SECTION 3

DEMAND FORECAST

Overview

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

Demand Areas

In 2016, Cascade has decided to forecast at the citygates level. Cascade has a total of 74 citygates. There are nine city gates that only feed non-core customers, and 65 that have at least one core customer behind it. Of the 65 citygates that serve core customers, 18 citygates are grouped into 8 different loops. Each citygates is assigned to a weather location. The citygates were assigned to either the closest weather location by distance or the closest weather location by climatic simile. This is a change of methodology from previous years where certain models were built from the district or zonal level. The CityGate results are rolled up into zones and districts which segregate Cascade's system based on pipelines and weather (see Appendix C). Table 3-1 provides a cross reference for the demand areas.

Table 3-1: Demand Areas

City Gate	Loop	State	Weather Location	Zone
7TH DAY SCHOOL		WA	Yakima	10
A/M RENDERING		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 STANDWOOD	East Stanwood Loop	WA	Bellingham	30-W
FINLEY		WA	Walla Walla	20
GILCHRIST		OR	Redmond	GTN

City Gate	Loop	State	Weather Location	Zone
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	Bend Loop	OR	Redmond	GTN
NORTH PASCO		WA	Walla Walla	20
NYSSA-ONTARIO		OR	Baker City	24
OAK HARBOR/STANWOOD	East Stanwood Loop	WA	Bellingham	30-W
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
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
WCT-CNG INTERCONNECT	Sumas SPE Loop	WA	Bellingham	30-W
WENATCHEE		WA	Yakima	11

City Gate	Loop	State	Weather Location	Zone
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 is sourced from Schneider Electric. Future weather is based on Cascade's 30-year normal developed in the forecast model. The forecast model takes the 30 previous years, converts the data to HDDs, then averages the HDDs into average months to create a normal year. Cascade has seven weather locations with four being located in Washington and three in Oregon. The 4 weather locations in Washington are Bellingham, Bremerton, Yakima, and Walla Walla.

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

Historically, Cascade has developed peak day forecasts based on a 65 HDD day (0°F) to reflect the coldest day in Cascade's 60-year weather history. Cascade's 2008 IRP changed this practice to reflect the coldest day during the past 30 years. Cascade's 2016 IRP will be based on a 60 HDD day (0°F) and will continue to reflect the coldest day during the past 30 years. Cascade chose to switch from a 65°F to a 60°F reference temperature because Cascades demand does not begin to significantly increase until temperatures dropped below 60°F. For further explanation, refer to pages 8-10 of the supporting Demand Forecast Design Document. This was tested and proved by the improved correlation between weather and demand. The coldest day on record for the past 30 years was December 21, 1990 at 56 HDDs. The peak day forecast is developed by applying the December 21, 1990 HDD to each citygates linear regression, by its respective weather location.

This method rests on the assumption that core market load shape does not significantly change throughout the forecast horizon. Cascade believes that the peak day forecast conservatively overestimates peak day usage as the base forecast does not explicitly include future conservation measures implemented by customers that would act to increase energy efficiency and reduce therm day usage.

Cascade will continue to investigate how the peak day standard affects those 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.

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 derived from Woods & Poole. Woods & Poole growth forecasts are provided at the county level and are directly assigned to a Citygate's previous year's customer count. It should be noted that Woods & Poole forecasts are adjusted based on near term billing information, whereas the internal intelligence about a demand area indicates a significant difference from Woods & Poole with regard to observed economic trends.

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 by applying Woods & Poole's forecasts to accurately predict Cascade's service territory's strongest and weakest performance over the next 20 years (Appendix B). These scenarios, along with the original best-estimate mid-case scenario, encapsulate a range of most-likely possibilities given known data. The most recent Woods & Poole data indicates an average growth of 1.25% between 2017 and 2036 for Cascade's service territory. The projected customer growth can be viewed in Appendix B. Based on historical experience; Cascade expects system load will likely remain within a range bounded by the low and high growth scenarios, given expected weather.

Cascade uses an ordinary least squares methodology with the goal of predicting demand based on weather and forecasted customers. Demand for each citygates and rate schedule takes on the formula:

$$
\begin{aligned}
&y = [(a * x) + c] * customers \\
&where, \\
&y = dekatherms \\
&a = UPC\ coefficient\ dekatherms\ per\ HDD\ per\ customer \\
&x = HDD \\
&c = baseload\ constant\ per\ customer\ in\ dekatherms \\
&customers = forecasted\ customers
\end{aligned}
$$

Cascade developed the Use per Customer (UPC) coefficient by gathering historical pipeline demand data by month. The pipeline demand data includes core and non-core usage. The non-core data is backed out using Cascade's non-core Aligne system which leaves us with monthly core usage data. The monthly data is then allocated to a rate schedule for each citygates by using Cascade's Customer Care and Billing System (CC&B). This data is then divided by customers to come up with a UPC number for each month for each rate schedule at each citygates. Then, a regression is run on the UPC and HDD actuals to come up with the formula above.

