CASCADE NATURAL GAS CORPORATION

A Subsidiary of MDU Resources Group, Inc.

In the Community to Serve®

2020
Integrated Resource Plan

February 26, 2021

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2020 INTEGRATED RESOURCE PLAN
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Chapter 1

Executive Summary

Introduction

Key Points
- Each chapter provides an *at-a-glance* summary of the key points.
- The Company's two-year action plan provides the road map for future resource and planning activities.
- Load growth is forecasted to average 1.56% per year over the 20-year planning horizon.
- Cascade modeled Social Cost of Carbon as its main carbon forecast.
- The total avoided cost ranges between \$0.79/therm and \$1.09/therm over the 20-year planning horizon.
- Cascade projects 44 million therms of energy efficiency in Washington over the 20-year planning horizon.
- Cascade does not anticipate any material deficiency in the 2020 IRP.
- 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.

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. Planning 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 2021 through 2040. While the Plan cannot predict the future, it is a useful guide. The following information is a progress report and a short summary of each chapter included in this IRP. The details regarding methodologies as well as specific results are found in the chapters and appendices.

Progress Report

As part of the 2018 IRP acknowledgement letter, Washington Utilities and Transportation Commission (WUTC or Staff) Staff made several suggestions on areas where Cascade could improve the IRP. The comments were regarded to validation of methods, greenhouse gas emissions modeling, modeling of significant emergency events, clarify distribution system planning priorities, continue to monitor renewable natural gas opportunities, and public participation. The progress from these recommendations are below:

Cascade has included a cross-validation section to Chapter 3, Demand Forecast. The cross-validation allows Cascade to review how well the forecast does when utilizing actual weather and customer data, rather than normal weather and forecasted customers.

Cascade has included the Social Cost of Carbon (SCC) with a 2.5% discount rate in Cascade's expected case. Cascade also included upstream emissions as part of the avoided cost calculation. The upstream emissions calculation can be found in Chapter 6, Environmental Policy. Cascade shows how the upstream emissions calculation is factored into the avoided cost in Chapter 5, Avoided Cost.

As mentioned in the 2018 IRP Acknowledgement letter, WUTC states "In its Plan, Cascade modeled several scenarios that limited supply from its various resources (including British Columbia) throughout the 20-year planning horizon." Cascade added narrative to Chapter 10, Resource Integration to further discuss these types of extreme scenarios.

Cascade's engineering group has made great strides in providing detailed justification for each distribution system plan that the company is seeking acknowledgement on. Those distribution system plans can be found in Appendix I.

The Company has continued to monitor renewable natural gas opportunities. The Company has expanded the IRP by included a brand new Renewable Natural Gas chapter. Chapter 9, Renewable Natural Gas (RNG) outlines how Cascade is monitoring and evaluating RNG opportunities.

Prior to the COVID-19 pandemic, Cascade had scheduled one TAG meeting in the city of Bellingham. Bellingham holds the largest number of customers in one city for Cascade's Washington service territory. The purpose of holding the TAG meeting in Bellingham was to increase public participation in the meeting. Unfortunately, due to the COVID-19 pandemic, all IRP meetings were held virtually. Public participation is extremely important for the IRP process and Cascade will continue to reach out to all interested parties in future IRP cycles.

Chapter 2: Company Overview

Cascade has been providing natural 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 299,000 customers located in smaller, mostly rural communities spread across Oregon and Washington. 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.

Chapter 3: Demand Forecast

Forecasting demand is useful for both long- and short-term planning. The Company initiated 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 temperature and wind.

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

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.

Load growth across Cascade's system through 2040 is expected to fluctuate between 0.92% and 2.19% 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 1.50% and 1.23%, respectively, while industrial expects a growth rate of around 1.58%.

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 grow annually at an average of 5.4 million therms. Residential customers are expected to grow from 52.5% of the total core load to 53.5% of the total core load by 2040.

Load across Cascade's two-state service territory is expected to increase 1.56% annually over the planning horizon, with the Oregon portion outpacing Washington at 1.83% versus 1.24%.

Chapter 4: Supply Side Resources

Chapter 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 underground and Plymouth Liquified Natural Gas (LNG) 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 underground storage and the Plymouth LNG facility are located directly on NWP's transmission system. In addition, Cascade has leased Mist storage from NW Natural. The Mist facility is located in Columbia County, near Mist, Oregon. Mist has a direct connection to NWP for withdrawals and injections. 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 Nova 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.

Besides currently used resources, Cascade considered alternative resources. Other potential incremental capacity options evaluated included: 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, and Southern Crossing. Other storage options considered were: AECO, Gill Ranch Storage, Mist, Spire Storage (formerly Ryckman Creek Storage), and Wild Goose Storage.

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

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 Energy Regulator (CER) 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 Hedge Execution Plan (HEP), approved by the Gas Supply Oversight Committee (GSOC), provides oversight and guidance for the Company's gas supply hedging strategy.

Chapter 5: Avoided Cost

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, upstream emissions, 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 compliance cost forecast was added in anticipation of carbon legislation. Currently, Cascade models the market driven costs to start at $78.13/metric ton CO_2e in 2021 and rising to $104.18/metric ton CO_2e in 2040. Cascade's use of this forecast does not indicate a preference towards this carbon future in Washington, but rather signifies what the Company believes is the most probable form of carbon legislation in the state.

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

For the 2020 IRP, the nominal system avoided costs ranges between $0.79/therm and $1.09/therm over the 20-year planning horizon. The increase over time is largely driven by the escalating cost of carbon.

Chapter 6: Environmental Policy

This chapter considers Greenhouse Gas (GHG) emission reduction policies and regulations that have the potential to impact natural gas distribution companies. In addition, this chapter 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. For this IRP, as suggested by WUTC and outlined in Docket U-190730, Cascade is applying the SCC with a two and one-half percent discount rate as the main CO_2 adder in modeling.

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

Cascade 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 November 17, 2020, 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 chapter 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.

Chapter 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 57 million therms systemwide over the 20-year planning horizon; 45 million therms in Washington and 12 million therms in Oregon.

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.

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 (ETO) with program planning developed through the Cascade Oregon IRP cycle.

Chapter 8: Renewable Natural Gas

Renewable Natural Gas has been introduced as its own chapter for the first time in this 2020 IRP. With there being a strong desire to mitigate the carbon footprint of the natural gas industry, the amount of information covered on RNG warranted a separate chapter. Cascade has been involved and committed to developing programs that follow RNG guidelines and rules stated in HB 1257 and SB 98.

The Company has met with several individuals and companies within the RNG industry such as producers, municipals, wastewater treatment plants, biodigesters, and landfills. Currently, none of the projects have a timeline to implement putting

RNG on the system in the near future.

Cascade has developed a potential RNG cost effectiveness methodology. Cascade is also utilizing SENDOUT® as another tool for analyzing RNG. Cascade will continue to monitor RNG guidelines and rules and incorporate any necessary changes to these models.

Chapter 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 optimal solution is determined, projects are ranked based on numerous criteria and are scheduled. Chapter 9, Distribution System Planning, presents a summary of costs by district and Appendix I lists all known distribution projects.

Chapter 10: 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, RNG, 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.

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. If DSM does not resolve all shortfalls, 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, 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.

The top-ranked candidate portfolio includes all existing resources, consideration of incremental NOVA transportation and Spire Storage, plus incremental DSM. A more detailed discussion regarding the Company's resource integration and the results can be found in Chapter 10, Resource Integration.

Chapter 11: 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. Due to travel and social distancing restrictions as a result of the COVID-19 pandemic, all meetings were held virtually using Microsoft Teams. Participants invited to these public meetings include interested customers, regional upstream pipelines, Pacific Northwest Local Distribution Companies, Commission Staff, stakeholder representatives such as the Northwest Gas Association, Public Counsel, Citizens' Utility Board, Washington Department of Ecology, Northwest Energy Coalition, 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.

Chapter 12: Two-Year Action Plan

Figure 1-1 on the following page shows Cascade's Two-Year Action Plan. Further descriptions can be found in Chapter 12, Two-Year Action Plan.

Figure 1-1: Highlights of 2020 Action Plan

Functional Area	Anticipated Action	Timing
Resource Planning	Cascade will: • Attend other regional LDC IRP meetings; • Work with NWP on realigning MDDOs; • Develop modeling scenarios that represent pipeline OFOs; • Improve the alignment of resource/costs between the PGA and the IRP; • Develop more scenarios that address changing Canadian Markets; • Develop scenarios that consider sensitivities around municipal natural gas bans or other deep decarbonization possibilities in Cascades service territory; • Add RNG as a candidate portfolio; and • Investigate the cost and feasibility of a potential hydrogen plant as an alternative resource.	Ongoing, for inclusion in 2022 IRP.
Avoided Cost	Cascade will: • Model sensitivity analysis regarding upstream emissions.	Ongoing, for inclusion in 2022 IRP.
Demand	Cascade will: • Add wind in the stochastic weather analysis; • Investigate climate change modeling scenarios; and • Develop, in collaboration with Staff and stakeholders, a new methodology for peak day. • Discuss, for the 2022 IRP, any potential impacts the COVID-19 crisis may have on demand.	Ongoing, for inclusion in 2022 IRP.
Environmental Policy	The Company will execute the Environmental Policy action items as described on page 12-3 and 12-4.	Ongoing, for inclusion in 2022 IRP.
DSM (Energy Efficiency)	The Company will execute the Demand Side Management action items as described on page 12-4.	Ongoing, for inclusion in 2022 IRP.
Renewable Natural Gas	Cascade will: • Continue to develop and update the cost-effective evaluation tool. • Continue to hold discussions with potential RNG partners. • Develop necessary internal protocols to offer RNG services to customers. • Develop a voluntary RNG program under RCW 80.28.390.	Ongoing, for inclusion in 2022 IRP.
Distribution System Planning	Cascade will: • Implement various stages or review of the of the list of projects that require an increase in capacity as shown in Appendix I. • Construct citygate upgrades, over the next several years, in Aberdeen, Kennewick, and Longview. • Focus on projects to include pipe upgrades as well as increased pipe capacity, while continuing to maintain compliance with Maximum Allowable Operation Pressure regulations.	Ongoing over the next four to five years.

Chapter 2

Company Overview

Company Overview

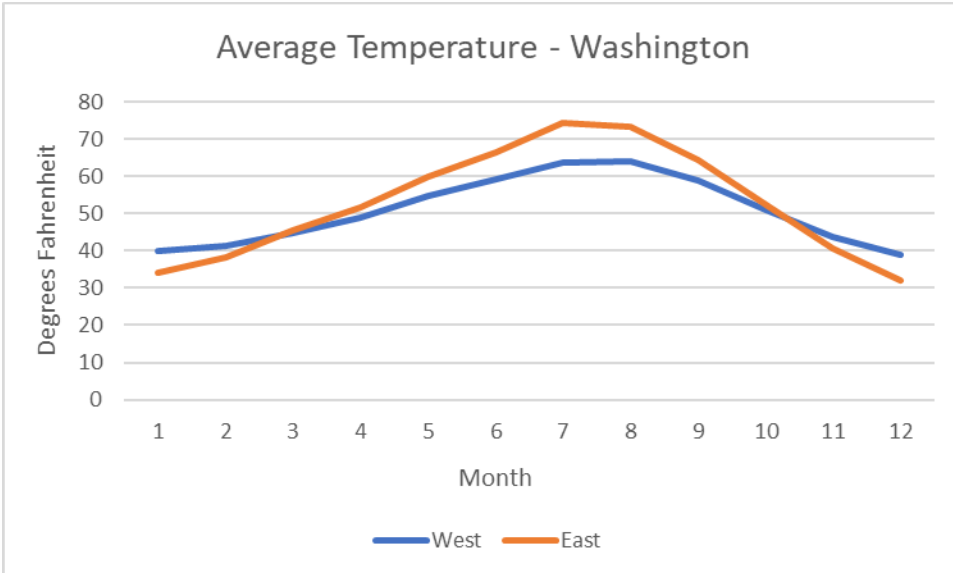
> **Key Points**
> - Cascade serves diverse geographical territories across Washington and Oregon.
> - Cascade's primary pipelines are NWP, GTN, and Enbridge, also known as WCT, with access to three other pipelines.
> - Core customers represent 25% of total throughput, while non-core customers represent 75% of total throughput.
> - Cascade is a subsidiary of MDU Resources Group, Inc. based in Bismarck, North Dakota.

Cascade Natural Gas Corporation (CNGC or Cascade or Company) has a rich history that began 68 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 natural gas 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 299,000 customers with approximately 77,000 customers in Oregon and 222,000 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 Cascade's 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. Figure 2-1 compares the average temperatures by month of the two regions. Oregon's service territory is in rural areas throughout northern central and central Oregon as well as eastern Oregon. All regions of Oregon have semi-arid climates with periods of arctic cold in the winter and heat waves in the summer.

Figure 2-1: Average Temperature by Region

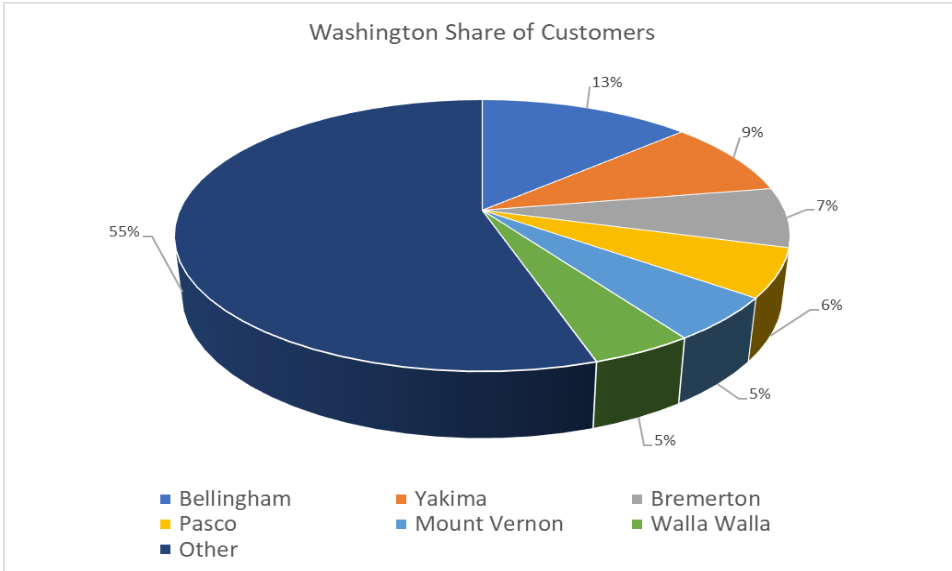


Below are some of the more populated towns within the regions Cascade provides distribution service:

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

Figure 2-2 shows a breakdown of Cascade's Washington customer density by town. A map of Cascade's certificated service territory is provided as Figure 13-13 in Chapter 13, Glossary and Maps.

Figure 2-2: Customer Density by Town in Washington



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 (FHBC), NOVA Gas Transmission Ltd. (also known as NGTL), and Ruby Pipeline. More information about the pipelines and the supply basins is provided in Chapter 4, Supply Side Resources. Maps of select pipelines are found in Chapter 13, Glossary and Maps.

Core vs Non-Core Service

Cascade offers core service, which is the procurement of gas supply from an upstream basin, such as Sumas or AECO, that is then transported to Cascade's citygates. From the citygate, Cascade then delivers gas on 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.[1] These customers, referred to as large volume transportation or non-core customers, procure their own supply and transportation through third parties such as marketers. Cascade is only responsible for the distribution of non-core gas supply from the upstream pipeline citygate to the point of delivery at the customer's site. The Company currently has approximately 247 large volume customers who have elected this type of 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). However, non-core demand is a consideration in distribution planning. While it is not the core substance of the IRP, it is included in Chapter 9, Distribution System Planning.

In 2020, Cascade's residential customers represent approximately 13% of the total natural gas delivered on Cascade's system, while commercial customers represent roughly 10%, and the core industrial customers account for around 2% of total gas throughput. The remaining non-core industrial customers represent the balance of the 75% 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 43 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, when combined, 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 2-3 provides a geographical representation of the various services/territories served by MDU Resources. Figure 2-4 shows the MDU Resources Electric and Natural Gas Services and Territory.

[1] *See* Natural Gas Wellhead Decontrol Act of 1989 amends the Natural Gas Policy Act of 1978 to declare that the price guidelines for the first sale of natural gas do not apply to: (1) expired, terminated, or post-enactment contracts executed after the date of enactment of this Act; and (2) certain renegotiated contracts. Decontrols as of May 15, 1991, natural gas produced from newly spudded wells. Repeals permanently wellhead price controls beginning on January 1, 1993.

Figure 2-3: MDU Resources Services and Territory

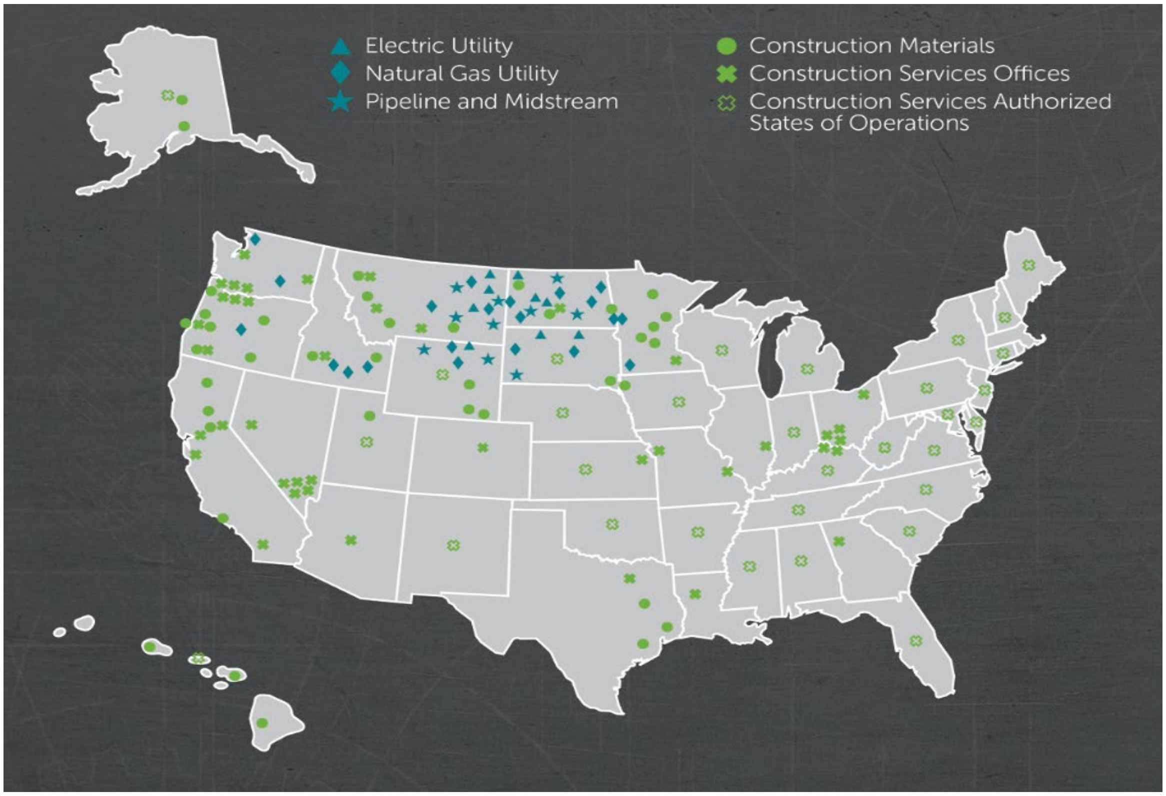
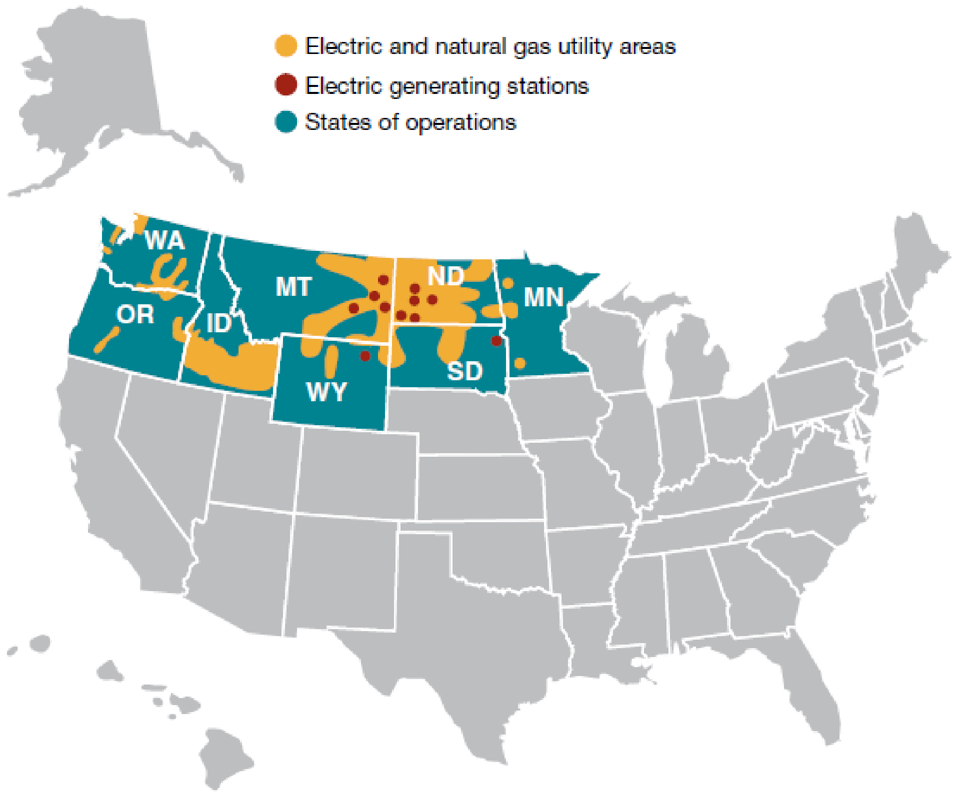


Figure 2-4: MDU Resources Electric and Natural Gas Services and Territory



Chapter 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. Sources of this forecast include historic data, market intelligence, and regional economic data from Woods & Poole. This forecast is a robust portfolio of estimates created by expanding a single best-estimate forecast, which includes various potential economic, demographic, and marketplace eventualities, into scenarios such as low, expected, and high growth. 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 energy efficiency resources, revenue budgeting, and load forecasts associated with the purchased gas cost process.

Key Points

- Cascade initiates its forecast with analyses of demand area, HDDs, and wind.
- 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 are included and alternative forecasting assumptions were considered.
- Cascade expects system load growth to average 1.56% per year over the 20-year planning horizon.
- For methodological changes from previous IRPs, please refer to Appendix K.
- Uncertainties in the future, such as economic and long-term weather conditions, as well as future legislation, may cause differences from the Company's forecast.

Demand Areas

For the 2021-2040 planning horizon, Cascade continued to forecast at both the citygate and rate class levels. Cascade has a total of 76 citygates of which nine citygates feed only 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 200 individual dynamic regression models. Each citygate is assigned to a weather location. For this IRP, the Company assigned the citygates to the closest weather location by distance. 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. Figure 3-1 provides a cross reference for the demand areas.

Figure 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		OR	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. Historically, Cascade has accessed data from NOAA (National Oceanic and Atmospheric Administration), but found many months/locations with missing data. 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 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.[1]

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 upstream pipeline 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

[1] The historical threshold for calculating HDD has been 65 °F. However, as discussed in prior IRPs, Cascade has determined that lowering the threshold to 60 °F produces more accurate results for the Company's service area.

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 is actively expanding its peak day methodology to include stochastic elements such as Monte Carlo analysis. Cascade is also considering different historical weather windows to better understand the effects of climate change on Cascade's service territory, which will be further expanded in the next IRP cycle. More on this peak day analysis can be found on page 3-10. Cascade will also continue to investigate how various peak day standards affect 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.

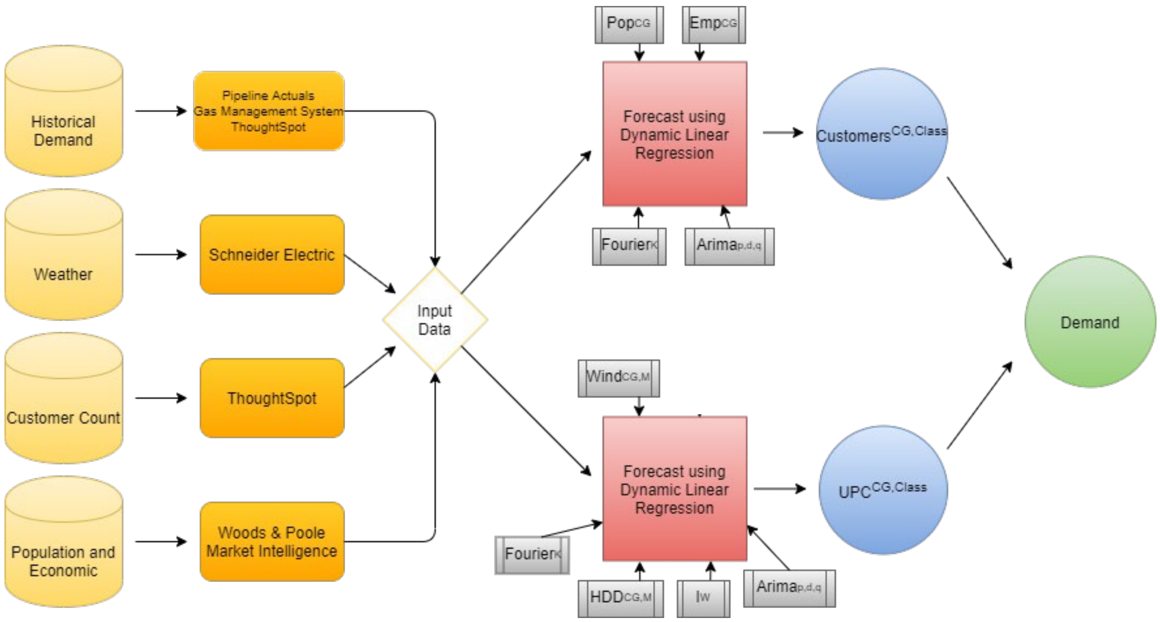
Wind

Wind values are calculated with the daily average wind speed, which is the simple average of the high and low wind speeds for a given day. Wind speeds are also weather location specific, similar to HDDs.

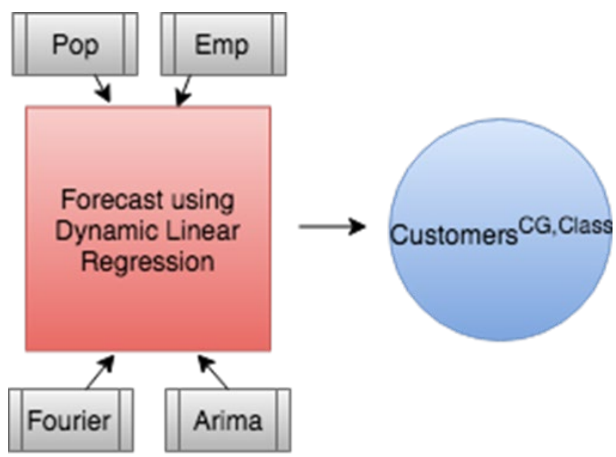
Demand Overview

Figure 3-4 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 3-4: Demand Forecasting Process Overview



Customer Forecast Methodology



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). Since the first quarter of 2020, Cascade has and will continue to monitor the COVID-19 impacts. Since Cascade relies on W&P for population and employment growth data, the Company is providing an update from W&P about the impacts of COVID-19 on those projections. W&P states "Despite significant 2020 impacts, COVID -19 itself does not appear to have made a quantifiable long-term economic impact that would affect forecasts: productive land area in the U.S. is still usable, productive capital (i.e. factories) are still in place, and the size of labor force has not been reduced significantly."[2] 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

[2] Woods & Poole's 2020 State Profile: State and County Projections to 2020

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 subchapter. 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 approximately 200 times to account for each customer class by citygate. 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 customer class by citygate, a forecast is performed using the selected model.

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 annual population growth of 0.852% between 2021 and 2040 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.

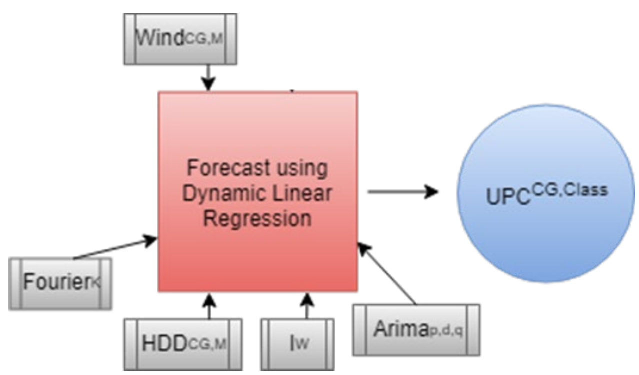
Cascade locked in the forecast model on June 10, 2020 as it is a key input for several other aspects of this IRP.

Among other reasons, the Company believes that high projected growth in the following regions is supported by the provided quantitative analysis:

- Burbank Heights Loop is expected to see a year over year average growth of 1.89%. This loop consists of the Pasco, North Pasco, and Burbank Heights citygates. These are located in southeastern Washington. Pasco sits in one of the fastest growing counties in the state, Franklin County. Future job growth is optimistic.[3]
- Kennewick Loop is expected to see a year over year average growth of 1.84%. This loop consists of the Richland Y, Kennewick, and Southridge citygates. These are located in southeastern Washington. Many new developments are a direct result of high population growth rates and optimistic job outlooks.[4]
- Longview South Loop is expected to see a year over year average growth of 1.94%. This loop consists of the South Longview and Kelso citygates. Both cities are located in western Washington. Both cities are seeing steady population growth coupled with optimistic job growth estimates.[5]

According to Tri-cities Business News and Washington's Office of Financial Management, the primary driver behind Washington's population growth is migration with net migration accounting for 76% of the population growth. The remaining 24% consisted of natural increases (births minus deaths).[6]

Use-Per-Customer 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 billing system data from ThoughtSpot. 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

[3] *See* According to bestplaces.net, worldpopulationreview.com, and city-data.com
[4] *See* According to bestplaces.net, worldpopulationreview.com, and city-data.com
[5] *See* According to bestplaces.net, worldpopulationreview.com, and city-data.com
[6] *See* https://www.tricitiesbusinessnews.com/2020/07/tri-city-regions-population/

backed out using Cascade's measurement data stored in the Company's Aligne energy transaction system which leaves only the daily core usage data. The daily data is then allocated to a rate schedule for each citygate by using Cascade's ThoughtSpot system, which analyzes the therms billed for each rate class. 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:

$$\frac{Therms}{C^{CG}_{Class}} = \alpha_0 + \alpha_1 HDD^{CG,M} + \alpha_2 I_w + \alpha_3 WIND^{CG,M} + Fourier(k) + ARIMA(p,d,q)$$

Model Notes:

- $C^{CG}_{Class} = Customers\ by\ Citygate\ by\ Class.$
- $HDD^{CG} = Heating\ Degree\ Days\ from\ Weather\ Location$
- $m = month$
- $w = weekend$
- $I = Indicator\ variable, 1\ if\ weekend, and\ 0\ if\ weekday.$
- $WIND^{CG} = Daily\ average\ wind\ speed\ from\ Weather\ Location$
- $Fourier(k) = Captures\ seasonality\ of\ k\ number\ of\ seasons.$
- $ARIMA(p,d,q) = Indicates\ model\ has\ p\ autoregressive\ terms,\ d\ difference\ terms, and\ q\ moving\ average\ terms.$

Cascade runs this model for each of the 55 citygates and citygate loops by customer class where applicable, resulting in approximately 200 models. Cascade starts with the above model for Residential, Commercial, and Industrial customer classes. A change in methodology from previous IRPs involves keeping variables in the model that may appear non-significant on a statistical level but relevant on an economic level. This could be a shoulder month, i.e. September, showing insignificance in a model but economically known to affect the annual load shape of residential customers. Also, Cascade now runs the UPC forecast with Fourier and ARIMA terms.

Peak Day Forecast Methodology

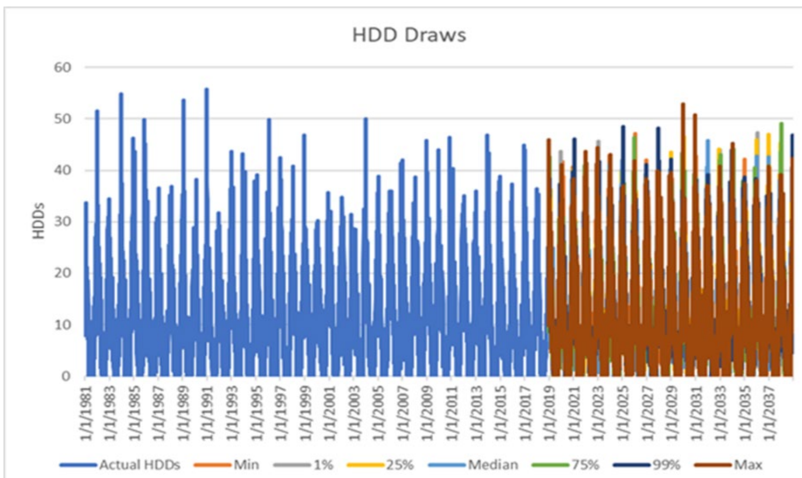
Cascade's methodology for peak day forecasting is similar to its forecast of demand. For a deterministic forecast, Cascade utilizes the same dynamic regressions as before but with a peak day HDD inserted. This peak day HDD comes from the coldest on record in the last 30 years. Once this peak day is inserted 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 Chapter 10, Resource Integration.

In this stochastic analysis, Cascade analyzed many attributes, including the minimum, the maximum, and percentiles such as the 1st, 25th, 75th, and the 99th. The 99th percentile is then used to calculate the Value-at-Risk (VaR) metric to compare with the VaR limits discussed in Chapter 10.

Figure 3-5 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 3-5: 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. Figure 3-6 identifies the list of scenarios.

Figure 3-6: Growth and Weather Scenarios

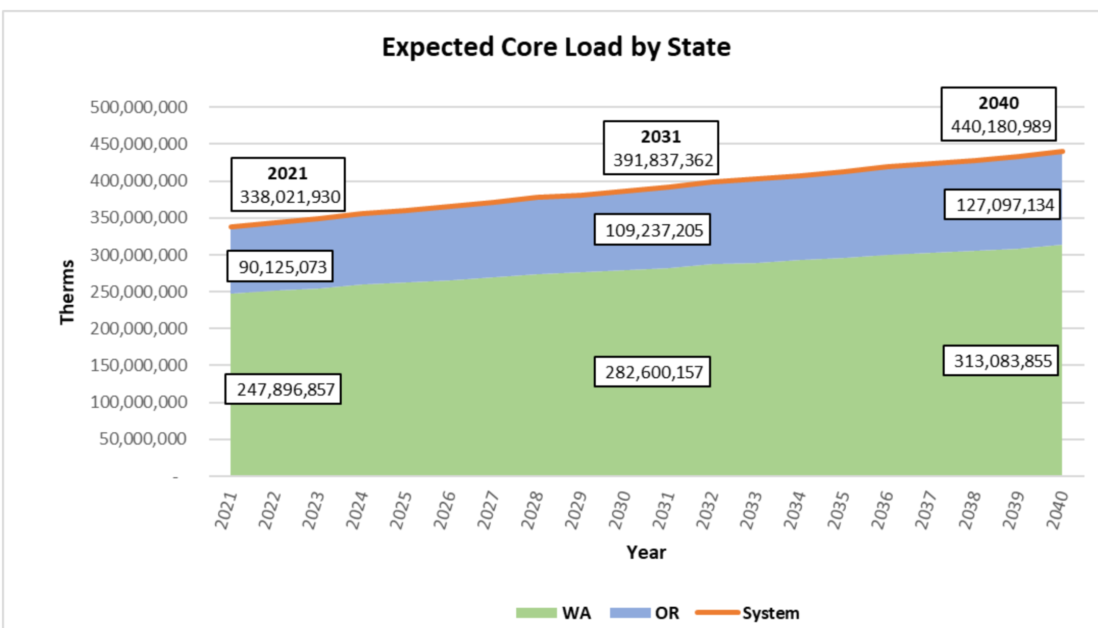
Scenario	Weather	Growth	UPC
Expected Case	Expected	Expected	Expected
Low Growth	Monte Carlo Weather	Low	Expected
High Growth	Monte Carlo Weather	High	Expected

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. Stochastic tests such as weather on demand are only to show how it can impact demand over the 20-year planning horizon. Cascade also performs a deep sensitivity analysis utilizing Monte Carlo runs for other variables such as price. Monte Carlo analysis is discussed further in Chapter 10.

Forecast Results

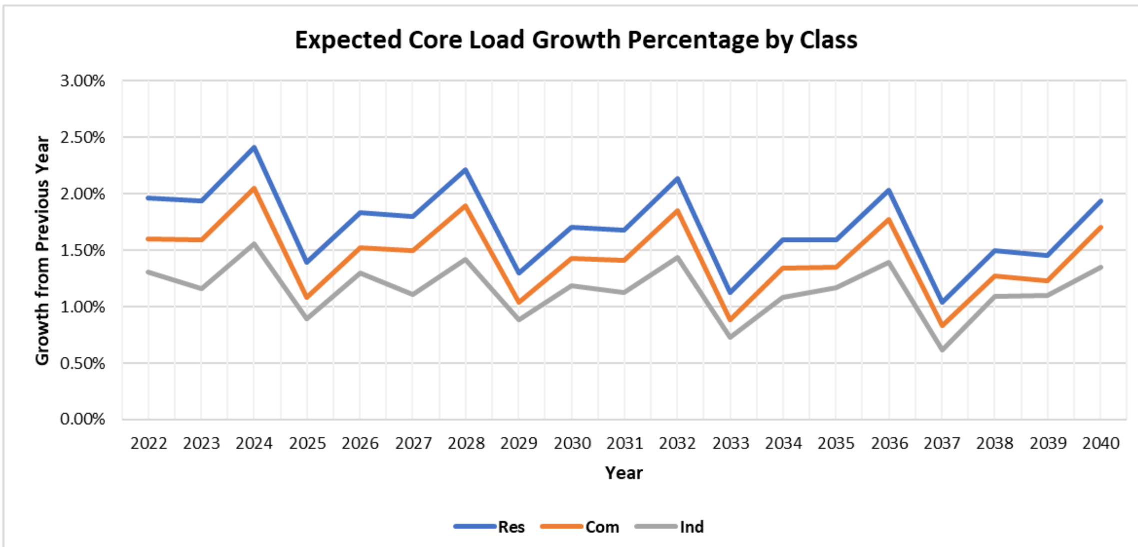
Load across Cascade's two-state service territory is expected to increase at an average annual rate of 1.56% over the planning horizon, with the Oregon portion outpacing Washington, 1.83% versus 1.24%. Figure 3-7 shows the expected core load volumes by state.

Figure 3-7: Expected Core Load by State (Volumes in Therms)



Load growth across Cascade's system through 2040 is expected to fluctuate between 0.92% and 2.19% annually, accounting for leap years. Load growth is split between residential, commercial, and industrial customers. Residential and commercial customer classes are expected to grow annually at an average rate of 1.50% and 1.23%, while industrial expects a growth rate of approximately 1.58%. Figure 3-8 shows the percentage of core growth by class over the planning horizon.

Figure 3-8: Expected Core Load Growth Percentage by Class



In absolute numbers, system load under normal weather conditions is expected to grow annually at an average of 5.4 million therms. 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 52.5% of the total core load to 53.5% of the total core load by 2040. Figure 3-9 compares the total system annual therm usage forecast of this IRP to past IRPs dating back to 2011. Figure 3-10 displays the relative percentage relationship of expected loads by class.

Figure 3-9: System Load Comparison to Previous IRPs

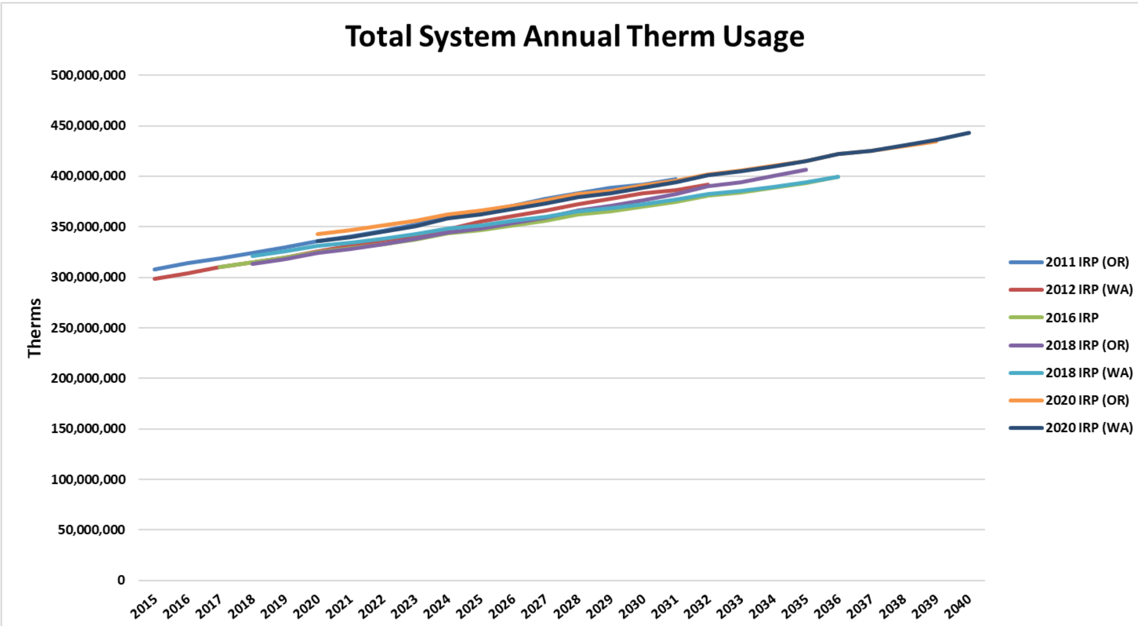
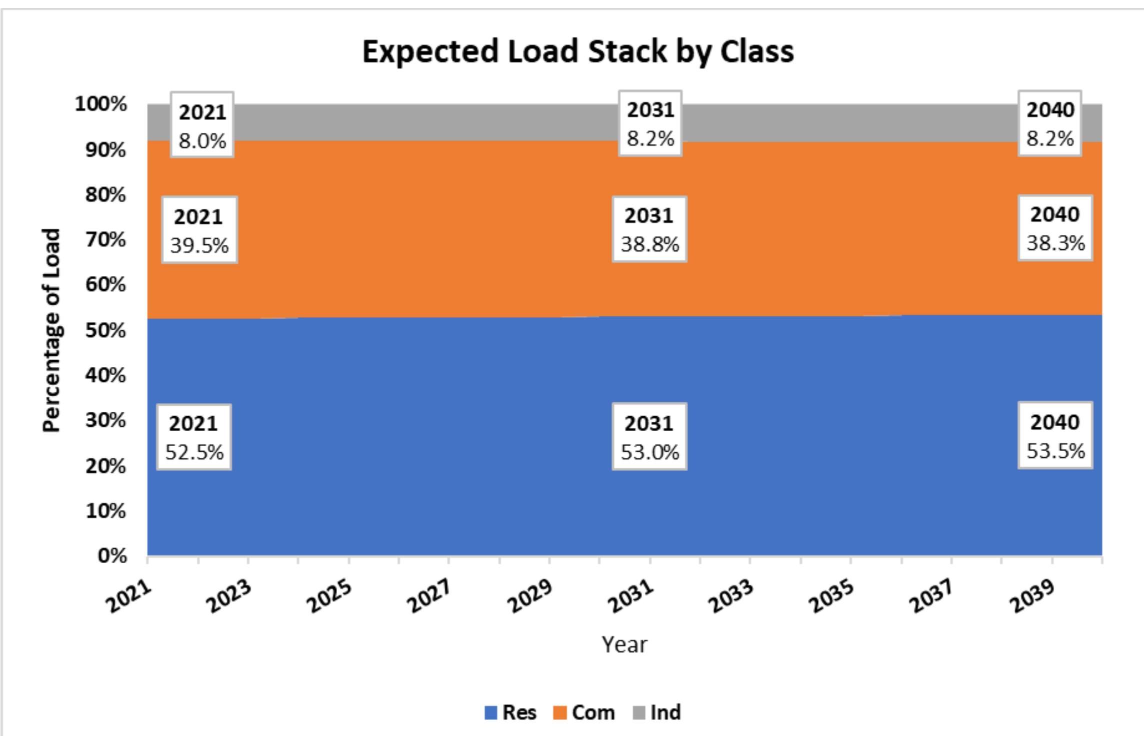
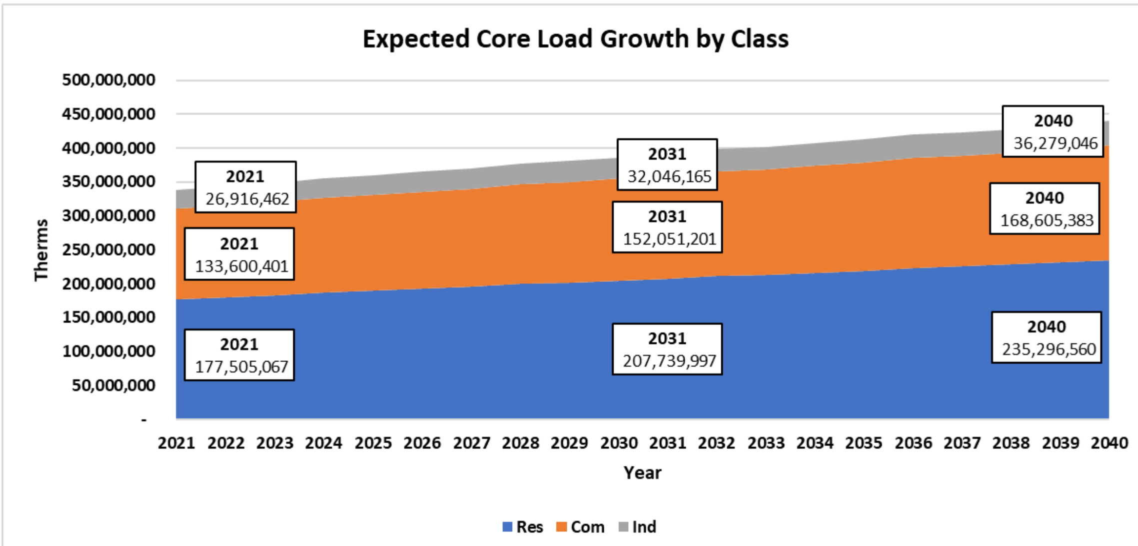


Figure 3-10: Expected Load Stack by Class



Cascade expects residential customers to increase load at an annual average growth of approximately 3 million therms and commercial core customers to increase load at an annual average growth of approximately 1.8 million therms over the 20-year planning horizon. Industrial customers are expected to increase load at an annual average growth of approximately 493,000 therms over the same period. Figure 3-11 displays the expected core load volumes by class.

