Office Equipment	Desktop Computer	Energy Star	0.28	$0.00	4	1.02	$0.00
Office Equipment	Desktop Computer	Climate Savers	0.39	$0.33	4	0.86	$0.22
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	1.00	$0.00
Office Equipment	Laptop Computer	Energy Star	0.03	$0.00	4	1.00	$0.01
Office Equipment	Laptop Computer	Climate Savers	0.04	$0.10	4	0.84	$0.61
Office Equipment	Server	Standard	-	$0.00	3	1.00	$0.00
Office	Server	Energy Star	0.05	$0.00	3	1.00	$0.03

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Equipment							
Office Equipment	Monitor	Standard	-	$0.00	4	1.00	$0.00
Office Equipment	Monitor	Energy Star	0.03	$0.01	4	0.99	$0.04
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	1.00	$0.00
Office Equipment	Printer/copier/fax	Energy Star	0.02	$0.01	6	0.96	$0.06
Office Equipment	POS Terminal	Standard	-	$0.00	4	1.00	$0.00
Office Equipment	POS Terminal	Energy Star	0.00	$0.00	4	0.99	$0.05
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-	$0.00
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.00	$0.06	15	-	$1.06
Miscellaneous	Non-HVAC Motor	High Efficiency	0.01	$0.00	15	1.00	$0.00
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.04	$0.06	15	0.97	$0.12
Miscellaneous	Non-HVAC Motor	Premium	-	$0.00	0	-	$0.00
Miscellaneous	Non-HVAC Motor	Premium (2015)	-	$0.00	0	-	$0.00
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-	$0.00
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	1.00	$0.00

Table C-15 Energy Efficiency Equipment Data, Electric—Extra Large Industrial, Existing Vintage, Washington

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	-	$0.00
Cooling	Central Chiller	0.60 kw/ton, COP 5.9	1.69	$0.33	20	1.10	$0.01
Cooling	Central Chiller	0.58 kw/ton, COP 6.1	1.91	$0.66	20	0.97	$0.02
Cooling	Central Chiller	0.55 kw/Ton, COP 6.4	2.25	$0.93	20	0.95	$0.03
Cooling	Central Chiller	0.51 kw/ton, COP 6.9	2.70	$1.59	20	0.90	$0.04
Cooling	Central Chiller	0.50 kw/Ton, COP 7.0	2.81	$1.92	20	0.87	$0.05
Cooling	Central Chiller	0.48 kw/ton, COP 7.3	3.04	$2.25	20	0.84	$0.05
Cooling	Central Chiller	Variable Refrigerant Flow	3.92	$39.62	20	0.15	$0.72
Cooling	RTU	EER 9.2	-	$0.00	16	-	$0.00
Cooling	RTU	EER 10.1	0.56	$0.39	16	-	$0.06
Cooling	RTU	EER 11.2	1.12	$0.73	16	1.00	$0.05
Cooling	RTU	EER 12.0	1.47	$1.22	16	0.92	$0.07
Cooling	RTU	Ductless VRF	1.79	$10.83	16	0.31	$0.50
Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-	$0.00
Cooling	Heat Pump	EER 10.3, COP 3.2	0.41	$0.92	15	-	$0.19
Cooling	Heat Pump	EER 11.0, COP 3.3	0.65	$2.75	15	1.00	$0.36
Cooling	Heat Pump	EER 11.7, COP 3.4	0.87	$3.66	15	0.95	$0.36
Cooling	Heat Pump	EER 12, COP 3.4	0.95	$4.58	15	0.90	$0.42
Cooling	Heat Pump	Ductless Mini-Split System	1.06	$26.86	20	0.45	$1.80
Space Heating	Electric Resistance	Standard	-	$0.00	25	1.00	$0.00
Space Heating	Furnace	Standard	-	$0.00	18	1.00	$0.00
Space Heating	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-	$0.00
Space Heating	Heat Pump	EER 10.3, COP 3.2	0.13	$0.92	15	-	$0.61
Space Heating	Heat Pump	EER 11.0, COP 3.3	0.25	$2.75	15	1.00	$0.95
Space Heating	Heat Pump	EER 11.7, COP 3.4	0.37	$3.66	15	0.95	$0.87
Space Heating	Heat Pump	EER 12, COP 3.4	0.47	$4.58	15	0.90	$0.84
Space Heating	Heat Pump	Ductless Mini-Split System	1.04	$26.86	20	0.45	$1.83
Space Heating	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-	$0.00
Space Heating	Heat Pump	EER 10.3, COP 3.2	0.13	$0.92	15	-	$0.61
Space Heating	Heat Pump	EER 11.0, COP 3.3	0.25	$2.75	15	1.00	$0.95
Space Heating	Heat Pump	EER 11.7, COP 3.4	0.37	$3.66	15	0.95	$0.87
Space Heating	Heat Pump	EER 12, COP 3.4	0.47	$4.58	15	0.90	$0.84
Space Heating	Heat Pump	Ductless Mini-Split System	1.04	$26.86	20	0.45	$1.83
Ventilation	Ventilation	Constant Volume	-	$0.00	15	1.00	$0.00
Ventilation	Ventilation	Variable Air Volume	8.88	$1.22	15	1.46	$0.01
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	1	-	$0.00
Interior Lighting	Interior Screw-in	Infrared Halogen	0.18	$0.04	1	1.00	$0.20
Interior Lighting	Interior Screw-in	CFL	0.76	$0.02	4	5.79	$0.01
Interior Lighting	Interior Screw-in	LED	0.84	$0.52	12	-	$0.06
Interior Lighting	High Bay Fixtures	Metal Halides	-	$0.00	6	1.00	$0.00
Interior Lighting	High Bay Fixtures	High Pressure Sodium	0.40	-$0.14	9	2.11	-$0.04
Interior Lighting	High Bay Fixtures	T8	0.40	-$0.28	6	4.58	-$0.13
Interior Lighting	High Bay Fixtures	T5	0.51	-$0.28	6	5.58	-$0.10
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	0.09	-$0.01	6	1.12	-$0.02

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Interior Lighting	Linear Fluorescent	Super T8	0.26	$0.08	6	0.88	$0.06
Interior Lighting	Linear Fluorescent	T5	0.27	$0.14	6	0.74	$0.09
Interior Lighting	Linear Fluorescent	LED	0.29	$1.21	15	-	$0.37
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	1	-	$0.00
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.01	$0.00	1	1.00	$0.24
Exterior Lighting	Exterior Screw-in	CFL	0.04	$0.00	4	6.00	$0.01
Exterior Lighting	Exterior Screw-in	Metal Halides	0.04	$0.00	4	3.36	$0.02
Exterior Lighting	Exterior Screw-in	LED	0.04	$0.03	12	-	$0.07
Exterior Lighting	HID	Metal Halides	-	$0.00	6	1.00	$0.00
Exterior Lighting	HID	High Pressure Sodium	0.05	-$0.04	9	2.10	-$0.11
Exterior Lighting	HID	Low Pressure Sodium	0.06	$0.18	9	0.57	$0.42
Process	Process Cooling/Refrigeration	Standard	-	$0.00	10	1.00	$0.00
Process	Process Cooling/Refrigeration	Efficient	18.88	$5.59	10	1.23	$0.04
Process	Process Heating	Standard	-	$0.00	10	1.00	$0.00
Process	Electrochemical Process	Standard	-	$0.00	10	1.00	$0.00
Process	Electrochemical Process	Efficient	13.16	$2.64	10	1.20	$0.02
Machine Drive	Less than 5 HP	Standard	-	$0.00	15	-	$0.00
Machine Drive	Less than 5 HP	High Efficiency	0.00	$0.06	15	-	$0.99
Machine Drive	Less than 5 HP	Standard (2015)	0.01	$0.00	15	1.00	$0.00
Machine Drive	Less than 5 HP	Premium	0.04	$0.06	15	1.04	$0.11
Machine Drive	Less than 5 HP	High Efficiency (2015)	-	$0.00	0	-	$0.00
Machine Drive	Less than 5 HP	Premium (2015)	-	$0.00	0	-	$0.00
Machine Drive	5-24 HP	Standard	-	$0.00	10	1.00	$0.00
Machine Drive	5-24 HP	High	0.01	$0.02	10	1.01	$0.17
Machine Drive	5-24 HP	Premium	-	$0.00	0	-	$0.00
Machine Drive	25-99 HP	Standard	-	$0.00	10	1.00	$0.00
Machine Drive	25-99 HP	High	0.03	$0.02	10	1.01	$0.06
Machine Drive	25-99 HP	Premium	-	$0.00	0	-	$0.00
Machine Drive	100-249 HP	Standard	-	$0.00	10	1.00	$0.00
Machine Drive	100-249 HP	High	0.02	$0.02	10	1.01	$0.10
Machine Drive	100-249 HP	Premium	-	$0.00	0	-	$0.00
Machine Drive	250-499 HP	Standard	-	$0.00	10	1.00	$0.00

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Machine Drive	250-499 HP	High	0.06	$0.02	10	1.01	$0.03
Machine Drive	250-499 HP	Premium	-	$0.00	0	-	$0.00
Machine Drive	500 and more HP	Standard	-	$0.00	10	1.00	$0.00
Machine Drive	500 and more HP	High	0.10	$0.02	10	1.01	$0.02
Machine Drive	500 and more HP	Premium	-	$0.00	0	-	$0.00
Miscellaneous	Miscellaneous	Miscellaneous	-	$0.00	5	1.00	$0.00

Table C-16 Energy Efficiency Equipment Data, Electric— Extra Large Industrial, New Vintage, Washington

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	-	$0.00
Cooling	Central Chiller	0.60 kw/ton, COP 5.9	1.58	$0.33	20	1.10	$0.01
Cooling	Central Chiller	0.58 kw/ton, COP 6.1	1.79	$0.66	20	0.97	$0.03
Cooling	Central Chiller	0.55 kw/Ton, COP 6.4	2.11	$0.93	20	0.95	$0.03
Cooling	Central Chiller	0.51 kw/ton, COP 6.9	2.53	$1.59	20	0.89	$0.04
Cooling	Central Chiller	0.50 kw/Ton, COP 7.0	2.63	$1.92	20	0.86	$0.05
Cooling	Central Chiller	0.48 kw/ton, COP 7.3	2.84	$2.25	20	0.83	$0.06
Cooling	Central Chiller	Variable Refrigerant Flow	3.67	$39.62	20	0.15	$0.76
Cooling	RTU	EER 9.2	-	$0.00	16	-	$0.00
Cooling	RTU	EER 10.1	0.56	$0.39	16	-	$0.06
Cooling	RTU	EER 11.2	1.12	$0.74	16	1.00	$0.05
Cooling	RTU	EER 12.0	1.47	$1.23	16	0.92	$0.07
Cooling	RTU	Ductless VRF	1.79	$10.88	16	0.30	$0.50
Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-	$0.00
Cooling	Heat Pump	EER 10.3, COP 3.2	0.39	$0.92	15	-	$0.20
Cooling	Heat Pump	EER 11.0, COP 3.3	0.62	$2.75	15	1.00	$0.38
Cooling	Heat Pump	EER 11.7, COP 3.4	0.83	$3.66	15	0.95	$0.38
Cooling	Heat Pump	EER 12, COP 3.4	0.91	$4.58	15	0.90	$0.43
Cooling	Heat Pump	Ductless Mini-Split System	1.01	$26.86	20	0.45	$1.88
Space Heating	Electric Resistance	Standard	-	$0.00	25	1.00	$0.00
Space Heating	Furnace	Standard	-	$0.00	18	1.00	$0.00
Space Heating	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-	$0.00
Space Heating	Heat Pump	EER 10.3, COP 3.2	0.13	$0.92	15	-	$0.62
Space Heating	Heat Pump	EER 11.0, COP 3.3	0.25	$2.75	15	1.00	$0.96
Space Heating	Heat Pump	EER 11.7, COP 3.4	0.36	$3.66	15	0.95	$0.88
Space Heating	Heat Pump	EER 12, COP 3.4	0.47	$4.58	15	0.90	$0.85
Space Heating	Heat Pump	Ductless Mini-Split System	1.02	$26.86	20	0.45	$1.86
Space Heating	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-	$0.00
Space Heating	Heat Pump	EER 10.3, COP 3.2	0.13	$0.92	15	-	$0.62
Space Heating	Heat Pump	EER 11.0, COP 3.3	0.25	$2.75	15	1.00	$0.96
Space Heating	Heat Pump	EER 11.7, COP 3.4	0.36	$3.66	15	0.95	$0.88
Space Heating	Heat Pump	EER 12, COP 3.4	0.47	$4.58	15	0.90	$0.85
Space Heating	Heat Pump	Ductless Mini-Split System	1.02	$26.86	20	0.45	$1.86
Ventilation	Ventilation	Constant Volume	-	$0.00	15	1.00	$0.00
Ventilation	Ventilation	Variable Air Volume	13.69	$1.22	15	1.63	$0.01
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	1	-	$0.00
Interior Lighting	Interior Screw-in	Infrared Halogen	0.21	$0.04	1	1.00	$0.18
Interior Lighting	Interior Screw-in	CFL	0.85	$0.02	4	5.65	$0.00
Interior Lighting	Interior Screw-in	LED	0.94	$0.52	12	-	$0.06
Interior Lighting	High Bay Fixtures	Metal Halides	-	$0.00	6	1.00	$0.00
Interior Lighting	High Bay Fixtures	High Pressure Sodium	0.40	-$0.14	9	2.11	-$0.04
Interior Lighting	High Bay Fixtures	T8	0.40	-$0.28	6	4.58	-$0.13
Interior Lighting	High Bay Fixtures	T5	0.51	-$0.28	6	5.58	-$0.10
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	0.09	-$0.01	6	1.12	-$0.02

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Interior Lighting	Linear Fluorescent	Super T8	0.27	$0.08	6	0.89	$0.06
Interior Lighting	Linear Fluorescent	T5	0.28	$0.14	6	0.75	$0.09
Interior Lighting	Linear Fluorescent	LED	0.29	$1.21	15	-	$0.36
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	1	-	$0.00
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.01	$0.00	1	1.00	$0.24
Exterior Lighting	Exterior Screw-in	CFL	0.04	$0.00	4	6.00	$0.01
Exterior Lighting	Exterior Screw-in	Metal Halides	0.04	$0.00	4	3.36	$0.02
Exterior Lighting	Exterior Screw-in	LED	0.04	$0.03	12	-	$0.07
Exterior Lighting	HID	Metal Halides	-	$0.00	6	1.00	$0.00
Exterior Lighting	HID	High Pressure Sodium	0.05	-$0.04	9	2.10	-$0.11
Exterior Lighting	HID	Low Pressure Sodium	0.06	$0.18	9	0.57	$0.42
Process	Process Cooling/Refrigeration	Standard	-	$0.00	10	1.00	$0.00
Process	Process Cooling/Refrigeration	Efficient	18.88	$5.59	10	1.23	$0.04
Process	Process Heating	Standard	-	$0.00	10	1.00	$0.00
Process	Electrochemical Process	Standard	-	$0.00	10	1.00	$0.00
Process	Electrochemical Process	Efficient	13.16	$2.64	10	1.20	$0.02
Machine Drive	Less than 5 HP	Standard	-	$0.00	15	-	$0.00
Machine Drive	Less than 5 HP	High Efficiency	0.00	$0.06	15	-	$0.99
Machine Drive	Less than 5 HP	Standard (2015)	0.01	$0.00	15	1.00	$0.00
Machine Drive	Less than 5 HP	Premium	0.04	$0.06	15	1.04	$0.11
Machine Drive	Less than 5 HP	High Efficiency (2015)	-	$0.00	0	-	$0.00
Machine Drive	Less than 5 HP	Premium (2015)	-	$0.00	0	-	$0.00
Machine Drive	5-24 HP	Standard	-	$0.00	10	1.00	$0.00
Machine Drive	5-24 HP	High	0.01	$0.02	10	1.01	$0.17
Machine Drive	5-24 HP	Premium	-	$0.00	0	-	$0.00
Machine Drive	25-99 HP	Standard	-	$0.00	10	1.00	$0.00
Machine Drive	25-99 HP	High	0.03	$0.02	10	1.01	$0.06
Machine Drive	25-99 HP	Premium	-	$0.00	0	-	$0.00
Machine Drive	100-249 HP	Standard	-	$0.00	10	1.00	$0.00
Machine Drive	100-249 HP	High	0.02	$0.02	10	1.01	$0.10
Machine Drive	100-249 HP	Premium	-	$0.00	0	-	$0.00
Machine Drive	250-499 HP	Standard	-	$0.00	10	1.00	$0.00

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Machine Drive	250-499 HP	High	0.06	$0.02	10	1.01	$0.03
Machine Drive	250-499 HP	Premium	-	$0.00	0	-	$0.00
Machine Drive	500 and more HP	Standard	-	$0.00	10	1.00	$0.00
Machine Drive	500 and more HP	High	0.10	$0.02	10	1.01	$0.02
Machine Drive	500 and more HP	Premium	-	$0.00	0	-	$0.00
Miscellaneous	Miscellaneous	Miscellaneous	-	$0.00	5	1.00	$0.00

Table C-17 Energy Efficiency Equipment Data, Electric—Extra Large Industrial, Existing Vintage, Idaho

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	-	$0.00
Cooling	Central Chiller	0.60 kw/ton, COP 5.9	1.69	$0.33	20	1.10	$0.01
Cooling	Central Chiller	0.58 kw/ton, COP 6.1	1.91	$0.66	20	0.97	$0.02
Cooling	Central Chiller	0.55 kw/Ton, COP 6.4	2.25	$0.93	20	0.95	$0.03
Cooling	Central Chiller	0.51 kw/ton, COP 6.9	2.70	$1.59	20	0.90	$0.04
Cooling	Central Chiller	0.50 kw/Ton, COP 7.0	2.81	$1.92	20	0.87	$0.05
Cooling	Central Chiller	0.48 kw/ton, COP 7.3	3.04	$2.25	20	0.84	$0.05
Cooling	Central Chiller	Variable Refrigerant Flow	3.92	$39.62	20	0.15	$0.72
Cooling	RTU	EER 9.2	-	$0.00	16	-	$0.00
Cooling	RTU	EER 10.1	0.56	$0.39	16	-	$0.06
Cooling	RTU	EER 11.2	1.12	$0.73	16	1.00	$0.05
Cooling	RTU	EER 12.0	1.47	$1.22	16	0.92	$0.07
Cooling	RTU	Ductless VRF	1.79	$10.83	16	0.31	$0.50
Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-	$0.00
Cooling	Heat Pump	EER 10.3, COP 3.2	0.41	$0.92	15	-	$0.19
Cooling	Heat Pump	EER 11.0, COP 3.3	0.65	$2.75	15	1.00	$0.36
Cooling	Heat Pump	EER 11.7, COP 3.4	0.87	$3.66	15	0.95	$0.36
Cooling	Heat Pump	EER 12, COP 3.4	0.95	$4.58	15	0.90	$0.42
Cooling	Heat Pump	Ductless Mini-Split System	1.06	$26.86	20	0.45	$1.80
Space Heating	Electric Resistance	Standard	-	$0.00	25	1.00	$0.00
Space Heating	Furnace	Standard	-	$0.00	18	1.00	$0.00
Space Heating	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-	$0.00
Space Heating	Heat Pump	EER 10.3, COP 3.2	0.13	$0.92	15	-	$0.61
Space Heating	Heat Pump	EER 11.0, COP 3.3	0.25	$2.75	15	1.00	$0.95
Space Heating	Heat Pump	EER 11.7, COP 3.4	0.37	$3.66	15	0.95	$0.87
Space Heating	Heat Pump	EER 12, COP 3.4	0.47	$4.58	15	0.90	$0.84
Space Heating	Heat Pump	Ductless Mini-Split System	1.04	$26.86	20	0.45	$1.83
Space Heating	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-	$0.00
Space Heating	Heat Pump	EER 10.3, COP 3.2	0.13	$0.92	15	-	$0.61
Space Heating	Heat Pump	EER 11.0, COP 3.3	0.25	$2.75	15	1.00	$0.95
Space Heating	Heat Pump	EER 11.7, COP 3.4	0.37	$3.66	15	0.95	$0.87
Space Heating	Heat Pump	EER 12, COP 3.4	0.47	$4.58	15	0.90	$0.84
Space Heating	Heat Pump	Ductless Mini-Split System	1.04	$26.86	20	0.45	$1.83
Ventilation	Ventilation	Constant Volume	-	$0.00	15	1.00	$0.00
Ventilation	Ventilation	Variable Air Volume	8.88	$1.22	15	1.46	$0.01
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	1	-	$0.00
Interior Lighting	Interior Screw-in	Infrared Halogen	0.18	$0.04	1	1.00	$0.20
Interior Lighting	Interior Screw-in	CFL	0.76	$0.02	4	5.79	$0.01
Interior Lighting	Interior Screw-in	LED	0.84	$0.52	12	-	$0.06
Interior Lighting	High Bay Fixtures	Metal Halides	-	$0.00	6	1.00	$0.00
Interior Lighting	High Bay Fixtures	High Pressure Sodium	0.40	-$0.14	9	2.11	-$0.04
Interior Lighting	High Bay Fixtures	T8	0.40	-$0.28	6	4.58	-$0.13
Interior Lighting	High Bay Fixtures	T5	0.51	-$0.28	6	5.58	-$0.10
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	0.09	-$0.01	6	1.12	-$0.02

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Interior Lighting	Linear Fluorescent	Super T8	0.26	$0.08	6	0.88	$0.06
Interior Lighting	Linear Fluorescent	T5	0.27	$0.14	6	0.74	$0.09
Interior Lighting	Linear Fluorescent	LED	0.29	$1.21	15	-	$0.37
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	1	-	$0.00
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.01	$0.00	1	1.00	$0.24
Exterior Lighting	Exterior Screw-in	CFL	0.04	$0.00	4	6.00	$0.01
Exterior Lighting	Exterior Screw-in	Metal Halides	0.04	$0.00	4	3.36	$0.02
Exterior Lighting	Exterior Screw-in	LED	0.04	$0.03	12	-	$0.07
Exterior Lighting	HID	Metal Halides	-	$0.00	6	1.00	$0.00
Exterior Lighting	HID	High Pressure Sodium	0.05	-$0.04	9	2.10	-$0.11
Exterior Lighting	HID	Low Pressure Sodium	0.06	$0.18	9	0.57	$0.42
Process	Process Cooling/Refrigeration	Standard	-	$0.00	10	1.00	$0.00
Process	Process Cooling/Refrigeration	Efficient	18.88	$5.59	10	1.23	$0.04
Process	Process Heating	Standard	-	$0.00	10	1.00	$0.00
Process	Electrochemical Process	Standard	-	$0.00	10	1.00	$0.00
Process	Electrochemical Process	Efficient	13.16	$2.64	10	1.20	$0.02
Machine Drive	Less than 5 HP	Standard	-	$0.00	15	-	$0.00
Machine Drive	Less than 5 HP	High Efficiency	0.00	$0.06	15	-	$0.99
Machine Drive	Less than 5 HP	Standard (2015)	0.01	$0.00	15	1.00	$0.00
Machine Drive	Less than 5 HP	Premium	0.04	$0.06	15	1.04	$0.11
Machine Drive	Less than 5 HP	High Efficiency (2015)	-	$0.00	0	-	$0.00
Machine Drive	Less than 5 HP	Premium (2015)	-	$0.00	0	-	$0.00
Machine Drive	5-24 HP	Standard	-	$0.00	10	1.00	$0.00
Machine Drive	5-24 HP	High	0.01	$0.02	10	1.01	$0.17
Machine Drive	5-24 HP	Premium	-	$0.00	0	-	$0.00
Machine Drive	25-99 HP	Standard	-	$0.00	10	1.00	$0.00
Machine Drive	25-99 HP	High	0.03	$0.02	10	1.01	$0.06
Machine Drive	25-99 HP	Premium	-	$0.00	0	-	$0.00
Machine Drive	100-249 HP	Standard	-	$0.00	10	1.00	$0.00
Machine Drive	100-249 HP	High	0.02	$0.02	10	1.01	$0.10
Machine Drive	100-249 HP	Premium	-	$0.00	0	-	$0.00
Machine Drive	250-499 HP	Standard	-	$0.00	10	1.00	$0.00

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Machine Drive	250-499 HP	High	0.06	$0.02	10	1.01	$0.03
Machine Drive	250-499 HP	Premium	-	$0.00	0	-	$0.00
Machine Drive	500 and more HP	Standard	-	$0.00	10	1.00	$0.00
Machine Drive	500 and more HP	High	0.10	$0.02	10	1.01	$0.02
Machine Drive	500 and more HP	Premium	-	$0.00	0	-	$0.00
Miscellaneous	Miscellaneous	Miscellaneous	-	$0.00	5	1.00	$0.00

Table C-18 Energy Efficiency Equipment Data, Electric— Extra Large Industrial, New Vintage, Idaho

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Cooling	Central Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	-	$0.00
Cooling	Central Chiller	0.60 kw/ton, COP 5.9	1.58	$0.33	20	1.10	$0.01
Cooling	Central Chiller	0.58 kw/ton, COP 6.1	1.79	$0.66	20	0.97	$0.03
Cooling	Central Chiller	0.55 kw/Ton, COP 6.4	2.11	$0.93	20	0.95	$0.03
Cooling	Central Chiller	0.51 kw/ton, COP 6.9	2.53	$1.59	20	0.89	$0.04
Cooling	Central Chiller	0.50 kw/Ton, COP 7.0	2.63	$1.92	20	0.86	$0.05
Cooling	Central Chiller	0.48 kw/ton, COP 7.3	2.84	$2.25	20	0.83	$0.06
Cooling	Central Chiller	Variable Refrigerant Flow	3.67	$39.62	20	0.15	$0.76
Cooling	RTU	EER 9.2	-	$0.00	16	-	$0.00
Cooling	RTU	EER 10.1	0.56	$0.39	16	-	$0.06
Cooling	RTU	EER 11.2	1.12	$0.74	16	1.00	$0.05
Cooling	RTU	EER 12.0	1.47	$1.23	16	0.92	$0.07
Cooling	RTU	Ductless VRF	1.79	$10.88	16	0.30	$0.50
Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-	$0.00
Cooling	Heat Pump	EER 10.3, COP 3.2	0.39	$0.92	15	-	$0.20
Cooling	Heat Pump	EER 11.0, COP 3.3	0.62	$2.75	15	1.00	$0.38
Cooling	Heat Pump	EER 11.7, COP 3.4	0.83	$3.66	15	0.95	$0.38
Cooling	Heat Pump	EER 12, COP 3.4	0.91	$4.58	15	0.90	$0.43
Cooling	Heat Pump	Ductless Mini-Split System	1.01	$26.86	20	0.45	$1.88
Space Heating	Electric Resistance	Standard	-	$0.00	25	1.00	$0.00
Space Heating	Furnace	Standard	-	$0.00	18	1.00	$0.00
Space Heating	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-	$0.00
Space Heating	Heat Pump	EER 10.3, COP 3.2	0.13	$0.92	15	-	$0.62
Space Heating	Heat Pump	EER 11.0, COP 3.3	0.25	$2.75	15	1.00	$0.96
Space Heating	Heat Pump	EER 11.7, COP 3.4	0.36	$3.66	15	0.95	$0.88
Space Heating	Heat Pump	EER 12, COP 3.4	0.47	$4.58	15	0.90	$0.85
Space Heating	Heat Pump	Ductless Mini-Split System	1.02	$26.86	20	0.45	$1.86
Space Heating	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-	$0.00
Space Heating	Heat Pump	EER 10.3, COP 3.2	0.13	$0.92	15	-	$0.62
Space Heating	Heat Pump	EER 11.0, COP 3.3	0.25	$2.75	15	1.00	$0.96
Space Heating	Heat Pump	EER 11.7, COP 3.4	0.36	$3.66	15	0.95	$0.88
Space Heating	Heat Pump	EER 12, COP 3.4	0.47	$4.58	15	0.90	$0.85
Space Heating	Heat Pump	Ductless Mini-Split System	1.02	$26.86	20	0.45	$1.86
Ventilation	Ventilation	Constant Volume	-	$0.00	15	1.00	$0.00
Ventilation	Ventilation	Variable Air Volume	13.69	$1.22	15	1.63	$0.01
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	1	-	$0.00
Interior Lighting	Interior Screw-in	Infrared Halogen	0.21	$0.04	1	1.00	$0.18
Interior Lighting	Interior Screw-in	CFL	0.85	$0.02	4	5.65	$0.00
Interior Lighting	Interior Screw-in	LED	0.94	$0.52	12	-	$0.06
Interior Lighting	High Bay Fixtures	Metal Halides	-	$0.00	6	1.00	$0.00
Interior Lighting	High Bay Fixtures	High Pressure Sodium	0.40	-$0.14	9	2.11	-$0.04
Interior Lighting	High Bay Fixtures	T8	0.40	-$0.28	6	4.58	-$0.13
Interior Lighting	High Bay Fixtures	T5	0.51	-$0.28	6	5.58	-$0.10
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	1.00	$0.00
Interior Lighting	Linear Fluorescent	T8	0.09	-$0.01	6	1.12	-$0.02

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Interior Lighting	Linear Fluorescent	Super T8	0.27	$0.08	6	0.89	$0.06
Interior Lighting	Linear Fluorescent	T5	0.28	$0.14	6	0.75	$0.09
Interior Lighting	Linear Fluorescent	LED	0.29	$1.21	15	-	$0.36
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	1	-	$0.00
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.01	$0.00	1	1.00	$0.24
Exterior Lighting	Exterior Screw-in	CFL	0.04	$0.00	4	6.00	$0.01
Exterior Lighting	Exterior Screw-in	Metal Halides	0.04	$0.00	4	3.36	$0.02
Exterior Lighting	Exterior Screw-in	LED	0.04	$0.03	12	-	$0.07
Exterior Lighting	HID	Metal Halides	-	$0.00	6	1.00	$0.00
Exterior Lighting	HID	High Pressure Sodium	0.05	-$0.04	9	2.10	-$0.11
Exterior Lighting	HID	Low Pressure Sodium	0.06	$0.18	9	0.57	$0.42
Process	Process Cooling/Refrigeration	Standard	-	$0.00	10	1.00	$0.00
Process	Process Cooling/Refrigeration	Efficient	18.88	$5.59	10	1.23	$0.04
Process	Process Heating	Standard	-	$0.00	10	1.00	$0.00
Process	Electrochemical Process	Standard	-	$0.00	10	1.00	$0.00
Process	Electrochemical Process	Efficient	13.16	$2.64	10	1.20	$0.02
Machine Drive	Less than 5 HP	Standard	-	$0.00	15	-	$0.00
Machine Drive	Less than 5 HP	High Efficiency	0.00	$0.06	15	-	$0.99
Machine Drive	Less than 5 HP	Standard (2015)	0.01	$0.00	15	1.00	$0.00
Machine Drive	Less than 5 HP	Premium	0.04	$0.06	15	1.04	$0.11
Machine Drive	Less than 5 HP	High Efficiency (2015)	-	$0.00	0	-	$0.00
Machine Drive	Less than 5 HP	Premium (2015)	-	$0.00	0	-	$0.00
Machine Drive	5-24 HP	Standard	-	$0.00	10	1.00	$0.00
Machine Drive	5-24 HP	High	0.01	$0.02	10	1.01	$0.17
Machine Drive	5-24 HP	Premium	-	$0.00	0	-	$0.00
Machine Drive	25-99 HP	Standard	-	$0.00	10	1.00	$0.00
Machine Drive	25-99 HP	High	0.03	$0.02	10	1.01	$0.06
Machine Drive	25-99 HP	Premium	-	$0.00	0	-	$0.00
Machine Drive	100-249 HP	Standard	-	$0.00	10	1.00	$0.00
Machine Drive	100-249 HP	High	0.02	$0.02	10	1.01	$0.10
Machine Drive	100-249 HP	Premium	-	$0.00	0	-	$0.00
Machine Drive	250-499 HP	Standard	-	$0.00	10	1.00	$0.00

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Machine Drive	250-499 HP	High	0.06	$0.02	10	1.01	$0.03
Machine Drive	250-499 HP	Premium	-	$0.00	0	-	$0.00
Machine Drive	500 and more HP	Standard	-	$0.00	10	1.00	$0.00
Machine Drive	500 and more HP	High	0.10	$0.02	10	1.01	$0.02
Machine Drive	500 and more HP	Premium	-	$0.00	0	-	$0.00
Miscellaneous	Miscellaneous	Miscellaneous	-	$0.00	5	1.00	$0.00

Table C-19 Energy Efficiency Non-Equipment Data—Small/Medium Commercial, Existing Vintage, Washington

