Appendix A

IRP PROCESS

UG-160453

Cascade Natural Gas Corporation

Integrated Resource Plan
Technical Advisory Group Meeting #1

June 16th, 2016
Seattle International Airport Conference Center

Agenda

- Introductions
- About Cascade Natural Gas
  - IRP Timeline
  - 2014 IRP issues
- Cascade's Demand Study Overview
  - Key Points
  - Inputs and Data Sources
  - Assumption
  - Scenarios
- Cascade Natural Gas Forecast Model
  - Demand Data
  - Growth Data
  - Weather Data
  - Regression Analysis changes
  - Scenarios
  - HDD Analysis
  - Demand Forecast
  - Peak Day
- Summary
- Next Steps

A LITTLE HISTORY LESSON…

- Prior to 1955, natural gas was virtually unheard-of in the Pacific Northwest. Seeing an opportunity, Lester Pettit, Spencer Clark, and Stewart Matthews led a group of associates to form a company that would rise to the challenge. Cascade Natural Gas Corporation was incorporated January 2, 1953.
- In July 2007, Cascade was acquired by MDU Resources headquartered in Bismarck, ND.
  - Founded in 1924 as an electric utility in eastern Montana.
  - Core businesses are construction, utilities, pipeline, and refinery.
  - Approximately 8,600 employees, operating in 48 states.
  - Operates four utilities across eight states:
    - Montana-Dakota Utilities Co.
    - Great Plains Natural Gas Co.
    - Cascade Natural Gas Corporation
    - Intermountain Gas Co.

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AND TODAY WE ARE …

- Cascade Natural Gas Corp. serves 276,000 customers in 96 communities – 68 of which are in Washington and 28 in Oregon. Cascade's service areas are concentrated in western and south central Washington and south central and eastern Oregon.

- Today, Cascade serves a diverse service territory covering more than 32,000 square miles and 700 highway miles from one end of the system to the other. Interstate pipelines transmit Cascade's natural gas from production areas in the Rocky Mountains and western Canada.

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Resource Decision Making Process Overview

- Construct a range of possible demand forecasts for the core market.
- Calculate avoidable distribution system enhancement costs.
- Provide the optimization model the existing supply side and demand side resource options to meet demand.
- Run the optimization model to identify resource needs including the types of resources and their timing requirements. The existing portfolio is modeled under a range of demand forecast conditions.
- Identify incremental supply and demand side resources to satisfy a range of incremental growth scenarios.
- Run the optimization and Monte-Carlo simulation models to identify the best fit portfolio given an expected range of forecasted core loads and operating conditions.

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Date	Process Element	Location (Subject to change)
Thursday, June 09, 2016	TAG 1 slides distributed to stakeholders	
Thursday, June 16, 2016	**TAG 1: Process, Key Assumptions, IRP Team, Timeline, Latest Economic Indicators, Price Forecast and Demand Forecast, Plan for dealing with issues raised in 2014 IRP**	
Thursday, July 14, 2016	TAG 2 slides distributed to stakeholders	
Tuesday, July 19, 2016	**TAG 2: Drilling down into segments of demand forecast, Current Supply Resources, Transport Issues, Alternative Resources, Update on 2 Year Plan**	**Seattle Airport Conference Center**
Friday, August 12, 2016	TAG 3 slides distributed to stakeholders	
Thursday, August 18, 2016	**TAG 3: Conservation, Distribution System Planning, Planned Scenarios and Sensitivities**	**Seattle Airport Conference Center**
Thursday, September 08, 2016	TAG 4 slides distributed to stakeholders	
Thursday, September 15, 2016	**TAG 4: Preliminary Resource Integration Results, Avoided Costs, Proposed new 2 year Plan**	**Seattle Airport Conference Center**
Tuesday, October 04, 2016	**TAG 5: Final Integration Results, finalization of plan components**	**Seattle Airport Conference Center**
Monday, October 17, 2016	Draft of 2016 IRP distributed	Kennewick, WebEx
Monday, November 07, 2016	Comments due on draft from all stakeholders	
Thursday, November 17, 2016	TAG 6, if needed	Seattle Airport Conference Center
Wednesday, November 23, 2016	Final IRP goes to press	
Thursday, December 01, 2016	Executive Summary Presentation to Senior Management	Kennewick, WebEx
Thursday, December 15, 2016	IRP filing in Washington	

- Resource Planning group
- Other Gas Supply members
- Regulatory Affairs
- Operations/Engineering
- Conservation, Energy Efficiency
- Finance/Accounting
- Information Technology

- **CASCADE WILL WORK WITH STAKEHOLDERS TO CLEARLY IDENTIFY BY TAG 5 THE SPECIFIC TIMING, POTENTIAL EXCEPTIONS, AND METHOD OF DEALING WITH UPSTREAM PIPELINE CAPACITY DEFICITS AT DEMAND AREAS.**

- **BY COMPLETION OF TAG 2, CASCADE WILL WORK WITH STAKEHOLDERS TO DEFINE THE SPECIFIC EXPECTATIONS FOR THIS ISSUE.**

- **CASCADE WILL WORK WITH STAKEHOLDERS DURING THE 2016 IRP PROCESS TO IDENTIFY STAFF'S SPECIFIC CONCERNS REGARDING THE INSUFFICIENT ANALYSIS AND EXPLANATION OF CONSERVATION POTENTIAL.**

- WITH THE PUBLICATION OF THE DRAFT 2016 IRP, CASCADE WILL PROVIDE AN IMPROVED DESCRIPTION OF THE STAKEHOLDER PARTICIPATION PROCESS THROUGH INCLUSION OF TAG MEETING PRESENTATIONS, MINUTES AND RESPONSEs TO COMMENTS.

- CASCADE IS CURRENTLY PARTICIPATING IN WUTC'S HEDGING DOCKET UG-132019. THROUGHOUT THIS PROCESS CASCADE HAS PROVIDED COMMENTS AND EXPLANATIONS OF OUR RISK MANAGEMENT EFFORTS. WE WILL CONTINUE TO PARTICIPATE IN UG-132019 AND WILL PROVIDE OUR 2016 IRP RISK MANAGEMENT GUIDANCE BY TAG 4.

- CASCADE IS COMMITTED TO WORKING ON AN IMPROVED NARRATIVE TAKING INTO ACCOUNT COMMENTS MADE BY STAKEHOLDERS IN REFERENCE TO THE 2014 IRP. THE NARRATIVE IN THE DRAFT 2016 WILL BE A SIGNIFICANT IMPROVEMENT.

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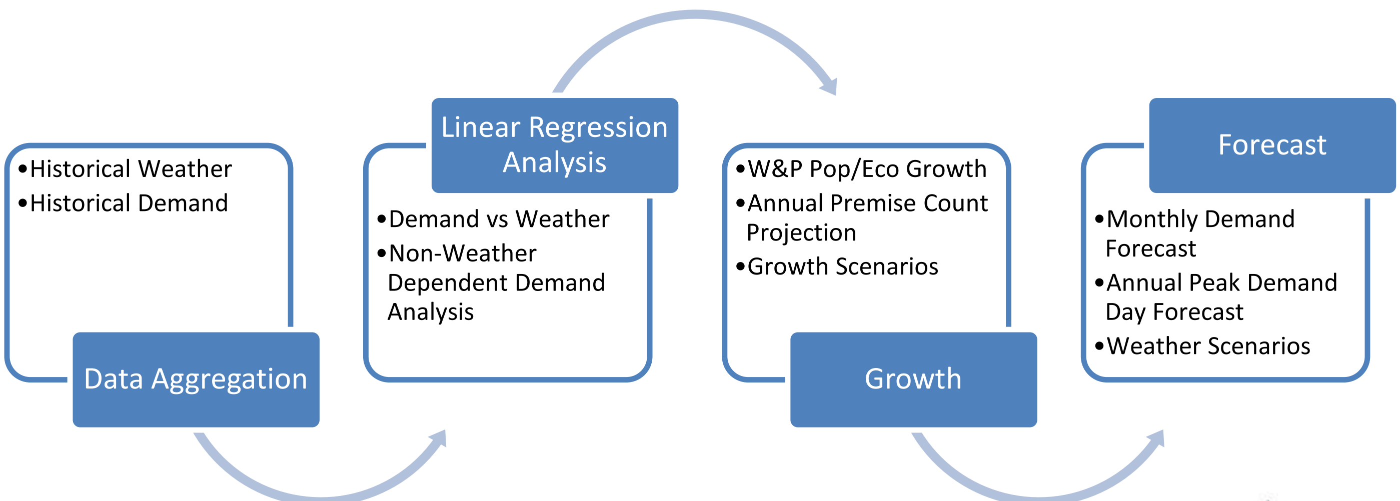
CASCADE DEMAND STUDY

High Level overview of the 20 Year demand forecast

Overview

- The Cascade demand forecast developed for the IRP is a forecast of customers, core natural gas demand, and core peak demand for the next 20 years.
- Cascade's core load consists of approximately 53% residential and 47% commercial and industrial.



Overview

- Forecast demand at the CityGate and CityGate Loop level.
- CityGate Loops are a group of CityGates that service a similar area that are forecasted together due to pipeline operations.
- CNGC forecast model is flexible giving Cascade the ability to:
  - Update input data (gas demand and weather)
  - Modify assumptions
  - Modify CityGates and loops to be forecasted
  - Run several scenarios

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Key Points

- Cascade's demand is principally weather and customer driven; the colder the weather or greater the customer count, the greater the demand.
- This forecast uses 30 years of recent weather history as the "normal" temperatures.
- Forecasted under various weather and growth scenarios – average year, cold year, warm year, extreme cold day, high growth, low growth, etc.
- Analyze weather and demand for each of 55 CityGates and CityGate Loops that serve Core customers.
- Growth factors are applied to each of the 20 years in the forecast for each CityGate.
- Heating demand does not appreciatively start until average temps dip below 60° F, therefore a 60° F threshold is used.

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Input Data

- Historical Demand
  - Pipeline actuals
  - Gas Management System (GMS)
  - Customer Care and Billing (CC&B)
- Weather
  - Schneider Electric
- Population and Economic
  - Woods & Poole
  - Acquiring local market intelligence
- Customer Count
  - CC&B

Key Assumptions

- Seven weather locations effectively cover Cascade's service territory.
- Using population growth assumes 1% increase in population translates to a 1% increase in residential customer count.
- Using employment growth assumes 1% increase in employment translates to a 1% increase in commercial and industrial customer count.

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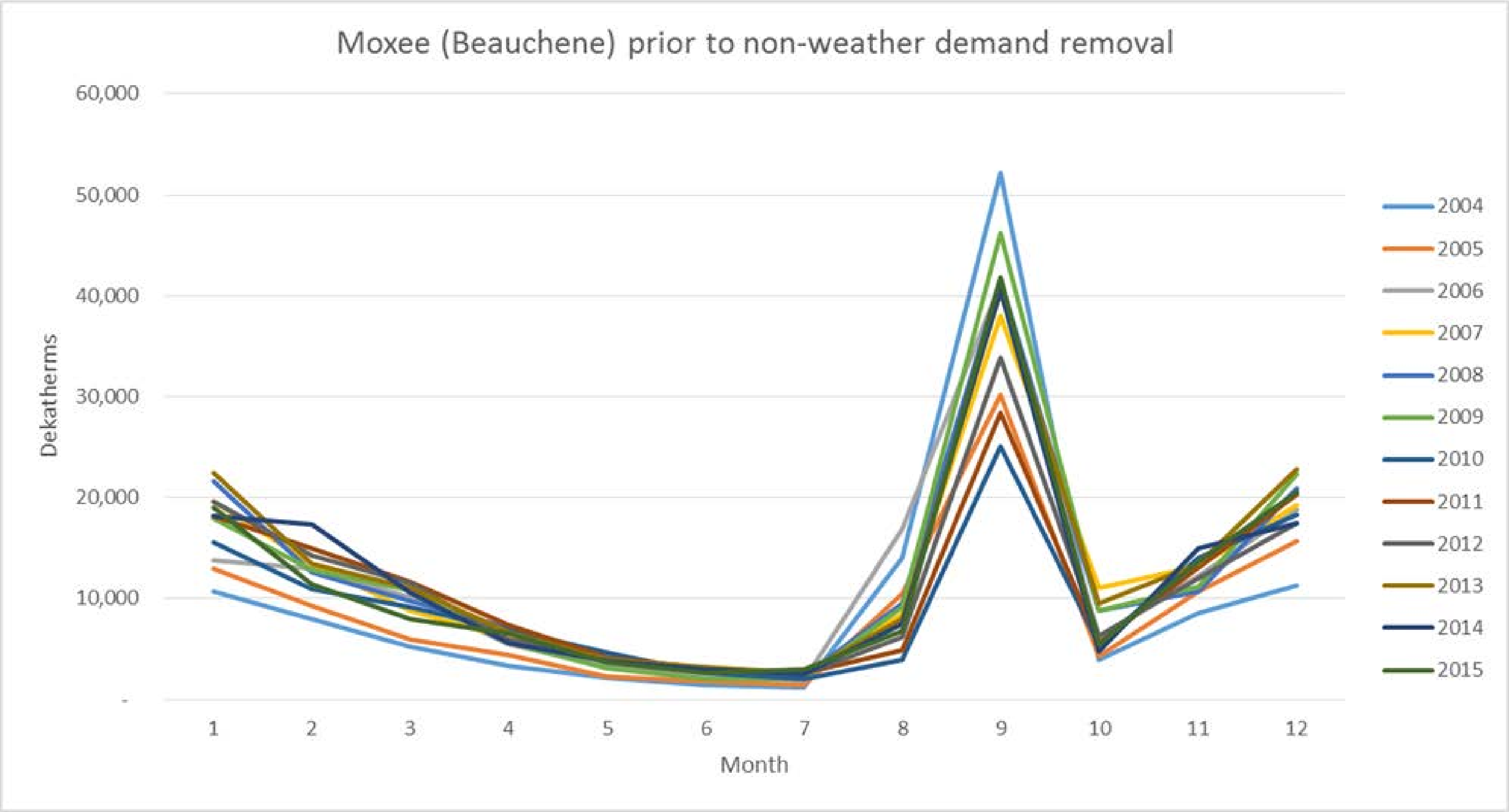
Forecast Scenarios

- Base case regression correlation of weather to demand by citygate and loops.
- Sensitivity capability for cold and warm weather.
- Sensitivity for low and high customer growth.

Non-Weather dependent demand

- Demand that is not influenced by weather.
- Typically caused by a customer who ramps up production based on the time of season.
- Demand is removed prior to running the demand vs. weather analysis.
- After the HDD and customer information is input in the regression to come up with the forecast the non-weather dependent demand is added back in.

Moxee (Beauchene)



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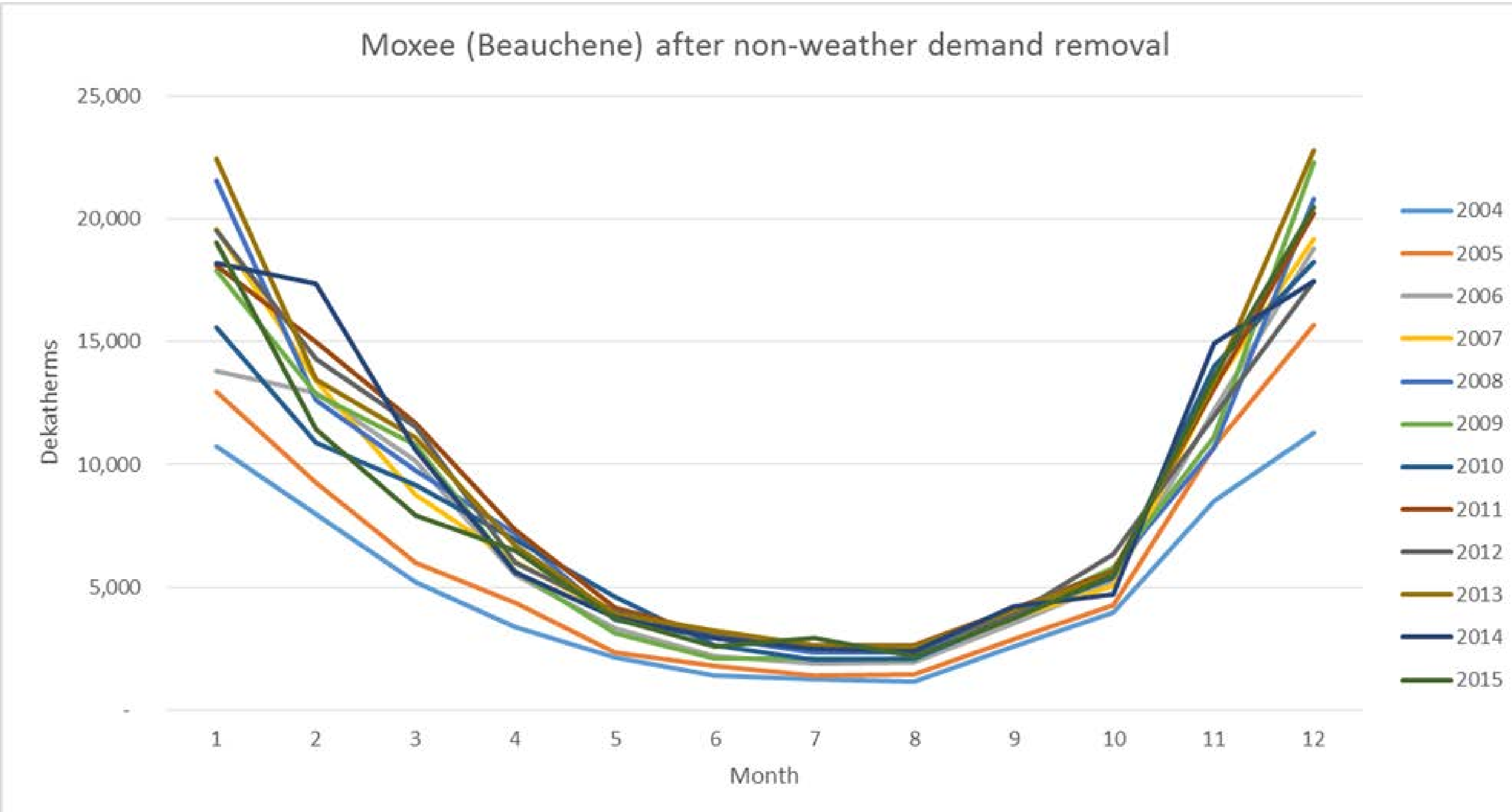
Moxee (Beauchene)



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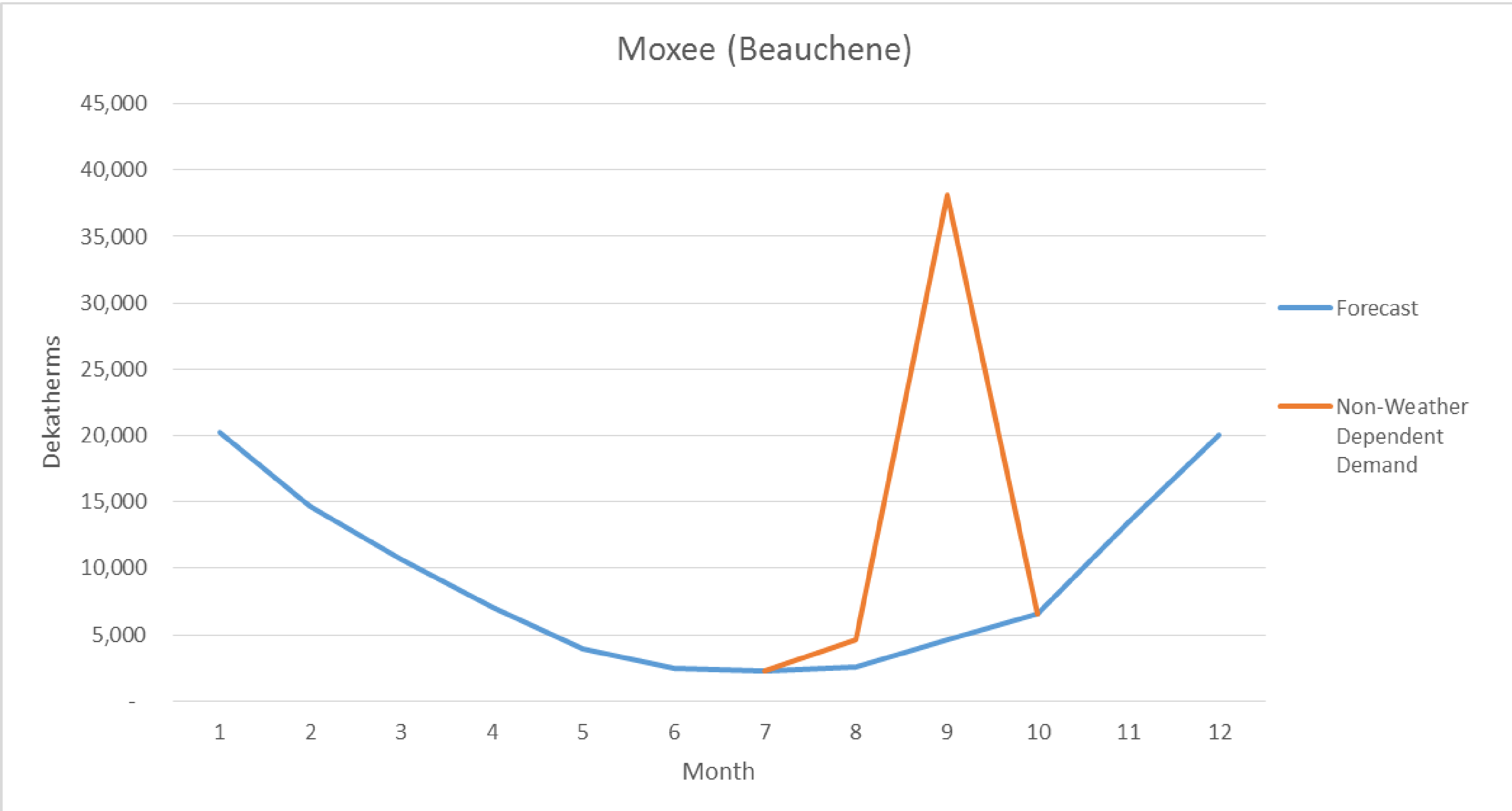

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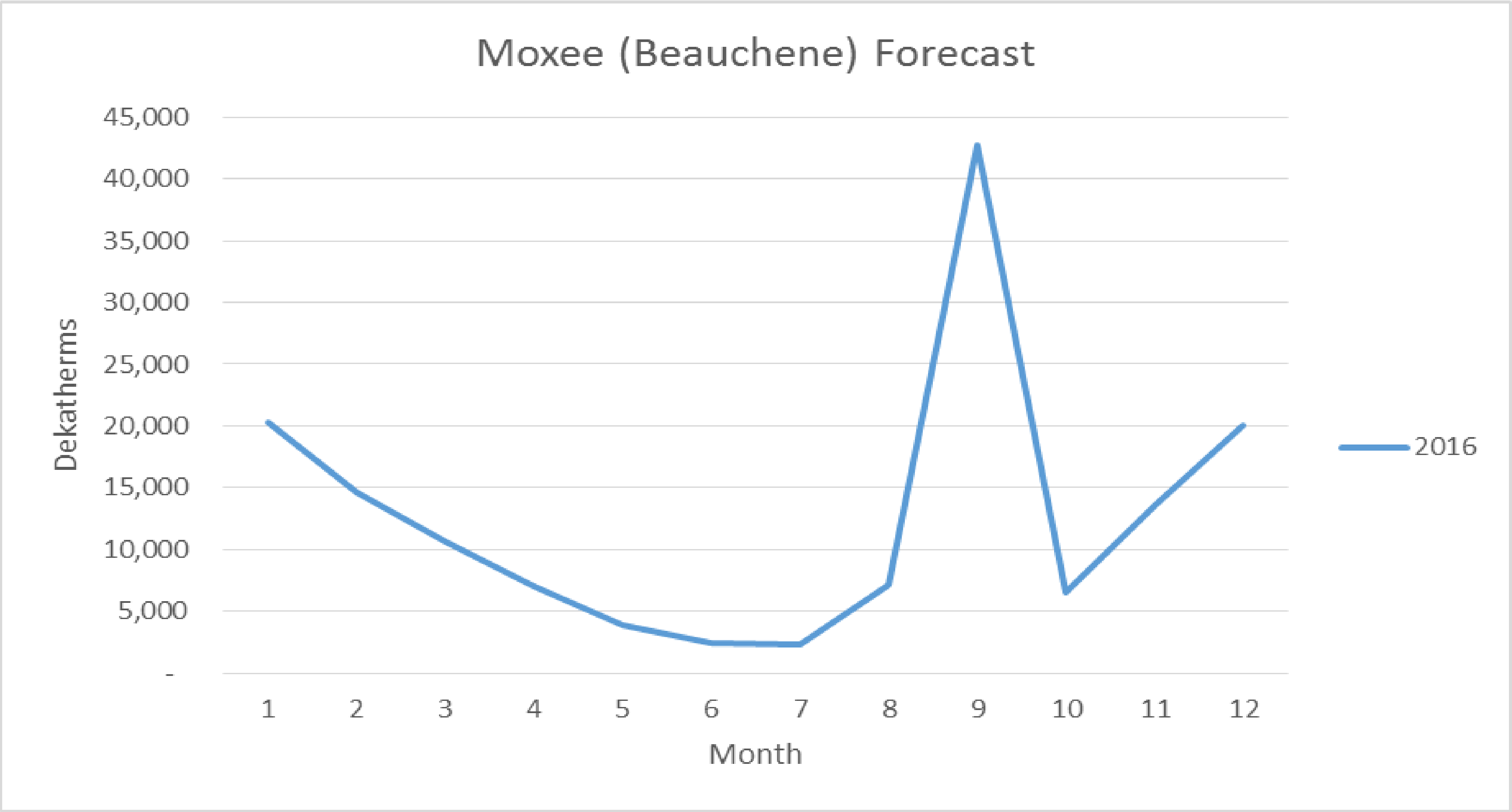

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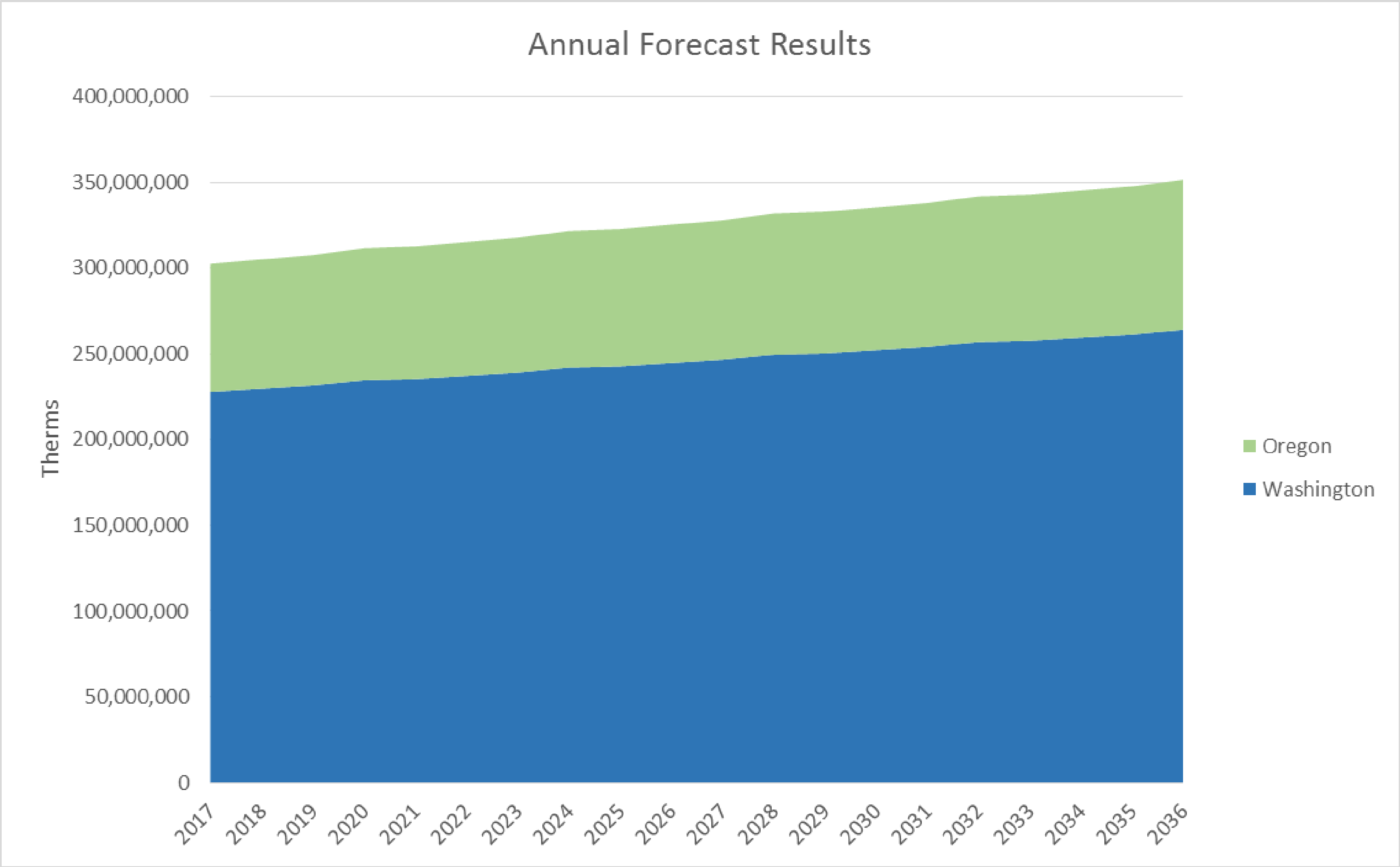
Forecast Results



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Cascade Natural Gas Forecast Model

Demand Data

- Historical core monthly demand by CityGate was primarily drawn from:
  - Pipeline actuals from Electronic Bulletin Board (EBB)
  - Cascade's own Gas Management System (GMS)
- Also examined CC&B (Customer Care and Billing) for data verification and premise count information.
- Analyzing demand data from 2004 to 2015.

Growth Data

- Woods & Poole State Profile data is used for customer forecast.
- Population data is used for the Residential Customers.
- Commercial and Industrial growth factors used Farm, Construction, and Manufacturing earnings in previous model.
- New model uses: Farm Employment, Forestry, Fishing, Related Activities & Other, Mining Employment, Utilities Employment, Construction Employment, Manufacturing Employment, Wholesale Trade Employment, Retail Trade Employment, Transportation & Warehousing Employment, Information Employment, Arts, Entertainment, & Recreation Employment, Finance & Insurance Employment, Real Estate, Rental & Leasing Employment, Professional & Technical Services Employment, Administrative & Waste Services Employment, Educational Services Employment, Health Care & Social Assistance Employment, Federal Civilian Government Employment, State & Local Government Employment, and Federal Military Government Employment

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Growth Data cont'd

- To project the natural gas demand forward, growth factors for each year are applied to gas demand predicted after assuming a weather scenario (average, cold, mild).
- Cascade uses regional (county) economic demographics data formulated by Woods and Poole to derive a projected customer growth by town and year or local economic growth information if available.
- Woods and Poole Employment, Income, Population, and Housing demographics were reviewed. Cascade derived Population and Economic growth factors formulated from Woods and Poole's forecasted Population and Employment growth.
- Growth factors derived from W&P can manually be replaced by Cascade derived growth figures based on such factors as customer growth, engineering estimates, and internal customer projections.

Residential Growth

- Cascade uses population growth data formulated by Woods and Poole to derive a projected residential customer growth by CityGate and year.

- Woods and Poole population growth forecast is provided by county and year and directly assigned to a CityGate. Cascade assumes a 1% growth in population translates to a 1% increase in customer growth.

Residential Growth Formulas

W&P Growth by CityGate was calculated utilizing the equations defined below:

$WP\_P_{[CityGate,Yr]} = \sum WP\_P_{[County,Yr]}$

$WP\_G_{[CityGate,Yr]} = (WP\_P_{[CityGate,Yr]} – WP\_P_{[CityGate,Yr-1]})/ WP\_P_{[CityGate,Yr-1]}$

Definitions:

- $WP\_P_{[County, Yr]}$: Woods and Poole annual population forecast based on numerous demographic factors by county and by year
- $WP\_P_{[CityGate,Yr]}$: Sum of all Woods and Poole annual population figures for all counties assigned to a CityGate
- **$WP\_G_{[CityGate,Yr]}$: Woods and Poole growth factor percentage calculated from Woods and Poole population forecast by CityGate and year**

Commercial and Industrial Growth

- To create an economic growth figure, Woods and Poole's employment factors were combined for each county and year (2015-2050) to produce a total employment number.
- The sum of all raw earning growth figures assigned to a CityGate was used to calculate the Economic Growth by year for each CityGate.

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Commercial and Industrial Growth formulas

W&P Economic Growth by CityGate was calculated utilizing the equations defined below:

$WP\_TE_{[County,\ Yr]}$ = (($WP\_FarmEmployment_{[County,\ Yr]}$ * Farm Employment Allocation) + ($WP\_Forestry_{[County,\ Yr]}$ * Forestry Allocation) + … + ($WP\_FederalMilitaryGovernment_{[County,\ Yr]}$ * Federal Military Government Allocation)

$WP\_TE_{[CityGate,\ Yr]} = \sum WP\_TE_{[County,\ Yr]}$

$WP\_EG_{[CG,\ Yr]} = (WP\_TE_{[CityGate,\ Yr]} - WP\_TE_{[CityGate,\ Yr-1]})/ WP\_TE_{[CityGate,\ Yr-1]}$

Definitions:

- $WP\_TE_{[County,\ Yr]}$: Woods and Poole total employment by county and by year
- $WP\_TE_{[CityGate,\ Yr]}$: Sum of all total employment by county and by year allocated to a CityGate
- **$WP\_EG_{[CG,\ Yr]}$: Woods and Poole commercial or industrial economic growth percentage by CityGate and year**

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Cumulative Impacts

- Growth factors are primarily cumulative, growth in one year impacts growth in subsequent years.
- Forecast model allows for non cumulative impacts that modify demand at a specified CityGate and time period.
- Normal demand resumes after non cumulative impact event is over.

Growth Scenarios

- Forecast assumes three different growth scenarios.
- Base case assumes expected growth with figures primarily from growth factors derived from W&P population and economic employment forecast.
- High growth scenario assumes high economic and population growth and boosts growth by a given percentage (50%).
- Low growth scenario assumes low economic and population growth and decreases growth by a given percentage (50%).

Growth Tab

GATE As Defined in Foreca:	Tariff	W&P population/economic growth	Apply EIA Efficiency	2015	2016	2017
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA502	Population Growth	No	0.0%	0.5%	1.0%
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA503	Population Growth	No	0.0%	0.5%	1.0%
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA504	Economic Growth	No	0.0%	1.2%	2.4%
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA505	Economic Growth	No	0.0%	0.5%	0.8%
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA511	Economic Growth	No	0.0%	1.4%	2.8%
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA570	Economic Growth	No	0.0%	0.4%	0.6%

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Weather Data

- Define weather in terms of HDDs (Heating Degree Day).
- 30 years of weather data for seven weather stations was used to make weather scenarios.
- Weather data is from Schneider Electric.
- Assign a weather station to each CityGate or CityGate Loop.

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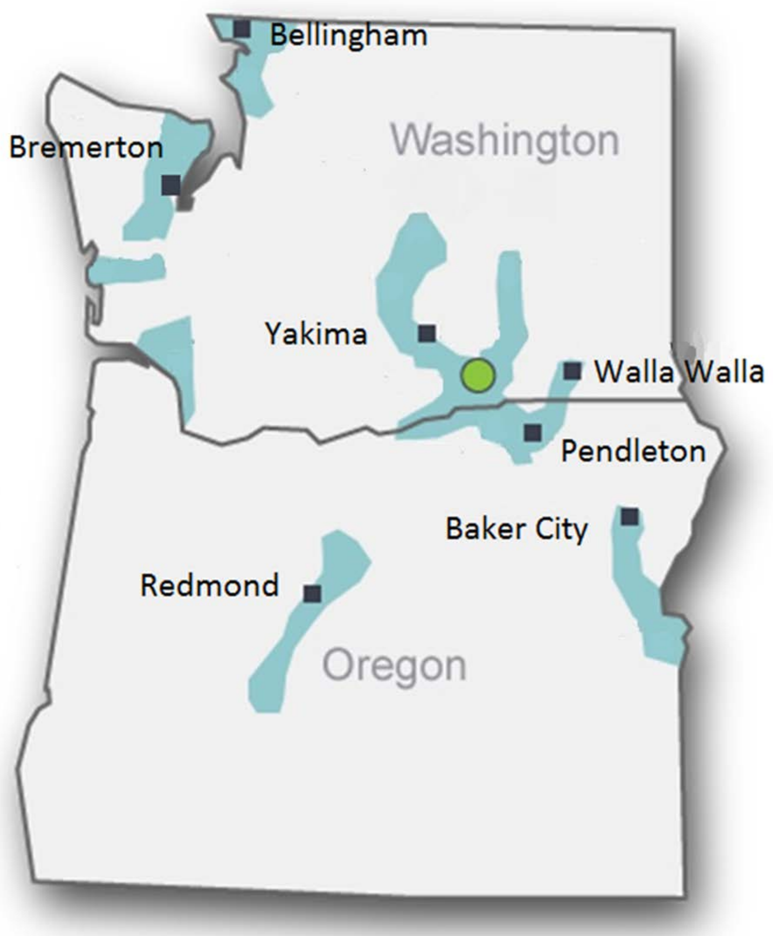
Weather Stations



Weather Scenario

- The average scenario forecast assumes weather (HDD) for 12 months of the year from the 30 year average.
- Average weather scenario is the base case forecast.
- Same demand equations were used to forecast the peak demand day for each citygate.

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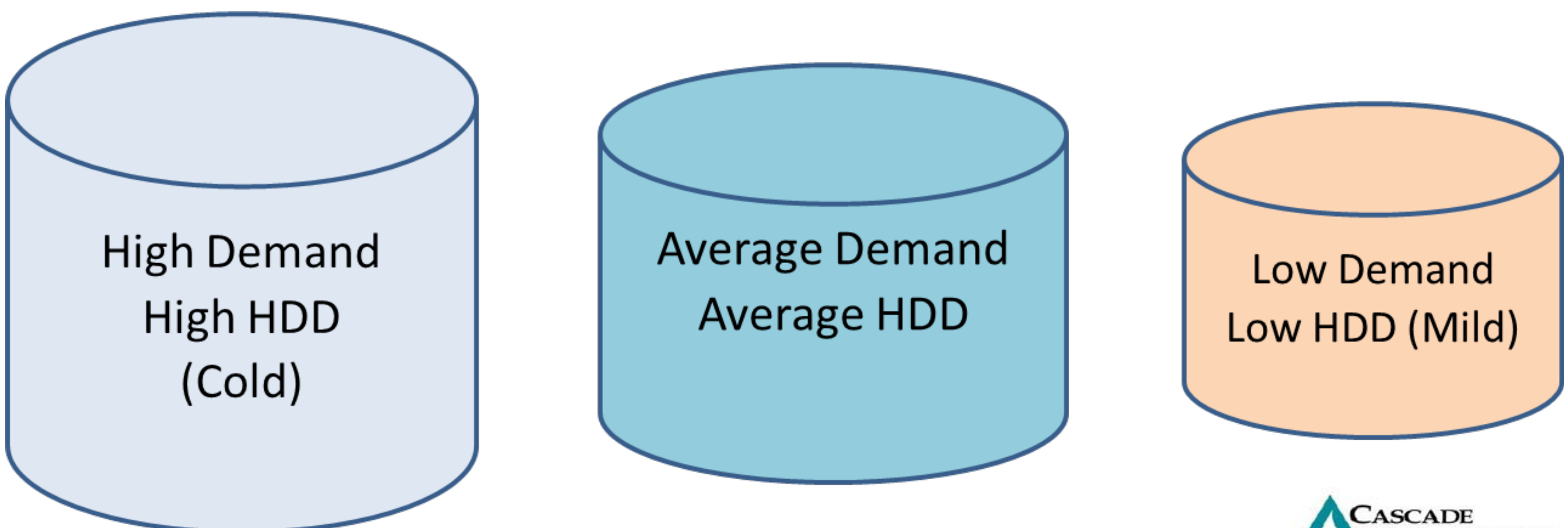
Weather Scenarios

- For weather scenarios, system wide HDDs are used by giving appropriate weight to the weather stations that have greater impact on system wide demand.
- To determine the high case HDD weather scenario, the six coldest years were selected (20% of the coldest years out of 30). These years have the highest yearly total of HDDs.
- To determine the low case HDD weather scenario, the six warmest years were selected (20% of the warmest years out of 30). These years have the lowest yearly total of HDDs.

Normal Weather 1986-2015

WeatherStatio	City	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
KBKE	Baker City	33.28	28.47	20.62	15.12	8.19	3.08	0.33	0.51	4.03	13.82	25.48	33.09
KBLI	Bellingham	19.89	18.45	15.02	10.74	5.64	1.96	0.34	0.26	2.58	8.94	15.91	20.53
KPWT	Bremerton	20.13	19.06	15.47	11.93	6.47	2.68	0.50	0.37	2.37	8.97	16.74	21.15
KPDT	Pendleton	24.72	21.64	14.81	9.60	4.11	0.82	0.03	0.04	1.03	8.05	18.59	25.84
KRDM	Redmond	25.64	24.20	18.88	14.79	8.58	3.36	0.54	0.58	3.66	11.56	21.16	27.37
KALW	Walla Walla	23.70	20.38	12.85	7.58	2.82	0.45	0.00	0.02	0.51	6.39	17.29	24.93
KYKM	Yakima	28.25	23.25	16.24	10.12	3.96	0.92	0.08	0.09	1.71	10.00	21.51	29.82



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Linear Regression Analysis for previous model

GATE As Defined in Fore	State	Weather Station	b	c	R^2
MCCLEARY (ABERDEEN/HOQUIAM)	Washington	Bremerton	111.71	657.73	0.93
ACME	Washington	Bellingham	2.03	2.56	0.98
ARLINGTON	Washington	Bellingham	98.60	611.77	0.96
ATHENA	Oregon	Pendleton	9.45	45.45	0.89
BAKER	Oregon	Baker City	55.67	153.95	0.98
BREMERTON (SHELTON)	Washington	Bremerton	631.49	2429.23	0.96
UMATILLA	Oregon	Pendleton	19.86	105.52	0.83
CASTLE ROCK	Washington	Bremerton	2.79	15.72	0.85
CHEMULT	Oregon	Redmond	0.75	5.55	0.80
WALLA WALLA	Washington	Walla Walla	238.55	1098.85	0.99
GILCHRIST	Oregon	Redmond	3.81	9.05	0.91
DEMING	Washington	Bellingham	3.21	9.21	0.95
WENATCHEE	Washington	Yakima	72.16	436.45	0.95

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Linear Regression Analysis for new model

GATE As Defined in Fo	Tariff		Weather Statio	Analysis Start	Analysis End	b	c	R^2
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA502	MCCLEARY (ABERDEEN/HOQUIAM)-CNGWA502	Bremerton	1/1/2004	12/1/2015	0.01	0.00	0.11
		MCCLEARY						0.36
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA503	MCCLEARY (ABERDEEN/HOQUIAM)-CNGWA503	Bremerton	1/1/2004	12/1/2015	0.02	0.04	0.95
		MCCLEARY						0.92
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA504	MCCLEARY (ABERDEEN/HOQUIAM)-CNGWA504	Bremerton	1/1/2004	12/1/2015	0.06	0.31	0.93
		MCCLEARY						0.88
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA505	MCCLEARY (ABERDEEN/HOQUIAM)-CNGWA505	Bremerton	1/1/2004	12/1/2015	0.27	1.76	0.76
		MCCLEARY						0.68
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA511	MCCLEARY (ABERDEEN/HOQUIAM)-CNGWA511	Bremerton	1/1/2004	12/1/2015	2.17	61.31	0.53
		MCCLEARY						0.37
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA570	MCCLEARY (ABERDEEN/HOQUIAM)-CNGWA570	Bremerton	1/1/2004	12/1/2015	0.31	35.53	0.03
		MCCLEARY						0.57

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Tariff Allocation

GATE	TARRIF	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA502	0.02%	0.02%	0.00%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.03%	0.02%	0.02%
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA503	44.00%	42.86%	42.46%	40.31%	35.21%	29.10%	26.83%	25.55%	32.25%	40.51%	44.80%	44.93%
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA504	40.36%	38.81%	38.47%	37.71%	37.42%	36.86%	38.51%	38.40%	38.31%	37.98%	39.81%	40.51%
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA505	1.96%	2.75%	2.30%	2.48%	2.47%	2.61%	2.70%	2.67%	2.60%	2.21%	2.23%	2.22%
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA511	11.97%	13.93%	14.70%	16.87%	21.80%	25.96%	27.93%	28.59%	23.80%	17.31%	12.40%	11.36%
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA570	1.69%	1.62%	2.06%	2.63%	3.09%	5.46%	4.03%	4.78%	3.04%	1.96%	0.74%	0.96%

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Linear Regression Analysis for new model

GATE As Defined in Fo	Tariff		Weather Statio	Analysis Start	Analysis End	b	c	R^2
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA502	MCCLEARY (ABERDEEN/HOQUIAM)-CNGWA502	Bremerton	1/1/2004	12/1/2015	0.01	0.00	0.11
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		MCCLEARY						0.37
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA570	MCCLEARY (ABERDEEN/HOQUIAM)-CNGWA570	Bremerton	1/1/2004	12/1/2015	0.31	35.53	0.03
		MCCLEARY						0.57

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Previous Linear Regression Analysis

- Weather is the input variable and gas demand is the output:

$$\boldsymbol{Demand = b \ \times WeatherHDD + C}$$

- Where b is demand/HDD and C is the constant baseload demand.

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New Linear Regression Analysis

- Weather and Customers are the input variables and gas demand is the output:

$$\boldsymbol{Demand = b \times WeatherHDD \times Customers + C \times Customers}$$

- Where b is demand/HDD/Customer and C is the constant baseload demand/Customer.
- Goal is to predict demand at each CityGate/loop based on given weather (HDD) and customer.
- Perform a linear regression or best fit analysis of monthly gas demand versus monthly HDDs and customers at each citygate for the past 12 years of data.

Linear Regression Analysis for new model

GATE As Defined in Fo	Tariff		Weather Statio	Analysis Start	Analysis End	b	c	R^2
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA502	MCCLEARY (ABERDEEN/HOQUIAM)-CNGWA502	Bremerton	1/1/2004	12/1/2015	0.01	0.00	0.11
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		MCCLEARY						0.92
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA504	MCCLEARY (ABERDEEN/HOQUIAM)-CNGWA504	Bremerton	1/1/2004	12/1/2015	0.06	0.31	0.93
		MCCLEARY						0.88
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA505	MCCLEARY (ABERDEEN/HOQUIAM)-CNGWA505	Bremerton	1/1/2004	12/1/2015	0.27	1.76	0.76
		MCCLEARY						0.68
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA511	MCCLEARY (ABERDEEN/HOQUIAM)-CNGWA511	Bremerton	1/1/2004	12/1/2015	2.17	61.31	0.53
		MCCLEARY						0.37
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA570	MCCLEARY (ABERDEEN/HOQUIAM)-CNGWA570	Bremerton	1/1/2004	12/1/2015	0.31	35.53	0.03
		MCCLEARY						0.57

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Goodness of fit

- In the previous model if the R^2 was below the 80% threshold, we would use previous year's demand with growth applied as the forecast.
- Using the previous year's demand is a type of forecasting. This is called the naïve forecast.

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Goodness of fit

- In the new model, both the linear forecast and the naïve forecast method were analyzed.
- The naïve method is a method of using the previous year's demand as the current year's demand. (Ex. January 2015 forecast would use January 2014 actuals).
- If the correlation for the naïve model is higher than the correlation for the linear regression, then the naïve method is used.
- If the correlation for the naïve model is lower than the correlation for the linear regression, then the linear regression is used.

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Heating Degree Day (HDD)

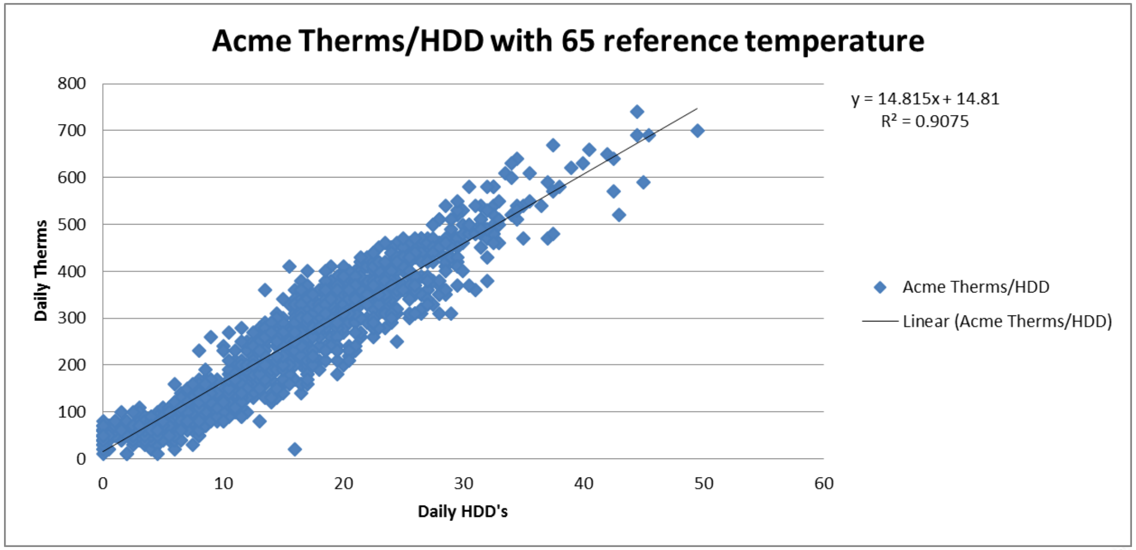
- Heating degree day is used as the unit of measure for weather in the linear regression analysis .

- Heating degree day is calculated by:
  - Determine average high and low temperature for a given day.
  - Daily average is subtracted from an HDD threshold (for example 60°F).
  - If this produces a negative number, a value of zero is assigned.

- Example:
  - Daily high temperature = 60°F; Daily low temperature = 50°F
  - Calculate average → 55°F
  - Subtract from HDD threshold (we will use 60): 60-55 = 5
  - This example day has 5 HDD

65 vs 60 HDD Threshold

- The historical threshold for calculating HDD has been 65°F .
- It was determined that lowering the threshold to 60°F produces better results for Cascade's service territory.
- The graph shows that heating demand does not begin to increase until an HDD of five if the traditional 65°F is utilized.



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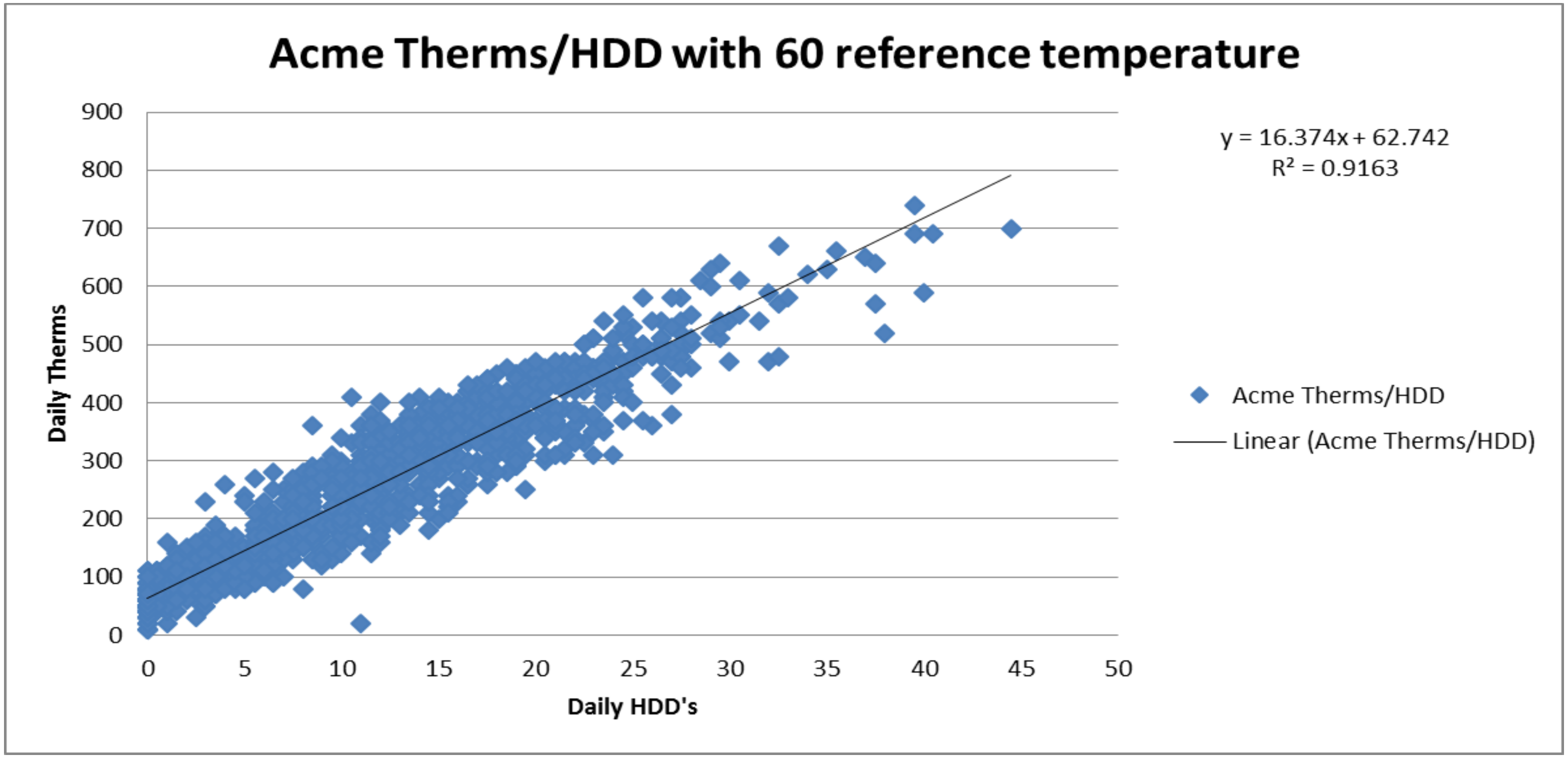
Acme Therms/HDD with 60 degree reference temperature



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Final Demand Forecast

- The Monthly Demand Forecast by year, month, rate schedule and CityGate was based upon:
  - The calculated forecast for weather dependent load plus the most recent year's (2015) non weather dependent core load with applied growth factors.
  - Core load was forecasted by CityGate by rate schedule.

Demand Forecast

Month	Tariff	System Demand (Dth)	OR Forecast (Dth)	WA Forecast (Dth)	PRINEVILLE	REDMOND	STANFIELD	STEARNS (SUNRIVER)	DAVE RASMUSSEN	PRONGHORN	SOUTH HERMISTON	KOSMOS FARMS	Bend Loop	MCCLEARY (ABERDEEN/HOQUIAM)	ACME	ARLINGTON
Jan-16	CNGOR101	639,215	639,215	-	18,831	63,707	2,634	52,297	-	3,950	-	-	318,275	-	-	-
Jan-16	CNGOR104	430,036	430,036	-	21,059	47,065	1,142	12,781	-	2,551	-	-	160,653	-	-	-
Jan-16	CNGOR105	34,191	34,191	-	3,892	5,387	-	179	-	-	-	-	4,044	-	-	-
Jan-16	CNGOR111	20,155	20,155	-	2,160	1,532	-	-	-	-	-	-	3,325	-	-	-
Jan-16	CNGOR170	31,670	31,670	-	-	-	-	-	-	-	-	-	-	-	-	-
Jan-16	CNGWA502	4,984	-	4,984	-	-	-	-	-	-	-	-	-	16	-	68
Jan-16	CNGWA503	1,927,602	-	1,927,602	-	-	-	-	-	-	-	-	-	38,396	793	48,833
Jan-16	CNGWA504	1,296,095	-	1,296,095	-	-	-	-	-	-	-	-	-	34,559	566	26,012
Jan-16	CNGWA505	187,013	-	187,013	-	-	-	-	-	-	-	-	-	2,865	-	4,016
Jan-16	CNGWA511	110,388	-	110,388	-	-	-	-	-	-	-	-	-	9,727	-	-
Jan-16	CNGWA512	349	-	349	-	-	-	-	-	-	-	-	-	-	-	-
Jan-16	CNGWA541	234	-	234	-	-	-	-	-	-	-	-	-	-	-	-
Jan-16	CNGWA570	49,771	-	49,771	-	-	-	-	-	-	-	-	-	1,233	-	-
Jan-16	CNGWA577	2,708	-	2,708	-	-	-	-	-	-	-	-	-	-	-	-
Feb-16	CNGOR101	536,778	536,778	-	16,468	55,474	1,524	45,802	-	3,547	-	-	280,495	-	-	-
Feb-16	CNGOR104	364,337	364,337	-	18,447	40,939	862	11,408	-	2,264	-	-	141,839	-	-	-
Feb-16	CNGOR105	28,667	28,667	-	4,151	4,789	-	146	-	-	-	-	3,270	-	-	-
Feb-16	CNGOR111	16,749	16,749	-	1,885	1,326	-	-	-	-	-	-	2,997	-	-	-
Feb-16	CNGOR170	17,880	17,880	-	-	-	-	-	-	-	-	-	-	-	-	-

Demand Forecast

Forecast T	System Demand (	OR Forecast (I	WA Forecast (I	Bend Loop	MCCLEARY (ABERDEEN/HOQUIAM)	ACME	ARLINGTON
Jan-16	4,734,411	1,155,266	3,579,145	486,297	86,796	1,359	78,930
Feb-16	3,931,601	964,411	2,967,189	428,601	77,123	1,180	65,915
Mar-16	3,191,664	773,888	2,417,776	358,506	68,394	1,042	60,937
Apr-16	2,328,744	588,224	1,740,520	280,209	54,363	740	48,654
May-16	1,531,821	390,361	1,141,460	194,486	38,447	447	32,638
Jun-16	1,010,988	244,620	766,368	120,806	27,163	223	22,231
Jul-16	870,305	203,300	667,005	91,787	22,041	140	19,073
Aug-16	870,069	205,127	664,941	92,242	21,805	136	19,382
Sep-16	1,144,404	270,682	873,722	125,496	25,866	260	25,180
Oct-16	2,086,188	517,724	1,568,464	240,219	42,302	647	41,865
Nov-16	3,656,233	917,597	2,738,637	397,236	66,929	1,056	70,562
Dec-16	5,018,787	1,251,669	3,767,118	537,912	86,668	1,404	85,358

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Peak Day Forecast

- 3 Peak Day Scenarios:
  - Average Peak Day
  - Max Peak Day
  - CityGate Peak Day
- HDD weighting
  - To determine the peak day HDDs Cascade had to weight each HDD based on weather location.
    - Held customer count to the December 2015 actual and used the coefficient b in the linear regressions.
    - The amount of demand at each weather location based on an increase in 1 HDD determined how each weather location should be weighted.

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System Weighted HDD

	b	Dec 2015 CC	ΔHDD					
Baker CNGOR101	0.01	3274	1	34.6				
	Baker City	**Bellingham**	**Bremerton**	**Pendleton**	**Redmond**	**Walla Walla**	**Yakima**	
Sum of Coefficient (b)	144	1,814	919	252	846	893	797	*5,667*
Weather Weight	3%	32%	16%	4%	15%	16%	14%	
12/31/2015	HDD	Weights						
Baker City	49	3%	1.23					
Bellingham	29	32%	9.28					
Bremerton	28	16%	4.54					
Pendleton	38	4%	1.69					
Redmond	40	15%	5.90					
Walla Walla	36	16%	5.60					
Yakima	42	14%	5.91					
			34					

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Average Peak Day Forecast

- The Average Peak Day Forecast ensures that Cascade can plan for the expected peak day during a year.
  - Using the weighted HDDs, Cascade found the coldest day in each of the most recent 30 years (1986-2015).
  - Using those HDDs, Cascade averaged each day for each weather location to come up with 7 HDDs.
  - Those HDDs were then applied to the regressions to come up with an average peak day forecast.