Figure 3-11: Expected Load Growth by Class (Volumes in Therms)



Load growth is primarily a result of increased customer counts. The number of commercial and industrial customers is expected to increase at a slightly faster rate than therm usage, whereas residential customer growth is similar to the residential load growth. Figure 3-12 displays the expected customer counts by class.

Figure 3-12: Expected Customer Counts by Class

Year	Residential	Commercial	Industrial
2021	267,686	37,703	767
2026	294,189	40,745	839
2031	320,672	43,785	912
2036	347,104	46,811	986
2040	368,209	49,225	1,042
Average Annual Change	**1.69%**	**1.41%**	**1.63%**

Geography

Southeastern Washington is a major driver in the growth rate. This area has multiple citygates serving counties with large increases in growth rates. Figure 3-13 shows the 20-year system load by each of Cascade's pipeline zones. Figure 3-14 shows the average annual percentage growth of load by each pipeline zone over the planning horizon. For a map of the pipeline zones, please refer to Figures 13-9 and 13-10. For a detailed list, Figure 3-1 gives information on each citygate's zone. Lastly, Figure 3-15 displays the expected system core peak day growth over the planning horizon. Peak day average annual growth is expected to be approximately 1.58%.

Figure 3-13: System 20-Year Load by Pipeline Zone (Volumes in Therms)

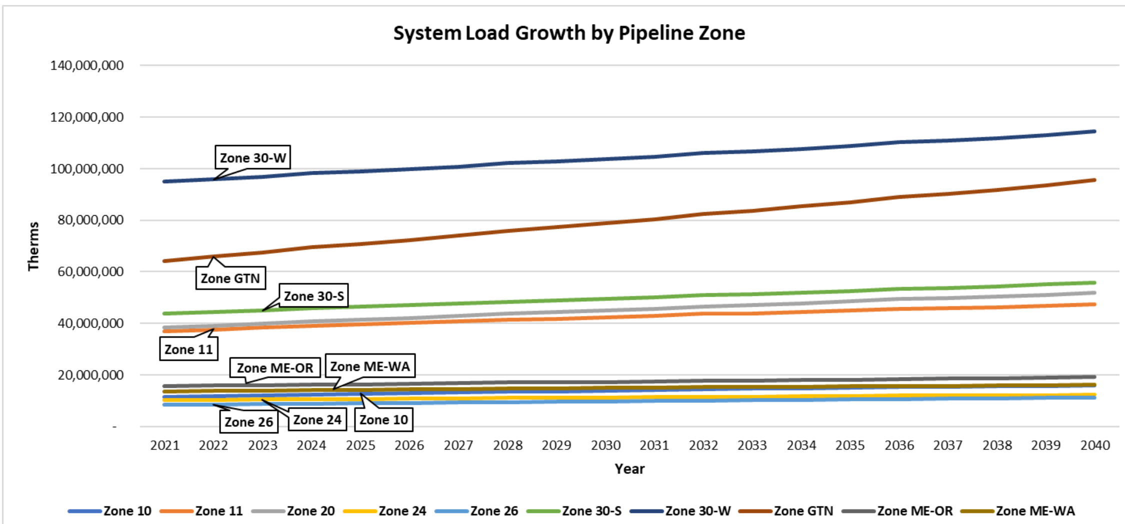
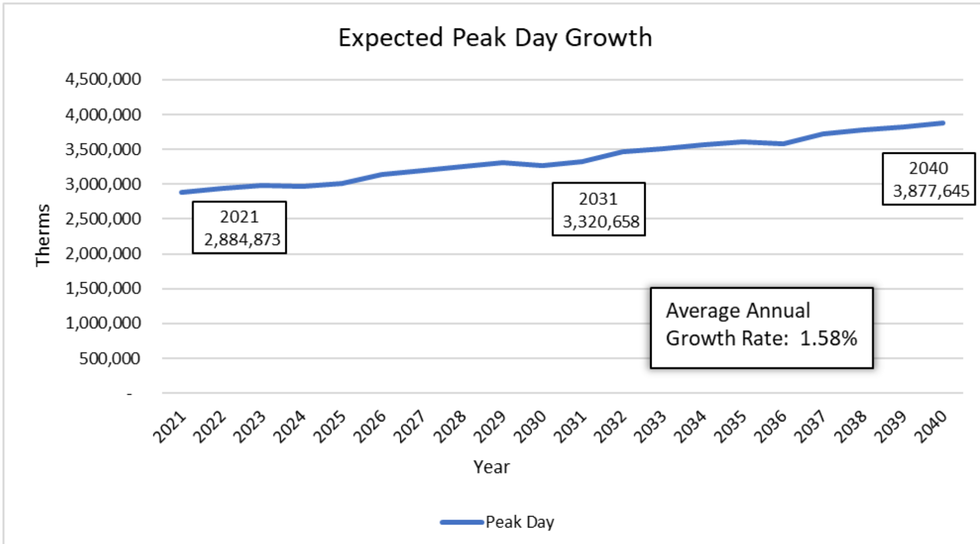


Figure 3-14: System 20-Year Average Load Growth by Pipeline Zone

Zone	Load Growth		Zone	Load Growth
Zone 10	1.75%		Zone 30-S	1.28%
Zone 11	1.30%		Zone 30-W	0.98%
Zone 20	1.61%		Zone GTN	2.12%
Zone 24	1.01%		Zone ME-OR	1.06%
Zone 26	1.58%		Zone ME-WA	0.90%

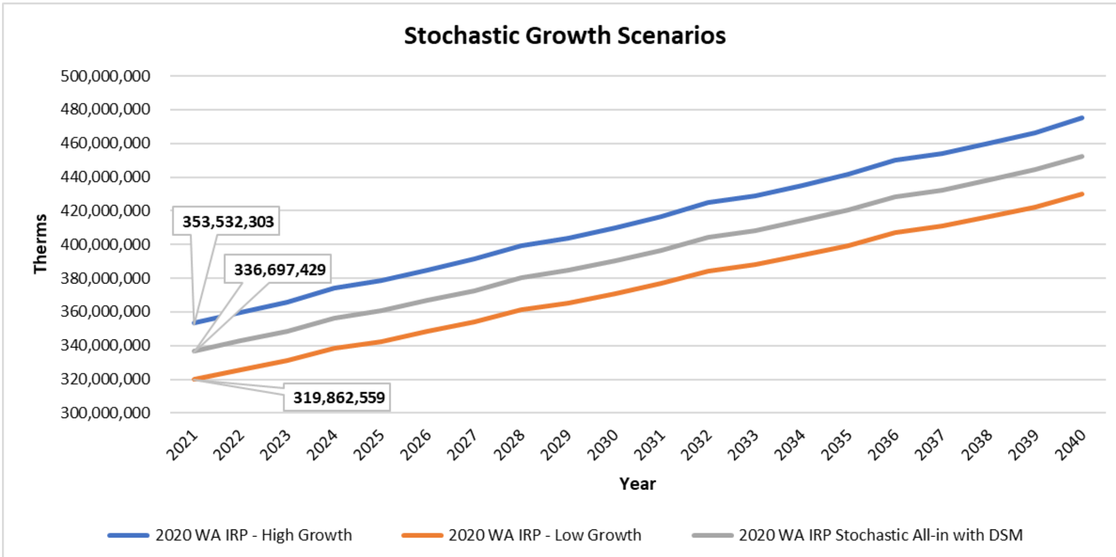
Figure 3-15: Expected System Peak Day Growth (Volumes in Therms)



High and Low Growth Scenarios

In previous IRPs, the high and low growth scenarios were built from the deterministic As-is portfolio. Cascade has moved to using the All-in portfolio as a means to compare low and high growth scenarios because Cascade believes it provides a more realistic view. There are two primary components of the growth scenarios. The first component involves varying the inputs to the model. These inputs are derived from the confidence intervals of the customer growth forecast, which were approximately 5%. The second component, new to this IRP, involves a stochastic element. This component uses stochastic weather (99th percentile) and stochastic price (95th percentile). By using both varied inputs as well as stochastic elements, Cascade can be more confident in the high and low growth scenarios. Figure 3-16 displays the stochastic total system load growth across the various stochastic scenarios.

Figure 3-16: Stochastic Total System Load Growth Across Scenarios



Load growth under the low stochastic scenario is showing approximately 17 million less therms per year while load growth under the high stochastic scenario is showing approximately 17 million more therms per year than the stochastic All-in scenario. By using Monte Carlo simulations and pulling the 99th percentile weather draw and 95th percentile price draw, Cascade can assert with a high degree of certainty that these scenarios accurately encompass a potential range of load growth scenarios. Figure 3-17 shows the values for stochastic growth scenarios.

Figure 3-17: Stochastic Total System Load Growth Across Scenarios in Therms

Year	Low	All-in + DSM	High
2021	319,862,559	336,697,429	353,532,303
2026	348,371,062	366,706,384	385,041,701
2031	376,770,704	396,600,742	416,430,775
2036	410,741,648	432,359,627	453,977,608
2040	429,748,623	452,366,973	474,985,319

Non-Core Outlook

Unlike the core, non-core (or transportation) customers are customers who schedule and purchase their own gas, generally through a marketer, to get gas to the citygate. The customer then uses Cascade's distribution system to receive the gas. Cascade has approximately 247 transportation customers, with six of those customers being electric generation customers. In both Washington and Oregon, the 2021 forecast for non-electric generation customers is approximately 581 million therms and the electric generation customers is about 417 million therms for a total of 998 million therms for the transportation customers.

Cross-Validation

Cascade continues to evolve and improve its forecasting methodologies. For this IRP, Cascade performed some model validation analysis, called cross-validation, in order to validate the assumptions going into the models as well as the results coming out. This process is time intensive, so Cascade picked a couple citygates to perform this analysis on. There are many ways to cross-validate a forecasting model such as hold-out validation, k-fold validation, and bootstrap validation. Each technique has its pros/cons when it comes to strength of validation and computational time. Cascade chose the hold-out method as it contains the best combination of having strong validation results with low computation time in reference to the other methodologies. The steps of the hold-out method involve selecting a specific citygate and rate class, limiting the historical data, developing a model using the same methodology as the original model, and then comparing the forecasted results to real world data. Cascade chose one of its more volatile citygates, Sumas SPE Loop, and one of its more stable citygates, Yakima Loop, in order to maximize the value of the cross-validation results. Figure 3-18 and Figure 3-19 show both these citygates' actual pipeline flow data compared to a forecast of a model made from only 2015 and 2016 data.

Figure 3-18: Sumas SPE Loop Cross-Validation

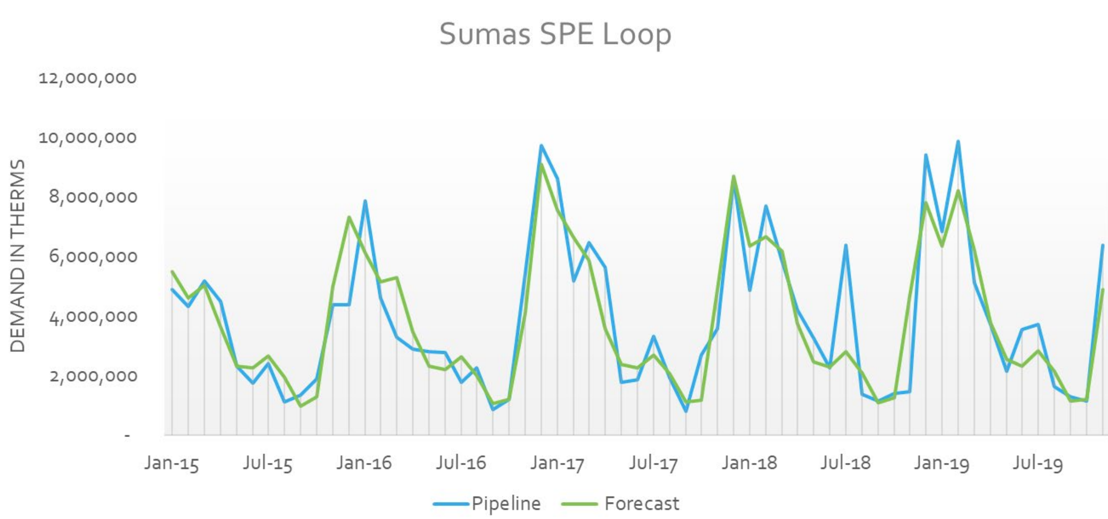
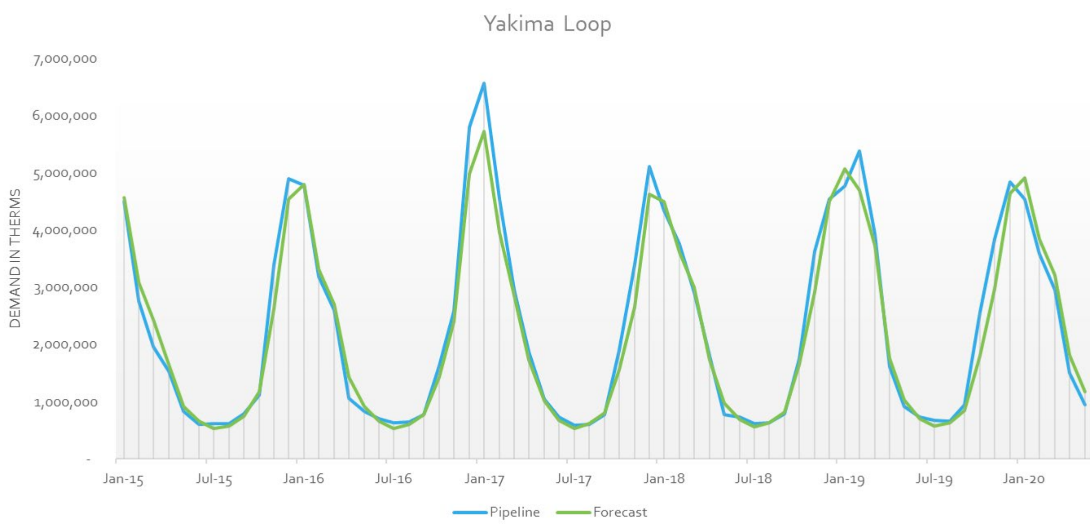


Figure 3-19: Yakima Loop Cross-Validation



Cascade will continue to perform cross-validation and will investigate ways to make this process more efficient in order to validate more models, more often.

Alternative Forecasting Methodologies

Cascade's forecasting methodologies used in the customer forecast and the UPC forecast have remained consistent. Cascade continues to utilize Fourier terms and ARIMA terms in its forecasting methods. Cascade utilizes R as its primary statistical analysis software and uses models that follow a dynamic regression methodology. The Company plans to continue improving the customer and demand forecast model through R to enhance the process' efficiency.

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 subchapter 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 growth, carbon legislation, building code changes, direct use campaigns, energy efficiency, and long-term weather patterns. The range of scenarios presented here and in Chapter 10 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.

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

Key Points

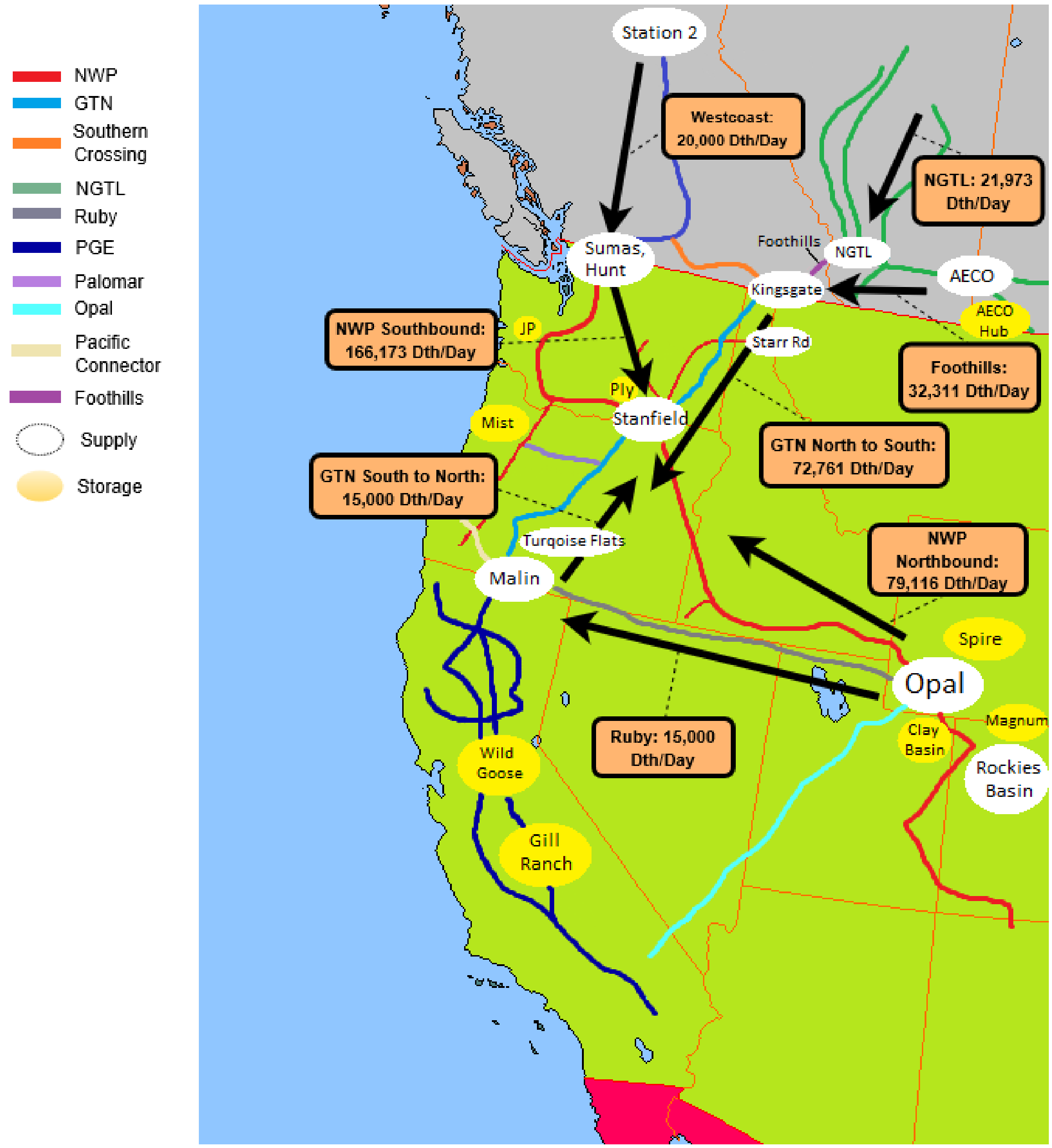
- To meet the Company's core market demand, Cascade accesses firm gas supplies and short-term gas supplies purchased on the open market, in addition to utilizing storage.
- Cascade purchases gas from the Rockies, British Columbia (Sumas), and Alberta (AECO). Gas is transported to the Company's system 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 2020 IRP.
- Risk management policies are implemented to promote price stability.
- Cascade's Gas Supply Oversight Committee (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 in 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 and other high demand periods.

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



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[1] This map does not reflect three contracts Cascade anticipates to acquire November 1st, 2023: GTN North to South of 10,000 dth/day, 20,000 dth/day on NGTL, and 10,000 dth/day on Foothills.

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 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.

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 identified in 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 (one to thirty 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.

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. 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 immediately upstream 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 paragraph 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.

In addition to the other storage facilities, the Company leases storage capacity from Mist. The Mist facility is located near Mist, Oregon and is adjacent to Northwest Natural Gas' distribution system and has a direct connection to NWP for withdrawals and injections. The Mist facility is owned and operated by Northwest Natural Gas. Cascade has 600,000 dth of leased capacity.

Both the Jackson Prairie and the Plymouth facilities are located directly on NWP's transmission system, while Mist Storage is located on the Northwest Natural Gas system that is connected to NWP via two different citygates 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

[2] *See:* Jackson Prairie Underground Natural Gas Storage Facility, https://www.pse.com/pages/energy-supply/natural-gas-storage, as of February 2, 2021.

service to meet its storage daily deliverability levels. The Company's contracted storage services are summarized in Figure 4-2.

Figure 4-2: 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
Mist	6,000,000	300,000

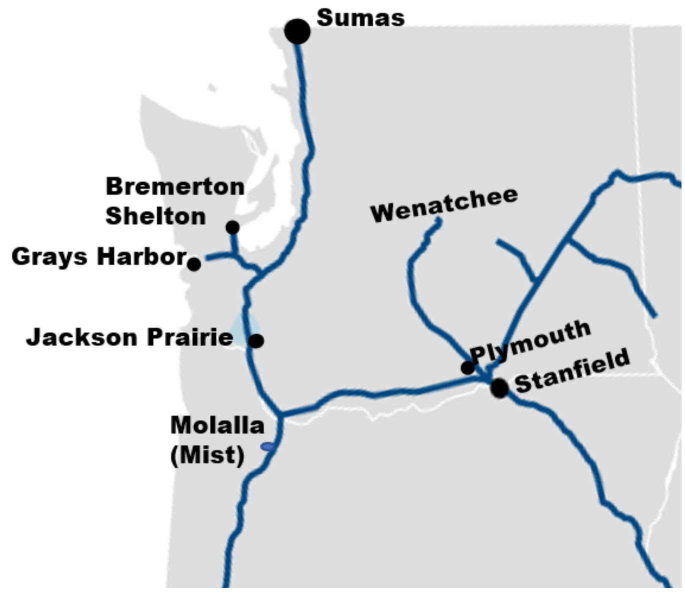
Capacity Resources

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, dependent upon the type of service the customer has contracted to receive.

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(s) 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 on page 4-3 provides a general flow of Cascade's combined contracted pipeline transportation rights.

Bremerton-Shelton Realignment Package



In the 2018 WA IRP Cascade indicated the Company was considering a proposed capacity realignment to firm up Cascade's long-term rights on the Bremerton Lateral. NWP had presented Cascade with a proposal to realign a portion of the Company's transportation capacity that runs from Sumas to eastern portions of Washington and Oregon. Part of the proposal required a series of amendments to existing pipeline capacity in addition to acquiring incremental capacity to address the projected shortfalls along the I-5 corridor. Cascade agreed to the realignment package on June 14, 2019. A summary of the major components of this package follows.

Cascade acquired an incremental 10,000 dth/d of NWP capacity via a hydraulic exchange. Through a series of releases and amendments, this 10,000 dth/d addressed the I-5 shortfall identified in the 2018 IRP. The Bremerton/Shelton realignment firmed up Cascade's primary rights through the Tumwater Compressor station, which supports the Bremerton/Shelton lateral. Cascade was able to increase an existing discounted storage redelivery capacity agreement from 8,960 to 10,000 dth/d. The rate for the modified redelivery agreement is at a fraction of NWP's year-round transportation rates.

To offset the incremental costs of the 10,000 dths gained from the hydraulic exchange, Cascade released the incremental capacity at max rate to a third party for the first ten years.

The package also gave Cascade the opportunity to segment 20,000 dth/d of existing capacity to generate 20,000 of capacity to move Mist storage on NWP's system. Cascade created two segments from our main NWP capacity agreement 100002 using a full transportation path from Sumas to eastern Washington and Oregon through October 31, 2032, at no incremental cost to Cascade:

- The first segment is 20,000 dths/d from Sumas to Shelton lateral and Jackson Prairie
- The second segment is 20,000 dths/d from Jackson Prairie to eastern WA/OR (retained by Cascade)

  - In order to provide upstream capacity to move Mist storage, the Company amended the second segment to change the receipt point from Jackson Prairie to Molalla (Mist) through March 31, 2024.
  - On April 1, 2024 the receipt point reverts back to Jackson Prairie for the remainder of the term.

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 Season (Apr-Jun);
- Spring/Summer Season (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 is closely monitoring the market for long term impacts of COVID-19. Cascade did reach out to its hedging consultant, Gelber & Associates, who provided the following analysis in the Company's 2020 Hedge Plan 'There has been a precipitous fall in oil prices early this year after a supply glut formed from the expected economic impacts of the COVID-19 outbreak and a nascent crude oil price war between Saudi Arabia and Russia. These items are both bullish for natural gas prices. This pricing relationship may be counterintuitive but approximately 15% of natural gas is produced as "associated gas". Associated gas is gas which is a direct result of crude oil production.

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 versus a monthly level. In order to capture the potential seasonality as well as the variances of monthly price within the producing basins, the Company blends the pricing data from these various forecast sources.

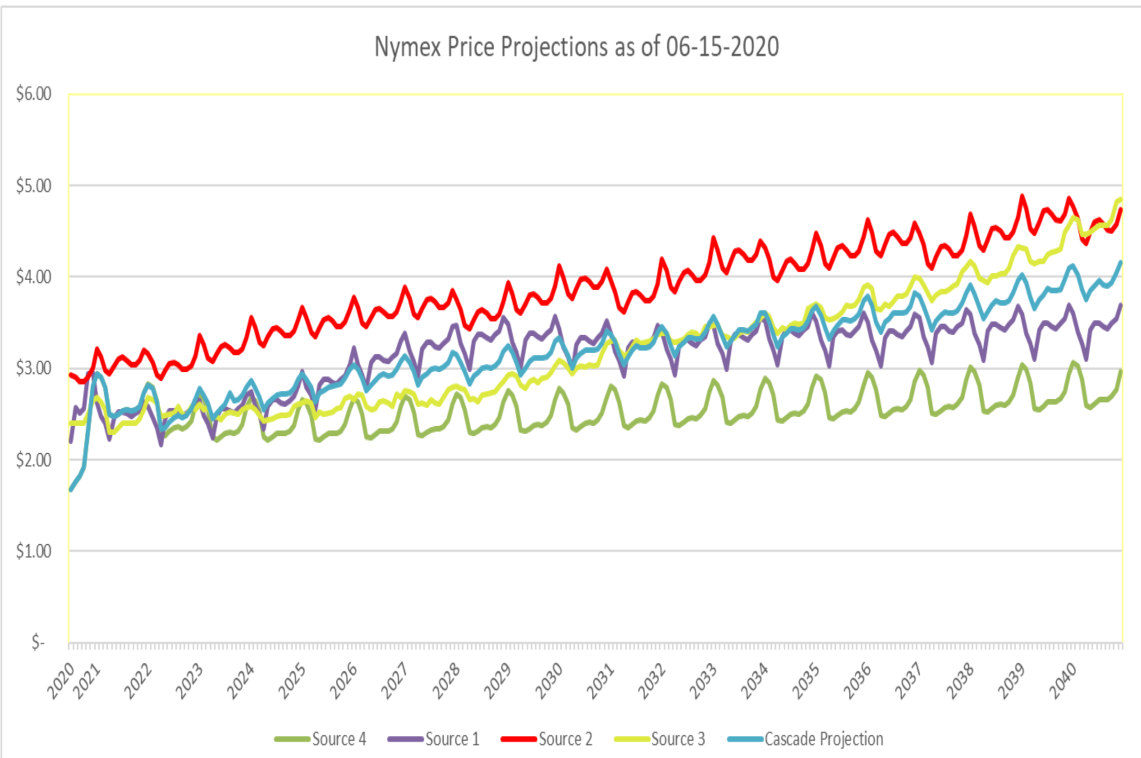
The fundamental forecasts of Wood Mackenzie, the EIA, NWPCC, Platts, S&P Global, and Cascade's trading partners are resources for the development of a blended long-range price forecast. Wood Mackenzie publishes a long-term price forecast twice a year to subscribing customers. This forecast was broken down by month through the planning horizon and includes Henry Hub as well as basis differentials, or price differential from Henry Hub, 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 Figure 4-3. A comparison of the sources Cascade uses in its forecast and the actual blended forecast is provided in Figure 4-4. Cascade's price forecast was locked in on June 15, 2020.

Figure 4-3: 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 4-4: 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.

Cascade weights 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.

Pros and Cons of Methodology Changes

The changes made to the 2018 IRP that carried over to the 2020 price forecast represent a continual 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 has mechanisms in place to allow for a manual adjustment if market intelligence deems such a modification to be appropriate.

Incremental Supply Side Resource Options

As is more thoroughly described in Chapter 10, Resource Integration, some of the load growth over the planning horizon may 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 current 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 a 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

- **Cross-Cascades, Trail West (Palomar, NMax, Sunstone, Blue Bridge, et al):** Trail West is a proposed 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. At this time, there has been no new activity associated with this project. The development of this project would likely have a two to three year lead time.

- **GTN Capacity Acquisition:** The Company would acquire currently unsubscribed capacity on GTN in order to secure its gas supplies at liquid trading points primarily 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. The development of this project would likely have a three or four year lead time. As of this writing, there hasn't been any new activity associated with the potential project.

- **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. Cascade, through the Company's active membership in various industry task forces and associations, works with regional pipelines and LDCs to consider potential pipeline expansions. The development of this project would likely have a three or four year lead time.

As of this writing, there hasn't been any new activity associated with the potential project.

- **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. The development of this project would likely have a three or four year lead time. As of this writing, there hasn't been any new activity associated with the potential project.

- **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. The development of this project would likely have a three or four year lead time. As of this writing, there hasn't been any new activity associated with the potential project.

- **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 would start 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 a bundled pipeline supply service from Malin to the Company's citygates. 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. On January 19, 2021 federal regulators upheld Oregon's decision to deny a water quality certification for Jordan Cove and Pacific Connector.[3] This latest event has led to some concern the project may not proceed.

- **Southern Crossing Expansion:** FortisBC Southern Crossing is considering an addition of 300-400 MMcf/d of bidirectional capacity. FortisBC has proposed a reinforcement project for the Southern Crossing

[3] *See* https://www.oregonlive.com/politics/2021/01/federal-regulators-deliver-potentially-fatal-blow-to-jordan-cove.html

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. 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 also 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 Storage:** This facility is located near Mist, Oregon and is adjacent to NW Natural Gas' distribution system and has a direct connection to NWP for withdrawals and injections. The Mist facility is owned and operated by NW Natural Gas. NW Natural's 2018 IRP (LC71), Chapter 9, Section 9.2.1 indicates that "Mist storage capacity is currently reserved for the core market… NW Natural has developed additional capacity in advance of core customer need. This capacity currently serves the interstate/intrastate storage (ISS) market but could be recalled for service to NW Natural's utility customers as those third-party firm storage agreements expire."

In the past several years NW Natural has held a Mist open season in 2017, followed by two Mist RFPs. Cascade became a Mist ISS customer for the first time in May 2019. The Company leases 600,000 dths of storage capacity. This lease is set to expire in 2024.

On January 14, 2021 NW Natural sent their latest RFP to Cascade with bids due by January 29, 2021. With assistance in modeling from Cascade's asset manager, Tenaska Marketing, Cascade's GSOC authorized Cascade to submit a bid at 76% of the maximum rate (for reference, the current Mist agreement is at 100% of the maximum rate). Cascade was awarded 540,000 dths of additional Mist capacity on February 1, 2021. The term of this additional Mist service is May 1, 2021 through April 30, 2026. Please note that as of this writing, this second Mist is still in the final contracting stage and technically is not yet part of the portfolio.

As the Company states throughout, the IRP is developed at a point in time. Unfortunately, Cascade had no advanced knowledge of the 2021 Mist RFP during the development of this IRP. Therefore, this latest Mist leased storage is not included in the IRP analysis. It is important to note that Cascade does not own any storage. In addition to the currently leased Mist storage, the Company leases storage at Jackson Prairie and Plymouth LNG. Given the Company's wide geographical and noncontiguous service territory, storage has a unique role in daily upstream operations compared to other regional LDCs. For Cascade, storage functions primarily as an operational tool for balancing and upstream pipeline operational flow orders as opposed to use primarily for price arbitrage. Also, Cascade continues to have the lowest ratio of customers to storage capacity in comparison to other regional LDCs. The addition of this second Mist account improves the Company's portfolio flexibility with minimal impact to customer rates.

- **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 is 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.

- **Magnum Gas Storage:** Magnum is currently developing the Magnum Gas Storage facility at the Western Energy Hub. Magnum Gas Storage will be the first high-deliverability storage facility in the Rocky Mountain Region. The facility will contain four solution mined storage caverns capable of storing 54 billion cubic feet (Bcf) of natural gas.[4] Magnum would be connected to the Kern River Gas Transmission and Questar Pipeline systems at Goshen, Utah. Incremental transport involving Questar and possibly Ruby would be necessary.

- **Clay Basin:** Clay Basin is located in Northeast Utah and is a 54 Bcf working gas storage facility. Clay Basin is connected to the Questar Pipeline system. Incremental transport involving Questar and possibly Ruby would 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. 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 such 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. A project of this nature would likely have a three-four year lead time.

- **Renewable Natural Gas (RNG):** Cascade is committed to the acquisition of cost-effective RNG under the current regulatory guidance provided by the OPUC and WUTC. An in-depth discussion of Cascade's RNG

[4] *See* https://www.wyopipeline.com/magnum-gas-storage-llc-western-energy-hub-project/

philosophy and analysis techniques can be found in Chapter 8, Renewable Natural Gas.

- **Additional transportation realignments:** The Company's geographically widespread service territory 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 an LNG Import Terminal, local bio-natural gas, or other manufactured gas supply opportunities as potentially speculative supply side resources at this point in time. Ultimately these 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 Energy Regulator (CER)[5] 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.

[5] The Canada Energy Regulator (CER) is the agency of the Government of Canada under its Natural Resources Canada portfolio, which licenses, supervises, regulates, and enforces all applicable Canadian laws as regards to interprovincial and international oil, gas, and electric utilities. The agency came into being on August 28, 2019, under the provision of the Canada Energy Regulator Act of the Parliament of Canada superseding the National Energy Board from which it took over responsibilities.

As the United States continues to search for environmentally friendly, economically viable options to displace gasoline and coal, natural gas is seen as a fuel that could be a viable resource in a greener future. It is worth noting that some planned and proposed projects could have a direct impact on the availability of supply or at least may pose potential risks to increasing the price of supplies sourced from British Columbia and Alberta. For example, Coastal GasLink Pipeline is currently under construction. Coastal GasLink, once completed in 2023, will transport natural gas from northeast British Columbia to an LNG export facility near Kitimat BC near the Pacific coast. Shippers using this pipeline will likely lead to increased competition for gas supplies in the region. Also, proposed expansions on the TransCanada pipelines in 2022 and 2023 may also increase competition for available gas supplies in Alberta and British Columbia. 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 mitigating 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 collars.

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 Swap Targets

- Year one target set at 50% of annual requirements.
- Year two target set at 30% of annual requirements.
- Year three target set at 10% of annual requirements.

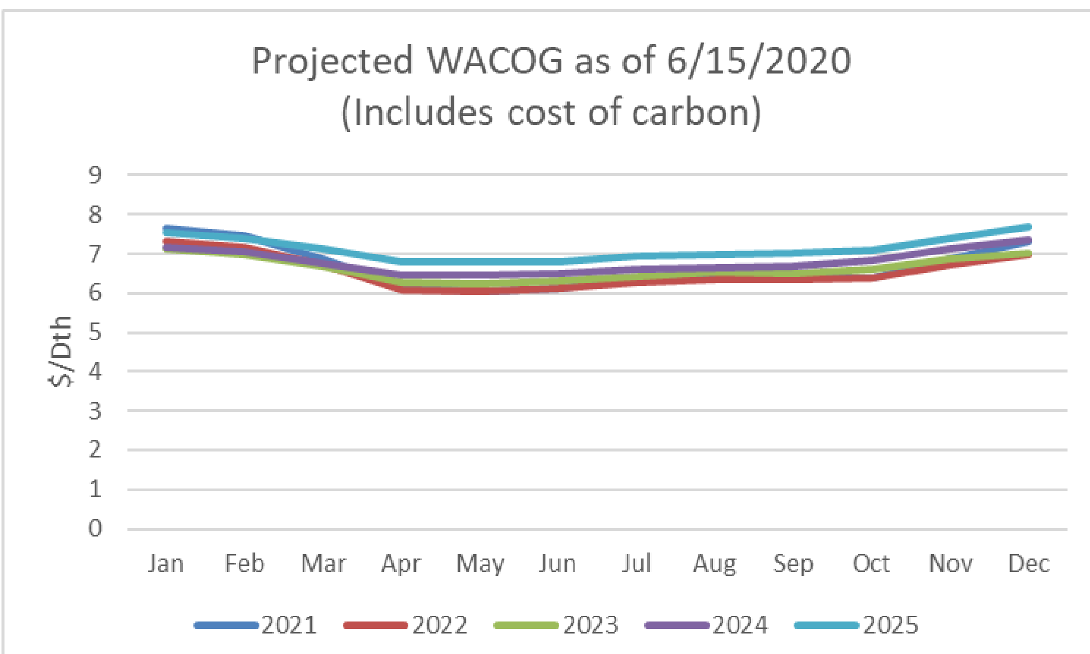
Depending on market conditions, the strategy allows for the ratchets to increase to 60%, 40%, and 20%, respectively, provided current market information supports moving to a different level.

Cascade employs 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 impact. 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 at approximately 50%. For the 2020 procurement design, GSOC felt that it prudent for Cascade to enter into its first financial derivative during the 2019-2020 period, which the Company successfully executed.

The Company entered into fixed price physical transactions and one financial swap for the current programmed buying period. The Company entered into fixed price physical transactions rather than executing financial swaps for the current programmatic buying period. Fixed prices consist of locked-in prices for physical supplies. As discussed in Appendix E, the Company utilizes a multi-tiered buying approach for locking in or hedging gas supply prices. The Company monitors market conditions and stands ready to execute financial swaps when market and pricing conditions warrant. At the time the current procurement strategy was made, the forward price spread between the November 2019 through October 2020 period and the November 2022 through October 2023 period was less than 20%, which was deemed a reasonable and manageable spread given market intelligence available. Figure 4-5 provides a graph showing the Company's projected weighted average cost of gas (WACOG), including the base case carbon adder, for the 2020 IRP.

Figure 4-5: Projected Cascade WACOG as of June 2020



With the assistance of Gelber & Associates (G&A or Gelber), an energy consulting firm with 30 years of experience in utility hedging, Cascade has continued to evolve 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 has been working in close coordination with 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 demonstrates 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 on Cascade's work with Gelber on an evolving hedge program can be found in the Company's 2020 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.

GSOC 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; 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. These teams are overseen by the Director, Gas Supply—Utility Group.

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 transactions under existing market conditions. The Company employs a variety of methods for securing the best possible deal under existing market conditions. CNGC employs a number of processes when procuring fixed-price physical and indexed-riced spot physical. There is a separate process for financial derivatives as discussed throughout this annual hedge plan.

Physical Supply

CNGC utilizes TruMarx's COMET transaction bulletin board system to assist in communicating, tracking, and awarding most activities involving the Company's physical supply portfolio. In the procurement process for physical natural gas the Company posts an RFP to Cascade's 25+ physical supply parties to solicit offers on needed supply. The Company then collect bids from these parties over a period, depending on the number or time requirements of 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, CNGC awards the posted packages. Please note that posting on COMET does not obligate CNGC to execute any proposal made by physical suppliers.

Naturally, price is the principal factor; however, CNGC also considers reliability, financial health, past performance, and the party's share of the overall portfolio as to ensure party diversity. It should be noted that there is always the possibility the lowest market price may be during 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 indicatives may start high and drop over time, allowing CNGC to capture the transaction on the downward swing. In the end, timing is always a factor as the market cannot be perfectly predicted.

Occasionally, an operational situation may occur where time is of essence, such as a need to acquire spot gas to meet sudden swings in load demand or in response to an upstream pipeline operational event. In such situations, CNGC may make a short procurement purchase within a narrow time window to procure and schedule the supply. The Company contacts one to three reliable physical parties to meet these short-term supply needs. Again, price is the principle but not the only driver for the awarding of these supply needs. Also, please note the Company always encourages physical suppliers to propose other transactions or packages that they feel may be of interest in helping CNGC secure cost effective and operationally flexible transactions to meet CNGC's needs. In addition to analysis using Excel, CNGC also uses the SENDOUT® resource optimization model, which is a useful tool for examining logical, operationally and financially feasible physical packages that best utilizes CNGC's various transportation, storage and operational capabilities.

Financial Derivatives

For financial derivatives, CNGC contacts Company-approved financial counterparties ("counterparties") to request bids consistent with the GSOC approved hedge execution plan (HEP). Naturally, this process requires additional analysis regarding financial reasonableness, timing, hedging strategy, and volumes. The Monthly Guidance and CNG Book Model are the primary tools used to identify and analyze potential financial derivatives possibilities. Price comparisons may also become more complicated since pricing could be tiered; part of a structure deal may be tied to an index or contain floors, caps, etc. Bids are received from the counterparties and, similar to the physical portfolio, the Company then collect bids from these parties over a period, depending on the number or time requirements of the packages sought, comparing the indicative pricing to each party as well as applying the information from market intelligence available at the time. Furthermore, G&A uses MarketView and CNGC has limited access to ICE. Both deliver real-time market pricing information for hedging transactions. Ideally, after monitoring these indicatives and the market, CNGC will award the specific packages to individual parties. Again, please note that CNGC is not obligated to execute any offer received. Further information regarding Cascade's evolving hedge program can be found in the Company's 2020 Annual Hedge Plan in Appendix E.

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.

Chapter 5

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 efficiency. The avoided cost forecast can be used as a guideline for comparing energy efficiency with the cost of acquiring and transporting natural gas to meet demand.

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

Key Points

- Avoided cost forecasting serves as a primary input for determining energy efficiency targets.
- Cascade's avoided costs include fixed transportation costs, variable transportation costs, commodity costs, carbon compliance costs, distribution system costs, a risk premium, and a 10% adder.
- As per WUTC guidelines, Cascade is using the Social Cost of Carbon with a 2.5% discount rate as its base carbon compliance costs
- The total avoided cost ranges between \$0.79 and \$1.09/therm over the 20-year planning horizon.

Costs Incorporated

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

$$AC_{nominal} = TC_f + TC_v + SC + \left((CC + C_{Comp}) * E_{adder}\right) + DSC + RP$$

Where:

- $AC_{nominal}$ = The nominal avoided cost for a given year. To put this into real dollars apply the following: Avoided Cost/ (1+inflation rate)^Years from the reference year.
- TC_f = Incremental Fixed Transportation Costs
- TC_v = Variable Transportation Costs
- SC = Storage Costs
- CC = Commodity Costs
- C_{Comp} = Carbon Compliance Costs
- 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 (6/10/2020);
- The inflation rate used to scale the Social Cost of Carbon (SCC) from Real $2007 to Real $2020 uses the chain type price index for the Gross Domestic Product from the Bureau of Economic Analysis (BEA)[1]
- The discount rate of 3.40% (30-year fixed mortgage rate as of 6/26/2020).

Understanding Each Component

- **Incremental Fixed Transportation Costs**

  In the 2020 IRP, Cascade has not included any additional upstream capacity in its preferred portfolio for the 20-year planning horizon. If such a need were to be identified, fixed transportation costs would 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 pipeline companies, and furthermore, are treated as confidential as any incremental fixed transportation costs could ultimately be a negotiated rate.

- **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 pipeline companies and can be changed if one of the pipeline companies 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) for U.S. pipelines and the Canadian Energy Regulator (CER) for Canadian pipelines. 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.

- **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

[1] *See* https://officeofbudget.od.nih.gov/gbiPriceIndexes.html

would include an on-system storage facility, or a satellite LNG facility connected to Cascade's distribution system.

- **Commodity Costs**

  Commodity costs are the costs of acquiring one therm of gas. Cascade first uses SENDOUT® to calculate the monthly 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 month's calculation is the monthly price from each year of Cascade's 20-year price forecast.

- **Carbon Compliance Costs**

  Once the Company has calculated its average cost of gas, a price for expected carbon compliance costs must be added. Cascade converts the cost of carbon in dollars per metric ton to dollars per dekatherm, accounting for the upstream natural gas value chain emissions in this calculation. Further information about this calculation can be found in Chapter 6, Environmental Policy. Accurate modeling of these costs has been challenging in years past due to uncertainty surrounding how these costs will ultimately be quantified. For this IRP, Cascade will follow the guidance outlined in Docket U-190730 by using the SCC with a 2.5% discount rate as its base case carbon compliance cost. Cascade will also follow the WUTC guidance for adjusting the values of the SCC from Real $2007 to Real $2020 by using GDP data published by the BEA.

  Cascade calculates the inflation adjusted SCC to start at $78.13/Metric Ton CO_2e in 2021, rising to $104.18/Metric Ton CO_2e in 2040. In Cascade's initial avoided cost calculation, these values were equivalent to $4.02/dth in 2021, rising to $5.36/dth in 2040. After valuable conversations with stakeholders, the Company enhanced its methodology with regards to the accounting of upstream emissions, leading to an adjustment of 2.51%-2.76% per year to the total avoided cost. The results of this adjustment can be seen in Appendix H, Avoided Cost. Overall, carbon compliance costs related to the SCC are a significant factor in Cascade's avoided cost calculation, accounting for a range of 49.64% to 54.69% of the total system avoided cost.