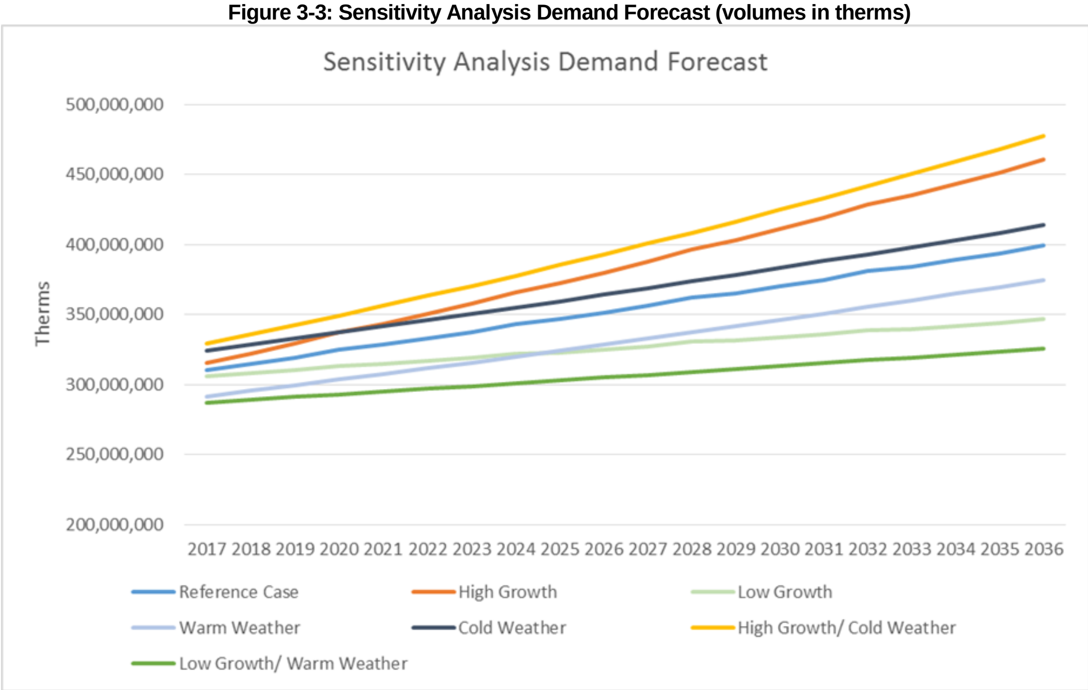
Sensitivity Analysis

Cascade stress tests the system in SENDOUT® by using alternative forecasting methodologies. These alternative forecasting methodologies refers to changing factors that influence demand. Alternative models include high and low customer growth, and high and low weather patterns, or a combination thereof. The combination between alternative growth and weather is high growth/cold weather, and low growth/warm weather because these test the extremes as they complement each other when it comes to influencing demand. Table 3-2 identifies the list of scenarios. Table 3-3 charts the sensitivity analysis over the planning horizon.

Table 3-2: Growth Scenarios

Scenario	Weather	Growth	Use per Customer
Reference Case	Expected	Expected	Expected
High Growth	Expected	High	Expected
Low Growth	Expected	Low	Expected
Warm Weather	Low HDDs	Expected	Expected
Cold Weather	High HDDs	Expected	Expected
High Growth/ Cold Weather	High HDDs	High	Expected
Low Growth/ Warm Weather	Low HDDs	Low	Expected

Figure 3-3: Sensitivity Analysis Demand Forecast (volumes in therms)