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/Sq Ft)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
RTU - Maintenance	14.0%	100.0%	4	$0.08	0.4	0.22	$0.060
RTU - Evaporative Precooler	0.0%	0.0%	15	$0.88	1.2	0.21	$0.061
Chiller - Chilled Water Reset	0.0%	0.0%	4	$0.86	0.4	0.03	$0.529
Chiller - Chilled Water Variable-Flow System	0.0%	0.0%	10	$0.86	0.1	0.02	$1.018
Chiller - VSD	0.0%	0.0%	20	$1.17	0.8	0.11	$0.105
Chiller - High Efficiency Cooling Tower Fans	0.0%	0.0%	10	$0.04	0.0	0.00	$10.961
Chiller - Condenser Water Temprature Reset	0.0%	0.0%	14	$0.87	0.4	0.07	$0.206
Cooling - Economizer Installation	51.8%	65.0%	15	$0.15	0.6	0.64	$0.020
Heat Pump - Maintenance	28.1%	100.0%	4	$0.03	0.9	1.42	$0.009
Insulation - Ducting	9.0%	100.0%	20	$0.41	0.2	0.36	$0.136
Repair and Sealing - Ducting	5.0%	50.0%	15	$0.38	0.7	0.47	$0.048
Energy Management System	34.8%	100.0%	14	$0.35	0.8	0.37	$0.040
Cooking - Exhaust Hoods with Sensor Control	1.0%	20.0%	10	$0.04	-	-	$0.000
Fans - Energy Efficient Motors	11.0%	100.0%	10	$0.05	0.1	0.25	$0.057
Fans - Variable Speed Control	10.9%	100.0%	10	$0.20	0.7	0.32	$0.033
Retrocommissioning - HVAC	15.0%	100.0%	4	$0.60	0.6	0.35	$0.280
Pumps - Variable Speed Control	0.0%	45.0%	10	$0.44	0.0	0.00	$5.336
Thermostat - Clock/Programmable	38.7%	50.0%	11	$0.11	0.3	0.32	$0.044
Insulation - Ceiling	19.0%	90.0%	20	$0.64	0.7	0.43	$0.066
Insulation - Radiant Barrier	10.3%	25.0%	20	$0.26	0.4	0.45	$0.050
Roofs - High Reflectivity	3.3%	100.0%	15	$0.18	0.2	0.21	$0.063
Windows - High Efficiency	66.1%	100.0%	20	$0.44	1.0	0.52	$0.032
Interior Lighting - Central Lighting Controls	81.2%	100.0%	8	$0.65	0.2	0.02	$0.581
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	0.9%	60.0%	8	$0.50	0.8	0.14	$0.085
Exterior Lighting - Daylighting Controls	1.6%	100.0%	8	$0.11	0.5	0.28	$0.029
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	10.0%	30.0%	8	$0.50	0.3	0.06	$0.212
Interior Fluorescent - High Bay Fixtures	10.0%	30.0%	11	$0.70	1.7	0.21	$0.046
Interior Lighting - Occupancy Sensors	7.1%	60.0%	8	$0.20	0.2	0.14	$0.179
Exterior Lighting - Photovoltaic Installation	5.0%	25.0%	5	$0.92	0.6	0.03	$0.307
Interior Screw-in - Task Lighting	25.0%	100.0%	5	$0.24	0.1	0.02	$0.500
Interior Lighting - Time Clocks and Timers	9.1%	75.0%	8	$0.20	0.1	0.07	$0.357
Water Heater - Faucet Aerators/Low Flow Nozzles	50.5%	100.0%	9	$0.01	0.1	0.68	$0.016
Water Heater - Pipe Insulation	45.6%	100.0%	15	$0.28	0.1	0.04	$0.216
Water Heater - High Efficiency Circulation Pump	0.0%	0.0%	10	$0.11	1.4	1.11	$0.009
Water Heater - Tank Blanket/Insulation	68.0%	100.0%	10	$0.02	0.1	0.44	$0.024
Water Heater - Thermostat Setback	5.0%	100.0%	10	$0.11	0.1	0.06	$0.163
Refrigeration - Anti-Sweat Heater/Auto Door Closer	0.0%	100.0%	16	$0.20	0.1	0.03	$0.264
Refrigeration - Floating Head Pressure	17.9%	50.0%	16	$0.35	0.0	0.01	$1.061
Refrigeration - Door Gasket Replacement	5.0%	100.0%	8	$0.10	0.0	0.01	$0.710
Insulation - Bare Suction Lines	5.0%	100.0%	8	$0.10	0.0	0.02	$0.525
Refrigeration - Night Covers	5.0%	100.0%	8	$0.05	0.0	0.02	$2.859
Refrigeration - Strip Curtain	5.0%	56.3%	4	$0.00	-	-	$0.000
Vending Machine - Controller	2.0%	10.0%	10	$0.27	0.0	0.01	$0.701
LED Exit Lighting	46.9%	90.0%	10	$0.00	0.0	4.04	$0.006
Retrocommissioning - Lighting	5.0%	100.0%	5	$0.10	0.3	0.15	$0.081
Refrigeration - High Efficiency Case	12.0%	56.0%	6	$0.04	0.0	0.01	$1.656

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/Sq Ft)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Lighting							
Exterior Lighting - Cold Cathode Lighting	14.6%	50.0%	5	$0.00	0.4	16.94	$0.001
Laundry - High Efficiency Clothes Washer	6.9%	10.0%	10	$0.00	0.0	4.82	$0.002
Interior Lighting - Hotel Guestroom Controls	0.0%	0.0%	8	$0.14	0.1	0.04	$0.211
Miscellaneous - Energy Star Water Cooler	5.0%	100.0%	8	$0.00	0.0	0.27	$0.044
Interior Lighting - Skylights	0.0%	0.0%	0	$0.00	0.2	1.00	$0.000
Ventilation - Demand Control Ventilation	6.4%	20.0%	10	$0.04	0.1	0.52	$0.065
Office Equipment - Smart Power Strips	15.4%	30.0%	7	$0.00	0.4	286.03	$0.000
Strategic Energy Management	0.0%	0.0%	3	$0.00	-	6.00	$0.000
Refrigeration - Multiplex - Floating section Pressure - Air-cooled Cond.	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex Controls - Floating section Pressure - Evap. Cond.	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex - Eff. Air-cooled Condenser	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex - Eff. Water-cooled Condenser	0.0%	0.0%	0	$0.00	-	1.00	$0.000
RTU - Maintenance	14.0%	100.0%	4	$0.08	0.4	0.22	$0.060
RTU - Evaporative Precooler	0.0%	0.0%	15	$0.88	1.2	0.21	$0.061
Chiller - Chilled Water Reset	0.0%	0.0%	4	$0.86	0.4	0.03	$0.529
Chiller - Chilled Water Variable-Flow System	0.0%	0.0%	10	$0.86	0.1	0.02	$1.018
Chiller - VSD	0.0%	0.0%	20	$1.17	0.8	0.11	$0.105
Chiller - High Efficiency Cooling Tower Fans	0.0%	0.0%	10	$0.04	0.0	0.00	$10.961
Chiller - Condenser Water Temprature Reset	0.0%	0.0%	14	$0.87	0.4	0.07	$0.206
Cooling - Economizer Installation	51.8%	65.0%	15	$0.15	0.6	0.64	$0.020
Heat Pump - Maintenance	28.1%	100.0%	4	$0.03	0.9	1.42	$0.009
Insulation - Ducting	9.0%	100.0%	20	$0.41	0.2	0.36	$0.136
Repair and Sealing - Ducting	5.0%	50.0%	15	$0.38	0.7	0.47	$0.048
Energy Management System	34.8%	100.0%	14	$0.35	0.8	0.37	$0.040
Cooking - Exhaust Hoods with Sensor Control	1.0%	20.0%	10	$0.04	-	-	$0.000
Fans - Energy Efficient Motors	11.0%	100.0%	10	$0.05	0.1	0.25	$0.057
Fans - Variable Speed Control	10.9%	100.0%	10	$0.20	0.7	0.32	$0.033
Retrocommissioning - HVAC	15.0%	100.0%	4	$0.60	0.6	0.35	$0.280
Pumps - Variable Speed Control	0.0%	45.0%	10	$0.44	0.0	0.00	$5.336
Thermostat - Clock/Programmable	38.7%	50.0%	11	$0.11	0.3	0.32	$0.044
Insulation - Ceiling	19.0%	90.0%	20	$0.64	0.7	0.43	$0.066
Insulation - Radiant Barrier	10.3%	25.0%	20	$0.26	0.4	0.45	$0.050

Table C-20 Energy Efficiency Non-Equipment Data— Small/ Medium Commercial, New Vintage, Washington

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
RTU - Maintenance	14.0%	100.0%	4	$0.08	0.2	0.14	$0.102
RTU - Evaporative Precooler	0.0%	0.0%	15	$0.88	1.0	0.18	$0.073
Chiller - Chilled Water Reset	0.0%	0.0%	4	$0.86	0.4	0.02	$0.641
Chiller - Chilled Water Variable-Flow System	0.0%	0.0%	10	$0.86	0.1	0.02	$0.823
Chiller - VSD	0.0%	0.0%	20	$1.17	0.7	0.10	$0.122
Chiller - High Efficiency Cooling Tower Fans	0.0%	0.0%	10	$0.04	0.0	0.00	$8.973
Chiller - Condenser Water Temprature Reset	0.0%	0.0%	14	$0.87	0.3	0.06	$0.247
Cooling - Economizer Installation	51.8%	65.0%	15	$0.15	-	0.28	$0.000
Heat Pump - Maintenance	28.1%	100.0%	4	$0.03	0.5	0.96	$0.015
Insulation - Ducting	9.0%	50.0%	20	$0.41	-	0.32	$0.000
Energy Management System	27.7%	100.0%	14	$0.35	1.9	0.63	$0.017
Cooking - Exhaust Hoods with Sensor Control	1.0%	20.0%	10	$0.04	-	-	$0.000
Fans - Energy Efficient Motors	11.0%	100.0%	10	$0.05	0.1	0.17	$0.067
Fans - Variable Speed Control	8.0%	100.0%	10	$0.20	0.5	0.25	$0.044
Pumps - Variable Speed Control	5.0%	45.0%	10	$0.44	0.0	0.00	$5.075
Thermostat - Clock/Programmable	34.0%	50.0%	11	$0.11	1.0	0.86	$0.012
Insulation - Ceiling	15.3%	90.0%	20	$0.16	-	0.38	$0.000
Insulation - Radiant Barrier	7.0%	25.0%	20	$0.26	-	0.30	$0.000
Roofs - High Reflectivity	5.0%	100.0%	15	$0.09	-	0.07	$0.000
Windows - High Efficiency	60.5%	100.0%	20	$0.35	-	0.31	$0.000
Interior Lighting - Central Lighting Controls	81.2%	100.0%	8	$0.65	-	-	$0.000
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	0.9%	60.0%	8	$0.38	0.7	0.16	$0.074
Exterior Lighting - Daylighting Controls	10.0%	100.0%	8	$0.09	-	0.00	$0.000
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	10.0%	30.0%	8	$0.50	0.3	0.05	$0.243
Interior Fluorescent - High Bay Fixtures	10.0%	30.0%	11	$0.70	1.5	0.20	$0.052
Interior Lighting - Occupancy Sensors	7.1%	60.0%	8	$0.20	-	0.07	$0.000
Exterior Lighting - Photovoltaic Installation	5.0%	25.0%	5	$0.92	-	-	$0.000
Interior Screw-in - Task Lighting	25.0%	100.0%	5	$0.24	0.1	0.03	$0.507
Interior Lighting - Time Clocks and Timers	9.1%	75.0%	8	$0.20	-	0.05	$0.000
Water Heater - Faucet Aerators/Low Flow Nozzles	50.5%	100.0%	9	$0.01	0.1	0.67	$0.017
Water Heater - Pipe Insulation	45.6%	100.0%	15	$0.28	0.1	0.04	$0.227
Water Heater - High Efficiency Circulation Pump	0.0%	0.0%	10	$0.11	1.3	1.09	$0.010
Water Heater - Tank Blanket/Insulation	40.4%	100.0%	10	$0.02	0.0	0.21	$0.051
Water Heater - Thermostat Setback	10.0%	100.0%	10	$0.11	0.1	0.06	$0.174
Refrigeration - Anti-Sweat Heater/Auto Door Closer	0.0%	100.0%	16	$0.20	0.1	0.03	$0.289
Refrigeration - Floating Head Pressure	17.9%	50.0%	16	$0.35	-	0.00	$0.000
Refrigeration - Door Gasket Replacement	5.0%	100.0%	8	$0.10	0.0	0.01	$1.014
Insulation - Bare Suction Lines	5.0%	100.0%	8	$0.10	-	-	$0.000
Refrigeration - Night Covers	5.0%	100.0%	8	$0.05	0.0	0.02	$3.122
Refrigeration - Strip Curtain	5.0%	56.3%	4	$0.00	-	-	$0.000
Vending Machine - Controller	2.0%	10.0%	10	$0.27	0.0	0.01	$0.804
LED Exit Lighting	91.2%	90.0%	10	$0.00	0.0	5.42	$0.006
Refrigeration - High Efficiency Case	26.1%	56.0%	6	$0.02	0.0	0.38	$0.559

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Lighting							
Exterior Lighting - Cold Cathode Lighting	14.6%	50.0%	5	$0.00	0.3	20.03	$0.001
Laundry - High Efficiency Clothes Washer	6.9%	10.0%	10	$0.00	0.0	5.78	$0.002
Interior Lighting - Hotel Guestroom Controls	0.0%	0.0%	8	$0.14	0.1	0.06	$0.213
Miscellaneous - Energy Star Water Cooler	5.0%	100.0%	8	$0.00	0.0	0.33	$0.037
Interior Lighting - Skylights	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Ventilation - Demand Control Ventilation	12.9%	20.0%	10	$0.04	-	0.38	$0.000
Office Equipment - Smart Power Strips	15.4%	30.0%	7	$0.00	0.5	393.51	$0.000
Strategic Energy Management	0.0%	0.0%	3	$0.00	-	6.00	$0.000
Refrigeration - Multiplex - Floating section Pressure - Air-cooled Cond.	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex Controls - Floating section Pressure - Evap. Cond.	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex - Eff. Air-cooled Condenser	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex - Eff. Water-cooled Condenser	0.0%	0.0%	0	$0.00	-	1.00	$0.000
RTU - Maintenance	14.0%	100.0%	4	$0.08	0.2	0.14	$0.102
RTU - Evaporative Precooler	0.0%	0.0%	15	$0.88	1.0	0.18	$0.073
Chiller - Chilled Water Reset	0.0%	0.0%	4	$0.86	0.4	0.02	$0.641
Chiller - Chilled Water Variable-Flow System	0.0%	0.0%	10	$0.86	0.1	0.02	$0.823
Chiller - VSD	0.0%	0.0%	20	$1.17	0.7	0.10	$0.122
Chiller - High Efficiency Cooling Tower Fans	0.0%	0.0%	10	$0.04	0.0	0.00	$8.973
Chiller - Condenser Water Temprature Reset	0.0%	0.0%	14	$0.87	0.3	0.06	$0.247
Cooling - Economizer Installation	51.8%	65.0%	15	$0.15	-	0.28	$0.000
Heat Pump - Maintenance	28.1%	100.0%	4	$0.03	0.5	0.96	$0.015
Insulation - Ducting	9.0%	50.0%	20	$0.41	-	0.32	$0.000
Energy Management System	27.7%	100.0%	14	$0.35	1.9	0.63	$0.017
Cooking - Exhaust Hoods with Sensor Control	1.0%	20.0%	10	$0.04	-	-	$0.000
Fans - Energy Efficient Motors	11.0%	100.0%	10	$0.05	0.1	0.17	$0.067
Fans - Variable Speed Control	8.0%	100.0%	10	$0.20	0.5	0.25	$0.044
Pumps - Variable Speed Control	5.0%	45.0%	10	$0.44	0.0	0.00	$5.075
Thermostat - Clock/Programmable	34.0%	50.0%	11	$0.11	1.0	0.86	$0.012
Insulation - Ceiling	15.3%	90.0%	20	$0.16	-	0.38	$0.000
Insulation - Radiant Barrier	7.0%	25.0%	20	$0.26	-	0.30	$0.000
Roofs - High Reflectivity	5.0%	100.0%	15	$0.09	-	0.07	$0.000
Windows - High Efficiency	60.5%	100.0%	20	$0.35	-	0.31	$0.000
Interior Lighting - Central Lighting Controls	81.2%	100.0%	8	$0.65	-	-	$0.000
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	0.9%	60.0%	8	$0.38	0.7	0.16	$0.074
Exterior Lighting - Daylighting Controls	10.0%	100.0%	8	$0.09	-	0.00	$0.000

Table C-21 Energy Efficiency Non-Equipment Data— Small/Medium Commercial, Existing Vintage, Idaho

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
RTU - Maintenance	31.3%	100.0%	4	$0.08	0.4	0.22	$0.060
RTU - Evaporative Precooler	0.0%	0.0%	15	$0.88	1.2	0.21	$0.061
Chiller - Chilled Water Reset	0.0%	0.0%	4	$0.86	0.4	0.03	$0.529
Chiller - Chilled Water Variable-Flow System	0.0%	0.0%	10	$0.86	0.1	0.02	$1.018
Chiller - VSD	0.0%	0.0%	20	$1.17	0.8	0.11	$0.105
Chiller - High Efficiency Cooling Tower Fans	0.0%	0.0%	10	$0.04	0.0	0.00	$10.961
Chiller - Condenser Water Temprature Reset	0.0%	0.0%	14	$0.87	0.4	0.07	$0.206
Cooling - Economizer Installation	51.8%	65.0%	15	$0.15	0.1	0.36	$0.140
Heat Pump - Maintenance	28.1%	100.0%	4	$0.03	0.9	1.41	$0.009
Insulation - Ducting	9.0%	100.0%	20	$0.41	0.0	0.31	$1.480
Repair and Sealing - Ducting	5.0%	50.0%	15	$0.38	0.1	0.32	$0.586
Energy Management System	34.8%	100.0%	14	$0.35	4.4	1.28	$0.007
Cooking - Exhaust Hoods with Sensor Control	1.0%	20.0%	10	$0.04	-	-	$0.000
Fans - Energy Efficient Motors	28.9%	100.0%	10	$0.05	0.5	0.98	$0.011
Fans - Variable Speed Control	26.5%	100.0%	10	$0.20	0.7	0.31	$0.033
Retrocommissioning - HVAC	15.0%	100.0%	4	$0.60	0.1	0.31	$1.917
Pumps - Variable Speed Control	0.0%	45.0%	10	$0.44	0.0	0.00	$5.336
Thermostat - Clock/Programmable	38.7%	50.0%	11	$0.11	2.8	2.30	$0.004
Insulation - Ceiling	10.0%	90.0%	20	$0.64	0.1	0.35	$0.580
Insulation - Radiant Barrier	7.0%	25.0%	20	$0.26	0.0	0.33	$0.567
Roofs - High Reflectivity	4.5%	100.0%	15	$0.18	0.0	0.12	$0.434
Windows - High Efficiency	60.5%	100.0%	20	$0.44	0.1	0.33	$0.392
Interior Lighting - Central Lighting Controls	81.2%	100.0%	8	$0.65	0.1	0.01	$1.389
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	0.9%	60.0%	8	$0.50	0.8	0.14	$0.085
Exterior Lighting - Daylighting Controls	1.6%	100.0%	8	$0.11	0.1	0.07	$0.121
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	10.0%	30.0%	8	$0.50	0.3	0.06	$0.212
Interior Fluorescent - High Bay Fixtures	15.4%	30.0%	11	$0.70	1.7	0.21	$0.046
Interior Lighting - Occupancy Sensors	18.3%	60.0%	8	$0.20	0.1	0.10	$0.427
Exterior Lighting - Photovoltaic Installation	5.0%	25.0%	5	$0.92	0.2	0.01	$1.278
Interior Screw-in - Task Lighting	25.0%	100.0%	5	$0.24	0.1	0.02	$0.500
Interior Lighting - Time Clocks and Timers	9.1%	75.0%	8	$0.20	0.0	0.05	$0.855
Water Heater - Faucet Aerators/Low Flow Nozzles	50.5%	100.0%	9	$0.01	0.1	0.67	$0.016
Water Heater - Pipe Insulation	45.6%	100.0%	15	$0.28	0.1	0.04	$0.216
Water Heater - High Efficiency Circulation Pump	0.0%	0.0%	10	$0.11	1.4	1.10	$0.009
Water Heater - Tank Blanket/Insulation	68.0%	100.0%	10	$0.02	0.1	0.43	$0.024
Water Heater - Thermostat Setback	5.0%	100.0%	10	$0.11	0.1	0.06	$0.163
Refrigeration - Anti-Sweat Heater/Auto Door Closer	0.0%	100.0%	16	$0.20	0.1	0.03	$0.264
Refrigeration - Floating Head Pressure	17.9%	50.0%	16	$0.35	-	0.00	$0.000
Refrigeration - Door Gasket Replacement	5.0%	100.0%	8	$0.10	0.0	0.01	$0.710
Insulation - Bare Suction Lines	5.0%	100.0%	8	$0.10	-	-	$0.000
Refrigeration - Night Covers	5.0%	100.0%	8	$0.05	0.0	0.02	$2.859
Refrigeration - Strip Curtain	5.0%	56.3%	4	$0.00	-	-	$0.000
Vending Machine - Controller	2.0%	10.0%	10	$0.27	0.0	0.01	$0.701

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
LED Exit Lighting	46.9%	90.0%	10	$0.00	0.0	3.34	$0.006
Retrocommissioning - Lighting	24.1%	100.0%	5	$0.10	0.1	0.05	$0.233
Refrigeration - High Efficiency Case Lighting	12.0%	56.0%	6	$0.04	0.0	0.01	$1.909
Exterior Lighting - Cold Cathode Lighting	14.6%	50.0%	5	$0.00	0.3	15.57	$0.001
Laundry - High Efficiency Clothes Washer	6.9%	10.0%	10	$0.00	0.0	4.79	$0.002
Interior Lighting - Hotel Guestroom Controls	0.0%	0.0%	8	$0.14	0.1	0.03	$0.211
Miscellaneous - Energy Star Water Cooler	24.1%	100.0%	8	$0.00	0.0	0.27	$0.044
Interior Lighting - Skylights	0.0%	0.0%	0	$0.00	0.1	1.00	$0.000
Ventilation - Demand Control Ventilation	10.2%	20.0%	10	$0.04	0.0	0.42	$0.134
Office Equipment - Smart Power Strips	15.4%	30.0%	7	$0.00	0.4	285.77	$0.000
Strategic Energy Management	0.0%	0.0%	3	$0.00	-	6.00	$0.000
Refrigeration - Multiplex - Floating section Pressure - Air-cooled Cond.	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex Controls - Floating section Pressure - Evap. Cond.	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex - Eff. Air-cooled Condenser	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex - Eff. Water-cooled Condenser	0.0%	0.0%	0	$0.00	-	1.00	$0.000
RTU - Maintenance	31.3%	100.0%	4	$0.08	0.4	0.22	$0.060
RTU - Evaporative Precooler	0.0%	0.0%	15	$0.88	1.2	0.21	$0.061
Chiller - Chilled Water Reset	0.0%	0.0%	4	$0.86	0.4	0.03	$0.529
Chiller - Chilled Water Variable-Flow System	0.0%	0.0%	10	$0.86	0.1	0.02	$1.018
Chiller - VSD	0.0%	0.0%	20	$1.17	0.8	0.11	$0.105
Chiller - High Efficiency Cooling Tower Fans	0.0%	0.0%	10	$0.04	0.0	0.00	$10.961
Chiller - Condenser Water Temprature Reset	0.0%	0.0%	14	$0.87	0.4	0.07	$0.206
Cooling - Economizer Installation	51.8%	65.0%	15	$0.15	0.1	0.36	$0.140
Heat Pump - Maintenance	28.1%	100.0%	4	$0.03	0.9	1.41	$0.009
Insulation - Ducting	9.0%	100.0%	20	$0.41	0.0	0.31	$1.480
Repair and Sealing - Ducting	5.0%	50.0%	15	$0.38	0.1	0.32	$0.586
Energy Management System	34.8%	100.0%	14	$0.35	4.4	1.28	$0.007
Cooking - Exhaust Hoods with Sensor Control	1.0%	20.0%	10	$0.04	-	-	$0.000
Fans - Energy Efficient Motors	28.9%	100.0%	10	$0.05	0.5	0.98	$0.011
Fans - Variable Speed Control	26.5%	100.0%	10	$0.20	0.7	0.31	$0.033
Retrocommissioning - HVAC	15.0%	100.0%	4	$0.60	0.1	0.31	$1.917
Pumps - Variable Speed Control	0.0%	45.0%	10	$0.44	0.0	0.00	$5.336
Thermostat - Clock/Programmable	38.7%	50.0%	11	$0.11	2.8	2.30	$0.004
Insulation - Ceiling	10.0%	90.0%	20	$0.64	0.1	0.35	$0.580
Insulation - Radiant Barrier	7.0%	25.0%	20	$0.26	0.0	0.33	$0.567

Table C-22 Energy Efficiency Non-Equipment Data— Small/ Medium Commercial, New Vintage, Idaho

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
RTU - Maintenance	21.4%	100.0%	4	$0.08	0.2	0.14	$0.102
RTU - Evaporative Precooler	0.0%	0.0%	15	$0.88	1.0	0.18	$0.073
Chiller - Chilled Water Reset	0.0%	0.0%	4	$0.86	0.4	0.02	$0.641
Chiller - Chilled Water Variable-Flow System	0.0%	0.0%	10	$0.86	0.1	0.02	$0.823
Chiller - VSD	0.0%	0.0%	20	$1.17	0.7	0.09	$0.122
Chiller - High Efficiency Cooling Tower Fans	0.0%	0.0%	10	$0.04	0.0	0.00	$8.973
Chiller - Condenser Water Temprature Reset	0.0%	0.0%	14	$0.87	0.3	0.06	$0.247
Cooling - Economizer Installation	51.8%	65.0%	15	$0.15	-	0.28	$0.000
Heat Pump - Maintenance	28.1%	100.0%	4	$0.03	0.5	0.96	$0.015
Insulation - Ducting	9.0%	50.0%	20	$0.41	-	0.32	$0.000
Energy Management System	34.8%	100.0%	14	$0.35	2.2	0.73	$0.014
Cooking - Exhaust Hoods with Sensor Control	1.0%	20.0%	10	$0.04	-	-	$0.000
Fans - Energy Efficient Motors	28.9%	100.0%	10	$0.05	0.1	0.21	$0.067
Fans - Variable Speed Control	50.5%	100.0%	10	$0.20	0.5	0.25	$0.044
Pumps - Variable Speed Control	5.0%	45.0%	10	$0.44	0.0	0.00	$5.075
Thermostat - Clock/Programmable	34.0%	50.0%	11	$0.11	1.4	1.19	$0.009
Insulation - Ceiling	21.5%	90.0%	20	$0.16	-	0.38	$0.000
Insulation - Radiant Barrier	7.0%	25.0%	20	$0.26	-	0.30	$0.000
Roofs - High Reflectivity	5.0%	100.0%	15	$0.09	-	0.07	$0.000
Windows - High Efficiency	60.5%	100.0%	20	$0.35	-	0.31	$0.000
Interior Lighting - Central Lighting Controls	81.2%	100.0%	8	$0.65	-	-	$0.000
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	0.9%	60.0%	8	$0.38	0.7	0.16	$0.074
Exterior Lighting - Daylighting Controls	10.0%	100.0%	8	$0.09	-	0.00	$0.000
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	10.0%	30.0%	8	$0.50	0.3	0.05	$0.243
Interior Fluorescent - High Bay Fixtures	13.7%	30.0%	11	$0.70	1.5	0.19	$0.052
Interior Lighting - Occupancy Sensors	11.9%	60.0%	8	$0.20	-	0.07	$0.000
Exterior Lighting - Photovoltaic Installation	5.0%	25.0%	5	$0.92	-	-	$0.000
Interior Screw-in - Task Lighting	25.0%	100.0%	5	$0.24	0.1	0.03	$0.507
Interior Lighting - Time Clocks and Timers	9.1%	75.0%	8	$0.20	-	0.05	$0.000
Water Heater - Faucet Aerators/Low Flow Nozzles	50.5%	100.0%	9	$0.01	0.1	0.66	$0.017
Water Heater - Pipe Insulation	45.6%	100.0%	15	$0.28	0.1	0.04	$0.227
Water Heater - High Efficiency Circulation Pump	0.0%	0.0%	10	$0.11	1.3	1.08	$0.010
Water Heater - Tank Blanket/Insulation	68.0%	100.0%	10	$0.02	0.0	0.21	$0.051
Water Heater - Thermostat Setback	10.0%	100.0%	10	$0.11	0.1	0.06	$0.174
Refrigeration - Anti-Sweat Heater/Auto Door Closer	0.0%	100.0%	16	$0.20	0.1	0.03	$0.289
Refrigeration - Floating Head Pressure	17.9%	50.0%	16	$0.35	0.1	0.03	$0.323
Refrigeration - Door Gasket Replacement	5.0%	100.0%	8	$0.10	0.0	0.01	$1.014
Insulation - Bare Suction Lines	5.0%	100.0%	8	$0.10	0.1	0.08	$0.160
Refrigeration - Night Covers	5.0%	100.0%	8	$0.05	0.0	0.02	$3.122
Refrigeration - Strip Curtain	5.0%	56.3%	4	$0.00	-	-	$0.000
Vending Machine - Controller	2.0%	10.0%	10	$0.27	0.0	0.01	$0.804
LED Exit Lighting	91.2%	90.0%	10	$0.00	0.0	5.18	$0.006
Refrigeration - High Efficiency Case	30.0%	56.0%	6	$0.02	0.0	0.32	$0.292

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Lighting							
Exterior Lighting - Cold Cathode Lighting	14.6%	50.0%	5	$0.00	0.3	18.13	$0.001
Laundry - High Efficiency Clothes Washer	6.9%	10.0%	10	$0.00	0.0	5.75	$0.002
Interior Lighting - Hotel Guestroom Controls	0.0%	0.0%	8	$0.14	0.1	0.05	$0.213
Miscellaneous - Energy Star Water Cooler	11.9%	100.0%	8	$0.00	0.0	0.33	$0.037
Interior Lighting - Skylights	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Ventilation - Demand Control Ventilation	19.7%	20.0%	10	$0.04	-	0.38	$0.000
Office Equipment - Smart Power Strips	15.4%	30.0%	7	$0.00	0.3	215.34	$0.000
Strategic Energy Management	0.0%	0.0%	3	$0.00	-	6.00	$0.000
Refrigeration - Multiplex - Floating section Pressure - Air-cooled Cond.	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex Controls - Floating section Pressure - Evap. Cond.	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex - Eff. Air-cooled Condenser	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex - Eff. Water-cooled Condenser	0.0%	0.0%	0	$0.00	-	1.00	$0.000
RTU - Maintenance	21.4%	100.0%	4	$0.08	0.2	0.14	$0.102
RTU - Evaporative Precooler	0.0%	0.0%	15	$0.88	1.0	0.18	$0.073
Chiller - Chilled Water Reset	0.0%	0.0%	4	$0.86	0.4	0.02	$0.641
Chiller - Chilled Water Variable-Flow System	0.0%	0.0%	10	$0.86	0.1	0.02	$0.823
Chiller - VSD	0.0%	0.0%	20	$1.17	0.7	0.09	$0.122
Chiller - High Efficiency Cooling Tower Fans	0.0%	0.0%	10	$0.04	0.0	0.00	$8.973
Chiller - Condenser Water Temprature Reset	0.0%	0.0%	14	$0.87	0.3	0.06	$0.247
Cooling - Economizer Installation	51.8%	65.0%	15	$0.15	-	0.28	$0.000
Heat Pump - Maintenance	28.1%	100.0%	4	$0.03	0.5	0.96	$0.015
Insulation - Ducting	9.0%	50.0%	20	$0.41	-	0.32	$0.000
Energy Management System	34.8%	100.0%	14	$0.35	2.2	0.73	$0.014
Cooking - Exhaust Hoods with Sensor Control	1.0%	20.0%	10	$0.04	-	-	$0.000
Fans - Energy Efficient Motors	28.9%	100.0%	10	$0.05	0.1	0.21	$0.067
Fans - Variable Speed Control	50.5%	100.0%	10	$0.20	0.5	0.25	$0.044
Pumps - Variable Speed Control	5.0%	45.0%	10	$0.44	0.0	0.00	$5.075
Thermostat - Clock/Programmable	34.0%	50.0%	11	$0.11	1.4	1.19	$0.009
Insulation - Ceiling	21.5%	90.0%	20	$0.16	-	0.38	$0.000
Insulation - Radiant Barrier	7.0%	25.0%	20	$0.26	-	0.30	$0.000
Roofs - High Reflectivity	5.0%	100.0%	15	$0.09	-	0.07	$0.000
Windows - High Efficiency	60.5%	100.0%	20	$0.35	-	0.31	$0.000
Interior Lighting - Central Lighting Controls	81.2%	100.0%	8	$0.65	-	-	$0.000
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	0.9%	60.0%	8	$0.38	0.7	0.16	$0.074
Exterior Lighting - Daylighting Controls	10.0%	100.0%	8	$0.09	-	0.00	$0.000

Table C-23 Energy Efficiency Non-Equipment Data— Large Commercial, Existing Vintage, Washington

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
RTU - Maintenance	27.0%	100.0%	4	$0.06	0.4	0.30	$0.044
RTU - Evaporative Precooler	0.0%	0.0%	15	$0.88	1.3	0.12	$0.060
Chiller - Chilled Water Reset	15.0%	100.0%	4	$0.18	0.4	0.11	$0.120
Chiller - Chilled Water Variable-Flow System	30.0%	45.0%	10	$0.18	0.1	0.04	$0.226
Chiller - VSD	15.0%	88.2%	20	$1.17	0.7	0.05	$0.117
Chiller - High Efficiency Cooling Tower Fans	15.0%	43.5%	10	$0.04	0.0	0.00	$11.820
Chiller - Condenser Water Temprature Reset	5.0%	100.0%	14	$0.18	0.4	0.17	$0.046
Cooling - Economizer Installation	51.6%	65.0%	15	$0.15	0.8	0.47	$0.015
Heat Pump - Maintenance	28.1%	100.0%	4	$0.06	0.8	0.61	$0.021
Insulation - Ducting	8.0%	100.0%	20	$0.41	0.0	0.31	$1.046
Repair and Sealing - Ducting	5.0%	50.0%	15	$0.38	0.1	0.32	$0.421
Energy Management System	44.0%	100.0%	14	$0.35	2.5	0.68	$0.013
Cooking - Exhaust Hoods with Sensor Control	1.0%	15.0%	10	$0.04	-	-	$0.000
Fans - Energy Efficient Motors	11.0%	100.0%	10	$0.05	0.1	0.17	$0.072
Fans - Variable Speed Control	2.0%	100.0%	10	$0.20	0.6	0.27	$0.040
Retrocommissioning - HVAC	15.0%	100.0%	4	$0.30	0.4	0.37	$0.216
Pumps - Variable Speed Control	0.0%	45.0%	10	$0.13	0.0	0.01	$1.381
Thermostat - Clock/Programmable	33.0%	50.0%	11	$0.11	0.8	0.65	$0.015
Insulation - Ceiling	9.0%	40.0%	20	$0.85	0.4	0.34	$0.152
Insulation - Radiant Barrier	7.0%	25.0%	20	$0.26	0.0	0.31	$0.521
Roofs - High Reflectivity	1.5%	100.0%	15	$0.08	0.1	0.07	$0.109
Windows - High Efficiency	71.9%	100.0%	20	$0.88	0.2	0.32	$0.385
Interior Lighting - Central Lighting Controls	85.7%	100.0%	8	$0.65	0.2	0.03	$0.384
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	0.9%	60.0%	8	$0.45	0.8	0.15	$0.078
Exterior Lighting - Daylighting Controls	1.6%	25.0%	8	$0.29	0.1	0.02	$0.549
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	10.0%	30.0%	8	$0.40	0.3	0.07	$0.173
Interior Fluorescent - High Bay Fixtures	10.0%	30.0%	11	$0.63	1.6	0.24	$0.042
Interior Lighting - Occupancy Sensors	12.6%	60.0%	8	$0.20	0.2	0.16	$0.118
Exterior Lighting - Photovoltaic Installation	5.0%	25.0%	5	$0.92	0.1	0.00	$2.235
Interior Screw-in - Task Lighting	10.0%	100.0%	5	$0.24	0.1	0.02	$0.531
Interior Lighting - Time Clocks and Timers	9.3%	75.0%	8	$0.20	0.1	0.09	$0.236
Water Heater - Faucet Aerators/Low Flow Nozzles	3.0%	100.0%	9	$0.03	0.1	0.27	$0.042
Water Heater - Pipe Insulation	0.0%	0.0%	15	$0.28	0.1	0.04	$0.185
Water Heater - High Efficiency Circulation Pump	0.6%	25.0%	10	$0.11	1.6	1.31	$0.008
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	10	$0.04	0.1	0.26	$0.041
Water Heater - Thermostat Setback	0.0%	0.0%	10	$0.11	0.1	0.07	$0.141
Refrigeration - Anti-Sweat Heater/Auto Door Closer	0.0%	100.0%	16	$0.20	0.1	0.02	$0.321
Refrigeration - Floating Head Pressure	38.0%	60.0%	16	$0.35	0.0	0.00	$1.320
Refrigeration - Door Gasket Replacement	5.0%	100.0%	8	$0.10	0.0	0.02	$0.463
Insulation - Bare Suction Lines	5.0%	100.0%	8	$0.10	0.0	0.02	$0.653
Refrigeration - Night Covers	5.0%	100.0%	8	$0.05	0.0	0.04	$0.449
Refrigeration - Strip Curtain	12.6%	56.3%	4	$0.00	0.0	19.02	$0.001
Vending Machine - Controller	2.0%	10.0%	10	$0.27	0.1	0.01	$0.596