- **Environmental Adder**

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

- **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 posted in the Company's tariffs. Distribution system projects that are not related to growth are then backed out of the weighted margin figure to capture only the costs that can be deemed avoidable. Cascade calculates distribution system costs for both peak day and peak hour, as distribution system analysis is most concerned about system capabilities during a peak hour scenario.

- **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. For the 2020 IRP, the Company worked closely with its stakeholders to create a methodology to quantify this premium. Cascade requested a hypothetical 20-year fixed price quote from its Asset Management Agreement (AMA) partner, Tenaska Marketing Ventures. The Company then compared the prices offered at each of its basins to its 20-year price forecast. Interestingly, the 20-year fixed prices offered by Tenaska were lower than projected floating market prices, which would lead to a negative risk premium. Thus, Cascade is following regional best practice and recording a value of zero for risk premium instead of the negative values that were calculated.

Application

The 2020 IRP makes several enhancements in calculating and applying the avoided costs, specifically related to its quantification of upstream emissions, accuracy around carbon compliance costs, and enhancements to the distribution system cost calculation methodology. This cost figure becomes the foundation for prudency determinations regarding energy efficiency, 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.

Cascade locked in the avoided cost on June 24, 2020 as it is a key input to Demand Side Management. The initial avoided cost, which was used for the IRP draft filing, did not include upstream emissions. An upstream emissions workshop was conducted after the fifth TAG meeting and a new avoided cost was locked in after that workshop, on October 15, 2020. As previously mentioned, the final IRP includes upstream emissions in the avoided cost calculation.

Results

Figure 5-1 displays a comparison of the average nominal avoided cost over the 20-year horizon for the current and past IRPs. Figure 5-2 displays the total avoided cost by each conservation zone over the 20-year IRP horizon, while Figure 5-3 provides the net present value of avoided costs over the planning period. Conservation Zone 1 covers the west side of Cascade's service territory, with load centers such as Bellingham, Stanwood, and the Sedro/Wooley area. Conservation Zone 2 refers to the central Washington service area, with load centers such as Bremerton, Longview, and Castle Rock. Conservation Zone 3 covers the eastern Washington service area, including Yakima, Walla Walla, and the Tri Cities. Finally, Zone 4 refers to Oregon citygates. A map of the Conservation Zones can be found in Figure 13-14 in Chapter 13, Glossary and Maps. For the 2020 IRP, nominal system avoided costs range between \$0.79/therm and \$1.09/therm.

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 2020 IRP are higher than in the 2018 IRP. The main driver of this is higher carbon compliance costs, specifically the change from using an SCC with a 3% discount rate to an SCC with a 2.5% discount rate, as well as the adjustment from real \$2007 to real \$2020. 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.

Figure 5-1: Avoided Cost Comparison to Previous IRPs

	2010 IRP	2012 IRP	2014 IRP	2016 IRP	2018 IRP	2020 IRP
Nominal \$/Therm	\$ 0.810	\$ 0.528	\$ 0.610	\$ 0.571	\$ 0.673	\$ 0.936

Figure 5-2: Nominal Avoided Costs by Zone (Cost per Therm)

Nominal Avoided Cost including upstream emissions (By Zone) - $/Therm							
	Zone 1	Zone 2	Zone 3	Zone 4	Oregon	Washington	System
2021	$ 0.885	$ 0.876	$ 0.878	$ 0.839	$ 0.839	$ 0.884	$ 0.849
2022	$ 0.842	$ 0.837	$ 0.838	$ 0.809	$ 0.809	$ 0.841	$ 0.816
2023	$ 0.814	$ 0.812	$ 0.812	$ 0.791	$ 0.791	$ 0.814	$ 0.795
2024	$ 0.838	$ 0.835	$ 0.836	$ 0.813	$ 0.813	$ 0.838	$ 0.817
2025	$ 0.882	$ 0.876	$ 0.877	$ 0.852	$ 0.852	$ 0.881	$ 0.858
2026	$ 0.903	$ 0.898	$ 0.899	$ 0.873	$ 0.873	$ 0.903	$ 0.879
2027	$ 0.916	$ 0.911	$ 0.912	$ 0.887	$ 0.887	$ 0.916	$ 0.893
2028	$ 0.919	$ 0.915	$ 0.916	$ 0.889	$ 0.889	$ 0.919	$ 0.894
2029	$ 0.935	$ 0.931	$ 0.931	$ 0.903	$ 0.903	$ 0.934	$ 0.909
2030	$ 0.951	$ 0.947	$ 0.948	$ 0.920	$ 0.920	$ 0.951	$ 0.925
2031	$ 0.958	$ 0.954	$ 0.954	$ 0.927	$ 0.927	$ 0.957	$ 0.932
2032	$ 0.977	$ 0.973	$ 0.974	$ 0.946	$ 0.946	$ 0.977	$ 0.952
2033	$ 0.995	$ 0.991	$ 0.992	$ 0.964	$ 0.964	$ 0.995	$ 0.969
2034	$ 1.002	$ 0.999	$ 0.999	$ 0.971	$ 0.971	$ 1.002	$ 0.977
2035	$ 1.020	$ 1.017	$ 1.017	$ 0.988	$ 0.988	$ 1.019	$ 0.993
2036	$ 1.033	$ 1.031	$ 1.031	$ 1.002	$ 1.002	$ 1.033	$ 1.007
2037	$ 1.057	$ 1.053	$ 1.054	$ 1.025	$ 1.025	$ 1.057	$ 1.031
2038	$ 1.079	$ 1.075	$ 1.076	$ 1.047	$ 1.047	$ 1.079	$ 1.053
2039	$ 1.103	$ 1.098	$ 1.099	$ 1.070	$ 1.070	$ 1.102	$ 1.076
2040	$ 1.117	$ 1.113	$ 1.114	$ 1.085	$ 1.085	$ 1.117	$ 1.091

Figure 5-3: Real $2020 Avoided Costs by Zone (Cost per Therm)

Real 2020$ Avoided Cost including upstream emissions (By Zone) - $/Therm							
	Zone 1	Zone 2	Zone 3	Zone 4	Oregon	Washington	System
2021	$ 0.885	$ 0.876	$ 0.878	$ 0.839	$ 0.839	$ 0.884	$ 0.849
2022	$ 0.814	$ 0.810	$ 0.810	$ 0.783	$ 0.783	$ 0.814	$ 0.789
2023	$ 0.761	$ 0.759	$ 0.760	$ 0.740	$ 0.740	$ 0.761	$ 0.744
2024	$ 0.758	$ 0.755	$ 0.756	$ 0.735	$ 0.735	$ 0.758	$ 0.739
2025	$ 0.771	$ 0.767	$ 0.768	$ 0.746	$ 0.746	$ 0.771	$ 0.751
2026	$ 0.764	$ 0.760	$ 0.760	$ 0.739	$ 0.739	$ 0.764	$ 0.744
2027	$ 0.750	$ 0.746	$ 0.746	$ 0.726	$ 0.726	$ 0.749	$ 0.731
2028	$ 0.727	$ 0.724	$ 0.725	$ 0.703	$ 0.703	$ 0.727	$ 0.708
2029	$ 0.715	$ 0.712	$ 0.713	$ 0.691	$ 0.691	$ 0.715	$ 0.696
2030	$ 0.704	$ 0.701	$ 0.702	$ 0.681	$ 0.681	$ 0.704	$ 0.685
2031	$ 0.685	$ 0.683	$ 0.683	$ 0.663	$ 0.663	$ 0.685	$ 0.667
2032	$ 0.677	$ 0.674	$ 0.674	$ 0.655	$ 0.655	$ 0.676	$ 0.659
2033	$ 0.666	$ 0.663	$ 0.664	$ 0.645	$ 0.645	$ 0.666	$ 0.649
2034	$ 0.649	$ 0.647	$ 0.647	$ 0.629	$ 0.629	$ 0.649	$ 0.633
2035	$ 0.639	$ 0.637	$ 0.637	$ 0.619	$ 0.619	$ 0.638	$ 0.622
2036	$ 0.626	$ 0.624	$ 0.624	$ 0.607	$ 0.607	$ 0.626	$ 0.610
2037	$ 0.619	$ 0.617	$ 0.617	$ 0.600	$ 0.600	$ 0.619	$ 0.604
2038	$ 0.611	$ 0.609	$ 0.609	$ 0.593	$ 0.593	$ 0.611	$ 0.596
2039	$ 0.604	$ 0.602	$ 0.602	$ 0.586	$ 0.586	$ 0.604	$ 0.589
2040	$ 0.592	$ 0.590	$ 0.590	$ 0.575	$ 0.575	$ 0.592	$ 0.578

Chapter 6

Environmental Policy

Purpose

This chapter considers Greenhouse Gas (GHG) emission reduction policies and regulations that have the potential to impact natural gas distribution companies. In addition, this chapter 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.

Since the last IRP, policymakers in Washington and Oregon continue to actively pursue GHG emission reductions while the Federal Government has lessened its focus on the pursuit of reductions.

Key Points

- State and federal agencies continue proposing GHG emission reduction regulations and are considered in the 2020 IRP.
- Cascade models SCC at 2.5% discount rate as its main carbon forecast, including sensitivities of a Cap and Trade pricing forecast and two Congressional Proposals: House of Representatives Raise Wages, Cut Carbon Act and the Market Choice Act.
- On Jan. 16, 2020 WA Supreme Court invalidated CAR WAC-173-442 for non-emitters.
- Cascade continues to monitor federal and state regulation and congressional and state legislative actions.
- On March 20, 2020 Oregon Governor Brown issues EO 20-04 directing state agencies to reduce GHG emission under their existing authority with DEQ to commence cap and reduce requirements by Jan. 1, 2022.

Company Environmental Policy

Cascade's policy states:

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

> *To minimize waste and maximize resources;*
>
> *To be a good steward of the environment while providing high quality and reasonably priced products and services; and*
>
> *To comply with or surpass all applicable environmental laws, regulations and permit requirements."*

Cascade is committed to maintaining compliance with all laws and regulations and strives to operate in a sustainable manner, while taking into consideration the cost to customers. Cascade actively engages in public proceedings related to federal and state legislative and regulatory activities. This includes offering comments on environmental policy, 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. Cascade's goal is to ensure safe, affordable, reliable energy for our customers while serving as stewards of our natural resources.

Overview

Cascade monitors environmental regulatory requirements in progress nationally, regionally, and locally that have the impacts to local distribution companies (LDCs). As of November 17, 2020, there are no regulations at the federal level that would require the Company to reduce GHG emissions. Also, there are currently no direct regulations or laws applying a carbon price to Cascade operational GHG emissions or GHG emissions resulting from customer use of natural gas which Cascade sells to customers. However, there are several policies with emergent implications for carbon emission pricing and reductions in both Washington State and Oregon. These include the WA Greenhouse Gas Assessment for Projects (GAP) rulemaking led by the Department of Ecology, and Governor Kate Brown's Executive Order 20-04 Directing State Agencies to Take Actions to Reduce and Regulate Greenhouse Gas Emissions.

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. With discussion in both states served by Cascade centering on the valuation and quantification of carbon and other GHG emissions there is a high potential for a cost of carbon to impact Cascade in the future.

Only a limited number of congressional bills proposing GHG reductions have been drafted during former President Trump's administration and those bills focused mainly on the electric industry and none passed into law. President Biden announced his "Build Back Better" plan for reducing GHG emissions during his campaign for president. Cascade will continue to monitor how this plan is introduced in legislation and review requirements that would apply to natural gas utilities.

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 about 50 other companies. Partners in the program demonstrate their commitment and concern for the environment through voluntary methane emissions reductions.

In the previous IRP, Cascade used 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. For this IRP, as suggested by WUTC and outlined in Docket U-190730, Cascade is applying the SCC with a two and one-half percent discount rate as the main CO_2 adder in modeling.

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.

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. Additionally, the Company is currently in the process of soliciting a third-party consultant to support an assessment of the total RNG potential available to Cascade as it seeks to ramp-up renewable efforts.

From a regional perspective, Cascade reviews energy and GHG emissions analyses published by the Northwest Power and Conservation Council (NWPCC or Council) to inform on cost impact and potential future regional policy development. Cascade reviewed the NWPPC Seventh Plan for the Company's IRP. The NWPCC is scheduled to release a new Plan in 2021.

There continues to be community-driven efforts in adopting GHG emission reduction targets within, and adjacent to, Cascade's service areas. Communities such as the city of Bellingham and Whatcom County, Washington, have adopted a decarbonization strategy which includes more challenging and aspirational GHG emission reduction measures. At the time this chapter was drafted, Bellingham City Council was currently working with City staff to assess a series of Climate Action Task Force (CATF) recommendations for potential integration into the City's Climate Action Plan. Such measures include exploring the electrification of new homes and buildings within Bellingham. The City of Bend, Oregon has also adopted GHG reduction measures. Their approved plan has expanded Cascade's discussions with the City regarding potential future partnership on RNG development and community-wide carbon offset programs. Cascade has engaged with these communities and is working with them to support GHG emission reduction targets and goals as appropriate while supporting the triple bottom line of economics, equity, and sustainability.

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. Cascade explains its approach and support for carbon cost modeling for this IRP. Cascade also includes further discussion on GHG emissions in general, as well as actions and commitments the Company has taken to reduce GHG emissions.

Federal Regulation and Policy

1. Congressional Actions

Cascade monitors congressional actions on reducing GHG emissions and a few recent examples, as well as President Biden's proposed plan for reducing GHG emissions, are provided below.

a. U.S. House of Representatives Market Choice Act (HR 6463)

The Market Choice Act was introduced in the U.S. House of Representatives on July 23, 2018. 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/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/year. Although this bill did not pass, it provides an example of a cost of carbon resulting from congressional action. The Company is using the Market Choice bill as a CO_2 adder sensitivity as it represents a recent congressional outlook of potential carbon pricing for fossil fuels.

b. U.S. House of Representatives Raise Wages, Cut Carbon Act (HR 3966)

In 2019, the Raise Wages, Cut Carbon Act (HR 3966) was introduced in the U.S. House of Representatives. This bill would apply a tax to importers of fossil fuels and fluorinated greenhouse gases and use tax revenues to reduce social security taxes, as well as increase funding for the low-income home energy assistance program and the weatherization assistance program for low-income persons. The tax would apply to (1) the manufacturer, producer, or importer of coal (including lignite and peat), petroleum and petroleum products, and natural gas; (2) any imported taxable product sold or used by its importer; and (3) fluorinated greenhouse gases. Generally, the tax would start at $40/metric ton of CO_2 equivalent emitted and increase 2.5%/year plus inflation but may also depend on other factors. This rate could be increased if emission reduction targets are not met. The Company is using the Raise Wages, Cut Carbon Act as a CO_2 adder sensitivity as it also represents a recent congressional outlook of potential carbon pricing for fossil fuels.

c. Other Congressional Activities

Other federal legislative activities Cascade has monitored include the Climate Leadership and Environmental Action for the Nation's (CLEAN) Future Act discussion draft developed in the U.S. House of Representatives Energy and Commerce Committee, American Energy Innovation Act (AEIA) S.2657 developed in the U.S. Senate Energy and Natural Resources Committee, U.S. Senate Clean Energy Innovation and Deployment Act (CEIDA) and President Biden's climate action GHG emissions reductions proposed in his "Build Back Better" plan. Each have national GHG emission reduction achievement targets or plans varying in application to certain sectors or economy-wide. Cascade is monitoring these ongoing congressional activities, but not including these proposals in modeling.

2. 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.

Cascade modeled societal costs of CO_2 emissions resulting from customers' combustion of natural gas in the previous IRP using the SCC with a three percent discount rate that was established by the U.S. Governmental Interagency Working Group (IWG) on Social Cost of Greenhouse Gases. In this IRP and in consideration of HB 1257 adding further instruction in RCW 80.28 on conducting avoided cost calculations, Cascade is applying the SCC with a two and one-half percent discount rate from the IWG's August 2016 SCC report as the main CO_2 adder in modeling impacts of a potential price that could be placed on CO_2 emissions from customers' usage of natural gas.

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. Some of these regulations could have the potential to increase Cascade operating costs and/or reduce sale of natural gas.

1. **Washington**

   Since the previous IRP, the Washington State Supreme Court invalidated the Clean Air Rule (CAR) for non-emitters (natural gas distribution companies) and remanded the case to Thurston County Superior Court for further proceedings. Washington environmental legislative action included carbon tax and cap and trade proposals that did not pass. The Clean Buildings Act passed which provides new targets for energy efficiency and allows utilities rate recovery on certain renewable natural gas investments. The state also continued to pursue energy and building code revisions.

   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 the court issued a 5-4 decision on January 16, 2020 vacating in-part and upholding in-part the lower court's decision to vacate CAR. The Court conclusively determined that the Clean Air Act's purpose section does not authorize Ecology to set emission standards for "indirect emitters" (such as natural gas utilities). The court went on to sever the portions of the rule as they applied to actual emitters (the direct emitter sources) and remanded to the Superior Court for further proceedings. HB 2957 was introduced to amend existing law to allow CAR to regulate "indirect emitters". A compromise between parties on certain issues in the bill was successful and the bill died when the legislature adjourned.

At this time, parties have filed status reports with the court agreeing to delay proceedings in Superior Court. Ecology has expressed the desire to evaluate its position on whether additional regulatory changes may be needed and requested additional time due to delays caused by COVID-19 and mandatory furloughs.

b. Washington Department of Ecology (Ecology) - GHG Assessment for Projects (GAP)

At the end of 2019, Governor Inslee directed Ecology to adopt a rule by Sept 1, 2021 to consider GHG emissions in environmental assessments for major industrial projects and major fossil fuel projects with significant environmental impacts. Ecology announced rulemaking commencement on April 30, 2020 and is currently engaging stakeholders to obtain input for drafting a proposed rule in late 2020. Ecology has requested input on whether and how the agency should incorporate mitigation of GHG emissions from projects that would require review. If mitigation of emission would be required, Cascade anticipate the cost to utilize natural gas for these types of projects would increase. This regulatory action does not have an impact on this IRP but may impact future IRPs.

c. 2019 Clean Buildings Act - HB 1257

On July 28, 2019 HB 1257, the Washington bill concerning energy efficiency improvements, went into effect. The law set new requirements for conservation planning, and energy efficiency target setting, as well as new rules governing the development of conservation potential assessments. It also added language to RCW 80.28 to allow for the recovery of certain renewable natural gas investments under the guidance of the WUTC. Cascade is currently engaged in workshops and other regulatory discussions to fully understand the changes that will need to be made to energy efficiency programs, and what opportunities may arise concerning renewable natural gas. Further details on energy efficiency and renewable natural gas plans can be found in Chapter 12, Two-Year Action Plan.

HB 1257 also added language to RCW 80.28 instructing utilities to utilize the two and one-half percent discount rate in Table 2 of the IWG August 2016 update to the Social Cost of Carbon, and adjust costs for inflation, in applying a cost of carbon in avoided cost calculations. Cascade has applied this methodology to avoided costs presented in this IRP.

d. Building Code Changes

On November 8, 2019, the Washington State Building Code Council (“SBCC”) voted to approve the Fuel Normalization and Additional Credits tables in Section R406.2 with an electric emissions factor of 0.7 lbs/kwh instead of the previously approved carbon emissions factor of 0.8 lbs/kwh for electricity. Under this new language, an electric heat pump receives one credit assigned when the 0.7 lbs/kwh carbon emissions factor is used. This results in a full credit going to homes using a minimum code electric heat pump and has tilted the selection of heating systems in that direction and away from efficient gas furnaces (which do not receive similar treatment under the code). Cascade continues to evaluate the impact of the code change and address this in the Company’s 2021 Conservation Plan.

e. Washington Department of Commerce (Commerce) State Energy Strategy

The Department of Commerce has released the first draft of its 2021 State Energy Strategy. As part of its planning efforts, Commerce commissioned a study with Evolved Energy Research to identify cost-effective pathways to decarbonization. The draft Energy Strategy concludes that full electrification is the best-cost pathway for decarbonization. The draft also includes several recommendations that would impact all facets of energy policy—such as integrated resources planning— and would have significant impacts on both energy costs and grid reliability. Cascade believes it will be essential for the Commerce report to be compared against a review of other decarbonization and economic studies before a final draft of policy recommendations is released. In the meantime, Cascade will continue to monitor Commerce's development of the State Energy Strategy and provide ongoing feedback as appropriate. This does not impact this IRP but may impact future IRPs.

f. Other Washington 2020 Legislative Activity

Cascade is keeping apprised of additional legislation in Washington State with the intent to reduce GHG emissions. No carbon pricing legislative initiatives in Washington passed into law in the last session. A couple bills affecting GHG emissions reductions from this last session that passed are HB 2311 and HB 2518. HB 2311 updated Washington's GHG emissions reduction goals to 45% below 1990 levels by 2035, 75% below 1990 levels by 2040, and 95% below 1990 levels by 2050. HB 2518, the Natural Gas Transmission bill, requires natural gas transmission and distribution companies to expedite mitigation of hazardous leaks, reduce as practicable non-hazardous leaks, and provides utilities rate recovery to mitigate these leaks. Cascade is working with the other distribution companies in Washington state on implementing these actions.

Cascade anticipates some form of carbon emissions reduction or carbon pricing legislation could be introduced in the next legislative session which would have a direct impact on the use and price of natural gas. These legislative activities do not impact this IRP but may impact future IRPs.

g. Preliminary Washington 2021 Legislative Activity

Two decarbonization bills have been introduced in the 2021 Washington legislative session that have significant potential to impact natural gas usage and rates in the State of Washington. These bills are not included in IRP modeling.

House Bill (HB) 1084 is a buildings decarbonization bill aiming to reduce statewide greenhouse gas emissions through electrification of residential and commercial buildings. The bill also promotes reduced energy consumption in buildings and institutes electrification of buildings by eliminating natural gas as a fuel choice for space and water heat. It would also remove a gas utility's obligation to serve. As introduced, the UTC would be required to establish a surcharge to natural gas utilities to switch their natural gas customers to electricity. The bill would additionally limit expansion of the natural gas distribution system for residential and commercial space and water heating.

As of the time of this filing, Senate Bill (SB) 5126 is a cap and invest program for reducing Washington economy-wide GHG emissions. Allowances, a portion of which would be required to be consigned at auction, would be provided to natural gas utilities at no cost for the benefit of customers, deposited for compliance, or a combination of both. The program would be implemented by the Department of Ecology by January 1, 2023.

Cascade is monitoring and engaging actively on both proposals.

2. Oregon

Since the previous IRP, Oregon environmental legislative action focused on GHG cap and trade programs and RNG development. As no GHG cap and trade program passed, Governor Brown released an Executive Order (EO) for state agencies to implement GHG reductions within their authority. Discussion of this EO is provided below. Discussion on Oregon RNG SB 98 legislation and subsequent PUC rulemaking are provided in Chapter 8, Renewable Natural Gas.

a. Executive Order (EO) No. 20-04

The Oregon State Legislature did not reach consensus on a direction this year regarding cap and invest legislation. As a result, Governor Kate Brown issued Executive Order 20-04, directing state commissions and agencies to facilitate achievement of new GHG emissions goals of at least 45% below 1990 levels by 2035, and at least 80% below 1990 levels by 2050. The order specifically directs the Environmental Quality Council (EQC) and Department of Environmental Quality (DEQ) to take actions necessary to cap and reduce GHG emissions. EO 20-04 is also intended to build on EO 17-20, Accelerating Efficiency in Oregon's Built Environment to Reduce Greenhouse Gas Emissions and Address Climate Change.

EO-20-04 includes 13 directives to multiple state agencies establishing reporting requirements and deadlines for implementing GHG reductions. Specifically, the EO directs the EQC and DEQ to take actions necessary to cap and reduce GHG emissions, consistent with the new GHG emissions goals from large stationary sources, transportation fuels, and other liquid and gaseous fuels, including natural gas. As the EQC and DEQ do not appear to have the authority to implement a market-based cap and trade type system, it is anticipated that emissions would be capped at a baseline emissions value with a limited number of allowances distributed to regulated entities and these allowances would decline over time. The EO directs DEQ to commence cap and reduce program options no later than January 1, 2022.

The first reporting deadline associated with EO 20-04 was on May 15, 2020. The Governor designated state agencies to report on proposed actions within their statutory authority to reduce GHGs and mitigate climate change impacts. DEQ published a report describing the EQC's legal authority to cap and reduce GHG emissions and proposed a process for rulemaking. DEQ has sought input from the public over the past months to inform the agency's rulemaking approach and design. Cascade has engaged in the public meetings and provided input to DEQ.

The GHG reductions for natural gas suppliers are likely to have substantive impacts to Cascade's customers. However, the rule has not yet been drafted and the cost impacts are currently unknown. If the same reduction goals are applied to natural gas distribution utilities as in past Oregon legislative actions, Cascade's residential and commercial customers may see rate increases in their bills starting in the first year the reductions are to be implemented and increase over time as compliance requirements would increase.

DEQ plans to commence formal rulemaking work with the appointment of a rules advisory committee (RAC) by the end of November 2020. To help inform the rulemaking design and considerations for natural gas suppliers, Cascade has nominated Alyn Spector from Cascade for the RAC. DEQ plans to host RAC meetings and any additional public or invited stakeholder meetings in early 2021 and to release a notice of rulemaking packet for public comment in Summer/Fall 2021. The rulemaking packet is expected to be provided to the EQC in Fall 2021. DEQ has not determined a final cap and reduce timeline/trajectory or compliance obligation for regulated entities. Cascade will continue to monitor these potential impacts as part of its resource planning. This rulemaking does not have an impact on this IRP but is provided for general understanding of regulatory activities occurring in Cascade service areas in the neighboring state of Oregon.

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 next Power Plan is expected to be published in 2021. 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% 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 and in 2017, former President Trump withdrew the U.S. from the Paris Climate Agreement. President Biden re-entered the U.S. into the Paris Climate Agreement on February 21, 2021. Cascade will monitor this for any impacts it may have on future IRP cycles.

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. Also, Snohomish County, which overlaps Cascade's service area, created an ad hoc Climate Advisory Committee in 2019 to provide recommendations in the next few years that encourage adoption of policies, programs, and practices in order to reduce GHGs, address climate change, protect public health, and preserve the natural environment within the county. The Company is considering how it should utilize local policies as these goals are stated as aspirational and goals continue to be evaluated by these local entities.

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. Cascade has also observed adoption of energy action plans to switch from gas to electric in the Cities of Ashland and Eugene.

1. **City of Bellingham, Washington**

   The City of Bellingham passed a GHG Reduction and Renewables Energy Targets resolution in March 2018 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 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 included 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. However, the City 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. Cascade worked together with PSE to include Cascade's input. Minimal input was accepted from Cascade, and efforts seemed primarily focused on electrification to the exclusion of other decarbonization strategies that utilize offsets and renewable natural gas as pathways to carbon reduction.

   The task force first met on September 5, 2018 and continued to meet regularly through late 2019. On December 2, 2019, the task force finalized a report of GHG reduction recommendations. City staff reviewed the Task Force recommendations and narrowed them down to those most likely to be integrated successfully and discussed the results with the City Council. City staff used a tiered ranking system for this evaluation, considering such factors as whether the measure has already been implemented, needed further research and analysis, or tabled for future review. The measures will go through a triple bottom line "plus" assessment before adding to the City's Climate Action Plan (CAP).

   In the next 6 months, the City Council will amend the CAP, and City staff will develop a Climate Implementation Plan. The implementation plan will be reviewed ongoing. The City is currently working cross-departmentally to determine which of the CATF's recommendations should be integrated into Bellingham's Climate Action Plan. Ten recommendations are currently being vetted, including encouraging the State to ban internal combustion engine vehicles, expanding weatherization efforts, and disallowing the use of natural gas in new homes and buildings. At this time, the City Council is seeking additional information before these measures are folded into the CAP. Additional detail can be found on the following City of Bellingham webpage: https://www.cob.org/services/environment/climate/Pages/program.aspx.

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.

Whatcom County established a Climate Impact Advisory Committee which provides review and recommendations to the Whatcom County Council and Executive on issues related to the preparation and adaptation for, and the prevention and mitigation of, impacts of climate change. The committee has continued to meet on climate and energy policy.

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 Council passed another resolution, Resolution 3099, which created a Climate Action Steering Committee (CASC). The CASC provided 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 was appointed to the CASC, and 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 authored a plan recommending a set of strategies to guide both the City and the surrounding community in achieving its goals.

On December 4, 2019, the Bend City Council approved the Climate Action Steering Committee's (CASC) recommendations concerning a pathway to reducing its fossil fuel use by 40% by 2030, and by 70% by 2050. Cascade publicly supported the recommendations presented to the City. Cascade is now engaged with Bend City staff and other members of the community to identify ways to help the City meet its targets. Possible pathways forward include partnerships on the integration of biogas, and possible carbon offset programs.

Natural Gas Industry Emissions

From review of EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2018, in 2018 the oil and gas sector was estimated to emit about 10.7% of the total GHG emissions from all industries, equating to approximately 319 million metric tons of CO_2 equivalent per year. LDC facilities and operations contribute to GHG emissions generally through fugitive methane emissions and leaks from pipeline infrastructure, as well as from combustion of fuel in compressors. EPA's emissions estimates indicate a little over four percent of oil and gas sector emissions are from LDC infrastructure, equating to about 13 million metric tons of CO_2 equivalent per year.

Cascade is required to report annual facility GHG emissions to EPA and the State of Washington. These emissions have generally been in the range of about 24,000 to 27,000 metric tons of CO_2 equivalent per year. Cascade's facility GHG emissions in Oregon are lower and have not been required to be reported to EPA or the State of Oregon in the past. However, the Oregon Department of Environmental Quality finalized a GHG reporting rule earlier in 2020 that requires Cascade to report annual facility GHG emissions to the State of Oregon starting in 2021.

Upstream Natural Gas Value Chain 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.

Noted in Chapter 3 of the NWPCC's Seventh Power Plan,[1] the uncertainty around how to consider impacts from methane emissions and what assumptions to make about methane impacts from the regions' supply of natural gas and infrastructure:

> *"…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 from new wells which have lower fugitive emissions…"*
>
> *"…unless new pipeline capacity is needed, fugitive emissions from pipeline leaks remain relatively constant…"*

As the NWPCC has prepared for the next Power Plan release, the Council further explored upstream emissions for modeling emissions from fossil-fired electric generating units. The Council created a Natural Gas Advisory Committee (NGAC)[2] in June 2020 which met to evaluate upstream methane emissions studies and to provide input to the Council on upstream methane emissions. Based on this review, the NGAC recommended the Council use an upstream methane release rate of 1.37% for natural gas used in the region. This was derived after reviewing studies and choosing a value that is a weighted mix from an estimate of gas from the British Columbia and U.S. Rockies. Cascade, through membership in the Northwest Gas Association (NWGA), expressed concern in a letter to the Council[3] about the upstream emissions loss rate chosen by the Council for the U.S. Rockies, among other concerns regarding the application of upstream emissions to only certain generation resources. In the letter, NWGA took exception to the application of a 2.47% emission rate for the U.S. Rockies since it is not believed to represent an appropriate regional emission rate, is an older snapshot in time, and was derived from site-based estimates in the Environmental Defense Fund (EDF) study published in Science Direct (Alvarez, 2018)[4] and not the source-based (life-cycle) emissions estimates reviewed in that study which were more closely approximate to the EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks.[5]

Per language added to RCW 80.28.395[6] from passage of HB 1257 in 2019, natural gas utilities are to include upstream emissions in the avoided cost calculations in

[1] NWPCC's Seventh Power Plan.
[2] NWPCC Natural Gas Advisory Committee webpage.
[3] Letter included in the June 17, 2020 Council briefing packet.
[4] Science, 13 Jul 2018, Vol. 361, Issue 6398, pp. 186-188.
[5] EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks website.
[6] RCW 80.28.395.

determining conservation program potential. Cascade reviewed the upstream emissions values from the Council's evaluation of natural gas supplied from Canada and the U.S. Rockies,[7] One Future Coalition[8] reported values, values chosen by other utility companies, and EPA reported GHG data from the oil and gas industry segments in choosing an upstream emissions factor for estimating upstream emissions. For this IRP, Cascade has chosen to use a 0.77% upstream emissions loss rate for natural gas supplied from Canada and a 1.0% upstream emissions loss rate for natural gas supplied from the U.S. Rockies.

For the U.S. Rockies, the 1.0% upstream emissions loss rate chosen is a rate calculated by the American Gas Association (AGA) in a June 2020 Energy Analysis Report[9] which is based on 2018 emissions data compiled by EPA in the agency's most recent Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018.[10] AGA's report explains the calculation of this emissions loss rate the assumptions applied. There are other estimates of upstream emissions reported by various entities and sources. Cascade has chosen to use the 1.0% loss rate AGA calculated for the U.S. Rockies since it is based on the EPA GHG inventory[11] which considers emissions data regularly evaluated and updated, vetted through engagement with industry and technical experts and other public stakeholders. This value is also in the range of other upstream emissions factors noted in recent project literature, as provided in Table B.4 of Appendix LCA-B: Upstream Lifecycle Emissions in Appendix B: PSE Tacoma LNG Project GHG Analysis Final Report of the Final Supplemental Environmental Impact Statement (SEIS) for the Proposed PSE Tacoma LNG Plant[12] and the 3-StudyResults tab of the NWPCC Methane 2021 Power Plan Workbook.[13]

Cascade also notes that the 1.0% loss rate chosen is in the range of, but notably higher than, the emissions intensity reported in One Future Coalition's 2018 Methane Intensities Report.[14] One Future reported an estimated 0.33% methane lost per methane throughput from the natural gas segment considering data compiled and reported through their membership. Some of the members of One Future are within the natural gas supply chain for Cascade and their One Future membership would serve to further support Cascade's use of a loss rate in the range of 1.0%.

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[7] Ibid 6-17.

[8] One Future 2018 Methane Emission Intensities – A Progress Report.

[9] AGA Energy Analysis 2020, June 2020, Understanding Updates to the EPA Inventory of Greenhouse Gas Emissions from Natural Gas Systems.

[10] Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018.

[11] Ibid.

[12] Final Supplemental Environmental Impact Statement for the Proposed PSE Tacoma LNG Plant.

[13] NWPCC Methane 2021 Power Plan Workbook.

[14] Ibid 6-18.

The British Columbia upstream emissions loss rate of 0.77% that Cascade is using for Canada sourced natural gas is based on data reported in a recent environmental impact study for the PSE Tacoma LNG plant, Kalama Manufacturing and Export Facility and the 2019 Puget Sound Energy IRP.[15] Also, NWPCC's NGAC applied this data in estimating the upstream emissions loss factor for Canada sourced natural gas in their analysis. The study for the PSE project includes data modeled by a consultant for the Puget Sound Clean Air Agency's review of life cycle GHG emissions for that project.

The emissions loss rates reviewed by Cascade and others above may also vary depending on whether they represent upstream methane emissions alone or if they also include upstream GHG combustion emissions. If the loss rates would only include methane fugitive emissions upstream, considering that those emissions are the majority of GHG emissions that occur upstream in the natural gas value chain as understood through review of the oil and gas industry emissions tables in EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018.[16]

Cascade acknowledges that the Canada and U.S. Rockies upstream emissions loss rates are estimates and may be updated in future as more accurate methods of estimating upstream emissions from the oil and gas industry are realized. The Company will continue to monitor developments and studies in this area to revisit and update the upstream emissions factor and estimation methodologies applied to avoided cost calculation in future IRPs.

[15] Ibid.

[16] Ibid 6-18.

Cascade's Upstream Emissions Factor Calculation

In this section, Cascade demonstrates the upstream emissions calculation. The equations and inputs for calculating upstream emissions and the emissions rate used in the avoided cost calculation are shown and explained below:

$$ER_T = \frac{1\ dekatherm}{10\ therms} * \frac{1\ mmbtu}{1\ dekatherm} * (UER_{CO2e} + CER_{CO2e})$$

And;

$$UER_{CO2e} = UER_{CH4} * GWP_{Methane}$$

And;

$$CER_{CO2e} = EF_{EPA\ Subpart\ NN}\ /Heating\ Value$$

And;

$$UER_{CH4} = \rho\ methane * \frac{\%\ methane\ in\ natural\ gas}{Heating\ Value} * ULF_{Weighted\ \%}$$

And;

$$ULF_{Weighted\ \%} = (ULF_{US\ Rockies\ \%} * \%\ Cascade\ U.S. Rockies\ Supply) + (ULF_{Canada\ \%} * \%\ Cascade\ Canada\ Supply)$$

Where;

- ER_T = Total emissions rate in CO_2e Metric tons per therm of natural gas delivered, the sum of the upstream emissions rate and the customer end-use emission rate.
- UER_{CO2e} = Upstream emissions rate (emissions estimated to occur upstream of customer receipt) in CO_2e metric tons per MMBtu of natural gas delivered.
- UER_{CH4} = Upstream emissions rate (emissions estimated to occur upstream of customer receipt) in CH_4 metric tons per MMBtu of methane delivered.
- CER_{CO2e} = the customer emission rate, from customer end-use combustion of natural gas delivered, in CO_2e metric tons per MMBtu.
- $GWP_{Methane}$ = 25, the global warming potential (GWP) of methane at 100 years. This GWP value is from Chapter 2, Table 2.14, of IPCC 4th Assessment Report AR4 Climate Change 2007: The Physical Science Basis)[17] to convert methane into CO_2e at 100 year.

[17] IPCC AR4 Climate Change 2007: The Physical Science Basis, Chapter 2.

- $EF_{EPA\ Subpart\ NN}$ = 0.0544 metric tons of CO_2 emitted per the combustion of 1 Mcf of natural gas, an EPA emission factor from 40 CFR Part 98 Subpart NN.[18]
- $Heating\ Value$ = 1.07904 mmbtu per Mcf of natural gas. This is a 2019 average of the heating value of gas supplied to Cascade's distribution system in Washington and was taken from Cascade's 2019 annual GHG emissions report to EPA.[19]
- $\rho\ methane$ = 0.0192 metric tons of methane per 1 Mcf of methane, the density of methane as provided in 40 CFR Part 98 Subpart W.[20]
- $\%\ methane\ in\ natural\ gas$ = 93.4%. This value represents an average percentage of methane in natural gas of 93.4% from EPA GHG inventory data and is discussed on page 14 of AGA's June 2020 Energy Analysis Report.[21] Cascade reviewed data from September and October 2020 on Williams', (Northwest Pipeline) website,[22] analyses posted for public review, and confirmed locations where Cascade receives natural gas were in the range of 93.4%.
- $ULF_{Weighted\ \%}$ = the upstream loss factor expressed in percent methane emitted upstream per total methane delivered and is a weighted average of the different methane emission loss factors representing the estimated natural gas that is supplied to Cascade from the U.S. Rockies or Canada.
- $ULF_{US\ Rockies\ \%}$ = 1.0%. This upstream loss factor represents an estimate of the percent of methane lost from infrastructure supplying natural gas from the U.S. Rockies. As discussed in the Upstream Natural Gas Value Chain Emissions section above, Cascade has chosen at this time to use a 1.0% loss rate for gas supplied from the U.S. Rockies.
- $ULF_{Canada\ \%}$ = 0.77%. This upstream loss factor represents an estimate of the percent methane lost from infrastructure supplying natural gas from Canada. As discussed in the Upstream Natural Gas Value Chain Emissions section above, Cascade has chosen at this time to use a 0.77% loss rate for gas supplied from Canada.
- $\%\ Cascade\ U.S.\ Rockies\ Supply$ = 35.8% for Cascade's Washington customers, estimated using 2019 gas supply data.
- $\%\ Cascade\ Canada\ Supply$ = 64.2% for Cascade's Washington customers, estimated using 2019 gas supply data.

[18] e-CFR 40 CFR Part 98 Mandatory Greenhouse Gas Reporting, Subpart NN – Suppliers of Natural Gas and Natural Gas Liquids.
[19] Cascade Natural Gas Corporation Washington 2019 EPA Subpart NN GHG Emission Report.
[20] e-CFR 40 CFR Part 98 Mandatory Greenhouse Gas Reporting, Subpart W – Petroleum and Natural Gas Systems.
[21] Ibid 6-18.
[22] Williams Northwest Pipeline Daily Gas Quality Values website.

Based on the equations and input explained above, Cascade estimated a total emissions rate, ER_T, to be 0.00540 CO_2e metric tons per therm of natural gas delivered and uses this value in avoided cost calculations. Further background on this calculation and spreadsheet used to memorialize this calculation was discussed in a supplemental TAG meeting on October 15, 2020.

As noted in the equations section, Cascade utilizes the 100-year global warming potential (GWP) for methane of 25 per Chapter 2, Table 2.14, of IPCC 4th Assessment Report (AR4) Climate Change 2007: The Physical Science Basis[23] to convert to CO_2e in the upstream emissions rate of UER_{CO2e} calculation. Cascade has chosen to follow EPA's application of GWPs for methane in the agency's Inventory of U.S. Greenhouse Gas Emissions and Sinks at this time. EPA provides explanation on the agency's *Understanding Global Warming Potentials* webpage,[24] explaining the agency is complying with the United Nations Framework Convention on Climate Change (UNFCCC) [Review Practice Guidance[25] published in March 2016] reporting standards. The UNFCCC's guidance instructs GHG inventories to be compiled using the AR4 GWPs.

Cascade acknowledges the IPCC 5th Assessment Report published in 2014 includes 100-year GWPs for methane in the range of about 28-36.[26] The company expects this range may continue to be refined in future. Cascade notes that ICF included some discussion on the uncertainties of the IPCC AR5 GWPs for methane in their report Finding the Facts on Methane Emissions: A Guide to the Literature, published for The National Gas Council in April 2016.[27] The report notes that the AR5 GWPs for methane have not been adopted by all parties and parties using the values appear to choose different GWP values with differing warming feedback impacts and it was not clear to Cascade how others are making choices in applying the different values and how Cascade would accurately apply the feedback impacts. Cascade will continue to monitor and adjust the GWPs used in IRPs as more refinement occurs and as EPA and UNFCCC consider adoption of more recent GWPs into their processes.

Cascade Customer Emissions from Natural Gas Combustion

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

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23 Ibid 6-20.
24 EPA - Understanding Global Warming Potentials.
25 UNFCCC Review Practice Guidance, March 3, 2016.
26 IPCC AR5 Synthesis Report: Climate Change 2014.
27 ICF's Finding the Facts on Methane Emissions: A Guide to the Literature.

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 about 1.4 million metric tons of CO_2. Emissions from non-core customers have totaled in the range of about 2.5 to 3 times higher than total emissions from core customers, depending on the year and whether customers switch from non-core to core customer arrangements.

Cascade GHG Emissions Reductions

Cascade 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 in the following section.

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, Cascade 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, Cascade will conduct incident analyses on all excavation damages and report the relevant data to EPA as the agency finalizes the reporting forms.

      Specifically, Cascade demonstrates its commitment to this program through implementation of BMPs to promote leak reductions.

Cascade created the position of Public Awareness and Damage Prevention Coordinator in 2018. 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 also focuses on working with contractors or third parties that are repeat offenders. By identifying and reaching out to these repeat offenders prior to work beginning on their respective project, Cascade expects to see a reduction in excavation damages throughout the Company's service areas.

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

Beyond Cascade'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 pipeline materials such as polyethylene and steel are used to replace older materials. Since 2012, Cascade has replaced nearly 75 miles of early vintage steel pipe in Washington with new steel or polyethylene pipe, ranging from service lines up to 12-inch mains. Also, Cascade has no unprotected steel pipe and no leak-prone cast iron pipe in its systems.

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 lowered energy consumption and 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 4,000 to 5,000 metric tons of CO_2/year. More emission reductions will be realized as the Company's programs mature and continue to grow. Please see Chapter 7, Demand Side Management, for additional details.

In addition to the conservation and efficient use of natural gas, the direct use of this resource can also be a significant source of carbon reduction. Source efficiency is an important consideration when developing programs and policies to achieve meaningful carbon reductions. 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 Cascade has encouraged the direct use of natural gas when paired with strong energy efficiency measures. Accelerating this effort in tandem with the integration of renewable natural gas 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 2020 IRP. Since there are currently no GHG reduction requirements finalized for 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 Chapter 10, Resource Integration.

1. 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. The new 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

Cascade is modeling the SCC as the main carbon adder in its IRP. Cascade is specifically modeling the two and one-half percent discount rate SCC published in the U.S. IWG on the Social Cost of Greenhouse Gases' Social Cost of Carbon. The IWG SCC values based on this discount rate are shown below in Figure 6-1, sourced from the IWG's publication Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866.[28] Cascade is following WUTC guidance as outlined in Docket U-190730 by using the SCC with a two and one-half percent discount rate, and by scaling it to real dollars by using the GDP price index as published by the Bureau of Economic Analysis.