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Max Peak Day Forecast

- The Max Peak Day Forecast allows Cascade to plan for the coldest day in the past 30 years with today's usage rates and customer counts.
  - Using the weighted HDDs, Cascade found the coldest day from the past 30 years (This is December 21st, 1990).
  - The HDDs for each weather location from this day were used in the regressions to come up with the Max Peak Day Forecast.

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CityGate Peak Day Forecast

- The CityGate Peak Day Forecast allows Cascade to plan for the coldest day in the past 30 years at each individual weather location.
  - Using weather location HDDs, Cascade found the coldest HDD in the past 30 years for each individual weather location.
  - The HDDs for each weather location were used in the regressions to come up with the CityGate Peak Day Forecast.

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Max and CityGate Peak HDDs

			Max Peak HDD						
Peak Rank	System Peak Day	System Peak HDD	Baker City	Bellingham	Bremerton	Pendleton	Redmond	Walla Walla	Yakima
1	12/21/90	55.9	70.5	46	46	67	70.5	65	58
2	02/03/89	53.7	68	46	46	63.5	64.5	60.5	55.5
3	12/29/90	52.4	60	47	44	65.5	53.5	59	60
4	12/20/90	51.6	59	46	42	63	62	57.5	53
5	12/22/90	51.4	72.5	41	41.5	61.5	62.5	60.5	57.5
6	02/02/89	51.2	52	51.5	45	60.5	50	53	53.5
7	01/05/04	50.0	70	39	37	63	55.5	64	61
8	01/30/96	50.0	61.5	40.5	37	64	55.5	63.5	59

			City Gate Peak HDD						
			Baker City	Bellingham	Bremerton	Pendleton	Redmond	Walla Walla	Yakima
			72.5	51.5	46	67	70.5	65.5	64.5

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Average Peak Demand Day Forecast

Forecast Tim	Peak Day Demand (Dtl	OR Peak Day (Dth)	WA Peak Day (Dth)	Bend Loop	MCCLEARY (ABERDEEN/HOQUIAM)	ACME	ARLINGTON	BREMERTON (SHELTON)	CASTLE ROCK	WALLA WALLA
2016	270,725	69,847	200,878	28,614	4,201	78	4,420	26,774	129	12,295
2017	273,626	70,809	202,817	29,022	4,236	79	4,478	27,159	130	12,423
2018	276,453	71,767	204,687	29,448	4,265	80	4,538	27,528	132	12,545
2019	279,289	72,693	206,596	29,856	4,295	82	4,595	27,896	134	12,662
2020	282,132	73,643	208,490	30,282	4,325	83	4,655	28,265	135	12,786
2021	285,000	74,613	210,387	30,727	4,355	84	4,712	28,634	137	12,902
2022	287,848	75,579	212,269	31,172	4,383	85	4,770	29,002	138	13,014
2023	290,743	76,545	214,198	31,617	4,411	86	4,827	29,370	140	13,129
2024	293,646	77,530	216,116	32,080	4,439	87	4,884	29,756	141	13,248
2025	296,561	78,517	218,044	32,544	4,466	89	4,940	30,124	143	13,359

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Max Peak Demand Day Forecast

Forecast Tim	Peak Day Demand (Dtl	OR Peak Day (Dth)	WA Peak Day (Dth)	Bend Loop	MCCLEARY (ABERDEEN/HOQUIAM)	ACME	ARLINGTON	BREMERTON (SHELTON)	CASTLE ROCK	WALLA WALLA
2016	349,810	95,986	253,825	41,080	5,481	97	5,387	34,675	153	17,211
2017	353,593	97,332	256,261	41,670	5,526	99	5,458	35,171	155	17,390
2018	357,287	98,675	258,612	42,287	5,563	100	5,531	35,646	157	17,560
2019	360,988	99,974	261,014	42,877	5,603	102	5,601	36,120	159	17,722
2020	364,703	101,307	263,396	43,494	5,643	103	5,674	36,594	161	17,895
2021	368,457	102,672	265,785	44,138	5,681	104	5,744	37,069	163	18,057
2022	372,183	104,031	268,152	44,782	5,718	106	5,814	37,543	165	18,213
2023	375,973	105,390	270,584	45,426	5,754	107	5,883	38,016	166	18,373
2024	379,776	106,778	272,998	46,096	5,790	109	5,953	38,513	168	18,538
2025	383,594	108,168	275,426	46,767	5,826	110	6,022	38,987	170	18,693

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CityGate Peak Demand Day Forecast

Forecast Tim	Peak Day Demand (Dtl	OR Peak Day (Dth)	WA Peak Day (Dth)	Bend Loop	MCCLEARY (ABERDEEN/HOQUIAM)	ACME	ARLINGTON	BREMERTON (SHELTON)	CASTLE ROCK	WALLA WALLA
2016	365,474	96,274	269,201	41,080	5,481	108	5,955	34,675	153	17,333
2017	369,388	97,622	271,766	41,670	5,526	110	6,033	35,171	155	17,514
2018	373,207	98,966	274,241	42,287	5,563	112	6,115	35,646	157	17,684
2019	377,039	100,266	276,772	42,877	5,603	113	6,192	36,120	159	17,847
2020	380,882	101,600	279,282	43,494	5,643	115	6,272	36,594	161	18,022
2021	384,765	102,966	281,800	44,138	5,681	116	6,349	37,069	163	18,185
2022	388,620	104,326	284,294	44,782	5,718	118	6,427	37,543	165	18,342
2023	392,544	105,685	286,858	45,426	5,754	120	6,504	38,016	166	18,503
2024	396,476	107,075	289,401	46,096	5,790	121	6,581	38,513	168	18,670
2025	400,427	108,466	291,961	46,767	5,826	123	6,657	38,987	170	18,825

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Summary

- Cascade acknowledges 2014 IRP issues and plans to resolve those in the 2016 IRP.
- Demand Forecast Model
  - Methodology
  - Assumptions
  - Scenarios
  - Results

Questions/Next Steps

- **Review Plans for TAG 2 Discussion**
  - **Update on any Action items.**
  - **Drill down further into the 20 year forecast, select CityGates and customer segments.**
  - **Current and Potential Supply Resources.**
  - **Next TAG is Tuesday, July 19th at SeaTac International Airport Conference Center.**

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1st External TAG Meeting

6/16/2016, 9:00 - 10:40 AM

Presenters: Mark Sellers-Vaughn & Brian Robertson

In attendance: Mark Sellers-Vaughn, Brian Robertson, Bob Morman, Mike Parvinen, Marty Saldivar – NWP, David Nightingale & Kathi Scanlan – WUTC

Called in: Kary Burin, Garret Senger, Amanda Sargent, Chad Luginbill, Josh Romine, Miki Bode Jones – NWP, Tom Pardee – Avista, Monica Cowlisha, Jeremy Ogden, Carolyn Stone, Pam Archer, Becky Mellinger, Brian Hoyle, Mike Clapp, Chris Robbins & Eric Wood

Minutes by: Carolyn P Stone

Bob Morman introduced himself and welcomed all of today's participants. He discussed the Cascade 2014 IRP not being recognized by the Commission. He assures that he, as well as the IRP staff at Cascade is committed to Success for the 2016 IRP!

Mark then lead the group through today's agenda

Mark named the members of the newly formed IRP Steering Committee as follows:

- Garret Senger
- Bob Morman
- Mike Parvinen

The finished plan to hire a consultant is to be presented for approval to the IRP Steering Committee.

Next was discussion of issues that caused the 2014 IRP to not be recognized. Mark went over our plans for resolution to all of these issues, including the organization and presentation of it. It will really be cleaned up!

Brian Robertson then went over the contents of the IRP, as follows:

CNG Demand Study:

●CNG contracted MRE and Gilbert & Associates to help build a model including customer core natural gas demand and peak demand for 20 years.
●Shows demand at the City Gate & City Gate loop level
●Demand is weather and customer driven, rolling 30 years using "Normal' temps

Inputs include:

*Historical demand = Pipeline EBB, GMS (Aligne), & CC&B
*Weather = Schneider Electric
*Population & Economic data = Woods & Poole
*Customer Count = CC&B

*Assumption of 1% increase in population & in employment

●Last year non-weather dependent demand was used. Customers ramp up production based on season... These customers were removed prior to the demand run. Demand was placed back in for forecast.

Question 1: Does this show a "system wide event" that drives heating demand?
Answer: We use 3 types of Peak Day forecasts. We will go through those.
Question 2: Is this linear only?
Answer: The current model is linear only. We will improve/change this forecast by analyzing other regressions to get a bigger broader picture in the future.

Forecast & Results:
●Demand data = Pipeline EBB's & GMS (Aligne)
●Data verification & customer count = CC&B

Growth Data:
●Woods & Poole State profile data used

Question: Were demand profiles done for each SIC code? Growth numbers for educational services for example....
Answer: We will be taking a look at that.

Residential Growth:
●Population growth (1%) via Woods & Poole

Growth Scenarios
●3 used, Base Case, high growth + 50% and low growth -50%

Weather Data = HDD
Using Schneider Electric data
●30 years
●Has a more rural focus representative of our service territory (not just airports)
●This service uses NOAA and provides consistency

Weather Stations:

●Uses 7 stations

Question: On the low side, would the growth get below zero...i.e. negative growth?
Answer: YES

Tariff Allocation:

●Weighted Average used for every Citygate and every Rate Schedule
●Manual adjustments can be made to correct and smooth data

Previous Linear Regression vs Current Linear Regression

Goodness of fit:
●Naïve Methodology vs Regression

HDD Calculation:
● High & Low average

Why use 65 vs 60?
●60 is better for our service territory
●Linear model is a better fit with 60.

Final Demand Forecast:
● Year, Month, RS, Citygate, Zone District (or can create an area "sectors")
●Core load forecasted by City Gate by RS

Weather Scenario:
●Average is base case
●6 warmest/coldest years selected for high/low scenario

Peak Day Forecasts:
●Weighted each HDD based on its weather location
●Average - Cascades plans for expected Peak day during the year!
●Max - Plan for coldest day in past 30 years, on 12/21/1990
●Citygate - At each weather location

Question: Max Peak Day – using the coldest day as they happen, projected forward?
Answer: YES
Question: Did you look at the engineering side and system planning?
Answer: YES

Mark Summarized:
1. We intend to resolve the 2014 issues
2. We will continue to work on solid methodologies

●Still 2 months until we lock down the forecast so those numbers CAN change.

Mark stated that if there are any particular Citygates or Customer Segments wanted, please let them know.

Action Plan:
1. Cascade will work on gathering growth information from other locations to compare with Woods & Poole.
2. We will verify distribution planning information with Engineering for peak day analysis.

Question: The City Gate Peak Demand is good, but how does Cascade use that information?
Answer: This will be addressed at TAG 3.

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Integrated Resource Plan
Technical Advisory Group Meeting #2

Tuesday, July 19, 2016
Seattle-Tacoma International Airport
Conference Center

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Agenda

- Introductions
- IRP staffing and Support Update
- Cascade demand study review from TAG 1
- Results
  - Comparison to 2011 and 2012 IRP
  - Annual base case
  - Scenario results
  - Tariff Breakdown
  - Peak Day
  - Scenario HDDs
- Cascade Gas Supply Overview
  - Current Resources
  - Transport
  - Supply
  - Alternative Resources
- Next Steps

IRP Staffing and Support

- Two positions added
- Resource planning analysts
- First new analyst starts late July
- Have posted for the second new analyst

- Hired Bruce Folsom as IRP consultant

IRP CONSULTANT

- Cascade has hired Bruce Folsom
- 23 years with Avista Corporation
- 8 years with the Washington Utilities and Transportation Commission (WUTC)
- Bruce has a B.S. in Environmental Studies from the University of Washington and an MBA in Business Administration from Seattle University.

Among consultant tasks and deliverables

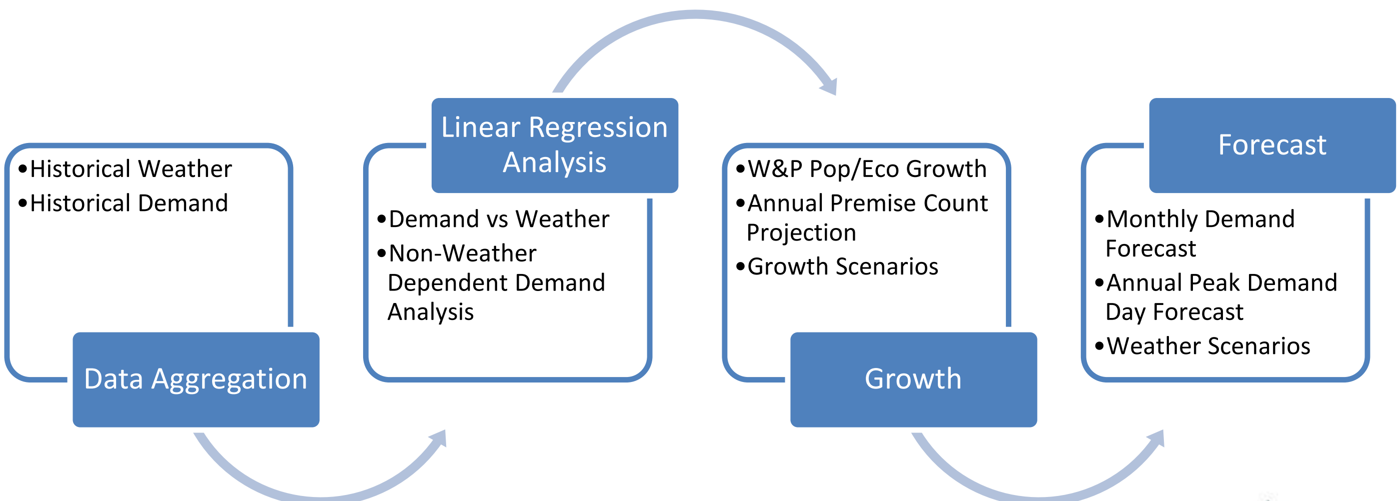
- Providing recommendations and guidance to internal IRP team, suggesting alternative solutions, identify potential regulatory solutions related to the IRP, and assist in the development of the narrative of the 2016 WA IRP and addressing the 2017 OR IRP Annual Update.
- Produce a discussion narrative on Alternative Forecasting Methodologies
- Produce a discussion narrative on price elasticity in the Pacific Northwest region
- Produce a discussion narrative on carbon legislation impacts on price forecast, system, supplies and recommend how Cascade should describe its "carbon policy" as it relates to the IRP
- Working with the internal IRP team on ensuring the Company meets all OR and WA IRP guidelines
- Assist Cascade in addressing open OPUC DRs from the 2014 IRP.

CASCADE DEMAND STUDY

Recap of the 20 Year demand forecast

Overview

- The Cascade demand forecast developed for the IRP is a forecast of customers, core natural gas demand, and core peak demand for the next 20 years.
- Cascade's core load consists of approximately 53% residential and 47% commercial and industrial.



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Overview

- Forecast demand at the CityGate and CityGate Loop level.
- CityGate Loops are a group of CityGates that service a similar area that are forecasted together due to pipeline operations.
- CNGC forecast model is flexible giving Cascade the ability to:
  - Update input data (gas demand and weather)
  - Modify assumptions
  - Modify CityGates and loops to be forecasted
  - Run several scenarios

Key Assumptions

- Seven weather locations effectively cover Cascade's service territory.
- Using population growth assumes 1% increase in population translates to a 1% increase in residential customer count.
- Using employment growth assumes 1% increase in employment translates to a 1% increase in commercial and industrial customer count.

Key Points

- Cascade's demand is principally weather and customer driven; the colder the weather or greater the customer count, the greater the demand.
- This forecast uses 30 years of recent weather history as the "normal" temperatures.
- Forecasted under various weather and growth scenarios – average year, cold year, warm year, extreme cold day, high growth, low growth, etc.
- Analyze weather and demand for each of 55 CityGates and CityGate Loops that serve Core customers.
- Growth factors are applied to each of the 20 years in the forecast for each CityGate.
- Heating demand does not appreciatively start until average temps dip below 60° F, therefore a 60° F threshold is used.

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Input Data

- Historical Demand
  - Pipeline actuals
  - Gas Management System (GMS)
  - Customer Care and Billing (CC&B)
- Weather
  - Schneider Electric
- Population and Economic
  - Woods & Poole
  - Acquiring local market intelligence
- Customer Count
  - CC&B

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Demand Data

- Historical core monthly demand by CityGate was primarily drawn from:
  - Pipeline actuals from Electronic Bulletin Board (EBB)
  - Cascade's own Gas Management System (GMS)
- Also examined CC&B (Customer Care and Billing) for data verification and premise count information.
- Analyzing demand data from 2004 to 2015.

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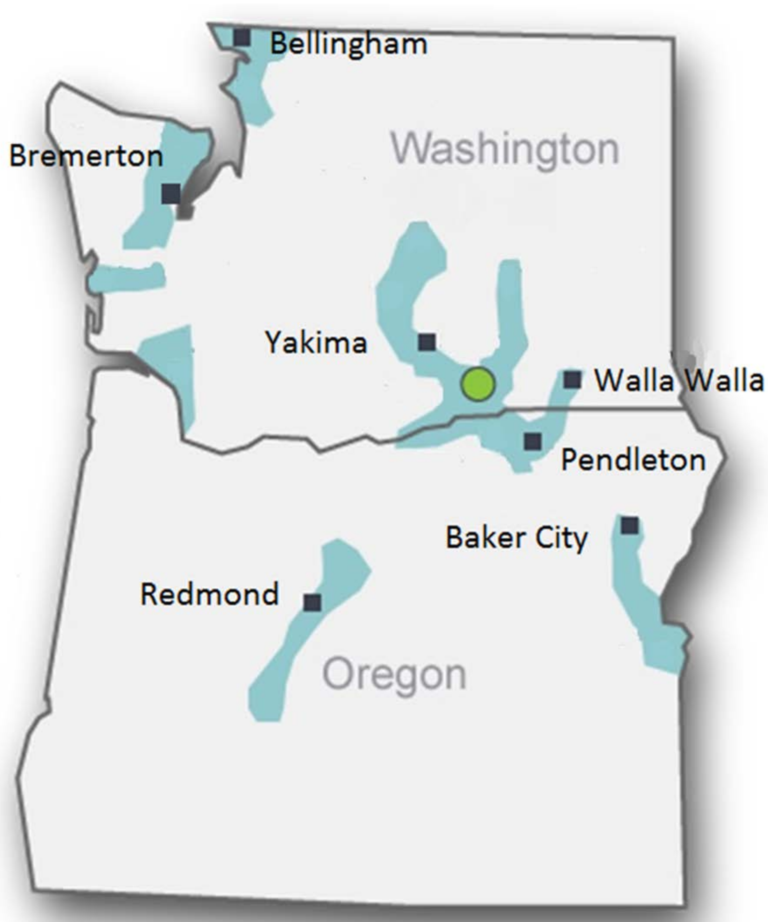
Weather Data

- Define weather in terms of HDDs (Heating Degree Day).
- 30 years of weather data for seven weather stations was used to make weather scenarios.
- Weather data is from Schneider Electric.
- Assign a weather station to each CityGate or CityGate Loop.

Weather Stations



- The seven weather stations are shown on the map.
- Cascade's customer base is shaded in aqua.
- Each CityGate and loop is assigned to a weather station.

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New Linear Regression Analysis

- Weather and Customers are the input variables and gas demand is the output:

$$\boldsymbol{Demand = b \times WeatherHDD \times Customers + C \times Customers}$$

- Where b is demand/HDD/Customer and C is the constant baseload demand/Customer.
- Goal is to predict demand at each CityGate/loop based on given weather (HDD) and customer.
- Perform a linear regression or best fit analysis of monthly gas demand versus monthly HDDs and customers at each citygate for the past 12 years of data.

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Linear Regression Analysis for new model

GATE As Defined in Fo	Tariff		Weather Statio	Analysis Start	Analysis End	b	c	R^2
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA502	MCCLEARY (ABERDEEN/HOQUIAM)-CNGWA502	Bremerton	1/1/2004	12/1/2015	0.01	0.00	0.11
		MCCLEARY						0.36
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA503	MCCLEARY (ABERDEEN/HOQUIAM)-CNGWA503	Bremerton	1/1/2004	12/1/2015	0.02	0.04	0.95
		MCCLEARY						0.92
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA504	MCCLEARY (ABERDEEN/HOQUIAM)-CNGWA504	Bremerton	1/1/2004	12/1/2015	0.06	0.31	0.93
		MCCLEARY						0.88
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA505	MCCLEARY (ABERDEEN/HOQUIAM)-CNGWA505	Bremerton	1/1/2004	12/1/2015	0.27	1.76	0.76
		MCCLEARY						0.68
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA511	MCCLEARY (ABERDEEN/HOQUIAM)-CNGWA511	Bremerton	1/1/2004	12/1/2015	2.17	61.31	0.53
		MCCLEARY						0.37
MCCLEARY (ABERDEEN/HOQUIAM)	CNGWA570	MCCLEARY (ABERDEEN/HOQUIAM)-CNGWA570	Bremerton	1/1/2004	12/1/2015	0.31	35.53	0.03
		MCCLEARY						0.57

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Heating Degree Day (HDD)

- Heating degree day is used as the unit of measure for weather in the linear regression analysis .
- Heating degree day is calculated by:
  - Determine average high and low temperature for a given day.
  - Daily average is subtracted from an HDD threshold (for example 60°F).
  - If this produces a negative number, a value of zero is assigned.
- Example:
  - Daily high temperature = 60°F; Daily low temperature = 50°F
  - Calculate average → 55°F
  - Subtract from HDD threshold (we will use 60): 60-55 = 5
  - This example day has 5 HDD

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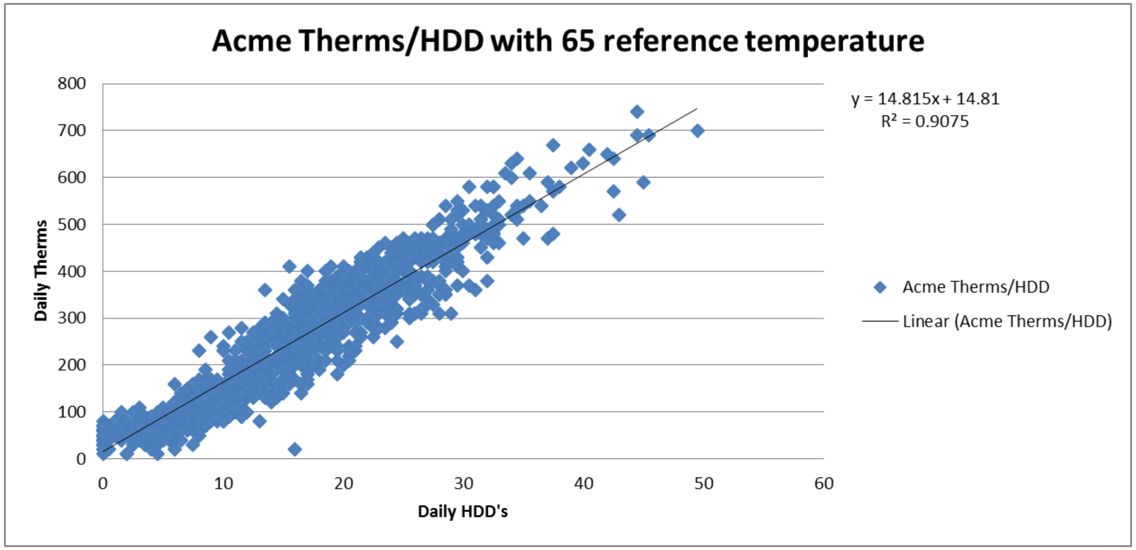
65 vs 60 HDD Threshold

- The historical threshold for calculating HDD has been 65°F .
- It was determined that lowering the threshold to 60°F produces better results for Cascade's service territory.
- The graph shows that heating demand does not begin to increase until an HDD of five if the traditional 65°F is utilized.



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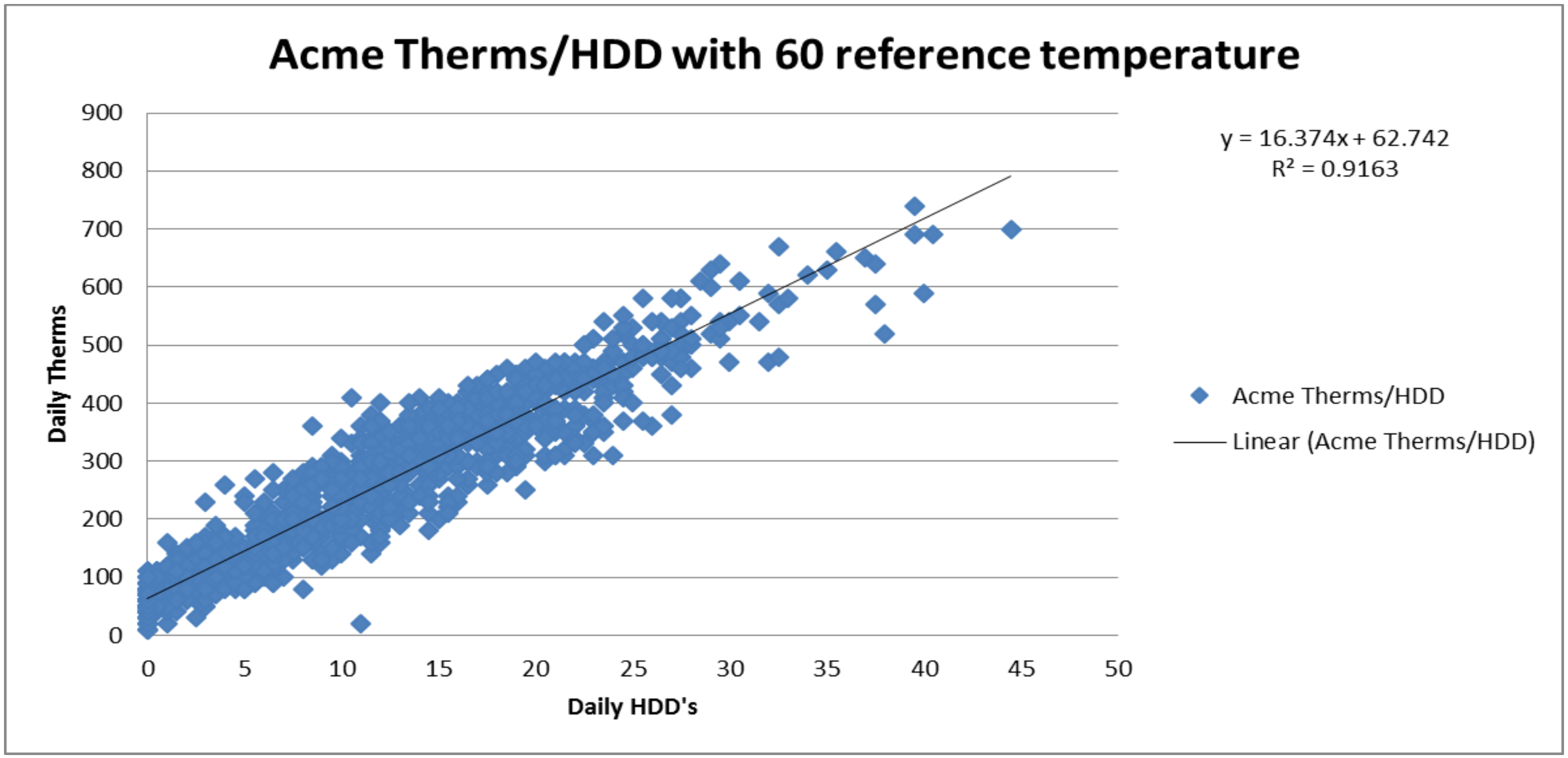
Acme Therms/HDD with 60 degree reference temperature



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Forecast Scenarios

- Base case is normal weather with expected customer growth.
- Sensitivity capability for cold and warm weather.
- Sensitivity for low and high customer growth.

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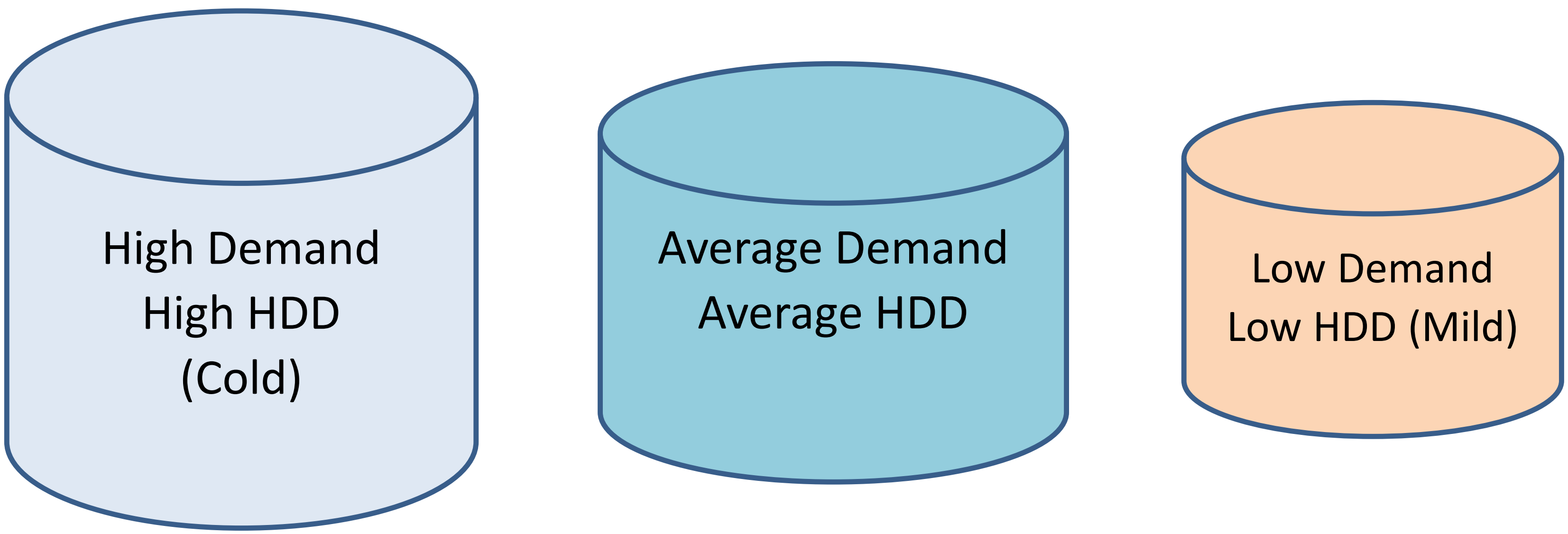
Weather Scenarios

- For weather scenarios, system wide HDDs are used by giving appropriate weight to the weather stations that have greater impact on system wide demand.
- To determine the high case HDD weather scenario, the six coldest years were selected (20% of the coldest years out of 30). These years have the highest yearly total of HDDs.
- To determine the low case HDD weather scenario, the six warmest years were selected (20% of the warmest years out of 30). These years have the lowest yearly total of HDDs.

Weather Scenarios



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Growth Data

- Woods & Poole State Profile data is used for customer forecast.
- Population data is used for the Residential Customers.
- Commercial and Industrial growth factors used Farm, Construction, and Manufacturing earnings in previous model.
- New model uses: Farm Employment, Forestry, Fishing, Related Activities & Other, Mining Employment, Utilities Employment, Construction Employment, Manufacturing Employment, Wholesale Trade Employment, Retail Trade Employment, Transportation & Warehousing Employment, Information Employment, Arts, Entertainment, & Recreation Employment, Finance & Insurance Employment, Real Estate, Rental & Leasing Employment, Professional & Technical Services Employment, Administrative & Waste Services Employment, Educational Services Employment, Health Care & Social Assistance Employment, Federal Civilian Government Employment, State & Local Government Employment, and Federal Military Government Employment

Residential Growth Formulas

W&P Growth by CityGate was calculated utilizing the equations defined below:

$WP\_P_{[CityGate,Yr]} = \sum WP\_P_{[County,Yr]}$

$WP\_G_{[CityGate,Yr]} = (WP\_P_{[CityGate,Yr]} - WP\_P_{[CityGate,Yr-1]}) / WP\_P_{[CityGate,Yr-1]}$

Definitions:

- $WP\_P_{[County,\ Yr]}$: Woods and Poole annual population forecast based on numerous demographic factors by county and by year
- $WP\_P_{[CityGate,Yr]}$: Sum of all Woods and Poole annual population figures for all counties assigned to a CityGate
- **$WP\_G_{[CityGate,Yr]}$: Woods and Poole growth factor percentage calculated from Woods and Poole population forecast by CityGate and year**

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Commercial and Industrial Growth formulas

W&P Economic Growth by CityGate was calculated utilizing the equations defined below:

$WP\_TE_{[County,\ Yr]}$ = (($WP\_FarmEmployment_{[County,\ Yr]}$ * Farm Employment Allocation) + ($WP\_Forestry_{[County,\ Yr]}$ * Forestry Allocation) + … + ($WP\_FederalMilitaryGovernment_{[County,\ Yr]}$ * Federal Military Government Allocation)

$WP\_TE_{[CityGate,\ Yr]} = \sum WP\_TE_{[County,\ Yr]}$

$WP\_EG_{[CG,\ Yr]} = (WP\_TE_{[CityGate,\ Yr]} - WP\_TE_{[CityGate,\ Yr-1]})/\ WP\_TE_{[CityGate,\ Yr-1]}$

Definitions:

- $WP\_TE_{[County,\ Yr]}$: Woods and Poole total employment by county and by year
- $WP\_TE_{[CityGate,\ Yr]}$: Sum of all total employment by county and by year allocated to a CityGate
- **$WP\_EG_{[CG,\ Yr]}$: Woods and Poole commercial or industrial economic growth percentage by CityGate and year**

Final Demand Forecast

- The Monthly Demand Forecast by year, month, rate schedule and CityGate was based upon:
  - The calculated forecast for weather dependent load plus the most recent year's (2015) non weather dependent core load with applied growth factors.
  - Core load was forecasted by CityGate by rate schedule.

Peak Day Forecast

- 3 Peak Day Scenarios:
  - Average Peak Day
  - Max Peak Day
  - CityGate Peak Day
- HDD weighting
  - To determine the peak day HDDs Cascade had to weight each HDD based on weather location.
    - Held customer count to the December 2015 actual and used the coefficient b in the linear regressions.
    - The amount of demand at each weather location based on an increase in 1 HDD determined how each weather location should be weighted.

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Average Peak Day Forecast

- The Average Peak Day Forecast ensures that Cascade can plan for the expected peak day during a year.
  - Using the weighted HDDs, Cascade found the coldest day in each of the most recent 30 years (1986-2015).
  - Using those HDDs, Cascade averaged each day for each weather location to come up with 7 HDDs.
  - Those HDDs were then applied to the regressions to come up with an average peak day forecast.

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Max Peak Day Forecast

- The Max Peak Day Forecast allows Cascade to plan for the coldest day in the past 30 years with today's usage rates and customer counts.
  - Using the weighted HDDs, Cascade found the coldest day from the past 30 years (This is December 21st, 1990).
  - The HDDs for each weather location from this day were used in the regressions to come up with the Max Peak Day Forecast.

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CityGate Peak Day Forecast

- The CityGate Peak Day Forecast allows Cascade to plan for the coldest day in the past 30 years at each individual weather location.
  - Using weather location HDDs, Cascade found the coldest HDD in the past 30 years for each individual weather location.
  - The HDDs for each weather location were used in the regressions to come up with the CityGate Peak Day Forecast.

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Max and CityGate Peak HDDs

			Max Peak HDD						
Peak Rank	System Peak Day	System Peak HDD	Baker City	Bellingham	Bremerton	Pendleton	Redmond	Walla Walla	Yakima
1	12/21/90	55.9	70.5	46	46	67	70.5	65	58
2	02/03/89	53.7	68	46	46	63.5	64.5	60.5	55.5
3	12/29/90	52.4	60	47	44	65.5	53.5	59	60
4	12/20/90	51.6	59	46	42	63	62	57.5	53
5	12/22/90	51.4	72.5	41	41.5	61.5	62.5	60.5	57.5
6	02/02/89	51.2	52	51.5	45	60.5	50	53	53.5
7	01/05/04	50.0	70	39	37	63	55.5	64	61
8	01/30/96	50.0	61.5	40.5	37	64	55.5	63.5	59
			City Gate Peak HDD						
			Baker City	Bellingham	Bremerton	Pendleton	Redmond	Walla Walla	Yakima
			72.5	51.5	46	67	70.5	65.5	64.5

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Average Peak Demand Day Forecast

Forecast Tim	Peak Day Demand (Dtl	OR Peak Day (Dth)	WA Peak Day (Dth)	Bend Loop	MCCLEARY (ABERDEEN/HOQUIAM)	ACME	ARLINGTON	BREMERTON (SHELTON)	CASTLE ROCK	WALLA WALLA
2016	270,725	69,847	200,878	28,614	4,201	78	4,420	26,774	129	12,295
2017	273,626	70,809	202,817	29,022	4,236	79	4,478	27,159	130	12,423
2018	276,453	71,767	204,687	29,448	4,265	80	4,538	27,528	132	12,545
2019	279,289	72,693	206,596	29,856	4,295	82	4,595	27,896	134	12,662
2020	282,132	73,643	208,490	30,282	4,325	83	4,655	28,265	135	12,786
2021	285,000	74,613	210,387	30,727	4,355	84	4,712	28,634	137	12,902
2022	287,848	75,579	212,269	31,172	4,383	85	4,770	29,002	138	13,014
2023	290,743	76,545	214,198	31,617	4,411	86	4,827	29,370	140	13,129
2024	293,646	77,530	216,116	32,080	4,439	87	4,884	29,756	141	13,248
2025	296,561	78,517	218,044	32,544	4,466	89	4,940	30,124	143	13,359

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Max Peak Demand Day Forecast

Forecast Tim	Peak Day Demand (Dtl	OR Peak Day (Dth)	WA Peak Day (Dth)	Bend Loop	MCCLEARY (ABERDEEN/HOQUIAM)	ACME	ARLINGTON	BREMERTON (SHELTON)	CASTLE ROCK	WALLA WALLA
2016	349,810	95,986	253,825	41,080	5,481	97	5,387	34,675	153	17,211
2017	353,593	97,332	256,261	41,670	5,526	99	5,458	35,171	155	17,390
2018	357,287	98,675	258,612	42,287	5,563	100	5,531	35,646	157	17,560
2019	360,988	99,974	261,014	42,877	5,603	102	5,601	36,120	159	17,722
2020	364,703	101,307	263,396	43,494	5,643	103	5,674	36,594	161	17,895
2021	368,457	102,672	265,785	44,138	5,681	104	5,744	37,069	163	18,057
2022	372,183	104,031	268,152	44,782	5,718	106	5,814	37,543	165	18,213
2023	375,973	105,390	270,584	45,426	5,754	107	5,883	38,016	166	18,373
2024	379,776	106,778	272,998	46,096	5,790	109	5,953	38,513	168	18,538
2025	383,594	108,168	275,426	46,767	5,826	110	6,022	38,987	170	18,693

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CityGate Peak Demand Day Forecast

Forecast Tim	Peak Day Demand (Dtl	OR Peak Day (Dth)	WA Peak Day (Dth)	Bend Loop	MCCLEARY (ABERDEEN/HOQUIAM)	ACME	ARLINGTON	BREMERTON (SHELTON)	CASTLE ROCK	WALLA WALLA
2016	365,474	96,274	269,201	41,080	5,481	108	5,955	34,675	153	17,333
2017	369,388	97,622	271,766	41,670	5,526	110	6,033	35,171	155	17,514
2018	373,207	98,966	274,241	42,287	5,563	112	6,115	35,646	157	17,684
2019	377,039	100,266	276,772	42,877	5,603	113	6,192	36,120	159	17,847
2020	380,882	101,600	279,282	43,494	5,643	115	6,272	36,594	161	18,022
2021	384,765	102,966	281,800	44,138	5,681	116	6,349	37,069	163	18,185
2022	388,620	104,326	284,294	44,782	5,718	118	6,427	37,543	165	18,342
2023	392,544	105,685	286,858	45,426	5,754	120	6,504	38,016	166	18,503
2024	396,476	107,075	289,401	46,096	5,790	121	6,581	38,513	168	18,670
2025	400,427	108,466	291,961	46,767	5,826	123	6,657	38,987	170	18,825

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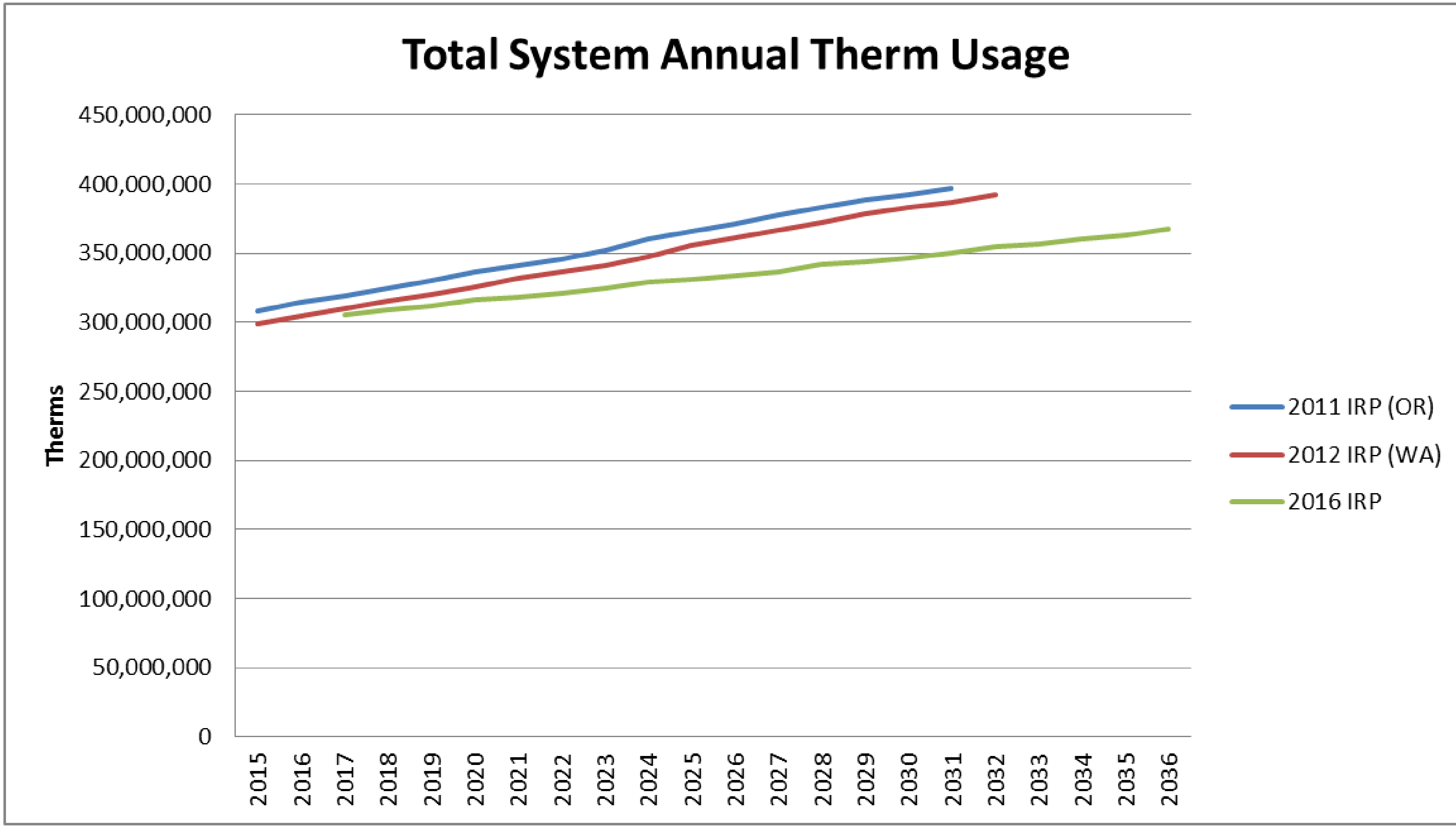
Total System



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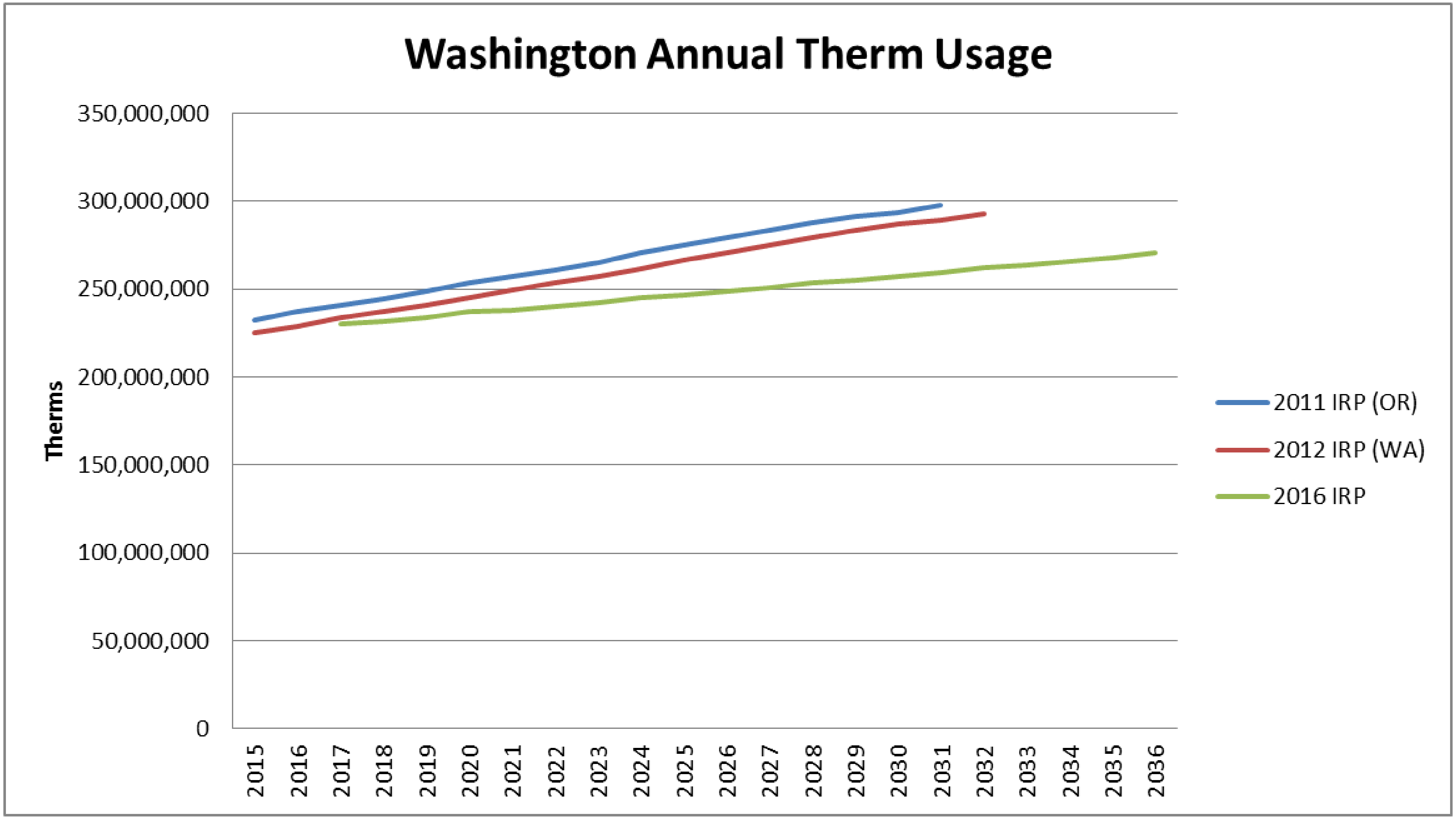
Washington



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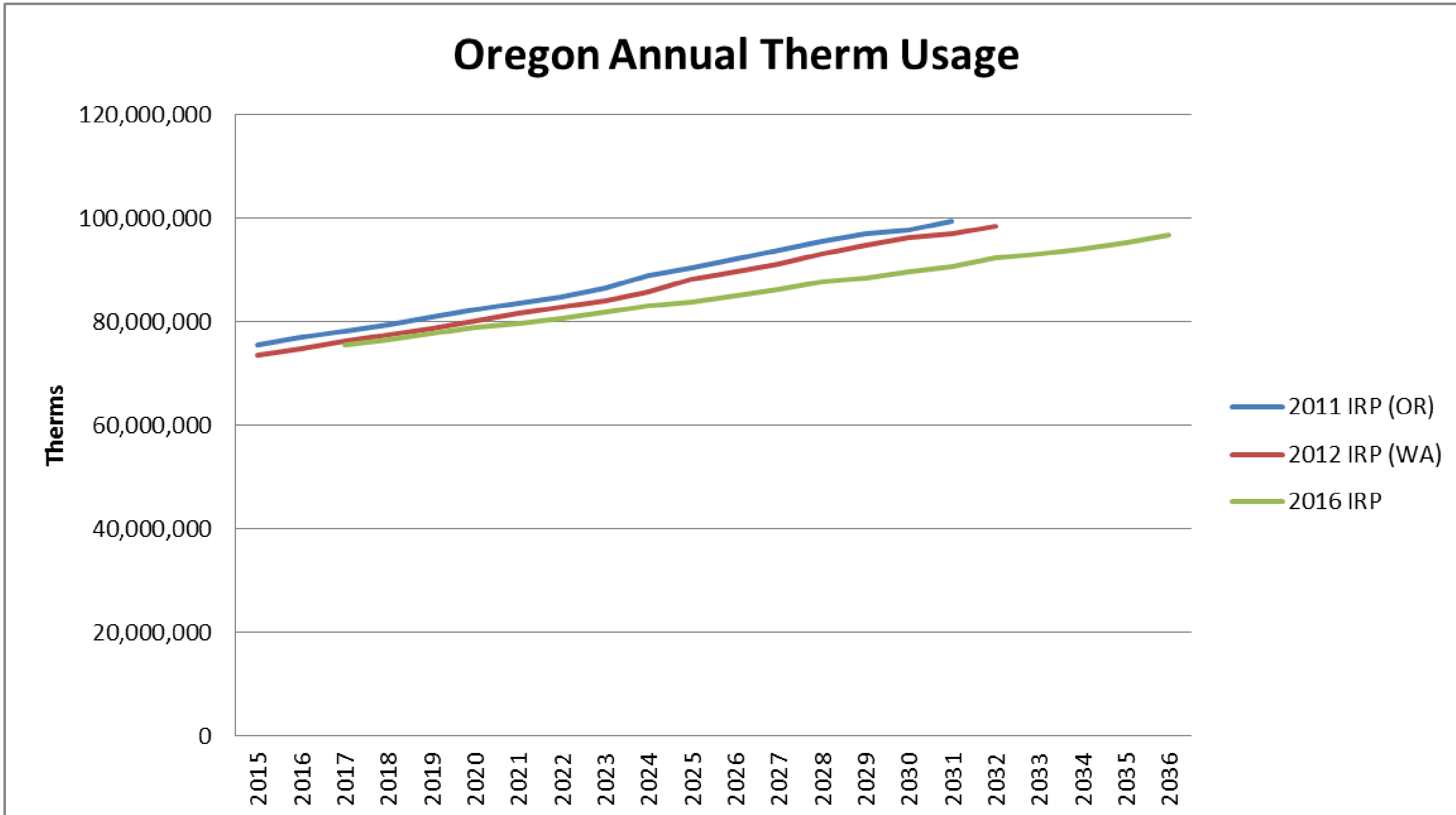
Oregon



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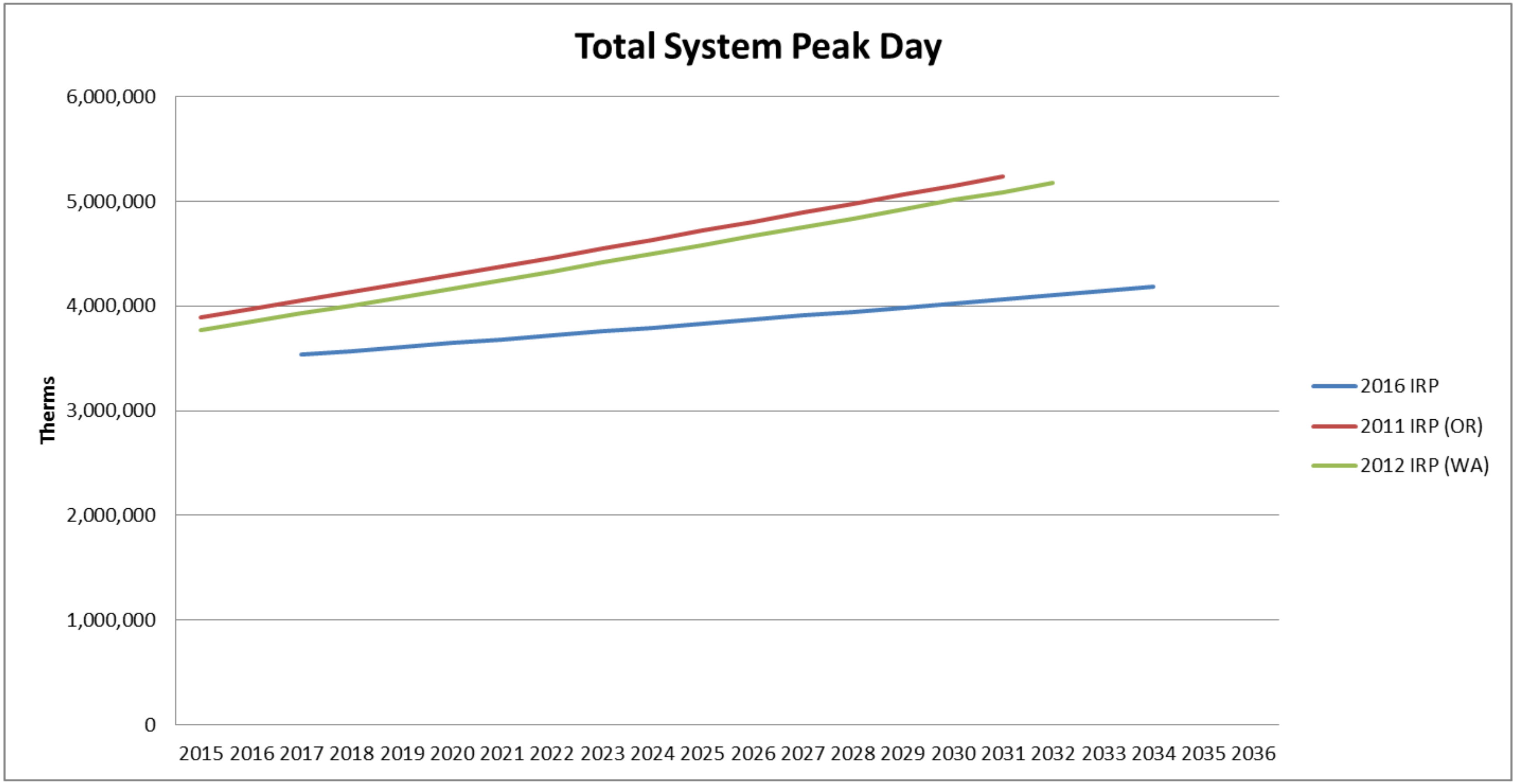
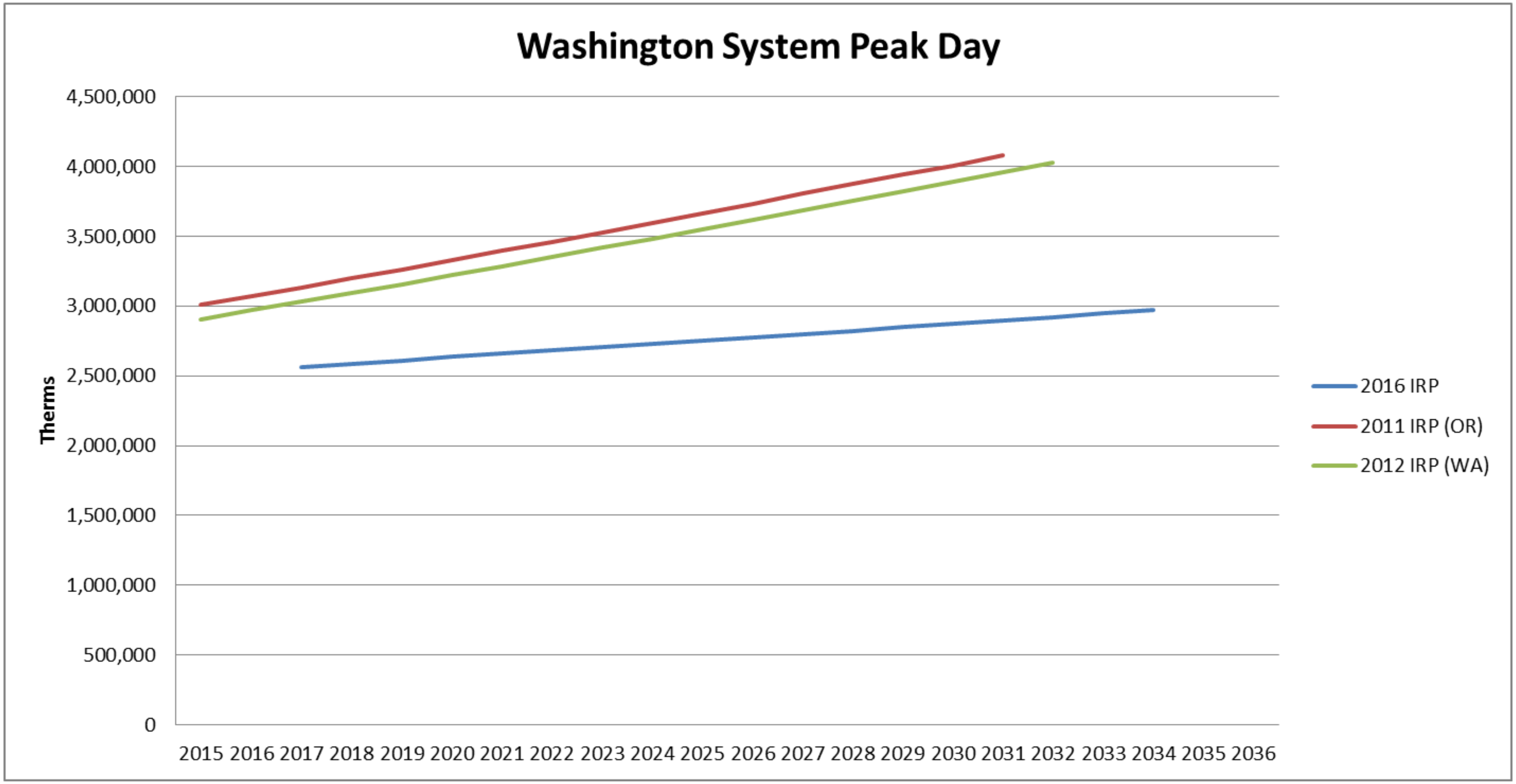
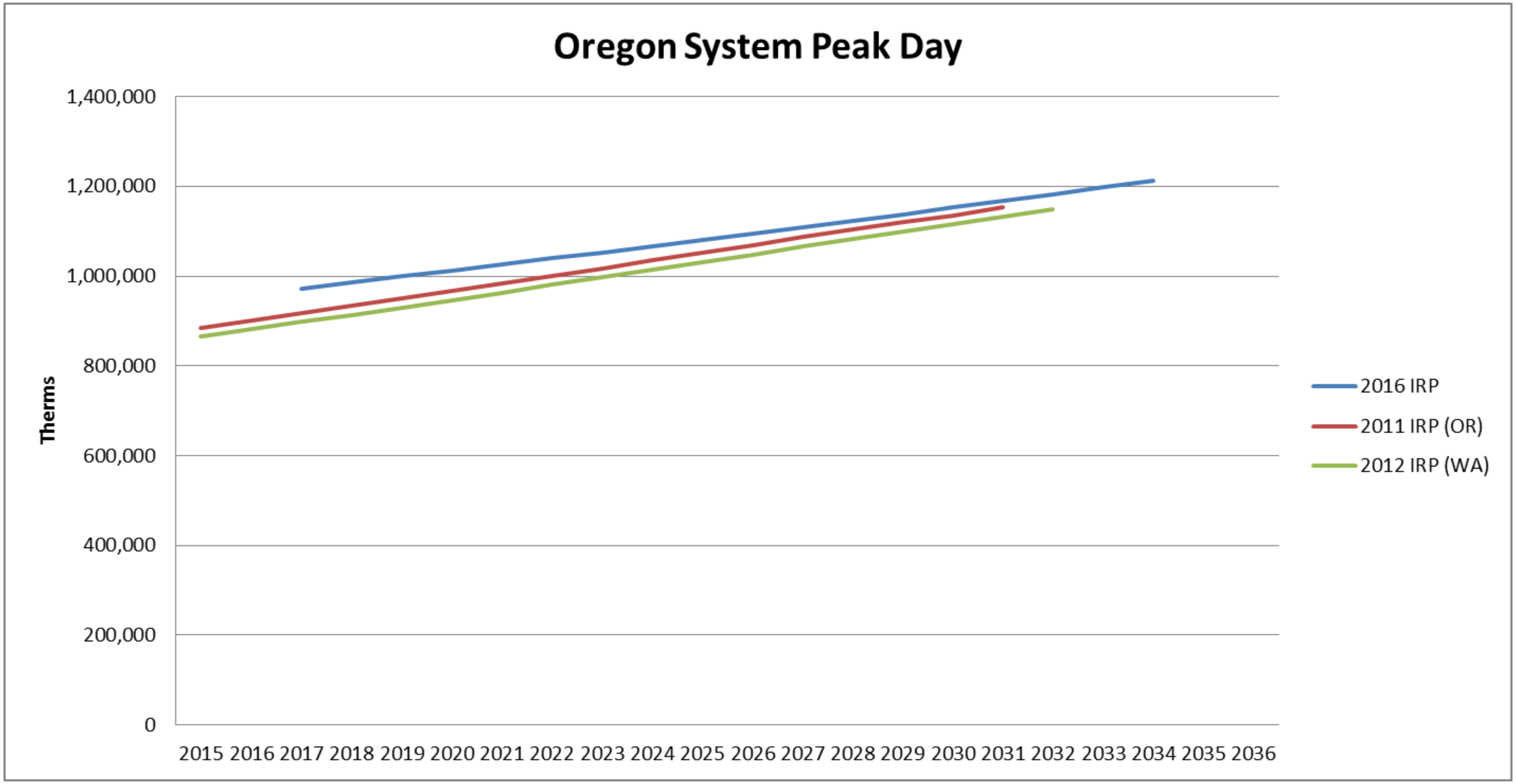
Total System Peak Day Comparison to previous IRP’s