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
LED Exit Lighting	46.9%	90.0%	10	$0.00	0.0	3.74	$0.006
Retrocommissioning - Lighting	5.0%	100.0%	5	$0.05	0.3	0.31	$0.042
Refrigeration - High Efficiency Case Lighting	12.0%	56.0%	6	$0.04	-	-	$0.000
Exterior Lighting - Cold Cathode Lighting	14.6%	50.0%	5	$0.00	0.3	15.65	$0.001
Laundry - High Efficiency Clothes Washer	6.9%	10.0%	10	$0.00	0.0	4.60	$0.002
Interior Lighting - Hotel Guestroom Controls	1.0%	2.0%	8	$0.14	0.1	0.04	$0.224
Miscellaneous - Energy Star Water Cooler	5.0%	100.0%	8	$0.00	0.0	0.26	$0.047
Interior Lighting - Skylights	0.0%	0.0%	0	$0.00	0.4	1.00	$0.000
Ventilation - Demand Control Ventilation	7.9%	15.0%	10	$0.04	0.2	0.88	$0.029
Office Equipment - Smart Power Strips	15.4%	30.0%	7	$0.00	0.3	208.80	$0.000
Strategic Energy Management	0.0%	0.0%	3	$0.00	-	6.00	$0.000
Refrigeration - Multiplex - Floating section Pressure - Air-cooled Cond.	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex Controls - Floating section Pressure - Evap. Cond.	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex - Eff. Air-cooled Condenser	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex - Eff. Water-cooled Condenser	0.0%	0.0%	0	$0.00	-	1.00	$0.000
RTU - Maintenance	27.0%	100.0%	4	$0.06	0.4	0.30	$0.044
RTU - Evaporative Precooler	0.0%	0.0%	15	$0.88	1.3	0.12	$0.060
Chiller - Chilled Water Reset	15.0%	100.0%	4	$0.18	0.4	0.11	$0.120
Chiller - Chilled Water Variable-Flow System	30.0%	45.0%	10	$0.18	0.1	0.04	$0.226
Chiller - VSD	15.0%	88.2%	20	$1.17	0.7	0.05	$0.117
Chiller - High Efficiency Cooling Tower Fans	15.0%	43.5%	10	$0.04	0.0	0.00	$11.820
Chiller - Condenser Water Temprature Reset	5.0%	100.0%	14	$0.18	0.4	0.17	$0.046
Cooling - Economizer Installation	51.6%	65.0%	15	$0.15	0.8	0.47	$0.015
Heat Pump - Maintenance	28.1%	100.0%	4	$0.06	0.8	0.61	$0.021
Insulation - Ducting	8.0%	100.0%	20	$0.41	0.0	0.31	$1.046
Repair and Sealing - Ducting	5.0%	50.0%	15	$0.38	0.1	0.32	$0.421
Energy Management System	44.0%	100.0%	14	$0.35	2.5	0.68	$0.013
Cooking - Exhaust Hoods with Sensor Control	1.0%	15.0%	10	$0.04	-	-	$0.000
Fans - Energy Efficient Motors	11.0%	100.0%	10	$0.05	0.1	0.17	$0.072
Fans - Variable Speed Control	2.0%	100.0%	10	$0.20	0.6	0.27	$0.040
Retrocommissioning - HVAC	15.0%	100.0%	4	$0.30	0.4	0.37	$0.216
Pumps - Variable Speed Control	0.0%	45.0%	10	$0.13	0.0	0.01	$1.381
Thermostat - Clock/Programmable	33.0%	50.0%	11	$0.11	0.8	0.65	$0.015
Insulation - Ceiling	9.0%	40.0%	20	$0.85	0.4	0.34	$0.152
Insulation - Radiant Barrier	7.0%	25.0%	20	$0.26	0.0	0.31	$0.521

Table C-24 Energy Efficiency Non-Equipment Data— Large Commercial, New Vintage, Washington

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
RTU - Maintenance	27.0%	100.0%	4	$0.06	0.2	0.19	$0.076
RTU - Evaporative Precooler	0.0%	0.0%	15	$0.88	1.0	0.11	$0.073
Chiller - Chilled Water Reset	30.0%	100.0%	4	$0.18	0.3	0.09	$0.151
Chiller - Chilled Water Variable-Flow System	30.0%	45.0%	10	$0.18	0.1	0.06	$0.168
Chiller - VSD	15.0%	88.2%	20	$1.17	0.6	0.05	$0.141
Chiller - High Efficiency Cooling Tower Fans	15.0%	43.5%	10	$0.04	0.0	0.00	$10.716
Chiller - Condenser Water Temprature Reset	25.0%	100.0%	14	$0.18	0.3	0.14	$0.058
Cooling - Economizer Installation	44.3%	65.0%	15	$0.15	0.0	0.04	$0.517
Heat Pump - Maintenance	14.7%	100.0%	4	$0.06	0.5	0.44	$0.034
Insulation - Ducting	8.0%	50.0%	20	$0.41	0.0	0.30	$15.903
Energy Management System	48.5%	100.0%	14	$0.35	2.9	0.81	$0.011
Cooking - Exhaust Hoods with Sensor Control	1.0%	15.0%	10	$0.04	-	-	$0.000
Fans - Energy Efficient Motors	11.0%	100.0%	10	$0.05	0.1	0.19	$0.084
Fans - Variable Speed Control	2.0%	100.0%	10	$0.20	0.5	0.22	$0.051
Pumps - Variable Speed Control	5.0%	45.0%	10	$0.13	0.0	0.01	$1.313
Thermostat - Clock/Programmable	33.0%	50.0%	11	$0.11	1.4	1.14	$0.009
Insulation - Ceiling	75.0%	90.0%	20	$0.35	0.0	0.31	$2.770
Insulation - Radiant Barrier	7.0%	25.0%	20	$0.26	0.0	0.30	$29.882
Roofs - High Reflectivity	5.0%	100.0%	15	$0.05	0.0	0.01	$2.520
Windows - High Efficiency	71.9%	100.0%	20	$0.88	0.0	0.30	$17.807
Interior Lighting - Central Lighting Controls	85.7%	100.0%	8	$0.65	-	-	$0.000
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	0.9%	60.0%	8	$0.34	0.7	0.18	$0.068
Exterior Lighting - Daylighting Controls	10.0%	25.0%	8	$0.19	-	0.00	$0.000
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	10.0%	30.0%	8	$0.40	0.3	0.06	$0.201
Interior Fluorescent - High Bay Fixtures	10.0%	30.0%	11	$0.63	1.4	0.21	$0.049
Interior Lighting - Occupancy Sensors	12.6%	60.0%	8	$0.20	-	0.06	$0.000
Exterior Lighting - Photovoltaic Installation	5.0%	25.0%	5	$0.92	-	-	$0.000
Interior Screw-in - Task Lighting	10.0%	100.0%	5	$0.24	0.1	0.03	$0.538
Interior Lighting - Time Clocks and Timers	9.3%	75.0%	8	$0.20	-	0.05	$0.000
Water Heater - Faucet Aerators/Low Flow Nozzles	3.0%	100.0%	9	$0.03	0.1	0.26	$0.044
Water Heater - Pipe Insulation	0.0%	0.0%	15	$0.28	0.1	0.03	$0.295
Water Heater - High Efficiency Circulation Pump	0.6%	25.0%	10	$0.11	1.6	1.30	$0.008
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	10	$0.04	0.1	0.25	$0.043
Water Heater - Thermostat Setback	0.0%	0.0%	10	$0.11	0.1	0.07	$0.147
Refrigeration - Anti-Sweat Heater/Auto Door Closer	0.0%	100.0%	16	$0.20	0.0	0.03	$0.355
Refrigeration - Floating Head Pressure	38.0%	60.0%	16	$0.35	-	0.00	$0.000
Refrigeration - Door Gasket Replacement	5.0%	100.0%	8	$0.10	0.0	0.02	$0.662
Insulation - Bare Suction Lines	5.0%	100.0%	8	$0.10	-	-	$0.000
Refrigeration - Night Covers	5.0%	100.0%	8	$0.05	0.0	0.04	$0.495
Refrigeration - Strip Curtain	12.6%	56.3%	4	$0.00	0.0	15.67	$0.001
Vending Machine - Controller	2.0%	10.0%	10	$0.27	0.0	0.01	$0.684
LED Exit Lighting	91.2%	90.0%	10	$0.00	0.0	4.71	$0.006
Refrigeration - High Efficiency Case	24.0%	56.0%	6	$0.02	0.1	0.23	$0.061

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Lighting							
Exterior Lighting - Cold Cathode Lighting	14.6%	50.0%	5	$0.00	0.3	18.50	$0.001
Laundry - High Efficiency Clothes Washer	6.9%	10.0%	10	$0.00	0.0	5.06	$0.002
Interior Lighting - Hotel Guestroom Controls	1.0%	2.0%	8	$0.14	0.1	0.05	$0.227
Miscellaneous - Energy Star Water Cooler	5.0%	100.0%	8	$0.00	0.0	0.29	$0.042
Interior Lighting - Skylights	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Ventilation - Demand Control Ventilation	12.4%	15.0%	10	$0.04	-	0.53	$0.000
Office Equipment - Smart Power Strips	15.4%	30.0%	7	$0.00	0.3	221.56	$0.000
Strategic Energy Management	0.0%	0.0%	3	$0.00	-	6.00	$0.000
Refrigeration - Multiplex - Floating section Pressure - Air-cooled Cond.	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex Controls - Floating section Pressure - Evap. Cond.	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex - Eff. Air-cooled Condenser	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex - Eff. Water-cooled Condenser	0.0%	0.0%	0	$0.00	-	1.00	$0.000
RTU - Maintenance	27.0%	100.0%	4	$0.06	0.2	0.19	$0.076
RTU - Evaporative Precooler	0.0%	0.0%	15	$0.88	1.0	0.11	$0.073
Chiller - Chilled Water Reset	30.0%	100.0%	4	$0.18	0.3	0.09	$0.151
Chiller - Chilled Water Variable-Flow System	30.0%	45.0%	10	$0.18	0.1	0.06	$0.168
Chiller - VSD	15.0%	88.2%	20	$1.17	0.6	0.05	$0.141
Chiller - High Efficiency Cooling Tower Fans	15.0%	43.5%	10	$0.04	0.0	0.00	$10.716
Chiller - Condenser Water Temprature Reset	25.0%	100.0%	14	$0.18	0.3	0.14	$0.058
Cooling - Economizer Installation	44.3%	65.0%	15	$0.15	0.0	0.04	$0.517
Heat Pump - Maintenance	14.7%	100.0%	4	$0.06	0.5	0.44	$0.034
Insulation - Ducting	8.0%	50.0%	20	$0.41	0.0	0.30	$15.903
Energy Management System	48.5%	100.0%	14	$0.35	2.9	0.81	$0.011
Cooking - Exhaust Hoods with Sensor Control	1.0%	15.0%	10	$0.04	-	-	$0.000
Fans - Energy Efficient Motors	11.0%	100.0%	10	$0.05	0.1	0.19	$0.084
Fans - Variable Speed Control	2.0%	100.0%	10	$0.20	0.5	0.22	$0.051
Pumps - Variable Speed Control	5.0%	45.0%	10	$0.13	0.0	0.01	$1.313
Thermostat - Clock/Programmable	33.0%	50.0%	11	$0.11	1.4	1.14	$0.009
Insulation - Ceiling	75.0%	90.0%	20	$0.35	0.0	0.31	$2.770
Insulation - Radiant Barrier	7.0%	25.0%	20	$0.26	0.0	0.30	$29.882
Roofs - High Reflectivity	5.0%	100.0%	15	$0.05	0.0	0.01	$2.520
Windows - High Efficiency	71.9%	100.0%	20	$0.88	0.0	0.30	$17.807
Interior Lighting - Central Lighting Controls	85.7%	100.0%	8	$0.65	-	-	$0.000
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	0.9%	60.0%	8	$0.34	0.7	0.18	$0.068
Exterior Lighting - Daylighting Controls	10.0%	25.0%	8	$0.19	-	0.00	$0.000

Table C-25 Energy Efficiency Non-Equipment Data— Large Commercial, Existing Vintage, Idaho

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
RTU - Maintenance	36.9%	100.0%	4	$0.06	0.4	0.30	$0.044
RTU - Evaporative Precooler	0.0%	0.0%	15	$0.88	1.3	0.12	$0.060
Chiller - Chilled Water Reset	15.0%	100.0%	4	$0.18	0.4	0.11	$0.120
Chiller - Chilled Water Variable-Flow System	30.0%	45.0%	10	$0.18	0.1	0.04	$0.226
Chiller - VSD	15.0%	88.2%	20	$1.17	0.7	0.05	$0.117
Chiller - High Efficiency Cooling Tower Fans	15.0%	43.5%	10	$0.04	0.0	0.00	$11.820
Chiller - Condenser Water Temprature Reset	18.5%	100.0%	14	$0.18	0.4	0.17	$0.046
Cooling - Economizer Installation	51.6%	65.0%	15	$0.15	0.2	0.14	$0.068
Heat Pump - Maintenance	28.1%	100.0%	4	$0.06	0.8	0.61	$0.021
Insulation - Ducting	8.0%	100.0%	20	$0.41	0.0	0.30	$2.323
Repair and Sealing - Ducting	5.0%	50.0%	15	$0.38	0.0	0.31	$0.792
Energy Management System	45.9%	100.0%	14	$0.35	1.7	0.47	$0.019
Cooking - Exhaust Hoods with Sensor Control	1.0%	15.0%	10	$0.04	-	-	$0.000
Fans - Energy Efficient Motors	11.0%	100.0%	10	$0.05	0.1	0.14	$0.072
Fans - Variable Speed Control	21.7%	100.0%	10	$0.20	0.6	0.27	$0.040
Retrocommissioning - HVAC	15.0%	100.0%	4	$0.30	0.1	0.31	$1.053
Pumps - Variable Speed Control	0.0%	45.0%	10	$0.13	0.0	0.01	$1.381
Thermostat - Clock/Programmable	33.0%	50.0%	11	$0.11	0.6	0.44	$0.022
Insulation - Ceiling	9.0%	40.0%	20	$0.85	0.1	0.31	$0.599
Insulation - Radiant Barrier	7.0%	25.0%	20	$0.26	0.0	0.30	$1.652
Roofs - High Reflectivity	1.5%	100.0%	15	$0.08	0.0	0.02	$0.482
Windows - High Efficiency	71.9%	100.0%	20	$0.88	0.1	0.31	$0.833
Interior Lighting - Central Lighting Controls	85.7%	100.0%	8	$0.65	0.3	0.03	$0.328
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	0.9%	60.0%	8	$0.45	0.8	0.15	$0.078
Exterior Lighting - Daylighting Controls	1.6%	25.0%	8	$0.29	-	0.00	$0.000
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	10.0%	30.0%	8	$0.40	0.3	0.07	$0.173
Interior Fluorescent - High Bay Fixtures	15.4%	30.0%	11	$0.63	1.6	0.23	$0.042
Interior Lighting - Occupancy Sensors	23.2%	60.0%	8	$0.20	0.3	0.17	$0.101
Exterior Lighting - Photovoltaic Installation	5.0%	25.0%	5	$0.92	-	-	$0.000
Interior Screw-in - Task Lighting	10.0%	100.0%	5	$0.24	0.1	0.02	$0.531
Interior Lighting - Time Clocks and Timers	9.3%	75.0%	8	$0.20	0.1	0.09	$0.202
Water Heater - Faucet Aerators/Low Flow Nozzles	47.9%	100.0%	9	$0.03	0.1	0.26	$0.042
Water Heater - Pipe Insulation	0.0%	0.0%	15	$0.28	0.1	0.04	$0.185
Water Heater - High Efficiency Circulation Pump	0.6%	25.0%	10	$0.11	1.6	1.30	$0.008
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	10	$0.04	0.1	0.26	$0.041
Water Heater - Thermostat Setback	0.0%	0.0%	10	$0.11	0.1	0.07	$0.141
Refrigeration - Anti-Sweat Heater/Auto Door Closer	0.0%	100.0%	16	$0.20	0.1	0.02	$0.321
Refrigeration - Floating Head Pressure	38.0%	60.0%	16	$0.35	-	0.00	$0.000
Refrigeration - Door Gasket Replacement	5.0%	100.0%	8	$0.10	0.0	0.02	$0.463
Insulation - Bare Suction Lines	5.0%	100.0%	8	$0.10	-	-	$0.000
Refrigeration - Night Covers	5.0%	100.0%	8	$0.05	0.0	0.04	$0.449
Refrigeration - Strip Curtain	12.6%	56.3%	4	$0.00	0.0	18.97	$0.001
Vending Machine - Controller	2.0%	10.0%	10	$0.27	0.1	0.01	$0.596

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
LED Exit Lighting	46.9%	90.0%	10	$0.00	0.0	3.00	$0.006
Retrocommissioning - Lighting	24.1%	100.0%	5	$0.05	0.3	0.33	$0.038
Refrigeration - High Efficiency Case Lighting	12.0%	56.0%	6	$0.04	0.0	0.00	$5.412
Exterior Lighting - Cold Cathode Lighting	14.6%	50.0%	5	$0.00	0.3	15.57	$0.001
Laundry - High Efficiency Clothes Washer	6.9%	10.0%	10	$0.00	0.0	4.57	$0.002
Interior Lighting - Hotel Guestroom Controls	1.0%	2.0%	8	$0.14	0.1	0.03	$0.224
Miscellaneous - Energy Star Water Cooler	24.1%	100.0%	8	$0.00	0.0	0.26	$0.047
Interior Lighting - Skylights	0.0%	0.0%	0	$0.00	0.4	1.00	$0.000
Ventilation - Demand Control Ventilation	7.9%	15.0%	10	$0.04	0.0	0.53	$0.315
Office Equipment - Smart Power Strips	15.4%	30.0%	7	$0.00	0.5	353.57	$0.000
Strategic Energy Management	0.0%	0.0%	3	$0.00	-	6.00	$0.000
Refrigeration - Multiplex - Floating section Pressure - Air-cooled Cond.	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex Controls - Floating section Pressure - Evap. Cond.	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex - Eff. Air-cooled Condenser	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex - Eff. Water-cooled Condenser	0.0%	0.0%	0	$0.00	-	1.00	$0.000
RTU - Maintenance	36.9%	100.0%	4	$0.06	0.4	0.30	$0.044
RTU - Evaporative Precooler	0.0%	0.0%	15	$0.88	1.3	0.12	$0.060
Chiller - Chilled Water Reset	15.0%	100.0%	4	$0.18	0.4	0.11	$0.120
Chiller - Chilled Water Variable-Flow System	30.0%	45.0%	10	$0.18	0.1	0.04	$0.226
Chiller - VSD	15.0%	88.2%	20	$1.17	0.7	0.05	$0.117
Chiller - High Efficiency Cooling Tower Fans	15.0%	43.5%	10	$0.04	0.0	0.00	$11.820
Chiller - Condenser Water Temprature Reset	18.5%	100.0%	14	$0.18	0.4	0.17	$0.046
Cooling - Economizer Installation	51.6%	65.0%	15	$0.15	0.2	0.14	$0.068
Heat Pump - Maintenance	28.1%	100.0%	4	$0.06	0.8	0.61	$0.021
Insulation - Ducting	8.0%	100.0%	20	$0.41	0.0	0.30	$2.323
Repair and Sealing - Ducting	5.0%	50.0%	15	$0.38	0.0	0.31	$0.792
Energy Management System	45.9%	100.0%	14	$0.35	1.7	0.47	$0.019
Cooking - Exhaust Hoods with Sensor Control	1.0%	15.0%	10	$0.04	-	-	$0.000
Fans - Energy Efficient Motors	11.0%	100.0%	10	$0.05	0.1	0.14	$0.072
Fans - Variable Speed Control	21.7%	100.0%	10	$0.20	0.6	0.27	$0.040
Retrocommissioning - HVAC	15.0%	100.0%	4	$0.30	0.1	0.31	$1.053
Pumps - Variable Speed Control	0.0%	45.0%	10	$0.13	0.0	0.01	$1.381
Thermostat - Clock/Programmable	33.0%	50.0%	11	$0.11	0.6	0.44	$0.022
Insulation - Ceiling	9.0%	40.0%	20	$0.85	0.1	0.31	$0.599
Insulation - Radiant Barrier	7.0%	25.0%	20	$0.26	0.0	0.30	$1.652

Table C-26 Energy Efficiency Non-Equipment Data— Large Commercial, New Vintage, Idaho

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
RTU - Maintenance	27.0%	100.0%	4	$0.06	0.2	0.19	$0.076
RTU - Evaporative Precooler	0.0%	0.0%	15	$0.88	1.0	0.11	$0.073
Chiller - Chilled Water Reset	30.0%	100.0%	4	$0.18	0.3	0.10	$0.151
Chiller - Chilled Water Variable-Flow System	30.0%	45.0%	10	$0.18	0.1	0.06	$0.168
Chiller - VSD	15.0%	88.2%	20	$1.17	0.6	0.05	$0.141
Chiller - High Efficiency Cooling Tower Fans	15.0%	43.5%	10	$0.04	0.0	0.00	$10.716
Chiller - Condenser Water Temprature Reset	31.4%	100.0%	14	$0.18	0.3	0.15	$0.058
Cooling - Economizer Installation	44.3%	65.0%	15	$0.15	-	0.03	$0.000
Heat Pump - Maintenance	28.1%	100.0%	4	$0.06	0.5	0.43	$0.034
Insulation - Ducting	8.0%	50.0%	20	$0.41	-	0.30	$0.000
Energy Management System	55.8%	100.0%	14	$0.35	1.6	0.47	$0.020
Cooking - Exhaust Hoods with Sensor Control	1.0%	15.0%	10	$0.04	-	-	$0.000
Fans - Energy Efficient Motors	28.9%	100.0%	10	$0.05	0.1	0.17	$0.084
Fans - Variable Speed Control	47.3%	100.0%	10	$0.20	0.5	0.23	$0.051
Pumps - Variable Speed Control	5.0%	45.0%	10	$0.13	0.0	0.01	$1.313
Thermostat - Clock/Programmable	33.0%	50.0%	11	$0.11	0.4	0.29	$0.033
Insulation - Ceiling	75.0%	90.0%	20	$0.35	-	0.30	$0.000
Insulation - Radiant Barrier	7.0%	25.0%	20	$0.26	-	0.30	$0.000
Roofs - High Reflectivity	5.0%	100.0%	15	$0.05	-	0.01	$0.000
Windows - High Efficiency	71.9%	100.0%	20	$0.88	-	0.30	$0.000
Interior Lighting - Central Lighting Controls	85.7%	100.0%	8	$0.65	0.4	0.06	$0.213
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	0.9%	60.0%	8	$0.34	0.7	0.18	$0.068
Exterior Lighting - Daylighting Controls	14.5%	25.0%	8	$0.19	1.7	0.75	$0.016
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	10.0%	30.0%	8	$0.40	0.3	0.06	$0.201
Interior Fluorescent - High Bay Fixtures	15.4%	30.0%	11	$0.63	1.4	0.21	$0.049
Interior Lighting - Occupancy Sensors	23.2%	60.0%	8	$0.20	0.4	0.24	$0.066
Exterior Lighting - Photovoltaic Installation	5.0%	25.0%	5	$0.92	2.0	0.15	$0.100
Interior Screw-in - Task Lighting	10.0%	100.0%	5	$0.24	0.1	0.02	$0.538
Interior Lighting - Time Clocks and Timers	15.2%	75.0%	8	$0.20	0.2	0.14	$0.131
Water Heater - Faucet Aerators/Low Flow Nozzles	47.9%	100.0%	9	$0.03	0.1	0.26	$0.044
Water Heater - Pipe Insulation	0.0%	0.0%	15	$0.28	0.1	0.03	$0.295
Water Heater - High Efficiency Circulation Pump	0.6%	25.0%	10	$0.11	1.6	1.28	$0.008
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	10	$0.04	0.1	0.25	$0.043
Water Heater - Thermostat Setback	0.0%	0.0%	10	$0.11	0.1	0.07	$0.147
Refrigeration - Anti-Sweat Heater/Auto Door Closer	0.0%	100.0%	16	$0.20	0.0	0.03	$0.355
Refrigeration - Floating Head Pressure	38.0%	60.0%	16	$0.35	0.1	0.02	$0.330
Refrigeration - Door Gasket Replacement	5.0%	100.0%	8	$0.10	0.0	0.02	$0.662
Insulation - Bare Suction Lines	5.0%	100.0%	8	$0.10	0.1	0.08	$0.163
Refrigeration - Night Covers	5.0%	100.0%	8	$0.05	0.0	0.04	$0.495
Refrigeration - Strip Curtain	29.7%	56.3%	4	$0.00	0.0	15.63	$0.001
Vending Machine - Controller	2.0%	10.0%	10	$0.27	0.0	0.01	$0.684
LED Exit Lighting	91.2%	90.0%	10	$0.00	0.0	4.50	$0.006
Refrigeration - High Efficiency Case	24.0%	56.0%	6	$0.02	0.0	0.14	$0.102

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Lighting							
Exterior Lighting - Cold Cathode Lighting	14.6%	50.0%	5	$0.00	0.3	18.13	$0.001
Laundry - High Efficiency Clothes Washer	6.9%	10.0%	10	$0.00	0.0	5.03	$0.002
Interior Lighting - Hotel Guestroom Controls	1.0%	2.0%	8	$0.14	0.1	0.05	$0.227
Miscellaneous - Energy Star Water Cooler	11.9%	100.0%	8	$0.00	0.0	0.29	$0.042
Interior Lighting - Skylights	0.0%	0.0%	0	$0.00	0.7	1.00	$0.000
Ventilation - Demand Control Ventilation	15.0%	15.0%	10	$0.04	-	0.54	$0.000
Office Equipment - Smart Power Strips	15.4%	30.0%	7	$0.00	0.3	219.97	$0.000
Strategic Energy Management	0.0%	0.0%	3	$0.00	-	6.00	$0.000
Refrigeration - Multiplex - Floating section Pressure - Air-cooled Cond.	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex Controls - Floating section Pressure - Evap. Cond.	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex - Eff. Air-cooled Condenser	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex - Eff. Water-cooled Condenser	0.0%	0.0%	0	$0.00	-	1.00	$0.000
RTU - Maintenance	27.0%	100.0%	4	$0.06	0.2	0.19	$0.076
RTU - Evaporative Precooler	0.0%	0.0%	15	$0.88	1.0	0.11	$0.073
Chiller - Chilled Water Reset	30.0%	100.0%	4	$0.18	0.3	0.10	$0.151
Chiller - Chilled Water Variable-Flow System	30.0%	45.0%	10	$0.18	0.1	0.06	$0.168
Chiller - VSD	15.0%	88.2%	20	$1.17	0.6	0.05	$0.141
Chiller - High Efficiency Cooling Tower Fans	15.0%	43.5%	10	$0.04	0.0	0.00	$10.716
Chiller - Condenser Water Temprature Reset	31.4%	100.0%	14	$0.18	0.3	0.15	$0.058
Cooling - Economizer Installation	44.3%	65.0%	15	$0.15	-	0.03	$0.000
Heat Pump - Maintenance	28.1%	100.0%	4	$0.06	0.5	0.43	$0.034
Insulation - Ducting	8.0%	50.0%	20	$0.41	-	0.30	$0.000
Energy Management System	55.8%	100.0%	14	$0.35	1.6	0.47	$0.020
Cooking - Exhaust Hoods with Sensor Control	1.0%	15.0%	10	$0.04	-	-	$0.000
Fans - Energy Efficient Motors	28.9%	100.0%	10	$0.05	0.1	0.17	$0.084
Fans - Variable Speed Control	47.3%	100.0%	10	$0.20	0.5	0.23	$0.051
Pumps - Variable Speed Control	5.0%	45.0%	10	$0.13	0.0	0.01	$1.313
Thermostat - Clock/Programmable	33.0%	50.0%	11	$0.11	0.4	0.29	$0.033
Insulation - Ceiling	75.0%	90.0%	20	$0.35	-	0.30	$0.000
Insulation - Radiant Barrier	7.0%	25.0%	20	$0.26	-	0.30	$0.000
Roofs - High Reflectivity	5.0%	100.0%	15	$0.05	-	0.01	$0.000
Windows - High Efficiency	71.9%	100.0%	20	$0.88	-	0.30	$0.000
Interior Lighting - Central Lighting Controls	85.7%	100.0%	8	$0.65	0.4	0.06	$0.213
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	0.9%	60.0%	8	$0.34	0.7	0.18	$0.068
Exterior Lighting - Daylighting Controls	14.5%	25.0%	8	$0.19	1.7	0.75	$0.016

Table C-27 Energy Efficiency Non-Equipment Data— Extra Large Commercial, Existing Vintage, Washington

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
RTU - Maintenance	47.0%	100.0%	4	$0.06	0.3	0.27	$0.050
RTU - Evaporative Precooler	0.0%	0.0%	15	$0.88	1.1	0.12	$0.068
Chiller - Chilled Water Reset	30.0%	100.0%	4	$0.09	0.3	0.19	$0.072
Chiller - Chilled Water Variable-Flow System	30.0%	45.0%	10	$0.09	0.1	0.11	$0.097
Chiller - VSD	3.0%	100.0%	20	$1.17	0.7	0.07	$0.118
Chiller - High Efficiency Cooling Tower Fans	25.0%	73.7%	10	$0.04	0.0	0.00	$12.451
Chiller - Condenser Water Temprature Reset	31.4%	100.0%	14	$0.09	0.3	0.32	$0.024
Cooling - Economizer Installation	73.4%	90.0%	15	$0.15	0.0	0.03	$0.577
Heat Pump - Maintenance	5.0%	100.0%	4	$0.06	0.4	0.30	$0.043
Insulation - Ducting	2.0%	100.0%	20	$0.41	0.1	0.33	$0.274
Repair and Sealing - Ducting	5.0%	50.0%	15	$0.38	0.3	0.39	$0.099
Energy Management System	81.3%	100.0%	14	$0.35	4.1	1.10	$0.008
Cooking - Exhaust Hoods with Sensor Control	1.0%	10.0%	10	$0.04	0.0	0.10	$0.103
Fans - Energy Efficient Motors	11.0%	100.0%	10	$0.05	0.1	0.17	$0.061
Fans - Variable Speed Control	2.0%	100.0%	10	$0.20	0.6	0.29	$0.037
Retrocommissioning - HVAC	15.0%	100.0%	4	$0.20	0.2	0.36	$0.268
Pumps - Variable Speed Control	1.0%	45.0%	10	$0.44	0.0	0.00	$7.933
Thermostat - Clock/Programmable	25.0%	50.0%	11	$0.11	2.1	1.71	$0.006
Insulation - Ceiling	2.0%	90.0%	20	$0.85	0.2	0.33	$0.265
Insulation - Radiant Barrier	2.0%	25.0%	20	$0.26	0.0	0.32	$0.426
Roofs - High Reflectivity	0.0%	100.0%	15	$0.18	0.0	0.02	$0.687
Windows - High Efficiency	94.6%	100.0%	20	$2.10	0.1	0.30	$1.632
Interior Lighting - Central Lighting Controls	78.1%	100.0%	8	$0.65	0.0	0.00	$3.005
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	2.5%	60.0%	8	$0.40	0.5	0.11	$0.105
Exterior Lighting - Daylighting Controls	1.6%	20.0%	8	$0.29	0.3	0.06	$0.135
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	10.0%	30.0%	8	$0.20	0.2	0.09	$0.131
Interior Fluorescent - High Bay Fixtures	10.0%	30.0%	11	$0.56	1.1	0.18	$0.056
Interior Lighting - Occupancy Sensors	41.7%	60.0%	8	$0.20	0.0	0.07	$0.925
Exterior Lighting - Photovoltaic Installation	5.0%	25.0%	5	$0.92	0.4	0.02	$0.549
Interior Screw-in - Task Lighting	5.0%	100.0%	5	$0.24	0.1	0.03	$0.366
Interior Lighting - Time Clocks and Timers	12.1%	75.0%	8	$0.20	0.0	0.05	$1.849
Water Heater - Faucet Aerators/Low Flow Nozzles	47.3%	100.0%	9	$0.03	0.1	0.43	$0.026
Water Heater - Pipe Insulation	0.0%	0.0%	15	$0.28	0.2	0.07	$0.115
Water Heater - High Efficiency Circulation Pump	0.6%	25.0%	10	$0.11	2.6	2.11	$0.005
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	10	$0.04	0.2	0.41	$0.026
Water Heater - Thermostat Setback	0.0%	0.0%	10	$0.11	0.1	0.12	$0.088
Refrigeration - Anti-Sweat Heater/Auto Door Closer	10.0%	100.0%	16	$0.20	0.0	0.01	$1.098
Refrigeration - Floating Head Pressure	10.0%	50.0%	16	$0.35	0.0	0.00	$2.158
Refrigeration - Door Gasket Replacement	5.0%	100.0%	8	$0.10	0.0	0.02	$0.505
Insulation - Bare Suction Lines	5.0%	100.0%	8	$0.10	0.0	0.01	$1.067
Refrigeration - Night Covers	5.0%	100.0%	8	$0.05	0.0	0.06	$0.239
Refrigeration - Strip Curtain	12.6%	56.3%	4	$0.00	0.0	3.75	$0.004
Vending Machine - Controller	2.0%	10.0%	10	$0.27	0.1	0.01	$0.566