[28] *See* Page 4 of https://www.utc.wa.gov/regulatedIndustries/utilities/Documents/Technical%20Support%20Document%20Social%20Cost%20of%20Carbon%20August%202016.pdf

Figure 6-1: Social Cost of CO_2, 2010-2050 (in 2007 dollars per metric ton of CO_2)

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. Cap and Trade

Cascade is modeling its cap and trade forecast after the California Energy Commission's Integrated Energy Policy Report (IERP) 2019 Preliminary GHG Allowance Price Projection. Cascade projects this to equate to a scaling carbon emissions cost, starting at $24.70/metric ton in 2021 and capping at $61.50/metric ton from 2030 onward. This provides an example of cap and trade program approach to carbon pricing, occurring in the nearby state of California and which has been in place for several years.

c. U.S. House of Representatives Market Choice Act

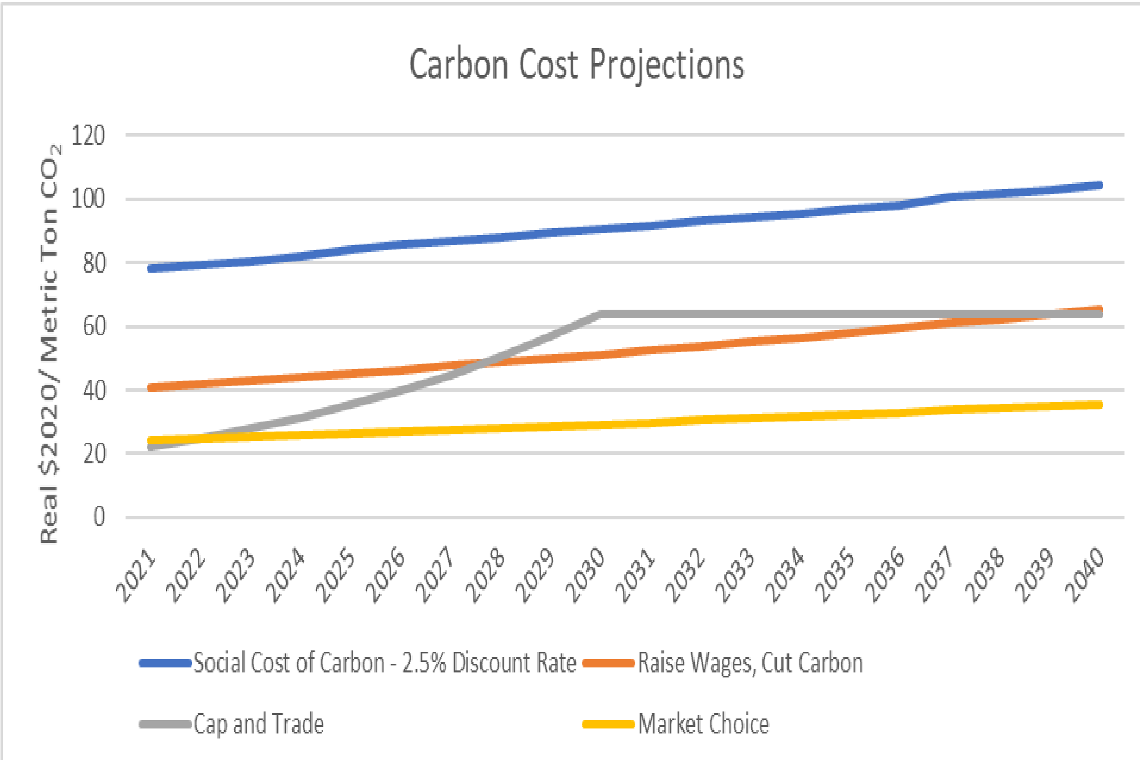
Cascade is modeling the Market Choice bill as a CO_2 adder sensitivity since it represents recent carbon legislation proposed at the federal level in the past couple years. This bill includes provisions for addressing GHGs, including a carbon tax for combustion of fossil fuels. The bill proposes to apply an initial tax of $24/ton of CO_2 equivalent emitted from fossil fuel combustion starting in 2020 which would escalate annually by two percent 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/year. Cascade models the two percent 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.

d. U.S. House of Representatives Raise Wages, Cut Carbon Act (HR 3966)

Cascade is modeling the Raise Wages, Cut Carbon Act as a CO_2 adder sensitivity since it represents the most current carbon legislation proposed at the Federal level. This bill would apply a tax to importers of fossil fuels and fluorinated greenhouse gases. The tax would start at $40/metric ton of CO_2 equivalent emitted and increase 2.5%/year plus inflation. Cascade models the 2.5% annual increase, plus inflationary adjustment, in this IRP analysis, and assumes GHG emissions caps are met and no additional penalties would be applied to the carbon tax.

Figure 6-2 illustrates all the CO_2 adder values discussed above over an approximate 20-year period.

Figure 6-2: Carbon Cost Projections



Conclusion

There are currently no GHG emissions reduction requirements that have been finalized for 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.

The Company is exploring renewable natural gas opportunities to comply with new requirements for the company to establish prudently acquired renewable natural gas projects or environmental attributes accordingly with HB 1257. Implementing renewable gas into Cascade's system would serve to reduce GHG emissions from the natural gas supply chain. Further discussion of renewable natural gas can be found in Chapter 8, Renewable Natural Gas.

Cascade will review the NWPCC's next Power Plan to inform the Company on regional energy and GHG emissions analyses, cost impacts and potential future regional policy development. The Company will continue to monitor and be engaged in Cascade's service area community-driven efforts in adopting GHG emission reduction targets. As state and federal GHG emissions policy and regulatory activity are introduced, Cascade will monitor to consider and incorporate these potential impacts into the Company's IRP process.

Chapter 7

Demand Side Management

Overview

Key Points

- Cascade projects 45.22 million therms of energy efficiency in Washington over the 20-year planning horizon.
- This plan is informed by Cascade's stand-alone Conservation Advisory Group (CAG).
- 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.
- 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 the reduction of natural gas consumption through the installation of energy efficiency measures such as insulation or more efficient gas-fired appliances, or through other load management programs such as demand response efforts that shift gas consumption to off-peak periods. The Company's primary means for reducing load is through energy efficiency programs that provide customers with financial incentives to install energy efficiency measures or appliances. The Company's energy efficiency programs in Washington and Oregon offer rebates/incentives to homeowners, commercial customers, industrial customers, and builders to invest in energy efficiency measures. Because the customer must ultimately make the decision to invest in an energy efficiency measure, DSM is unlike other supply side resources which the Company can independently secure.

This Chapter presents the methodology used to determine the Company's DSM supply curve for the 20-year planning period, the Company's annual savings targets, and a narrative DSM goal achievement.

Chapter 6 considers state and federal policy initiatives addressing carbon mitigation that may increase the cost of natural gas service, thus increasing the amount of cost-effective DSM.

Chapter 5 outlines the avoided cost of natural gas which 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 serves to represent the cost that could be avoided through energy efficiency programs. The average avoided cost per therm increased from ~$0.32 in 2018 to ~$0.57 in 2020, representing an average increase of ~78%. Further, the long-term discount rate decreased from 4.43% to 3.40%, aligned with this IRP's models is tied to the average 30-year mortgage rate; a lower discount rate combined with higher avoided costs increases efficiency potential.

The Company's energy efficiency (or demand side) resources are acquired from individual customers in the form of unused energy. This Chapter is responsive to the Washington Utilities and Transportation Commission's (WUTC or Commission) requirement that natural gas utilities consider cost-effective DSM resources in their energy portfolio on an equal and comparable basis with supply side resources.

In the natural gas industry, DSM resources are energy efficiency 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 other commercial/industrial equipment. By influencing customers through energy efficiency outreach to reduce their individual demand for gas, Cascade can reduce 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.

By incentivizing efficiency from customers versus conservation to reduce overall system load, the Company can more accurately track load reduction and does not solely depend on customer behavioral change. Energy conservation involves using less energy by adjusting behaviors and habits. Energy efficiency, on the other hand, involves using technology that requires less energy to perform the same function.

Cascade targets the saving of approximately 57 million therms systemwide over the 20-year planning horizon; 45 million therms in Washington and 12 million therms in Oregon.

DSM Resources

There are two basic types of demand side resources: base load resources and weather dependent resources. Base load resources offset gas supply requirements throughout the year, regardless of weather conditions. Base load DSM resources include equipment such as high-efficiency water heaters and higher efficiency cooking equipment. Weather dependent DSM resources are measures whose therm savings increase during cold weather. For example, a high-efficiency furnace will lower therm usage in the winter months and will provide little to no savings in the summer months. These types of weather dependent measures for space heating offset some peaking or seasonal gas supply resources and are typically more expensive than base load supplies (such as water heating).

Energy efficiency is delivered to Cascade customers through a portfolio of services in Washington and Oregon.

Cascade's Washington Energy Efficiency Program

Cascade delivers energy efficiency services to its Washington core customers through the Company's Energy Efficiency (EE) department for the Residential program and a third-party implementer, TRC Companies, for Commercial/Industrial (C/I). Cascade also is a funding member of the Northwest Energy Efficiency Alliance (NEEA) which provides additional efficiency savings by joining with other utilities to promote market transformation.

NEEA is a consortium of funding utilities and energy efficiency stakeholders:
- Natural gas market transformation efforts have longstanding effects on future therm saving opportunities.
- The goal is to increase market adoption of energy efficient natural gas products and practices in the future.

Cascade manages the following Washington residential incentive programs:
- Residential (Existing and New Home Construction, and some Multifamily)
    - Single family, moderate income, manufactured homes
    - Weatherization, HVAC & water heating equipment
    - Low income

TRC Companies manage the following Washington C/I programs on Cascade's behalf:
- Commercial (Existing and New Construction)
    - Retail, offices, schools, groceries & other associated market segments
        - Weatherization, controls, HVAC & water heating equipment
- Industrial & Agriculture (core customers)
    - Manufacturing facilities, greenhouses
        - Process improvements, HVAC & water heating equipment, operations and maintenance

The Company is committed to meeting 100 percent of its conservation target. Cascade files an annual conservation plan by December 1 of each year, and files an annual conservation achievement report by June 1 each year. The Conservation Plan serves to provide greater specificity for achieving energy efficiency and conservation where possible and will serve as a biennial report from 2021 forward.

Cascade's Oregon Energy Efficiency Program

Energy Efficiency and conservation offerings for the Company's Oregon customers are offered through the Energy Trust of Oregon with program planning developed through the Cascade Oregon IRP cycle. (This subsection regarding Oregon DSM is included for informational purposes only to depict different program delivery in Oregon, although with similar methodologies.)

Energy Trust administers the following EE programs in Oregon on Cascade's behalf:

- Residential (Existing and New Home Construction)
    - Single family, moderate income, manufactured homes
        - Weatherization, Heating Ventilation and Air Conditioning (HVAC) & water heating equipment
- Commercial (Existing, New and Multifamily)
    - Retail, offices, schools, groceries & other associated market segments

    - Weatherization, controls, HVAC & water heating equipment
- Industrial & Agriculture (Core Sites)
  - Manufacturing facilities, greenhouses
    - Process improvements, HVAC & water heating equipment, operations and maintenance

Conservation Potential Assessment

Cascade now performs a Conservation Potential Assessment (CPA) biennially. A CPA consists of estimates of potential reductions in annual energy usage for natural gas customers in the Cascade service territory from energy efficiency. This process is outsourced as a means to maintain impartial findings.

Cascade employs a third-party firm, Applied Energy Group (AEG), for the development of its CPA. AEG is an industry leader who developed Cascades’ 2018 CPA and who works with other regional utilities on their assessments. The conservation potential for this IRP is calculated through AEG’s forecasting model.

Load Management Analysis and Planning Tool (LoadMAP)

AEG’s LoadMAP model is separated into three results modules:

- LoadMAP Baseline takes a units-based approach to stock turnover, tracking equipment installations in each year.

- LoadMAP Potential forecasting module calculates potential savings relative to the baseline projection developed in the previous module. This model begins with the detailed stock accounting results from the LoadMAP Baseline analysis but converts all measures to single line-items for transparency and ease of review.

- LoadMAP Results summarizes modeling outputs from the two prior modules at both a high level and in measure-by-measure detail. This module does not perform any potential estimation calculations but is instead intended to serve as a centralized location for reviewing model outputs and summarizing results.

The model then forecasts efficiency potential in terms of Technical Potential, Achievable Technical Potential, Achievable Economic Utility Cost Test (UCT) Potential, and Achievable Economic Total Resource Cost (TRC) Potential. The end result provides Cascade with a full twenty-year forecast and the tools to develop a two-year action plan for Cascade stakeholders.

AEG's forecasting term definitions for the CPA and LoadMAP:[1]

> ***"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.*
>
> ***"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 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.*

Note: The cost-effectiveness threshold at 0.9 functions as a proxy for cost effectiveness measures seen as attractive but not cost-effective e.g. February 1, 2021, 0.30 windows are being offered at a UCT value of 0.75. This example demonstrates CNGC's response to market forces that require consideration of all portfolio possibilities.

> ***"TRC Achievable Economic** Potential is similar to UCT achievable economic potential in that it refines achievable technical potential through cost-effectiveness analysis. The TRC test assesses cost-effectiveness from a combined utility and participant perspective. As such, this test includes full*

[1] 2018 IRP, Appendix D

measure costs but also includes non-energy impacts realized by the customer if quantifiable and monetized."

Energy Efficiency 20-Year Potential Forecast

This IRP provides Cascade's Washington service territory therm savings potential as calculated by AEG in Phase 1 of the 2020 CPA. It is intended to add an improved level of transparency and granularity to the Company's planning processes from previous iterations.

AEG's updates for Phase I of Cascade's CPA included revised:

- Sector and segment energy baseline totals using 2019 billing data from CNGC
- Saturations (presence of equipment) based on updated billing data
- Residential annual equipment consumption data based on most recent DOE data
- Commercial end use intensities to align with Commercial Building Stock Assessment 2019
- Measure achievability ramp rates to improve model alignment with achieved program results
- Avoided costs to be consistent with Chapter 5 and include the social cost of carbon adder
- Model engine files to reflect the current AEG versions
- Reviewed and updated incentives for measures currently active in CNGC programs

A Phase 2 CPA will launch in January 2021 and will provide greater granularity on measure assumptions based off of 2020 program results. This will bring energy efficiency program models in line with natural gas regional protocols creating a nuanced approach to natural gas forecasting that works in parallel with the electric-focused Northwest Power and Conservation Council (NWPCC) 2021 Power Plan. At the completion of Phase 2 the Company will file the CPA with the Commission in early summer of 2021.

Phase 2 will cover:

- Calibration to 2020 calendar year actuals
- Comprehensive updates to all measure characterizations, including new and emerging measures identified during phase I
- Revisit electric NWPCC Power Plan participation rates in the context of gas programs
- Update non-energy impacts (NEIs) and values and evaluate potential under the UCT and TRC as well as the Resource Value test, which will be available pending future WUTC direction.
- Pending scope/budget addition: Characterize measures and estimate energy efficiency potential specific to Cascade's low-income customer

Please see Cascade conservation and energy efficiency climate zones used for program planning and evaluation within the CPA in Figure 13-14 in Chapter 13, Glossary and Maps.

The efficiency potential forecast in this IRP is calculated through the AEG LoadMAP model. The forecast is categorized by the three customer classes: Residential, Commercial and Industrial. The forecast for each class includes individual savings assumptions, market segmentations, and end uses (weather dependent measures have different residential savings potential by climate zone). The demand planning assumptions were provided by Cascade's Resource Planning Team (RPT) and, thereafter, the efficiency potential forecast outcome was delivered to the RPT for integration into the IRP demand forecast model.

> *"Load Management Analysis and Planning (LoadMAP™) 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."*[2]

This modeling tool 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. Recent annual program performance and measure data collected through energy efficiency programs are incorporated to establish incremental costs reflective of Cascade's service territory. This model provides transparency to all assumptions and calculations for estimating market potential.

Avoided costs are a key input to the potential model. They are variable costs for a unit of energy, or capacity, or both that are avoided through energy efficiency adoption. There is a direct correlation between variable energy costs and savings potential. The higher the variable energy costs, the greater the savings potential when those costs are avoided through energy efficiency. These per therm avoided costs flow through the forecast and are the primary factor in calculating efficiency potential.

The economic merits of the portfolio are gauged through standard industry cost-effectiveness tests. Each test compares the benefits of the energy efficiency savings to their costs defined in terms of net present value of future cash flows.

[2] 2018 IRP, Appendix D

While Technical and Achievable Technical potential are both theoretical limits to efficiency savings, Achievable Economic potential embodies a set of assumptions about decisions consumers will make regarding the cost and benefits of the equipment they purchase. Based on Northwest regional standard practice, Cascade's Energy Efficiency planning adopts the Achievable Economic potential to set goals under an array of possible future conditions.

Cascade applies the UCT for evaluating the Benefit Cost ratio across its programs. The Benefits in the UCT calculation are the avoided energy capacity costs for the lifetime of the measure; the Costs in this test are the program administrator's incentive costs and administrative costs.

In addition, LoadMAP concurrently runs all scenarios under the TRC for comparison. The cumulative long-term potential under the UCT remains higher at the programmatic level than the TRC, whereas this may not always be the case in the short-term.

Washington Market Segmentation & End Use

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.

The Residential market has three Climate Zone segments for Single family and some Multi Family housing stock, resulting in six market segments.

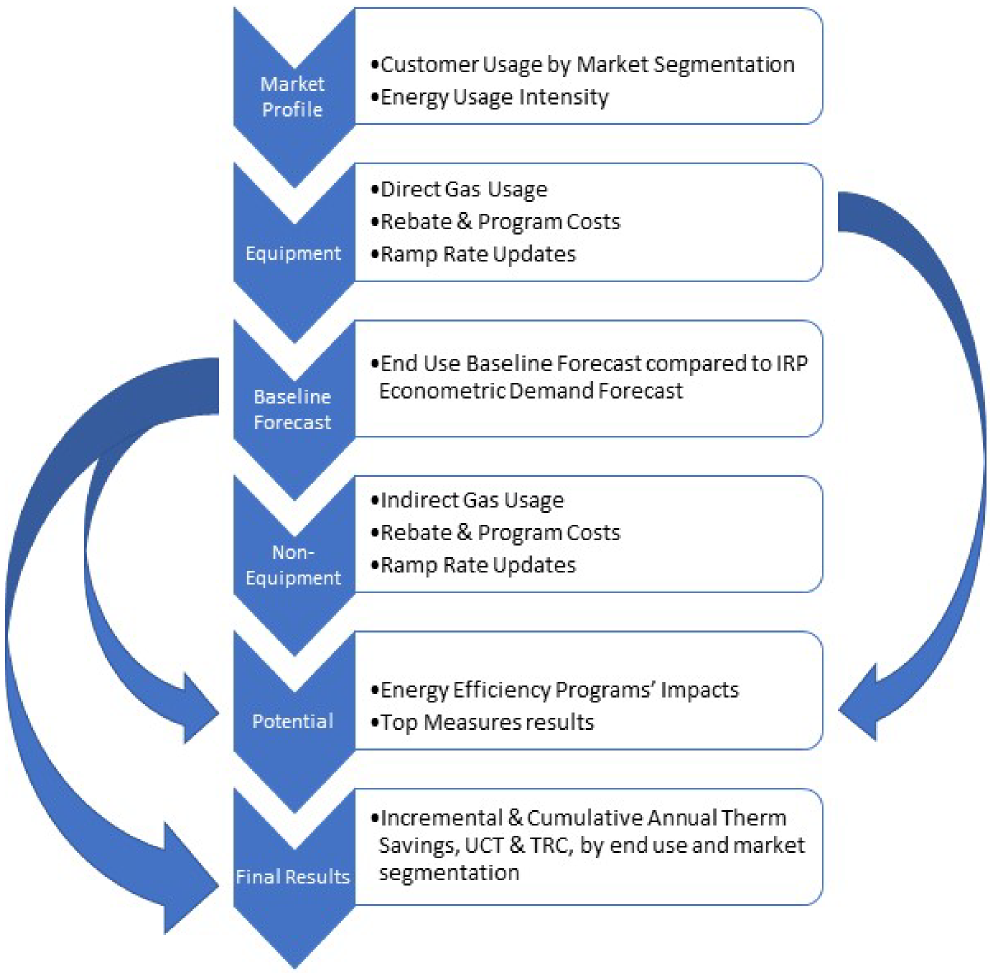
Commercial market segmentation includes: Office, Retail, Restaurant, Grocery, Education, Healthcare, Lodging, Warehouse, and a "Miscellaneous" category.

Industrial market is segmented by: Food Processing, Agriculture, Primary Metals, Stone/ Clay/ Glass, Petroleum, Paper & Printing, Instruments, Wood & Lumber Products, and an "Other" category.

End use categories include: Space Heating, Water Heating, Secondary Heating, Food Preparation, Appliances, Process Heating, and miscellaneous. All of these are ultimately categorized into baseline and peak load.

Figure 7-1 illustrates the LoadMAP efficiency potential process.

Figure 7-1: Savings Potential Process in LoadMAP



There are six separate workbooks that make up the full DSM forecast for each customer class. These 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.

AEG also provides advice on how to update ramp rates based on the NWPCC methodology and industry best practices.

As part of Phase 1 of the 2020 CPA, AEG updated ramp rates for measures within the Residential Program where appropriate, allowing for select measures to move forward more quickly along the NWPCC's ramp rates than initially anticipated. These include furnaces and insulation measures.

For example, the 2019 achievement for furnace savings is very close to the 2023 forecast. This demonstrates the adaptiveness of the model because the Company can intuitively update its progression along the ramp rates as appropriate. Figure 7-2 provides residential furnace ramp rate potential.

Figure 7-2: Residential Furnace ramp rate potential

Measure Category	CNGC 2019 Achievement	LoadMAP UCT Incremental Savings		
		2021	2022	2023
Furnace	170,680	144,883	149,666	171,801

The participation forecast is a function of the ramp rate and unit turnover from the baseline. In 2021, LoadMAP predicts 13,495 units will be retired in Cascade's Washington market, the majority of which could be incentivized as high-efficiency units (the baseline assumes some customers already buy higher efficiency units without program intervention). The ramp rate states that 32% of the available customers in 2021 will participate, which comes out to 3,409 units. Savings per unit vary by segment based on their base consumption, but run between 30-48 therms/year, depending on climate zone and segment. This type of analysis is repeated across all measures and programs to develop potential savings.

Progress to Plan

The Company's DSM efforts for this cycle and associated incorporation into the IRP provides context on the service territory current potential as calculated by AEG in Phase 1 of the 2020 CPA.

Company therm savings achievements for the past four IRP's compared to the 2020 IRP are in Figure 7-3. Totals for 2020 accomplishments will not be available until the annual report is filed in June 2021. The *Difference* column represents the percent change from goal to actual and the *Growth* column represents the percent change from one biennium IRP to the next.

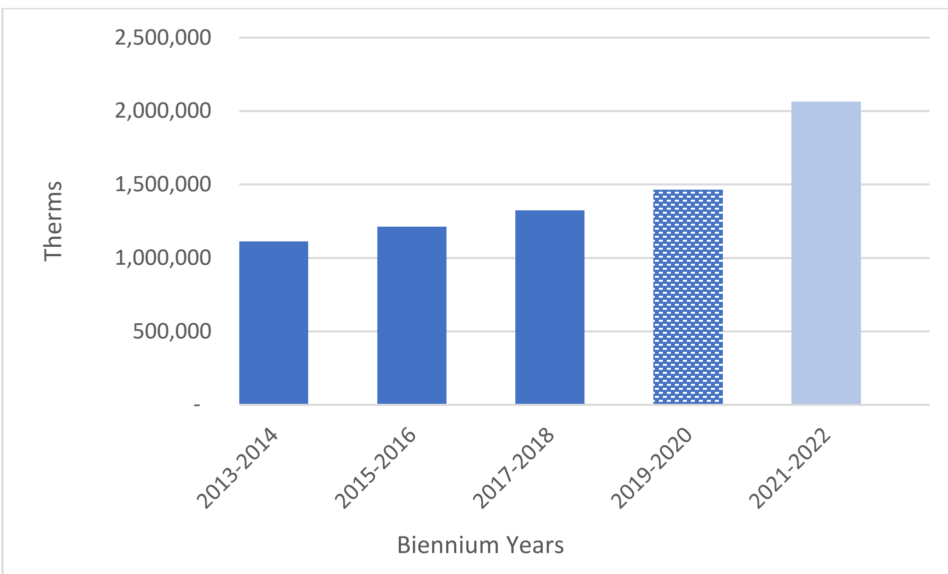
Figure 7-3: Historical IRP Goal to Actual Therm Accomplishments

Years	Biennium	Goals	Actuals	Difference	Growth
2013 2014	**2012 IRP**	1,076,661	1,113,046	**3%**	**-9%**
2015 2016	**2014 IRP[1]**	1,496,969	1,213,591	**-19%**	**9%**
2017 2018	**2016 IRP**	1,456,143	1,324,030	**-9%**	**9%**
2019 2020	**2018 IRP**	1,419,636	**1,463,165[2]**	**3%**	***11%***
2021 2022	**2020 IRP**	2,063,892	**TBD**	**TBD**	***45%***

[1]2014 goals were not acknowledged by the WUTC
[2]This number is year to date and subject to final reporting for 2020, which occurs by June 1, 2021

Figure 7-4 shows the actual historical performance and short-term biennium forecast.

Figure 7-4: Incremental Portfolio Biennium Actuals + Forecast



Nexant

As the Company moves into 2021, the "iENERGY DSM Central" software product from Nexant Inc. remains Cascade's tool for processing residential and low income (LI) projects and assisting with management of the TA program. In 2018 the Company implemented a joint effort to design an interim solution to internal eM&V (evaluation, Measurement, and Verification) on the Nexant software platform. For the software design, development and testing cycles, Nexant required Cascade to serve as thought leaders (as beta testers) 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 areas to concentrate efforts. While it will not take the place of external EM&V it does allow for some independent verification of savings.

Low Income

Cascade is committed to increasing participation from Community Action Agencies to serve more customers through the Company's Weatherization Incentive Program (WIP) and Enhanced Weatherization Incentive Program (E-WIP).

In Phase II of the CPA, AEG will work with Cascade to develop a suitable scope to characterize the "low-income" demographic for the purpose of better understanding customer end use and to establish better alignment between LI and Residential program potential. AEG will primarily rely on two data sources to inform the LI analysis.

1. The American Community Survey will be used to estimate the share of Cascade's residential customers that fall above and below the defined low-income threshold. These percentages will be used to apportion Cascade's total residential customer population into these two groups within the LoadMAP model.

2. The 2016-2017 Residential Building Stock Assessment (RBSA) will be used to inform differences in building characteristics (e.g., home size, number of water fixtures, existing insulation levels), equipment efficiency, and saturations of energy efficient technologies for homes above and below the defined low-income threshold. This information will allow AEG to develop separate market profiles for, and more accurately assess, the remaining energy efficiency potential of low-income homes.

AEG will update the existing LoadMAP segmentation to separate LI and non-LI residential customers in each of Cascade's climate zones; base-year market profiles will be developed for each of the segments, beginning with the market profiles from Phase 1 of the current CPA, and on the results of the RBSA analysis as well as actual customer consumption.

The Company also expects the support of the agencies and their outreach efforts to be increased to local communities to reach those customers who have yet to engage in the Energy Efficiency Incentive Programs (EEIP). 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.

Budget to Plan

Cascade set an administrative budget to plan and operate programs under the avoided costs shown in Appendix H. This budget currently estimates a 70/30 ratio of Direct Benefit to Customer (DBtC) compared to program costs. Since therm savings offset the costs of administrative investment, the greater the achievement, the more cost-effective the programs. See Figure 7-5 for the goals and budgets for 2021 and 2022 (rounded to the nearest dollar) for reference. These will be used in development of the 2021 Conservation Plan.

Figure 7-5: Program Goals & Budgets at a Glance 2021 & 2022

	Calendar Year 2021				Calendar Year 2022			
	Residential	C/I	Low Income	Total	Residential	C/I	Low Income	Total
Admin Budget[1]	$1,066,042	$1,436,858	$59,900[3]	$2,562,800	$1,110,764	$1,494,332	$61,697	$2,666,793
Therm Targets[2]	471,164	578,483	12,180	1,061,827	504,604	509,641	13,000	1,027,245
NEEA Natural Gas Market Transformation				$127,663				$183,025
Regional Technical Forum				$31,400				$31,400
Conservation Potential Assessment				$98,386				

[1] *Note budgets in this table are estimates and refer to administrative costs for program implementation, not rebate payments*
[2] *Therm targets from this graph have been developed through LoadMAP. Calendar Year 2022 targets will be revised through the 2022 Biennial Conservation Plan*
[3] *Represents only Cascade staff salary and outreach costs associated with weatherization program delivery that are not part of payments to agencies*

LoadMAP generated targets are acknowledged in the Conservation Plan and programs are managed to ensure cost effectiveness is maintained.

Energy Efficiency Programs Forecasted Savings

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.

Figure 7-6 shows the residential, commercial, industrial cumulative DSM forecast by Technical, Achievable Technical and both UCT/TRC Achievable Economic Potentials.

Figure 7-6: Cumulative Residential, Commercial, Industrial Potential Forecasts

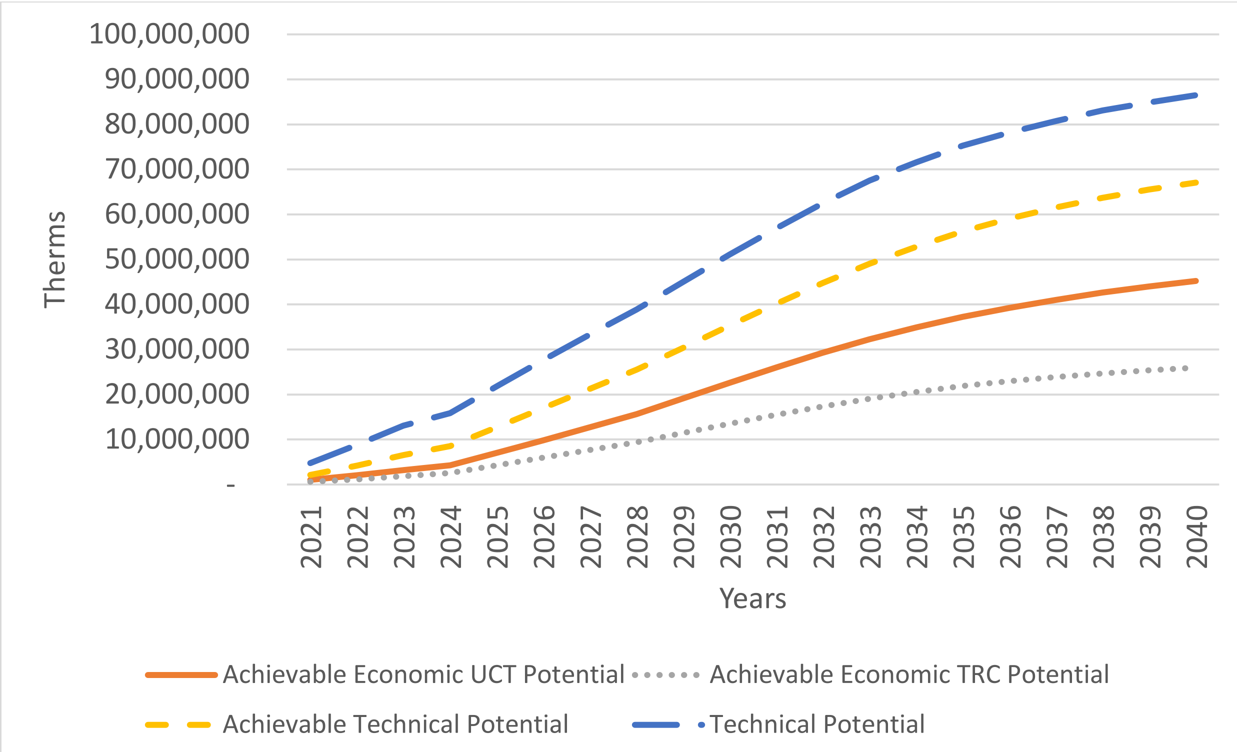


Figure 7-7 shows cumulative savings potential across programs through 2040.

Figure 7-7: DSM Cumulative Forecast by Program

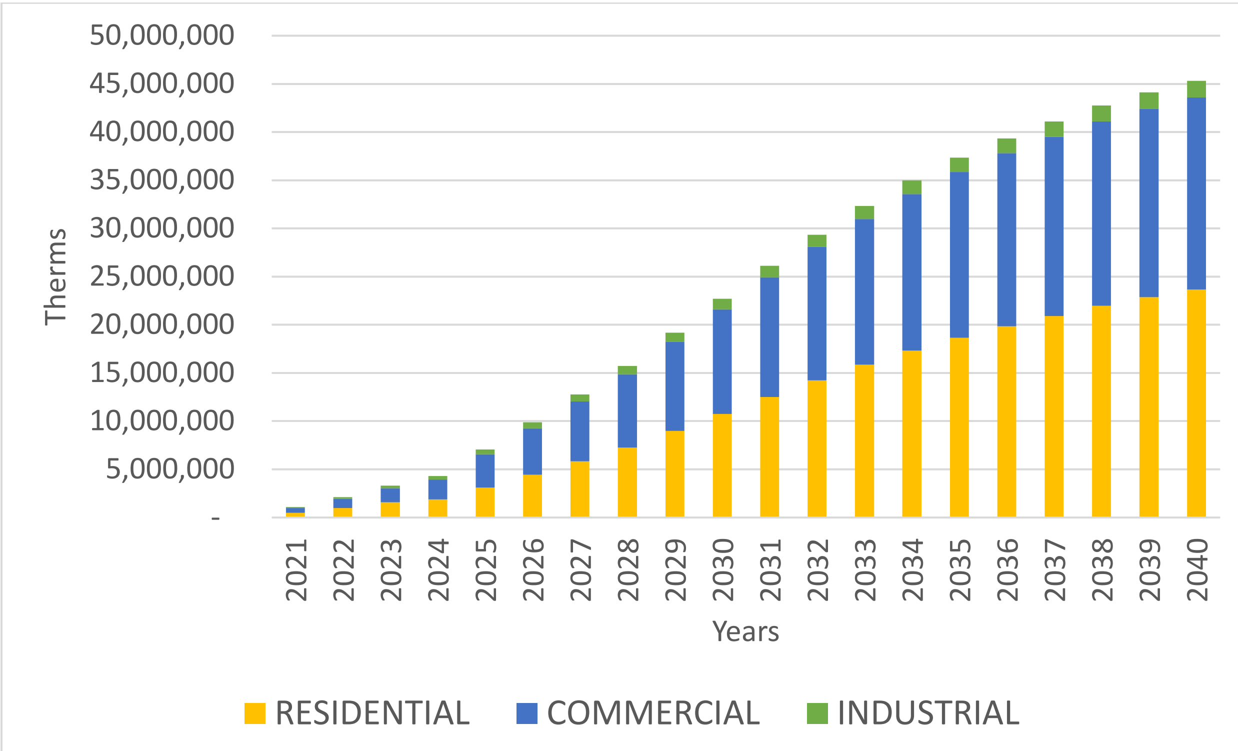
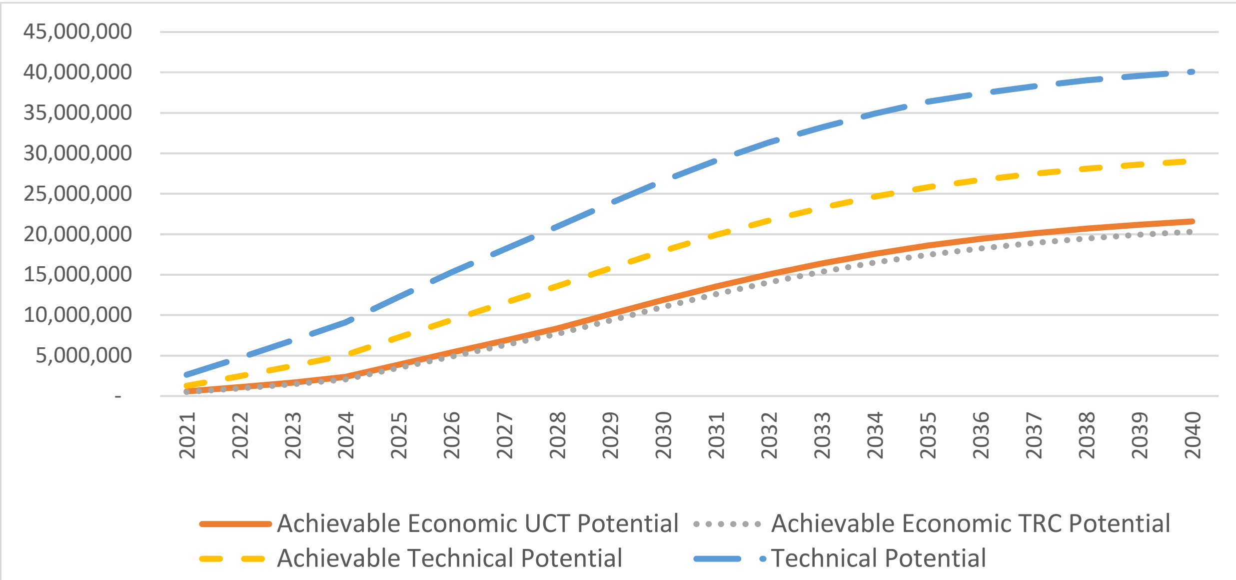


Figure 7-8 shows the C/I cumulative DSM forecast by Technical, Achievable Technical and both UCT/TRC Achievable Economic Potentials for the base case.

Figure 7-8: Cumulative Commercial & Industrial Forecasts



Figures 7-9, 7-10, and 7-11 show the top 10 measures by sector with the most potential for 2021. Top ten measures account for more than 90% of all potential across programs.

Figure 7-9 shows 2021 top ten UCT measures for Residential

Figure 7-9: 2021 Top Ten UCT Residential Measures

Rank	Measure	2021 Savings (therms)	% of Total Savings
1	Natural Gas - Furnace - Direct Fuel	111,535	25.3%
2	Natural Gas - Insulation - Infiltration Control (Air Sealing)	83,388	18.9%
3	Natural Gas - Insulation - Ceiling, Installation	74,668	17.0%
4	Natural Gas - Water Heater <= 55 gal.	42,423	9.6%
5	Natural Gas - Doors - Storm and Thermal	37,375	8.5%
6	Natural Gas - ENERGY STAR Connected Thermostat	18,167	4.1%
7	Natural Gas - Built Green homes	16,016	3.6%
8	Natural Gas - Fireplace	10,424	2.4%
9	Natural Gas - Water Heater > 55 gal.	7,537	1.7%
10	Natural Gas - Ducting - Repair and Sealing	7,332	1.7%

Figure 7-10 shows 2021 top ten UCT measures for Commercial

Figure 7-10: 2021 Top Ten UCT Commercial Measures

Rank	Measure	2021 Savings (therms)	% of Total Savings
1	Boiler	152,831	29.7%
2	Insulation - Roof/Ceiling	38,017	7.4%
3	Gas Boiler - Insulate Steam Lines/Condensate Tank	29,847	5.8%
4	Gas Furnace - Maintenance	26,241	5.1%
5	Fryer	21,815	4.2%
6	Insulation - Wall Cavity	20,422	4.0%
7	Water Heater	20,098	3.9%
8	Gas Boiler - Insulate Hot Water Lines	19,943	3.9%
9	HVAC - Shut Off Damper	19,213	3.7%
10	Gas Boiler - High Turndown	18,533	3.6%

Figure 7-11 shows 2021 top ten UCT measures for Industrial

Figure 7-11: 2021 Top Ten UCT Industrial Measures

Rank	Measure	2021 Savings (therms)	% of Total Savings
1	Strategic Energy Management	18,870	23.7%
2	Retrocommissioning	16,055	20.2%
3	Gas Boiler - Hot Water Reset	9,180	11.5%
4	Gas Boiler - Stack Economizer	6,218	7.8%
5	Gas Boiler - High Turndown	5,251	6.6%
6	Boiler	5,111	6.4%
7	Insulation - Roof/Ceiling	3,851	4.8%
8	Gas Boiler - Maintenance	3,614	4.5%
9	Insulation - Wall Cavity	2,991	3.8%
10	Unit Heater	2,774	3.5%

Based on the Company's experience, legislative trends, work with AEG, and current technologies, the EE team updated key measure assumptions and added new measure permutations in Phase 1 of the 2020 CPA. The rest of the measures in LoadMAP will be updated in Phase 2, these measures may include:

Commercial:

- Furnaces
  - C/I: add second unit tier 97% AFUE
- C/I Boilers: Tier at 86% AFUE (lower incentives, lower therm savings) and a tier at 94% (higher incentives, higher therms)
- Commercial tankless water heaters
  - Updating savings assumptions

Residential:

- Furnaces:
  - Rebate for Furnace tune-ups with combustion safety testing
    - Furnace filter replacement pilot program, potential microbial filter for increased indoor health
- Windows – add 2nd tier to support efficient window installs
  - Windows: two tiers, $5/sq. ft. for U Factor 0.30 and $7/sq. ft. for U Factor 0.27
  - Windows: Remove "single pane" condition; research alternative condition to allow incentivization for old, aluminum frame double pane windows
- Advanced new construction (ENERGY STAR®, Built Green© update ramp rate)
  - Incentive tier for 4 & 5 Star Built Green, potentially remove 3 star rebate eligibility due to code changes
- Residential Multi Family combination units
- Insulation: $1/sq. ft. for all insulation: wall, floor and attic/roof/ceiling
- Remove residential tankless tiers
  - 5.4% are 0.87 UEF; set all rebates to 0.91 UEF

Some of the measures initially deemed cost effective by AEG are program offerings new to the Company. Further research is needed to determine whether the cost-effectiveness would be negatively affected by several technical and operational factors driving up costs. For example, the Solar 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, several barriers to uptake were determined. Current installation costs approach $20,000 and few, if any, Trade Allies (TA) offer the equipment to customers, with inconsistent manufacturer support and documentation. With these issues identified, after the initial run the Company updated the measure's ramp rate by shifting it three years into the future. This allows for product maturity while awaiting market transformation efforts including those spearheaded by the Northwest Energy Efficiency Alliance (NEEA).

Further details around new measure inclusion and research are available in the 2021 Conservation Plan.

The Company develops its rebate offerings with the objectives to:

1. Maximize the inclusiveness of viable, industry-acknowledged conservation measures.
2. Set incentive levels as meaningful price signals to consumers to upgrade to high-efficiency natural gas equipment and energy saving measures.
3. Remain 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.

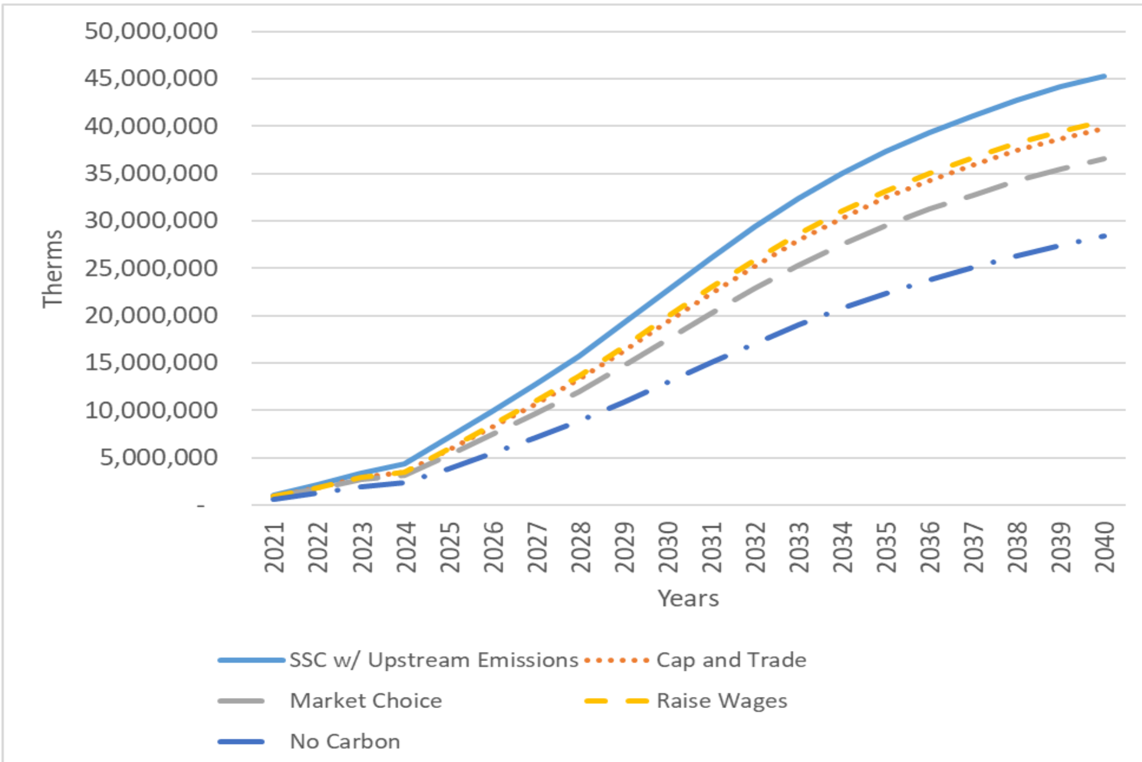
Carbon Scenario Modeling

Cascade modeled alternative carbon scenarios using three sets of potential costs of carbon; Cap and Trade, Market Choice, and Raise Wages. Thus, LoadMAP was re-run under these scenarios. Under all three scenarios, relative to the base, the program identifies an 11% decline in residential and commercial potential energy savings over the cumulative forecasts due to the two and one-half percent social cost of carbon and decreased discount rate from 4.43% to 3.4%; this is seen in the short-term as well. There are minimal differences between scenarios. In the Industrial sector, Cap and Trade and Raise Wages yielded no change while Market Choice reflected a -1.1% change over the cumulative forecast. Details of the results can be found in Appendix D.

In an attempt to show the impact these carbon scenario's have on energy efficiency, Cascade created a no carbon scenario for the other carbon scenario's to compare against.