Forecast Results

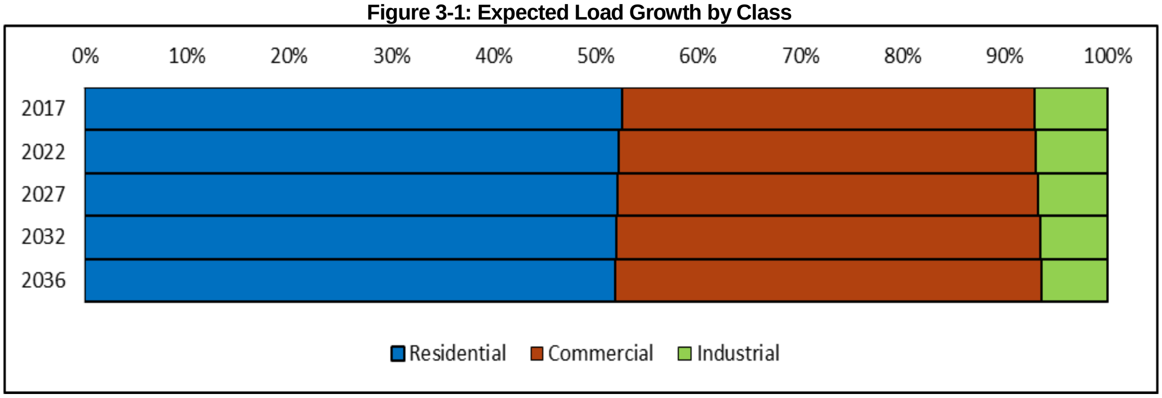
Load growth across Cascade's system through 2036 is expected to fluctuate between 1.16% and 1.31% annually after smoothing the leap year anomaly. Load growth is split between residential, commercial, and industrial customer. Residential and commercial customer classes are expected to grow at a rate above 1% annually while industrial expects a growth rate of around 0.5%. Table 3-3 shows the percentage of core growth by class over the planning horizon.

Table 3-3: Expected Load Growth by Class

	Residential	Commercial	Industrial	System
2017 - 2021	1.25%	1.69%	0.75%	1.31%
2022 - 2026	1.24%	1.56%	0.46%	1.28%
2027 - 2031	1.21%	1.48%	0.33%	1.24%
2032 - 2036	1.13%	1.39%	0.26%	1.16%
2017 - 2036	1.21%	1.53%	0.45%	1.25%

In absolute numbers, system load under normal weather conditions is expected to reach over 397 million therms in 2036. A majority of core load today is residential. Cascade projects the ratio between residential, commercial, and industrial to increase significantly in favor of commercial customers**.** Figure 3-1 displays the relative percentage relationship of expected loads by class.

Figure 3-1: Expected Load Growth by Class



Cascade expects residential and commercial core customers to increase load by around 40-42 million therms each over the 20 -planning period. The industrial customer class expects to increase load by approximately 4 million therms over the same time period. Cascade expects load to increase by about 89 million therms. Table 3-4 displays the expected core load volumes by class.

Table 3-4: Expected Load Growth by Class (volumes in therms)

	Residential	Commercial	Industrial
2017	162,191,299	124,556,975	21,888,875
2022	173,002,864	135,106,639	23,006,406
2027	184,425,511	145,676,974	23,892,422
2032	197,089,261	157,102,305	24,702,016
2036	206,484,956	165,833,234	25,233,289
2017 - 2036	27.31%	33.14%	15.28%

Load growth is primarily a result of increased customer counts. The number of commercial and industrial customers is expected to increase slightly faster than therm usage. Several factors are believed to be the cause of this phenomenon; among them are the adoption of soft conservation and more stringent building codes, and improved efficient technologies. Table 3-5 displays the expected customer counts by class.

Table 3-5: Expected Customer Counts by Class

	Residential	Commercial	Industrial
2017	244,177	36,339	598
2022	259,872	39,483	620
2027	276,412	42,640	634
2032	293,424	45,863	644
2036	306,867	48,472	651
2017 - 2036	25.67%	33.39%	8.83%

Geography

Load across Cascade's two-state service territory is expected to increase 26% over the planning horizon, with the Oregon portion outpacing Washington at 36% versus 26%. Table 3-6 shows the expected core load volumes by state.

Table 3-6: Expected Load by State (volumes in therms)

	Washington	Oregon	System
2015	232,414,950	76,222,198	308,637,148
2020	248,096,580	83,019,329	331,115,909
2025	263,898,367	90,096,540	353,994,907
2030	281,006,139	97,887,443	378,893,582
2034	293,590,373	103,961,106	397,551,479

Within Washington, the western part of the state as well as Walla Walla is expected to see a large increase in growth. Yakima is expected to experience minimal growth. Commercial customers have a higher temperature sensitivity than residential customers. Because of their increasing profile on Cascade's system over the coming 20 years, weather-sensitive peak demand will increase faster than annual load. The

2017 load on 56 HDDs is expected to be 3.5 million therms, rising to 4.5 million by 2036. Peak day load will increase at 1.33% annually, while annual load increases by 1.25%. Table 3-7 shows the percentage growth of load by each of Cascade's weather locations. Table 3-8 shows the percentage growth of load by each pipeline zone over the planning horizon. Lastly, Table 3-9 displays a range of core peak day growth over the planning horizon along with a sampling peak day therms.