Washington Peak Day Comparison to previous IRP's



Oregon Peak Day Comparison to previous IRP's



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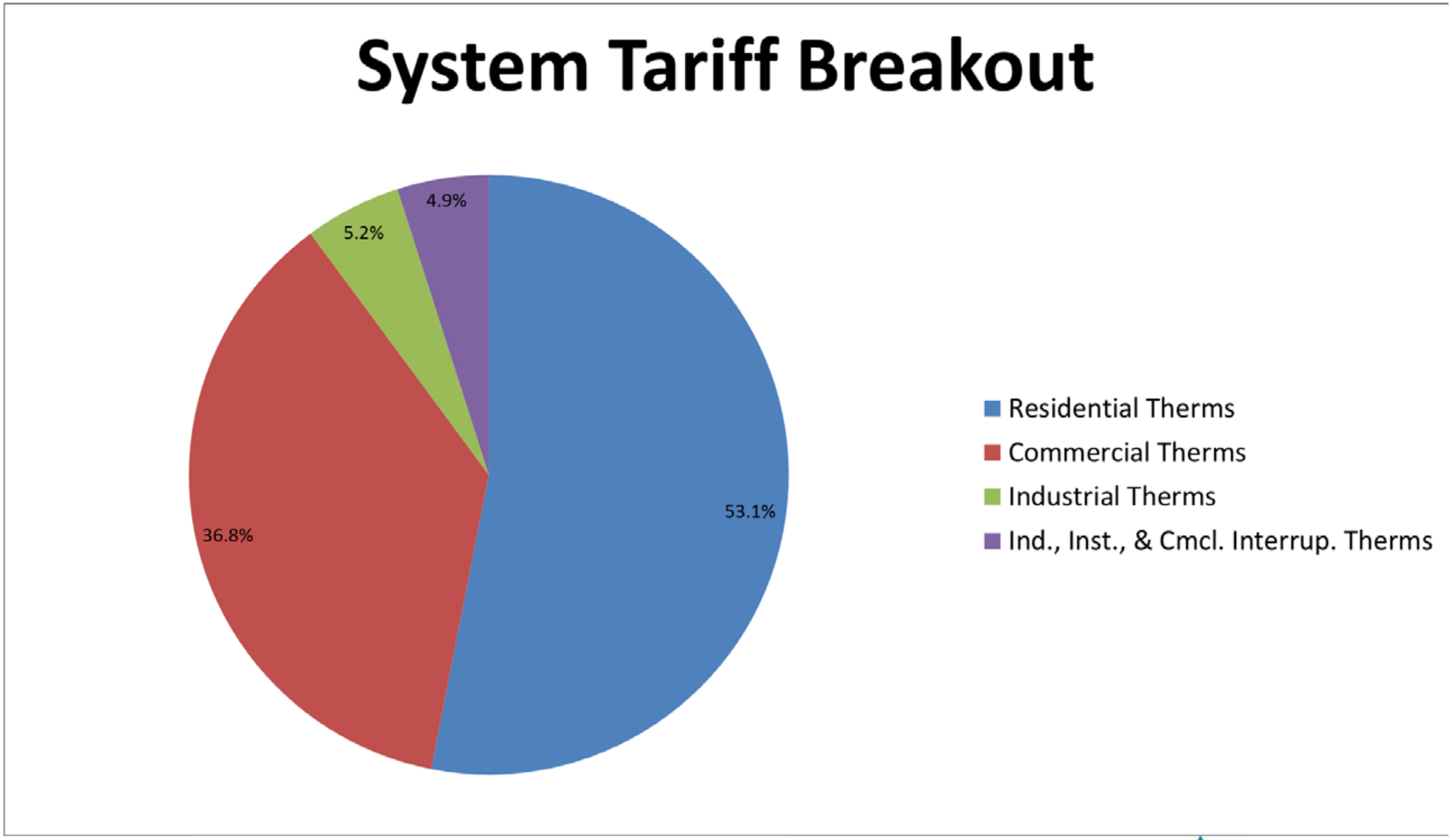
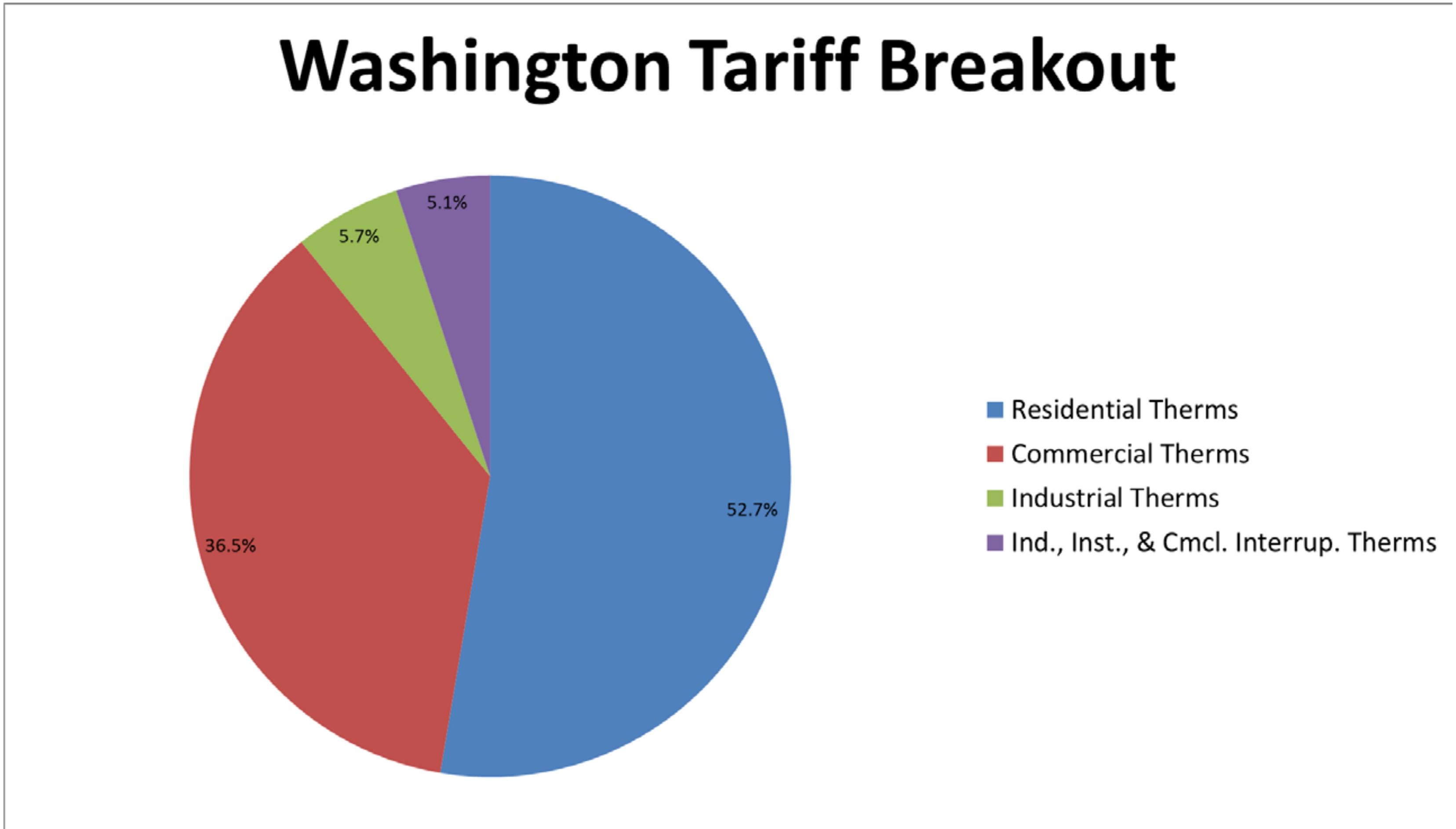
Total System Tariff Breakout



Washington Tariff Breakout



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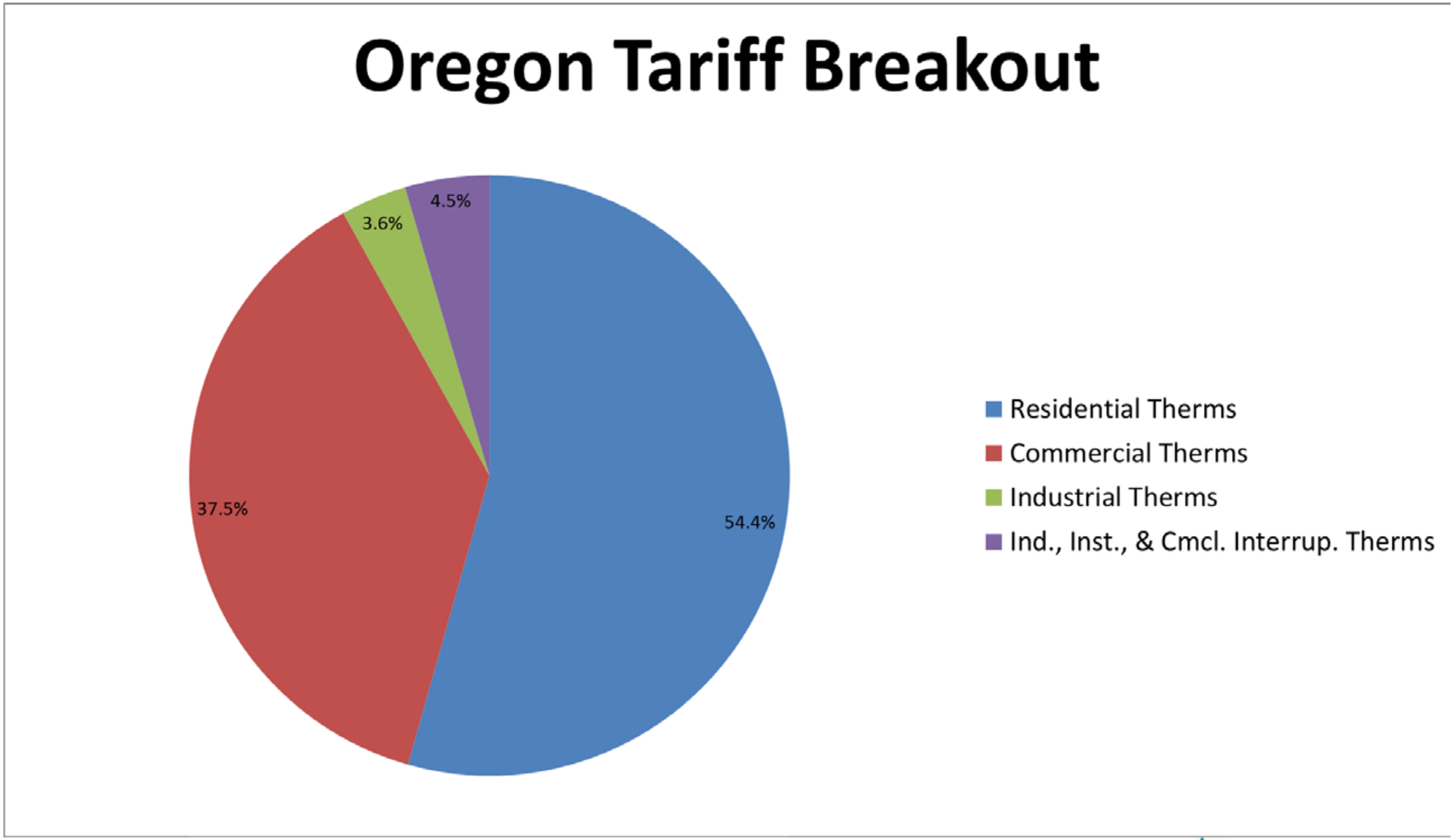
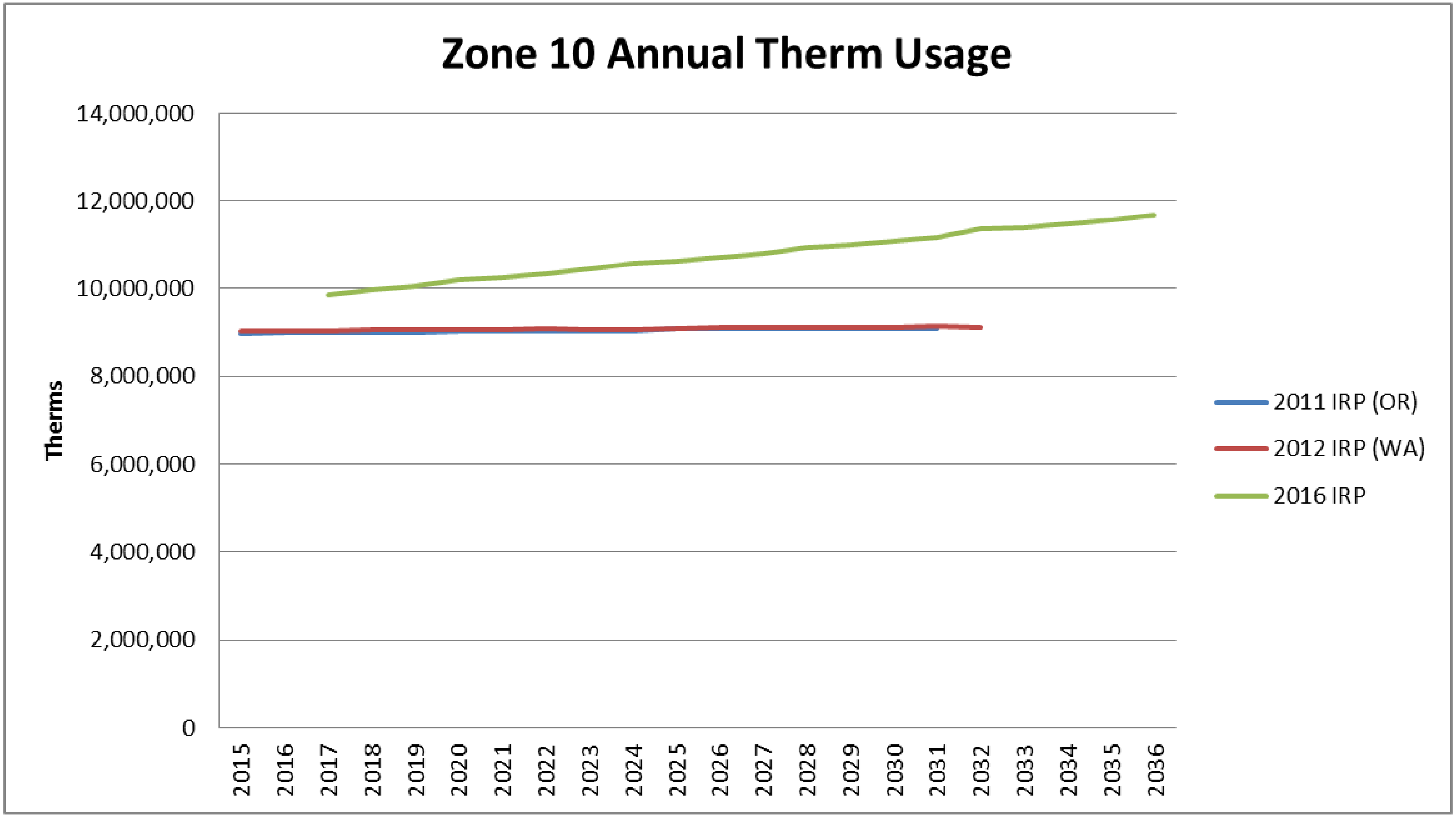
Oregon Tariff Breakout



Zone 10



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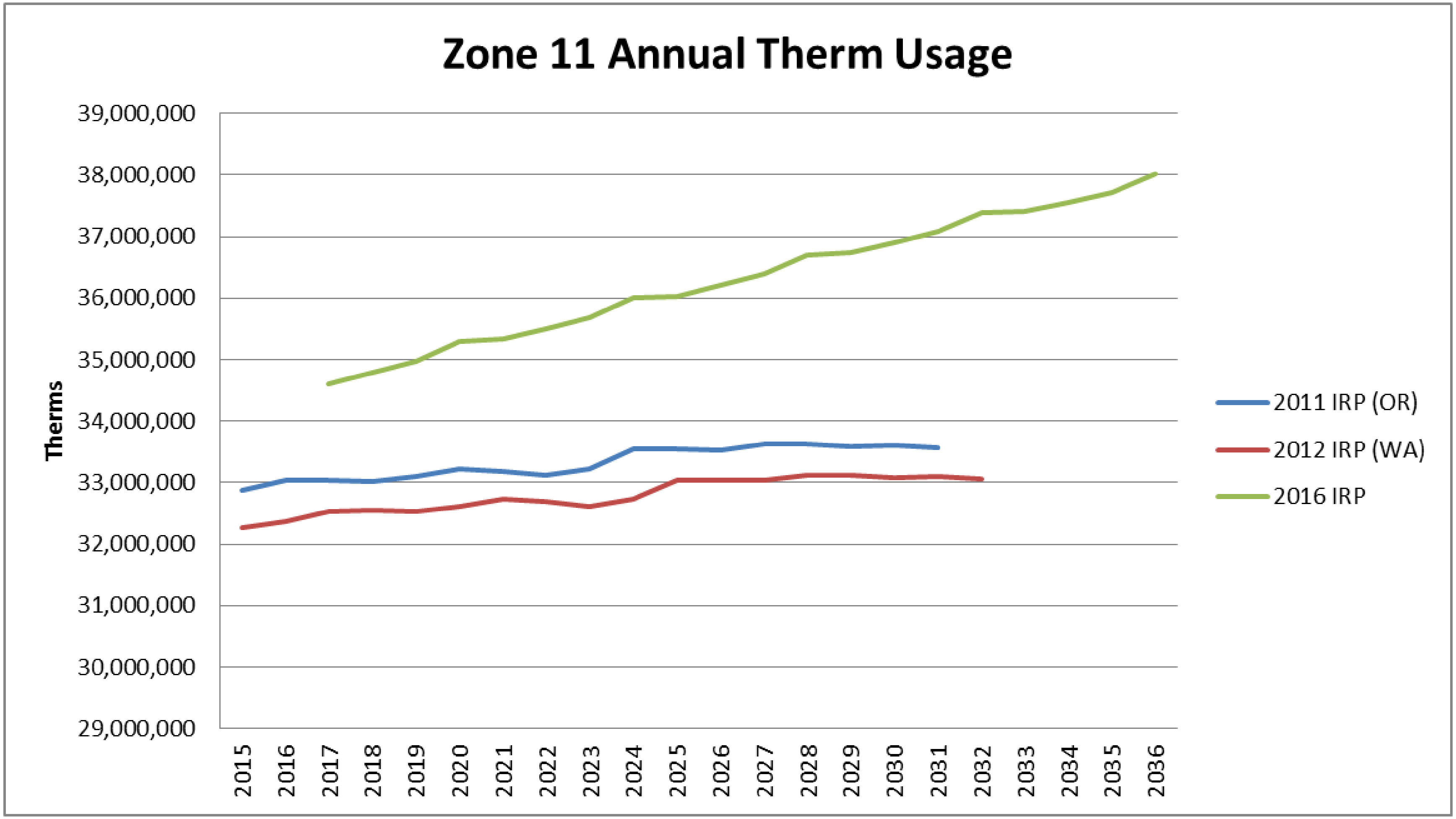
Zone 11



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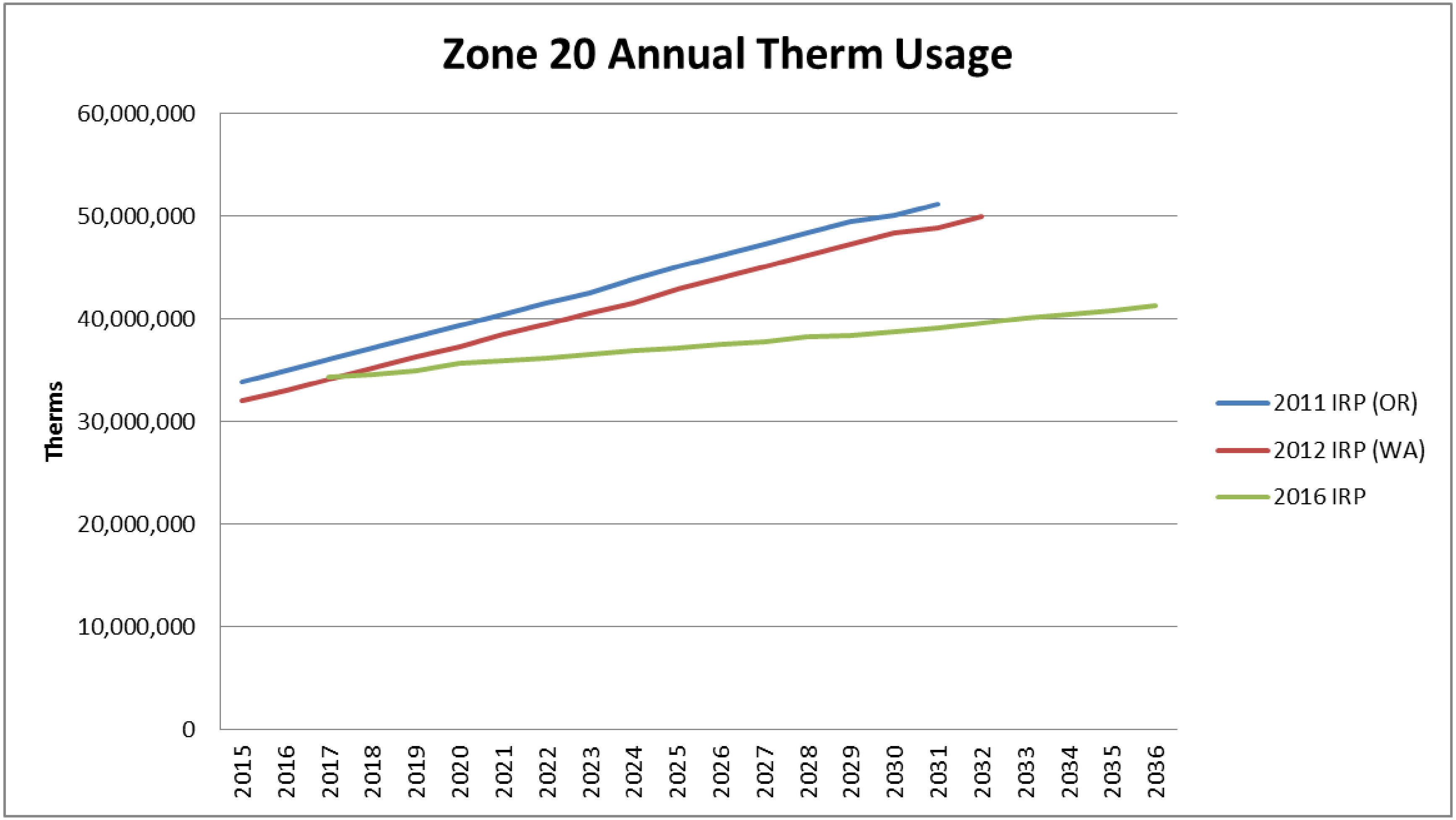
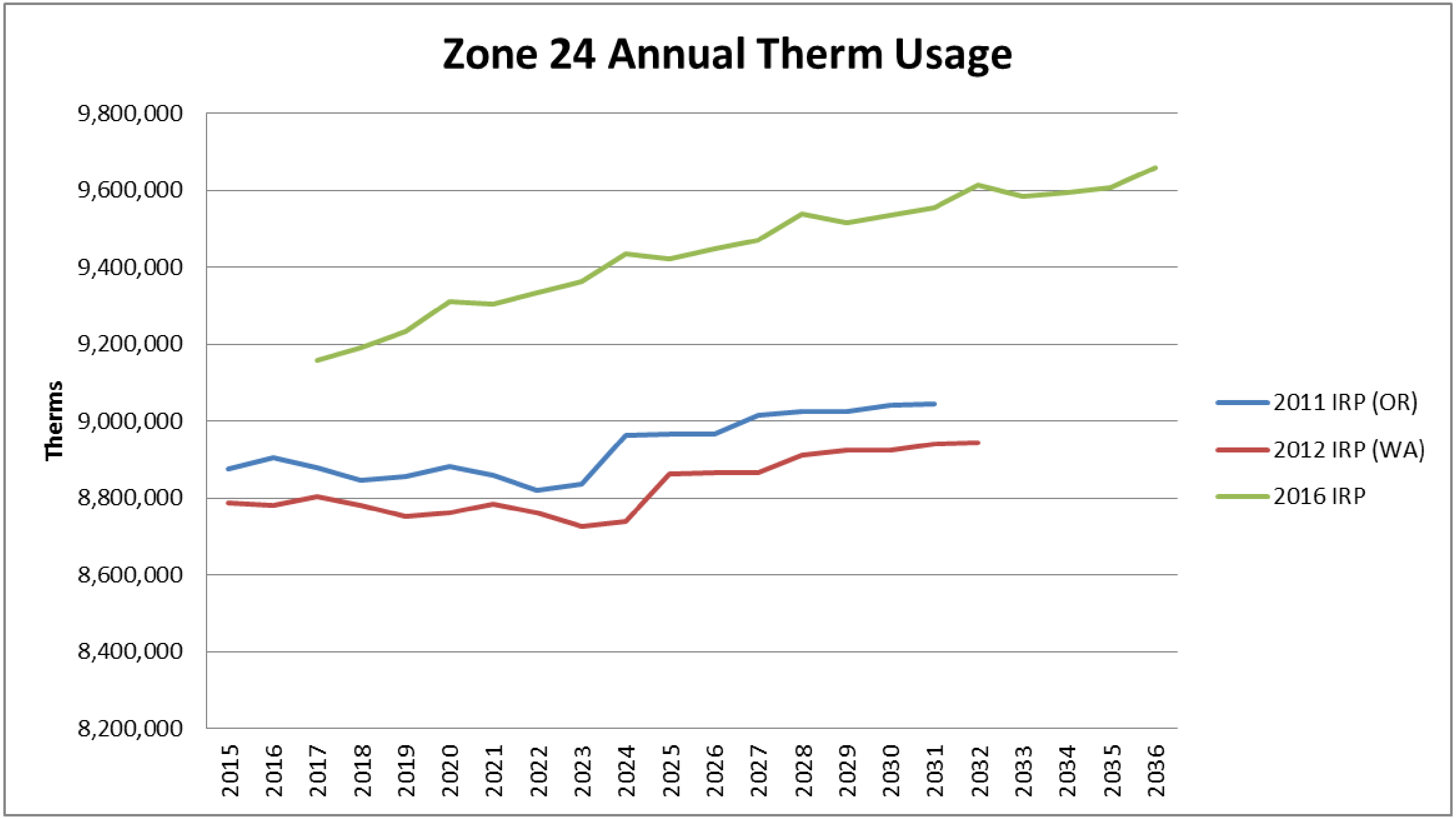
Zone 20


Zone 20 Annual Therm Usage
Therms
60,000,000
50,000,000
40,000,000
30,000,000
20,000,000
10,000,000
0
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2011 IRP (OR)
2012 IRP (WA)
2016 IRP

Zone 24


Zone 24 Annual Therm Usage
Therms
9,800,000
9,600,000
9,400,000
9,200,000
9,000,000
8,800,000
8,600,000
8,400,000
8,200,000
2015
2016
2017
2018
2019
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2021
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2023
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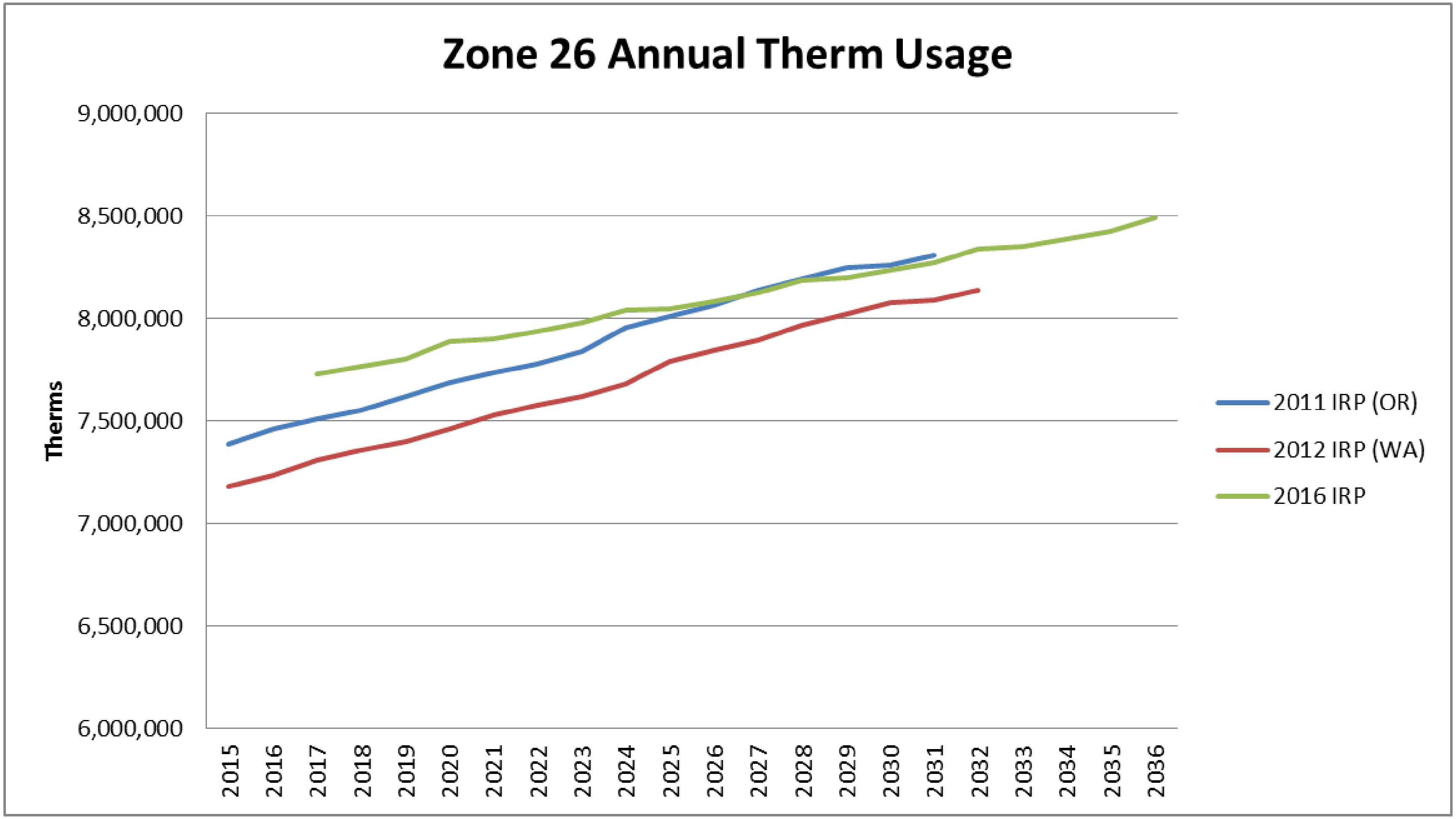
2034
2035
2036
2011 IRP (OR)
2012 IRP (WA)
2016 IRP

Zone 26



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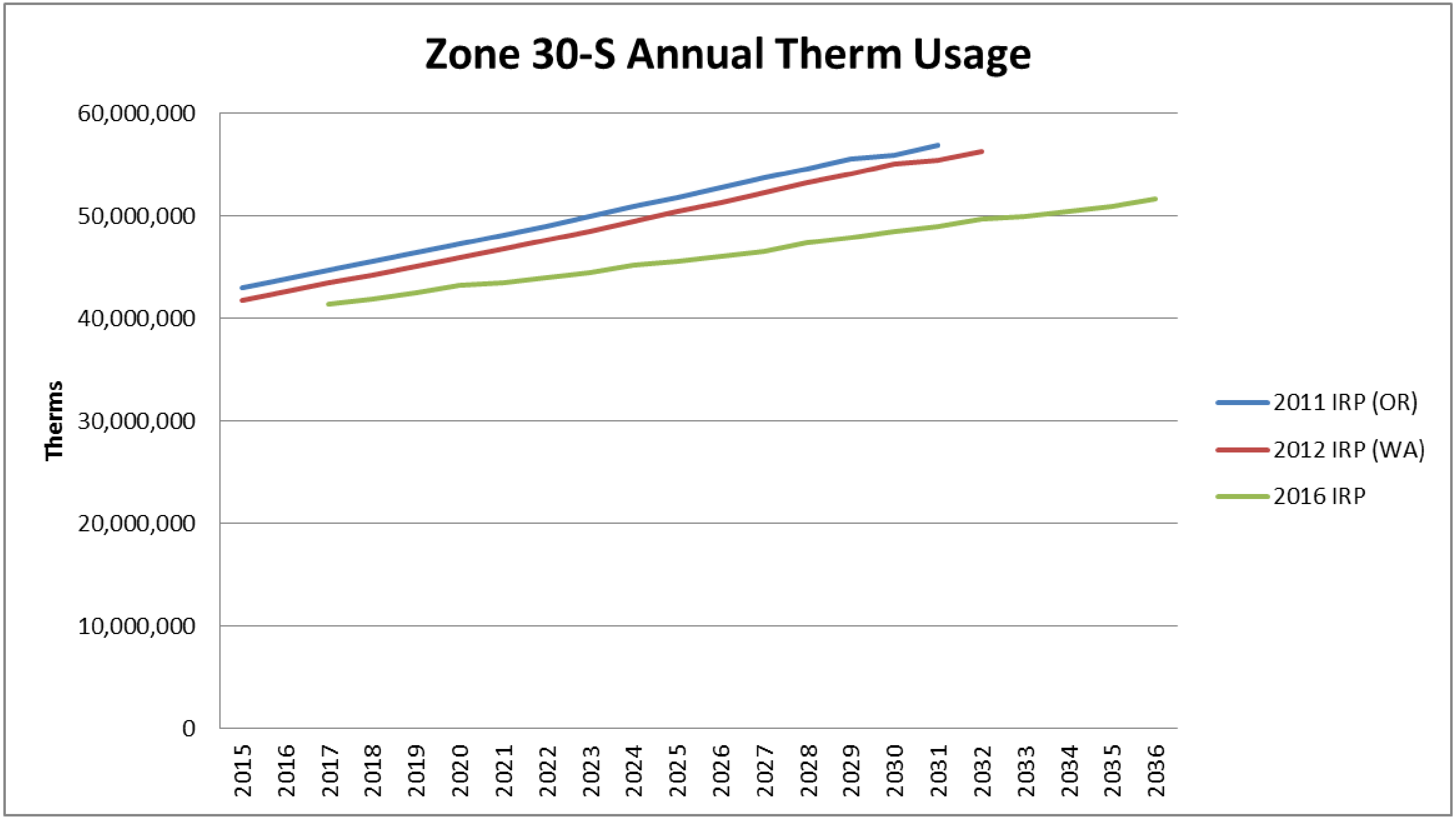
Zone 30-S


Zone 30-S Annual Therm Usage
Therms
60,000,000
50,000,000
40,000,000
30,000,000
20,000,000
10,000,000
0
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
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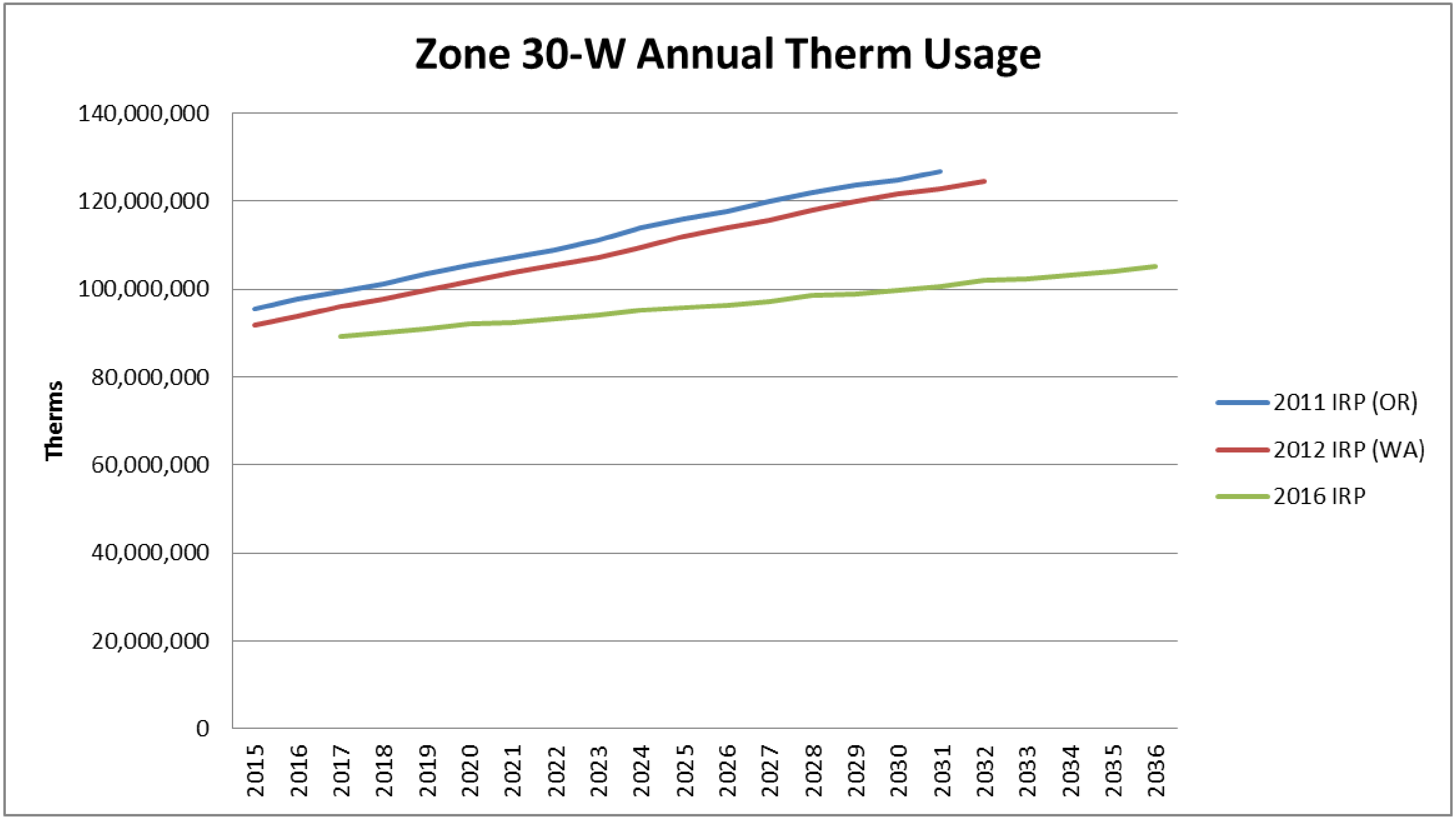
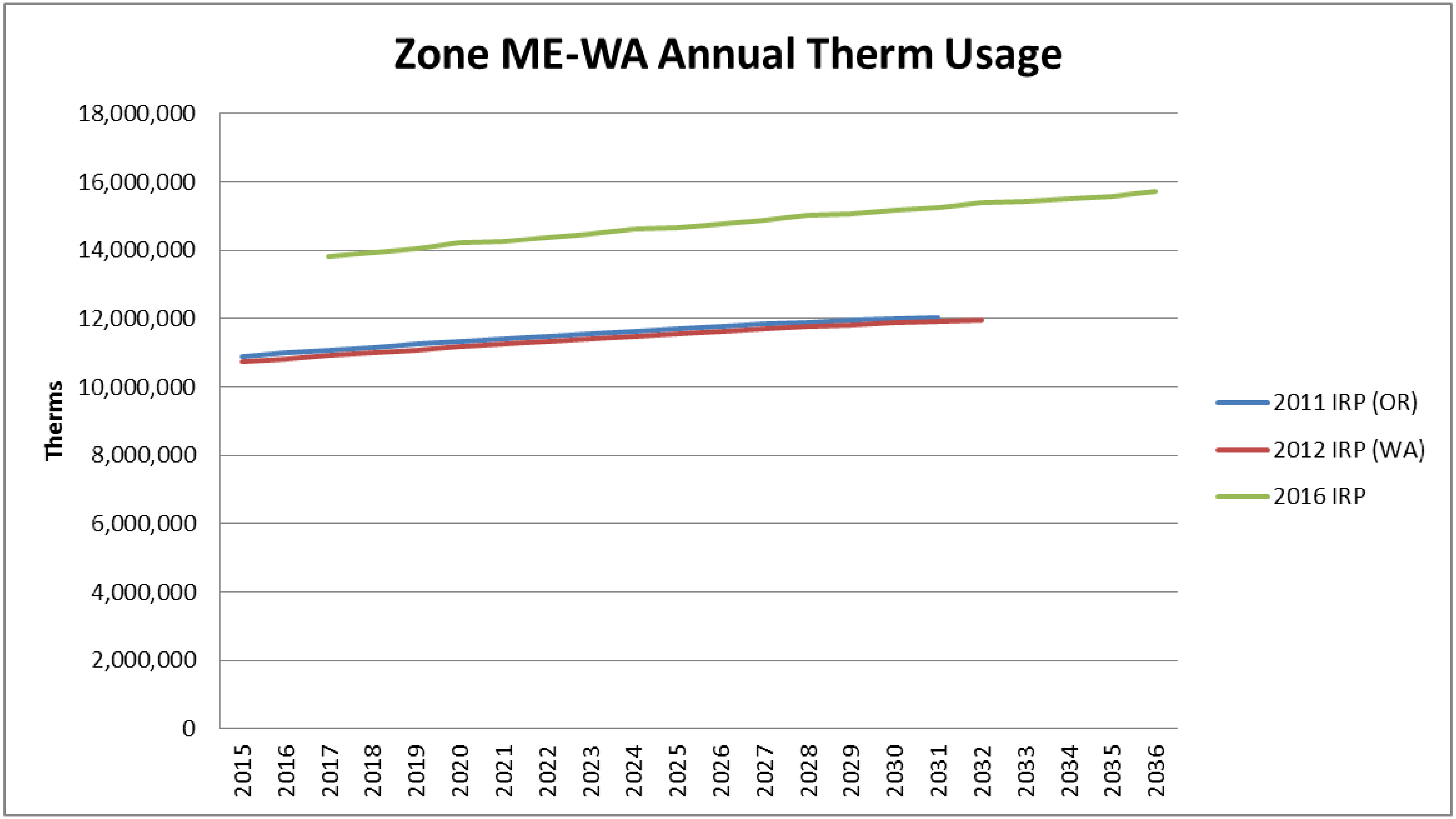
2031
2032
2033
2034
2035
2036
2011 IRP (OR)
2012 IRP (WA)
2016 IRP

Zone 30-W


Zone 30-W Annual Therm Usage
140,000,000
120,000,000
100,000,000
80,000,000
60,000,000
40,000,000
20,000,000
0
Therms
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2011 IRP (OR)
2012 IRP (WA)
2016 IRP

Zone ME-WA



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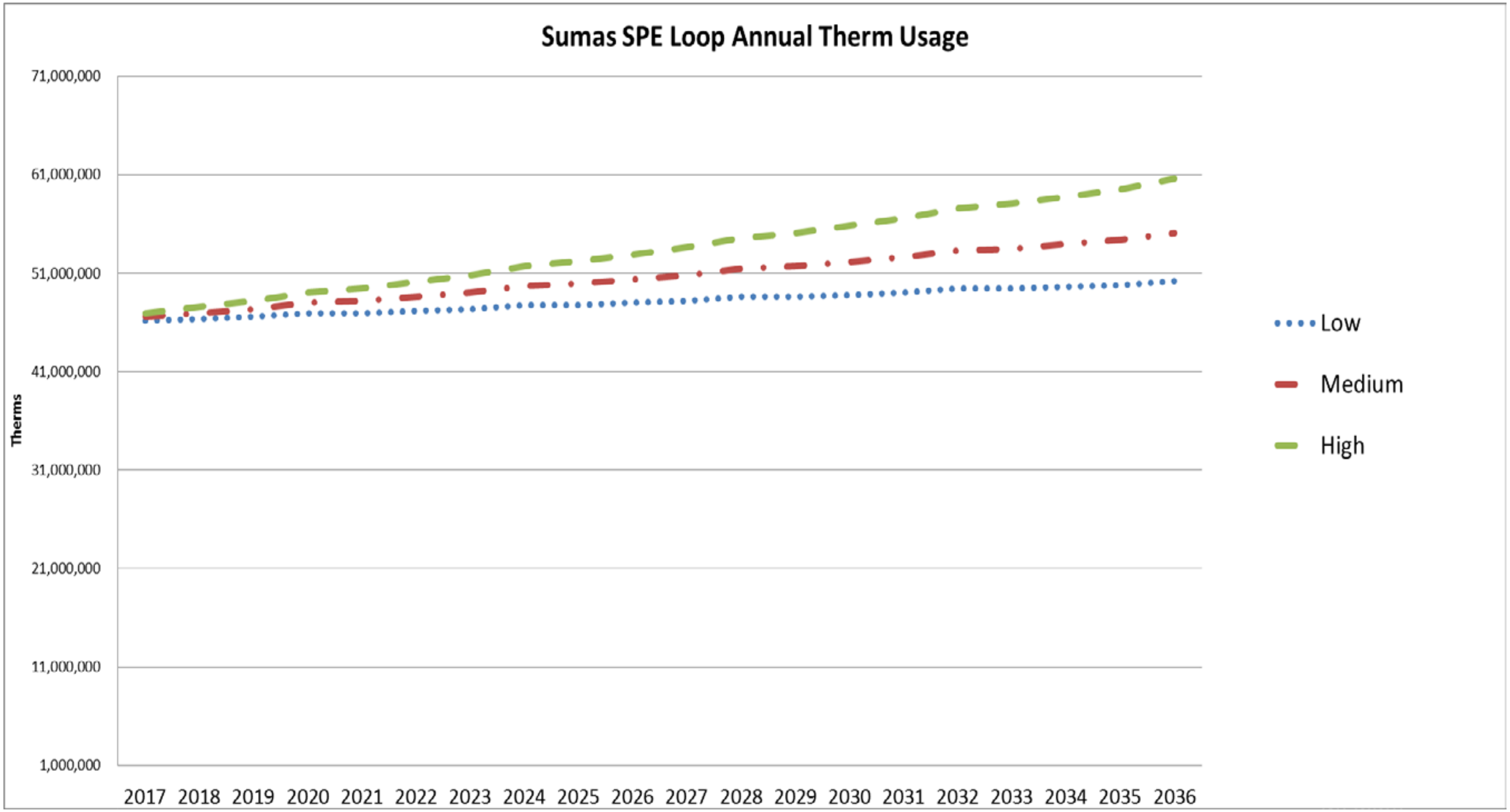
Sumas SPE Loop with Normal Weather



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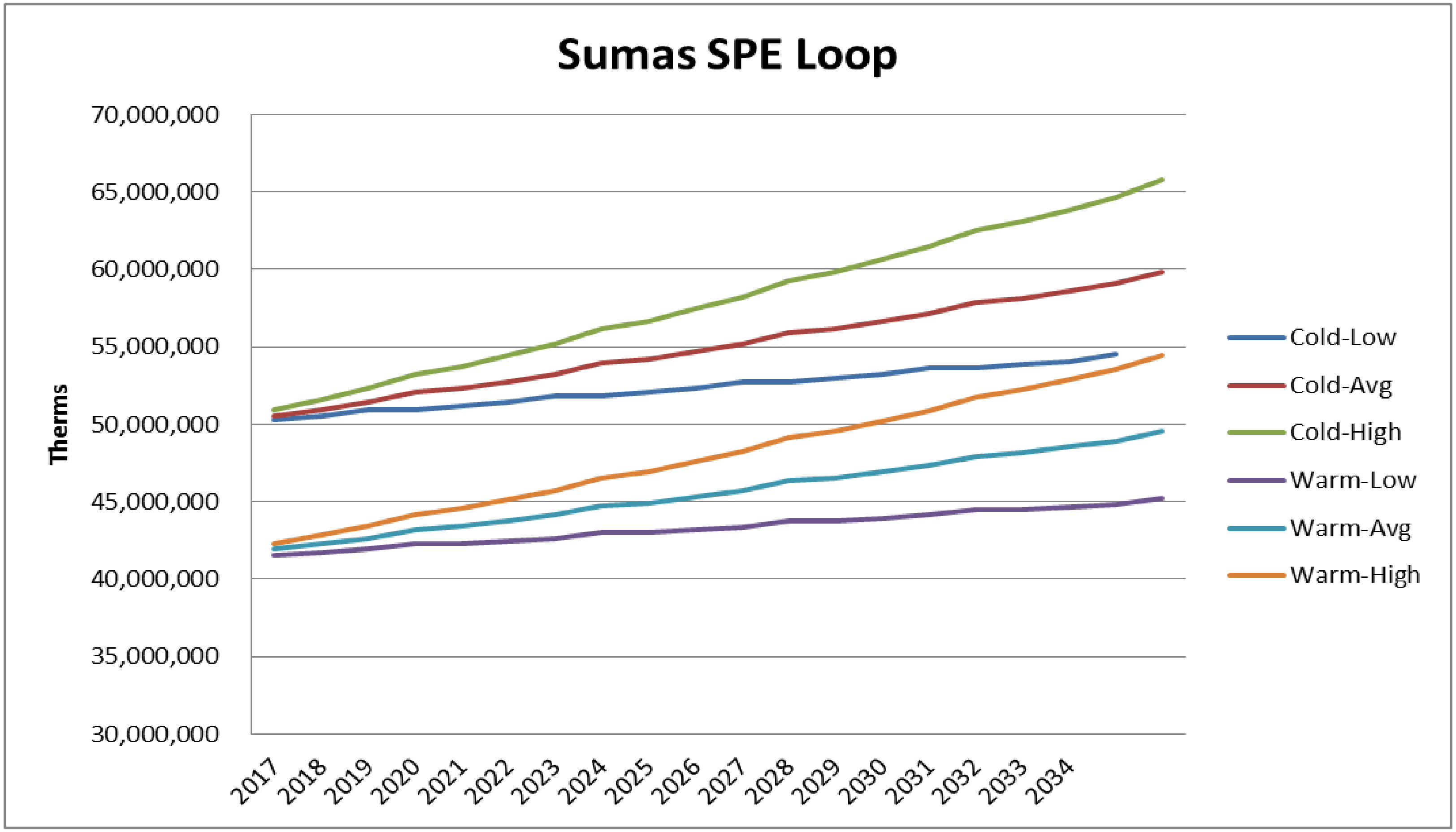
Sumas SPE Loop with High and Low Weather Scenarios



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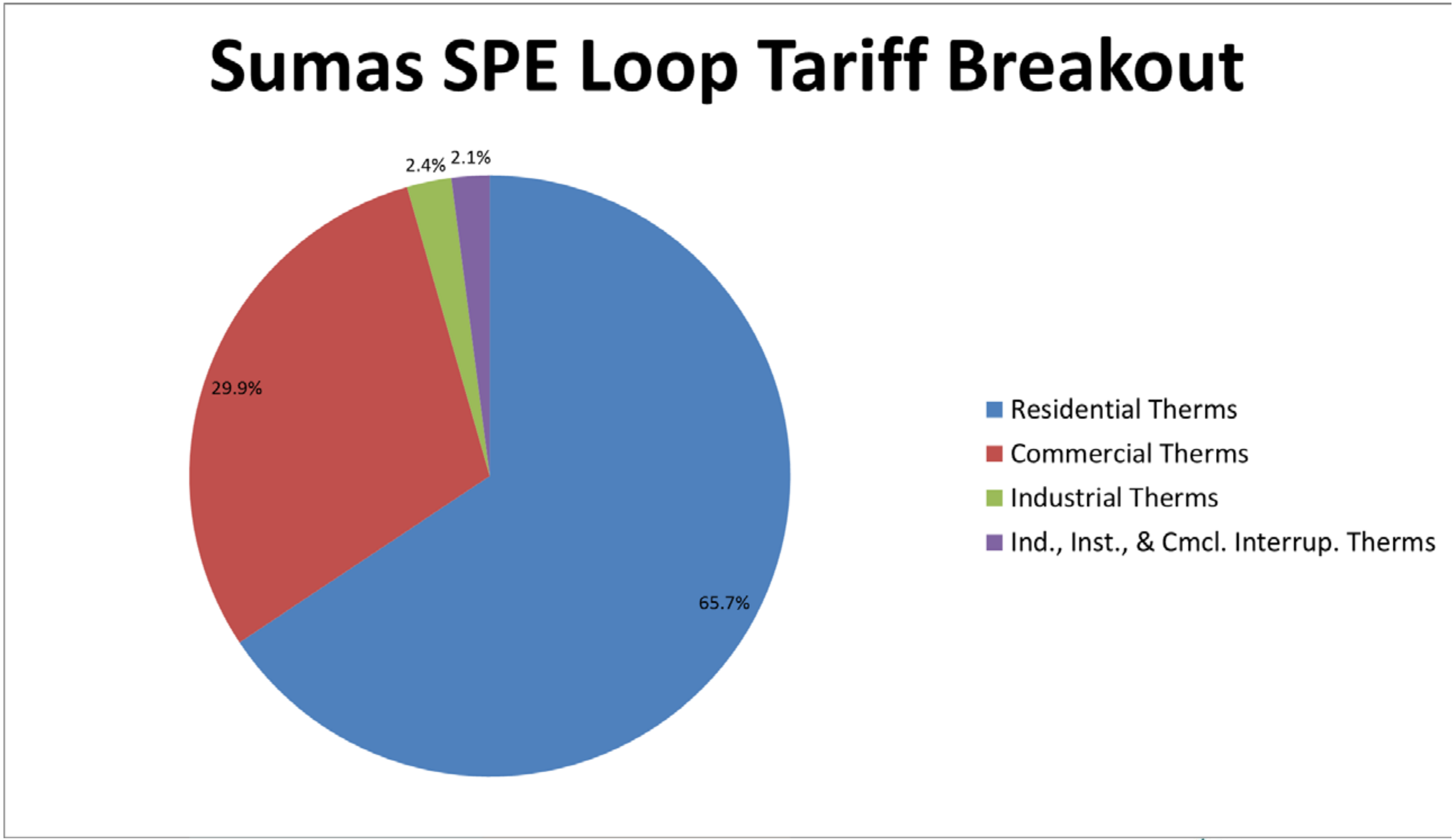
Tariff Breakout