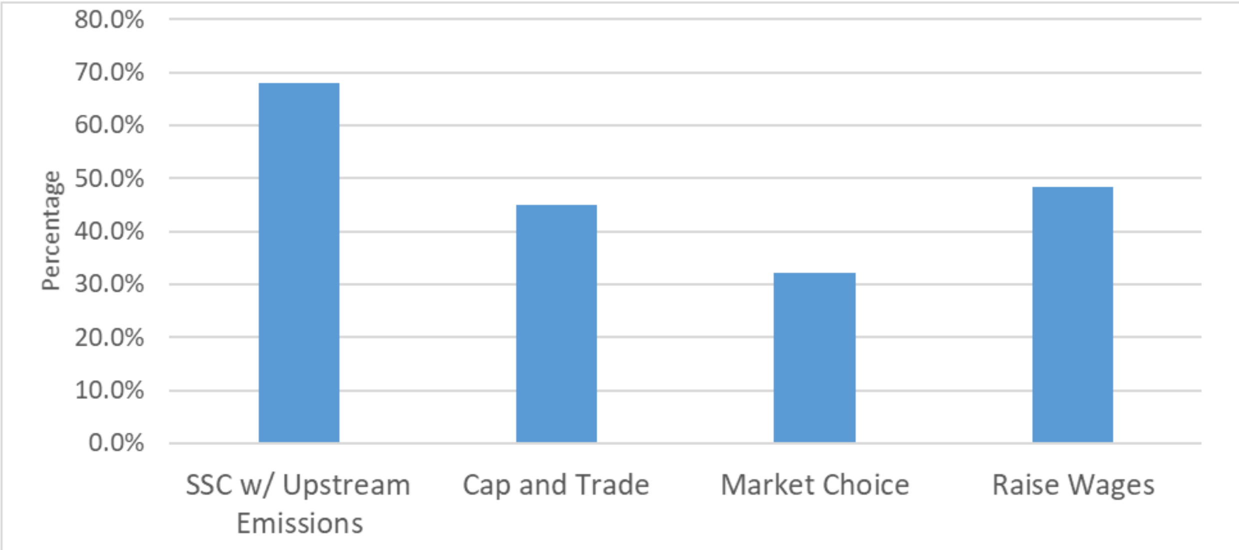
Figure 7-12 shows the cumulative UCT potential forecast across each carbon sensitivity for residential and C/I programs combined, including the no carbon scenario.

Figure 7-12: Cumulative UCT for RES/COM/IND per Carbon Sensitivity



Relative to a no carbon scenario, potential savings from the other carbon scenarios ranged 28.7% to 54.0% higher at the culmination of the 20-year time horizon. Figure 7-13 shows the percent delta, on average, between the cumulative UCT potential forecast across each carbon sensitivity for residential and C/I programs combined relative to a no carbon scenario over the 20 year time horizon.

Figure 7-13: Cumulative UCT for RES/COM/IND per Carbon Sensitivity



Importance of Outreach and Cohesive Messaging

The Company will continue to increase its savings achievements through supporting outreach and community engagement. The EE department regularly reaches out to the Company's customers through the following channels:

- 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, low cost/no cost savings recommendations, furnaces, combination units, etc.
- Radio campaigns in select territories to promote the incentive program and general low cost/no cost options for reducing natural gas consumption
- Leveraged messaging with community organizations and other utilities
- Community project engagement:
    - When able 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
- The Company has also expanded social media and virtual advertising as a result of being unable to implement standard in person outreach
- When viable, business exposition tabling and exhibition
- Targeted direct mail and email efforts
- Virtual videos and event participation
- Targeted magazine and newspaper advertising

In addition to the standard practices, the Company provides 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 partners with local community-based energy programs to support their energy reduction efforts and leverage the opportunity to promote the EEIP to the public. The Company will continue to seek partnerships and support EE efforts throughout its service territory.

In line with Cascade's commitment to community engagement and the desire to increase awareness of its conservation programs, Cascade personnel also partners with the Western Washington University Institute for Energy Studies to provide guest lectures on DSM and energy efficiency, provided a 2020 internship, and supports 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. The goal is to increase market adoption of energy efficient natural gas products and practices in the future.

The Natural Gas Alliance is well into its second cycle. The Company continues working with this collaborative on the planned activities for cycle 6 (2020-2024). CY 2019 provided the first reportable savings from the market transformation efforts through NEEA. As these savings become more impactful later in the cycle, the Company will work with its CAG on how cost allocations associated with the NEEA efforts will be determined once sufficient savings are accrued and reportable. Company investment in NEEA is shown in Figure 7-14.

Figure 7-14: CNGC NEEA Financial Commitment Schedule

Year	CNGC Washington Commitment at 9.3% for Cycle 5 & 9.2% for Cycle 6
2015	$145,872
2016	$244,996
2017	$313,174
2018	$452,285
2019	$548,804
Cycle 5 Total	**$1,705,130**
2020	$348,908*
2021	$348,908*
2022	$348,908*
2023	$348,908
2024	$348,908
Cycle 6 Total	**$1,744,542**

*Note Cascade pays quarterly - Q4 2020 through Q3 2022 will be at reduced rates due to cycle 5 credit

To further support the Company's engagement in these efforts, Cascade, as well as Northwest Natural Gas are members of the Board of Directors. Cascade's representative is also the current Chair of the NEEA's Natural Gas Board committee and is charged with leading the natural gas discussions on behalf of the Board of Directors and gas funders for the organization.

COVID-19 Response and Future Planning

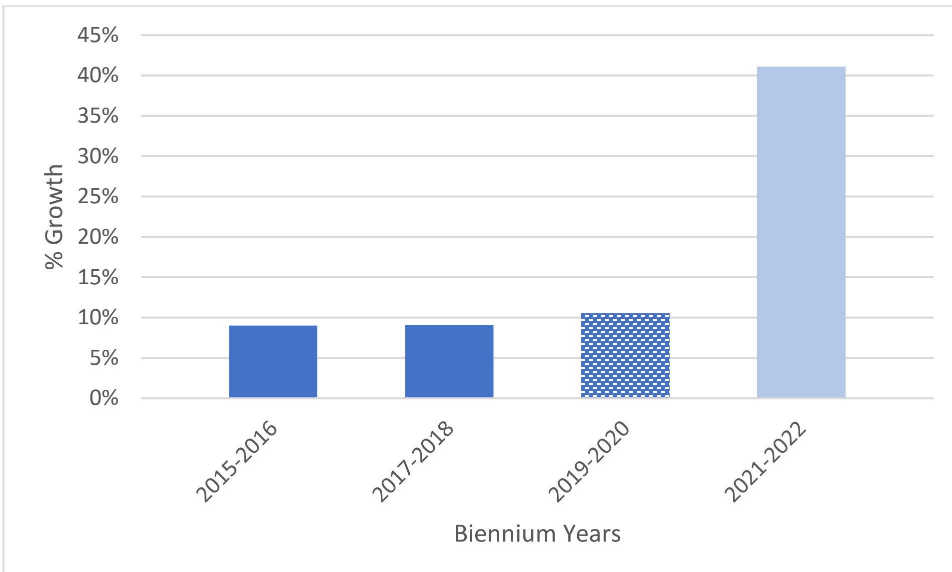
The current economic model does not take into consideration the impacts of COVID-19 and the subsequent economic downturn. Currently, the C/I program is operating at approximately 70% of therms goal and impacts are likely to carry into 2021. The residential program is forecasted to exceed its therm goal for 2020, but it is unclear if this trend will continue into 2021 given the economic uncertainty of the pandemic. The EE team has employed an adaptive management strategy to respond to the ever-changing economic landscape. Cascade will be working with the CAG on potential alternative scenarios and inputs for LoadMAP to accommodate some of the unknowns and will be addressing issues in real time to remain flexible and responsive to customer needs.

Conclusion and Outlook for Two Year Action Plan

The LoadMAP modelling tool developed by AEG provides a detailed forecast of EE potential. Cascade's EE Department develops strategies to capture this savings potential across its service territory through implementation of programs, outreach, Trade Ally partnerships, and the use of its third-party implementer TRC Companies for C/I program delivery. Cascade draws on years of experience to adaptively manage its DSM services and will continue to explore all options to actively capture savings to provide value to CNGC's residential, commercial, and industrial customers.

Cascade is projected to exceed its 2018 IRP goal by 3% and is on track to realize an 11% growth over the 2016 IRP. The goal for the 2020 IRP is to grow 41%. Figure 7-15 highlights the portfolio level biennium over biennium growth DSM has seen dating back to the 2014 IRP.

Figure 7-15: Portfolio level Biennium over Biennium Growth



To assist with increasing its capacity to capture energy savings, Cascade has implemented a two-part strategy for the residential program to minimize and reduce information missing from rebate applications. The first part of the strategy was to redesign the application to create a more user-friendly experience and the second step was to work closer with the Trade Ally network to reduce disqualifications. The impetus behind the effort was to reduce the instances of missing information by increasing clarity in document requirements for rebate eligibility. This along with other improvements to processes sets the program up for increasing capacity to manage higher rebate submissions in 2021.

The program has proven itself adaptable to economic shocks to allow continued success toward efficiency targets. This has been achieved through open communication across departments and continued collaboration with company stakeholders. The EE department is taking a variety of steps including implementation of a new customer online interface through Nexant for easier application submittal, to working with AEG to explore adapting LoadMAP to forecast COVID-19 effects on savings potential.

Cascade has developed formulas for its reporting tools that can accurately forecast savings trends on a month-over-month basis. This provides an opportunity for a proactive approach to analyzing how resources are spent to keep savings goals on track throughout the year.

Under this adaptive management philosophy during the COVID-19 pandemic, Cascade increased outreach and marketing through digital platforms increasing awareness across energy efficiency programs. This has been effective for the residential program in 2020, which is expected to exceed goals by 20%. C/I savings have been affected differently by this economic shock, and due to this adverse effect is tracking to achieve under 80% of goal for the year. Cascade is working closely with its C/I vendor to adjust to the needs of the C/I market to seek additional savings opportunities. For example, a mid-stream high efficiency condensing tankless water heater pilot program is now in place. This is intended to further cut incremental costs to customers and drive decisions earlier in the distribution chain to increase the use of commercial energy efficient measures.

Increased cross-departmental collaboration between RPT and EE Team allows for greater understanding of the complete cycle of resource planning and savings potential integration with SENDOUT® allowing for more accurate forecasting and long-term system planning.

Chapter 8

Renewable Natural Gas

Overview

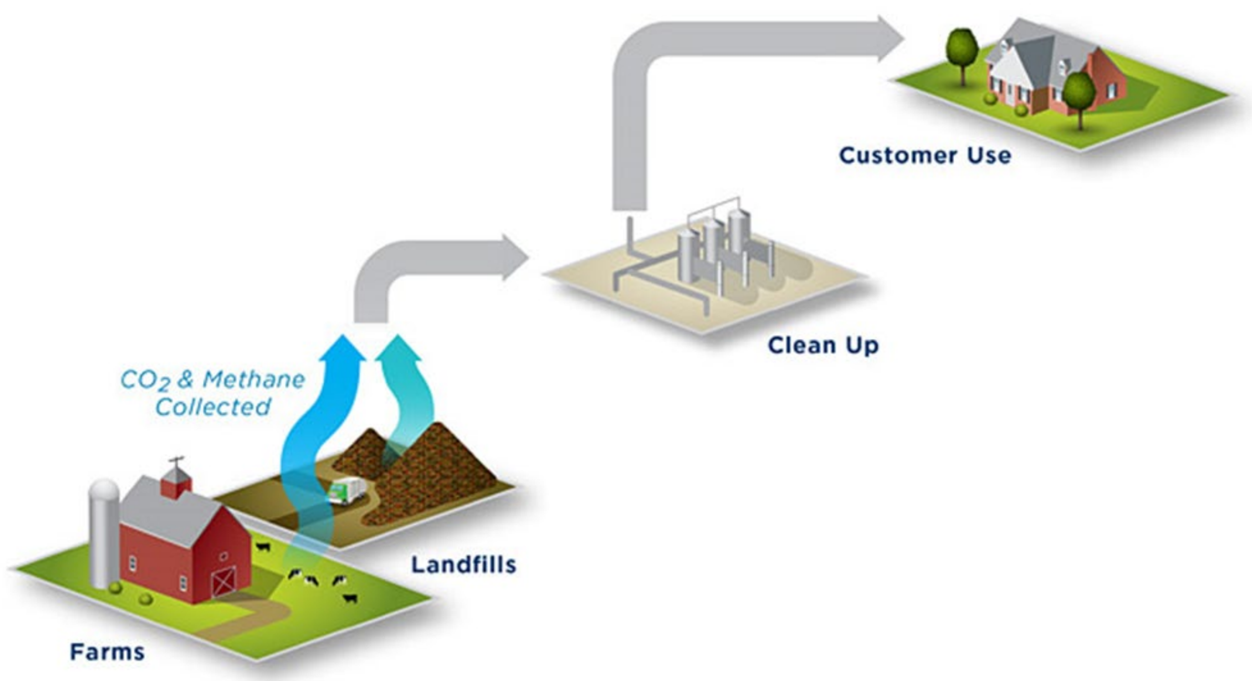
Renewable Natural Gas (RNG), as defined in RCW 54.04.190,[1] is a gas consisting largely of methane and other hydrocarbons derived from the decomposition of organic material in landfills, wastewater treatment facilities, and anaerobic digesters. Cascade is committed to developing programs that allow the Company to acquire RNG under guidelines and rules stated in Washington HB 1257 and Oregon SB 98.

Figure 8-1,[2] provides an example of a general RNG process from landfill to enduser.

Key Points

- Cascade is committed to developing programs that will allow the Company to acquire RNG under guidelines and rules stated in Washington HB-1257 and Oregon SB 98.
- The Company has met with several individuals, companies, and producers, potentially sponsoring RNG projects such as municipalities, wastewater treatment plants, biodigesters, and landfills.
- On December 4, 2019, the Bend City Council approved its citywide Community Climate Action Plan which includes options for RNG & offsets.
- Taking best practices from other regional LDCs, Cascade has developed a potential RNG cost effectiveness methodology.

Figure 8-1: Example of RNG process from landfill to end user



[1] *See* https://app.leg.wa.gov/rcw/default.aspx?cite=54.04.190
[2] U.S. Department of Energy, Alternative Fuels Data Center, Renewable Natural Gas

Renewable natural gas, biomethane and biogas are sometimes used interchangeably but they are different biofuel products along the value chain:

- Biogas is a mixture of carbon dioxide and hydrocarbons, primarily methane gas, from the biological decomposition of organic materials.
- Biomethane is a biogas-derived, high BTU gas that is predominately methane after the biogas is upgraded to remove contaminants.
- Renewable natural gas is biomethane upgraded to natural gas pipeline-quality standards so it can substitute or blend with conventional natural gas.[3]

Examples of RNG sources include:

- Biogas from Landfills
  - Collect waste from residential, industrial, and commercial entities.
  - Digestion process takes place in the ground, rather than in a digester.
- Biogas from Livestock Operations
  - Collects animal manure and delivers to anaerobic digester.
- Biogas from Wastewater Treatment
  - Produced during digestion of solids that are removed during the wastewater treatment process.
- Other sources include organic waste from food manufacturers and wholesalers, supermarkets, restaurants, hospitals, and more.[4]

Biofuel estimates vary, for example, E3 estimates 25 million dry tons of biomass supply available to Washington and Oregon, compared to Washington State's deep decarbonization study which assumed 23.8 million dry tons available to the state.[5]

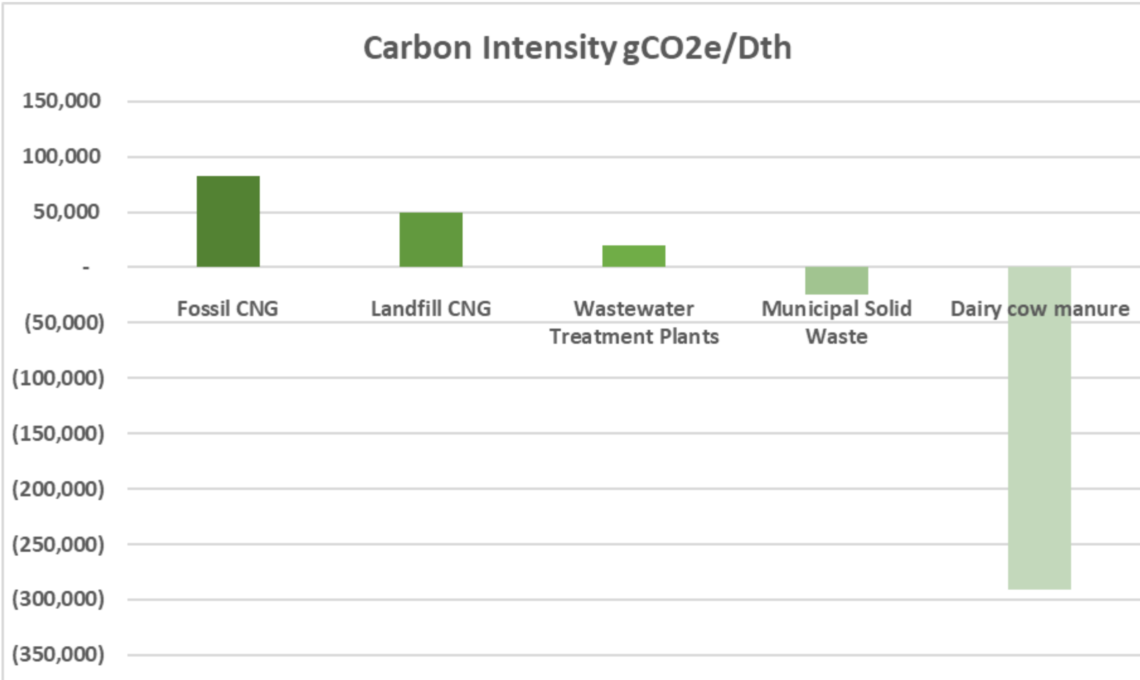
Carbon Intensity

A major driving force behind investment in RNG is the potential to mitigate the carbon footprint associated with traditionally sourced natural gas. For some types of projects such as compressed natural gas (CNG) from landfills, the resulting RNG still emits carbon into the environment, but at a lower intensity. For other projects, such as gas sourced from solid waste and dairy cow manure, high carbon intensity gas that would have otherwise been vented into the atmosphere is captured through the production of RNG. In these cases, no new carbon is placed into the environment as a result of the biogas consumption, and less carbon enters the atmosphere than would have

[3] American Natural Gas.com
[4] U.S. Department of Energy, Alternative Fuels Data Center, Renewable Natural Gas
[5] Energy + Environmental Economics, Pacific NW Pathways to 2050: Achieving an 80% reduction in economy-wide greenhouse gases by 2050

otherwise occurred without the project. Figure 8-2 highlights the various impacts of five different types of natural gas.[6]

Figure 8-2: Carbon Intensity of Natural Gas by Source



Regulatory discussions in both Washington and Oregon have focused on how differences in carbon intensity should be addressed when assessing the carbon neutralizing benefits of renewable natural gas. Some parties believe it is best to treat all RNG the same to encourage investment in any projects available to produce RNG. Others argue it is critical to capture the exact impact of each RNG project. Cascade will closely monitor the emerging laws and regulations in both states to ensure the Company properly evaluates all future RNG projects.

6 *See* https://ww2.arb.ca.gov/sites/default/files/classic//research/apr/past/13-307.pdf

RNG Regulation and Policy in Washington

On April 15, 2019 House Bill 1257[7] (HB 1257) was passed by the Senate and on April 18, 2019 the bill was passed by the House. Several sections within the bill are related to RNG and will be covered in this chapter.

Below, Cascade lists key portions of the House Bill relevant to RNG:

Sec. 12. (1) The legislature finds and declares that:

(a) Renewable natural gas provides benefits to natural gas utility customers and to the public; and

(b) The development of renewable natural gas resources should be encouraged to support a smooth transition to a low carbon energy economy in Washington.

(2) It is the policy of the state to provide clear and reliable guidelines for gas companies that opt to supply renewable natural gas resources to serve their customers and that ensure robust ratepayer protections.

Following the adoption of HB 1257 into law,[8] workshops were convened to determine how best to comply with these new mandates. Cascade has actively participated in all relevant workshops under UG-190818, RNG Staff Investigation. Multiple company representatives engaged in these proceedings. The Company has also worked closely with its trade organization, the Northwest Gas Association, to provide the information and feedback necessary to support proposals submitted on behalf of the northwest LDCs.

In addition to Section 12, HB 1257 included two other sections with language pertaining to the development of renewable natural gas and offset programs:

Sec. 13. A new section is added to chapter 80.28 RCW to read as follows:

(1) A natural gas company may propose a renewable natural gas program under which the company would supply renewable natural gas for a portion of the natural gas sold or delivered to its retail customers. The renewable natural gas program is subject to review and approval by the commission. The customer charge for a renewable natural gas program may not exceed five percent of the amount charged to retail customers for natural gas.

(2) The environmental attributes of renewable natural gas provided under this section must be retired using procedures established by the commission and may not be used for any other purpose. The commission must approve procedures for banking and transfer of environmental attributes.

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[7] *See* http://lawfilesext.leg.wa.gov/biennium/2019-20/Pdf/Bills/House%20Passed%20Legislature/1257-S3.PL.pdf?q=20201020144814

[8] Signed by Govermnor Jay Inslee on May 13, 2019 with an effective date of July 28, 2019.

(3) As used in this section, "renewable natural gas" includes renewable natural gas as defined in RCW 54.04.190. The commission may approve inclusion of other sources of gas if those sources are produced without consumption of fossil fuels.

Cascade looks forward to identifying viable pathways for the inclusion of renewable natural gas as part of its fuel mix, following the guidelines developing from the UG-190818, RNG Staff Investigation workshops. To date, Cascade has been in discussions with several RNG producers and is also considering a more comprehensive analysis of available RNG resources across its Washington and Oregon service areas. In the spring of 2019, CNGC initiated exploratory discussions regarding the City of Bellingham's new Post Point waste plant and with WWU's Campus Energy Manager to identify potential opportunities for RNG and to emphasize CNGC's interest in partnering on RNG projects. Such an analysis would be accompanied by a Request for Information (RFI) to identify viable biogas sources and determine the appropriate volume of RNG to include on Cascade's system. The Company may also solicit recommendations from a third party consultant for program design and structure.

The Company does not currently have a timeline to implement incorporating RNG onto the system. However, Cascade has developed a cost effectiveness evaluation tool for RNG to allow the Company to model the impact to retail customers in order to not exceed the five percent of the amount charged from section 13.1 of the bill.

Sec. 14. A new section is added to chapter 80.28 RCW to read as follows:

(1) Each gas company must offer by tariff a voluntary renewable natural gas service available to all customers to replace any portion of the natural gas that would otherwise be provided by the gas company. The tariff may provide reasonable limits on participation based on the availability of renewable natural gas and may use environmental attributes of renewable natural gas combined with natural gas. The voluntary renewable natural gas service must include delivery to, or the retirement on behalf of, the customer of all environmental attributes associated with the renewable natural gas.

(2) For the purposes of this section, "renewable natural gas" includes renewable natural gas as defined in RCW 54.04.190. The commission may approve inclusion of other sources of gas if those sources are produced without consumption of fossil fuels.

As noted above, Cascade is currently assessing options for how to best acquire RNG and its associated attributes. These resources would be applied for the purposes described under Sec 13 and 14 of HB 1257. Cascade is in the process of identifying internal and external resources to support the acquisition of environmental attributes and renewable gas to support the voluntary renewable natural gas service required under law. This process will likely include an assessment of customer interest in such a program, so that attributes can be acquired in a prudent and cost-effective manner.

RNG Regulation and Policy in Oregon

For informational purposes only, the following describes related RNG activity in Oregon. On January 14, 2019, SB 98 was introduced in Oregon legislation. SB 98 requires the Oregon Public Utility Commission (OPUC) to adopt by rule a renewable natural gas program for natural gas utilities. The program allows utilities to recover prudently incurred qualified investments in meeting certain targets for including renewable natural gas in gas purchases for distribution to retail natural gas customers. On June 23, 2019, SB 98 was signed into law effective September 29, 2019.

On August 27, 2019, the OPUC initiated docket UM 2030, an investigation into the use of Northwest Natural's RNG evaluation methodology. Cascade is an active participant in UM 2030. The Company has developed its own potential Cost Effectiveness Evaluation Methodology which is described in the next section.

On October 1, 2019, the OPUC Staff initiated docket AR 632, in the matter of rulemaking regarding the 2019 SB 98 RNG programs. Cascade has participated in multiple meetings regarding this docket. On February 20, 2020, the OPUC provided informal draft rules for the docket. On July 16, 2020, OPUC Order 20-227 adopted the rules from AR 632.

Below is a brief description of the preliminary rule followed by the Company's compliance with its relevant sections:

(1) According to preliminary rule 860-150-100 of AR 632, each large natural gas utility and small natural gas utility must, as part of an integrated resource plan (IRP) filed after August 1, 2020, include information relevant to the RNG market, prices, technology, and availability that would otherwise be required under the Commission's IRP guidelines, by order of the Commission, or by administrative rules.

Cascade has provided information relative to the RNG market, prices, technology, and availability under the Cascade Market Research subsection later on in the chapter.

(3) In addition to the information required under section (1), each small natural gas utility must also include in its IRP:

> (a) An indication whether and when the utility expects to make a filing with the Commission, pursuant to OAR 860-150-0400, of its intent to begin participating in the RNG program described in these rules, if the utility has not already started to participate in the RNG program;

Cascade has been in discussions with several RNG producers. The Company may also seek the support of a third party consultant or consultants to help identify its full biogas potential in both WA and OR, and to support offset and attribute acquisition as appropriate. Currently, there is no immediate timeline for putting RNG on the system. The Company will update stakeholders, though, as events warrant.

> (b) Information about opportunities, challenges, perceived barriers, and the natural gas utility's strategy for participation in the RNG program described in these rules; and

Cascade has listed information about opportunities, challenges, and perceived barriers in the Cascade Market Research section. Cascade's current strategy is to gather all market intelligence regarding RNG. This includes meeting with RNG producers and other regional LDCs, looking into third party consultant support, and monitoring RNG legislation. Gathering as much information as possible will give Cascade the opportunity to make prudent decisions when the Company begins participation in RNG programs.

> (c) The cost effectiveness calculation that the utility will use, pursuant to OAR 860-150-0200, to evaluate RNG resources, if the utility has not already filed this with the Commission pursuant to OAR 860-150-0400.

Cascade's cost effectiveness calculation is described in the following section.

Cascade Project Cost Effectiveness Evaluation Methodology

Several departments within the Company have collaborated to create a model that allows Cascade to evaluate the cost-effectiveness of all potential RNG projects before entering into an agreement with potential suppliers. Similar to the Company's SENDOUT® modeling, the results of this calculation help inform final acquisition decisions, but ultimately must be combined with qualitative analysis from RNG subject matter experts. This subsection will present the model notes, a discussion of the static and dynamic inputs to the model, and provide an understanding of how the results should be interpreted.

Cost Effectiveness Evaluation Model Notes

$$\boldsymbol{C_{RNG} = I_{RNG} - AC_U - AC_D + \sum_{T=1}^{365} (P_{RNG} + VC - CIF) * Q}$$

$$\boldsymbol{C_{Conventional} = \sum_{T=1}^{365} (P_{Conventional} + VC) * Q}$$

Where:

$\boldsymbol{C_{RNG}}$ = The all-inclusive annual cost of a proposed RNG project
$\boldsymbol{I_{RNG}}$ = The annual required investment to procure a proposed RNG resource. If Cascade is simply buying the gas and/or environmental attributes, this value is zero.
$\boldsymbol{AC_U}$ = Avoided upstream costs
$\boldsymbol{AC_D}$ = Avoided distribution system costs
$\boldsymbol{P_{RNG}}$ = Daily price of renewable natural gas being evaluated
Q = Daily quantity of gas being evaluated
VC = Variable cost to move one dekatherm of gas to Cascade's distribution system. This value can be zero if a project connects directly to the Company's system.
CIF = Carbon Intensity Factor. This is calculated by multiplying the Company's expected carbon compliance cost by 1 minus the ratio of a proposed project's carbon intensity to conventional gas' carbon intensity.
$\boldsymbol{C_{Conventional}}$ = The all-inclusive annual cost of conventional natural gas.
If $\boldsymbol{C_{Conventional}} \geq \boldsymbol{C_{RNG}}$, a project can be considered cost effective, and should be acquired. If not, the project may still be considered under the regulatory exceptions discussed earlier in this chapter.

Static Versus Dynamic Inputs

Inputs to Cascade's model can be classified as either static or dynamic. Static inputs are ones that are not project specific, but rather related to the Company's system as a whole. They include Cascade's avoided costs, costs associated with the price of conventional gas, and regulatory factors that are used to calculate the impact to revenue requirement. Dynamic inputs on the other hand, are ones that need to be updated on a project by project basis. These include the price and quantity of the RNG, initial investment required, and carbon intensity of the project.

Model Results

Once all inputs are populated, the model provides three main pieces of information: The potential enterprise value of the project over its lifetime, the first year dollar impact to revenue requirement, and the first year percentage impact to revenue requirement. As discussed in the model notes, if the cost of conventional gas is greater than or equal to the cost of RNG, the project can be considered cost effective. If not, the impact to revenue requirement provides a valuable insight as to whether the project is attractive from a regulatory perspective.

RNG Scenarios

For the 2020 IRP, Cascade is introducing two new scenarios related to RNG modeling. Both scenarios are hypothetical and do not reflect current negotiations with actual RNG producers, but rather allow the Company to model the financial impacts of adding either off-system or on-system RNG to its portfolio. An on-system project is a project that connects directly to Cascade's distribution system. An off-system project requires upstream pipeline capacity to deliver the RNG to Cascade's distribution system. Additionally, it is important to reiterate while the information from these scenarios is valuable, SENDOUT® modeling is only one tool that will be used in the RNG evaluation process. Qualitative review of these results, along with other elements that cannot be captured in SENDOUT® but are discussed in Cascade's Project Cost Effectiveness Evaluation Methodology, will be key to the final decisions regarding the acquisition of RNG.

Figure 8-3 compares the annual costs of the Company's portfolio to the costs when an on-system RNG project is added, while Figure 8-4 shows the impact of an off-system RNG project. For both scenarios, Cascade modeled 300 dth/day of must take supply at $13.50/dth before environmental attributes. Also, the carbon intensity savings modeled was a simple average of the intensities of each different type of RNG that Cascade considers.

Figure 8-3: RNG Cost Comparison – On-System RNG

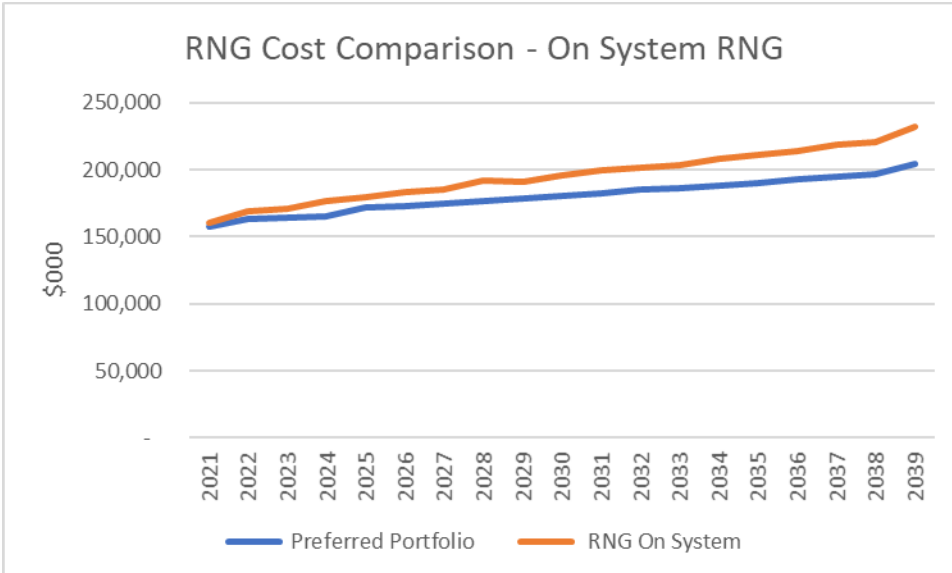
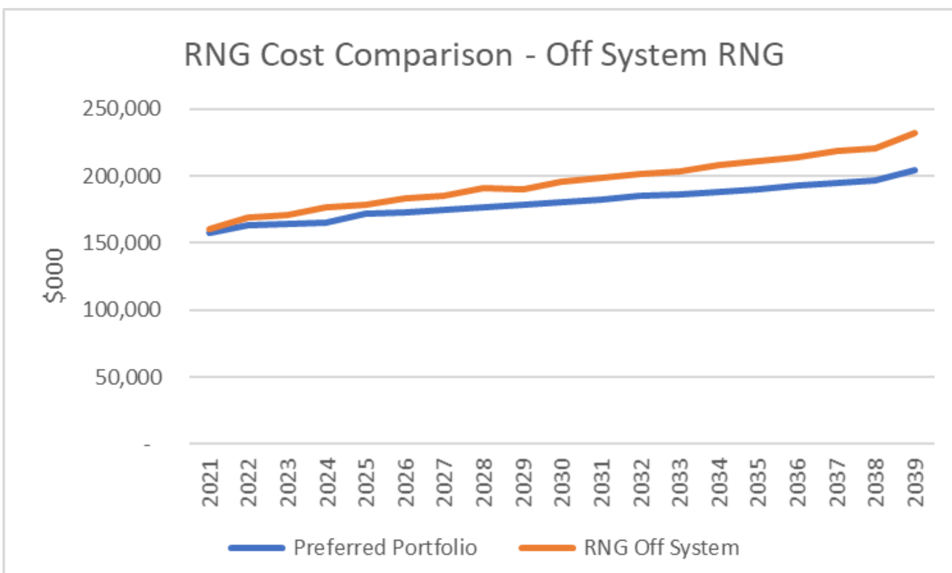


Figure 8-4: RNG Cost Comparison – Off-System RNG



Cascade Market Research

The Company has met with several individuals and companies within the RNG industry such as producers, municipalities, wastewater treatment plants, biodigesters, and landfills. During these conversations, Cascade has gathered market intelligence around RNG. Some of the Company's findings include:

- Options for securing RNG will involve purchase and/or participation in infrastructure.
- No "spot market" for RNG at this point due to long off-take commitments.
- Lead times on new RNG projects up to 36 months.
- Landfill projects are typically the largest RNG opportunity at 300-600 dth/day and usually require the lowest capital investment.
- Digester projects, due to higher carbon intensity, do very well in the Renewable Identification Numbers (RINs) market and run 50-500 dth/day (expensive to operate).
- Food waste/wastewater treatment projects seen as an ideal option for utilities as they have low RINs and Low Carbon Fuel Standards (LCFS) potential.
- $13-$30/dth long-term off-take deals.

Cascade will continue to refine its understanding of available RNG resources, market characteristics, and overall potential for RNG use and intergration by the Company on behalf of its customers.

City of Bend Climate Action Plan

On December 4, 2019, the Bend, Oregon City Council (the City) approved its citywide Community Climate Action Plan. The plan, which was developed with the guidance of the Climate Action Steering Committee (CASC), is designed to guide the City and the community in pursuit of reducing fossil fuel use by 40% by 2030 and by 70% by 2050.

The Climate Action Plan is comprised of voluntary efforts to encourage greater energy efficiency, use of renewable energy, and resource management in the Bend community. Cascade served as an active participant on Bend's CASC, and continues to support the City's carbon reduction planning efforts.

Cascade and the City share a mutual desire to identify areas of partnership on RNG development. Cascade is currently in discussion with Bend on the exploration of renewable natural gas through the City's wastewater treatment plant, or similar facilities. The Company is also considering the development of a voluntary program to offset fossil gas usage.

Cascade will continue to work with Bend in exploration of RNG and other low carbon opportunities in support of its climate ambitions. The Company will also keep apprised of other communities interested in placing RNG in the distribution system and will coordinate as appropriate.

RNG Projects

As mentioned earlier, the Company has met with several individuals and companies within the RNG industry such as producers, municipalities, wastewater treatment plants, biodigesters, and landfills. Location, type of project, and other details are discussed throughout this process to evaluate specific resources. Due to the sensitivite nature regarding the detailed information of actual RNG projects, Cascade provides details in Appendix J under confidential treatment.

RNG Goals

An internal committee composed of Business Development, Gas Supply, Operations, Resource Planning, Engineering, Energy Efficiency, and Regulatory personnel has been working with senior management with the goal of developing Cascade's long-term strategy for RNG. As part of these discussions the Company is considering creating a dedicated staff position for RNG policy, practice, and direction within the corporate structure. This RNG specific function would likely have overall responsibility for coordinating among various corporate departments and activities (including those related to the IRP) that are effected by RNG activities. Cascade is also considering the services of a third party consultant with expertise in biogas procurement to assess the full breadth of resources available across Cascade's Washington and Oregon service areas, and to help develop a viable long-term strategy for RNG. Additional support may also be considered for the assessment and development of the Washington mandated offset program described earlier in this chapter.

Additionally, the Company has a goal of continued participation in various RNG rulemakings across the region. Cascade is actively engaged with other LDCs and industry groups to respond to RNG-related legislation in Washington and Oregon (e.g. Washington HB 1257 and Oregon SB 98, respectively). Cascade is working towards ensuring compliance with RNG rules and regulations identified in dockets such as WUTC docket U-190818 and OPUC dockets AR 632, UM 2030.

Cascade recognizes RNG related rules include the development of possible programs to make RNG directly available to requesting customers. The Company will work to develop programs that allow Cascade to acquire RNG, while ensuring that related costs to rate base don't result in rate increases of over 5% of the Company's authorized revenue requirement. These resources may ultimately be required to comply with rules and create required programs.

Please see Chapter 12, Two-Year Action Plan, for more information about future RNG action items.

Conclusion

RNG presents Cascade with an exciting opportunity to introduce a new resource into the Company's IRP. Cascade echoes the sentiment of Washington and Oregon regulatory bodies and the general public to provide for RNG in its system. The Company is actively participating in the process of crafting emerging requirements in state law and regulatory principles.

Because of the uncertainty surrounding what will ultimately be the value of environmental attributes, Cascade cannot at this time definitively conclude what types of RNG programs will prove to be cost effective during the 2020 IRP planning horizon. The Company will update its models and analysis in future IRPs as more information becomes available.

Chapter 9

Distribution System Planning

Overview

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 enhance-ments include analyses of pipe-lines, regulators, and compressor stations.
- Impacts of proposed conser-vation 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 enhancement projects over the next four years.

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 elements for providing gas to the customer; the other essential element is ensuring the distribution system growth behind the citygates is not constrained. Important parts of the planning process include forecasting local demand growth, determining potential distribution system constraints, analyzing possible solutions, and estimating costs for distribution system enhancements.

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 supplements the goals, objectives, risks, and solutions as resource planning.

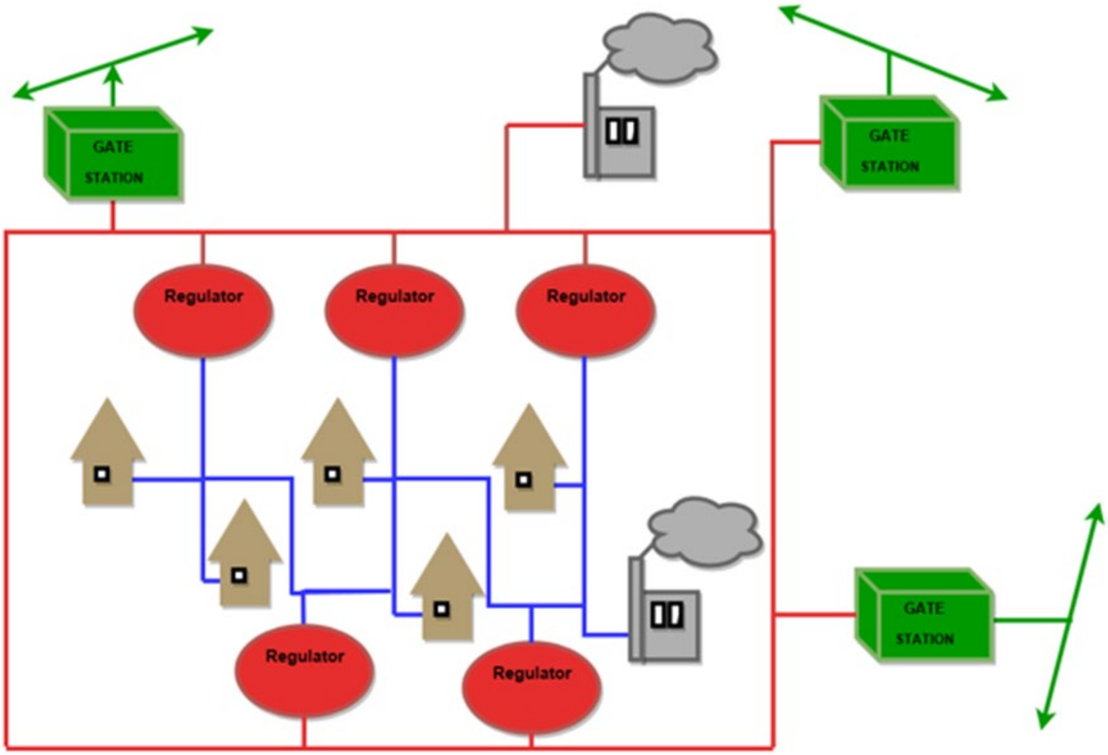
Cascade's natural gas distribution system consists of approximately 4,744 miles of distribution main pipelines in Washington, and 1,604 miles in Oregon, as well as numerous regulator stations, service distribution lines, monitoring and metering devices, and other equipment. Cascade operates one compressor station 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 upstream interstate/provincial transportation pipelines.

Network Design Fundamentals

Gas distribution networks rely on pressure differentials to move gas from one location 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

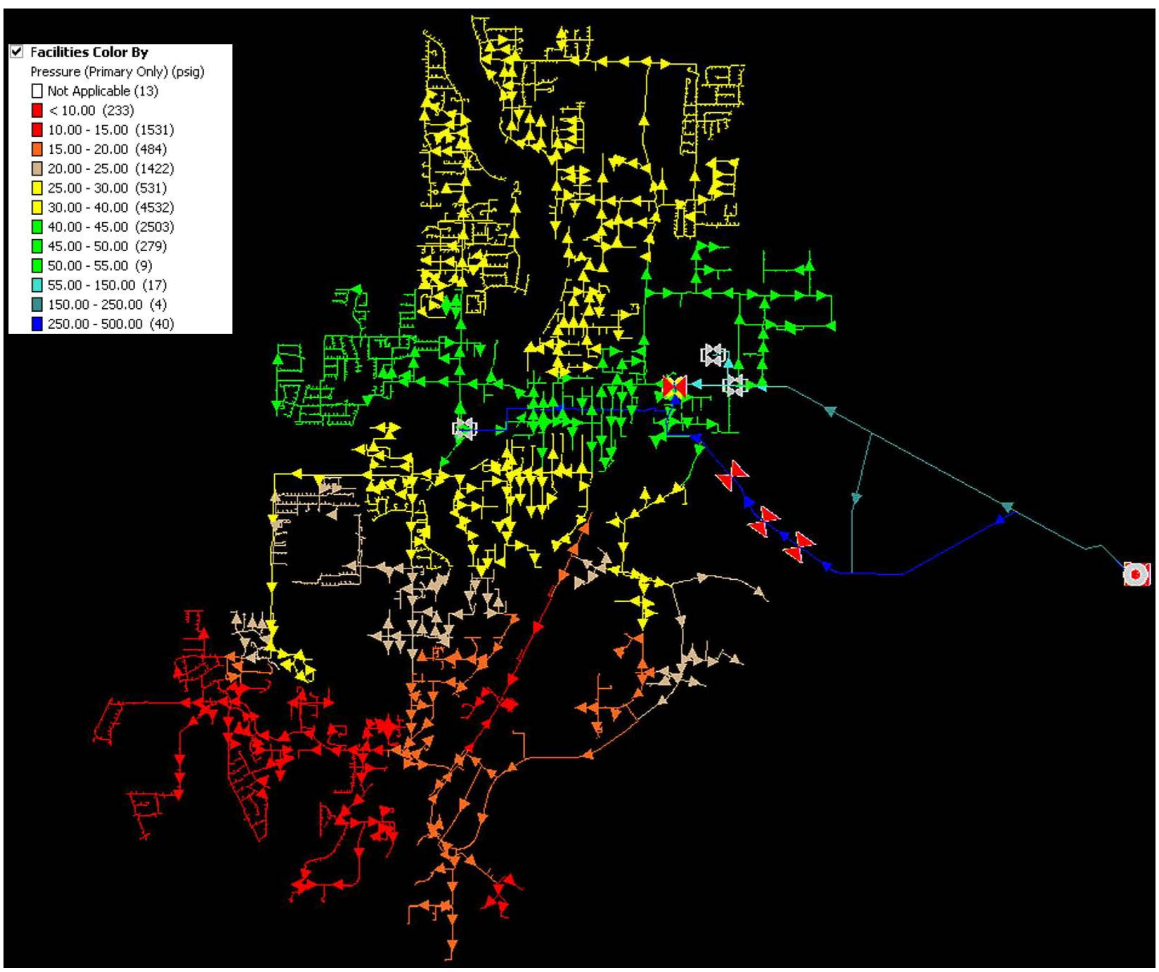


Computer Modeling

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 are 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 demand 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 cost-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 creates 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 provides a design day model that can predict a worst-case scenario. Design day models predicting a constraint area are identified and remedied before a real problem is encountered. Figure 9-2 is an example of a low-pressure scenario (constraint area) identified using Synergi®. Ultimately the planned projects can be funneled through the Distribution System Planning Process Flow (Figure 9-4 on Page 9-10) to be prioritized and slotted into the budget.

Figure 9-2: Constraint Area 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 field operations coordinators, energy services representatives, 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 can increase the overall capacity of a distribution pipeline system while utilizing existing gate station supply points. The purpose of this is to get in front of potential constraints on the distribution system. Distribution system enhancements do not reduce demand, nor do they create additional supply. 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 installing 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 Cascade's pipeline 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 Cascade historically provides utility-sponsored energy efficiency 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 Chapter 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 Cascade attempts to influence these decisions through its energy efficiency programs, the consumer is still the ultimate decision maker regarding the purchase of an energy efficiency measure. Therefore, Cascade does not anticipate that the peak day load reductions resulting from incremental energy efficiency measures will be adequate to eliminate distribution system constraint areas at this time. However, over the longer term (through 2027), the opportunity for targeted energy efficiency programs to provide a cumulative benefit that offsets potential constraint areas may be an effective strategy.

