CASCADE NATURAL GAS CORPORATION®

A Subsidiary of MDU Resources Group, Inc.

In the Community to Serve®

2018
Integrated Resource Plan

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CASCADE NATURAL GAS CORPORATION
2018 INTEGRATED RESOURCE PLAN (UG-171186)
TABLE OF CONTENTS

Section 1 – Executive Summary Page

- Introduction 1-2
- Section 2: Company Overview 1-2
- Section 3: Demand Forecast 1-3
- Section 4: Supply Side Resources 1-4
- Section 5: Environmental Considerations 1-6
- Section 6: Avoided Costs 1-7
- Section 7: Demand Side Management 1-7
- Section 8: Resource Integration 1-9
- Section 9: Distribution System Planning 1-10
- Section 10: Stakeholder Engagement 1-11
- Section 11: Two-year Action Plan 1-11

Section 2 – Company Overview

- Company Overview 2-2
- Pipeline and Basin Locations 2-3
- Core vs. Non-Core Service 2-3
- Company Organization 2-4

Section 3 – Demand Forecast

- Overview 3-2
- Demand Areas 3-2
- Weather 3-4
- Heating Degree Days 3-5
- Peak Day HDD's 3-6
- Demand Overview 3-8
- Customer Growth 3-9
- Use-Per-Customer (UPC) Forecast Methodology 3-11
- Peak Day Forecast Methodology 3-12
- Scenario Analysis 3-13
- Forecast Results 3-14
- Geography 3-16
- High and Low Growth Scenarios 3-18
- Alternative Forecasting Methodologies 3-19
- Uncertainties 3-20

Section 4 – Supply Side Resources

- Overview 4-2
- Gas Supply Resources 4-2
- Firm Supply Contracts 4-4
- Storage Resources 4-6

- Capacity Resources 4-8
- Natural Gas Price Forecast 4-9
- Development of the Basis Differential for Sumas, AECO and Rockies 4-12
- Pros and Cons of New Methodology 4-12
- Incremental Supply Side Resource Options 4-13
- Supply Side Uncertainties 4-18
- Financial Derivatives and Risk Management 4-19
- Portfolio Purchasing Strategy 4-24
- Conclusion 4-27

Section 5 – Environmental Considerations
- Purpose 5-2
- Company Environmental Policy 5-2
- Overview 5-3
- Federal Regulation and Policy 5-4
- State Regulation and Policy 5-8
- Regional Policy 5-14
- Local Policy 5-14
- Natural Gas Industry GHG Emissions 5-17
- Cascade GHG Emissions 5-18
- CO_2 Adder Analyses 5-21
- Conclusion 5-25

Section 6 – Avoided Costs
- Overview 6-2
- Costs Incorporated 6-2
- Understanding Each Component 6-3
- Application 6-5
- Results 6-5

Section 7 – Demand Side Management
- Overview 7-2
- Conservation Planning 7-3
- DSM Deliverables from the 2016 IRP 7-4
- Pathways to Achieve Goals in the Mid Term 7-5
- Cascade's Stimulus for Demand Side Management 7-9
- Progress Report 7-10
- Potential Estimates 7-12
- DSM Forecast Modeling 7-14
- Target Development 7-18
- Conservation Potential 7-18

- Analysis of the Washington Territory Potential Through LoadMAP 7-20
- Conservation Two-Year Action Plan 7-27
- Paths to Increase Conservation Forecast Precision 7-29
- Importance of Outreach and Cohesive Messaging 7-30
- Community Energy Program Partnerships 7-31
- Regional Efforts and Long-Term Benefits 7-31
- Targeted Outreach 7-32

Section 8 – Resource Integration
- Overview 8-2
- Supply Resource Optimization Process 8-2
- Planning and Modeling 8-9
- Stochastic Methodology Discussion 8-11
- Resource Optimization Output and Analysis Reports 8-11
- Key Inputs 8-15
- Decision Making Tool 8-16
- Resource Integration 8-17
- Results 8-21
- Analysis of Unserved Demand 8-22
- Portfolios Evaluated 8-22
- Top-Ranking Candidate Portfolio 8-24
- Alternative Resources Selected 8-27
- Alternative Resources Not Selected 8-28
- Impact of Top-Ranking Candidate Portfolio on Unserved Demand 8-29
- Portfolio Evaluation: Additional Scenario/Sensitivity Analyses 8-30
- Stochastic Analyses - Annual Load Requirements & Weather Uncertainty 8-33
- Conclusion 8-36

Section 9 – Distribution System Planning
- Overview 9-2
- Network Design Fundamentals 9-2
- Computer Modeling 9-3
- Distribution System Planning 9-5
- Distribution System Enhancements 9-5
- Pipelines 9-5
- Regulators 9-7
- Compression 9-7
- Conservation Resources 9-7
- Distribution Scenario Decision-Making Process 9-8
- Planning Results 9-10
- Conclusion 9-11

TABLE OF CONTENTS

Section 10 – Stakeholder Engagement
- Overview 10-2
- Approach to Meetings and Workshops 10-2
- Stakeholders 10-2
- TAG Meetings and Workshops 10-3
- Opportunity for Public Participation 10-4

Section 11 – Two-year Action Plan
- 2018 Action Plan 11-2
- Supply Side Resources 11-2
- Environmental Policy 11-2
- Avoided Costs 11-3
- Demand Side Management (Conservation) 11-3
- Distribution System Planning 11-4
- IRP Process 11-4
- Two-Year Action Plan Table 11-5

Section 12 – Glossary and Maps
- Glossary of Terms and Acronyms 12-2
- Citygate/Zone Cross Reference 12-17
- Maps of System Infrastructure 12-20

Appendices
- Appendix A - IRP Process
- Appendix B - Demand Forecast
- Appendix C - Regulatory Compliance Matrix
- Appendix D - Demand Side Management
- Appendix E - Current & Alternative Supply Resources
- Appendix F - Capacity Requirements & Peak Day Planning
- Appendix G - Weather & Price Uncertainty Analysis
- Appendix H - Avoided Cost
- Appendix I - Distribution System Planning
- Appendix J - Renewable Natural Gas
- Appendix K - 2016 IRP Quarterly Updates
- Appendix L - Methodological Changes
- Appendix M - Comments Matrix

SECTION 1

EXECUTIVE SUMMARY

Introduction

Cascade Natural Gas Corporation's (Cascade, CNGC, or the Company) Integrated Resource Plan (IRP or Plan) forecasts 20 years of expected system-wide customer and demand growth, and analyzes the most reliable and least cost supply side and demand side resources that could be used to fulfill future customers' gas service needs. Predicting how to best meet customers' future demand includes the consideration of possible policy changes and the resulting impact on customer prices, the Company's operations, and the ability of Cascade's distribution system to serve gas reliably as regional demand increases. This plan discusses these elements that impact how the Company may serve its customers from 2019 through 2038. While the Plan cannot predict the future, it is a useful guide. Below is a short summary of each section included in this IRP. The details regarding methodologies as well as specific results are found in the sections and appendices.

Key Points

- Cascade's first material deficiency occurs in 2019 absent the planned Bremerton/Shelton Acquisition. Once this resource is acquired, 2023 is the next forecasted shortfall.
- The Company's two-year action plan provides the road map for resource acquisition.
- Load growth is forecasted to be 1.12% per year, or 25% over the 20-year planning horizon.
- Cascade modeled the Social Cost of Carbon with a 3% discount rate as its main carbon forecast.
- The total avoided cost ranges between \$0.2918/therm and \$0.8111/therm over the 20-year planning horizon.
- Cascade projects 46.70 million therms of energy efficiency in Washington over the 20-year planning horizon.
- This plan was informed by five Technical Advisory Group meetings, with active engagement by stakeholders.
- Cascade continues to be fully committed to the IRP process.
- Each section provides an *at-a-glance* summary of the key points.

Section 2: Company Overview

Cascade has been providing gas service since 1953. Over the years, the Company has expanded its service territory by purchasing and merging with other small natural gas utilities. As of 2007, Cascade is a subsidiary of Montana Dakota Utilities (MDU) Resources Inc. which is based in Bismarck, North Dakota.

Cascade serves over 288,000 customers located in smaller, mostly rural communities spread across Washington and Oregon. The Company's service territory poses some challenges for operating an energy distribution system, including the fact that the areas served are noncontiguous and the weather in each area can be vastly different. To capture this, Cascade groups its citygates into seven weather zones.

Cascade purchases natural gas from a variety of suppliers and transports gas supplies to its distribution system using primarily three natural gas pipeline companies. Northwest Pipeline LLC (NWP) provides access to British Columbia and domestic Rocky Mountain gas, Gas Transmission Northwest (GTN) provides access to Alberta and Malin gas, and Enbridge (Westcoast Transmission) provides British Columbia gas directly into the Company's distribution system.

Section 3: Demand Forecast

Forecasting demand is useful for both long- and short-term planning. The Company began its demand forecasting process by looking at each citygate serving firm or uninterruptible service. These citygates were then assigned a weather zone because a significant portion of Cascade's customer usage fluctuates with the weather.

Cascade developed a normal, or expected, future weather year by shaping 30 years of proprietary, historical weather data. Heating degree day (HDD values) were assigned to each day in the model weather year. To ensure the Company will be able to serve its firm customers during extreme weather, the Company tested a system weighted peak HDD (the system weighted coldest day in the last 30 years).

Peak day demand was then derived for each weather scenario by applying the HDD to the peak day forecast for each citygate.

Demand forecasting first requires a customer forecast. The Company developed a unique customer forecast for each county by incorporating population and employment growth data from Woods and Poole as well as from internal market intelligence into a dynamic regression model.

Load growth across Cascade's system through 2038 is expected to fluctuate between 0.68% and 1.73% annually. Load growth is split between residential, commercial, and industrial customers. Residential and commercial customer classes are expected to grow at an annual rate near 1.44% and 0.49%, respectively, while industrial expects a growth rate of around 0.45%.

After determining system-wide demand over the planning period by multiplying the use per customer times the number of customers in the forecast, Cascade stress tested its results with high and low scenarios for varying future economic conditions.

In absolute numbers, system load under normal weather conditions is expected to exceed 406 million therms in 2038. Residential customers are expected to grow from 54.5% of the total core load to 57% of the total core load by 2038.

Load across Cascade's two-state service territory is expected to increase 25% over the planning horizon, with the Oregon portion outpacing Washington at 35.6% versus 21.5%.

Section 4: Supply Side Resources

Section 4 provides an in-depth description of the supply side options the Company considered in this Plan.

Cascade's gas supply portfolio is sourced from three areas of North America: British Columbia, Alberta, and the Rockies. The Company secures its gas through firm gas supply contracts and open market purchases.

Firm supply contracts commit both the seller and the buyer to deliver and take gas on a firm basis, except during *force majeure* conditions. Supply contract terms for firm commodity supplies vary greatly. Some contracts specify fixed prices, while others are based on indices that float from month to month. Open market purchases are short-term and are subject to more volatile pricing.

The Company evaluates its demand curve and defines four categories of supply for meeting its demand. First, base load supply resources are used for the constant demand that occurs all year and does not fluctuate based on weather. Base load supplies are typically taken day in and day out, 365 days a year. Next, winter supplies meet demand occurring due to cooler weather. Winter gas supplies are firm gas supplies that are purchased for a short period during the winter months to cover increased loads, primarily for space heating. The contracts are typically three to five months in duration (primarily November through March). Next are peaking gas supplies which are used when colder weather spikes demand. Peaking gas supplies, similar to storage, are firm contracts purchased only as load actually materializes due to high winter demand. That is, the seller must deliver the gas when the Company requires it, but the Company is not required to take gas unless it is needed to meet customer load requirements. Lastly are needle peaking resources which are utilized during severe or arctic cold snaps when demand increases sharply for a few days. These resources are very expensive and are available for a very short period of time.

Cascade also utilizes natural gas storage to meet a portion of the requirements of its core market. Storing gas supplies, purchased and injected during periods of low demand, is a cost-effective way of meeting some of the peak requirements of Cascade's firm market. Cascade does not own any storage facilities and, therefore, must contract with storage owners to lease a portion of those owners' unused storage capacity.

Cascade has contracted for storage service directly from NWP since 1994. Storage is held in their Jackson Prairie and Plymouth facilities. Jackson Prairie is located in Lewis County, Washington, approximately ten miles south of Chehalis. Plymouth is located in Benton County, Washington approximately 30 miles south of Kennewick. Both Jackson Prairie facilities and the Plymouth facility are located directly on NWP's transmission system. Therefore, storage withdrawal rates can be changed several times during an individual gas day to accommodate weather driven changes in core customer requirements.

Cascade uses interstate pipeline transportation resources to deliver the firm gas supplies it purchases from three different regions or basins. Cascade has over 30 long-term annual contracts with NWP, numerous long-term annual and winter-only transportation contracts with GTN (including the upstream capacity on TransCanada Pipeline's Foothills and Alberta systems), a long-term, annual contract with Ruby Pipeline, and one long-term annual contract with Enbridge (Westcoast Transmission) in British Columbia, Canada. These contracts do not include storage or other peaking services that may provide additional delivery capability rights ranging from nine to 120 days.

In order to evaluate the price of resource options, the Company analyzed gas price forecasts from various sources. Cascade used Wood Mackenzie, the Energy Information Administration (EIA), the Northwest Power and Conservation Council (NWPCC), and Cascade's trading partners to develop a blended long-range price forecast. With a monthly Henry Hub price from the above sources, the Company derived a weight for each source to develop the monthly Henry Hub price forecast for the 20-year planning horizon. These weights were calculated from the Symmetric Mean Absolute Percentage Error (SMAPE or Errors) of each source versus actual Henry Hub pricing since 2010. The inverse of these Errors was then used to determine the weight given to each source.

In order to determine the low case and high case, the Company utilized the EIA economic growth factors which are 1.5 for the Low Case, 2.0 for the Reference Case, and 2.6 for the High Case.[1]

Besides currently used resources, Cascade considered alternative resources. Other potential incremental capacity options evaluated included: NWP Proposed Bremerton-Shelton Realignment, the Cross-Cascades Trail-West pipeline; additional GTN capacity, NWP Eastern Oregon Expansion, NWP Express Project or the I-5 Sumas expansion project, NWP Wenatchee Expansion, NWP Zone 20 (Spokane) Expansion, Pacific Connector. Other storage options considered were: AECO, Gill Ranch Storage, Mist (the North Mist III expansion), Spire Storage (formerly Ryckman Creek Storage), Wild Goose Storage.

Cascade also considered unconventional supplies such as satellite LNG, bio-natural gas, and the realignment of its Maximum Daily Delivery Obligations (MDDOs) on NWP.

[1] EIA 2018 Annual Energy Outlook

Long-term planning is not an exact science. The Company has considered the various risks that may challenge the assumptions used in this analysis. Risk can stem from potential Federal Energy Regulatory Commission (FERC) or Canada's National Energy Board (NEB) rulings that may impact the cost or availability of gas. The Company also considers the risk that firm supply may not be available when Cascade needs it or that pricing could vary due to any factor impacting the economy of supply and demand.

To mitigate risk, Cascade constantly seeks methods to ensure price stability for customers to the extent that it is reasonable. In addition to methods such as long-term physical fixed price gas supply contracts and storage, another means for creating stability is through the use of financial derivatives. Derivatives generally lock-in a forward natural gas price with a hedge, consequently eliminating exposure to significant swings in rising and falling prices. The Company's Annual Hedging Plan, approved by the Gas Supply Oversight Committee (GSOC), provides oversight and guidance for the Company's gas supply hedging strategy.

Section 5: Environmental Considerations

This section considers Greenhouse Gas (GHG) emission reduction policies and regulations that have the potential to impact natural gas distribution companies. In addition, this section examines methodologies for applying a cost of carbon to natural gas distribution companies and identifies the assumptions made in determining a 45-year avoided cost of natural gas, and pairs these costs with associated two-year action items.

Significant emission policy development has occurred since Cascade's last IRP. The Federal government as well as policy-makers at the state and local levels in Washington and Oregon have actively pursued GHG emission reductions, and primarily CO_2 emission reductions.

CNGC monitors environmental regulatory requirements in progress nationally, regionally, and locally that may have the potential to apply to a local distribution company (LDC) in the future. As of October 5, 2018, there are no direct regulations that would require the Company to reduce GHG emissions. Also, there are currently no regulations or laws applying a carbon price to CNGC operational GHG emissions or GHG emissions resulting from customer use of natural gas which Cascade sells to customers. The requirements discussed in this section are projected to be the most informative for the Company to determine how to model potential impacts of carbon pricing in the IRP, absent any current requirements and understanding that there is a potential for a cost of carbon to impact Cascade in the future.

Section 6: Avoided Costs

The avoided cost is the estimated cost to serve the next unit of demand with a supply side resource option at a point in time. Avoided cost forecasts are used to establish a cost-effective threshold for demand side resources. If demand side resources cost as much as or less than the avoided cost, then the demand side resource is cost-effective and should be the next resource added to the Company's stack of resources.

Cascade's avoided cost includes fixed transportation costs, variable transportation costs, storage costs, commodity costs, a carbon tax, a 10% adder, distribution system costs, and a risk premium. Essentially, the avoided cost is the cost of the Company's resource stack on a per therm basis plus three values for benefits specifically acquired with energy efficiency.

The largest part of the avoided cost is the cost of gas. A carbon tax forecast was added in anticipation of carbon legislation. The Company priced carbon at $42/metric ton in 2020 with this cost of carbon escalating by approximately $1 per year. This is based on guidance from the Washington Utilities and Transportation Commission (WUTC or Commission) Staff and stakeholders to use the Social Cost of Carbon Forecast with a 3% Discount Rate.

Next, 10% is added to the commodity portion of the avoided cost to account for nonquantifiable, environmental benefits. This 10% adder was first recommended by NWPCC.

New to the 2018 IRP, Cascade has included distribution system costs in its avoided cost calculation. Distribution system costs capture the costs of sending gas from the citygate to Cascade's customers. For this IRP cycle, Cascade calculates distribution system costs as the Company's system weighted average of its authorized margins, as approved in UG-152286. These costs are inflated by the Consumer Price Index (CPI) escalator every year.

For the 2018 IRP, the nominal system avoided costs ranges between $0.2918/therm and $0.8111/therm over the 20-year planning horizon. The increase over time is largely driven by the escalating cost of carbon.

Section 7: Demand Side Management

Demand Side Management (DSM) refers to the reduction of natural gas consumption through the installation of energy efficiency measures such as insulation, more efficient gas-fired appliances, or through load management programs. Cascade targets the saving of approximately 58.56 million therms systemwide over the 20-year planning horizon; 11.86 million therms in Oregon and 46.7 million therms in Washington.

Unlike supply side resources, which are purchased directly from a supplier, demand side resources are purchased from individual customers in the form of unused energy as a result of energy efficiency. The WUTC requires gas utilities to consider cost-effective DSM resources in their energy portfolio on an equal and comparable basis with supply side resources. In the gas industry, DSM resources are conservation measures that include, but are not limited to: ceiling, wall, and floor insulation; higher efficiency natural gas appliances, insulated windows and doors, ventilation heat recovery systems and various other commercial/industrial equipment. By prompting customers and influencing customers through energy efficiency outreach to reduce their individual demand for gas, Cascade can supplant the need to purchase additional gas supplies, displace or delay contracting for incremental pipeline capacity, and possibly negate or delay the need for reinforcements on the Company's distribution system. It's also essential to recognize that the Company can prompt and encourage customers to reduce their consumption to aid load management, but it's ultimately the choice of the end user to manage consumption by recognizing an inherent value in energy efficiency.

There are two basic types of demand side resources: base load resources and heat sensitive resources. Base load resources offset gas supply requirements throughout the year, regardless of the weather and outside conditions. Base load DSM resources include measures like high efficiency water heaters, higher efficiency cooking equipment and ozone injection laundry systems. Heat sensitive DSM resources are measures whose therm savings increase during cold weather (meaning the measure is used more often during colder weather). For example, a high efficiency furnace will lower therm usage in the winter months when the furnace is utilized the most and will provide little if any savings in the summer months when the furnace is rarely used. Examples of heat sensitive DSM measures include ceiling, floor, and wall insulation measures, high efficiency gas furnaces, and improvements to ductwork and air sealing. These types of heat sensitive measures offset more of the peaking or seasonal gas supply resources, which are typically more expensive than base load supplies.

Prior to the 2016 IRP, Cascade addressed its DSM program development and planning through a dedicated section in the IRP. As of the last iteration of the IRP, the Company committed to transitioning the majority of the planning outside of the forecast to a stand-alone planning document released annually to the Commission by December 1st of each year. In December 2015, the Company provided its first companion report to the IRP, the 2016 Washington Conservation Plan (Conservation Plan) in alignment with this commitment.

The conservation potential for this IRP is calculated through the Applied Energy Group (AEG)'s LoadMAP model, separated into the three customer classes for individual savings assumptions, market segmentations, and end uses (heat-sensitive resources have different savings potential by climate zone for the Residential section).

Energy efficiency and conservation efforts for the Company's Oregon customers are offered through the Energy Trust of Oregon with program planning developed through the Cascade Oregon IRP cycle.

Section 8: Resource Integration

Cascade utilizes SENDOUT® for resource optimization. This software permits the Company to develop and analyze a variety of resource portfolios to help determine the type, size, and timing of resources best matched to forecast requirements. The model knows the exact load and price for every day of the planning period based on input and can therefore minimize costs in a way that would not be possible in the real world. It is important to acknowledge that SENDOUT® provides helpful but not perfect information to guide decisions.

One of the purposes of integrated resource planning is to identify an illustrative resource portfolio to help guide specific resource acquisitions. In this planning cycle, the Company considered a host of resource alternatives that could potentially be added to its resource portfolio, including additional conservation programs, incremental off-system storage alternatives at AECO Hub, Mist, Spire, Wild Goose, and Gill Ranch. Additionally, incremental transportation capacity on NWP, Ruby, Nova Gas Transmission Ltd. (NGTL), Foothills and GTN pipeline systems was considered, along with on-system satellite LNG facilities, bio-natural gas, and imported LNG. Typically, utility infrastructure projects are "lumpy," since demand grows annually at a small percentage rate, while capacity is typically added on a project-by-project basis. Utilities often have surplus capacity and must "grow into" their new pipeline capacity, because it is more cost effective for pipelines to build for several years of load growth at one time than to make small additions each year. However, the Company can minimize the impacts through the acquisition of citygate peaking resources which include both the supplies and the associated pipeline delivery for a certain number of days or through the purchase of other's excess capacity through short- or medium-term capacity releases.

Even after the savings from energy efficiency programs are realized, Cascade will need to acquire additional capacity resources or enter into other supply arrangements to meet anticipated peak day requirements, primarily due to continued growth in the Company's residential and commercial customer base. Utilizing the SENDOUT® resource optimization model, several portfolios were run to test the viability of acquiring incremental storage and transportation resources based on existing recourse rates and discounted rates, and via capacity release through a third party. Basin prices in the model over the 20-year planning horizon have AECO trading at a discount to Rockies, Malin, and Sumas. The acquisition of additional traditional pipeline capacity is the most reasonable resource to address most capacity shortfalls on a peak day.

Using input from these alternative resources discussed, SENDOUT® derives a portfolio of existing and incremental resources that Cascade defines as the Preferred Portfolio. This provides guidance as to what resources should be considered to reduce unserved demand with a reasonable least cost and least risk mix of demand and supply side resources under expected pricing, weather, and growth environments.

20-year portfolio costs under a multitude of scenarios/sensitivities are expected to range between $4,125,624,000 to $5,210,896,000 for the planning period, with an average cost per therm ranging between $0.634 and $0.707.

A more detailed discussion regarding the Company's resource integration and the results can be found in Section 8, Resource Integration, beginning on page 8-21.

Section 9: Distribution System Planning

Cascade uses computer modeling for network demand studies to ensure its distribution system is designed to deliver gas reliably to customers as the number of customers and their demand change.

Cascade's geographical information system (GIS) keeps an up-to-date record of pipe and facilities, complete with all system attributes such as date of install and operation pressure. Using the Company's GIS environment and other input data, Cascade is able to create system models through the use of Synergi® software. The software provides the means to theoretically model piping and facilities to represent current pressure and flow conditions while predicting future events and growth. Combining these models with historical weather data can provide a design day model that will predict a worst-case scenario. Design day models that experience less than ideal conditions can then be identified and remedied before a real problem is encountered.

When modeling demonstrates that a portion of the distribution system is unable to meet future demand, Cascade engineers consider many possible remedies including reinforcements or expansions. Enhancements include pipeline looping, upsizing, and uprating. Pipeline looping is the most common method of increasing capacity in an existing distribution system. Pipeline upsizing involves replacing existing pipe with a larger size pipe. Pipeline uprating increases the maximum allowable operating pressure of an existing pipeline.

Besides modifying the pipelines, regulators or regulator stations can be added to reduce pipeline pressure at various stages in the distribution system. If pressures are too low, compressor stations can be added to boost downstream pressures.

Another possible solution is targeted conservation. Area specific incentives for installed energy efficiency measures can reduce demand in a constrained area either eliminating or forestalling the need to add or reinforce infrastructure.

Once the best solution is determined, projects are ranked based on numerous criteria and are scheduled. Section 9, Distribution System Planning, presents three sample projects and Appendix I lists all known distribution projects.

Section 10: Stakeholder Engagement

Input and feedback from Cascade's Technical Advisory Group (TAG) is an important resource for ensuring the IRP includes perspectives beyond the Company's and is responsive to stakeholders' concerns. Cascade held five public TAG meetings with internal and external stakeholders. Participants invited to these public meetings include interested customers, regional upstream pipelines, Pacific Northwest LDCs, Commission Staff, stakeholder representatives such as the Northwest Gas Association, Public Counsel, Citizens' Utility Board, Oregon Department of Ecology, and the Alliance of Western Energy Consumers. Cascade has a dedicated internet webpage where customers and parties can view the IRP timeline, TAG presentations and minutes, as well as current and past IRPs. This information can be found at https://www.cngc.com/rates-services/rates-tariffs/washington-integrated-resource-plan.

Section 11: Two-Year Action Plan

Table 1-1 on the following page shows Cascade's Two-Year Action Plan. Further descriptions can be found in Section 11, Two-Year Action Plan.

Table 1-1: Highlights of 2018 Action Plan

Functional Area	Anticipated Action	Timing
Supply Side Resources	Cascade will continue to work with Gelber & Associates to design and implement processes and analytics to comply with the WUTC UG-132019 policy statement. Cascade will make a recommendation to GSOC regarding the volume and timing of acquiring incremental GTN capacity. Cascade will also continue to monitor NGTL incremental capacity and Spire storage. Cascade will complete discussions with NWP regarding their Shelton lateral proposal. Cascade will also continue to explore biogas opportunities.	Ongoing, for inclusion in 2020 IRP.
Environmental Policy	Cascade will either begin or continue to participate/monitor the multiple items listed on page 11-2.	Ongoing, for inclusion in 2020 IRP.
Avoided Cost	Investigate incorporating a risk premium into the avoided cost calculation.	Ongoing, for inclusion in 2020 IRP.
DSM	The Company will execute the Demand Side Management action items as described on page 11-3.	Ongoing, for inclusion in 2020 IRP.
Distribution System Planning	These projects are budgeted over the next two years: • FP-316029 - MAOP; 3" HP; GRANGER; PH1 • FP-316033 - MAOP; 3" HP; ZILLAH; 873' • FP-316034 - MAOP; 4" HP; OTHELL0; 9,801' • FP-316035 - MAOP; 4" HP; ARLINGTON; 4,700' • FP-316573 - MAOP RPL; 4" HP, MADRAS PH2 • FP-316574 - MAOP RPL; 4" HP, MADRAS PH3 • FP-316575 - MAOP RPL; 6" HP, BEND HP PH2 • FP-316576 - MAOP RPL; 6" HP, BEND HP PH3 • FP-316579 - MAOP; 2,6,8" HP; ANACORTES; PH2 • FP-316580 - MAOP; 2,6,8" HP; ANACORTES; PH3 • FP-101505 - ARLINGTON GATE UPGRADE • FP-300233 - ARLINGTON 6" HP REINFORCEMENT • FP-302596 - WALLULA GATE STATION; GTN • FP-306987 - BURLINGTON REIN. @ PETERSON ROAD • FP-306988 - WALLA WALLA HP LINE • FP-306998 - NEW SOUTH WALLA WALLA GATE • FP-307221 - 8" YAKIMA HP PIPELINE • FP-309960 - RP 20" HP ANACORTES LATERAL • FP-316429 - RF; 6" HP; ABER; 12,500' BASICH BLV • FP-316431 - RF; 6" PE; ABER; 1,200' OAK ST • FP-316586 - RP; R-TBD ARLINGTON GATE • FP-316587 - RF; R-TBD; WALLULA GATE STATION • FP-316589 - RF; R-TBD; NEW WALLA WALLA GATE • FP-316670 - RF; 12" HP; KENN; WALLULA HP LINE • FP-316872 - RF; 8" HP; YAKIMA; 18,500' • FP-316980 - YAKIMA GATE STATION	Beginning in 2019, updates will be provided to WUTC on a quarterly basis.
IRP Process	Active participation in regional LDC IRP processes. The Company will attempt to increase stakeholder engagement for the IRP process. Cascade will cross-validate new methodologies to ensure the accuracy of new modeling techniques.	Ongoing, for inclusion in all future IRPs.

SECTION 2

COMPANY OVERVIEW

Company Overview

> **Key Points**
> - Cascade serves diverse geographical territories across Washington and Oregon.
> - Cascade's primary pipelines are NWP, GTN, and Enbridge, also known as WCT, with access to three other pipelines.
> - Core customers represent 23% of total throughput, while non-core customers represent 77% of total throughput.
> - Cascade is a subsidiary of MDU Resources Inc., based in Bismarck, North Dakota.

Cascade Natural Gas Corporation (CNGC or Cascade or Company) has a rich history that began 66 years ago when business leaders and public officials in the Pacific Northwest initiated a campaign to bring natural gas to the region to replace other more expensive fuels. In 1953, five small utilities serving fifteen communities merged to form Cascade. Over the years, Cascade continued to grow, merging with and purchasing other utility providers. The Company stock first traded on the New York Stock Exchange in 1973. In 2007, Cascade merged with Montana Dakota Utilities (MDU) Resources Group Inc. which is headquartered in Bismarck, North Dakota. Cascade's headquarters moved from Seattle, Washington to Kennewick, Washington in 2010.

Today, Cascade's service territory covers about 32,000 square miles and extends over 700 highway miles from end to end, encompassing a diverse economic base as well as varying climatological areas. Cascade delivers natural gas service to more than 288,000 customers with approximately 74,000 customers in Oregon and 214,000 customers in Washington. The Company's customers reside in 96 communities--28 in Oregon and 68 in Washington. Cascade's service area consists of smaller, rural communities in central and eastern Oregon, as well as communities across Washington.

The climate of the service territory is almost as diverse as its geographical extension. The western Washington portion of the service territory, nicknamed the I-5 corridor, has a marine climate with occasionally significant snow events. In general, the climate in the western part of the service territory is mild with frequent cloud cover, winter rain, and warm summers. Cascade's eastern Washington service territory has a semi-arid climate with periods of arctic cold in the winter and heat waves in the summer.[1]

Below are some of the more populated towns within the regions Cascade provides distribution service:

- **Northwest** – Bellingham, Mt. Vernon, Oak Harbor/Anacortes, the Kitsap Peninsula, the Grays Harbor area and Kelso/Longview;
- **Central** – Sunnyside, Wenatchee/Moses Lake, Tri-Cities, Walla Walla and Yakima areas; and

[1]Western Regional Climate Center, https://wrcc.dri.edu/Climate/narrative_wa.php, as of August 30, 2018.

- **Southern** – Bend and surrounding communities, Ontario, Baker City and the Pendleton/Hermiston areas.

A map of Cascade's certificated service territory is provided as Figure 12-13 in Section 12, Glossary and Maps.

Pipeline and Basin Locations

Cascade purchases natural gas from a variety of suppliers and transports gas supplies to its distribution system using three natural gas pipeline companies. Northwest Pipeline LLC (NWP) provides access to British Columbia and domestic Rocky Mountain gas, Gas Transmission Northwest (GTN) provides access to Alberta and Malin gas, and Enbridge (WCT) provides British Columbia gas directly into the Company's distribution system. Cascade also holds upstream transportation contracts on TransCanada Pipeline's Foothills Pipeline (formerly ANG), NOVA Gas Transmission Ltd. (also known as NGTL), and Ruby Pipeline. More information about the pipelines and the supply basins is provided in Section 4, Supply Side Resources. Maps of select pipelines are found in Section 12.

Core vs Non-Core Service

Cascade offers to all its customers core service which is the provision of gas supply that has been transported to Cascade's citygates, and which Cascade then delivers over its distribution system to the end-use customer. Although Cascade offers core service to all its customers, not all of them take advantage of this type of firm service.

In 1989, concurrent with the passage of the Natural Gas Wellhead Decontrol Act, Cascade began allowing its large volume customers to purchase their own gas supplies and gas transportation services upstream of Cascade's distribution system. These customers, referred to as large volume transportation or non-core customers, procure from Cascade the distribution of their gas supply from citygate to the point of delivery at the customer's site. The Company currently has approximately 250 large volume customers who have elected non-core service.

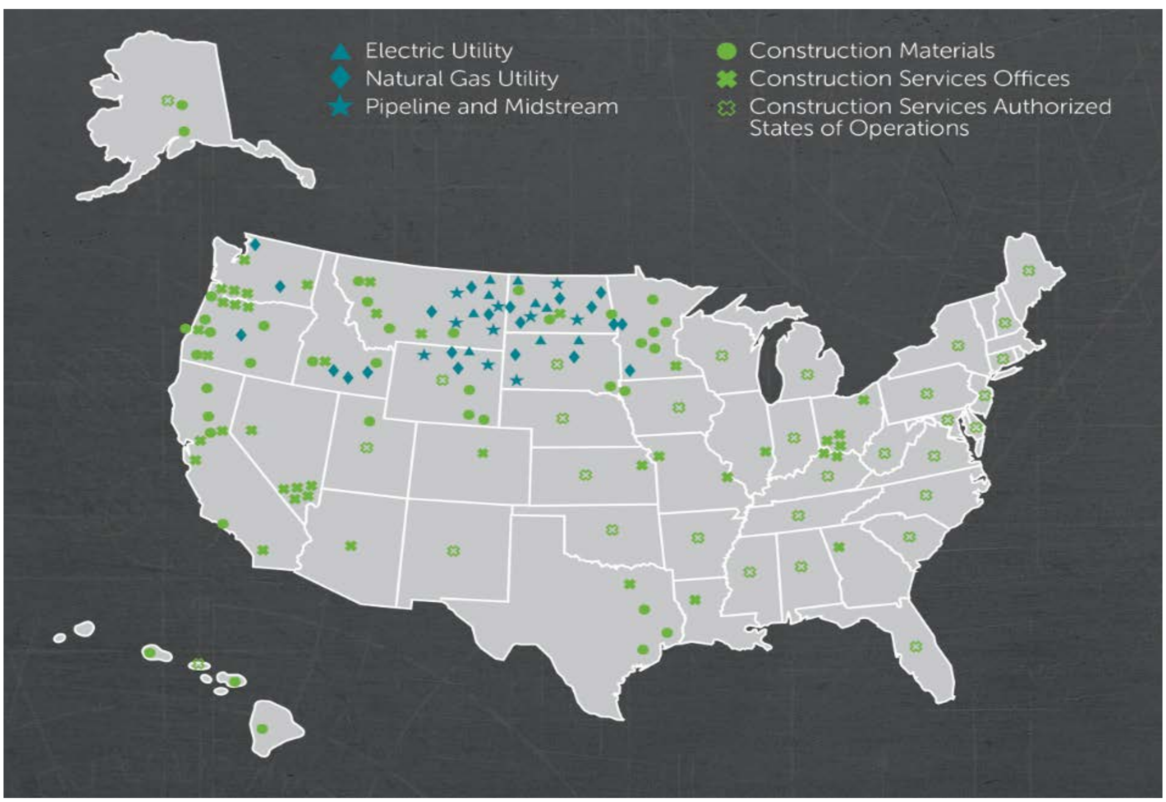
Since the Company does not provide gas supply and upstream pipeline transportation capacity resources to non-core customers, the Company does not plan for non-core customers in the upstream resource analysis of its Integrated Resource Plan (IRP). Non-core demand is a consideration in distribution planning. While it is not the core substance of the IRP, it is included in Section 9, Distribution System Planning.

As of second quarter 2018, Cascade's residential customers represent approximately 12% of the total natural gas delivered on Cascade's system, while commercial customers represent roughly 9%, and the approximately 500 core industrial customers consumed around 2% of total gas throughput. The remaining non-core industrial customers represent the remaining 77% of total throughput.

Company Organization

In 2007, Cascade became a subsidiary of MDU Resources Group, Inc., a multidimensional regulated energy delivery and construction materials and services business, operating in 48 states and traded on the New York Stock Exchange under the symbol MDU. Cascade, with headquarters in Kennewick, Washington, is part of its utility group of subsidiaries. MDU Resources Group's utility companies serve more than one million customers. Cascade distributes natural gas in Oregon and Washington. Great Plains Natural Gas Co. distributes natural gas in western Minnesota and southeastern North Dakota. Intermountain Gas Company distributes natural gas in southern Idaho. Montana-Dakota Utilities Co. generates, transmits and distributes electricity and distributes natural gas in Montana, North Dakota, South Dakota and Wyoming. Figure 2-1 provides a geographical representation of the various services/territories served by MDU Resources.

Figure 2-1: MDU Resources Services and Territory



SECTION 3

DEMAND FORECAST

Overview

Each year Cascade develops a 20-year forecast of customers, therm sales, and peak requirements for use in short-term (annual budgeting) and long-term (distribution and integrated resource planning) planning processes. This forecast is a robust portfolio of estimates created by enhancing a single best-estimate forecast with various potential economic, demographic, and marketplace eventualities into low, medium, and high growth forecast scenarios. The scenarios are used for distribution system enhancement planning and as inputs in optimization models to determine the reasonable least cost, least risk mix of supply and Demand Side Management(DSM) resources, revenue budgeting, and load forecasts associated with the purchased gas cost process.

Key Points

- Cascade initiates its forecast with analyses of demand area, weather, and HDDs.
- Peak day is analyzed deterministically with coldest day in 30 years, and stochastically using 10,000 Monte Carlo simulated draws.
- Cascade uses a 60 °F reference temperature to calculate HDDs.
- The Company utilizes dynamic regression modeling techniques for customer and annual demand forecasts.
- High and low scenarios were included and alternative forecasting assumptions were considered.
- Cascade expects system load growth to average 1.12% per year or 25% over the 20-year planning horizon.
- Uncertainties in the future may cause differences from the Company's forecast.

Demand Areas

For the 2019-2038 planning horizon, Cascade forecasted at both the citygate and rate class levels. This is a change of methodology from previous years where certain models were built from the district or zonal level. Cascade has a total of 76 citygates of which only nine citygates feed non-core customers and the remaining 67 serve at least one core customer. Of the 67 citygates that serve core customers, twenty are grouped into eight different citygate loops. Therefore, Cascade forecasts a total of 55 areas. Each of these areas contain multiple rate classes, resulting in approximately 209 individual dynamic regression models. Each citygate is assigned to a weather location. For this IRP, the Company assigned the citygates to either the closest weather location by distance or the closest weather location by climatic similarity. The citygate results are rolled up into zones and districts which segregate Cascade's system based on pipelines and weather, as shown in Appendix B. Table 3-1 provides a cross reference for the demand areas.

Table 3-1: Demand Areas

Citygate	Loop	State	Weather Location	Zone
7TH DAY SCHOOL		WA	Yakima	10
A/M RENDERING	Sumas SPE Loop	WA	Bellingham	30-W
ACME		WA	Bellingham	30-W
ARLINGTON		WA	Bellingham	30-W
ATHENA		OR	Pendleton	ME-OR
BAKER		OR	Baker City	24
BELLINGHAM 1 (FERNDALE)	Sumas SPE Loop	WA	Bellingham	30-W
BEND	Bend Loop	OR	Redmond	GTN
BREMERTON (SHELTON)		WA	Bremerton	30-S
BURBANK HEIGHTS	Burbank Heights Loop	WA	Walla Walla	20
CASTLE ROCK		WA	Bremerton	26
CHEMULT		OR	Redmond	GTN
DEHAWN DAIRY		WA	Yakima	10
DEMING		WA	Bellingham	30-W
EAST STANWOOD	East Stanwood Loop	WA	Bellingham	30-W
FINLEY		WA	Walla Walla	20
GILCHRIST		OR	Redmond	GTN
GRANDVIEW		WA	Yakima	10
HERMISTON		OR	Pendleton	ME-OR
HUNTINGTON		OR	Baker City	24
KALAMA #1		WA	Bremerton	26
KALAMA #2		WA	Bremerton	26
KENNEWICK	Kennewick Loop	WA	Walla Walla	20
LA PINE		OR	Redmond	GTN
LAWRENCE		WA	Bellingham	30-W
LDS CHURCH		WA	Bellingham	30-W
LONGVIEW-KELSO	Longview South Loop	WA	Bremerton	26
LYNDEN	Sumas SPE Loop	WA	Bellingham	30-W
MADRAS		OR	Redmond	GTN
MCCLEARY (ABERDEEN/HOQUIAM)		WA	Bremerton	30-S
MILTON-FREEWATER		OR	Walla Walla	ME-OR
MISSION TAP		OR	Pendleton	ME-OR
MOSES LAKE		WA	Yakima	20
MOUNT VERNON	Sedro-Woolley Loop	WA	Bellingham	30-W
MOXEE (BEAUCHENE)		WA	Yakima	11
NORTH BEND		OR	Redmond	GTN
NORTH PASCO	Burbank Heights Loop	WA	Walla Walla	20
NYSSA-ONTARIO		OR	Baker City	24
OAK HARBOR/STANWOOD	East Stanwood Loop	WA	Bellingham	30-W

Citygate	Loop	State	Weather Location	Zone
OTHELLO		WA	Walla Walla	20
PASCO	Burbank Heights Loop	WA	Walla Walla	20
PATTERSON		WA	Yakima	26
PENDLETON		OR	Pendleton	ME-OR
PRINEVILLE		OR	Redmond	GTN
PRONGHORN		Redmond	Redmond	GTN
PROSSER		WA	Yakima	10
QUINCY		WA	Yakima	11
REDMOND		OR	Redmond	GTN
RICHLAND (Richland Y)	Kennewick Loop	WA	Walla Walla	20
SEDRO/WOOLLEY	Sedro-Woolley Loop	WA	Bellingham	30-W
SELAH	Yakima Loop	WA	Yakima	11
SOUTHRIDGE	Kennewick Loop	WA	Walla Walla	20
SOUTH BEND	Bend Loop	OR	Redmond	GTN
SOUTH LONGVIEW	Longview South Loop	WA	Bremerton	26
STANFIELD		OR	Pendleton	GTN
STEARNS (SUNRIVER)		OR	Redmond	GTN
SUNNYSIDE		WA	Yakima	10
UMATILLA		OR	Pendleton	ME-OR
WALLA WALLA		WA	Walla Walla	ME-WA
WALLULA		WA	Walla Walla	ME-WA
WCT-CNG INTERCONNECT	Sumas SPE Loop	WA	Bellingham	30-W
WENATCHEE		WA	Yakima	11
WOODLAND		WA	Bremerton	26
YAKIMA CHIEF RANCH		WA	Yakima	10
YAKIMA TRAINING CENTER		WA	Yakima	11
YAKIMA/UNION GAP	Yakima Loop	WA	Yakima	11
ZILLAH (TOPPENISH)		WA	Yakima	10

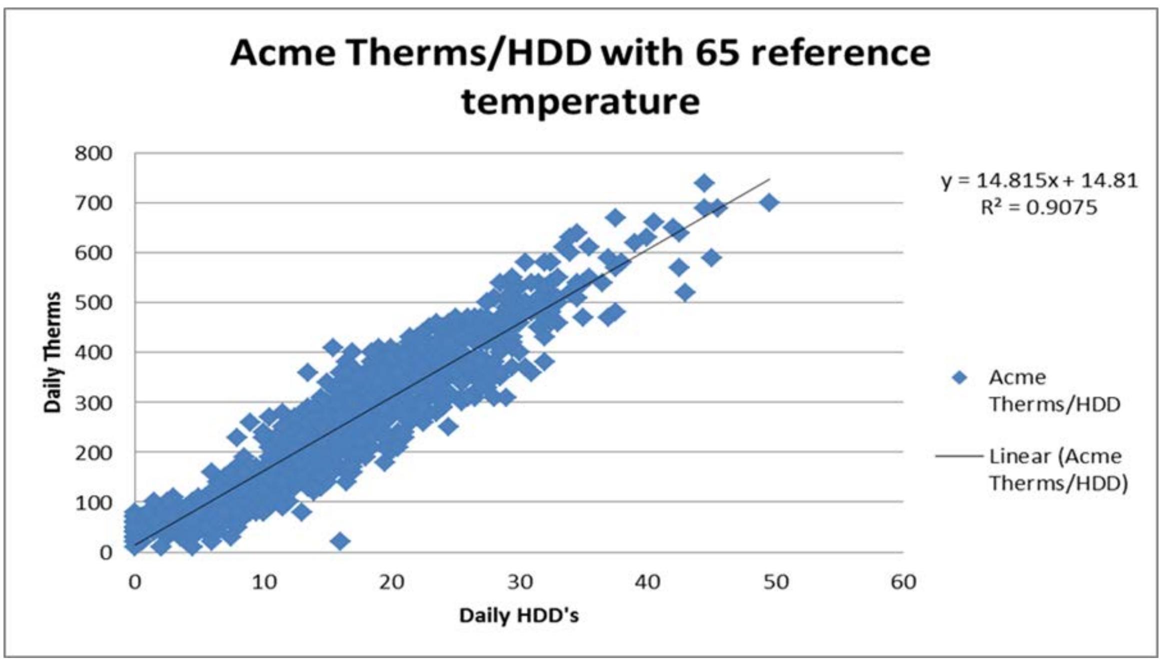
Weather

Historical weather data is provided by a contractor, Schneider Electric. The current forecast uses 30 years of recent history as the normal or expected weather. The forecast model takes the 30 previous years, converts the data to heating degree days (HDDs), then averages the HDDs into average days to create a normal or expected year. Cascade has seven weather locations with four located in Washington and three in Oregon. The four weather locations in Washington are Bellingham, Bremerton, Walla Walla, and Yakima.

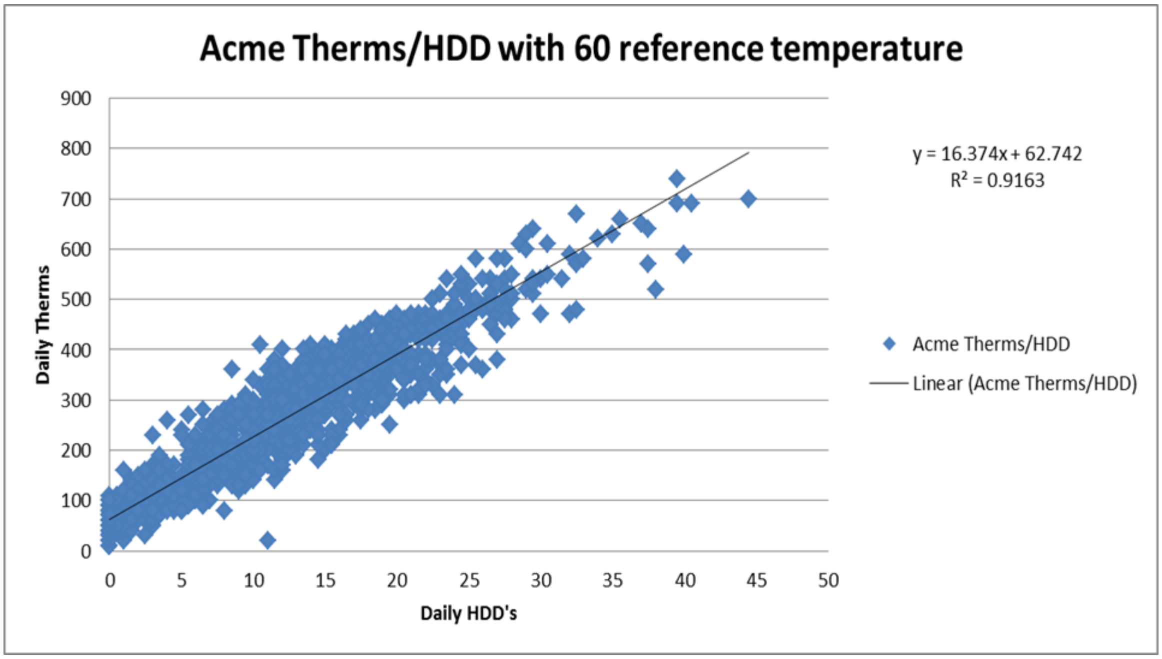
Heating Degree Days

HDD values are calculated with the daily average temperature, which is the simple average of the high and low temperatures for a given day. The daily average is then subtracted from an HDD degree threshold (for example 60 °F) to create the HDD for a given day. Should this calculation produce a negative number, a value of zero is assigned as the HDD. Therefore, HDDs can never be negative. The HDD threshold number is designed to reflect a temperature below which heating demand begins to significantly rise. The historical threshold for calculating HDD has been 65 °F. However, when modeling gas demand based on weather, Cascade has determined that lowering the threshold to 60 °F produces more accurate results for the Company's service area. Graphs 3-1 and 3-2 illustrate why the lower threshold is preferable. These graphs show that heating demand does not begin to increase significantly until an HDD of five (65 °F minus 60 °F) is reached, if the traditional HDD threshold of 65 °F is utilized. Lowering the HDD threshold improves the R^2 statistic, thus giving a better measure of the relation between HDD and therms (measurement of heat usage). Cascade ran a cross-validation analysis to compare the forecast with actual weather and customer counts in the regressions (e.g. 2011 customers, with 2011 weather, to cross-validate 2011). When comparing, using a 65 °F reference temperature, the cross-validation analysis had a mean absolute percentage error (MAPE) of 14.9%. When using a 60 °F reference temperature, the MAPE improved to 7.62%.

Graph 3-1: Acme Therm/HDD with 65°F Reference Temperature



Graph 3-2: Acme Therm/HDD with 60°F Reference Temperature



Peak Day HDDs

In order to ensure satisfaction of core customer demand on the coldest days, Cascade develops a deterministic and a stochastic peak day usage forecast in conjunction with annual base load forecasts. Peak day forecasts enable Cascade to make prudent distribution system and peak capacity planning decisions to fulfill its responsibility to provide heating under all but *force majeure* conditions, particularly as most space-heating customers will have no alternative heating source during the coldest days in the event gas does not flow.

The deterministic peak day that was analyzed in the forecast model is a system-wide weighted HDD coldest in 30 years value.

This peak day will give Cascade the deterministic outcome with varying amounts of demand. The deterministic peak HDD methodology allows Gas Supply to plan for the highest peak event during a heating season.

System-wide maximum peak HDDs are determined by first selecting the system-wide single coldest day recorded in the past 30 years. To determine the system-wide single coldest day, HDDs from all seven weather stations are considered, giving appropriate weight to the weather stations. The weights are determined by the increase in demand experienced with an increase in one HDD. Cascade has found December 21, 1990, to have the highest, system-weighted HDD, at 56 HDDs for this period.

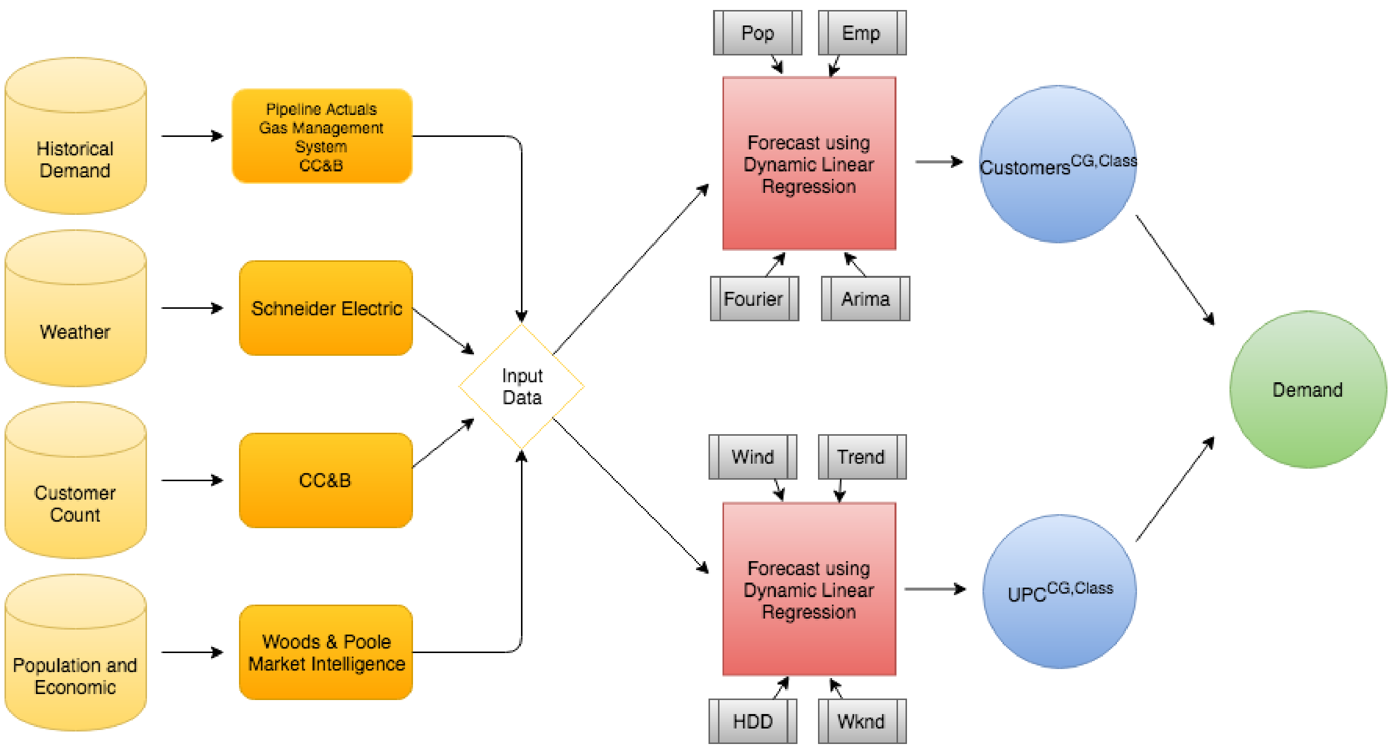
For SENDOUT®, Cascade uses the system-wide maximum peak HDDs method. Cascade applies the HDDs experienced on December 21, 1990, to each of the regressions in the forecast model. For example, all citygates associated with the Yakima weather station use the HDD for Yakima on December 21, 1990, and similarly for all the other weather stations and citygates. This provides a highest demand scenario for peak demand load based on 30 years of weather history for each citygate. Applying December 21, 1990 weather temperatures to today's forecast methodology gives Cascade an accurate representation of the demand the Company could expect to experience if this weather happened during the planning horizon.

Cascade will continue to investigate how the peak day standard affects the core demand load areas which are short of capacity. This investigation will include (but not be limited to) analysis of how other regional utilities look at peak day, discussions with the various weather services, and continued dialogue with Commission Staff and other interested parties.

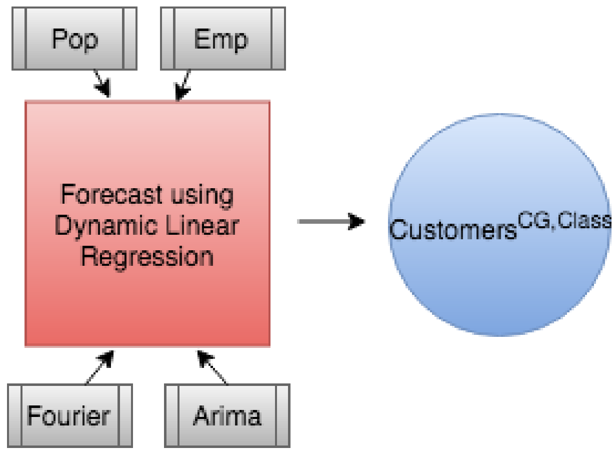
Demand Overview

Figure 3-1 provides a roadmap for Cascade's demand forecast. The inputs are displayed along with their sources in yellow and gold. The customer forecast and use-per-customer (UPC) forecast are shown in red along with their respective inputs into the model. Finally, the customer forecast is multiplied by the use-per-customer forecast to create the final demand forecast.

Figure 3-1: Demand Forecasting Process Overview



Customer Growth



Customer count forecasts are designed to reflect both demographic trends and economic conditions both in the short- and long-term. Cascade uses population and employment growth data from Woods & Poole (W&P). W&P growth forecasts are provided at the county level. It should be noted that W&P forecasts are adjusted when the internal intelligence about a demand area indicates a significant difference from W&P regarding observed economic trends. Cascade utilizes dynamic regression models for the customer forecast as well as regression models for the UPC forecast, which will be discussed in the next subsection. Below is the formula the Company used to run the regressions:

$$C_{Class}^{CG} = \alpha_0 + \alpha_1 Pop^{CG} + \alpha_2 Emp^{CG} + Fourier(k) + ARIMA\epsilon(p,d,q)$$

Model Notes:

- $C_{Class}^{CG} = Customers\ by\ Citygate\ by\ Class$
- $Pop^{CG} = Population\ by\ Citygate$
- $Emp^{CG} = Employment\ by\ Citygate$
- $Fourier = Terms\ used\ to\ capture\ seasonal\ patterns$
- $k = Number\ of\ Fourier\ terms\ used\ in\ model$
- $ARIMA\epsilon(p,d,q) =$ $Indicates\ that\ the\ model\ has\ p\ autoregressive\ terms, d\ difference\ terms, and\ q\ moving\ average\ terms.$

Cascade runs this model for each of its 24 counties by customer class. The Company begins by testing seven different combinations of the regressors in both dynamic regression models and one Autoregressive Integrated Moving Average (ARIMA) model. The dynamic regression models test: Fourier, Population, Employment, Population + Fourier, Employment + Fourier, and Employment + Population + Fourier. The last model is called an ARIMA model, which uses ARIMA terms and no regressors. Unlike the dynamic regression models, the 'ARIMA Only' model's ARIMA term is not strictly modeling the errors, but is used as a model for the entire data set. The method used to compare and select a model is called the AIC, or the Akaike Information Criterion. This is a measure of the relative quality of statistical models, relative to each of the other models. In each of the models, except for the 'ARIMA Only' model, an ARIMA term is used to capture any structure in the errors (or residuals) of the model. In other words, there could be predictability in the errors, so they could be modeled as well. If the data is non-stationary, the ARIMA function will difference the data. Most times, the data does not require differencing, or only needs to be differenced once. Once the best model is selected for each county, a forecast is performed using the selected model. Lastly, when the customer forecast is finished, the Company allocates the customers to each citygate within the county.