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
LED Exit Lighting	46.9%	90.0%	10	$0.00	0.0	4.54	$0.004
Retrocommissioning - Lighting	5.0%	100.0%	5	$0.05	0.1	0.09	$0.118
Refrigeration - High Efficiency Case Lighting	12.0%	56.0%	6	$0.04	0.2	0.34	$0.043
Exterior Lighting - Cold Cathode Lighting	14.6%	50.0%	5	$0.00	0.4	19.92	$0.000
Laundry - High Efficiency Clothes Washer	6.9%	10.0%	10	$0.00	0.0	2.68	$0.004
Interior Lighting - Hotel Guestroom Controls	0.0%	0.0%	8	$0.14	0.1	0.06	$0.154
Miscellaneous - Energy Star Water Cooler	5.0%	100.0%	8	$0.00	0.0	0.15	$0.080
Interior Lighting - Skylights	0.0%	0.0%	0	$0.00	0.0	1.00	$0.000
Ventilation - Demand Control Ventilation	1.0%	10.0%	10	$0.04	0.0	0.13	$0.415
Office Equipment - Smart Power Strips	15.4%	30.0%	7	$0.00	0.3	207.83	$0.000
Strategic Energy Management	0.0%	0.0%	3	$0.00	-	6.00	$0.000
Refrigeration - Multiplex - Floating section Pressure - Air-cooled Cond.	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex Controls - Floating section Pressure - Evap. Cond.	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex - Eff. Air-cooled Condenser	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex - Eff. Water-cooled Condenser	0.0%	0.0%	0	$0.00	-	1.00	$0.000
RTU - Maintenance	47.0%	100.0%	4	$0.06	0.3	0.27	$0.050
RTU - Evaporative Precooler	0.0%	0.0%	15	$0.88	1.1	0.12	$0.068
Chiller - Chilled Water Reset	30.0%	100.0%	4	$0.09	0.3	0.19	$0.072
Chiller - Chilled Water Variable-Flow System	30.0%	45.0%	10	$0.09	0.1	0.11	$0.097
Chiller - VSD	3.0%	100.0%	20	$1.17	0.7	0.07	$0.118
Chiller - High Efficiency Cooling Tower Fans	25.0%	73.7%	10	$0.04	0.0	0.00	$12.451
Chiller - Condenser Water Temprature Reset	31.4%	100.0%	14	$0.09	0.3	0.32	$0.024
Cooling - Economizer Installation	73.4%	90.0%	15	$0.15	0.0	0.03	$0.577
Heat Pump - Maintenance	5.0%	100.0%	4	$0.06	0.4	0.30	$0.043
Insulation - Ducting	2.0%	100.0%	20	$0.41	0.1	0.33	$0.274
Repair and Sealing - Ducting	5.0%	50.0%	15	$0.38	0.3	0.39	$0.099
Energy Management System	81.3%	100.0%	14	$0.35	4.1	1.10	$0.008
Cooking - Exhaust Hoods with Sensor Control	1.0%	10.0%	10	$0.04	0.0	0.10	$0.103
Fans - Energy Efficient Motors	11.0%	100.0%	10	$0.05	0.1	0.17	$0.061
Fans - Variable Speed Control	2.0%	100.0%	10	$0.20	0.6	0.29	$0.037
Retrocommissioning - HVAC	15.0%	100.0%	4	$0.20	0.2	0.36	$0.268
Pumps - Variable Speed Control	1.0%	45.0%	10	$0.44	0.0	0.00	$7.933
Thermostat - Clock/Programmable	25.0%	50.0%	11	$0.11	2.1	1.71	$0.006
Insulation - Ceiling	2.0%	90.0%	20	$0.85	0.2	0.33	$0.265
Insulation - Radiant Barrier	2.0%	25.0%	20	$0.26	0.0	0.32	$0.426

Table C-28 Energy Efficiency Non-Equipment Data— Extra Large Commercial, New Vintage, Washington

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
RTU - Maintenance	47.0%	100.0%	4	$0.06	0.2	0.17	$0.086
RTU - Evaporative Precooler	0.0%	0.0%	15	$0.88	0.9	0.11	$0.082
Chiller - Chilled Water Reset	60.0%	100.0%	4	$0.09	0.3	0.16	$0.091
Chiller - Chilled Water Variable-Flow System	30.0%	45.0%	10	$0.09	0.1	0.08	$0.127
Chiller - VSD	3.0%	100.0%	20	$1.17	0.6	0.06	$0.138
Chiller - High Efficiency Cooling Tower Fans	25.0%	73.7%	10	$0.04	0.0	0.00	$11.601
Chiller - Condenser Water Temprature Reset	57.1%	100.0%	14	$0.09	0.3	0.34	$0.030
Cooling - Economizer Installation	73.4%	90.0%	15	$0.15	-	0.02	$0.000
Heat Pump - Maintenance	5.0%	100.0%	4	$0.06	0.2	0.18	$0.082
Insulation - Ducting	2.0%	50.0%	20	$0.41	-	0.31	$0.000
Energy Management System	80.0%	100.0%	14	$0.35	2.7	0.78	$0.012
Cooking - Exhaust Hoods with Sensor Control	1.0%	10.0%	10	$0.04	0.0	0.10	$0.117
Fans - Energy Efficient Motors	11.0%	100.0%	10	$0.05	0.1	0.16	$0.070
Fans - Variable Speed Control	2.0%	100.0%	10	$0.20	0.6	0.31	$0.037
Pumps - Variable Speed Control	1.0%	45.0%	10	$0.44	0.0	0.00	$7.545
Thermostat - Clock/Programmable	25.0%	50.0%	11	$0.11	2.0	1.61	$0.006
Insulation - Ceiling	2.0%	90.0%	20	$0.35	-	0.31	$0.000
Insulation - Radiant Barrier	2.0%	25.0%	20	$0.26	-	0.30	$0.000
Roofs - High Reflectivity	5.0%	100.0%	15	$0.18	-	0.01	$0.000
Windows - High Efficiency	94.6%	100.0%	20	$1.69	-	0.30	$0.000
Interior Lighting - Central Lighting Controls	78.1%	100.0%	8	$0.65	-	-	$0.000
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	2.5%	60.0%	8	$0.30	0.5	0.14	$0.086
Exterior Lighting - Daylighting Controls	10.0%	20.0%	8	$0.19	-	0.00	$0.000
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	10.0%	30.0%	8	$0.20	0.2	0.09	$0.143
Interior Fluorescent - High Bay Fixtures	10.0%	30.0%	11	$0.56	1.0	0.17	$0.061
Interior Lighting - Occupancy Sensors	41.7%	60.0%	8	$0.20	-	0.06	$0.000
Exterior Lighting - Photovoltaic Installation	5.0%	25.0%	5	$0.92	-	-	$0.000
Interior Screw-in - Task Lighting	25.0%	100.0%	5	$0.24	0.1	0.04	$0.376
Interior Lighting - Time Clocks and Timers	12.1%	75.0%	8	$0.20	-	0.04	$0.000
Water Heater - Faucet Aerators/Low Flow Nozzles	47.3%	100.0%	9	$0.03	0.1	0.43	$0.027
Water Heater - Pipe Insulation	0.0%	0.0%	15	$0.28	0.1	0.05	$0.180
Water Heater - High Efficiency Circulation Pump	0.6%	25.0%	10	$0.11	2.5	2.10	$0.005
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	10	$0.04	0.1	0.21	$0.052
Water Heater - Thermostat Setback	0.0%	0.0%	10	$0.11	0.1	0.12	$0.090
Refrigeration - Anti-Sweat Heater/Auto Door Closer	10.0%	100.0%	16	$0.20	0.0	0.01	$1.217
Refrigeration - Floating Head Pressure	10.0%	50.0%	16	$0.35	0.2	0.04	$0.188
Refrigeration - Door Gasket Replacement	5.0%	100.0%	8	$0.10	0.0	0.02	$0.721
Insulation - Bare Suction Lines	5.0%	100.0%	8	$0.10	0.2	0.13	$0.093
Refrigeration - Night Covers	5.0%	100.0%	8	$0.05	0.0	0.06	$0.263
Refrigeration - Strip Curtain	29.7%	56.3%	4	$0.00	0.0	3.12	$0.005
Vending Machine - Controller	2.0%	10.0%	10	$0.27	0.0	0.01	$0.784
LED Exit Lighting	91.2%	90.0%	10	$0.00	0.0	5.08	$0.004
Refrigeration - High Efficiency Case	26.1%	56.0%	6	$0.02	0.1	0.87	$0.041

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Lighting							
Exterior Lighting - Cold Cathode Lighting	14.6%	50.0%	5	$0.00	0.3	22.34	$0.001
Laundry - High Efficiency Clothes Washer	6.9%	10.0%	10	$0.00	0.0	2.95	$0.004
Interior Lighting - Hotel Guestroom Controls	0.0%	0.0%	8	$0.14	0.1	0.07	$0.158
Miscellaneous - Energy Star Water Cooler	5.0%	100.0%	8	$0.00	0.0	0.17	$0.073
Interior Lighting - Skylights	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Ventilation - Demand Control Ventilation	5.9%	10.0%	10	$0.04	-	0.11	$0.000
Office Equipment - Smart Power Strips	15.4%	30.0%	7	$0.00	0.3	219.19	$0.000
Strategic Energy Management	0.0%	0.0%	3	$0.00	-	6.00	$0.000
Refrigeration - Multiplex - Floating section Pressure - Air-cooled Cond.	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex Controls - Floating section Pressure - Evap. Cond.	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex - Eff. Air-cooled Condenser	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex - Eff. Water-cooled Condenser	0.0%	0.0%	0	$0.00	-	1.00	$0.000
RTU - Maintenance	47.0%	100.0%	4	$0.06	0.2	0.17	$0.086
RTU - Evaporative Precooler	0.0%	0.0%	15	$0.88	0.9	0.11	$0.082
Chiller - Chilled Water Reset	60.0%	100.0%	4	$0.09	0.3	0.16	$0.091
Chiller - Chilled Water Variable-Flow System	30.0%	45.0%	10	$0.09	0.1	0.08	$0.127
Chiller - VSD	3.0%	100.0%	20	$1.17	0.6	0.06	$0.138
Chiller - High Efficiency Cooling Tower Fans	25.0%	73.7%	10	$0.04	0.0	0.00	$11.601
Chiller - Condenser Water Temprature Reset	57.1%	100.0%	14	$0.09	0.3	0.34	$0.030
Cooling - Economizer Installation	73.4%	90.0%	15	$0.15	-	0.02	$0.000
Heat Pump - Maintenance	5.0%	100.0%	4	$0.06	0.2	0.18	$0.082
Insulation - Ducting	2.0%	50.0%	20	$0.41	-	0.31	$0.000
Energy Management System	80.0%	100.0%	14	$0.35	2.7	0.78	$0.012
Cooking - Exhaust Hoods with Sensor Control	1.0%	10.0%	10	$0.04	0.0	0.10	$0.117
Fans - Energy Efficient Motors	11.0%	100.0%	10	$0.05	0.1	0.16	$0.070
Fans - Variable Speed Control	2.0%	100.0%	10	$0.20	0.6	0.31	$0.037
Pumps - Variable Speed Control	1.0%	45.0%	10	$0.44	0.0	0.00	$7.545
Thermostat - Clock/Programmable	25.0%	50.0%	11	$0.11	2.0	1.61	$0.006
Insulation - Ceiling	2.0%	90.0%	20	$0.35	-	0.31	$0.000
Insulation - Radiant Barrier	2.0%	25.0%	20	$0.26	-	0.30	$0.000
Roofs - High Reflectivity	5.0%	100.0%	15	$0.18	-	0.01	$0.000
Windows - High Efficiency	94.6%	100.0%	20	$1.69	-	0.30	$0.000
Interior Lighting - Central Lighting Controls	78.1%	100.0%	8	$0.65	-	-	$0.000
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	2.5%	60.0%	8	$0.30	0.5	0.14	$0.086
Exterior Lighting - Daylighting Controls	10.0%	20.0%	8	$0.19	-	0.00	$0.000

Table C-29 Energy Efficiency Non-Equipment Data— Extra Large Commercial, Existing Vintage, Idaho

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
RTU - Maintenance	54.2%	100.0%	4	$0.06	0.3	0.26	$0.050
RTU - Evaporative Precooler	0.0%	0.0%	15	$0.88	1.1	0.12	$0.068
Chiller - Chilled Water Reset	36.0%	100.0%	4	$0.09	0.3	0.19	$0.072
Chiller - Chilled Water Variable-Flow System	30.0%	45.0%	10	$0.09	0.1	0.11	$0.097
Chiller - VSD	3.0%	100.0%	20	$1.17	0.7	0.06	$0.118
Chiller - High Efficiency Cooling Tower Fans	25.0%	73.7%	10	$0.04	0.0	0.00	$12.451
Chiller - Condenser Water Temprature Reset	31.4%	100.0%	14	$0.09	0.3	0.37	$0.025
Cooling - Economizer Installation	73.4%	90.0%	15	$0.15	0.0	0.02	$1.832
Heat Pump - Maintenance	24.1%	100.0%	4	$0.06	0.8	0.66	$0.021
Insulation - Ducting	2.0%	100.0%	20	$0.41	0.0	0.32	$0.695
Repair and Sealing - Ducting	5.0%	50.0%	15	$0.38	0.1	0.34	$0.240
Energy Management System	82.8%	100.0%	14	$0.35	2.9	0.78	$0.011
Cooking - Exhaust Hoods with Sensor Control	1.0%	10.0%	10	$0.04	0.0	0.11	$0.098
Fans - Energy Efficient Motors	11.0%	100.0%	10	$0.05	0.1	0.17	$0.061
Fans - Variable Speed Control	21.7%	100.0%	10	$0.20	0.6	0.29	$0.037
Retrocommissioning - HVAC	15.0%	100.0%	4	$0.20	0.1	0.32	$0.714
Pumps - Variable Speed Control	1.0%	45.0%	10	$0.44	0.0	0.00	$7.933
Thermostat - Clock/Programmable	25.0%	50.0%	11	$0.11	1.3	1.02	$0.010
Insulation - Ceiling	2.0%	90.0%	20	$0.85	0.1	0.32	$0.687
Insulation - Radiant Barrier	2.0%	25.0%	20	$0.26	0.0	0.31	$1.057
Roofs - High Reflectivity	0.0%	100.0%	15	$0.18	0.0	0.02	$2.179
Windows - High Efficiency	94.6%	100.0%	20	$2.10	0.0	0.30	$3.948
Interior Lighting - Central Lighting Controls	78.1%	100.0%	8	$0.65	-	-	$0.000
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	2.5%	60.0%	8	$0.40	0.5	0.11	$0.105
Exterior Lighting - Daylighting Controls	1.6%	20.0%	8	$0.29	-	0.00	$0.000
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	10.0%	30.0%	8	$0.20	0.2	0.09	$0.131
Interior Fluorescent - High Bay Fixtures	11.4%	30.0%	11	$0.56	1.1	0.17	$0.056
Interior Lighting - Occupancy Sensors	43.5%	60.0%	8	$0.20	-	0.06	$0.000
Exterior Lighting - Photovoltaic Installation	0.0%	0.0%	0	$0.00	-	-	$0.000
Interior Screw-in - Task Lighting	0.0%	0.0%	0	$0.00	-	-	$0.000
Interior Lighting - Time Clocks and Timers	0.0%	0.0%	0	$0.00	-	-	$0.000
Water Heater - Faucet Aerators/Low Flow Nozzles	0.0%	0.0%	0	$0.00	-	-	$0.000
Water Heater - Pipe Insulation	0.0%	0.0%	0	$0.00	-	-	$0.000
Water Heater - High Efficiency Circulation Pump	0.0%	0.0%	0	$0.00	-	-	$0.000
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	0	$0.00	-	-	$0.000
Water Heater - Thermostat Setback	0.0%	0.0%	0	$0.00	-	-	$0.000
Refrigeration - Anti-Sweat Heater/Auto Door Closer	0.0%	0.0%	0	$0.00	-	-	$0.000
Refrigeration - Floating Head Pressure	0.0%	0.0%	0	$0.00	-	-	$0.000
Refrigeration - Door Gasket Replacement	0.0%	0.0%	0	$0.00	-	-	$0.000
Insulation - Bare Suction Lines	0.0%	0.0%	0	$0.00	-	-	$0.000
Refrigeration - Night Covers	0.0%	0.0%	0	$0.00	-	-	$0.000
Refrigeration - Strip Curtain	0.0%	0.0%	0	$0.00	-	-	$0.000
Vending Machine - Controller	0.0%	0.0%	0	$0.00	-	-	$0.000

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
LED Exit Lighting	0.0%	0.0%	0	$0.00	-	-	$0.000
Retrocommissioning - Lighting	0.0%	0.0%	0	$0.00	-	-	$0.000
Refrigeration - High Efficiency Case Lighting	0.0%	0.0%	0	$0.00	-	-	$0.000
Exterior Lighting - Cold Cathode Lighting	0.0%	0.0%	0	$0.00	-	-	$0.000
Laundry - High Efficiency Clothes Washer	0.0%	0.0%	0	$0.00	-	-	$0.000
Interior Lighting - Hotel Guestroom Controls	0.0%	0.0%	0	$0.00	-	-	$0.000
Miscellaneous - Energy Star Water Cooler	0.0%	0.0%	0	$0.00	-	-	$0.000
Interior Lighting - Skylights	0.0%	0.0%	0	$0.00	-	-	$0.000
Ventilation - Demand Control Ventilation	0.0%	0.0%	0	$0.00	-	-	$0.000
Office Equipment - Smart Power Strips	0.0%	0.0%	0	$0.00	-	-	$0.000
Strategic Energy Management	0.0%	0.0%	0	$0.00	-	-	$0.000
Refrigeration - Multiplex - Floating section Pressure - Air-cooled Cond.	0.0%	0.0%	0	$0.00	-	-	$0.000
Refrigeration - Multiplex Controls - Floating section Pressure - Evap. Cond.	0.0%	0.0%	0	$0.00	-	-	$0.000
Refrigeration - Multiplex - Eff. Air-cooled Condenser	0.0%	0.0%	0	$0.00	-	-	$0.000
Refrigeration - Multiplex - Eff. Water-cooled Condenser	0.0%	0.0%	0	$0.00	-	-	$0.000
RTU - Maintenance	54.2%	100.0%	4	$0.06	0.3	0.26	$0.050
RTU - Evaporative Precooler	0.0%	0.0%	15	$0.88	1.1	0.12	$0.068
Chiller - Chilled Water Reset	36.0%	100.0%	4	$0.09	0.3	0.19	$0.072
Chiller - Chilled Water Variable-Flow System	30.0%	45.0%	10	$0.09	0.1	0.11	$0.097
Chiller - VSD	3.0%	100.0%	20	$1.17	0.7	0.06	$0.118
Chiller - High Efficiency Cooling Tower Fans	25.0%	73.7%	10	$0.04	0.0	0.00	$12.451
Chiller - Condenser Water Temprature Reset	31.4%	100.0%	14	$0.09	0.3	0.37	$0.025
Cooling - Economizer Installation	73.4%	90.0%	15	$0.15	0.0	0.02	$1.832
Heat Pump - Maintenance	24.1%	100.0%	4	$0.06	0.8	0.66	$0.021
Insulation - Ducting	2.0%	100.0%	20	$0.41	0.0	0.32	$0.695
Repair and Sealing - Ducting	5.0%	50.0%	15	$0.38	0.1	0.34	$0.240
Energy Management System	82.8%	100.0%	14	$0.35	2.9	0.78	$0.011
Cooking - Exhaust Hoods with Sensor Control	1.0%	10.0%	10	$0.04	0.0	0.11	$0.098
Fans - Energy Efficient Motors	11.0%	100.0%	10	$0.05	0.1	0.17	$0.061
Fans - Variable Speed Control	21.7%	100.0%	10	$0.20	0.6	0.29	$0.037
Retrocommissioning - HVAC	15.0%	100.0%	4	$0.20	0.1	0.32	$0.714
Pumps - Variable Speed Control	1.0%	45.0%	10	$0.44	0.0	0.00	$7.933
Thermostat - Clock/Programmable	25.0%	50.0%	11	$0.11	1.3	1.02	$0.010
Insulation - Ceiling	2.0%	90.0%	20	$0.85	0.1	0.32	$0.687
Insulation - Radiant Barrier	2.0%	25.0%	20	$0.26	0.0	0.31	$1.057

Table C-30 Energy Efficiency Non-Equipment Data— Extra Large Commercial, New Vintage, Idaho

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
RTU - Maintenance	48.7%	100.0%	4	$0.06	0.2	0.17	$0.086
RTU - Evaporative Precooler	0.0%	0.0%	15	$0.88	0.9	0.11	$0.082
Chiller - Chilled Water Reset	60.0%	100.0%	4	$0.09	0.3	0.17	$0.091
Chiller - Chilled Water Variable-Flow System	30.0%	45.0%	10	$0.09	0.1	0.09	$0.127
Chiller - VSD	3.0%	100.0%	20	$1.17	0.6	0.06	$0.138
Chiller - High Efficiency Cooling Tower Fans	25.0%	73.7%	10	$0.04	0.0	0.00	$11.601
Chiller - Condenser Water Temprature Reset	57.1%	100.0%	14	$0.09	0.3	0.37	$0.030
Cooling - Economizer Installation	73.4%	90.0%	15	$0.15	-	0.02	$0.000
Heat Pump - Maintenance	24.1%	100.0%	4	$0.06	0.6	0.58	$0.026
Insulation - Ducting	4.6%	50.0%	20	$0.41	0.3	0.38	$0.088
Energy Management System	82.8%	100.0%	14	$0.35	2.5	0.73	$0.013
Cooking - Exhaust Hoods with Sensor Control	1.0%	10.0%	10	$0.04	0.0	0.10	$0.111
Fans - Energy Efficient Motors	28.9%	100.0%	10	$0.05	0.1	0.18	$0.070
Fans - Variable Speed Control	47.3%	100.0%	10	$0.20	0.6	0.31	$0.037
Pumps - Variable Speed Control	1.0%	45.0%	10	$0.44	0.0	0.00	$7.545
Thermostat - Clock/Programmable	30.3%	50.0%	11	$0.11	1.6	1.33	$0.007
Insulation - Ceiling	14.5%	90.0%	20	$0.35	0.4	0.43	$0.056
Insulation - Radiant Barrier	5.5%	25.0%	20	$0.26	0.9	0.62	$0.021
Roofs - High Reflectivity	5.0%	100.0%	15	$0.18	-	0.01	$0.000
Windows - High Efficiency	94.6%	100.0%	20	$1.69	1.1	0.36	$0.106
Interior Lighting - Central Lighting Controls	82.5%	100.0%	8	$0.65	3.0	0.39	$0.031
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	2.5%	60.0%	8	$0.30	0.5	0.14	$0.086
Exterior Lighting - Daylighting Controls	10.0%	20.0%	8	$0.19	0.3	0.16	$0.079
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	10.0%	30.0%	8	$0.20	0.2	0.09	$0.143
Interior Fluorescent - High Bay Fixtures	10.8%	30.0%	11	$0.56	1.0	0.17	$0.061
Interior Lighting - Occupancy Sensors	48.7%	60.0%	8	$0.20	3.0	1.32	$0.009
Exterior Lighting - Photovoltaic Installation	5.0%	25.0%	5	$0.92	0.4	0.03	$0.481
Interior Screw-in - Task Lighting	25.0%	100.0%	5	$0.24	0.1	0.04	$0.376
Interior Lighting - Time Clocks and Timers	25.4%	75.0%	8	$0.20	1.5	0.67	$0.019
Water Heater - Faucet Aerators/Low Flow Nozzles	47.3%	100.0%	9	$0.03	0.1	0.44	$0.027
Water Heater - Pipe Insulation	0.0%	0.0%	15	$0.28	0.1	0.05	$0.180
Water Heater - High Efficiency Circulation Pump	0.6%	25.0%	10	$0.11	2.5	2.16	$0.005
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	10	$0.04	0.1	0.21	$0.052
Water Heater - Thermostat Setback	0.0%	0.0%	10	$0.11	0.1	0.12	$0.090
Refrigeration - Anti-Sweat Heater/Auto Door Closer	0.0%	100.0%	16	$0.20	0.0	0.01	$1.217
Refrigeration - Floating Head Pressure	10.0%	50.0%	16	$0.35	0.5	0.13	$0.063
Refrigeration - Door Gasket Replacement	5.0%	100.0%	8	$0.10	0.0	0.02	$0.721
Insulation - Bare Suction Lines	18.5%	100.0%	8	$0.10	0.5	0.39	$0.031
Refrigeration - Night Covers	5.0%	100.0%	8	$0.05	0.0	0.06	$0.263
Refrigeration - Strip Curtain	29.7%	56.3%	4	$0.00	0.0	3.11	$0.005
Vending Machine - Controller	2.0%	10.0%	10	$0.27	0.0	0.01	$0.784
LED Exit Lighting	91.2%	90.0%	10	$0.00	0.0	5.56	$0.004
Refrigeration - High Efficiency Case	24.0%	56.0%	6	$0.02	0.0	0.09	$0.170

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Lighting							
Exterior Lighting - Cold Cathode Lighting	14.6%	50.0%	5	$0.00	0.3	23.65	$0.001
Laundry - High Efficiency Clothes Washer	6.9%	10.0%	10	$0.00	0.0	2.93	$0.004
Interior Lighting - Hotel Guestroom Controls	1.0%	2.0%	8	$0.14	0.1	0.08	$0.158
Miscellaneous - Energy Star Water Cooler	5.0%	100.0%	8	$0.00	0.0	0.17	$0.073
Interior Lighting - Skylights	0.0%	0.0%	0	$0.00	4.5	1.00	$0.000
Ventilation - Demand Control Ventilation	10.2%	10.0%	10	$0.04	0.6	1.34	$0.009
Office Equipment - Smart Power Strips	15.4%	30.0%	7	$0.00	0.3	232.67	$0.000
Strategic Energy Management	0.0%	0.0%	3	$0.00	-	6.00	$0.000
Refrigeration - Multiplex - Floating section Pressure - Air-cooled Cond.	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex Controls - Floating section Pressure - Evap. Cond.	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex - Eff. Air-cooled Condenser	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex - Eff. Water-cooled Condenser	0.0%	0.0%	0	$0.00	-	1.00	$0.000
RTU - Maintenance	48.7%	100.0%	4	$0.06	0.2	0.17	$0.086
RTU - Evaporative Precooler	0.0%	0.0%	15	$0.88	0.9	0.11	$0.082
Chiller - Chilled Water Reset	60.0%	100.0%	4	$0.09	0.3	0.17	$0.091
Chiller - Chilled Water Variable-Flow System	30.0%	45.0%	10	$0.09	0.1	0.09	$0.127
Chiller - VSD	3.0%	100.0%	20	$1.17	0.6	0.06	$0.138
Chiller - High Efficiency Cooling Tower Fans	25.0%	73.7%	10	$0.04	0.0	0.00	$11.601
Chiller - Condenser Water Temprature Reset	57.1%	100.0%	14	$0.09	0.3	0.37	$0.030
Cooling - Economizer Installation	73.4%	90.0%	15	$0.15	-	0.02	$0.000
Heat Pump - Maintenance	24.1%	100.0%	4	$0.06	0.6	0.58	$0.026
Insulation - Ducting	4.6%	50.0%	20	$0.41	0.3	0.38	$0.088
Energy Management System	82.8%	100.0%	14	$0.35	2.5	0.73	$0.013
Cooking - Exhaust Hoods with Sensor Control	1.0%	10.0%	10	$0.04	0.0	0.10	$0.111
Fans - Energy Efficient Motors	28.9%	100.0%	10	$0.05	0.1	0.18	$0.070
Fans - Variable Speed Control	47.3%	100.0%	10	$0.20	0.6	0.31	$0.037
Pumps - Variable Speed Control	1.0%	45.0%	10	$0.44	0.0	0.00	$7.545
Thermostat - Clock/Programmable	30.3%	50.0%	11	$0.11	1.6	1.33	$0.007
Insulation - Ceiling	14.5%	90.0%	20	$0.35	0.4	0.43	$0.056
Insulation - Radiant Barrier	5.5%	25.0%	20	$0.26	0.9	0.62	$0.021
Roofs - High Reflectivity	5.0%	100.0%	15	$0.18	-	0.01	$0.000
Windows - High Efficiency	94.6%	100.0%	20	$1.69	1.1	0.36	$0.106
Interior Lighting - Central Lighting Controls	82.5%	100.0%	8	$0.65	3.0	0.39	$0.031
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	2.5%	60.0%	8	$0.30	0.5	0.14	$0.086
Exterior Lighting - Daylighting Controls	10.0%	20.0%	8	$0.19	0.3	0.16	$0.079

Table C-31 Energy Efficiency Non-Equipment Data— Extra Large Industrial, Existing Vintage, Washington

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Refrigeration - System Controls	5.0%	45.0%	10	$0.40	0.2	0.06	$0.198
Refrigeration - System Maintenance	13.6%	45.0%	10	$0.00	0.1	7.74	$0.001
Refrigeration - System Optimization	5.0%	45.0%	10	$0.80	0.2	0.03	$0.396
Motors - Variable Frequency Drive	25.0%	50.0%	10	$0.10	-	0.00	$0.000
Motors - Magnetic Adjustable Speed Drives	20.0%	25.0%	10	$0.10	-	0.02	$0.000
Compressed Air - System Controls	0.0%	0.0%	15	$0.01	-	0.08	$0.000
Compressed Air - System Optimization and Improvements	35.0%	75.0%	10	$0.20	-	0.01	$0.000
Compressed Air - System Maintenance	0.0%	0.0%	3	$0.03	-	-	$0.000
Compressed Air - Compressor Replacement	14.6%	17.1%	10	$0.06	-	0.02	$0.000
Fan System - Controls	7.8%	8.2%	10	$0.01	0.0	0.37	$0.036
Fan System - Optimization	6.6%	8.9%	10	$0.13	0.2	0.15	$0.085
Fan System - Maintenance	3.0%	11.3%	3	$0.01	0.0	0.07	$0.251
Pumping System - Controls	6.9%	9.3%	10	$0.01	-	0.02	$0.000
Pumping System - Optimization	6.7%	9.0%	10	$0.28	-	0.01	$0.000
Pumping System - Maintenance	1.5%	10.1%	3	$0.02	-	-	$0.000
RTU - Maintenance	21.9%	100.0%	4	$0.06	0.4	0.29	$0.045
Chiller - Chilled Water Reset	30.0%	100.0%	4	$0.09	0.4	0.22	$0.062
Chiller - Chilled Water Variable-Flow System	30.0%	45.0%	10	$0.20	0.1	0.04	$0.236
Chiller - VSD	15.0%	89.0%	20	$1.17	0.8	0.06	$0.105
Chiller - High Efficiency Cooling Tower Fans	25.0%	100.0%	10	$0.04	0.0	0.00	$9.998
Chiller - Condenser Water Temprature Reset	0.0%	100.0%	14	$0.20	0.4	0.17	$0.045
Cooling - Economizer Installation	29.1%	45.0%	15	$0.15	0.1	0.03	$0.211
Heat Pump - Maintenance	21.7%	100.0%	4	$0.03	1.1	1.82	$0.007
Insulation - Ducting	11.8%	100.0%	20	$0.41	0.0	0.31	$4.048
Repair and Sealing - Ducting	5.0%	50.0%	15	$0.38	0.0	0.31	$1.794
Energy Management System	11.0%	100.0%	14	$0.35	4.3	1.10	$0.007
Fans - Energy Efficient Motors	0.0%	0.0%	10	$0.14	0.1	0.07	$0.159
Fans - Variable Speed Control	0.0%	0.0%	10	$0.20	0.4	0.17	$0.057
Retrocommissioning - HVAC	1.4%	93.3%	4	$0.25	0.0	0.31	$2.167
Pumps - Variable Speed Control	0.1%	0.0%	10	$0.44	-	0.00	$0.000
Thermostat - Clock/Programmable	59.0%	70.0%	11	$0.11	2.0	1.71	$0.006
Interior Lighting - Central Lighting Controls	83.7%	100.0%	8	$0.65	0.0	0.00	$22.297
Exterior Lighting - Daylighting Controls	1.6%	53.6%	8	$0.08	-	0.00	$0.000
Interior Fluorescent - High Bay Fixtures	19.1%	50.0%	11	$0.20	1.7	0.59	$0.013
LED Exit Lighting	46.9%	90.0%	10	$0.00	0.0	1.34	$0.006
Retrocommissioning - Lighting	9.0%	93.0%	5	$0.05	0.0	0.00	$2.594
Interior Lighting - Occupancy Sensors	14.7%	60.0%	8	$0.20	0.0	0.00	$6.861
Exterior Lighting - Photovoltaic Installation	5.0%	25.0%	5	$0.92	-	-	$0.000
Interior Screw-in - Task Lighting	10.0%	100.0%	5	$0.24	0.1	0.02	$0.500
Interior Lighting - Time Clocks and Timers	2.4%	75.0%	8	$0.20	0.0	0.04	$13.721
Exterior Lighting - Cold Cathode Lighting	14.6%	50.0%	5	$0.00	0.4	16.94	$0.001
Interior Lighting - Skylights	1.2%	40.6%	8	$0.29	0.0	0.00	$6.518
Ventilation - Demand Control Ventilation	1.0%	10.0%	10	$0.04	0.0	0.14	$0.103
Strategic Energy Management	0.0%	20.0%	3	$0.02	0.0	0.09	$0.173
Transformers	8.6%	9.4%	10	$0.13	0.0	0.04	$0.413

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Motors - Synchronous belts	17.3%	21.0%	10	$0.22	-	0.00	$0.000
Refrigeration - Multiplex - Floating section Pressure - Air-cooled Cond.	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex Controls - Floating section Pressure - Evap. Cond.	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex - Eff. Air-cooled Condenser	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex - Eff. Water-cooled Condenser	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - System Controls	5.0%	45.0%	10	$0.40	0.2	0.06	$0.198
Refrigeration - System Maintenance	13.6%	45.0%	10	$0.00	0.1	7.74	$0.001
Refrigeration - System Optimization	5.0%	45.0%	10	$0.80	0.2	0.03	$0.396
Motors - Variable Frequency Drive	25.0%	50.0%	10	$0.10	-	0.00	$0.000
Motors - Magnetic Adjustable Speed Drives	20.0%	25.0%	10	$0.10	-	0.02	$0.000
Compressed Air - System Controls	0.0%	0.0%	15	$0.01	-	0.08	$0.000
Compressed Air - System Optimization and Improvements	35.0%	75.0%	10	$0.20	-	0.01	$0.000
Compressed Air - System Maintenance	0.0%	0.0%	3	$0.03	-	-	$0.000
Compressed Air - Compressor Replacement	14.6%	17.1%	10	$0.06	-	0.02	$0.000
Fan System - Controls	7.8%	8.2%	10	$0.01	0.0	0.37	$0.036
Fan System - Optimization	6.6%	8.9%	10	$0.13	0.2	0.15	$0.085
Fan System - Maintenance	3.0%	11.3%	3	$0.01	0.0	0.07	$0.251
Pumping System - Controls	6.9%	9.3%	10	$0.01	-	0.02	$0.000
Pumping System - Optimization	6.7%	9.0%	10	$0.28	-	0.01	$0.000
Pumping System - Maintenance	1.5%	10.1%	3	$0.02	-	-	$0.000
RTU - Maintenance	21.9%	100.0%	4	$0.06	0.4	0.29	$0.045
Chiller - Chilled Water Reset	30.0%	100.0%	4	$0.09	0.4	0.22	$0.062
Chiller - Chilled Water Variable-Flow System	30.0%	45.0%	10	$0.20	0.1	0.04	$0.236
Chiller - VSD	15.0%	89.0%	20	$1.17	0.8	0.06	$0.105
Chiller - High Efficiency Cooling Tower Fans	25.0%	100.0%	10	$0.04	0.0	0.00	$9.998
Chiller - Condenser Water Temprature Reset	0.0%	100.0%	14	$0.20	0.4	0.17	$0.045
Cooling - Economizer Installation	29.1%	45.0%	15	$0.15	0.1	0.03	$0.211
Heat Pump - Maintenance	21.7%	100.0%	4	$0.03	1.1	1.82	$0.007
Insulation - Ducting	11.8%	100.0%	20	$0.41	0.0	0.31	$4.048
Repair and Sealing - Ducting	5.0%	50.0%	15	$0.38	0.0	0.31	$1.794
Energy Management System	11.0%	100.0%	14	$0.35	4.3	1.10	$0.007
Fans - Energy Efficient Motors	0.0%	0.0%	10	$0.14	0.1	0.07	$0.159
Fans - Variable Speed Control	0.0%	0.0%	10	$0.20	0.4	0.17	$0.057