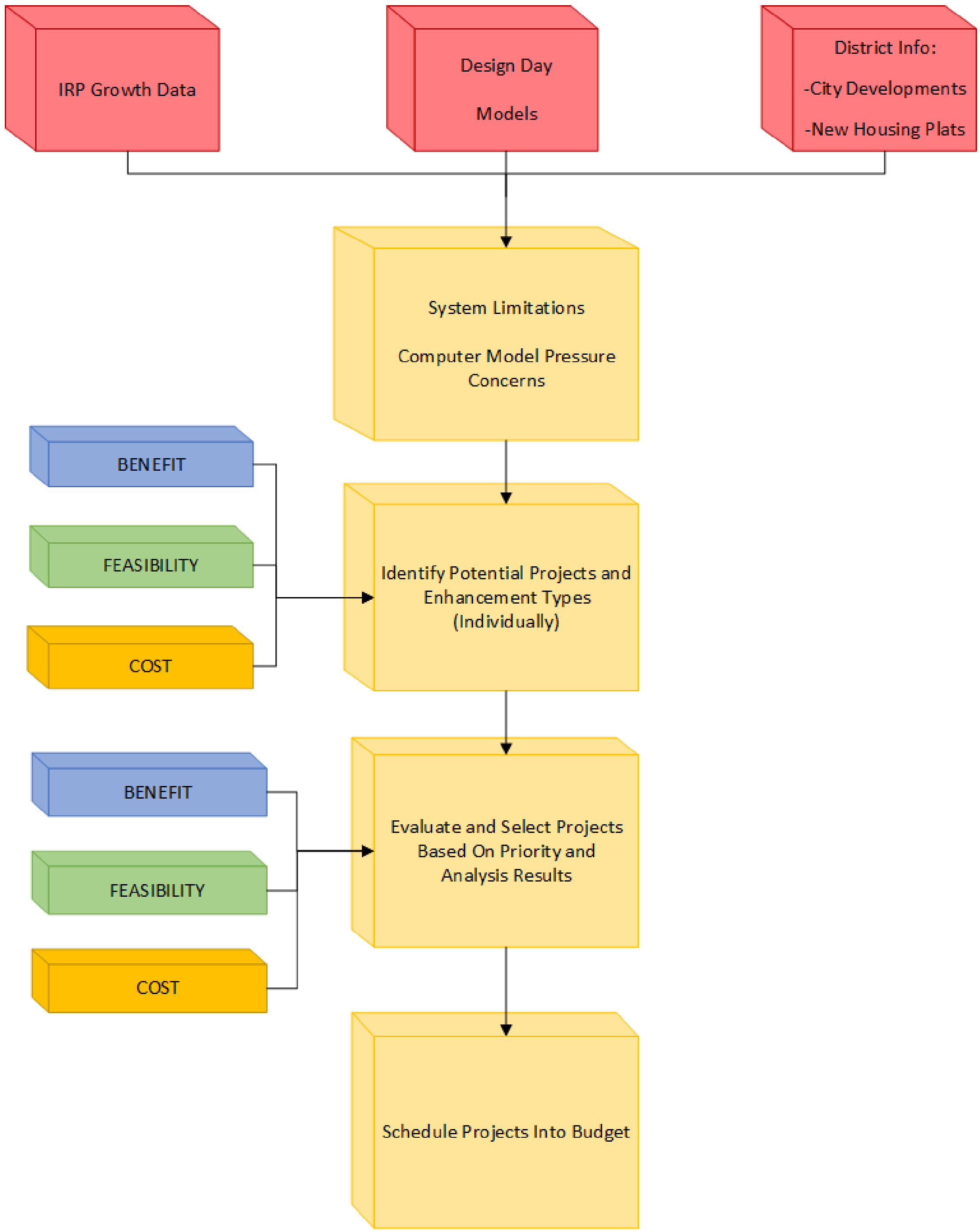
Distribution System Planning Process Flow

After developing a working demand study, analyses are performed on every system at design day conditions to identify areas where potential outages may occur. These constraint areas are then prioritized against each other to ensure the areas with the greatest constraints 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, field operations coordinator, or energy services representative 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 system planning process flow.

Figure 9-4: Distribution System Planning Process Flow



Distribution System Planning Results

Figure 9-5 summarizes the estimated costs and timing of distribution system enhancements in Cascade's nine Washington districts. The summary of these enhancements provides preliminary estimates of timing and costs of major reinforcement solutions addressing growth-related system constraints. The scope and needs of distribution system enhancement projects generally evolve with new information requiring ongoing reassessment. Actual solutions may differ due to changes in growth patterns and/or construction conditions that diverge from the initial assessment.

Figure 9-5 provides a summary of Cascade's upcoming growth projects. The specific engineering projects can be found in Appendix I. With the use of the computer modeling software and Cascade's Distribution System Planning Process Flow, Cascade can identify projects for the longer term. As projects are completed they are integrated into the system to ensure the model is current.

Figure 9-5: Distribution Planning Project Summary

Location	2021	2022	2023	2024
Aberdeen District	$2,551,000.00	$-	$891,000.00	$4,698,000.00
Bellingham District	$1,574,000.00	$1,245,000.00	$-	$-
Bremerton District	$-	$-	$-	$-
Kennewick District	$3,963,000.00	$5,682,000.00	$-	$-
Longview District	$1,318,000.00	$-	$-	$-
Mount Vernon District	$779,000.00	$-	$-	$-
Walla Walla District	$1,308,000.00	$-	$-	$-
Wenatchee District	$-	$-	$-	$-
Yakima District	$3,013,000.00	$-	$-	$-

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.

Chapter 10

Resource Integration

Overview

Resource integration is the last step in Cascade's IRP process. It involves finding the reasonable least cost and least risk mix of reliable 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 Value at Risk (VaR) analysis.
- The Top-Ranked Candidate portfolio includes all existing resources, consideration of incremental NGTL transportation and Spire Storage, plus incremental DSM.
- Cascade does not forecast any shortfalls over the 20-year planning horizon, but this does not supplant the need for incremental resources such as storage to improve supply reliability and operational balancing needs.
- For the 2020 IRP, Cascade evaluates seventeen traditional scenarios and seven sensitivities, plus four extreme scenarios.
- The Preferred Portfolio is Cascade's least cost, least risk solution to how to serve its customers over the planning horizon.

Supply Resource Optimization Process

The process for optimizing supply resources is summarized in the following eight steps and is shown graphically in Figure 10-2 on page 10-5.

- **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 2020 IRP, Cascade tested seven potential portfolios. Figure 10-1 groups these portfolios by the source of each resource. Further details

regarding the components of each candidate portfolio can be found in Appendix G.

Figure 10-1: Breakdown of Candidate Portfolios

	GTN	No GTN
NWP	- All-In - All-In Less DSM	- NWP Only - NWP Only w/ Storage
No NWP	- GTN Only - GTN Only w/ Storage	- Storage Only

- **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 VaR of the portfolios. For its modeling purposes, the Company defines VaR as the 99th percentile of unserved demand and 95th percentile of total system cost. This is a generally-accepted methodology for determining 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 reliable energy supply resources and energy efficiency for Cascade and its customers. This is now deemed to be the Top Ranked Candidate Portfolio, a term that Cascade will use often in this chapter to represent the portfolio that appears to be optimal under expected conditions. It is important to note that it is still just a Candidate Portfolio until it has passed a rigorous scenario and sensitivity analysis, after which point it will become the Preferred Portfolio for Cascade over the 20-year planning horizon.

- **Step 5: Stochastic Scenarios of Top Ranked Candidate Portfolio**
  - Cascade created seventeen different traditional scenarios, and four extreme scenarios, to stochastically test its top ranked candidate portfolio. These scenarios, which are detailed in Figure 10-3, measure how the portfolio performed in high and low growth environments, as well as under

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 99^{th} percentile was recorded as the VaR for the portfolio in that scenario.

- **Step 6: Scenario Analysis of Top Ranked Candidate Portfolio**
  - The VaR of the Top Ranked 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 traditional 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 Top Ranked Candidate Portfolio**
  - Cascade created seven different pricing environments to stochastically test its Top Ranked candidate portfolio. These sensitivities, which are detailed in Figure 10-4 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 price simulation, and the total system cost at the 95^{th} percentile was recorded as the VaR for the Candidate Portfolio in that sensitivity.

- **Step 8: Sensitivity Analysis of Top Ranked Candidate Portfolio**
  - Similar to comparing the scenarios in Step 6, the VaR of the Top Ranked 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 10-2 displays this process as a flowchart.

Figure 10-2: Supply Resource Optimization Process Flow Chart

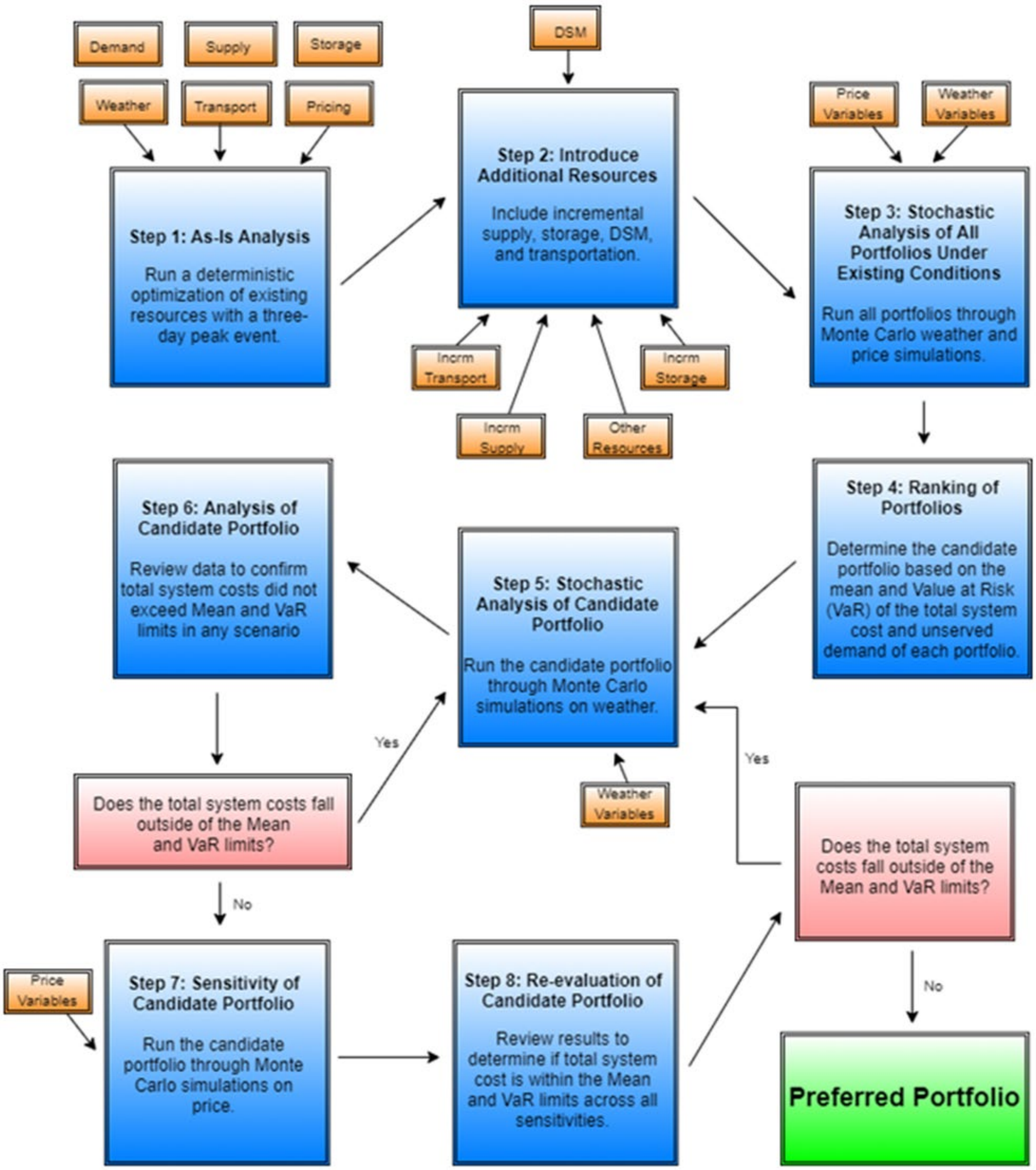


Figure 10-3: Breakdown of Scenarios Modeled

Scenarios		Assumptions					First Year Unserved
		Growth	**Weather**	**Price**	**Carbon Forecast**	**Constraints**	
Expected Conditions		Medium Load Growth	Stochastic Weather	Stochastic Pricing	SCC w/ 2.5% Discount Rate	None	N/A
Transportation	**No Evergreen**	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 2.5% Discount Rate	No Current Contracts Evergreen	2032
Growth	**High Growth**	High Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 2.5% Discount Rate	None	
	Low Growth	Low Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 2.5% Discount Rate	None	
Extreme Scenarios	**No Alberta Supply**	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 2.5% Discount Rate	No gas from Alberta	
	No BC Supply	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 2.5% Discount Rate	No gas from British Columbia	2021
	No Canadian Supply	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 2.5% Discount Rate	No gas from Canada	2021
	No Rockies Supply	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 2.5% Discount Rate	No gas from Rockies	
Limit Supply	**Limit Alberta**	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 2.5% Discount Rate	No day gas from Alberta	2024
	Limit BC	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 2.5% Discount Rate	No day gas from British Columbia	
	Limit Rockies	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 2.5% Discount Rate	No day gas from Rockies	2025
	Limit Canada	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 2.5% Discount Rate	No day gas from Canada	
No Storage	**No JP**	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 2.5% Discount Rate	No access to Jackson Prairie	
	No Plymouth	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 2.5% Discount Rate	No access to Plymouth storage	
	No Mist	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 2.5% Discount Rate	No access to Mist storage	
	No Storage	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 2.5% Discount Rate	No access to any storage	2022
Limit Storage	**Limit JP**	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 2.5% Discount Rate	25% access to Jackson Prairie	
	Limit Plymouth	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 2.5% Discount Rate	25% access to Plymouth storage	
	Limit Mist	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 2.5% Discount Rate	25% access to Mist storage	
	Limit Storage	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 2.5% Discount Rate	25% access to any storage	2033
RNG	**On System RNG**	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 2.5% Discount Rate	Must take RNG supply injected on Cascade's system	
	Off System RNG	Medium Load Growth	Stochastic Weather	Medium Pricing Environment	SCC w/ 2.5% Discount Rate	Must take RNG supply injected off Cascade's system	

Figure 10-4: Breakdown of Sensitivities Modeled

Sensitivities		Assumptions					First Year Unserved
		Growth	Weather	Price	Carbon Forecast	Constraints	
Expected Conditions		Medium Load Growth	Stochastic Weather	Stochastic Pricing	SCC w/ 2.5% 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/ 2.5% Discount Rate	None	
	20%	Medium Load Growth	Average Weather with Peak Event	Stochastic Pricing with a 20% Environmental Adder	SCC w/ 2.5% Discount Rate	None	
	30%	Medium Load Growth	Average Weather with Peak Event	Stochastic Pricing with a 30% Environmental Adder	SCC w/ 2.5% Discount Rate	None	
Carbon Forecasts	Raise Wages, Cut Carbon	Medium Load Growth	Average Weather with Peak Event	Stochastic Pricing	House of Representatives Raise Wages, Cut Carbon Proposal	None	
	Cap and Trade	Medium Load Growth	Average Weather with Peak Event	Stochastic Pricing	Market driven carbon pricing based on a Cap and Trade system	None	
	Market Choice	Medium Load Growth	Average Weather with Peak Event	Stochastic Pricing	House of Representatives' Market Choice Proposal	None	
Price Forecast	High Price Forecast	Medium Load Growth	Average Weather with Peak Event	Stochastic High Pricing Environment	SCC w/ 2.5% Discount Rate	None	

While Chapter 13 includes a full glossary, terms related to Figure 10-3 and 10-4 are shown below for convenience.

Terms Used in Figure 10-3 and 10-4

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.

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

Stochastic Pricing – NYMEX Pricing was modeled by running Cascade's price forecast through a Monte Carlo simulation, which allows the Company to identify the 95th percentile of potential NYMEX pricing based on the deterministic projections.

Stochastic High Pricing Environment – NYMEX Pricing was modeled by running Cascade's price forecast through a Monte Carlo simulation, which allows the Company to identify the 95th percentile of potential NYMEX pricing based on the deterministic projections. Prices were then increased by 5% at all markets to simulate a high pricing environment over the 20-year period.

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.

Cap and Trade – This was modeled as an adder to Cascade 20-year price forecast and avoided cost starting in 2021. The Company used the California Energy Commission's Integrated Energy Policy Report (IERP) 2019 Preliminary GHG Allowance Price Projection[1] as a proxy for the projected pricing of an Oregon Marketplace.

SCC w/ 2.5% Discount Rate – This was modeled as the base case for the 2020 IRP, as an adder to Cascade's 20-year price forecast and avoided cost

[1] *See* 2019 IEPR Preliminary GHG Allowance Price Projections
Energy Assessment Division 3-13-19 (https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=19-IEPR-03)

starting in 2021. The source of this forecast was 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.[2]

House of Representatives' Market Choice Proposal – A carbon sensitivity based on the proposed carbon tax that was introduced to the U.S. House of Representatives on January 24, 2019 (H.R. 763).[3] The proposal is not expected to pass but is a good proxy for a potential national tax. This was modeled as an adder to Cascade's 20-year price forecast and avoided cost starting in 2020.

House of Representatives' Raise Wages, Cut Carbon Act – A carbon sensitivity based on the proposed carbon tax that was introduced to the U.S. House of Representatives on July 25th, 2019 (H.R. 3996).[4] The proposal is not expected to pass but is a good proxy for a potential national tax. This was modeled as an adder to Cascade's 20-year price forecast and avoided cost starting in 2020.

Must Take On-System RNG – This is a hypothetical renewable natural gas resource that is inserted into the scenario at the zonal level, meaning no additional upstream capacity is needed to inject the supply at a citygate. Pricing, quantity, and timing of the resource, as well as the impact of this resource, is discussed further in Chapter 8, Renewable Natural Gas.

Must Take Off-System RNG – This is a hypothetical renewable natural gas resource that is inserted into the scenario at the supply basin level, meaning additional upstream capacity is needed to inject the supply at a citygate. Pricing, quantity, and timing of the resource, as well as the impact of this resource, is discussed further in Chapter 8, Renewable Natural Gas.

Planning and Modeling

SENDOUT® has broad capabilities that allow the Company to develop supply and demand relationships that closely mirror Cascade's existing operations. Figure 10-5 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.

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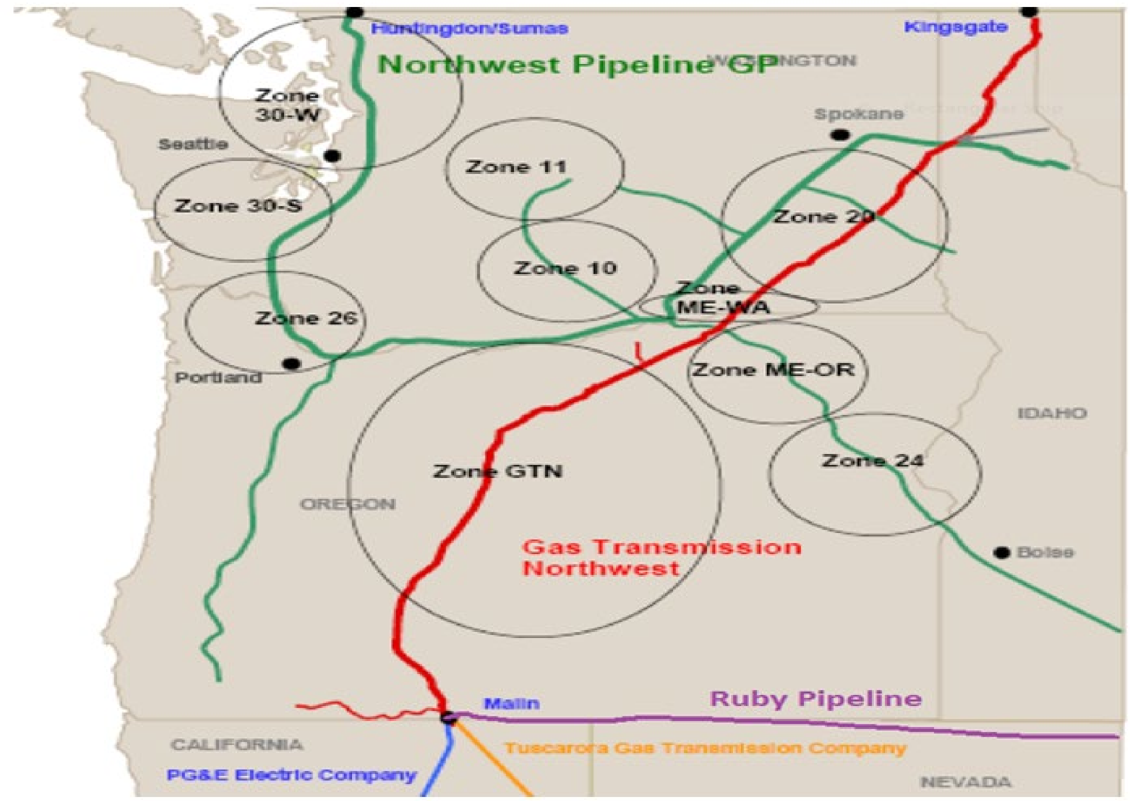
[2] *See* Interagency Working Group on Social Cost of Greenhouse Gases, United States Government, Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866 (https://www.epa.gov/sites/production/files/2016-12/documents/sc_co2_tsd_august_2016.pdf)

[3] *See* H.R.763 - Energy Innovation and Carbon Dividend Act of 2019 (https://www.congress.gov/bill/116th-congress/house-bill/763/text)

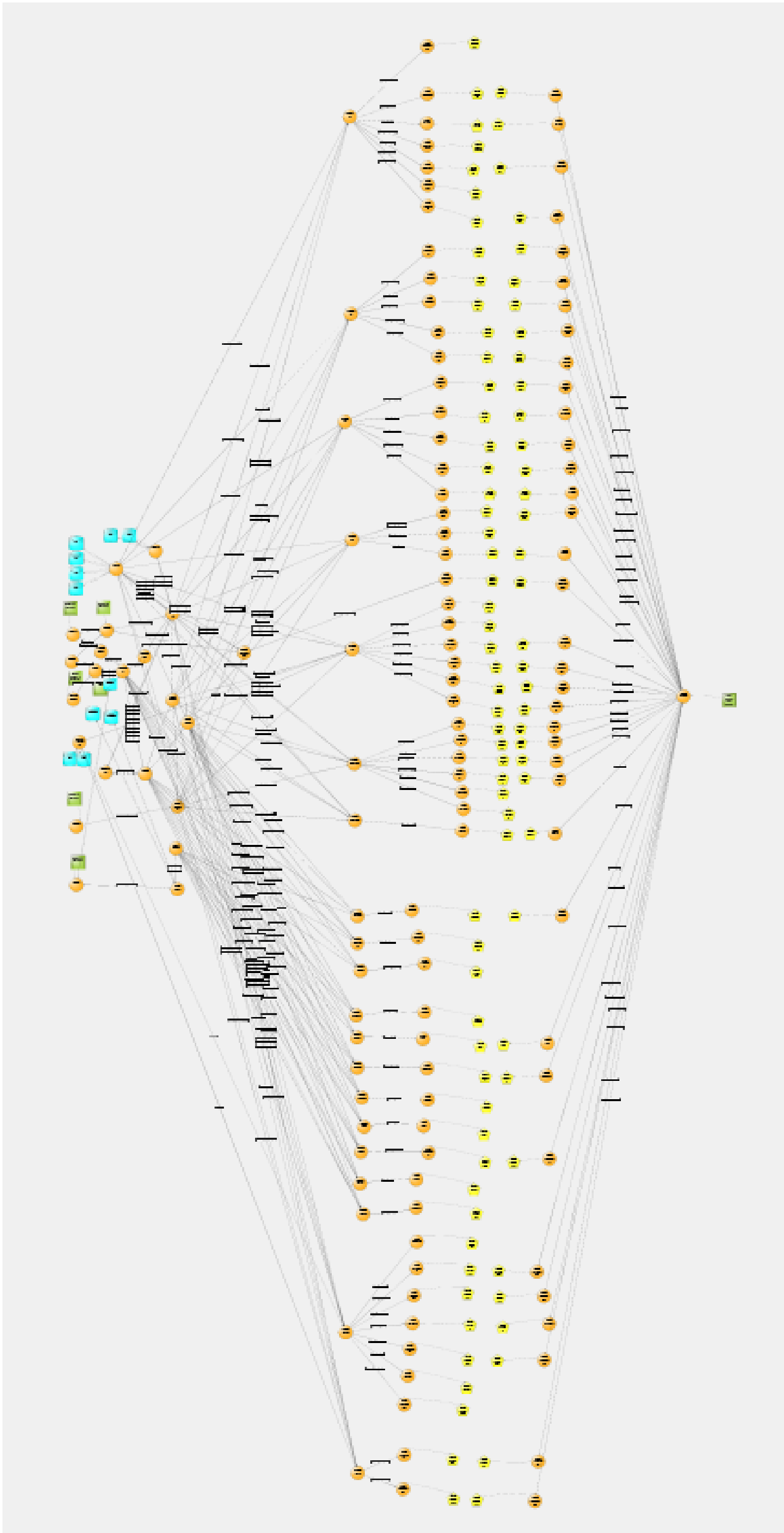
[4] *See* H.R.3996 – Raise Wages, Cut Carbon Act of 2019 (https://www.congress.gov/bill/116th-congress/house-bill/3966

Figure 10-5: Pipeline Zones Used in this IRP



With the in-house load forecast model (LFM) application, which is discussed in detail in Chapter 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 10-6. 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 10-6: SENDOUT® Network Diagram of Cascade's System



Stochastic Methodology Discussion

Cascade runs its Monte Carlo simulations on all candidate portfolios, which are 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.

The Company has moved from using the Monte Carlo functionality within SENDOUT® to building its own simulation engine in 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. This 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 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. Figure 10-7 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. Cascade is monitoring this by constantly evaluating and cross-validating the results.

Figure 10-7: 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 performs its Monte Carlo simulation on each of its basins, correlating the simulation results to each other similar to how weather is correlated. 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 of Gaussian distributions in weather stochastic analysis, and while the month to month percentage changes in gas prices are shown 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 two elements: a drift term and a shock term. The drift term is the expected movement of the basin pricing, 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 are used to 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 a resource planning 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 analyst 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 to provide greater detail than is available 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 the Load Factor Summary Report, which some analysts may prefer to use in their approach to analyze 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 report determines 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 Report 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 an analyst a menu of report information sources from which to choose specific items. The analyst 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 analyst 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 analyst 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® configured to 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 analyses to form the actual resource decisions.

Resource Integration

The following subchapters summarize the preceding chapters bringing together the demand forecast, existing supply and demand side resources and potential alternative resources to develop the 20-year, most reasonably priced reliable portfolio.

Demand Forecast

Load growth across Cascade's system through 2040 is expected to fluctuate between 0.92% and 2.19% annually, accounting for leap years. Load growth is split between residential, commercial, and industrial customers. Residential and commercial customer classes are expected to grow annually at an average rate of 1.50% and 1.23%, while industrial expects a growth rate of approximately 1.58%. Load across Cascade's two-state service territory is expected to increase at an average annual rate of 1.56% over the planning horizon, with the Oregon portion outpacing Washington, 1.83% versus 1.24%.

Long-Term Price Forecast

In Chapter 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 10-8 shows the history of regional and Henry Hub prices over the past ten years. 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, with one noticeable exception occurring at the end of 2018 with the Enbridge pipeline explosion. The inability to move gas from British Columbia to the U.S. Pacific Northwest created extreme upward pricing pressure across the region, and specifically at the Sumas basin. Once the pipeline was repaired and pricing stabilized by the summer of 2019.

Figure 10-8: Historical Regional Pricing for Past Ten Years

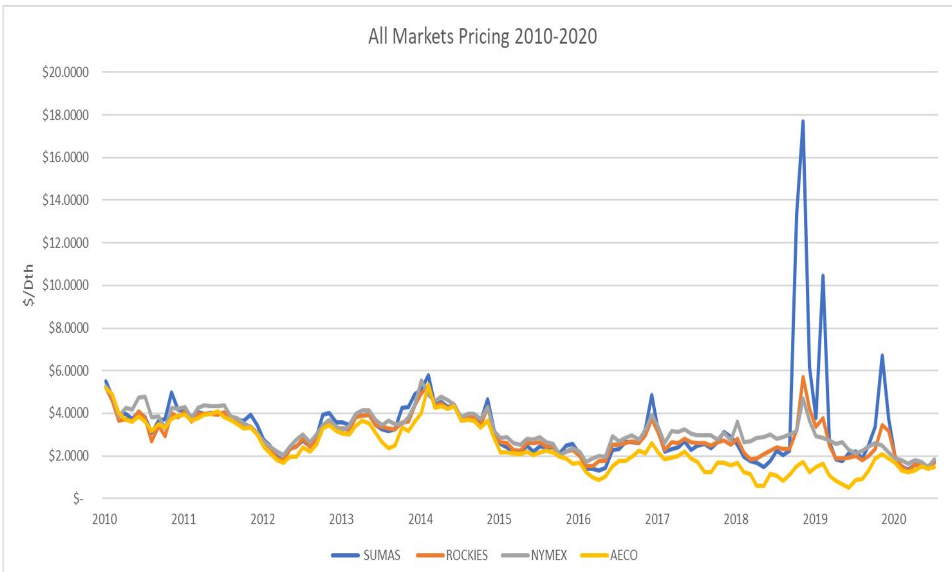
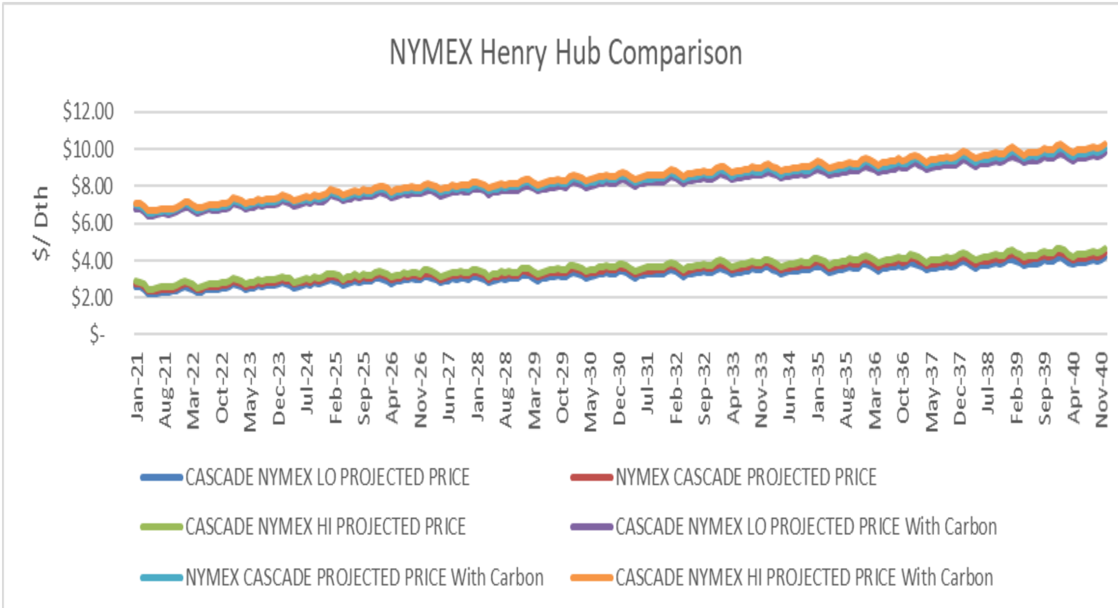


Figure 10-9 shows the comparison of ranges of pricing for the planning horizon, including the expected low, medium and high price, with and without a carbon adder for the impact of the Social Cost of Carbon with a 2.5% discount rate on pricing.

Figure 10-9: NYMEX Annual Price Comparison



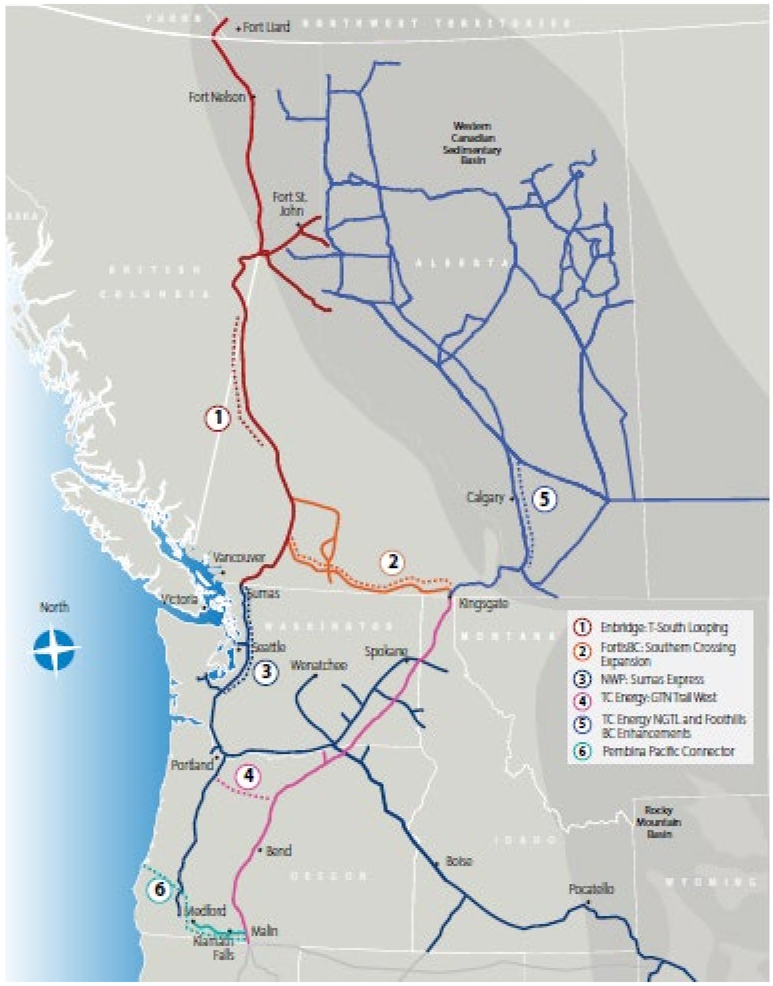
Environmental Adder

As discussed in Chapter 5, Avoided Cost, Cascade included a 10% environmental adder in its 2020 IRP's 20-year price forecast.

Transportation/Storage

Chapter 4, Supply Side Resources, 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 10-10, 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 delivery rights (Maximum Daily Delivery Obligations, or MDDOs) to citygates with potential peak day capacity shortfalls. The Company also uses 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 10-10: Alternative Transportation Resources[5]



Demand Side Management

Chapter 7, Demand Side Management, describes the methodology used to identify energy efficiency potential and the interactive process that utilizes avoided cost thresholds for determining the cost effectiveness of energy efficiency measures on an equivalent basis with supply side resources. For the 2020 IRP the nominal system avoided costs ranges between $0.79/therm and $1.09/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 otherwise 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. The peak day factor is the ratio of forecasted peak day demand to annual demand, while the

[5] Northwest Gas Association (NWGA) 2020 Pacific Northwest Gas Market Outlook 2020

non-peak factor is equal to one divided by the number of days in that year. 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 energy efficiency quantities before any resource acquisition decisions are made.

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 energy efficiency. For the first time in recent IRP history, Cascade is not forecasting any potential shortfalls over the entire planning horizon in its As-Is modeling. This is in large part a function of an additional 10,000 dth/day of GTN, 20,000 dth/day of NGTL, and 10,000 dth/day of Foothills capacity acquired in late 2019, which allows the Company to flow additional gas to central Oregon citygates that had forecasted shortfalls in previous IRPs. This capacity is anticipated to be in-service and added to Cascade's portfolio in 2023 and can be seen in Appendix E. It is important to note that this does not remove the necessity of the resource optimization process, as often times there may be additional resources that can be acquired to solve Cascade's goal of finding its least cost, least risk resource mix. A good example of this is the evaluation of additional capacity on the NGTL/Foothills systems near Alberta. Often times, AECO gas is cheaper than gas from Sumas or Rockies, so the Company must evaluate whether it is cost-effective to acquire the capacity to move more gas from AECO, at the expense of the reservation and demand charges associated with this capacity. Because of the complexity of Cascade's system, it is impossible to perform this analysis without the help of an optimization tool like SENDOUT®.

Portfolios Evaluated

For the 2020 IRP, Cascade elected to evaluate seven 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 seven portfolios after discussions with various stakeholders throughout its technical advisory group process. In future IRPs, Cascade will consider evaluating additional portfolios.

Figure 10-11 outlines the key components of each portfolio identified in Figure 10-1. 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.

Figure 10-11: Resource Composition of All Evaluated Portfolios

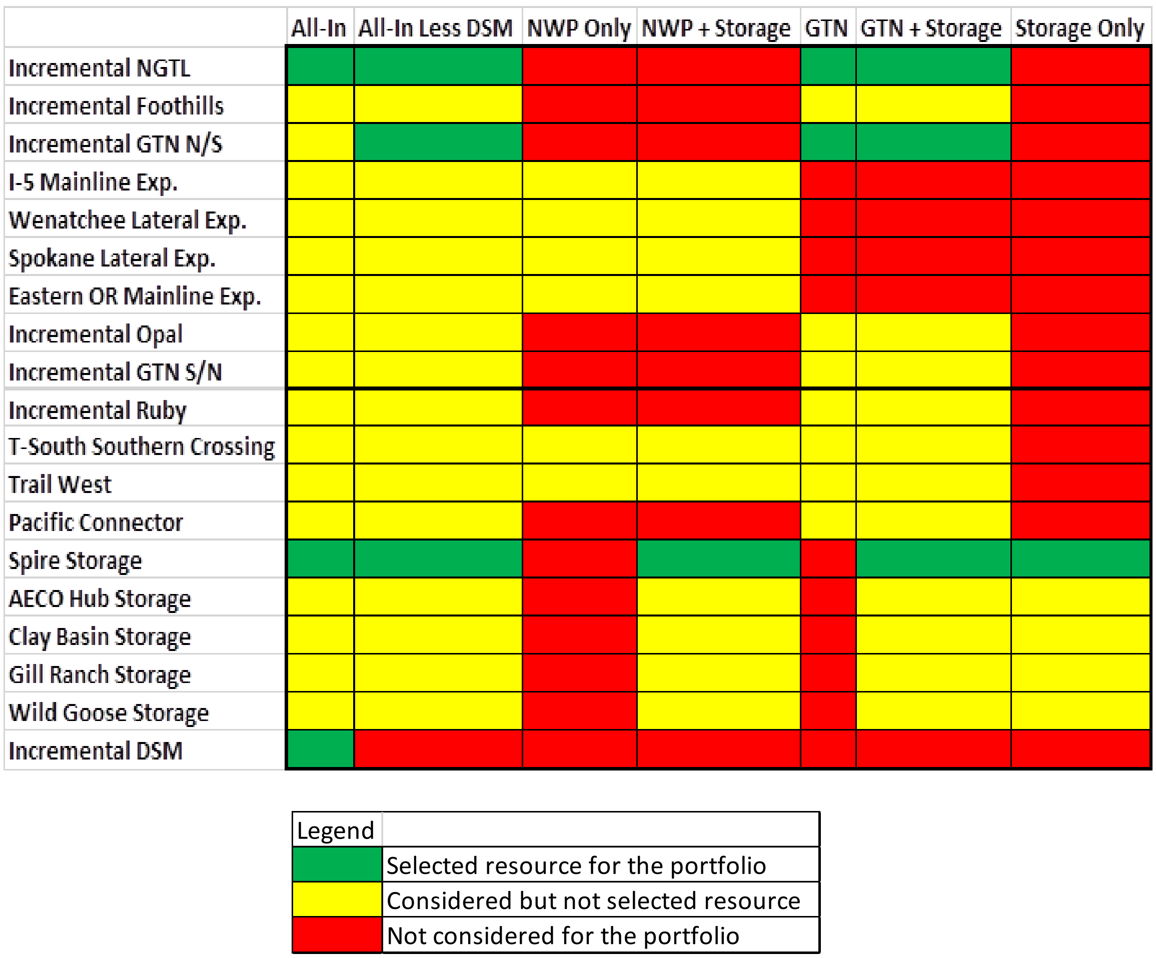


Figure 10-12 uses the mean and VaR of the total system cost and unserved demand of the portfolios considered to calculate the risk adjusted value of each portfolio. Given Cascade's mission to serve its customers, portfolios are first evaluated on unserved demand, and then mean total system cost.

Figure 10-12: Final Ranking of Portfolios – Mean and VaR

	Deterministic		Stochastic		Risk Adjusted Results	
Portfolio	Unserved Demand (DT)	Total System Cost ($000)	Unserved Demand (DT)	Total System Cost ($000)	Risk Adjusted Unserved Demand (DT)	Risk Adjusted Total System Cost ($000)
All-In	-	3,492,023	-	4,083,151	-	3,639,805
GTN + Storage	-	3,592,846	-	4,107,476	-	3,721,504
All-In Less DSM	-	3,593,146	-	4,107,451	-	3,721,722
GTN	-	3,596,248	-	4,112,461	-	3,725,302
Storage Only	-	3,590,294	-	4,096,099	-	3,716,746
NWP + Storage	-	3,590,508	-	4,096,087	-	3,716,903
NWP	-	3,593,933	-	4,101,127	-	3,720,731

Top-Ranking Candidate Portfolio

Using input from the alternative resources selected, the All-In portfolio was selected as the least cost, least risk solution for Cascade's system over the planning horizon. 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 portfolio 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 is shown graphically in Figures 10-13 through 10-16.

Figure 10-13: Annual Supply Take vs Demand – Top Ranked Candidate Portfolio

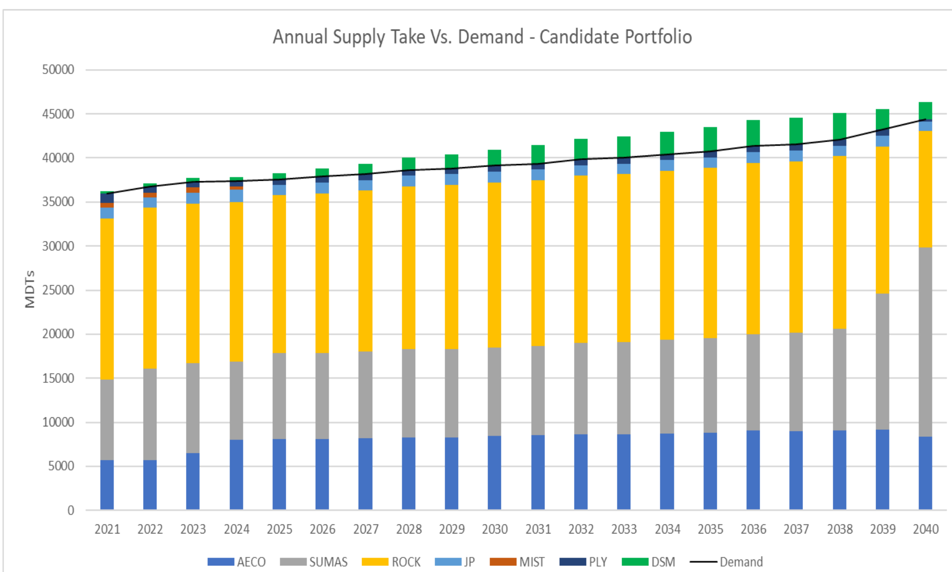


Figure 10-14: Peak Day Supply Take vs Demand – Top Ranked Candidate Portfolio

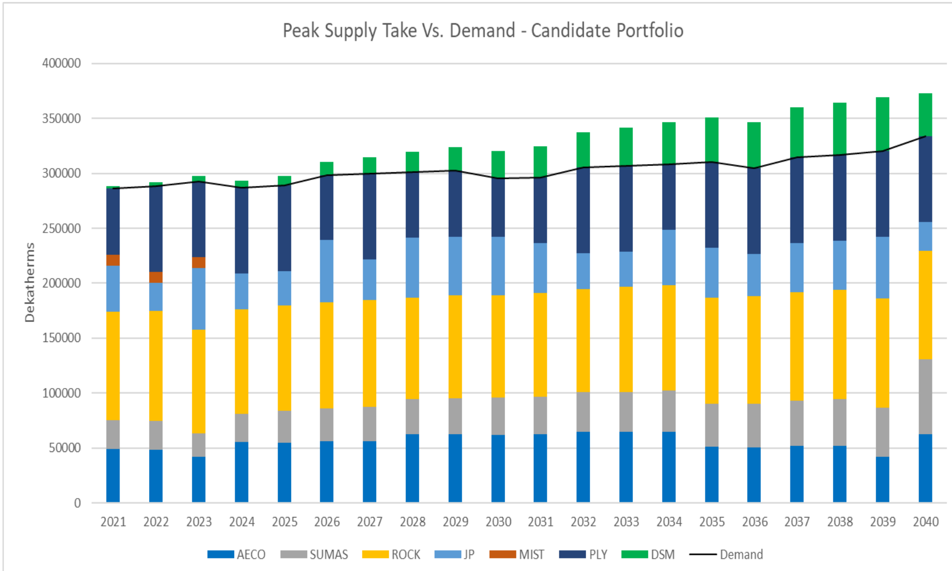


Figure 10-15: Annual Transport vs Demand –Top Ranked Candidate Portfolio

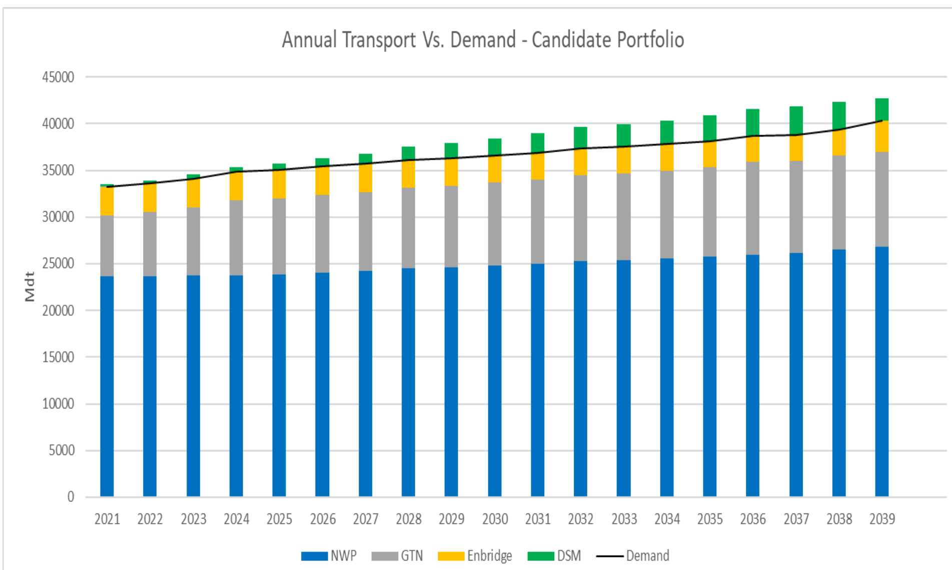
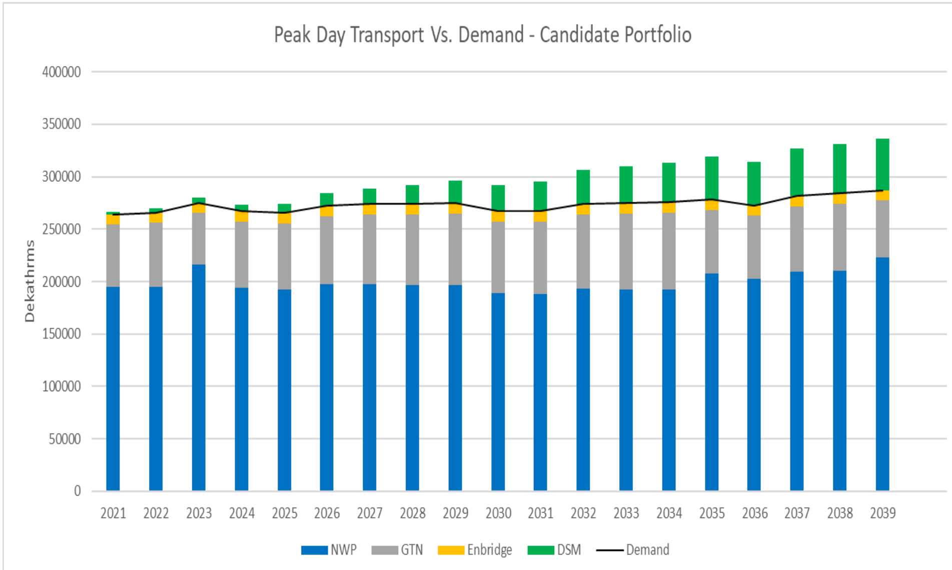


Figure 10-16: Peak Day Transport vs Demand – Top Ranked Candidate Portfolio



Alternative Resources Selected

The primary resource in the Top-Ranking Candidate Portfolio was incremental energy efficiency. The quantity and timing of this resource, using SCC with a 2.5% discount rate as the cost of carbon, is summarized in Figure 10-17.