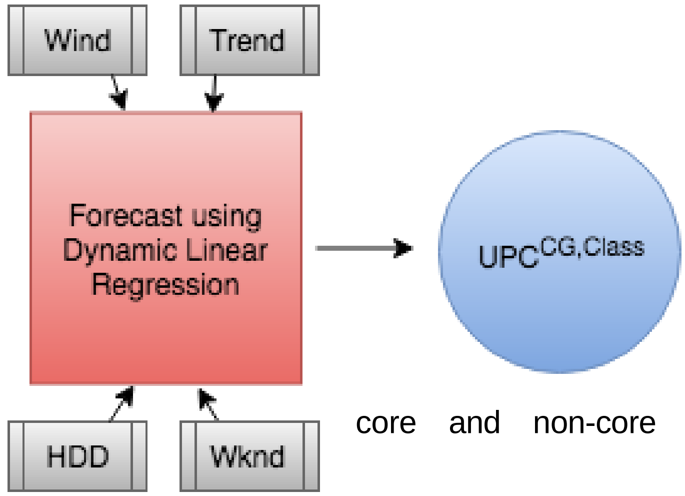
Customer count and therm forecasts are augmented by revisions to the base data and output to create a portfolio of potential scenarios. Low and high growth scenarios are created from the confidence intervals from the forecast model. These scenarios, along with the original, best-estimate, expected scenario encapsulate a range of most-likely possibilities given known data. The most recent W&P data indicates an average population growth of 1.49% between 2019 and 2038 for Cascade's service territory. The projected customer growth is provided in Appendix B. Based on historical experience and given expected weather, Cascade expects system load will likely remain within a range bound by the low and high growth scenarios.

Among other reasons, the Company believes that growth in the following regions will be a major factor in any forecasted system-wide deficiency:

- Bend, Oregon – The city of Bend is estimated to have over a 20% growth rate. This is in large part due to the economy growing across all industries as well as a historically low unemployment rate. Bend recently approved an urban growth plan that is projected to allow for the development of 2,380 acres of land. City planners project this will add more than 17,000 homes and 21,000 jobs. No specific timeline for the completion of this expansion is provided in their May 2016 project update. On June 7, 2017, the city of Bend and Deschutes County adopted a joint management agreement to define responsibilities within the urban growth plan.[1]
- Walla Walla, Washington – The city of Walla Walla is heavily focused on promoting small business growth, tourism, and its reputation as a leading wine producer in a competitive eastern Washington wine market. Cascade currently projects growth of approximately 30% in this area over the 20-year planning horizon.[2]
- Tri-Cities, Washington – Richland, Kennewick, and Pasco have been a hotbed for growth in recent years. As of the most recent census numbers, population grew by 10% in the past four years. Furthermore, Pasco is currently in the top ten cities for population growth in Washington State. Cascade currently projects growth of over 35% in this area over the 20-year planning horizon.[3]

[1] *See* City of Bend Urban Growth Boundary Project Update, issued June 2017, updated September 2018
[2] *See* http://www.wallawallatrends.ewu.edu/, updated September 2018
[3] *See* http://www.tri-cityherald.com/news/local/article32225670.html, issue May 2015, updated September 2018

Use-Per-Customer (UPC) Forecast Methodology



As previously mentioned, Cascade utilizes regression models for the UPC part of the demand forecast as well. Sources for the inputs into this model are pipeline actuals, Cascade's gas management system, and Cascade's Customer Care and Billing System (CC&B). Cascade developed the UPC coefficient by gathering historical pipeline demand data by day. The pipeline demand data includes core and non-core usage. The non-core data is backed out using Cascade's measurement data stored in the Company's Aligne energy transaction system which leaves daily core usage data. The daily data is then allocated to a rate schedule for each citygate by using CC&B. This data is then divided by number of customers to come up with a UPC number for each day and for each rate schedule at each citygate.

Below is the model used for the UPC forecast:

$$\frac{Therms}{C_{Class}^{CG}} = \alpha_0 + \alpha_1 HDD^{CG,M} + \alpha_2 I_w + \alpha_3 T + \alpha_4 WIND^{CG,M}$$

Model Notes:

- $C_{Class}^{CG} = Customers\ by\ Citygate\ by\ Class.$
- $HDD^{CG} =$ $Heating\ Degree\ Days\ assigned\ to\ Citygate\ from\ Weather\ Location$
- $m = month$
- $w = weekend$
- $T = Trend$
- $I =$ $Indicator\ variable, where\ 1\ if\ it\ is\ a\ weekend, and\ 0\ if\ it\ is\ a\ weekday.$
- $WIND^{CG} =$ $Daily\ average\ wind\ speed\ assigned\ to\ Citygate\ from\ Weather\ Location$

Cascade runs this model for each of the 55 citygates and citygate loops by customer class where applicable, resulting in approximately 209 models. Cascade starts with the above model for Residential, Commercial, and Industrial. A change in methodology from previous IRP's involves keeping variables in the model that may appear non-significant on a statistical level, but are relevant on an economic level.

Peak Day Forecast Methodology

Cascade's methodology for peak day forecasting is similar to its forecast of demand. For a deterministic forecast, Cascade utilizes the same dynamic regressions as before but with a peak day HDD inserted. This peak day HDD comes from the coldest on record in the last 30 years. Once this peak day is inserted for every year of the forecast, Cascade deterministically derives a peak day usage forecast.

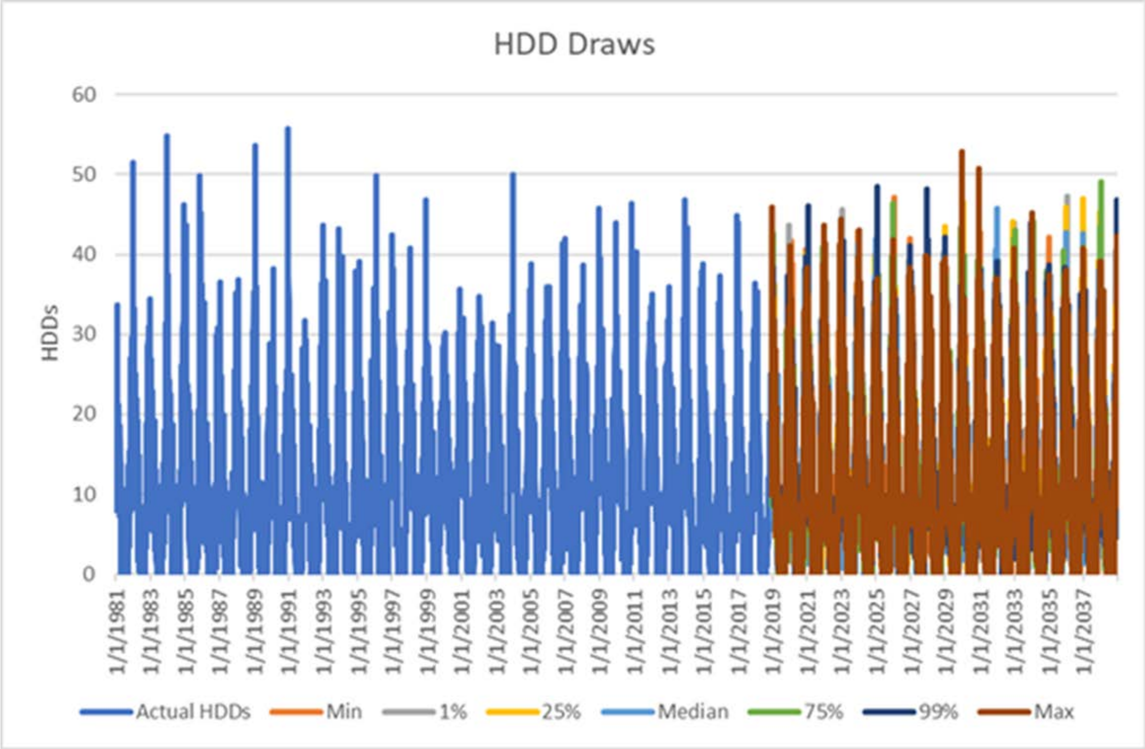
The Company also utilizes Monte Carlo simulation to stochastically analyze the peak day behavior. Through the statistical program R, Cascade runs 10,000 Monte Carlo draws in each weather zone, making sure to correlate the draws based on historical correlations between each weather zone. This results in 10,000 draws of various weather behavior based on historical averages, standard deviations, and correlations between weather zones. Further discussion regarding the Monte Carlo methodology can be found in Section 8, Resource Integration.

In this stochastic analysis, Cascade analyzed many attributes, including the minimum, the maximum, and percentiles such as the 1^{st}, 25^{th}, 75^{th}, and the 99^{th}.

The 99^{th} percentile is then used to calculate the Value-at-Risk (VaR) metric to compare with the VaR limits discussed in Section 8.

Figure 3-2 on the following page displays the historical weather data along with the Monte Carlo simulated weather forecast. The historical weather data represents actual HDDs. The 10,000 draw simulation includes the following draws: Minimum, 1%, 25%, median, 75%, 99%, and maximum.

Figure 3-2: Historical vs. Monte Carlo Simulated Weather



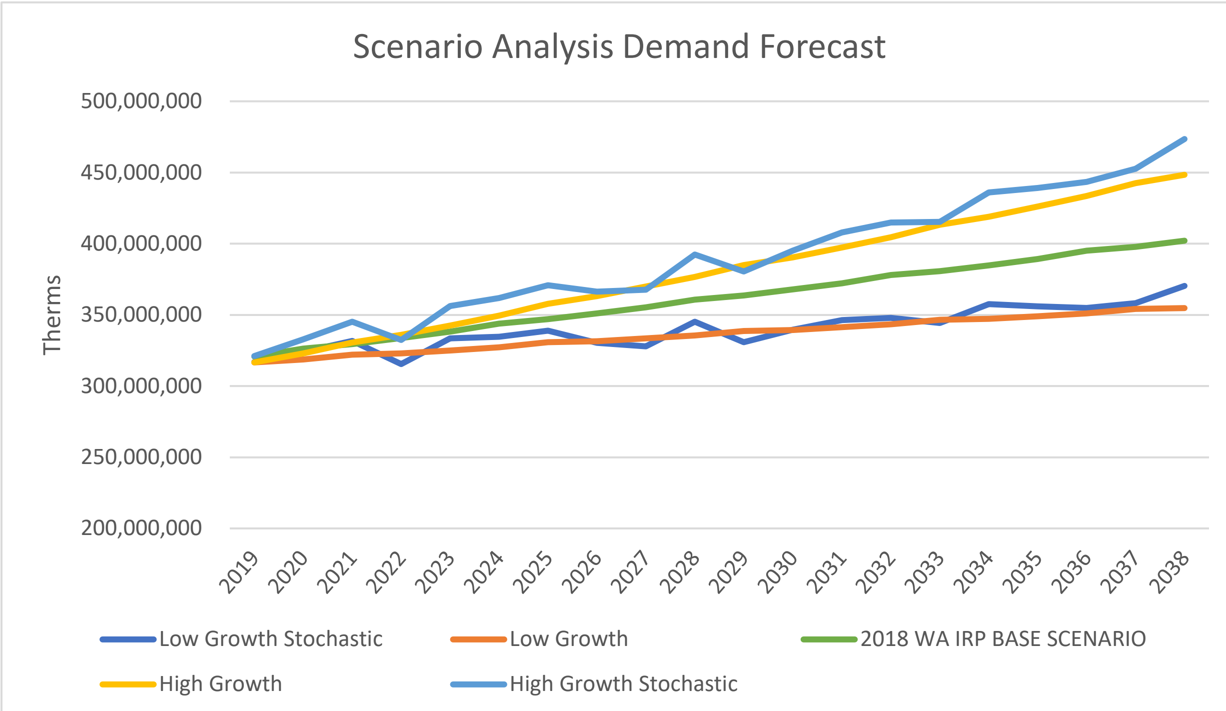
Scenario Analysis

Cascade stress tests the load forecast in SENDOUT® by using alternative forecasting assumptions. These alternative forecasting assumptions refer to changing factors that influence demand. Alternative assumptions include high and low customer growth, and a stochastic study of weather using Monte Carlo simulations. These altered assumptions provide an effective tool for analyzing and stress testing the forecasts. Table 3-2 identifies the list of scenarios. Figure 3-3 displays the scenario analysis over the planning horizon.

Table 3-2: Growth and Weather Scenarios

Scenario	Weather	Growth	UPC
Base Case	Expected	Expected	Expected
Low Growth	Expected	Low	Expected
Low Growth Stochastic	Monte Carlo Weather	Low	Expected
High Growth	Expected	High	Expected
High Growth Stochastic	Monte Carlo Weather	High	Expected

Figure 3-3: Scenario Analysis Demand Forecast (Volumes in Therms)



The base case contains expected weather, customer growth, and use per customer. The base case also has one max peak day event for each weather zone. Expected weather is the average weather over the past 30 years. High and low growth scenarios, discussed more on page 3-18, explain that Cascade uses modifiers to represent higher than expected growth and lower than expected growth. The high and low growth stochastic scenarios represent the 99th percentile of 10,000 Monte Carlo runs done through R. This provides a stochastic stress test of Cascade's growth scenarios. These tests on demand are only to show how weather and growth can impact demand over the 20-year planning horizon. Cascade performs a deeper sensitivity analysis by analyzing Monte Carlo runs in SENDOUT®. Monte Carlo analysis is discussed further in Section 8.

Forecast Results

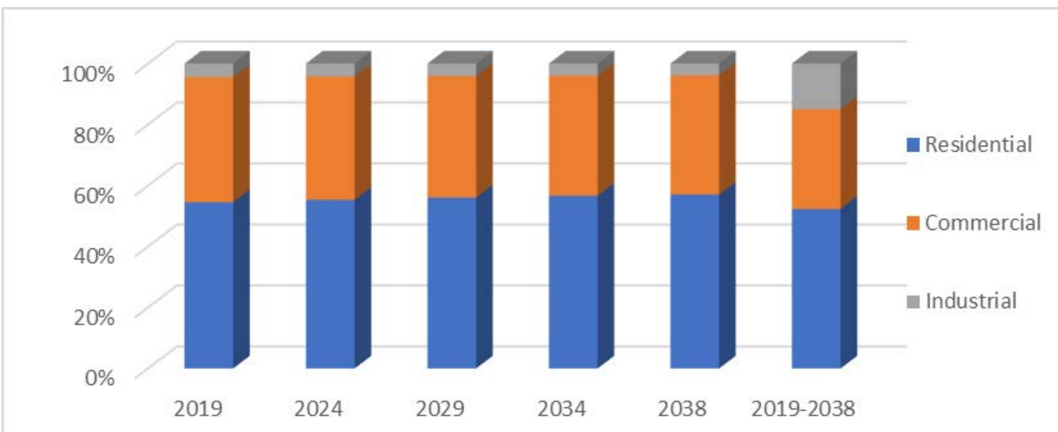
Load growth across Cascade's system through 2038 is expected to fluctuate between 0.68% and 1.73% annually, accounting for leap years. Load growth is split between residential, commercial, and industrial customers. Residential and commercial customer classes are expected to grow at an average rate near 1.44% and 0.94% annually, while industrial expects a growth rate of around 0.45%. Table 3-3 shows the percentage of core growth by class over the planning horizon.

Table 3-3: Expected Load Growth by Class

	Residential	Commercial	Industrial	System
2019-2023	1.63%	1.02%	0.36%	1.31%
2024-2028	1.58%	1.02%	0.49%	1.29%
2029-2033	1.30%	0.84%	0.42%	1.07%
2034-2038	1.28%	0.90%	0.52%	1.09%
2019-2038	1.44%	0.94%	0.45%	1.25%

In absolute numbers, system load under normal weather conditions is expected to exceed 406 million therms in 2038. A majority of core load today is residential. Cascade projects the ratio between residential, commercial, and industrial to increase in favor of residential customers. Residential customers are expected to grow from 54.5% of the total core load to 57% of the total core load by 2038. Figure 3-4 displays the relative percentage relationship of expected loads by class.

Figure 3-4: Expected Load Growth by Class



Cascade expects residential customers to increase their load by about 54 million therms and commercial core customers to increase load by approximately 25 million therms each over the 20-year planning horizon. Industrial customers are expected to increase load by approximately 1.2 million therms over the same period. Cascade expects load to increase about 81 million therms. Table 3-4 displays the expected core load volumes by class.

Table 3-4: Expected Load Growth by Class (Volumes in Therms)

	Residential	Commercial	Industrial
2019	174,896,500	131,638,212	14,231,019
2024	190,278,782	139,088,555	14,569,279
2029	203,892,127	144,993,581	14,796,976
2034	218,007,659	151,671,016	15,170,306
2038	229,314,886	157,268,442	15,497,686
2019-2038	31%	19%	9%

Load growth is primarily a result of increased customer counts. The number of commercial and industrial customers is expected to increase slightly faster than therm usage. Table 3-5 displays the expected customer counts by class.

Table 3-5: Expected Customer Counts by Class

	Residential	Commercial	Industrial
2019	254,442	36,681	599
2024	275,878	38,594	616
2029	296,815	40,501	633
2034	317,351	42,403	656
2038	333,726	43,919	671
2019-2038	31%	20%	12%

Geography

Load across Cascade's two-state service territory is expected to increase 25% over the planning horizon, with the Oregon portion outpacing Washington at 35.6% versus 21.5%. Table 3-6 shows the expected core load volumes by state.

Table 3-6: Expected Load by State (Volumes in Therms)

	Washington	Oregon	System
2019	243,965,938	81,477,174	325,443,112
2024	259,250,732	89,385,312	348,636,044
2029	271,774,986	96,585,284	368,360,270
2034	285,393,065	104,133,133	389,526,198
2038	296,296,639	110,461,757	406,758,396

Within Oregon, Bend is a major driver in the growth rate. The central part of the state is expected to see a large increase in growth. Table 3-7 shows the percentage growth of load by each of Cascade's weather locations. Table 3-8 shows the percentage growth of load by each pipeline zone over the planning horizon. Lastly, Table 3-9 displays a range of core peak day growth over the planning horizon along with a sampling of peak day therms. Peak Day growth is expected to grow approximately 1.24%, similar to annual growth rate.

Table 3-7: Washington 20-Year Load Growth by Weather Location

Weather Location	**Load Growth**	**2019 Load (Dth)**	**2038 Load (Dth)**
Bellingham	19.78%	9,575,890	11,470,454
Bremerton	17.68%	4,989,550	5,871,684
Walla Walla	41.53%	4,878,356	6,904,329
Yakima	8.73%	4,996,207	5,432,438
Washington	**21.44%**		

Table 3-8: System 20-Year Load Growth by Pipeline Zone

Zone	Load Growth
Zone 10	11.66%
Zone 11	8.50%
Zone 20	46.67%
Zone 24	8.77%
Zone 26	19.61%
Zone 30-S	17.21%
Zone 30-W	19.78%
Zone GTN	45.89%
Zone ME-OR	14.46%
Zone ME-WA	16.04%

Table 3-9: Expected Peak Day Growth (Volumes in Therms)

Period	Peak Growth	Year	Peak Day Therms
2019 – 2023	1.36%	2023	3,676,838
2024 – 2028	1.34%	2028	3,932,714
2029 – 2033	1.16%	2033	4,166,993
2034 – 2038	1.12%	2038	4,419,494

High and Low Growth Scenarios

High and low growth scenarios were created by examining the confidence intervals resulting from the customer forecast model. Cascade derived from these intervals a high growth modifier of 1.5 times the expected growth, and a low growth modifier of 0.5 times the expected growth. Cascade projects about 1.25% in customer load growth on the expected case, 1.12% on the low band and 1.42% on the high band. Table 3-10 displays the expected total system load growth across various scenarios.

Table 3-10: Expected Total System Load Growth (By Percentage) Across Scenarios

	Low	Mid	High
2019 - 2023	1.02%	1.05%	1.08%
2024 – 2028	1.03%	1.05%	1.08%
2029 – 2033	1.02%	1.05%	1.07%
2034 – 2038	1.02%	1.04%	1.07%
2019 - 2038	1.12%	1.25%	1.42%

Load growth under poor economic conditions is expected to be around 1.12% annually over the forecast period, while load growth under good economic conditions is expected to be around 1.42% annually. The cumulative effect of high growth over 20 years could result in an additional load of 53 million therms, while low growth could result in a load with 45 million therms less than predicted in the medium growth scenario. Table 3-11 shows the expected total system load across these scenarios.

Table 3-11: Expected Total System Load Growth Across Scenarios (Volumes in Therms)

	Low	Mid	High
2019	318,640,050	320,765,731	322,891,466
2024	330,784,032	343,936,616	357,741,358
2029	339,410,482	363,682,685	390,386,739
2034	349,000,793	384,848,981	425,989,120
2038	356,702,530	402,081,015	455,894,036
Deviation	(45,378,485)		53,813,021

Alternative Forecasting Methodologies

Cascade has made a slight change to the forecast methodology this year by using a dynamic regression approach to modeling. Dynamic regression is simply an ARIMA term in a standard regression model. Also, Cascade has used wind as a predictor for usage, and therefore a coefficient for the demand forecast formula. Cascade has utilized R along with SAS Analytics, statistical analysis software programs, and has used models that follow a dynamic regression methodology. The Company plans to continue improving the customer and demand forecast model through R and SAS.

The Company is responsive to several regulatory principles in forecasting. These include:

- A desire for precision and a high degree of accuracy;
- A universal understanding that forecasts should mirror future realities but may have unanticipated swings in either direction;
- A disconnect between planning and operational functions, in that natural gas purchasing and dispatch will be based on immediate needs which, in actuality, are guaranteed to vary from the plan (per the previous bullet);
- An understanding that an increased cost of improved precision sometimes has decreasing customer benefits;
- A need to meet Regulators' expectation that the Company show continual improvement because new tools are available. For example, the concept of "adaptive management" can be applied;
- The major differences in accounting treatment between the states regarding test years for ratemaking purposes (that is, for general rate case filings) and not necessarily for planning. At this time, Oregon uses future test year accounting while Washington employs a historic test year;
- The fuzziness of historic data that includes effects of energy efficiency, retail price (from annual PGA—purchased gas adjustment—changes and other rate changes), sometimes abnormal weather, new technology, and then-unique economic conditions (e.g., recession, interest rates, etc.). Cascade uses actual historic data. The term fuzziness is used in the context of basing forecasts on past-period data that includes many variables, any one of which may have increased or decreased in the intervening time between historical occurrence and forecasted periods. This causes difficulty for utilities trying to isolate primary factors for greater precision of long-term calculations.
- Unknown and uncertain future changes such as the assumptions around carbon policy and other environmental externalities; and
- A need to demonstrate support for assumptions such as growth in customers, use per customer and changes from previous forecasts, type of use (i.e., heating, manufacturing, etc.), to name a few.

The preceding subsection illustrates the complexity of forecasting and highlights areas of stakeholder attention. Best efforts at appropriate reasonable cost distill these factors into a generally-accepted forecast with recognition of inherent uncertainties.

Uncertainties

This forecast represents Cascade's best estimate about future events. At this time, several important factors make predicting future demand particularly difficult – continued economic recovery, carbon legislation, building code changes, direct use campaigns, conservation, and long-term weather patterns. The range of scenarios presented here and in Section 8 encompass the full range of possibilities through econometric analysis. These forecasts were created after running through a matrix of different functional forms and economic indicators. The chosen indicators were selected because of their consistency in returning statistically valid results. While they may be the best results mathematically, they are not the sole and only determinants of demand. As a result, while Cascade believes that the numbers presented here are accurate and that the scenarios presented represent the full range of possibilities, there are and always will be uncertainties in forecasting future periods.

SECTION 4

SUPPLY SIDE RESOURCES

Overview

Cascade's core market residential and small volume commercial and industrial customers expect and require the highest reliability of energy service. Because of the Company's obligation to provide gas service to these customers, the Company must determine and achieve the needed degree of service reliability and attain it at the most reasonable lowest cost and least risk possible while maintaining infrastructure that is sufficient for customer growth. Assuming such infrastructure is operating effectively, the most important functions necessary for reliable natural gas service are planning for, providing, and administering the gas supply, interstate pipeline transportation capacity, and distribution service purchased by core market customers.

This section describes the various gas supply resources, storage delivery services from Jackson Prairie and Plymouth liquified natural gas (LNG) service, and transportation resource options available to the Company as supply side resources.

Key Points

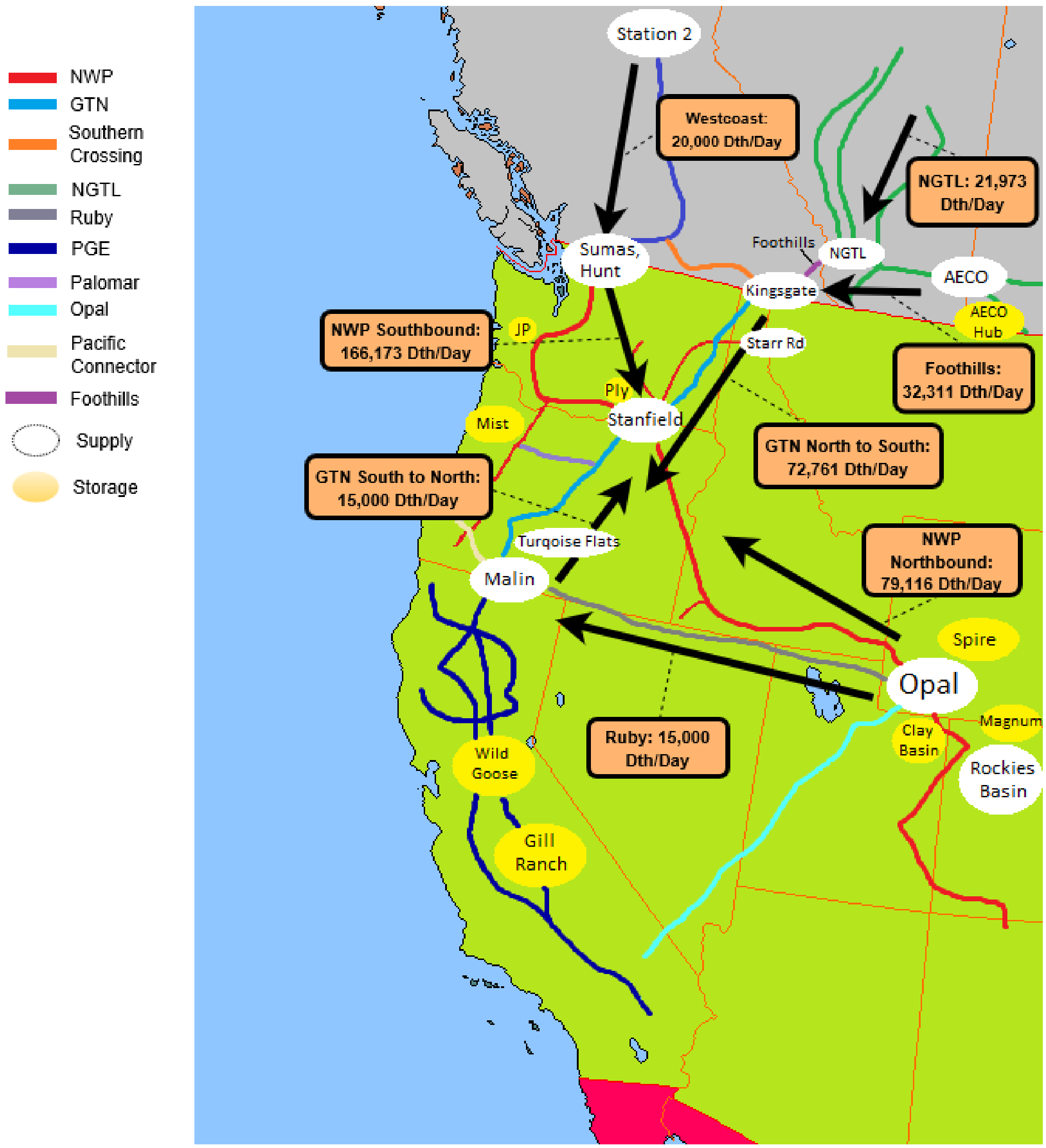
- To meet the Company's core market demand, Cascade accesses firm gas supplies and short-term gas supplies purchased on the open market, in addition to utilizing storage.
- Cascade purchases gas from the Rockies, British Columbia (Sumas), and Alberta (AECO). Gas is transported to the Company's system via pipelines by either bundled or unbundled contracts.
- The long-term planning price forecast is based on a blend of futures market pricing along with long-term fundamental price forecasts from multiple sources.
- The Company identifies potential incremental supply resources for the 2018 IRP.
- Risk management policies are implemented to promote price stability.
- Cascade's GSOC oversees the Company's gas supply purchasing strategy.
- Modeling of Cascade's available resources results in the lowest reasonably priced optimum portfolio.

Gas Supply Resources

Gas supply options available to Cascade to meet the core market demand requirements generally fall into two groups: 1) Firm gas supplies on a short- or long-term basis, and 2) Short-term gas supplies purchased on the open market as needed for a particular month for one or more days. A separate and important source of gas supply is natural gas storage service, which is required to provide economical service to low load factor customers during seasonal peak and the needle peaks of the heating season.

Cascade's gas supply portfolio is sourced from three basic areas of North America: British Columbia, Alberta, and the Rockies. Figure 4-1 provides a general overview of regional gas flows to Cascade's distribution system.[1]

Figure 4-1: Regional Map Showing General Flow Paths for System Gas Supplies



[1] GTN North to South reflects 10,000 dth/day acquired by Cascade on December 1st, 2017.

Firm Supply Contracts

Firm supply contracts commit both the seller and the buyer to deliver and take gas on a firm basis, except during *force majeure* conditions. From Cascade's perspective, the most important consideration is the seller's contractual commitment to make gas available day in and day out regardless of market conditions. Firm supplies are a necessary component of Cascade's core market portfolio given its obligation to serve and the lack of easily obtainable alternatives for customers during periods of peak demand. Firm supply contracts can provide base load services, seasonal load increases during winter months, or they can be used to meet daily needle peaking requirements. Quantities vary, depending on the need and length of the contract. Operational considerations regarding available upstream pipeline transportation capacity and any known constraints must also be considered. Base load contracts can range from as small as 500 dths/day to quantities in excess of 10,000 dths/day. Blocks of 1,000, 2,500, 5,000 and 10,000 dths/day are standard as these are the most operationally and financially viable blocks for suppliers.

Base load supply resources are those that are typically taken day in and day out, usually 365 days a year. As a result, base load gas tends to be the least expensive of the firm supply contracts because it matches the production of gas and guarantees the producer that the volumes will be taken. The Company’s ability to contract for base load supplies is limited because of the relatively low summer demand on Cascade’s system. Base load resources are used to meet the non-weather sensitive portion of the core market requirements or may be used to refill storage reservoirs during periods of lower demand.

Winter gas supplies are firm gas supplies that are purchased for a short period during the winter months to cover increased loads, primarily for space heating. The contracts are typically three to five months in duration (primarily November through March). This enables the Company to ensure firm winter supplies without incurring obligations for high levels of supply contracts during periods of low demand in the summer months. Winter supplies combined with base load supplies are adequate to cover the moderately cold days in winter.

Peaking gas supplies, similar to storage, are firm contracts purchased only as load actually materializes due to high winter demand. That is, the seller must deliver the gas when the Company requires it, but the Company is not required to take gas unless it is needed to meet customer load requirements. Peaking resources typically allow the Company to take between fifteen and twenty days of service during the winter period. These resources are usually more expensive than base load or winter supplies and typically include fixed charges to cover the costs for the sellers to stand by to deliver the supplies.

Needle peaking resources are utilized during severe or arctic cold experiences when demand can increase sharply. These resources are very expensive and are available for a very short period of time. One source of needle peaking gas supply is actually a form of demand side management that may be obtained from Cascade's core interruptible customer base. These customers are required to maintain standby or alternate fuel capability so that Cascade can request the customer switch to its alternate fuel source so Cascade can utilize (divert) the gas supply and transportation capacity to meet the Company's core firm market requirements. The benefits associated with this type of resource include lowering the demand of the industrial facility and providing a like amount of additional gas supply with pipeline capacity to meet core demand. Needle peaking requirements can also be met through the use of propane air plants or on-site LNG facilities. Currently, Cascade does not own or operate any LNG facilities along the distribution system.

Supply contract terms for firm commodity supplies vary greatly. Some contracts specify fixed prices, while others are based on indices that float from month to month. Most contain penalty provisions for failure to take the minimum supply according to the North American Energy Standards Board (NAESB) contract terms. Contract details will also vary for each individual supplier's needs and the NAESB contract special addendums.

Gas that is purchased for a short period of time (1 to 30 days) when neither the seller nor the buyer has a longer-term firm commitment to deliver or take the gas is referred to as a spot market purchase. Spot market supplies differ from firm resources in that they are more volatile, both in terms of availability and price, and are largely influenced by the laws of supply and demand.

In general, spot market supplies (also called day gas) are provided from gas supplies not under any long-term firm contract. Therefore, as firm market demand decreases, more gas becomes available for the spot market. Prices for spot market supplies are market driven and may be either lower or higher than prices under firm supply contracts. In warmer weather, as firm market demand requirements decrease, usually more gas becomes available for the spot market, resulting in lower prices. In colder weather, as firm markets demand their gas supplies, the remaining spot market supplies can carry higher prices.

Due to the potential for interruption of the spot market, these supplies are not considered a reliable source of gas supply for the winter peaking requirements of Cascade's core market. As identified earlier, part of the reason these supplies are considered less reliable is that these volumes are made available after longer-term firm commitments have been contracted for delivery by upstream suppliers. The available volumes are likely to vary daily, depending on production or the suppliers' ability to store un-marketed supply. Under a NAESB contract, parties can identify firm, variable, or interruptible quantities for these supplies. Buyers and sellers use this standard contract when entering into short-term supply transactions. Therefore, these spot volumes are more susceptible to daily operational constraints on the upstream pipelines. This is particularly true in the case of Northwest Pipeline (NWP), which is a displacement pipeline with bi-directional flow. Depending on how gas is scheduled versus how it physically flows between compressor stations, constraints can possibly occur. This is further complicated because each of the upstream pipelines has multiple supply scheduling deadlines, allowing scheduled volumes to be adjusted. As a result, at any given point in the process, constraints can occur, leading to the potential of the scheduled spot supply volumes being reduced or not delivered to the citygate at all.

The role for spot market gas supply in the core market portfolio is based on economics. Spot market supplies may be used to supplement firm contracts during periods of high demand or to displace other volumes when it is cost effective to do so. For example, should prices in one basin drop radically compared to another basin, a supply contract may allow the flexibility to reduce takes in order to take advantage of spot supply from a lower priced basin. Depending upon availability and price, spot market volumes may be used in place of storage withdrawal volumes to meet firm requirements on a given day or for mid-heating season refills of storage inventory during periods of moderate weather.

Storage Resources

Cascade also utilizes natural gas storage to meet a portion of the requirements of its core market. Storing gas supplies, purchased and injected during periods of low demand, is a cost-effective way of meeting some of the peak requirements of Cascade's firm market. Natural gas can be stored in naturally occurring reservoirs, such as depleted oil or gas fields, salt caverns or other geological formations with an impermeable cap over a porous reservoir. Gas can also be stored in vessels or tanks under pressure as compressed natural gas (CNG) or cooled to a liquid state (LNG).

Natural gas storage service is not only an excellent supply source for meeting peak winter demand, but it can also be an important gas supply management tool. Storing excess or unused supply during periods of low demand increases the annual utilization rate of a supply contract, thereby improving the annual load factor for the Company's gas supplies. Improving the annual load factor of a supply contract improves the Company's ability to purchase gas supplies on a more economical basis. Purchasing natural gas for storage during periods of low demand generally yields prices at the low point on the seasonal price curve.

Depending upon the location of the storage facility, pipeline transportation may also be required to move the gas from the facility to the distribution system. Storage facilities located within the Company's distribution system or on the interstate pipeline are preferable to those located off-system. Off-system storage requires additional upstream pipeline transportation and may limit the flexibility of the resource. Cascade does not own any storage facilities and, therefore, must contract with storage owners to lease a portion of those owners' unused storage capacity. Figure 4-1 on page 4-3 displays the location of some of the storage facilities in the region.

Cascade has contracted for storage service directly from NWP since 1994. Jackson Prairie is located in Lewis County, Washington, approximately ten miles south of Chehalis. The following extract explaining the Jackson Prairie facility is found on Puget Sound Energy's website.[2] Puget is a one-third owner of the Jackson Prairie 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 at JP to both inject and withdraw natural gas at 45 wells spread across the 3,200-acre facility. Currently it is estimated that Jackson Prairie can store nearly 25 BCF of working gas. The facility also includes "cushion" gas which provides pressure in the reservoir of approximately 48 BCF. In terms of withdrawal capability, the facility is capable of delivering 1.15 BCF of natural gas per day.

The Company also has contracted for service from NWP's Plymouth, Washington LNG facility. Plymouth is located in Benton County, Washington approximately 30 miles south of Kennewick. According to NWP's website, the total facility has storage capacity of 2.4 BCF. Cascade has leased approximately 28% of this storage capacity.

Both the Jackson Prairie and the Plymouth facilities are located directly on NWP's transmission system. Therefore, storage withdrawal rates can be changed several times during an individual gas day to accommodate weather driven changes in core customer requirements. This type of operating flexibility would not necessarily be available with off-system storage. Withdrawal capabilities must also be accompanied by firm capacity on the transporting pipeline(s) to be of any value as a reliable source of gas supply. Cascade's Jackson Prairie storage and Plymouth LNG service require TF-2 firm transportation service for storage withdrawals; Cascade has sufficient firm TF-2 service to meet its storage daily deliverability levels. The Company's contracted storage services are summarized in Table 4-1.

[2] *See* https://pse.com/aboutpse/PseNewsroom/MediaKit/052_Jackson_Prairie.pdf, as of October 1, 2018.

Table 4-1: Cascade Leased Storage Services (Volumes in Therms)

Facility	Storage Capacity	Withdrawal Rights
Jackson Prairie (Principle)	6,043,510	167,890
Jackson Prairie (Expansion)	3,500,000	300,000
Jackson Prairie (2012)	2,812,420	95,770
Plymouth LNG (Principle)	5,622,000	600,000
Plymouth LNG (2016)	1,000,000	181,250

Capacity Resources

Capacity options are either interstate pipeline transportation resources or capacity on Cascade's local distribution system. Cascade's local distribution system is built to serve the entire connected load in its various distribution service areas on a coincidental demand basis, regardless of the type of service the customer may have been receiving.

Pipeline transportation resources are utilized to transport the gas supplies from the producer/supply sources to Cascade's system. Cascade currently purchases supplies from three different regions or basins: U.S. Rockies, British Columbia, and Alberta, Canada. Unless the supplier has bundled its sale of gas supplies with capacity (i.e. a citygate delivery), these resources require pipeline transportation to deliver them to Cascade's local distribution system. Transportation resources historically have been purchased from the pipeline at the time of an expansion under long-term (20 to 30 year) contracts.

Cascade has over 30 long-term annual contracts with NWP, numerous long-term annual and winter-only transportation contracts with GTN (including the upstream capacity on TransCanada Pipeline's Foothills and Alberta systems), a long-term, winter-only contract with Ruby Pipeline, and one long-term annual contract with Enbridge (Westcoast Transmission) in British Columbia, Canada. These contracts do not include storage or other peaking services that may provide additional delivery capability rights. Figure 4-1 from page 4-3 provides a general flow of Cascade's combined contracted pipeline transportation rights.

A complete listing of Cascade's current transportation agreements is provided in Appendix E.

At a minimum, in order to ensure a diversified physical portfolio, the basic design of Cascade's transportation portfolio considers incorporating these general physical products or elements:

- Annual supply package;
- November through March (the whole heating season);
- December through February (peak of the heating season);
- Spring Seasonal (Apr-Jun);
- Spring/Summer Seasonal (April through October);
- Day Gas; and
- No more than 25% of the overall portfolio can be supplied by a single party.

Natural Gas Price Forecast

For IRP purposes, the Company develops a baseline, high, and low natural gas price forecast. Demand, oil price volatility, the global economy, electric generation, opportunities to take advantage of new extraction technologies, hurricanes and other weather activity will continue to impact natural gas prices for the foreseeable future. Cascade considers price forecasts from several sources, such as Wood Mackenzie, Energy Information Administration (EIA), S&P Global, NYMEX Henry Hub, Northwest Power and Conservation Council (NWPCC), as well as Cascade's own observations of the market to develop the low, base, and high price forecasts. For confidentiality purposes, the Company refers to the selected sources as Sources 1-4 when discussing how these sources are weighted in Cascade's Henry Hub forecast. The following discussion provides an overview of the development of the baseline forecasts.

Cascade's long-term planning price forecast is based on a blend of futures market pricing along with long-term fundamental price forecasts from multiple sources. Since pricing on the market is heavily influenced by Henry Hub prices, the Company closely monitors this market trend. While not a guarantee of where the market will ultimately finish, the futures market (NYMEX) is the most current information available that provides some direction as to future market prices. On a daily basis, Cascade can see where Henry Hub is trading and how the future basis differential in the Company's physical supply receiving areas (Sumas, AECO, Rockies) is trading.

Cascade believes that relying on a single source for developing the Company's 20-year price forecast is not the most reasonable approach. Some sources such as EIA and Wood Mackenzie produce Henry Hub pricing over the long-term; whereas other sources like the NYMEX basis (e.g., Sumas) provide price indicators over a shorter period of time. Additionally, price forecast sources produce their forecasts or indicators at varying points in time throughout the year. Finally, most forecasts are at an annual level vs a monthly level. In order to capture the potential seasonality as well as the variances of monthly price within the producing basins, the Company blended the pricing data from these various forecast sources.

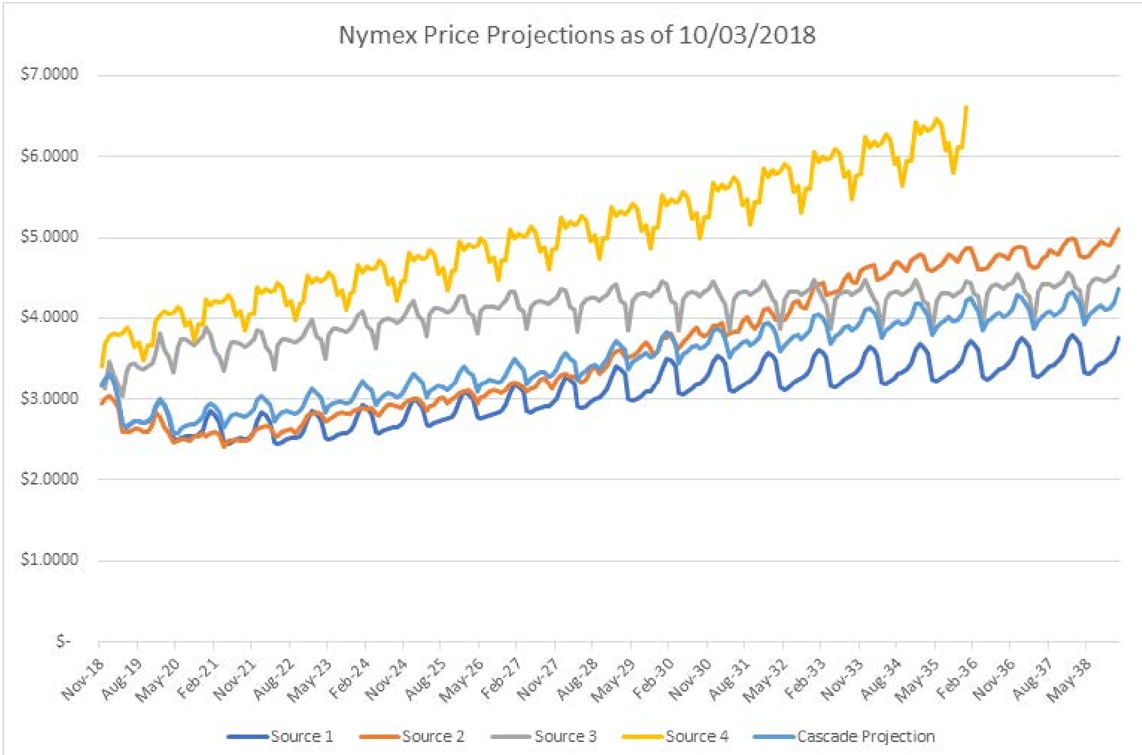
The fundamental forecasts of Wood Mackenzie, the EIA, NWPCC, Platts, S&P Global, Bentek, and Cascade's trading partners are resources for the development of a blended long-range price forecast. Wood Mackenzie publishes a long-term price forecast twice a year to subscribing customers. This forecast was broken down by month through the planning horizon and includes Henry Hub as well as basis differentials for the Company's receiving areas. Cascade also considers the EIA forecast; however, it has its limitations since it is not always as current as the most recent market activity. Further, the EIA forecast provides monthly breakdowns in the short-term, but longer-term forecasts are only by year. Many of the other sources mentioned only provide price forecasts by year. Given Cascade's load profile and the need for more winter gas than summer, the Company developed a pattern based on the market monthly forward prices to create a long-term, monthly Henry Hub price.

With a monthly Henry Hub price determined from the above sources, the Company assigned a weight to each source to develop the monthly Henry Hub price forecast for the 20-year planning horizon. These weights were derived by calculating the Symmetric Mean Absolute Percentage Error (SMAPE) of each source versus actual Henry Hub pricing since 2010. The inverse of these error terms was then used to determine the weight given to each source. A sample of the forecast weighting factors are shown in Table 4-2. A comparison of the sources Cascade uses in its forecast and the actual blended forecast is provided in Figure 4-2.

Table 4-2: Sample of Cascade's Henry Hub Price Forecast Weights

Date	Source 1	Source 2	Source 3	Source 4
T+1	9.115%	47.371%	29.499%	14.015%
T+2	10.772%	44.692%	29.580%	14.955%
T+3	9.570%	49.212%	28.405%	12.812%
T+4	12.002%	43.537%	30.386%	14.075%
T+5	11.523%	43.476%	32.206%	12.796%
T+6	14.850%	32.243%	37.449%	15.458%
T+7	13.972%	35.110%	36.448%	14.470%
T+8	15.837%	31.029%	37.275%	15.859%
T+9	15.074%	35.022%	34.192%	15.712%
T+10	16.913%	31.090%	34.166%	17.831%
T+11	16.168%	34.193%	31.641%	17.999%
T+12	17.183%	29.466%	32.449%	20.902%

Figure 4-2: Henry Hub Price Forecast by Source ($US/Dth)



Age-Dampening Mechanism

To ensure that the forecast is accounting for the most current information in the market, Cascade has introduced an age dampening mechanism to its price forecast. Every month, if there is a source that is over one year old, all sources' weights are reduced by their share of the total number of months that all sources are outdated by. For example, if Source 1's forecast was fifteen months old, Source 2's was seven months old, and Source 3's was two months old, then each of these sources would be reduced by 15/24, 7/24, and 2/24 respectively. The detracted weights are then added back into the weight of the forwards market, since that will always be the most current source (as it is updated daily). The one-year threshold was chosen qualitatively, as this methodology could be too punishing if all sources were not that old. For example, if one source was two months old, another was one month old, and another brand new, the first source would lose 66% of its weight to the forward curve, even though it still contains relatively current information regarding the market.

Also new to the 2018 WA IRP, Cascade has decided to weight the futures market at 100% for the first fifteen months of the forecasting period. The weights are then linearly interpolated over the next two years in order to align them with the calculated weights as described above.

The Company recognizes the importance of verifying forecast accuracy periodically and as such, will perform routine cross-validation to evaluate the impact of any modifications to the price forecast.

Development of the Basis Differential for Sumas, AECO and Rockies

Cascade utilizes the basis differential from Wood Mackenzie's most recently available update and compares that to the future markets' basis trading as reported in the public market because the Company's physical supply receiving areas (Sumas, AECO, and Rockies) are typically traded at a discount to Henry Hub. Correspondingly, the Company applied a weighted average to determine the individual basis differential in the price forecast.

In order to determine the low case and high case, the Company utilized the EIA economic growth factors which are 1.5 for the Low Case, 2.0 for the Reference Case, and 2.6 for the High Case.[3]

Pros and Cons of New Methodology

The changes made to the 2018 price forecast represent a significant methodological improvement over the forecasts in previous IRPs. Using the daily NYMEX forwards for short term forecasting allow the Company's forecast to incorporate current market data, such as weather and *force majeure* events, into its projections. Additionally, the age dampening mechanism favors sources that have been updated more recently, which better captures a paradigm shift in the markets on a long-term basis versus a forecast that may be a few months or even years old. Finally, the use of SMAPE to assign weights to the sources creates a more scientific rationale for the blending of forecasts.

While Cascade is pleased with this forecast, there are always areas of potential improvement. Since the forecast is a blending of other forecasts, the Company relies on the accuracy of its sources. While the SMAPE calculation helps to reward the more accurate forecasts, if all sources failed to capture a major market movement, Cascade's forecast would ultimately end up inaccurate as well. Additionally, some sources produce fairly infrequent forecasts, creating a small sample size for them to be evaluated in the SMAPE calculation. The Company is monitoring these problems to ensure they do not skew the forecast, and does have mechanisms in place to allow

[3] EIA 2018 Annual Energy Outlook

for a manual adjustment if market intelligence deem such a modification to be appropriate.

Incremental Supply Side Resource Options

As is more thoroughly described in Section 8, some of the load growth over the planning horizon will require Cascade to secure incremental supply side resources. The purpose of this section is to identify the potential incremental supply resources the Company considered for the 2018 IRP.

Cascade models its incremental resources simultaneously through SENDOUT®. This allows the Company to evaluate each resource as a potential solution relative to all other resources, without any bias towards any particular option. Cascade utilizes functionality within SENDOUT® to allow the program to deterministically select the optimum timing and quantity of incremental supply resources. Any of the following resources that do not appear in Cascade's final preferred portfolio were deemed by SENDOUT® to be either not cost effective or not optimal in comparison with other resource options.

Pipeline Capacity

- **Bremerton-Shelton Realignment:** NWP has presented Cascade with a proposal to realign a portion of its capacity that runs from Sumas to Plymouth. This capacity would instead give the Company lateral rights along the Shelton lateral. Additionally, Cascade would be given the option to acquire a storage redelivery contract from Jackson Prairie to Stanfield Delivery.

- **Cross-Cascades, Trail West (Palomar, NMax, Sunstone, Blue Bridge, et al):** Trail West is a pipeline starting at GTN's system near Madras, Oregon, and connecting NWP's Grants Pass Lateral near Molalla, Oregon. Since portions of the Company's distribution system are not connected to Molalla, incremental pipeline capacity would be needed to transport gas northbound to certain load centers. NWP has proposed a transport service that would bundle Trail West capacity with NW Natural's northbound Grants Pass Lateral capacity. From Cascade's perspective, this might present an alternative means to move Rockies' gas to the I-5 corridor.

- **GTN Capacity Acquisition:** The Company would acquire currently unsubscribed capacity on GTN in order to secure its gas supplies at liquid trading points to serve Central Oregon.

- **NWP Eastern Oregon Expansion:** This alternative resource would be incremental NWP capacity from a Washington State receipt point that is designed to serve load growth needs in Zone 24 and Zone ME-OR. Examples of the Cascade service areas that would benefit from this project are Pendleton and Baker City. Similar to a proposed NWP Wenatchee expansion, it would be relatively small scale and could be expected to have a relatively high unit cost.

- **NWP Express Project/I-5 Sumas Expansion Project (Regional or Cascade Specific Project):** Cascade envisions this project as expanding capacity from Sumas on a potential NWP project that is the successor to the Western Expansion project. It would potentially combine Cascade's infrastructure expansion needs with other regional requests from parties such as local distribution companies (LDCs), power generators, and large petrochemical projects. The scale of this project is larger, potentially resulting in a more favorable unit cost; although with scale and multiple parties involved, timing for in-service dates may vary by the various participants. Examples of the Cascade service areas that would benefit from this project are Bellingham, Mount Vernon, Bremerton and Longview. Recently, Avista, Cascade, NW Natural, and Puget Sound Energy agreed to combine their efforts as a group to work with the regional pipelines (GTN, NWP) on potential expansions in the region.

- **NWP Wenatchee Expansion:** This alternative resource would be incremental NWP capacity from a Washington State receipt point (e.g. Sumas) that is designed to serve load growth needs in Zone 10 and Zone 11. Examples of the Cascade service areas that would benefit from this project are Yakima and Wenatchee. Accordingly, it would have a relatively small scale and so could be expected to have a relatively high unit cost.

- **NWP Zone 20 Expansion:** This alternative resource would be incremental NWP capacity from a Washington State receipt point that is designed to serve load growth needs in Zone 20. Examples of the Cascade service areas that would benefit from this project are Kennewick and Moses Lake. Similar to a proposed NWP Wenatchee expansion, it would have a relatively small scale and so could be expected to have a relatively high unit cost.

- **Pacific Connector:** The Pacific Connector Pipeline project is tied to the development of the Jordan Cove LNG export terminal in Coos Bay, Oregon. This pipeline starts near Malin, Oregon, and would cross NWP's Grants Pass Lateral (GPL) in the vicinity of Roseburg, Oregon. This project presents an opportunity as a potential supply resource for this IRP. Cascade would not be seeking to become a shipper on Pacific Connector. The Company views this project as bundled pipeline supply service from

Malin to the Company's citygate. The project was initially denied due to lack of demand, which has since increased, but faces considerable opposition including but not limited to landowners, activists, and protesters. Incremental transport involving GTN might be necessary to ensure transport from Malin to Cascade's GTN receipt point at Turquoise Flats.

- **Southern Crossing Expansion:** FortisBC has proposed a reinforcement project for the Southern Crossing Pipeline that would permit more flow of Alberta gas to Sumas. This would also require an expansion of NWP from Sumas at the Canadian border which in the Company's view does not need to be modeled since it essentially is replicated by the current inclusion of the NWP I-5 expansion project. This is primarily a price arbitrage opportunity, but the Company does not see any significant advantage to the system at this point given limited availability to move the gas from Sumas. However, Cascade will continue to consider this resource to see if it might make sense as a potentially cost-effective dedicated resource for the Company's direct connect with Westcoast.

Storage Opportunities

- **AECO Hub Storage:** This is Niska's commercial natural gas storage business in Alberta, Canada. The service is comprised of two gas storage facilities: Suffield (South-eastern Alberta) and Countess (South-central Alberta). Although the two AECO facilities are geographically separated across Alberta, the toll design of the Nova Gas Transmission Ltd. (NGTL) system means they are both at the same commercial point. Capacity at one of the facilities is possible as an alternative resource. Currently, no open season is planned. However, some services are available for limited periods of time but are subject to possible interruption. Incremental transport involving NGTL, Foothills, GTN, and possibly NWP would be necessary.

- **Gill Ranch Storage:** Gill Ranch Storage is an underground intra-state natural gas storage facility near Fresno, Calif. It includes a pipeline that links the facility to Pacific Gas & Electric Company's (PG&E) mainline transmission system, allowing it to serve customers throughout California. Storage from this facility would require California Gas Transmission (CGT) transport, which has a potentially cost-prohibitive demand charge of $1.68/Dth. Incremental transport involving GTN would also be necessary.

- **Mist (North Mist II):** According to NW Natural's 2016 IRP (LC 64), Chapter 3, pages 3.34 and 3.35, NW Natural is in the midst of a project called North Mist that would combine new underground storage at Mist and a new transmission pipeline to serve Portland General Electric (PGE) at Port Westward called North Mist. The storage reservoirs currently in service at Mist and those that would be developed as North Mist for PGE do not collectively exhaust Mist's storage potential; other Mist *production reservoirs* that theoretically could be developed by NW Natural into additional storage resources. The primary impediment in doing so is not geological, but the challenges associated with developing new pipeline capacity to move the gas from Mist to the Company's load centers.

NW Natural identifies a prospective Mist expansion project for core customer use in this IRP as 'North Mist II.' North Mist II involves 100 MMcf/day of maximum delivery capacity coupled with a maximum storage capacity of 2.0 billion cubic feet (Bcf), and includes a new compressor station and associated appurtenances. These capabilities would be exclusively for utility use. Should a third party want to subscribe to a North Mist II expansion, total deliverability and storage capacity would increase to match those additional subscribed amounts.

New to the 2018 IRP, Cascade contacted the operators of Mist to gather updated data to properly model this storage facility in SENDOUT®. The results of this can be found in Section 8.

- **Spire (formerly Ryckman Creek) Storage:** As of December 2017, Ryckman Creek, LLC operates as a subsidiary of Spire Inc. Spire Gas Storage Facility is located near the town of Evanston, Wyoming and approximately twenty-five miles southwest of the Opal Hub. Spire Storage has converted a partially depleted oil and gas reservoir into a gas storage facility with 35 BCF of working gas and a maximum daily withdrawal rate of 480,000 Dths/d. Spire Storage currently has interconnects with Questar Gas Pipeline, Kern River Transmission, Questar Overthrust Pipeline, Ruby Pipeline, and NWP. Incremental transport involving Questar and possibly Ruby would be necessary.

- **Wild Goose Storage:** Wild Goose is located north of Sacramento in northern California and was the first independent storage facility built in the state. The facility commenced full commercial operations in April 1999 and in April 2004 completed its first expansion. Storage from this facility would require California Gas Transmission (CGT) transport, which has a potentially cost-prohibitive demand charge of $1.68/Dth. Incremental transport involving GTN would also be necessary.

Other Alternative Gas Supply Resources

- **Satellite LNG:** Some gas utilities rely on satellite LNG tanks to meet a portion of their peaking requirements. The term satellite is commonly used because the facility is scaled-down and has no liquefaction capability. Instead, its usefulness revolves around the availability of another (no doubt larger) facility with the ability to supply the LNG to fill its tank(s). LNG facilities in this context are peaking resources because they provide only a few days of deliverability, and should not be confused with the much larger facilities contemplated as LNG export or import terminals. The concept is that a small tank serving a remote area would be filled with LNG as winter approaches, and the site operated during cold weather episodes when vaporization is required. Since Satellite LNG has no on-site liquefaction process, the facility is fairly simple in design and operation. While likely as expensive as some pipeline projects, Satellite LNG may be more practical in areas where pipeline capacity shortfalls for peak day are the highest and most immediate. The addition of satellite LNG could defer significant pipeline infrastructure investments for several years.

- **Bio-natural gas (BNG):** BNG typically refers to gas produced by the biological breakdown of organic matter in the absence of oxygen. BNG originates from biogenic material and is a type of biofuel. One type of BNG is produced by anaerobic digestion or fermentation of biodegradable materials such as biomass, manure or sewage, municipal waste, green waste, and energy crops. This type of BNG is comprised primarily of methane and carbon dioxide. The principal type of BNG is wood gas, which is created by gasification of wood or another biomass. This type of BNG is comprised primarily of nitrogen, hydrogen, and carbon monoxide, with trace amounts of methane. The gases, methane, hydrogen and carbon monoxide, can be combusted or oxidized with oxygen. Air contains 21% oxygen. This energy release allows BNG to be used as a fuel. It can also be utilized in modern waste management facilities where it can be used to run any type of heat engine to generate either mechanical or electrical power. BNG is a renewable fuel, which can be used for transport and electricity production, so it attracts renewable energy subsidies in some parts of the world. Cascade has had preliminary discussions with several bio digester developers who are looking to participate in California's Renewable Identification Number (RINs) market. Also, the Company has had discussions with developers on biogas projects that use renewable energy to capture Greenhouse Gases from industrial processes and convert it to several commodities, one being methane. This biogas can then be re-injected into a distribution system. Costs are projected to be $30/dth and are not economically viable at this time. Cascade continues to monitor the BNG activities of companies such as PG&E, Intermountain Gas, Sempra Utilities, and Puget Sound Energy. Cascade has included a preliminary renewable natural gas analysis in Appendix J.