Table C-32 Energy Efficiency Non-Equipment Data— Extra Large Industrial, New Vintage, Washington

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Refrigeration - System Controls	5.0%	45.0%	10	$0.40	0.2	0.06	$0.198
Refrigeration - System Maintenance	13.6%	45.0%	10	$0.00	0.1	7.89	$0.001
Refrigeration - System Optimization	5.0%	45.0%	10	$0.80	0.2	0.03	$0.396
Motors - Variable Frequency Drive	25.0%	50.0%	10	$0.10	0.2	0.15	$0.072
Motors - Magnetic Adjustable Speed Drives	24.0%	25.0%	10	$0.10	0.7	0.65	$0.017
Compressed Air - System Controls	0.0%	0.0%	15	$0.01	0.3	2.98	$0.003
Compressed Air - System Optimization and Improvements	44.8%	75.0%	10	$0.20	0.8	0.38	$0.029
Compressed Air - System Maintenance	0.0%	0.0%	3	$0.03	0.1	0.10	$0.175
Compressed Air - Compressor Replacement	17.6%	17.1%	10	$0.06	0.6	0.84	$0.013
Fan System - Controls	7.8%	8.2%	10	$0.01	0.0	0.37	$0.036
Fan System - Optimization	6.6%	8.9%	10	$0.13	0.2	0.15	$0.085
Fan System - Maintenance	3.0%	11.3%	3	$0.01	0.0	0.07	$0.251
Pumping System - Controls	8.6%	9.3%	10	$0.01	0.1	1.04	$0.011
Pumping System - Optimization	6.7%	9.0%	10	$0.28	0.8	0.28	$0.040
Pumping System - Maintenance	1.5%	10.1%	3	$0.02	0.1	0.15	$0.117
RTU - Maintenance	21.9%	100.0%	4	$0.06	0.2	0.20	$0.073
Chiller - Chilled Water Reset	60.0%	100.0%	4	$0.09	0.3	0.19	$0.077
Chiller - Chilled Water Variable-Flow System	30.0%	45.0%	10	$0.20	0.1	0.06	$0.158
Chiller - VSD	25.0%	89.0%	20	$1.17	0.7	0.06	$0.119
Chiller - High Efficiency Cooling Tower Fans	25.0%	100.0%	10	$0.04	0.0	0.01	$1.019
Chiller - Condenser Water Temprature Reset	5.0%	100.0%	14	$0.20	0.4	0.16	$0.051
Cooling - Economizer Installation	29.1%	45.0%	15	$0.15	-	-	$0.000
Heat Pump - Maintenance	21.7%	100.0%	4	$0.03	0.6	1.07	$0.014
Insulation - Ducting	11.8%	50.0%	20	$0.41	-	0.31	$0.000
Energy Management System	23.6%	100.0%	14	$0.35	4.9	1.28	$0.007
Fans - Energy Efficient Motors	0.0%	0.0%	10	$0.14	0.1	0.06	$0.187
Fans - Variable Speed Control	0.0%	0.0%	10	$0.34	0.4	0.10	$0.114
Pumps - Variable Speed Control	0.1%	0.0%	10	$0.44	0.2	0.03	$0.316
Thermostat - Clock/Programmable	59.0%	70.0%	11	$0.11	1.7	1.41	$0.007
Interior Lighting - Central Lighting Controls	83.7%	100.0%	8	$0.65	1.4	0.18	$0.067
Exterior Lighting - Daylighting Controls	19.7%	53.6%	8	$0.08	1.4	1.52	$0.008
Interior Fluorescent - High Bay Fixtures	19.1%	50.0%	11	$0.20	1.2	0.58	$0.018
LED Exit Lighting	91.2%	90.0%	10	$0.00	0.0	1.62	$0.006
Interior Lighting - Occupancy Sensors	25.0%	60.0%	8	$0.20	1.4	0.58	$0.021
Exterior Lighting - Photovoltaic Installation	5.0%	25.0%	5	$0.92	2.7	0.21	$0.072
Interior Screw-in - Task Lighting	10.0%	100.0%	5	$0.24	0.1	0.03	$0.527
Interior Lighting - Time Clocks and Timers	2.4%	75.0%	8	$0.20	0.7	0.34	$0.041
Exterior Lighting - Cold Cathode Lighting	8.4%	50.0%	5	$0.00	0.3	19.87	$0.001
Interior Lighting - Skylights	5.3%	40.6%	8	$0.19	2.1	0.92	$0.013
Ventilation - Demand Control Ventilation	10.2%	10.0%	10	$0.04	0.2	0.55	$0.022
Strategic Energy Management	2.8%	20.0%	3	$0.02	1.9	4.54	$0.004
Transformers	8.6%	9.4%	10	$0.13	0.4	0.28	$0.040
Motors - Synchronous belts	17.3%	21.0%	10	$0.22	-	0.00	$0.000
Refrigeration - Multiplex - Floating section Pressure - Air-cooled Cond.	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex Controls -	0.0%	0.0%	0	$0.00	-	1.00	$0.000

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Floating section Pressure - Evap. Cond.							
Refrigeration - Multiplex - Eff. Air-cooled Condenser	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex - Eff. Water-cooled Condenser	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Commissioning - HVAC	60.0%	100.0%	25	$0.70	0.1	0.02	$0.481
Commissioning - Lighting	78.5%	100.0%	25	$0.10	2.2	2.28	$0.003
Advanced New Construction Designs	11.9%	100.0%	35	$2.00	3.5	0.17	$0.030
Refrigeration - System Controls	5.0%	45.0%	10	$0.40	0.2	0.06	$0.198
Refrigeration - System Maintenance	13.6%	45.0%	10	$0.00	0.1	7.89	$0.001
Refrigeration - System Optimization	5.0%	45.0%	10	$0.80	0.2	0.03	$0.396
Motors - Variable Frequency Drive	25.0%	50.0%	10	$0.10	0.2	0.15	$0.072
Motors - Magnetic Adjustable Speed Drives	24.0%	25.0%	10	$0.10	0.7	0.65	$0.017
Compressed Air - System Controls	0.0%	0.0%	15	$0.01	0.3	2.98	$0.003
Compressed Air - System Optimization and Improvements	44.8%	75.0%	10	$0.20	0.8	0.38	$0.029
Compressed Air - System Maintenance	0.0%	0.0%	3	$0.03	0.1	0.10	$0.175
Compressed Air - Compressor Replacement	17.6%	17.1%	10	$0.06	0.6	0.84	$0.013
Fan System - Controls	7.8%	8.2%	10	$0.01	0.0	0.37	$0.036
Fan System - Optimization	6.6%	8.9%	10	$0.13	0.2	0.15	$0.085
Fan System - Maintenance	3.0%	11.3%	3	$0.01	0.0	0.07	$0.251
Pumping System - Controls	8.6%	9.3%	10	$0.01	0.1	1.04	$0.011
Pumping System - Optimization	6.7%	9.0%	10	$0.28	0.8	0.28	$0.040
Pumping System - Maintenance	1.5%	10.1%	3	$0.02	0.1	0.15	$0.117
RTU - Maintenance	21.9%	100.0%	4	$0.06	0.2	0.20	$0.073
Chiller - Chilled Water Reset	60.0%	100.0%	4	$0.09	0.3	0.19	$0.077
Chiller - Chilled Water Variable-Flow System	30.0%	45.0%	10	$0.20	0.1	0.06	$0.158
Chiller - VSD	25.0%	89.0%	20	$1.17	0.7	0.06	$0.119
Chiller - High Efficiency Cooling Tower Fans	25.0%	100.0%	10	$0.04	0.0	0.01	$1.019
Chiller - Condenser Water Temprature Reset	5.0%	100.0%	14	$0.20	0.4	0.16	$0.051
Cooling - Economizer Installation	29.1%	45.0%	15	$0.15	-	-	$0.000
Heat Pump - Maintenance	21.7%	100.0%	4	$0.03	0.6	1.07	$0.014
Insulation - Ducting	11.8%	50.0%	20	$0.41	-	0.31	$0.000
Energy Management System	23.6%	100.0%	14	$0.35	4.9	1.28	$0.007
Fans - Energy Efficient Motors	0.0%	0.0%	10	$0.14	0.1	0.06	$0.187
Fans - Variable Speed Control	0.0%	0.0%	10	$0.34	0.4	0.10	$0.114
Pumps - Variable Speed Control	0.1%	0.0%	10	$0.44	0.2	0.03	$0.316

Table C-33 Energy Efficiency Non-Equipment Data— Extra Large Industrial, Existing Vintage, Idaho

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Refrigeration - System Controls	11.1%	45.0%	10	$0.40	12.0	2.67	$0.004
Refrigeration - System Maintenance	11.1%	45.0%	10	$0.00	4.0	356.66	$0.000
Refrigeration - System Optimization	13.6%	45.0%	10	$0.80	12.0	1.34	$0.008
Motors - Variable Frequency Drive	32.5%	50.0%	10	$0.10	0.4	0.33	$0.033
Motors - Magnetic Adjustable Speed Drives	24.0%	25.0%	10	$0.10	1.5	1.41	$0.008
Compressed Air - System Controls	0.0%	0.0%	15	$0.01	0.7	6.38	$0.001
Compressed Air - System Optimization and Improvements	44.8%	75.0%	10	$0.20	1.8	0.82	$0.013
Compressed Air - System Maintenance	0.0%	0.0%	3	$0.03	0.1	0.22	$0.081
Compressed Air - Compressor Replacement	17.6%	17.1%	10	$0.06	1.3	1.81	$0.006
Fan System - Controls	7.8%	8.2%	10	$0.01	0.3	2.66	$0.004
Fan System - Optimization	8.3%	8.9%	10	$0.13	1.6	1.12	$0.010
Fan System - Maintenance	5.2%	11.3%	3	$0.01	0.1	0.61	$0.029
Pumping System - Controls	8.6%	9.3%	10	$0.01	0.3	2.23	$0.005
Pumping System - Optimization	8.4%	9.0%	10	$0.28	1.8	0.60	$0.018
Pumping System - Maintenance	2.9%	10.1%	3	$0.02	0.1	0.33	$0.054
RTU - Maintenance	37.6%	100.0%	4	$0.06	0.9	0.73	$0.018
Chiller - Chilled Water Reset	39.9%	100.0%	4	$0.09	1.3	0.74	$0.019
Chiller - Chilled Water Variable-Flow System	30.0%	45.0%	10	$0.20	0.3	0.13	$0.071
Chiller - VSD	50.0%	89.0%	20	$1.17	2.6	0.19	$0.032
Chiller - High Efficiency Cooling Tower Fans	25.0%	100.0%	10	$0.04	0.0	0.00	$2.995
Chiller - Condenser Water Temprature Reset	14.2%	100.0%	14	$0.20	1.3	0.55	$0.014
Cooling - Economizer Installation	29.1%	45.0%	15	$0.15	-	-	$0.000
Heat Pump - Maintenance	21.7%	100.0%	4	$0.03	1.0	1.70	$0.008
Insulation - Ducting	11.8%	100.0%	20	$0.41	-	0.30	$0.000
Repair and Sealing - Ducting	5.0%	50.0%	15	$0.38	-	0.31	$0.000
Energy Management System	11.0%	100.0%	14	$0.35	4.7	1.23	$0.007
Fans - Energy Efficient Motors	0.0%	0.0%	10	$0.14	0.6	0.73	$0.027
Fans - Variable Speed Control	0.0%	0.0%	10	$0.34	2.5	0.59	$0.016
Retrocommissioning - HVAC	1.4%	93.3%	4	$0.25	-	0.30	$0.000
Pumps - Variable Speed Control	0.1%	0.0%	10	$0.44	0.4	0.08	$0.146
Thermostat - Clock/Programmable	59.0%	70.0%	11	$0.11	2.5	2.04	$0.005
Interior Lighting - Central Lighting Controls	83.7%	100.0%	8	$0.65	-	-	$0.000
Exterior Lighting - Daylighting Controls	1.6%	53.6%	8	$0.08	-	0.00	$0.000
Interior Fluorescent - High Bay Fixtures	19.1%	50.0%	11	$0.20	0.6	0.19	$0.040
LED Exit Lighting	46.9%	90.0%	10	$0.00	0.0	0.39	$0.018
Retrocommissioning - Lighting	9.0%	93.0%	5	$0.05	-	-	$0.000
Interior Lighting - Occupancy Sensors	14.7%	60.0%	8	$0.20	-	0.00	$0.000
Exterior Lighting - Photovoltaic Installation	5.0%	25.0%	5	$0.92	-	-	$0.000
Interior Screw-in - Task Lighting	10.0%	100.0%	5	$0.24	0.0	0.01	$1.514
Interior Lighting - Time Clocks and Timers	2.4%	75.0%	8	$0.20	-	0.00	$0.000
Exterior Lighting - Cold Cathode Lighting	14.6%	50.0%	5	$0.00	0.1	5.34	$0.002
Interior Lighting - Skylights	1.2%	40.6%	8	$0.29	-	0.00	$0.000
Ventilation - Demand Control Ventilation	1.0%	10.0%	10	$0.04	-	-	$0.000
Strategic Energy Management	2.8%	20.0%	3	$0.02	0.3	0.64	$0.026
Transformers	9.8%	9.4%	10	$0.13	0.3	0.18	$0.060

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Motors - Synchronous belts	17.3%	21.0%	10	$0.22	-	0.01	$0.000
Refrigeration - Multiplex - Floating section Pressure - Air-cooled Cond.	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex Controls - Floating section Pressure - Evap. Cond.	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex - Eff. Air-cooled Condenser	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex - Eff. Water-cooled Condenser	0.0%	0.0%	0	$0.00	12.0	1.00	$0.000
Refrigeration - System Controls	11.1%	45.0%	10	$0.40	12.0	2.67	$0.004
Refrigeration - System Maintenance	11.1%	45.0%	10	$0.00	4.0	356.66	$0.000
Refrigeration - System Optimization	13.6%	45.0%	10	$0.80	12.0	1.34	$0.008
Motors - Variable Frequency Drive	32.5%	50.0%	10	$0.10	0.4	0.33	$0.033
Motors - Magnetic Adjustable Speed Drives	24.0%	25.0%	10	$0.10	1.5	1.41	$0.008
Compressed Air - System Controls	0.0%	0.0%	15	$0.01	0.7	6.38	$0.001
Compressed Air - System Optimization and Improvements	44.8%	75.0%	10	$0.20	1.8	0.82	$0.013
Compressed Air - System Maintenance	0.0%	0.0%	3	$0.03	0.1	0.22	$0.081
Compressed Air - Compressor Replacement	17.6%	17.1%	10	$0.06	1.3	1.81	$0.006
Fan System - Controls	7.8%	8.2%	10	$0.01	0.3	2.66	$0.004
Fan System - Optimization	8.3%	8.9%	10	$0.13	1.6	1.12	$0.010
Fan System - Maintenance	5.2%	11.3%	3	$0.01	0.1	0.61	$0.029
Pumping System - Controls	8.6%	9.3%	10	$0.01	0.3	2.23	$0.005
Pumping System - Optimization	8.4%	9.0%	10	$0.28	1.8	0.60	$0.018
Pumping System - Maintenance	2.9%	10.1%	3	$0.02	0.1	0.33	$0.054
RTU - Maintenance	37.6%	100.0%	4	$0.06	0.9	0.73	$0.018
Chiller - Chilled Water Reset	39.9%	100.0%	4	$0.09	1.3	0.74	$0.019
Chiller - Chilled Water Variable-Flow System	30.0%	45.0%	10	$0.20	0.3	0.13	$0.071
Chiller - VSD	50.0%	89.0%	20	$1.17	2.6	0.19	$0.032
Chiller - High Efficiency Cooling Tower Fans	25.0%	100.0%	10	$0.04	0.0	0.00	$2.995
Chiller - Condenser Water Temprature Reset	14.2%	100.0%	14	$0.20	1.3	0.55	$0.014
Cooling - Economizer Installation	29.1%	45.0%	15	$0.15	-	-	$0.000
Heat Pump - Maintenance	21.7%	100.0%	4	$0.03	1.0	1.70	$0.008
Insulation - Ducting	11.8%	100.0%	20	$0.41	-	0.30	$0.000
Repair and Sealing - Ducting	5.0%	50.0%	15	$0.38	-	0.31	$0.000
Energy Management System	11.0%	100.0%	14	$0.35	4.7	1.23	$0.007
Fans - Energy Efficient Motors	0.0%	0.0%	10	$0.14	0.6	0.73	$0.027
Fans - Variable Speed Control	0.0%	0.0%	10	$0.34	2.5	0.59	$0.016

Table C-34 Energy Efficiency Non-Equipment Data— Extra Large Industrial, New Vintage, Idaho

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Refrigeration - System Controls	13.6%	45.0%	10	$0.40	4.0	0.91	$0.012
Refrigeration - System Maintenance	13.6%	45.0%	10	$0.00	12.0	1,086.05	$0.000
Refrigeration - System Optimization	5.0%	45.0%	10	$0.80	0.4	0.05	$0.215
Motors - Variable Frequency Drive	32.5%	50.0%	10	$0.10	1.9	1.72	$0.006
Motors - Magnetic Adjustable Speed Drives	24.0%	25.0%	10	$0.10	0.9	0.81	$0.013
Compressed Air - System Controls	0.0%	0.0%	15	$0.01	0.2	1.56	$0.005
Compressed Air - System Optimization and Improvements	44.8%	75.0%	10	$0.20	2.2	1.00	$0.011
Compressed Air - System Maintenance	0.0%	0.0%	3	$0.03	1.5	2.36	$0.007
Compressed Air - Compressor Replacement	14.6%	17.1%	10	$0.06	0.1	0.14	$0.082
Fan System - Controls	7.8%	8.2%	10	$0.01	0.7	5.80	$0.002
Fan System - Optimization	8.3%	8.9%	10	$0.13	1.2	0.81	$0.013
Fan System - Maintenance	5.2%	11.3%	3	$0.01	0.4	2.02	$0.009
Pumping System - Controls	8.6%	9.3%	10	$0.01	2.2	18.15	$0.001
Pumping System - Optimization	6.7%	9.0%	10	$0.28	0.2	0.06	$0.185
Pumping System - Maintenance	3.5%	10.1%	3	$0.02	0.6	1.26	$0.014
RTU - Maintenance	37.6%	100.0%	4	$0.06	1.0	0.94	$0.015
Chiller - Chilled Water Reset	63.4%	100.0%	4	$0.09	0.5	0.33	$0.048
Chiller - Chilled Water Variable-Flow System	34.5%	45.0%	10	$0.20	2.3	1.03	$0.010
Chiller - VSD	25.0%	89.0%	20	$1.17	0.0	0.00	$5.329
Chiller - High Efficiency Cooling Tower Fans	40.1%	100.0%	10	$0.04	1.2	2.65	$0.004
Chiller - Condenser Water Temprature Reset	5.0%	100.0%	14	$0.20	0.2	0.08	$0.103
Cooling - Economizer Installation	35.5%	45.0%	15	$0.15	0.5	0.29	$0.027
Heat Pump - Maintenance	21.7%	100.0%	4	$0.03	0.5	0.89	$0.017
Insulation - Ducting	11.8%	50.0%	20	$0.41	0.3	0.36	$0.114
Energy Management System	23.6%	100.0%	14	$0.35	4.7	1.26	$0.007
Fans - Energy Efficient Motors	0.0%	0.0%	10	$0.14	2.1	1.36	$0.008
Fans - Variable Speed Control	0.0%	0.0%	10	$0.34	0.1	0.03	$0.361
Pumps - Variable Speed Control	0.1%	0.0%	10	$0.44	0.1	0.01	$1.018
Thermostat - Clock/Programmable	63.1%	70.0%	11	$0.11	3.5	2.86	$0.003
Interior Lighting - Central Lighting Controls	83.7%	100.0%	8	$0.65	0.3	0.04	$0.283
Exterior Lighting - Daylighting Controls	19.7%	53.6%	8	$0.08	0.4	0.46	$0.028
Interior Fluorescent - High Bay Fixtures	10.0%	50.0%	11	$0.20	0.0	0.00	$3.499
LED Exit Lighting	91.2%	90.0%	10	$0.00	0.3	25.24	$0.000
Interior Lighting - Occupancy Sensors	25.0%	60.0%	8	$0.20	0.7	0.28	$0.044
Exterior Lighting - Photovoltaic Installation	5.0%	25.0%	5	$0.92	0.0	0.00	$6.107
Interior Screw-in - Task Lighting	10.0%	100.0%	5	$0.24	0.2	0.04	$0.315
Interior Lighting - Time Clocks and Timers	2.4%	75.0%	8	$0.20	0.1	0.04	$0.324
Exterior Lighting - Cold Cathode Lighting	8.4%	50.0%	5	$0.00	0.5	33.17	$0.000
Interior Lighting - Skylights	2.4%	40.6%	8	$0.19	0.1	0.06	$0.235
Ventilation - Demand Control Ventilation	6.0%	10.0%	10	$0.04	0.1	0.15	$0.082
Strategic Energy Management	2.8%	20.0%	3	$0.02	0.8	1.77	$0.010
Transformers	9.8%	9.4%	10	$0.13	0.3	0.23	$0.049
Motors - Synchronous belts	17.3%	21.0%	10	$0.22	0.0	0.01	$1.550
Refrigeration - Multiplex - Floating section Pressure - Air-cooled Cond.	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Refrigeration - Multiplex Controls -	0.0%	0.0%	0	$0.00	-	1.00	$0.000

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio (2015)	Levelized Cost of Energy ($/kWh)
Floating section Pressure - Evap. Cond.							
Refrigeration - Multiplex - Eff. Air-cooled Condenser	0.0%	0.0%	0	$0.00	0.3	1.00	$0.000
Refrigeration - Multiplex - Eff. Water-cooled Condenser	0.0%	0.0%	0	$0.00	0.2	1.00	$0.000
Commissioning - HVAC	78.5%	100.0%	25	$0.70	0.9	0.14	$0.046
Commissioning - Lighting	78.5%	100.0%	25	$0.10	0.5	0.57	$0.011
Advanced New Construction Designs	11.9%	100.0%	35	$2.00	2.9	0.14	$0.035
Refrigeration - System Controls	13.6%	45.0%	10	$0.40	4.0	0.91	$0.012
Refrigeration - System Maintenance	13.6%	45.0%	10	$0.00	12.0	1,086.05	$0.000
Refrigeration - System Optimization	5.0%	45.0%	10	$0.80	0.4	0.05	$0.215
Motors - Variable Frequency Drive	32.5%	50.0%	10	$0.10	1.9	1.72	$0.006
Motors - Magnetic Adjustable Speed Drives	24.0%	25.0%	10	$0.10	0.9	0.81	$0.013
Compressed Air - System Controls	0.0%	0.0%	15	$0.01	0.2	1.56	$0.005
Compressed Air - System Optimization and Improvements	44.8%	75.0%	10	$0.20	2.2	1.00	$0.011
Compressed Air - System Maintenance	0.0%	0.0%	3	$0.03	1.5	2.36	$0.007
Compressed Air - Compressor Replacement	14.6%	17.1%	10	$0.06	0.1	0.14	$0.082
Fan System - Controls	7.8%	8.2%	10	$0.01	0.7	5.80	$0.002
Fan System - Optimization	8.3%	8.9%	10	$0.13	1.2	0.81	$0.013
Fan System - Maintenance	5.2%	11.3%	3	$0.01	0.4	2.02	$0.009
Pumping System - Controls	8.6%	9.3%	10	$0.01	2.2	18.15	$0.001
Pumping System - Optimization	6.7%	9.0%	10	$0.28	0.2	0.06	$0.185
Pumping System - Maintenance	3.5%	10.1%	3	$0.02	0.6	1.26	$0.014
RTU - Maintenance	37.6%	100.0%	4	$0.06	1.0	0.94	$0.015
Chiller - Chilled Water Reset	63.4%	100.0%	4	$0.09	0.5	0.33	$0.048
Chiller - Chilled Water Variable-Flow System	34.5%	45.0%	10	$0.20	2.3	1.03	$0.010
Chiller - VSD	25.0%	89.0%	20	$1.17	0.0	0.00	$5.329
Chiller - High Efficiency Cooling Tower Fans	40.1%	100.0%	10	$0.04	1.2	2.65	$0.004
Chiller - Condenser Water Temprature Reset	5.0%	100.0%	14	$0.20	0.2	0.08	$0.103
Cooling - Economizer Installation	35.5%	45.0%	15	$0.15	0.5	0.29	$0.027
Heat Pump - Maintenance	21.7%	100.0%	4	$0.03	0.5	0.89	$0.017
Insulation - Ducting	11.8%	50.0%	20	$0.41	0.3	0.36	$0.114
Energy Management System	23.6%	100.0%	14	$0.35	4.7	1.26	$0.007
Fans - Energy Efficient Motors	0.0%	0.0%	10	$0.14	2.1	1.36	$0.008
Fans - Variable Speed Control	0.0%	0.0%	10	$0.34	0.1	0.03	$0.361
Pumps - Variable Speed Control	0.1%	0.0%	10	$0.44	0.1	0.01	$1.018

APPENDIX | **D**

MARKET ADOPTION FACTORS

A set of market adoption factors are applied to Economic potential to estimate Achievable Potential. These estimate customer adoption of economic measures when delivered through efficiency programs under realistic market and customer preference conditions. They reflect expected program participation given barriers to customer acceptance and program implementation. These adoption rates generally increase over time, reflecting an increasing awareness and willingness to adopt energy-efficient measures. However, in some cases, where a new technology is introduced, the adoption rates drop to reflect that the new technology may not yet be accepted in the market. For mature measures, information channels are assumed to be established for marketing, educating consumers, and coordinating with trade allies and delivery partners. For evolving measures, this is not the case and thus the factors start at a lower level.

The market adoption rates for the Avista study were developed using the ramp rates from the Northwest Power & Conservation Council's Sixth Plan as a starting point. The ramp rates were then adjusted based on actual Avista program history and information from program evaluations. These adjustments mainly set the potential in the first years of the study to match with recent program achievements and thus show continuity of results.

Table D-1 through Table D-2 present the Achievable Potential market adoption factors for the residential sector, first for equipment measures and then for non-equipment measures. Table D-3 through Table D-4 present the market adoption factors for the commercial and industrial sector

.

Table D-1 Residential Equipment Measures—Achievable Potential Market Adoption Factors

End Use	Fuel	Technology	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Cooling	Electric	Central AC	77%	78%	79%	80%	81%	82%	83%	84%	85%	85%	85%	85%	85%
Cooling	Electric	Room AC	77%	78%	79%	80%	81%	82%	83%	84%	85%	85%	85%	85%	85%
Cooling	Electric	Air Source Heat Pump	77%	78%	79%	80%	81%	82%	83%	84%	85%	85%	85%	85%	85%
Cooling	Electric	Geothermal Heat Pump	77%	78%	79%	80%	81%	82%	83%	84%	85%	85%	85%	85%	85%
Cooling	Electric	Ductless HP	56%	58%	59%	62%	66%	71%	76%	81%	83%	85%	85%	85%	85%
Space Heating	Electric	Electric Resistance	6%	9%	11%	14%	17%	20%	23%	26%	28%	31%	34%	37%	40%
Space Heating	Electric	Electric Furnace	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Space Heating	Electric	Supplemental	11%	17%	23%	28%	34%	40%	45%	51%	57%	62%	68%	74%	79%
Space Heating	Electric	Air Source Heat Pump	77%	78%	79%	80%	81%	82%	83%	84%	85%	85%	85%	85%	85%
Space Heating	Electric	Geothermal Heat Pump	56%	58%	59%	62%	66%	71%	76%	81%	83%	85%	85%	85%	85%
Space Heating	Electric	Ductless HP	28%	32%	37%	40%	43%	45%	46%	49%	52%	57%	62%	68%	73%
Water Heating	Electric	Water Heater <= 55 Gal	5%	7%	9%	10%	12%	15%	20%	25%	30%	35%	40%	45%	50%
Water Heating	Electric	Water Heater > 55 Gal	2%	3%	5%	8%	10%	12%	14%	34%	39%	45%	50%	50%	50%
Interior Lighting	Electric	Screw-in	25%	25%	26%	27%	29%	31%	33%	35%	38%	41%	45%	50%	55%
Interior Lighting	Electric	Linear Fluorescent	25%	25%	26%	27%	29%	31%	33%	35%	38%	41%	45%	50%	55%
Interior Lighting	Electric	Specialty	25%	25%	26%	27%	29%	31%	33%	35%	38%	41%	45%	50%	55%
Exterior Lighting	Electric	Screw-in	25%	25%	26%	27%	29%	31%	33%	35%	38%	41%	45%	50%	55%
Appliances	Electric	Clothes Washer	56%	58%	59%	62%	66%	71%	76%	81%	83%	85%	85%	85%	85%
Appliances	Electric	Clothes Dryer	56%	58%	59%	62%	66%	71%	76%	81%	83%	85%	85%	85%	85%
Appliances	Electric	Dishwasher	56%	58%	59%	62%	66%	71%	76%	81%	83%	85%	85%	85%	85%
Appliances	Electric	Refrigerator	56%	58%	59%	62%	66%	71%	76%	81%	83%	85%	85%	85%	85%
Appliances	Electric	Freezer	56%	58%	59%	62%	66%	71%	76%	81%	83%	85%	85%	85%	85%
Appliances	Electric	Second Refrigerator	56%	58%	59%	62%	66%	71%	76%	81%	83%	85%	85%	85%	85%
Appliances	Electric	Stove	56%	58%	59%	62%	66%	71%	76%	81%	83%	85%	85%	85%	85%
Appliances	Electric	Microwave	56%	58%	59%	62%	66%	71%	76%	81%	83%	85%	85%	85%	85%
Electronics	Electric	Personal Computers	5%	8%	10%	13%	16%	19%	23%	26%	30%	33%	37%	40%	44%
Electronics	Electric	TVs	11%	16%	21%	26%	31%	36%	41%	47%	52%	58%	63%	68%	72%
Electronics	Electric	Set-top boxes/DVR	6%	9%	12%	15%	18%	22%	25%	29%	31%	34%	37%	40%	43%
Electronics	Electric	Devices and Gadgets	6%	9%	12%	15%	18%	22%	25%	29%	31%	34%	37%	40%	43%
Miscellaneous	Electric	Pool Pump	5%	8%	10%	13%	16%	19%	23%	26%	30%	33%	37%	40%	44%
Miscellaneous	Electric	Furnace Fan	9%	13%	17%	21%	25%	29%	34%	39%	45%	49%	54%	57%	60%
Miscellaneous	Electric	Miscellaneous	23%	31%	39%	47%	54%	62%	68%	73%	76%	78%	78%	78%	79%

Table D-2 Residential Non-Equipment Measures— Achievable Potential Market Adoption Factors

Measures	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Central AC - Early Replacement	1%	3%	5%	7%	9%	11%	14%	16%	19%	21%	24%	27%	30%
Central AC - Maintenance and Tune-Up	5%	9%	13%	17%	20%	23%	26%	29%	31%	35%	38%	42%	46%
Room AC - Removal of Second Unit	1%	3%	5%	7%	9%	11%	14%	16%	19%	21%	24%	27%	30%
Attic Fan - Installation	5%	7%	9%	11%	14%	16%	18%	20%	23%	25%	27%	29%	32%
Attic Fan - Photovoltaic - Installation	1%	3%	5%	7%	9%	11%	14%	16%	19%	21%	24%	27%	30%
Ceiling Fan - Installation	6%	9%	9%	11%	14%	16%	18%	20%	23%	25%	27%	29%	32%
Whole-House Fan - Installation	2%	8%	15%	22%	31%	39%	48%	57%	59%	62%	64%	67%	69%
Air Source Heat Pump - Maintenance	3%	5%	7%	9%	10%	12%	13%	14%	16%	17%	18%	20%	22%
Insulation - Ducting	1%	3%	5%	7%	9%	11%	14%	16%	19%	21%	24%	27%	30%
Repair and Sealing - Ducting	2%	3%	6%	8%	10%	11%	12%	14%	15%	16%	18%	19%	21%
Thermostat - Clock/Programmable	1%	3%	5%	7%	9%	11%	14%	16%	19%	21%	24%	27%	30%
Doors - Storm and Thermal	5%	7%	9%	11%	14%	16%	18%	20%	23%	25%	27%	29%	32%
Insulation - Infiltration Control	5%	9%	13%	17%	20%	23%	26%	29%	31%	35%	38%	42%	46%
Insulation - Ceiling	12%	13%	14%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%
Insulation - Radiant Barrier	5%	9%	15%	20%	24%	29%	34%	39%	44%	50%	56%	62%	69%
Roofs - High Reflectivity	1%	3%	5%	7%	9%	11%	14%	16%	19%	21%	24%	27%	30%
Windows - Reflective Film	5%	7%	9%	11%	14%	16%	18%	20%	23%	25%	27%	29%	32%
Windows - High Efficiency/Energy Star	5%	7%	9%	11%	14%	16%	18%	20%	23%	25%	27%	29%	32%
Interior Lighting - Occupancy Sensor	10%	19%	27%	35%	43%	51%	60%	68%	68%	68%	68%	68%	68%
Exterior Lighting - Photovoltaic Installation	2%	8%	15%	22%	31%	39%	48%	57%	59%	62%	64%	67%	69%
Exterior Lighting - Photosensor Control	1%	4%	10%	17%	24%	33%	41%	50%	59%	62%	64%	67%	69%
Exterior Lighting - Timeclock Installation	2%	8%	15%	22%	31%	39%	48%	57%	59%	62%	64%	67%	69%
Water Heater - Faucet Aerators	1%	3%	5%	7%	9%	11%	14%	16%	19%	21%	24%	27%	30%
Water Heater - Pipe Insulation	1%	3%	5%	7%	9%	11%	14%	16%	19%	21%	24%	27%	30%
Water Heater - Low Flow Showerheads	2%	3%	6%	8%	10%	11%	12%	14%	15%	16%	18%	19%	21%
Water Heater - Tank Blanket/Insulation	3%	5%	7%	9%	10%	12%	13%	14%	16%	17%	18%	20%	22%
Water Heater - Thermostat Setback	3%	5%	7%	9%	10%	12%	13%	14%	16%	17%	18%	20%	22%
Electronics - Reduce Standby Wattage	3%	5%	7%	9%	10%	12%	13%	14%	16%	17%	18%	20%	22%
Refrigerator - Early Replacement	3%	4%	6%	8%	11%	13%	16%	19%	23%	25%	27%	29%	32%
Refrigerator - Remove Second Unit	3%	4%	6%	8%	11%	13%	16%	19%	23%	25%	27%	29%	32%
Freezer - Early Replacement	3%	4%	6%	8%	11%	13%	16%	19%	23%	25%	27%	29%	32%
Freezer - Remove Second Unit	3%	4%	6%	8%	11%	13%	16%	19%	23%	25%	27%	29%	32%
Behavioral Measures	1%	3%	5%	7%	9%	11%	14%	16%	19%	21%	24%	27%	30%
Pool - Pump Timer	3%	6%	9%	11%	14%	16%	19%	21%	24%	27%	30%	33%	37%
Insulation - Foundation	3%	6%	9%	11%	14%	16%	19%	21%	24%	27%	30%	33%	37%
Insulation - Wall Cavity	5%	9%	15%	20%	24%	29%	34%	39%	44%	50%	56%	62%	69%
Insulation - Wall Sheathing	1%	3%	5%	7%	9%	11%	14%	16%	19%	21%	24%	27%	30%
Water Heater - Drainwater Heat Reocvery	4%	6%	9%	11%	13%	15%	17%	19%	21%	23%	26%	28%	30%
Advanced New Construction Designs	4%	6%	9%	11%	13%	15%	17%	19%	21%	23%	26%	28%	30%
Energy Star Homes	9%	10%	14%	15%	20%	21%	26%	28%	34%	36%	40%	43%	45%