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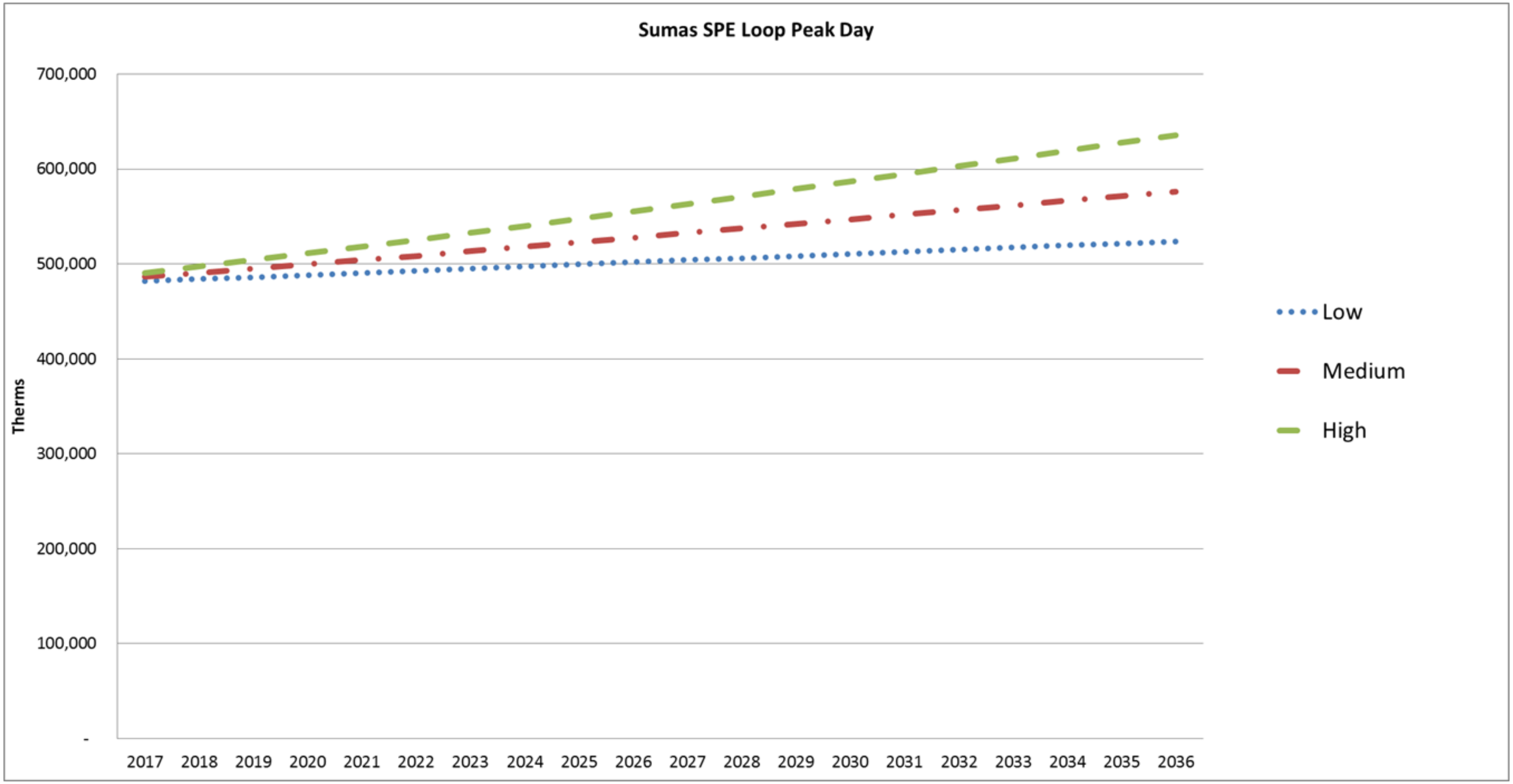
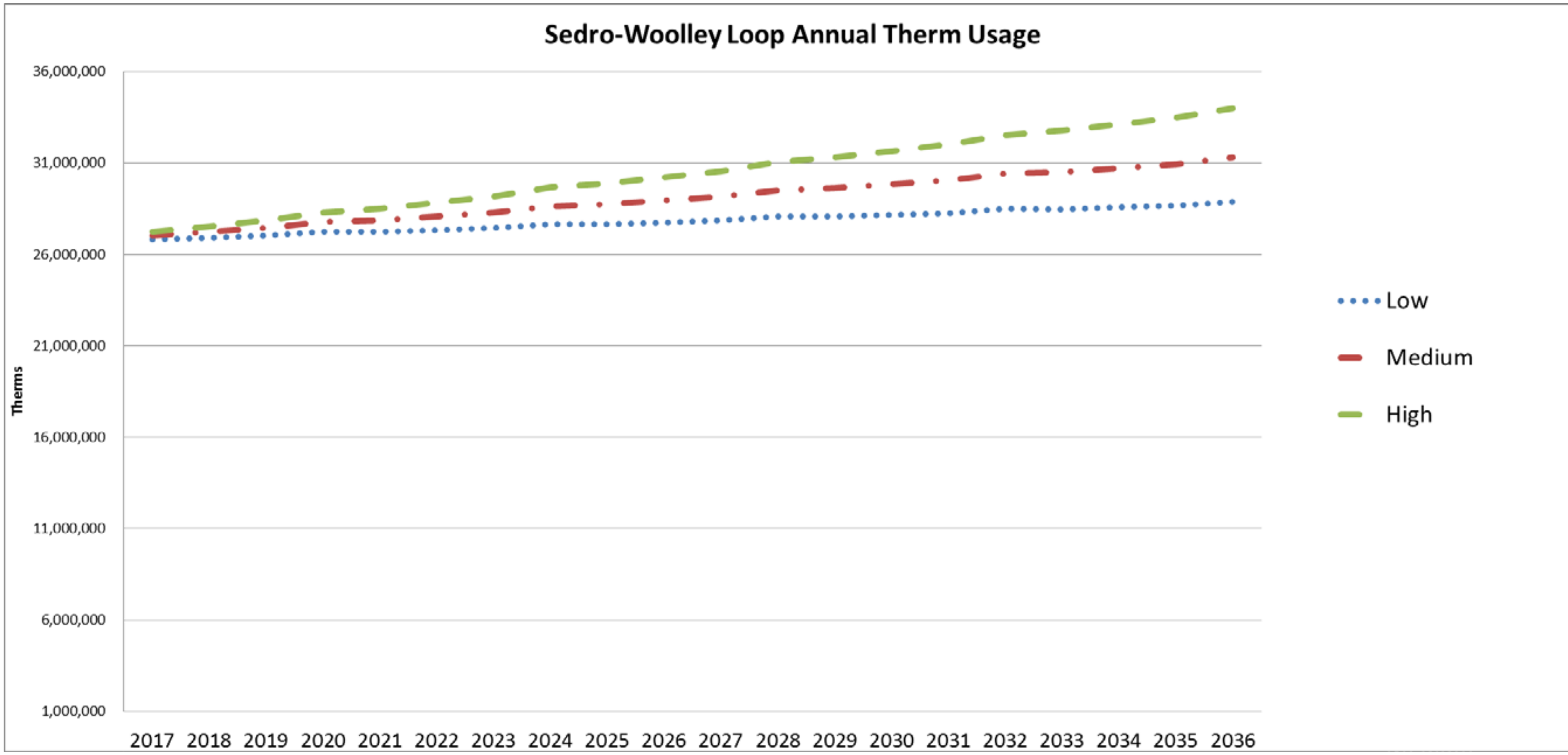
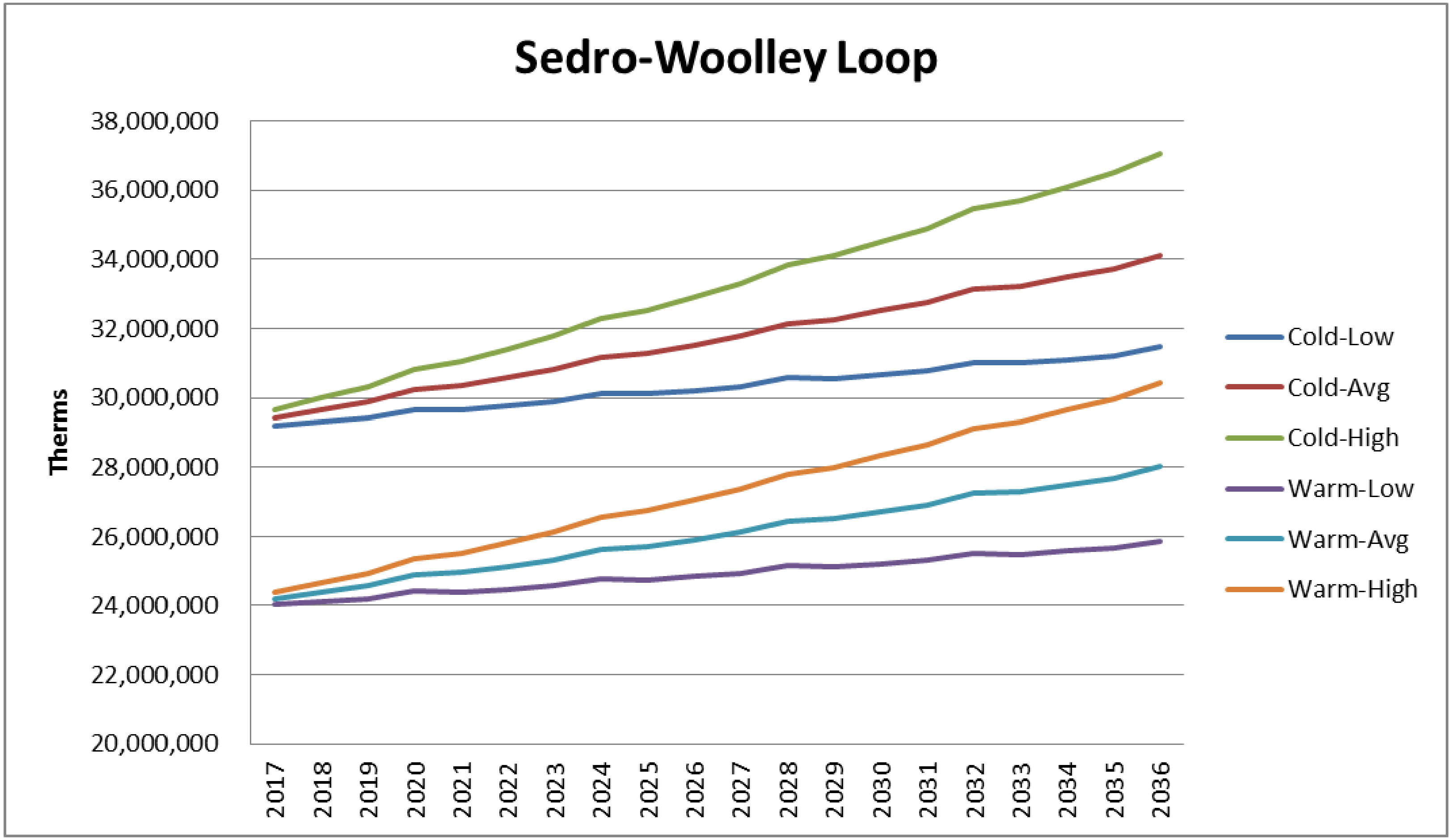
Sumas SPE Loop Peak Day



Sedro-Woolley Loop With Average Weather



Sedro-Woolley Loop with High and Low Weather Scenarios



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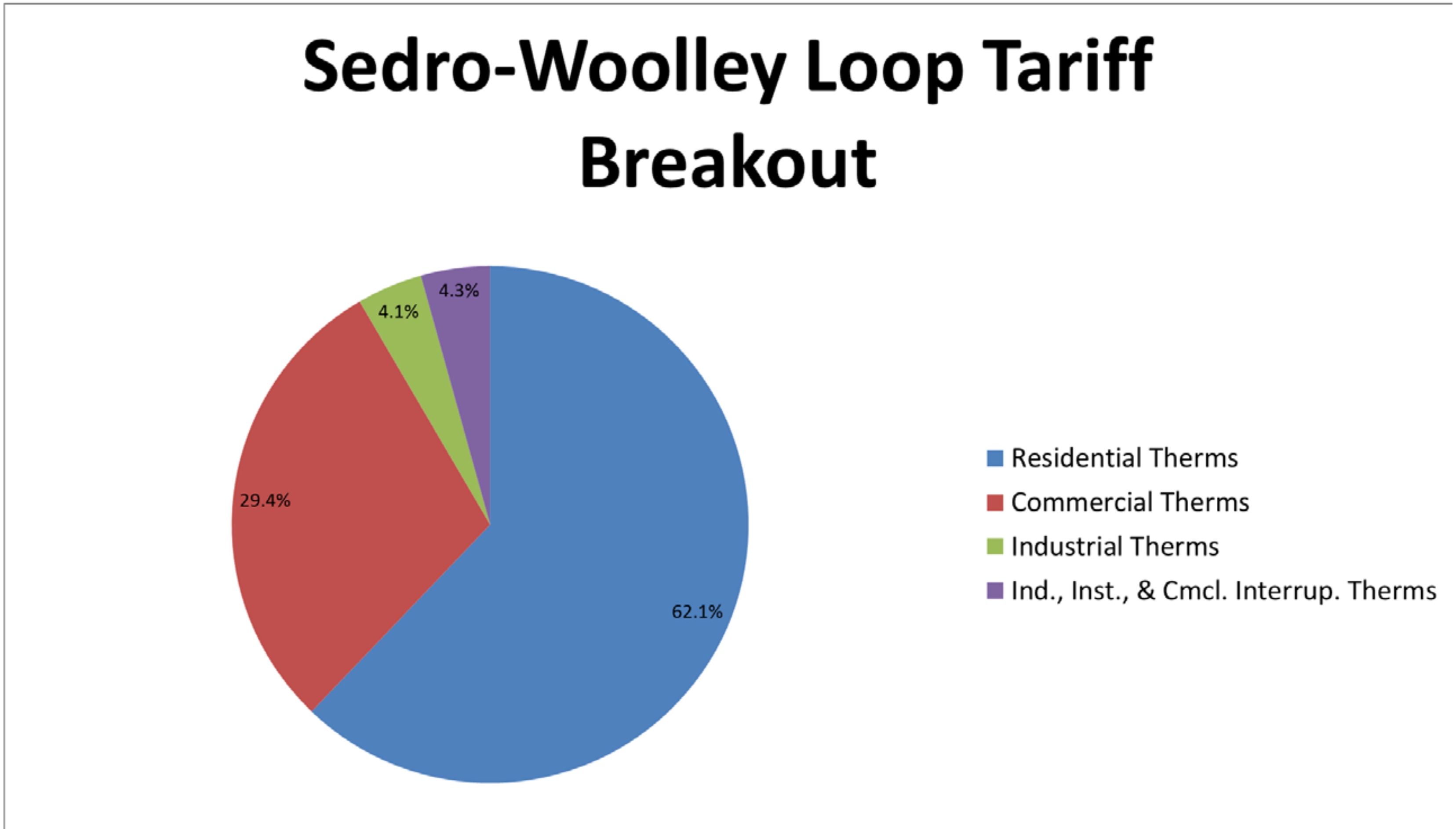
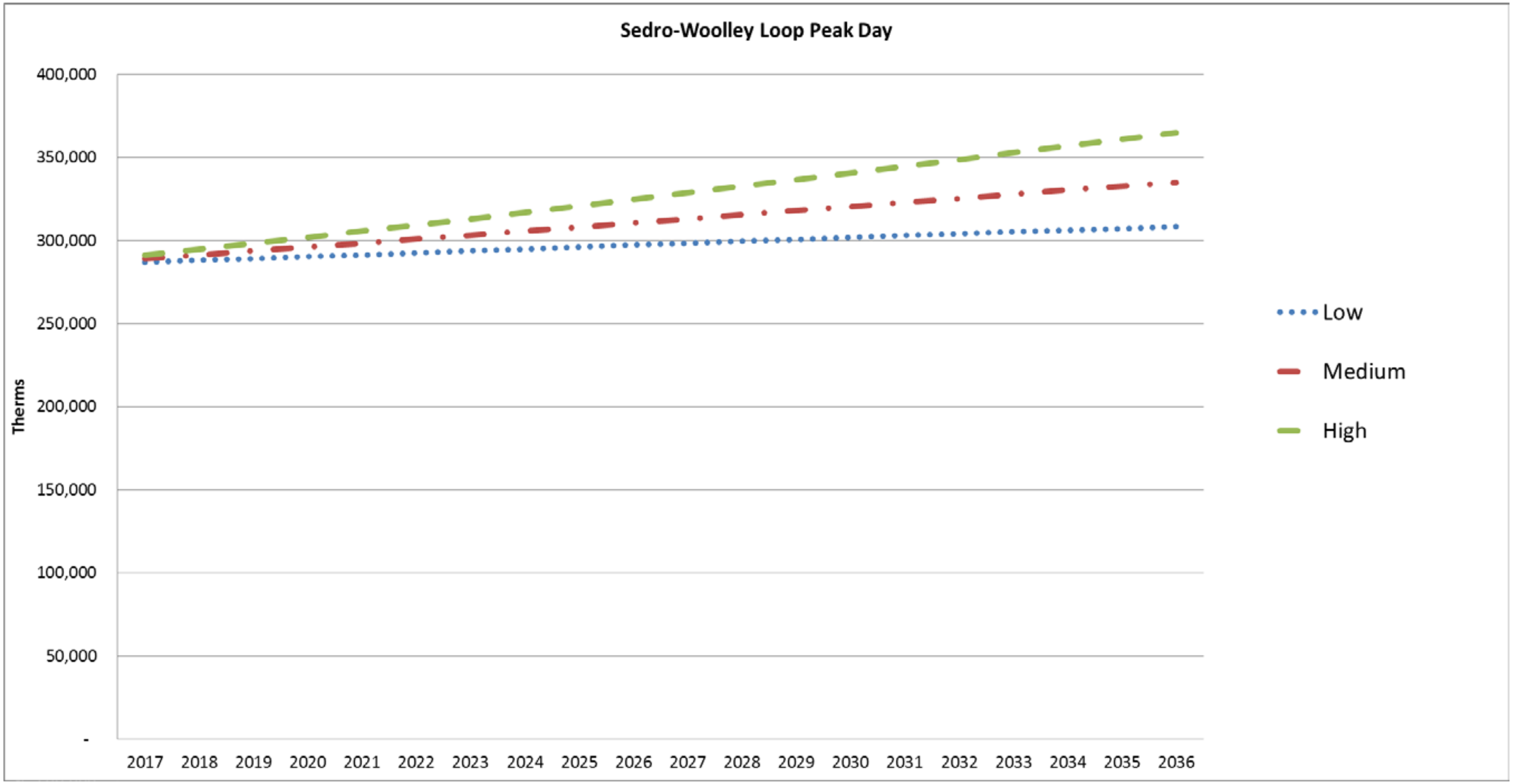
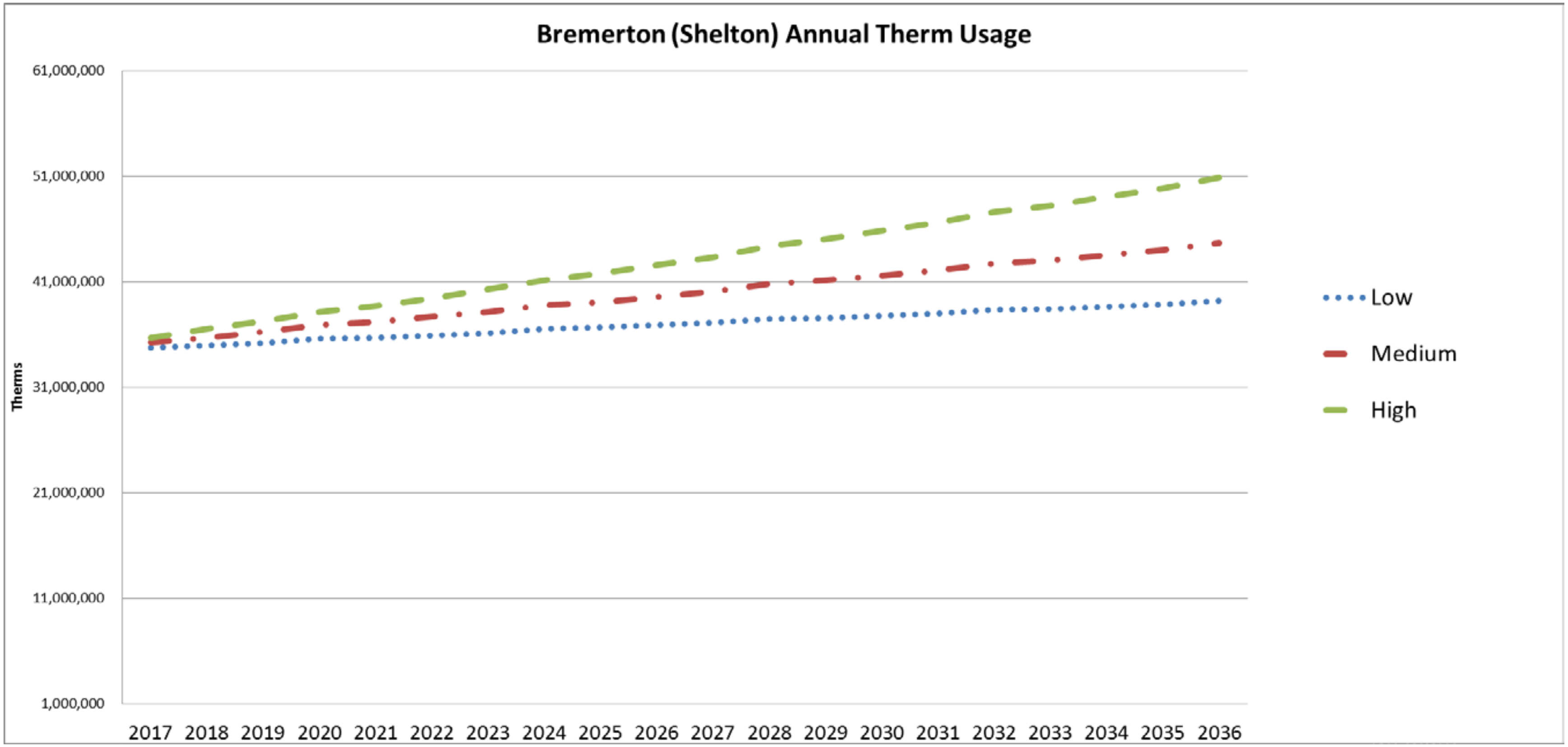
Tariff Breakout



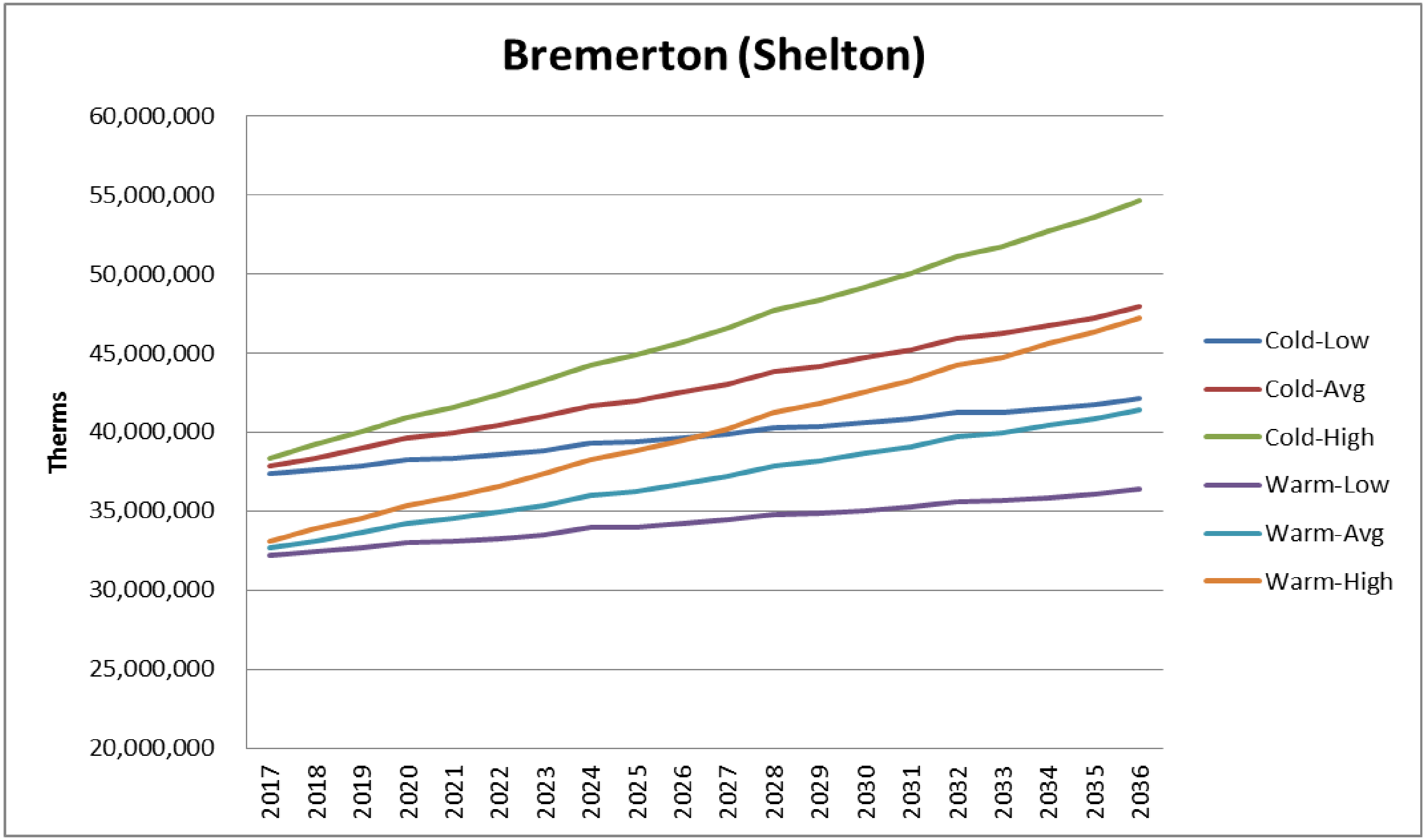
Sedro-Woolley Loop Peak Day



Bremerton (Shelton) With Average Weather



Bremerton (Shelton) with High and Low Weather Scenarios



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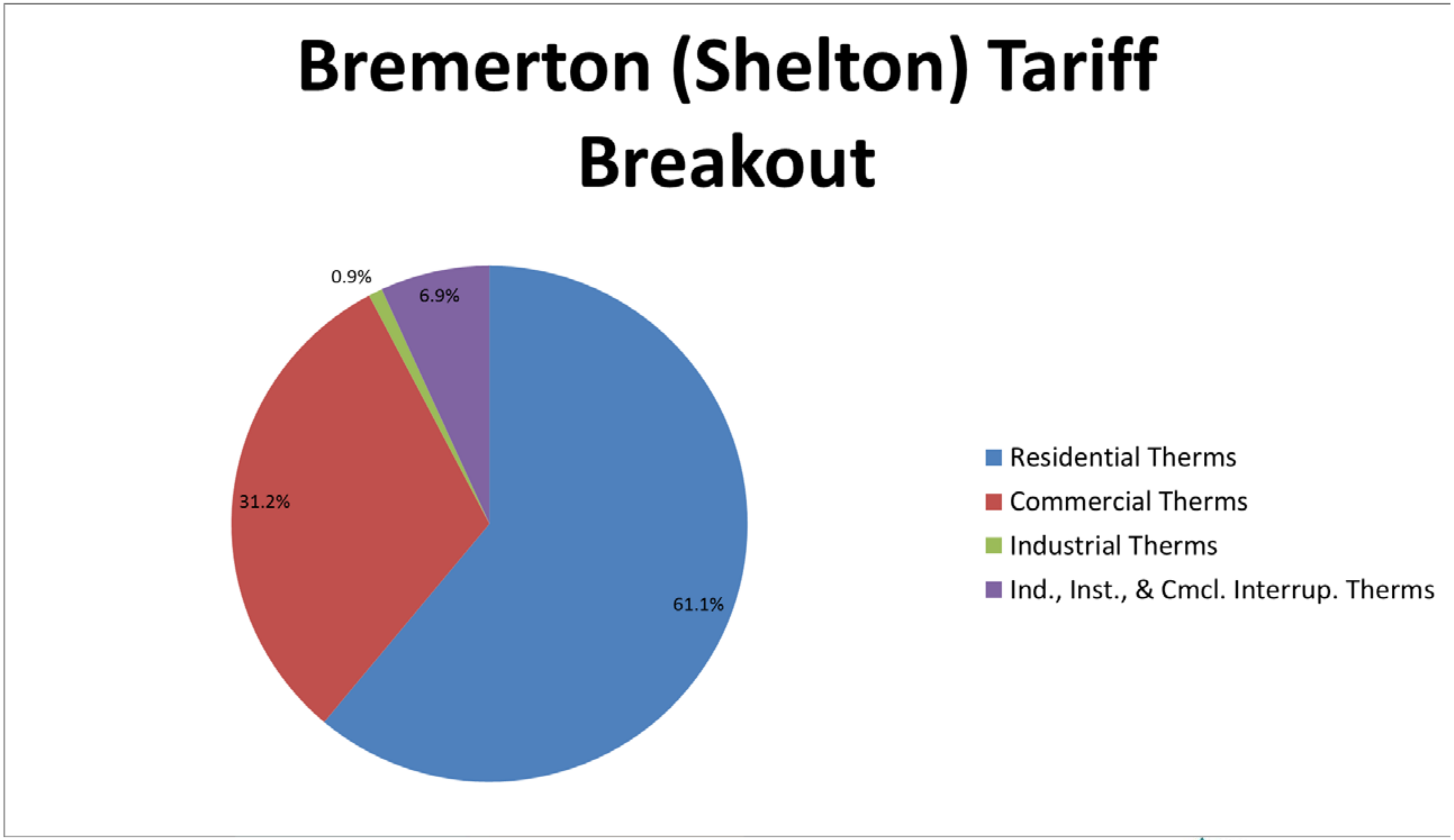
Tariff Breakout



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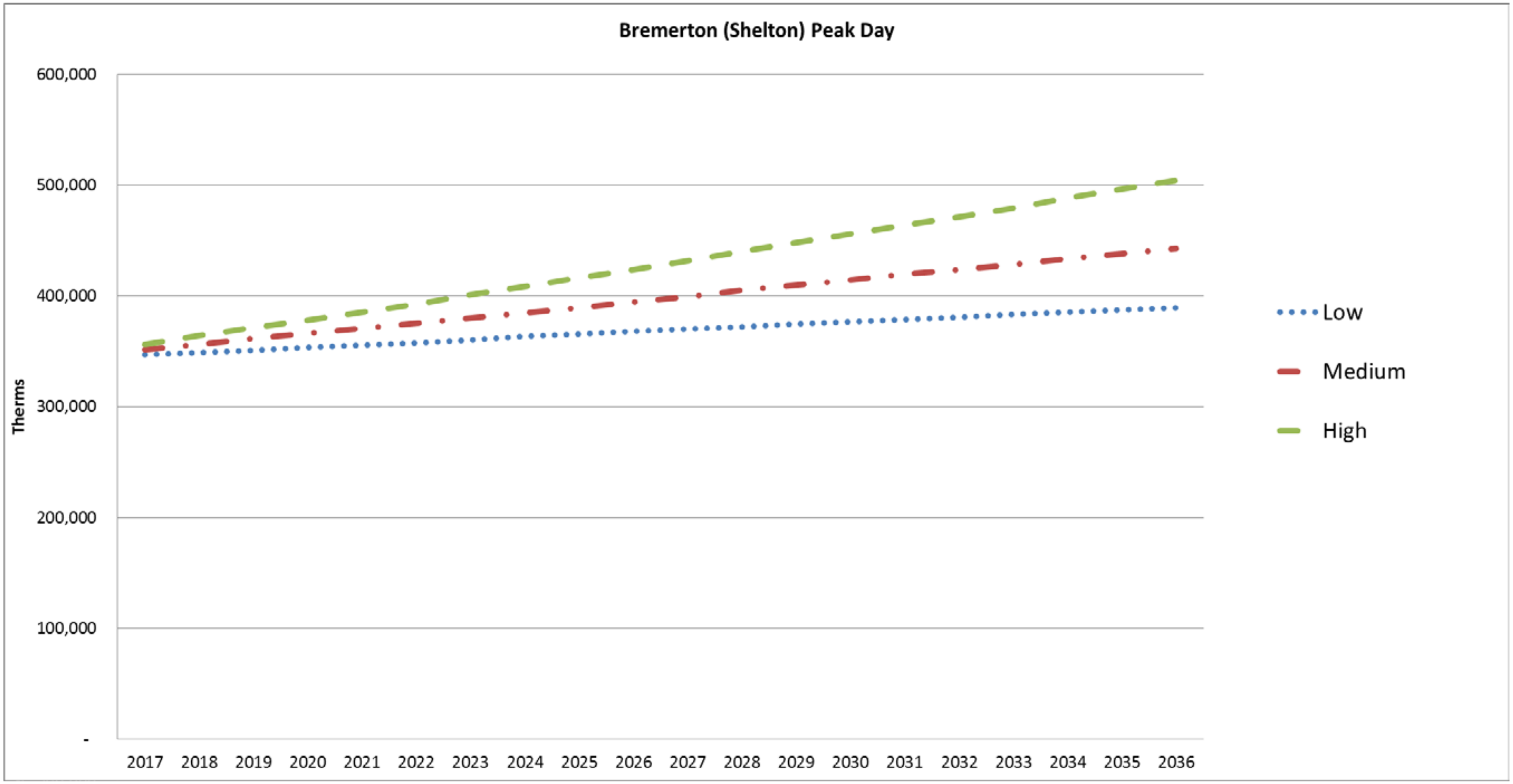
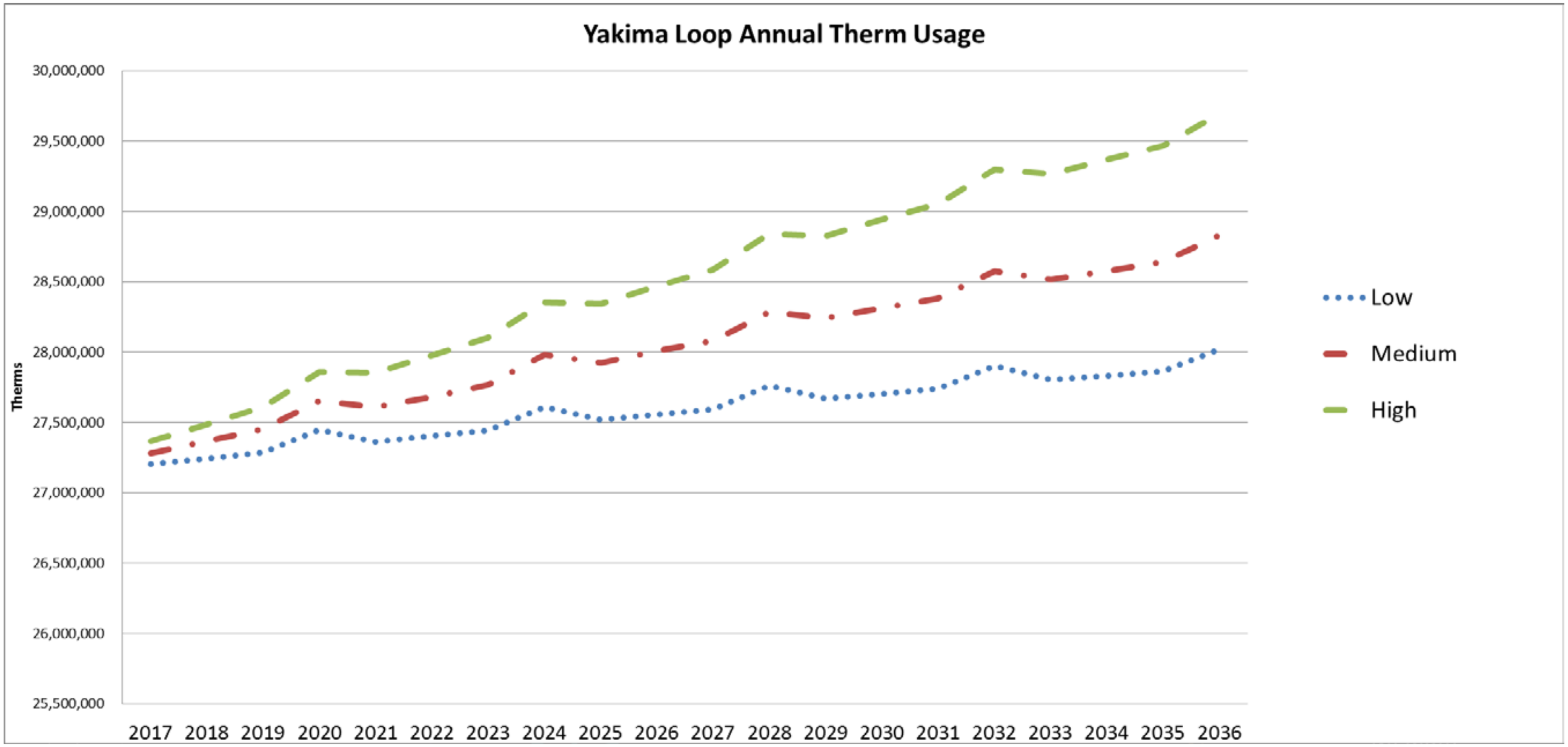
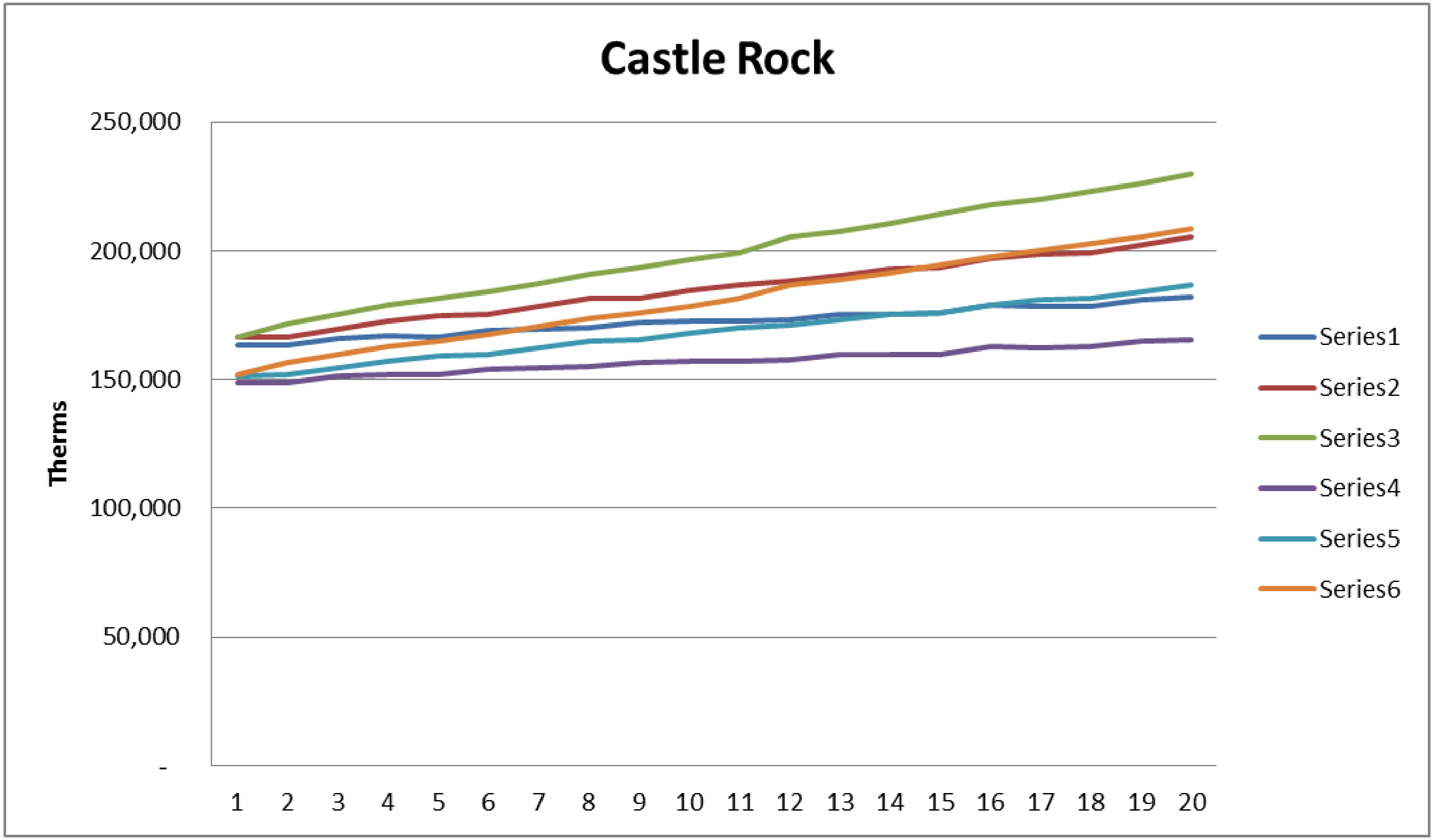
Bremerton (Shelton) Peak Day



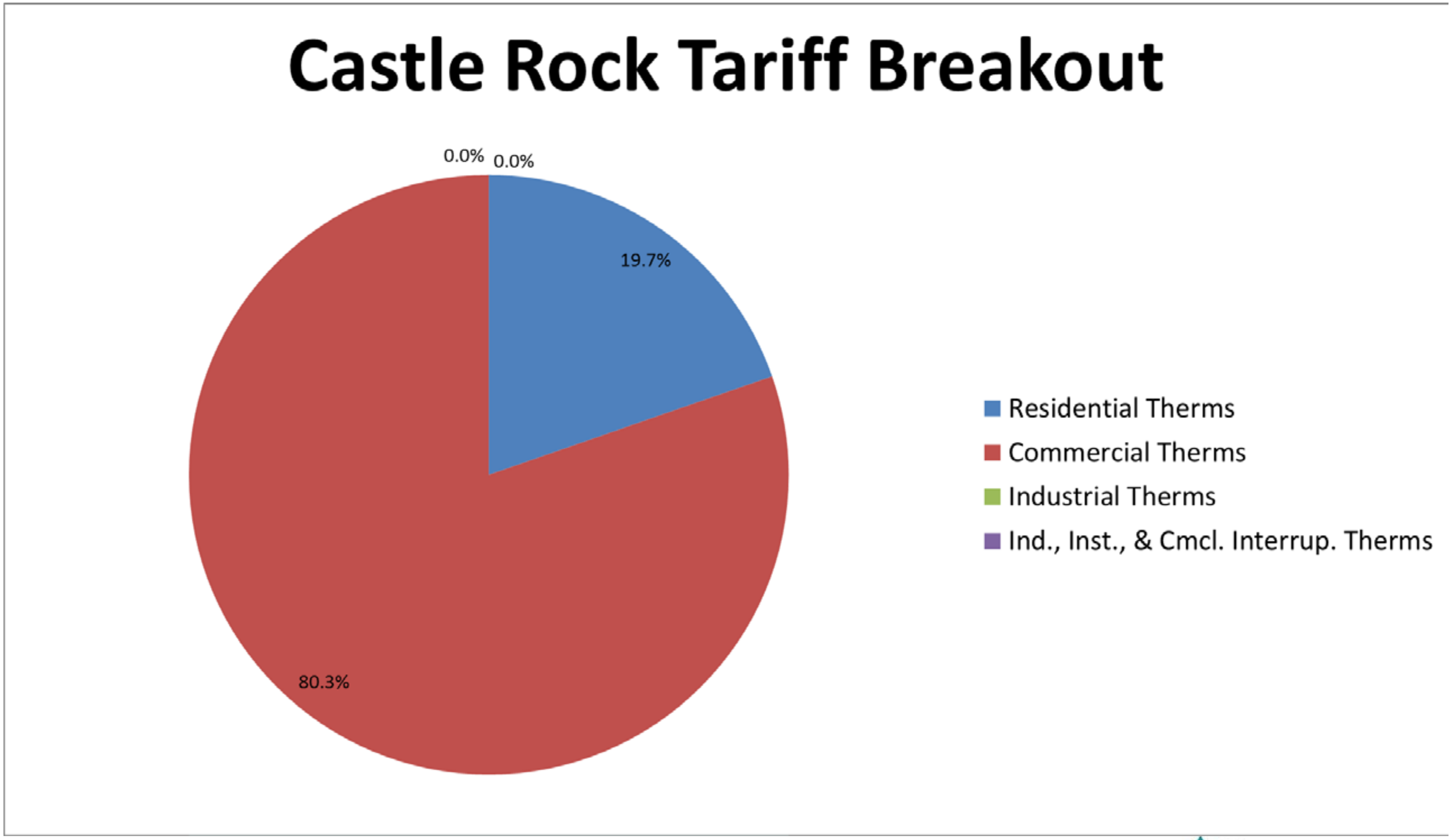
Castle Rock with Normal Weather



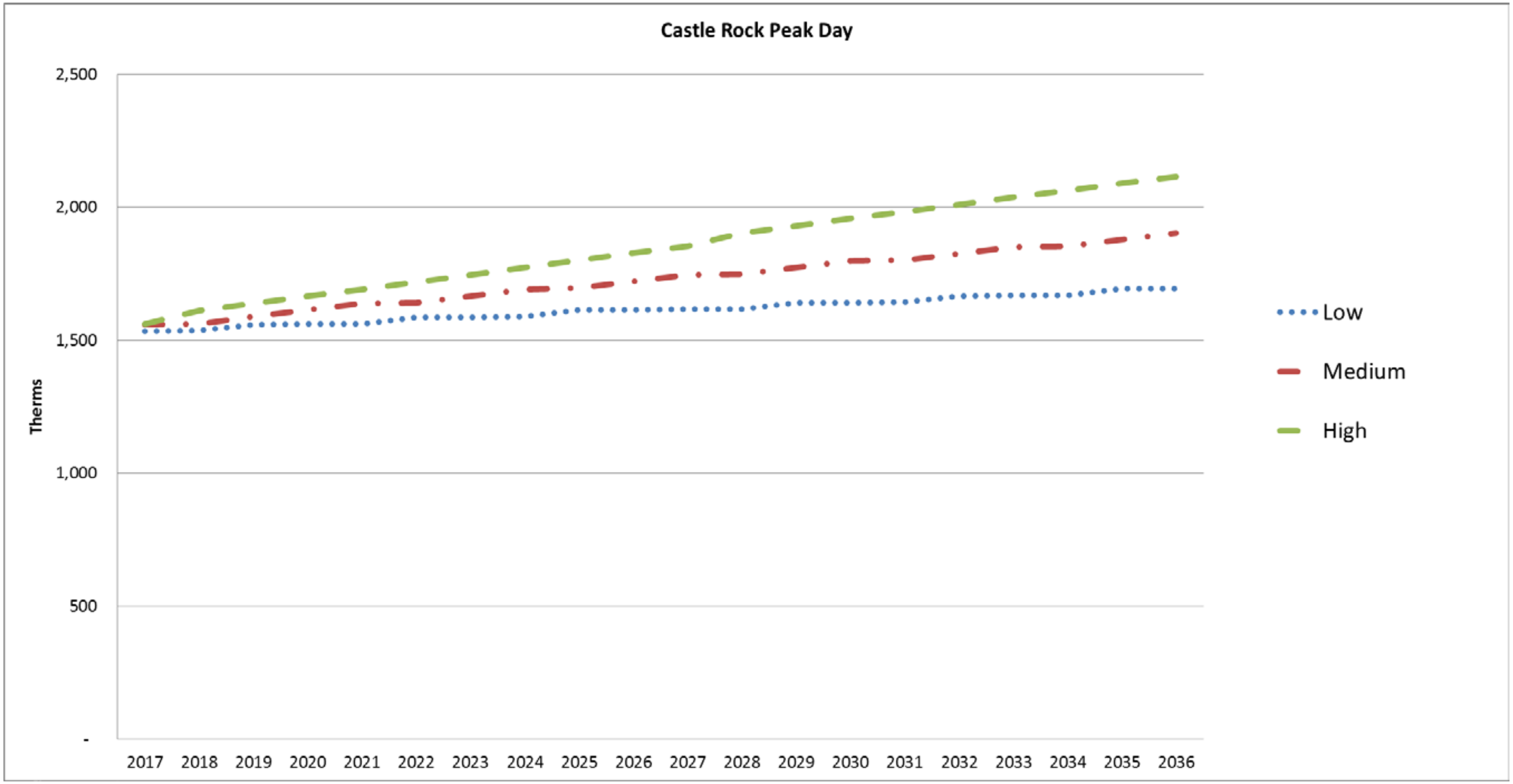
Castle Rock with High and Low Weather Scenarios



Tariff Breakout



Castle Rock Peak Day



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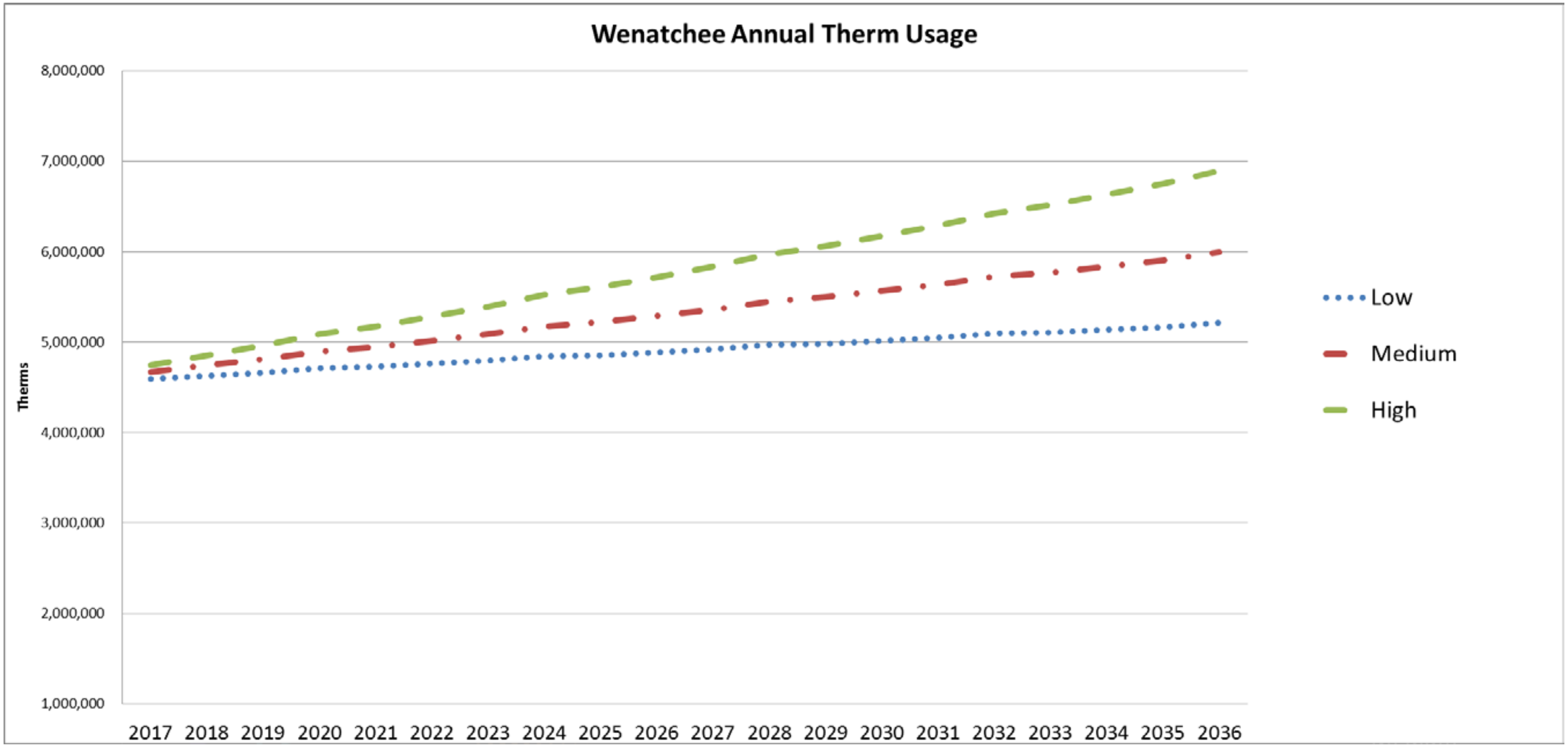
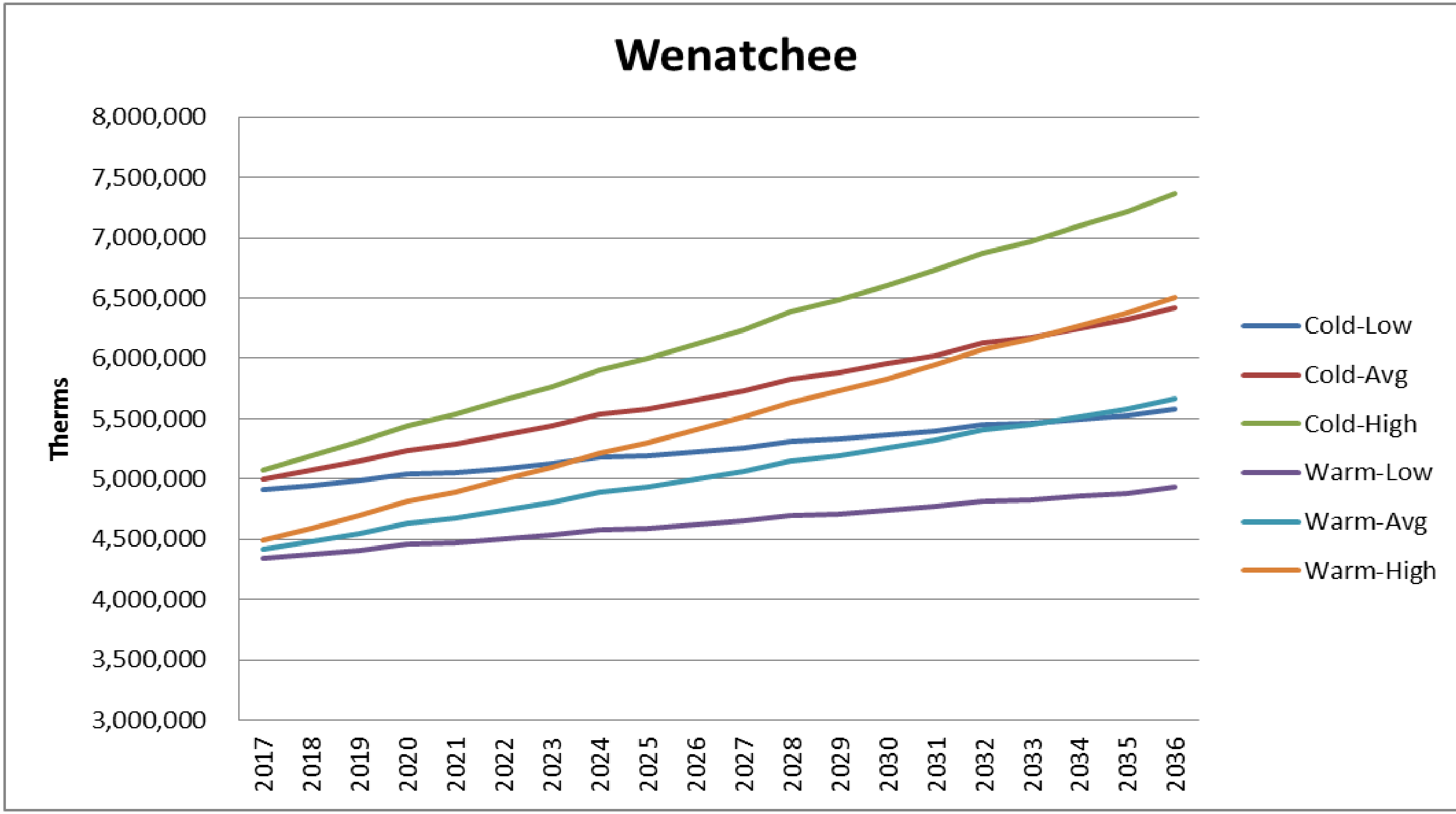
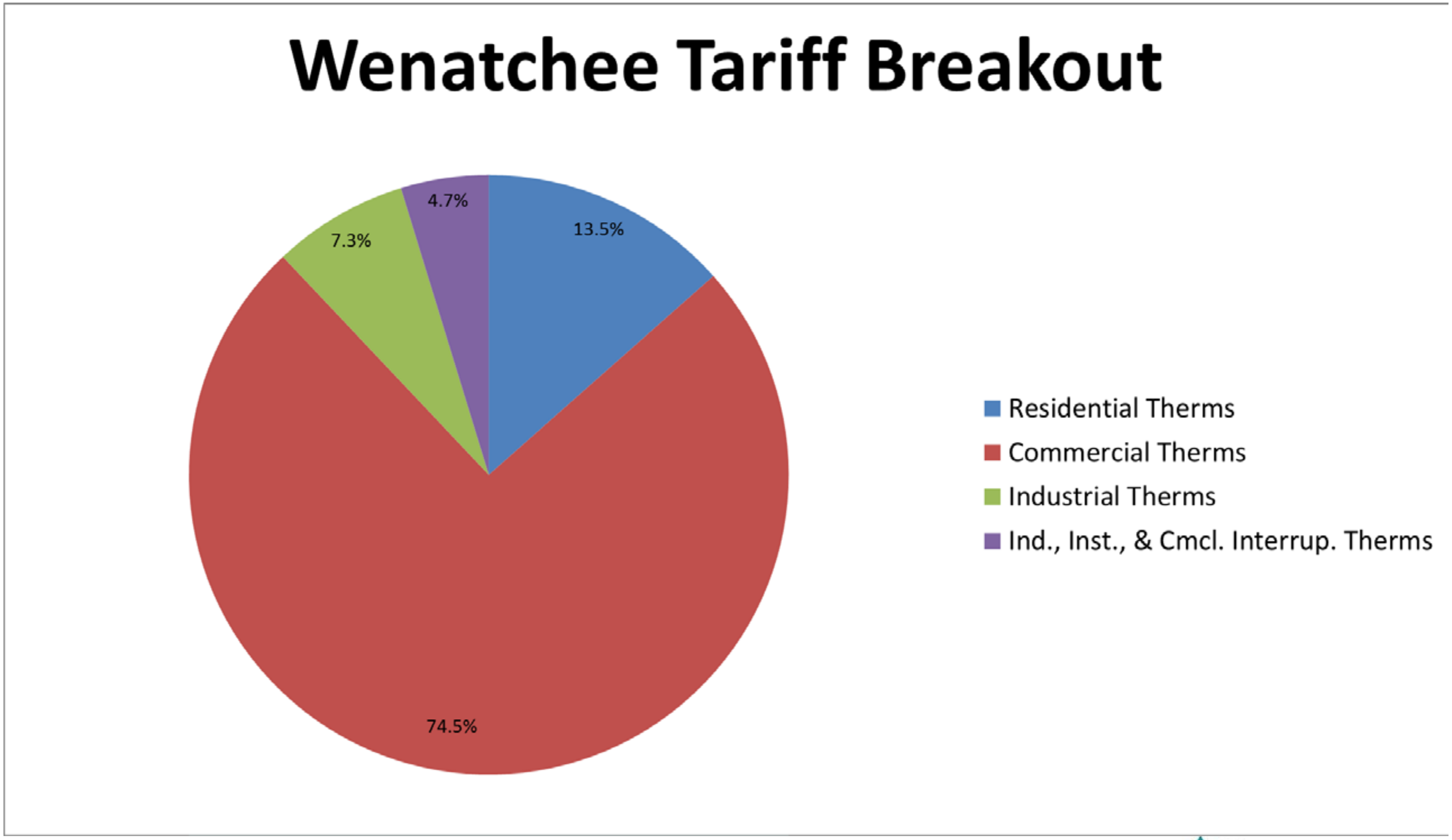
Wenatchee With Average Weather