- **Realignment of Maximum Daily Delivery Obligations (MDDO):** Cascade has long held more delivery rights than receipt rights on NWP under its principle 100002 agreement. This was a result of FERC Order 636, when NWP was required to assign upstream capacity directly on GTN (formerly known as Pacific Gas Transmission) to the shippers that were using that capacity. NWP allowed the direct assignment as part of the conversion from their merchant role to an open access pipeline. However, NWP did not lower its capacity contract to reflect the direct assignment. In effect, this increased Cascade's system capacity by the amount GTN would directly be providing to Cascade. On the plus side, this gives Cascade great flexibility to utilize 316,994 Dths/day of delivery rights vs 205,123 Dths/day of receipt rights. Cascade has the right to deliver gas to any delivery point within Washington and Oregon so long as the total MDDOs are not exceeded. Cascade and NWP have worked continuously in recent years for ways to address Cascade's potential peak day capacity shortfalls through re-alignment of the Company's contractual rights where possible, which mitigates the need to acquire incremental NWP capacity through expansions.

Cascade considers Unconventional Gas Supply Resources such as supplies from a LNG Import Terminal, local bio-natural gas or other manufactured gas supply opportunities as speculative supply side resources at this point in time. Ultimately these unconventional gas supply resources are treated as alternative resources and have to compete with traditional gas supplies from the conventional gas fields in Canada or the Rockies for inclusion in the Company's portfolio planning.

Supply Side Uncertainties

Several uncertainties exist in evaluating supply side resources. These include regulatory risks, deliverability risks, and price risks. Regulatory risks include the unknown impacts of future Federal Energy Regulatory Commission (FERC) or Canada's National Energy Board (NEB) rulings that may impact the availability and cost of interstate pipeline transportation.

Deliverability risk is the risk that the firm supply will not be available for delivery to the Company's distribution system. Purchasing resources from larger producers or marketers who typically have gas reserves in multiple locations may minimize this risk. The risks associated with prices rising or falling during any winter period represent another supply side uncertainty. To the extent the Company purchases firm contracts that are tied to an index price, it may be at risk for paying more than was initially anticipated for the resource after the resource decision has been made. Price risks associated with climbing prices can be minimized through the use of fixed price contracts or through the use of financial derivatives.

As the United States continues to search for environmentally friendly, economically viable options to displace gasoline, natural gas is seen as a fuel that could significantly contribute to lessening American dependency on foreign oil. It should be noted that several proposals being discussed or that are in process involve a number of Canadian upstream pipelines which could have a direct impact on the availability of supply or at least may pose potential risks to increases in the price of supplies sourced from British Columbia and Alberta. For example, in late 2017 TransCanada executed transportation agreements with 23 companies to transport approximately 1.42 million dekatherms per day at a notable discount rate of approximately $0.65 US/Dth from Empress, Alberta, to southwestern Ontario on their mainline system. This new service may impact the amount of Alberta gas available for companies such as Cascade. The Company will continue to monitor and be actively involved in the various pipeline forums as these initiatives develop.

Financial Derivatives and Risk Management

Cascade constantly seeks methods to ensure customers of price stability. In addition to methods such as long-term physical fixed price gas supply contracts and storage, another means for creating stability is through the use of financial derivatives. The general concept behind a derivative is to lock-in a forward natural gas price with a hedge, consequently eliminating exposure to significant swings in rising and falling prices. Financial derivatives include futures, swaps, and options on futures or some combination of these.

Natural gas futures contracts are actively traded on the NYMEX. The use of futures allows parties to lock-in a known price for extended periods of time (up to six years) in the future. Contracts are typically made in quantities of 10,000 Dths to be delivered to agreed-upon points (e.g., NWP Sumas, Westcoast Station 2, NGTL AECO, NWP Rockies, etc.).

In a swap, parties agree to exchange an index price for a fixed price over a defined period. In this scenario, Cascade would be able to provide its customers with a fixed price over the duration of the swap period. In theory, the price would be levelized over the long-term. Futures and swaps are typically called costless because they have no up-front cost.

Unlike futures and swaps, an option-only provides protection in one direction - either against rising or falling prices. For example, if Cascade wanted to protect customers against rising gas prices but keep the ability to take advantage of falling prices, Cascade would purchase a call option on a natural gas future contract. This arrangement would give the Company the right (but not the obligation) to buy the futures contract at a previously determined price (strike price). Similar to insurance, this transaction only protects the Company from volatile price spikes, via a premium. The premium is typically a function of the variance between the strike price compared to the underlying futures price, the period of time before the option expires, and the volatility of the futures contract.

Cascade's Gas Supply Oversight Committee (GSOC) oversees the Company's gas supply hedging strategy. The Company's current gas hedging strategy is outlined below:

Hedged Fixed-Price Physical or Financial Swaps

- Year one up to 40% of annual requirements
- Year two set at up to 25%
- Up to 20% hedged volumes for year three

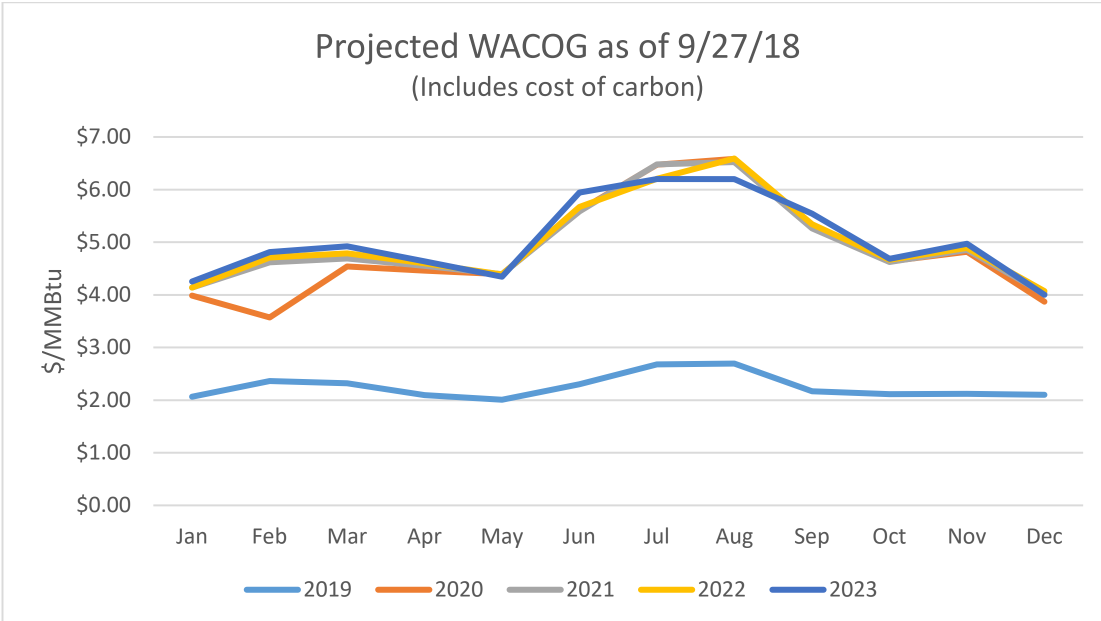
Depending on market conditions, the strategy allows for the ratchets to increase to 75%, 50%, and 30%, respectively, provided current market information supports moving to a different level.

Cascade may employ prudent risk management strategies within designated parameters to minimize the risk of operating losses or assumption of liabilities from commodity price increases because the price the Company pays for gas is subject to market conditions. Risk is associated with business objectives and the external environment. The number of hedging strategies to deal with risk are almost infinite. The decision making process to manage a risk categorizes whether the risk is one to be avoided, one to be accepted and controlled, or a risk left uncontrolled. When a risk is high impact with a high likelihood of occurrence, the risk is probably too high in relation to the reward and should be avoided. It is reasonable to accept business risks that can be managed and controlled. For some risk, the measurable impact is low and the risk may not be worth controlling at all. These are risks where the Company can absorb a loss with little financial or operational effect. The Company's policy is directed toward those risks that are considered manageable, controllable, and worth the potential reward to customers. This manageable risk includes acceptable analysis of the possible side effects on the financial position of the Company as compared to the rewards.

The use of derivatives is permitted only after identified risks have been determined to exceed defined tolerance levels and are considered unavoidable. Cascade's GSOC makes these decisions. In recent years, GSOC has adjusted the percentage of the portfolio hedged based on volatility of the market. For example, in the early 2000s, the Company hedged up to 90% of the base gas supply portfolio. When MDU Resources acquired Cascade in 2007, this threshold was reduced to 75% to align with MDU Resources' Corporate Derivatives Policy. As the market began to fall dramatically in the 2008-2010 period, the Company continued to lower the percentage to approximately 30%. Current MDU Resources' corporate policy encourages Cascade to keep the hedging percentage less than 50%. For the 2018 procurement design, GSOC felt that with Cascade's unique load and wide geographical profile, the lack of price volatility would potentially expose the Company to unreasonable premiums on derivatives. Therefore, GSOC chose to hedge using fixed priced physicals. Currently, Cascade hedges approximately 40% of the portfolio using fixed priced physicals.

The Company entered into fixed price physical transactions rather than executing financial swaps for the current programmed buying period. Fixed prices consist of locked-in prices for physical supplies. As will be further described in this section, the Company utilizes a programmed buying approach for locking in or hedging gas supply prices. In light of the relative lack of volatility in current prices, abundant supply, concerns regarding the administrative impacts of the Dodd-Frank Wall Street Reform Act, and an open hedging docket in Oregon and a new hedging policy in Washington, Cascade has not executed any new financial derivatives or considered any for the 2018 IRP. The Company still monitors the outer years and stands ready to execute financial swaps when market and pricing conditions are more favorable. At the time the current procurement strategy was made the forward price spread between the November 2017 through October 2018 period and the November 2020 through October 2021 period was less than 20%, which was deemed a reasonable and manageable spread given market intelligence available. Figure 4-3 provides a graph showing the Company's projected weighted average cost of gas (WACOG), including the base case carbon adder, for the 2018 IRP.

Figure 4-3: Projected Cascade WACOG as of September, 2018



On March 13, 2017, the Washington Utilities and Transportation Commission (WUTC) issued its Policy and Interpretative Statement on Local Distribution Companies' (LDCs) Natural Gas Hedging Practices in Docket UG-132019.[4] This statement provided guidance on how LDCs should develop and implement more robust risk management strategies, analyses and reporting related to hedging activities.

In Docket UG-132019, the WUTC reviewed hedging practices by utilities in the State of Washington and found that local LDCs experienced opportunity costs associated with price risk mitigation techniques upwards of $1.1 billion over a ten-year period. The WUTC discovered that many of these costs were caused by adherence to programmatic "set-it-and-forget-it" price risk mitigation techniques (herein called hedging or hedging strategies) that did not respond well to the downward trending market which prevailed in recent years. The WUTC concluded that, while hedging is necessary to limit upside price risk, an effective program should also give flexibility that can mitigate downside hedge losses by adjusting to changing market conditions. To achieve this goal, the Commission identified a need for a risk-responsive hedge plan with a robust analytical framework.

GSOC oversees the Company's gas supply purchasing and hedging strategy. Members of GSOC include Company senior management from Gas Supply, Regulatory, Finance and Operations. In preparing the Company's hedging

[4] https://www.utc.wa.gov/docs/Pages/DocketLookup.aspx?FilingID=132019

document, Cascade has relied on the following points when interpreting the WUTC hedging policy statement:

- WUTC affirmed its preference that natural gas LDCs utilize risk responsive hedging practices.
- Hedging practices should not be speculative in nature. Hedging is an activity designed to reduce price uncertainty, not an attempt to realize profits based on predictions of anticipated market movements.
- The Commission believes that while there is no right mix of methods that may be applied unilaterally due to utility specific operations, LDCs must reasonably plan for market volatility and appropriately react to balance ratepayer exposure to hedging losses. This includes recognizing dual protection from upside price risk and downside hedging loss, along with annual validation of acceptable hedging outcomes.
- Based on the WUTC hedging policy statement the Company is aware that the WUTC views the Gettings White Paper as a resource in helping LDCs develop more robust risk management programs. While Cascade has considered portions of the White Paper to inform the Company's enhanced risk management strategies, analysis and reporting, Cascade has hired a consultant, Gelber & Associates, to assist the Company in developing the proper risk responsive process and analyses.
- WUTC expects LDCs to make reasonable progress in developing a more sophisticated risk management framework, targeting the submission of the 2019 PGA filing to contain plans that exhibit the full hedging strategy to implement for 2020 and beyond.

With the assistance of Gelber & Associates (G&A or Gelber), an energy consulting firm with 30 years of experience in utility hedging, CNGC has reexamined its hedging practices to develop a hedging plan that uses a data-driven approach, and provides the flexibility to manage both upside price risk and downside hedge loss risk.

Gelber & Associates has been working in close coordination with the Cascade to design and implement processes and analytics to comply with the Washington Utility and Transportation Commission UG-132019 policy statement while simultaneously complying with Oregon Public Utility Commission UM-1286 PGA integrated hedging guidelines.

WUTC's Docket UG-132019 requires that hedging programs steer away from inflexible, programmatic practices employed previously to become more "risk responsive" and "data driven". WUTC requires an annual hedging plan submission that demonstrate risk responsive strategies in addition to retrospective hedge reporting. Gelber believes and Cascade concurs that the use of a diversified portfolio of hedging instruments including swaps, call options, and fixed-price physicals is the appropriate design criteria to satisfy Commission requirements.

An update of Cascade's work with Gelber on a more risk-responsive hedge design can be found in the Company's 2018 Annual Hedge Plan in Appendix E.

Portfolio Purchasing Strategy

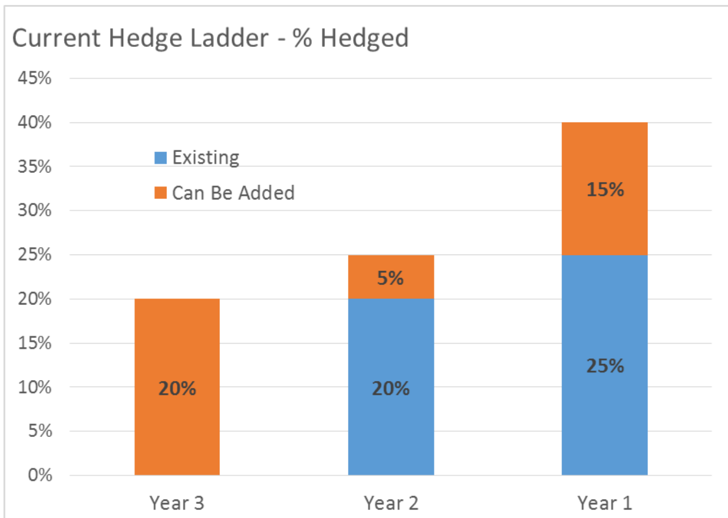
As stated earlier, GSOC oversees the Company's gas supply purchasing strategy. Based on current stable prices and a robust supply picture, the Company considers contracting physical supplies for up to five years (based on a warmer-than-normal weather pattern). The Company's current gas procurement strategy is to secure physical gas supplies for approximately one-third of the core portfolio supply needs each year for the subsequent rolling three-year period. This method ensures some portion of the current market prices will affect a portion of the next three years of the portfolio.

The current hedging plan for CNGC, approved by GSOC in the spring of 2018, is comprised of 100% physical purchases in a ladder design in which hedges are added and accumulated every year prior to the final consumption of the gas. The natural gas is considered hedged when its price is locked-in and scheduled for delivery in the physical market using a fixed-price physical purchase. The program currently allows up to 20% of expected purchases to be hedged three years prior to delivery, up to 25% hedged two years prior, and up to 40% hedged the year prior to the final consumption of the gas. The portfolio percentage of fixed priced purchases is defined in the Cascade Natural Gas NOV17-OCT18 PGA Hedging Plan dated September 28, 2017.

The gas supply portfolio design is overseen by GSOC, which determines the framework for the portfolio design including the allowable percentage of fixed-priced purchases. The execution of the portfolio and the hedging plan is accomplished primarily by the Supervisor of Gas Supply, under the leadership of the Manager of Gas Control & Supply for the Western Region. Either the Supervisor or Manager can execute purchases under the current plan (under the proposed plan they will retain this function), additionally, they may designate a backup within Gas Supply with the responsibility to execute trades in the event of their absence. The Manager of Supply Resource Planning functions as compliance manager regarding the WUTC's UG-132019 policy statement. This team is overseen by the Director, Gas Supply—Utility Group.

As depicted on Figure 4-4, the structure of the current plan is as follows: Year 1 is currently hedged at 25% (blue bars) which leaves 15% (orange bar) of additional hedges that can be added for Year 1. Year 2 is currently hedged at 20% which leaves 5% of additional hedges that can be added for Year 2. (For clarity, when Year 2 becomes Year 1, the hedge percentage will increase from a maximum of 25% to a maximum of 40% unless overridden by the GSOC portfolio design discussed previously). Year 3 is currently unhedged which leaves 20% of additional hedges that can be added for Year 3.

Figure 4-4: Current Hedge Ladder



Additional characteristics of the current strategy are described below:

- Stay the course. Portfolio procurement for 2018 should continue with same guidance as 2017's plan. This is the most reasonable action while the Company works with Gelber & Associates to identify modifications to future portfolio and hedging designs for GSOC to consider.
- Annual load expectation (Nov-Oct) is approximately 30,000,000 dekatherms, consistent with recent load history.
- Portfolio procurement design based on a declining percentage each year, accordingly: Year 1: approximately 80% of annual load expectation; Year 2: 40%, Year 3: 20%.
- Portfolio must contain a variety of parties, locations, contract volume and terms.
- Considerations of structured products, caps, floors, derivatives, etc. are not to exceed 5% of overall contract supply target. These items are principally used as a potential offset to fixed priced physicals being "out of the money".
- GSOC can always modify the plan to include additional years if a significant discount price materializes.

- GSOC may make further modifications to this portfolio plan based on the results of the Company's hedging initiative to be in compliance with WUTC docket UG-132019.

Under this procurement strategy, approximately 10% to 20% of the annual portfolio is to be met with spot purchases. Spot purchases consist of either first of the month transactions, executed during bid week for the upcoming month, or day purchases which are utilized to meet incremental daily needs.

Once GSOC has approved the portfolio procurement strategy and design, the Company employs a variety of methods for securing the best possible transaction under existing market conditions. Cascade employs a bidding process when procuring fixed priced physical, indexed spot physical, as well as financial swaps used to hedge the price of underlying index based physical supplies. In the bidding process, the Company alerts a minimum of three suppliers and/or financial counterparties of the specific gas supply transactions Cascade plans to fill. Cascade then collects bids from these parties over a period of time for the packages sought, comparing the indicative pricing to each party as well as comparing the information to market intelligence available at the time. Ideally, after monitoring these indicatives and the market, Cascade awards the specific packages to individual parties. Naturally, price is the principle factor; however, Cascade also considers reliability, financial health, past performance, and the party's share of the overall portfolio so that the Company ensures party diversity. It should be noted that the lowest market price may occur during a period when the Company is initially gathering the price indicatives; in that situation there is a risk that a sudden price run-up may lead to filling the transaction at the higher end of the bids over time, or delay the acquisition to another time. However, the reverse is also true—the initial price indicators may start high and drop over time allowing Cascade to capture the transaction on the downward swing. In the end, timing is always a factor as the market cannot be predicted with any certainty.

Cascade follows a similar process when it submits a formal request for proposals (RFP) to the various suppliers. Parties are asked to provide offers on specific packages, but are also encouraged to propose other transactions or packages that they feel may be of interest in helping Cascade secure financially attractive and flexible transactions to meet the Company's needs. This process requires additional analysis regarding operational reasonableness, timing, and volumes. Price comparisons also become more complicated since pricing could be tiered; part of a structure deal may be tied to an index or contains floors, caps, etc. Cascade utilizes TruMarx's COMET transaction bulletin board system to assist in communicating, tracking, and analyzing these RFP activities.

Conclusion

Cascade's 20-year supply side resource goal is to continue to meet the energy needs of its core market customers. This is accomplished through a package of services that combines adequate gas supplies and cost-effective winter peaking services with long-term pipeline transportation contracts and sufficient distribution system capacity at the lowest possible cost. The Company has identified several transport, storage, and other alternative resources which may be modeled to join the Company's existing demand and supply side resources to address the load demand needs over the planning horizon.

SECTION 5

ENVIRONMENTAL CONSIDERATONS

Purpose

This section considers Greenhouse Gas (GHG) emission reduction policies and regulations that have the potential to impact natural gas distribution companies. In addition, this section examines methodologies for applying a cost of carbon to natural gas distribution companies and identifies the assumptions made in determining a 45-year avoided cost of natural gas, and pairs these costs with associated two-year action items.

Significant emission policy development has occurred since Cascade's last IRP. The Federal government as well as policy-makers in Washington and Oregon have actively pursued GHG emission reductions, and primarily Carbon Dioxide (CO_2) emission reductions.

Key Points

- State and federal agencies are proposing GHG emission reduction regulations, which must be considered in the 2018 IRP.
- On December 15, 2017, Thurston County Superior Court invalidated the Washington Department of Ecology's CAR WAC-173-442.
- Cascade will be closely monitoring the Protect Washington Act (I-1631) on the November 2018 ballot
- Carbon tax legislation proposed in WA in 2017-2018 with no passage, but expect additional bill proposals in future legislative sessions.
- Cascade models SCC at 3% discount rate as its main carbon forecast, including sensitivities of I-1631 Ballot Initiative, SB 6203 Carlyle/Inslee 2018 proposed tax, and Congressional House of Representatives Market Choice to examine carbon cost impacts on prices.

Company Environmental Policy

Cascade's policy states:

"Our Company will operate efficiently to meet the needs of the present without compromising the ability of future generations to meet their own needs. Our environmental goals are:

- *To minimize waste and maximize resources;*
- *To support environmental laws and regulations that are based on sound science and cost-effective technology; and*
- *To comply with or exceed all applicable environmental laws, regulations and permit requirements."*

Cascade strives to maintain compliance and operate in an environmentally proactive manner, while taking into consideration the cost to customers. Cascade actively provides comments to federal and state legislative and regulatory activities related to environmental issues, including air emissions and other environmental requirements. The Company has also established memberships in relevant trade organizations to assist in monitoring the potential impact of proposed legislation and regulation to the Company's operations.

Overview

CNGC monitors environmental regulatory requirements in progress nationally, regionally, and locally that may have the potential to apply to local distribution companies (LDCs) in the future. As of October 5, 2018, there are no direct regulations that would require the Company to reduce GHG emissions. Also, there are currently no regulations or laws applying a carbon price to CNGC operational GHG emissions or GHG emissions resulting from customer use of natural gas which Cascade sells to customers. The requirements discussed in this section are projected to be the most informative for the Company to determine how to model potential impacts of carbon pricing in the IRP, absent any current requirements and understanding that there is a potential for a cost of carbon to impact Cascade in the future.

At the federal level, U.S. Environmental Protection Agency (EPA) has finalized significant air emissions regulations for energy companies, including proposed significant new regulations that aim to reduce GHG emissions at fossil-fired electric generating facilities, as well as oil and natural gas facilities and infrastructure. Although many of these regulations have not been projected to impact CNGC, the Company continues to monitor regulation development as it evolves and where it may have the potential to impact LDCs. Only a limited amount of congressional law-making activity has occurred over the past few years that would involve GHG reductions for LDCs.

Further, on a federal level, there have been programs established to provide platforms to encourage LDCs to make voluntary commitments in reducing GHG emissions. One of the voluntary platforms is EPA's Natural Gas Star Methane Challenge Program. The Methane Challenge Program was established by EPA in collaboration with oil and natural gas companies with Cascade participating as a founding partner of the program in March 2016 along with 50 other companies. Partners in the program demonstrate their commitment and concern for the environment through voluntary methane emissions reductions.

WUTC Staff suggested CNGC consider using the Social Cost of Carbon (SCC) with a three percent discount rate that was established by the Interagency Working Group (IWG) on Social Cost of Greenhouse Gases to model societal costs of GHG emissions resulting from customers' combustion of natural gas. The SCC is estimated using different discount rates to develop a range of costs in dollars per ton of CO_2 that would represent the avoided cost of long-term damage from climate change caused by a ton of CO_2 emitted in a given year. Agencies, such as the EPA, have used the SCC in determining the cost of climate impacts from rulemakings. Other agencies, such as the Federal Energy Regulatory Commission, continue to consider whether and/or how to incorporate the SCC into their permitting and rulemaking processes.

From the state perspective, Washington and Oregon have adopted regulations and legislation limiting GHG emissions predominantly from electric utility fossil-fired electric generation resources and continue to explore expansion of GHG regulation to other sectors. From a regional perspective, Cascade reviews energy and GHG emissions analyses published by the Northwest Power and Conservation Council (NWPCC) to inform on cost impact and potential future regional policy development. The Company has been involved in state-focused evaluation of renewable natural gas (RNG) opportunities in Washington and Oregon, and also monitors federal efforts on development of RNG policy through the Company's membership in trade organizations. Cascade has included a preliminary analysis of renewable natural gas projects in the Company's service area in Appendix J.

Most recently, there has been increased local-focus on adopting GHG emission reduction targets from communities within, and adjacent to, Cascade's service areas. Communities such as the city of Bellingham and Whatcom County, Washington, have adopted more challenging and aspirational GHG emission reduction measures for municipal and county facilities and operations, that may also extend community-wide in future. The city of Bend, Oregon has also adopted GHG reduction measures. CNGC has engaged with these communities and is working with them to meet GHG emission reduction targets and goals.

Cascade examines the policies and regulatory activities mentioned above in determining the GHG emission or carbon costs to model in IRP analyses. The Company considers both proposed and final regulations and legislation in this process. The following subsections provide more explanation of the policy and regulatory development that would be most informative in determining how to best model potential carbon impacts on Cascade's operations and customers. CNGC explains its approach and support for carbon cost modeling for this IRP. Cascade also includes discussion further below on GHG emissions in general, as well as actions and commitments the Company has taken to reduce GHG emissions.

Federal Regulation and Policy

1. EPA Regulatory Actions

a. Clean Power Plan (CPP) Status

On October 23, 2015, the EPA published the final Clean Power Plan (CPP) rule, Clean Air Act (CAA) 111(d) rulemaking, that requires existing fossil fuel-fired electric generation facilities to reduce GHG emissions. However, on February 9, 2016, the United States Supreme Court granted an application for a stay of the CPP until the

D.C. Circuit Court of Appeals (Court) issues a decision. The following year, EPA requested that the Court hold the case in abeyance as the agency reviews and potentially replaces the CPP rule and Court granted EPA's request. EPA proposed to repeal the CPP in December 2017 and requested comment on whether to replace or repeal the rule.

On August 30, 2018, EPA published a proposed rule, the Affordable Clean Energy (ACE) rule, revising the CPP to apply to existing coal-fired units and identifying the best system of emission reduction (BSER) to be set by states considering heat rate improvements that can be implemented at a source itself. A final rule is expected to be published in 2019. Cascade does not project any impacts to its operations from this rulemaking since the Company does not own or operate any fossil-fired electric generation facilities and is therefore not subject to the proposed rule.

b. New Source Performance Standard (NSPS) OOOOa Rulemaking

The New Source Performance Standard (NSPS) OOOOa Rule regulates methane monitoring and leak repair at standards of performance for crude oil and natural gas facilities for which construction, modification or reconstruction commenced after September 18, 2015. EPA limits regulation to oil and gas production facilities upstream of natural gas LDC facilities. EPA excluded local LDC systems from the rule since LDC systems generally operate at lower pressures than interstate pipelines and due to the downward trend of LDC methane emissions from implementation of voluntary process improvements that have reduced fugitive emissions. Therefore, only oil and gas facilities upstream of LDC custody transfer meters are regulated by this rule.

This rule has been challenged by the oil and gas industry, as well as environmental groups. On September 18, 2018, EPA proposed amendments to this rule that would address issues brought forward for reconsideration by industry. The rule continues to exclude LDC facilities.

c. Vehicle Fuel Economy Standards

On August 2, 2018, the U.S. Department of Transportation (DOT) and EPA proposed amendments to the Corporate Average Fuel Economy (CAFE) and GHG standards for vehicles with the Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years

2021–2026 Passenger Cars and Light Trucks. The rule would lessen the previously promulgated stringency of fuel economy standards for years 2021 to 2026 new cars, SUVs and light duty trucks. In support of the amendments, EPA cited concerns with maintaining the safety and affordability of vehicles, while still achieving lower pollution. Although these vehicle standards are not expected to significantly impact the use of natural gas, the Company will continue to monitor how vehicle regulations evolve for potential future impacts of use of compressed natural gas in vehicles.

2. Congressional Actions – U.S. House of Representatives Market Choice Bill

CNGC has continued to monitor federal legislative actions focused on regulation of GHG emissions. One recent proposed action on July 23, 2018, the Market Choice bill was introduced in the U.S. House of Representatives. This bill includes provisions for addressing GHGs, including a carbon tax for combustion of fossil fuels. The bill proposes to apply an initial tax of $24 per ton of CO_2 equivalent emitted from fossil fuel combustion starting in 2020 which would escalate annually by 2% plus an inflationary adjustment. Affected emissions would be quantified annually to determine if annual caps identified in the bill are met. If GHG emissions caps are not met, the tax would increase an additional $2 per year.

Although 2018 election year politics are expected to make passage of bills addressing GHG emissions very challenging, if not impossible, the Company is using the Market Choice bill as a CO_2 adder sensitivity as it represents the current congressional outlook of potential carbon pricing for fossil fuels. The subsection titled CO_2 Adders Modeled further below summarizes the main CO_2 adder and sensitivities Cascade is modeling. CNGC will continue to monitor congressional activity on GHG emissions to remain informed of potential nation-wide GHG requirements.

3. Federal Energy Regulatory Commission (FERC) Actions

Cascade has monitored a recent District of Columbia (DC) Circuit Court of Appeals decision pertaining to the FERC's approval of the Southeast Market's Sabal Trail natural gas pipeline project. The Sierra Club had challenged FERC's decision to approve the project's permit arguing that FERC was supposed to determine the impacts of GHG emissions downstream of the project. On August 22, 2017, the Court held that FERC is obligated to consider downstream GHG emissions in the agency's permitting analysis and remanded FERC's approval of the Southeast Market's Sabal Trail pipeline project for further review of downstream GHG emissions. FERC did not challenge the decision and moved forward with quantifying downstream GHG emissions. However, FERC chose not to use the SCC or any other method of monetizing GHG emissions in the analysis and did not utilize a method in identifying the significance of the emissions, and approved the permit for the project on August 10, 2018. Environmental groups asked for a rehearing on the permit, but FERC denied the request.

Other circuit courts that have reviewed similar challenges to FERC project approvals have concluded that FERC is not required to consider downstream emissions in approving a permit. Due to the split decisions in courts and to gain clarity going forward, FERC issued a notice of inquiry in April 19, 2018 and sought public input by July 25, 2018, on how they should consider GHG emissions and climate change impacts within the agency's National Environmental Policy Act (NEPA) policies and procedures for approving projects. FERC has not set a date for acceptance of reply comments or in finalizing any potential revisions to the agency's NEPA policies and procedures. This decision does not directly impact operations, but could be informative in the future understanding of how federal energy agencies consider monetizing GHG emissions.

4. Social Cost of Carbon (SCC)

The SCC is estimated using different discount rates to develop a range of costs in dollars per ton of CO_2 that would represent the avoided cost of long-term damage from climate change caused by a ton of CO_2 emitted in a given year. Agencies, such as the EPA, have used the SCC in determining the cost of climate impacts from rulemakings. Other agencies, such as FERC, continue to consider whether and/or how to incorporate the SCC into their permitting and rulemaking processes.

WUTC Staff suggested Cascade consider using the SCC with a three percent discount rate that was established by the U.S. Governmental Interagency Working Group on Social Cost of Greenhouse Gases to model societal costs of CO_2 emissions resulting from customers' combustion of natural gas. The IWG's last revised the SCC in August 2016. The IWG noted in their August 2016 publication that, "the central value is the average of SC-CO_2 estimates based on the 3 percent discount." However, the SCC provides that due to uncertainty of the estimates, agency regulatory impact analysis should consider all four discount rate SCC estimates. In this IRP, Cascade will be using the three percent discount rate SCC as the main CO_2 adder in modeling impacts of a potential price that could be placed CO_2 emissions from customers' usage of natural gas sells.

State Regulation and Policy

New environmental regulations and policies continue to be proposed in Washington and Oregon. The purpose of these proposals is to address GHG emissions resulting from the use of fossil fuels. Considering Cascade is a natural gas distribution company, some of these regulations could have the potential to significantly increase CNGC operating costs.

1. Washington

Since the last IRP, the Clean Air Rule (CAR) was invalidated by Thurston County Superior Court Judge James Dixon. From 2017 to 2018, Washington environmental legislative action focused mainly on carbon tax bills. Meanwhile, the state continued to pursue potential energy code revisions; an analysis of Washington State RNG potential was undertaken; and a ballot initiative applying carbon fees to fossil fuel combustion and fossil fuel distributors has qualified for the 2018 election in Washington.

a. Washington Department of Ecology (Ecology) Clean Air Rule (CAR)

On September 15, 2016, the Washington Department of Ecology (Ecology) issued the final Washington CAA CAR WAC-173-442 requiring greenhouse gas emission reductions from various industries in the state, including emissions from the combustion of natural gas supplied to end-use customers by natural gas distribution companies, such as Cascade. On the same date, Ecology finalized requirements for reporting GHG emissions from natural gas distributors under WAC 173-441.

On September 27, 2016 and September 30, 2016, Cascade and three other natural gas distribution utilities jointly filed complaints in the United States District Court for the Eastern District of Washington and the State of Washington Thurston County Superior Court, respectively, challenging the legal underpinnings of CAR. On December 15, 2017, Thurston County Superior Court Judge James Dixon ruled that Ecology can limit GHG emission from direct emitters, but LDC and petroleum producers are not direct emitters, and invalidated CAR based on that argument. Later that December, Ecology suspended all rule requirements.

On May 16, 2018, Ecology filed an appeal with the Supreme Court of Washington and briefing is underway. Oral argument has been scheduled for March 19, 2019. A decision from the Supreme

Washington Court is expected sometime in 2019, after Cascade's 2018 IRP filing.

b. Washington Ballot Initiative 1631 (I-1631) – Protect Washington Act

Washington Ballot Initiative 1631 (I-1631), identified as the Washington Carbon Emissions Fee and Revenue Allocation Initiative, will appear on the November 2018 ballot in Washington. I-1631 is termed a pollution fee and is applicable to all fossil fuels, including natural gas, and would be collected upon sale of natural gas distributed to customers. The fee starts at $15 per ton and escalates annually by $2 plus an inflationary adjustment. By 2030, the fee is projected to be about $40 per ton. There is no cap on the fee, although the fee may be capped if the state achieves its statutory greenhouse gas reduction goals by 2035. By 2045, the fee is projected to be about $88 per ton. CNGC is modeling I-1631 costs as a CO_2 adder sensitivity since it represents a current potential carbon pricing for fossil fuels in Washington.

Energy Intensive-Trade Exposed (EITE) industries appear to be exempt from the fee if they are on a list of exempted entities cited directly from the state's CAR, which has been invalidated by Washington State Superior Court. Some Cascade customers may qualify as EITE.

Utilities may be authorized to spend the proceeds of the fee by developing a Clean Energy Investment Plan that would include carbon reduction programs, such as natural gas conservation and energy efficiency programs. A utility's Clean Energy Investment plan would need to be approved by a new government agency proposed as a Public Oversight Board created within the Office of the Governor, as well as the WUTC.

After the filing of the Draft 2018 WA IRP, Washington voters struck down this initiative by a vote of 57-43 against.

c. Washington 2018 Legislative Activity

Potential other carbon legislative initiatives were proposed through the Washington legislature in 2018, but no bills passed into law. Many of the bills involved annual carbon taxes applied to industries that have combusted fossil fuels and/or are suppliers of fossil fuels. Some examples of these bills included SB 6335 sponsored by

Senator Steve Hobbs, SB 6096 sponsored by Senator Kevin Ranker and SB 6203 sponsored by Senator Reuven Carlyle and supported by Governor Jay Inslee. SB 6335 included a $15 per ton CO_2 tax, which would have been capped at $25 in 2024 and ongoing. SB 6096 included a $15 per ton CO_2 tax with a $2.50 annual escalation and would have been capped at $30 per ton in 2025. SB 6203 was considered by some to have the highest potential to pass and in its final version included a $12 per ton CO_2 tax starting in 2020 plus a $1.80 annual escalation and a $30 per ton price cap.

Cascade expects more carbon tax or other GHG legislation to be considered in the 2019 session, possibly depending on the outcome of I-1631. CNGC is modeling SB 6203 as a CO_2 adder sensitivity since it represents a current potential carbon pricing for fossil fuels in Washington.

Other legislation the Company monitored in Washington in 2018 included SHB 2580, a bill promoting RNG which passed into law. This law requires the Washington State University Extension Energy Program and the Washington Department of Commerce, in consultation with WUTC, to submit a report of recommendations to the Governor and legislative energy committees by September 1, 2018 on how to promote sustainable development of RNG. However, it was determined that more time was needed to successfully complete the report and it is now projected to be final by December 1, 2018. The report is to include an inventory of practical RNG opportunities in the state, costs to produce RNG, projected state usage of RNG, and whether to adopt a procurement standard for RNG. Cascade will review a draft report when it becomes available.

Several Energy Code proposals were introduced in 2018. These included several proposals which would have impacts on natural gas usage including EW 101 for service water heating; EM050 which would affect energy simulation methodologies for buildings; and EM141 which proposes to use Appendix G from ASHRAE 90.1 as the chosen energy code performance path. As of October 2018, the State Building Code Council is in the process of taking comment and deliberating on these, and other proposed adjustments.

d. Washington Volkswagen (VW) Settlement Funds

Volkswagen (VW) violated the CAA through implementation of fraudulent emissions software in vehicles VW sold in the U.S. from about 2008 to 2015. EPA settled with VW in 2017 and designated settlement money to each state based on VW vehicle sales within the state. The State of Washington was allocated $112.7 million from the settlement. Ecology developed and proposed a mitigation plan for spending the settlement allocation and received public comment on the draft mitigation plan in late 2017. Ecology proposed spending the VW allocation on electrification of public fleets (especially transit buses), non-road electrification at airports, electrification of publicly-owned locomotives, electrification of ferries and marine vessels, light-duty zero emission vehicle supply equipment and for increasing matching funds within the Diesel Emissions Reduction Act Option. The State of Washington's VW Steering Committee is currently reviewing comments on the mitigation plan. The next steps will be to finalize the plan, prioritize categories for project solicitation, and design funding processes for awarding money for projects. As the Washington Steering Committee has prioritized funding from the settlement to focus on transportation electrification, CNGC operations would not appear to be significantly impacted. Cascade will continue to monitor Washington's prioritization of the VW settlement as the mitigation plan is made final.

2. Oregon

Since the last IRP, Oregon environmental legislative action in 2017 and 2018 focused mainly on carbon cap and trade programs. Other areas of legislative focus included building code revision for GHG emission reductions, appliance energy efficiency standards, and understanding the potential of RNG.

a. Executive Order (EO) No. 17-20

EO 17-20 was developed with the goal of reducing GHG emissions and addressing climate change. EO 17-20 offers several directives with potential impacts on the natural gas sector. These include new performance and equipment standards for state buildings; residential compliance with the Zero Energy Ready Standard by October 1, 2023; and state building code amendments for commercial construction requiring that newly constructed commercial buildings exceed International Energy Conservation Code and ASHRAE 90.1 by October 1, 2022.

More immediate outcomes resultant from EO 17-20 include the directive that the Oregon Department of Energy (ODOE) work with appliance industry stakeholders to identify categories of appliances for improved efficiency standards, while considering appliance standards of other states, potential efficiency gains, potential costs, and regional market supply chains for appliances. ODOE is to also provide the Governor with a report of its analysis and identify categories of appliances for improved efficiency by November 1, 2018. ODOE is currently seeking the ability to make direct updates to Oregon appliance standards via a legislative concept that would be introduced as a bill in January 2019. Since appliance standards through this legislation may impact usage of natural gas, CNGC will continue to monitor and engage in this process as appropriate.

The Oregon Public Utility Commission (OPUC) has been directed to work with The Energy Trust of Oregon (ETO) and interested stakeholders to expand meter-based savings pilot programs, including pay-for-performance pilot programs, by January 1, 2019. The OPUC has been asked by the Governor to consider inclusion of pilot programs which do not significantly raise energy efficiency delivery costs, and that focus on existing single-family homes, multi-family homes, multi-family residential buildings, commercial buildings and methods to incentivize energy efficiency in building stock that is significantly below current building code requirements. As a result, the ETO has begun to work with Cascade and the other LDCs to enact a pilot mobile home replacement program for income-qualified customers. This effort also meets the EO provision directing ODOE, the OPUC, Oregon Housing and Community Services, Bonneville and the ETO to expand its existing multi-family energy program and green energy path requirements, including a manufactured home replacement program through pilot programs and initiatives, while considering multiple values from energy efficiency improvements such as health and habitability.

b. SB 334 – Inventory of Biogas and Renewable Natural Gas in Oregon

SB 334, which was passed during the Oregon 2018 legislative session, directs the ODOE to create a detailed inventory of biogas and renewable natural gas resources in the state. The inventory, which was finalized in September of 2018, includes a narrative of opportunities and barriers to implementation of biogas and RNG in the State of Oregon. Cascade has strongly supported the development of this inventory as a member of the SB 334 Advisory Committee.

The report was finalized and submitted to the Oregon legislature and Governor in mid-September 2018. Cascade and the other members of the advisory group have now been tasked with addressing data gaps and next steps including: development of a practical statewide RNG potential assessment; lifecycle economic analysis of RNG production pathways; tracking and accounting for RNG in transportation and stationary fuel use; a future carbon policy study; detailed analysis of market economics and drivers; and a more comprehensive feedstock inventory and other biogas production pathways. The Company intends to be an active participant in this effort.

c. 2018 Oregon Cap and Trade Legislation

Legislation that was monitored in Oregon in 2018 included proposed carbon cap and trade program bills. A few bills that stood out to Cascade were GHG cap and trade program bills HB 4001 and SB 1507 which applied to most fossil combustion emissions, including natural gas distribution. No bills passed in 2018. Additional cap and trade programs proposals may be introduced in the 2019 legislative session and the Company will continue to monitor impacts from proposed Oregon legislation that may be informative for determining carbon pricing for modeling CNGC impacts in Washington.

d. Joint Interim Committee on Carbon Reductions

The Oregon legislature set appropriated funding for a Carbon Policy Office and Joint Interim Committee on Carbon Reductions. The Joint Interim Committee convened in April 2018 and continued to meet over the summer and through the fall. The goal of the Joint Interim Committee is to lay groundwork for 2019 legislation that would place a price on carbon. There was a strong focus placed on transportation and electric generation sectors, although all sectors are being considered. Coordination of legislation is taking place with the Governor’s Carbon Policy Office. The Carbon Policy Office will manage research studies on forest carbon sequestration, EITEs, and economic impact analysis.

It is possible that other state or federal regulation and legislation may potentially be adopted in the future that could require Cascade to address GHG emissions. Cascade will continue to monitor GHG regulation and legislation for potential impacts to natural gas distribution companies.

e. Oregon Volkswagen (VW) Settlement Funds

As explained above under the Washington VW Settlement subsection, state environmental agencies have requested public comment over the past couple years on how to utilize federal funding allocations from the VW settlement monies made eligible to states. The State of Oregon Department of Environmental Quality has decided to utilize these funds for replacement or retrofit of diesel powered school buses considering exhaust control retrofitting or bus replacement. Districts were selected among those holding buses in the median model year of the state's fleet which represent 2006 to 2007 model years. Out of the approximate 450 buses state-wide, 20 buses qualified in CNGC's service area. Cascade has reached out to these districts and Mid Columbia Bus Company in case compressed natural gas (CNG) is considered as a fuel for those bus retrofits and replacements. The Company will continue to monitor how allocation of these settlement funds for CNG fuel for transportation is considered with potential carbon pricing legislative actions.

Regional Policy

The NWPCC examines CO_2 costs in its periodically published Power Plans. The NWPCC's Seventh Power Plan, released in May 2016 is considered a recognized standard for carbon analysis in the Pacific Northwest and Cascade utilized the Seventh Plan's projected CO_2 costs to model cost impacts to natural gas distribution utilities in the 2016 IRP. The NWPCC has not published an updated Power Plan in the past two years, but is expected to publish an update in early 2019. As there is a possibility that the Seventh Power Plan may have dated CO_2 cost projections, Cascade will be utilizing other CO_2 adders to model cost impacts in the 2018 IRP. The Company will continue to review and consider NWPCC's updated reports for modeling costs in future IRPs.

Local Policy

In the past few years, Cascade has observed a heightened interest by local jurisdictions and municipalities in committing to the reduction of GHG emissions within a municipality, as well as some applying commitments community-wide. Those cities or counties establishing commitments are focusing on goals and aspirations in the range of 80 percent GHG reductions relative to 1990 levels by 2050, which is consistent with the Paris Climate Agreement.

For background, the Paris Climate Agreement was a pact made by many countries across the globe, responding to concerns regarding climate change. In the pact, countries committed to GHG reductions to limit increasing global temperatures and fund response to impacts of climate change. The U.S. had been a party to the pact in 2015, committing to GHG reductions identified in the CPP. However, in 2017, President Trump withdrew the U.S. from the Paris Climate Agreement.

Within Cascade's service areas, the City of Bellingham and Whatcom County in Washington, and the City of Bend, Oregon have developed GHG reduction goals. A summary of those commitments is provided below. The Company is not utilizing local policies in modeling CO_2 cost impacts in this IRP as these goals are stated as aspirational and goals continue to be evaluated by these local entities.

Cascade has not observed any other area within the Company's Washington and Oregon service areas having similar commitments at this time. However, there are other areas adjacent to Cascade's service areas adopting similar commitments, such as Tacoma, Seattle, and Edmonds, Washington, Multnomah County and Portland, Oregon, and Vancouver, British Columbia. These items are further discussed below.

1. **City of Bellingham, Washington**

   The City of Bellingham recently passed a resolution updating emission reduction targets for municipal facilities and operations to reduce emissions 85% below 2000 levels by 2030, and 100% below 2000 levels by 2050, making the city facilities and operations carbon-neutral. Bellingham also included in the resolution a target to reduce community-wide emissions 70% below 2000 levels by 2030, and 85% below 2000 levels by 2050. Specifically, the goals are to obtain energy from all renewable resources and remove use of fossil fuels by 2030 and 2035 within the city, including transportation. The City Council has acknowledged that the goals may not be practical and are aspirational.

   The City of Bellingham has established GHG reduction targets since about 2012 and has been working on emissions reductions for some time. For City infrastructure, the City states on its website that city infrastructure and operations dropped GHG emissions by almost 70% between 2000 and 2012. In 2015, municipal emissions increased slightly but the City believes it is still on track to meet the 2020 goal with continued reductions in natural gas usage and fleet emissions.

   The City determined that community-wide emissions fell 17 percent between 2000 and 2012, exceeding the goal of a seven percent reduction.

In 2015, community emissions increased compared to 2012, which may make it more challenging to reach emissions targets in 2020 and beyond.

The City's past Climate Protection Action Plan was updated to reflect the new targets. The City created the Climate Action Task Force to explore and recommend how the city and community can meet these new targets, taking into account technology, feasibility, possible accelerated targets, funding mechanisms, as well as costs and other impacts. The task force will include community members that have experience in renewable energy, energy conservation, land use, energy/resource economics, community engagement, transportation, and finance. Energy utility representation and public transportation representatives were identified, as well. The City of Bellingham department staff are on the task force, and the task force is supported by Mayor-designated staff and City Council-designated staff.

The City of Bellingham did not allow more than one utility representative at the table and Puget Sound Energy (PSE) was chosen by the City to represent utilities on the task force. CNGC is working together with PSE to ensure Cascade's input is considered. The Company is also engaging with other task force members to ensure the Company's input is considered by the task force as much as possible. The task force began meeting on September 5, 2018.

2. Whatcom County, Washington

Whatcom County, in which the City of Bellingham is situated, has committed to the "Ready for 100" campaign that the Sierra Club is advocating and has established goals through a county ordinance. The "Ready for 100" campaign website recommends a goal of 100% renewable electricity by 2035 and 100% renewable for all other energy sectors by 2050, but participants can target less stringent goals. Whatcom County has chosen to commit to 100% renewable electricity for county operations by 2035, and plans to also apply the goal for the larger Whatcom County community.

3. City of Bend, Oregon

The City Council of Bend, Oregon passed Resolution 3044 in 2016 establishing voluntary GHG emission reduction goals for City facilities and operations of 40% reduction of 2010 baseline year emissions by 2030 and 70% reduction of 2010 baseline year emissions by 2050. The City may determine to use more recent years for its baseline. After further review, the City may determine to apply the same voluntary goals community-wide.

The City Council passed another resolution, Resolution 3099, which created a Climate Action Steering Committee (CASC). The CASC provides recommended actions to the City Council that encourage and incentivize businesses and residents, through voluntary efforts, to reduce GHG emissions and fossil fuel use considering the voluntary goals.

Cascade has a representative from its staff appointed to the CASC, and is actively engaged in supporting the development of a viable pathway forward that considers the essential balance between the City's economic vitality, reliability of its energy supply, and environmental goals. The CASC will author a plan recommending a set of strategies to guide both the City and the surrounding community in achieving its goals, which the City may choose to adopt in a Community Climate Action Plan. The target date for the plan adoption is September 2019.

The CASC has already met several times and commissioned Good Company to complete a community GHG emissions inventory which was presented to CASC and the public on August 2, 2018. The CASC is currently finalizing its Vision Statement, and holding a series of subcommittee workshops focused on Energy Supply; Energy Efficiency in Buildings; Transportation; and Waste & Materials Management. Members of the greater community have been invited to participate.

Natural Gas Industry GHG Emissions

GHG emissions in the oil and gas sector include fugitive methane emissions from well/pipeline infrastructure and well completion processes, as well as GHG emissions from natural gas flaring, compressor engines and other combustion equipment. There is continued debate on contribution of these emissions and how to consider emissions in total energy supply chain since emissions studies vary. For consideration, the NWPCC's Seventh Power Plan notes:

> *"…there is considerable uncertainty around such issues as whether its impacts compared to carbon dioxide are over or under-stated…and whether accounting for the methane emissions from coal production would also raise that fuel's full life-cycle climate impacts…"*
>
> *"…will likely draw on gas production new wells which have lower fugitive emissions…"*
>
> *"…unless new pipeline capacity is needed, fugitive emissions from pipeline leaks remain relatively constant…"*

The Company will continue to review future outlooks of the NWPCC's Power Plan when an updated plan is released.

From review of EPA published GHG emissions reports in 2016, the oil and gas sector emitted about 9.5 percent of the total GHG emissions from all industries, equating to approximately 283 million metric tons of CO_2 equivalent per year. LDC facility and operations contributes to GHG emissions generally through fugitive methane emissions and leaks from pipeline infrastructure, as well as from combustion of fuel in compressors. For instance, CNGC has one small natural gas-fired compressor station near Mt. Vernon, Washington.

EPA GHG emissions estimates from 2016 indicate that about five percent of oil and gas sector emissions are from LDC infrastructure, equating to about 14 million metric tons of CO_2 equivalent per year. However, due to conservative emission factors used in calculating and reporting emissions, Cascade expects that the LDCs' contribution may actually be lower.

Cascade is required to report annual facility GHG emissions to the State of Washington and emissions have generally been in the range of about 27,000 metric tons of CO_2 equivalent per year. CNGC's facility GHG emissions in Oregon are lower and are not required to be reported to EPA or the State of Oregon.

GHG emissions are generated by Cascade's customers due to combustion of natural gas. Over time, the Company's sales of natural gas have grown to accommodate customers' demand for natural gas, and therefore, GHG emissions have increased from customers' combustion of natural gas. Increased demand is expected to be due to currently stable natural gas prices and steady economic growth.

The total annual emissions from Cascade's core customers are in the range of 2 to 2.5 million metric tons of CO_2 per year. Emissions from non-core customers have totaled in the range of about 2.5 million tons per year, and this can vary significantly by year.

Cascade GHG Emissions Reductions

CNGC is not currently subject to any GHG emissions reduction requirements. However, the Company has achieved GHG emissions reductions through economically prudent voluntary efforts. Some of Cascade's GHG emissions reductions have been realized through implementing operational changes and capital projects required through other regulatory requirements. These GHG emissions reductions are discussed below.

1. Fugitive Methane Emissions Reductions

EPA has focused on reducing fugitive methane emissions from the oil and gas sector, but has not applied emission reduction requirements specifically to LDCs. Instead, the agency has focused on sponsoring voluntary programs to encourage commitments to reduce methane emissions from LDCs.

a. EPA Natural Gas Star Methane Challenge Program.

Cascade became a Founding Partner of the EPA's Natural Gas Star Methane Challenge Program in March 2016. As a Founding Partner, CNGC has chosen to participate in the program under the Best Management Practice (BMP) Commitment – Excavation Damages within the natural gas distribution sector. The BMP Commitment entails a Partner's commitment to company-wide implementation of BMPs to reduce methane emissions. Involvement in this program also provides a forum for companies to share knowledge on successfully implementing BMPs and methane emissions reductions. During the initial commitment timeframe, the Company will conduct incident analyses on all excavation damages and report the relevant data to EPA.

Specifically, CNGC demonstrates its commitment to this program through implementation of BMPs to promote leak reductions. Recently, Cascade created the position of Public Awareness and Damage Prevention Coordinator. This position assists in providing community education and outreach opportunities, focusing on damage prevention and further reducing potential releases of methane from excavation damages. This position will also focus on working with contractors or third parties that are repeat offenders. By identifying and reaching out to these third parties prior to work beginning on the respective project, the Company expects to see a reduction in excavation damages throughout the Company's service areas.

Cascade also actively participates in 811, Common Ground Alliance, and damage complaint programs in Washington and Oregon. The Company continues to explore other voluntary actions which could reduce methane emissions resulting from excavation damage.

Beyond CNGC's commitment to reduce methane emissions from excavation damages, Cascade has completed operational and infrastructure changes to comply with federal requirements which have resulted in lower methane emissions, and therefore lower GHG emissions, in the State of Washington. This has mainly been realized through pipeline replacement projects where newer and more leak proof pipeline materials such as polyethylene and steel are used to replace older more leak-prone materials. From 2012 to mid-2018, the Company has replaced nearly 91 miles of early vintage steel pipe, ranging from service lines up to 12-inch mains, with new steel or polyethylene pipe.

Further, CNGC is better positioned than most U.S. utilities as the Company has no unprotected steel pipeline and none of the potentially leak-prone cast iron pipe seen elsewhere. There are many LDCs who still have cast iron pipe in their systems and are focusing on replacement of that infrastructure. Cascade has not yet quantified reductions of fugitive emissions and continues to explore the best methodology for estimating reductions.

b. Energy Efficiency Program Greenhouse Gas Emission Reductions

Cascade's conservation programs help reduce GHG emissions by providing incentives to customers for a comprehensive set of prescriptive and custom energy efficiency upgrades designed to streamline their use of natural gas, thus reducing their overall carbon footprint. Space, water heating, and weatherization incentives drive positive energy behavior in customers' homes and businesses. This leads to lowered demand, bill reductions, and overall carbon emission reductions in the communities. Cascade's energy efficiency programs currently save about 40,000 to 80,000 dekatherms annually, about 5,000 metric tons of CO_2 per year. More emission reductions will be realized as the Company's programs mature and continue to grow. Please see Section 7, Demand Side Management, for additional details.

In addition to the conservation of natural gas, the direct use of this resource can also be a significant source of carbon reduction. When natural gas is transported to electric generation facilities which, in turn, transmit electricity for customers' end-uses (e.g., space heating, water heating, cooking, etc.), 50% to 75% of the Btu content of the power is lost when compared to the same end-uses which have been supplied by natural gas. According to the American Gas Association's whitepaper, Dispatching Direct Use: Achieving Greenhouse Gas Reductions with Natural Gas in Homes and Businesses, a typical gas water heater uses half the energy of an electric resistance hot water heater, emits half the CO_2, and costs less than half as much to operate on an annual basis. This opportunity for carbon savings applies to space heating equipment as well.

In fact, EPA recognizes source efficiency as the method utilized when assessing the energy efficiency value of conservation equipment and measures.

It is for these reasons that CNGC has encouraged the direct use of natural gas when paired with strong energy conservation measures. Accelerating this effort would be of benefit from both a demand response and a GHG emissions reduction standpoint—a win for the community, Company, and customers.

CO_2 Adder Analyses

Cascade has chosen to model CO_2 adders from a review of the information compiled above for the 2018 IRP. Since there are currently no GHG reduction requirements applicable to LDCs, the Company has chosen the most representative of state and federal GHG policies for modeling potential carbon regulatory impacts on operations and customers.

Although this section is dedicated to CO_2 adder discussion, Cascade also applies environmental adder sensitivity analyses in modeling environmental general impacts of 0%, 20%, and 30%, as well as impacts on timing and quantity of demand side resources, total system costs of candidate portfolio under stochastic conditions, and timing and quantity of viability of renewable natural gas. For detail and discussion on the application of the adders in the modeling analysis, see Section 8, Resource Integration.

1. Washington and Oregon Commission-Jurisdictional Planning Treatment

WUTC has acknowledged in recent regional IRPs the strong desire for LDCs to use the SCC with a three percent discount rate to model impacts in carbon analyses, as referenced in the acknowledgements below:

- PSE UE-160918 and UG-160919
- Pacific Power UE-160353
- Avista UE-161036

Based on WUTC's request that Cascade also consider this in the Company's modeling analysis, as well as through guidance received from stakeholders in workshops, the Company has chosen to model the SCC at a three percent discount rate as its baseline carbon forecast as the main carbon adder scenario in the 2018 IRP.

2. CO_2 Adders Modeled

Cascade has chosen to use one main CO_2 adder scenario and three sensitivities to model cost impacts from potential future carbon pricing that could apply to customer's usage of natural gas. Cascade is not using CAR as a CO_2 adder due to Thurston County Court invalidating the rule. The methodologies chosen to model are discussed below. The Company discussed the proposed CO_2 adders and modeling approaches in Technical Advisory Group (TAG) meetings and received no objections.

a. Social Cost of Carbon (SCC)

Cascade is modeling the SCC as the main carbon adder in its IRP. CNGC is specifically modeling the three percent discount rate SCC published by the U.S. IWG on the Social Cost of Greenhouse Gases' Social Cost of Carbon. The IWG SCC costs based on the three percent discount rate are included in the subsequent table, which was taken from the IWG's publication Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866. Table 5-1 provides a snapshot of the modeled costs from the SCC Technical Support Document from 2010 to 2050.