Table D-3 C/I Equipment Measures — Achievable Potential Market Adoption Factors

End Use	Fuel	Technology	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Cooling	Electric	Central Chiller	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Cooling	Electric	RTU	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Cooling	Electric	PTAC	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Cooling	Electric	Heat Pump	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Space Heating	Electric	Electric Resistance	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%
Space Heating	Electric	Furnace	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Space Heating	Electric	Heat Pump	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Ventilation	Electric	Ventilation	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Interior Lighting	Electric	Interior Screw-in	33%	45%	54%	61%	66%	70%	73%	76%	78%	80%	81%	82%	82%
Interior Lighting	Electric	High Bay Fixtures	50%	60%	70%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Interior Lighting	Electric	Linear Fluorescent	61%	66%	70%	73%	76%	78%	80%	81%	82%	82%	83%	83%	84%
Exterior Lighting	Electric	Exterior Screw-in	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%
Exterior Lighting	Electric	HID	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%
Water Heating	Electric	Water Heater	13%	15%	18%	20%	23%	25%	28%	30%	33%	35%	38%	40%	45%
Food Preparation	Electric	Fryer	50%	60%	70%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Food Preparation	Electric	Oven	50%	60%	70%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Food Preparation	Electric	Dishwasher	50%	60%	70%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Food Preparation	Electric	Hot Food Container	50%	60%	70%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Food Preparation	Electric	Food Prep	50%	60%	70%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Refrigeration	Electric	Walk in Refrigeration	80%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Refrigeration	Electric	Glass Door Display	80%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Refrigeration	Electric	Reach-in Refrigerator	80%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Refrigeration	Electric	Open Display Case	80%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Refrigeration	Electric	Vending Machine	80%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Refrigeration	Electric	Icemaker	80%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Office Equipment	Electric	Desktop Computer	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%
Office Equipment	Electric	Laptop Computer	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%
Office Equipment	Electric	Server	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%
Office Equipment	Electric	Monitor	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%
Office Equipment	Electric	Printer/copier/fax	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%
Office Equipment	Electric	POS Terminal	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%
Miscellaneous	Electric	Non-HVAC Motor	50%	60%	70%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Miscellaneous	Electric	Other Miscellaneous	50%	60%	70%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Process	Electric	Process Cooling/Refrigeration	50%	60%	70%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%

End Use	Fuel	Technology	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Process	Electric	Process Heating	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%
Process	Electric	Electrochemical Process	50%	60%	70%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Machine Drive	Electric	Less than 5 HP	50%	60%	70%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Machine Drive	Electric	5-24 HP	50%	60%	70%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Machine Drive	Electric	25-99 HP	50%	60%	70%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Machine Drive	Electric	100-249 HP	43%	51%	60%	68%	72%	72%	72%	72%	72%	72%	72%	72%	72%
Machine Drive	Electric	250-499 HP	43%	51%	60%	68%	72%	72%	72%	72%	72%	72%	72%	72%	72%
Machine Drive	Electric	500 and more HP	43%	51%	60%	68%	72%	72%	72%	72%	72%	72%	72%	72%	72%
Miscellaneous	Electric	Miscellaneous	21%	26%	30%	34%	38%	43%	47%	51%	55%	60%	64%	68%	72%

Table D-4 C/I Non-Equipment Measures — Achievable Potential Market Adoption Factors

Measures	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
RTU - Maintenance	8%	16%	24%	34%	43%	51%	60%	68%	68%	68%	68%	68%	68%
RTU - Evaporative Precooler	8%	16%	24%	34%	43%	51%	60%	68%	68%	68%	68%	68%	68%
Chiller - Chilled Water Reset	40%	41%	42%	42%	41%	41%	41%	42%	44%	46%	48%	49%	50%
Chiller - Chilled Water Variable-Flow System	40%	41%	42%	42%	41%	41%	41%	42%	44%	46%	48%	49%	50%
Chiller - VSD	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Chiller - High Efficiency Cooling Tower Fans	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Chiller - Condenser Water Temprature Reset	40%	41%	42%	42%	41%	41%	41%	42%	44%	46%	48%	49%	50%
Cooling - Economizer Installation	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Heat Pump - Maintenance	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Insulation - Ducting	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Repair and Sealing - Ducting	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Energy Management System	40%	41%	42%	42%	41%	41%	41%	42%	44%	46%	48%	49%	50%
Cooking - Exhaust Hoods with Sensor Control	4%	8%	12%	17%	21%	26%	30%	34%	38%	43%	47%	51%	55%
Fans - Energy Efficient Motors	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Fans - Variable Speed Control	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Retrocommissioning - HVAC	40%	41%	42%	42%	41%	41%	41%	42%	44%	46%	48%	49%	50%
Pumps - Variable Speed Control	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Thermostat - Clock/Programmable	40%	41%	42%	42%	41%	41%	41%	42%	44%	46%	48%	49%	50%
Insulation - Ceiling	40%	41%	42%	42%	41%	41%	41%	42%	44%	46%	48%	49%	50%
Insulation - Radiant Barrier	40%	41%	42%	42%	41%	41%	41%	42%	44%	46%	48%	49%	50%
Roofs - High Reflectivity	20%	21%	23%	25%	26%	28%	30%	31%	33%	35%	37%	38%	40%
Windows - High Efficiency	40%	41%	42%	42%	41%	41%	41%	42%	44%	46%	48%	49%	50%
Interior Lighting - Central Lighting Controls	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Exterior Lighting - Daylighting Controls	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Interior Fluorescent - High Bay Fixtures	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Interior Lighting - Occupancy Sensors	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Exterior Lighting - Photovoltaic Installation	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Interior Screw-in - Task Lighting	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Interior Lighting - Time Clocks and Timers	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Water Heater - Faucet Aerators/Low Flow Nozzles	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Water Heater - Pipe Insulation	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Water Heater - High Efficiency Circulation Pump	20%	21%	23%	25%	26%	28%	30%	31%	33%	35%	37%	38%	40%

Measures	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Water Heater - Tank Blanket/Insulation	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Water Heater - Thermostat Setback	20%	21%	23%	25%	26%	28%	30%	31%	33%	35%	37%	38%	40%
Refrigeration - Anti-Sweat Heater/Auto Door Closer	20%	21%	23%	25%	26%	28%	30%	31%	33%	35%	37%	38%	40%
Refrigeration - Floating Head Pressure	40%	41%	42%	42%	41%	41%	41%	42%	44%	46%	48%	49%	50%
Refrigeration - Door Gasket Replacement	40%	41%	42%	42%	41%	41%	41%	42%	44%	46%	48%	49%	50%
Insulation - Bare Suction Lines	40%	41%	42%	42%	41%	41%	41%	42%	44%	46%	48%	49%	50%
Refrigeration - Night Covers	40%	41%	42%	42%	41%	41%	41%	42%	44%	46%	48%	49%	50%
Refrigeration - Strip Curtain	40%	41%	42%	42%	41%	41%	41%	42%	44%	46%	48%	49%	50%
Vending Machine - Controller	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
LED Exit Lighting	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Retrocommissioning - Lighting	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Refrigeration - High Efficiency Case Lighting	40%	41%	42%	42%	41%	41%	41%	42%	44%	46%	48%	49%	50%
Exterior Lighting - Cold Cathode Lighting	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Laundry - High Efficiency Clothes Washer	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Interior Lighting - Hotel Guestroom Controls	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Miscellaneous - Energy Star Water Cooler	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Commissioning - HVAC	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Commissioning - Comprehensive	20%	21%	23%	25%	26%	28%	30%	31%	33%	35%	37%	38%	40%
Commissioning - Lighting	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Advanced New Construction Designs	20%	21%	23%	25%	26%	28%	30%	31%	33%	35%	37%	38%	40%
Insulation - Wall Cavity	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Roofs - Green	20%	21%	23%	25%	26%	28%	30%	31%	33%	35%	37%	38%	40%
Interior Lighting - Skylights	20%	21%	23%	25%	26%	28%	30%	31%	33%	35%	37%	38%	40%
Ventilation - Demand Control Ventilation	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Office Equipment - Smart Power Strips	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Strategic Energy Management	40%	41%	42%	42%	41%	41%	41%	42%	44%	46%	48%	49%	50%
Refrigeration - Multiplex - Floating section Pressure - Air-cooled Cond.	40%	41%	42%	42%	41%	41%	41%	42%	44%	46%	48%	49%	50%
Refrigeration - Multiplex Controls - Floating section Pressure - Evap. Cond.	40%	41%	42%	42%	41%	41%	41%	42%	44%	46%	48%	49%	50%
Refrigeration - Multiplex - Eff. Air-cooled Condenser	40%	41%	42%	42%	41%	41%	41%	42%	44%	46%	48%	49%	50%
Refrigeration - Multiplex - Eff. Water-cooled Condenser	40%	41%	42%	42%	41%	41%	41%	42%	44%	46%	48%	49%	50%
Refrigeration - System Controls	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Refrigeration - System Maintenance	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Refrigeration - System Optimization	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Motors - Variable Frequency Drive	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Motors - Magnetic Adjustable Speed Drives	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Compressed Air - System Controls	40%	41%	42%	42%	41%	41%	41%	42%	44%	46%	48%	49%	50%

Measures	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Compressed Air - System Optimization and Improvements	40%	41%	42%	42%	41%	41%	41%	42%	44%	46%	48%	49%	50%
Compressed Air - System Maintenance	40%	41%	42%	42%	41%	41%	41%	42%	44%	46%	48%	49%	50%
Compressed Air - Compressor Replacement	40%	41%	42%	42%	41%	41%	41%	42%	44%	46%	48%	49%	50%
Fan System - Controls	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Fan System - Optimization	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Fan System - Maintenance	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Pumping System - Controls	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Pumping System - Optimization	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Pumping System - Maintenance	54%	55%	56%	57%	58%	59%	60%	60%	61%	62%	63%	64%	65%
Transformers	40%	41%	42%	42%	41%	41%	41%	42%	44%	46%	48%	49%	50%
Motors - Synchronous belts	40%	41%	42%	42%	41%	41%	41%	42%	44%	46%	48%	49%	50%

APPENDIX E

ANNUAL SAVINGS

This section presents the estimates of annual savings. Selected years are shown in Chapter 4 of the CPA report. Table E-1 and Table E-2show the overall annual savings for all sectors combined. Table E-3 through Table E-6 show the annual savings for the individual sectors.

Table E-1 Annual Electric Energy Savings, All Sectors (1,000 MWh)

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Cumulative Savings (1,000 MWh)										
Achievable Potential	51	100	168	240	325	417	458	515	579	634
Economic Potential	315	476	679	881	1,079	1,284	1,361	1,447	1,552	1,655
Technical Potential	1,161	1,368	1,656	1,966	2,239	2,517	2,695	2,862	3,029	3,173
Incremental Savings (1,000 MWh)										
Achievable Potential	51	50	68	72	84	93	41	57	64	55
Economic Potential	315	162	202	203	198	204	78	86	104	103
Technical Potential	1,161	206	289	310	273	278	178	168	166	144

Table E-2 Annual Electric Energy Savings, All Sectors (1,000 MWh) (continued)

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Cumulative Savings (1,000 MWh)										
Achievable Potential	685	761	834	903	977	1,037	1,103	1,175	1,262	1,352
Economic Potential	1,751	1,896	2,020	2,138	2,259	2,315	2,388	2,468	2,561	2,652
Technical Potential	3,302	3,472	3,617	3,752	3,884	3,979	4,070	4,163	4,252	4,340
Incremental Savings (1,000 MWh)										
Achievable Potential	51	76	73	69	74	60	66	71	88	90
Economic Potential	96	145	124	118	121	56	74	79	93	91
Technical Potential	129	170	145	135	133	94	91	93	89	88

Table E-3 Annual Electric Energy Savings, Residential (1,000 MWh)

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Cumulative Savings (1,000 MWh)										
Achievable Potential	22	43	75	110	148	189	209	224	241	252
Economic Potential	231	335	469	611	745	879	926	955	998	1,042
Technical Potential	963	1,038	1,154	1,266	1,338	1,409	1,430	1,433	1,454	1,473
Incremental Savings (1,000 MWh)										
Achievable Potential	22	21	32	35	37	42	19	16	16	11
Economic Potential	231	104	134	142	133	135	46	30	43	43
Technical Potential	963	74	116	112	73	70	22	3	20	20

Table E-4 Annual Electric Energy Savings, Residential (1,000 MWh) (continued)

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Cumulative Savings (1,000 MWh)										
Achievable Potential	263	293	324	357	392	419	447	477	510	547
Economic Potential	1,083	1,164	1,239	1,314	1,390	1,412	1,442	1,474	1,512	1,549
Technical Potential	1,492	1,553	1,611	1,669	1,727	1,765	1,802	1,840	1,876	1,912
Incremental Savings (1,000 MWh)										
Achievable Potential	11	30	31	32	35	27	28	30	34	37
Economic Potential	42	81	75	75	76	21	30	32	38	38
Technical Potential	19	61	58	58	59	37	38	38	36	35

Table E-5 Annual Electric Energy Savings, C/I (1,000 MWh)

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Cumulative Savings (1,000 MWh)										
Achievable Potential	29	57	93	130	177	228	250	291	338	382
Economic Potential	84	141	210	270	334	404	436	492	554	613
Technical Potential	198	330	503	701	901	1,108	1,264	1,429	1,575	1,700
Incremental Savings (1,000 MWh)										
Achievable Potential	29	29	36	37	47	51	22	41	48	43
Economic Potential	84	58	69	60	64	70	31	57	61	60
Technical Potential	198	132	173	198	200	208	156	165	146	125

Table E-6 Annual Electric Energy Savings, C/I (1,000 MWh) (continued)

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Cumulative Savings (1,000 MWh)										
Achievable Potential	422	468	509	546	585	618	656	698	752	805
Economic Potential	668	732	781	824	868	903	946	994	1,049	1,103
Technical Potential	1,809	1,919	2,006	2,083	2,157	2,214	2,268	2,323	2,376	2,428
Incremental Savings (1,000 MWh)										
Achievable Potential	40	46	42	37	39	34	38	42	54	53
Economic Potential	54	64	49	43	45	34	43	47	56	53
Technical Potential	110	109	87	77	74	57	53	55	53	52

About EnerNOC Utility Solutions Consulting

EnerNOC Utility Solutions Consulting is part of EnerNOC Utility Solutions group, which provides a comprehensive suite of demand-side management (DSM) services to utilities and grid operators worldwide. Hundreds of utilities have leveraged our technology, our people, and our proven processes to make their energy efficiency (EE) and demand response (DR) initiatives a success. Utilities trust EnerNOC to work with them at every stage of the DSM program lifecycle – assessing market potential, designing effective programs, implementing those programs, and measuring program results.

EnerNOC Utility Solutions delivers value to our utility clients through two separate practice areas – Program Implementation and EnerNOC Utility Solutions Consulting.

- Our Program Implementation team leverages EnerNOC's deep "behind-the-meter expertise" and world-class technology platform to help utilities create and manage DR and EE programs that deliver reliable and cost-effective energy savings. We focus exclusively on the commercial and industrial (C&I) customer segments, with a track record of successful partnerships that spans more than a decade. Through a focus on high quality, measurable savings, EnerNOC has successfully delivered hundreds of thousands of MWh of energy efficiency for our utility clients, and we have thousands of MW of demand response capacity under management.
- The EnerNOC Utility Solutions Consulting team provides expertise and analysis to support a broad range of utility DSM activities, including: potential assessments; end-use forecasts; integrated resource planning; EE, DR, and smart grid pilot and program design and administration; load research; technology assessments and demonstrations; evaluation, measurement and verification; and regulatory support.

The EnerNOC Utility Solutions Consulting team has decades of combined experience in the utility DSM industry. The staff is comprised of professional electrical, mechanical, chemical, civil, industrial, and environmental engineers as well as economists, business planners, project managers, market researchers, load research professionals, and statisticians. Utilities view our experts as trusted advisors, and we work together collaboratively to make any DSM initiative a success.

2013 Electric Integrated Resource Plan

Appendix D – 2013 Electric IRP Transmission Studies

AVISTA

Interoffice Memorandum
System Planning

MEMO: **SP-2012-09**
DATE: **August 14, 2012**
TO: **Scott Waples**
FROM: **Richard Maguire**
SUBJECT: **2013 IRP Generation Study – Nine Mile HED**

Introduction

This study addresses a request from Avista's Power Supply Department for the 2013 IRP regarding increasing the capacity of Nine Mile HED to 60 MW.

The study addresses the following:
- Power flow impact to the transmission system
- Voltage level impact to the transmission system
- Transmission system upgrades necessary to deliver requested generation

History

The Nine Mile project was built by a private developer 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.

Currently Unit 1 provides no generation and Unit 2 is limited to half load and unit 4 failed in the spring of 2011. These units will be replaced, and the desired capacity of the plant upon replacement of the new units is 60 MW. Avista expects the new capacity will add incremental energy towards meeting Washington State Energy Independence Act goals.

Study Methodology and Assumptions

Avista's five year planning horizon planning cases are used and modified with the following projects prior to transmission system analysis:
- Spokane Valley Transmission Reinforcement Project
- Moscow Transformer Replacement Project
- Lancaster Loop-In Project
- Palouse Wind Phase I (LGIP #5)

Study Results

Studies for this request confirm that Avista's transmission system has adequate capacity to integrate the Nine Mile HED at a total plant output of 60 MW under all conditions studied.

The limiting element is the Nine Mile – Indian Trail 115 kV transmission line, and figures showing the base case plus two limiting contingencies follow.

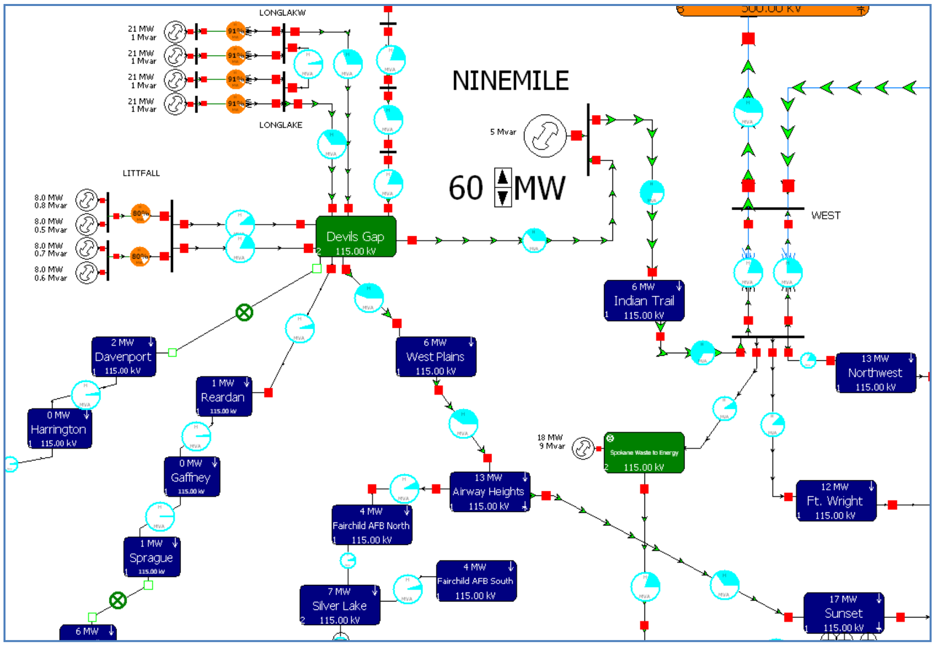


Figure 1. N-0, Avista Spring Case AVA-11ls1ae-16BA1328-WOH4140

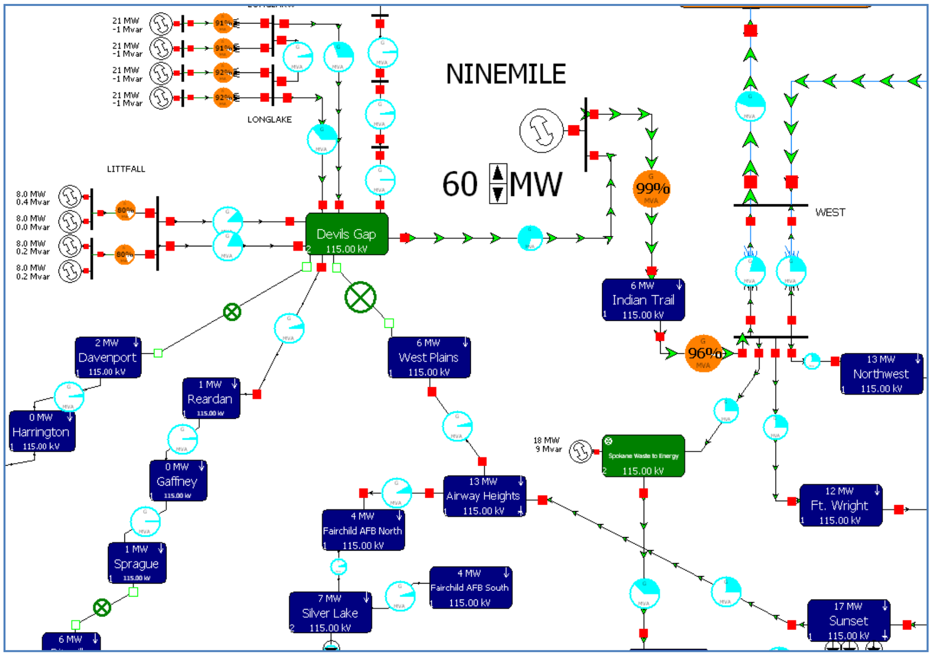


Figure 2. Limiting Contingency: N-1: Airway Heights - Devils Gap 115 kV Open @ DGP

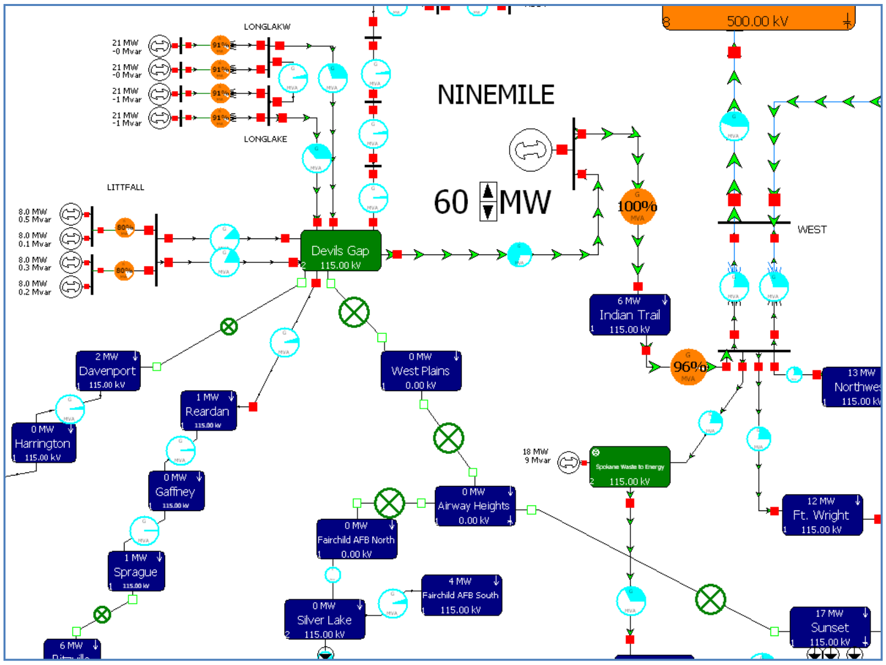


Figure 3. **Limiting Contingency: BF A180 Airway Heights 115 kV, Airway Heights - Devils Gap**

Distribution:

S. Waples
Sharepoint (System Planning)
OASIS Posting
Power Supply (J. Gall)

AVISTA

Interoffice Memorandum
System Planning

MEMO: **SP-2013-04**
DATE: **January 14, 2013**
TO: **Scott Waples**
FROM: **Richard Maguire**
SUBJECT: **2013 IRP Generation Study – Long Lake HED**

Introduction

This study addresses a request from Avista's Power Supply Department for the 2013 IRP regarding increasing the capacity of Long Lake HED by 68 MW.

This preliminary study addresses the following:
- Power flow impact to the transmission system
- Voltage level impact to the transmission system
- Transmission System upgrades necessary to deliver requested generation

History

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 it was completed in 1915. The plant was upgraded with 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.

Study Methodology and Assumptions

The five year planning horizon, Avista planning cases, as documented in SP-2011-03 – 2011 Planning Cases Summary Data are modified with the following projects and adjustments before system analysis:
- LGIR #5
- Lind 115 kV Substation Reactive Support
- 2013 IRP Generation Request for Nine Mile HED (60 MW Total)
- Nine Mile HED and Little Falls HED set to maximum generation dispatch
- Increases in Long Lake generation are balanced by decrementing an injection group including all Avista generation with the exception of Long Lake HED, Nine Mile HED, and Little Falls HED.
- *Western Montana Hydro* is limited to 1650 MW
- *West of Hatwai* is limited to 4277 MW

The most limiting case found during this study is the Light Summer with High West of Hatwai Flows (High Transfer Case) numbered *AVA-11ls1ae-12BA1251-WOH4277*. This is the primary case used in this study.

Figure 1 below presents a high-level view of the Transmission System near Devil's Gap with Long Lake HED generating an additional 68 MW. Note the loading on the Nine Mile – Westside 115 kV Transmission Line. **Table 1** below shows regional power flows with the additional generation.

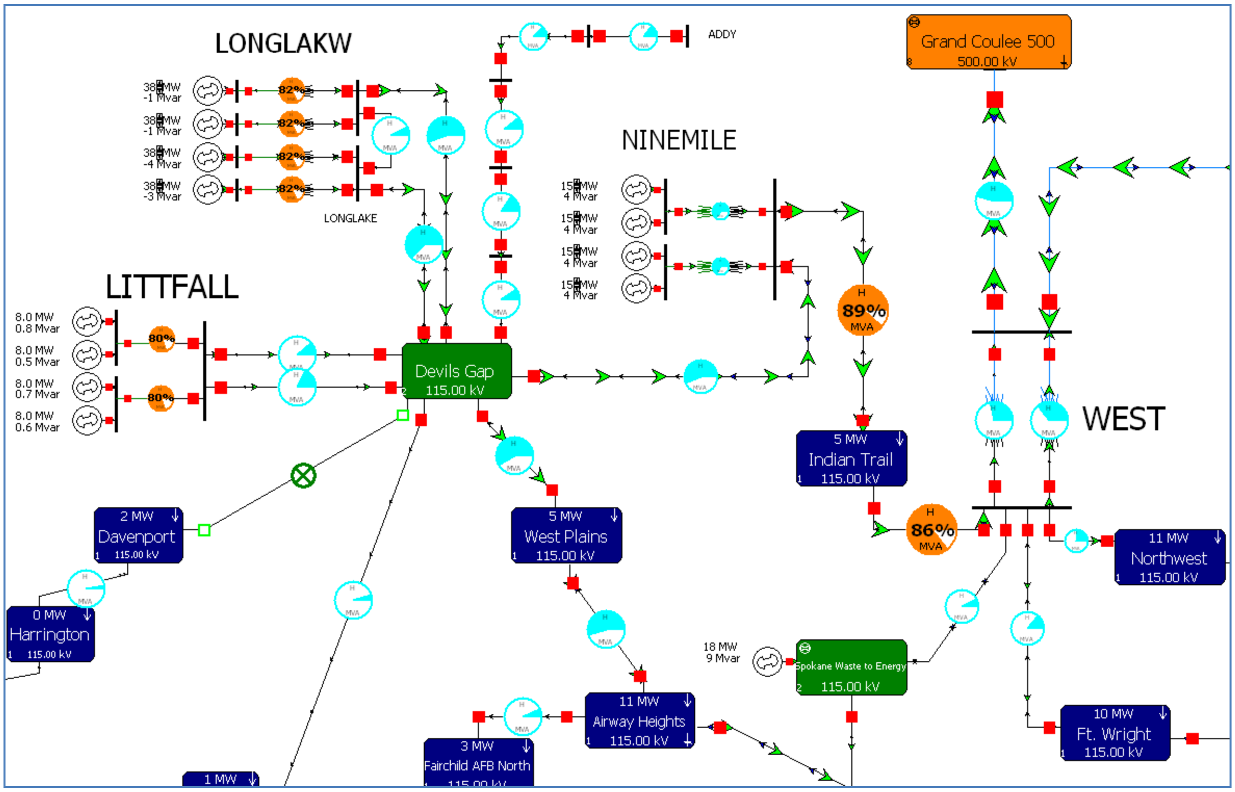


Figure 1: Avista Transmission System near Long Lake HED

Table 1: Regional Power Flows used during system study

Western Montana Hydro	1624.3 MW
Noxon Rapids (562MW)	483.0 MW
Cabinet Gorge (265MW)	221.3 MW
Libby (605MW)	540.0 MW
Hungry Horse (430MW)	380.0 MW

Colstrip Total	
Colstrip 1 (330MW)	330.0 MW
Colstrip 2 (330MW)	330.0 MW
Colstrip 3 (823MW)	787.5 MW
Colstrip 4 (823MW)	792.8 MW

Rathdrum Thermal (175MW)	130.0 MW
Lancaster Thermal (270MW)	249.0 MW
Spokane River Hydro	291.8 MW
Boundary Hydro (1040MW)	975.0 MW

Lower Snake/N.F. Clearwater	
Dworshak (458MW)	344.6 MW
Lower Granite (930MW)	155.0 MW
Little Goose (930MW)	155.0 MW
Lower Monumental (930MW)	273.5 MW

Coulee Generation	
Coulee 500 kV	546.7 MW
Coulee 230 kV	125.0 MW

West of Hatwai (Path 6)	4231.3 MW
Lolo-Oxbow 230kV	129.2 MW
Dry Creek-Walla Walla 230kV	176.8 MW

West of Cabinet	3301.6 MW
Montana-Northwest (Path 8)	2065.1 MW

Idaho-Northwest (Path 14)	751.2 MW
Midpoint-Summer Lake (Path 75)	819.6 MW
Idaho-Montana (Path 18)	-191.9 MW

South of Boundary	963.5 MW
North of John Day (Path 73)	4525.6 MW
TOT 4A (Path 37)	454.4 MW
Miles City DC	200.0 MW

Path C (Path 20)	537.4 MW
Borah West (Path 17)	1578.2 MW
Bridger West (Path 19)	2104.2 MW
Pacific AC Intertie (Path 66)	2855.0 MW
Pacific DC Intertie (Path 65)	1999.9 MW

Northwest Load	17796.4 MW
Idaho Load	2326.0 MW
Montana Load	1339.5 MW
Avista Native Load	-837.0 MW
Avista Balancing Area Load	1179.9 MW
Clearwater Load	63.6 MW

Study Results

Thermal Performance during N-0 conditions

This preliminary study indicates the Avista Transmission System has adequate capacity to integrate an additional 68 MW of generation at Long Lake HED with all lines in service.

Thermal Performance during N-1 conditions

Table 2 shows the results of a study using PowerWorld Simulator's *Available Transfer Capability* tool for Long Lake HED. The table shows limiting transmission segments for contingencies in violation as generation at Long Lake is incremented. In order to incorporate 68 MW of additional generation at Long Lake HED while maintaining Transmission System thermal reliability under N-1 conditions, the following 115 kV Transmission Lines would need upgrades to at least 795 ACSS conductor:

1. Devils Gap – Long Lake #1
2. Devils Gap – Long Lake #2
3. Devils Gap – Ninemile
4. Ninemile – West Side
5. Airway Heights – Devils Gap
6. Airway Heights – Sunset

An approximate cost to reconductor 57.54 miles of 115 kV transmission line would be $ 9.9M[1].