Wenatchee with High and Low Weather Scenarios



Tariff Breakout



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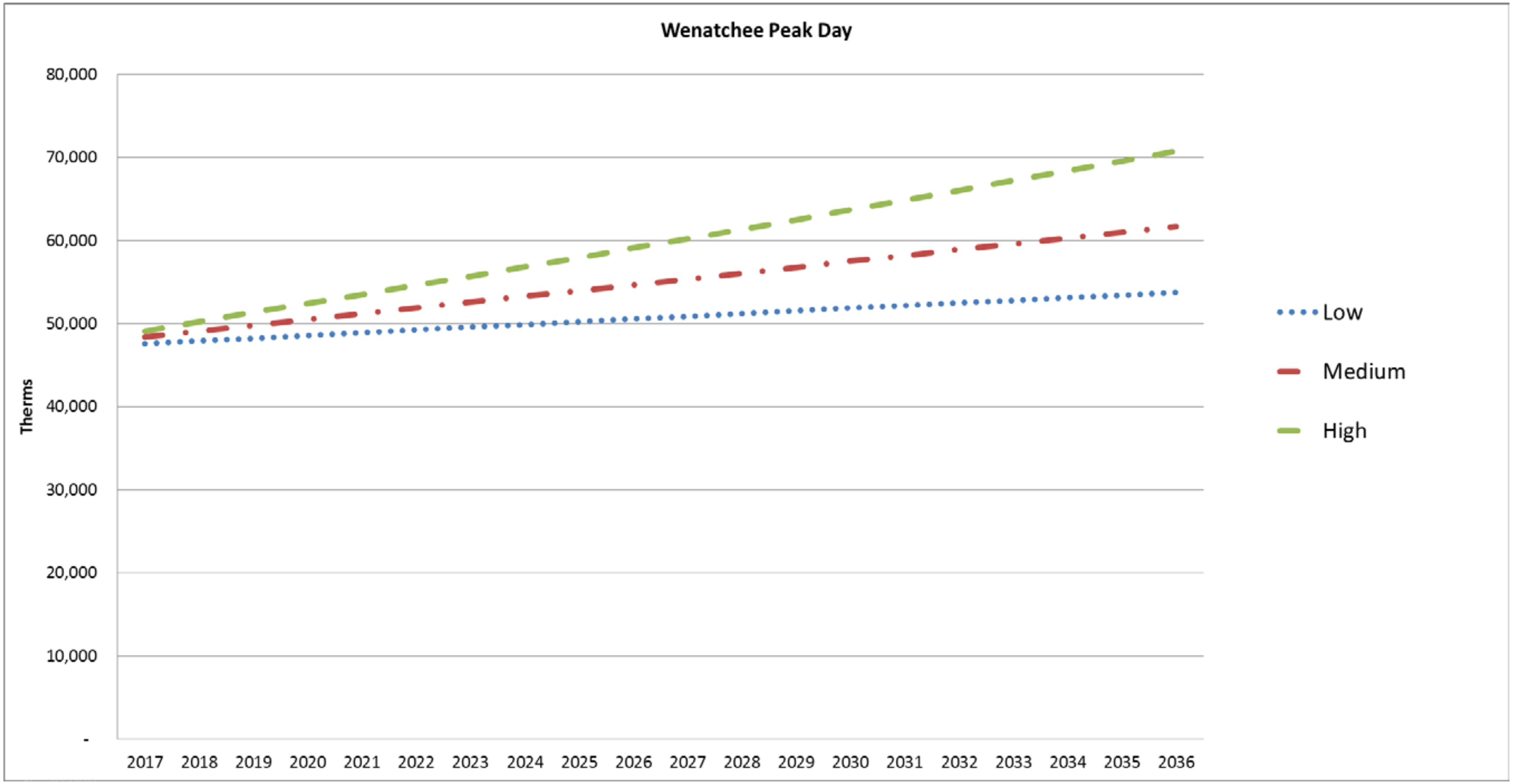
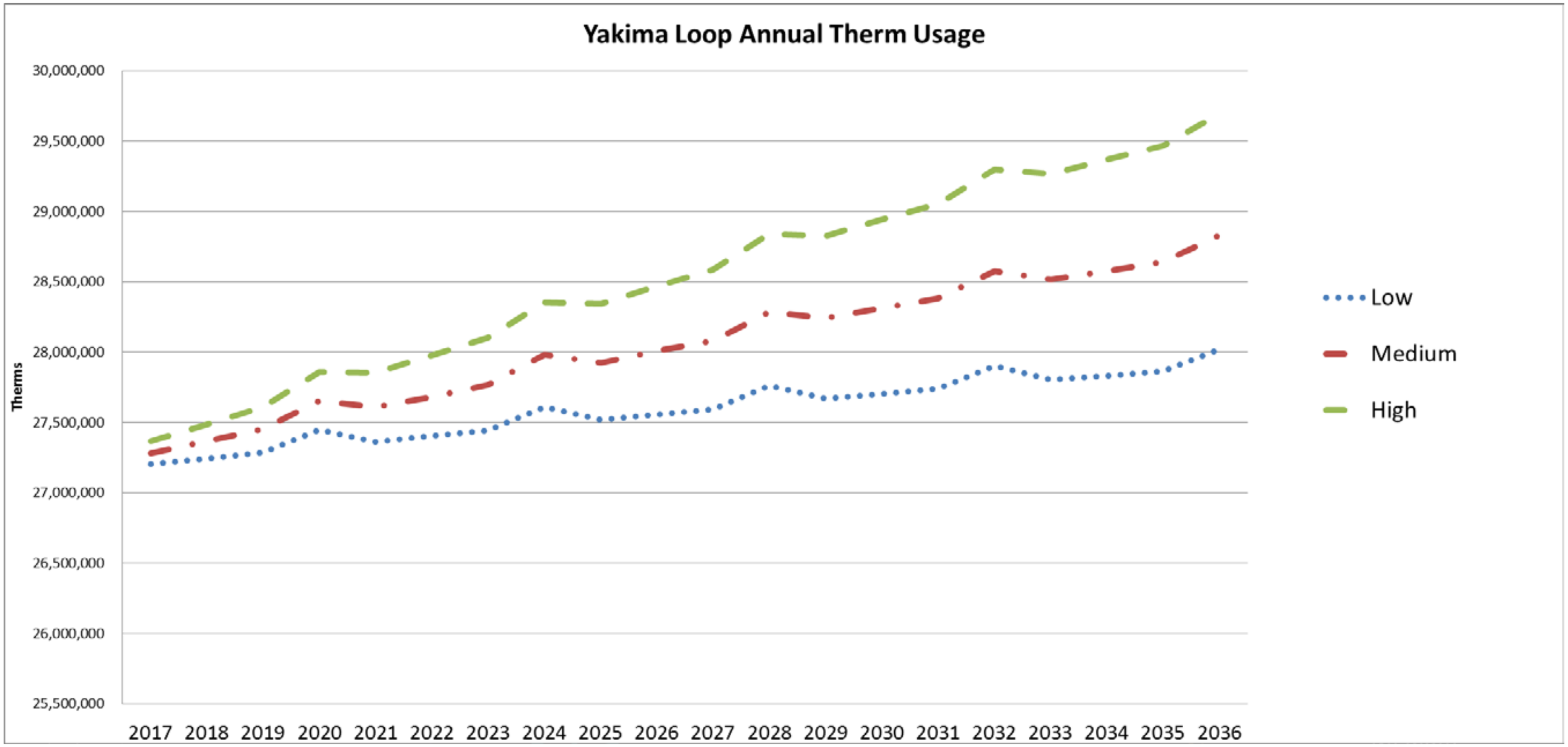
Wenatchee Peak Day



Yakima Loop with Normal Weather



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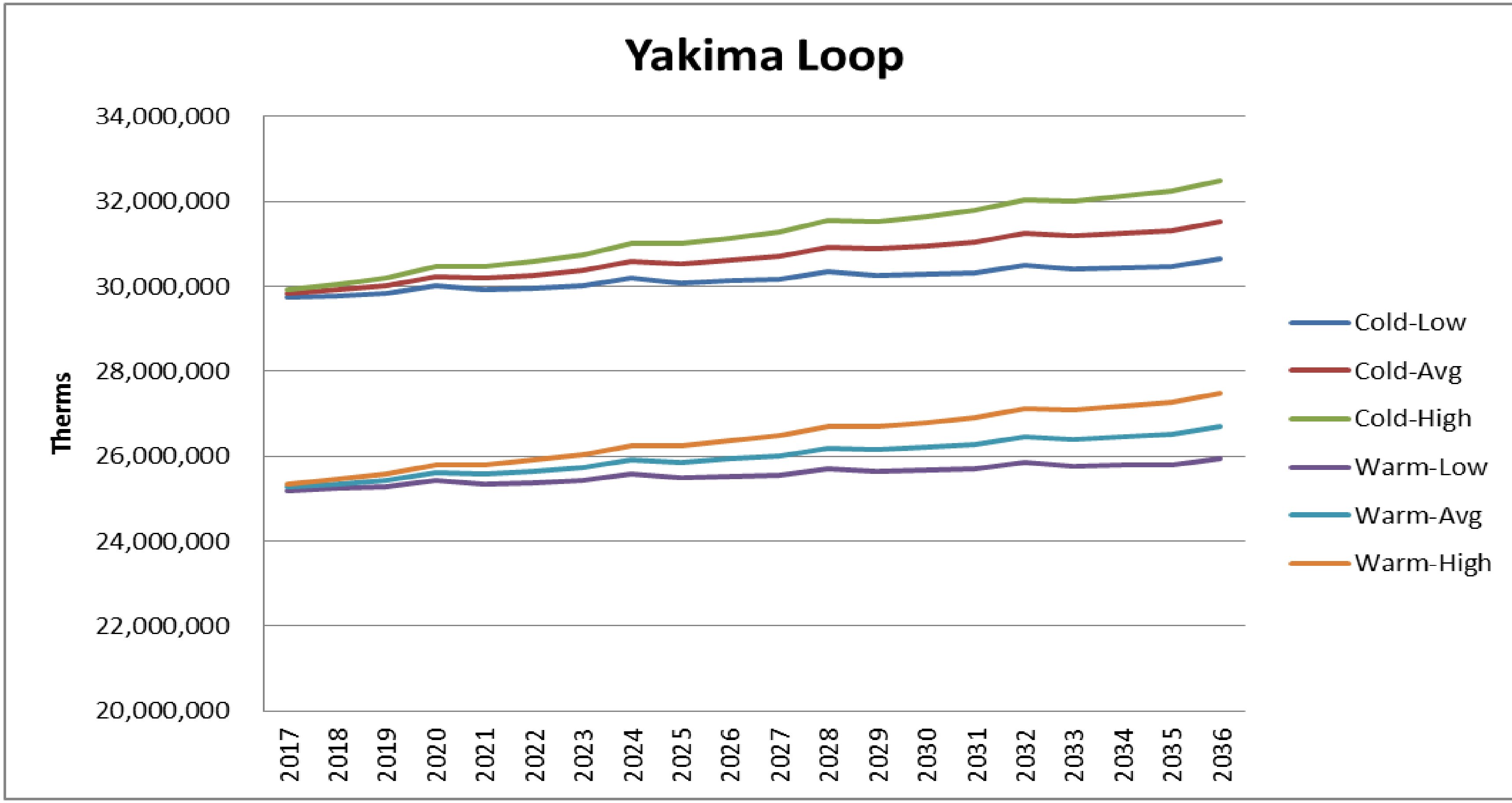
Yakima Loop with High and Low Weather Scenarios



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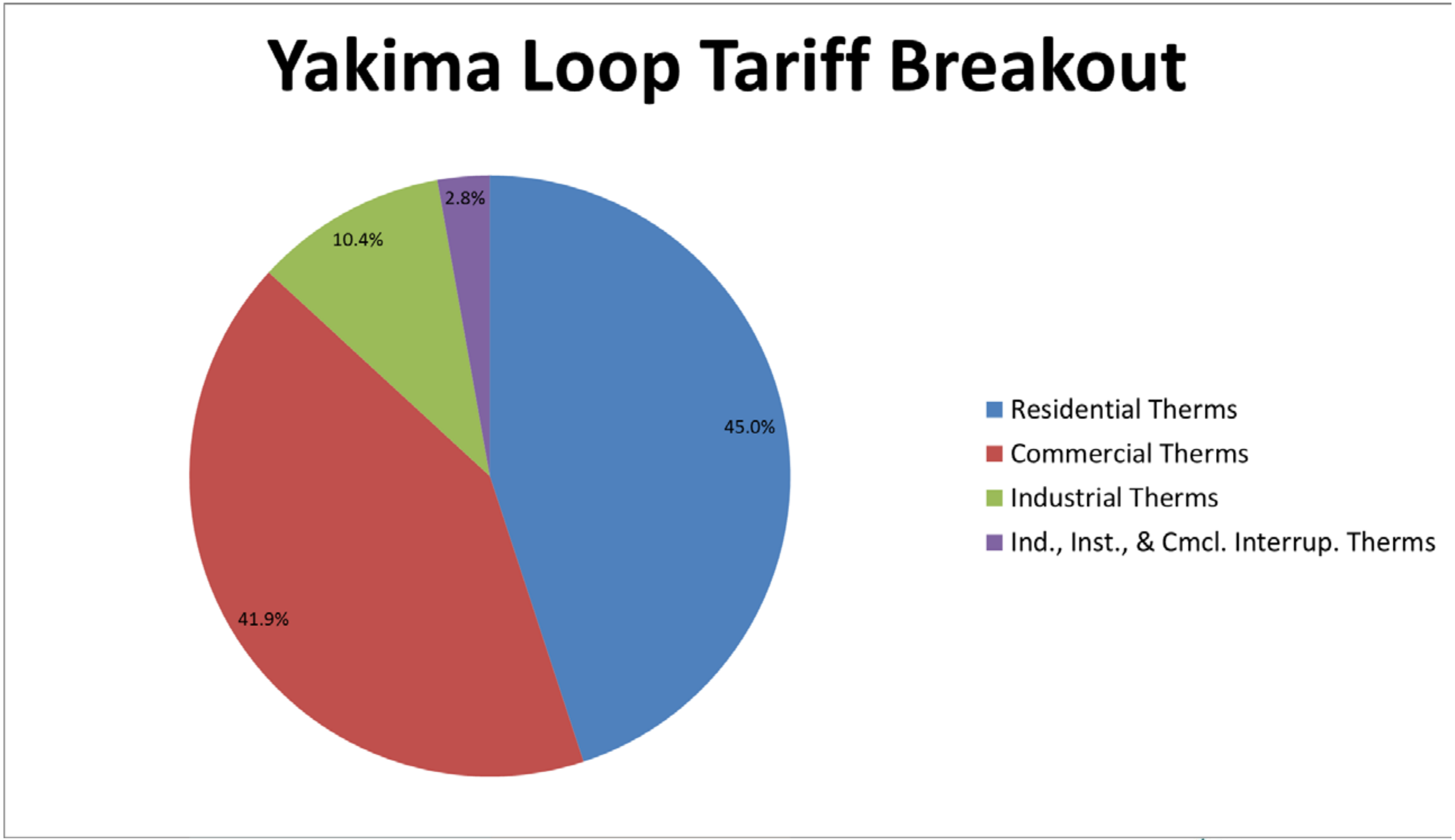
Tariff Breakout



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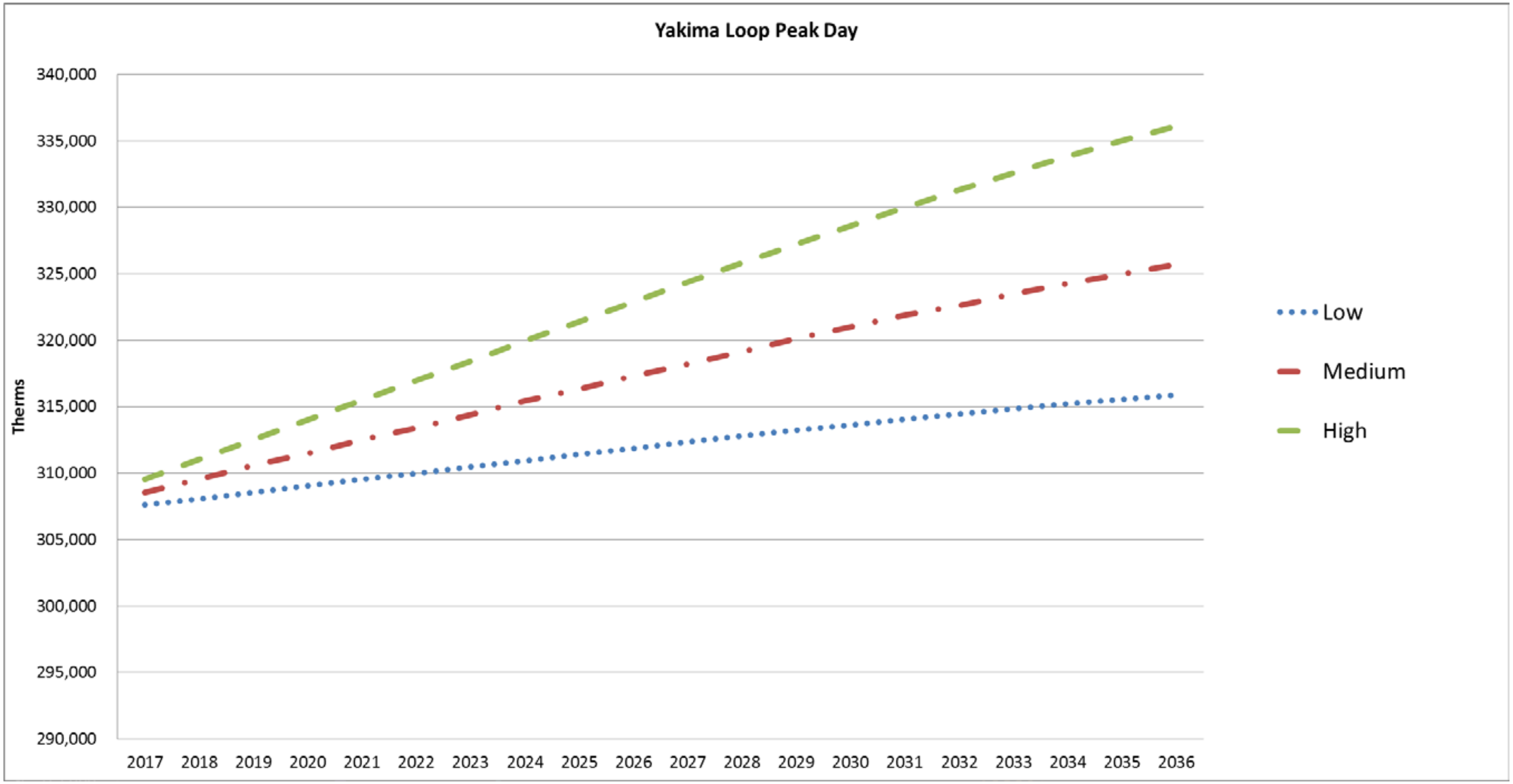
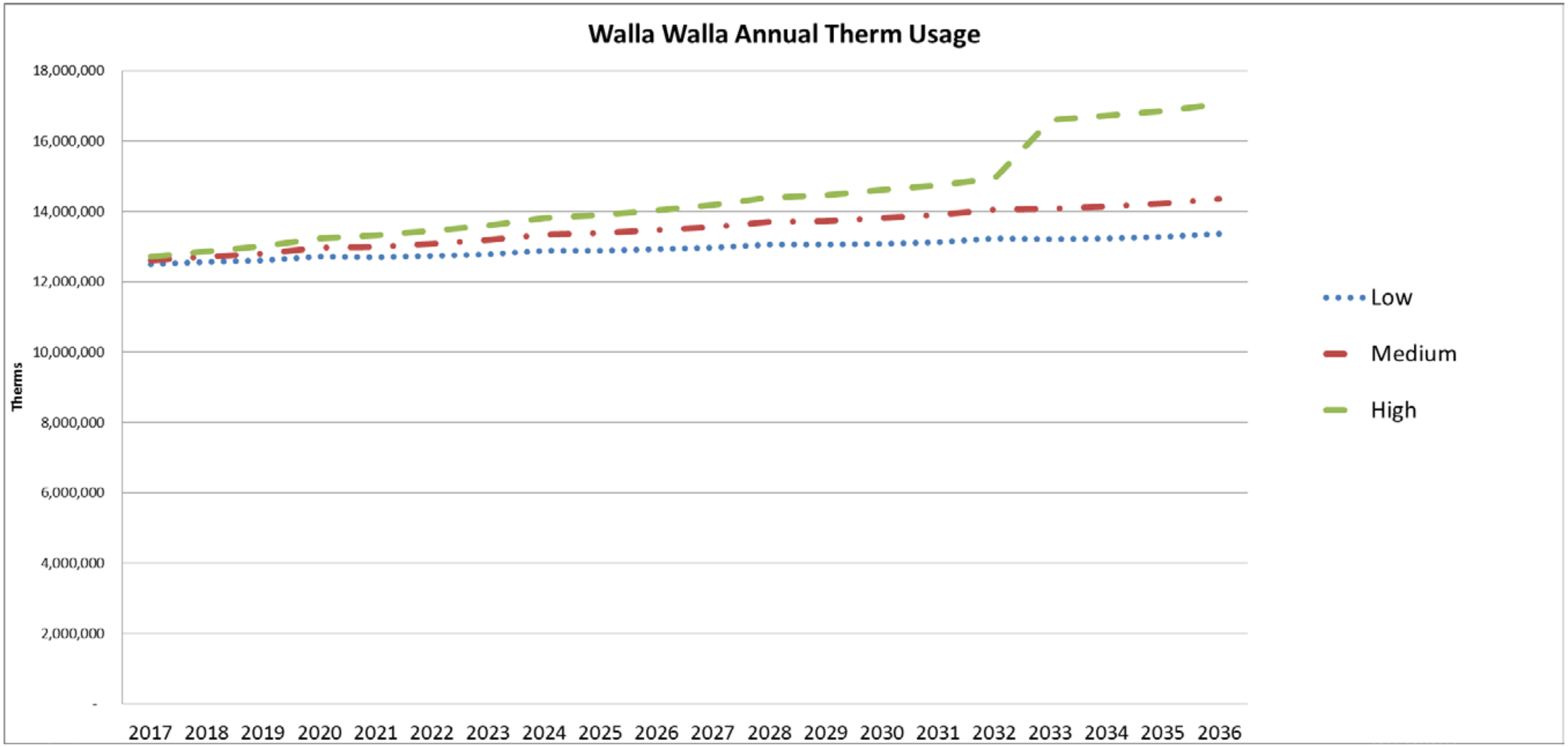
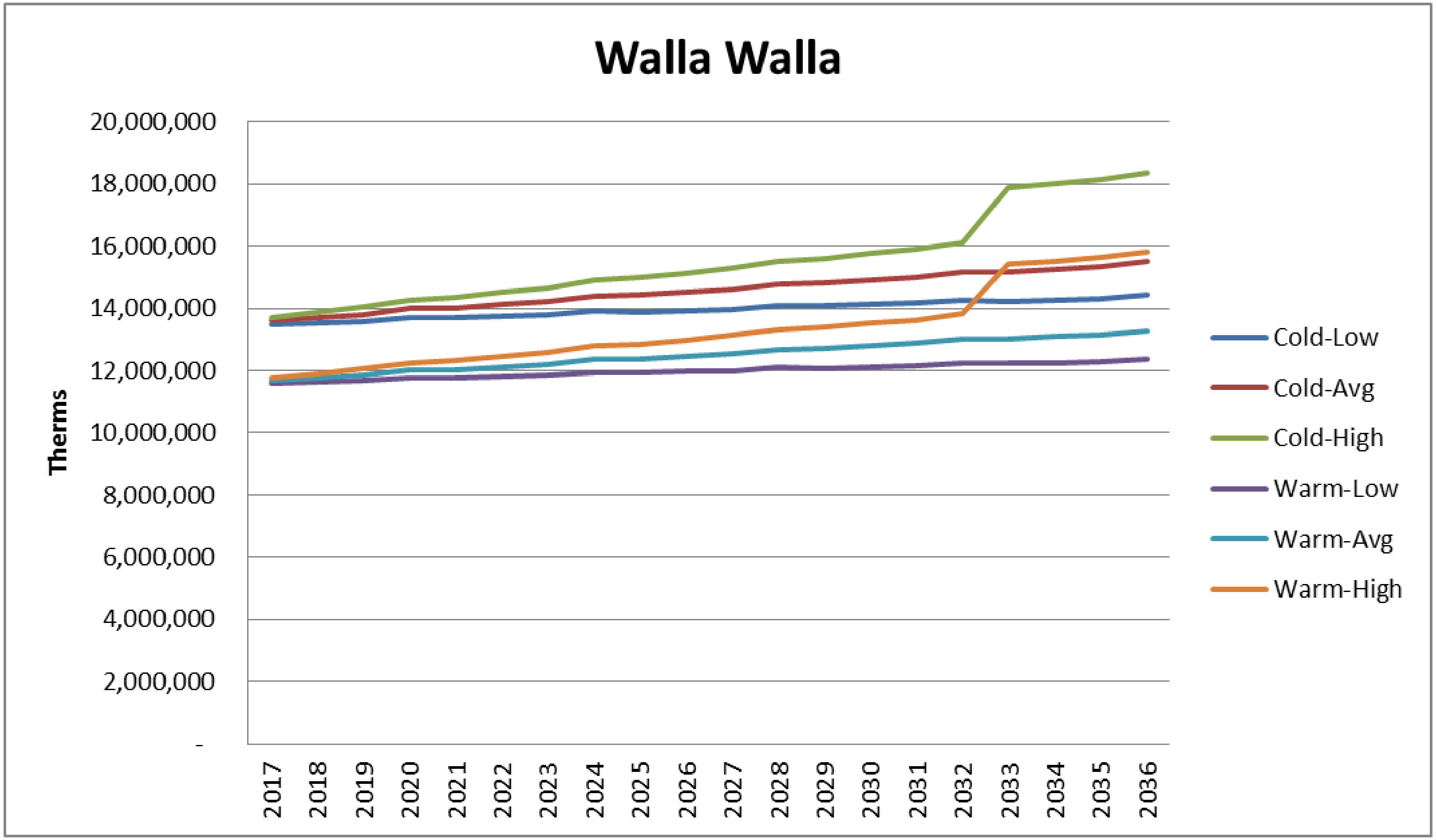
Yakima Loop Peak Day



Walla Walla with Normal Weather



Walla Walla with High and Low Weather Scenarios



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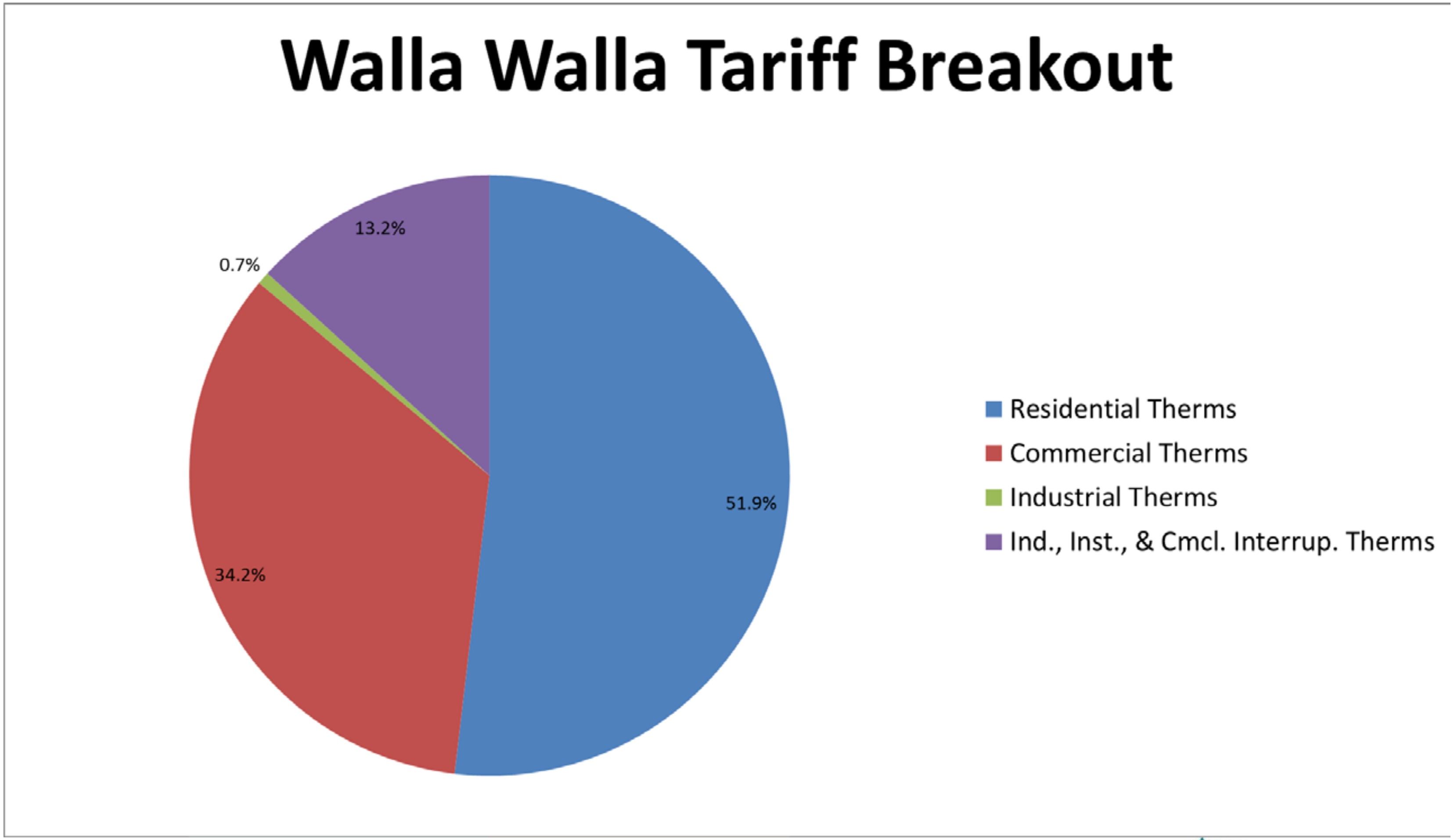
Tariff Breakout



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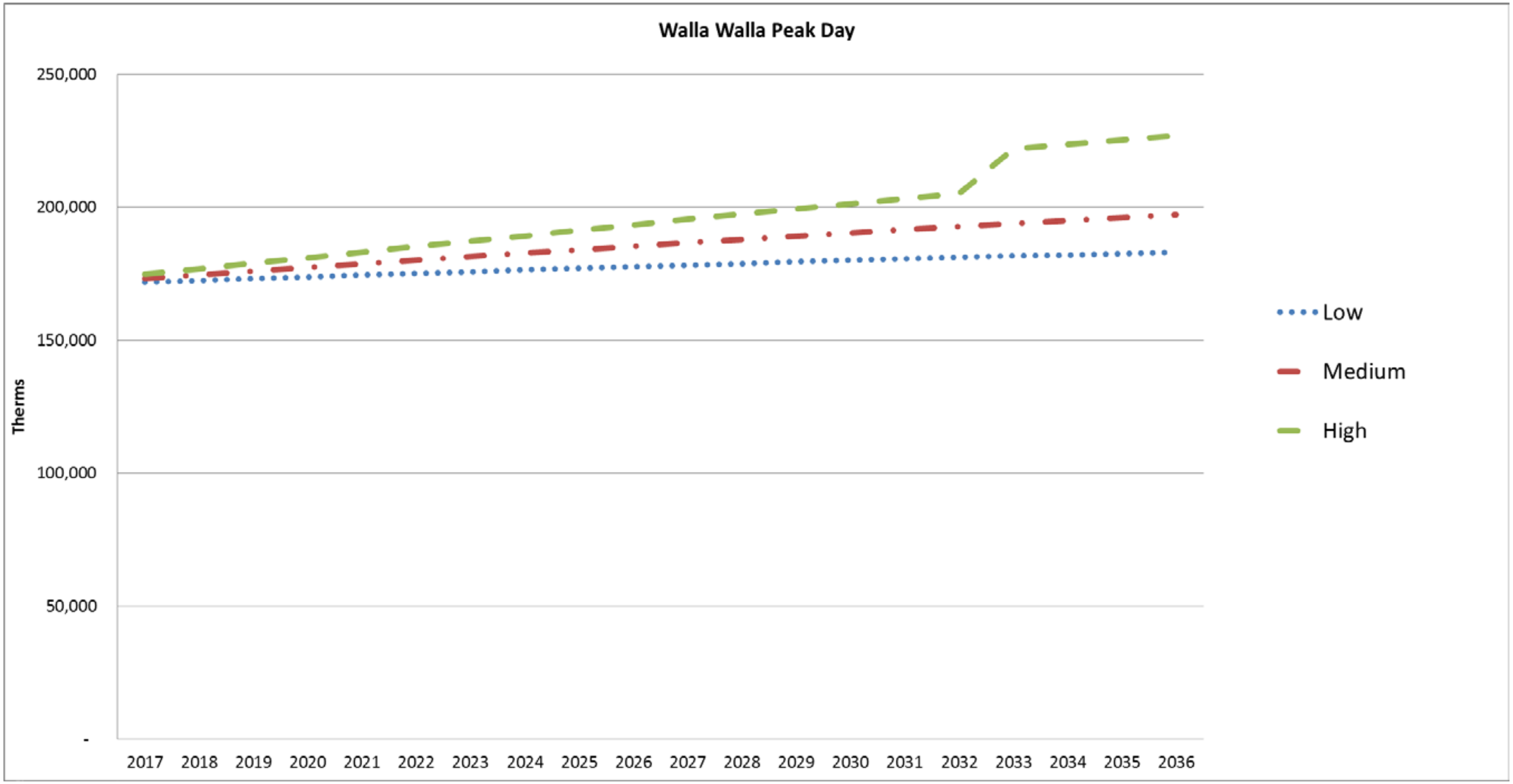
Walla Walla Peak Day



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Average HDD by month for each Weather Station (30 year history)

City	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baker City	33.28	28.47	20.62	15.12	8.19	3.08	0.33	0.51	4.03	13.82	25.48	33.09
Bellingham	19.89	18.45	15.02	10.74	5.64	1.96	0.34	0.26	2.58	8.94	15.91	20.53
Bremerton	20.13	19.06	15.47	11.93	6.47	2.68	0.50	0.37	2.37	8.97	16.74	21.15
Pendleton	24.72	21.64	14.81	9.60	4.11	0.82	0.03	0.04	1.03	8.05	18.59	25.84
Redmond	25.64	24.20	18.88	14.79	8.58	3.36	0.54	0.58	3.66	11.56	21.16	27.37
Walla Walla	23.70	20.38	12.85	7.58	2.82	0.45	0.00	0.02	0.51	6.39	17.29	24.93
Yakima	28.25	23.25	16.24	10.12	3.96	0.92	0.08	0.09	1.71	10.00	21.51	29.82

Cold Scenario HDD by month for each Weather Station (6 years out of 30 year history)

City	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baker City	35.73	29.63	23.12	16.78	8.62	3.78	0.58	0.55	4.33	14.67	27.00	33.37
Bellingham	23.12	19.85	16.24	11.80	6.59	2.24	0.43	0.49	2.92	9.63	17.38	23.31
Bremerton	22.77	20.07	17.20	13.73	7.16	3.28	0.78	0.65	2.80	9.75	18.24	22.79
Pendleton	27.20	23.94	17.36	10.55	4.35	0.88	0.00	0.04	1.34	9.23	20.38	28.14
Redmond	29.18	26.62	21.06	16.18	9.32	3.80	0.96	0.84	4.07	12.94	22.80	28.49
Walla Walla	26.13	23.13	15.15	8.47	3.01	0.44	0.00	0.01	0.74	7.30	18.84	27.27
Yakima	31.34	25.58	18.54	12.05	4.55	0.88	0.11	0.14	2.33	10.87	24.37	32.97

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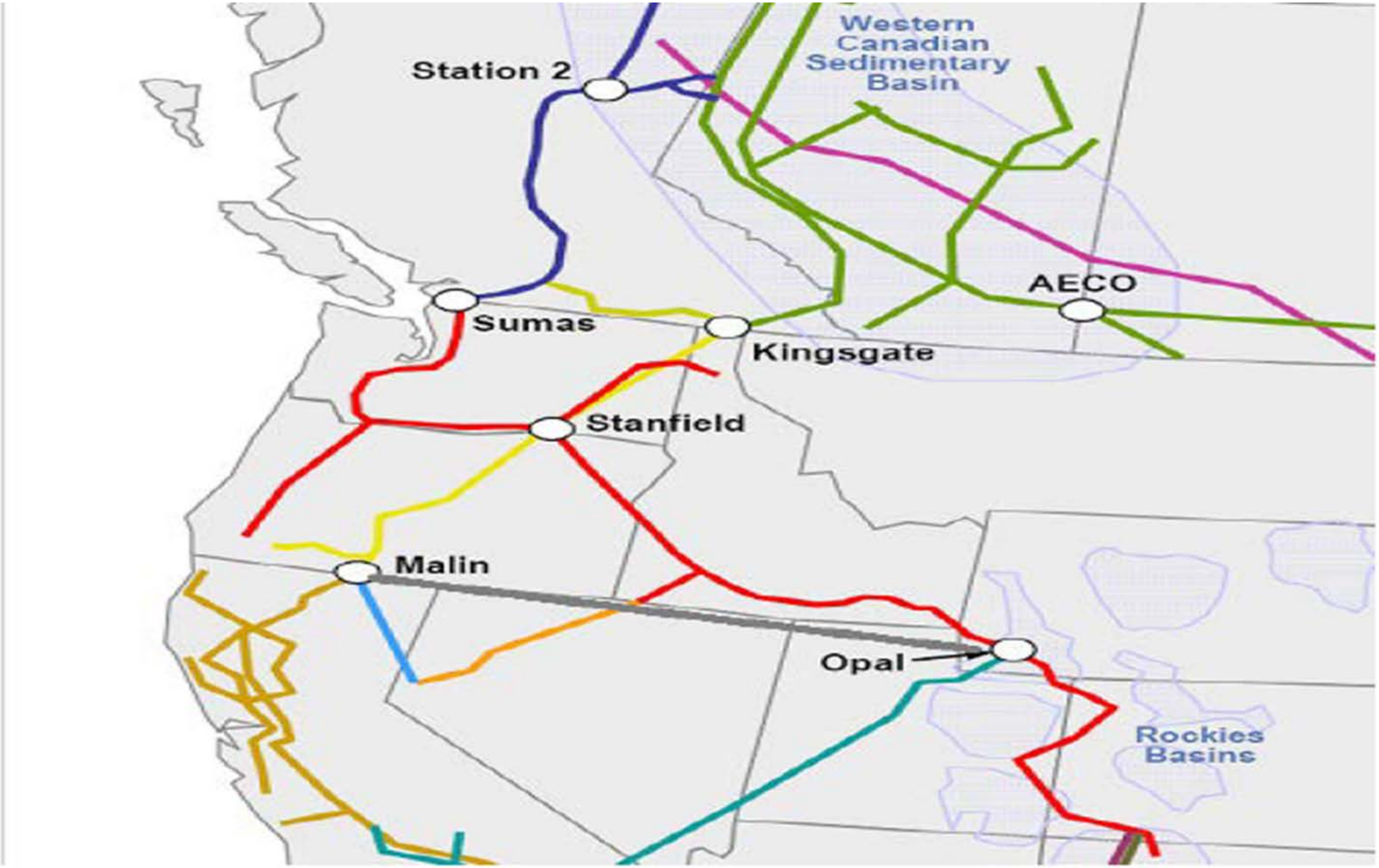
Warm Scenario HDD by month for each Weather Station (6 years out of 30 year history)

City	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baker City	30.28	24.86	18.57	13.18	5.78	2.19	0.23	0.58	3.11	11.98	26.69	31.76
Bellingham	17.33	16.94	12.56	8.94	3.46	0.91	0.10	0.19	1.68	6.97	15.13	19.74
Bremerton	18.18	17.47	12.96	10.22	4.48	1.78	0.28	0.33	1.94	7.34	16.48	21.06
Pendleton	23.78	20.46	12.74	8.38	2.53	0.68	0.06	0.05	0.74	6.29	19.04	25.13
Redmond	23.19	22.35	16.85	13.26	6.58	2.57	0.49	0.62	2.97	9.49	22.35	27.19
Walla Walla	21.92	18.56	10.41	5.88	1.18	0.32	0.02	0.04	0.28	4.65	17.33	23.38
Yakima	25.94	21.57	14.03	8.43	2.12	0.70	0.01	0.10	1.30	7.95	20.83	28.82

Cascade Gas Supply Overview
Current Resources


Bellingham
Mount Vernon
Bremerton
Washington
Seattle
Wenatchee
Moses Lake
Aberdeen
Yakima
Longview
Sunnyside
Walla Walla
Kennewick
Hermitson
Pendleton
Service Area
District Offices
Headquarters
Baker City
Bend
Ontario
Oregon

System Overview



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Transport

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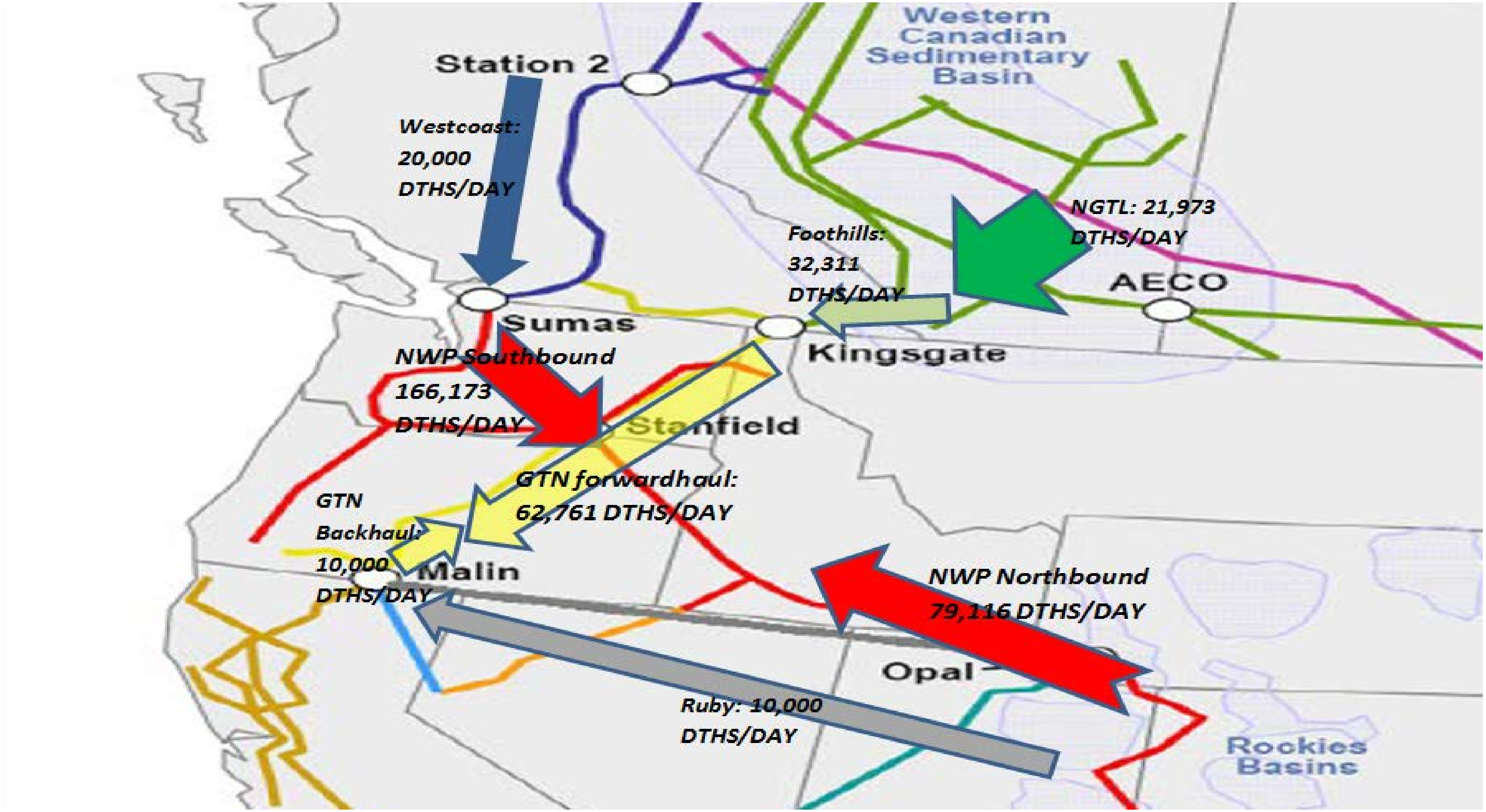
EXAMPLE OF POSSIBLE CNGC WINTER TRANSPORT CAPACITY FLOW



NWP Transport

CONTRACT			Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16
DESCRIPTION	RECEIPT	DELIVERY	31	29	31	30	31	30	31	31	30	31	30	31
NWP														
Contract #100002	all rec	all del	205123	205123	205123	205123	205123	205123	205123	205123	205123	205123	205123	205123
Contract #135384	jackson prairie	bremerton/mt vernon	30420	30420	30420	30420	30420	30420	30420	30420	30420	30420	30420	30420
Contract #135558	sumas	stanfield/portland west	25400	25400	25400	25400	25400	25400	25400	25400	25400	25400	25400	25400
Contract #139382	sumas	sedro wooley	6191	6191	6191	6191	6191	6191	6191	6191	6191	6191	6191	6191
Contract #139383	sumas	sedro wooley	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050
Contract #139384	sumas	sedro wooley	3259	3259	3259	3259	3259	3259	3259	3259	3259	3259	3259	3259
Contract #100134	sumas/ignacio	burbank/yakima/aberdeen	330	330	330	330	330	330	330	330	330	330	330	330
Contract #100149	sumas/ignacio	walla walla	75	75	75	75	75	75	75	75	75	75	75	75
Contract #100150	sumas/ignacio	menan starch	160	160	160	160	160	160	160	160	160	160	160	160
Contract #100064	sumas	hermiston/pasco	1078	1078	1078	1078	1078	1078	1078	1078	1078	1078	1078	1078
Contract #132329	sumas	kern river	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
Contract #139090	sumas	plymouth/umatilla/bellingham	27063	27063	27063	27063	27063	27063	27063	27063	27063	27063	27063	27063
Contract #139637	sumas	hermiston/oak harbor/selah	7241	7241	7241	7241	7241	7241	7241	7241	7241	7241	7241	7241
Contract #139630	stanfield	durkee/pendelton/mission	7,450	7,450	7,450	7,450	7,450	7,450	7,450	7,450	7,450	7,450	7,450	7,450
Contract #140047	sumas	bellingham/ferndale	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000
Contract #140748	Opal	Portland West/Scappoose	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
			335,840	335,840	335,840	335,840	335,840	335,840	335,840	335,840	335,840	335,840	335,840	335,840

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GTN Transport

CONTRACT			Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16
DESCRIPTION	RECEIPT	DELIVERY	31	29	31	30	31	30	31	31	30	31	30	31
GTN														
#17037	kingsgate	malin	23,980	23,980	23,980	23,980							23,980	23,980
#17019	kingsgate	Spokane NPC	11,558	11,558	11,558	11,558	11,558	11,558	11,558	11,558	11,558	11,558	11,558	11,558
#17021	kingsgate	Kosmos Farm	200	200	200	200	200	200	200	200	200	200	200	200
#17022	kingsgate	Stanfield City	232	232	232	232	232	232	232	232	232	232	232	232
#17023	kingsgate	Madras	2,078	2,078	2,078	2,078	2,078	2,078	2,078	2,078	2,078	2,078	2,078	2,078
#17025	kingsgate	Prineville	2,984	2,984	2,984	2,984	2,984	2,984	2,984	2,984	2,984	2,984	2,984	2,984
#17026	kingsgate	Redmond	2,734	2,734	2,734	2,734	2,734	2,734	2,734	2,734	2,734	2,734	2,734	2,734
#17028	kingsgate	Bend	8,927	8,927	8,927	8,927	8,927	8,927	8,927	8,927	8,927	8,927	8,927	8,927
#17031	kingsgate	Stearns	2,189	2,189	2,189	2,189	2,189	2,189	2,189	2,189	2,189	2,189	2,189	2,189
#17033	kingsgate	LaPine	45	45	45	45	45	45	45	45	45	45	45	45
#17034	kingsgate	Gilchrist	313	313	313	313	313	313	313	313	313	313	313	313
#17036	kingsgate	Chemult	75	75	75	75	75	75	75	75	75	75	75	75
#17023	kingsgate	Madras	331	331	331								331	331
#17025	kingsgate	Prineville	827	827	827								827	827
#17026	kingsgate	Redmond	662	662	662								662	662
#17028	kingsgate	Bend	4,137	4,137	4,137								4,137	4,137
#17031	kingsgate	Stearns	1,241	1,241	1,241								1,241	1,241
#17034	kingsgate	Gilchrist	248	248	248								248	248
#13687	turqouise flats	stanfield	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
#13688	turqouise flats	stanfield	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
			77,761	77,761	77,761	70,315	46,335	46,335	46,335	46,335	46,335	46,335	77,761	77,761

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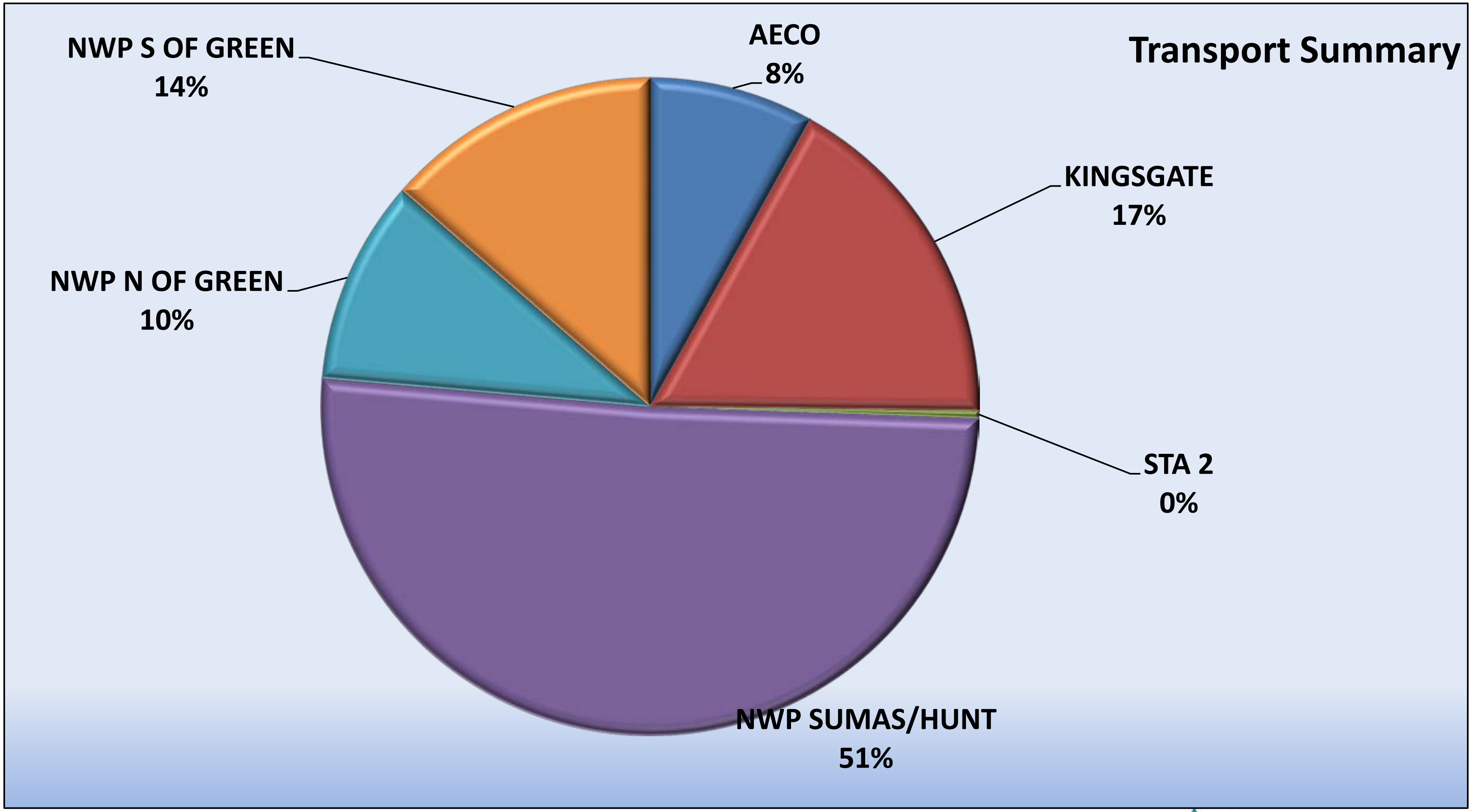
Other Transport

CONTRACT			Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16
DESCRIPTION	RECEIPT	DELIVERY	31	29	31	30	31	30	31	31	30	31	30	31
FOOTHILLS														
(CNG FS-2)	AB/C border	kingsgate	3,126	3,126	3,126	3,126	3,126	3,126	3,126	3,126	3,126	3,126	3,126	3,126
(CNG FS-3)	AB/C border	kingsgate	21,583	21,583	21,583	21,583	21,583	21,583	21,583	21,583	21,583	21,583	21,583	21,583
(CNG FS-1)	AB/C border	kingsgate	7,602	7,602	7,602								7,602	7,602
			32,311	32,311	32,311	24,709	24,709	24,709	24,709	24,709	24,709	24,709	32,311	32,311
NOVA														
(NOVA) (#2003039348-1)	NIT	AB/C border	21,973	21,973	21,973	21,973	21,973	21,973	21,973	21,973	21,973	21,973	21,973	21,973
SPECTRA														
(#FI-2583-B-00)	station 2	huntingdon	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000
RUBY PIPELINE LLC														
#61036000B	pearl creek	turqouise flats	15,000	15,000	15,000	15,000							15,000	15,000


Transport Summary
AECO
8%
KINGSGATE
17%
STA 2
0%
NWP SUMAS/HUNT
51%
NWP N OF GREEN
10%
NWP S OF GREEN
14%

Impact of Constraints, OFO's and Entitlements

- Tools used by the pipeline to ensure appropriate pressure , flow and deliveries.
- NWP will use line pressure and storage volumes to balance deliveries with receipts of gas.
- Entitlement Examples
  - If pressures sag and deliveries are low- Entitlement may be called. (NWP Storage Level is Critical)
  - Entitlement places penalties on shipper to stay within a tolerance.
  - Same scenario can apply in reverse- pressure too high
  - Places Penalties on Shippers for non-compliance
- OFO Examples
  - Pricing may be low in the Rockies.
  - Shippers modify behavior to take advantage of pricing.
  - This cause a displacement of more flows from South to North
  - Constraints come into Play- ie.Kemmerer
  - NWP may issue OFO from Sumas south to alleviate shortfall in the north.
- NWP may use Proposed Entitlements or OFO's as warnings.
  - NWP will use their own resources first.
  - Notices may be issued to attempt shipper to modify behavior
  - OFO and Entitlements used as last resort.

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Asset Management Agreement

- Tenaska Marketing Ventures-
  - Transport and Storage Released to Tenaska in exchange for annual payment made to CNG
  - Provide Scheduling Services
  - Market Analysis as needed
  - Can help to Isolate CNG from Cuts and potential Pipeline Operational issues.
  - Tenaska is very familiar with our assets – extracting maximum value from our assets. Competitive pricing for AMA compared to others.
  - Privately help company that assumes more risk that CNG can tolerate.
  - Expertise that Cascade doesn't currently possess.

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Storage Resources

- Jackson Prairie-
  - 4 account with 1,235,593 Dth Capacity
  - We were approximately 90% Cycled over the past winter season
  - CNGC remains committed to cycling or Jackson Prairie
- Plymouth-
  - 2 accounts with 662,200 Dth Capacity
  - New account of 100,000 Dth added for the upcoming season
  - In addition to above we acquired TF-2 (Firm Redelivery Transportation) of 10,675
  - Plymouth returned to fully functional operation for 04/01/2016.
  - CNGC remains committed to using Plymouth as a peaking resource.

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Supply

HIGHLIGHTS FOR THE 2016 PORTFOLIO DESIGN

- PORTFOLIO PROCURMENT DESIGN BASED ON A DECLINING PERCENTAGE EACH YEAR, ACCORDINGLY: Approximately Year 1: 80% of annual requirements; Year 2: 40%, Year 3: 20%.
  - 80% allows more flexibility operationally
  - Allows us to be in the market monthly through FOM purchase or Day Gas purchases
- GSOC would consider a modification from a three year rolling portfolio if: 1) reasonable concerns exist regarding the availability of supply in a particular basin; 2) the outer year 3 year forward price is 20% higher/lower than the front month over a reasonably sustained period.
- Hedged Percentages (fixed-price physical) Currently max 40% of annual requirements. Second year should be set at 25%, and 20% hedged volumes for year three.
- GSOC would consider a modification of this plan if the outer year 3 year forward price is 20% higher/lower than the front month over a reasonably sustained period.
- Annual load expectation (Nov-Oct) is approximately 30,000,000 dths, consistent with recent load history.
- GSOC has requested a review of possible 5 year deal at AECO. Gas Supply currently analyzing scenarios.