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

Bellingham	28.5%
Bremerton	24.2%
Walla Walla	30.5%
Yakima	18.1%
Washington	26.1%

Table 3-8: System Load Growth by Pipeline Zone

Zone 10	15.9%
Zone 11	14.8%
Zone 20	32.8%
Zone 24	4.1%
Zone 26	23.2%
Zone 30-S	22.2%
Zone 30-W	27.0%
Zone GTN	44.4%
Zone ME-OR	14.0%
Zone ME-WA	12.1%

Table 3-9: Expected Peak Day Growth (volumes in therms)

Period	Peak Growth	Year	Peak Day Therms
2017 - 2021	1.43%	2021	3,776,574
2022 - 2026	1.36%	2026	4,041,751
2027 - 2031	1.30%	2031	4,313,247
2032 - 2036	1.22%	2036	4,584,628

High and Low Scenarios

High and low scenarios were created by examining the percentage errors of previous Woods & Poole forecasts. The percentage errors show the average percentage difference between a Woods & Poole forecast and actual results. The previous forecasts averaged a percentage error of .5% or less of the actual forecast. Since Cascade is expecting about a 1.25% growth, a reasonable high and low scenario band is .65% above or below that growth level. Table 3-10 displays the expected total system load growth across various scenarios.

Table 3-10: Expected Total System Load Growth (by percentage) across Scenarios

	Low	Mid	High
2017 - 2021	0.65%	1.31%	1.97%
2022 - 2026	0.64%	1.28%	1.94%
2027 - 2031	0.61%	1.24%	1.89%
2032 - 2036	0.57%	1.16%	1.78%
2017 - 2036	0.62%	1.25%	1.90%

Load growth under poor economic conditions is expected to be around 0.6% annually over the forecast period, while load growth under good economic conditions is expected to be around 1.9% annually. The cumulative effect of high growth over 20 years could result in additional load of 61 million therms, while low growth could result in a load with 52 million therms less than predicted in the medium growth scenario. Table 3-11 shows the expected total system load across these scenarios.

Table 3-11: Expected Total System Load Growth across Scenarios (volumes in therms)

	Low	Mid	High
2017	303,968,666	308,637,148	313,346,208
2021	312,685,907	326,602,114	341,104,474
2026	323,326,756	349,373,660	377,602,786
2031	333,769,148	372,643,579	416,609,463
2036	345,227,222	397,551,479	458,654,121
Deviation	(52,324,257)		61,102,642

Alternative Forecasting Methodologies

Cascade has made a slight change to the forecast methodology this year by using customers in the coefficient for the demand forecast formula. Cascade plans to continue to look at alternative forecast methodologies. Cascade has already purchased SAS, a statistical analysis software, and plans to look into non-linear forecasting methodologies.

Confounding regulatory principles are manifest in forecasting. These include:

- A desire for precision and a high degree of accuracy.
- A universal understanding that forecasts should be “close” to 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 increased cost of improved precision sometimes has decreasing customer benefits.
- Regulators expect continual improvement because new tools are available and they expect to see what the Washington Commission calls "adaptive management" for all of its jurisdictional energy companies.
- Major differences in accounting treatment between the states regarding "test years" must be considered because, while these are for ratemaking purposes (that is, for general rate case filings) and not necessarily for planning, Oregon uses "future test year" accounting while Washington employs an "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.)
- Unknown and uncertain future changes such as the assumptions for CO_2 required for carbon policy and other environmental externalities.
- 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.

This illustrates the complexity of forecasting and highlights areas of stakeholder attention. Best efforts, at the appropriate cost, distills these factors into a generally-accepted forecast with recognition of inherent uncertainties.

Uncertainties

This forecast represents Cascade's best estimate about future events. Several important factors make predictions of future load at this time particularly difficult – economic recovery, carbon legislation, building code changes, direct use campaigns, conservation, and long term weather patterns. The range of scenarios presented here encompasses 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 chosen 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 load. As a result, while Cascade believes that the numbers presented here are accurate, and that the scenarios presented represent the full range of possibility, there are and always will be uncertainties in predicting the future.