Table 5-1: Carbon Costs from SCC ($/Metric Ton CO_{2e})

Year	5% Average	3% Average	2.5% Average	High Impact (95th Pct at 3%)
2010	10	31	50	86
2015	11	36	56	105
2020	12	42	62	123
2025	14	46	68	138
2030	16	50	73	152
2035	18	55	78	168
2040	21	60	84	183
2045	23	64	89	197
2050	26	69	95	212

b. Washington SB 6203

Cascade considered a sensitivity for modeling carbon pricing using the carbon tax values proposed in SB 6203 as it was considered by some to have the highest potential to pass in the Washington 2018 legislative section. In its final version, the bill included a $12 per ton CO_2 tax starting in 2020 plus a $1.80 annual escalation and a $30 per ton price cap. The Company expects more carbon tax or other GHG legislation to be considered in the 2019 session, which could be similar to SB 6203.

c. Protect Washington Act (I-1631)

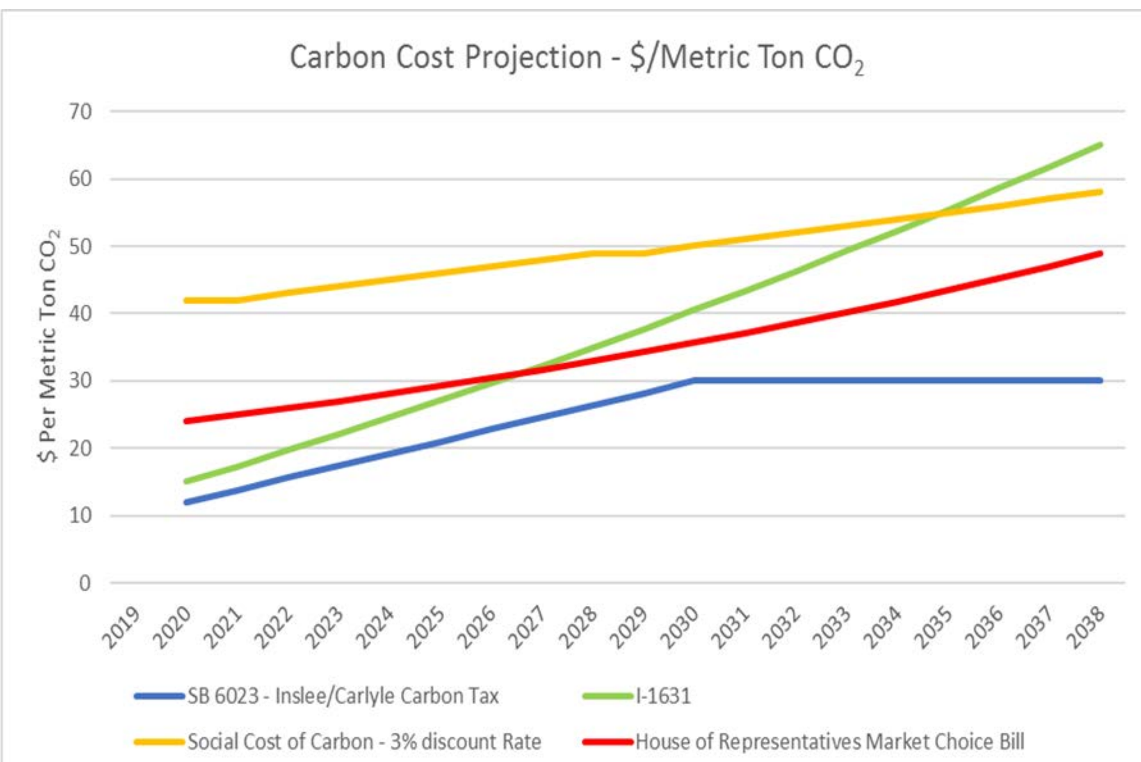
A third scenario that is modeled is the proposed Washington Ballot Initiative 1631 (I-1631). Cascade is modeling I-1631 as a CO_2 adder sensitivity since this proposed measure will be on the November ballot in Washington and is representative of a potential pollution fee that would be collected upon sale of natural gas distributed to customers. The fee starts at $15 per ton of CO_2 and escalates annually by $2 plus an inflationary adjustment. By 2030, the fee is projected to be about $40 per ton. There is no cap on the fee, although the fee may be capped if the state achieves its statutory greenhouse gas reduction goals by 2035. By 2045, the fee is projected to be about $88 per ton.

d. U.S. House of Representatives Market Choice Bill

CNGC is modeling the Market Choice bill as a CO_2 adder sensitivity since it currently represents the most current carbon legislation proposed at the Federal level. This bill includes provisions for addressing GHGs, including a carbon tax for combustion of fossil fuels. The bill proposes to apply an initial tax of $24 per ton of CO_2 equivalent emitted from fossil fuel combustion starting in 2020 which would escalate annually by 2% plus an inflationary adjustment. Affected emissions would be quantified annually to determine if annual caps identified in the bill are met. If GHG emissions caps are not met, the tax would increase an additional $2 per year. Cascade models the 2% annual increase, plus inflationary adjustment, in this IRP analysis, but assumes GHG emissions caps are met and no additional penalties would be applied to the carbon tax.

Figure 5-1 illustrates all of the CO_2 adder values discussed above over an approximate 20-year period.

Figure 5-1: Carbon Cost Projections



Conclusion

There are currently no GHG emissions reduction requirements that apply to LDCs. Although there are no applicable GHG reduction requirements for LDCs, Cascade has been voluntarily reducing fugitive methane emissions and reducing GHG emissions from customer combustion of natural gas through implementation of energy efficiency and conservation programs.

WUTC has stated in recent regional IRPs the strong desire for LDCs to use the SCC with a three percent discount rate to model impacts in carbon analyses. Based on WUTC's request that Cascade consider this in the Company's modeling analysis, as well as through guidance received from stakeholders in workshops, the Company has chosen to model the SCC at a three percent discount rate as the main carbon adder scenario in the 2018 IRP. For additional CO_2 adder sensitivity analyses, Cascade reviewed GHG emissions policies and regulatory activities in progress at the federal, state, region and local levels and chose to model Washington SB 6203, Washington Ballot Initiative 1631, and the U.S. House of Representatives Market Choice bill.

SECTION 6

AVOIDED COSTS

Overview

The avoided cost is the estimated cost to serve the next unit of demand with a supply side resource option at a point in time. This incremental cost to serve represents the cost that could be avoided through energy conservation. The avoided cost forecast can be used as a guideline for comparing energy conservation with the cost of acquiring and transporting natural gas to meet demand.

This section presents Cascade's avoided cost forecast and explains how it was derived. While the IRP is only a 20-year plan, avoided costs are forecasted for 45 years to account for the full measure life of some conservation measures, such as insulation, which has a 30-year life. The avoided cost forecast is based on the performance of Cascade's portfolio under expected conditions.

Key Points

- Avoided cost forecasting serves as a guideline for determining energy conservation targets.
- Cascade's avoided costs include fixed transportation costs, variable transportation costs, commodity costs, a carbon tax, distribution system costs, a risk premium, and a 10% adder.
- New to the 2018 IRP, the Company has included a value for avoided or delayed distribution investment.
- The total nominal avoided cost ranges between $0.2918 and $0.8111/therm over the 20-year planning horizon.

Costs Incorporated

The components that go into Cascade's avoided cost calculation are as follows:

$$AC_{nominal} = TC_f + TC_v + SC + ((CC + C_{tax}) * E_{adder}) + DSC + RP$$

Where:

- $AC_{nominal}$ = The nominal avoided cost for a given year. To put this into real dollars apply the following: Avoided Cost/ (1+discount rate)^Years from the reference year.
- TC_f = Incremental Fixed Transportation Costs
- TC_v = Variable Transportation Costs
- SC = Storage Costs
- CC = Commodity Costs
- C_{tax} = Carbon Tax
- E_{adder} = Environmental Adder, as recommended by the Northwest Power and Conservation Council
- DSC = Distribution System Costs

- RP = Risk Premium

The following parameters are also used in the calculation of the avoided cost:

- The most recent load forecast (7/30/2018);
- The inflation rate used is tied to the Consumer Price Index (CPI); and
- The discount rate of 4.43% (30-year fixed mortgage rate as of 6/1/2018).

Understanding Each Component

- **Incremental Fixed Transportation Costs**

  For the 2018 IRP, after the planned acquisition of the Bremerton/Shelton realignment, Cascade projects shortfalls to begin in 2023. To this end, fixed transportation costs after 2022 represent the average reservation rate of all incremental contracts that would be used to solve shortfalls. Importantly, in some cases, these costs are an estimate based on information from the pipelines, and furthermore, should be treated as confidential as any incremental fixed transportation costs could ultimately be a negotiated rate. These costs are inflated by the CPI escalator every four years to mimic the occurrence of potential rate cases.

- **Variable Transportation Costs**

  Variable transportation costs are the cost per therm that Cascade pays only if the Company moves gas along a pipeline. This rate is set by the various pipelines and can be changed if the pipeline files a rate case. The final rates filed at the conclusion of a rate case (whether reached through a settlement or a hearing) must be approved by the Federal Energy Regulatory Commission (FERC). To model rate changes in its forecast, Cascade multiplies its transportation costs by the CPI escalator every four years. Four years is a proxy, since rate cases may not be filed each year. Variable transportation costs differ based on the jurisdiction the calculation represents. Some contracts do not serve Oregon, for instance, so these would be excluded from an Oregon-specific avoided cost, but would be included in a Washington- or system-wide calculation.

  For its 2018 IRP, Cascade projects shortfalls to begin in 2023. Once these shortfalls begin, the next therm saved would no longer apply to existing contracts, but would rather prevent the need to acquire additional transportation. To this end, variable transportation costs after 2022 represent the average demand charge of all incremental contracts that would be used to solve shortfalls. It is worth noting that these costs are estimated based on information from the pipelines, and should be treated as confidential as any incremental variable transportation costs could ultimately be a negotiated rate. These costs are inflated by the CPI escalator every four years to mimic the occurrence of potential rate cases.

- **Storage Costs**

  Storage costs are the cost per therm that Cascade would pay for a storage contract that solved some or all of Cascade's peak day shortfalls. This would include an on-system storage facility, or a satellite LNG facility into Cascade's distribution system. Cascade does not forecast a need to acquire additional storage, so this value is zero for the 2018 IRP.

- **Commodity Costs**

  Commodity costs are the costs of acquiring one therm of gas. For each climate zone, Cascade first uses SENDOUT® to calculate the annual percentage of gas that the optimizer would purchase from each of the three basins to serve that climate zone. These weights are then used to derive a single price for the acquisition of that therm. The source for the price that is used for each year's calculation is the peak monthly price from each year of Cascade's 20-year price forecast, as it would be expected that the therm of gas saved would occur on Cascade's peak day.

- **Carbon Tax**

  Once the Company has calculated its average cost of gas, a price for an expected carbon tax must be added. Cascade converts the cost of a tax in dollars per metric ton to dollars per dekatherm. Currently, Cascade projects a scaling carbon tax, starting at $42/metric ton in 2020 and increasing by approximately $1 per year. This is based on guidance from the WUTC Staff and stakeholders to use the Social Cost of Carbon Forecast with a 3% Discount Rate.[1] This results in a $0.516/Dth increase, or $0.0516/therm increase, for each $10/metric ton.

- **Environmental Adder**

  Cascade includes a 10% adder for non-quantifiable environmental benefits as initially recommended by the Northwest Power and Conservation Council. The 10% adder is added after the cost of gas and taxes are applied.

[1] United States Government. Interagency Working Group on Social Cost of Greenhouse Gases. *Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis – Under Executive Order 12866.* August 2016

- **Distribution System Costs**

  Distribution system costs capture the costs of sending gas from the citygate to Cascade's customers. For this IRP cycle, Cascade calculates distribution system costs as its system weighted average of its authorized margins, as approved in UG-152286. These costs are inflated by the CPI escalator every year.

- **Risk Premium**

  Cascade views a risk premium as a cost associated with uncertainty around the other avoided cost factors, versus relative certainty of the costs around energy efficiency programs. Cascade is not fully convinced that there is more uncertainty around the supply side costs when considering the relative stability of gas markets. Additionally, there is some debate regarding certainty of the impact of energy efficiency programs, also known as the rebound effect, which creates uncertainty about the true risk premium. Cascade is assigning a zero value to risk premium for this IRP cycle because of this uncertainty, not to say that there is no uncertainty. The Company will explore changing this in future IRPs, especially as it engages in workshops related to the UM 1893 docket on avoided cost methodologies in Oregon.

Application

The 2018 IRP makes several enhancements in calculating and applying the avoided costs. This cost figure becomes the foundation for many prudency determinations both operationally and from a resource planning perspective. It may be helpful to think of the final avoided cost figure as something of a cutoff point. Any action that would save a therm of gas could be evaluated based on the cost per therm saved of that measure. If that number is lower than the avoided cost, it may make sense to implement that measure. If not, such a measure may not be optimal to engage in.

Results

Table 6-1 displays the nominal avoided cost by each conservation zone over the 20-year IRP horizon. For the 2018 IRP, the system avoided costs range between $0.2918/therm and $0.8111/therm over the 20-year planning horizon.

As mentioned earlier, the avoided cost is based on the performance of the portfolio under expected conditions for the entire 20-year planning horizon. Overall, avoided costs for the 2018 IRP are lower than in the 2016 IRP. The main driver of this is falling gas prices, and the continued low volatility of prices keeps Cascade's price forecast low throughout the planning horizon. The 45-year avoided costs and other detailed tables of avoided costs, including various carbon scenarios, are found in the Excel version of Appendix H.

Table 6-1: Nominal Avoided Costs by Conservation Zone (Cost per Therm)

	Zone 1	Zone 2	Zone 3	Oregon	Washington	System
2019	0.315674	0.314198	0.314463	0.286939	0.31556297	0.291824
2020	0.526823	0.524909	0.525252	0.504577	0.52667916	0.50871
2021	0.537009	0.535074	0.53542	0.516695	0.53686295	0.520555
2022	0.641692	0.637629	0.638357	0.61647	0.64138646	0.62202
2023	0.656337	0.652354	0.653067	0.633806	0.65603683	0.638925
2024	0.674909	0.6703	0.671125	0.651377	0.6745623	0.656929
2025	0.671493	0.669792	0.670097	0.65534	0.6713648	0.658483
2026	0.688032	0.686152	0.686489	0.671975	0.68789004	0.675185
2027	0.676129	0.674155	0.674508	0.660145	0.67598051	0.663388
2028	0.693811	0.691788	0.69215	0.677956	0.69365827	0.681203
2029	0.706177	0.703757	0.704191	0.690421	0.70599504	0.693834
2030	0.720546	0.718255	0.718665	0.704873	0.72037392	0.708216
2031	0.73087	0.728992	0.729328	0.715176	0.73072858	0.718333
2032	0.745755	0.74433	0.744585	0.730035	0.74564766	0.732989
2033	0.761016	0.759829	0.760041	0.745318	0.76092638	0.74816
2034	0.773553	0.772309	0.772532	0.757914	0.77345907	0.760773
2035	0.784337	0.783065	0.783293	0.768762	0.78424126	0.771625
2036	0.800463	0.798213	0.798616	0.787233	0.80029363	0.790198
2037	0.807866	0.805617	0.806019	0.794636	0.80769708	0.797602
2038	0.8214	0.81915	0.819553	0.80817	0.82123029	0.811135

SECTION 7

DEMAND SIDE MANAGEMENT

Overview

> **Key Points**
> - This plan is informed by Cascade's stand-alone Conservation Advisory Group.
> - Cascade conducted a new Conservation Potential Assessment in 2018 and these results have been incorporated into the IRP
> - Cascade examines the Technical, Achievable Technical and Achievable Economic Potential of DSM programs through the LoadMAP model.
> - LoadMAP generates targets used within the Conservation Plan, based on unique service territory therm savings potential.
> - Cascade's cumulative DSM forecast is 46,697,673 therms.
> - Programs are based on incentives, research, information, outreach, and engagement of key parties – and are designed and implemented to achieve DSM savings targets.

Demand Side Management (DSM) refers to resources acquired through the reduction of natural gas consumption due to increases in efficiency of energy use and/or load management. Unlike supply side resources, which are purchased directly from a supplier, demand side resources are purchased from individual customers in the form of unused energy from energy efficiency. The Washington Utilities and Transportation Commission (WUTC or Commission) requires gas utilities to consider cost-effective DSM resources in their energy portfolio on an equal and comparable basis with supply side resources. In the gas industry, DSM resources are conservation measures that include, but are not limited to: ceiling, wall, and floor insulation; higher efficiency natural gas appliances, insulated windows and doors, ventilation heat recovery systems and various other commercial/industrial equipment. By prompting customers and influencing customers through energy efficiency outreach to reduce their individual demand for gas, Cascade can supplant the need to purchase additional gas supplies, displace or delay contracting for incremental pipeline capacity, and possibly negate or delay the need for reinforcements on the Company's distribution system. It's also essential to recognize that the Company can prompt and encourage customers to reduce their consumption to aid load management, but ultimately the end user chooses to manage consumption by recognizing an inherent value in energy efficiency.

There are two basic types of demand side resources: base load resources and heat sensitive resources. Base load resources offset gas supply requirements throughout the year, regardless of the weather and outside conditions. Base load DSM resources include measures like high efficiency water heaters, higher efficiency cooking equipment and ozone injection laundry systems. Heat sensitive DSM resources are measures whose therm savings increase during cold weather (meaning the measure is used more often during colder weather). For example, a high efficiency furnace will lower therm usage in the winter months when the furnace is utilized the most and will provide little if any savings in the summer months. Examples of heat sensitive DSM measures include ceiling, floor, and wall insulation measures, high efficiency gas furnaces, and improvements to ductwork and air sealing. These types of heat sensitive measures offset more of the typically more expensive peaking or seasonal gas supply resources.

Prior to the 2016 IRP, Cascade addressed its DSM program planning through a dedicated section in the IRP. As of the last iteration of the IRP, the Company committed to transitioning the majority of the planning outside of the forecast to a stand-alone annual document submitted to the Commission by December 1st. In December 2015, the Company provided its first companion report to the IRP, the 2016 Washington Conservation Plan (Conservation Plan) in alignment with this commitment.

Energy-efficiency and conservation efforts for the Company's Oregon customers are offered through the Energy Trust of Oregon with program planning developed through the Cascade Oregon IRP cycle.

Conservation Planning

The Conservation Plan for 2019 will include the same elements as the 2018 iteration with additional detail on current outreach efforts and avenues to increase awareness of program offerings moving forward. Additional information is included for the following:

- Program goals and budgets;
- Program cost-effectiveness discussions;
- The existing portfolio of measures;
- Emerging technologies;
- Potential inclusion of new measures to the portfolio of offerings and their associated costs;
- Incentive levels;
- Targets;
- Possible improvements and collaboration opportunities with Community Action Organizations participating in Cascade's Low-Income weatherization programs to increase participation;
- Outreach communications plans; and
- An examination of the short-term goals and actions in the next two years for implementation of the programs, as well as the longer-term outlook.

The Company's energy efficiency program offerings are based on a carefully selected assortment of high-efficiency upgrades and envelope improvements designed to reduce natural gas consumption by residential, commercial and industrial customers on qualifying rate schedules. The portfolio of measures is chosen based on a variety of elements, primarily the cost effectiveness of the upgrade, regional market availability, measure maturity, territory applicability and administrative feasibility. Further elaboration on the current portfolio of offerings will be housed in the Conservation Plan, as will discussions on potential additions to the existing portfolio and options for amending incentive levels to improve uptake

DSM Deliverables from the 2016 IRP

Upon submission of the 2016 IRP the Company, in collaboration with WUTC Staff, added an addendum to the IRP that noted steps would be taken to further develop and update the Energy Efficiency program's potential modeling tools. The addendum[1] stated the Company would perform the following actions between 2017 and 2018:

- Q2 2017 - RFP for Conservation Potential Assessment (CPA)
    - Develop an RFP in consultation with the Conservation Advisory Group (CAG) for a new CPA paired with a new or revised modeling tool using the Northwest Power and Conservation Council's methodology.
- Q4 2017 – 2018 IRP Work Plan
    - The Company would submit a workplan that would outline the content of the IRP and the method for assessing potential resources, including conservation.
- Q1 2018 – Conservation Potential Assessment
    - The Consultant from the successful RFP would finalize the CPA, which would be included in the 2018 IRP.
- Q2 2018 – Calculate Economic Potential in 2018 IRP
    - Using the NWPCC methodology, the Company will calculate its Economic Potential within the IRP.
    - The Company would work with its CAG to evaluate moving toward using the Total Resource Cost (TRC) and incorporating it into its model revisions.

The Company has taken the necessary steps to meet the commitments from the addendum and is utilizing the newly acquired tool to forecast Achievable Economic potential, while elaborating on the method employed, throughout the DSM section. Additionally, the complete 2017 Cascade Natural Gas CPA report from Applied Energy Group (AEG) is incorporated into the IRP as Appendix D.[2]

The Company continues to prioritize integration of the elements of the DSM programs into the IRP planning process. Prior to 2016 IRP, the DSM section had customarily operated as a stand-alone process where the Company reduced consumption in the near term through the Energy Efficiency programs and the conservation team then forecast savings potential into the 20-year horizon at a state level. Once the savings potential forecasts were available at that statewide level the

[1] The addendum was filed March 10, 2017, in Docket No. 160453.
[2] Applied Energy Group: 2017 Cascade Natural Gas Conservation Potential Assessment Volume 1, Final Report 04/16/18.

inputs were provided to the Resource Planning Team (RPT) in the final stages of the load forecast where they were subtracted from the long-term load forecast. The process has been improved in this IRP to better align the potential savings inputs with those performed for other supply side resources into the Company's demand forecast.

The Energy Efficiency Department worked closely with the RPT and the CPA vendor to verify both inputs and resulting outputs for the new model met the Company's needs to alter forecasting, specifically regarding ramp rate application. This collaborative approach has been noted as a key element of better understanding of how the DSM efforts can address some of the Company's resource needs versus simply reducing consumed therms in the short term.

When viewing overall supply requirements for the 20-year forecast, the impact from conservation and energy efficiency efforts has historically had a modest impact. However, when approached from the standpoint that every therm saved is one less to acquire, and viewed from a cumulative perspective, the conservation programs have significant capacity to impact the Company's planning processes. The key is to approach DSM with a long-term view towards exploring ways to reduce consumption.

Pathways to Achieve Goals in the Mid Term

Combining DSM efforts into the Company's resource planning processes requires incorporating the savings goals from its Conservation Programs into its resource allocation planning, including load management. As mentioned previously, and demonstrated here, the Company's IRP will have an expanded plan development approach allowing for improved collaboration and alignment of conservation goals and traditional supply resource alternatives. The Company notes the 2018 IRP work plan process enhanced opportunities to integrate DSM into the IRP while setting the groundwork for future approaches.

Calendar Years 2017 and 2018 have demonstrated a significant step increase in residential program therm savings for the Energy Efficiency Department as the Company set the stage to increase program accomplishments commensurate with the potential indicated by the Nexant TEA-Pot model (the tool used for savings potential calculations in the 2016 IRP). Significant improvements have been enacted to the program to encourage a steady increase in activities with the associated development of improved administrative processes and additional internal staffing to support expansion of programs to meet increasing savings goals for the next ten years.

As the Company moves into its third year of delivering its residential programs directly to customers, it has become apparent internal implementation of the programs has allowed critical review and integral insight into areas to improve customer experiences through successful interactions with the program. The easier the process to apply, the more likely the customer is to recall the programs positively, and the more likely to choose higher-efficiency upgrades in the future. The Energy Efficiency 2019 Quality Plan is a framework to identify and track strategies that expand program outreach and uptake.

The significant increase in residential program participation has necessitated increasing program staff to accommodate additional workload. The past three years of processing has identified a cyclical pattern of install and submission of rebates dependent on winter seasonal uptake. As this pattern has become more apparent, and in alignment with the increased rebate offerings, the Company identified additional staffing needs and has hired an Energy Efficiency Support Specialist while increasing all staff to full time to accommodate a large steady state queue of projects. In alignment with the expectation the Company will continue to see increased rebates and continue in the cyclical pattern, management will monitor the size of the queue and the need to maintain customer satisfaction to evaluate staffing.

Cascade continually reviews its residential applications, program requirements and terms and conditions aiming to remove barriers and ease submissions. Additionally, program and data integrity remain a key motivation of all program activities. In fact, this data integrity focus is demonstrated in the near real-time program accomplishment updates sent to Commission Staff on a monthly basis since a June 2017 tariff update where the Company increased a significant percentage of rebates to promote customer uptake.

The Company has developed a more nuanced approach to tracking, reporting and forecasting program accomplishments. This method allows for review of current customer barriers, lags in program uptake and encourages identification of issues while they are occurring and can be addressed. This knowledge permits management to pivot efforts to improve program performance. This ability has been integral in keeping the program apprised of outside efforts occurring within the Company's territory that affect the programs and the Company's customers.

Another venue the Company is exploring to improve program uptake includes improving relationships and offerings to its Trade Ally (TA) Contractor network. These include the addition of a point of sale offering through authorized residential TA contractors to help remove upfront expense barriers frequently encountered in high-efficiency equipment installs. The Company also plans on enhancing TA engagement by driving commercial TA participation through the commercial program. While many of the existing TA contractors report they work with both residential and commercial customers, few report and submit commercial program *installs* on an annual basis. The primary objective of this effort will be to make the incentive program a simple part of the install process for all TAs in the Company's network working within commercial/industrial (C/I) properties and, second, to increase the TA commercial/industrial network where gaps exist within the Cascade service territory.

The Company's third-party implementer for the C/I program has identified potential barriers to program uptake and has proposed recommendations to overcome them. Some of the anecdotal barriers have been identified as: 1) disinterest in completing forms for rebates that do not directly benefit the individual submitting the paperwork, 2) a desire to simplify all requirements to reduce requisite paperwork, 3) avoidance of discussing program availability due to a misconception that the utility is selling a product versus offering a service through the rebate programs, and 4) simple unfamiliarity with program availability. Potential efforts to reduce these barriers include increased TA engagement, focus group discussions with local installers who work directly with customers, increased outreach, case studies and highlighting key customer projects. The vendor is also focusing on identifying and working with major accounts and working through the Company's local district personnel to identify potential projects at an earlier stage in the planning phase, allowing program staff to influence purchasing decisions prior to completion.

The Company continues to target missing information submittals, allowing it to approve as many viable incentives as possible while cultivating a positive customer experience. This is a key element in reducing the amount of "Disqualified" applicants (DNQ'd). While the onus is ultimately on the customer to provide all required data, it's also important to contribute to their success (when feasible within administrative budgetary constraints) and help with what can be a confusing application process. This emphasis on customer assistance has proven effective and helps nurture the TA network through a collaborative approach to problem solving.

All program updates and changes influence savings the Company can achieve. These changes allow Cascade staff to focus more time on implementing the program and looking toward future outreach opportunities to obtain additional savings.

Outside of the continual improvement process internally implemented as part of the residential program's efforts to increase therm savings achievements, Cascade also expanded its administrative support for the C/I Energy Efficiency incentive program. The C/I program has encountered difficulty in meeting its goals since the 2016 Washington IRP. As a result of this underperformance the Company and the vendor, Lockheed Martin, have critically evaluated the program's approach to delivery and are taking additional steps to reach the Company's business customers in future years.

The Company has transitioned its contract structure to a pay-for-performance format based on therm savings supplemented with an administrative portion to accommodate non therm savings activities imperative for successful program implementation. This update requires the vendor to closely examine its efforts as it is directly accountable for goal achievements. The Company will continue to monitor the C/I vendor's processes and achievements throughout the year and, as needed, will explore alternative delivery methods either via a Request for Proposal, bring the process in house as it has with the residential program, or possibly a combination of more robust internal support paired with the expertise of an external vendor's experience and resources.

At this point the focus of the C/I outreach is on the customer with messaging around program availability to key sectors (adult living communities for example) and major account support (based on customer usage patterns). Cascade has also engaged its District field personnel through an updated customer feasibility workbook which offers an early indication of commercial customer interest in Cascade's energy efficiency offerings. Additionally, increased attention is placed on working with commercial and industrial TA contractors, by implementing a marketing and outreach campaign to highlight success stories taken directly from local communities to encourage customers and TAs alike. This is an ongoing effort and is showing dividends, year-to-date, with an improved forecast and media response. The Company will continue to monitor response to the outreach campaign and revise as necessary.

To meet ever-increasing goals, the Company recognizes continuous improvement and ingenuity are necessary to reach its goals and notes the programs are constantly evolving to meet these needs from Commission directives, market changes, technological improvements and policy changes amid a vast array of externalities.

As the Company moves into 2019 the "I DSM" software product from Nexant Inc. remains the tool used to process residential and Low-Income projects and assist with management of the TA program. The Company has been heading a two-year effort to implement Nexant's eM&V (evaluation Measurement and Verification) offering through their software platform. Although initially thought to be further along than currently available, the software design, development and testing cycles have allowed Cascade to serve as thought leaders during the development process, helping to shape the capabilities of the software. Once fully functional, the product should allow the Company access to advanced reporting through limited internal measurement and verification to develop plans on key areas to concentrate efforts. While it will not take the place of external EM&V it does allow for some independent verification of savings in the years when full third-party EM&V is not cost effective to implement.

Recent program alterations to the Low income (LI) weatherization program enacted as part of the Company's recent rate case settlement agreement Docket UG-

170929[3] will play a key role in efforts to increase participation from Community Action Agencies in the next two to ten years to serve more customers through the Company's Weatherization Incentive Program (WIP) and Enhanced Weatherization Incentive Program (E-WIP). The Company updated Schedule 301 in August of 2018 to align with the settlement agreement as it worked closely with The Energy Project and the agencies. Additional information around program specific steps will be addressed in the Conservation Plan; however, the Company is including the following item in the two-year action plan pertinent to the LI WA program and further elaborates on those steps in Section 11, Two-Year Action Plan.

> Increase engagement with the agencies delivering the Company's LI Weatherization Incentive Program for facilitating increased weatherization services delivered to qualified natural gas customers in Cascade's service area.

The Company also expects messaging and outreach will be increased to local communities to reach those customers who have yet to engage in the Conservation Incentive Programs (CIP). Cascade will also take the opportunity to partner with other utilities, and community programs, as appropriate and available, to promote a more widely understood goal toward high-efficiency uptake and energy conservation in its service territory.

Cascade's Stimulus for Demand Side Management

A variety of factors motivate Cascade to engage in DSM efforts. One of the reasons is that the energy efficiency programs provide the Company an opportunity to demonstrate its commitment to responsible environmental stewardship while assisting its customers and ensuring customer satisfaction. If the Company encourages efficient and wise use of natural gas, customers not only receive the value from their investment, but also reduce their future expenses. This helps set the groundwork for future conscientious energy consumption choices.

Additionally, the Company needs to meet the WUTCs directives and settlement agreements including Docket UG-152286 whereby "The Parties state that the conservation commitments in the Settlement solidify the conservation efforts that Cascade is already undertaking and add structure and accountability."[4]

Another factor that is becoming more pronounced stems from state and federal policy changes, in addition to future greenhouse gas emissions parameters, as discussed in Section 5, Environmental Considerations. The Energy Efficiency

[3] https://www.utc.wa.gov/docs/Pages/DocketLookup.aspx?FilingID=170929
[4] https://www.utc.wa.gov/docs/Pages/DocketLookup.aspx?FilingID=152286.

efforts keep abreast of these policy changes as they have the potential to greatly impact program offerings.

Lastly, the Company has a decoupling mechanism in place for its Washington territory. This allows the Company to “decouple” or disassociate recovery of its revenue requirement with volumetric gas sales. As gas sales fluctuate up or down due to conservation or weather, the decoupling mechanism ensures the Company will recover the costs it needs to do business, making it fiscally indifferent to conservation. The Company was already committed to its conservation programs prior to the approval of the decoupling mechanism (and previously had decoupling in Washington). This further cements the Company’s ability to support and grow its Energy Efficiency Incentive Programs.

Progress Report

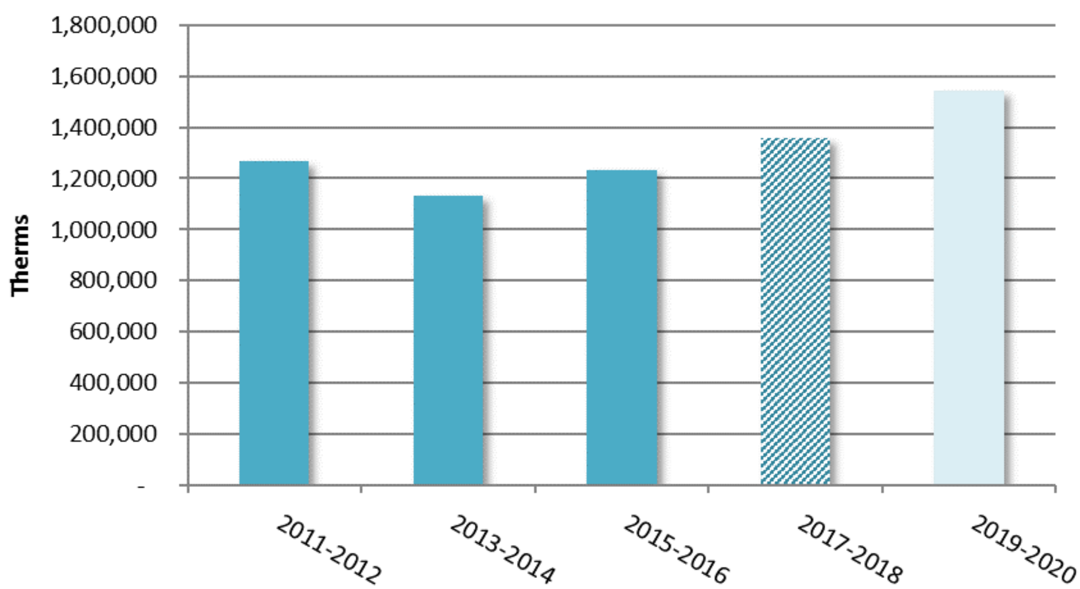
The Company’s DSM efforts for this cycle and associated incorporation into the IRP represent a more holistic approach to resource planning with a concerted effort made toward incorporation of the conservation efforts as a true resource toward planning for future demand. This IRP also provides context on the current service territory potential as calculated by AEG in the 2017 CPA to add an updated level of transparency and granularity to the Company’s planning processes with incorporation of regional best practices. The conservation potential for this IRP is calculated through the AEG LoadMAP model, separated into the three customer classes for individual savings assumptions, market segmentations, and end uses (heat-sensitive resources have different savings potential by Climate Zone for the Residential section). The inputs were provided by the RPT and the outcome has been sent back, full circle, to resource planning at the end use level for integration into the IRP demand forecast model.

Company therm savings achievements for the past two years compared to the 2012 IRP and the 2014 IRP goals are in Table 7-1 inclusive of the next two years’ worth of goals (2017 and 2018) to demonstrate what the Company is striving toward. Totals for 2018 accomplishments will not be available until the annual report is filed in June 2019. Figure 7-1 shows the biennium historical performance and short-term forecast while Figure 7-2 demonstrates the recent annual program performance and short term annual forecast.

Table 7-1: Recent IRP Goal to Actual Therm Accomplishments

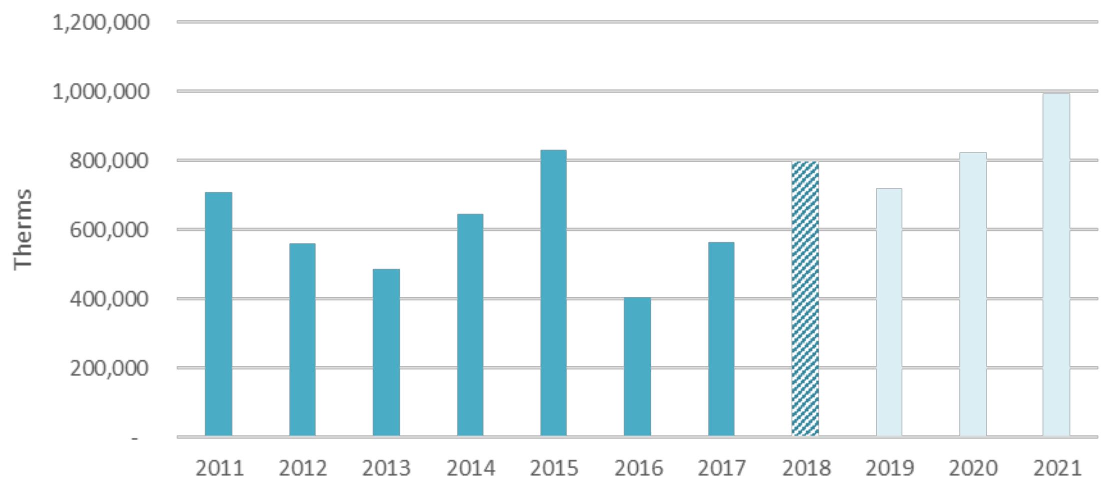
Years	BIENNIUM	GOALS	ACTUAL SAVINGS	DIFFERENCE BETWEEN ACTUALS AND GOALS	GROWTH FROM PREVIOUS BIENNIUM
2013 2014	**2012 IRP**	1,077,661	1,113,046	**+3%**	**-11%**
2015 2016	**2014 IRP**	1,204,469	1,225,315	**+2%**	**+10%**
2017 2018	**2016 IRP**	1,456,143	***1,358,955****	***-7%****	**+11%***
2019 2020	**2018 IRP**	1,541,748	**TBD**	**TBD**	**+13%***

Figure 7-1 Incremental Portfolio Biennium Actuals and Upcoming Goals*



*The historical years are showing actuals. 2017-2018 is made up of 2017 actual and 2018 YTD expected therms. 2019-2020 represents the biennium goal relative to recent past performance.

Figure 7-2 Incremental Portfolio Annual Goals



See Table 7-2 for the goals and budgets for 2019 and 2020. These are used in the 2019 Conservation Plan.

Table 7-2: Program Goals & Budgets at a Glance 2019 & 2020

	Calendar Year 2019				Calendar Year 2020			
	Residential	Commercial Industrial	Low Income	Total	Residential	Commercial Industrial	Low Income	Total
Admin Budget[1]	$924,186	$1,261,274	$25,568	$2,211,028	$952,000	$1,300,000	$26,500	$2,278,500
Therm Targets[2]	333,424	370,587	15,000	719,011	369,466	437,271	16,000	822,737
NEEA Natural Gas Market Transformation				$548,804				TBD

[1] *Note budgets in this table are estimates and are referring to administrative budgets for program implementation, not rebate payments to customers.*
[2] *Therm targets from this graph have been developed through the LoadMAP modeling tool. Calendar Year 2020 targets will be revised through the 2020 Conservation Plan as part of the annual planning process.*

Potential Estimates

The AEG CPA estimated energy efficiency savings developed into three types of potential: Technical potential, Achievable Technical and Achievable Economic potential. Appropriate, gas specific market penetration rates were developed based on the NWPCC's ramp rates. AEG analyzed this potential via a customized tool developed from a Microsoft Excel-based modeling tool, LoadMAP for the Cascade CPA.

> *"Load Management Analysis and Planning (LoadMAP^{TM}) tool was developed in 2007 and was first used for the EPRI National Potential Study. Since that time, LoadMAP has been used to develop end-use forecasts and perform dozens of energy efficiency (EE) potential studies. The LoadMAP model provides forecasts of energy use by sector, segment, end use and technology for existing and new buildings. It can also be used to isolate and estimate savings from DSM measures and programs. LoadMAP was developed by Global Energy Partners, LLC (GEP) under the direction of Ingrid Rohmund. EnerNOC acquired GEP and the LoadMAP model in 2011. In June 2014, AEG acquired EnerNOC's Utility Solutions Consulting Group and the LoadMAP model. AEG supports ongoing enhancements to the model*."[5]

This modeling tool was built on a platform that provides the ability to run multiple scenarios and re-calculate potential savings based on variable inputs, such as the customer and demand forecasts, IRP long term discount rate, transmission loss rate and avoided costs as well as recent annual program performance and measure data collected through energy efficiency applications to establish incremental costs reflective of service territory. This model provides transparent assumptions and calculations for estimating market potential.

While Technical and Achievable Technical potential are both theoretical limits to efficiency savings, Achievable Economic potential embodies a set of assumptions about the decisions consumers make regarding the efficiency of the equipment they purchase. Cascade's conservation program adopted the Achievable Economic potential to set goals under an array of possible future conditions.

The Company's cumulative Achievable Technical DSM forecast over the 20-year-planning horizon is forecasted at 46,697,673 therms under the Utility Cost Test (UCT).

The following subsection elaborates on the methods used by the LoadMAP model to develop the three levels of Potential for the programs and subsequent creation of the Company's two-year short-term plan.

Industry standard cost-effectiveness tests were performed to gauge the economic merits of the portfolio. Each test compared the benefits of the energy efficiency metric to their costs defined in terms of net present value of future cash flows.

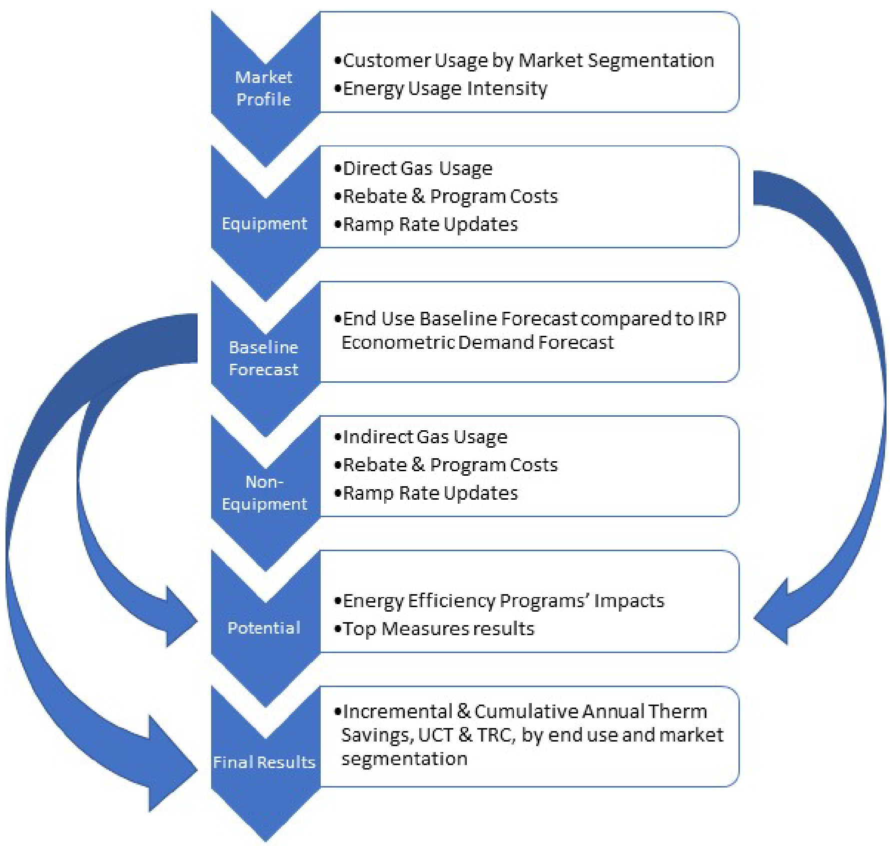
Cascade applies the UCT. The benefits of the UCT are the avoided energy costs and avoided capacity costs for the lifetime of the measure. The costs in this test are the program administrator's incentive costs and administrative costs. Note, LoadMAP concurrently runs all scenarios under the TRC and Resource Value Test (RVT) as well for comparison.

[5] CPA, Appendix H, page i

DSM Forecast Modeling

Figure 7-3 represents the savings potential process LoadMAP uses. There are six separate workbooks that make up the full DSM forecast for each customer class. They all follow the same order of operation, starting with the Market Profile, which feeds into the Equipment workbook. The Equipment then feeds into the Baseline which feeds into Non-Equipment. When running the Potential model, the Equipment, Baseline, and Non-Equipment are all imported. The Final results import the Potential results and the Baseline.

Figure 7-3: New Savings Potential Process in LoadMAP



An important first step in calculating Cascade's energy efficiency potential estimates is to establish baseline energy usage characteristics and disaggregate the market by sector, segment, and end use.

Residential market segmentation is split by Climate Zone (same as in the Company's previous modeling software TEA-Pot) and into Single family and Multi Family, resulting in six market segments.

Commercial market segmentation is split into nine segments: Office, Retail, Restaurant, Grocery, Education, Healthcare, Lodging, Warehouse, and a "Miscellaneous" category.

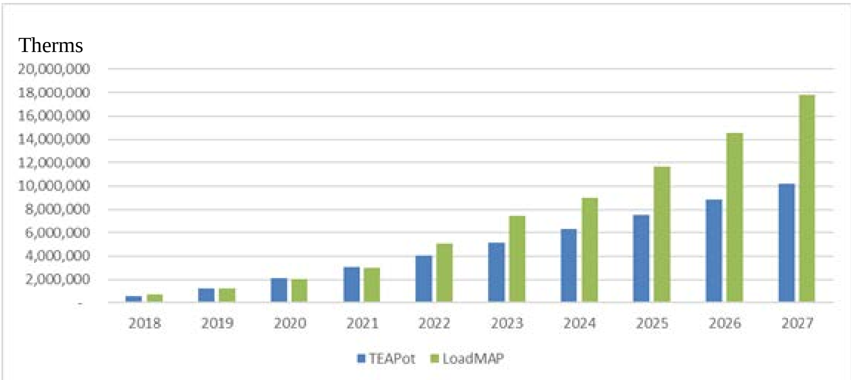
Industrial market segmentation is also split into nine segments: Food Processing, Agriculture, Primary Metals, Stone/ Clay/ Glass, Petroleum, Paper & Printing, Instruments, Wood & Lumber Products, and an "Other" category.

End uses are split into Heating, Water Heating, Secondary Heating, Food Preparation, Appliances, Process Heating, and miscellaneous. All of these are ultimately categorized into baseline and peak load shaving. This is the first time the DSM forecast has provided the RPT with a cumulative forecast by baseline or peak load, which in turn also allowed the DSM forecast to be run under two sets of avoided costs – one for the annualized average and one for the peak load average avoided costs. This is an example of the Company working to more fully integrate the DSM planning into the IRP by providing inputs at a much more granular level to the RPT.

Note, LoadMAP allows for more sets of avoided costs to be run concurrently and has a placeholder for the RVT.

A comparison of the previous TEA-Pot forecast from the 2016 IRP to the new LoadMAP results for the 2018 IRP is shown in Figure 7-4.

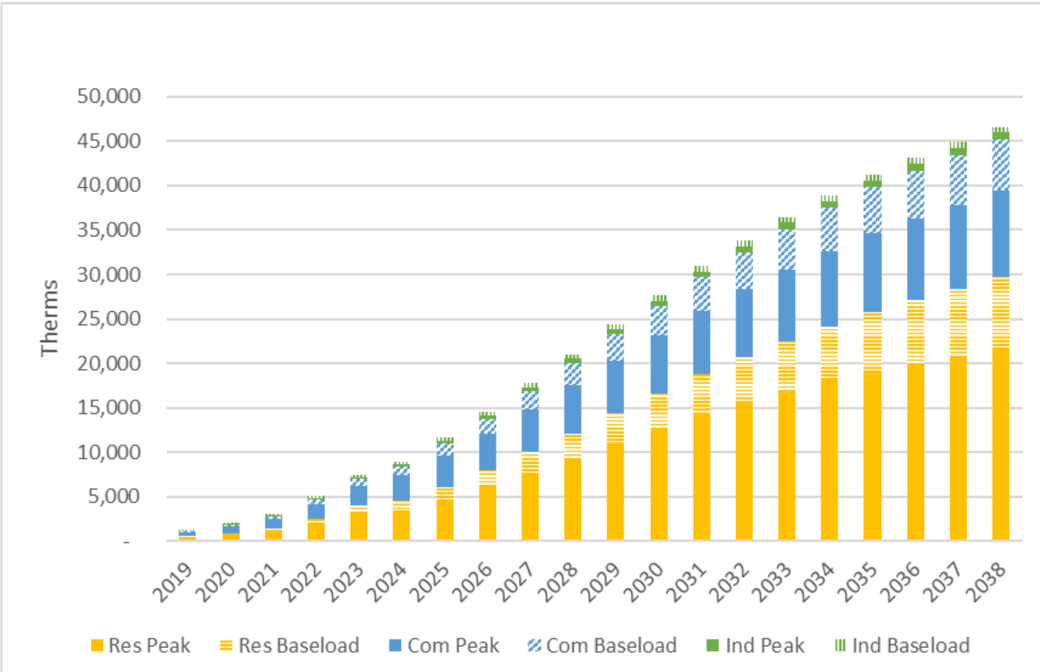
Figure 7-4: Forecast Comparison of TEA-Pot v LoadMAP (i.e. Last IRP to Current) in Therms



Of note, one process change between LoadMAP and TEA-Pot is present in how administrative costs are incorporated. TEA-Pot needed them entered as dollars per therm by end use amount. LoadMAP requires entry as a percent of the incremental costs in the Equipment and Non-Equipment models. This allows for input of administrative costs at a more granular level, by each measure, rather than by grouping of measures by end-use.

The DSM forecast is split into the new baseline and peak load end uses in Figure 7-5.

Figure 7-5: DSM Cumulative Forecast by Program, Baseline versus Peak Shaving



LoadMAP provides the Company with a much more nuanced and manageable method to developing its portfolio than was used in the past. The CPA also provided advice on how to update ramp rates based from the NWPCC methodology and industry best practices. For further narrative around the pros and cons between the two methodologies see Appendix L.

Ramp rates were updated for a portion of the measures in the Residential Program based on significant changes since the CPA's 2016 base year. Residential Program performance has increased substantially in the past eighteen months, allowing for select measures to move forward more quickly along the NWPCC's ramp rates than initially anticipated by AEG. These include furnaces and insulation measures.

Some of the measures deemed cost effective by AEG and able to contribute potential to the programs in the first runs would be new additions to the program offerings for the Company. Due to their untried nature in the territory, further research is needed to determine their realistic ability to contribute therm savings to the Company's rebate programs. For example, the Solar Hot Water heater was shown cost effective with a rebate set close to $300. However, upon further investigation into the technology's prices and availability in the Company's service territory, it was determined current installation costs approached $20,000 and few, if any, TAs offered the equipment to customers and had inconsistent manufacturer support and documentation. With these issues identified, the Company updated the measure's ramp rate by shifting it three years into the future allowing for product maturity while awaiting market transformation efforts similar to those performed by the Northwest Energy Efficiency Alliance (NEEA) to adequately launch these newer technologies.

Cascade worked closely with the CAG to solicit feedback on these measures and incorporate suggestions. CAG recommendations involved:

- Only including measures which the Company had high confidence could contribute toward meeting goals in the following year's portfolio.
- Potentially incorporating a discount factor or a stretch goal to offset those measures with lower (unknown) confidence. In this iteration the Company has elected to adjust their ramp rates rather than discount or set a separate stretch goal.

Further details around new measure inclusions and research will be provided in the 2019 Conservation Plan.

The Company's objectives in developing its rebate offerings include:

1. Maximizing the number of viable, industry-acknowledged conservation measures.
2. Setting incentive levels that send meaningful price signals to consumers to upgrade to high-efficiency natural gas equipment and energy saving measures.
3. Remaining cost effective at the Company's most recently acknowledged avoided costs.

Cascade set an administrative budget to plan and operate programs under the avoided costs shown in Appendix H. This budget must ensure an acceptable ratio of costs balanced with therm savings achievements. Since therm savings offset the costs of administrative investment, the greater the achievement, the more cost-effective the programs. If the budget or therm savings upon which the portfolio is built are unrealistic, the Company risks developing a scale-dependent portfolio unable to maintain cost effectiveness.

Alternative scenarios using three sets of potential costs of carbon, discussed earlier in Section 5, were developed into new avoided costs and LoadMAP was re-run with these scenarios in mind. The impacts of the Ballot I-1631 (-3.3% cumulatively over the full forecast time horizon), Governor Jay Inslee's proposal (-4%), or Market

Choice (-2%) options were minimal to the energy efficiency program. Details of the results can be found in Appendix D.

Target Development

LoadMAP-generated targets will be acknowledged in the Conservation Plan and Cascade will aggressively strive toward them throughout the year. However, the programs are built in a way that ensures cost effectiveness can be maintained independent of target completion.

Below is a brief list of what has been altered in this iteration of the conservation forecast from previous IRP submissions:

- Divided DSM forecast into Climate Zones for Residential;
  - Updated all model inputs, which are discussed in depth, under the Analysis of the Washington Territory Potential through LoadMAP section
- Updated Residential Program ramp rates in line with recent program performance increases

Conservation Potential

In the following subsections, the Company will explain its modeling processes, modeling tool and provide an analysis of the future potential as well as opportunities for increased participation while briefly discussing steps to achieve the Achievable Economic goals.

The unique inputs used for Climate Zone market segmentations in the Residential forecast included customer count, demand forecasts and the avoided costs. All other factors were held constant across each Climate Zone's scenario, such as the inflation rate, long-term discount rate, load profile, transmission loss rate, cost-effectiveness threshold, and ramp rates. A map of the Climate Zones in the Company's Washington service territory is provided in Figure 7-6.

Figure 7-6: Cascade Conservation Climate Zones

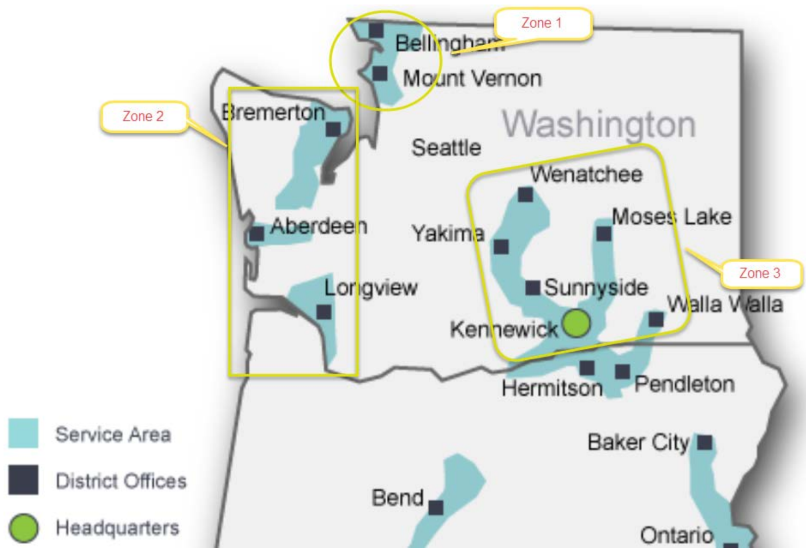
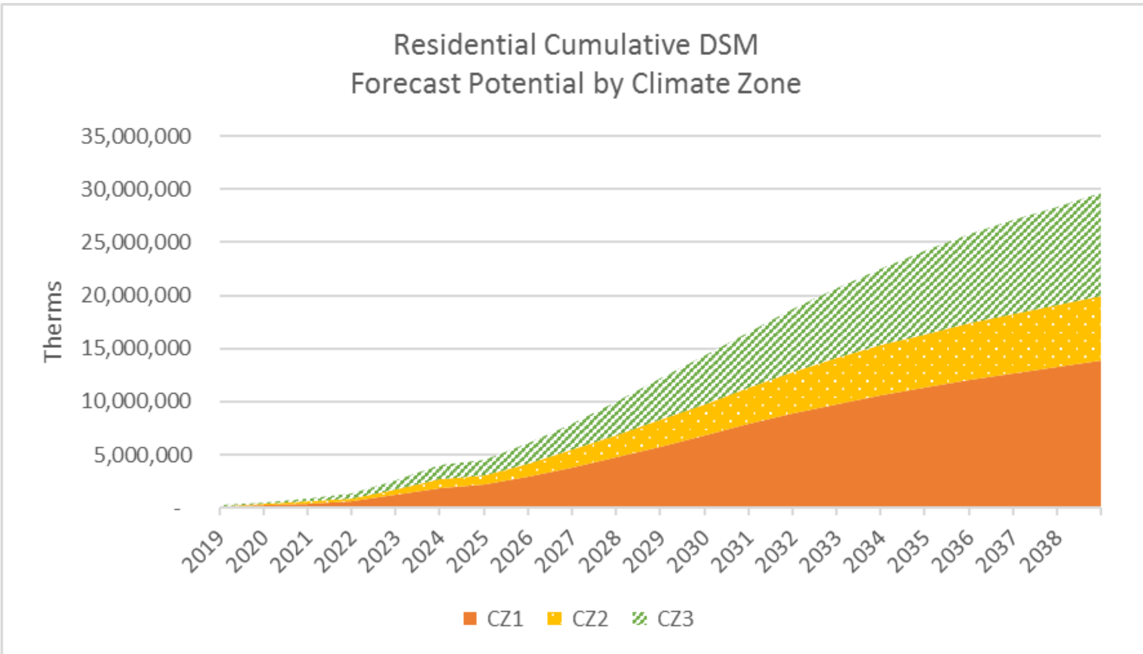


Figure 7-7 shows the Residential portion of the DSM forecast, split by Climate Zone.

Figure 7-7: Residential Potential by Climate Zone in Therms



Analysis of the Washington Territory Potential through LoadMAP

Cascade hired AEG to produce a Conservation Potential Study and LoadMAP model in 2017. The study's analysis was based on calendar year 2016 and was tailored to Cascade's distinct service territory.

As mentioned earlier Cascade utilizes the UCT to measure the program's cost effectiveness. The UCT Test is the optimal vehicle for valuation of these measures since it is a straightforward and clean calculation of the utility's investment in DSM and does not penalize customers for making independent determinations regarding the cost-benefit of an energy efficiency upgrade. The UCT instead treats the rebate from utility run natural gas efficiency programs as a leveraged partnership that drives positive market change and the installation of measures with the potential for long-lived and deeper energy savings.

As per the 2016 IRP and Addendum the Company has worked with its CAG to explore moving toward a more fully balanced TRC, which included seeking feedback and recommendations from AEG during the assessment performed in CY 2018 Q1. The Company has identified additional Non-Energy Impacts (NEIs) to more accurately calculate a TRC, however Cascade continues to choose the UCT over the TRC as the primary metric of cost effectiveness because the cumulative forecast potential over the IRP time horizon is greater under the UCT than the TRC across Residential and Commercial/Industrial programs. The cumulative UCT is forecasted at 46,697,673 therms and the cumulative TRC is forecasted at 34,483,696 therms.

The Company is engaged with the WUTC and regional stakeholders in current discussion on impacts to include in an RVT and is prepared to move toward program valuation under the RVT through its LoadMAP model as statewide policy evolves.

Measures are defined as having heating, cooling, neither or both NEIs. LoadMAP includes the measures' equipment, labor, operations and maintenance costs based on the Cascade program's application and invoice data collected since the last CPA, as well as DEER, DOE, ENERGY STAR, Illinois TRM, Michigan Energy Measure Database, NWPCC's 7th Plan (the previous TEA-Pot model-based data on an earlier version of NWPCC's Plan), and the RTF. NEIs, such as water savings values, are incorporated as O&M savings in the model. Water savings values are specifically pulled from the NWPCC's 7th Plan. See Appendix D for the full CPA and additional context on NEIs[6] and measure libraries.

[6] See Volume 1 page 62 of the AEG CPA Final Report, available in Appendix D of the IRP.