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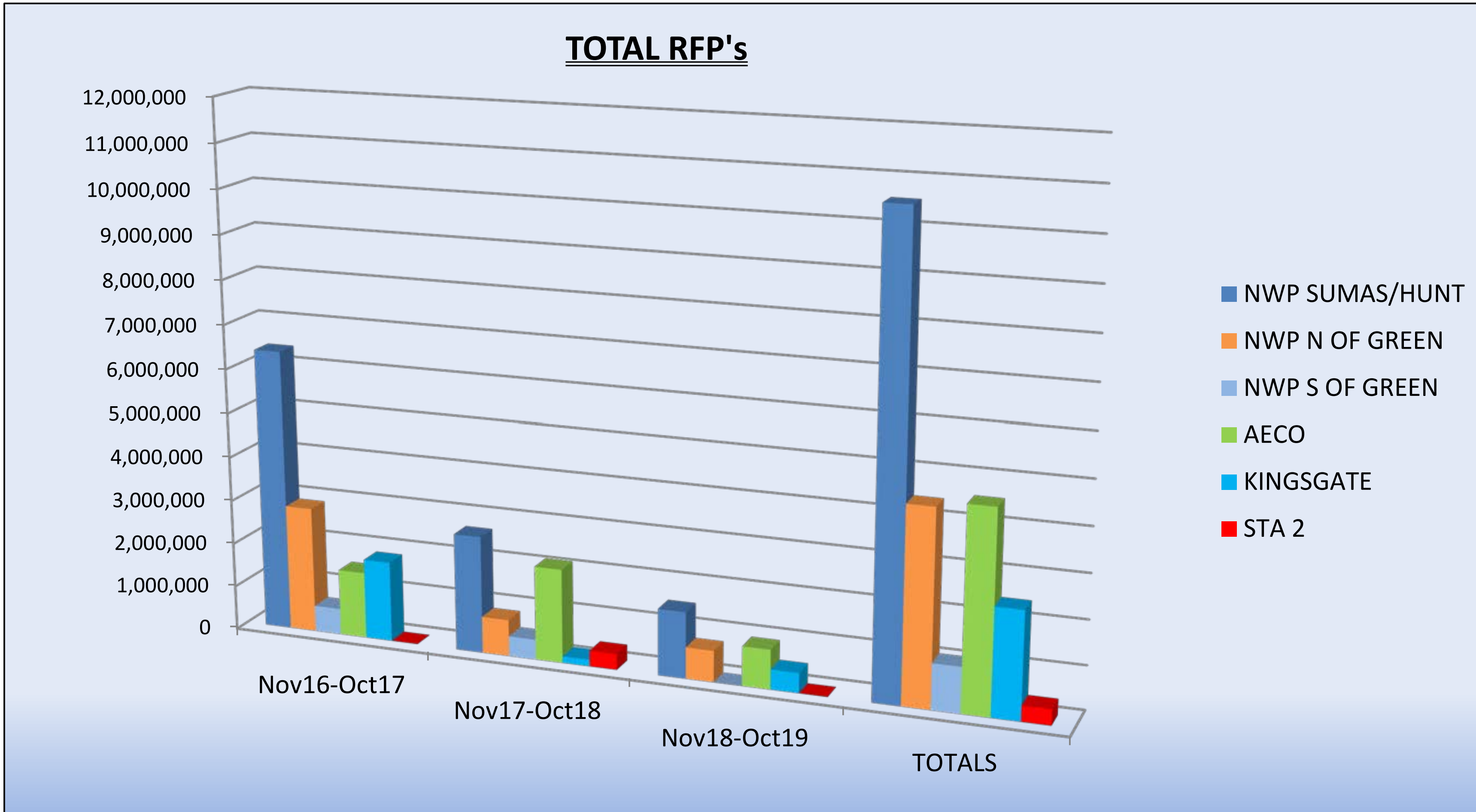
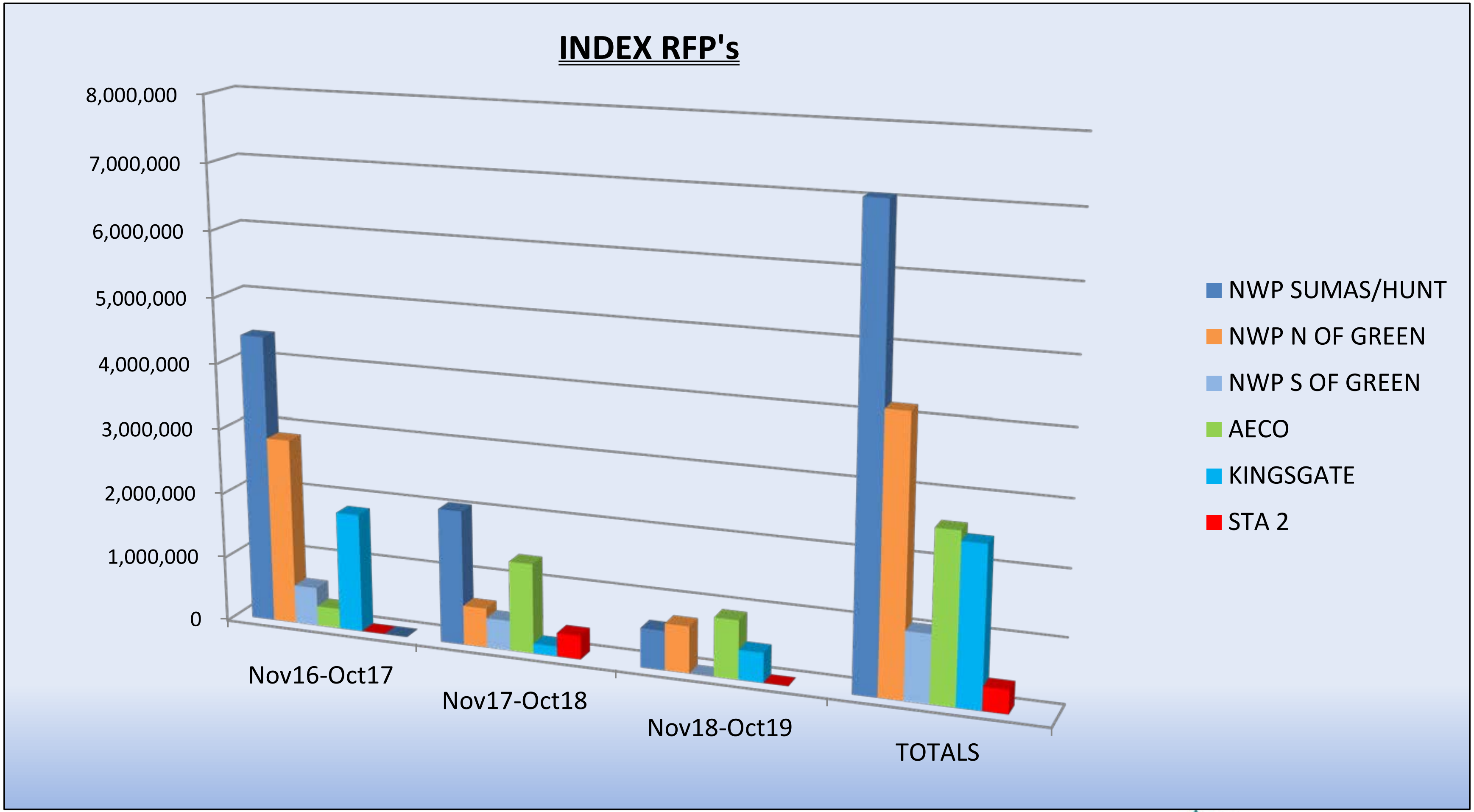
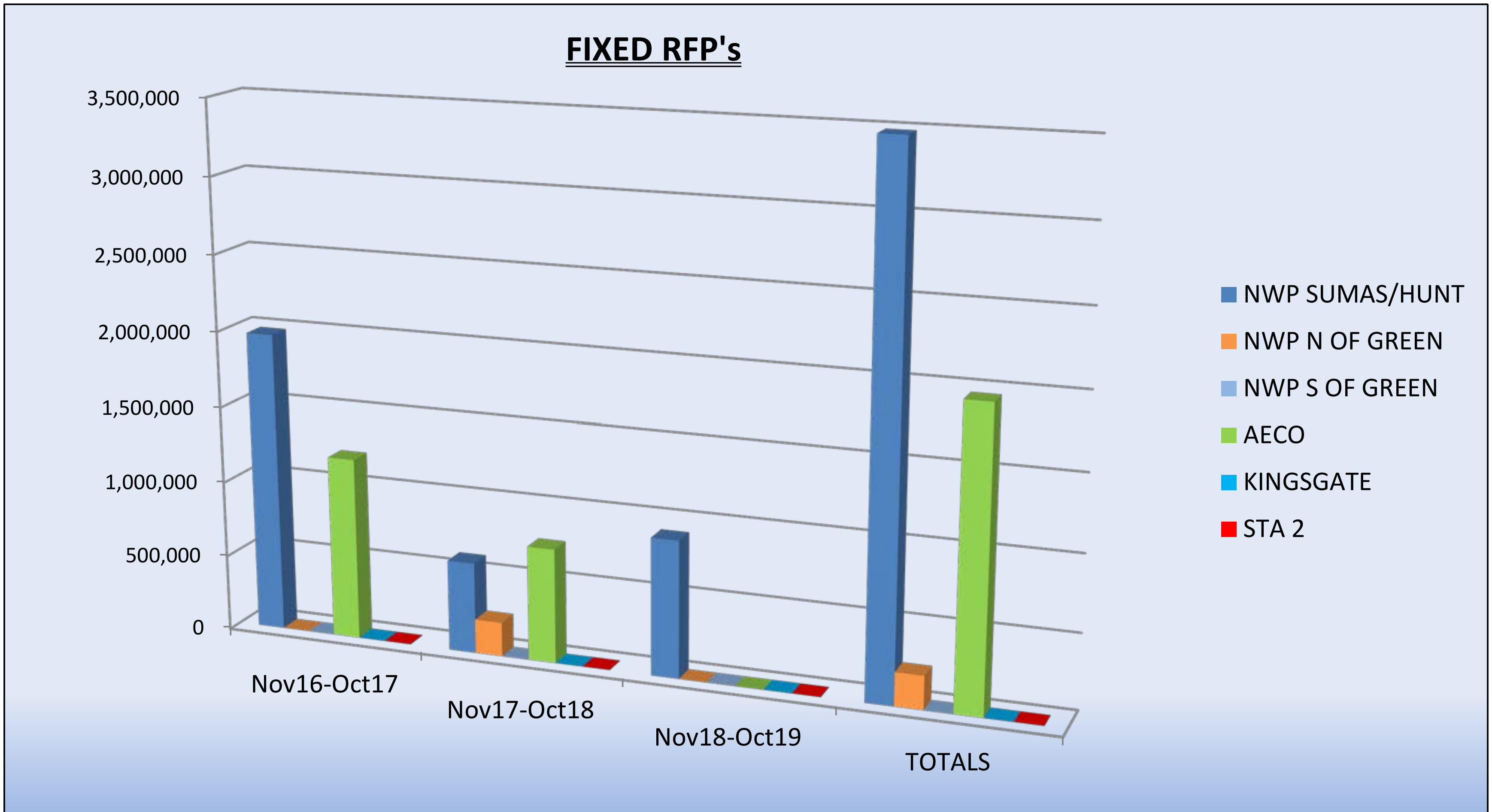

TOTAL RFP's
12,000,000
11,000,000
10,000,000
9,000,000
8,000,000
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
Nov16-Oct17
Nov17-Oct18
Nov18-Oct19
TOTALS
NWP SUMAS/HUNT
NWP N OF GREEN
NWP S OF GREEN
AECO
KINGSGATE
STA 2


INDEX RFP's
8,000,000
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
Nov16-Oct17
Nov17-Oct18
Nov18-Oct19
TOTALS
NWP SUMAS/HUNT
NWP N OF GREEN
NWP S OF GREEN
AECO
KINGSGATE
STA 2



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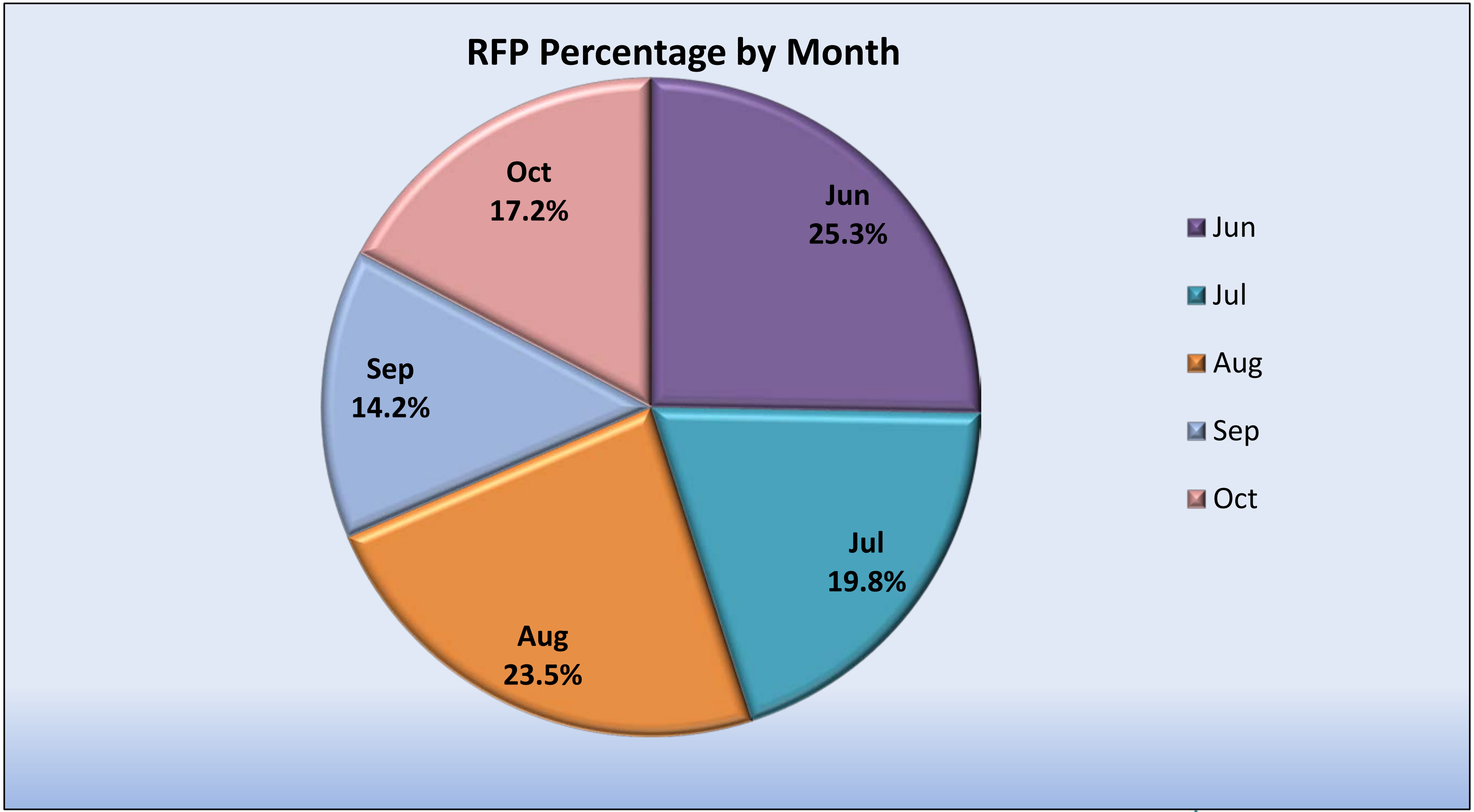

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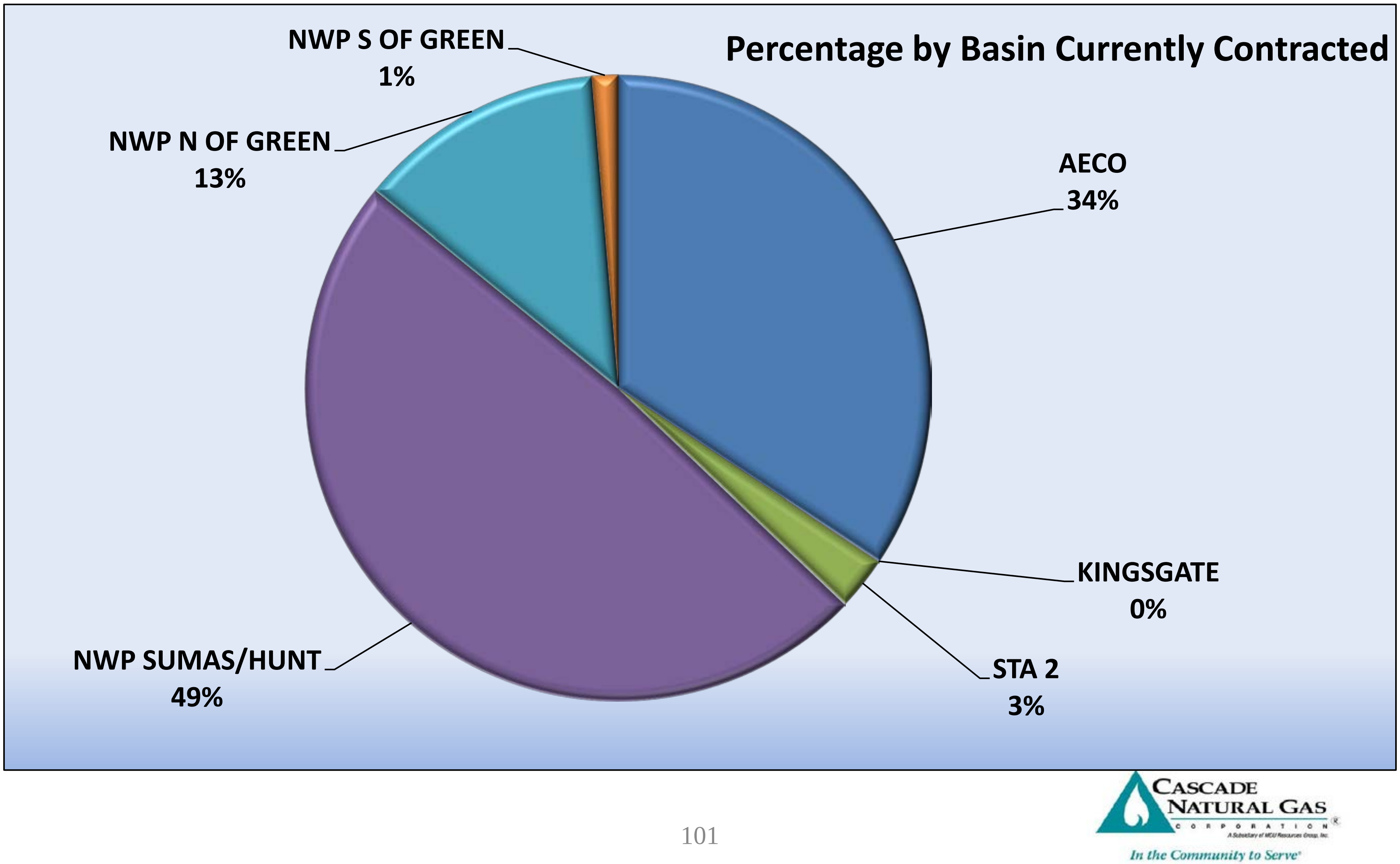
Percentage by Basin Currently Contracted
NWP S OF GREEN
1%
NWP N OF GREEN
13%
AECO
34%
KINGSGATE
0%
STA 2
3%
NWP SUMAS/HUNT
49%
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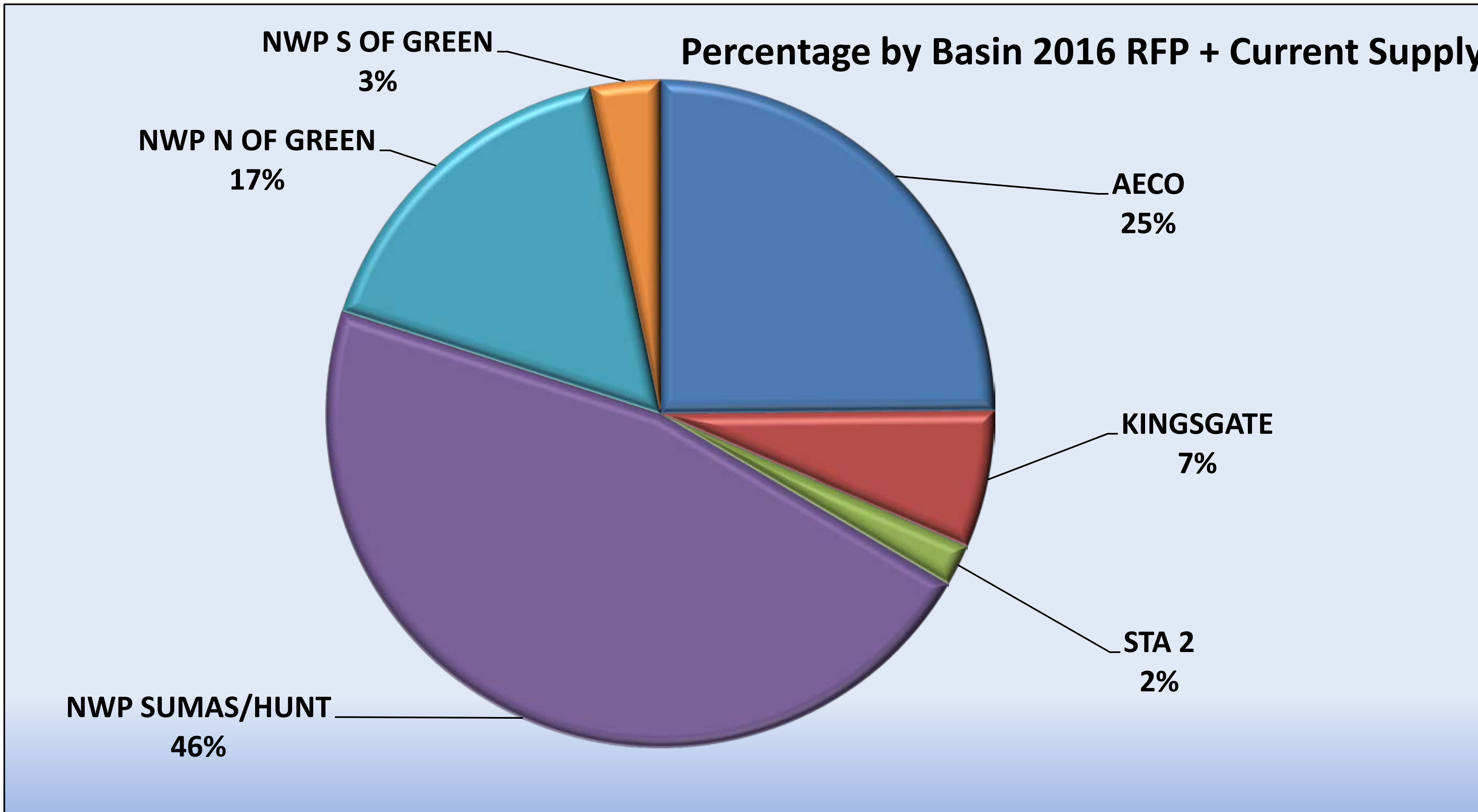
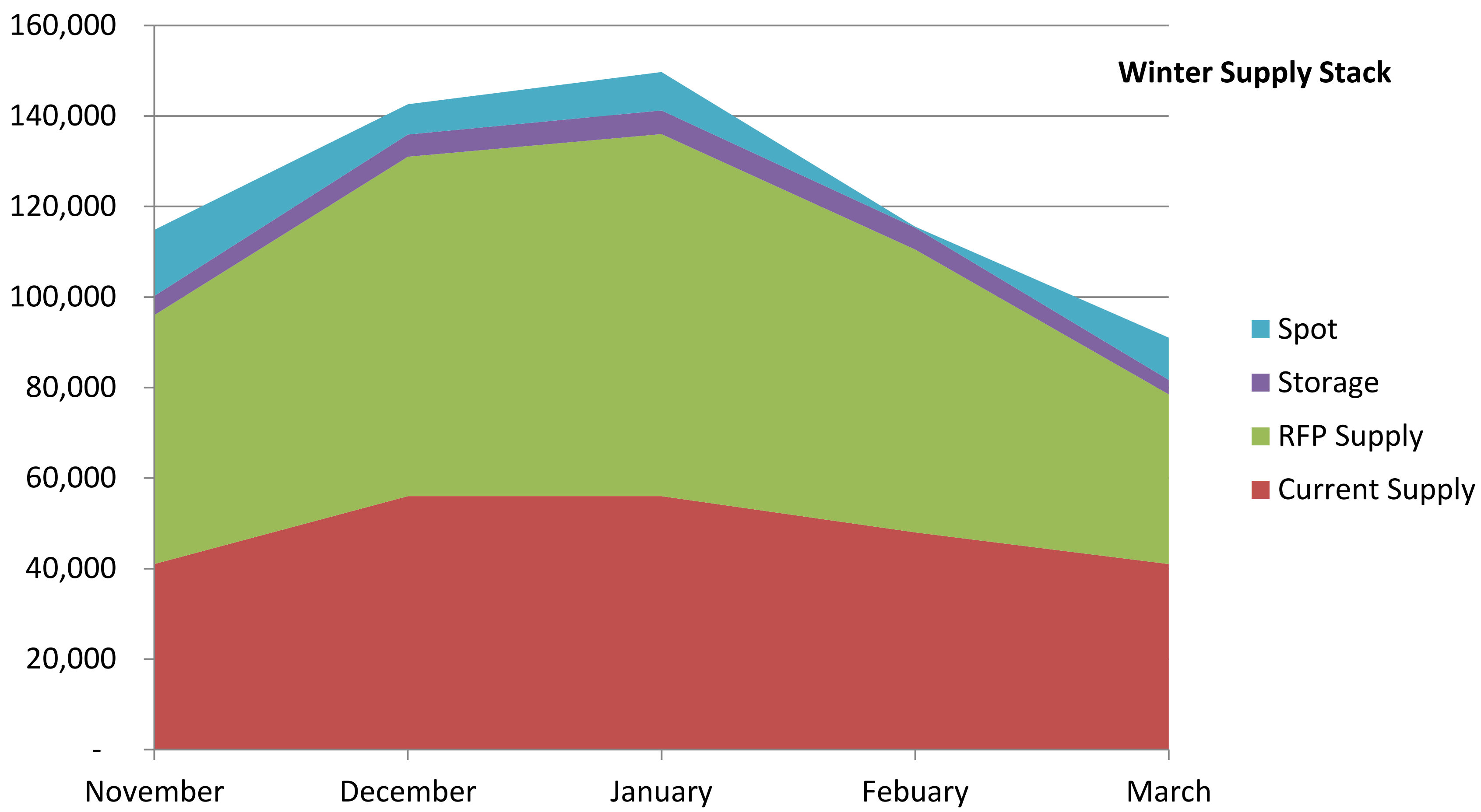
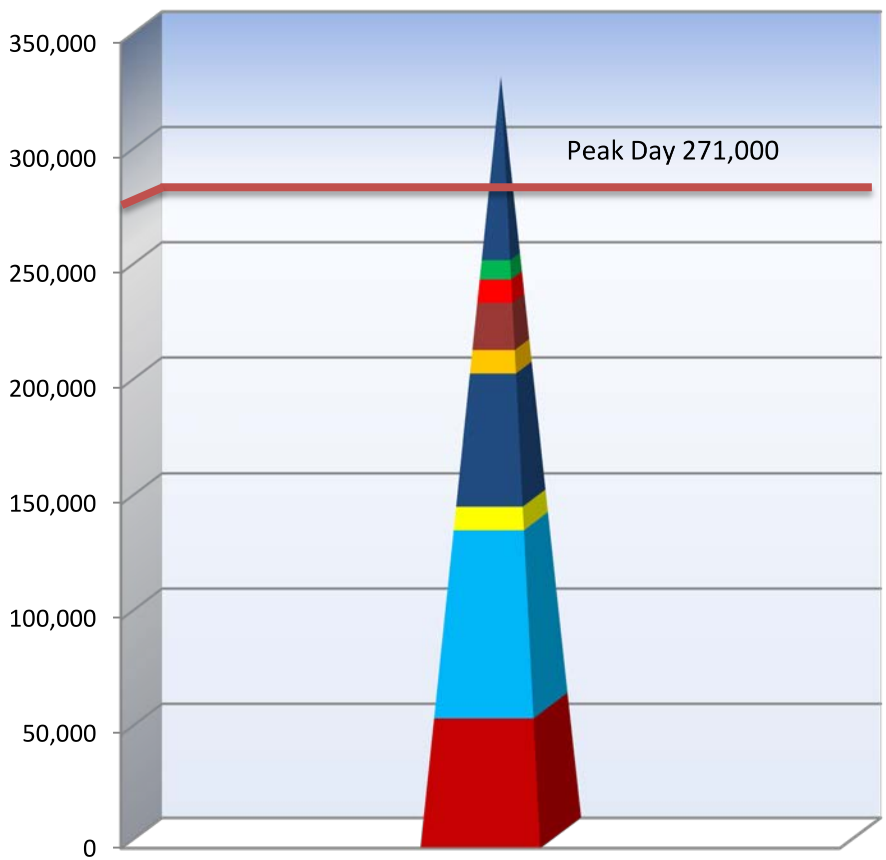

Percentage by Basin 2016 RFP + Current Supply
NWP S OF GREEN 3%
NWP N OF GREEN 17%
AECO 25%
KINGSGATE 7%
STA 2 2%
NWP SUMAS/HUNT 46%


Winter Supply Stack
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
-
November
December
January
Febuary
March
Spot
Storage
RFP Supply
Current Supply

Peak Day Stack Example

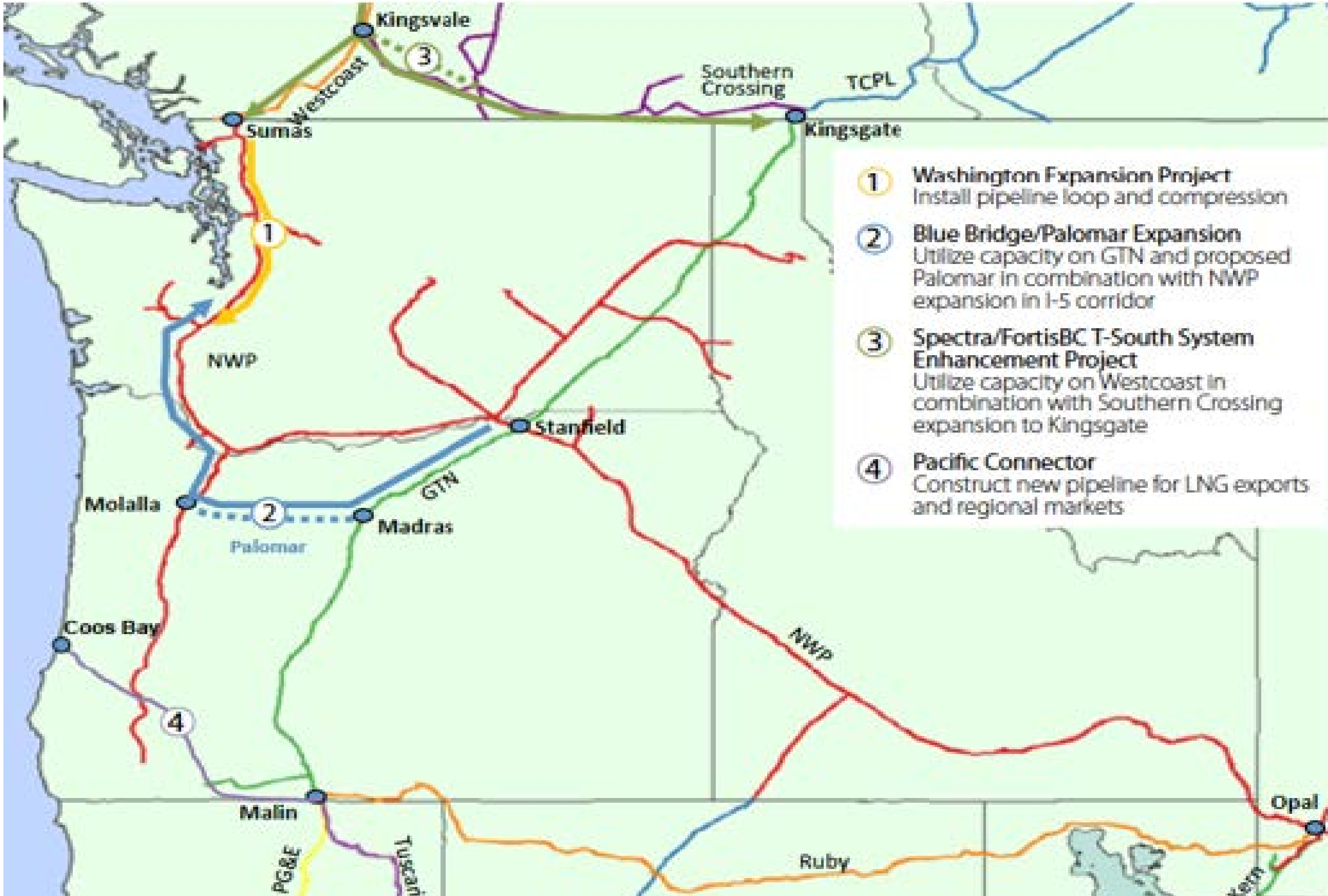


78,125	LS Storage
8,156	Pipeline Pack
10,000	3rd Party Citygate
20,000	Peaking Deal
10,000	Daily Spot Gas
56,366	SGS Storage
10,000	FOM Spot Gas
80,000	RFP Supply
56,000	Current Supply

Cascade Gas Supply Overview
Alternative Resources

Proposed Natural Gas Infrastructure Projects

(source: Northwest Gas Association draft 2016 Outlook)



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Washington Expansion Project

- In response to a request for an incremental 750 million cubic feet per day (MMcf/d) of capacity, Williams Northwest Pipeline (NWP) is planning to construct the Washington Expansion Project.
- 140 miles of 36-inch diameter loop to be constructed in 10 different segments in or near NWP's existing right-of-way along the I-5 corridor between Sumas and Woodland, WA, plus additional compression at five existing compressor stations.
- In conjunction with this project, NWP is also proposing an incremental scalable expansion from Sumas to markets in the I-5 corridor as far south as Molalla, OR.
- This phase of the project is not contingent upon the aforementioned expansion and could go in service fall of 2018.
- Opportunity to potentially address any shortfalls along the I-5 corridor

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Northwest Market Access Expansion (NWP N-MAX)/Trail West (aka Palomar)

- NWP is working with NW Natural and TransCanada GTN
- In conjunction with an expansion of the existing NWP system. The project would consist of a 106-mile, 30-inch diameter pipeline that would run from GTN’s mainline in central Oregon to a NW Natural/NWP hub near Molalla — enhancing delivery capacity to the I-5 Corridor.
- Project’s initial design capacity is 300 MMcf/d, expandable to 750 MMcf/d. It would be linked to the N-MAX project on the NWP system to deliver gas to other markets along the I-5 corridor.
- Potential to make additional supplies available to Central Oregon
- Potential to move supplies to I-5 corridor

Spectra T-South Expansions

- Spectra Energy continues to evaluate expansion of its T-South system to provide incremental delivery options for growing Western Canada gas supply to markets in the Pacific Northwest.
- All expansions on T-South would require pipeline looping and compression and can be brought into service between 2018-2020.
- T-South expansion options include the following from Station 2:
  - to Sumas delivering gas to the BC Lower Mainland and Northwest Markets
  - to Kingsvale delivering up to 450 MMcf/day gas to Fortis Energy's Southern Crossing system;
  - to Summit Lake delivering gas to PNG's pipeline system

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FortisBC Kingsvale–Oliver Reinforcement Project (KORP)

- Expanding Fortis Energy’s existing bi-directional Southern Crossing system (connecting Spectra’s T-South system at Kingsvale, BC, to TransCanada’s system at Yahk, BC)
- Would facilitate access to an additional 300-400 MMcf/d of AECO priced gas supply for westbound delivery to markets in the Lower Mainland of BC and the I-5 corridor where several new large industrial projects are proposed.
- The expansion of the Southern Crossing system will require a 100-mile pipeline-looping project on the Kingsvale to Oliver, BC, segment, as well as an expansion of Spectra’s T-South system from Kingsvale to Huntingdon to meet the incremental flow.

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Pacific Connector Gas Pipeline Project (PCGP)

- The Pacific Connector Gas Pipeline Project (PCGP) is a 232-mile 36-inch diameter pipeline extending from Malin to Coos Bay, OR.
- Williams and Veresen, Inc. are proposing PCGP to serve the Jordan Cove LNG export terminal, as well as potential regional markets between Malin and Coos Bay.
- PCGP includes 41,000 horsepower of compression to be installed near Malin yielding a total project design capacity of 1.06 Bcf/d.
- PCGP will provide access to supplies from Western Canada and the U.S. Rockies via interconnections with Gas Transmission Northwest and the Ruby Pipeline.
- This could be a potential source of additional supplies for the distribution system

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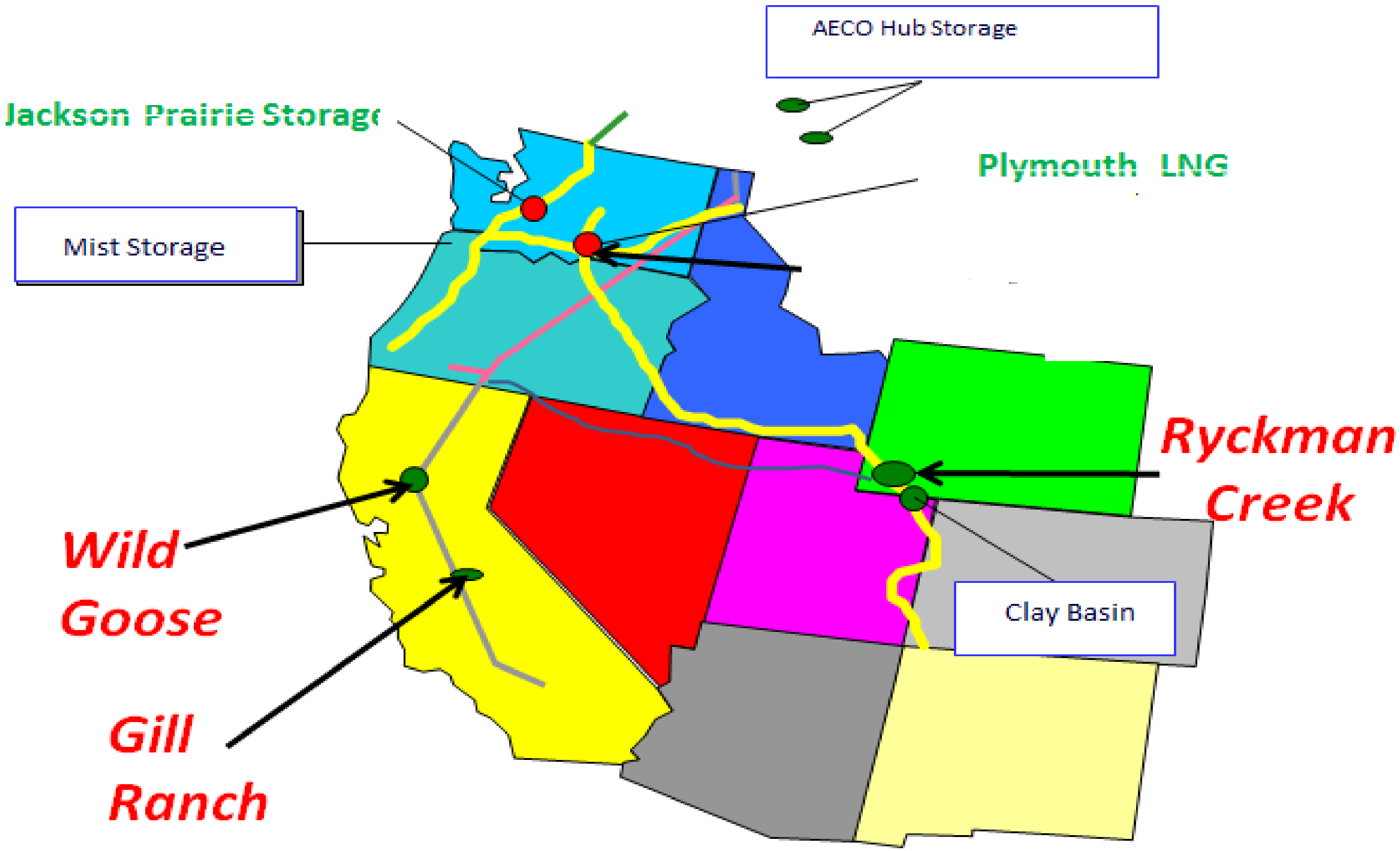
Regional Storage



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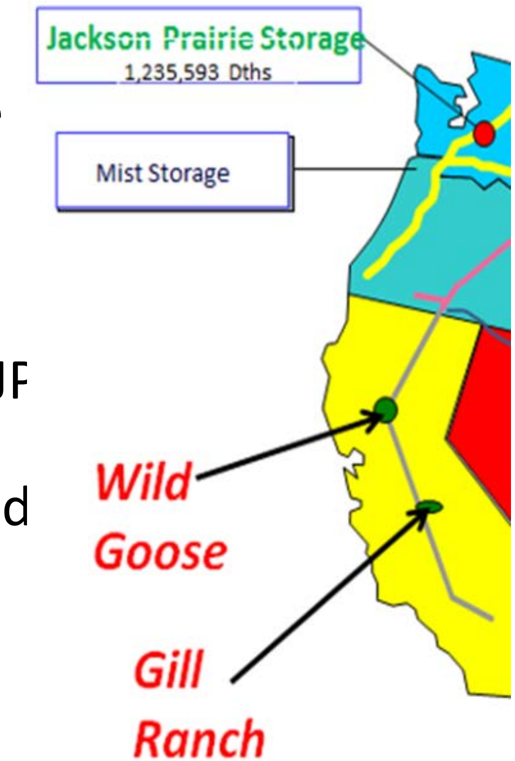
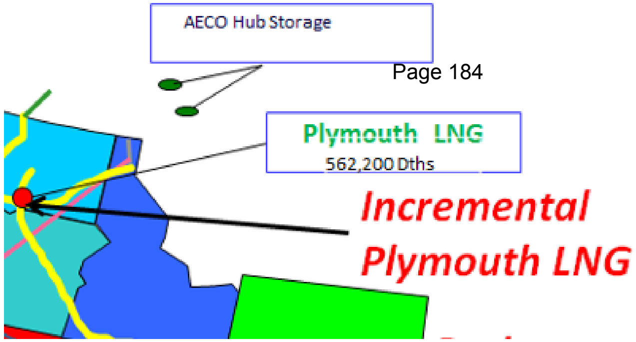
Jackson Prairie (JP)

- PSE, NWP and Avista Utilities each own an undivided one-third interest in the Jackson Prairie Gas Storage Project (Jackson Prairie), which is operated by PSE under FERC authorization
- Jackson Prairie is a potential resource for expansion opportunities. At this time, any future JP storage expansion capacity does not include transportation and therefore cannot be considered an incremental peak day resource.
- We will continue to look for exchange and transportation release opportunities that could fully utilize these additional resource options
- There are no current plans for immediate expansion of Jackson Prairie.



AECO Hub Storage



- The AECO Hub™, Niska's commercial natural gas storage business in Alberta, Canada, is comprised of two gas storage facilities:
  - Suffield (South-eastern Alberta)
  - Countess (South-central Alberta)
- Although the two AECO facilities are geographically separated across Alberta, the toll design of the NOVA (NGTL) system means that they are both, commercially, at the same point.
- Total gas storage and deliverability capacity of the AECO Hub™:
  - Working Gas Capacity 154 BCF
  - Peak Withdrawal Rate 3.05 BCF per day
  - Peak Injection Rate 2.75 BCF per day
- Capacity at one of the facilities are possibilities as alternative resources. Currently, there is no open season planned. However, some services are available for limited periods of time. Incremental transport involving Nova, Foothills, GTN and possibly NWP would be necessary.

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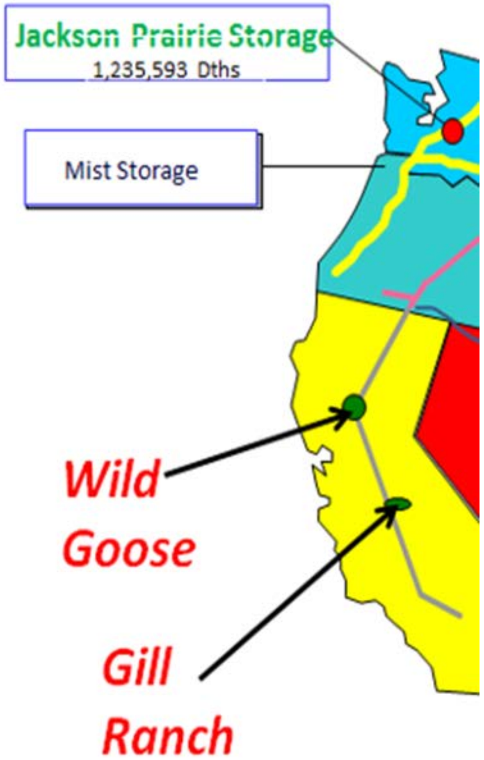
Wild Goose Storage

- Wild Goose is located north of Sacramento in northern California and was the first independent storage facility built in the state. The facility commenced full commercial operations in April 1999 and in April 2004 completed its first expansion. Customers have direct access to Pacific Gas and Electric's (PG&E) backbone system.

- Total gas storage and deliverability capacity at Wild Goose currently is as follows:

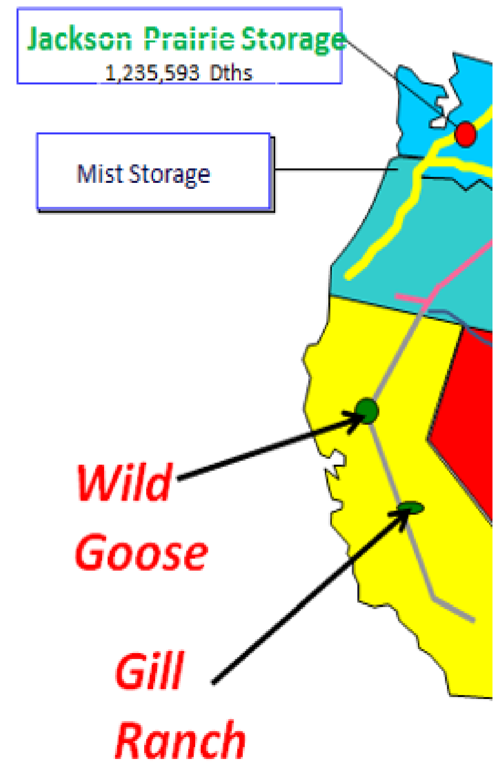
- Working Gas Capacity: 75.0 Bcf
- Peak Withdrawal Rate 950 mmcf/d
- Peak Injection Rate 525 mmcf/d
- Key Features

- Citygate pricing, liquidity, arbitrage opportunities;
- the ability to manage OFO/EFO's on the PG&E system; and
- supply reliability



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.
- GRS has the capacity to ultimately provide approximately 20 billion cubic feet (Bcf) of underground natural gas storage.
- The facility is located about 25 miles west of Fresno and includes an approximately 27-mile, 30-inch pipeline, which is connected to the PG&E Line 401 north of Panoche, Calif.
- The premium storage location offers a unique opportunity to access five interconnects.
- The site was developed in a joint agreement by Gill Ranch Storage, LLC, a subsidiary of NW Natural, and PG&E.
- The site has potential for future expansion.



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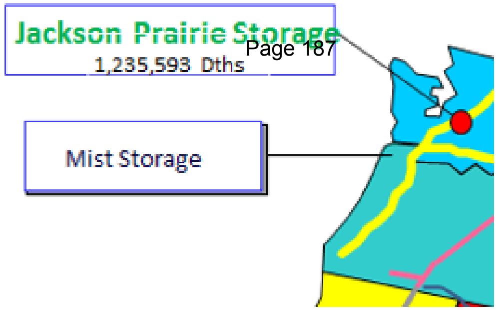
Mist



- NW Natural Gas Company, the owner and operator of the Mist underground storage facility near Portland, Ore., is investigating a potential expansion project to be completed in 2016-2017.
- We are modeling the assessing the cost-effectiveness of leasing storage capacity beginning November 2018, once Mist is built.
- This would also require expansion of NWP's interstate along the I-5 corridor and possibly across the Columbia Gorge. We may be able to acquire discounted winter only capacity from a third party from Mist to our citygates if NWP their system from Sumas to Portland (NWP I-5 expansion)

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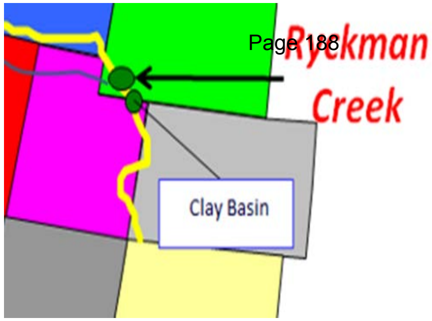
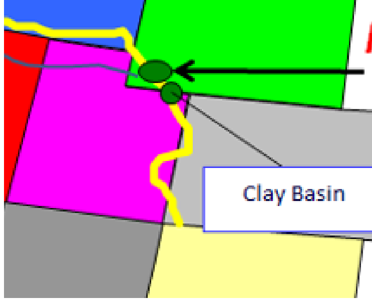
Clay Basin



- Questar Pipeline owns and operates the Clay Basin storage facility in Daggett County, Utah. This reservoir stores gas during the summer for withdrawal in the winter.
- Earlier this year Shell Energy offered to temporarily or permanently assign to CNGC their Clay Basin capacity prior to notice period.
- QPC stated they would accept a 1 year extension vs. the 3yr previously discussed, and CNGC would obtain annual renewal rights thereafter.
- Clay Basin would require incremental capacity from Overthrust Pipeline. Ruby was willing to consider allowing Cascade to re-align portions of our seasonal Ruby capacity to move gas during the heating season.
- We elected to pass on the opportunity at the time. First, we still have long-term concerns regarding Kemmerer constraints to address on NWP. Most importantly, we didn't know if we could make the case for Washington to absorb the bulk of Clay Basin's expense; OPUC would still ask why is Washington getting yet more storage when Oregon is still lacking a significant storage resource.
- We will consider Clay Basin again with the 2016 IRP.

Ryckman Creek Storage



- Ryckman Creek Resources, LLC, a wholly-owned subsidiary of Peregrine Midstream Partners, LLC
- Ryckman Creek is located in Uinta County, Wyoming, near the Opal Hub.
- Ryckman Creek 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.
- Ryckman Creek Gas Storage Facility is located near the town of Evanston, Wyoming and approximately twenty-five miles southwest of the Opal Hub.
- Ryckman Creek currently has interconnects with Questar Gas Pipeline, Kern River Transmission, Questar Overthrust Pipeline, Ruby Pipeline and Northwest Pipeline.
- Previously conducted a non- binding Open Season to determine the interest of prospective customers in contracting for up to 8 BCF of firm working gas storage capacity beginning April 1, 2013.
- Ryckman still has a bit of proving to do regarding reliability since the NRU fire a few years ago; the facility is up and running. Ryckman Creek began commercial operations in August 2012. The facility currently has approximately 25 Bcf under contracts of varying lengths (longest belonging to Anadarko through March 2023). A lengthy force majeure at Ryckman was lifted in January 2016.
- Still, even with the combination of plunging gas prices, bankruptcy and a fire the facility is still open. Ryckman is currently flowing about 60-70,000 dths day to Ruby.

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Conclusions about the proposals

- Historically, our incremental storage focus has been directed at providing Oregon with a larger storage resource other than the 10% of JP/LS they currently have.
- All the alternatives except Ryckman require incremental GTN capacity.
- Ryckman storage would utilize our 15,000 dths/day of winter only capacity that would be used for both storage activities and regular nomination activities.
- The two California storage alternatives would also require California Gas Transmission capacity to Malin. The demand charge is huge - $1.68 p/dth
  - Ruby still is an option for the California storage, but due to rate stacking Ruby would be at a lower contracted level, primarily for the purposes of injecting Rockies gas and to provide supply diversity in the storage facility.
- Ryckman Creek appears to be the least expensive and most flexible option; however, Ryckman's on-going operational difficulties are a concern.
- All storage alternatives will be modeled for the 2016 IRP. Resource Planning will provide an update on modeling results at a GSOC meeting later this summer.

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Major resource issues on the horizon

- **Addition alternatives to be considered during IRP process**
  - **NWP I-5 Expansion**
  - **Realignment of MDDOs to citygates**
  - **Palomar/Cross Cascades**
  - **Pacific Connector**
  - **Incremental Nova**
  - **Incremental Foothills**
  - **Incremental GTN (north to south)**
  - **Biofuel**
  - **Satellite LNG**
  - **Mist Storage**
  - ***AECO Storage***
  - ***Wild Goose Storage***
  - ***Gill Ranch Storage***
  - ***Ryckman Creek Storage***

- Began discussions with Niska Partners to gather information to model AECO Hub Storage in the 2016 IRP. In addition, we will be considering Wild Goose, Gill Ranch, Mist and Ryckman Creek storage

- Working with GTN to develop a narrative to explain how our long path capacity can be used to meet peak day shortfalls.

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NEXT STEPS

- TAG 3 is scheduled for August 23rd and will be held at Cascade's Headquarters in Kennewick, WA.
- TAG 3 will cover Conservation, Distribution System Planning, and Planned Scenarios and Sensitivities.
- Other items Cascade has not mentioned?

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Integrated Resource Plan
Technical Advisory Group Meeting #2

Tuesday, July 19, 2016
Seattle-Tacoma International Airport
Conference Center

2nd External TAG Meeting

07/17/2016 – 09:00-11:30 AM

Presenters: Mark Sellers-Vaughn & Brian Robertson

In attendance: Mark Sellers-Vaughn, Brian Robertson, Mike Parvinen, Chris Robbins, Eric Wood, Bruce Folsom – Consultant, Connor Reiten – NWGA, Deborah Reynolds – WUTC, Kathy Scanlan- WUTC

Called in: Bob Morman, Garret Senger, Laura Flanders - NWP, Chad Luginbill, Josh Romine, Tom Pardee – Avista, Monica Cowlisha, Carolyn Stone, Pam Archer, Mark Chiles, Deborah Reynolds, Ed Finklea – NWIGU, Brian Cunnington.

Minutes by: Carolyn P Stone

The meeting began with introductions to those attending in person and by phone. Bruce Folsom talked briefly about his experience with IRP's. Garret Senger thanked everyone for attending. Bob Morman reiterated that he is committed to the IRP and thanked everyone.

IRP Staffing & Support

Mark Sellers-Vaughn went over the Agenda and then began the meeting discussing new and changed staffing for the IRP as follows:

1. Brian Robertson is now a Senior Resource Analyst and will head up the IRP work.
2. One additional analyst has been hired and will start at the end of this month.
3. Another analyst will be hired soon as well.
4. The IRP staff has a new Consultant, Bruce Folsom.

Mark went over the deliverables Bruce will provide for Cascade. He explained that Bruce has already suggested areas for improvement. His input will provide transparency for stakeholders.

Bruce went over his experience and said that he believes Cascade to be 100% committed to the IRP.

Mark also mentioned that today's meeting has a lot of information contained within and if there is some confusion or further need for clarification on this material another meeting will be scheduled.

Case Demand Study

Brian Robertson then went over his Demand Forecast, starting with Slide #7. Brian explains the overview shows the changes from the old forecast model to the new. He emphasized the model is flexible as many inputs can be modified.

Question: How big is Non-core load?
Answer: Mark said Non-core has the largest load but we only supply distribution services to Non-core customers, not transport.

Question: Would CNG provide more descriptive labels in the last 3 columns, referencing Slide 16?
Answer: YES

Brian explained the use and calculation of Heating Degree Day (HDD) on Slide #17. On Slide 18 & 19 you can see what the difference is in using a 60 degree HDD vs. a 65 degree HDD. Demand is flat using 65, but increases using 60.

Question: Is that true with all scenarios? Did you calculate using each CityGate?
Answer: Brian explained that each CityGate has different temperatures so it would be possible to test this using Citygate but "tricky".

Question: Does your weather data show that cold or warm weather "trends" at the beginning or end of the years used?
Answer: I do not know, but I can say that for year 2015 warmer temperatures are more recent. We can look this up for you.
***Staff would like that sent to them*.

Brian then went over the Growth Data. This data is obtained from Woods & Poole's (W&P) State Profiles

Question: Is this data used for just CORE or all customers?
Answer: Just Core customers. Mark mentioned that the average data is over a 3-5 year time period and that there must be care in how this information is applied to certain locations.

Question: How do the W&P numbers compare with the State Economist Report? This analysis will likely be needed.
Answer: We have not done this analysis yet.

Brian then went over the Commercial and Industrial Growth formulas and definitions used by W&P. He stated that the final Demand forecast is done by year, month, rate schedule and CityGate.

Brian explained that the HDD weighting is applied to CityGates to determine which day produced the coldest day in 30 years (1986-2015). This ensures Cascade can plan for that coldest day. The coldest day was Dec 21, 1990.

Question: What was the coldest day reported in the last IRP?
Answer: The same date. Although this coldest day hasn't happened in recent years it is still applied to the forecast.

Question by CNG: Do you want us to prepare a forecast using the 2014, unacknowledged IRP or a narrative comparing 2014's IRP to 2016's?
Answer: I don't know, I will ask the commissioners and get back to you.

Question by CNG: Mark asked if CNG should show the rate schedules for each of the regions?
Answer: Staff said yes, at some point.

Question: Staff asked if it is more useful to have these graphs to show residential vs commercial or number of therms?
Answer: Mark said it depends on the CityGate.

Cascade Gas Supply Overview – Current Resources
Eric Wood discussed current resources, transport, and supply.

The next Slide #88 shows our NWP (Northwest Pipeline) Transport by transport contract. This slide is a little hard to see but Eric notes that some contracts drop off during the summer months.

Question: GTN has a TF-2 rate schedule?
Answer: TF-2 is essentially storage but treated as "firm". TF-1 is considered "firm". Laura Flanders from NWP, on the on phone agrees this is correct. Mark stated that historically TF-2 came out of JP (Jackson Prairie storage facility) but 2 years ago that changed and Plymouth became available. We can now access Plymouth 100% on a Peak Day!

Eric showed the "Transport Summary" graph Slide #91 & the Impact of Constraints, OFO's and Entitlements explanation Slide, #92. He explains that the OFO's and Entitlements are "tools" NWP uses to get customer behavior to change.

Question: What does "drafting" mean?
Answer: That is when the gas that is being delivered is less than that being used. This means we "owe" the pipeline more gas.

Question: What is an "OFO"?
Answer: That is an "Operational Flow Order". Eric gives an example of a Kemmerer OFO. There can be a constraining in this area and not enough gas can get through to satisfy NWP customers. In this case NWP wants shippers to modify their behavior to redirect supply. NWP can call individual shippers.

Eric then discussed Gas Supply's Asset Management Agreement (AMA) with Tenaska Marketing Ventures (TMV). TMV provides scheduling services, isolates CNG from cuts and pipeline operational issues, and assumes risk that CNG cannot tolerate, Slide #93.

Eric then discussed the portfolio that was agreed upon by the Gas Supply Oversight Committee (GSOC).

Mark clarified that the GSOC consisting of senior management (Regulatory, Gas Supply, Finance & Operations executives) approves the Portfolio and reviews our Risk Management policy and our Hedging Policy.

On Slide #100 it shows RFP Percentage by Month, and Slide #101 by Basin. Sumas/Hunt is the highest.

Question: Are these "actual" purchases?
Answer: These are planned purchases. Some have already been purchased but not all.

Mark mentioned that CNG has 25 signed NAESB's and Comet automatically sends out RFP's to all of our suppliers (who are signed up with Comet) at the same time. Comet provides liquidity and transparency.

Mark discussed the "Hedging Strategy". CNG has been contributing to a docket regarding our Hedging Strategies for LDC's and the possibility of Financial Hedges. CNG is waiting to see what the other LDC's have done. We are working with Staff and other stakeholders on this matter!

Cascade Gas Supply Overview Alternative Resources

Mark started this presentation by mentioning that in the previous IRP there were indications of shortfalls in Oregon and parts of Washington. He will talk more about this in Tag meeting #4.

Mark then discusses potential storage solutions. Choices include Mist, AECO Hub, Clay Basin, Wild Goose, Ryckman Creek & Gill Ranch.

*Ryckman Creek - is near OPAL in Wyoming. This would be an ideal location for us but it has a reliability concerns.
*Wild Goose - has a high demand cost at .41 per Dth! Customers have access to PG&E system.
*Gill Ranch - charges $1.16 for transportation, located in California. This site has potential
*Mist storage may not be available now. This is owned by Northwest Natural. It is a long way to get storage!
*Jackson Prairie – is a potential resource for expansion but doesn't include transportation so can't be used as a peak day resource. There are no plans to model JP as an alternative resource at this time.
AECO Hub – Possible alternative.
Clay Basin – Not a good fit for our system at this time due to possible constraints and financial concerns.

All of the above mentioned storage resources except Ryckman Creek require incremental GTN capacity!

Mark then showed Slide #121, Major Resource Issues on the horizon…

Question: Mike Parvinen asked if these are resources in which someone else would be the "driver"?
Answer: Mark said we wouldn't "drive", we would "zig zag"! We would use the one which fits into our optimum Portfolio.

Mark explained that the ultimate decision will be made by the GSOC including analysis. The IRP is a "**tool**" not the end result!

Question: There are a lot of stakeholders here today, but some are missing. How can we make sure everyone sees this presentation?
Answer: Mark reassures that everyone gets the material and can make comments and states that CNG will be happy to come to your shop for a day and explain everything but reminds that Stakeholders have some responsibility to look at the materials and provide input!

Deborah asked if there will be minutes. She also said perhaps Mark could state who is "expected" to attend. She mentioned that it might be worth a call to Public Council.

Next Steps (Slide #122)

1. TAG #3 is on August 23rd, all day at the Kennewick GO
2. TAG #3 covers conservation, distribution system planning, planned scenarios & sensitivities
3. Other items??

Cascade Natural Gas Corporation

Integrated Resource Plan
Technical Advisory Group Meeting #3

Tuesday, August 23, 2016

Cascade HQ – Kennewick, WA

AGENDA

- Safety and housekeeping items
- Introductions
- Demand Side Management
- IRP Carbon Assumptions
- Market Outlook and Long Range Price Forecast
- Price Elasticity
- Scenarios, Sensitivities Planned
- Avoided Costs Methodology
- 2016 IRP Timeline
- Adjournment

DEMAND SIDE MANAGEMENT

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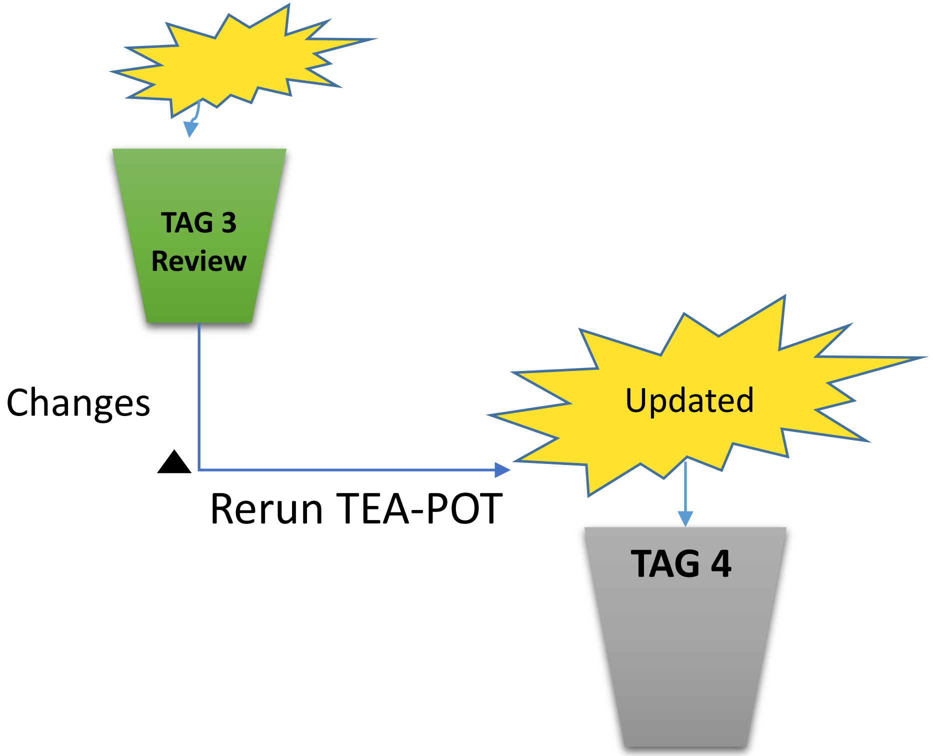
Purpose [of re-Running TEA-Pot]

Cascade Natural Gas uses Nexant Inc.'s in house developed Microsoft Excel-based modeling tool – TEA-POT (Technical/Economic/Achievable Potential) to run multiple scenarios to establish our market potential savings based on variable inputs within our Washington Service territory.