Figure 10-17: Projected Cumulative Incremental DSM – in Therms

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Residential	471,164	974,111	1,578,956	1,664,485	2,844,476	4,088,454	5,395,325	6,764,328	8,393,160	10,067,040
Commercial	498,905	930,610	1,420,034	2,009,041	3,387,777	4,763,631	6,135,739	7,512,601	9,150,274	10,783,868
Industrial	79,578	155,218	254,159	354,002	479,934	606,423	728,910	849,812	965,438	1,075,362
Total	1,049,647	2,059,939	3,253,148	4,027,528	6,712,187	9,458,508	12,259,974	15,126,741	18,508,872	21,926,270

	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Residential	11,743,786	13,372,059	14,908,466	16,283,004	17,526,175	18,628,570	19,593,238	20,549,194	21,381,778	22,120,024
Commercial	13,515,456	15,038,830	16,386,460	17,578,046	18,598,487	19,418,437	20,114,312	20,707,027	21,190,089	21,585,060
Industrial	1,176,772	1,268,979	1,347,877	1,419,439	1,483,832	1,542,668	1,596,719	1,647,172	1,691,860	1,734,372
Total	26,436,013	29,679,868	32,642,803	35,280,489	37,608,494	39,589,675	41,304,269	42,903,393	44,263,727	45,439,456

In an effort to mitigate the risk around the uncertain nature of DSM potential, particularly with the major role energy efficiency has in the Company's Top-Ranking Candidate Portfolio, Cascade has evaluated the impact of different carbon futures on DSM. The results of this analysis are presented in Figure 10-18.

Figure 10-18: Analysis of Alternative Carbon Futures – in Therms

Scenario	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
SCC w/ 2.5% Discount	1,049,647	2,059,939	3,253,148	4,027,528	6,712,187	9,458,508	12,259,974	15,126,741	18,508,872	21,926,270
Cap and Trade	882,218	1,729,964	2,756,515	3,370,666	5,702,977	8,116,942	10,604,337	13,174,753	16,204,473	19,280,163
% Change	-16%	-16%	-15%	-16%	-15%	-14%	-14%	-13%	-12%	-12%
Market Choice	821,733	1,609,871	2,568,400	3,097,757	5,169,009	7,331,476	9,576,666	11,913,918	14,644,627	17,422,266
% Change	-22%	-22%	-21%	-23%	-23%	-22%	-22%	-21%	-21%	-21%
Raise Wages	897,529	1,760,511	2,804,538	3,440,924	5,843,046	8,325,823	10,881,071	13,518,404	16,629,574	19,784,978
% Change	-14%	-15%	-14%	-15%	-13%	-12%	-11%	-11%	-10%	-10%

Scenario	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
SCC w/ 2.5% Discount	26,436,013	29,679,868	32,642,803	35,280,489	37,608,494	39,589,675	41,304,269	42,903,393	44,263,727	45,439,456
Cap and Trade	22,302,342	25,185,561	27,847,043	30,237,390	32,369,612	34,202,349	35,808,051	37,329,465	38,602,398	39,704,411
% Change	-16%	-15%	-15%	-14%	-14%	-14%	-13%	-13%	-13%	-13%
Market Choice	20,162,361	22,791,032	25,234,970	27,444,785	29,433,714	31,157,907	32,684,628	34,154,008	35,391,230	36,466,536
% Change	-24%	-23%	-23%	-22%	-22%	-21%	-21%	-20%	-20%	-20%
Raise Wages	22,879,884	25,825,191	28,538,476	30,968,511	33,129,547	34,982,190	36,601,092	38,130,603	39,408,445	40,513,953
% Change	-13%	-13%	-13%	-12%	-12%	-12%	-11%	-11%	-11%	-11%

While this analysis does present a substantive delta, sensitivity testing of the Top-Ranked Candidate Portfolio provides some insight into the impact of these reduced therm savings to the Company's ability to serve its customers while not exceeding established risk tolerances. The results of this analysis can be seen in Figure 10-19.

Alternative Resources Not Selected

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

Upstream Transport

- Incremental GTN – At this time the additional Oregon capacity expected in 2023, in conjunction with incremental energy efficiency, offsets the need for more GTN capacity.
- Incremental I-5 Capacity –The Company does not forecast a need for additional I-5 capacity at this time because of the Bremerton-Shelton realignment Cascade discussed in Chapter 4, Supply Side Resources. Cascade will continue to monitor growth in Western Washington, as prior IRPs have identified the region as an area with potential shortfalls in the future.
- Incremental Foothills – Since the Company has more capacity on Foothills versus NGTL, Cascade would need to identify a significant amount of additional NGTL capacity needed before its modeling would recommend additional Foothills capacity.
- Incremental Ruby/Turquoise Flats – Without a need for additional capacity on GTN, Cascade does not need incremental capacity on Ruby and at Turquoise Flats to move supplemental gas to GTN.

- Wenatchee Expansion – Cascade's SENDOUT® modeling identified no forecasted shortfalls in central Washington in its As-Is analysis, and no cost savings from acquiring additional capacity in this region. As a result, a Wenatchee expansion is not required at this time.
- Zone 20 Expansion – Cascade's SENDOUT® modeling identified no forecasted shortfalls in eastern Washington in its As-is analysis, and no cost savings from acquiring additional capacity in this region. As a result, a Zone 20 expansion is not required at this time.
- Incremental Starr Road – SENDOUT® determined that with Cascade's current price forecast it did not make sense to purchase incremental upstream capacity to move AECO gas from GTN to NWP.
- Eastern Oregon Expansion – Cascade's SENDOUT® modeling identified no forecasted shortfalls in eastern Oregon in its as-is analysis, and no cost savings from acquiring additional capacity in this region. As a result, an eastern Oregon expansion is not required at this time.
- T-South Southern Crossing – SENDOUT® determined that based on Cascade's current price forecast it did not make sense to purchase incremental upstream 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 there was no need for incremental Ruby capacity, there is 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– 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's market intelligence indicates that Spire does not currently have available capacity. The Company will monitor Spire's capacity offerings for opportunities to acquire this resource in future IRPs.

Portfolio Evaluation: Additional Scenario/Sensitivity Analyses

Figure 10-19 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 Figure 10-3 and 10-4. The results of all scenarios are also shown graphically in Figures 10-20 and 10-21.

Figure 10-19: Total System Cost and Average Cost/Served Therm of Additional Scenarios/Sensitives

Scenario	Total System Cost ($000)	$/Therm Served	Distance from VaR Limit ($000)	Unserved Start Year	Total Therms Unserved
Raise Wages, Cut Carbon	3,699,953	0.4813	849,540	N/A	N/A
Cap and Trade Carbon Forecast	3,691,584	0.4802	857,909	N/A	N/A
Market Choice Carbon Forecast	3,663,054	0.4765	886,439	N/A	N/A
Price Forecast High	3,742,673	0.4868	806,819	N/A	N/A
Environmental Adder 0%	3,721,462	0.4841	828,030	N/A	N/A
Environmental Adder 20%	3,761,528	0.4893	787,965	N/A	N/A
Environmental Adder 30%	3,781,354	0.4918	768,139	N/A	N/A
No Evergreen	3,816,203	0.5271	733,289	2032	706,635,518
Low Growth	3,825,655	0.5068	723,837	N/A	N/A
High Growth	4,205,058	0.5040	344,435	N/A	N/A
Limit BC	4,169,076	0.5246	380,417	N/A	N/A
No BC*	3,022,081	0.4837	1,527,412	2021	1,698,605,802
Limit Alberta	4,205,333	0.5292	344,159	N/A	N/A
No Alberta*	4,395,393	0.5533	154,100	2024	2,374,033
No Rockies*	4,920,722	0.6300	(371,230)	2026	135,654,971
Limit Rockies	4,417,382	0.5559	132,111	N/A	N/A
Limit Canada	4,464,871	0.5619	84,622	N/A	N/A
No Canada*	2,881,779	0.5226	1,667,714	2021	2,432,839,477
No Plymouth	4,093,948	0.5152	455,545	N/A	N/A
Limit Plymouth	4,073,095	0.5126	476,397	N/A	N/A
Limit JP	4,127,268	0.5194	422,224	N/A	N/A
No JP	4,168,125	0.5245	381,368	N/A	N/A
Limit Mist	4,019,504	0.5058	529,989	N/A	N/A
No Mist	4,021,987	0.5061	527,506	N/A	N/A
Limit Storage	4,205,825	0.5293	343,668	2033	570,920
No Storage	4,280,853	0.5391	268,640	2022	5,116,642
RNG #1	4,015,358	0.5053	534,135	N/A	N/A
RNG #2	4,017,026	0.5055	532,466	N/A	N/A
***Denotes Extreme Scenario, see Extreme Scenario Discussion subsection for analysis**					

VaR Limit	**4,549,493**

Figure 10-20: Total System Cost Comparison by Scenarios/Sensitivity

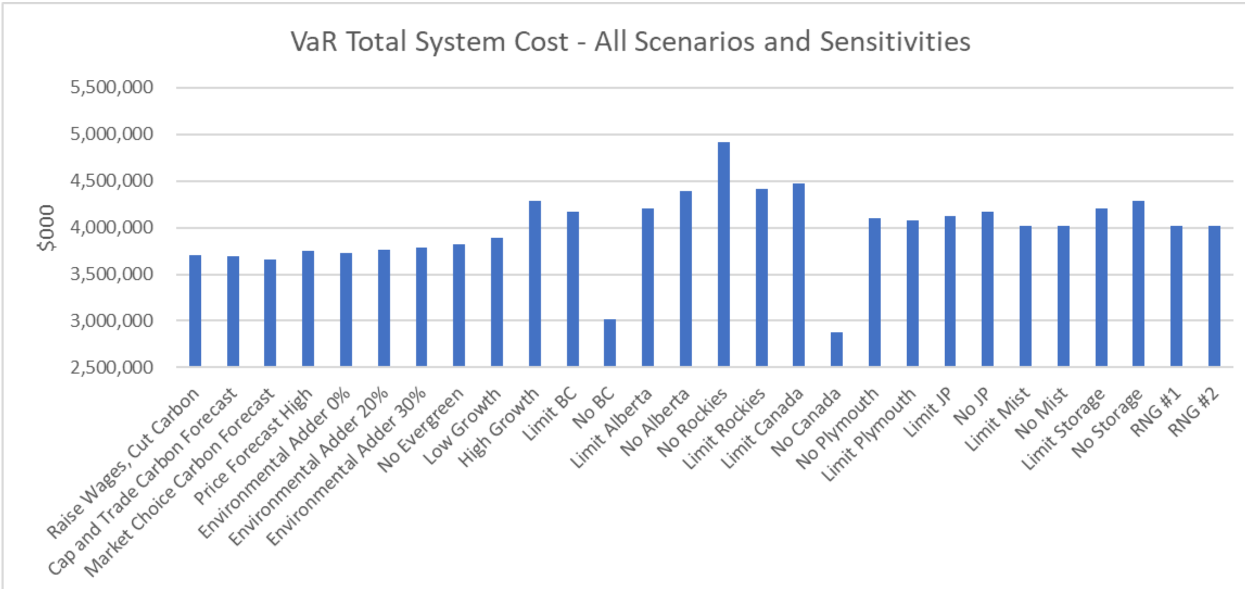
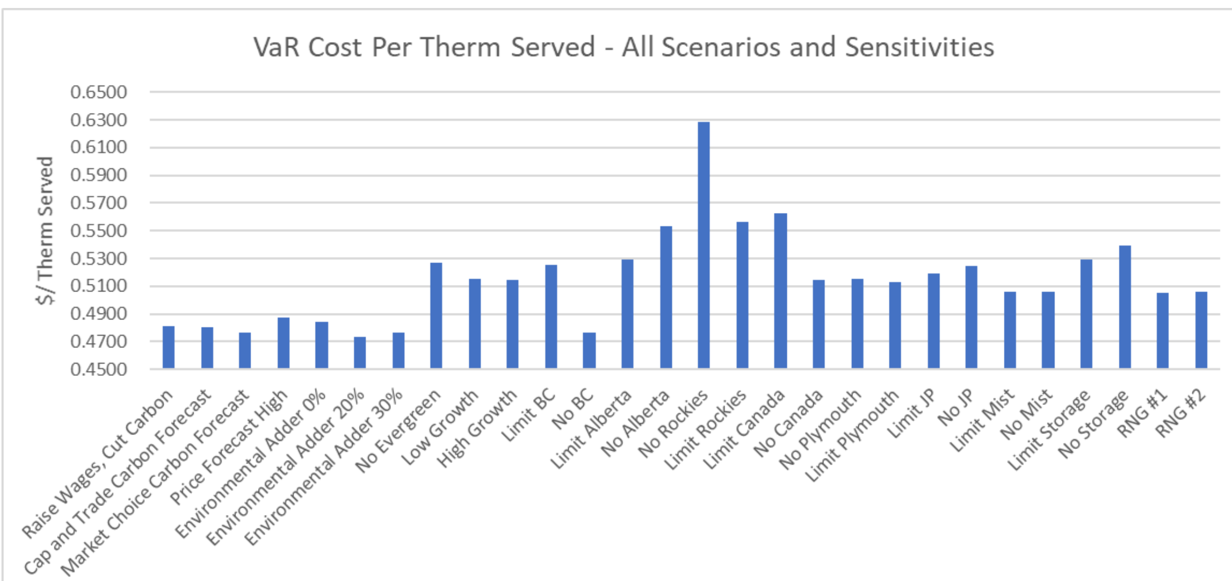


Figure 10-21: Cost per Therm Served by Scenario/Sensitivity



Holistically, one interesting conclusion to draw from this data is that Cascade's system is far more sensitive to the availability of its resources versus the cost or demand for these resources. In Figure 10-20 costs are fairly static across the scenarios and sensitives where gas prices or load are the primary variable (high/low growth and the various carbon sensitivities) but become more volatile when the ability to access one or more basins or storage facilities is limited or removed. Two traditional scenarios in particular provide intriguing results that merit further discussion: No Evergreen and No Storage.

In Cascade's No Evergreen scenario, the Company assumes that, upon expiration, Cascade will not renew any of its upstream transportation contracts. In theory, this could provide some significant savings to Cascade's customers if the Company no longer needed to pay reservation rates on unnecessary contracts. Unfortunately, this analysis has identified that without renewing these contracts, the Company may begin to experience shortfalls starting in 2032. While this does not invalidate the Top-Ranking Candidate Portfolio, it does reinforce the necessity to review all contracts prior to expiration to evaluate if it is prudent to renew the contract, a process that the Company undertakes well before all contracts are set to terminate.

In Cascade's No Storage scenario, the Company assumes that it will no longer have access to any storage facilities as of the start of the planning horizons. Obviously, this would be problematic for a number of reasons, as storage is both a vital cost mitigation tool and a key peaking resource in high demand situations. As expected, under this scenario Cascade would experience both an increase in cost (although not above the VaR limit) and potential shortfalls almost immediately. Once again this does not invalidate the Top-Ranking Candidate portfolio as it is unrealistic to expect to lose access to all storage facilities, but it does reinforce the value of Cascade's existing storage, and the Company's desire to continue to acquire storage when cost-effective or operationally beneficial, as was the case when Cascade leased capacity at the Mist storage facility.

Extreme Scenario Discussion

New to the 2020 IRP, the Company has elected to label four of its scenarios as extreme scenarios: No Rockies, No Alberta, No BC, and No Canada. In each of these scenarios, Cascade loses the ability to purchase gas from the referenced basin. While possible for the short term, these scenarios are not meant to evaluate potential real world activities, but rather to examine how valuable access to these basins are relative to each other.

The extremely low total system costs in the No Canada and No BC scenarios are a function of Cascade's inability to serve a significant portion of its customers without Canadian gas, while the high cost of the No Rockies scenario is a result of an excessive reliance on Sumas gas when gas from the Rockies is removed from the portfolio. Finally, the No Alberta scenario's impacts are mitigated by the fact that Cascade is already limited in the amount of supply it can purchase from AECO by its existing relatively smaller share of transportation contracts from Alberta, as illustrated in Figures 10-13 and 10-14. That being said, without this gas, Cascade loses its primary resource to serve its central Oregon customers. Alberta gas also tends to be the cheapest of the three basins, which leads to a higher cost per therm served than most other scenarios/sensitivities.

While Cascade is hesitant to label scenarios as analogs to real life events, it is worth discussing the No BC scenario in the context of the 2018 Enbridge explosion. The Company's scenarios assume a permanent impact to supplies at Sumas, while the Enbridge incident only temporarily restricted access to gas in British Columbia. If such an explosion were to cause permanent damage, the data from this scenario analysis would seem to indicate that Cascade's system could survive restricted access to British Columbia supplies as evidenced in the Limit BC scenario, but would struggle to maintain the capacity to serve customers if Sumas gas were to be fully inaccessible for a sustained period of time.

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 proprietary Monte Carlo functionality, the Company has the ability to analyze the impacts of stochastic weather on its load forecast. Figure 10-22 shows the daily HDD pattern at each of Cascade's seven weather stations, while Figure 10-23 compares the system weighted stochastic weather to the deterministic system weighted weather profile to emphasize the potential volatility of weather that is captured in stochastic analysis.

Figure 10-22: Stochastic HDDs by Weather Station

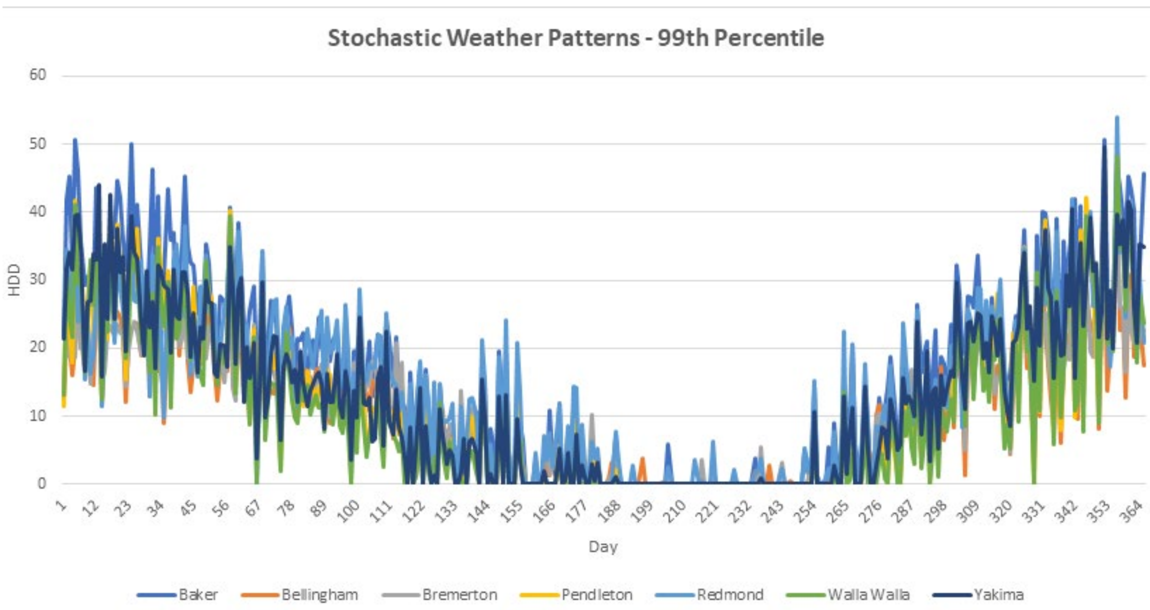
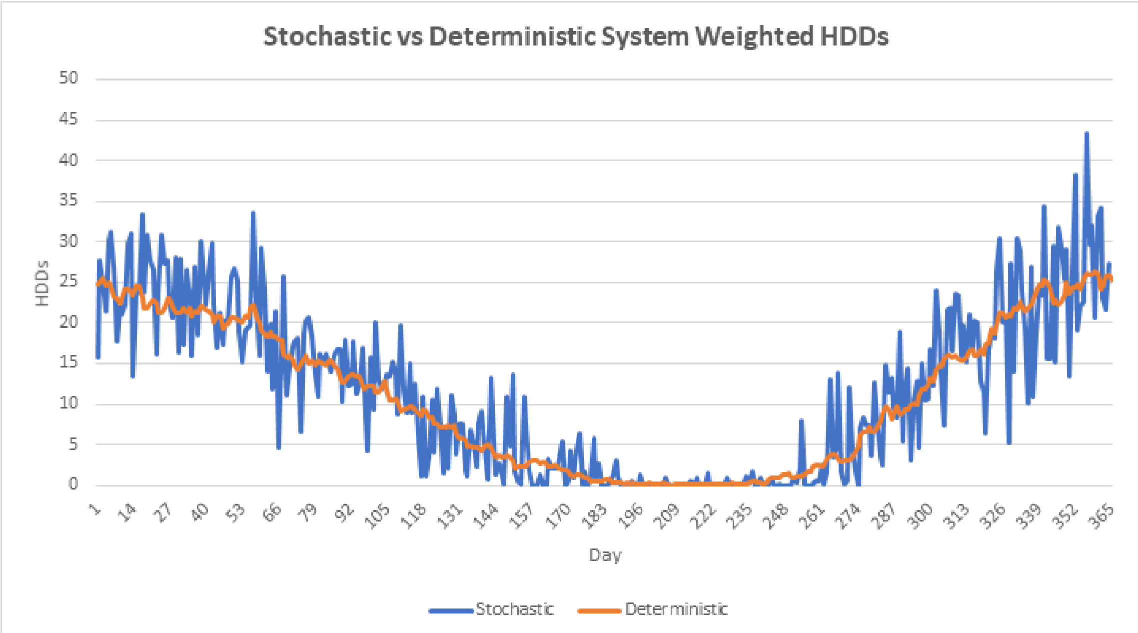


Figure 10-23: Stochastic Vs. Deterministic System Weighted HDDs



Stochastic Analyses – Price Uncertainty

Similar to weather analysis, uncertainty related to future gas prices can have a significant impact on Cascade's forecasted costs over the 20-year planning horizon. The Company analyzes the risk of price projections by running the 95th percentile of monthly load weighted prices with a variety of carbon and environmental externality costs as its sensitivity analyses. The 95th percentile can be viewed as a value in which all potential values fall beneath it 95% of the time. Figure 10-24 provides a potentially extreme price forecast, especially the 95th percentile of possible pricing, for each basin. Figure 10-25 compares these stochastic forecasts to their deterministic counterparts as a visual representation of the impact of a one-in-twenty price movement, also known as a black swan event, on the regional pricing paradigm. All of these prices include the cost of carbon compliance at the SCC with a two and one-half percent discount rate.

Figure 10-24: 95th Percentile Price Forecast by Basin – Monte Carlo Data

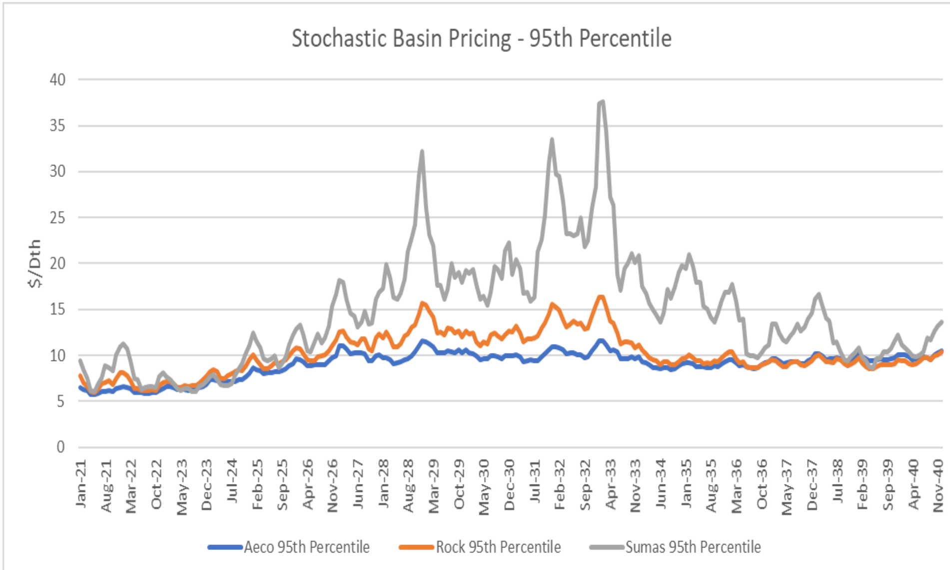
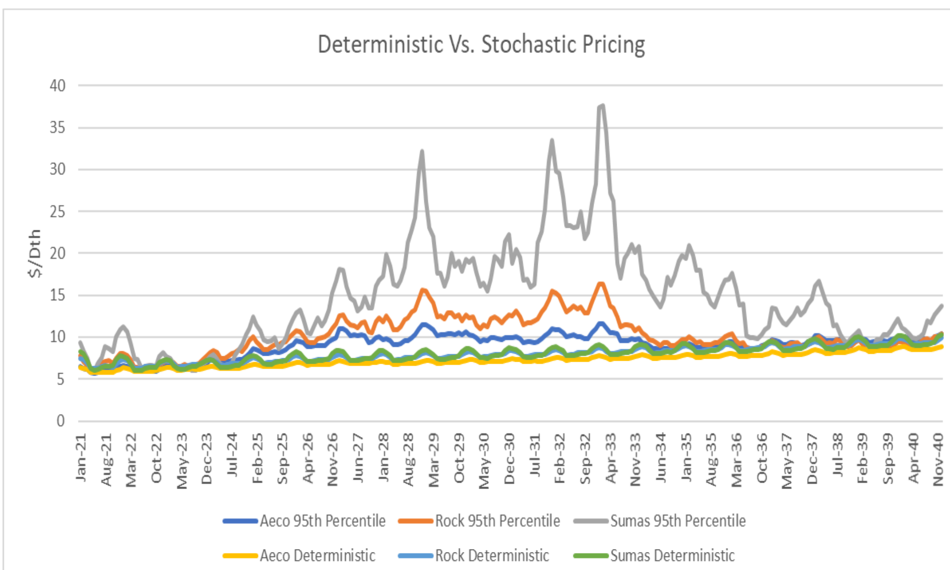


Figure 10-25: Deterministic Vs. Stochastic Pricing



It is important to note that the forecasted spikes in Sumas pricing do not correlate to a projection of any specific event. Sumas has shown historically to have the highest variance among the three basins Cascade can purchase gas from, and this variance can lead to extreme pricing when one is modeling black swan pricing, which is the case at the 95th percentile.

Conclusion

Cascade's All-In portfolio includes all existing supply side resources as discussed in Chapter 4, all projected DSM savings discussed in Chapter 7, and all incremental resources discussed in this chapter. The All-In portfolio did not exceed the VaR Limit in any traditional 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, provide a base foundation to meet the load needs of Cascade's core customers. However, Cascade's unique geographical reach also 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 demand analysis provides an opportunity 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 to be prepared. 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.

Chapter 11

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. Due to the COVID-19 pandemic, all TAG meetings were held virtually.
- Multiple opportunities for public participation were available, including 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

Typically, the Company holds a series of public meetings in the state of Washington for the development of this specific IRP. Cascade's IRP stakeholders are widely spread out geographically; cities in western Washington are generally more easily accessible for individuals to attend than Kennewick for TAG meetings. Cascade scheduled five TAG meetings between April and September 2020. Due to travel and social distancing restrictions as a result of the COVID-19 pandemic, these meetings were held virtually using Microsoft Teams. Additionally, Cascade held an upstream emissions workshop following the fifth IRP TAG meeting. Cascade also offered to hold a TAG 6 meeting after the draft IRP had been distributed and comments were returned to Cascade, but it was determined by all stakeholders that a sixth TAG meeting was not required.

In an effort to further clarify roles and responsibilities for the Company as well as stakeholders, Cascade follows a stakeholder engagement document, which can be found in Appendix A. 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, Commission Staff, stakeholder representatives such as the Northwest Gas Association, Public Counsel, Citizens' Utility Board, Washington Department of Ecology, Northwest Energy Coalition, and the Alliance of Western Energy Consumers.

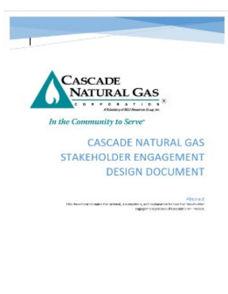
Internally, the Cascade IRP stakeholders and participants are from the following departments:

- 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 2020 IRP schedule.

TAG Meetings and Workshops

Cascade held five public TAG meetings with internal and external stakeholders. Due to the COVID-19 pandemic, all meetings were held as virtual with Microsoft Team meetings. Robust discussion occurred, in particular, around energy efficiency, carbon, and renewable natural gas during TAG 4. This meeting is a good example of stakeholder participation and good input to the Company. Information about each meeting date and major agenda items are provided below as well as in Appendix A.



2020 IRP TAG 1 Meeting – Wednesday, April 15, 2020
- Virtual: 9 am to 12 pm
- Process
- Key Points
- IRP Team
- Timeline
- Regional Market Outlook
- Plan for dealing with issues raised in 2018 IRP

2020 IRP TAG 2 Meeting – Wednesday, May 27, 2020
- Virtual: 9 am to 12 pm
- Demand and Customer Forecast and Non-Core Outlook
- Drilling down into segments of demand forecast

2020 IRP TAG 3 Meeting – Wednesday June 24, 2020
- Virtual: 9 am to 12 pm
- Presentation from Ruby Pipeline of Kinder Morgan
- Distribution System Planning

- Planned Scenarios and Sensitivities
- Alternative Resources
- Price Forecast
- Avoided Cost
- Current Supply Resources
- Transport Issues.

2020 IRP TAG 4 Meeting – Thursday, August 13, 2020
- Virtual: 9 am to 1 pm
- Carbon Impacts
- Energy Efficiency (Energy Trust of Oregon)
- Renewable Natural Gas
- Preliminary Resource Integration Results

2020 IRP TAG 5 Meeting – Wednesday, September 23, 2020
- Virtual: 9 am to 12 pm
- Final Integration Results
- Finalization of plan components
- Two-year Action Plan

2020 IRP Upstream Emissions Meeting – Thursday, October 15, 2020
- Virtual: 9 am to 12 pm
- Upstream Emissions Calculation

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

Chapter 12

Two-Year Action Plan

2020 Action Plan

The IRP 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 2020 Action Plan focuses on:

- Supply Side Resources
- Environmental Policy
- Avoided Cost
- Demand Side Management
- Renewable Natural Gas
- Distribution System Planning
- IRP Process

Resource Planning

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, updates to Company website, and/or other means. The Company will also perform cross validation on new methodologies to ensure the accuracy of the new models.

Cascade will also:

- Continue to work with Northwest Pipeline to pursue opportunities to better align Maximum Daily Delivery Obligations (MDDO) contract delivery rights at no incremental costs to customers through the use of segmentation or other proposals.
- Continue to work on developing scenarios to replicate potential supply and transport impacts for pipeline operational flow orders (OFO) and consideration of other strategies to minimize OFO impacts.
- Continue to develop SENDOUT® direct models for gas cost workbooks provided to commissions during PGA filings to better improve the alignment of resources/costs between the PGA and the IRP.
- Develop more scenarios to specifically address potential Canadian supply market changes such as diversion of Station 2 supplies to Liquified Natural Gas facilities and/or Nova Gas Transmission, Limited, and the impact of the Canadian federal fuel charge on the price and potential switching of supply basins utilization/needs of upstream pipeline transportation over time.
- Develop scenarios that consider sensitivities around municipal natural gas bans or other deep decarbonization possibilities in Cascades service territory.
- Add renewable natural gas as a candidate portfolio for the supply resource optimization process.
- Cascade will investigate the cost and feasibility of a potential hydrogen plant as an alternative resource.

Avoided Cost

Work with stakeholders to ensure Cascade is properly quantifying upstream emissions reductions benefits in the Company's avoided cost calculation.

Demand

Cascade will look into making adjustments to a few methodologies on the demand forecast and scenarios. Those adjustments include:

- Adding wind in the stochastic weather analysis.
- Investigate climate change modeling scenarios.
- Develop a new methodology for peak day. Cascade's peak day is currently the coldest day in past 30 years. Beginning with the 2022 IRP, Cascade's current peak day will fall outside of the 30-year range.
- Discuss, for the 2022 IRP, any potential impacts the COVID-19 crisis may have on demand.

Environmental Policy

Cascade will either begin or continue to participate/monitor the following items:

- Engage and provide feedback as part of public discussions surrounding City of Bellingham Climate Actions.
- Continue to identify opportunities to engage with City of Bend on renewable gas or offset opportunities as implementation of Climate Action Plan begins.
- Monitor service areas for potential GHG reduction goal development relating to energy delivery and supply.
- Identify county level climate initiatives and monitor regional discussions on alternative energy delivery.
- Monitor and provide feedback on carbon pricing and policy developments (i.e., carbon tax or cap and trade bills, ballot measures, electrification bills, etc.).
- Monitor and adapt programs and policies to meet federal and state GHG regulations for energy industry.
- Identify impacts of evolving energy code on energy delivery and supply and continue to pursue maximum-efficiency natural gas technologies for inclusion in DSM efforts.
- Continue current emission reduction and monitoring endeavors (i.e., Methane Challenge Program, Renewable Natural Gas studies).
- Model sensitivity analysis regarding upstream emissions.

Demand Side Management (Energy Efficiency)

Long-term program success requires a commitment to support and advance the Company's EE programs. In this context, Cascade notes the following actions it will take, keeping in mind some are driven by legislative requirements and others are part of operating ever-evolving programs.

Adherence to the Washington Clean Buildings Act, HB 1257,[1] is a key proponent of the EEIP two-year action plan. While a variety of the elements of the bill pertain to energy efficiency programs the Company will focus on the following:

- Implementation and completion of Phase 2 of the CPA with a WUTC filing by Summer 2021.
    - This allows for a complete review of measure assumptions, market availability and ramp rates per the Northwest Power and Conservation Council's Seventh Power Plan.
    - It will also include a low-income specific market segment review to better determine energy efficiency potential in the at-needs community.
    - Provide an updated reality check to the goals set for 2021 through Phase 1 of the CPA.
- Revise the Conservation Plan development timeline from annual to biannual beginning in fall of 2021 and meet all requirements associated with the biannual plan development.
- Meet WA Clean Buildings requirements for early adopters (applies to Commercial property owners of 50,000 square feet or more buildings) including baseline data submission and review through ENERGY STAR®'s Portfolio Manager.

In addition, the program will focus on the following areas to increase uptake in alignment with the higher goals set through LoadMAP:

- Evaluate the progress, and potentially expand, the C/I Mid-Stream pilot for tankless water heaters;
- Research both multi-family offerings to target the sector within Cascade's territories for specialized building upgrades and alternative no cost-low cost options to the existing Energy Savings Kits; and
- Continue to leverage partnerships (NEEA and GTI) to incorporate new technologies as they become viable.

And, not to be understated, Calendar Year 2021 will require consistent adaptive management of the programs based on COVID-19 impacts. Some of the elements of this management will include:

- Exploration of assumptions with the CAG to run alternative potential scenarios through LoadMAP;

[1] *See* http://lawfilesext.leg.wa.gov/biennium/2019-20/Pdf/Bills/House%20Passed%20Legislature/1257-S3.PL.pdf?q=20201020144814

- Efforts to target C/I customers based on their economic impact, closures and renovation opportunities;
- Exploration of efficiency opportunities associated with improvements to air quality in buildings; and
- Implementation of remote quality inspection processes to initially replace in-person inspections, and eventually transition to a complementary offering with potential to offer light audit review to customers prior to measure installs.

Renewable Natural Gas

While actively participating in RNG policy and rules development in Washington and Oregon, Cascade has created an RNG Project Cost Effectiveness Evaluation Methodology as shown on page 8-8. Due to uncertainty around environmental attributes, as well as other rules and guidelines for RNG, Cascade will continue to develop and update the cost-effective evaluation tool. In addition, the following Action Items will be pursued:

- Continue to hold discussions with potential RNG partners.
- Develop necessary internal protocols to offer RNG services to customers.
- Develop a voluntary RNG program under RCW 80.28.390.

Distribution System Planning

The Company will address the following Action Items for Distribution System Planning.

- Implement various stages or review of the of the list of projects that require an increase in capacity as shown in Appendix I.
- Construct citygate upgrades, over the next several years, in Aberdeen, Kennewick, and Longview.
- Focus on projects to include pipe upgrades as well as increased pipe capacity, while continuing to maintain compliance with Maximum Allowable Operation Pressure regulations.

Figure 12-1 on the following page highlights specific activities of the 2020 Action Plan.

Figure 12-1: Highlights of 2020 Action Plan

Functional Area	Anticipated Action	Timing
Resource Planning	Cascade will: • Attend other regional LDC IRP meetings; • Work with NWP on realigning MDDOs; • Develop modeling scenarios that represent pipeline OFOs; • Improve the alignment of resource/costs between the PGA and the IRP; • Develop more scenarios that address changing Canadian Markets; • Develop scenarios that consider sensitivities around municipal natural gas bans or other deep decarbonization possibilities in Cascades service territory; • Add RNG as a candidate portfolio; and • Investigate the cost and feasibility of a potential hydrogen plant as an alternative resource.	Ongoing, for inclusion in 2022 IRP.
Avoided Cost	Cascade will: • Model sensitivity analysis regarding upstream emissions.	Ongoing, for inclusion in 2022 IRP.
Demand	Cascade will: • Add wind in the stochastic weather analysis; • Investigate climate change modeling scenarios; and • Develop, in collaboration with Staff and stakeholders, a new methodology for peak day. • Discuss, for the 2022 IRP, any potential impacts the COVID-19 crisis may have on demand.	Ongoing, for inclusion in 2022 IRP.
Environmental Policy	The Company will execute the Environmental Policy action items as described on page 12-3 and 12-4.	Ongoing, for inclusion in 2022 IRP.
DSM (Energy Efficiency)	The Company will execute the Demand Side Management action items as described on page 12-4.	Ongoing, for inclusion in 2022 IRP.
Renewable Natural Gas	Cascade will: • Continue to develop and update the cost-effective evaluation tool. • Continue to hold discussions with potential RNG partners. • Develop necessary internal protocols to offer RNG services to customers. • Develop a voluntary RNG program under RCW 80.28.390.	Ongoing, for inclusion in 2022 IRP.
Distribution System Planning	Cascade will: • Implement various stages or review of the of the list of projects that require an increase in capacity as shown in Appendix I. • Construct citygate upgrades, over the next several years, in Aberdeen, Kennewick, and Longview. • Focus on projects to include pipe upgrades as well as increased pipe capacity, while continuing to maintain compliance with Maximum Allowable Operation Pressure regulations.	Ongoing over the next four to five years.

Chapter 13

Glossary and Maps

Glossary of Definitions and Acronyms

The glossary is provided to allow the reader to maintain a location of definitions and acronyms for the content provided in this Integrated Resource Plan. Definitions and Acronyms can be found on pages 13-2 through 13-16. Cascade's citygates and the zone and pipeline each gate is associated with are listed on pages 13-17 through 13-19. Pipeline maps of gas systems that Cascade utilizes are provided on pages 13-20 through 13-33.

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.

CANADIAN ENERGY REGULATOR (CER)
The Canadian equivalent to the Federal Energy Regulatory Commission (FERC). The CER replaced the National Energy Board (NEB) on August 14, 2019.

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.

MDT
Thousands of dekatherms.

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 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 or NGTL)
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 energy 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.