Below is a summary of the other model inputs, updated from the last IRP:

- Inflation rate increased to 2.00% from 1.00% and is in line with the remainder of the IRP.
- Transmission Loss rate decreased from 0.1959% to 0.1615%.
- Long-term discount rate increased from 4.17% to 4.43%, aligned with the rest of the IRP sections' models and tied to the average 30-year mortgage rate. The lower the long-term discount rate, the higher the therm savings potential because future years' therm savings' avoided cost values are discounted less, and thus more of the avoided costs can be included, thereby allowing the benefit-cost ratios for measures to pass the 0.90 cost-effectiveness threshold.
- Administrative costs increased, commensurate with processing capacity, thereby increasing accuracy of reporting and improving control of the customers' rebate processing experiences. It also allowed expansion of commercial and industrial CIP outreach. While this may appear to have a negative impact on the benefit-cost ratio for each measure, and raises the costs needed to acquire therm savings, it is necessary to accommodate higher therm savings goals over the next few years.
- Avoided costs were updated per Appendix H, Avoided Cost Calculations, and divided by Climate Zone for the residential portion as well as into baseline and end use for peak shaving measures. Finally, alternative carbon pricing scenarios were provided and run through the model to determine their impact on DSM. The higher the avoided costs, the higher the therm savings potential because avoided costs under the UCT increase the benefit-cost ratio to allow more measures to be considered cost effective. Conversely, the lower the avoided costs, the lower the therm savings potential forecasted.
- Customers and volume (divided by Climate Zone for residential only) were updated per Section 3, Demand Forecast.

Below are AEG's forecasting term definitions used in the CPA and LoadMAP:

*"**Baseline Projection**: Projection of baseline energy consumption under a naturally occurring efficiency case, described at the end-use level. The LoadMAP models were first aligned with actual sales and Cascade's official, weather-normalized econometric forecast [per Section 3, Demand Forecast] and then varied to include the impacts of future federal standards, ongoing impacts of the 2015 Washington State Energy Code on new construction, and future technology purchasing decisions.*

***Technical Potential** is defined as the theoretical upper limit of EE potential. It assumes 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.*

Technical potential also assumes the adoption of every other available measure, where technically feasible. For example, it includes installation of high-efficiency windows in all new construction opportunities and furnace maintenance in all existing buildings with installed furnaces. These retrofit measures are phased in over a number of years to align with the stock turnover of related equipment units, rather than modeled as immediately available all at once.

***Achievable Technical** Potential refines technical potential by applying customer participation rates that account for market barriers, customer awareness and attitudes, program maturity, and other factors that affect market penetration of conservation measures. The customer adoption rates used in this study were the ramp rates developed for the Northwest Power & Conservation Council's Seventh Plan based on the electric-utility model, tailored for use in natural gas EE programs.*

***UCT Achievable Economic** Potential further refines achievable technical potential by applying an economic cost-effectiveness screen. In this analysis, primary cost-effectiveness is measured by the utility cost test (UCT), which assesses cost-effectiveness from the utility's perspective. This test compares lifetime energy benefits to the costs of delivering the measure through a utility program, excluding monetized non-energy impacts. These costs are the incentive, as a percent of incremental cost of the given efficiency measure, relative to the relevant baseline course of action (e.g. federal standard for lost opportunity and no action for retrofits), plus any administrative costs that are incurred by the program to deliver and implement the measure. If the benefits outweigh the costs (that is, if the UCT ratio is greater than 0.9), a given measure is included in the economic potential. Note that we set the measure-level cost-effectiveness threshold at 0.9 for this analysis since Cascade is allowed to include non-cost-effective measures as long as the entire portfolio is cost effective. This is important because a portfolio considers more than just energy savings. Cascade may include popular measures that are on the cusp of cost-effectiveness, accommodate variance between Climate Zones, maintain a robust portfolio, or include a measure that improves customer outreach and communication.*

***TRC Achievable Economic** Potential is similar to UCT achievable economic potential in that it refines achievable technical potential through cost-effectiveness analysis. The total resource cost (TRC) test assesses cost-effectiveness from a combined utility and participant perspective. As such, this test includes full measure costs but also includes non-energy impacts realized by the customer if quantifiable and monetized. In addition to non-energy impacts, we assessed the impacts of non-gas impacts following Council methodology. This includes a calibration credit for space heating equipment consumption to account for* *secondary heating equipment present in an average home as well as other electric end-use impacts such as cooling and interior lighting as applicable on a measure-by-measure basis. As a secondary screen, we include TRC results for comparative purposes were included.*

***RVT Achievable Economic** Potential is similar to the UCT and TRC achievable economic potential but assesses cost-effectiveness from a regional perspective. The resource value test (RVT) reframes the analysis around accomplishing a jurisdiction's regional policy goals and includes hard-to-quantify impacts through quantitative or qualitative approaches. This test allows jurisdictions to define policy goals which may include additional impacts beyond the traditional utility-customer TRC approach. In May of 2017, the National Efficiency Screening Project (NESP) released a National Standard Practice Manual (2017 NSPM) which details an approach for conducting screening measures under the RVT. AEG assessed preliminary estimates of potential under the RVT as part of this study, but since policy goals are defined at the regional level under this test, we are awaiting recommendations on non-energy impacts and values from the Washington Utilities and Transportation Commission (WUTC). The model has been configured to accommodate these future updates as they become available."* [7]

Table 7-3 demonstrates the UCT and TRC incremental and cumulative forecasts for Residential and Combined C/I and combined portfolio total (excluding Low Income).

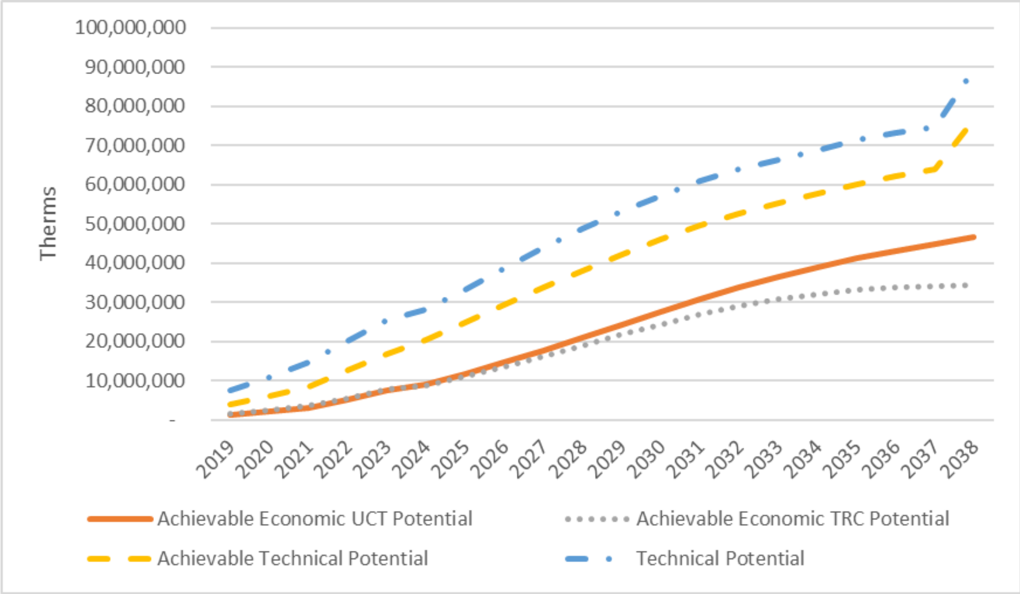
[7] Per the 2018 CPA Volume 1, page 7

Table 7-3: 20-Year Technical Achievable Forecast Incremental, Cumulative, UCT/TRC, in Therms

YEAR	Total Technical Achievable Forecast Comparison											
	UCT				TRC				Total UCT Incremental	Total TRC Incremental	Total UCT Cumulative	Total TRC Cumulative
	Incremental		Cumulative		Incremental		Cumulative					
	Residential	Commercial/ Industrial	Residential	Commercial / Industrial	Residential	Commercial/ Industrial	Residential	Commercial/ Industrial				
2019	333,424	370,587	529,565	701,507	527,930	293,012	990,215	570,871	704,011	820,941	1,231,071	1,561,086
2020	369,466	437,271	900,529	1,137,156	559,955	337,526	1,551,164	906,591	806,737	897,481	2,037,686	2,457,755
2021	465,165	513,429	1,358,618	1,652,579	632,796	396,405	2,170,058	1,304,929	978,595	1,029,202	3,011,197	3,474,987
2022	1,167,261	874,586	2,514,790	2,526,220	1,352,349	716,252	3,501,276	2,019,777	2,041,847	2,068,601	5,041,010	5,521,053
2023	1,470,421	937,533	3,971,553	3,470,221	1,388,303	759,659	4,867,741	2,783,484	2,407,954	2,147,962	7,441,774	7,651,226
2024	1,400,354	1,009,699	4,494,103	4,464,761	1,253,099	800,814	5,258,346	3,570,390	2,410,053	2,053,913	8,958,864	8,828,736
2025	1,655,317	1,075,933	6,085,454	5,533,750	1,490,184	854,519	6,674,851	4,421,711	2,731,250	2,344,702	11,619,205	11,096,561
2026	1,906,745	1,122,763	7,915,828	6,639,919	1,693,465	893,120	8,283,939	5,301,742	3,029,508	2,586,586	14,555,747	13,585,681
2027	2,141,647	1,150,392	9,990,652	7,793,084	1,870,654	915,633	10,079,700	6,220,031	3,292,039	2,786,287	17,783,735	16,299,731
2028	2,294,752	1,157,387	12,131,400	8,896,692	1,973,374	920,329	11,887,092	7,096,144	3,452,139	2,893,703	21,028,092	18,983,237
2029	2,374,396	1,151,617	14,337,529	10,010,605	2,003,806	913,758	13,712,293	7,983,188	3,526,013	2,917,564	24,348,134	21,695,481
2030	2,395,168	1,128,402	16,560,699	11,059,731	1,957,970	895,990	15,491,267	8,828,888	3,523,570	2,853,960	27,620,430	24,320,155
2031	2,343,010	1,120,965	18,783,285	12,140,770	1,834,043	890,165	17,197,109	9,688,085	3,463,974	2,724,208	30,924,055	26,885,194
2032	2,213,606	1,082,389	20,727,722	13,086,766	1,629,289	853,923	18,565,086	10,426,779	3,295,996	2,483,212	33,814,488	28,991,865
2033	2,055,326	1,036,614	22,529,619	13,953,487	1,389,698	811,204	19,714,537	11,093,147	3,091,940	2,200,901	36,483,107	30,807,684
2034	1,847,416	993,755	24,157,655	14,720,152	817,708	772,011	20,360,425	11,664,452	2,841,171	1,589,719	38,877,806	32,024,877
2035	1,732,839	976,101	25,773,217	15,475,010	602,938	748,979	20,887,862	12,213,185	2,708,940	1,351,917	41,248,227	33,101,047
2036	1,639,133	951,859	27,095,797	16,055,640	424,899	727,458	21,088,725	12,624,081	2,590,992	1,152,357	43,151,437	33,712,806
2037	1,568,946	928,766	28,373,916	16,555,865	286,506	704,534	21,181,206	12,964,882	2,497,712	991,040	44,929,782	34,146,087
2038	1,594,933	884,551	29,737,376	16,960,296	208,493	669,399	21,261,815	13,221,881	2,479,484	877,891	46,697,673	34,483,696

Figure 7-8 shows the cumulative DSM forecast by Technical, Achievable Technical and both UCT/TRC Achievable Economic Potentials.

Figure 7-8: Cumulative Potential by Forecast



Figures 7-9 and 7-10 show the cumulative DSM forecast for the Residential and C/I sectors by Technical, Achievable Technical and both UCT/TRC Achievable Economic Potentials. Figure 7-11 demonstrates the Cumulative Forecast by program.

Figure 7-9: Cumulative Potential Forecasts for Residential

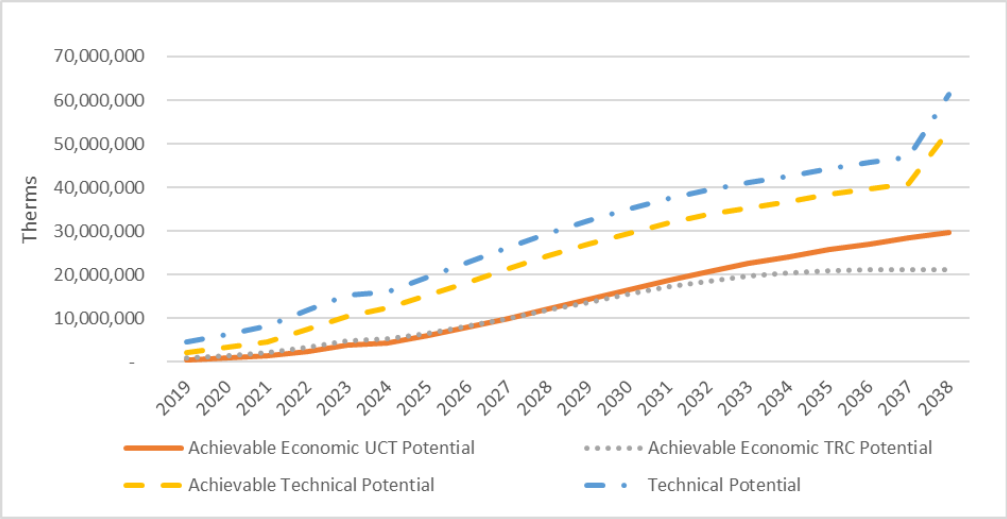


Figure 7-10: Cumulative Potential Forecasts for C/I

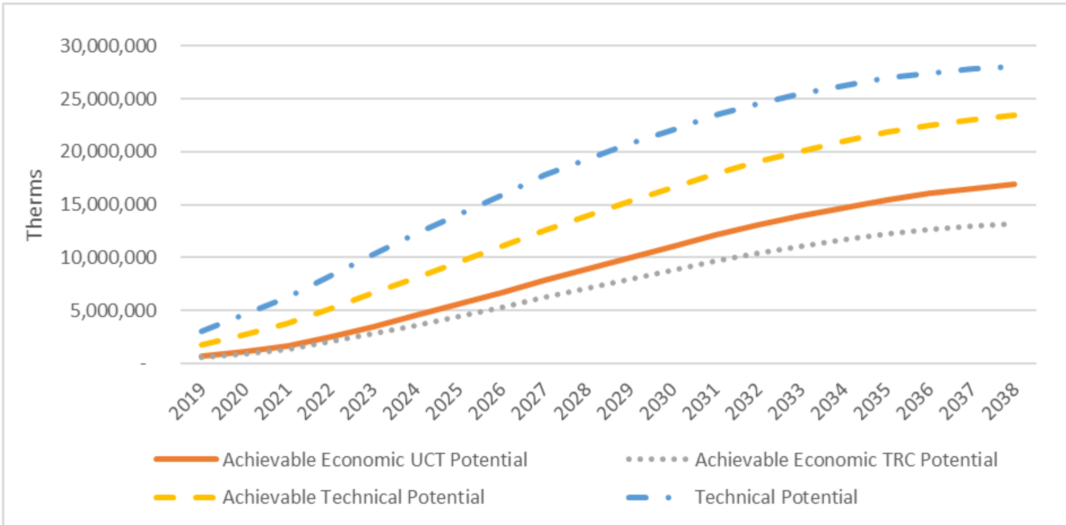


Figure 7-11: Cumulative Achievable Economic UCT Potential by Program

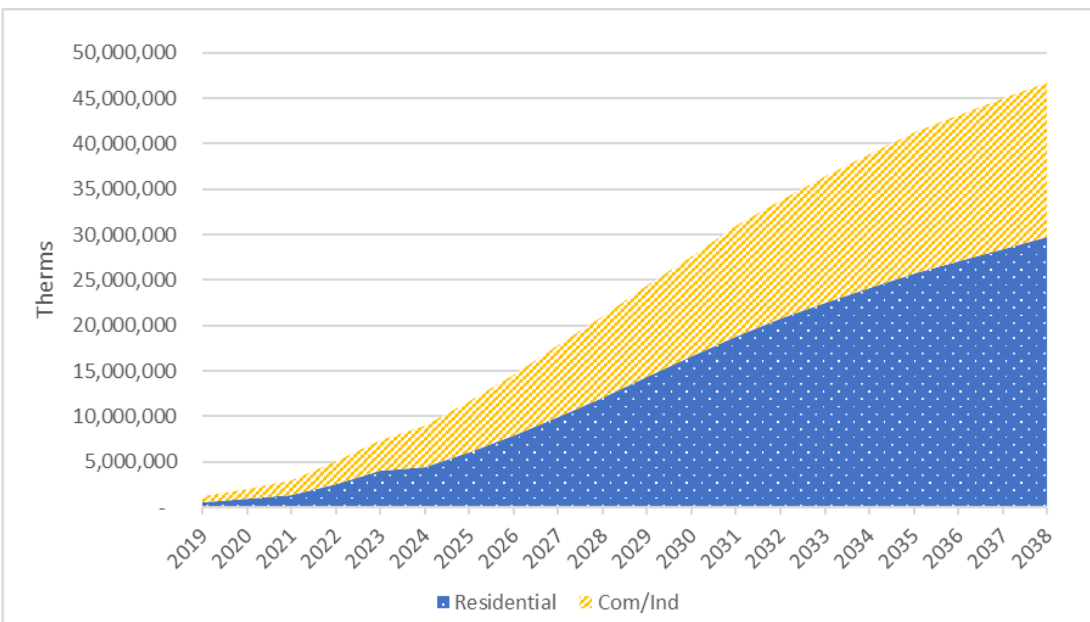
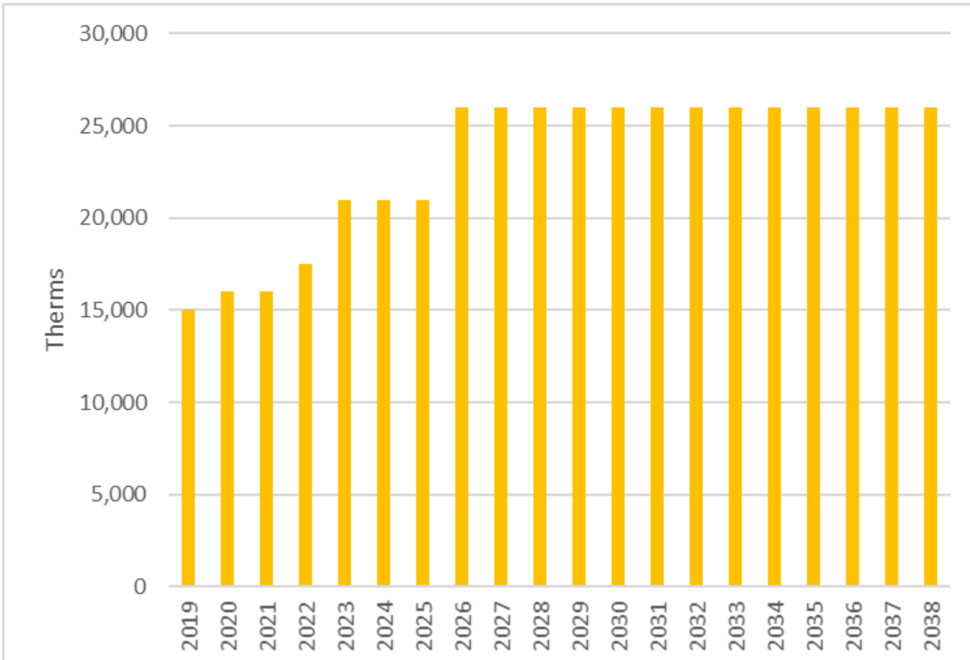


Figure 7-12 represents the incremental low-income forecast developed outside of LoadMAP incorporating estimated savings attributable to savings from Community Action Agency participation. In the near term, Low Income represents an additional 4% to the residential forecast noted previously.

Figure 7-12: Incremental Low-Income Weatherization Program Potential



Conservation Two-Year Action Plan

Based on the identified potential and goals for the Cascade Energy Efficiency Incentive Programs, the Company will be concentrating on the following areas as part of a two-year action plan.

- Perform continual technical review of new measures identified by the AEG CPA as well as through participation in the Gas Technology Institute Emerging Technology workgroup for inclusion into the Energy Efficiency program portfolio:
    - This will allow the Company to determine whether the technology is available to installers within the Cascade's service territory as well as enabling updates to incremental/install costs as applicable.
- Review and revise ramp rates within the LoadMAP model in compliance with best practices as recommended from the NWPCC and AEG, to align with measure maturity.
- Increase builder outreach;

- Partner with Cascade District Offices to increase customer awareness of Energy Efficiency programs.
- Extend Northwest Energy Efficiency Alliance membership into Cycle 6 (2020-2024) and elevate CNGC's participation to equal status with electric and dual fuel utilities on the Board of Directors allowing regional natural gas market transformation efforts to grow:
  - Fully engage in NEEA's Next Step Homes program starting in 2019 to support the Company's expanding residential builder outreach efforts and participation.
- Expand Commercial/Industrial program outreach and customer engagement:
  - Host customer forums;
  - Identify opportunities for dual fuel solutions;
  - Expand SPIF offerings; and
  - Provide selective technical audit support.
- Enhanced Trade Ally engagement:
  - Drive commercial Trade Ally participation through the commercial program with the primary objective being to make the incentive program a simple part of the install process for all Trade Allies in the Company's network installing in commercial/industrial properties and second, to increase the network where gaps exist.
  - Provide CNGC Sponsored TA training for underperforming measures including air sealing and potential duct sealing if added to the portfolio.
  - Expand a Point of Sale offering to residential Trade Allies to remove upfront cost barriers for customers to install higher-efficiency upgrades.
- Explore geographic pilots and efforts for specific offerings to underperforming areas within the service territory – for example in Zone 2 (Aberdeen, Longview, etc.).
- Increase engagement with the agencies delivering the Company's LI Weatherization Incentive Program to facilitate increased weatherization service delivery to qualified natural gas customers in Cascade's service area:
  - In addition to regular communication by phone and email, the Company will meet with the agencies in-person at least once a year, beginning in October 2018. The purpose of the Company's in-person will be to ensure effective coordination and provide ongoing support to agencies to help meet their goals.
  - Continue careful review and verification of program costs as the $10,000 per project cap on weatherization spending is removed, and tariff-approved funding is expanded.
  - In addition to estimated project completion targets, the Company shall also give agencies the opportunity to include a budget estimate

in its memorandum of understanding with the agencies to provide additional assurance to these partners that funds will be available as needed.
  - Continue to maintain open communication with agencies regarding potential barriers to serving natural gas homes and determining which can be overcome in coordination with the Company.
  - Keep apprised of home energy auditing techniques and make adjustments to allowed methodologies as new best practices emerge in the state.

While addressing the conservation two-year action plan, the Company will consistently monitor the state of natural gas conservation technologies within its service territory and make adjustments commensurate with evolving ENERGY STAR® standards, and updated building code requirements. In line with these efforts, and as part of a focus on cultivating more new builders within the residential program's bandwidth, the Company is just starting to work with NEEA staff on their Next Step Homes program to encourage ENERGY STAR® and Built Green certification for more construction throughout its territory.

The Company is also monitoring the residential natural gas furnace code standards as well as water heater criteria and will alter the program offerings as standards and building codes change in the next few years.

Paths to Increase Conservation Forecast Precision

The Energy Efficiency and Community Outreach Department continues to explore ways to improve its DSM forecasting. Adoption of the new LoadMAP model is key to the improvements as are the following:

- Engage in a regular cadence of technical review and evaluation of equipment availability to feed into the new LoadMAP model.
- Annually review and update incremental costs for measures with the CNGC service territory as occurred during the AEG CPA.
- Annual review of measure maturity along existing ramp rates combined with feedback from CAG meetings to confirm the Company remains in line with achievements.
- Additional scanning of new measures and inclusion of same whenever feasible to align the portfolio of offerings to the customers with those noted as viable options within LoadMAP.
- Careful review of measure viability with the CAG to advise of market drivers behind reliability, manufacturer availability and TA engagement. In the event a measure is found not to be viable for various market reasons the Company will

account for the associated potential by adjusting the ramp rates and/or potential.

Importance of Outreach and Cohesive Messaging

One step the Company is taking to increase its savings achievements is to commit more fully in outreach and community engagement. It has been made clear through recent program achievements that the more information available and reminders to the community (whether that's the residential, commercial or industrial customer) the more likely they are to participate. The Energy Efficiency department consistently reaches out to the Company's customers through the following means:

- Bill inserts to all qualifying Washington rate schedule customers:
    - These are both hard copy and electronic with topics ranging from Low Income weatherization availability, high efficiency water heating, whole home weatherization, commercial rebate availability, energy savings kits, furnaces, combination units, etc.
- Radio campaigns in select territories to promote the CIP and general low cost/no cost options for reducing natural gas consumption.
- The Company continues to explore this avenue by leveraging local community energy events like Earth Day and is looking to feature TAs to encourage high efficiency upgrades through knowledgeable experts.
- Leveraged messaging with community organizations and other utilities as applicable.
- Community project engagement:
    - The Energy Efficiency Department works with local nonprofit groups including Clean Air Agencies to promote more efficient use of natural gas over alternative heating fuels like uncertified wood burning fireplaces.
- Home Builder's Association directories, Tours of Homes and Home and Garden Show participation.
- Messaging is placed in directories, through radio, at the model homes and local CNGC reps are occasionally available to promote the programs directly.
- Business Exposition tabling and exhibition; and
- Targeted direct mail efforts.

In addition to the standard practices, the Company will provide specific details as part of its Conservation Plan where additional efforts above and beyond standard messaging are underway to help increase program participation.

Community Energy Program Partnerships

Cascade has partnered with local community-based energy programs for years to both support their reduction accomplishments and leverage the opportunity to provide messaging about the CIP to the public. A few of the programs the Company has supported include Sustainable Connections, Sustainable Living Center and the Community Energy Challenge.

In line with the Company's commitment to community engagement and the desire to increase awareness of its conservation programs, Cascade's staff also continues its partnership with the Western Washington University Institute for Energy Studies to provide guest lectures on DSM and energy efficiency since CY 2015 and has fully supported and engaged with the Women in Energy Mentoring Network.

Regional Efforts and Long-Term Benefits

Community engagement efforts in tandem with regional endeavors like the NEEA Natural Gas Market Transformation Collaborative have longstanding effects on future therm saving opportunities. As mentioned previously, the Company has elected to partner through NEEA with other regional gas utilities to engage in the first Gas Market Transformation Collaborative in the nation. The goal is to increase market adoption of energy efficient natural gas products and practices in the future. As part of the project the NEEA Natural Gas Collaborative currently pilots five technologies by increasing their use in the funders' joint service territories to improve availability, performance and cost effectiveness of these natural gas technologies. The five-year effort began in 2015 and should result in additional savings, if not immediately, then as the technology is adapted and installs increase in future years. Company investment in the initial pilot is shown in Table 7-4.

Table 7-4: Cascade NEEA Collaborative Funding Commitment

Year	Cascade's Washington Commitment at 9.3% of total budget for five-year pilot
2015	$145,848
2016	$244,956
2017	$313,122
2018	$452,211
2019	$548,804
Total	$1,704,849

As the Natural Gas Market Transformation pilot expires at the end of 2019 the funding utilities, NEEA's Board and NEEA staff are in the process of finalizing the Cycle 6 Strategic Plan, the Business Plans and the 2019 Operations plans. The Company has been highly engaged in this planning process to help steer the future efforts, while keeping in mind lessons learned as part of the mid-cycle program review performed through a third-party evaluator.

To further support the Company's engagement in these efforts, Cascade Natural Gas and Northwest Natural were successful in obtaining Board Director appointments on the Company's behalf as one of two gas-only funder representatives. Although exact funder contributions for the Cycle 6 budget have not yet been calculated, it is estimated funding will be at a similar level as that offered for the initial pilot assuming all funders remain engaged throughout the efforts.

Targeted Outreach

The CIP has identified areas where it will continue to target outreach activities into CY 2020. These audiences offer a new opportunity for efficiency messaging and continued partnerships.

The Company plans to tailor presentations and messaging to the real-estate community as many customers seeking to purchase a home are best able to consider efficiency upgrades in line with that new home purchase. Along with the real-estate outreach, the program will engage in conversations and provide program materials to the banking community within the towns (namely the property loan departments) as financing of homes allows for an opportunity to tailor messages relevant to efficiency when the purchaser is thinking of overall costs of home ownership and future expenses.

Additionally, the company is increasing outreach to new home builders directly and will continue to develop its messaging to represent the programs as a value add to these contractors. The Company recently updated its outreach and tools to include a specialized batch application submission process in addition to a specialized incentive sheet geared toward promoting only those measures applicable for new homes to reduce confusion. The Company's Builder Coordinator will also travel to target communities to speak directly to new builders about the benefits of participating in the programs and encourage high-efficiency installs at the planning stage for new construction whenever possible.

Another element of program outreach as noted previously involves messaging up the value chain to TAs and general contractors – those individuals who are in the home with the customers and are helping them make the decision whether to install high-efficiency or standard efficiency equipment. The program has always worked within a TA network, but the purchase and availability of the iTrade Ally software through Nexant Inc., has greatly increased the program's reach and acceptance by TAs. This is paired with internal coordination of the TA program by Company staff who are familiar with the programs and have the technical expertise to support the industry. This is now to be supported with proposed trainings and focus groups from the C/I program to nurture the Company's commercial and industrial customers in helping to promote higher-efficiency commercial installs while engaging more thoroughly with manufacturers.

Lockheed Martin is also on a path to increased program communications and marketing about the commercial and industrial CIP. Implemented as of mid-2016 and beyond the goal is to highlight customer success stories as samples of projects that other customers may wish to emulate and provide a well-reasoned and represented return on investment opportunity for high-efficiency upgrades to business owners. The Lockheed Martin team has placed program articles in Chamber of Commerce publications, industry publications and has provided press releases, video testimonials and public recognition to highlight successful projects. Additional insight into marketing plans can be reviewed in the 2019 Conservation Plan.

Through the steps noted previously in this section DSM is readily becoming a more integral part of the Company's resource acquisition and planning activities. As the Energy Efficiency programs continue to mature and grow the effect of these efforts will become more apparent and represent a greater impact toward reducing carbon emissions via these cumulative savings. The Company's new LoadMAP model, vastly increased data analysis activities, robust customer engagement and Conservation Planning document set the groundwork for increased savings goals throughout the next 20 years.

SECTION 8

RESOURCE INTEGRATION

Overview

Resource integration is the last step in Cascade's IRP process. It involves finding the reasonable least cost least risk mix of demand and supply side resources to serve the forecasted load requirements of the core customers. The tool used to accomplish this task is a computer optimization model known as SENDOUT®.

SENDOUT® is very powerful and complex. It operates by combining a series of existing and potential demand side and supply side resources, and optimizing their utilization at the lowest net present cost over the entire planning period for a given demand forecast. SENDOUT® permits the Company to develop and analyze a variety of resource portfolios quickly, to determine the type, size, and timing of resources best matched to forecast requirements.

Key Points

- Cascade utilizes SENDOUT® to find the optimal solve for forecasted resource deficiencies, as well as alternative portfolios.
- Once a solution is found under expected conditions, the candidate portfolio is stress-tested through stochastic and deterministic scenarios using VaR analysis.
- The optimal portfolio includes a combination of incremental transportation on GTN and NWP.
- Cascade's first material deficiency occurs in 2019 along the I-5 corridor. Once the Company acquires the planned Bremerton/Shelton resource, the next identified shortfall occurs in 2023 across Cascade's GTN citygates.
- With incremental resources, all forecasted deficiencies are eliminated, at costs that are within Cascade's VaR limit.

Supply Resource Optimization Process

- **Step 1: As-Is Analysis**
  - Cascade began its optimization process by running a deterministic analysis of its existing resources with a three-day peak event. This allowed the Company to uncover the timing and quantity of resource deficiencies. Once the resource need was identified, Cascade utilized its market intelligence to identify all potential options to solve for the projected shortfall.

- **Step 2: Introduce Additional Resources**
  - Once shortfalls were identified, Cascade utilized SENDOUT® to derive a diverse selection of potential portfolios to eliminate the deficiency. This was done through a deterministic analysis of the alternative resources. For the 2018 IRP, Cascade tested six potential portfolios. Table 8-1 groups these portfolios by the source of each resource. Further details regarding the components of each Candidate Portfolio can be found in Appendix E.

Table 8-1: Breakdown of Candidate Portfolios

	GTN	No GTN
NWP	• ALL-IN	• NWP Only • NWP Only w/ Storage
No NWP	• GTN Only • GTN Only w/ Storage	• Only Storage

- **Step 3: Stochastic Analysis of All Portfolios Under Existing Conditions**
  - Once Cascade selected its portfolios, each one was tested stochastically. Each portfolio was run through a 10,000 draw Monte Carlo weather simulation under normal growth, pricing, and storage/supply accessibility. The Company recorded the total system cost and unserved demand of each draw, as these are the metrics used to rank the portfolios.

- **Step 4: Ranking of Portfolios**
  - Cascade took the unserved demand and total system cost of all draws in each portfolio and calculated the mean and Value at Risk (VaR) of the portfolios. For its modeling purposes, the Company defines VaR as the 99^{th} percentile of unserved demand and total system cost. This is considered a reasonable worst-case scenario for risk analysis. Cascade ranked its portfolios by first giving preference to any portfolio that fully solved for unserved demand in both stochastic and deterministic analysis. After that, portfolios were ranked based on a risk-adjusted total system cost metric, which gives 75% weight to the total system cost under deterministic conditions for a given portfolio, and 25% weight to the costs under stochastic conditions. Cascade believes the top ranked portfolio is the one with the most reasonable least cost and least risk mix of energy supply resources and conservation for Cascade and its customers. This is now deemed to be the Top Ranked Candidate Portfolio, but it is still just a Candidate Portfolio until it has passed a rigorous scenario and sensitivity analysis.

- **Step 5: Stochastic Scenarios of Candidate Portfolio**
  - Cascade created sixteen different scenarios to stochastically test its candidate portfolio. These scenarios, which are detailed in Table 8-2, measure how the portfolio performed in high and low growth

environments, as well as various restrictions related to storage availability. In each scenario, the portfolio was run through a 10,000 draw Monte Carlo weather simulation, and the total system cost at the 99th percentile was recorded as the VaR for the Candidate Portfolio in that scenario.

- **Step 6: Scenario Analysis of Candidate Portfolio**
  - The VaR of the Candidate Portfolio in each scenario was compared to the Company's VaR limit, which was set by Cascade's Gas Supply Oversight Committee (GSOC) and was equal to 1.25 times the mean total system cost of the portfolio under expected conditions. If the VaR in any scenario exceeded this limit, that portfolio may be rejected, and the next highest ranked portfolio would become the new Top Ranked Candidate Portfolio for scenario analysis. If the VaR of all scenarios did not exceed this limit, the portfolio passed scenario testing and moved to sensitivity testing.

- **Step 7: Sensitivity Testing of Candidate Portfolio**
  - Cascade created nine different pricing environments to stochastically test its candidate portfolio. These sensitivities, which are detailed in Table 8-2, measure how the portfolio performed in high and low price situations, as well as with a range of adders related to carbon legislation. In each sensitivity, the portfolio was run through a 10,000 draw Monte Carlo NYMEX price simulation, and the total system cost at the 99th percentile was recorded as the VaR for the Candidate Portfolio in that sensitivity.

- **Step 8: Sensitivity Analysis of Candidate Portfolio**

  - The VaR of the Candidate Portfolio in each sensitivity was compared to the Company's VaR limit, which was set by Cascade's GSOC and was equal to 1.25 times the mean total system cost of the portfolio under expected conditions. If the VaR in any sensitivity exceeded this limit, that portfolio may be rejected, and the next highest ranked portfolio would become the new Top Ranked Candidate Portfolio for scenario analysis. If the VaR of all sensitivities did not exceed this limit, the portfolio passed sensitivity testing and could be confirmed as Cascade's Preferred Portfolio. Figure 8-1 displays this process as a flow chart.

Figure 8-1: Supply Resource Optimization Process Flow Chart

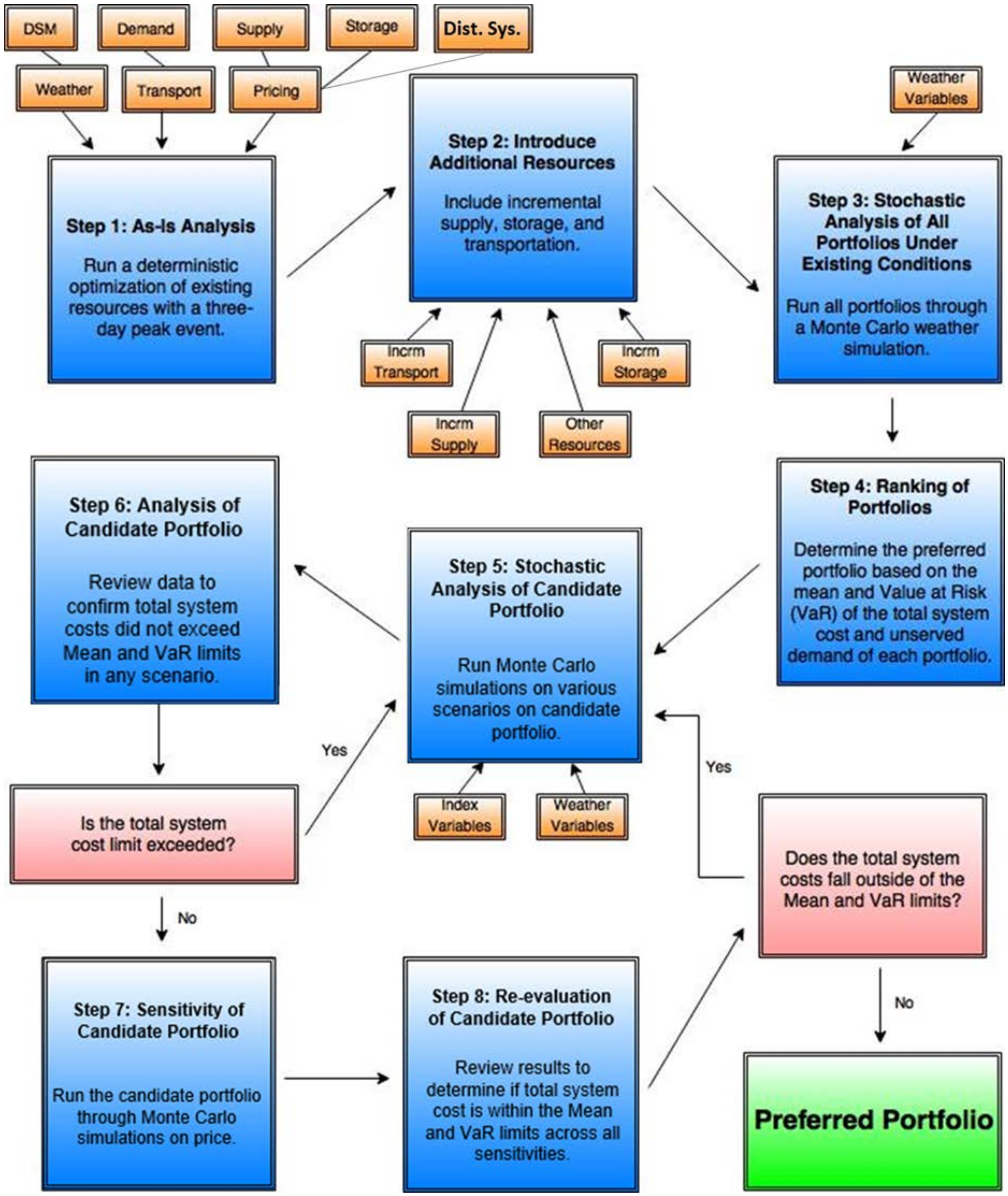


Table 8-2: Breakdown of Scenarios & Sensitivities Modeled

Scenarios and Sensitivities		Assumptions: Growth	Weather	Price	Carbon Forecast	Constraints	First Year Unserved
Expected Conditions		Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 3% Discount Rate	None	N/A
Transportation	**No Evergreen**	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 3% Discount Rate	No Current Contracts Evergreen	2028
Growth	**High Growth**	High Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 3% Discount Rate	None	2021
	Low Growth	Low Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 3% Discount Rate	None	N/A
Environmental Adder	**0%**	Medium Load Growth	Average Weather with Peak Event	Stochastic Pricing with a 0% Environmental Adder	SCC w/ 3% Discount Rate	None	N/A
	20%	Medium Load Growth	Average Weather with Peak Event	Stochastic Pricing with a 20% Environmental Adder	SCC w/ 3% Discount Rate	None	N/A
	30%	Medium Load Growth	Average Weather with Peak Event	Stochastic Pricing with a 30% Environmental Adder	SCC w/ 3% Discount Rate	None	N/A
No Supply	**No Alberta Supply**	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 3% Discount Rate	No gas from Alberta	2019
	No BC Supply	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 3% Discount Rate	No gas from British Columbia	2019
	No Rockies Supply	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 3% Discount Rate	No gas from Rockies	2019
Limit Supply	**Limit Alberta**	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 3% Discount Rate	No day gas from Alberta	N/A
	Limit BC	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 3% Discount Rate	No day gas from British Columbia	N/A
	Limit Rockies	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 3% Discount Rate	No day gas from Rockies	N/A
	Limit Canada	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 3% Discount Rate	No day gas from Canada	N/A
No Storage	**No JP**	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 3% Discount Rate	No access to Jackson Prairie	2019
	No Plymouth	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 3% Discount Rate	No access to Plymouth storage	2019
	No JP or Plymouth	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 3% Discount Rate	No access to any storage	2019
Limit Storage	**Limit JP**	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 3% Discount Rate	25% access to Jackson Prairie	2026
	Limit Plymouth	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 3% Discount Rate	25% access to Plymouth storage	2020
	Limit JP or Plymouth	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 3% Discount Rate	25% access to any storage	2019
Carbon Forecasts	**Ballot Initiative**	Medium Load Growth	Average Weather with Peak Event	Stochastic Pricing	I-1631 Ballot Initiative	None	N/A
	Inslee/Carlyle Carbon Tax	Medium Load Growth	Average Weather with Peak Event	Stochastic Pricing	SB 6203 – Inslee/Carlyle Carbon Tax	None	N/A
	Market Choice	Medium Load Growth	Average Weather with Peak Event	Stochastic Pricing	House of Representatives' Market Choice Proposal	None	N/A
Price Forecast	**High Price Forecast**	Medium Load Growth	Average Weather with Peak Event	High Pricing Environment	SCC w/ 3% Discount Rate	None	N/A
	Low Price Forecast	Medium Load Growth	Average Weather with Peak Event	Low Pricing Environment	SCC w/ 3% Discount Rate	None	N/A
	High Volatility	Medium Load Growth	Average Weather with Peak Event	Medium Pricing Environment with high volatility	SCC w/ 3% Discount Rate	None	N/A

While Section 12 includes a full Glossary, terms related to Table 8-2 are shown below for convenience.

Terms Used in Table 8-2

Average Weather with Peak Event. The weather pattern was modeled using historical weather data in each of Cascade's climate zones for the past

30 years. In addition, a design peak day was inserted on December 21st of each year to allow for conservative forecasting to model the coldest day in Cascade's system over the past 30 years.

Stochastic Weather. The weather pattern was modeled using historical weather data in each of Cascade's climate zones. This data is run through a Monte Carlo simulation, which allows the Company to derive the 99th percentile of potential system weighted heating degree days (HDDs).

No Evergreen – A transportation constraint where Cascade models the impact of not renewing any contracts with a termination date before the end of the 20-year planning horizon.

Low Customer Growth. Low customer growth scenarios were created by examining the low end of the confidence intervals of Cascade's customer forecast, as mentioned on page 3-18.

Medium Customer Growth. Cascade used its expected customer forecast, as mentioned on page 3-18 for the expected growth scenario

High Customer Growth. High customer growth scenarios were created by examining the high end of the confidence intervals of Cascade's customer forecast, as mentioned on page 3-18.

Low Pricing Environment. Price was modeled using Cascade's price forecast, which was derived by weighting the forecasts from a number of sources over the 20-year planning horizon. Prices were then reduced by 6% at all markets (i.e., NYMEX, Sumas, Rockies, AECO) to simulate a low pricing environment over the 20-year period.

Medium Pricing Environment. Price was modeled using Cascade's price forecast, which was derived by weighting the forecasts from multiple consultants over the 20-year planning horizon.

High Pricing Environment. Price was modeled using Cascade's price forecast, which was derived by weighting the forecast of a number of sources over the 20-year planning horizon. Prices were then increased by 5% at all markets to simulate a high pricing environment over the 20-year period.

Stochastic Pricing. NYMEX Pricing was modeled by running Cascade's price forecast through a Monte Carlo simulation, which allows the Company to identify the 99th percentile of potential NYMEX pricing based on the deterministic projections.

Stochastic Pricing with 0% Adder. Price was modeled using Cascade's price forecast, which was derived by weighting the forecasts from its sources over the 20-year planning horizon. Cascade then removed the 10% environmental adder, originally in place to simulate the impact of unforeseen environmental conditions.

Stochastic Pricing with 20% Adder. Price was modeled using Cascade's price forecast, which was derived by weighting the forecast of its sources over the 20-year planning horizon. Prices were then increased by 20% at all markets to simulate the impact of unforeseen environmental conditions.

Stochastic Pricing with 30% Adder. Price was modeled using Cascade's price forecast, which was derived by weighting the forecast of its sources over the 20-year planning horizon. Prices were then increased by 30% at all markets to simulate the impact of unforeseen environmental conditions.

SCC w/ 3% Discount Rate – Cascade's base case Carbon Forecast. This is modeled as an adder to Cascade 20-year price forecast and avoided cost starting in 2020. The source of this forecast is the Interagency Working Group on Social Cost of Greenhouse Gases' Technical Support Document: Technical Update of the Social Cost of Carbon (SCC) for Regulatory Impact Analysis Under Executive Order 12866.

I-1631 Ballot Initiative – A carbon sensitivity based on the proposed carbon tax that Washington voters will consider in November 2018. This is modeled as an adder to Cascade 20-year price forecast and avoided cost starting in 2020.

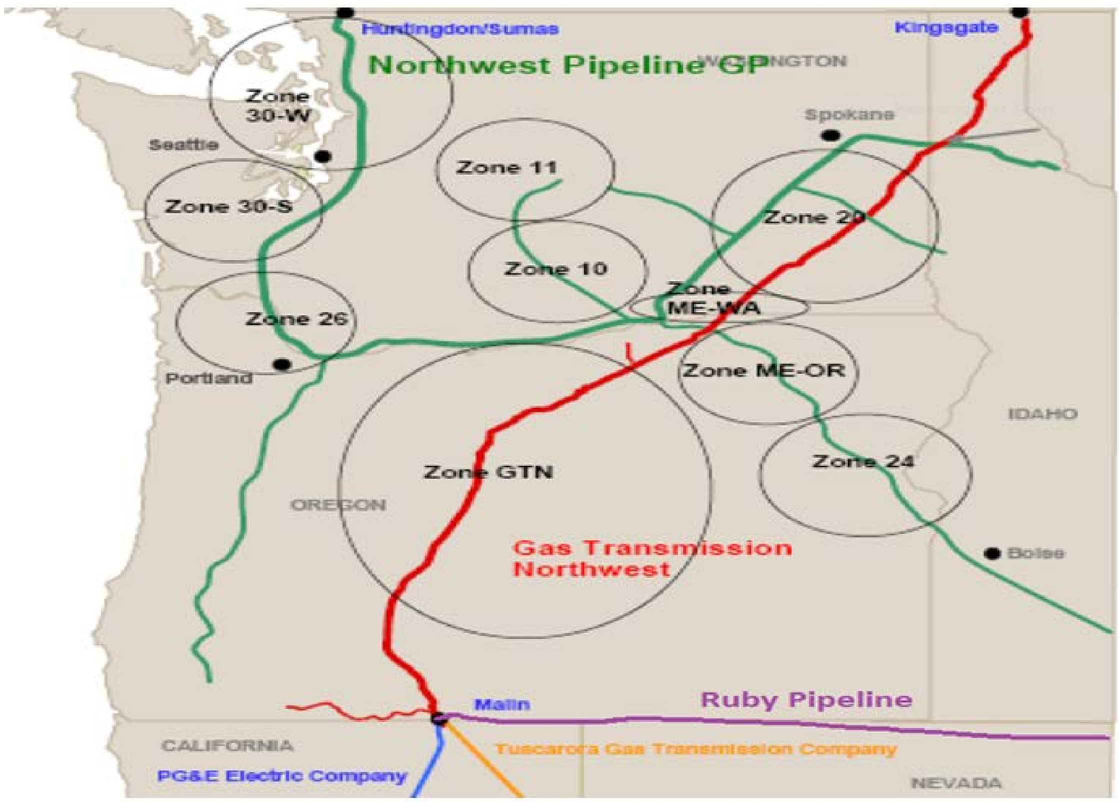
SB 6203 – Inslee/Carlyle Carbon Tax – A carbon sensitivity based on the proposed carbon tax that failed to pass in Washington state House of Representative in early 2018. This is modeled as an adder to Cascade 20-year price forecast and avoided cost starting in 2020.

House of Representatives' Market Choice Proposal – A carbon sensitivity based on the proposed carbon tax that was introduced to the US House of Representative in mid-2018. The proposal is not expected to pass but is a good proxy for a potential national tax. This is modeled as an adder to Cascade 20-year price forecast and avoided cost starting in 2020.

Planning and Modeling

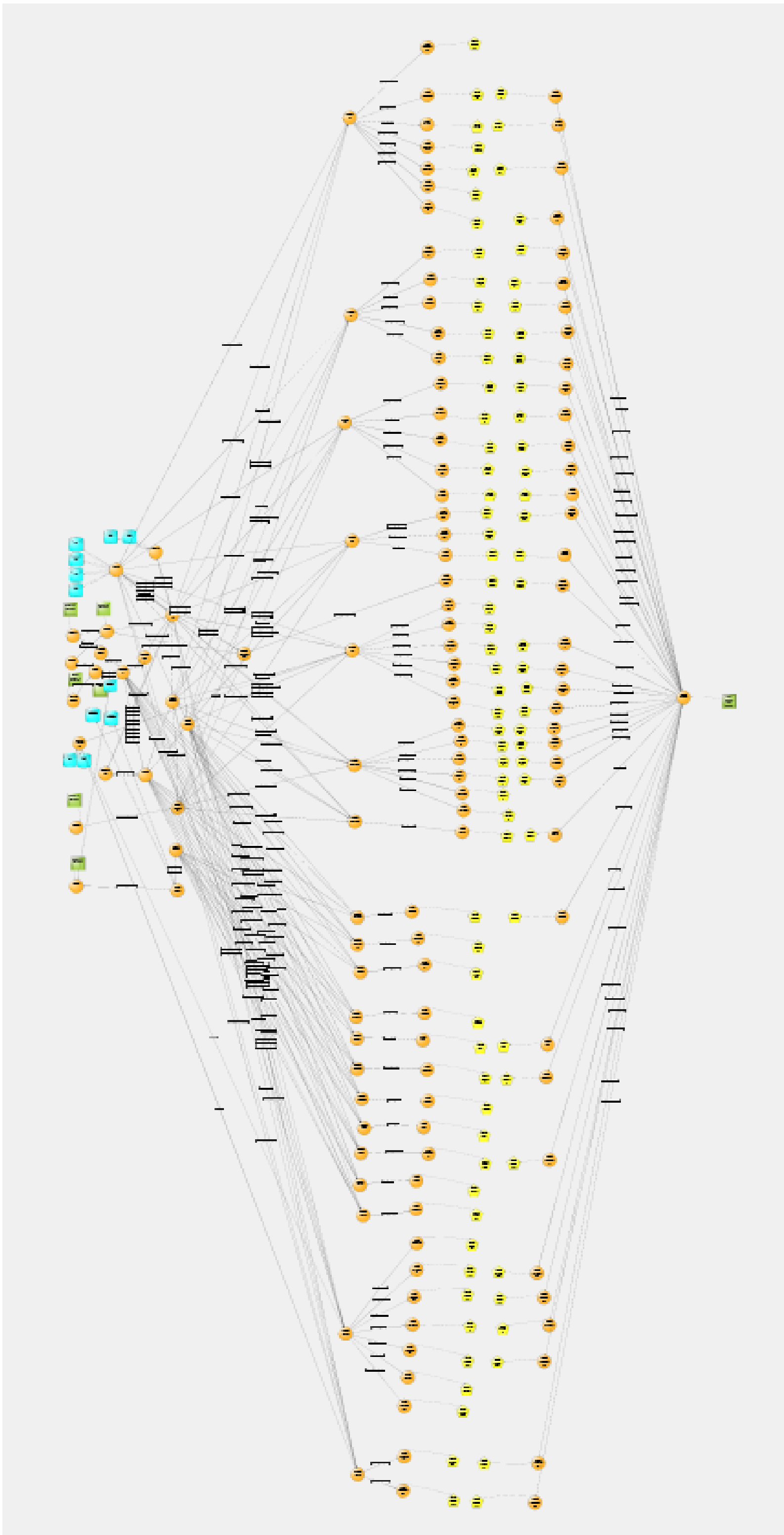
SENDOUT® has broad capabilities that allow the Company to develop supply and demand relationships that closely mirror Cascade's existing operations. Beginning with the 2008 IRP, Cascade expanded its modeling from the district level to modeling the system grouped by the various pipeline zones. Figure 8-2 shows the location of these pipeline zones. These pipeline zones reflect Cascade's customers being served from either Northwest Pipeline LLC (NWP) or Gas Transmission Northwest (GTN) interstate pipeline facilities.

Figure 8-2: Pipeline Zones Used in this IRP



With the in-house load forecast model (LFM) application, which is discussed in detail in Section 3, Demand Forecast, modeling dives into an even more granular level. This IRP takes more of a citygate and rate schedule view, which allows Cascade to take a deeper view of capacity shortfalls and potential constraints. A copy of the network diagram is shown in Figure 8-3. The network diagram is provided for illustrative purposes to emphasize the difficulties in configuring the model to best replicate Cascade's complex system rather than being provided for its readability.

Figure 8-3: SENDOUT® Network Diagram of Cascade's System



Stochastic Methodology Discussion

During the 2016 IRP process, Washington Utilities and Transportation Commission Staff identified Cascade's stochastic analysis methodology as an opportunity for improvement in future IRPs. Specifically, Staff was concerned with the fact that Cascade's Monte Carlo simulation was only performed on one portfolio. To this end, Cascade has implemented a couple of major changes to its stochastic process

First, the Company now runs its Monte Carlo simulations on all candidate portfolios, which is used to create the risk-adjusted metrics discussed in Step 4 of Cascade's Supply Resource Optimization Process. The rationale behind this is to use the deterministic results to capture the intrinsic value of each portfolio, while the stochastic results capture the extrinsic value of the portfolios. Cascade chose to weight these with a 75/25 split, as the Company believes this mix properly assigns value to results under expected conditions versus results under unexpected conditions. Additionally, this follows the regional best practices.

Second, Cascade has moved from using the Monte Carlo functionality within SENDOUT® to building its own simulation engine in Excel and R. While SENDOUT® was able to generate adequate results in the past, the Company wanted to run a more robust simulation to supplement the functionality of SENDOUT®. SENDOUT® ran Monte Carlo simulations on monthly data and then used historical patterns to create weather patterns. The new methodology allows Cascade to be more detailed by running Monte Carlo simulations on daily data and creating multiple weather patterns. The new methodology of utilizing R to run stochastic analysis allows Cascade to be transparent on each step of the stochastic analysis process. Using historical data for weather, along with Cholesky Decomposition Matrices, Cascade can now run a 10,000 draw Monte Carlo simulation on price and weather, which will allow for a more accurate distribution when identifying what is the 99th percentile of price and weather for stochastic analysis. The negative aspect of running stochastic analysis outside of SENDOUT® is that Cascade needs to manually insert the weather data of a specific stochastic analysis draw to run the linear optimization of that weather profile. The Monte Carlo functionality embedded within in SENDOUT® allows the program to read and optimize the stochastic weather results from all generated draws automatically.

The Cholesky Decomposition Matrix is a positive-definite covariance matrix. This matrix is used to draw or sample random vectors from the N-dimensional multivariate normal distribution that follow a desired distribution. In Cascade's case, this allows for correlations between weather zones to be included when drawing or sampling data distributions for Monte Carlo runs. Table 8-3 shows Cascade's historical correlations between weather stations for the month of January. A realistic Monte Carlo draw would show similar correlations between weather stations, which Cascade manages to accomplish with the Cholesky Decomposition Matrix. By correlating random variables, there is always the potential issue of overfitting and not allowing for enough randomness between each draw. Also, Cascade is aware of the possibility of introducing bias into its models. This is something Cascade is keeping a close eye on by constantly evaluating and cross-validating the results.

Table 8-3: January Historical Correlations between Weather Stations

City	Baker City	Bellingham	Bremerton	Pendleton	Redmond	Walla Walla	Yakima
Baker City	1.00000						
Bellingham	0.63383	1.00000					
Bremerton	0.65848	0.86889	1.00000				
Pendleton	0.70245	0.73001	0.69979	1.00000			
Redmond	0.71736	0.76293	0.76183	0.79743	1.00000		
Walla Walla	0.71051	0.72579	0.69180	0.95952	0.78995	1.00000	
Yakima	0.66974	0.69391	0.68315	0.79445	0.70062	0.81950	1.00000

Stochastic analysis of price presents a different set of challenges. Cascade only performs its Monte Carlo simulation on NYMEX, as the basins are ultimately calculated as a function of the NYMEX price plus or minus a basis differential. This eliminates the need to correlate multiple variables, while simplifying the process. Prices also follow a different distribution from weather, which adds a layer of complexity. HDDs have historically shown to be distributed normally, which allows for the use Gaussian distributions in weather stochastic analysis, and while the month to month percentage changes in gas prices show to be normally distributed, gas prices tend to follow a more lognormal distribution. Practically speaking, prices appear to be just as likely to move up or down month over month, but the dollar impact of these movements is greater for price increases. For example, with a starting price of $2/dth, five straight months of 10% gains result in an increase of $1.22/dth, while five straight months of 10% losses result in a loss of $0.82/dth.

Cascade models these price movements with a Geometric Brownian Motion stochastic process. For each of its 10,000 draws, the month over month price change is determined by 2 elements: a drift term and a shock term. The drift term is the expected movement of NYMEX, derived from the Company's price forecast. The shock term is the main stochastic element, which takes the month over month return variance and multiplies it by a random normal variable to create a normal distribution of price movements for a given month, and a lognormal distribution of prices as illustrated above.

A more in-depth breakdown of the data justifying this new methodology, including the monthly present value revenue requirement (PVRR) calculations of a sampling of stochastic draws, can be found in Appendix G.

Resource Optimization Output and Analysis Reports

After the model run is performed and SENDOUT® selects the optimal set of resources from the available portfolio, output reports are generated. SENDOUT® provides an assortment of Input and Output reports that it can generate, provided they are selected prior to the optimization run. SENDOUT® offers dozens of separate input reports that summarize various items such as demand inputs, the resulting forecast, temperature patterns as well as supply, storage, and transportation resource inputs. These reports verify that the information supplied to SENDOUT® is being accurately interpreted by the model.

The results of the optimization process are provided in the dozens of output summary reports. These reports summarize various aspects of the optimal portfolio resource size and selection as well as cost and utilization over the planning period. For purposes of this discussion, certain key output reports will be summarized below.

Key Output Report - Cost and Flow Summary

The Cost and Flow Summary Report consolidates a myriad of informative aspects of the optimization run. The report provides a breakdown of portfolio costs on a yearly basis, unit cost detail, as well as a total planning period basis, in several different formats. For example, an aggregate portfolio cost total is provided for comparison between years, as well as between various optimization runs, if the analyst is attempting to compare the impact that one or more resources can have on the portfolio. This total portfolio cost figure is also broken down into supply, storage and transportation cost summaries on both a yearly and planning period basis.