TEA-POT was rerun with updated inputs for the Demand Side Management Chapter of Cascade's 2016 Integrated Resource Plan. For the first time, it was run at the climate zone level of granularity, with separate unique inputs for each of the three geographic service territories.

This run represents proposed revisions to the Conservation Incentive Program tariffs discussed with our Conservation Advisory Group which will be submitted to the WUTC in September.

Key Inputs



- Long term discount rate updated to 3.52% from 4.17%, derived from the average U.S. 30 year mortgage.
- Inflation rate – decreased from 2% to 1%.
- Updated transmission loss rate of 0.1348%.
- Revised Administrative Budget forecast -Residential \$550k based on transition to in-house rebate processing. Commercial/Industrial expected total investment increased to \$900k for additional outreach efforts.
- New proportional measure category cost distribution.
- Updated Load Profile
- New Demand Forecast & Avoided Costs* by Climate Zone.

*NOTE – Avoided Costs differ from July and may be updated one last time in September.

NEW SCENARIOS

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Scenarios

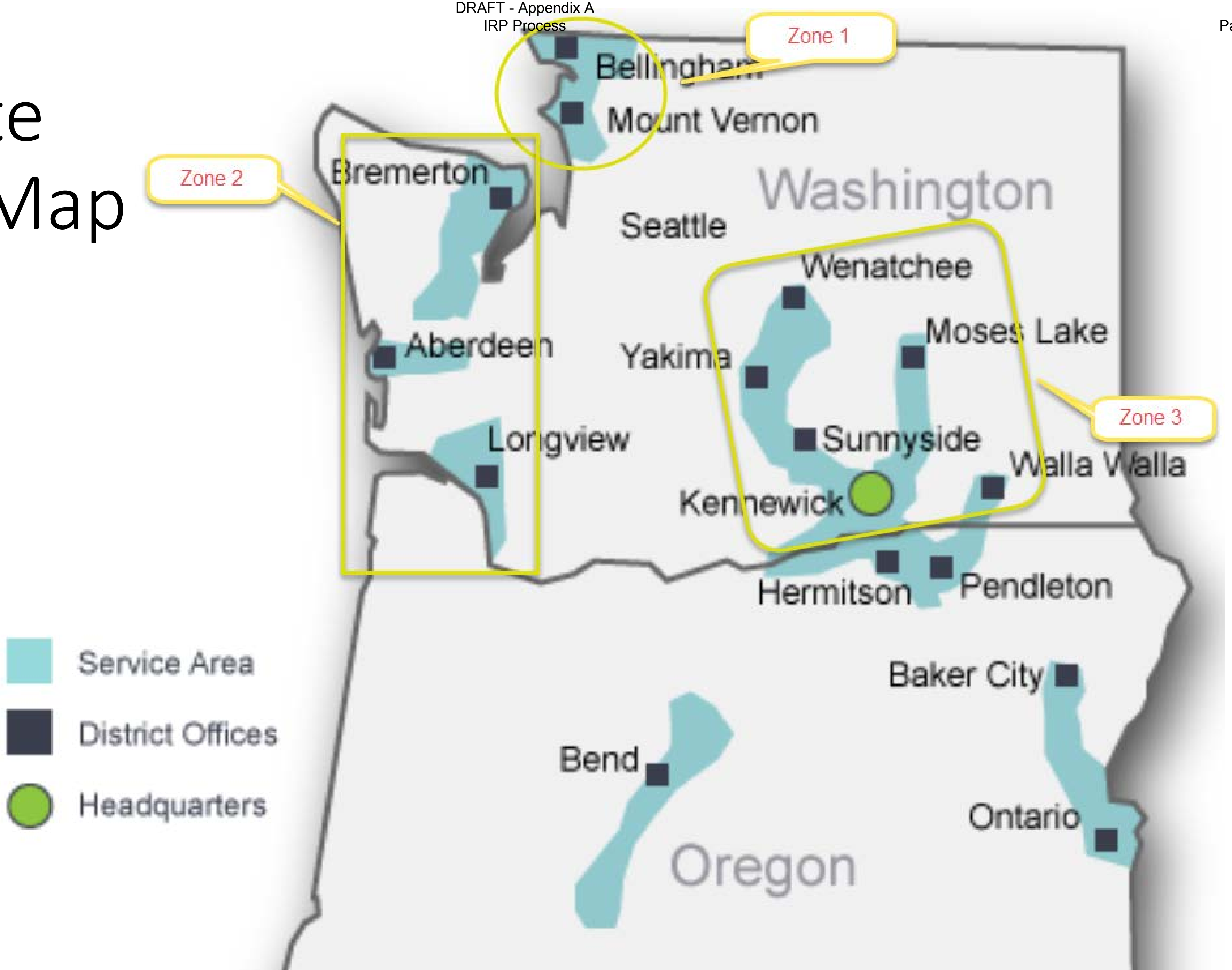
Residential

- Uses measures offered under the new proposed tariff
- A mix of 30 and 50 percent of incremental costs for the incentive level, dependent upon the measure’s cost-effectiveness – as per consultation with the CAG.

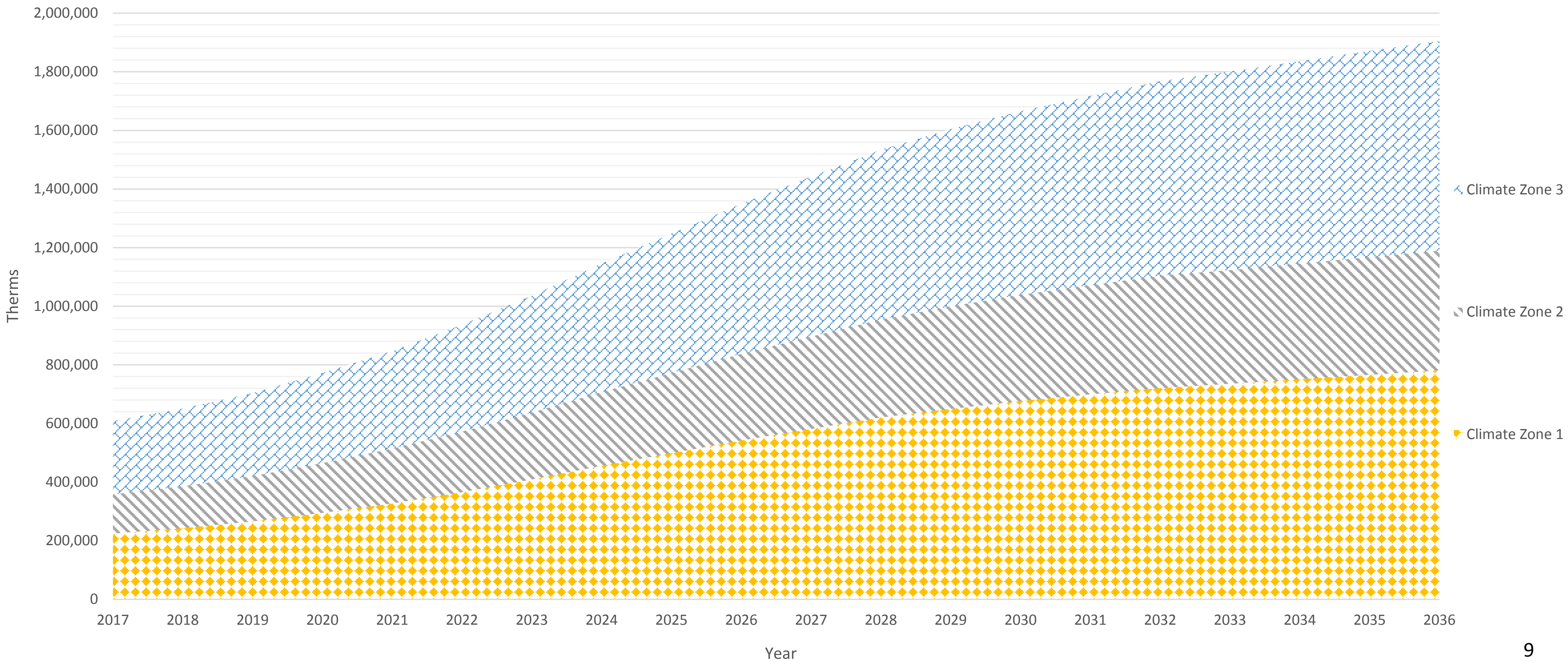
Commercial & Industrial

- Includes ALL measures from the Nexant Potential Study to reflect both Custom and Prescriptive program offerings
- A mix of 30 & 50 percent incentive levels based on each measure’s cost-effectiveness

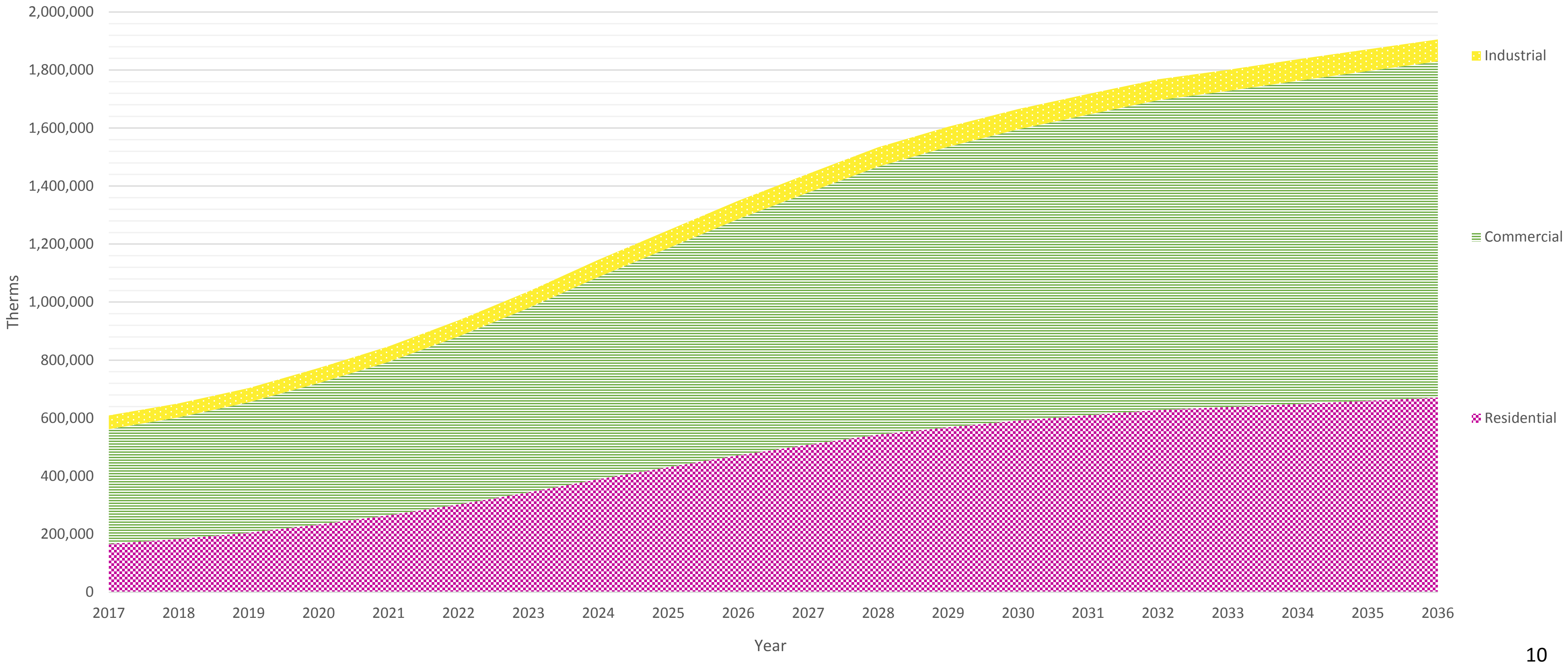
Climate Zone Map



Full Portfolio by Climate Zone



Full Portfolio by Customer Class



REGIONAL AWARENESS

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Areas of interest

- Clean Air Rule
- NEEA Regional Market Transformation Collaboration
  - Building Stock Studies
- GUEP (Georgetown Utility Energy Prize) & other community involvement

DSM IN THE IRP

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Noteworthy Changes

- The DSM Chapter will be an Executive Summary in accordance with the commitment made to transition towards a separate Conservation Plan provided each December where the majority of the energy-efficiency planning process will take place
- The majority of the Low Income program elements have been pulled out of the IRP to be addressed in the annual Conservation Plan per the July Conservation Advisory Group meeting
- Smoother assimilation into the other IRP chapters will be reflected by moving from statewide conservation forecasts to a climate zone granularity. Focus will also be placed on how the Company incorporates the goals into its resource allocations and how the Company has the pieces in place to make sure its achievement potential is reached, including insights into items needing to be accomplished in the future10 year range to meet its goals
- The DSM Chapter will discuss the Company's motivation (through policy, commission directive, etc.), what has been accomplished, and how the Company is going to move forward including what the Company will do differently to accomplish our goals in the near future
- Contains information pertaining to the Company's study needs, Company's regional collaborative efforts and the long-term benefits to its service territory in relation to those efforts

Residential Scenarios

- Uses measures offered under the new proposed tariff
- A mix of 30 and 50 percent of incremental costs for the incentive level, dependent upon the measure's cost-effectiveness – as per consultation with the CAG.

Residential Measures' Incentive Levels

30% of Incremental Costs

- Tankless Hot Water Heater
- All Non Equipment Measures:
  - Insulation
  - Air Sealing
  - Built Green®
  - ENERGY STAR®
  - Entry Door
  - ESKs

50% of Incremental Costs

- Water Heater 0.67 EF
- Combination Hydronic Space & Water Heat
- Furnace, 95 percent AFUE
- Hearths

Commercial & Industrial Scenario

- Includes ALL measures from the Nexant Potential Study to reflect both Custom and Prescriptive program offerings
- A mix of 30 & 50 percent incentive levels based on each measure's cost-effectiveness

Commercial: Equipment Measures

30% Incentive Level

- Combination Boiler and Hot Water Heater
- Combination Oven
- Conveyor Oven
- Direct Fired Radiant Heater
- High Efficiency Condensing Boiler
- High Efficiency Condensing Unit Heater 92% AFUE
- High Efficiency Non-Condensing Unit Heater
- High Efficiency Tank Condensing Water Heater
- High Efficiency Tankless Water Heater
- High Efficiency Water Heater
- Solar Hot Water Heater
- Heat Pump Water Heater
- Natural Gas Heat Pump

50% Incentive Level

- ENERGY STAR
- Convection Oven
- ENERGY STAR Fryer
- ENERGY STAR Griddle
- High Efficiency Condensing Furnace
- High efficiency steam cooker

Commercial: NON-Equipment Measures

30% Incentive Level

- Boiler Power Burner
- Boiler Repair/Maintenance
- Boiler Stack Economizer
- Boiler Steam Trap
- Boiler vent damper
- Boiler Waste Water Heat Exchanger
- Duct Sealing and Insulation
- Faucet Aerator
- Floor Insulation
- Heat Recovery
- Hot Water Temperature Reset
- HVAC Controls
- HVAC System Commissioning
- Low Flow Showerhead
- Low-flow Pre-Rinse Spray Valve
- Low-temp Door-Type ENERGY STAR Dishwasher
- Ozone injection laundry systems
- Pool Cover
- Pool Spa Solar Heat
- Refrigeration system superheat recovery DHW
- Roof insulation (retrofit only)R-45
- Solar Wall
- Steam System Efficiency Improvements
- Variable Volume Air System
- Wall insulation - Tier 2: Min R-19
- Windows - Non-Tinted AL Code to Class 36
- Windows - Non-Tinted AL Code to Class 45
- Windows - Tinted AL Code to Class 36
- Windows - Tinted AL Code to Class 45
- Ventilation Hood / Makeup Air

50% Incentive Level

- Boiler Pipe Insulation
- Demand Controlled Ventilation
- Drainwater Heat Recovery
- High Efficiency Commercial Gas Clothes Washer
- Hot Water Pipe Insulation
- Hot Water Temperature Setback
- Motion Faucet Controls
- Multi-tank Conveyor ENERGY STAR Dishwasher
- Recirculation Controls
- Roof insulation (retrofit only) R-30
- Wall insulation (Retrofit Only) R-11
- Windows - Add Argon to Vinyl Lowe
- Windows - Add Low E and Argon to Vinyl Tint
- Windows - Add Low E to Vinyl Tint
- Windows - Non-Tinted AL Code to Class 40

Industrial Measures

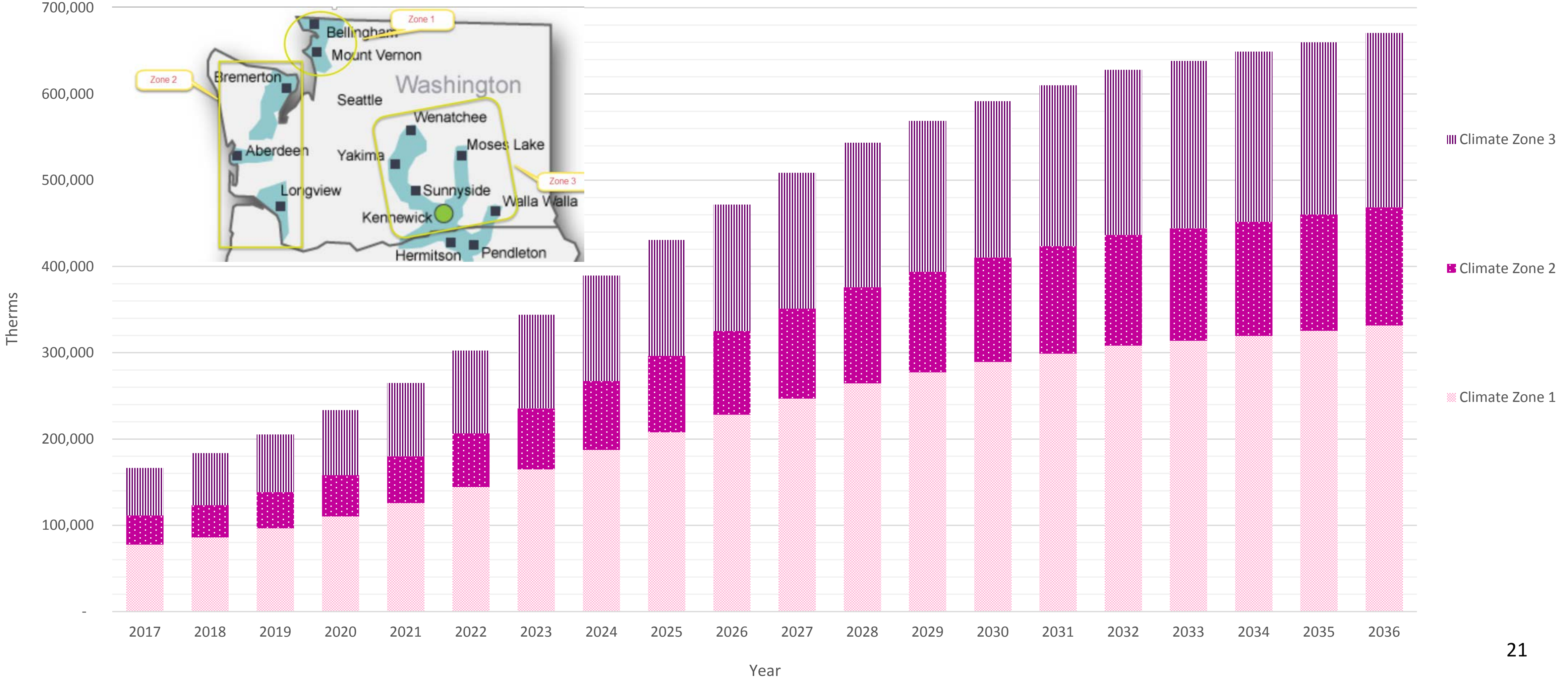
50% Incentive Level

- Direct Fired Radiant Heater
- Demand Controlled Ventilation
- Improved Process Heating Controls
- Optimized Furnace Operations/Improved O&M
- Windows - Add Argon to Vinyl Lowe
- Windows - Add Low E and Argon to Vinyl Tint
- Windows - Add Low E to Vinyl Tint

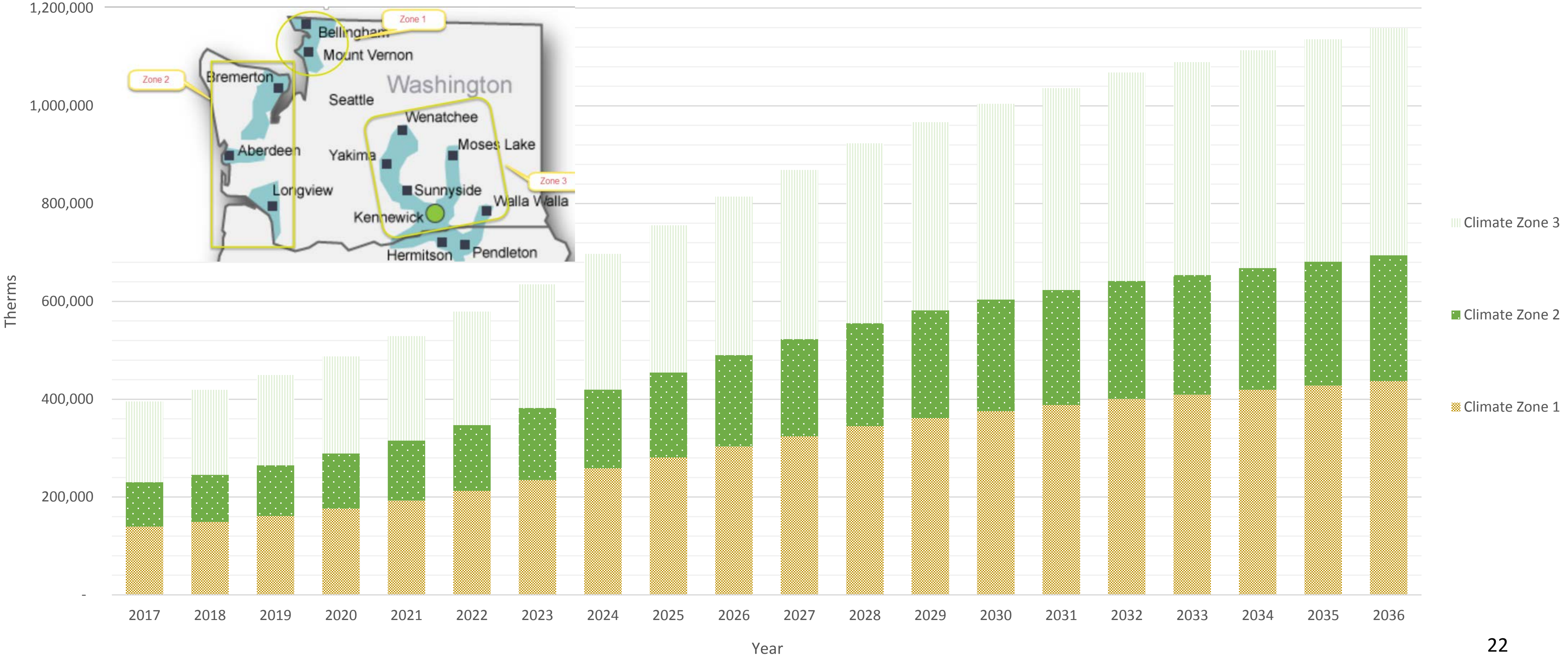
30% Incentive Level

- Condensing Boiler
- Condensing Unit Heater 92% AFUE
- Non-Condensing Unit Heater
- Process Heating: HE Furnace
- HE Condensing Furnace
- Boiler Power Burner
- Boiler Repair/Maintenance
- Boiler Stack Economizer
- Boiler Steam Trap
- Boiler vent damper
- Duct Sealing and Insulation
- HVAC Controls
- HVAC System Commissioning
- Refrigeration system superheat recovery
- Roof insulation (retrofit only) R-30
- Roof insulation (retrofit only) R-45
- Space Heating O&M
- Steam System Eff. Improvements
- Wall insulation (retrofit only)R-11
- Wall insulation (retrofit only)R-19
- Waste Water Heat Exchanger
- Windows - Non-Tinted AL Code to Class 36
- Windows - Non-Tinted AL Code to Class 40
- Windows - Non-Tinted AL Code to Class 45
- Windows -Tinted AL Code to Class 36
- Windows -Tinted AL Code to Class 45

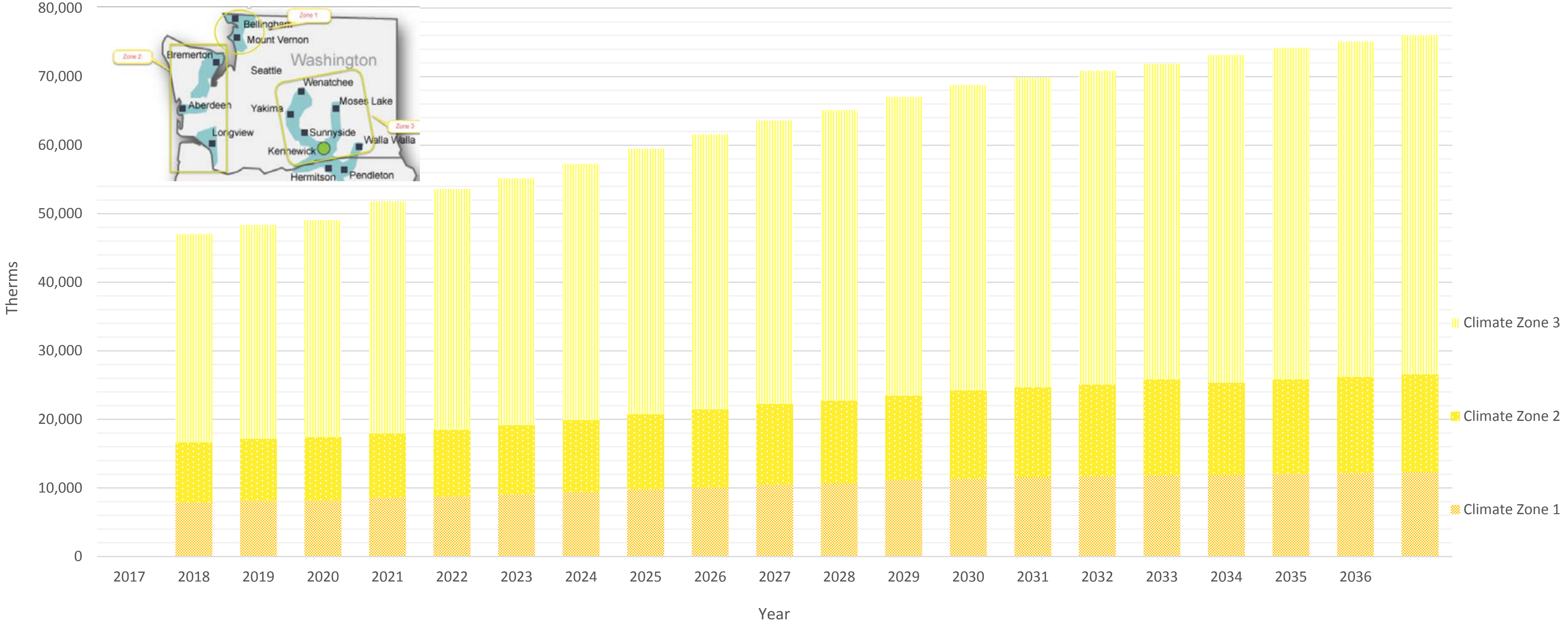
Residential Conservation Forecast Potential



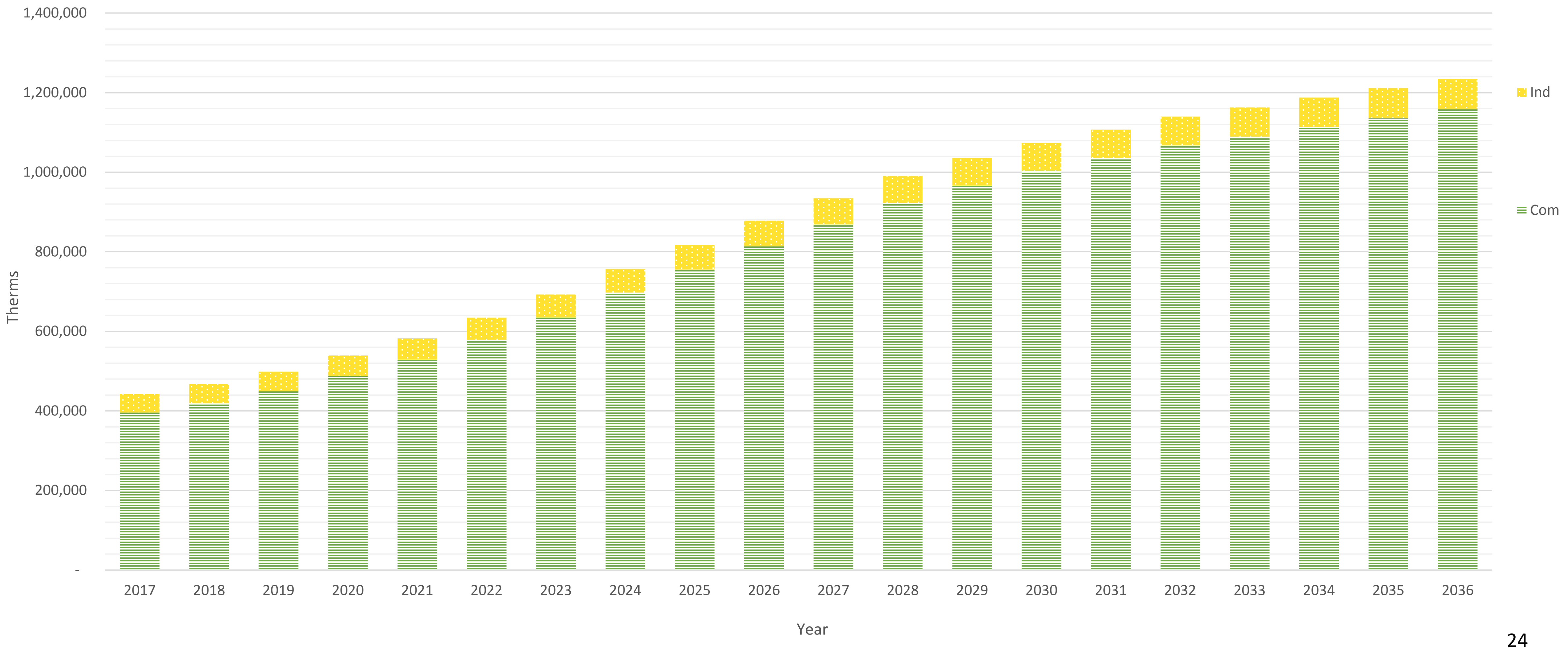
Commercial Conservation Forecast Potential



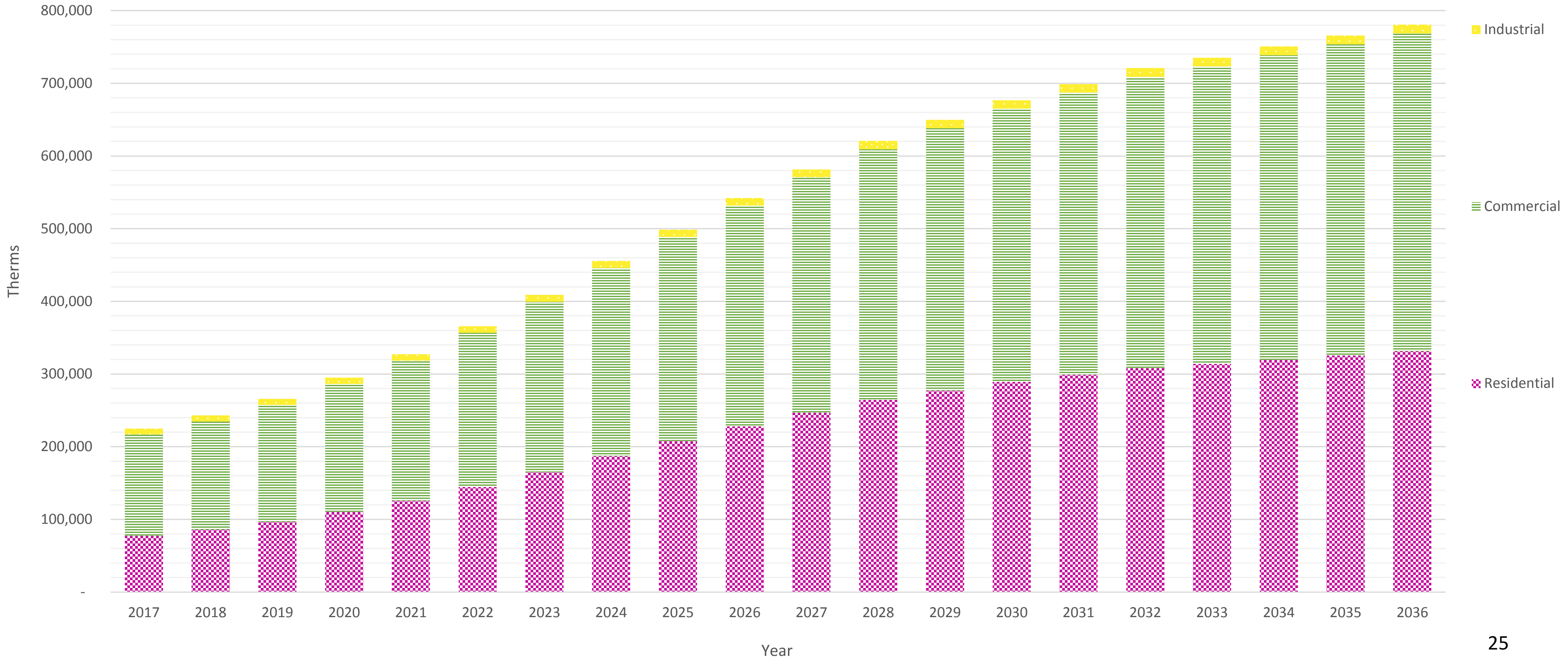
Industrial Conservation Forecast Potential



Commercial/Industrial combined Savings Potential Forecast



Climate Zone 1: Bellingham & Mt Vernon



Climate Zone 2: Bremerton, Aberdeen & Longview

Climate Zone 3: Kennewick, Walla Walla, Wenatchee, & Yakima

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Monica Cowlishaw

MGR, Energy Efficiency & Community Outreach
Monica.Cowlishaw@cngc.com

Amanda Sargent

Conservation Analyst II
Amanda.Sargent@cngc.com

IRP CARBON ASSUMPTIONS

MARK SELLERS-VAUGHN AND BRUCE FOLSOM

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Topics to Cover Today

- Purpose
- Laying the Foundation
- The National Focus
- The Regional Focus
- Washington
- Oregon
- Types of CO2 Adder Analyses
- Fugitive Methane Emissions
- Washington and Oregon Commission-Jurisdictional Planning Treatment
- Sensitivities and Impacts on Prices
- Proposed Direction
- Next Steps and Conclusion

Purpose

- To support policies that cost-effectively achieve state and federal carbon emission reduction policies and regulations

- To determine carbon methodology and assumptions for calculating inputs towards a 20 year avoided cost of natural gas, with associated two-year action items

Laying the Foundation

- Carbon dioxide is the primary source of greenhouse gas emissions (GHG)

- The US Environmental Protection Agency (EPA) released its final Clean Power Plan (August 2015) rule with required CO2 reductions by state, primarily directed towards electric generation

- Electricity production fueled by natural gas produces significantly less CO2 emissions than coal plants; fugitive methane emissions from natural gas production wells, pipelines, storage, and distribution is a contributor to GHG but involves considerable uncertainty

- CO2 cost-adders are to be applied to avoided costs to address the above

(NOTE: Numbers shown in this presentation are “draft” as this remains a work-in-process)

The National Focus

- Clean Air Act, Section 111(d) gave the US EPA authority to promulgate state Clean Power Plan rules
  - Reduce greenhouse gas emissions from covered power plants by 32% from 2005 levels by 2030
  - US Supreme Court stayed implementation (February 2015)
  - Oral arguments heard June 2016 (DC Circuit Court of Appeals)

- States may comply in two ways:
  - Rate-based – Reducing the average CO_2 emissions rate (pounds of CO_2/kilowatt-hour) from electric generating plants
  - Mass-based – Limiting the total emissions (tons of CO_2 per year)

The Regional Focus

- The Northwest Power Planning and Conservation Council (NPPC or Council) recently published its 7th Power Plan
  - Released May 2016
  - Significant discussion, analysis, and scenarios regarding CO2 contained in Chapters 3 and 15

- Considerable prior regional collaboration regarding GHG
  - Such as the proposed cap and trade program of the Western Climate Initiative

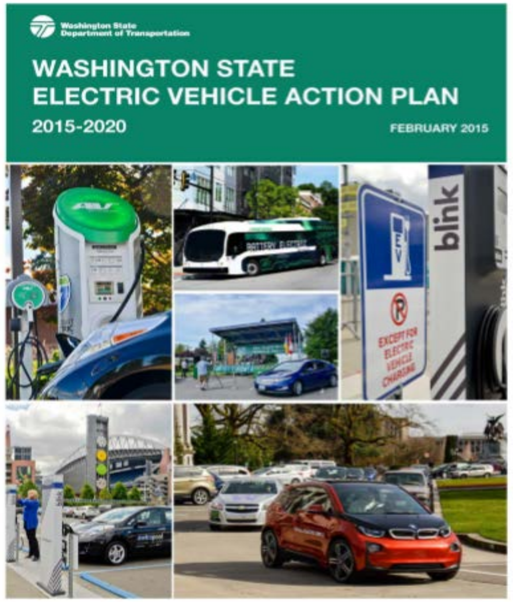
Washington

- Draft Clean Air Rule published by the Department of Ecology (January 2016), with new draft in June
  - If adopted, would require LDCs to reduce CO2 emissions by 5% from a rolling baseline
  - Reductions to come from efficiency, investment in Washington facilities, and/or purchased allowances and offsets
- Initiative 732 (I-732) – Clean Energy Future
  - Charges a carbon tax of $25 per ton of carbon
  - Lowers the sales tax by 1%
  - Grants tax rebate of up to $1,500 annually to 400,000 low income families
  - Eliminates the business and occupation (B&O) tax on manufacturing

Washington (continued)

- Potential other initiative in-progress

- Significant other state policies with CO2 impacts
  - Energy Independence Act ("I-937")
  - Electric Vehicle Action Plan
  - And others



Oregon

- "Coal to Clean" law adopted in 2016 (SB 1547)
  - Effectively eliminates coal power by 2030
  - 50% renewable electric generation by 2040
- Several other legislative proposals considered without adoption in 2016:
  - Replace GHG emission goal with cap and trade program (SB 1574)
  - Repeal GHG emission goal; requires Environmental Quality Commission to adopt goals and limits (HB 4068)
- Additional proposals expected in the 2017 legislative session
- Monitoring Northwest Natural Gas' carbon program

Types of CO2 Adder Analyses

- The Northwest Power and Planning Council summarizes applicable approaches. While directed to the electric industry, these are provided as illustrations of the potential scope of methodologies and recently-performed analyses

- Eight approaches were applied by the Council:
  - Social Cost of Carbon (Mid-Range and High) – two approaches
  - Carbon Cost Risk (e.g., $0 - $110/ton) – one approach
  - Regional Renewable Portfolio Standards at 35% – one approach
  - Maximum Carbon Reduction (Existing Technology, Coal Retirement, Coal Retirement with the Social Cost of Carbon, Coal Retirement with the Social Cost of Carbon and No New Gas) – four approaches

Types of CO2 Adder Analyses (continued)

- Four additional scenarios included:
  - Planned Loss of a Major Non-GHG Emitting Resource (i.e., 1,000 aMW of hydro)
  - Unplanned Loss of a Major Non- GHG Emitting Resource
  - Faster Conservation Deployment
  - Slower Conservation Deployment

- Four sensitivity analyses were performed:
  - No Demand Response
  - Low Natural Gas and Wholesale Electricity Prices
  - Increased Market Reliance
  - Lower Conservation

Fugitive Methane Emissions

- Fugitive methane (a major component of natural gas) occurs during production, transportation and distribution
  - Ranges of methane emissions vary, with new production facilities now coming in around 1%
- Council's 7th Power Plan
  - "…there is considerable uncertainty around such issues as whether its impacts compared to carbon dioxide are over or under-stated…and whether accounting for the methane emissions from coal production would also raise that fuel's full life-cycle climate impacts…"
  - "…will likely draw on gas production new wells which have lower fugitive emissions…"
  - "…unless new pipeline capacity is needed, fugitive emissions from pipeline leaks remain relatively constant…"
- Summary: Electric generation fueled by natural gas has significantly less CO2 emissions than electric generation from coal. Including fugitive methane emissions, natural gas remains with lower CO2 emissions

Washington and Oregon Commission-Jurisdictional Planning Treatment of CO2 Emissions

- Local Distribution Companies:
  (note all based on NPPC forecast using the carbon cost risk approach)
  - PSE
    - In its 2015 IRP, modeled three CO2 prices: No Federal CO2 price ($0/ton); Mid CO2 price ($13/ton in 2016 to $54/ton in 2035); High CO2 price ($35/ton in 2020 to $120/ton in 2035)

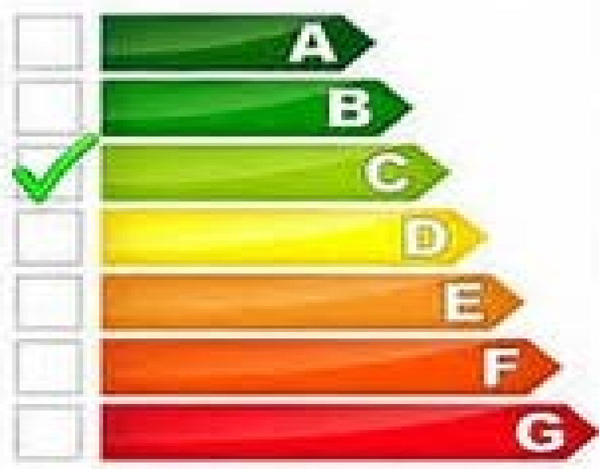
  - Northwest Natural Gas
    - In its "2016 IRP Draft for Public Comment," for Oregon, begins in 2021 at $7/ton with $28/ton in 2035 and for Washington, starts at $7/ton in 2017 with $32/ton in 2035)
  - Avista
    - In it draft 2016 slides, adder begins in 2018 ($10/ton), escalating to $20/ton (2035)

Current Efforts by Cascade re GHG Reduction

- Cascade is addressing CO2 in the following manner
    - Energy efficiency programs
    - Encouragement of the direct use of natural gas
    - Methane recapturing and leak prevention

Proposed Direction

- Apply CO_2 adders from 7th Plan
  - Apply Carbon Cost Risk approach
  - Near time price of $10/ton escalating to $35 per ton in 2035

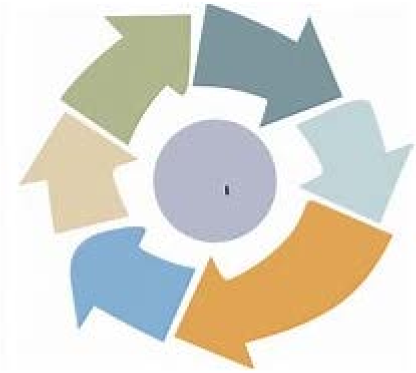


- Include:
  - Ranges
  - Sensitivity analyses

- Determine impact on prices

Next Steps and Conclusion

- Incorporate carbon planning assumptions into modeling
- Will provide a brief update of the modeling impacts at TAG 4
- Conclusion…
  - Regarding expectations, lesser impact on customers as compared to the electric utility industry
  - Impact of ranges and sensitivity analyses will be presented to the TAG when modeling is performed



Questions…

…and thank you

MARKET OUTLOOK AND LONG RANGE PRICE FORECAST

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Market Outlook

- **Reductions in projected demand, a slow economic recovery, and the new reality of a vast North American supply of natural gas all combined to change the nature of projects now being considered by the region. Today's market for regional infrastructure capacity has evolved from valuing diversity to equally valuing reliability**
- **Although US Economic growth underperformed many projections, there are reasons to be optimistic about the US economy on a macro level, including fairly low unemployment rates and a possible signaling of an increase to the Fed Funds rate before the end of the year**
- **Currently, the Yakima River Basin reservoir is filled to about 54% capacity, while the 5 major Oregon River Basins are filled to about 44% capacity. According to a recent report by the DoE, the US has the ability to increase the amount of gigawatts generated by dams by 50%, by the year 2050, through a more efficient use of our current dam system.**
- **With CO2 emissions from Natural Gas surpassing that of Coal for the first time since 1972, regulators are looking at cracking down on Methane emissions from the Oil and Gas industries. These regulations are being challenged by industry groups, who look to highlight the positive impact natural gas has had in lowering CO2 emissions.**
- **Natural Gas Storage continues to rise. As of August 12th 2016 stocks are 361 Bcf higher than last year YoY, a 12.2% increase. Forward projections indicate that storages will continue to rise in the US over the next few weeks. In addition, the Southern California Gas Company is looking to resume injections at their Aliso Canyon facility, subject to regulatory review and well tests.**
- **US Economic Growth was only 1.2% for Q2 2016, unemployment at 4.9%**
- **Indications from the President of the NY Fed may be signaling at least one more Fed rate increase before the end of 2016**

Long Range Price Forecast

- Cascade’s long term planning price forecast is based on a blend of current market pricing along with long term fundamental price forecasts.
- The fundamental forecasts include Wood Mackenzie, the Energy Information Administration (EIA), the Northwest Power Planning Council, Bentek and the Financial Forecast Center’s long term price forecasts.
- Market, particularly in near term is heavily influenced by Henry Hub prices
- While not a guarantee of where the market will ultimately finish, Henry Hub NYMEX is the most current information that provides some direction as to future market prices

Long Range Price Forecast

- Wood Mackenzie's long-term forecast is at a monthly level by basin. We use this to help shape the forecast's monthly basis pricing.
- We also rely on EIA's 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.
- We assign a weight to each source to develop the monthly Henry Hub price forecast for the 20 year planning horizon.
- Although it is impossible to accurately estimate the future, for trading purposes the most recent period has been the best indicator of the direction of the market. However, Cascade also considers other factors (historical constraints) which can lead to minor adjustments to the final long range forecast.

Long Range Price Forecast

- Considerations in weight assignments
  - Typically, highest weight is given to NYMEX for the near term (approximately 3-5 years) then the others take on increasing weight over the horizon
    - Wood Mackenzie (monthly, covers all basins)
    - EIA (industry barometer, annual long term
    - NPPC (regional perspective, but recognize it is also a blend)
    - Bentek (3-5 years out years)
    - Financial Forecast Center (typically only a few years)

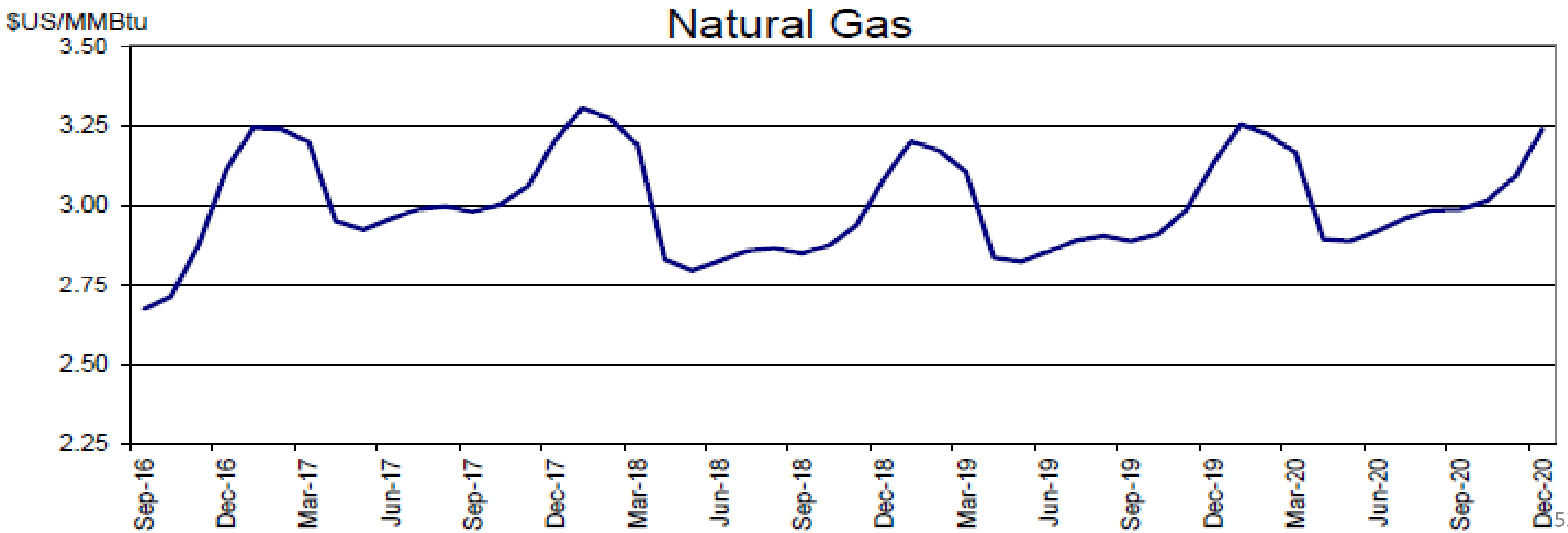
Current Pricing

• The Henry Hub natural gas spot price averaged $2.82/MMBtu in July, up 24 cents/MMBtu from the June average.

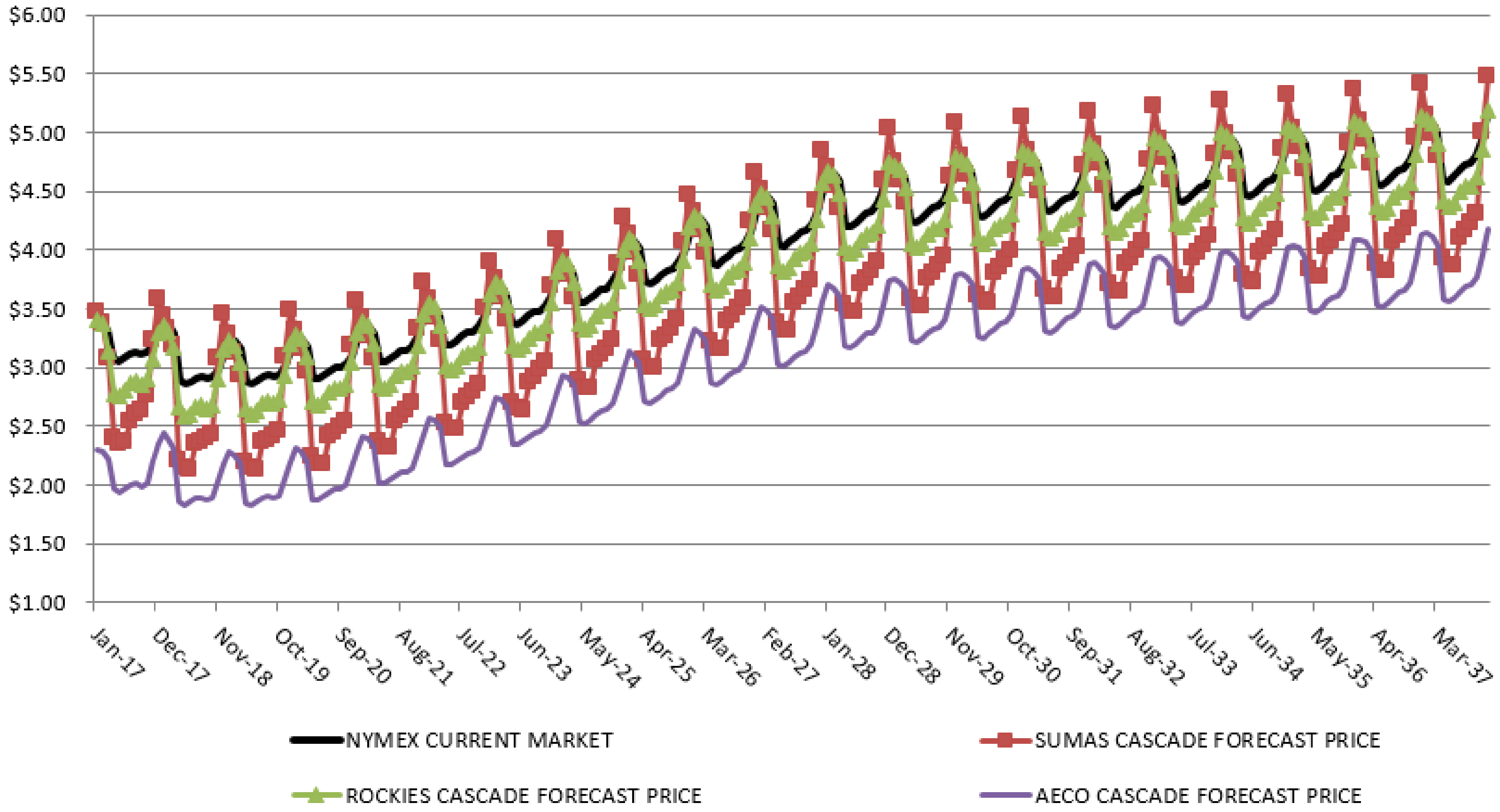
• Price increases reflected warmer-than-normal temperatures in July, which led to increased demand from the electric power sector. Despite the increase in spot prices, prices still remain low enough to support significant natural gas-fired generation.

• EIA expects natural gas prices to gradually rise throughout the forecast period. Forecast Henry Hub prices average $2.41/MMBtu in 2016 and $2.95/MMBtu in 2017.

As of Thursday, August 18th Natural gas prices are relatively unchanged this morning with the prompt contract up about a cent from August 17th's close. September futures contract was also unchanged, settling 0.2 cents higher at $2.619/MMBtu, as the market stands pat in anticipation of Thursday's EIA storage report. The rest of the curve was slightly higher, as the Calendar 2017 and Calendar 2018 swaps increased by 1.7 and 0.9 cents, respectively. Prices in the Northeast cash market were mostly lower due to expectations that temperatures will return to historical norms



Long Range Price Forecast



Base Weights in Draft 2016 IRP Price Forecast

Year	Current NYMEX	Source 1	Source 2	Source 3	Source 4
2017	50%	20%	25%	5%	0%
2018	45%	20%	30%	5%	0%
2019	40%	20%	35%	5%	0%
2020	35%	25%	35%	5%	0%
2021	30%	30%	35%	5%	0%
2022	25%	30%	40%	5%	0%
2023	20%	30%	45%	5%	0%
2024	15%	25%	55%	5%	0%
2025	10%	25%	60%	5%	0%
2026	10%	20%	65%	5%	0%
2027	5%	20%	70%	5%	0%
2028	5%	20%	75%	0%	0%
2029	0%	25%	75%	0%	0%
2030	0%	25%	75%	0%	0%
2031	0%	25%	75%	0%	0%
2032	0%	25%	75%	0%	0%
2033	0%	25%	75%	0%	0%
2034	0%	25%	75%	0%	0%
2035	0%	25%	75%	0%	0%
2036	0%	25%	75%	0%	0%

PRICE ELASTICITY OVERVIEW

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Price Elasticity—Context and Import

- Price elasticity is an economic concept which recognizes that customer consumption changes as prices rise or fall. The amount of this change (or "elasticity") is a function of other available products (i.e., substitutes) or the ability for customers to go without or use less, with no meaningful impact on their personal life or in commerce. "Price signals" is a term used to describe how customers see or expect future pricing to affect them.

- Price elasticity is expressed mathematically as a coefficient describing the amount of change in consumption per change in price. By way of example, a price elasticity factor of negative 0.10 means a consumer will reduce usage by one percent if the price increases by 10%. Conversely, a positive 0.10 coefficient factor for a 10% price decrease would predict customers would increase consumption by 1.0%. For products with high substitutability, the coefficient factors are high (e.g., greater than 0.50) and *vice versa*.

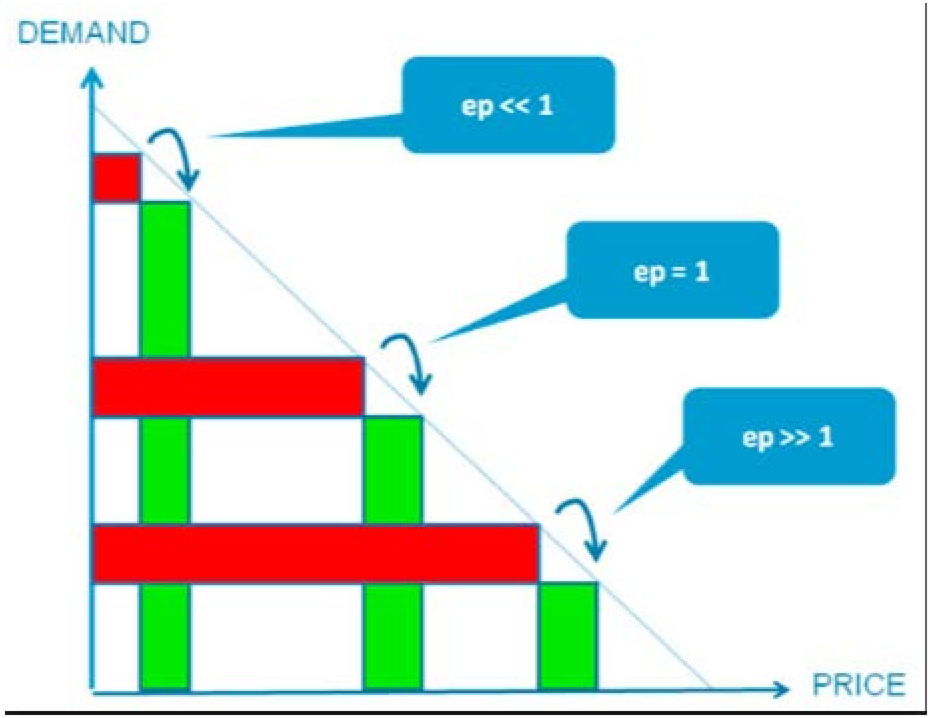
- Price elasticity can be highly temporal. Consumers may not be able to make changes to short-term price increases or decreases. Yet, several years out, that same customer may replace equipment or make behavioral changes to use significantly less or more of a product depending on whether, over the long term, the product is more or less expensive, respectively.

Price Elasticity—Context and Import (cont'd)

- The import of price elasticity to natural gas integrated resource planning lies in the twenty year period over which the demand forecasts are estimated. This forecast (or range of forecasts under scenario planning) is a key determinant of the avoided cost. Low price elasticity in a rising natural gas price environment, would suggest forecasted higher load would not change and more natural gas would need to be acquired, with corresponding delivery infrastructure. However, if usage materially decreases with higher prices, then less purchases and capital investment by a local distribution company (LDC) would be necessary. Thus price elasticity effects the avoided cost.