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 (NGTL); 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 13-1: Map – AECO Hub Storage

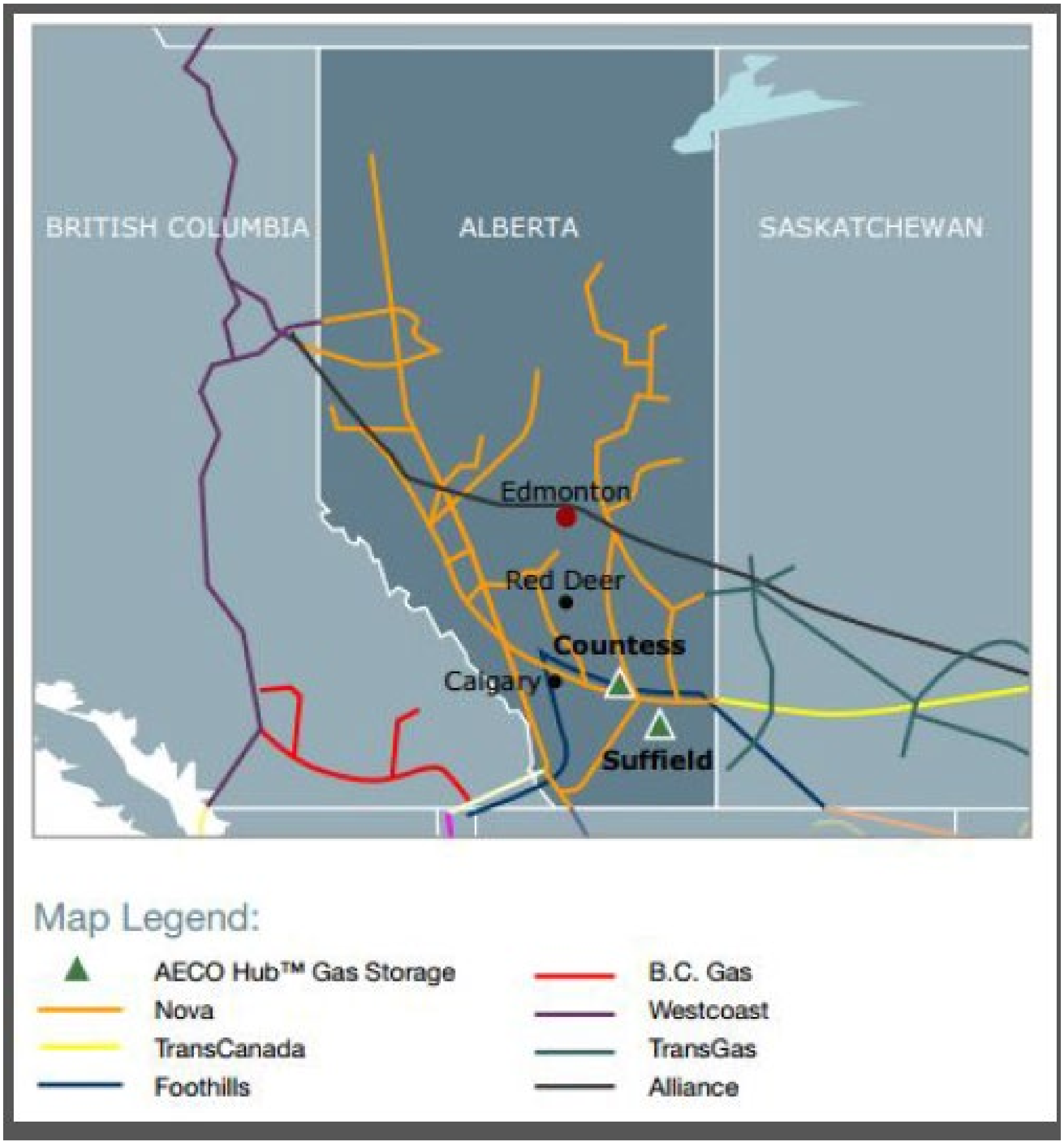


Figure 13-2: Map – California Storage Map

Figure 13-3: Map – Cascade Natural Gas Pipeline System

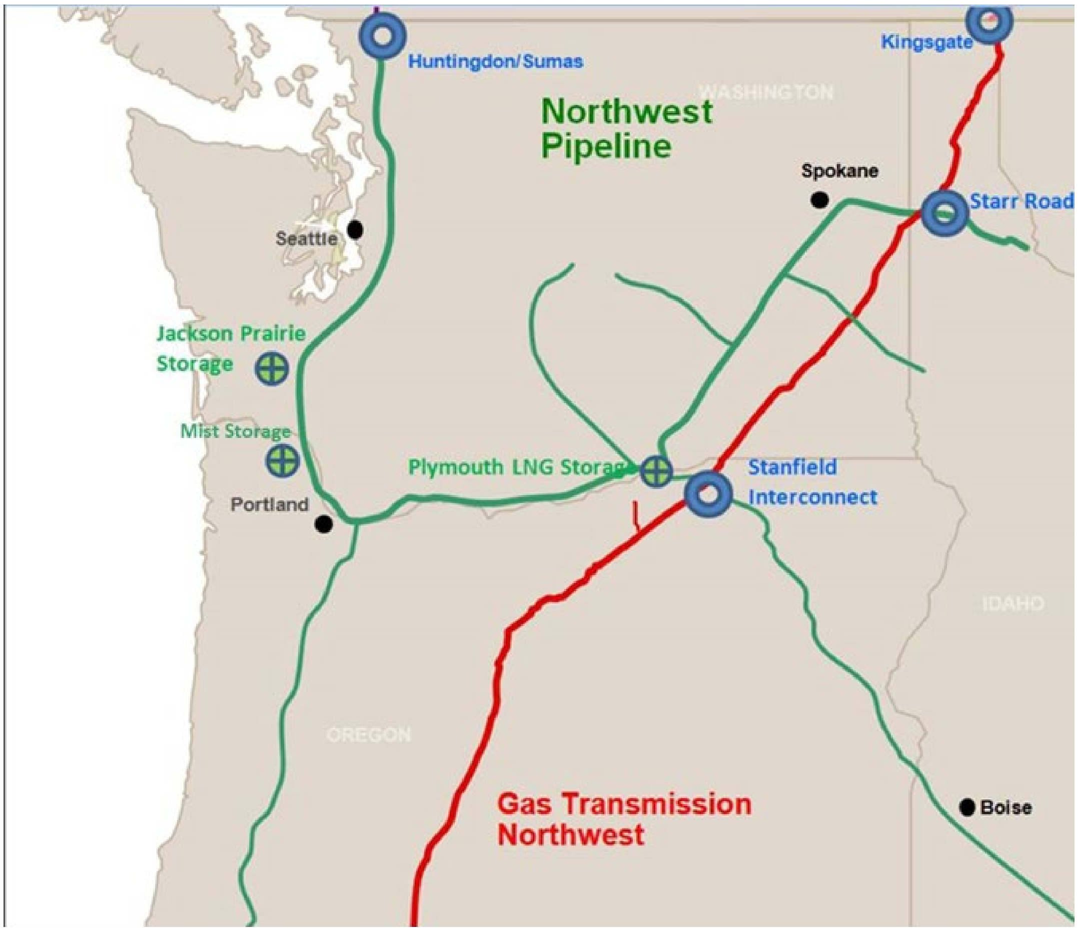


Figure 13-4: Map – Foothills-British Columbia Map

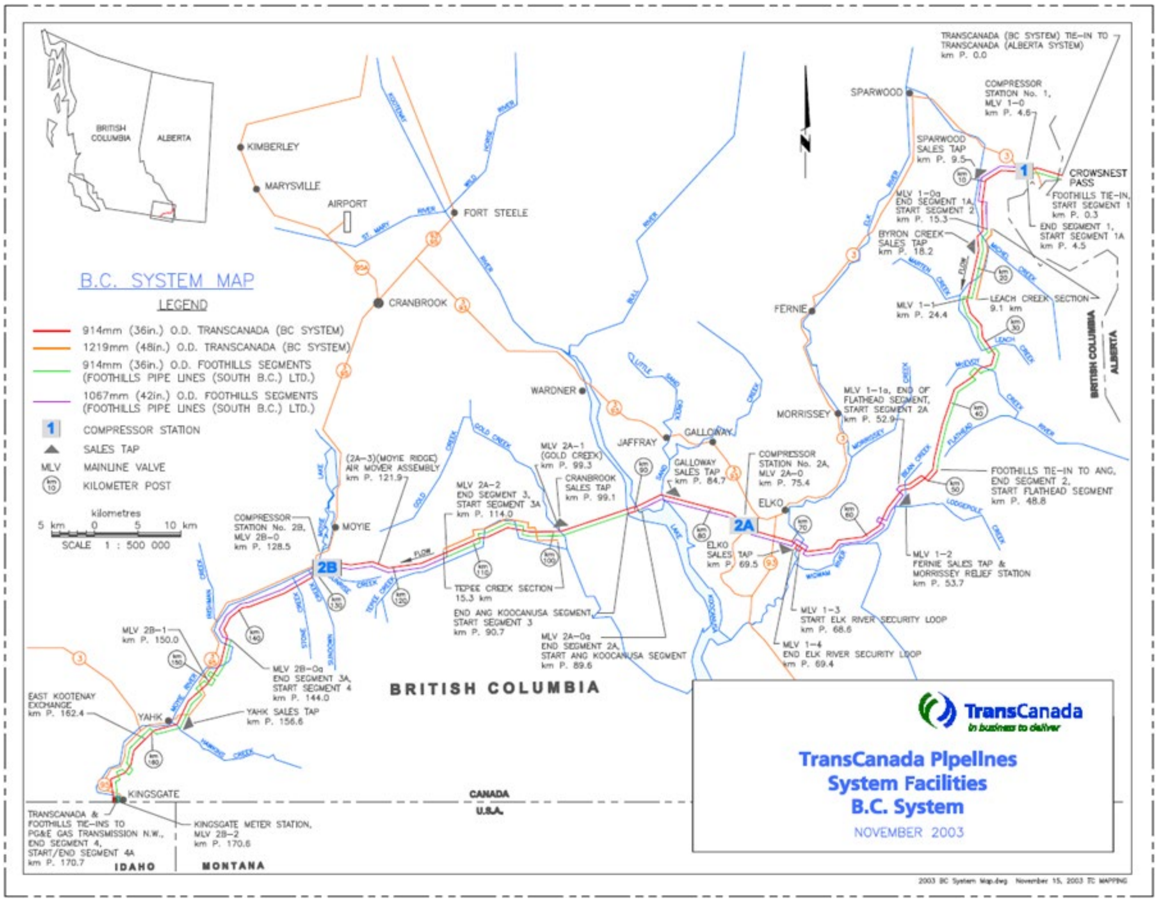


Figure 13-5: Map – Foothills-Full System

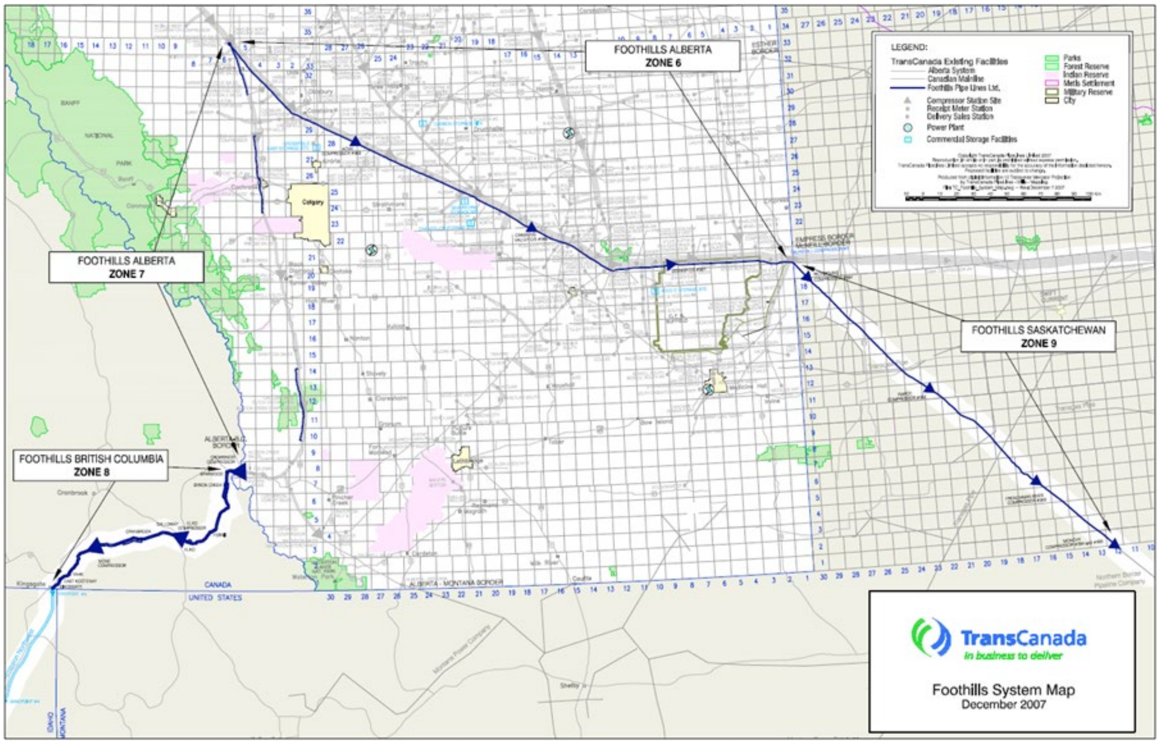
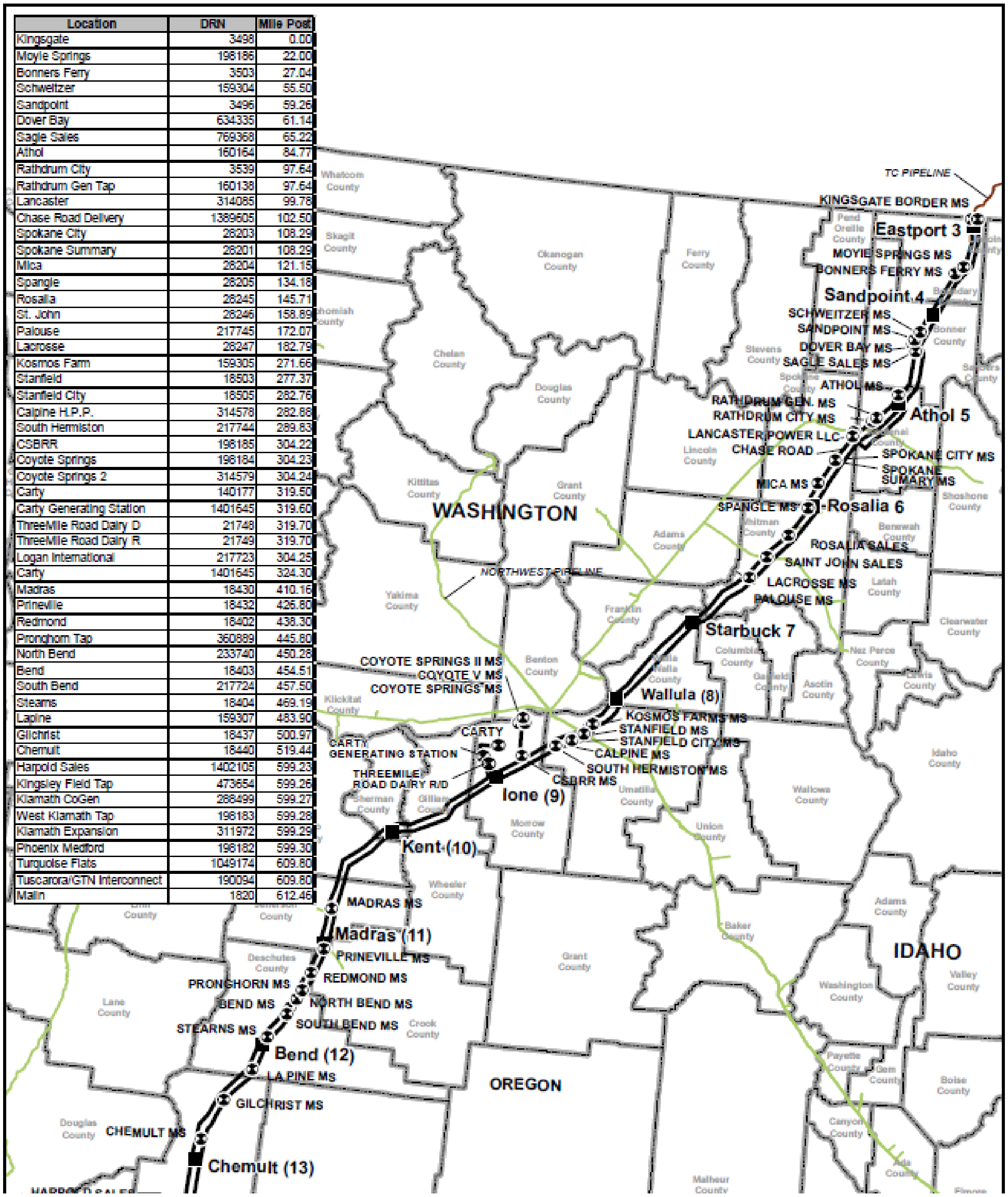


Figure 13-6: Map – GTN System Map

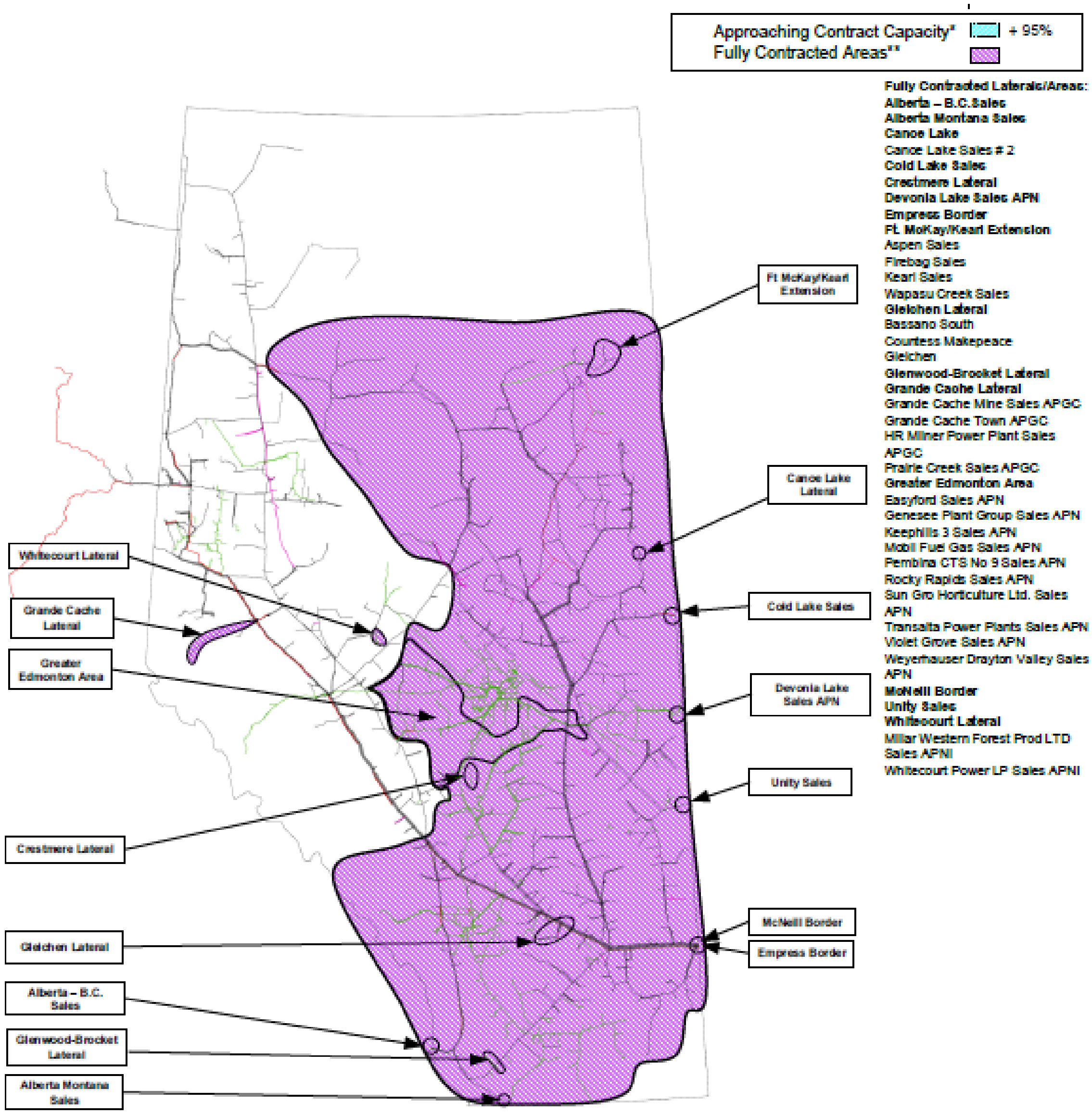


Location	DRN	Mile Post
Kingsgate	3498	0.00
Moyie Springs	198186	22.00
Bonners Ferry	3503	27.04
Schweitzer	159304	55.50
Sandpoint	3496	59.26
Dover Bay	634335	61.14
Sagle Sales	769368	65.22
Athol	160164	84.77
Rathdrum City	3539	97.64
Rathdrum Gen Tap	160138	97.64
Lancaster	314085	99.78
Chase Road Delivery	1389605	102.50
Spokane City	28203	108.29
Spokane Summary	28201	108.29
Mica	28204	121.15
Spangle	28205	134.18
Rosalia	28245	145.71
St. John	28246	158.89
Palouse	217745	172.07
Lacrosse	28247	182.79
Kosmos Farm	159305	271.66
Stanfield	18503	277.37
Stanfield City	18505	282.76
Calpine H.P.P.	314578	282.88
South Hermiston	217744	289.83
CSBRR	198185	304.22
Coyote Springs	198184	304.23
Coyote Springs 2	314579	304.24
Carty	140177	319.50
Carty Generating Station	1401645	319.60
ThreeMile Road Dairy D	21748	319.70
ThreeMile Road Dairy R	21749	319.70
Logan International	217723	304.25
Carty	1401645	324.30
Madras	18430	410.16
Prineville	18432	426.80
Redmond	18402	438.30
Pronghorn Tap	360889	445.80
North Bend	233740	450.28
Bend	18403	454.51
South Bend	217724	457.50
Stearns	18404	469.19
Lapine	159307	483.90
Gilchrist	18437	500.97
Chemult	18440	519.44
Harpold Sales	1402105	599.23
Kingsley Field Tap	473654	599.26
Klamath CoGen	288499	599.27
West Klamath Tap	198183	599.28
Klamath Expansion	311972	599.29
Phoenix Medford	198182	599.30
Turquoise Flats	1049174	609.80
Tuscarora/GTN Interconnect	190094	609.80
Malin	1820	612.46

Figure 13-7: Map – NGTL Delivery System Map

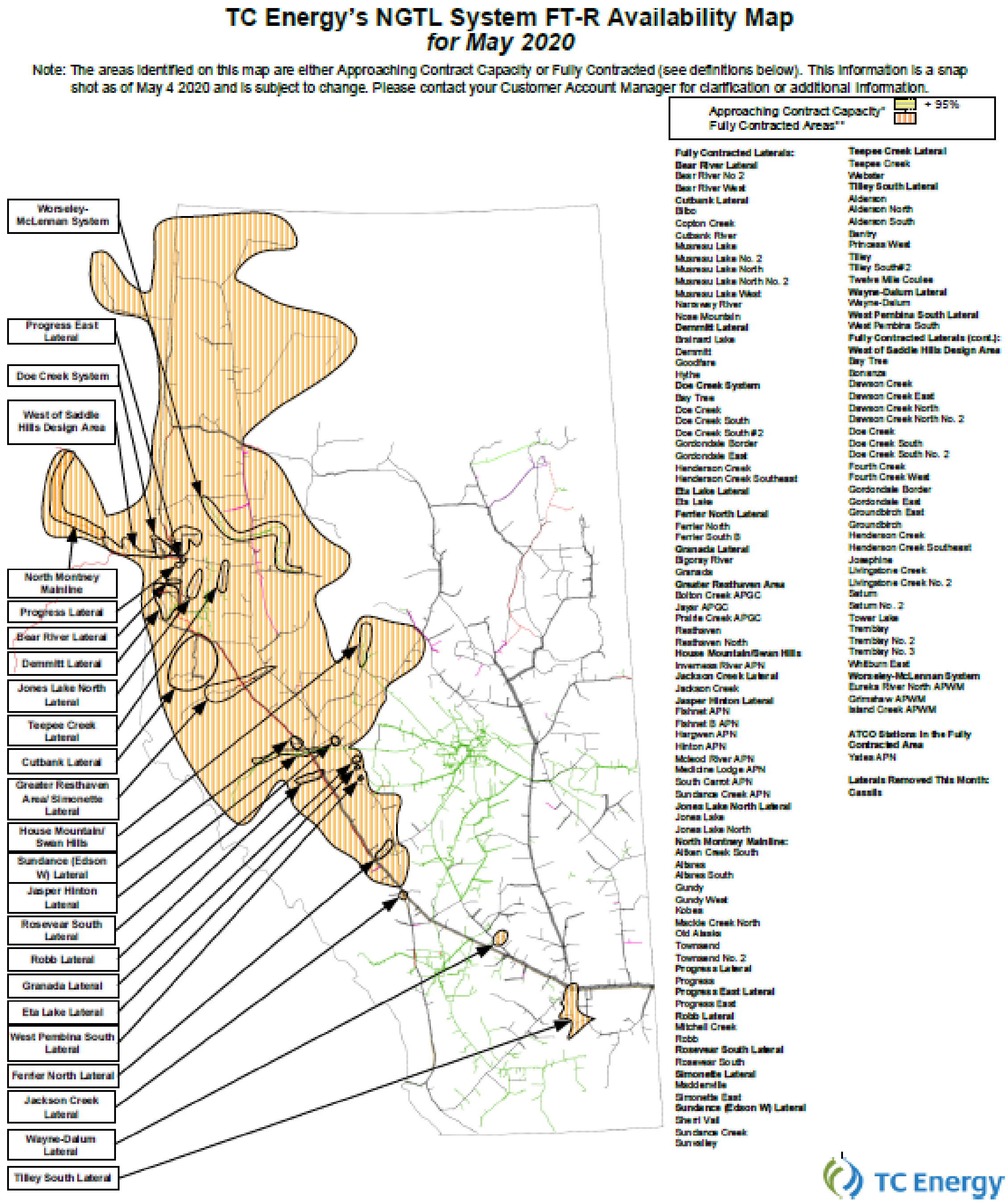
TC Energy's NGTL System FT-R Availability Map *for May 2020*

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 May 4 2020 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, Project Area Receipt and Delivery Capacity Update. Last Updated: May 4 2020
Capacity within any portion of the NGTL System can become fully contracted at any time and without prior notice. NGTL encouages customers to review their FT-D requirements to ensure that their FT-D levels align with their expected flow requirements.	

Figure 13-8: 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 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, Project Area Receipt and Delivery Capacity Update. Last Updated: May 4 2020

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. New changes to the fully contracted stations list this month are identified in red.

Figure 13-9: Map – NWP North System Map

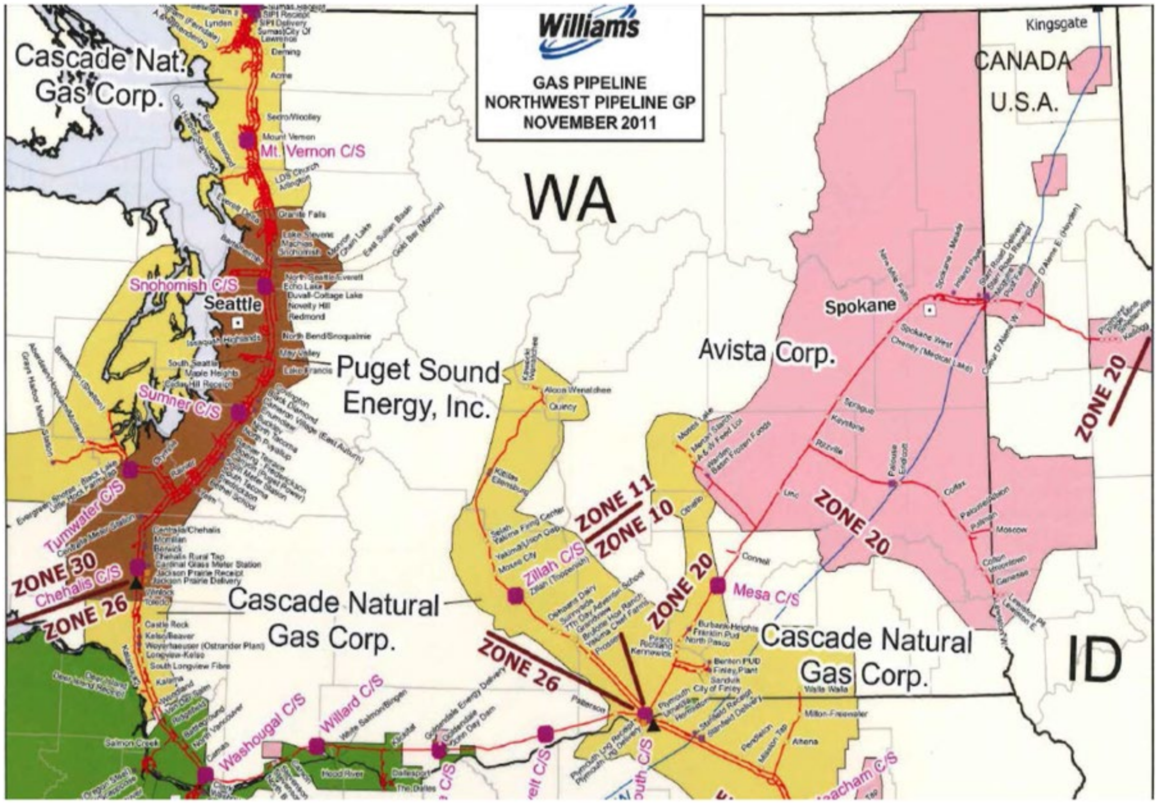


Figure 13-10: Map – NWP South System Map

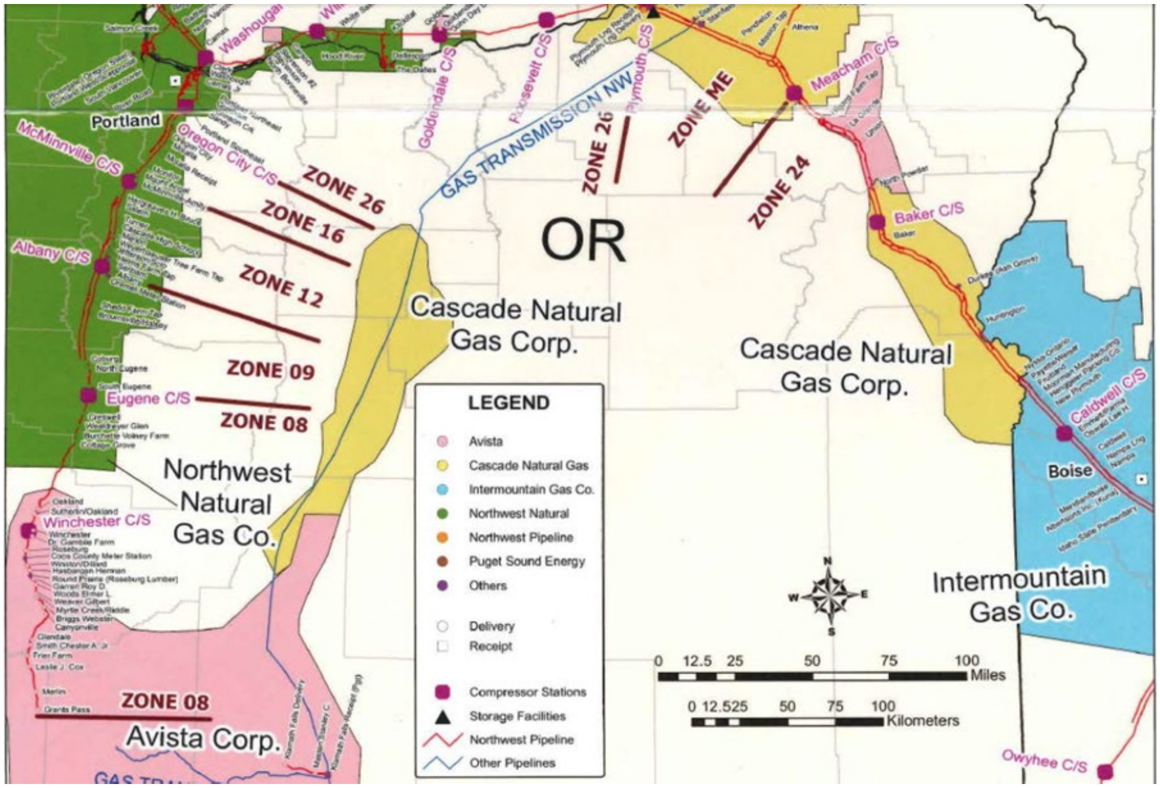


Figure 13-11: Map – Westcoast Sectional Map

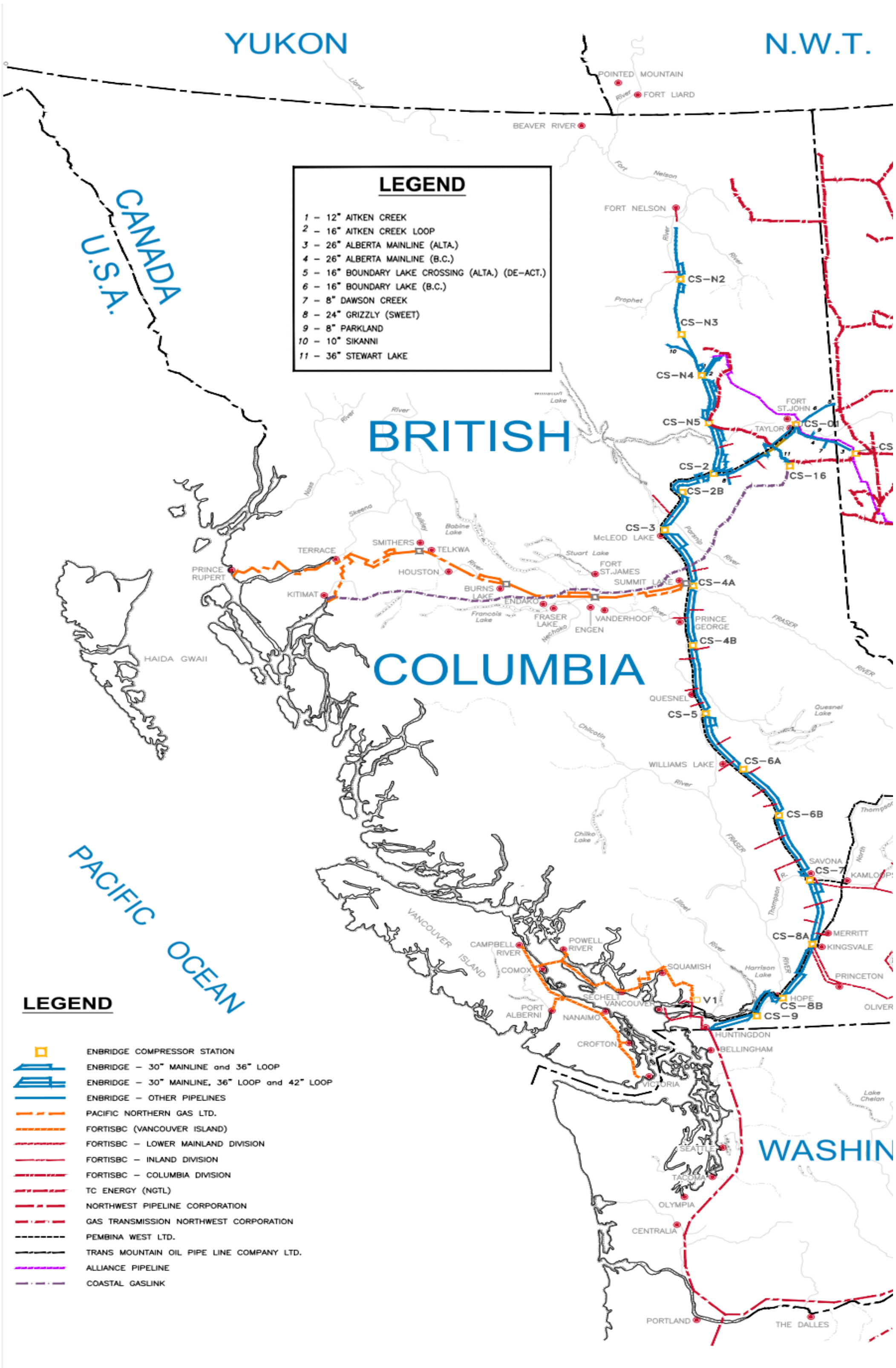


Figure 13-12: Map – Western U.S. and Canadian Pipeline Map

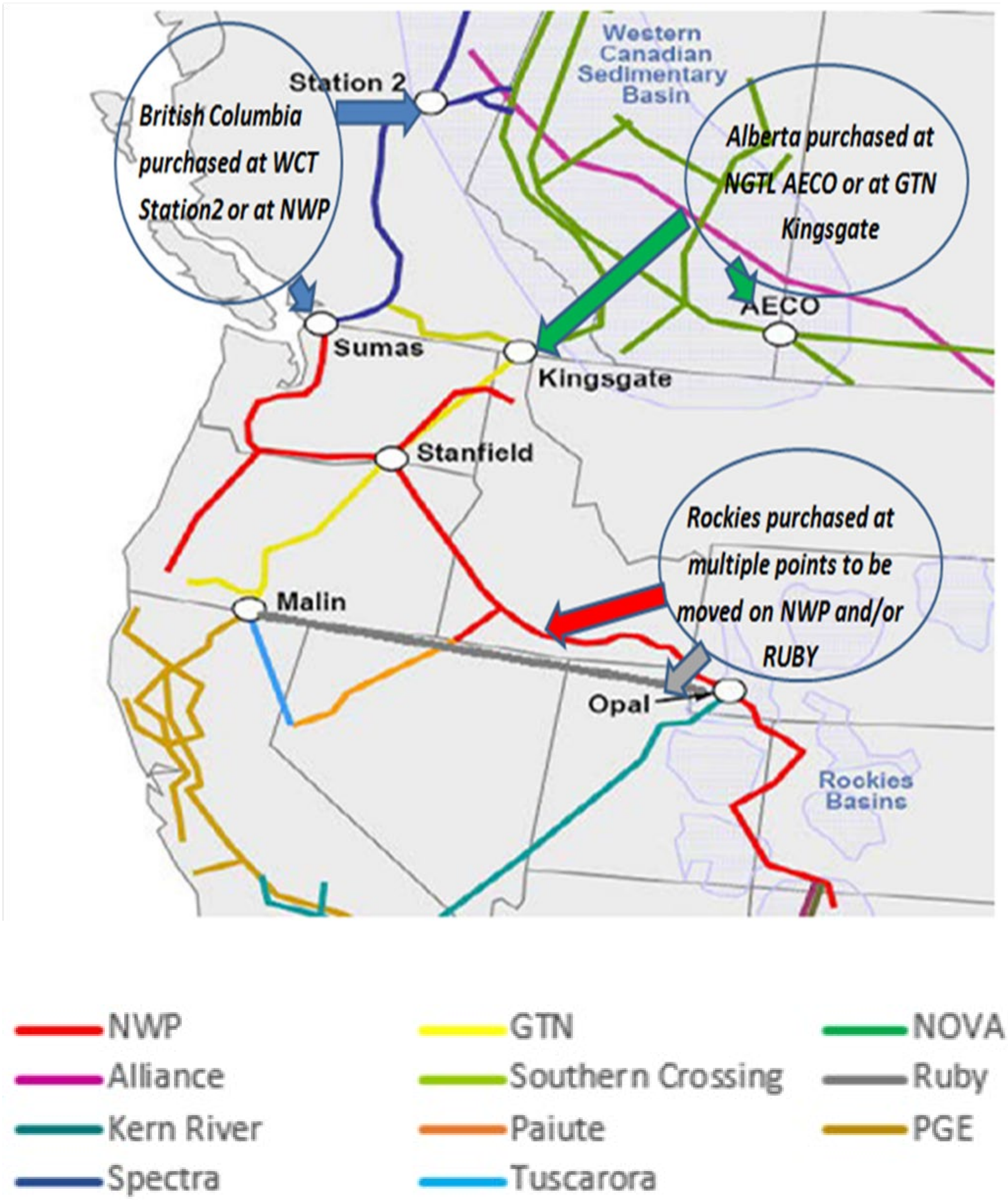
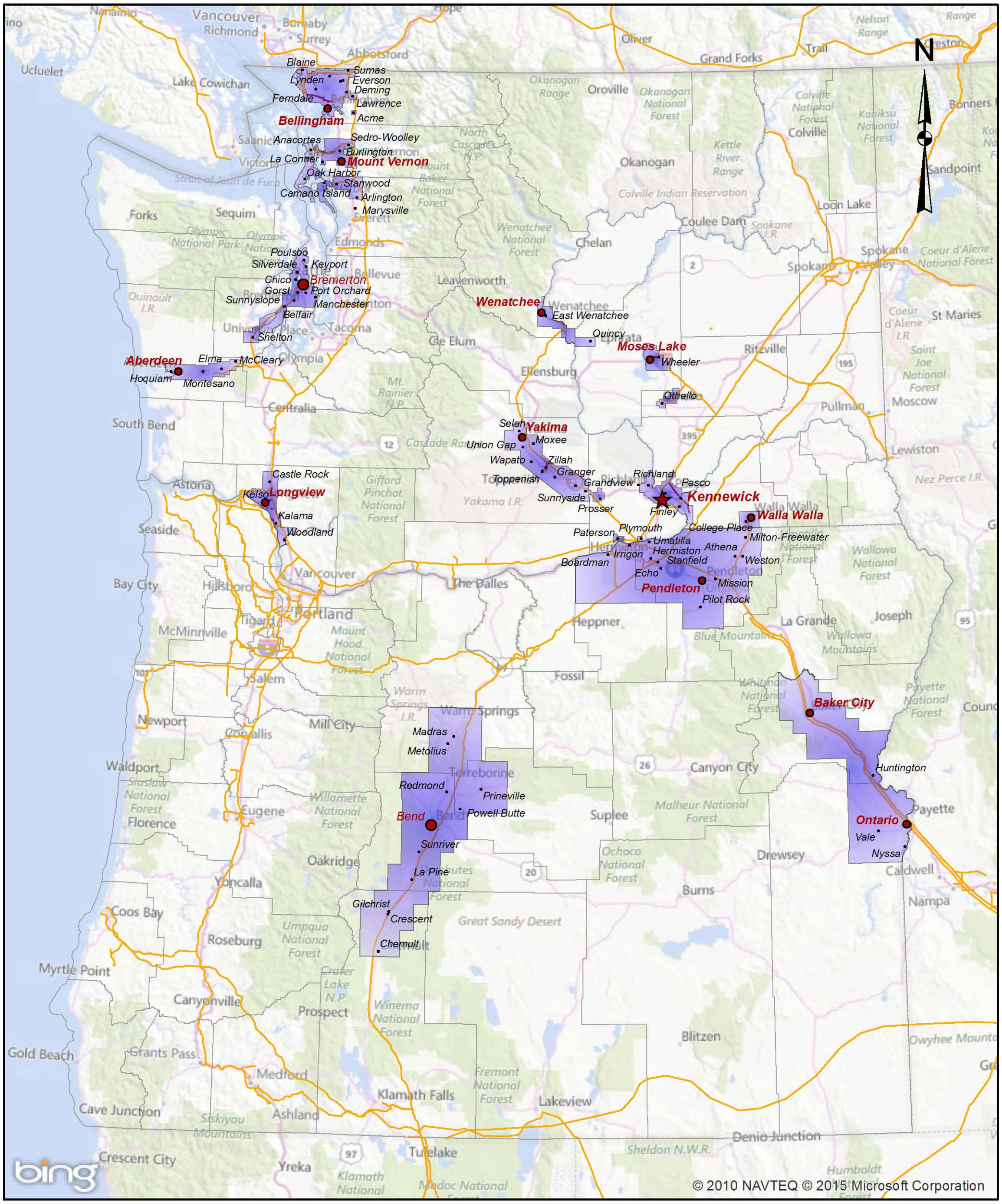


Figure 13-13: Map – Certificated Service Areas as Specified in RCW 80.28.190



CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve

Service Boundaries

Communities
- N
- District Office
- Region Office
- General Office

Document Path: G:\Dept\Mapping\SYSTEM MAP\System Map.mxd /Date: 11/13/2015

Figure 13-14: Map – Pipeline Transportation Capacity Usage

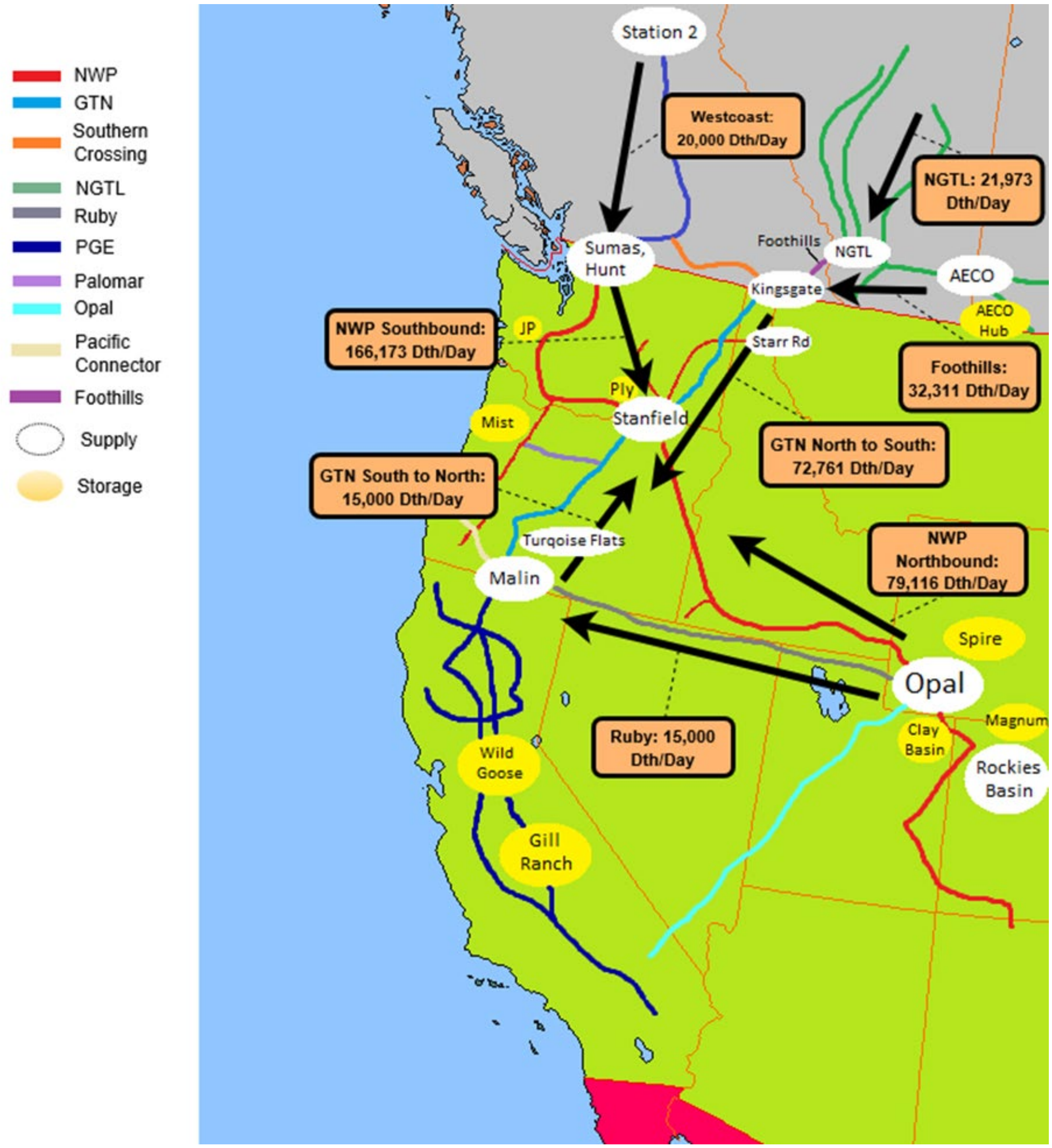


Figure 13-14: Map – Washington Conservation Zones