The report also contains the Resource Mix summary. This summarizes SENDOUT® decisions regarding the sizing and optimal mix of incremental resources, which determines whether one or many different types of resources should be considered for inclusion in the total resource portfolio.

Key Output Report - Month to Month Summary

While the Cost and Flow summary provides an indication of individual resource utilization, the Month to Month summary allows greater examination of how SENDOUT® utilizes each resource. The user can determine if the particular type of resources presented to SENDOUT® are being utilized as envisioned or whether other types of resources would more closely match requirements. For example, as has been done by Cascade, the analyst may offer annual supply contracts to SENDOUT® to address load growth over the planning period. The analyst can examine this report to determine if SENDOUT® uses these supplies throughout the year or only occasionally. If SENDOUT® utilizes this resource on a short-term basis during the winter, the analyst can introduce seasonal resources to SENDOUT® to determine whether it would choose them over the annual supplies already available in the portfolio.

SENDOUT® also presents monthly information in other specific reports. For example, the supply information provided in this Month to Month report is also available in greater detail in the Supply Summary Report. The same is true with the Transportation Summary Report and the Storage Summary Report. SENDOUT® also offers monthly supply utilization information in a Load Factor Summary Report, which some analysts may prefer to use in their approach to analyzing the SENDOUT® results.

Key Output Report - Supply vs. Requirements

The Supply vs. Requirements report compares a particular forecast's monthly demand requirement quantity against the optimal portfolio's various supply quantities. This shows supply utilization as well as determines whether the supply portfolio quantities are sufficient to meet demand. If an insufficiency exists, the report isolates the shortfall by month as well as the location of the Company's demand requirement. With this information, the Daily Unserved Demand reports determine if a pattern exists with respect to the shortfall. For example, if the daily report indicates that the shortfall occurs on the peak day the analyst could turn to the Peak Day Reports to determine if the shortfall is supply or transportation related. If the shortfall occurs on any number of days surrounding the peak or at other times during the year, the analyst can turn to the Daily Supply Take and Daily Transport Flow reports to determine whether the portfolio is constrained by supply availability or transport capacity on those particular days.

Key Output Reports - Custom Report Writer

Ultimately, the availability and interpretation of information gained through SENDOUT® output reports contribute to developing better resource portfolios. SENDOUT® output report(s) contains vast amounts of information, which may overwhelm the casual observer. Therefore, SENDOUT® offers the user a Custom Report Writer (or Report Agent) module, which can isolate certain information contained in the various output reports and improve the analysis activity. Report Agent provides the user a menu of report information sources from which to choose specific items. The user has the option of viewing or downloading the information into spreadsheets or databases. Provided the information is available, the analyst can readily access specific items, which simplifies the data acquisition process if further analysis is desired. While the report writer is a useful tool in this regard, not all SENDOUT® output information can be accessed through this module.

Key Inputs

Individual transportation segments, storage, supply and demand side resources, both existing and potential, are targeted to demand segments representing the citygates connected to the system and the various classes of core customers behind those gates. This level of precision allows SENDOUT® to consider each resource on an individual basis within the portfolio while also recognizing where physical system limitations exist. Resource characteristics such as a supply contract's daily delivery capability, minimum take requirements, maximum daily transport capability by individual segment, storage inventory limitations and withdrawal, and injection curve characteristics are part of each resource's basic model inputs. The ability to model resources in this fashion allows SENDOUT® to tailor the optimization within envisioned constraints and ensures that the model's optimal solution can work under anticipated operating conditions.

The optimization process compares a portfolio of resources against a specific demand requirement. SENDOUT® generates a daily demand forecast by combining base load and temperature sensitive usage factor inputs with a specified daily temperature pattern input. For IRP purposes usage factor inputs were specifically developed under high, medium, or low demand profiles culled from Cascade's in-house LFM. Daily temperature patterns are available as either design or average weather. Due to the complexity of the SENDOUT® application, the model has some combined demand areas compared to the LFM. Therefore, both usage factor and temperature pattern inputs from the LFM may be slightly adjusted within SENDOUT® on an area specific basis without creating any material difference in the load demand.

In SENDOUT®, each supply contract requires a Maximum Daily Quantity (MDQ) input to establish its specific delivery capabilities. Review of the daily, annual, monthly, or seasonal minimum utilization of the contract is required. Maximum take quantities can also be established on either an annual, monthly, or seasonal basis. The Commodity Rate input can reflect either a known price, in the case of a fixed cost contract, or index prices, if the user has established a representative index as a separate input item. Several fixed and variable cost rate inputs are also available for establishing separate contract cost items, if necessary. Most of the gas supply options discussed above are also available as transportation inputs.

Penalty Rates on an annual, seasonal, monthly or daily basis are needed if either minimum or maximum utilization requirements are required or desired. The penalty rate can be any amount desired or a specific amount if known. The intent of the penalty option is to direct SENDOUT® to adhere to whatever minimum or maximum characteristic is specified.

Resource Mix is one of the more powerful and highly desirable input tools available in the model. By toggling on Resource Mix and providing an MDQ maximum and minimum, the user directs SENDOUT® to appraise the supply contract, on a total cost basis, against all other supply resources available within the portfolio. Under Resource Mix, SENDOUT® will determine whether the resource is desirable within the portfolio and at what MDQ size, within the MDQ Maximum and Minimum, the resource should be made available within the portfolio. This aspect of SENDOUT® is crucial to the evaluation of potential resources, as the Company conducts its resource planning, appraisal, and acquisition activities.

In addition to most of the items discussed above, storage resources have additional input considerations. Instead of MDQ inputs, the analyst establishes inventory maximums and/or minimums. If monthly inventory levels are to change over the years or within a year, SENDOUT® allows the analyst to establish that target. Injection and withdrawal capability, as well as the period within the year that each is available, are also input decisions.

A unique feature of SENDOUT® storage input is the Storage Volume - Dependent Deliverability (SVDD) Tables. This input item allows the user to tailor injection and withdrawal rates as either a line or step function based upon whether the facility has varying operating pressure constraints as the injection or withdrawal activity is conducted. The analyst can also establish whether inventory exists at the beginning of the planning period, and whether various prices and specific quantities exist at that time. SENDOUT® provides the analyst with five separate volume and price levels to reflect existing inventories.

Finally, SENDOUT® allows for input of a penalty rate for unserved demand. Cascade uses this functionality to give SENDOUT® a way to prioritize which rate tariff to serve when demand is higher than the resources available to serve that demand. These penalties are always higher than the cost of any incremental resources, as SENDOUT® should always elect to purchase these resources versus leaving demand unserved. Residential customers are always assigned the highest penalty. This tells SENDOUT® to prioritize serving these customers above all others. Commercial customers have the next highest penalty, followed by Commercial/Industrial customers, and finally Industrial customers. It is important to note the customers on an interruptible tariff do not have a penalty assigned to leaving their demand unserved. This allows SENDOUT® the flexibility to serve the demand of these customers when possible, while making sure not to purchase additional resources if they will only be used to serve interruptible demand.

Decision Making Tool

Analysis of optimization model results and other operational and contractual constraints allows Cascade to make more informed resource decisions. The IRP optimization model output and Monte Carlo simulation analysis provide the quantifiable output from numerous model inputs. The model does not prescribe the ultimate resource portfolio. It can only calculate the least cost set of resources given their specific pricing and quantifiable constraint characteristics. However, many other resource combinations may be available over the planning horizon. Therefore, Cascade must include subjective risk judgments about unquantifiable and intangible issues related to resource selections. These include future flexibility, supplier deliverability risk, pipeline(s) risk, financial risk to the utility and its customers, operational constraints, regulatory risk, etc. The risk judgments are combined with the quantitative IRP analysis to form the actual resource decisions.

Resource Integration

The following subsections summarize the analysis of the preceding sections bringing together the demand forecast, existing supply and demand side resources and potential alternative resources to develop the 20-year, most reasonably priced portfolio.

Demand Forecast

Load growth across Cascade's system through 2038 is expected to fluctuate between .68% and 1.73% annually, accounting for leap years. Load growth is split between residential, commercial, and industrial customers. Residential and commercial customer classes are expected to grow at an average rate near 1.44% and 0.94% annually, while industrial expects a growth rate of around 0.45%. Load across Cascade's two-state service territory is expected to increase 25% over the planning horizon, with the Oregon portion outpacing Washington at 35.6% versus 21.5%.

Long-Term Price Forecast

In Section 4, Supply Side Resources, Cascade discusses how the 20-year price forecast is based on a blend of current market pricing along with long-term fundamental price forecasts. Since pricing on the market is heavily influenced by Henry Hub prices, the Company closely monitors this market trend. The fundamental forecasts of Wood Mackenzie, the Energy Information Administration, the Northwest Power and Conservation Council, and trading partners are resources for the development of Cascade's blended long-range price forecast. Since the Company's physical supply-receiving areas (Sumas, AECO, and Rockies) are usually at a discount to Henry Hub, the Company utilizes the basis differential from Wood Mackenzie's most recently available update and compares that to the future markets' basis trading as reported in the public market.

Natural gas prices have stabilized after dramatic fluctuations over the course of the last ten years. Figure 8-4 shows the history of regional and Henry Hub prices over the past ten years. The Great Recession, the shale boom, environmental concerns around carbon, conservation efforts, and improvements in renewable energy have led to a market with prices as low as they have been in recent history. Recently, prices have remained relatively stable due to abundant supply and no major economic shock events in the past few years. This in turn has lead to a relatively low price forecast compared to prior IRPs.

Figure 8-4: Historical Regional Pricing for Past Ten Years

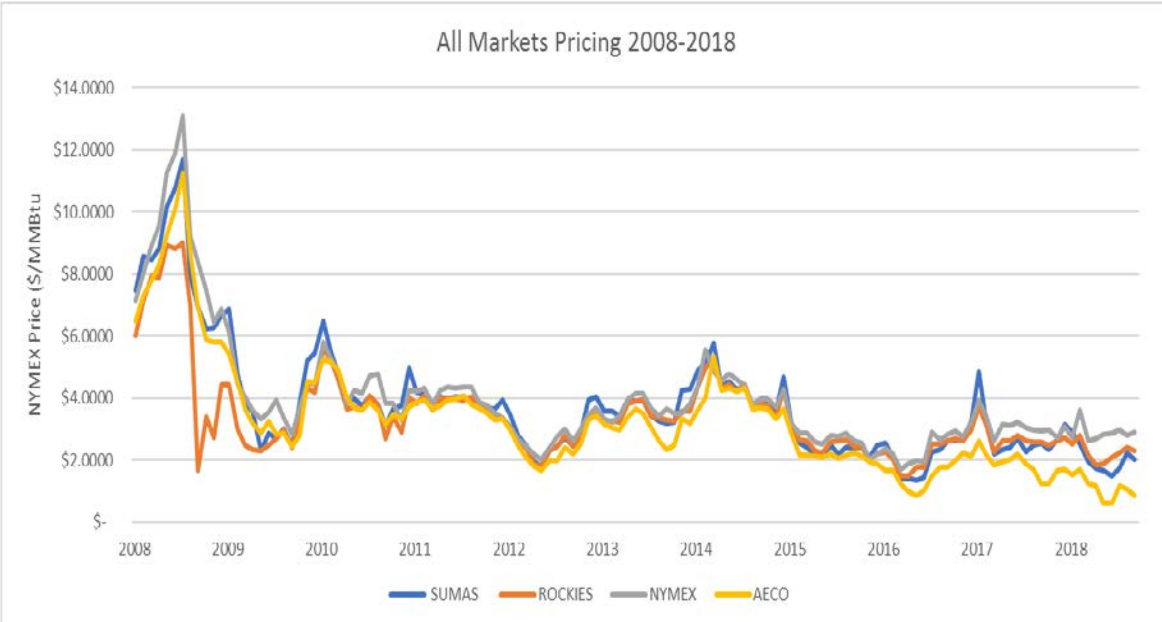
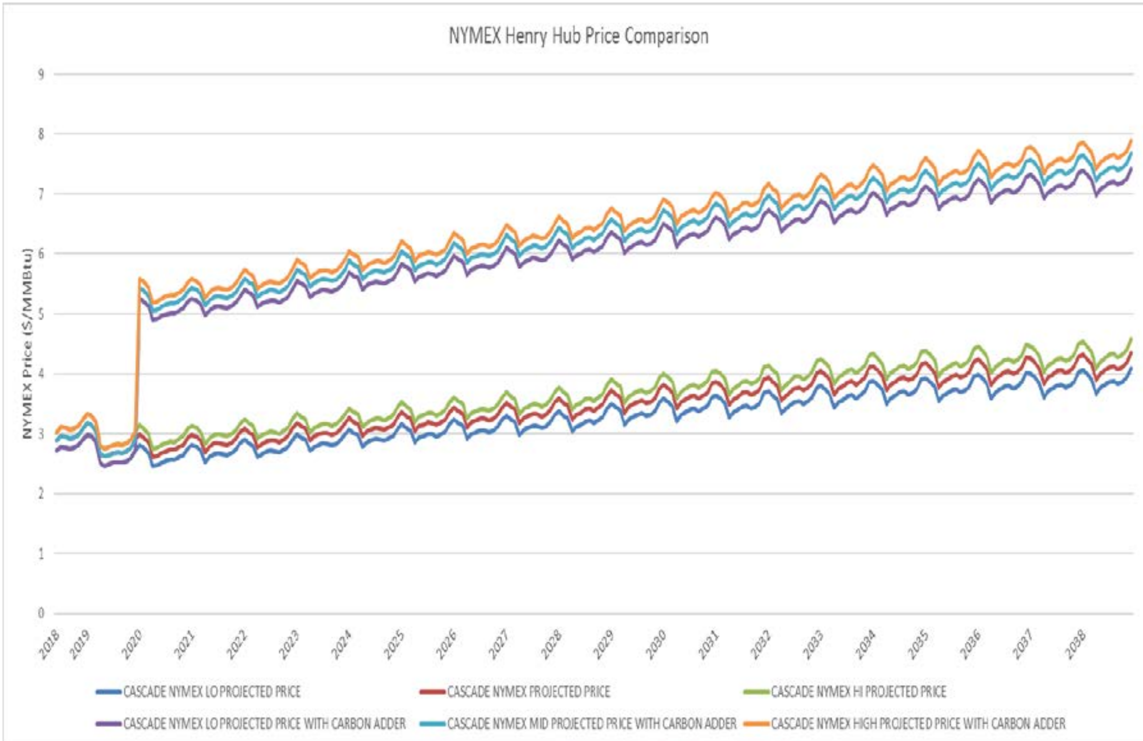


Figure 8-5 shows the comparison of ranges of pricing for the planning horizon, including the expected low, medium and high price, with and without a carbon adder for the impact of the SCC. The large jump starting in 2020 is a result of Cascade modeling that year as the start of the carbon tax.

Figure 8-5: NYMEX Annual Price Comparison



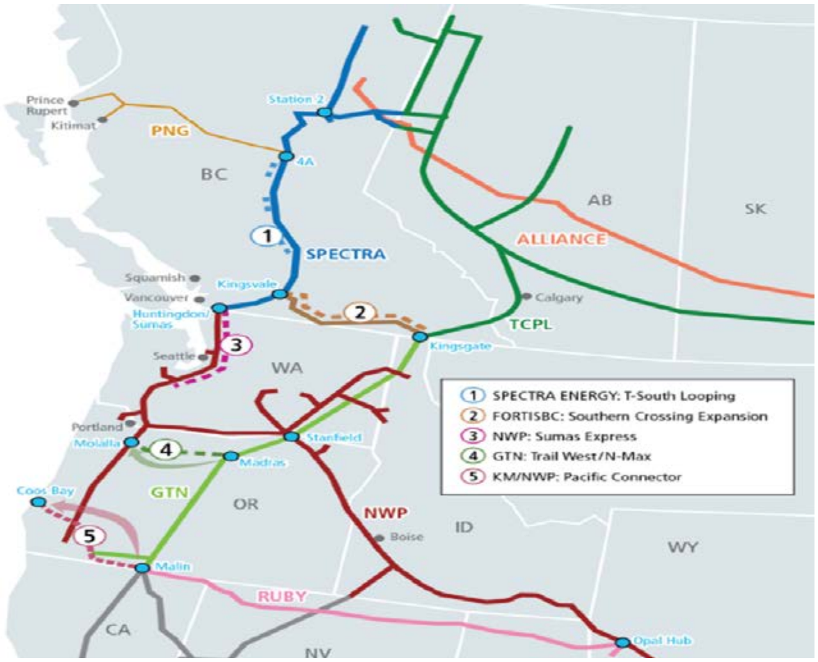
Environmental Adder

As discussed in Section 6, Avoided Cost, Cascade included a 10% environmental adder in its 2018 IRP's 20-year price forecast.

Transportation/Storage

Section 4 describes the range of current upstream pipeline transportation capacity and storage services under contract to serve core customers. Additionally, the Company identified several proposed transportation resources, as seen in Figure 8-6, such as a potential expansion of NWP along the I-5 corridor and acquiring currently unsubscribed GTN capacity that can be used to meet customer growth and address potential capacity shortfalls. The Company also continues to work with NWP to look at re-aligning Cascade's contracted demand rights (Maximum Daily Delivery Obligations, or MDDOs) to citygates with potential peak day capacity shortfalls. The Company also works to use segmenting pipeline capacity as a way to maximize the utilization of Cascade's capacity. These resources plus leasing incremental storage at several regional facilities were all considered as a resource mix of possibilities to form the Company's 20-year integrated resource portfolio.

Figure 8-6: Alternative Transportation Resources[1]



Demand Side Management

Section 7, Demand Side Management, describes the methodology used to identify conservation potential and the interactive process that utilizes avoided cost thresholds for determining the cost effectiveness of conservation measures on an equivalent basis with supply side resources. For the 2018 IRP the nominal system avoided costs ranges between $0.2918/therm and $0.8111/therm over the 20-year planning horizon. Through the cost-effective use of conservation programs, the Company is able to reduce the load demand that must be met by more costly supply resources, such as a pipeline capacity expansion.

Cascade's DSM forecast is incorporated into its optimization modeling by converting the heat and base load forecasts into a peak and non-peak DSM factor. These values are then allocated to the pipeline zonal level and loaded into SENDOUT® to model the impact of conservation on resource acquisition needs. From a technical standpoint this is done by creating a must-take resource that acts like a supply at the zonal level equal to the peak and non-peak DSM values. While it is not actually a supply, this methodology tells SENDOUT® to use DSM to decrement demand by the forecasted conservation quantities before any resource acquisition decisions are made.

[1] NWGA Proposed Projects, July 2017

Results

After incorporating these inputs into the SENDOUT® model, Cascade analyzed the demand compared to the existing resources as well as the demand against various portfolios of available resources. This served as the foundation for the Company to see what resources are taken to meet system demand with the least cost, lowest risk mix of natural gas supply and conservation. Table 8-4 provides a snapshot of the potential peak day unserved demand across Cascade's system prior to applying any realignment of delivery rights, transportation contract segmentation or other alternative resources. Table 8-5 displays the same information as Table 8-4, but for Washington citygates only.

Table 8-4: Load Centers with Potential Peak Day Unserved Demand in Dekatherms– As-Is Modeling

Area	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Zone GTN	-	-	-	-	577	1,478	2,934	5,150	6,640	8,136
Zone 30-S	7,840	8,450	8,660	8,640	8,640	8,370	8,290	8,590	8,450	8,370
Total	7,840	8,450	8,660	8,640	9,217	9,848	11,224	13,740	15,090	16,506

Area	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Zone GTN	9,624	10,327	11,836	14,004	15,511	17,020	18,532	19,273	21,755	24,143
Zone 30-S	8,180	7,680	7,590	7,900	7,870	7,910	8,020	7,810	8,330	8,470
Total	17,804	18,007	19,426	21,904	23,381	24,930	26,552	27,083	30,085	32,613

Table 8-5: Washington Load Centers with Potential Peak Day Unserved Demand in Dekatherms – As-Is Modeling

Area	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Zone 30-S	7,840	8,450	8,660	8,640	8,640	8,370	8,290	8,590	8,450	8,370
Total	7,840	8,450	8,660	8,640	8,640	8,370	8,290	8,590	8,450	8,370

Area	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Zone 30-S	8,180	7,680	7,590	7,900	7,870	7,910	8,020	7,810	8,330	8,470
Total	8,180	7,680	7,590	7,900	7,870	7,910	8,020	7,810	8,330	8,470

Because Cascade has more delivery rights than receipt rights, the Company must allocate the delivery rights to match up with receipt capability. First, the Company allocates capacity on transportation contracts that have a single receipt point. Next, Cascade allocates capacity on conjunctive contracts that provide corridor and delivery point flexibility (re-allocation of MDDOs). The Company also gives consideration to critical delivery areas, constrained laterals and maximizing corridor flexibility—longest haul contractual rights. Cascade illustrates reallocation of MDDOs in Appendix F.

Analysis of Unserved Demand

As discussed in Section 3, the Pacific Northwest will experience significant growth over the 20-year planning horizon. Cascade will need to acquire additional resources to solve for the deficiency caused by this growth. Of note, growth at one of the Company's citygates may cause unexpected shortfalls at other, seemingly unrelated citygates. For example, Cascade's Bremerton-Shelton citygate serves a significant number of residential customers. If that area were to experience rapid growth, existing resources for customers on an interruptible tariff, in Yakima for example, may be realigned to Bremerton-Shelton to serve this increased demand using a transportation contract with a broadly defined receipt point. This would make it appear as though Yakima had experienced the rapid growth, since that is where the shortfall would be appearing, even though this would not be the case in this hypothetical example. Page 3-10 goes into further detail regarding some of the major growth drivers.

Shortfalls in the citygates Cascade serves off the GTN pipeline are consistent with the Company's significant growth projections for its service areas in Oregon, particularly the city of Bend. Potential unserved demand in NWP's Zone 30-S is a result of the pipeline's contractual philosophy of mainline versus lateral rights. Cascade has enough mainline rights to serve these citygates, but additional lateral rights may be required to reach the areas in Zone 30-S. This is not strictly enforced in a non-peak day situation, but such flexibility cannot be relied upon on peak day. Figure 12-9 shows a map that illustrates the difference between the mainline and a lateral.

Portfolios Evaluated

For the 2018 IRP, Cascade has elected to evaluate six potential portfolios. These portfolios represent a wide variety of potential solutions for Cascade's resource deficiency, with an evaluation of all available resources in the Pacific Northwest for natural gas. Unlike electric utilities, who have a variety of options for power generation (hydro, wind, solar, etc.), Cascade is limited to a single resource, natural gas, which hinders the scope of potential portfolio analysis. The Company selected these six portfolios after discussions with various stakeholders throughout its technical advisory group process. In future IRPs, Cascade will consider evaluating additional portfolios.

Table 8-6 outlines the key components of each portfolio identified in Table 8-1. SENDOUT® deterministically selects the optimal quantity of each resource based on its Resource Mix functionality. These quantities, which are provided in Appendix E, are then tested stochastically, and ranked in order of unserved demand and total system cost.

Table 8-6: Resource Composition of All Evaluated Portfolios

	All-In	NWP Only	NWP + Storage	GTN	GTN + Storage	Storage Only
Bremerton-Shelton Realignment	Green	Green	Green	Red	Red	Red
Incremental NGTL	Green	Red	Red	Green	Green	Red
Incremental Foothills	Yellow	Red	Red	Yellow	Yellow	Red
Incremental GTN N/S	Green	Red	Red	Green	Green	Red
I-5 Mainline Exp.	Yellow	Yellow	Yellow	Red	Red	Red
Wenatchee Lateral Exp.	Yellow	Yellow	Yellow	Red	Red	Red
Spokane Lateral Exp.	Yellow	Yellow	Yellow	Red	Red	Red
Eastern OR Mainline Exp.	Yellow	Yellow	Yellow	Red	Red	Red
Incremental Opal	Yellow	Red	Red	Yellow	Yellow	Red
Incremental GTN S/N	Yellow	Red	Red	Yellow	Yellow	Red
Incremental Ruby	Yellow	Red	Red	Yellow	Yellow	Red
T-South Southern Crossing	Yellow	Yellow	Yellow	Yellow	Yellow	Red
Trail West	Yellow	Yellow	Yellow	Yellow	Yellow	Red
Pacific Connector	Yellow	Red	Red	Yellow	Yellow	Red
Spire Storage	Green	Red	Green	Red	Green	Green
AECO Hub Storage	Yellow	Red	Yellow	Red	Yellow	Yellow
Clay Basin Storage	Yellow	Red	Yellow	Red	Yellow	Yellow
Gill Ranch Storage	Yellow	Red	Yellow	Red	Yellow	Yellow
Wild Goose Storage	Yellow	Red	Yellow	Red	Yellow	Yellow
Mist Storage	Yellow	Red	Yellow	Red	Yellow	Yellow

Legend	
Green	Selected resource for the portfolio
Yellow	Considered but not selected resource
Red	Not considered for the portfolio

Table 8-7 uses the mean and VaR of the total system cost and unserved demand of the portfolios considered to calculate the risk adjusted value of each portfolio. Given Cascade's mission to serve its customers, portfolios are first evaluated on unserved demand, and then mean total system cost.

Table 8-7: Final Ranking of Portfolios – Mean and VaR

	Deterministic		Stochastic		Risk Adjusted Results	
Portfolio	Unserved Demand (MDT)	Total System Cost ($000)	Unserved Demand (MDT)	Total System Cost ($000)	Risk Adjusted Unserved Demand (MDT)	Risk Adjusted Total System Cost ($000)
All Resources	-	4,812,330	-	4,875,788	-	4,828,195
GTN Only + Storage	-	4,818,349	-	4,872,369	-	4,831,854
GTN Only	-	4,820,946	-	4,875,284	-	4,834,530
NWP Only + Storage	190	4,837,394	10	4,913,766	145	4,856,487
Storage Only	190	4,837,422	10	4,913,790	145	4,856,514
NWP Only	190	4,838,756	10	4,915,119	145	4,857,847

Top-Ranking Candidate Portfolio

Using input from the alternative resources selected, the All-In portfolio was selected as the least cost, least risk solution to Cascade's forecasted unserved demand. This portfolio is now defined as the Top-Ranking Candidate Portfolio. This portfolio provides guidance as to what resources should be considered to reduce the unserved demand with the least cost mix of all of the alternatives that the Company has considered. Furthermore, this was derived deterministically assuming average weather with a peak day event, Cascade's average price forecast, and expected growth system-wide. The impact of these resources on both unserved demand and Cascade's resource mix shown graphically in Figures 8-7 through 8-11.

Figure 8-7: Annual Supply Take vs Demand – Candidate Portfolio

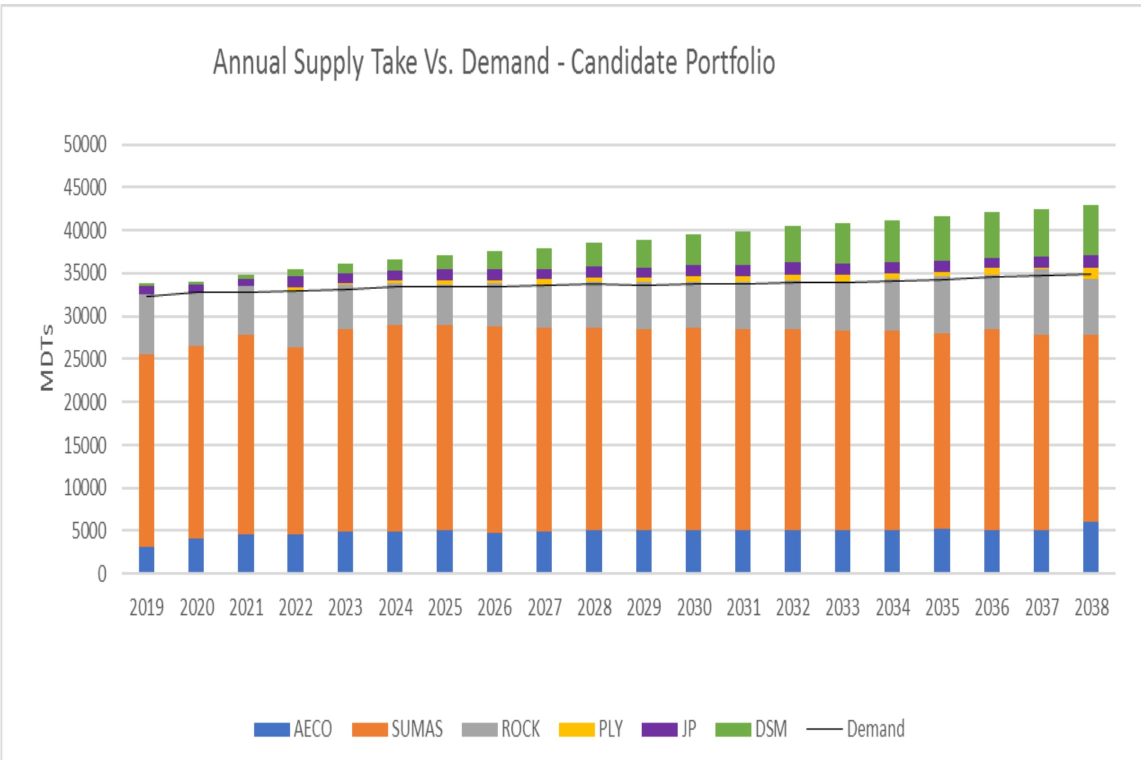


Figure 8-8: Peak Day Supply Take vs Demand – Candidate Portfolio

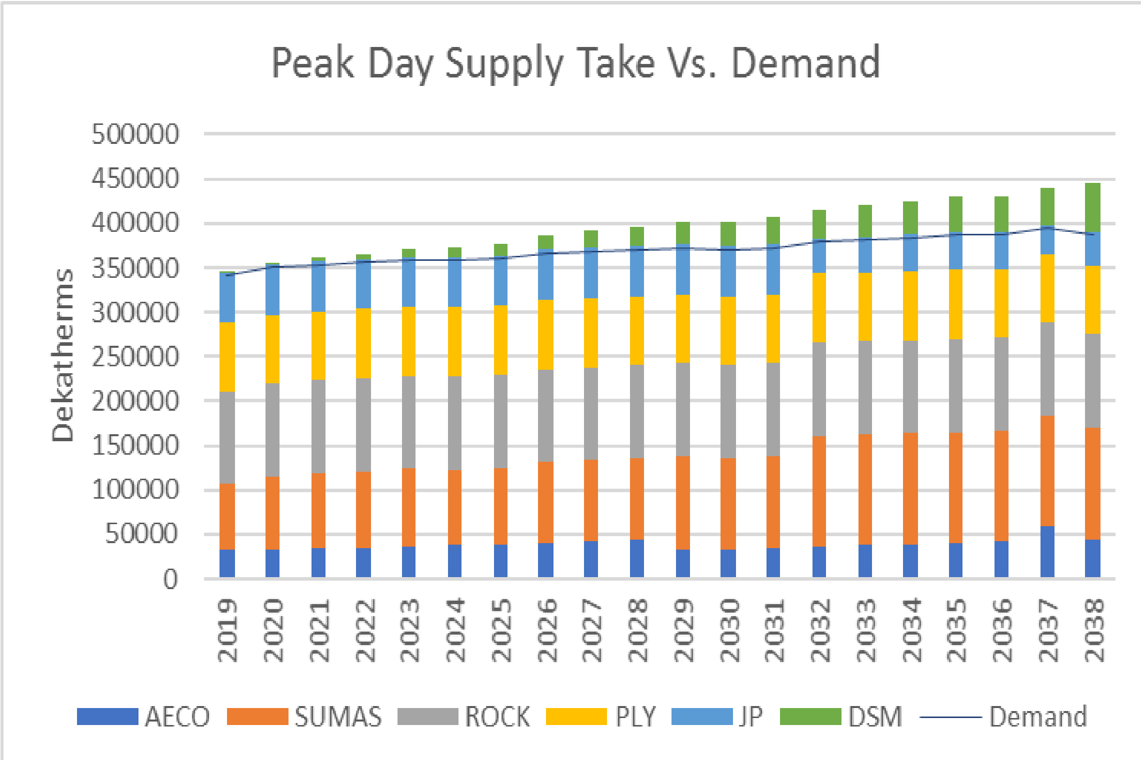


Figure 8-9: Peak Day Transport vs Demand, Incremental Broken Out – Candidate Portfolio

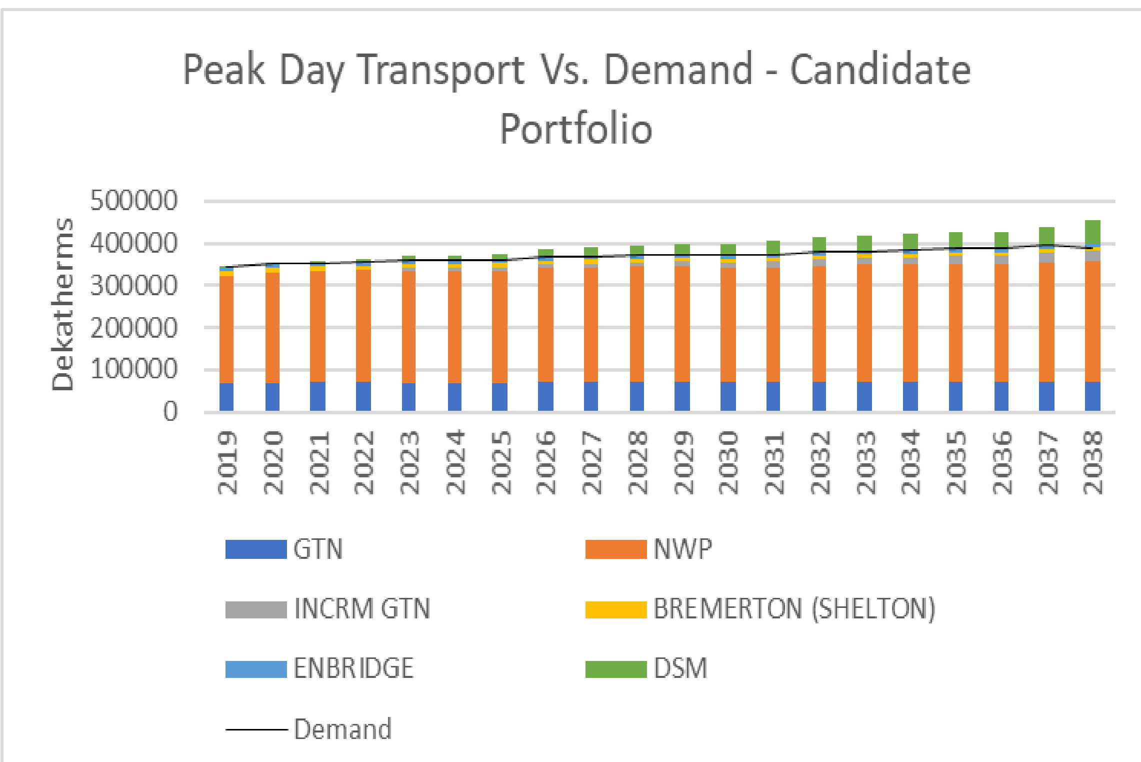


Figure 8-10: Annual Transport vs Demand – Candidate Portfolio

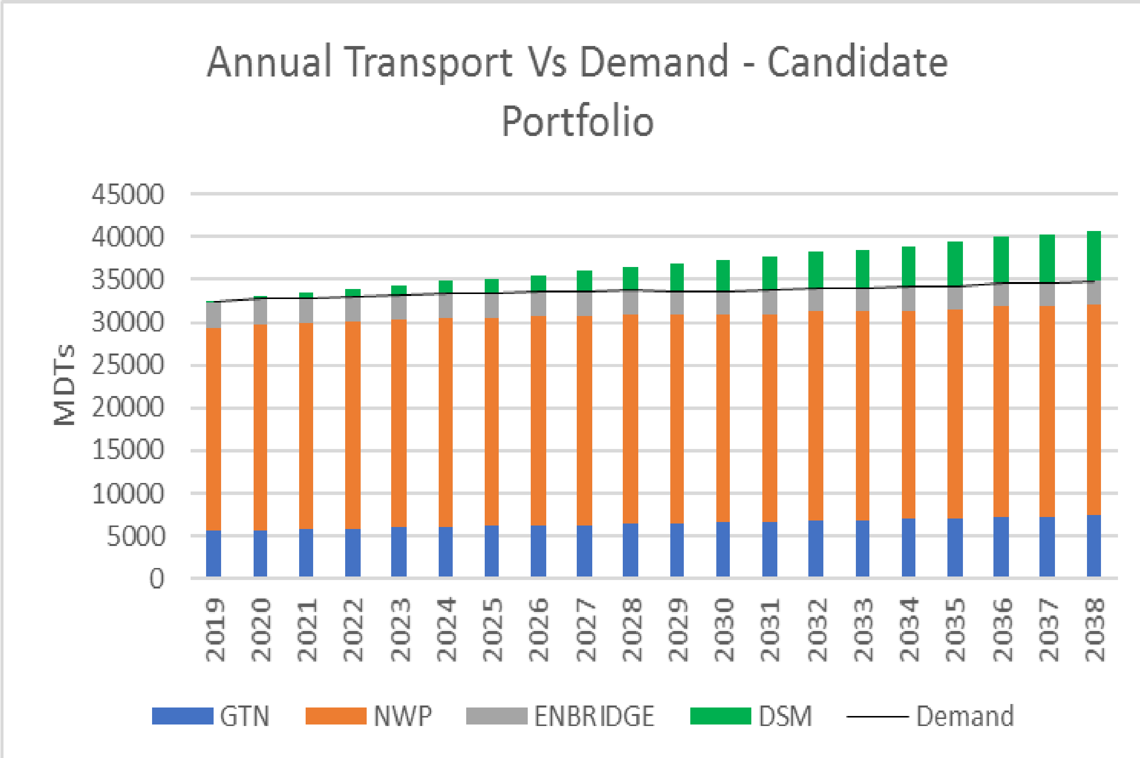
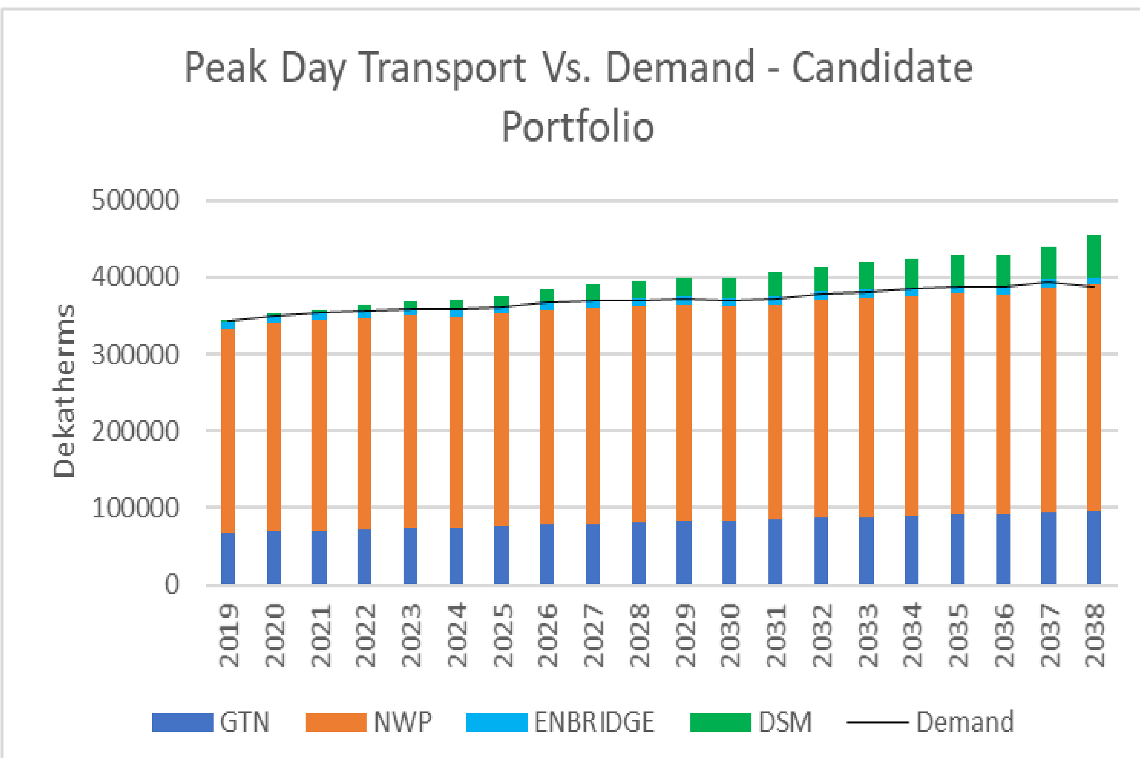


Figure 8-11: Peak Day Transport vs Demand – Candidate Portfolio



Alternative Resources Selected

The SENDOUT® model selected the following resources for the Top-Ranking Candidate 20-year Portfolio. These resources and the quantities and timing that the resources are needed by are summarized in Table 8-8. As a reminder, the acquisition of new resources is a lumpy process, and as such Cascade would enter into one long large-term deal versus multiple short term deals each year. Therefore, this table helps to inform any deal Cascade would make, but does not decide when and how Cascade should contract new capacity. The Bremerton-Shelton acquisition is not included on this because it is a fixed deal.

Table 8-8: Projected Cumulative Incremental Transport Needed – in Dekatherms

Resource	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Incremental GTN - Stanfield to Malin	0	7,900	7,971	8,028	8,081	8,023	8,089	8,252	8,307	8,369
Incremental GTN - Kingsgate to Malin	0	48	48	48	48	-	48	48	48	48

Resource	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Incremental GTN - Stanfield to Malin	22,934	22,828	22,901	23,109	23,174	23,233	23,287	23,221	23,513	23,575
Incremental GTN - Kingsgate to Malin	-	47	47	249	-	249	249	249	47	249

Transport

- Incremental GTN – Allows Cascade to continue to serve customers as the Company's core load grows in citygates that are fed by GTN capacity, specifically around Bend, Oregon, where the Company expects shortfalls. 8,417 dths/day by 2028, escalating to 23,824 dths/day by 2038.
- Bremerton-Shelton Realignment – Provides the Company with the ability to secure additional firm lateral rights along the I-5 corridor. Additionally, allows Cascade to move additional gas from its' Jackson Prairie facility to Stanfield, which can then be moved to the Company's Oregon citygates via incremental GTN capacity from Stanfield to Malin.
- Incremental NOVA – Provides Cascade with a cost-effective opportunity to move gas from AECO to Kingsgate, versus buying gas at Kingsgate directly. No significant quantities were identified by the model, so the Company will continue to model open seasons on NOVA.

Alternative Resources Not Selected

The SENDOUT® model did not select the following resources for the Top-Ranking Candidate Portfolio:

Transport

- Incremental Foothills – Since the Company has more capacity on foothills versus NOVA, Cascade would need to identify a significant amount of additional NOVA capacity needed before its modeling would recommend additional foothills capacity.
- Incremental Ruby/Turquoise Flats – SENDOUT® determined it was more cost effective for the Company to acquire unsubscribed north to south transport from GTN to serve the incremental demand these incremental contracts would otherwise serve.
- Wenatchee Expansion – Cascade's market intelligence, in conjunction with its SENDOUT® modeling determined that it would be more cost-effective to acquire incremental NWP capacity via the Bremerton-Shelton realignment while redirecting existing flexible transportation to central Washington.
- Zone 20 Expansion – Cascade's market intelligence, in conjunction with its SENDOUT® modeling, determined that it would be more cost-effective to acquire incremental NWP capacity via the Bremerton-Shelton realignment while redirecting existing flexible transportation to eastern Washington.
- Incremental Starr Road – SENDOUT® determined that with Cascade's current price forecast it did not make sense to purchase incremental capacity to move AECO gas from GTN to NWP.
- Eastern Oregon Expansion – Cascade's market intelligence, in conjunction with its SENDOUT® modeling, determined that it would be more cost effective to acquire incremental NWP capacity via the Bremerton-Shelton realignment while redirecting existing flexible transportation to eastern Oregon.
- T-South Southern Crossing – SENDOUT® determined that based on Cascade's current price forecast it did not make sense to purchase incremental capacity to move in either direction along the Canadian border.
- Trails West (Palomar) – SENDOUT® determined that with Cascade's current price forecast it did not make sense to purchase incremental capacity to move in either direction across central Oregon.

Supply

- Opal Incremental – Since SENDOUT® determined it was best to serve increasing demand through picking up unsubscribed GTN capacity, there was no need to purchase additional gas to move along Ruby.
- Pacific Connector - Cascade's market intelligence determined that at this time, the Pacific Connector would not create a significant enough impact on liquidity at Malin to impact Cascade's modeling.

Storage

- Gill Ranch, Clay Basin, Wild Goose, AECO Hub, Mist Storage – No incremental storage was selected. None of these storage facilities modeled were cost effective or led to an increase in served demand. The primary reason appears to be that each storage facility modeled required long-term incremental transportation.
- Spire Storage – The Company's modeling identified this as a potentially cost-effective resource, but Cascade has concerns about the reliability of Spire Storage due to past incidents. Cascade will include an action item in this IRP to evaluate the viability of Spire further prior to the 2020 IRP.

Impact of Top-Ranking Candidate Portfolio on Unserved Demand

As discussed earlier, the primary metric that all portfolios are evaluated on is unserved demand. If at all feasible, the Top-Ranking Candidate Portfolio must solve for all forecasted shortfalls under expected conditions. Tables 8-9 and 8-10 show the forecasted Peak Day Unserved Demand under expected growth and carbon forecasts. Weather and price are modeled using the risk adjusted methodology referenced in Step 4 of the Supply Resource Optimization Process.

Table 8-9: Load Centers w/ Deterministic Forecasted Peak Day Unserved Demand in Dekatherms – Top Ranking Candidate Portfolio

Area	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Zone GTN	-	-	-	-	-	-	-	-	-	-
Zone 30-S	-	-	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	-	-	-
Area	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**
Zone GTN	-	-	-	-	-	-	-	-	-	-
Zone 30-S	-	-	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	-	-	-

Table 8-10: Washington Load Centers w/ Deterministic Forecasted Peak Day Unserved Demand in Dekatherms – Top Ranking Candidate Portfolio

Area	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Zone 30-S	-	-	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	-	-	-

Area	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Zone 30-S	-	-	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	-	-	-

Portfolio Evaluation: Additional Scenario/Sensitivity Analyses

Table 8-11 summarizes the net present value of the PVRR of all additional demand scenarios and sensitivities reviewed. After the Candidate Portfolio was selected, the Company tested it stochastically through various extreme situations, which are further explained in Appendix E. As discussed during Cascade's Supply Resource Optimization Process, the objective of this analysis is to ensure that the costs of the Candidate Portfolio do not exceed the VaR limit in any of the scenarios/sensitivities discussed in Table 8-2. The results of all scenarios are also shown graphically in Figures 8-12 and 8-13.

Table 8-11: Total System Cost and Average Cost/Served Therm of Additional Scenarios/Sensitives

Scenarios and Sensitivities	VaR Total System Cost	Cost/Therm Served	Distance from VaR Limit
No Evergreening Contracts	4,125,624,156	0.633553252	1,909,619,844
Low Growth	4,623,709,804	0.673674531	1,411,534,196
No BC Supply	4,658,068,904	0.706776209	1,377,175,096
Price Volatility - High	4,747,123,656	0.64750492	1,288,120,344
Andgar RNG	4,792,828,146	0.653738986	1,242,415,854
Inslee 10% adder	4,809,859,116	0.656061246	1,225,384,884
No Rockies Supply	4,830,949,022	0.667045651	1,204,294,978
2018 WA IRP BASE SCENARIO	4,839,607,779	0.660292566	1,195,636,221
2018 WA IRP Storage Only	4,846,113,000	0.661180108	1,189,131,000
2018 WA IRP GTN Only + Storage	4,850,641,482	0.661624089	1,184,602,518
2018 WA IRP GTN Only	4,853,228,025	0.661976891	1,182,015,975
Price Forecast - Low	4,854,344,008	0.662129714	1,180,899,992
2018 WA IRP NWP Only + Storage	4,871,791,125	0.664683507	1,163,452,875
2018 WA IRP NWP Only	4,873,132,874	0.664866568	1,162,111,126
I-1631 10% adder	4,877,282,229	0.665257709	1,157,961,771
Richland RNG	4,880,700,758	0.66572476	1,154,543,242
Market Choice	4,890,987,418	0.667127086	1,144,256,582
No Plymouth Storage	4,892,979,368	0.668247815	1,142,264,632
Limit Plymouth Storage	4,896,316,722	0.668355086	1,138,927,278
Limit JP and Plymouth Storage	4,898,011,353	0.669346785	1,137,232,647
2018 WA IRP CANDIDATE PORTFOLIO	4,899,113,981	0.668236313	1,136,130,019
Limit Alberta	4,900,271,228	0.66839416	1,134,972,772
Limit JP Storage	4,904,134,687	0.669165971	1,131,109,313
Limit BC	4,909,309,169	0.66962693	1,125,934,831
Limit Canada	4,915,778,285	0.670509314	1,119,465,715
Limit Rockies	4,921,122,448	0.671238255	1,114,121,552
No JP or Plymouth Storage	4,925,541,918	0.673718693	1,109,702,082
No JP Storage	4,926,893,937	0.672499741	1,108,350,063
Price Forecast - High	4,930,179,139	0.672473582	1,105,064,861
No Alberta Supply	4,941,709,528	0.674599845	1,093,534,472
Environmental Adder 0%	4,993,048,905	0.681048198	1,042,195,095
Environmental Adder 20%	5,110,320,555	0.697043965	924,923,445
Environmental Adder 30%	5,157,545,031	0.703485349	877,698,969
High Growth	5,210,895,656	0.6634030	824,348,344

VaR Limit	**6,035,244,000**

Figure 8-12: Total System Cost Comparison by Scenarios/Sensitivity

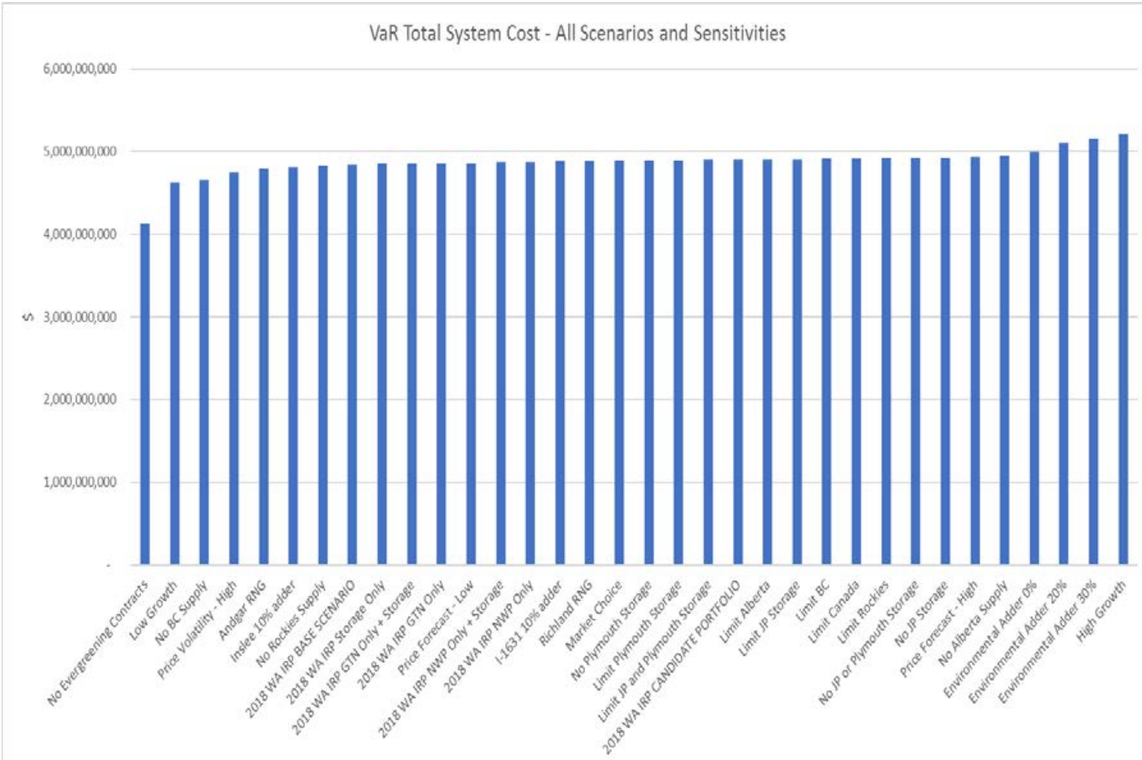
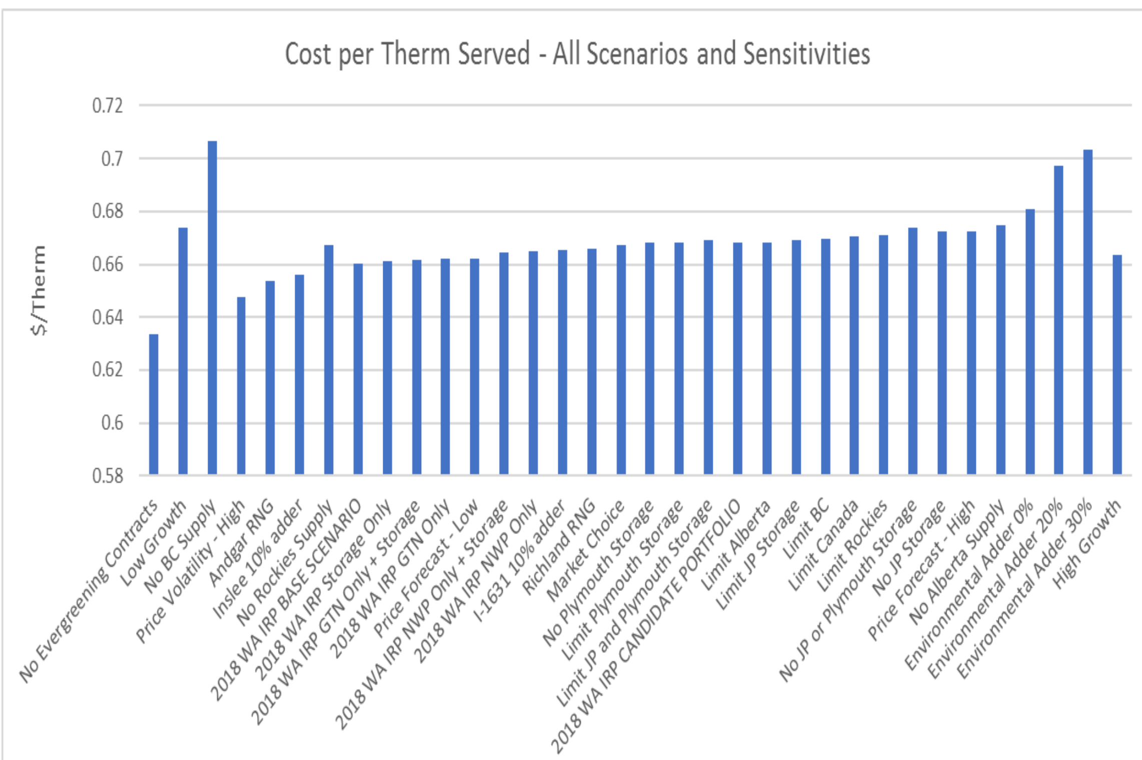


Figure 8-13: Cost per Therm Served by Scenario/Sensitivity



Stochastic Analyses - Annual Load Requirements & Weather Uncertainty

The annual load requirements will vary dramatically based on the weather assumptions. Through the use of its new Monte Carlo functionality, the Company has the ability to analyze the impacts of weather and growth projections on its load forecast. Figure 8-14 provides a range of potential load forecasts for a mix of weather and growth profiles. Figure 8-15 shows the annual HDDs of a sampling of significant draws. Capturing the uncertainty around load growth forecasting was accomplished through Cascade's proprietary Monte Carlo functionality. The Monte Carlo simulation performed 10,000 draws with each draw calculating the daily HDDs based on historical weather as randomly determined by the model for each of the weather zones. The percentiles used represent the system weighted HDDs of each draw, totaled up for the entire 20-year planning horizon. In other words, the 99th percentile draw represents the 9,900th highest total system weighted HDDs of the 10,000 random draws.

Figure 8-14: Annual Demand by Stochastic Draw/Growth Profile – Monte Carlo Data

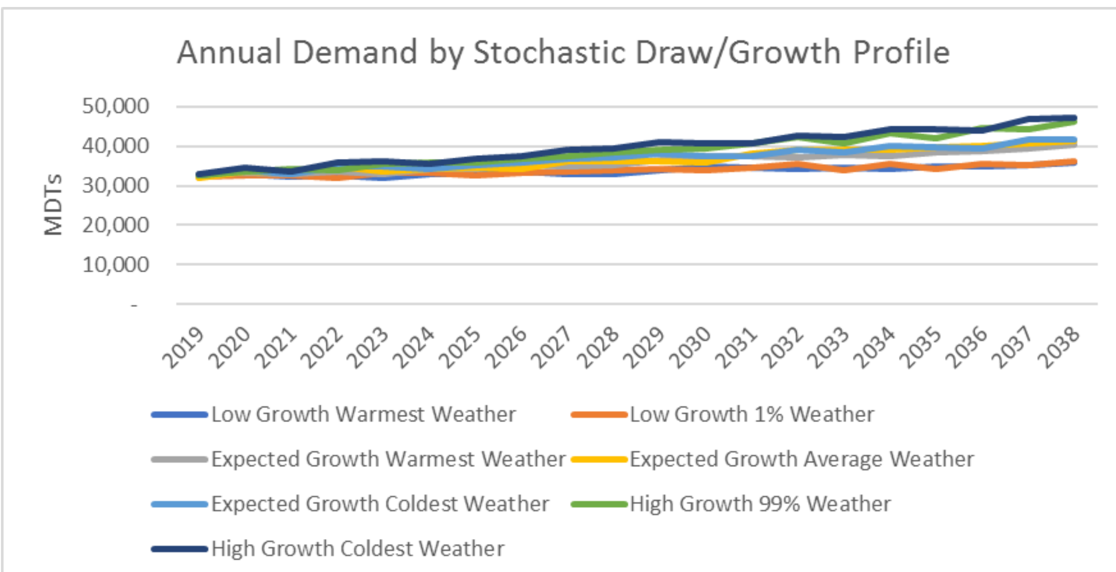
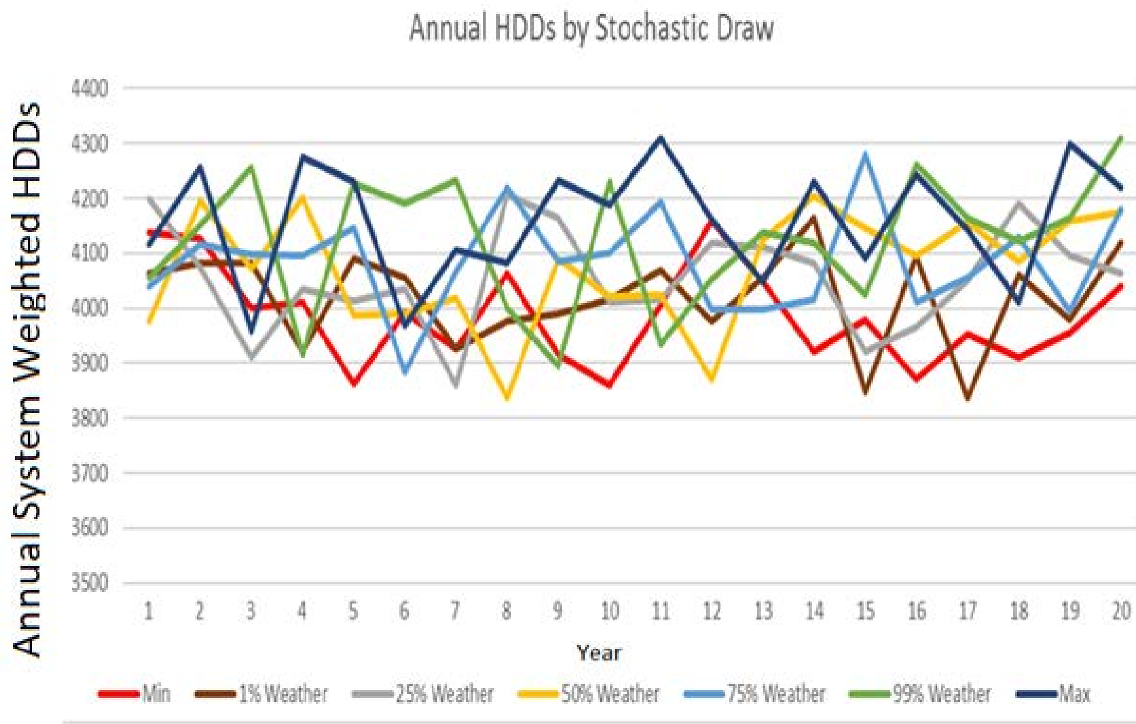


Figure 8-15: Annual HDDs by Stochastic Draw – Monte Carlo Data



Stochastic Analyses – Price Uncertainty

Similar to weather analysis, uncertainty related to future gas prices can have a significant impact on Cascade forecasted costs over the 20-year planning horizon. The Company analyzes the risk of price projections by running the 99th percentile of monthly load weighted prices with a variety of carbon and environmental externality costs as its sensitivity analyses. Figure 8-16 provides a range of potential costs for a mix of price and carbon profiles. Figure 8-17 shows the monthly pricing of the draws shown in 8-16.