Table 2: Available Transfer Capability for Long Lake HED

Incremental Generation	Limiting CTG	From Name	To Name
1.86	BF: A413 Westside 115 kV, Ninemile-Westside	AIRWAYHT	SUNSET
1.89	N-1: Airway Heights - Devils Gap 115 kV Open @ DGP	INDTRAIL	WEST
3.32	N-1: Airway Heights - Devils Gap 115 kV	INDTRAIL	WEST
4.05	PSF: Westside 115 kV	AIRWAYHT	SUNSET
4.12	BF: A180 Airway Heights 115 kV, Airway Heights-Devils Gap	INDTRAIL	WEST
4.19	PSF: Airway Heights 115 kV	INDTRAIL	WEST
4.52	N-1: Nine Mile - Westside 115 kV Open @ WES	AIRWAYHT	SUNSET
8.13	N-1: Airway Heights - Devils Gap 115 kV Open @ AIR	INDTRAIL	WEST
11.58	N-1: Nine Mile - Westside 115 kV Open @ NMS	DEVILGPE	W.PLAINS
11.8	N-1: Nine Mile - Westside 115 kV	DEVILGPE	W.PLAINS
15.03	BF: A413 Westside 115 kV, Ninemile-Westside	DEVILGPE	W.PLAINS
17.21	PSF: Westside 115 kV	DEVILGPE	W.PLAINS
17.29	N-1: Nine Mile - Westside 115 kV Open @ WES	DEVILGPE	W.PLAINS
20.54	N-1: Nine Mile - Westside 115 kV Open @ NMS	AIRWAYHT	W.PLAINS
20.75	N-1: Nine Mile - Westside 115 kV	AIRWAYHT	W.PLAINS
24.19	BF: A413 Westside 115 kV, Ninemile-Westside	AIRWAYHT	W.PLAINS
26.27	N-1: Nine Mile - Westside 115 kV Open @ WES	AIRWAYHT	W.PLAINS
26.36	PSF: Westside 115 kV	AIRWAYHT	W.PLAINS
35.57	N-1: Devils Gap - Long Lake #1 115 kV	DEVILGPE	LONGLAKW
45.31	N-1: Devils Gap - Long Lake #2 115 kV	DEVILGPE	LONGLAKE
68.26	N-1: Airway Heights - Devils Gap 115 kV Open @ DGP	DEVILGPE	NINEMILE
69.63	N-1: Airway Heights - Devils Gap 115 kV	DEVILGPE	NINEMILE
70.43	BF: A180 Airway Heights 115 kV, Airway Heights-Devils Gap	DEVILGPE	NINEMILE
70.43	PSF: Airway Heights 115 kV	DEVILGPE	NINEMILE
74.43	N-1: Airway Heights - Devils Gap 115 kV Open @ AIR	DEVILGPE	NINEMILE

---

[1] All construction costs are in 2013-year dollars and are based on engineering judgment only with +/- 50% error

Voltage Stability

Preliminary voltage studies show that 68 MW of additional generation at Long Lake HED does not introduce any new voltage issues on the Avista Transmission System.

Conclusion

This study indicates the requested new generation at Long Lake HED performs adequately on the local Transmission System with potential updates to several 115 kV Transmission Lines in the West Spokane area.

Potential cost of upgrading Transmission Lines is $9.9 M, and further costs might be necessary to mitigate issues uncovered in more detailed thermal and transient stability studies.

Distribution:

Scott Waples
SharePoint (System Planning)
Avista OASIS Posting
James Gall - Power Supply & Resource Planning

Interoffice Memorandum
System Planning

MEMO: **SP-2013-03**
DATE: **January 22, 2013**
TO: **Scott Waples**
FROM: **Richard Maguire**
SUBJECT: **2013 IRP Generation Study – Monroe Street HED**

Introduction

This study addresses a request from Avista's Power Supply Department for the 2013 IRP regarding adding 80 MW of additional capacity to Monroe Street HED.

This preliminary study addresses the following:
- Thermal impact to the transmission system
- Voltage stability impact to the transmission system
- Transmission System upgrades necessary to deliver requested generation

History

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

Study Methodology and Assumptions

The five year planning horizon, Avista planning cases, as documented in SP-2011-03 – 2011 Planning Cases Summary Data are modified with the following projects and adjustments before system analysis:
- LGIR #5
- LGIR #35
- Lind 115 kV Substation Reactive Support
- Increases in Monroe Street generation are balanced by decrementing an injection group including all Avista generation with the exception of generation at Monroe Street HED and Upper Falls HED.
- *Western Montana Hydro* is limited to 1650 MW
- *West of Hatwai* is limited to 4277 MW

The most limiting case found during this study is the *Light Summer with High West of Hatwai Flows* (Heavy Summer, High Hydro Case) numbered *AVA-11ls1ae-12BA1251-WOH4277*. This is the primary case used in this study.

Figure 1 below presents a high-level view of the Transmission System near Monroe Street HED with the additional 80 MW of generation supplied by a study generator.

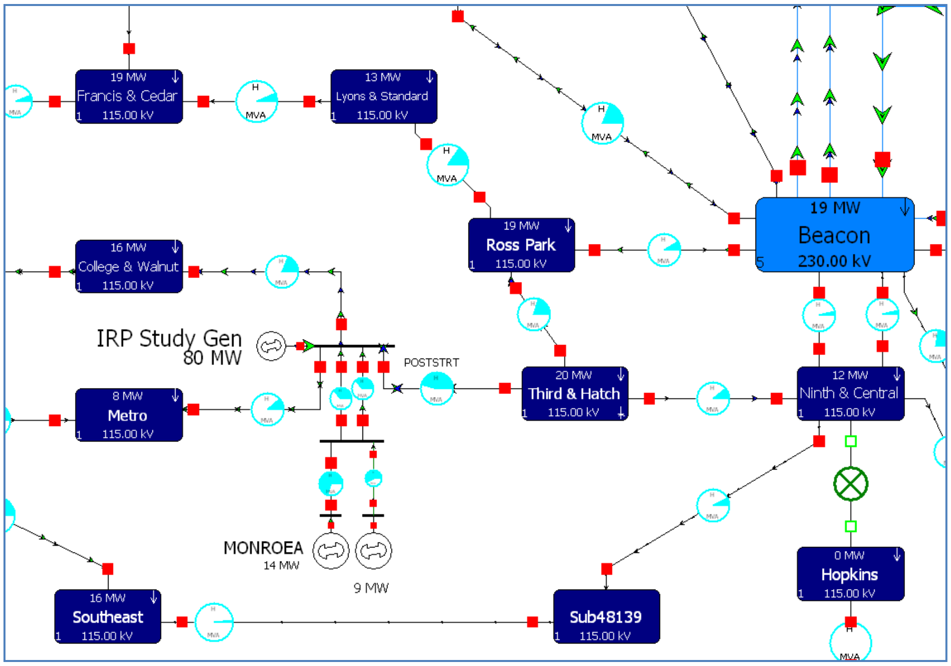


Figure 1: Avista Transmission System near Monroe Street HED

Study Results

Thermal Performance during N-0

This preliminary power flow study indicates the Avista Transmission System has adequate capacity to integrate 80 MW of additional generation at Monroe Street HED with all lines in service.

Thermal Performance during N-1

This preliminary power flow study indicates the Avista Transmission System has adequate capacity to integrate 80 MW of additional generation at Monroe Street HED during N-1 contingency conditions. Table 1 shows the results of a study using PowerWorld Simulator's *Available Transfer Capability* tool for Monroe Street HED. The study reveals the next closest N-1 contingency violation as an overload of the Post Street – Third and Hatch 115 kV transmission line during the PSF: Westside 115 kV contingency if the additional generation capacity at Monroe Street HED was 122.85 MW.

Table 1: PowerWorld ATC results for Monroe Street HED

Trans Lim	From Name	To Name	Limiting CTG
122.85	POSTSTRT	THIRHACH	PSF: Westside 115 kV
132.47	POSTSTRT	THIRHACH	BF: A470 Westside 115 kV, College & Walnut-Westside
135.41	POSTSTRT	THIRHACH	BF: A410 Westside 115 kV, Sunset-Westside
139.77	POSTSTRT	THIRHACH	BF: A413 Westside 115 kV, Ninemile-Westside
142.54	POSTSTRT	THIRHACH	BUS: Westside 115 kV

Voltage Stability

Preliminary voltage studies show that 80 MW of additional generation at Monroe Street HED does not introduce any new voltage issues on the Avista Transmission System.

Conclusion

This preliminary study indicates the requested generation at Monroe Street HED performs adequately on the local Transmission System pending any conditions revealed through further detailed thermal, voltage, and transient stability studies.

Distribution:

Scott Waples
SharePoint (System Planning)
Avista OASIS Posting
James Gall – Power Supply & Resource Planning

Interoffice Memorandum
System Planning

MEMO: **SP-2013-05**
DATE: **January 22, 2013**
TO: **Scott Waples**
FROM: **Richard Maguire**
SUBJECT: **2013 IRP Generation Study – Upper Falls HED**

Introduction

This study addresses a request from Avista's Power Supply Department for the 2013 IRP regarding adding 40 MW of additional capacity to Upper Falls HED. This study will be undertaken as a coincident generation request with the Monroe Street IRP request for three reasons:

- Upper Falls HED and Monroe Street HED connect to the Avista 115 kV Transmission System at the same bus
- The Monroe Street HED IRP request of 80 MW was found to require no transmission system modifications, thereby showing no individual study of the Upper Falls request would be necessary given the lesser requested capacity
- It would be useful to understand the overall impact to the transmission system if both Upper Falls HED and Monroe Street HED IRP requests are pursued

This preliminary study addresses the following:

- Thermal impact to the transmission system
- Voltage stability impact to the transmission system
- Transmission system upgrades necessary to deliver requested generation

History

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.

Study Methodology and Assumptions

The five year planning horizon, Avista planning cases, as documented in SP-2011-03 – 2011 Planning Cases Summary Data are modified with the following projects and adjustments before system analysis:

- LGIR #5
- LGIR #35
- 2013 IRP Monroe Street Request
- Lind 115 kV Substation Reactive Support
- Increases in Upper Falls generation are balanced by decrementing an injection group including all Avista generation with the exception of generation at Monroe Street HED and Upper Falls HED.
- *Western Montana Hydro* is limited to 1650 MW
- *West of Hatwai* is limited to 4277 MW

The most limiting case found during this study is the *Light Summer with High West of Hatwai Flows* (Heavy Summer, High Hydro Case) numbered *AVA-11ls1ae-12BA1251-WOH4277*. This is the primary case used in this study.

Figure 1 below presents a high-level view of the Transmission System near Upper Falls HED with the additional 120 MW of coincidental generation supplied by a study generator.

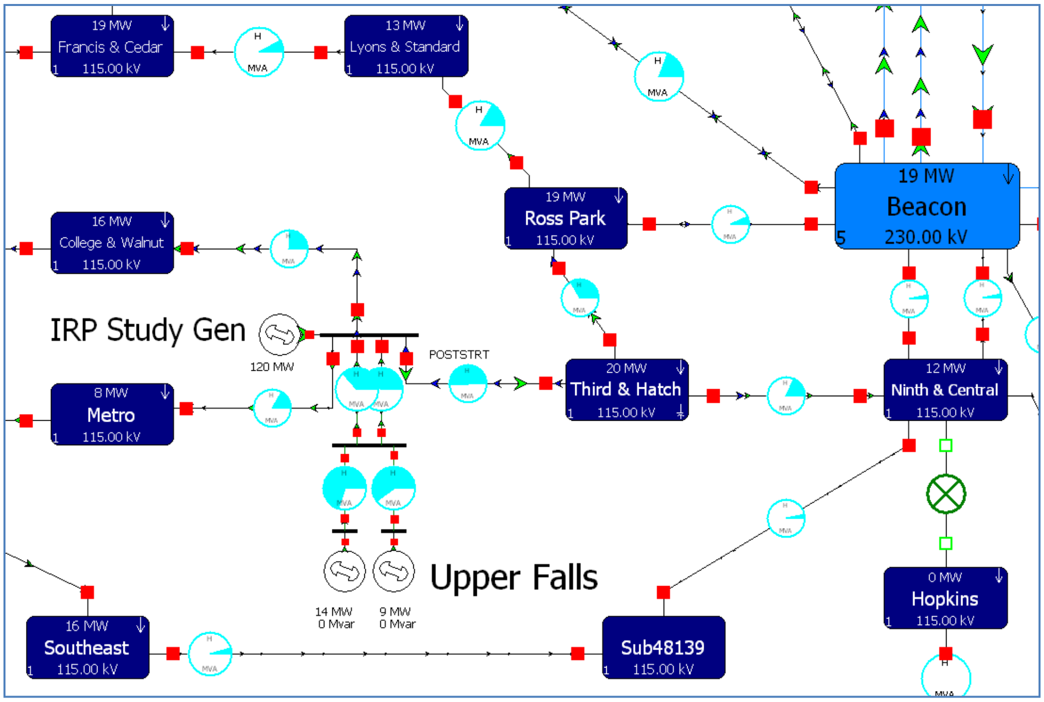


Figure 1: Avista Transmission System near Upper Falls HED

Study Results

Thermal Performance during N-0

This preliminary power flow study indicates the Avista Transmission System has adequate capacity to integrate 40 MW of additional generation at Upper Falls HED with all lines in service. The closest N-0 violation occurs when attempting to integrate 47 MW of generation at Upper Falls which overloads the Post Street-Third & Hatch 115 kV Transmission Line.

Thermal Performance during N-1

This preliminary power flow study indicates the Avista Transmission System has adequate capacity to integrate 40 MW of additional generation at Upper Falls HED during N-1 contingency conditions. Table 1 shows the results of a PowerWorld Simulator *Available Transfer Capability* analysis done for Upper Falls HED. The ATC study reveals the next closest N-1 contingency violation as an overload of the Post Street-Third & Hatch 115 kV Transmission Line during the PSF: Westside 115 kV contingency if the additional generation capacity at Upper Falls HED exceeds 49.49 MW.

Table 1: ATC results for Upper Falls HED

Incremental Generation	Limiting CTG	From Name	To Name
49.49	PSF: Westside 115 kV	POSTSTRT	THIRHACH
58.69	BF: A470 Westside 115 kV, College & Walnut-Westside	POSTSTRT	THIRHACH
62.04	BF: A410 Westside 115 kV, Sunset-Westside	POSTSTRT	THIRHACH
65.93	BF: A413 Westside 115 kV, Ninemile-Westside	POSTSTRT	THIRHACH
68.98	BUS: Westside 115 kV	POSTSTRT	THIRHACH

Voltage Stability

Preliminary voltage studies show that 40 MW of additional generation at Upper Falls HED does not introduce any new voltage issues on the Avista Transmission System.

Conclusion

This preliminary study indicates the requested generation at Upper Falls HED performs adequately on the local Transmission System pending any conditions revealed through further detailed thermal, voltage, and transient stability studies.

Distribution:

Scott Waples
SharePoint (System Planning)
Avista OASIS Posting
James Gall - Power Supply & Resource Planning

Interoffice Memorandum
System Planning

MEMO: **SP-2013-02**
DATE: **January 22, 2013**
TO: **Scott Waples**
FROM: **Richard Maguire**
SUBJECT: **2013 IRP Generation Study – Post Falls HED**

Introduction

This study addresses a request from Avista's Power Supply Department for the 2013 IRP regarding increasing the capacity of Post Falls HED to a total output of 33.5 MW.

This preliminary study addresses the following:
- Thermal impact to the transmission system
- Voltage stability impact to the transmission system
- Transmission System upgrades necessary to deliver requested generation

History

Avista's upper most hydroelectric facility on the Spokane River is the Post Falls project, located at its Idaho namesake near the Washington/Idaho border. The project began operation in 1906 and maintains lake elevation during the summer for 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.

Study Methodology and Assumptions

The five year planning horizon, Avista planning cases, as documented in SP-2011-03 – 2011 Planning Cases Summary Data are modified with the following projects and adjustments before system analysis:
- LGIP #5
- Lind 115 kV Substation Reactive Support
- Increases in Post Falls generation are balanced by decrementing an injection group including all Avista generation with the exception of Post Falls HED.
- *Western Montana Hydro* is limited to 1650 MW
- *West of Hatwai* is limited to 4277 MW

The most limiting case found during this study is the Heavy Summer with High Local Hydro Generation (Heavy Summer, High Hydro Case) numbered *AVA-11hs2a-12BA2085*. This is the primary case used in this study.

Figure 1 below presents a high-level view of the Transmission System near Post Falls HED. Note the relatively large amount of local load immediately connected to the Post Falls substation when compared to the requested 33.5 MW total plant output.

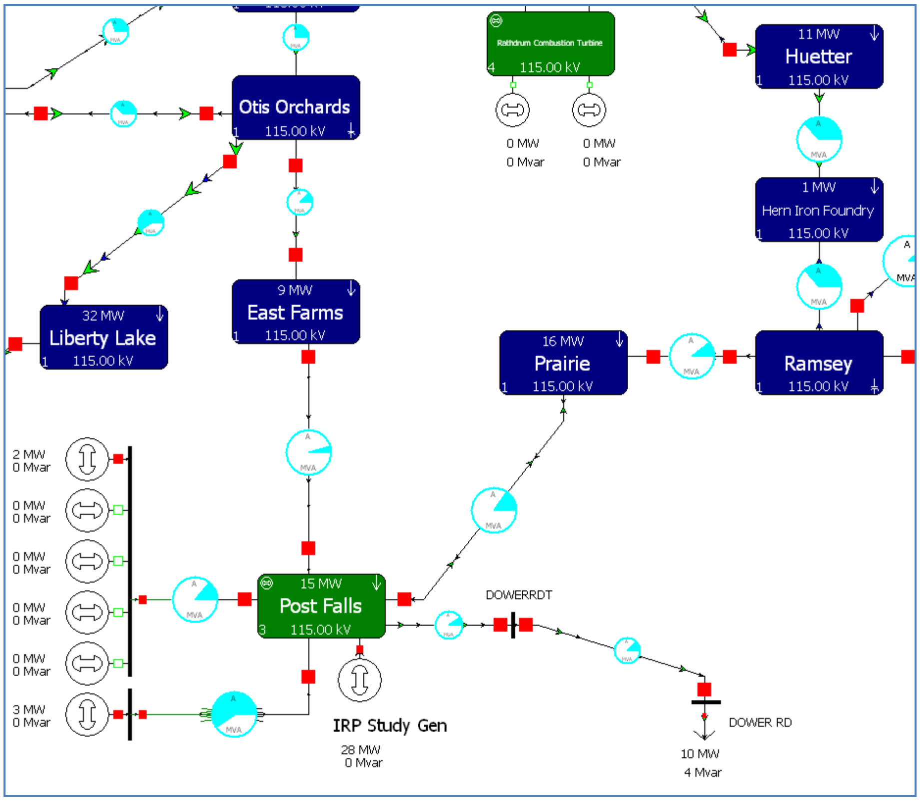


Figure 1: Avista Transmission System near Post Falls HED

Study Results

Thermal Performance during N-0

This preliminary power flow study indicates the Avista Transmission System has adequate capacity to integrate 33.5 MW of total generation at Post Falls HED with all lines in service.

Thermal Performance during N-1

This preliminary power flow study indicates the Avista Transmission System has adequate capacity to integrate 33.5 MW of total generation at Post Falls HED during N-1 contingency conditions. Table 1 shows the results of a PowerWorld Simulator *Available Transfer Capability* analysis done for Post Falls HED. The ATC study reveals the next closest N-1 contingency violation as an overload of the Post Falls – Prairie B 115 kV Transmission Line during the N-1: Otis Orchards – Post Falls 115 kV Open @ PF contingency when the total generation capacity at Post Falls HED is 112.15 MW.

Table 1: ATC study results for Post Falls HED

Trans Lim	From Name	To Name	Limiting CTG
112.15	POST FLS	PRAIRIEB	N-1: Otis Orchards - Post Falls 115 kV Open @ PF
112.16	POST FLS	PRAIRIEB	BF: A642 Otis Orchards 115 kV, Otis Orchards-Post Falls
112.17	POST FLS	PRAIRIEB	N-1: Otis Orchards - Post Falls 115 kV
112.18	POST FLS	PRAIRIEB	PSF: Otis Orchards 115 kV
138.87	EASTFARM	POST FLS	N-1: Post Falls - Ramsey 115 kV Open @ PF
139.68	EASTFARM	POST FLS	N-1: Post Falls - Ramsey 115 kV
139.68	EASTFARM	POST FLS	N-2: Post Falls - Ramsey 115 kV & Ramsey - Rathdrum #1 115 kV
147.42	OTIS	LIBTYLK	SUB: Beacon 230 & 115 (AVA)
173.04	CLEARWTR	N LEWIST	N-2: Dry Creek - North Lewiston 230 kV and Dry Creek - North Lewiston 115 kV and North Lewiston - Tucannon River 115 kV
1638.3	POST FLS	PRAIRIEB	PSF: Post Falls 115 kV

Voltage Stability

Preliminary voltage studies show that 33.5 MW of total generation at Post Falls HED does not introduce any new voltage issues on the Avista Transmission System.

Conclusion

This preliminary study indicates the requested generation at Post Falls HED performs adequately on the local Transmission System pending any conditions revealed through further detailed thermal, voltage, and transient stability studies.

Distribution:

Scott Waples
SharePoint (System Planning)
Avista OASIS Posting
James Gall – Power Supply & Resource Planning

Interoffice Memorandum
System Planning

MEMO: **SP-2012-14**
DATE: **October 4, 2012**
TO: **Scott Waples**
FROM: **Richard Maguire**
SUBJECT: **2013 IRP Generation Study – Cabinet Gorge HED**

Introduction

This brief study addresses a request from Avista's Power Supply Department for the 2013 IRP regarding adding up to 110 MW of new generation capacity in the form of two new units to Cabinet Gorge HED.

History

The Cabinet Gorge project started generating power in 1952 with two units. The plant was expanded with two additional generators in the following year. The current maximum 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 was upgraded in 2001 and Unit 2 was upgraded in 2004. The final unit, Unit 4, received a $6 million turbine upgrade in 2007, increasing its generating capacity from 55 MW to 64 MW, and adding 2.1 aMW of additional energy.[1]

Study Methodology and Assumptions

Two of Avista's five year planning horizon cases are modified with the following projects prior to analysis:

- Spokane Valley Transmission Reinforcement Project
- Moscow Transformer Replacement Project
- Lancaster Loop-In Project
- Palouse Wind Phase I (LGIP #5)

The two cases used in this study are:

- AVA-16hs2a-16BA2213; Heavy Summer High Hydro (HSHH)
- AVA-11ls1ae-16BS1328-WOH4140; Light Loading High Transfer (HT)

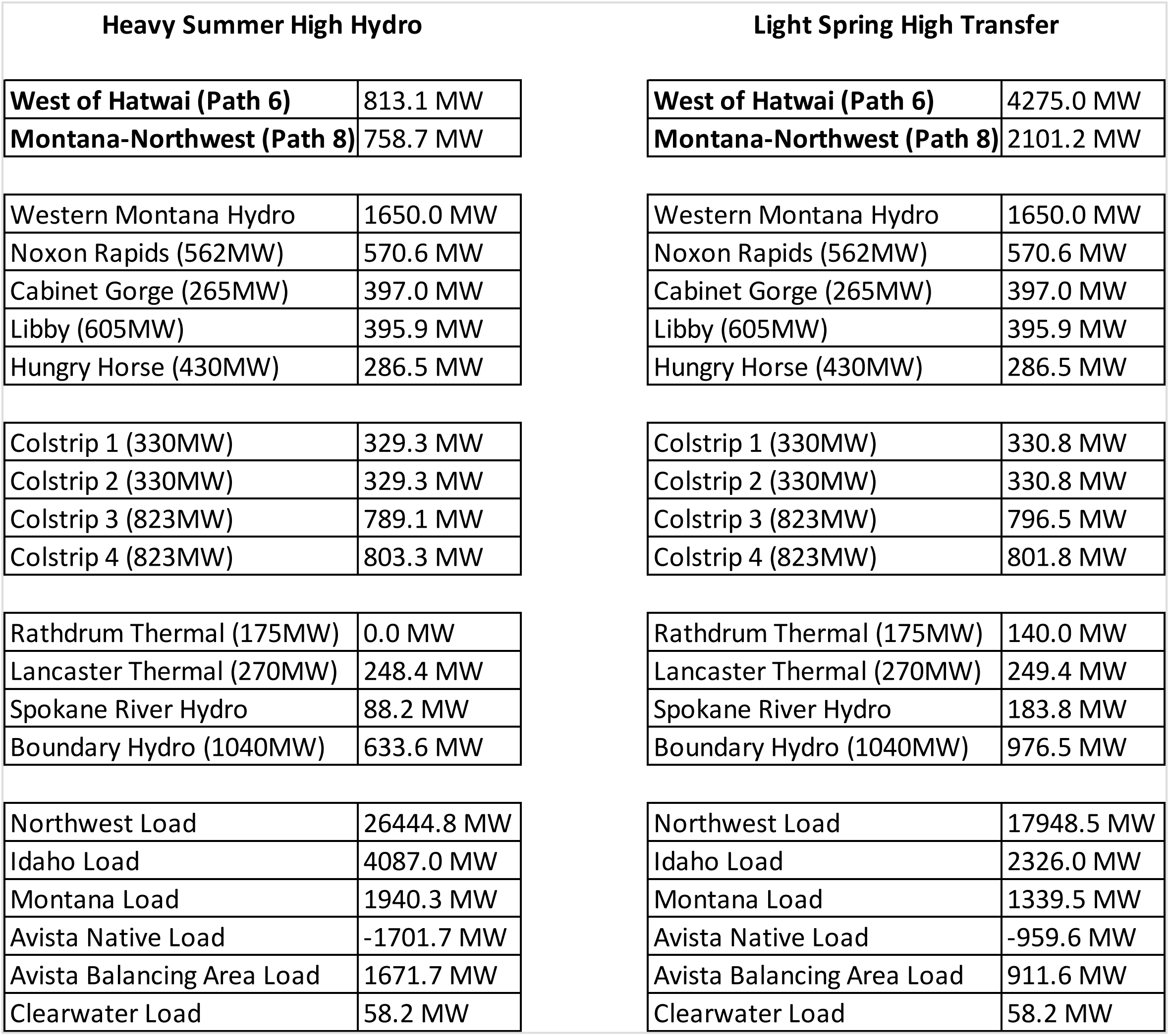
These cases represent two seasonal times when maximum hydro generation is possible.

Table 1 below shows the power flow values with an additional 110 MW of generation at Cabinet Gorge. All changes in generation are coupled with:

- Limiting *Western Montana Hydro* to 1650 MW by reducing outputs of Libby and Hungry Horse
- Limiting *West of Hatwai* to 4277 MW via control of off-system generation

---

[1] Cabinet Gorge history taken from Avista 2011 Electric Integrated Resource Plan



Heavy Summer High Hydro		Light Spring High Transfer	
West of Hatwai (Path 6)	813.1 MW	**West of Hatwai (Path 6)**	4275.0 MW
Montana-Northwest (Path 8)	758.7 MW	**Montana-Northwest (Path 8)**	2101.2 MW
Western Montana Hydro	1650.0 MW	Western Montana Hydro	1650.0 MW
Noxon Rapids (562MW)	570.6 MW	Noxon Rapids (562MW)	570.6 MW
Cabinet Gorge (265MW)	397.0 MW	Cabinet Gorge (265MW)	397.0 MW
Libby (605MW)	395.9 MW	Libby (605MW)	395.9 MW
Hungry Horse (430MW)	286.5 MW	Hungry Horse (430MW)	286.5 MW
Colstrip 1 (330MW)	329.3 MW	Colstrip 1 (330MW)	330.8 MW
Colstrip 2 (330MW)	329.3 MW	Colstrip 2 (330MW)	330.8 MW
Colstrip 3 (823MW)	789.1 MW	Colstrip 3 (823MW)	796.5 MW
Colstrip 4 (823MW)	803.3 MW	Colstrip 4 (823MW)	801.8 MW
Rathdrum Thermal (175MW)	0.0 MW	Rathdrum Thermal (175MW)	140.0 MW
Lancaster Thermal (270MW)	248.4 MW	Lancaster Thermal (270MW)	249.4 MW
Spokane River Hydro	88.2 MW	Spokane River Hydro	183.8 MW
Boundary Hydro (1040MW)	633.6 MW	Boundary Hydro (1040MW)	976.5 MW
Northwest Load	26444.8 MW	Northwest Load	17948.5 MW
Idaho Load	4087.0 MW	Idaho Load	2326.0 MW
Montana Load	1940.3 MW	Montana Load	1339.5 MW
Avista Native Load	-1701.7 MW	Avista Native Load	-959.6 MW
Avista Balancing Area Load	1671.7 MW	Avista Balancing Area Load	911.6 MW
Clearwater Load	58.2 MW	Clearwater Load	58.2 MW

Table 1: Base Case Power Flow Summary

Study Results

Thermal Performance during N-0 conditions

The study indicates that the Avista transmission system has enough capacity to integrate an additional 110 MW of generation at Cabinet Gorge HED with all lines in service during some, but not all, conditions. One example of a limiting condition occurs during hot summer months when the loading is high and full hydro generation is possible. During this heavy summer, high hydro scenario, the present Avista transmission system has just enough transmission capacity for existing generation. Figure 1 below shows the Avista system isolated from neighbor systems for the purpose of determining transmission capacity. This is a unique test for this study, and no other cases are evaluated with the system isolated in this way. The image represents flows in the 2016 heavy summer high hydro case with Cabinet Gorge and Noxon operating at maximum capacity.

Note:

- This study uses existing line ratings. Avista has projects underway raising line ratings in the area, which will result in more transmission capacity once the projects are completed.
- Generation at Cabinet Gorge HED and Noxon Rapids HED could be governed within a nomogram to mitigate thermal overloads during summer conditions when electric loading is high.
- NOTE: these conclusions are contingent upon further detailed studies

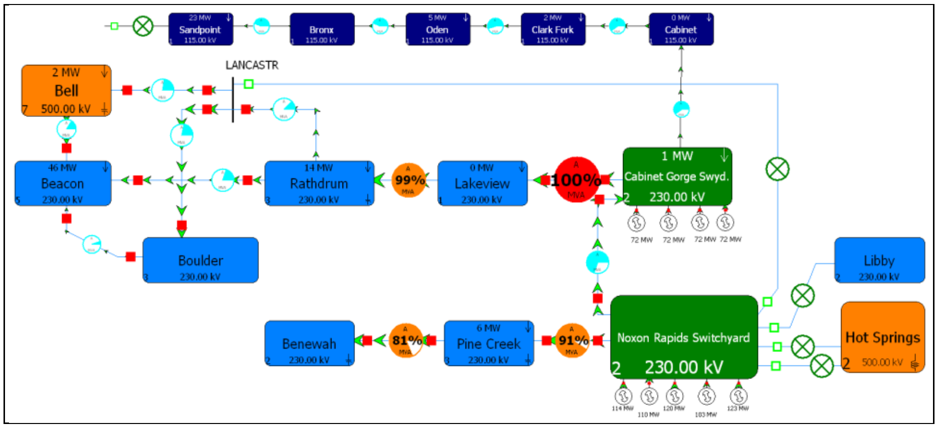


Figure 1: 2016 HSHH, all facilities in service, Cabinet Gorge @287MW

Thermal Performance during N-1 conditions

Given the current study reveals Cabinet Gorge HED must be limited to zero additional capacity when operating under conditions similar to those used in the Heavy Summer, High Hydro case, *only the High Transfer case is used to consider N-1 contingency violations.*

All new N-1 contingency violations found during this study are in the immediate vicinity of the Cabinet Gorge HED. Figure 2 shows the most limiting contingency occuring when the Cabinet to Noxon 230 kV line overloads with a loss of the 230 kV line to Rathdrum for a failure of breaker R404.[2] As noted in the notes above, Avista has transmission projects underway that lessen the severity of all of the N-1 contingency violations found in this study, and further detailed study will determine what, if any, N-1 violations still exist once the local projects are completed.

Note: Reducing the new generation at Cabinet Gorge to values less than the requested 110 MW directly impacts the new limiting N-1 contingency violations. This behavior likely reduces the steady state nomogram discussed above.

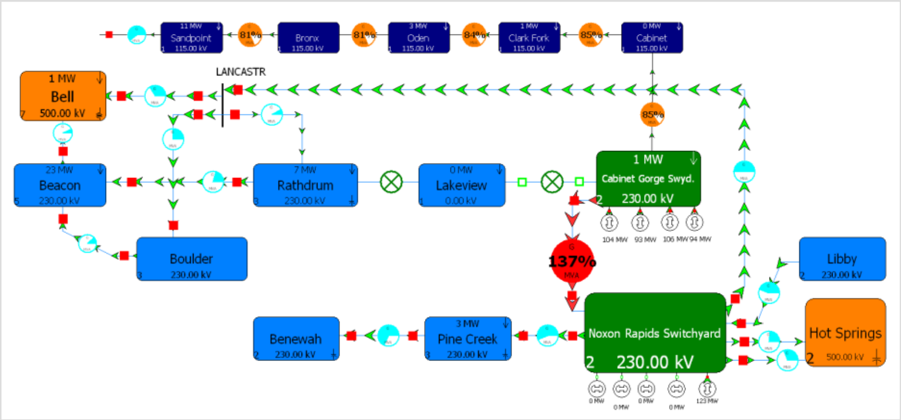


Figure 2: Cabinet-Noxon 230 kV overload during R404 breaker failure

Voltage Stability

With all lines in service, an addition of 110 MW at Cabinet Gorge does not introduce any new voltage violations during N-0 conditions. However, this study indicates several new voltage violations are present during N-1 conditions. The limiting contingency regarding voltage stability occurs at Bus 48057, the Cabinet Gorge 230 kV bus, during the N-1: Cabinet – Noxon 230 kV contingency. The voltage limit used is 1.015 pu, the initial value is 1.045 pu, and the value during contingency is 1.0049 pu. Figure 3 shows the violation.

---

[2] BF: R404 Cabinet-Rathdrum, Rathdrum #2 230/115 Transformer

All of the newly created voltage violations can be mitigated by reducing generation at Cabinet Gorge to levels above present values but below the requested 110 MW addition. Additionally, existing and planned projects on the Avista transmission system positively influence these new voltage violations. Further detailed studies are necessary to fully characterize voltage performance.

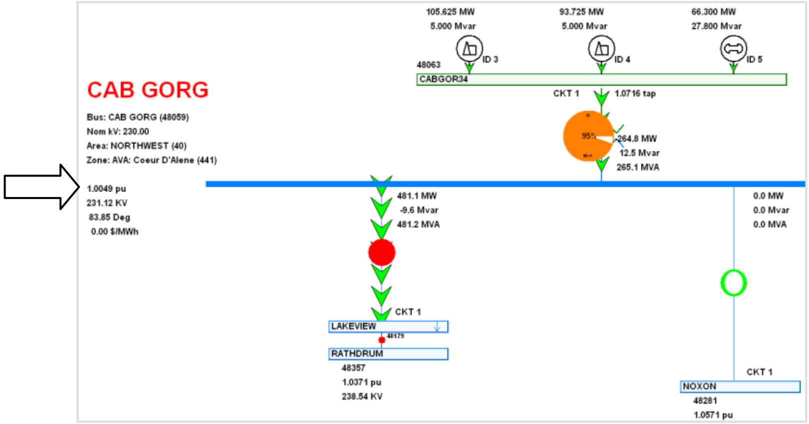


Figure 3: 2016 HT, Voltage Limit Violation, N-1: Cabinet – Noxon 230 kV

Transient Stability

Preliminary studies indicate new generation at Cabinet Gorge adds stability violations during N-1 conditions, and additional generation exacerbates stability issues addressed by the existing Clark Fork remedial action scheme (i.e. RAS). Adding any new generation to the existing RAS scheme clears several of the new N-1 violations, but further studies are necessary to accurately assess solutions for the other violations. Possible solutions could be changes to the existing RAS, a nomogram as discussed above, and/or transmission projects to mitigate violations.