Figure 8-16: Annual Total System Cost by Stochastic Draw/Carbon Profile – Monte Carlo Data

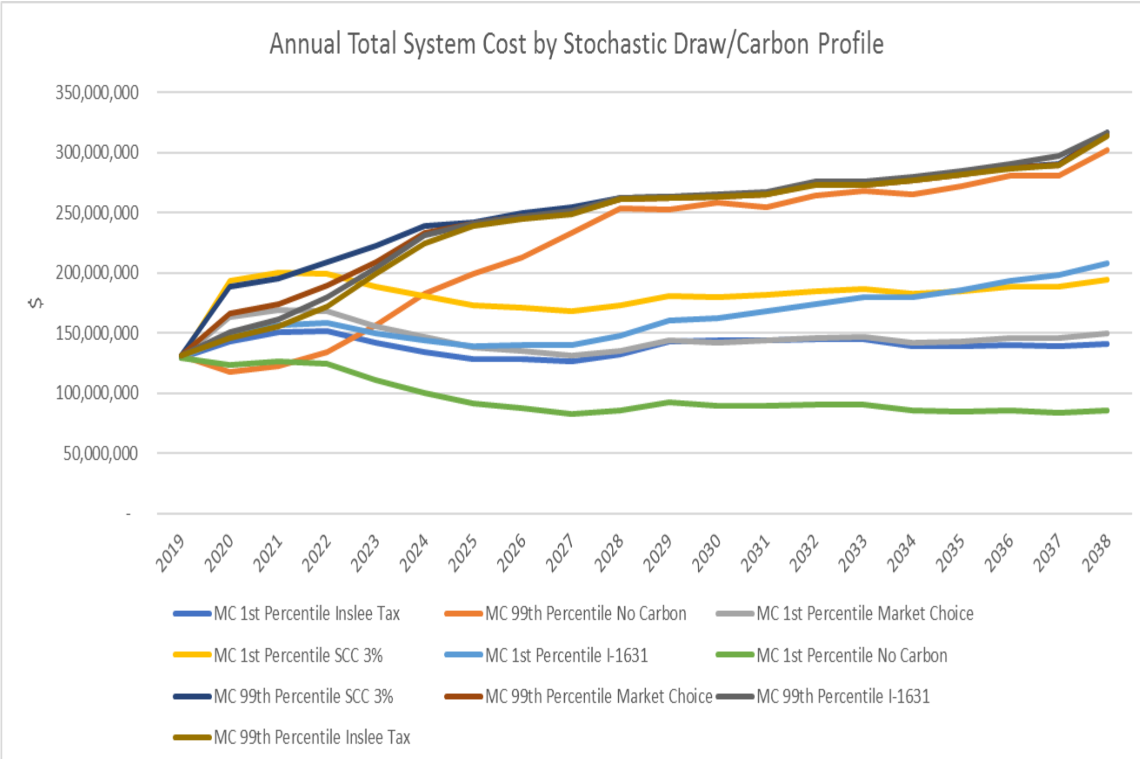
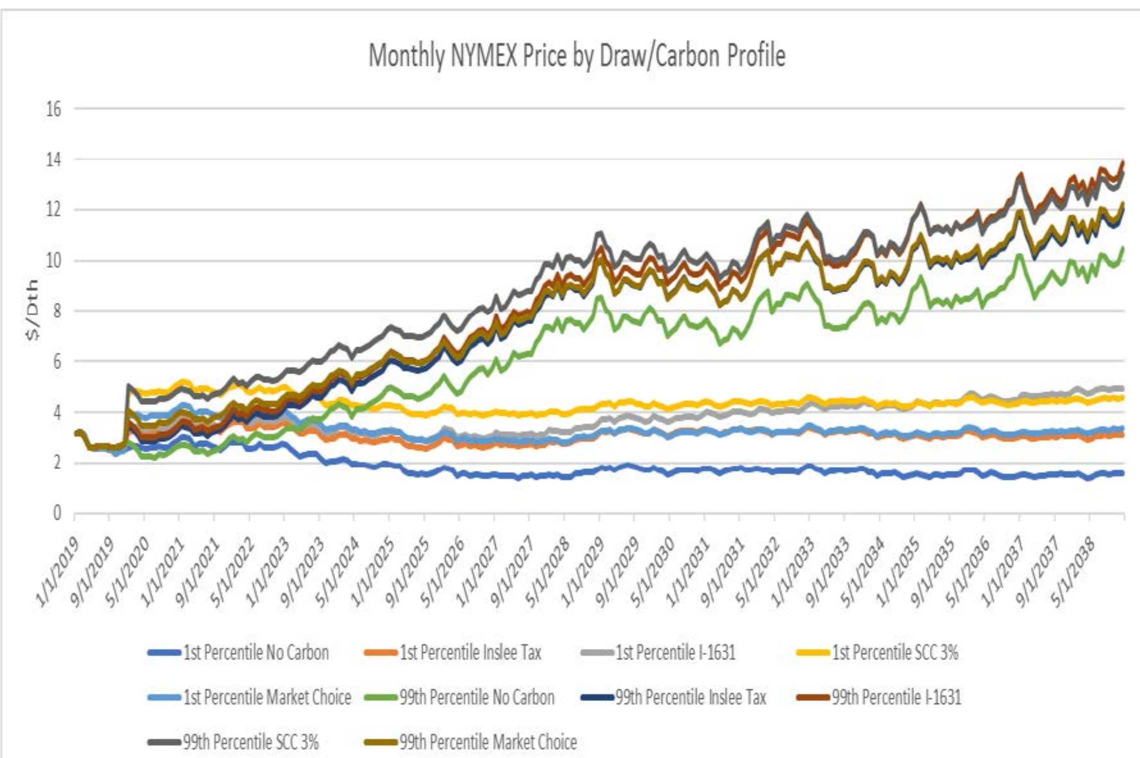


Figure 8-17: Monthly NYMEX Pricing by Stochastic Draw/Carbon Profile – Monte Carlo Data



Conclusion

Cascade's All-In portfolio includes all existing supply side resources as discussed in Section 4, all projected DSM savings discussed in Section 7, and all incremental resources discussed in this section. This portfolio did not exceed the VaR Limit in any scenarios or sensitivities run by the Company. This allows Cascade to deem this to be the Preferred Portfolio, which is the lowest cost and risk as expected when considering all alternate supply and demand side resources. This is primarily due to Cascade's geographical spread across the region. The Company's existing long-term transportation contracts, coupled with robust supply basins, provides a base foundation to meet load needs of Cascade's core customers. However, Cascade's unique geographical reach creates particular challenges as the system is non-contiguous, often requiring the Company to hold transportation capacity on multiple upstream pipelines to feed the single upstream pipeline that is connected to a particular citygate.

The High Customer Growth and Low Customer Growth demand analyses provide a range for evaluating demand trajectories relative to the expected scenario. Based on this analysis sufficient time is expected to be available to plan for forecasted resource needs. Even under extreme pricing sensitivities related to the cost of carbon legislation compliance, Cascade has determined that this portfolio solves for resource deficiencies at an acceptable cost. Many events could occur between now and when the first resource needs materialize, so Cascade will employ adaptive management. The Company will continue to monitor and analyze system demand through reconciling and comparing forecast to actual customer counts, and will continually update and evaluate all demand side and supply side alternatives.

SECTION 9

DISTRIBUTION SYSTEM PLANNING

Overview

Cascade's IRP includes the evaluation of safe, economical, and reliable full-path delivery of natural gas from basin to the customer meter. Securing adequate natural gas supply and ensuring sufficient pipeline transportation capacity to Cascade's citygates are necessary if distribution system growth behind the citygates become severely constrained. Important parts of the planning process include forecasting local demand growth, determining potential distribution system constraints, analyzing possible solutions, and estimating costs for eliminating constraints.

Key Points

- Distribution system network design fundamentals anticipate demand requirements and identify potential constraints.
- Cascade utilizes its internal GIS environment and other input data to create system models through the use of Synergi® software.
- Distribution system enhancements include analyses of pipelines, regulators, and compressor stations.
- Impacts of proposed conservation resources on anticipated distribution constraints are reviewed.
- Analyses are performed on every system at design day conditions to identify areas where potential outages may occur.
- Cascade has identified three major enhancement projects over the next three years.

Analyzing resource needs in the IRP ensures adequate upstream capacity is available to the citygates, especially during a peak event. Distribution planning focuses on determining if adequate pressure will be available during a peak hour. Given this nuance, distribution planning addresses many of the same goals, objectives, risks, and solutions as resource planning.

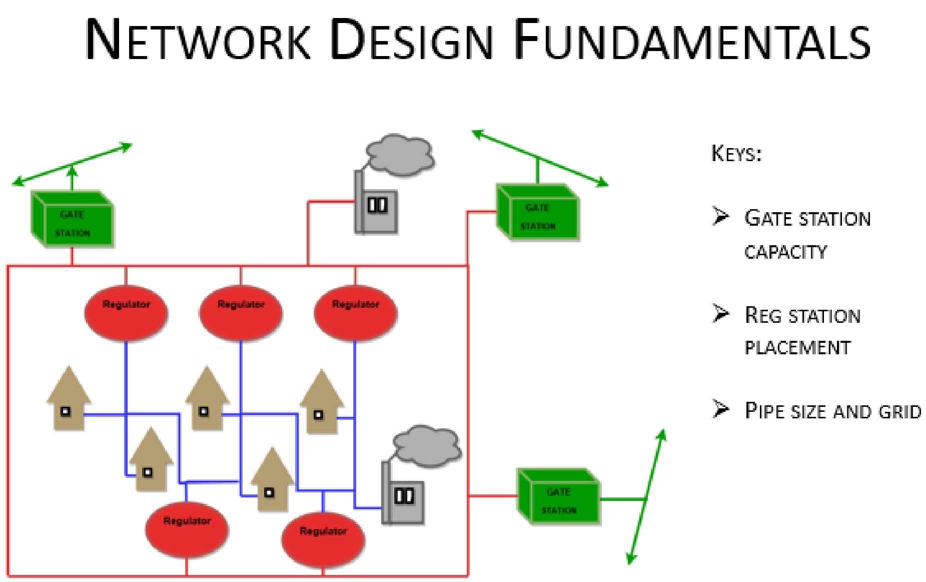
Cascade's natural gas distribution system consists of approximately 4,744 miles of distribution main pipelines in Washington, and 1,604 miles in Oregon, as well as numerous regulator stations, service distribution lines, monitoring and metering devices, and other equipment. Currently, a compressor station is located within Cascade's distribution system near Fredonia, Washington. The vast majority of the distribution network pipelines and regulating stations operate and maintain system pressure solely from the pressure provided by the interstate transportation pipelines.

Network Design Fundamentals

Gas distribution networks rely on pressure differentials to move gas from one place to another. If the pressure is exactly the same on both ends of a pipe, the gas will not flow. Therefore, it is important that gas engineers design the distribution network such that the pressure in the pipe will always be high enough that a differential can be created when gas leaves the system. As gas flow increases, pressure is lost due to friction. Using the laws of fluid mechanics, engineers informed by flow modeling data determine the maximum flow of gas through a pipe of a certain diameter and length that will not cause pressure drops that are too great.

Not all natural gas flows equally throughout a network. Certain points within the network constrain flow and restrict overall network capacity. Network constraints can occur as demand requirements evolve. Anticipating these demand requirements, identifying potential constraints and forming cost-effective solutions with sufficient lead time without overbuilding infrastructure are the key challenges in network design. Figure 9-1 provides an example of a network diagram.

Figure 9-1: Network Design Fundamentals

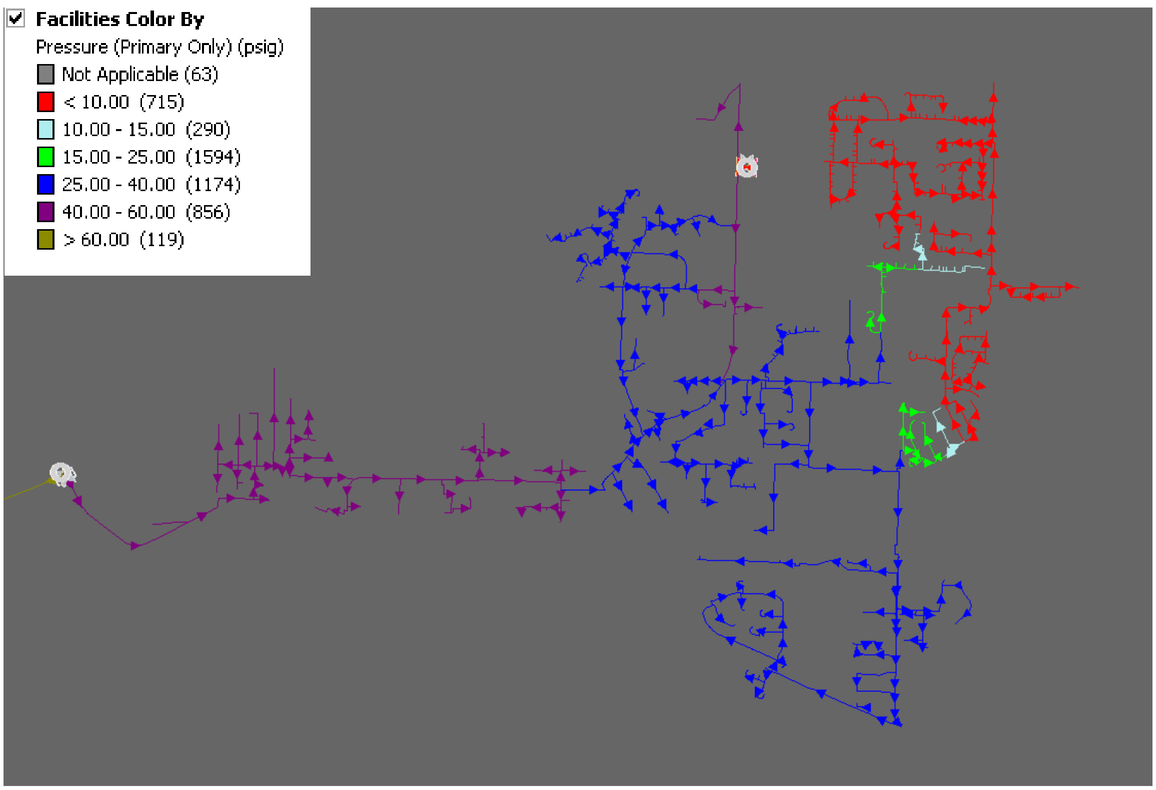


Computer Modeling

Developing and maintaining effective network design is aided by computer modeling for network demand studies. Demand studies have evolved with technology in the past decade to become a highly technical and powerful means of analyzing distribution system performance. Utilizing computer software, individual models were created for each of Cascade's different systems. These models include both high-pressure lines and distribution system networks. As gas loads are simulated to increase according to the load forecasts, the pressures within each system are checked. When the simulation shows the pressure dropping to an unacceptable level, that system and the surrounding area are determined to be a constraint area. When constraint areas are found, an engineer determines the most effective way of solving the problem.

Cascade's geographical information system (GIS) keeps an up-to-date record of pipe and facilities, complete with all system attributes such as date of installation and operating pressure. Using the internal GIS environment and other input data, Cascade is able to create system models through the use of Synergi® software. The software provides the means to model piping and facilities to represent current pressure and flow conditions while predicting future events and growth. Combining these models with historical weather data can provide a design day model that will predict a worst-case scenario. Design day models that experience less than ideal conditions can then be identified and remedied before a real problem is encountered. Figure 9-2 is an example of a low-pressure scenario identified using Synergi®. Ultimately the identified projects can be funneled through the Project Process Flow (Figure 9-4 on Page 9-9) to be prioritized and slotted into the budget.

Figure 9-2: Low Pressure Design Example



Synergi® is used in conjunction with the GasWorks models that were built years ago and have been upgraded as needed. Cascade's philosophy is that models should be reviewed for significant changes annually and recalibrated to represent the system more accurately. Synergi® is more advanced than GasWorks and is much more user-friendly. Synergi® is also the modeling software of choice for many other Local Distribution Companies (LDCs).

Distribution System Planning

Many LDCs conduct two primary types of evaluations in their distribution system planning efforts to determine the need for resource additions such as distribution system reinforcements and expansions. A reinforcement is an upgrade to existing infrastructure or new system additions, which increases system capacity, reliability, and safety. An expansion is a new system addition to accommodate an increase in demand. Collectively, these are known as distribution enhancements.

The engineering department works closely with engineer associates and district management to assure the system is safe and reliable. As towns develop, the need for pipeline expansions and reinforcements increases. The expansions are historically driven by new city developments or new housing plats. Before expansions and installation can be constructed to serve these new customers, engineering analysis is performed. Using system modeling software to represent cold weather scenarios, predictions can be made about the capacity of the system. As new groups of customers seek natural gas service, the models provide feedback on how best to serve them reliably.

Another aspect of system planning involves gate capacity analysis and forecasting. Over time each gate station will take on more and more demand and it is Cascade's goal to get out in front with predictions. The IRP growth data received, along with design day modeling, allows for forecasting of necessary gate upgrades. SCADA technology utilized by Cascade allows verification of numbers with real time and historic gate flow and pressure data. The data proves reliable in verifying models and forecasting projects.

Distribution System Enhancements

Demand studies facilitate modeling multiple demand forecasting scenarios, constraint identification and corresponding optimum combinations of pipe modification, and pressure modification solutions to maintain adequate pressures throughout the network. Distribution system enhancements do not reduce demand nor do they create additional supply. Enhancements can increase the overall capacity of a distribution pipeline system while utilizing existing gate station supply points. The two broad categories of distribution enhancement solutions are pipelines and regulators.

Pipelines

Pipeline solutions consist of looping, upsizing and uprating. Pipeline looping is the most common method of increasing capacity in an existing distribution system. It involves constructing new pipe parallel to an existing pipeline that has, or may become, a constraint point. Constraint points inhibit flow capacities downstream of the constraint creating inadequate pressures during periods of high demand. When the parallel line connects to the system, this alternative path allows natural gas flow to bypass the original constraint and bolsters downstream pressures. Looping can also involve connecting previously unconnected mains. The feasibility of looping a pipeline depends upon the location where the pipeline will be constructed. Installing gas pipelines through private easements, residential areas, existing asphalt, and steep or rocky terrain can increase the cost to a point where alternative solutions are more cost effective.

Pipeline upsizing involves replacing existing pipe with a larger size pipe. The increased pipe capacity relative to surface area results in less friction, and therefore, a lower pressure drop. This option is usually pursued when a pipe is damaged or has integrity issues. If the existing pipe is otherwise in satisfactory condition, looping augments existing pipe, which remains in use.

Pipeline uprating increases the maximum allowable operating pressure of an existing pipeline. This enhancement can be a quick and relatively inexpensive method of increasing capacity in the existing distribution system before constructing more costly additional facilities. However, safety considerations and pipe regulations may prohibit the feasibility or lengthen the time before completion of this option. Also, increasing line pressure may produce leaks and other pipeline damage creating costly repairs. A thorough review is conducted to ensure pipeline integrity before pressure is increased. Figure 9-3 provides a snapshot of some of the major components of the system.

Figure 9-3: Cascade System Pipeline Overview

PIPELINE:

- DIAMETER – ½" TO 20"
- MATERIAL – POLYETHYLENE AND STEEL
- OPERATING PRESSURE - 20 PSI TO 900 PSI
- WASHINGTON – APPROX. 4,744 MILES OF DISTRIBUTION MAIN
- OREGON – APPROX. 1,604 MILES OF DISTRIBUTION MAIN

Regulators

Regulators or regulator stations reduce pipeline pressure at various stages in the distribution system. Regulation provides a specified and constant outlet pressure before natural gas continues its downstream travel to a city's distribution system, a customer's property, or a natural gas appliance. Regulators also ensure that flow requirements are met at a desired pressure regardless of pressure fluctuations upstream of the regulator. Regulators are at citygate stations, district regulator stations, farm taps, and customer services. Utilization and strategic positioning of new stations can be very helpful in increasing system reliability and capacity. Cascade has over 700 regulator stations along its system.

Compression

Compressor stations present a capacity enhancing option for pipelines with significant natural gas flow and the ability to operate at higher pressures. For pipelines experiencing a relatively high and constant flow of natural gas, a large volume compressor installation along the pipeline boosts downstream pressure.

A second option is the installation of smaller compressors located close together or strategically placed along a pipeline. Multiple compressors accommodate a large flow range and use smaller and very reliable compressors. These smaller compressor stations are well suited for areas where gas demand is growing at a relatively slow and steady pace, so that purchasing and installing these less expensive compressors over time allow a pipeline to serve growing customer demand into the future.

Compressors can be a cost-effective option to resolving system constraints; however, regulatory and environmental approvals to install a station, along with engineering and construction time, can be a significant deterrent. Adding compressor stations typically involves considerable capital expenditure. Based on Cascade's detailed knowledge of the distribution system, there are no foreseeable plans to add compressors to the distribution network.

Conservation Resources

Reviewing the impacts of proposed conservation resources on anticipated distribution constraints is equally important. Although the Company historically provides utility-sponsored conservation programs throughout a particular jurisdiction (i.e. all of Cascade's Washington or Oregon service territory), there may be instances where a more targeted approach could reduce or delay the estimated reinforcement for a specific area. As discussed in Section 7, Demand Side Management, the acquisition of conservation resources is entirely dependent upon the individual consumer's day-to-day purchasing and behavior decisions.

While the utility attempts to influence these decisions through its conservation programs, the consumer is still the ultimate decision maker regarding the purchase of a conservation measure. Therefore, the Company does not anticipate that the peak day load reductions resulting from incremental conservation will be adequate to eliminate distribution system constraint areas at this time. However, over the longer term (through 2027), the opportunity for targeted conservation programs to provide a cumulative benefit that offsets potential constraint areas may be an effective strategy.

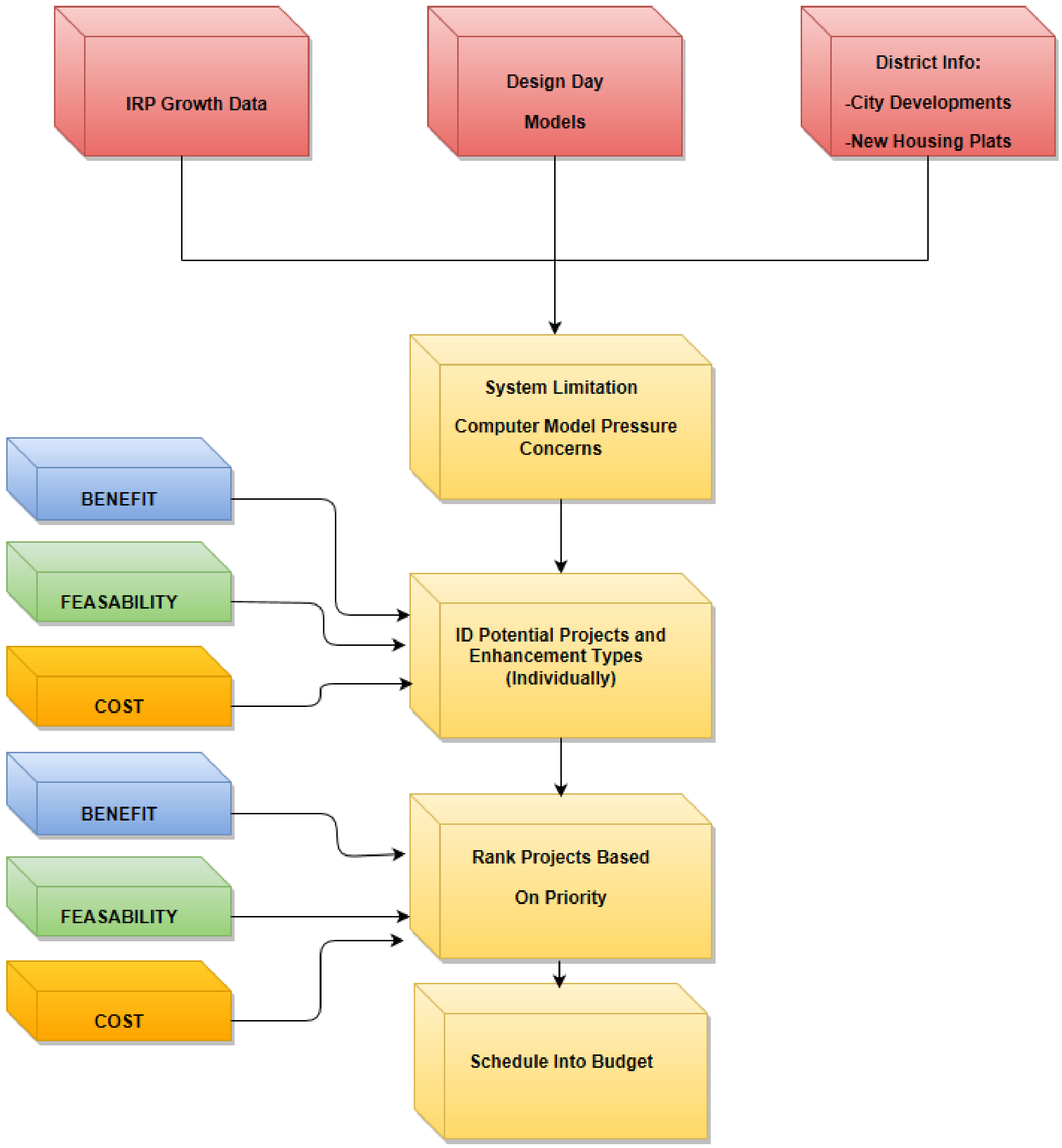
Distribution Scenario Decision-Making Process

After developing a working load study, analyses are performed on every system at design day conditions to identify areas where potential outages may occur. These areas of concern are then risk-ranked against each other to ensure the highest risk areas are corrected first and that others are properly addressed. Within a given area, projects/reinforcements are selected using the following criteria:

- The shortest segment(s) of pipe that improves the deficient part of the distribution system.
- The segment of pipe with the most favorable construction conditions, such as ease of access or rights or traffic issues.
- Minimal to no water, railroad, major highway crossings, etc.
- The segment of pipe that minimizes environmental concerns including minimal to no wetland involvement, and the minimization of impacts to local communities and neighborhoods.
- The segment of pipe that provides opportunity to add additional customers.
- Total construction costs including restoration.

Once a project/reinforcement is identified, the design engineer or construction project coordinator (CPC) begins a more thorough investigation by surveying the route and filing for permits. This process may uncover additional impacts such as moratoriums on road excavation, underground hazards, discontent among landowners, etc., resulting in another iteration of the above project/reinforcement selection criteria. Figure 9-4 provides a schematic representation of the distribution scenario process.

Figure 9-4: Distribution Scenario Process



Planning Results

Table 9-1 summarizes the cost and timing of three major distribution system enhancements addressing growth-related system constraints, system integrity issues and the timing of expenditures. These projects were chosen as examples. Cascade will work with external stakeholders in future IRPs to determine which projects are better examples for the narrative portion of the IRP. The detail on these projects provides preliminary estimates of timing and costs of major reinforcement solutions. The scope and needs of distribution system enhancement projects generally evolve with new information requiring ongoing reassessment. Actual solutions may differ due to differences in actual growth patterns and/or construction conditions that differ from the initial assessment.

The following discussion provides information about the three near-term projects:

- Bend 4" IP PE Reinforcement: Archie Briggs Rd - This intermediate pressure reinforcement will tie together two separate sections of the Bend system in northwestern Bend. This area has seen a great deal of growth and design day models are forecasting pressure issues in the future. The project consists of almost 1,950' of 4" PE. The project cost is estimated to be $ 191,066 and it is expected to be completed in 2019.

- Bend 4" IP PE Reinforcement: Hayes Ave. - This intermediate pressure reinforcement will help strengthen the center of the Bend distribution system. Model forcasts with continued growth show there will be pressure concerns in this area of the system between Bend Parkway and the Deschutes River. The project will consist of 1,200' of 4" PE and will tie together two segments isolated from each other by the Bend Parkway. It is expected to cost about $204,454 and is forecasted to be completed in 2019.

- Prineville Gate Rebuild – This rebuild of the gate will result in an increase of capacity to the distribution system. Currently, the gate is reaching near max capacity during peak heating season. The project will consist of installing a new regulator station, new odorizer, new valves, new heater and associated piping. Williams Northwest Pipeline will also need to complete some work to upgrade their facilities. It is expected to cost about $550,945 in 2020 and $2,322,372 in 2021.

Table 9-1: Distribution Planning Capital Projects

Location	2019	2020	2021
Bend 4" IP PE Reinforcement: Archie Briggs Rd	$ 191,066		
Bend 4" IP PE Reinforcement: Hayes Ave	$ 204,454		
Prineville Gate Rebuild		$ 550,945	$ 2,322,372

Table 9-1 highlights just a few of Cascade's upcoming growth projects. All engineering projects can be found in Appendix I. With the use of the computer modeling software and Cascade's Distribution Scenario Process, the Company can identify projects for the longer term. As projects are completed they are integrated into the system to assure the model is current.

Conclusion

Cascade's goal is to maintain its natural gas distribution system's reliablity and to cost effectively deliver natural gas to every core customer. This goal relies on modeling to increase the capacity and reliability of the distribution system by identifying specific areas that may require changes. The ability to meet the goal of reliable and cost-effective natural gas delivery is enhanced through localized distribution planning, which enables coordinated targeting of distribution projects responsive to customers' growth patterns.

SECTION 10

STAKEHOLDER ENGAGEMENT

Overview

Input and feedback from Cascade's Technical Advisory Group (TAG) are an important resource for ensuring the IRP includes perspectives beyond the Company's and is responsive to stake-holders' concerns.

Key Points

- Five TAG meetings were held in Seattle.
- Multiple opportunities for public participation were available, including two workshops and access to the Company's Resource Planning Team through phone discussions and email.
- TAG meeting agendas and presentations are available at www.cngc.com.

Approach to Meetings and Workshops

The Company holds a series of public meetings, typically in Seattle. Cascade's IRP stakeholders are widely spread out geographically; Seattle is more easily accessible for individuals to attend than Kennewick. For those unable to travel, all meetings were available by Skype/teleconference. Cascade scheduled five TAG meetings, two of which were held on the same day, between March and September of 2018. Cascade offered to hold a Skype/teleconference meeting after the draft IRP was released, but stakeholders found this not to be necessary.

Cascade recognizes that involvement in the Company's TAG represents a material time commitment. The Company appreciates the investment of time attendees provide to this process by reviewing multiple documents and making subsequent suggestions. This IRP has benefited from the focus of the engaged stakeholders.

Stakeholders

The Company encourages public participation in the IRP process. Participants invited to these public meetings include interested customers, regional upstream pipelines, Pacific Northwest Local Distribution Companies and other utilities, Commission Staff, stakeholder representatives such as the Northwest Gas Association, Oregon Department of Ecology, Public Counsel, Citizens' Utility Board, and the Alliance of Western Energy Consumers.

Internally, the Cascade IRP stakeholders and participants are from the following departments:

- Resource Planning;
- Gas Supply/Gas Control;
- Regulatory Affairs;
- Operations/Engineering;
- Energy Efficiency;

- Finance/Accounting;
- Information Technology; and
- Executive group.

Additionally, Cascade contracted the services of an IRP consultant, Bruce W Folsom Consulting LLC, to assist the Company with meeting the 2018 IRP schedule.

TAG Meetings and Workshops

Cascade held four public TAG meetings with internal and external stakeholders, an advisory workshop with Washington Utilities and Transportation Commission (WUTC) prior to the TAG meetings, and two workshops on Cascade's price forecast and SENDOUT® modeling. Information about each meeting date and major agenda items are provided below as well as in Appendix A.

Advisory workshop with WUTC – Monday, June 18, 2018

- Location: WUTC Offices in Olympia, WA, 1 pm to 4 pm
- Discussion with WUTC on Cascade's system and IRP Process

2018 IRP TAG 1 Meeting – Thursday, March 15, 2018

- Location: Seattle-Tacoma International Airport Conference Center, 9 am to 12 pm
- Process
- Key Points
- IRP Team
- Timeline
- Regional Market Outlook
- Plan for dealing with issues raised in 2016 IRP
- Clean Air Rule

2018 IRP TAG 2/3 Meeting – Thursday, July 12, 2018

- Location: Seattle-Tacoma International Airport Conference Center, 9 am to 4 pm
- Demand and Customer Forecast and Non-Core Outlook
- Drilling down into segments of demand forecast
- NWP Capacity Overview/GTN Presentation on Demand Taps
- Distribution System Planning
- Planned Scenarios and Sensitivities
- Alternative Resources
- Price Forecast
- Current Supply Resources
- Transport Issues.

2018 IRP TAG 4 Meeting – Thursday, August 16, 2018

- Location: Seattle-Tacoma International Airport Conference Center, 9 am to 4 pm
- Avoided Cost
- Carbon Impacts
- Conservation (Energy Efficiency)
- Bio-Natural Gas
- Preliminary Resource Integration Results

Price Forecast Workshop – Tuesday, August 28, 2018

- Location: Skype, 10 am
- Walkthrough of Cascade's Price Forecast model

2018 IRP TAG 5 Meeting and SENDOUT® walkthrough – Tuesday, September 18, 2018

- Location: Seattle-Tacoma International Airport Conference Center, 9 am to 4 pm
- Final Integration Results
- Finalization of plan components
- Two-year Action Plan
- Walkthrough of Cascade's SENDOUT® modeling

Opportunity for Public Participation

Cascade is fully committed to ensuring the public is invited to participate in its IRP process. Cascade has a dedicated Internet webpage where customers and parties can view the IRP timeline, TAG presentations and minutes, as well as current and past IRPs.[1]

[1] *See:* https://www.cngc.com/rates-services/rates-tariffs/washington-integrated-resource-plan

SECTION 11

TWO-YEAR ACTION PLAN

2018 Action Plan

The two-year action plan demonstrates Cascade's commitment to implementing the Company's Integrated Resource Plan and creating a portfolio of resources with the reasonable least cost mix of energy supply resources and conservation.

Key Points
Cascade's 2018 Action Plan focuses on:
- Supply Side Resources
- Environmental Policy
- Avoided Cost
- Demand Side Management
- Distribution System Planning
- IRP Process

Supply Side Resources

On March 13, 2017, the Washington Utilities and Transportation Commission (WUTC) issued its Policy and Interpretative Statement on Local Distribution Companies' (LDCs) Natural Gas Hedging Practices in Docket UG-132019. This statement provided guidance on how LDCs should develop and implement more robust risk management strategies, analyses and reporting related to hedging activities. Cascade will continue to work with Gelber & Associates to design and implement processes and analytics to comply with the WUTC's UG-132019 policy statement while simultaneously complying with Oregon Public Utility Commission UM-1286 PGA integrated hedging guidelines.

By year-end 2018, Cascade will make a recommendation to the Gas Supply Oversight Committee (GSOC) regarding the volume and timing of acquiring incremental Gas Transmission Northwest (GTN) capacity. Cascade will also continue to monitor Nova Gas Transmission Ltd. (NOVA or NGTL) incremental capacity as well as Spire storage. Furthermore, by year-end 2018, Cascade will complete discussions with NWP regarding their Shelton lateral proposal.

The Company will continue to explore the viability of biogas as a supply side resource, modeling costs and availably of supply as appropriate. The Company will provide a summary in its next Plan documenting the viability of biogas under different carbon pricing scenarios. In addition, Cascade will continue to engage with interested customers, such as Western Washington University, to determine the feasibility of pilot biogas efforts.

Environmental Policy

Cascade will either begin or continue to participate/monitor the following items:
- Participate in City of Bellingham Climate Action Plan discussions;
- Participate on City of Bend Climate Action Steering Committee;
- Monitor service areas for potential Greenhouse Gas (GHG) reduction goal development relating to energy delivery and supply;

- Monitor carbon pricing and policy developments nationally and statewide (i.e., Washington ballot measure (I-1631), Washington Clean Air Rule (CAR) litigation, 2019 carbon tax or cap and trade bills, Market Choice, etc.);
- Monitor federal and state GHG regulation development for energy industry; and
- Continuation of current emission reduction and monitoring endeavors (i.e., Methane Challenge Program, Renewable Natural Gas studies).

Avoided Cost

Currently, Cascade does not include a risk premium in the Company's avoided cost calculation. The Company will work on developing a methodology for quantifying a risk premium, with any guidance from the WUTC as well as from the UM 1893/AR 621 rulemaking in Oregon, for inclusion in its 2020 IRP.

Demand Side Management (Conservation)

- Perform continual technical reviews of new measures identified by the Applied Energy Group (AEG) Conservation Potential Assessment (CPA) as well as through participation in the Gas Technology Institute Emerging Technology workgroup for inclusion into the Energy Efficiency program portfolio.
- Review and revise ramp rates within the LoadMAP model in compliance with best practices as recommended by the Northwest Power and Conservation Council (NWPCC) and AEG, to align with measure maturity.
- Extend Northwest Energy Efficiency Alliance membership into Cycle 6 (2020-2024) and elevate CNGC's participation to equal status with electric and dual fuel utilities on the Board of Directors allowing regional natural gas market transformation efforts to grow.
- Expand Commercial/Industrial program outreach and customer engagement.
- Enhance Trade Ally Engagement.
- Explore geographic pilots and efforts for specific offerings to underperforming areas within the service territory – for example in Climate Zone 2 (Aberdeen, Longview, etc.).
- Increase engagement with the agencies delivering the Company's Low-Income Weatherization Incentive Program for the purpose of facilitating increased weatherization services delivered to qualified natural gas customers in Cascade's service area.
- Monitor the state of natural gas conservation technologies within its service territory and make adjustments commensurate with evolving ENERGY STAR® standards, and updated building code requirements.

- Monitor the residential natural gas furnace code standards as well as water heater criteria and will alter the program offerings as standards and building codes change in the next few years.

Distribution System Planning

The Company has provided a list of projects that require an increase in capacity as shown in Appendix I. Over the next two years, Cascade plans to construct citygate upgrades in Arlington, Wallula, South Walla Walla, and Yakima. A few of the other projects include pipe upgrades as well as increased pipe capacity, while continuing to maintain compliance with MAOP regulations.

IRP Process

Cascade recognizes the importance of gathering best practices from other jurisdictional LDCs. To that end, the Company will continue to participate in the IRP process of at least three regional utilities over the course of the next two years with the objective of incorporating aspects that may enhance Cascade's IRP. Cascade will also attempt to get additional stakeholder involvement through convening the IRP TAG meetings in various locations within Cascade's territory, bill inserts, and/or other means. The Company will also perform cross validation on new methodologies to ensure the accuracy of the new models.

Table 11-1 on the following page highlights specific activities of the 2018 Action Plan.

Table 11-1: Highlights of 2018 Action Plan

Functional Area	Anticipated Action	Timing
Supply Side Resources	Cascade will continue to work with Gelber & Associates to design and implement processes and analytics to comply with the WUTC UG-132019 policy statement. Cascade will make a recommendation to GSOC regarding the volume and timing of acquiring incremental GTN capacity. Cascade will also continue to monitor NGTL incremental capacity and Spire storage. Cascade will complete discussions with NWP regarding their Shelton lateral proposal. Cascade will also continue to explore biogas opportunities.	Ongoing, for inclusion in 2020 IRP.
Environmental Policy	Cascade will either begin or continue to participate/monitor the multiple items listed on page 11-2.	Ongoing, for inclusion in 2020 IRP.
Avoided Cost	Investigate incorporating a risk premium into the avoided cost calculation.	Ongoing, for inclusion in 2020 IRP.
DSM	The Company will execute the Demand Side Management action items as described on page 11-3.	Ongoing, for inclusion in 2020 IRP.
Distribution System Planning	These projects are budgeted over the next two years: • FP-316029 - MAOP; 3" HP; GRANGER; PH1 • FP-316033 - MAOP; 3" HP; ZILLAH; 873' • FP-316034 - MAOP; 4" HP; OTHELL0; 9,801' • FP-316035 - MAOP; 4" HP; ARLINGTON; 4,700' • FP-316573 - MAOP RPL; 4" HP, MADRAS PH2 • FP-316574 - MAOP RPL; 4" HP, MADRAS PH3 • FP-316575 - MAOP RPL; 6" HP, BEND HP PH2 • FP-316576 - MAOP RPL; 6" HP, BEND HP PH3 • FP-316579 - MAOP; 2,6,8" HP; ANACORTES; PH2 • FP-316580 - MAOP; 2,6,8" HP; ANACORTES; PH3 • FP-101505 - ARLINGTON GATE UPGRADE • FP-300233 - ARLINGTON 6" HP REINFORCEMENT • FP-302596 - WALLULA GATE STATION; GTN • FP-306987 - BURLINGTON REIN. @ PETERSON ROAD • FP-306988 - WALLA WALLA HP LINE • FP-306998 - NEW SOUTH WALLA WALLA GATE • FP-307221 - 8" YAKIMA HP PIPELINE • FP-309960 - RP 20" HP ANACORTES LATERAL • FP-316429 - RF; 6" HP; ABER; 12,500' BASICH BLV • FP-316431 - RF; 6" PE; ABER; 1,200' OAK ST • FP-316586 - RP; R-TBD ARLINGTON GATE • FP-316587 - RF; R-TBD; WALLULA GATE STATION • FP-316589 - RF; R-TBD; NEW WALLA WALLA GATE • FP-316670 - RF; 12" HP; KENN; WALLULA HP LINE • FP-316872 - RF; 8" HP; YAKIMA; 18,500' • FP-316980 - YAKIMA GATE STATION	Beginning in 2018, updates will be provided to WUTC on a quarterly basis.
IRP Process	Active participation in regional LDC IRP processes. The Company will attempt to increase stakeholder engagement for the IRP process. Cascade will cross-validate new methodologies to ensure the accuracy of new modeling techniques.	Ongoing, for inclusion in all future IRPs.

SECTION 12

GLOSSARY AND MAPS

GLOSSARY OF TERMS AND ACRONYMS

ABB™
Add-in product to the SENDOUT® model that facilitates the ability to model gas price and load uncertainty (driven by weather) into the future. ABB™ brings a Monte Carlo approach into the linear programming approach utilized in SENDOUT®.

ACEEE
American Council for an Energy-Efficient Economy.

ACHIEVABLE POTENTIAL
Represents a realistic assessment of expected energy savings, recognizing and accounting for economic and other constraints that preclude full installation of every identified conservation measure.

AECO INDEX
Alberta Canada natural gas trading price.

AKAIKE INFORMATION CRITERION (AIC)
A measure of the relative quality of statistical models for a given set of data. Given a collection of models for the data, AIC estimates the quality of each model, relative to each of the other models. Hence, AIC provides a means for model selection.

ANNUAL FUEL UTILIZATION EFFICIENCY (AFUE)
Thermal efficiency measure of combustion equipment like furnaces, boilers, and water heaters.

ANNUAL MEASURES
Conservation measures that achieve generally uniform year-round energy savings independent of weather temperature changes. Annual measures are also often called base load measures.

ARIMA MODELING
Autoregressive integrated moving average. A time series analysis technique employed by Cascade in its demand and customer forecast.

ASSET MANAGEMENT AGREEMENT (AMA)
An arrangement that an LDC may enter into with a marketing company to assist with transportation and storage assistance.

AVOIDED COST
Marginal cost of serving the next unit of demand, which is saved through conservation efforts.

BASE LOAD
As applied to natural gas, a given demand for natural gas that remains fairly constant over a period of time, usually not temperature sensitive.

BASE LOAD MEASURES
Conservation measures that achieve generally uniform year-round energy savings independent of weather temperature changes. Base load measures are also often called annual measures.

BIO NATURAL GAS (BNG)
Typically refers to a gas produced by the biological breakdown of organic matter in the absence of oxygen.

BRITISH THERMAL UNIT (BTU)
The amount of heat required to raise the temperature of one pound of pure water one-degree Fahrenheit under stated conditions of pressure and temperature; a therm of natural gas has an energy value of 100,000 BTUs and is approximately equivalent to 100 cubic feet of natural gas.

CHOLESKY DECOMPOSITION
A positive-definite covariance matrix. This matrix is used to draw or sample random vectors from the N-dimensional multivariate normal distribution that follow a desired distribution. This allows for correlations between weather zones to be included when drawing or sampling data distributions for Monte Carlo runs.

CITYGATE (ALSO KNOWN AS GATE STATION OR PIPELINE DELIVERY POINT)
The point at which natural gas deliveries transfer from the interstate pipelines to Cascade's distribution system.

CITYGATE LOOP
Two or more citygates that transfer natural gas from the interstate pipeline to the same distribution system. Citygates are combined into a loop for modeling purposes because it is difficult to distinguish which citygate feeds a certain distribution system.

CLEAN AIR RULE (CAR)
Greenhouse gas emissions standards codified in WAC 173-442. Invalidated Dec. 15, 2017.

COEFFICIENT OF PERFORMANCE (COP)
The coefficient of performance or COP of a heat pump, refrigerator or air conditioning system is a ratio of useful heating or cooling provided to work required. Higher COPs equate to lower operating costs.

COMPRESSION
Increasing the pressure of natural gas in a pipeline by means of a mechanically driven compressor station to increase flow capacity.

COMPRESSOR
Equipment which pressurizes gas to keep it moving through the pipelines.

CONSERVATION MEASURES
Installations of appliances, products, or facility upgrades that result in energy savings.

CONSUMER PRICE INDEX (CPI)
As calculated and published by the U.S. Department of Labor, Bureau of Labor Statistics.

CONTRACT DEMAND (CD)
The maximum daily, monthly, seasonal, or annual quantities of natural gas, which the supplier agrees to furnish or the pipeline agrees to transport, and for which the buyer or shipper agrees to pay a demand charge.

CORE CUSTOMERS
Residential, firm industrial and commercial gas customers who require utility gas service.

COST EFFECTIVENESS
The determination of whether the present value of the therm savings for any given conservation measure is greater than the cost to achieve the savings.

CUSTOMER CARE & BILLING (CC&B)
Internal billing data system for Cascade Natural Gas.

DAY GAS
Gas that can be purchased as needed to cover demand in excess of the base load.

DEKATHERM (DTH)
Unit of measurement for natural gas; a dekatherm is 10 therms, which is 1000 cubic feet (volume) or 1,000,000 BTUs (energy).

DEMAND SIDE MANAGEMENT (DSM)
The activity pursued by an energy utility to influence its customers to reduce their energy consumption or change their patterns of energy use away from peak consumption periods.

DEMAND SIDE RESOURCES
Energy resources obtained through assisting customers to reduce their demand or use of natural gas. Also represents the aggregate energy savings attained from installation of conservation measures.

ELECTRONIC BULLETIN BOARD (EBB)
Online communication systems where one can share, request, or discuss information on just about any subject.

ENERGY INFORMATION ADMINISTRATION (EIA)
The U.S. Energy Information Administration (EIA) is a principal agency of the U.S. Federal Statistical System responsible for collecting, analyzing, and disseminating energy information to promote sound policymaking, efficient markets, and public understanding of energy and its interaction with the economy and the environment. EIA programs cover data on coal, petroleum, natural gas, electric, renewable and nuclear energy. EIA is part of the U.S. Department of Energy.

ENTITLEMENTS
Flow management tool used by upstream pipelines, in conjunction with operational flow orders.

EXTERNALITIES
Costs and benefits that are not reflected in the price paid for goods or services.

FEDERAL ENERGY REGULATORY COMMISSION (FERC)
The government agency charged with the regulation and oversight of interstate natural gas pipelines, wholesale electric rates and hydroelectric licensing; the FERC regulates the interstate pipelines with which Cascade does business and determines rates charged in interstate transactions.

FIRM SERVICE OR FIRM TRANSPORTATION
Service offered to customers under schedules or contracts that anticipate no interruptions; the highest quality of service offered to customers.

FIRST OF THE MONTH PRICE (FOM)
Supply contracts entered into on a short-term basis to cover expected demand for that month.

FORCE MAJEURE
An unexpected event or occurrence not within the control of the parties to a contract, which alters the application of the terms of a contract; sometimes referred to as "an act of God;" examples include severe weather, war, strikes, pipeline failure, and other similar events.

FOURIER TERMS
An alternative to using seasonal dummy variables, especially for long seasonal periods, is to use Fourier terms. Fourier terms consist of a series of sine and cosine terms of frequencies that can approximate any periodic function. These terms can be used for seasonal patterns with great advantage over seasonal dummy variables.

FUEL-IN-KIND (FUEL LOSS)
A statutory percent of gas based on the tariff from the pipeline that is lost and unaccounted for from the point where the gas was purchased to the citygate.

FUGITIVE METHANE EMISSIONS
Natural gas that escapes the system during drilling, extraction, and/or transportation and distribution of gas.

GAS MANAGEMENT SYSTEM (GMS)
A transactional and reporting system to consolidate natural gas nominations, contracts, balancing and pricing data.

GAS SUPPLY OVERSIGHT COMMITTEE (GSOC)
Oversees the Company's gas supply purchasing and hedging strategy. Members of GSOC include Company senior management from Gas Supply, Regulatory, Accounting & Finance, Engineering, and Operations.

GAS TRANSMISSION NORTHWEST (GTN)
A subsidiary of TransCanada Pipeline which owns and operates a natural gas pipeline that runs from the Canada/U.S. border to the Oregon/California border. One of the six natural gas pipelines Cascade transacts with directly.

GAUSSIAN (NORMAL) DISTRIBUTION
A distribution of many random variables that form a symmetrical bell-shaped graph.

GEOMETRIC BROWNIAN MOTION (GBM)
A continuous-time stochastic process in which the log of the randomly varying quantity follows a random shock combined with a drift element.

GREENHOUSE GAS (GHG)
A greenhouse gas is a gas that absorbs and emits radiant energy within the thermal infrared range. Increasing greenhouse gas emissions cause the greenhouse effect. The primary greenhouse gases in Earth's atmosphere are water vapor, carbon dioxide, methane, nitrous oxide and ozone.

HEATING DEGREE DAY (HDD)
A measure of the coldness of the weather experienced, based on the extent to which the daily average temperature falls below 60 degrees Fahrenheit; a daily average temperature representing the sum of the high and low readings divided by two.

HENRY HUB (NYMEX)
The physical location found in Louisiana that is widely recognized as the most important pricing point in the United States. It is also the trading hub for the New York Mercantile Exchange (NYMEX).

INJECTION
The process of putting natural gas into a storage facility or biomethane into the distribution system.

INTEGRATED RESOURCE PLAN (IRP)
The document that explains Cascade's long-range plans and preparations to maintain sufficient resources to meet customer needs at a reasonable price.

INTERRUPTIBLE SERVICE
A service of lower priority than firm service, offered to customers under schedules or contracts that anticipate and permit interruptions on short notice; interruption occurs when the demand of all firm customers exceeds the capability of the system to continue deliveries to all firm customers.

INTERSTATE PIPELINE
A federally regulated company that transports and/or sells natural gas across state lines.

JACKSON PRAIRIE
An underground storage facility jointly owned by Avista Corp., Puget Sound Energy, and NWP. The facility is a naturally occurring aquifer near Chehalis, Washington, which is located some 1,800 feet beneath the surface and capped with a very thick layer of dense shale.

LINEAR PROGRAMMING
A mathematical method of solving problems by means of linear functions where the multiple variables involved are subject to constraints; this method is utilized in the SENDOUT® Gas Model.

LIQUEFIED NATURAL GAS (LNG)
Natural gas that has been liquefied by reducing its temperature to minus 260 degrees Fahrenheit at atmospheric pressure. It is liquefied to reduce its volume and thereby facilitate bulk storage and transport.

LOAD FACTOR
The average load of a customer, a group of customers, or an entire system, divided by the maximum load factor that can be calculated over any time period.

LOAD FORECAST
A forecast, an estimate, or a prediction of how much gas will be needed for residences, companies, and other institutions.

LOAD MANAGEMENT
The reduction of peak demand during specific, limited time periods by temporarily curtailing usage or shifting usage to other time periods. Load management reduces system peak demand very well, but can have little or no effect on total energy use. Its effects are temporary and of short duration.

LOAD PROFILE
The pattern of a customer's gas usage, hour to hour, day to day, or month to month.

LOADMAP
Microsoft Excel-based modeling tool developed by AEG to determine the Technical/Economic/Achievable Potential savings of various proposed DSM programs

LOCAL DISTRIBUTION COMPANY (LDC)
LDCs are regulated utilities involved in the delivery of natural gas to consumers within a specific geographic area.

LOOPING
The construction of a second pipeline parallel to an existing pipeline over the whole or any part of its length, thus increasing the capacity of that section of the system.

LOWEST REASONABLE COST (LRC)
LRC methodology is used when evaluating alternatives to determine the optimal solution to a given problem.

MCF
A unit of volume equal to 1,000 cubic feet.

MDDO
Maximum daily delivery obligation.

MDQ
Maximum daily quantity.

MEMORANDUM OF UNDERSTANDING (MOU)
A memorandum of understanding (MOU) is a nonbinding agreement between two or more parties outlining the terms and details of an understanding, including each parties' requirements and responsibilities. An MOU is often the first stage in the formation of a formal contract.

MONTE CARLO ANALYSIS
A type of stochastic mathematical simulation which randomly and repeatedly samples input distributions (e.g. reservoir properties) to generate a results distribution.

NATIONAL ENERGY BOARD (NEB)
The Canadian equivalent to the Federal Energy Regulatory Commission (FERC).

NATIONAL ENVIRONMENTAL POLICY ACT (NEPA)
A United States environmental law that promotes the enhancement of the environment and established the President's Council on Environmental Quality (CEQ). The law was enacted on January 1, 1970.

NATURAL GAS
A naturally occurring mixture of hydrocarbon and non-hydrocarbon gases found in porous geologic formations beneath the earth's surface, often in association with petroleum; the principal constituent is methane, and it is lighter than air.

NEEDLE PEAKING RESOURCE
Utilized during severe or “arctic” cold weather.

NEW YORK MERCANTILE EXCHANGE (NYMEX)
An organization that facilitates the trading of several commodities including natural gas.

NGV
Natural gas vehicles.

NOMINAL
Discounting method that does not adjust for inflation.

NOMINATION
The scheduling of daily natural gas requirements.

NON-COINCIDENT PEAK
The sum of two or more peak loads on individual systems that do not occur in the same time interval. Meaningful only when considering loads within a limited period of time, such as a day, week, month, a heating or cooling season, and usually for not more than one year.

NON-CORE CUSTOMER
Large customers who contract with a third party for supply and upstream pipeline capacity. Cascade provides distribution services only. Typical customers include large commercial, industrial, cogeneration, wholesale, and electric generation customers.

NORTH AMERICAN ENERGY STANDARDS BOARD (NAESB)
Serves as an industry forum for the development and promotion of standards which will lead to a seamless marketplace for wholesale and retail natural gas and electricity, as recognized by its customers, business community, participants, and regulatory entities.

NORTHWEST BUILDER OPTION PACKAGES (NWBOP)
A prescriptive method for labeling new homes as ENERGY STAR. BOPs specify levels and limitations for the thermal envelope (insulation and windows), HVAC and water heating equipment efficiencies for the Pacific Northwest. BOPs require a third-party verification, including testing the leakage of the envelope and duct system, to ensure the requirements have been met.

NORTHWEST GAS ASSOCIATION (NWGA)
A trade organization of the Pacific Northwest natural gas industry. The NWGA's members include six natural gas utilities serving communities throughout Idaho, Oregon, Washington and British Columbia; and three natural gas transmission pipelines that transport natural gas from supply basins into and through the region.

NORTHWEST PIPELINE CORPORATION (NWP)
A principal interstate pipeline serving the Pacific Northwest and one of six natural gas pipelines Cascade transacts with directly. NWP is a subsidiary of The Williams Companies and is headquartered in Salt Lake City, Utah.

NORTHWEST POWER AND CONSERVATION COUNCIL (NWPCC)
NWPCC consists of two members from each of the four Northwest states- Oregon, Washington, Idaho and Montana- who develop a plan for meeting the region's electric demand.

NOVA GAS TRANSMISSION (NOVA)
See TransCanada Alberta System.

OFF-SYSTEM
Any point not on or directly interconnected with a transportation, storage, and/or distribution system operated by a natural gas company within a state.

OPAL (OPAL HUB)
Natural gas trading hub in Lincoln County, Wyoming.

OPERATIONAL FLOW ORDER (OFO)
A mechanism to protect the operational integrity of the pipeline. Upstream pipelines may issue and implement System-Wide or Customer-Specific OFOs in the event of high or low pipeline inventory. OFOs require shippers to take action to balance their supply with their customers' usage on a daily basis within a specified tolerance band. Shippers may deliver additional supply or limit supply delivered to match usage. Violations or failure to comply with an OFO can result in the pipeline assessing penalties to offending shippers.

OREGON PUBLIC UTILITY COMMISSION (OPUC)
The chief electric, gas and telephone utility regulatory agency of the government of the U.S. state of Oregon. It sets rates and establishes rules of operation for the state's investor-owned utility companies. The OPUC's official name is Public Utility Commission of Oregon.

PACIFIC CONNECTOR GAS PIPELINE PROJECT (PCGP)
A proposed 232-mile, 36-inch diameter pipeline designed to transport up to 1 billion cubic feet of natural gas per day from interconnects near Malin, Oregon, to the Jordan Cove LNG terminal in Coos Bay, Oregon, where the natural gas will be liquefied for transport to international markets

PEAK DAY
The greatest total natural gas demand forecasted in a 24-hour period used as a basis for planning peak capacity requirements.