Conclusions

This study indicates the requested new generation at Cabinet Gorge performs adequately on the local transmission system with potential updates to the Clark Fork RAS and limits to Cabinet Gorge and Noxon combined output via a seasonally adjusted nomogram determined by further study.

If operating Cabinet Gorge without limitation is desired, preliminary studies show this is possible via potential projects on one or more of the 230 kV transmission lines carrying power to the load center.

<u>Distribution:</u>

S. Waples
Sharepoint (System Planning)
OASIS Posting
Power Supply (J. Gall)

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

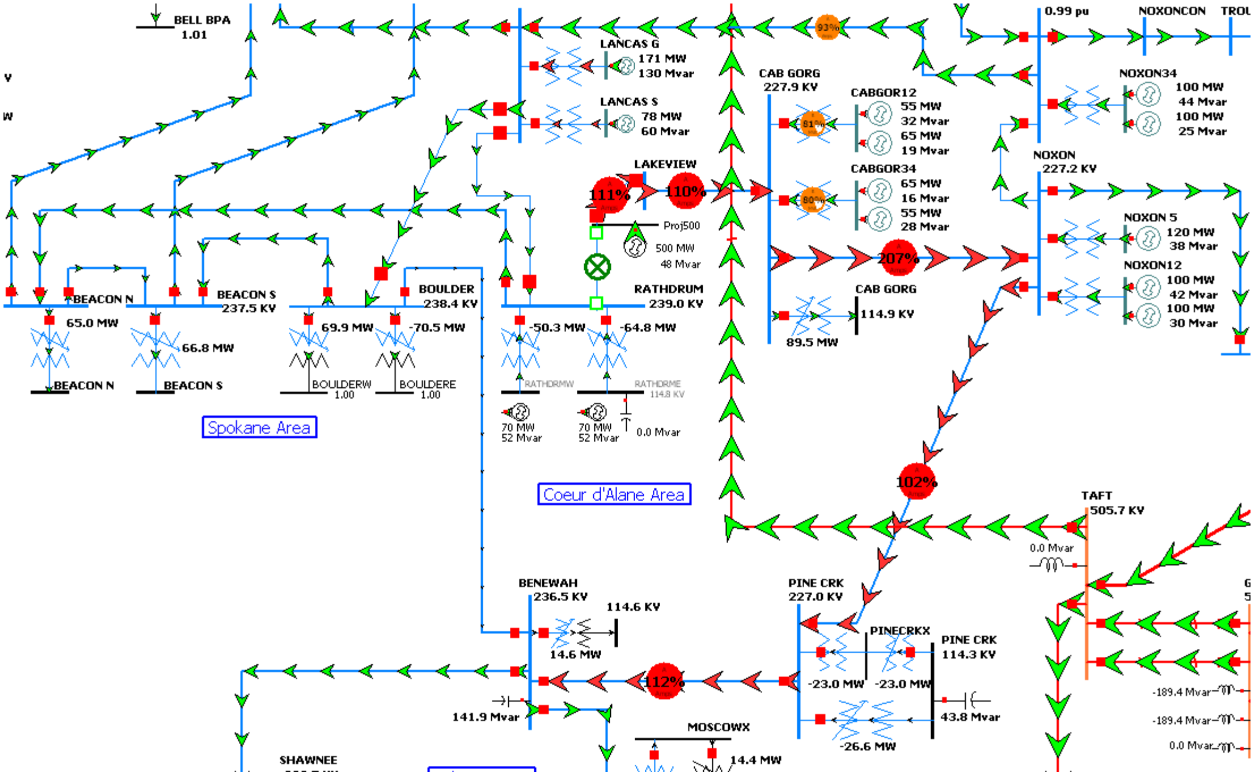


Figure 1 – N-1 Contingency

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.

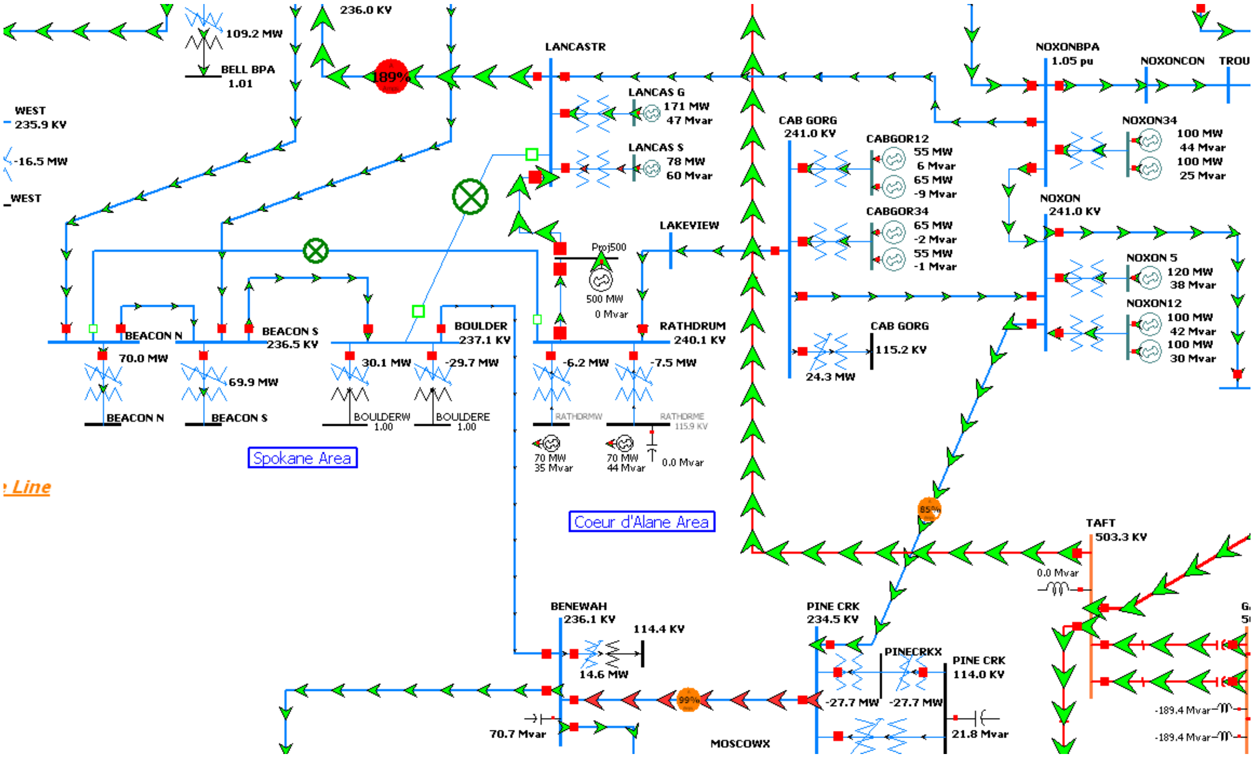


Figure 2 - N-2 Contingency

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.

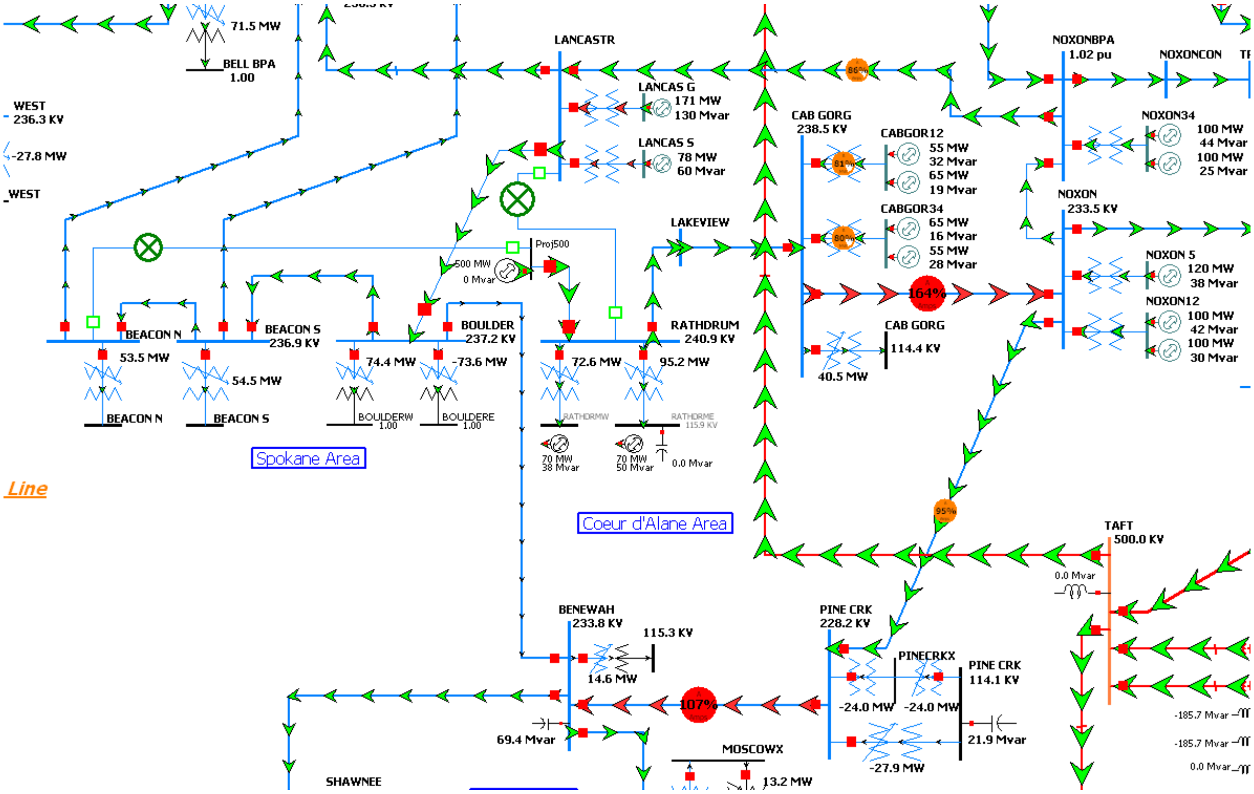


Figure 3 - N-2 Contingency

---

[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.

Interoffice Memorandum
System Planning

MEMO: **SP-2013-07**
DATE: **February 15, 2012**
TO: **Scott Waples**
FROM: **Richard Maguire**
SUBJECT: **IRP Generation Study - Benewah to Boulder 230kV (BB-IRP)**

Introduction

This study addresses a request from Avista's Power Supply Department for the 2013 IRP regarding new generation on the Benewah - Boulder 230 kV Transmission Line at one of two capacity levels:

- 150 MW
- 300 MW

The study presents information and discussion on the follow topics:

- Power flow impact to the transmission system
- Transmission system upgrades necessary to deliver requested generation

Study Assumptions and Methodology

The five year planning horizon Avista planning cases, as documented in *SP-2011-03 – 2011 Planning Cases Summary Data*, are modified with the following projects and adjustments prior to system analysis:

- LGIR #35 project (200 MW at Thornton 230 kV Substation)
- LGIR #36 project (105 MW at Thornton 230 kV Substation)
- BB-IRP topology:
  - Benewah – Boulder 230kV Transmission Line tapped 13.1 electrical miles North of Benewah 230 kV Substation
  - Generic generator installed on new BB-IRP 230 kV bus

The following cases are used during this study:

- Avista Heavy Summer High Hydro ("HSHH") case: AVA-11hs2a-12BA2085
  - Table 1 shows power flows for this case
- Avista Heavy Summer Low Hydro ("HSLH") case: AVA-11hs2a-12BA2085-LH
  - Table 2 shows power flows for this case
- Avista Light Summer with High West of Hatwai (High Transfers or "HT")Flows: AVA-11ls1ae-12BA1251-WOH4277
  - Table 3 shows power flows for this case with BB-IRP output = 300 MW

Table 1: Regional Power Flows for Heavy Summer Case

Western Montana Hydro	1098.1 MW	West of Hatwai (Path 6)	951.8 MW
Noxon Rapids (562MW)	399.4 MW	Lolo-Oxbow 230kV	296.0 MW
Cabinet Gorge (265MW)	184.7 MW	Dry Creek-Walla Walla 230kV	184.1 MW
Libby (605MW)	324.0 MW		
Hungry Horse (430MW)	190.0 MW	West of Cabinet	1581.7 MW
		Montana-Northwest (Path 8)	979.0 MW
Colstrip Total			
Colstrip 1 (330MW)	330.0 MW	Idaho-Northwest (Path 14)	-585.4 MW
Colstrip 2 (330MW)	330.0 MW	Midpoint-Summer Lake (Path 75)	-48.9 MW
Colstrip 3 (823MW)	795.5 MW	Idaho-Montana (Path 18)	-296.3 MW
Colstrip 4 (823MW)	804.9 MW		
		South of Boundary	582.9 MW
Rathdrum Thermal (175MW)	0.0 MW	North of John Day (Path 73)	7034.7 MW
Lancaster Thermal (270MW)	249.0 MW	TOT 4A (Path 37)	407.0 MW
Spokane River Hydro	88.3 MW	Miles City DC	142.0 MW
Boundary Hydro (1040MW)	635.0 MW		
		Path C (Path 20)	118.7 MW
Lower Snake/N.F. Clearwater		Borah West (Path 17)	837.4 MW
Dworshak (458MW)	316.0 MW	Bridger West (Path 19)	2191.6 MW
Lower Granite (930MW)	554.2 MW	Pacific AC Intertie (Path 66)	4430.9 MW
Little Goose (930MW)	555.5 MW	Pacific DC Intertie (Path 65)	2980.0 MW
Lower Monumental (930MW)	531.5 MW		
		Northwest Load	25129.6 MW
Coulee Generation		Idaho Load	3702.5 MW
Coulee 500 kV	2308.5 MW	Montana Load	1836.8 MW
Coulee 230 kV	1292.7 MW	Avista Native Load	-1594.3 MW
		Avista Balancing Area Load	1885.6 MW
		Clearwater Load	58.3 MW

Table 2: Regional Power Flows for Light Summer Case

Western Montana Hydro	627.1 MW	West of Hatwai (Path 6)	120.3 MW
Noxon Rapids (562MW)	138.8 MW	Lolo-Oxbow 230kV	277.0 MW
Cabinet Gorge (265MW)	82.3 MW	Dry Creek-Walla Walla 230kV	159.6 MW
Libby (605MW)	216.0 MW		
Hungry Horse (430MW)	190.0 MW	West of Cabinet	1110.7 MW
		Montana-Northwest (Path 8)	970.1 MW
Colstrip Total			
Colstrip 1 (330MW)	330.0 MW	Idaho-Northwest (Path 14)	-585.9 MW
Colstrip 2 (330MW)	330.0 MW	Midpoint-Summer Lake (Path 75)	-76.0 MW
Colstrip 3 (823MW)	764.2 MW	Idaho-Montana (Path 18)	-274.8 MW
Colstrip 4 (823MW)	776.0 MW		
		South of Boundary	299.4 MW
Rathdrum Thermal (175MW)	0.0 MW	North of John Day (Path 73)	6931.9 MW
Lancaster Thermal (270MW)	249.0 MW	TOT 4A (Path 37)	399.6 MW
Spokane River Hydro	58.1 MW	Miles City DC	142.0 MW
Boundary Hydro (1040MW)	310.0 MW		
		Path C (Path 20)	133.4 MW
Lower Snake/N.F. Clearwater		Borah West (Path 17)	830.6 MW
Dworshak (458MW)	316.0 MW	Bridger West (Path 19)	2188.8 MW
Lower Granite (930MW)	554.2 MW	Pacific AC Intertie (Path 66)	4222.6 MW
Little Goose (930MW)	555.5 MW	Pacific DC Intertie (Path 65)	2980.0 MW
Lower Monumental (930MW)	531.5 MW		
		Northwest Load	25129.6 MW
Coulee Generation		Idaho Load	3702.5 MW
Coulee 500 kV	3066.4 MW	Montana Load	1836.8 MW
Coulee 230 kV	1292.7 MW	Avista Native Load	-1594.3 MW
		Avista Balancing Area Load	1874.1 MW
		Clearwater Load	75.8 MW

Table 3: Regional Power Flows for High Transfer Case

Western Montana Hydro	1548.0 MW
Noxon Rapids (562MW)	432.2 MW
Cabinet Gorge (265MW)	195.8 MW
Libby (605MW)	540.0 MW
Hungry Horse (430MW)	380.0 MW
Colstrip Total	
Colstrip 1 (330MW)	330.0 MW
Colstrip 2 (330MW)	330.0 MW
Colstrip 3 (823MW)	777.6 MW
Colstrip 4 (823MW)	782.9 MW
Rathdrum Thermal (175MW)	116.4 MW
Lancaster Thermal (270MW)	118.1 MW
Spokane River Hydro	152.4 MW
Boundary Hydro (1040MW)	975.0 MW
Lower Snake/N.F. Clearwater	
Dworshak (458MW)	168.2 MW
Lower Granite (930MW)	0.0 MW
Little Goose (930MW)	141.8 MW
Lower Monumental (930MW)	310.0 MW
Coulee Generation	
Coulee 500 kV	825.7 MW
Coulee 230 kV	125.0 MW

West of Hatwai (Path 6)	4251.2 MW
Lolo-Oxbow 230kV	140.1 MW
Dry Creek-Walla Walla 230kV	189.5 MW
West of Cabinet	3204.5 MW
Montana-Northwest (Path 8)	2040.8 MW
Idaho-Northwest (Path 14)	741.0 MW
Midpoint-Summer Lake (Path 75)	831.7 MW
Idaho-Montana (Path 18)	-198.3 MW
South of Boundary	961.8 MW
North of John Day (Path 73)	4775.0 MW
TOT 4A (Path 37)	448.4 MW
Miles City DC	200.0 MW
Path C (Path 20)	528.7 MW
Borah West (Path 17)	1570.2 MW
Bridger West (Path 19)	2098.0 MW
Pacific AC Intertie (Path 66)	3136.7 MW
Pacific DC Intertie (Path 65)	1999.9 MW
Northwest Load	17796.4 MW
Idaho Load	2326.0 MW
Montana Load	1339.5 MW
Avista Native Load	-837.0 MW
Avista Balancing Area Load	680.3 MW
Clearwater Load	71.1 MW

Study Results

Thermal Performance during Category A conditions[1]

This preliminary study indicates the Avista Transmission System has adequate capacity to integrate 300 MW at the proposed interconnection point during Category A all lines in service conditions.

Thermal Performance during Category B and Category C conditions

Table 4 shows preliminary results of a study using PowerWorld Simulator's *Available Transfer Capability* (ATC) tool for generation injections at BB-IRP. This tool generates a list of facility thermal violations (From To) that arise under contingency conditions for incremental increases in generation output (BB WM). When the results for each case under study are collected and analyzed together with results from standard contingency analysis studies, this tool provides an idea of what facilities overload for rising levels of generation output.

As the table shows, there are six facilities that come into violation for a requested BB-IRP output of 150 MW, and there are an additional five facilities that come into violation for a requested BB-IRP output of 300 MW.

Table 4: Incremental generation analysis for BB-IRP IRP request[2]

Case	MW Output	Limiting Contingency	From Name	To Name
HSLH	27.11	BF: A470 Westside 115 kV, College & Walnut-Westside	GLENTAP	NINTHCNT
HSHH	28.2	BUS: Westside 115 kV	POSTSTRT	THIRHACH
HT	84.08	N-1: Hatwai - Moscow 230 230 kV	MOSCOW	MOSCOWX
HSLH	106.34	BUS: Westside 115 kV	ROSSPARK	THIRHACH
HSHH	106.63	BF: A413 Westside 115 kV, Ninemile-Westside	POSTSTRT	THIRHACH
HSHH	112.15	BF: A689 Ninth & Central South 115 kV, Ninth & Central-Otis Orchards	POSTSTRT	THIRHACH
HSLH	116.64	N-2: Bell - Westside 230 kV & Coulee - Westside 230 kV	GLENTAP	NINTHCNT
HSLH	117.24	BUS: Westside 230 kV	GLENTAP	NINTHCNT
HSLH	123.43	BF: A370 Bell S1 & S2 230 kV	BEACON N	BEACON N
HSHH	160.37	N-1: Shawnee - Thornton 230 kV	MOSCOW	MOSCOWX
HSHH	164.3	N-1: North Lewiston - Shawnee 230 kV	TERRVIEW	NPULLMAN
HSHH	173.34	BUS: North Lewiston 230 kV	TERRVIEW	NPULLMAN
HSLH	184.24	BF: A413 Westside 115 kV, Ninemile-Westside	ROSSPARK	THIRHACH
HT	206.31	N-2: Beacon - Boulder 230 kV & Beacon - Rathdrum 230 kV	BOULDERE	IRVIN
HT	215.35	BF: R427 Beacon North & South 230 kV	BOULDERE	IRVIN
HT	215.68	N-2: Beacon - Boulder 230 kV & Beacon - Rathdrum 230 kV	IRVIN	MILLWOOD
HT	223.63	BF: R427 Beacon North & South 230 kV	IRVIN	MILLWOOD
HSHH	253.83	N-2: Shawnee - Thornton 230 kV & Lind - Shawnee 115 kV	MOSCOW	MOSCOWX
HT	269.19	N-2: Beacon - Boulder 230 kV & Beacon - Rathdrum 230 kV	BOULDERW	SPKINDPK
HT	271.24	BUS: Hatwai 230 kV	MOSCOWX	MOSCOW
HSLH	272.76	BUS: Hatwai 230 kV	MOSCOWX	MOSCOW
HSLH	275.44	PSF: Ninth & Central South 115 kV	BEACON S	NINTHCNT
HSHH	275.67	BUS: Westside 230 kV	POSTSTRT	THIRHACH
HSHH	275.84	N-2: Bell - Westside 230 kV & Coulee - Westside 230 kV	POSTSTRT	THIRHACH
HT	280.08	BF: R427 Beacon North & South 230 kV	BOULDERW	SPKINDPK
HSLH	298.33	BUS: North Lewiston 230 kV	HATWAI	LOLO
HT	300.27	N-2: Bell - Taft 500 kV and Bell - Lancaster 230 kV	BOULDER	BB-IRP

---

[1] Contingency category descriptions can be found at: http://www.nerc.com/files/TPL-001-0.pdf

[2] BF = Breaker Failure; PSF = Protection System Failure; N-X contingencies refer to 'X' transmission element outages

Notes regarding thermal performance:

- Avista has planned projects that mitigate some of the above mentioned facility violations. However, some of the planned projects also result in new facility thermal violations during contingencies. Further study of planned projects and potential options will be necessary.
- Preliminary studies indicate some reduction in the above thermal violations when Projects #35 and #36 are removed from study, but the reduction in thermal violations is confined mainly to limiting facilities south of BB-IRP. Without Projects #35 and #36, significant power continues to flow north through the Boulder 230 kV substation and onto the local 115 kV Transmission System in the Spokane and Spokane Valley areas.

Voltage Performance

Preliminary studies show voltage issues of a nature that can be addressed with properly sited reactive support. Further detailed studies can be used to determine the exact amount and location of any reactive support necessary to mitigate facility voltage violations.

Potential Solutions Options[3]

230 kV Switching station required for all options mentioned below:

- 4 position double bus double breaker ~ $4 M

Option 1: Reconductor facilities brought into violation due to the requested generation

- 150 MW option would require:
  - $3.41 M of 115 kV upgrades
- 300 MW option would require an additional:
  - $1.9 M of 115 kV upgrades
  - $5.36 M of 230 kV upgrades

Option 2: Complete currently planned projects and reconductor limiting facilities

- Currently Planned Projects:
  - Lancaster Interconnection
  - Spokane Valley Transmission Reinforcement
  - Moscow Transformer Replacement
  - Westside Transformer Replacement
- 150 MW option would require:
  - $2.4 M of 115 kV upgrades
- 300 MW option would require an additional:
  - $932 K of 115 kV upgrades
  - $5.36 M of 230 kV upgrades

Conclusion

This project is a feasible project based on the preliminary analysis performed. A summary of options and cost estimates is given in Table 3.

Option	Maximum Output	Total Cost ($000)
1	150 MW	$7,410
1	300 MW	$14,670
2	150 MW	$6,400
3	300 MW	$12,690

---

[3] All construction costs are in 2013-year dollars and based on engineering judgment alone with +/- 50% accuracy

Interoffice Memorandum
System Planning

MEMO: **SP-2011-09 Rev B - Final**
DATE: **January 13, 2012**
TO: **James Gall, IRP Group**
FROM: **Reuben Arts**
SUBJECT: **New Generation, 300 MW in the Rathdrum Area and 200 MW in the Rosalia 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

As a follow up to the IRP informational request for 500 MW in N. Idaho, SP-2011-08, the IRP group requests the following additional cost studies.

1) Split the 500 MW into ~200 MW connecting at the Thornton substation by the end of 2018, then ~300 MW integrated at Lancaster substation by the end of 2023.
2) Split the 500 MW into ~200 MW connecting at the Thornton substation by the end of 2018, then ~300 MW integrated at the Boulder- Lancaster line by the end of 2023.
3) Split the 500 MW into ~200 MW connecting at the Thornton substation by the end of 2018, then ~300 MW integrated at the Rathdrum substation by the end of 2023.

Power Flow Analysis

The case that was used to highlight the impacts of an additional 300 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

300 MW of new generation in the Rathdrum area, near the BPA Lancaster substation and 200 MW in the Rosalia area is option 1. The 300 MW portion, assumes a new 230/13 kV Avista generator substation would be required. Several connection possibilities exist for connecting this substation to the 230 kV transmission system in this area. For simplification it will be assumed that the new substation will tap the to-be-constructed Rathdrum – Lancaster 230 kV transmission line. This option has no N-0 issues at the full 300 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 164%, or roughly 320 MW above its thermal limit. See Figure 2.

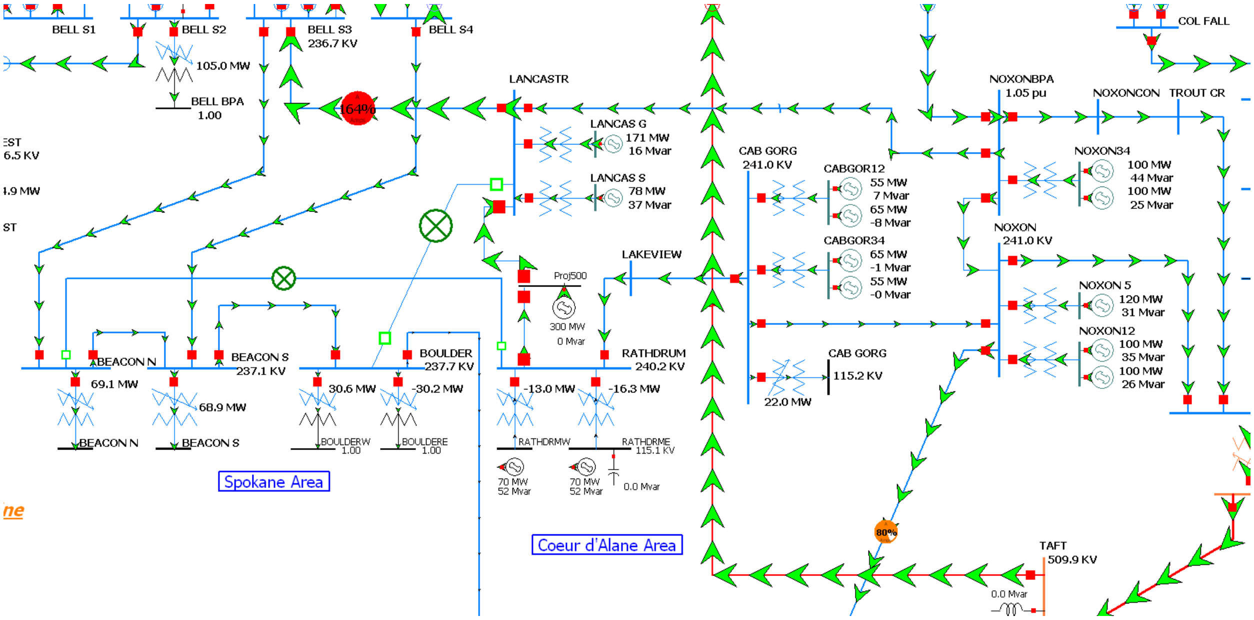


Figure 2 - N-2 Contingency

To alleviate these overloads a new 230 kV transmission line, 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. A RAS solution would have to integrate with the existing Clark Fork RAS scheme and additionally trip all generation at Lancaster and the proposed new 300 MW facility.

For the 200 MW option, to be located in Rosalia WA, it is assumed that the generation will interconnect at the new Thornton 230 kV switching station (scheduled to be finished in 2012). The steady state impacts from this additional 200 MW would be similar to previously studied LGIR #14 – which sought to connect 220 MW in the Colton WA area. No new transmission system upgrades, with the exception of the interconnection substation, were required. At this time, pending no new queue additions that could be considered senior to this proposed 200 MW, the results are expected to be similar to LGIR #14. Therefore the total cost of integrating 200 MW in the Rosalia area should be $4M, the cost of another breaker position at Thornton 230 kV switching station.

Option 1	N-0 Max. Output	Facility Requirement[1]	Total[2] ($000)
Solution 1	500 MW	New 230 kV DB-DB Station and RAS. New Breaker Position @ Thornton.	15,000
Solution 2	500 MW	New line from Lancaster to New Project. New 230 kV DB-DB Station. New Breaker Position @ Thornton.	32,000

Option 2

This is essentially the same option as Option 1. Placing the new generation within 1 mile of Lancaster switching station will have roughly the same reliability performance. The major outage of concern is the simultaneous loss of the Rathdrum – Beacon and Rathdrum – Boulder (soon to be Lancaster – Boulder) 230 kV lines. This contingency will cause BPA's Lancaster – Bell 230 kV transmission line to load to roughly 164% without RAS. There is no room in the Rathdrum area for 300 MW, without RAS or some major transmission upgrades, as outlined in the table below.

Option 2	N-0 Max. Output	Facility Requirement[3]	Total[4] ($000)
Solution 1	500 MW	New 230 kV DB-DB Station and RAS. New Breaker Position @ Thornton.	15,000
Solution 2	500 MW	New line from Lancaster to New Project. New 230 kV DB-DB Station. New Breaker Position @ Thornton.	32,000

Option 3

300 MW of new generation in the Rathdrum area, near the BPA Lancaster substation and 200 MW in the Rosalia area is option 1. The 300 MW portion, assumes a new 230/13 kV Avista generator substation would be required. Several connection possibilities exist for connecting this substation to the 230 kV transmission system in this area. For simplification it will be assumed that the new substation will tap the to-be-constructed Rathdrum – Lancaster 230 kV transmission line. This option has no N-0 issues at the full 300 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. The result is the same as with Option 1. Additionally there with Option 2, there is the opportunity for the Rathdrum-Beacon and the Rathdrum-Boulder (soon to be Rathdrum-Lancaster) 230 kV to be simultaneously lost, as they both share the same structure. This would cause the Cabinet – Noxon 230 kV transmission line to load to 123%.

To alleviate these overloads a new 230 kV transmission line, 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. Another 230 kV transmission line, with new right-of-way, from Rathdrum to Lancaster 230 kV switching station, must be built. The loaded cost for this roughly 3 mile line is $4M. 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] Cost estimates do not include costs of the radial line to the POI, the generator or generator station if applicable.
[4] Total is for network and direct assigned costs, are in 2011 dollars, and is +/- 50%.

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. A RAS solution would have to integrate with the existing Clark Fork RAS scheme and additionally trip all generation at Lancaster and the proposed new 300 MW facility.

For the 200 MW option, to be located in Rosalia WA, it is assumed that the generation will interconnect at the new Thornton 230 kV switching station (scheduled to be finished in 2012). The steady state impacts from this additional 200 MW would be similar to previously studied LGIR #14 – which sought to connect 220 MW in the Colton WA area. No new transmission system upgrades, with the exception of the interconnection substation, were required. At this time, pending no new queue additions that could be considered senior to this proposed 200 MW, the results are expected to be similar to LGIR #14. Therefore the total cost of integrating 200 MW in the Rosalia area should be $4M, the cost of another breaker position at Thornton 230 kV switching station.

Option 3	**N-0 Max. Output**	**Facility Requirement**[5]	**Total**[6] **($000)**
Solution 1	500 MW	New Breaker Position @ Rathdrum and RAS. New Breaker Position @ Thornton.	11,000
Solution 2	500 MW	New line from Lancaster to Rathdrum. New line from Lancaster to Boulder, New Breaker Position @ Rathdrum. New Breaker Position @ Thornton.	36,000

Conclusion

All options are feasible and vary in cost by roughly $4M. There are not any great differences in price, reliability or future growth (MW) potential.

Option 3 with RAS represents the cheapest option. There are no substantial reliability gains in putting the project closer to Lancaster. Connecting the project at Rathdrum represents a much cleaner solution that would not require Avista to add yet another substation in the Rathdrum – Lancaster area.

---

[5] Cost estimates do not include costs of the radial line to the POI, the generator or generator station if applicable.

[6] Total is for network and direct assigned costs, are in 2011 dollars, and is +/- 50%.

2013 Electric Integrated Resource Plan

Appendix E – 2013 Electric IRP New Resource Table for Transmission

2013 Avista Electric IRP

New Resource Table For Transmission

	Resource	POR				Capacity	Year
Resource	**Location**	**or Local Area**	**POD**	**Start**	**Stop**	**MW**	**Total**
Coyote Springs 2	Boardman, OR	Coyote Springs 2	AVA System	1/1/2014	Indefinite	10.0	
Lancaster CCCT	Rathdrum, ID	Bell/Westside	AVA System	1/1/2014	10/31/2026	125.0	
Lancaster CCCT	Rathdrum, ID	Mid-C	AVA System	1/1/2014	10/31/2026	150.0	285.0
Nine Mile	Nine Mile Falls, WA	Nine Mile	AVA System	12/1/2015	Indefinite	7.6	7.6
SCCT	TBD	TBD	AVA System	10/1/2019	Indefinite	83.0	83.0
CCCT	TBD	TBD	AVA System	11/1/2026	Indefinite	270.0	270.0
Rathdrum CT	Rathdrum, ID	Rathdrum	AVA System	5/1/2028	Indefinite	6.0	6.0
SCCT	TBD	TBD	AVA System	10/1/2032	Indefinite	50.0	50.0
					Total	702	702