PEAK DAY GAS
Gas that is purchased in a peak day situation to serve demand that cannot be satisfied by base or day gas.

PERFORMANCE TESTED COMFORT SYSTEMS (PTCS)
Northwest regional programs with a focus on improving HVAC system comfort and increasing savings. They promote contractor training for properly sealing ducts and installing high-efficiency heat pumps, with a focus on sizing, commissioning, and setting controls. Technicians must complete a BPA-approved training to be certified to perform work in this program. These programs are supported by BPA and Northwest Public Utilities.

POUNDS PER SQUARE INCH (PSI)
The standard unit of measure when determining how much pressure is being applied when gas is flowing through a pipe.

PREFERRED PORTFOLIO
Cascade's term of art for the optimal mix of resources to solve for forecasted shortfalls in the 20-year planning horizon.

PRESENT VALUE OF REVENUE REQUIREMENT (PVRR)
The annual revenues required by the firm to cover both its expenses and have the opportunity to earn a fair rate of return. The annual costs to provide safe and reliable service to the company's customers that the company is allowed to recover through rates. The present value a future sum of money or stream of cash flows given a specified rate of return. Future cash flows are discounted at the discount rate, and the higher the discount rate, the lower the present value of the future cash flows.

PRICE ELASTICITY
Economic concept which recognizes that customer consumption changes as prices rise or fall.

R
A programming language and free software environment for statistical computing and graphics supported by the R Foundation for Statistical Computing.

REAL
Discounting method that adjusts for inflation.

RECOURSE RATE
Cost-of-service based rate for natural gas pipeline service that is on file in a pipeline's tariff and is available to customers who do not negotiate a rate with the pipeline company. Also see negotiated rate. (Source: FERC https://www.ferc.gov/resources/glossary.asp#R)

REFERENCE CASE
Average annual demand from the forecast results without peak day.

REGASIFICATION RESOURCE
Process by which LNG is heated, converting it to a gaseous state. Designed for vaporizing LNG where and when it will be used.

REGULATOR STATION
A point on a distribution system responsible for controlling the flow of gas from higher to lower pressures.

RENEWABLE FUEL
A power source that is continuously or cyclically renewed by nature, i.e. solar, wind, hydroelectric, geothermal, biomass, or similar sources of energy.

ROCKIES INDEX
Natural gas trading price near the Rocky Mountains.

SATELLITE LNG FACILITIES
A facility for storing and vaporizing LNG to meet relatively modest demands at remote locations or to meet short-term peak demands. LNG is usually trucked to such facilities.

SEASONAL PEAKING SERVICE
The delivery of gas, firm or interruptible, sold only during certain times of the year, generally when system demands are not high.

SENDOUT®
Natural gas planning system from ABB™; a linear programming model used to solve gas supply and transportation optimization questions.

SERVICE TERRITORY
Territory in which a utility system is required or has the right to provide natural gas service to ultimate customers.

SPOT MARKET GAS
Natural gas purchased under short-term agreements as available on the open market; prices are set by market pressure of supply and demand.

STANDBY
Support service that is available, as needed, to supplement a consumer, a utility system, or to another utility to replace normally scheduled power that becomes unavailable.

STORAGE
The utilization of facilities for storing natural gas which has been transferred from its original location for the purposes of serving peak loads, load balancing, and the optimization of basis differentials. The facilities are usually natural geological reservoirs such as depleted oil or natural gas fields or water-bearing sands sealed on the top by an impermeable cap rock. The facilities may be man-made or natural caverns. LNG storage facilities generally utilize above ground insulated tanks.

SUMAS INDEX
Natural gas trading price near the city of Sumas, which is on the Washington/Canadian border approximately 25 miles from the Pacific Ocean.

SWAP
A financial instrument where parties agree to exchange an index price for a fixed price over a defined period.

SYNERGI®
Engineering software used to model piping and facilities to represent current pressure and flow conditions, while also predicting future events and growth.

TARIFF
A published volume of regulated rate schedules plus general terms and conditions under which a product or service will be supplied.

TEA-POT
Microsoft Excel-based modeling tool developed by Nexant Inc. to determine the Technical/Economic/Achievable Potential savings of various proposed DSM programs.

TECHNICAL ADVISORY GROUP (TAG)
Industry, customer, and regulatory representatives that advise Cascade during the IRP planning process.

TECHNICAL POTENTIAL
An estimate of all energy savings that could theoretically be accomplished if every customer that could potentially install a conservation measure did so without consideration of market barriers such as cost and customer awareness.

THERM
A unit of heating value used with natural gas that is equivalent to 100,000 British thermal units (BTU); also, approximately equivalent to 100 cubic feet of natural gas.

THROUGHPUT
The total of all natural gas volume moved through a pipeline system, including sales, company use, storage, transportation, and exchange.

TOTAL RESOURCE COST (TRC)
Measures the net costs of a demand side management program as a resource option based on the total costs of the program, including both the participants' and the utility's costs. The test is applicable to conservation, load management, and fuel substitution programs.

TRANSCANADA ALBERTA SYSTEM
Previously known as NOVA Gas Transmission; a natural gas gathering and transmission corporation in Alberta that delivers natural gas into the TransCanada BC System pipeline at the Alberta/British Columbia border; one of six natural gas pipelines Cascade transacts with directly.

TRANSCANADA BC SYSTEM
Also known as Foothills Pipeline. Previously known as Alberta Natural Gas; a natural gas transmission corporation of British Columbia that delivers natural gas between the TransCanada-Alberta System and GTN pipelines that runs from the Alberta/British Columbia border to the United States border; one of six natural gas pipelines Cascade transacts with directly.

TRANSPORTATION GAS
Natural gas purchased either directly from the producer or through a broker, and used for either system supply or for specific end-use customers, depending on the transportation arrangements; NWP and GTN transportation may be firm or interruptible.

TRANSPORTATION SERVICE AGREEMENT (TSA)
A transportation services agreement is a contract made between goods providers and those who offer transportation for those goods. In the context of the IRP, this refers to shippers and upstream pipelines.

TURN-BACK CAPACITY
When natural gas shippers, upon expiration of their contract(s) for pipeline capacity do not renew capacity rights, in whole or in part, with the original pipeline, return said capacity rights back to the pipeline.

UPSTREAM PIPELINE CAPACITY
The pipeline delivering natural gas to another pipeline at an interconnection point where the second pipeline is closer to the consumer. In the context of the IRP this refers to any transmission pipeline that is upstream of the Cascade distribution system.

VALUE AT RISK (VaR)
A metric used to quantify uncertainty into a tangible number.

WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION (WUTC)
A three-member commission appointed by the governor and confirmed by the state senate. The Commission's mission is to protect the people of Washington by ensuring that investor-owned utility and transportation services are safe, available, reliable and fairly priced.

WINTER GAS SUPPLIES
Gas supply purchased for all (base gas) or part (day gas) of the heating season.

WITHDRAWAL
The process of removing natural gas from a storage facility, making it available for delivery into the connected pipelines; vaporization is necessary to make withdrawals from an LNG plant.

WOODS & POOLE (W&P)
An independent firm that specializes in long-term county economic and demographic projections.

ZONE
A geographical area. A geological zone means an interval of strata of the geologic column that has distinguishing characteristics from surrounding strata.

ZONE - IRP
For modeling purposes, Cascade's distribution system is divided into several zones. These zones are generally organized by the location of compressor stations on upstream pipelines or by specific weather areas. Where appropriate, the Zone-IRP is separated by state. Please see the chart on the next page that references the citygate/location to the appropriate IRP zone.

DESCRIPTION	METER	ZONEID	PIPELINE
7TH DAY ADVENTIST FARM TAP	ADVENSCH	ZONE 10	NWP
A & M RENDERING	AMRENDER	ZONE 30-W	NWP
A & W FEED LOT FARM TAP	AWFEED	ZONE 20	NWP
ABERDEEN/HOQUIAM/MCCLEARY	ABRNDHOQ	ZONE 30-S	NWP
ACME	ACME	ZONE 30-W	NWP
ALCOA, WENATCHEE	ALCOA	ZONE 11	NWP
ARLINGTON	ARLINGTN	ZONE 30-W	NWP
ATHENA/WESTON	ATHENA	ZONE ME-OR	NWP
BAKER	BAKER	ZONE 24	NWP
BELLINGHAM II	BLLINGII	ZONE 30-W	NWP
BELLINGHAM/FERNDALE	BLHAM	ZONE 30-W	NWP
BEND TAP	BEND	ZONE GTN	GTN
BREMERTON (SHELTON)	BREMERTON	ZONE 30-S	NWP
BRULOTTE HOP RANCH	BRULOTTE	ZONE 10	NWP
BURBANK HEIGHTS	BURBANKH	ZONE 20	NWP
CASTLE ROCK	CASTLERK	ZONE 26	NWP
CHEMICAL LIME	CHEMLIME	ZONE 24	NWP
CHEMULT	CHEM	ZONE GTN	GTN
DEHANNS DAIRY FARM TAP	DEHANDRY	ZONE 10	NWP
DEMING	DEMING	ZONE 30-W	NWP
EAST STANWOOD	EAST STANWOOD	ZONE 30-W	NWP
FINLEY	FINLEY	ZONE 20	NWP
GILCHRIST TAP	GILC	ZONE GTN	GTN
GRANDVIEW	GRDVEW	ZONE 10	NWP
GREEN CIRCLE FARM TAP	GRENCIRL	ZONE 26	NWP
HERMISTON	HERMSTON	ZONE ME-OR	NWP
HUNTINGTON	HTINGTON	ZONE 24	NWP
KALAMA FARM TAP	KALAMA	ZONE 26	NWP
KALAMA NO. 2	KALAMA2	ZONE 26	NWP
KAWECKI, WENATCHEE	KAWECKI	ZONE 11	NWP
KENNEWICK	KENEWICK	ZONE 20	NWP
KOMOS FARMS TAP	KOMO	ZONE GTN	GTN
LA PINE TAP	LAPI	ZONE GTN	GTN
LAMBERT'S HORTICULTURE	LAMBERTS	ZONE 10	NWP

LAWRENCE	LAWRENCE	ZONE 30-W	NWP
LDS CHURCH FARM TAP	LDSCHURC	ZONE 30-W	NWP
LONGVIEW-KELSO	LONGVIEW	ZONE 26	NWP
LYNDEN	LYNDEN	ZONE 30-W	NWP
MADRAS TAP	MADR	ZONE GTN	GTN
MENAN STARCH	MEMANSTR	ZONE 20	NWP
MILTON FREEWATER	MILFREE	ZONE ME-OR	NWP
MISSION TAP	MISSION	ZONE ME-OR	NWP
MOSES LAKE	MOS LAKE	ZONE 20	NWP
MOUNT VERNON	MTVERNON	ZONE 30-W	NWP
MOXEE CITY	MOXEE	ZONE 11	NWP
NORTH BEND	NBEND	ZONE GTN	GTN
NORTH PASCO METER STATION	NPASCO	ZONE 20	NWP
NYSSA-ONTARIO	NYSSA	ZONE 24	NWP
OAK HARBOR/STANWOOD	OAKHAR	ZONE 30-W	NWP
OTHELLO	OTHELLO	ZONE 20	NWP
PASCO	PASCO	ZONE 20	NWP
PATERSON	PATERSON	ZONE 26	NWP
PENDLETON	PENDLETN	ZONE ME-OR	NWP
PLYMOUTH	PLYMTH	ZONE 20	NWP
PRINEVILLE TAP	PRVL	ZONE GTN	GTN
PRONGHORN TAP	PRONGHORN	ZONE GTN	GTN
PROSSER	PROSSER	ZONE 10	NWP
QUINCY	QUINCY	ZONE 11	NWP
REDMOND TAP	REDM	ZONE GTN	GTN
RICHLAND	RICHLAND	ZONE 20	NWP
SANDVIK, KENNEWICK	SANDVIK	ZONE 20	NWP
SEDRO/WOOLLEY ET AL.	SEDRO	ZONE 30-W	NWP
SELAH	SELAH	ZONE 11	NWP
SOUTHRIDGE	STHRDG	ZONE 20	NWP
SOUTH BEND	S BEND	ZONE GTN	GTN
SOUTH HERMISTON TAP	SHRM	ZONE GTN	GTN
SOUTH LONGVIEW FIBRE	SOLONG	ZONE 26	NWP
STANFIELD CITY TAP	STTAP	ZONE GTN	GTN

STEARNS TAP	STEA	ZONE GTN	GTN
SUMAS, CITY OF	SUMASC	ZONE 30-W	NWP
SUNNYSIDE	SUNSIDE	ZONE 10	NWP
TOPPENISH ET AL. (ZILLAH)	TOPENISH	ZONE 10	NWP
U & I SUGAR, MOSES LAKE	UI SUGAR	ZONE 20	NWP
UMATILLA	UMATILLA	ZONE ME-WA	NWP
WALLA WALLA	WALLA	ZONE ME-WA	NWP
WALULA	WALULA	ZONE ME-WA	GTN
WENATCHEE	WENATCHE	ZONE 11	NWP
WOODLAND WA	WOODLAND	ZONE 26	NWP
YAKIMA CHIEF FARMS	YAKCHFRM	ZONE 11	NWP
YAKIMA FIRING CENTER	YAKFIRCR	ZONE 11	NWP
YAKIMA/UNION GAP	YAKIMA	ZONE 11	NWP

Maps of System Infrastructure

Figure 12-1: Map – AECO Hub Storage

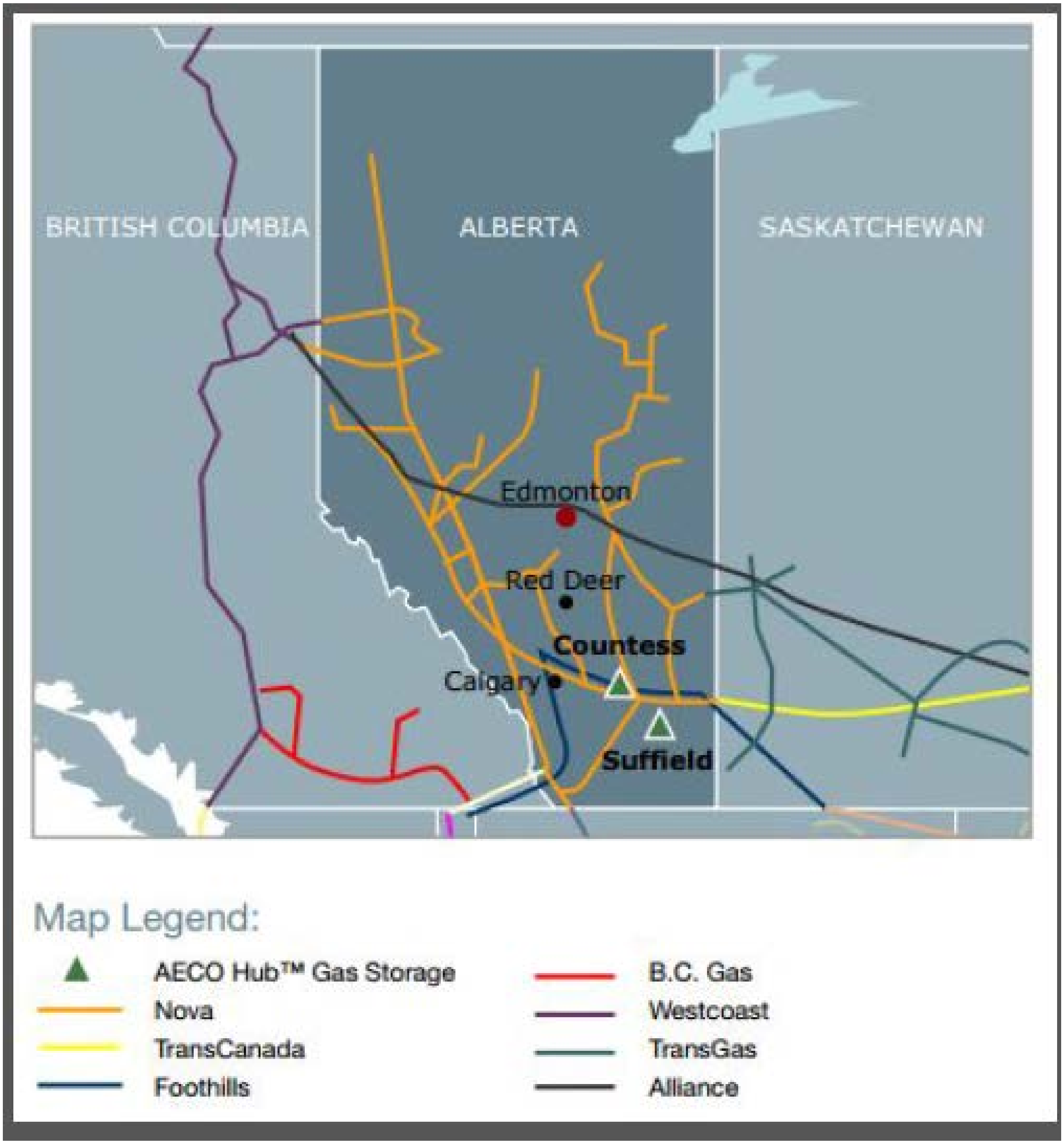


Figure 12-2: Map – California Storage Map

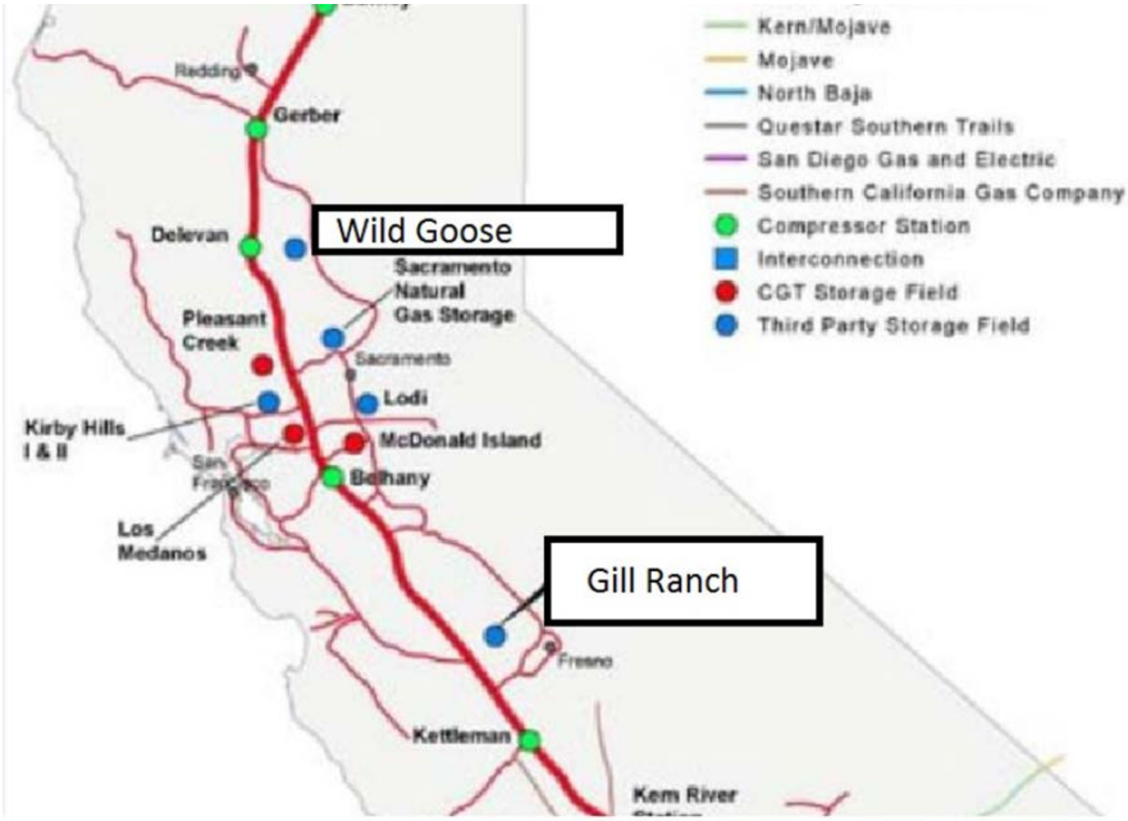


Figure 12-3: Map – Cascade Natural Gas Pipeline System

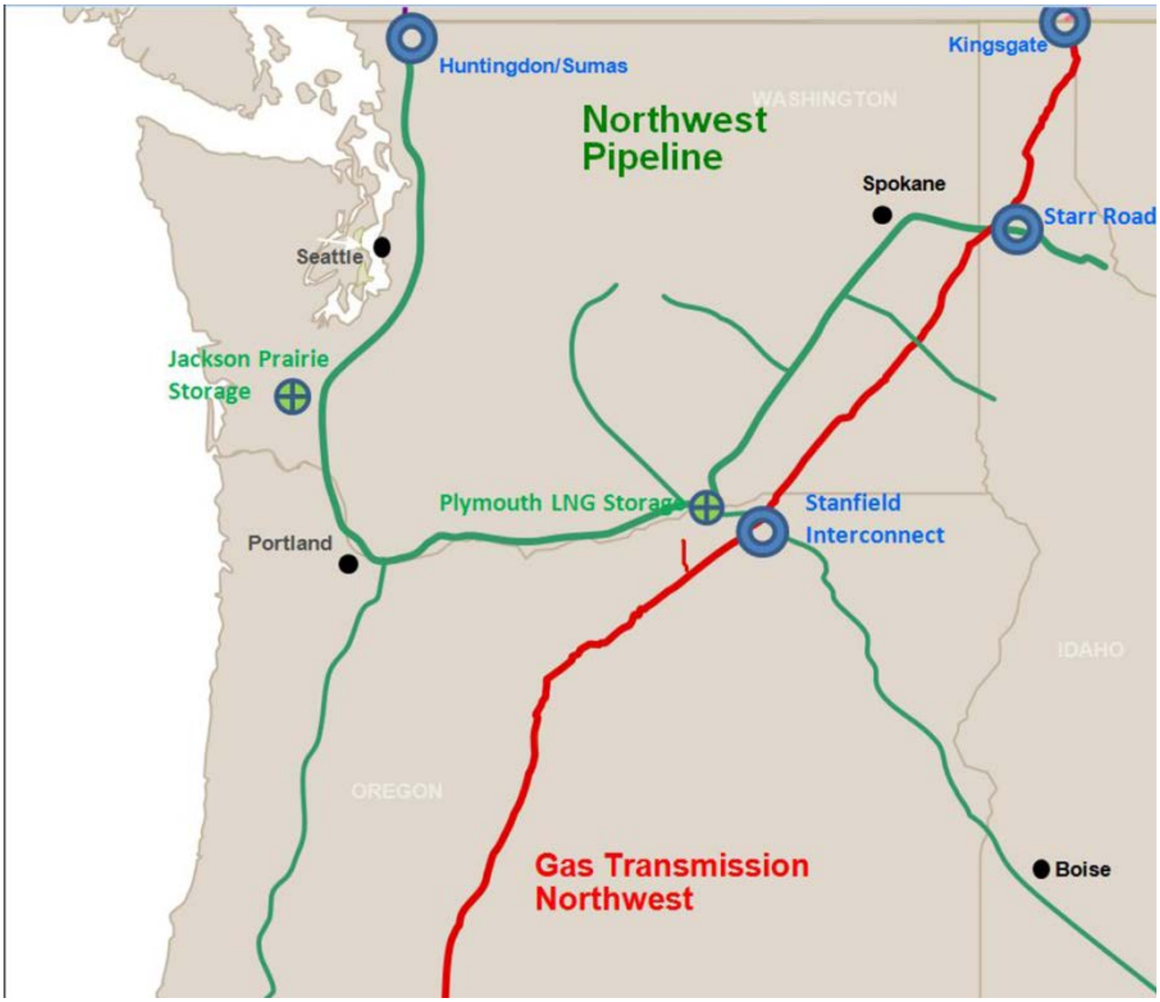


Figure 12-4: Map – Foothills-British Columbia Map

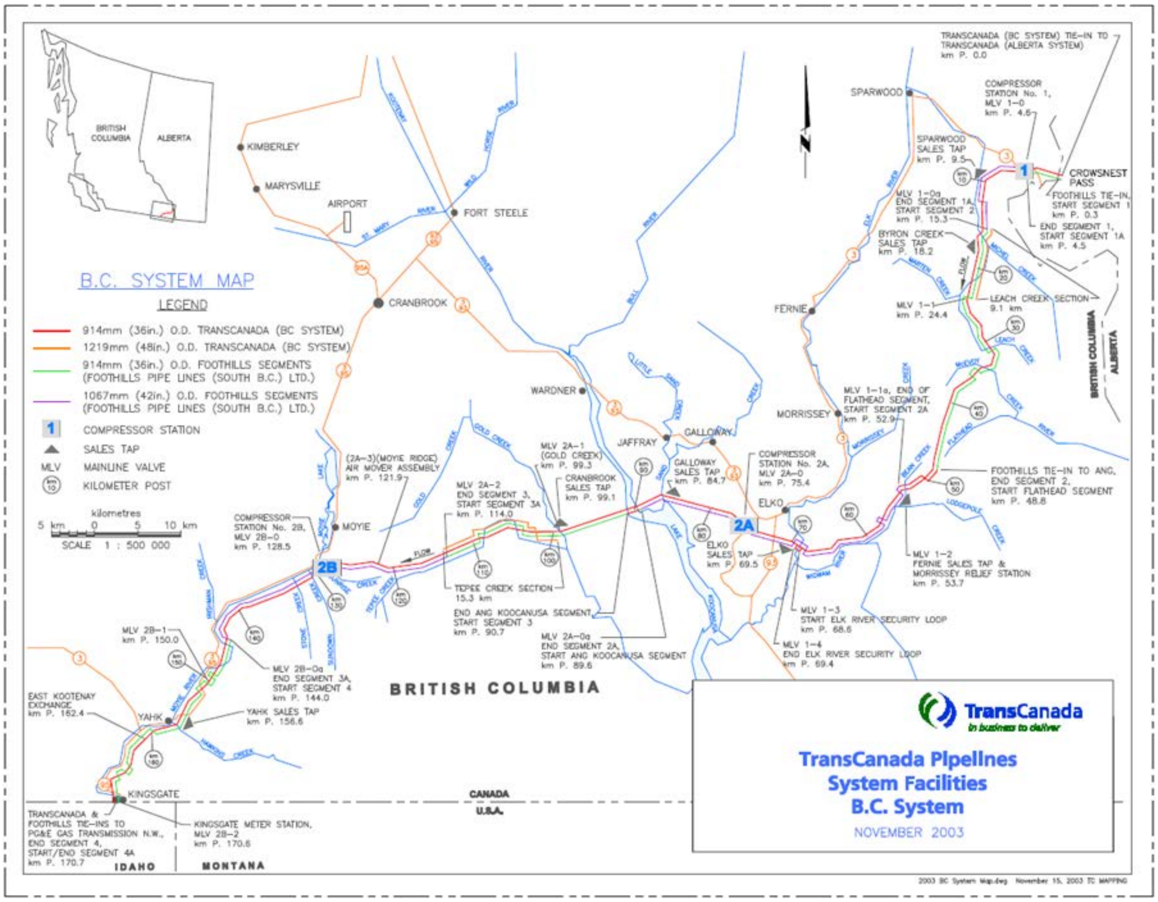


Figure 12-5: Map – Foothills-British Columbia Map 2

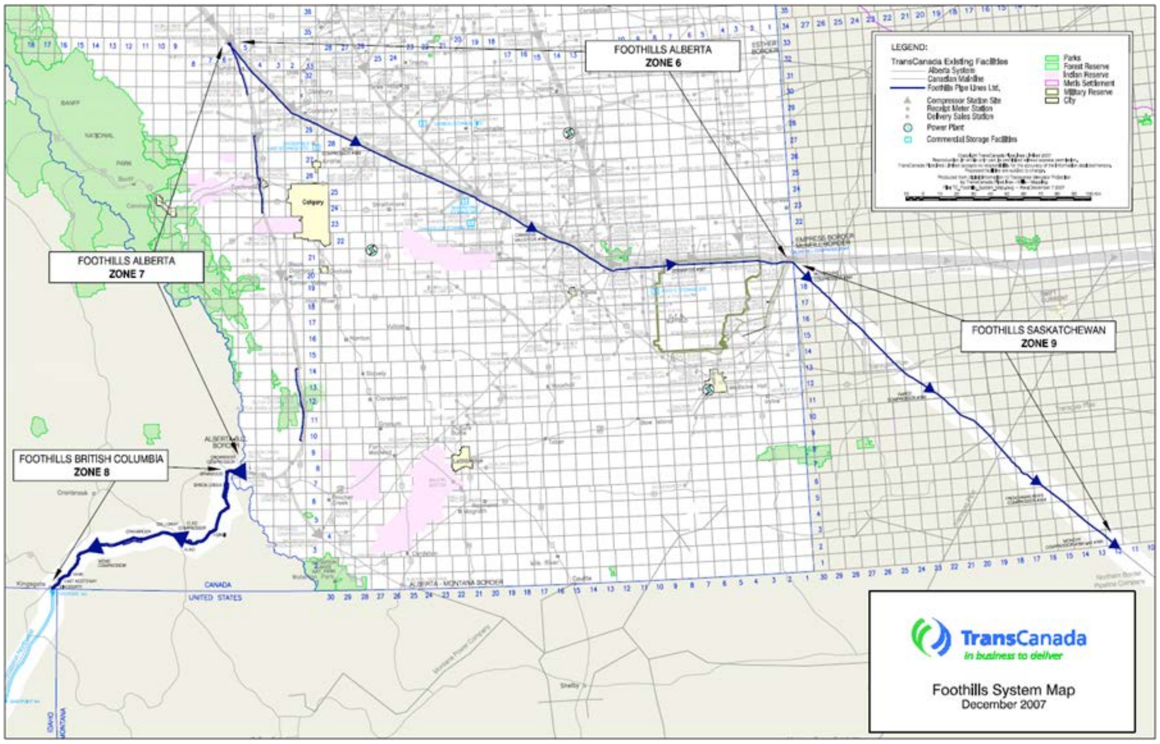


Figure 12-6: Map – GTN System Map

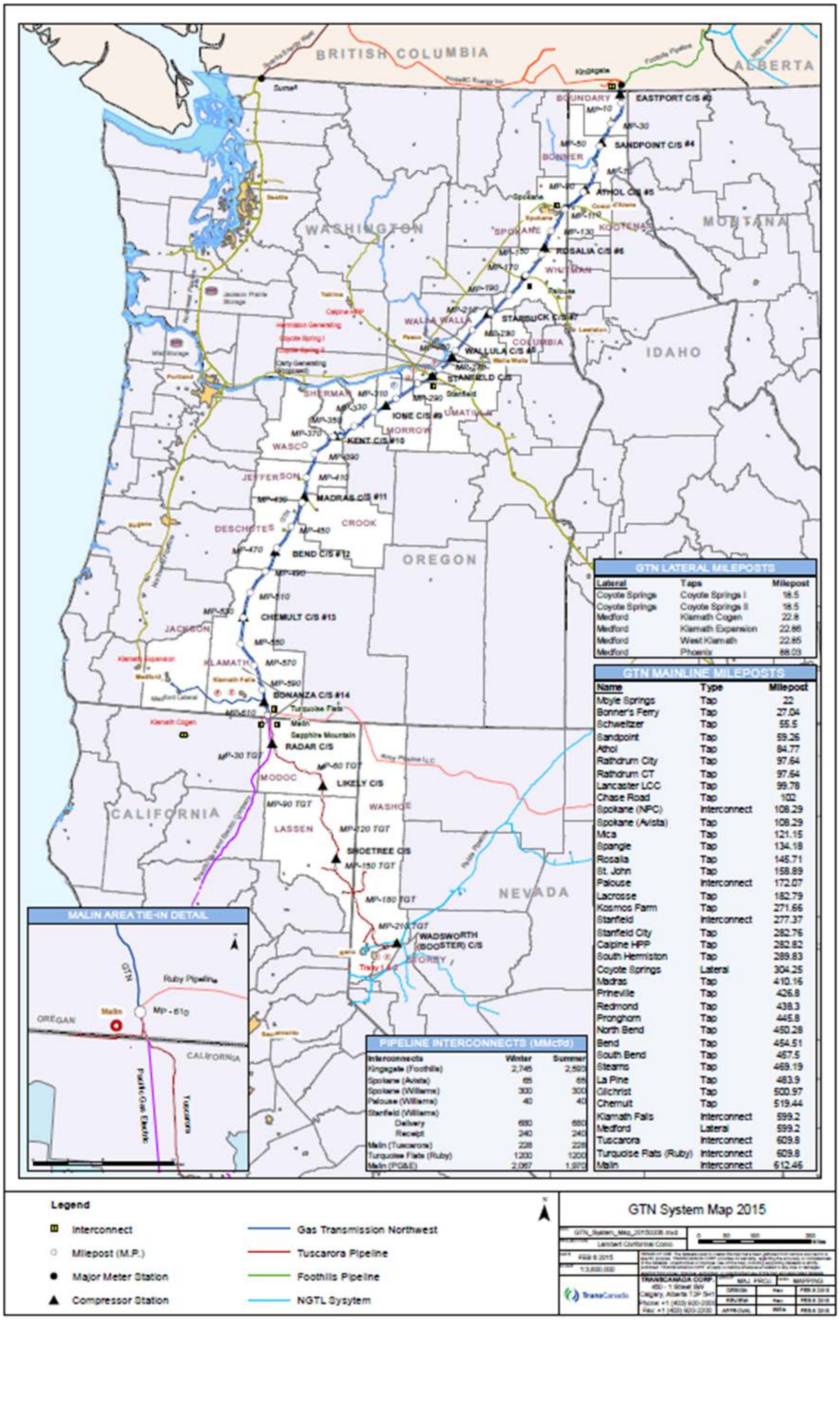
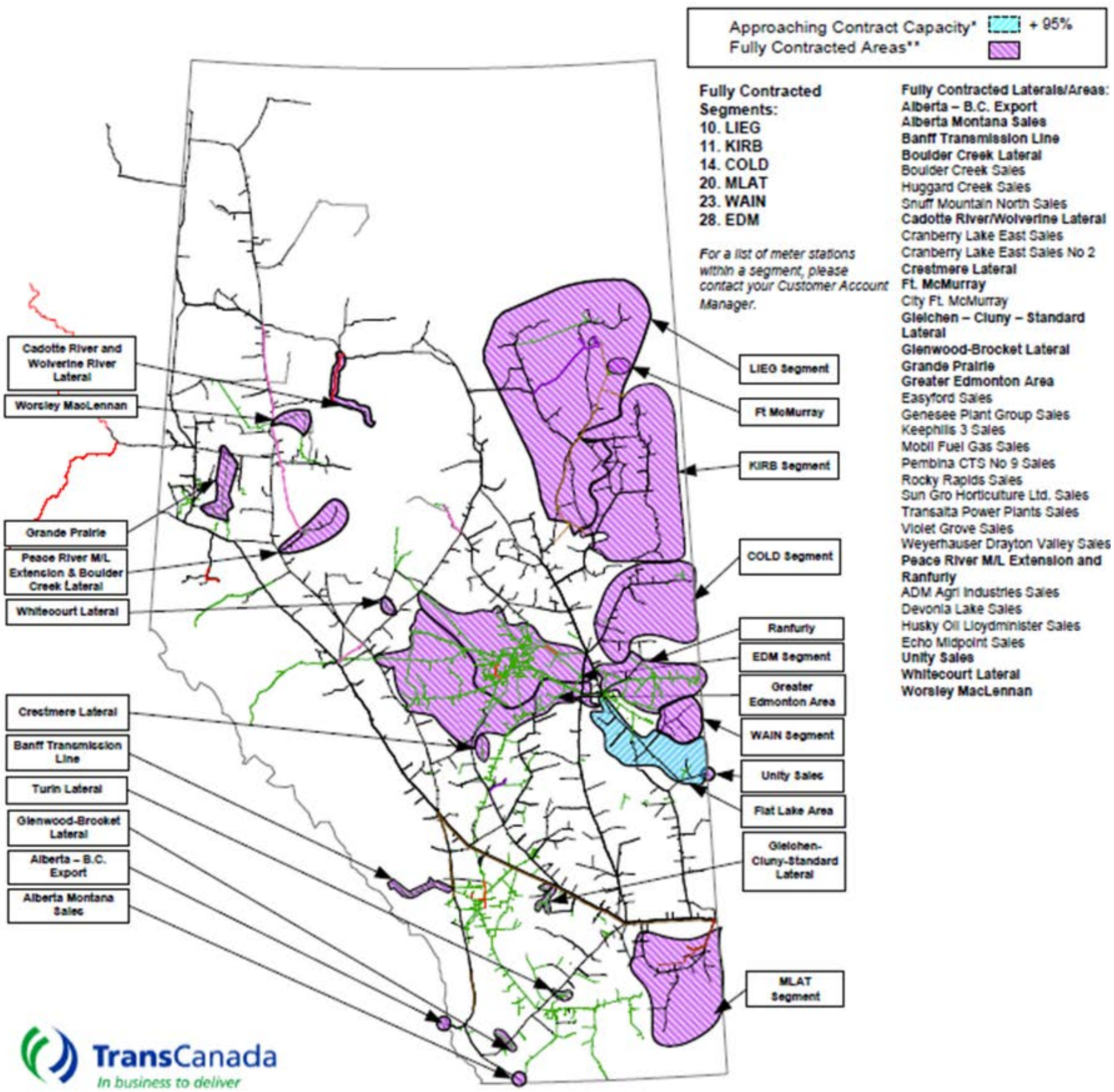


Figure 12-7: Map – NGTL Delivery System Map

TransCanada's NGTL System FT-D Availability Map
as of September 9, 2016

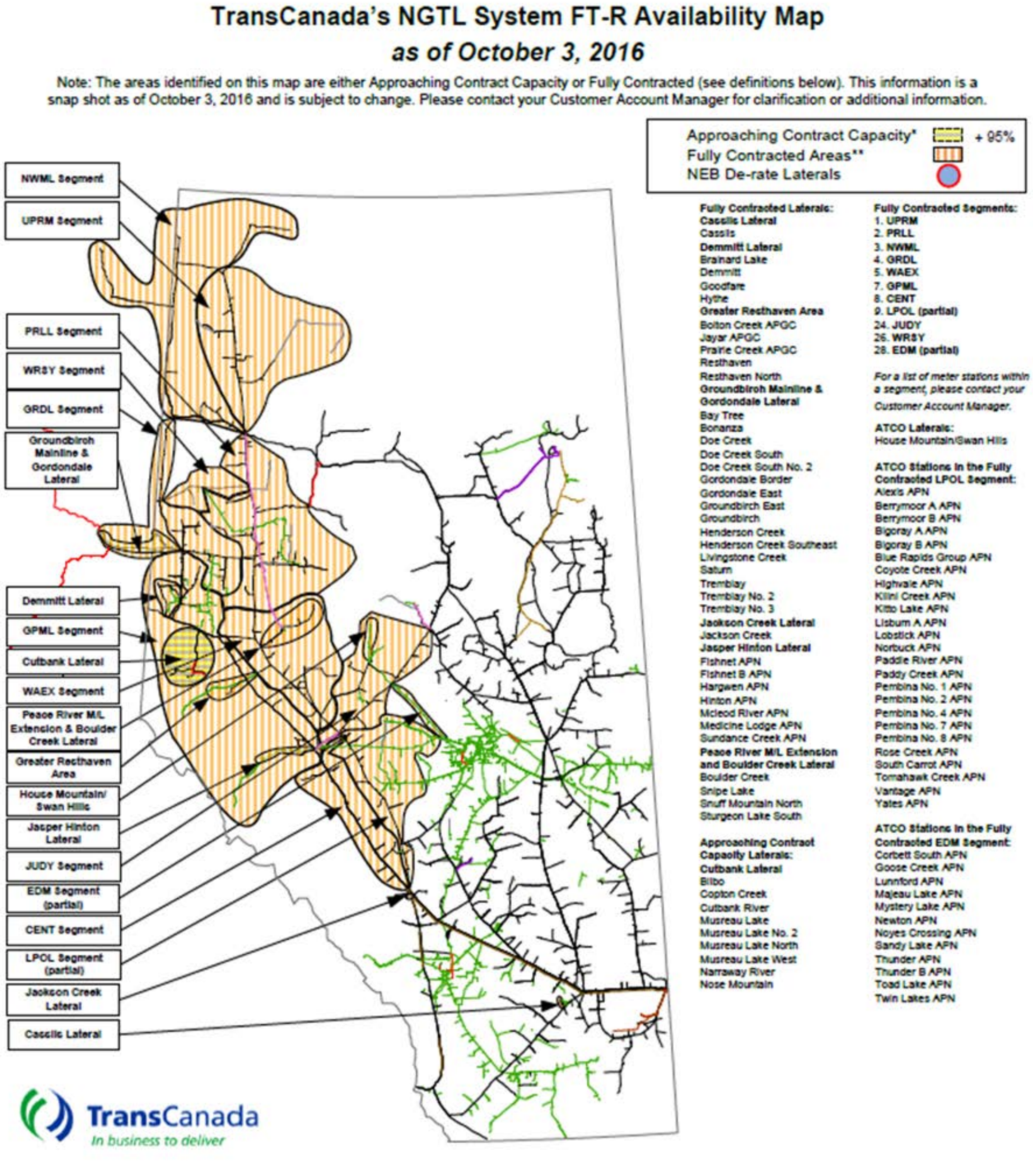
Note: The areas identified on this map are either Approaching Contract Capacity or Fully Contracted (see definitions below). This information is a snap shot as of September 9, 2016 and is subject to change. Please contact your Customer Account Manager for clarification or additional information.



Approaching Contract Capacity*	Contracts are greater than 95% of the area or facility capability. It is recommended that Firm Transfers or New Firm Contracts be confirmed with TCPL Customer Sales.
Fully Contracted**	Area is fully contracted. Firm Transfers allowed within restricted area; upstream at 1 to 1 ratio and downstream at determined hydraulic equivalence. New requests for Firm Transportation service will be held pending availability of Area capacity. For additional information refer to the Informational Postings on Customer Express, Delivery Capacity Update – **September 9, 2016.**

Capacity within any portion of the NGTL System can become fully contracted at any time and without prior notice. NGTL encourages customers to review their FT-D requirements to ensure that their FT-D levels align with their expected flow requirements.

Figure 12-8: Map – NGTL Receipt System Map



Approaching Contract Capacity*	Contracts are greater than 95% of the area or facility capability. Firm Transfers or New Firm to be confirmed with TCPL Customer Sales.
FTR Fully Contracted**	Area is fully contracted. Firm Receipt Transfers allowed within restricted area; downstream at 1 to 1 ratio and upstream at determined hydraulic equivalence. Non-renewable firm service (FT-RN) may be available. For additional information refer to the Informational Postings on Customer Express, Project Area Receipt Capacity Update – **July 27, 2016.**
Capacity within any portion of the NGTL System can become fully contracted at any time and without prior notice. NGTL encourages customers to review their future FT-R requirements to ensure their FT-R levels align with their expected flow requirements.	

Figure 12-9: Map – NWP North System Map

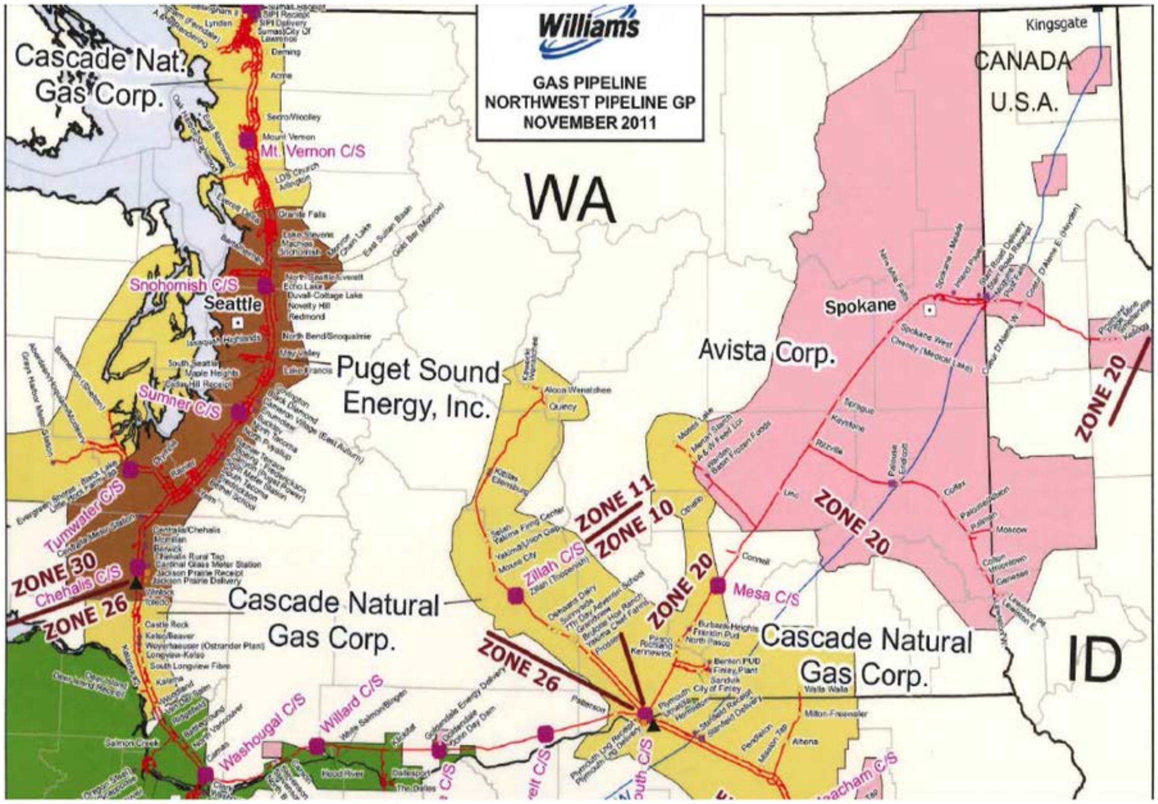


Figure 12-10: Map – NWP South System Map

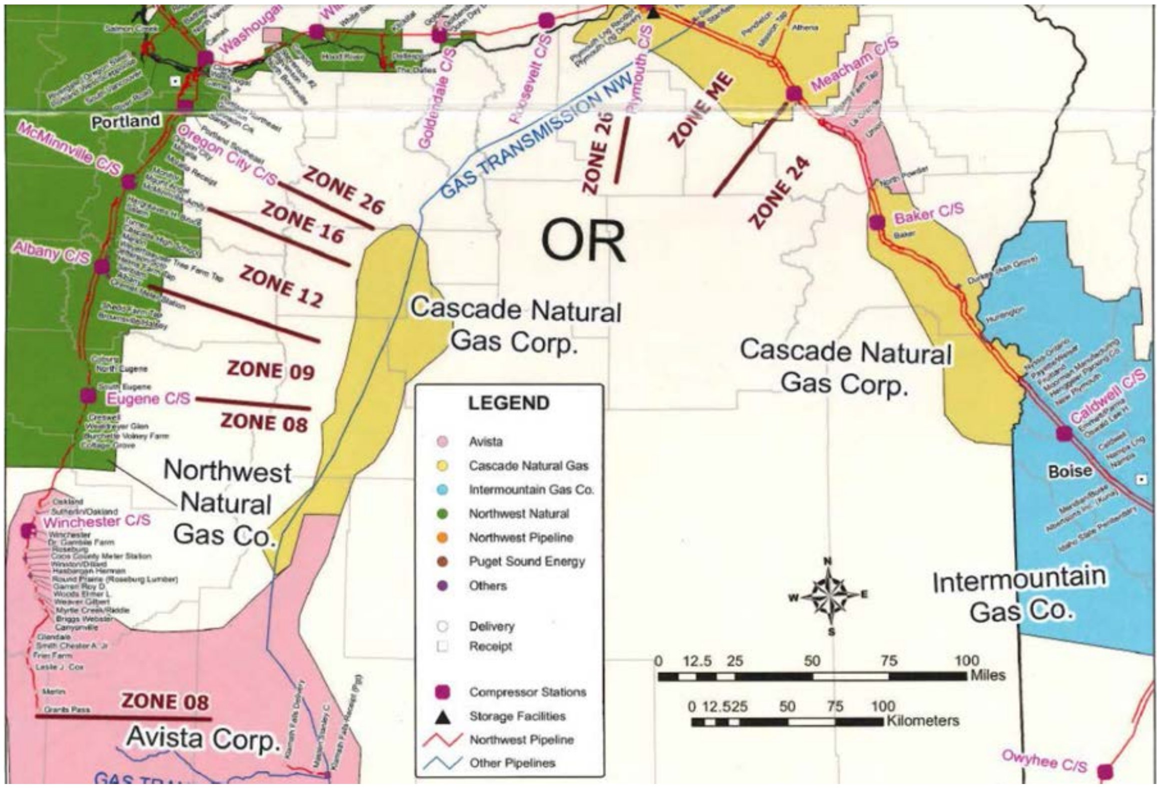


Figure 12-11: Map – Westcoast Sectional Map

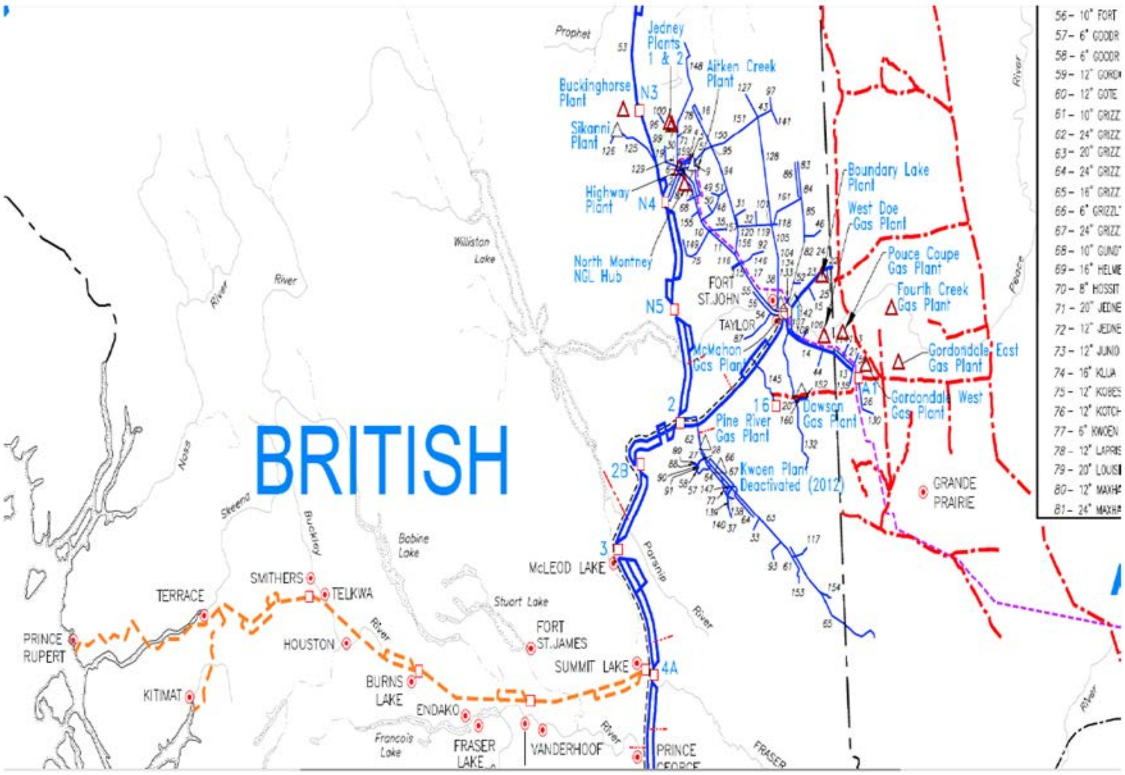


Figure 12-12: Map – Western U.S. and Canadian Pipeline Map

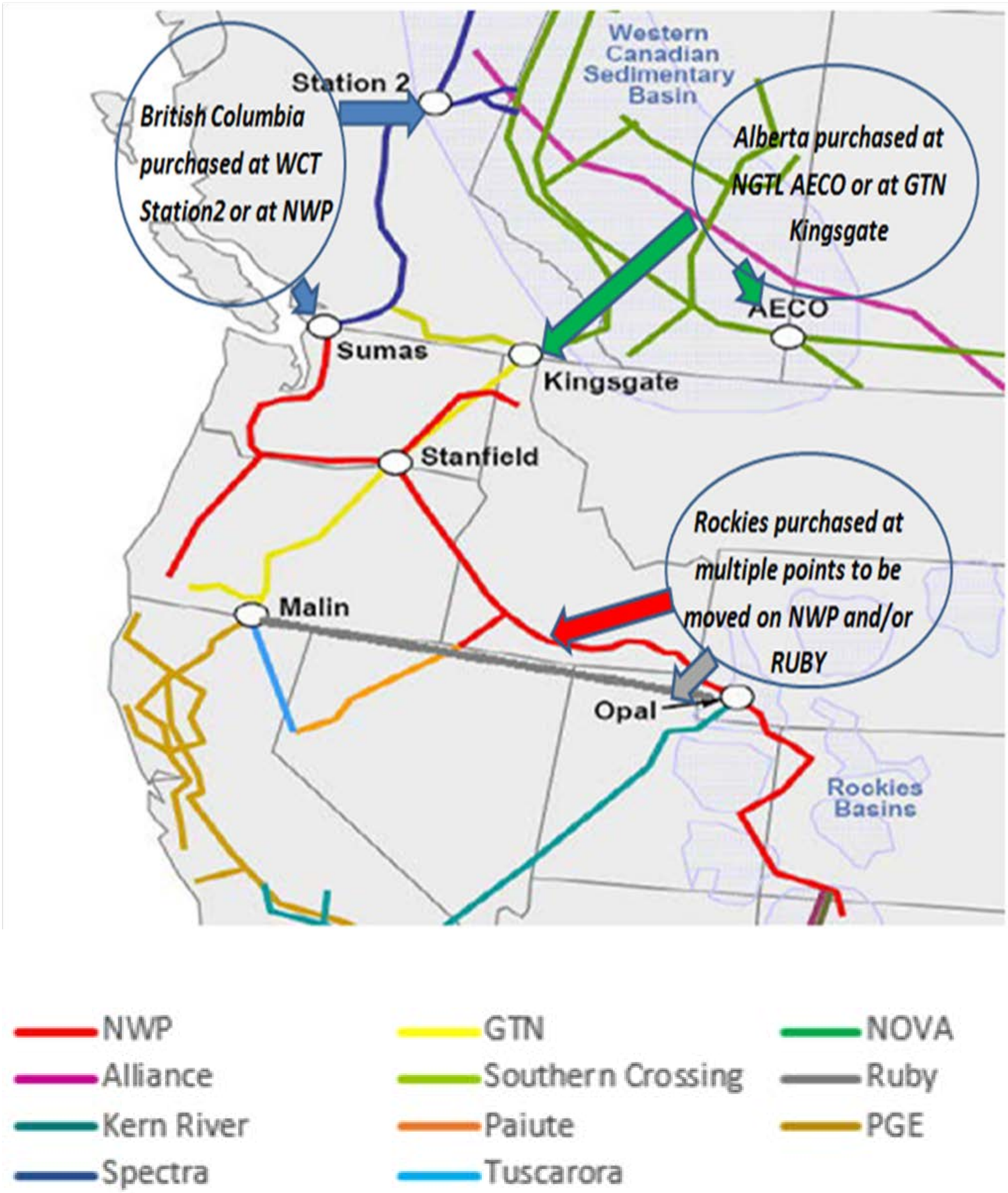


Figure 12-13: Map – Certificated Service Areas as Specified in RCW 80.28.190

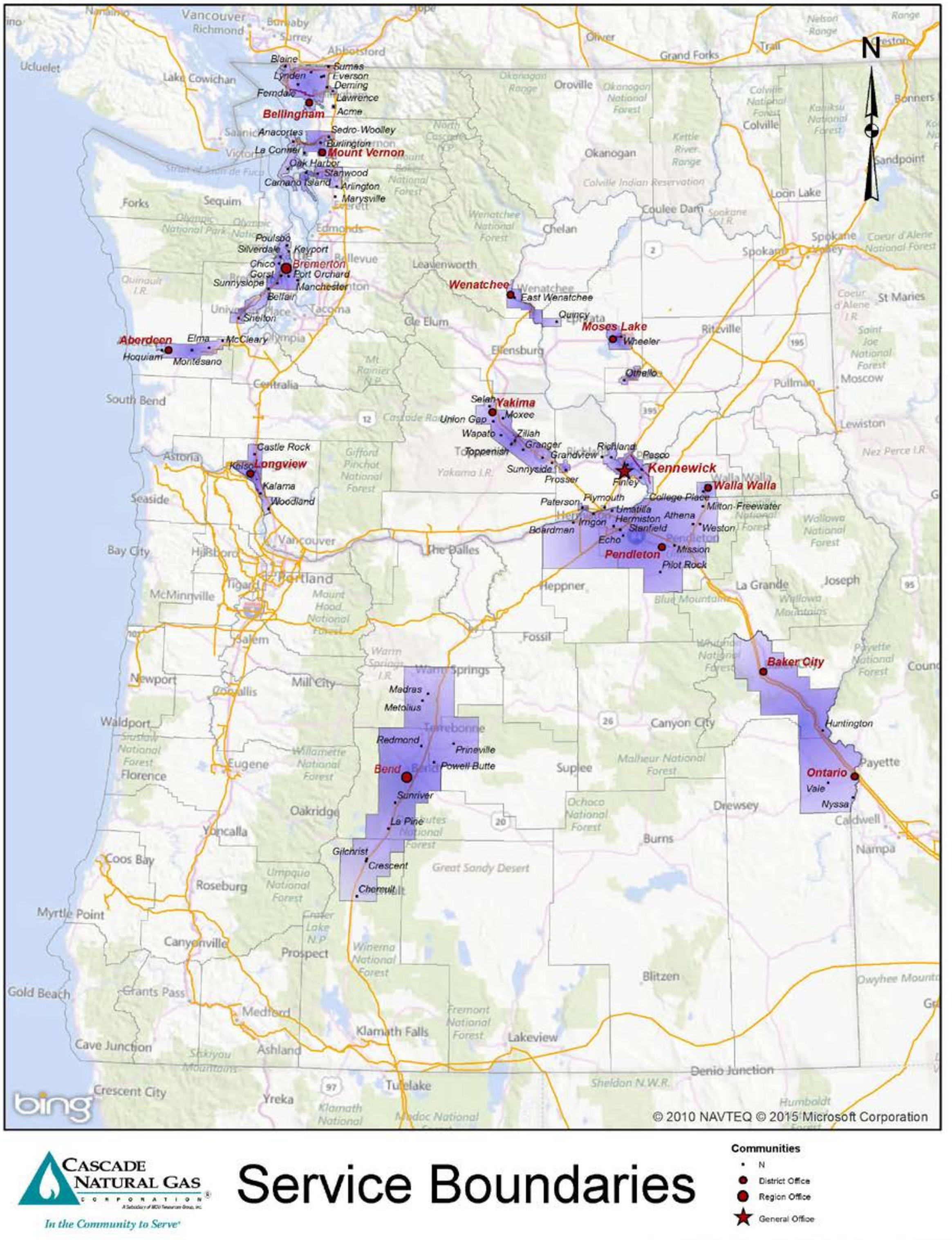


Figure 12-14: Map – Pipeline Transportation Capacity Usage