- Because avoided costs are integral to conservation planning, among other components, the impact of price elasticity on consumer consumption is particularly important.

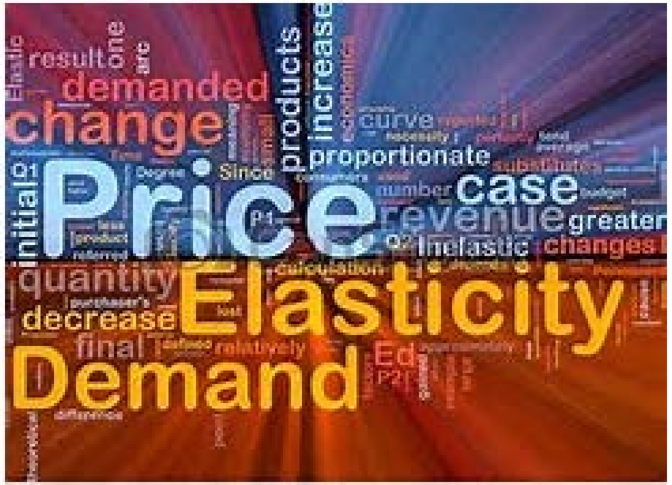
- The previous discussion is a relatively academic explanation. Application of price elasticity to natural gas resource planning presents several confounding issues.



Factors Affecting Price Elasticity

Several attributes of the regulated utility environment cause price elasticity calculations to be difficult to calculate with precision. These include…

- Within customer classes, the type of customer usage varies:
  - Residential—heating and non-heating
  - Commercial—heating and processing
    - …leading to a general inability to make short-term changes in usage other than some behavioral modifications.



Factors Affecting Price Elasticity (cont’d)

- Regulatory protocols reduce direct price signals:
  - Annual purchased gas adjustments can be increases or decreases of unknown magnitude
  - General rate cases and price changes are assumed by customers to occur annually or biannually
    - …leading to customer uncertainty of future pricing other than a preconception that prices will rise.

- Billing plans reduce direct price signals:
  - Average, or levelized, billing which results in twelve equal monthly payments adjusted annually, is a service to customers but does not send direct price signals. For customers not on a level payment plan, seasonal temperature changes appear as increases in monthly bills during cold months and decreases during warmer months
    - …leading to a misunderstanding by customers of future pricing.

Other Factors

Several items reduce load growth over time, regardless of price elasticity and price signals:

- Economic conditions
- Conservation
- Building codes and appliance standards (which are already built into forecasts)
- Technology
  - …leading to historical data that includes reductions in usage irrespective of pricing.

- To the above can be added subjective items such as customers' general propensity to use less of many products. Additionally, electricity and natural gas pricing now move in tandem.

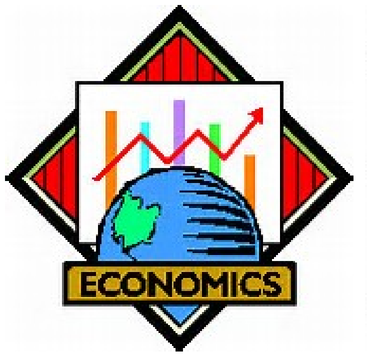
- This causes difficulty for customers to receive meaningful price signals and difficulty for utilities to isolate primary factors for long term price elasticity calculations (other than inflation). Regardless, it isn't clear that customers may not return (or rebound) to historic usage after a higher or lower price excursions.

Other Studies

Several price elasticity inquiries are traditionally referenced in regional price elasticity discussions. These include:

- The American Gas Association (AGA) released a study in 2007 identifying the short-run price elasticity coefficients for the Pacific and Mountain regions to each be -0.07 with a low and high range of -.03 and -0.13 respectively. The long-run estimates were -0.12 (Pacific) and -0.10 (Mountain), with the range being between -0.01 and -0.29.

- Regional differences in price elasticity for demand of energy were examined, with the conclusion that the geographic area of a utility's service territory results in the statistical significance of price becoming more uncertain. This suggests that for Cascade—with its customers spread over two states in smaller sections—relatively precise price elasticity coefficient factors would either not be available or would be costly to determine with lesser benefits of doing so.



- Use per customer has been decreasing over the past thirty years prompted by multiple factors, including systemic items such as conservation, building codes and appliance standards and behavioral influences such as the 2008 recession.

Options for Price Elasticity Treatment

- Options exist for treatment of price elasticity in IRPs. One option is to incorporate coefficient factors into linear modeling.

- Alternatively, modeling of future pricing effects can be pursued through calculations that iterate a series of cost environments based on primary variables. This is part of evolving forecast methodologies.

- Other regions are experiencing similar examinations of appropriate coefficient factors and/or more exhaustive and iterative modeling methods.

- A short-run coefficient factor of -0.10 and a long-run factor of -0.12 would be justifiable for Cascade's current IRP process, given the temperature differentials of its service territory, east and west of the Cascade Mountains. Low and high ranges would be justifiable at plus or minus 0.07.

Price Elasticity - Conclusion

- Integrated Resource Planning (IRP) includes demand forecasting over a twenty-year horizon. Load growth needs to take into account several factors over this period due to aspects effecting customer usage. Price elasticity (or changes in consumption based on changes in price) is one such factor.
- Price elasticity exists, yet determining specific coefficient factors for linear modeling is inexact.
- A range of coefficient factors will be used to test sensitivities of the factors and impacts to the forecasts.
- Given Cascade's diverse geographical territory, statistical significance of price elasticity coefficients is uncertain.

Price Elasticity – Conclusion (cont'd)

- Several complicating factors effect price elasticities:
  - Regulatory mechanisms (e.g., purchased gas adjustments—PGAs—and general rate cases) which dampen price signals
  - Historical data (embedded with effects of conservation, technology, and economic conditions) renders reliance on this data imperfect for precise price elasticity determination
  - The retail price of most "substitutable" fuel—electricity—moves with the cost of natural gas, thereby lessening the economic value of alternative fuels to customers.
- Evolution of modeling suggests that future IRP modeling should incorporate iterative quantitative equations to allow built-in price elasticity effects.
- Regardless of the above, price elasticity must be taken into account. For Cascade's current IRP cycle, a short-run coefficient factor of -0.10 and a long-run factor of -0.12 with ranges of plus or minus 0.07 is justifiable, given regional studies and other utilities' modeling efforts.

SENDOUT SCENARIOS AND INPUTS

Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

SENDOUT model

- Cascade utilizes SENDOUT™ for resource optimization
- This model 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.
- SENDOUT™ is very powerful and complex. It operates by combining a series of existing and potential demand side and supply side resources and optimizes their utilization at the lowest net present cost over the entire planning period for a given demand forecast.

SENDOUT model

- SENDOUT™ utilizes a linear programming approach
- The model knows the exact load and price for every day of the planning period based on the analyst's input and can therefore minimize costs in a way that would not be possible in the real world.
- Therefore, it is important to acknowledge that linear programming analysis provides helpful but not perfect information to guide decisions.

Modeling Transportation In SENDOUT®

IS A BALANCING ACT OF REALITY AND SUBJECTIVE APPLICATION

- Start with a point in time look at each jurisdiction's resources
- We start with the Nov16-Oct17 PGA portfolio
- Contracts –Receipt and Delivery Points
- We start with current transport contracts, using centralized receipts and approx. 66 delivery locations
- Rates
- Current contractual, with CPI increase every 3 years

- Contractual vs. Operational
- Contractual can be overly restrictive
- Operational can be overly flexible
- Incorporating operational realities into our modeling can defer the need to acquire new resources.
- Gas Supply's job is to get gas from the supply basin to the pipeline citygate.
- IRP focus is on the core
- Operations job is to take gas from the pipeline gate to our customers.
- Operations focus is on the system, not just the core
- Limiting factor is receipt quantity –how much can you bring into the system?

Modeling Challenges

- Supply needs to get gas to the citygate.
- Many of our transport agreements were entered into decades ago, based on demand projections at that point in time.
- Sum of receipt quantity and aggregated delivery quantity can help identify resource deficiency depending on how you allocation the rights
- The aggregated look can mask individual city gate issues for looped sections, and the disaggregated look can create deficiencies where they don’t exist.
- In many cases operational capacity is greater than contracted.
- SENDOUT has perfect knowledge

Major resource issues on the horizon

- **Addition alternatives to be considered during IRP process**
  - **NWP I-5 Expansion**
  - **Realignment of MDDOs to citygates**
  - **Palomar/Cross Cascades**
  - **Pacific Connector**
  - **Incremental Nova**
  - **Incremental Foothills**
  - **Incremental GTN (north to south)**
  - **Biofuel**
  - **Satellite LNG**
  - **Mist Storage**
  - **AECO Storage**
  - **Wild Goose Storage**
  - **Gill Ranch Storage**
  - **Ryckman Creek Storage**

- Began discussions with Niska Partners to gather information to model AECO Hub Storage in the 2016 IRP. In addition, we will be considering Wild Goose, Gill Ranch, Mist and Ryckman Creek storage

- Working with GTN to develop a narrative to explain how our long path capacity can be used to meet peak day shortfalls.

Considerations

- Does is get supply to the gate?
- Is it reliable/firm?
- Does it have a long lead time?
- How much does it cost?
- New build vs. depreciated cost
- The rate pancake
- Is it a base load resource or peaking?
- How many dekatherms do I need?
- What is the "shape" of resource?
- Is it tried and true technology, new technology, or yet to be discovered?
- Who else will be competing for the resource?

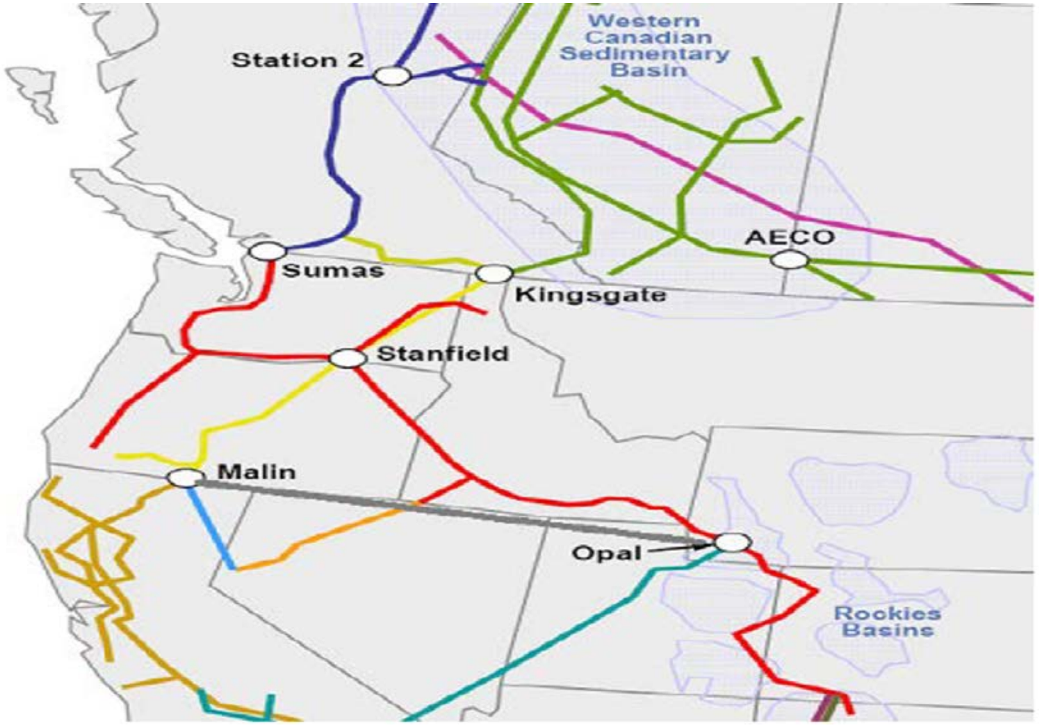
SENSITIVITIES ANALYSES

Scenario Name	Key Assumptions
High Growth	Strong Economic Growth result in High Load growth, Average Weather, Medium Gas Prices
Low Growth	Economic Conditions result in Low Load growth, Average Weather, Medium Gas Prices
Environmental Externalities Carbon 1	Medium Load Growth, Average Weather, Assumes Carbon Adder Implemented in 2018 for CO2 emissions at $10/ton with adder increasing annually by 3% plus CPI (Consumer Price Index)
Environmental Externalities Carbon 2	Medium Load Growth, Average Weather, Assumes Carbon Adder Implemented in 2016 for CO2 emissions at $20/ton with adder increasing annually by 3% plus CPI (Consumer Price Index)
Environmental Externalities Carbon 3	Medium Load Growth, Average Weather, Assumes Carbon Adder Implemented in 2017 for CO2 emissions at $30/ton with adder increasing annually by 3% plus CPI (Consumer Price Index)

Supply Side Alternatives Modeled

Resource	Scenario Considered
Conventional Gas Supply Contracts with annual, seasonal or winter only characteristics delivered to Northwest Pipeline & GTN Systems	All
Conventional Gas Supply Peaking Contracts Delivered to Northwest Pipeline & GTN Systems	All
Gas Supply Peaking Contract delivered to Cascade's citygates	All
Incremental Storage Delivered to Northwest Pipeline and GTN systems	All
Satellite LNG Storage within Cascade's distribution system	All
Additional Pipeline Capacity secured through medium--long term capacity agreements	All

Current Station2	Incremental NOVA	AECO Year, Seas, Spot
Current NOVA-Foothills	Incremental GTN	Sumas Year, Seas, Spot
Current GTN	Incremental NWP	Rockies Year, Seas, Spot
Current NWP	Incremental Fthls	Station2Year, Seas, Spot
Current Ruby	JP1, JPExp, JP3-4, LS	Citygate GTN, NWP
Ryckman Crk Storage	T-South-So Crossing	BioNatualGas
AECO Hub Storage	Pacific Connector	Satellite LNG
Mist Storage	Palomar	WA Expansion
California Storage	MDDO Realignment	DSM as supply source



The All In Case run allows the company to see what the model would select if all current and probably resources are available.

SCENARIO NAME	KEY ELEMENTS IN SENDOUT SCENARIO Medium Load Growth, Medium Gas Price Forecast, Average weather with Peak Event. All elements considered. All items in **RED** mean those elements were excluded from the scenario		
Mist	Current Station2 Current NOVA-Foothills Current GTN Current NWP Current Ruby *Ryckman Crk Storage* *Incremental JP* Mist Storage	Incremental NOVA Incremental GTN Incremental NWP Incremental Ruby JP1, JPExp, JP3-4, LS *T-South-So Crossing* *Pacific Connector* *N-MAX-Stan-Madr* *N-MAX Madr I-5*	AECO Year, Seas, Spot Sumas Year, Seas, Spot Rockies Year, Seas, Spot Station2Year, Seas, Spot Citygate GTN, NWP BioNatualGas Satellite LNG *WA Expansion*
Mist and Ryckman Creek	Current Station2 Current NOVA-Foothills Current GTN Current NWP Current Ruby Ryckman Crk Storage *Incremental JP* Mist Storage	Incremental NOVA Incremental GTN Incremental NWP Incremental Ruby JP1, JPExp, JP3-4, LS *T-South-So Crossing* *Pacific Connector* *N-MAX-Stan-Madr* *N-MAX Madr I-5*	AECO Year, Seas, Spot Sumas Year, Seas, Spot Rockies Year, Seas, Spot Station2Year, Seas, Spot Citygate GTN, NWP BioNatualGas Satellite LNG *WA Expansion*
T-South Enhancement/Southern Crossing with Limited Canadian	Current Station2 Current NOVA-Foothills Current GTN Current NWP Current Ruby Ryckman Crk Storage *Incremental JP* *Mist Storage*	Incremental NOVA Incremental GTN Incremental NWP Incremental Ruby JP1, JPExp, JP3-4, LS T-South-So Crossing *Pacific Connector* *N-MAX-Stan-Madr* *N-MAX Madr I-5*	AECO *Year, Seas*, Spot Sumas Year, Seas, Spot Rockies Year, Seas, Spot Station2 *Year, Seas*, Spot Citygate GTN, NWP BioNatualGas Satellite LNG *WA Expansion*
T-South Enhancement/Southern Crossing	Current Station2 Current NOVA-Foothills Current GTN Current NWP Current Ruby Ryckman Crk Storage *Incremental JP* *Mist Storage*	Incremental NOVA Incremental GTN Incremental NWP Incremental Ruby JP1, JPExp, JP3-4, LS T-South-So Crossing *Pacific Connector* *N-MAX-Stan-Madr* *N-MAX Madr I-5*	AECO Year, Seas, Spot Sumas Year, Seas, Spot Rockies Year, Seas, Spot Station2 Year, Seas, Spot Citygate GTN, NWP BioNatualGas Satellite LNG *WA Expansion*

SCENARIO NAME	KEY ELEMENTS IN SENDOUT SCENARIO Medium Load Growth, Medium Gas Price Forecast, Average weather with Peak Event. All elements considered. All items in **RED** mean those elements were excluded from the scenario		
Pacific Northwest Regional (NMAX, WA Expansion, Palomar)	Current Station2 Current NOVA-Foothills Current GTN Current NWP Current Ruby Ryckman Crk Storage *Incremental JP* *Mist Storage*	Incremental NOVA Incremental GTN Incremental NWP Incremental Ruby JP1, JPExp, JP3-4, LS *T-South-So Crossing* *Pacific Connector* N-MAX-Stan-Madr N-MAX Madr I-5	AECO Year, Seas, Spot Sumas Year, Seas, Spot Rockies Year, Seas, Spot Station2Year, Seas, Spot Citygate GTN, NWP BioNatualGas Satellite LNG WA Expansion
Pacific Connector	Current Station2 Current NOVA-Foothills Current GTN Current NWP Current Ruby Ryckman Crk Storage *Incremental JP* *Mist Storage*	Incremental NOVA Incremental GTN Incremental NWP Incremental Ruby JP1, JPExp, JP3-4, LS *T-South-So Crossing* Pacific Connector *N-MAX-Stan-Madr* *N-MAX Madr I-5*	AECO Year, Seas, Spot Sumas Year, Seas, Spot Rockies Year, Seas, Spot Station2Year, Seas, Spot Citygate GTN, NWP BioNatualGas Satellite LNG *WA Expansion*

Some additional guidance from stakeholders needed…

- LRC analysis considers public policies adopted by the Federal government or Washington state regarding resource preference
- LRC analysis considers risks imposed on ratepayers
- LRC analysis considers cost of risks associated with environmental effects including the emission of carbon dioxide
- Plan develops forecasts using methods that address changes in the number, type and efficiency of natural gas end-users
- Plan includes at least a 10-year long range planning horizon

Supply Resource Optimization Process

Step 1: Resource Portfolio Selection

- run an optimization that includes a peak day, a peak week, and a peak heating season for *every* year in the planning horizon for each Scenario to ensure adequate resources are held to meet peak load

Step 2: Resource Portfolio Expected Costs

- optimize each portfolio from Step 1 under normal weather in each year to determine expected PVRR of each portfolio

Step 3: Resource Portfolio Stochastic Risk Assessment

- test the robustness of the expected resource choice from Step 2 by determining the PVRR of the portfolios from the previous steps under a wide slate of future environments that represent the uncertainty of natural gas prices, weather, and resource costs

Monte Carlo Stochastic Simulation Risk Analysis

1. Two separate 100 draw simulations that need to be combined to evaluate total portfolio cost risk
2. Simulation 1: Variable Costs
   - Stochastic inputs: Gas Prices and Weather (Load)
   - After the simulation is complete (100 prices and weather futures are simulated), each portfolio is optimized (a daily dispatch cost minimization) for each of the simulation draw to determine PVRR
3. Simulation 2: Fixed Costs
   - Stochastic input: Supply resource option costs
   - After the simulation is complete and 100 different revenue requirement cost outcomes have been obtained, the total PVRR difference relative to the base case for each of the prospective resources is calculated for each simulation draw for all of the portfolios
4. Every PVRR outcome from the two simulation process is paired to determine the total portfolio PVRR for each Scenario under the same 10,000 prospective future environments

Avoided Cost Overview

- As part of the IRP process, Cascade calculates a 20-year forecast and 45 years of avoided costs.
- The avoided cost is an estimated cost to serve the next unit of demand with a supply side resource option at a point in time. This incremental cost to serve represents the cost that could be avoided through energy conservation.
- The avoided cost forecast can be used as a guideline for comparing energy conservation with the cost of acquiring and transporting natural gas to meet demand.
- Cascade evaluates the impact that a range of environmental externalities, including CO2 emission prices, would have on the avoided costs in terms of cost adders and supply costs.
- We produce an expected avoided cost case based on the medium forecast (base case) peak day.

Costs included in the avoided cost calculation

- The long term gas price forecast compiled from a consultant’s gas price forecast (which is the majority of the cost);
- A price for carbon included in the gas price forecast, which has been embedded by price forecast consultant
- Gas storage variable and fixed costs
- Upstream variable and fixed transmission costs;
- Peak related on-system transmission costs; and
- A 10 percent adder for unidentified environmental benefits, as recommended by the Northwest Power and Conservation Council (“NWPCC”).

METHODOLOGY

- The SENDOUT® resource planning model is used to generate the avoided costs.
- SENDOUT® contains a marginal cost report which lists the daily incremental cost to serve the next unit of demand for each demand region.
- The model determines the lowest cost method for serving the next unit of demand and computes a marginal cost.

ALTERNATIVE RESOURCES CONSIDERED

- With regards to alternative resources considered in the optimization of the portfolio, there is a level of uncertainty as to when certain alternative supply side resources will materialize and yet a base case needs to be created to calculate the avoided cost.

- Using the base case demand parameters as inputs, including the design weather pattern, and base case customer and gas price forecasts, in addition to existing supply side resources, the Company's resource portfolio for purposes of the avoided cost calculation ***might*** include:
    - Ryckman Creek storage
    - Incremental NGTL, Foothills, GTN and NWP transport (all of which are allocated between Oregon and Washington).
    - Also, a small level of satellite LNG and biogas is also included in the base case—however; these two alternative resources are assigned directly to Washington.

NOTE: The optimal portfolio will be available until TAG 5. Some of the assumptions above are subject to change.

2016 IRP Timeline

Monday, August 22, 2016	**"Gas Supply 101" for WUTC**	**Cascade HQ in Kennewick WA**
Tuesday, August 23, 2016	**TAG 3: Conservation, Carbon Assumptions, Price Forecast, Avoided Costs, Planned Scenarios**	**Cascade HQ in Kennewick WA**
Thursday, September 08, 2016	TAG 4 slides distributed to stakeholders	
Thursday, September 15, 2016	**TAG 4: Distribution System Planning, Preliminary Resource Integration Results, Proposed new 2 year Plan**	**Seattle Airport Conference Center**
Friday, October 07, 2016	**TAG 5: Final Integration Results, finalization of plan components**	**Seattle Airport Conference**
Friday, October 14, 2016	Internal review of draft fililng of IRP complete	
Monday, October 17, 2016	Draft of 2016 IRP distributed	
Monday, November 07, 2016	Comments due on draft from all stakeholders	
Thursday, November 17, 2016	TAG 6, if needed	Seattle Airport Conference Center
Wednesday, November 23, 2016	Final IRP goes to press	
Thursday, December 01, 2016	Executive Summary Presentation to Senior Management	Kennewick, WebEx
Wednesday, December 14, 2016	IRP filing in Washington	

NEXT STEPS?

Cascade Natural Gas Corporation

Integrated Resource Plan
Technical Advisory Group Meeting #3

Tuesday, August 23, 2016

Cascade HQ – Kennewick, WA

CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.

3rd External TAG Meeting

Date & time: 08/23/2016 – 08:00-11:30 AM

Location: Kennewick GO

Presenters: Mark Sellers-Vaughn, Monica Cowlishaw, Bruce Folsom

In attendance: Mark Sellers-Vaughn, Bruce Folsom, Monica Cowlishaw, Brian Robertson, Devin McGreal, Mike Parvinen, Eric Wood, Brian Cunnington, Amanda Sargent, Carolyn Stone, Brian Hoyle, Jennifer Gross, David Nightingale - WUTC, Kathi Scanlon-WUTC, Cooper Wright - WUTC

Called in: Bob Morman, Laura Flanders - NWP, Chad Luginbill, Josh Romine, Mark Chiles, Deborah Reynolds, Ed Finklea – NWIGU, Jeremy Twitchell - WUTC

Minutes by: Carolyn P Stone

Mark began the meeting by welcoming everyone. Mark also reminded everyone that today's meeting is a "workshop" and feedback is welcomed! He then went over the Agenda. Bob also welcomed Staff to the meeting and said he looked forward to the presentation.

Presentation #1 – Monica Cowlishaw
Demand Side Management
Monica began her presentation with Slide #4 discussing the purpose of rerunning their model called "TEA-Pot".

- Monica stated that conservation is changing the Demand Side Management within the IRP to an "Executive Summary".
- The TEA-Pot model re-runs the forecast in 3 geographic areas at the climate zone level for Washington and 1 climate zone for Oregon.
- Amanda then went through TEA-Pot stating inputs have changed and will change again. One of the conservation forecast changes is that administrative costs have increased due to increased outreach.

Scenarios

- Amanda explains that the scenarios include 30% and 50 % of incremental costs for the residential incentives. It is a robust portfolio! It includes both custom and prescriptive programs.
- Amanda states that the Service Territory map helps smooth the scenarios into the IRP and better reflects the Conservation forecast.

Slide #9 – Full Portfolio by Climate Zone

- Amanda states that these are preliminary numbers. Zone 2 is the smallest because there are fewer customers. This forecast is in line with the average of the last 2 years.

Slide #10 – Full Portfolio by Customer Class

- Amanda noted this scenario will change. There are very few large industrial customers included here. If there is even 1, it makes a large impact!
- Monica mentioned that there are other items included in the IRP such as Billing Studies (both residential & commercial).
- She went on to say that Cascade & other LDC's will make an $18.3m investment as a collective effort to make high efficiency gas appliances more efficient. Examples include the Energy Star Dryer product improvement, a water heater, rooftop units and piloting LNG in Union Gap.

Question: Was the water heater gas?
Answer: Yes

CNG is involved in community projects, i.e. Georgetown Prize competition. There is one in Walla Walla & Corvallis.

Slide #14 – Noteworthy Changes
Monica explained that CNG will work with Shawn Collins on low income efficiency programs.

Question: What is the "incremental cost"?
Answer: This is the difference between the costs involved to install standard appliances as compared to high efficiency appliances. The difference is the incremental cost.

- Monica explained that conservation will be pushing the 30% and 50% incentive levels in 2017 to get new customers. The Commercial & Industrial will be a mix of 30% & 50 % incentive levels too.

Question: How do you determine which goes in 30% or 50% incentive level buckets?
Answer: The TEA-Pot model calculates this, breaking down the customer benefit by climate zone.

- Monica mentioned these programs are cost effective on a portfolio level.

Question: What level is the Executive Summary going to?
Answer: Climate Zone level

Question: Are there any custom projects included?
Answer: No, custom projects take about 2 years to complete, so not included here.

There was a brief discussion of the Conservation Advisory Group. Monica says they attend 4 times per year and talk about changes in programs, evaluation of financing options and any "issues" associated with programs.

Presentation #2 – Bruce Folsom
IRP Carbon Assumptions
Slide #33 – The National Focus

- Bruce explains that the Clean Air Act, section 111(d) has changed the reduction of greenhouse gas emissions from power plants to 32% from 30% by 2030. States can comply by rate or mass based reductions.
- Regionally, the NWPPC released a CO2 discussion, analysis and scenarios in May of 2016 having to do with the electric industry. Regionally, there is a proposed cap and trade program as well.
- Washington State is very active as the governor has proposed carbon regulation. All emitters are on a rolling baseline from which reductions need to come. Department of Ecology rules will probably be pulled into states' implementation plans.
- Initiative 732 changes carbon taxes, but the labor and utilities groups are not supporting it.

- Environmental communities have an "initiative" in process.
- In Oregon there are a host of proposals for Legislature. The electric industry is behind "Coal to Clean" law. Northwest NG carbon program has an impact to CNG because of the fugitive methane pilot program. It would be cost effective for CNG to follow this program because methane may have a high impact on CO_2 emissions.

Slide #38 – Types of CO2 Adder Analyses

- The NWPPC summarizes 8 approaches. There are 39 more additional methodologies and 4 additional scenarios, along with 4 sensitivity analyses. The focus here is again on electricity.
- There was a brief discussion of the Snake River Dams proposed removal.

Slide #40 – Fugitive Methane Emissions

- Initially, studies show this could be as much as 10% but concluded with only 1% impact. The council discussed this and there is a great deal of uncertainty as to whether it, compared to CO2 is under or over stated. The Natural Gas (NG) industry is focused on R&D. Bruce stated the NG industry is ahead of the Electric industry on this matter!
- Mike Parvinen stated that CNG is around 1%, but that the East Coast runs higher.
- CNG is currently engaged in conservation & energy efficiency programs that save customers $ and reduce emissions. The more an LDC pushes gas, the better!

Slide #43 – Proposed Direction

There was some discussion regarding NG being considered a monopoly.

- Mike Parvinen pointed out that when you advertise and compare electricity to gas you get the option to choose gas over electricity…and since electricity is already there we do compete and NG is the "alternative choice".
- Ed Finklea from the phone said that if you incentivize users to get NG then are penalized for emissions is an "unintended consequence" of encouraging NG use! This is counterintuitive… to penalize fossil fuels no matter how efficiently they are used!

Question: What is the metering accuracy requirement?
Answer: Accuracy requirement is +-2%

Presentation #3 – Mark Sellers-Vaughn
Market Outlook and Long Range Price Forecast

Slide #47 - Market Outlook

- Mark stated that the US Economy is "sluggish" right now!
- 54% capacity in Washington and 44% in Oregon
- CO_2 emissions are an issue – the impact is higher gas costs.
- Storage is high, above the 5 year average!

Slide #48 – Long Range Forecast

- This forecast blends current market prices with long-term fundamental prices.
- This forecast uses resources from Wood Mac, NWPPC, EIA, Bentek, FF Center, and various market reports from suppliers (TD, BP, Powerex).

Slide #53 – Long Range Price Forecast

- The long range price forecast includes a 20-year planning horizon, prices look reasonable!
- Mike Parvinen added to the conversation saying 2037 is a realistic price, inflation puts it higher and any event could change the price.

- Mark said that they anticipate demographic increases but we are already over-supplied. We use a conservative approach!

Presentation #4 – Bruce Folsom
Price Elasticity Overview

Slide #56 – Piece Elasticity – Context and Import
Bruce explains that there are 3 take aways from today's presentation as follows:
1. Price Elasticity is important!
2. Precision in our industry is difficult to come by!

Slide #58 – Factors Affecting Price Elasticity
- Customer usage varies! If conservative usage then less input = useful output.
- Customers may not know the pricing outlook…i.e. confusing signals!
- Levelized billing
- Economic changes
- Building codes
- Technology
- Customer spending habits
- Fracking
- Spark/spread – now moves in tandem

Questions: Is there any evidence in the last 5 years of consumer responsibility for the dramatic decrease in prices? Is it the same on the industrial side? Are you distinguishing between CORE or Large Volume users?
Answers: Ironically, there is lower usage throughout the industry. Fuel switching could have impact. Not distinguishing between CORE and large volume users.

Slide #61 – Other Factors
- Bruce states that there hasn't been a lot of academic work on this. A utility can run many studies, but at what cost??
- David Nightingale adds that the customer may not act rationally!

Slide #63 – Price Elasticity – Conclusion
- Many complicating factors!
- Customers can use alternative fuels such as propane, firewood, electricity

Presentation #5 – Mark Sellers-Vaughn
SENDOUT Model
- Mark started the presentation by defining the SENDOUT model as a "resource Optimization model.
- It is a regional standard for the LDC's.
- It is powerful & complex but "archaic". The software is 15 years old! We are planning to move to a new platform in 2 to 3 years.
- SENDOUT uses a Linear approach
- It is a "tool" to help inform and shape it is **NOT** a final decision maker!

Slide #70 – Major Resource Issues on the Horizon
- Alternative resource issues
- AECO – issue because NOVA has a CAP and could become a receipt issue.
- Ryckman Creek (OPAL/Wyoming area) resource is reasonably priced but there are reliability concerns!

Question: Mark Sellers Vaughn asks Bob Morman on the phone, are we within 2 to 3 years in getting biofuels?
Answer: Bob said they are working on getting one in place, could happen any time.

Slide #71 – Considerations

- "Pancake" – Rate stacking for example…AECO moves to Foothills, then to GTN pipeline, then to NWP, each has their own rate, called rate "Pancaking" or resource stacking.
- Some considerations are factors & numbers that are "stress tested" with the Monte Carlo.

Slide #73 – Supply Side Alternatives Modeled

- Incremental Storage – Ryckman or Mist

Question: What is the medium contract length?
Answer: Medium is 3 to 5 years. Right now CNG cannot do anything farther out than 3 years but there are discussions about that with Senior Management.

Question: Mark asks WUTC if this should be displayed in narrative or appendix?
Answer: David said he will consult with the others first.

Slide #83 – 2016 IRP Timeline

- TAG #4 will be Distribution System Planning. There will be a few days to look over this presentation. This meeting will be at SeaTac Conference Center (SeaTac)
- TAG #5 is Oct 7th.
- The Draft IRP will be done on 10/17 and you will have 3 weeks for comments.
- Reminder… this is a very aggressive schedule.
- Nov 23rd the IRP goes to press.
- Dec 14 it is filed in Washington.

Mark said his group is trying to make the IRP concise, but the details will be in the Appendix.

Cascade Natural Gas Corporation

Integrated Resource Plan
Technical Advisory Group Meeting #4

Thursday, September 15th, 2016

Seattle-Tacoma International Airport Conference Center

CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.

In the Community to Serve®

AGENDA

- Safety and housekeeping items
- Introductions
- Cascade’s New Webpage
- IRP Update
- Distribution System Planning
- SENDOUT Model
- Scenarios, Sensitivities Planned
- Avoided Costs Methodology
- 2016 IRP Timeline
- Adjournment

Cascade's New IRP Webpage

- https://www.cngc.com/rates-services/rates-tariffs/integrated-resource-plan

Distribution System Planning

Chris Bolton, Engineer II

Technical Advisory Group

September 15th, 2016

Cascade Natural Gas Corporation
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In the Community to Serve®

OUTLINE

I. COMPANY OVERVIEW

II. NETWORK DESIGN FUNDAMENTALS

III. INTERSTATE PIPELINE COMPANIES

IV. SOFTWARE TECHNOLOGY

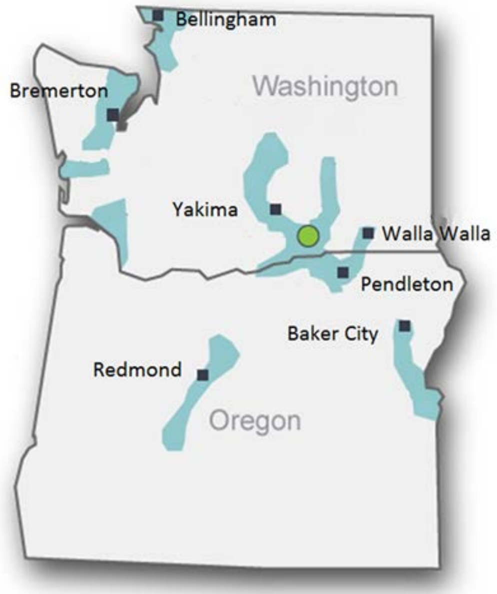
V. DATA GATHERING

VI. DATA ANALYSIS

VII. SYSTEM ENHANCEMENT TECHNIQUES

VIII. FUTURE PLANNING PROCESS FLOW

IX. FUTURE PROJECTS



CNG System Overview

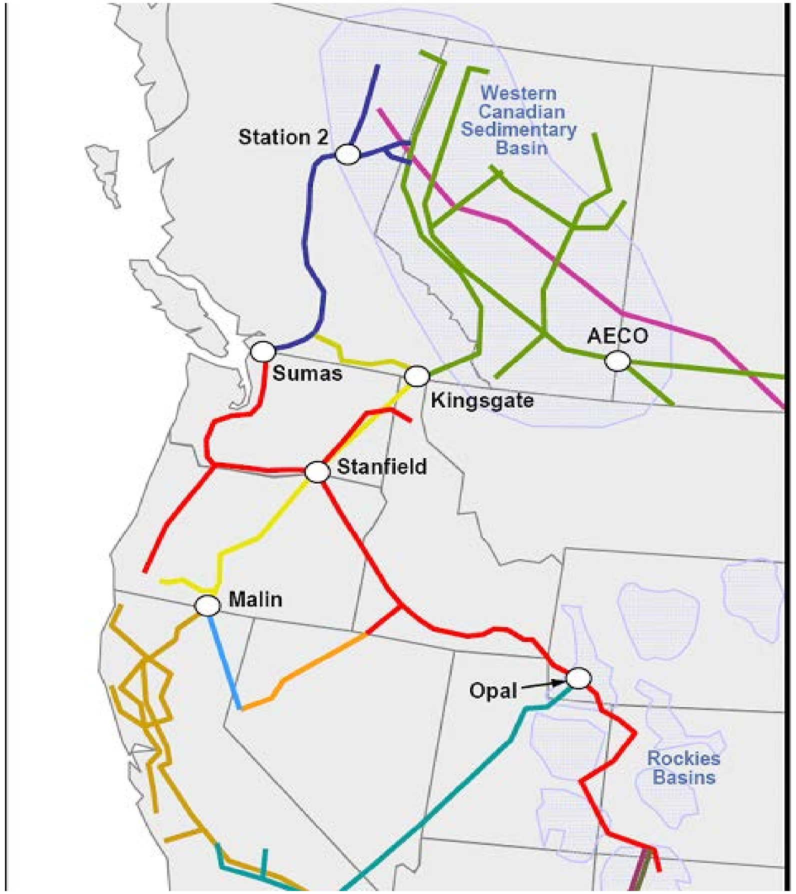
Pipeline:

- 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

FACILITIES:

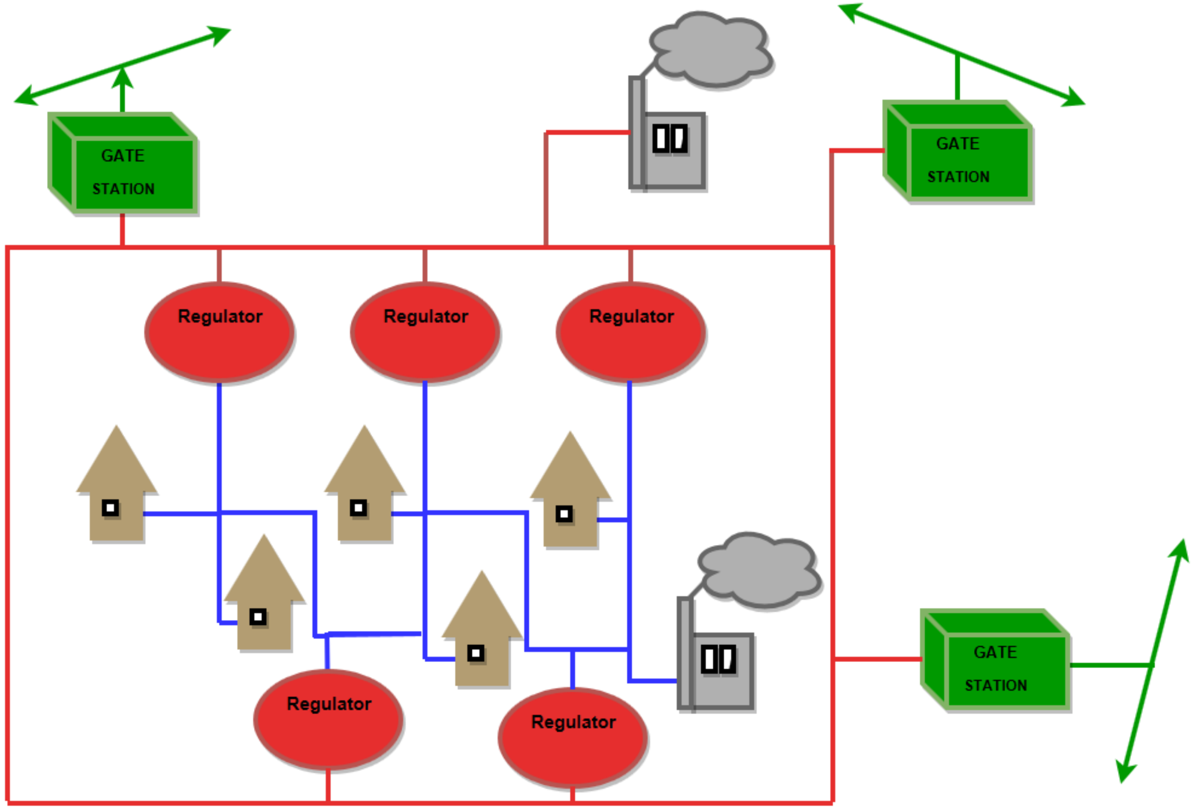
- ➢ REGULATOR STATIONS – OVER 700
- ➢ VALVES – OVER 1600
- ➢ ALSO OTHER EQUIPMENT SUCH AS HEATERS, ODORIZERS AND COMPRESSORS.

WHERE DO WE GET OUR GAS?



- MANY INTERSTATE PIPELINE COMPANIES
- WILLIAMS NORTHWEST PIPELINE (RED)
- TRANSCANADA PIPELINES (YELLOW)

Network Design Fundamentals

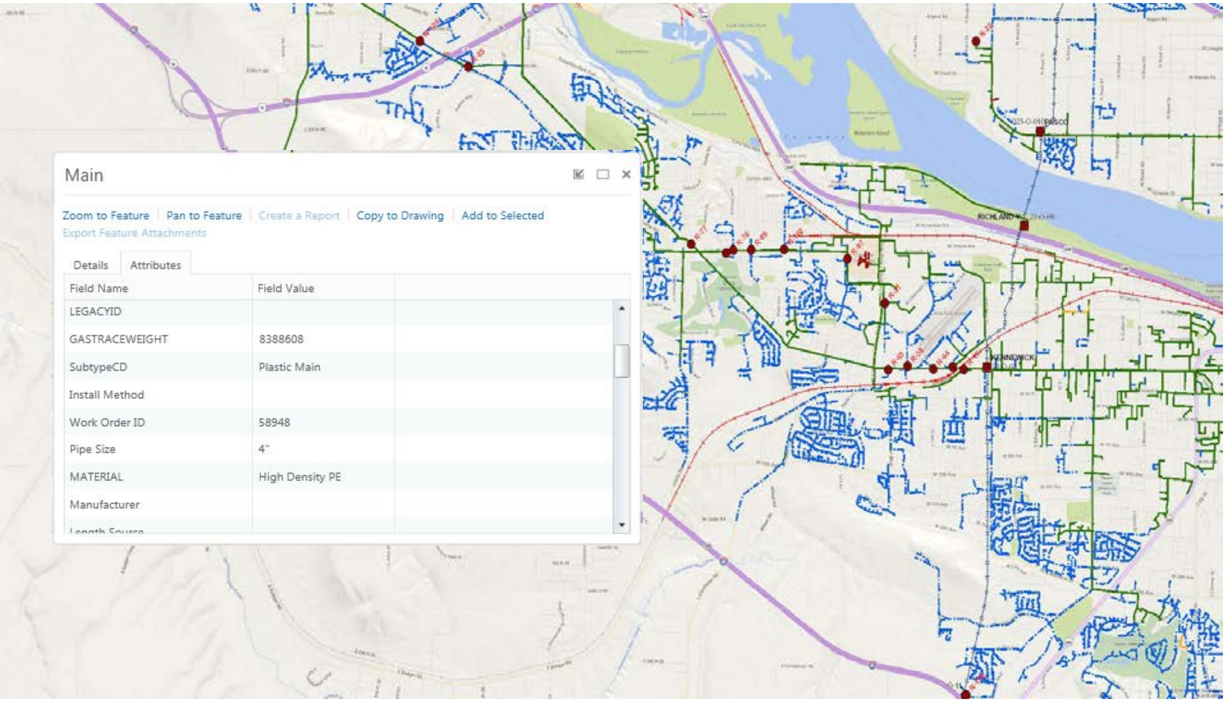


Keys:

- Gate station capacity
- Reg station placement
- Pipe size and grid

GIS – Geographic Information System

-GIS system keeps an up to date record of pipe and facilities complete with all system attributes



- Pipe Size (Dia.)
- Material
- Date of Install
- Operating Pressure
- Work Order

Etc……

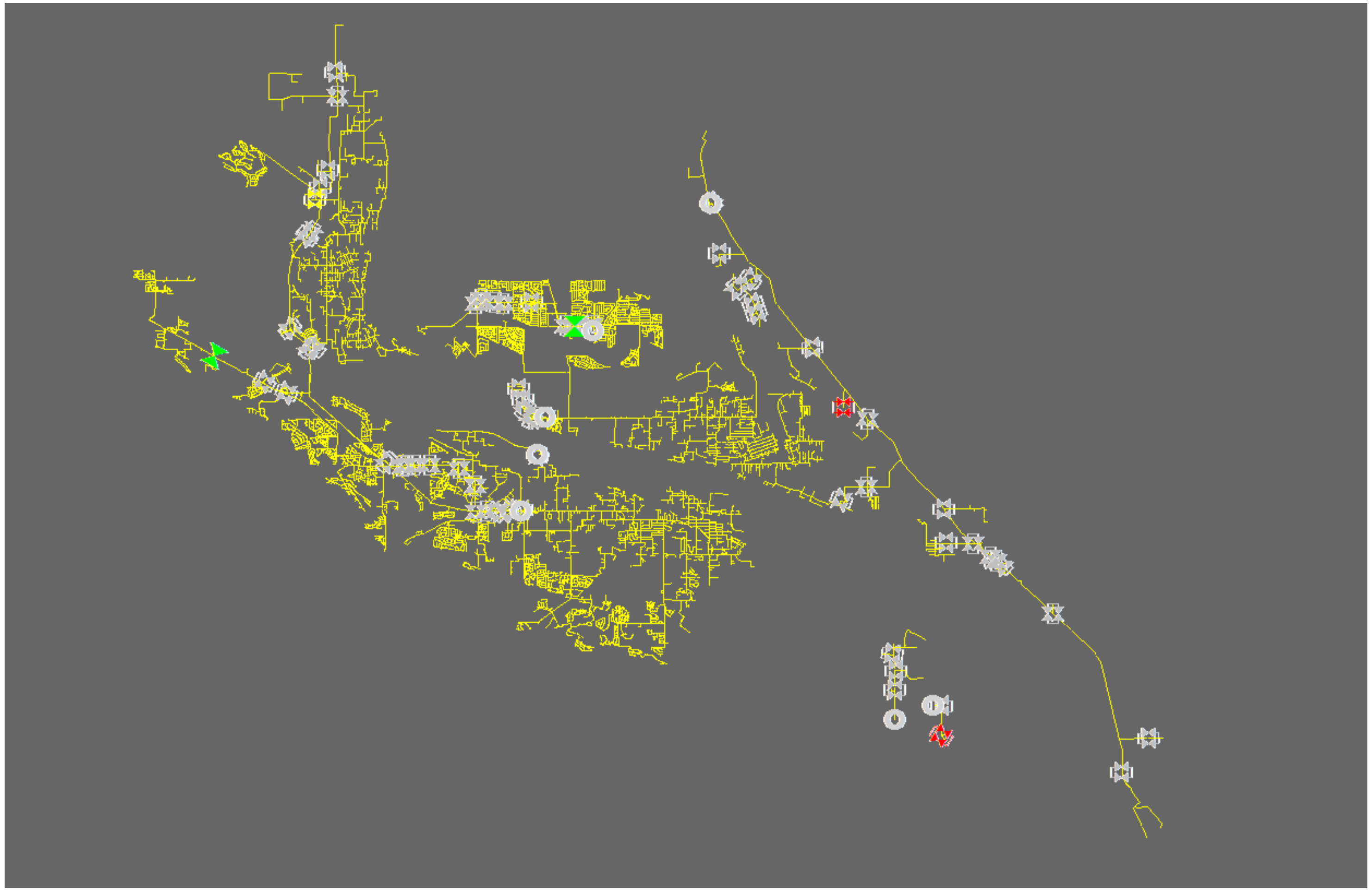
System Modeling

…Using internal GIS environment and other input data CNG is able to create system models through the software – Synergi.

What is Synergi?

- Software to theoretically model piping and facilities to represent current pressure and flow conditions while also predicting future events and growth.

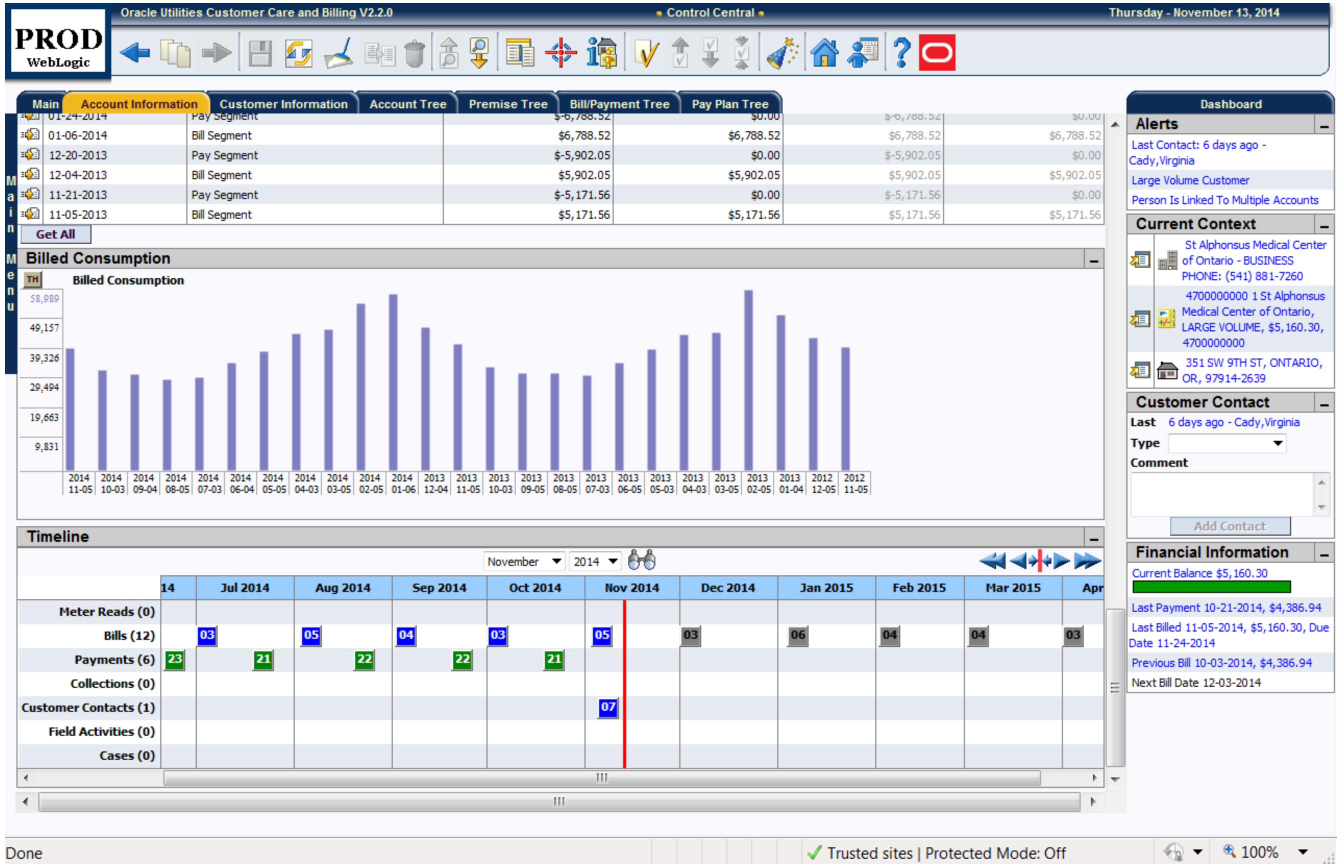
MODEL EX.



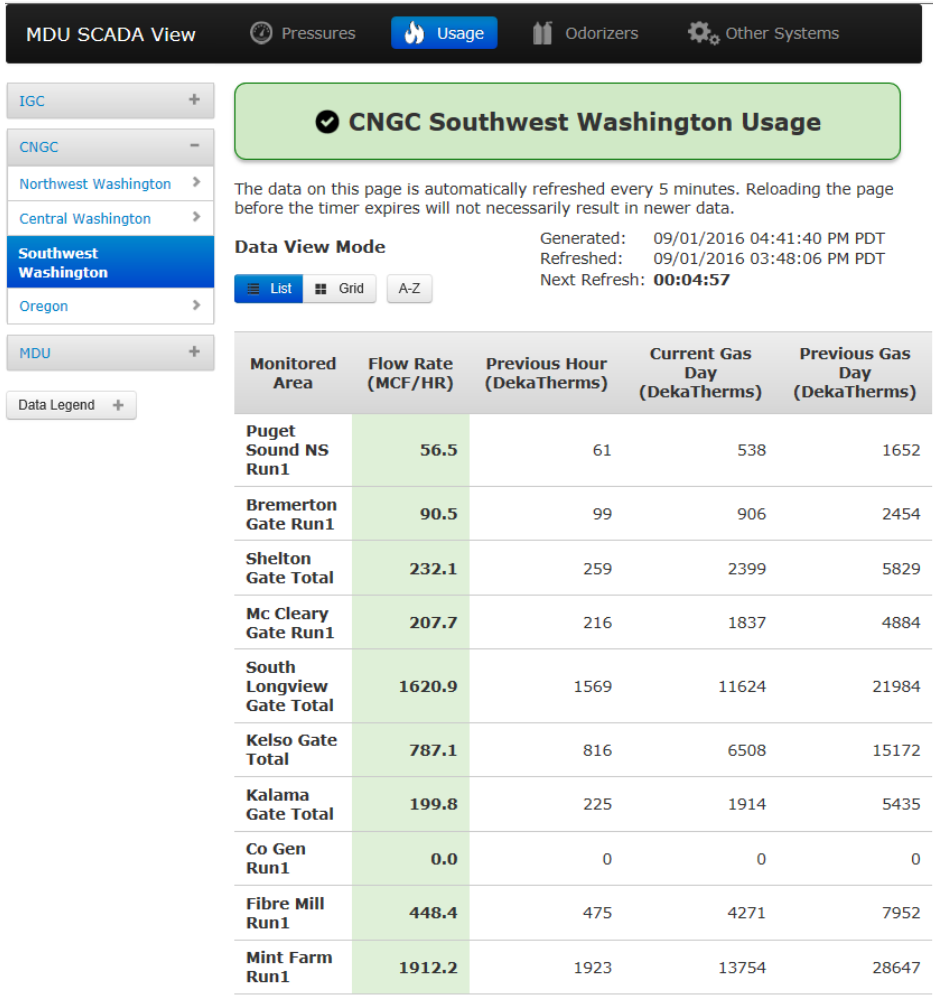
HOW DO WE MAKE THIS MODEL ACCURATE?

DATA GATHERING

➢ CC&B (CUSTOMER BILLING DATA)



DATA GATHERING (CONT.)



MDU SCADA View | Pressures | Usage | Odorizers | Other Systems

IGC
CNGC
Northwest Washington
Central Washington
Southwest Washington
Oregon
MDU
Data Legend

CNGC Southwest Washington Usage

The data on this page is automatically refreshed every 5 minutes. Reloading the page before the timer expires will not necessarily result in newer data.

Data View Mode List | Grid | A-Z

Generated: 09/01/2016 04:41:40 PM PDT
Refreshed: 09/01/2016 03:48:06 PM PDT
Next Refresh: **00:04:57**

Monitored Area	Flow Rate (MCF/HR)	Previous Hour (DekaTherms)	Current Gas Day (DekaTherms)	Previous Gas Day (DekaTherms)
Puget Sound NS Run1	56.5	61	538	1652
Bremerton Gate Run1	90.5	99	906	2454
Shelton Gate Total	232.1	259	2399	5829
Mc Cleary Gate Run1	207.7	216	1837	4884
South Longview Gate Total	1620.9	1569	11624	21984
Kelso Gate Total	787.1	816	6508	15172
Kalama Gate Total	199.8	225	1914	5435
Co Gen Run1	0.0	0	0	0
Fibre Mill Run1	448.4	475	4271	7952
Mint Farm Run1	1912.2	1923	13754	28647

- SCADA DATA : REAL TIME AND HISTORICAL FLOW CHARACTERISTICS AT SPECIFIC LOCATIONS IN THE SYSTEM.

DATA GATHERING (CONT.)

➢ IRP CUSTOMER GROWTH

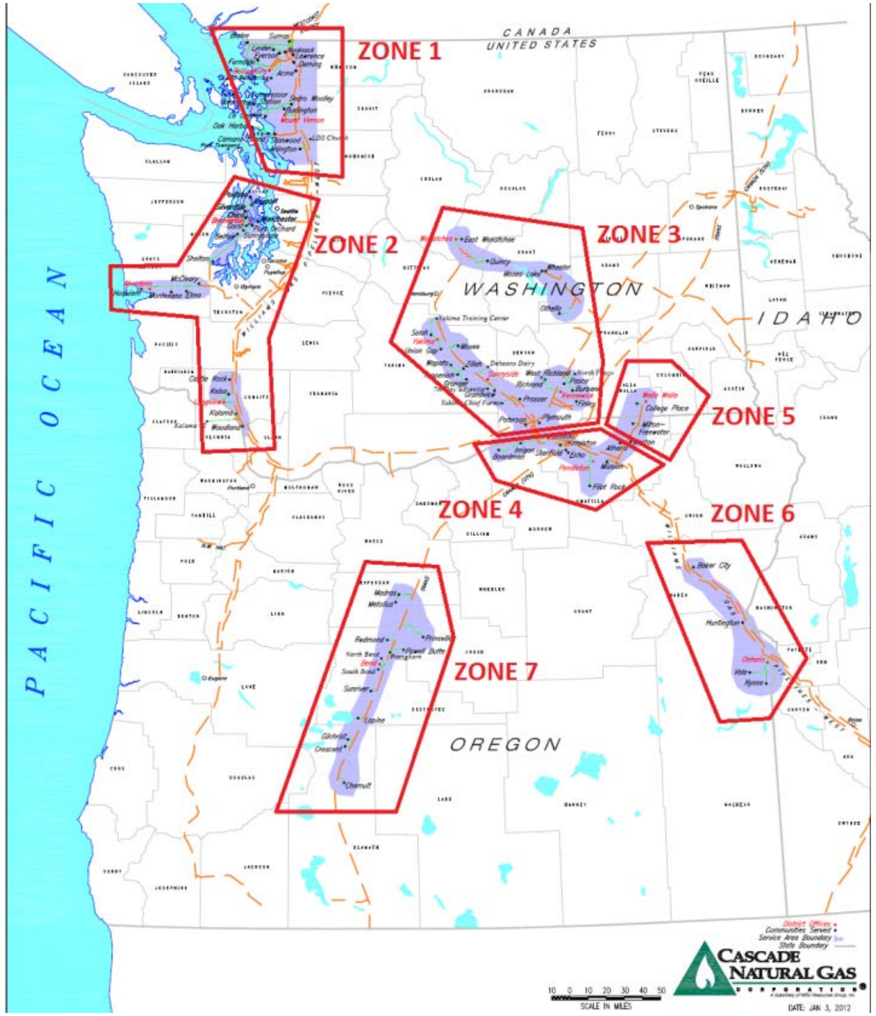
WASHINGTON											
YEAR	MCCLEARY (ABERDEEN/HOQUIAM)	ACME	ARLINGTON	BREMERTON (SHELTON)	CASTLE ROCK	WALLA WALLA	DEMING	WENATCHEE	FINLEY	GRANDVIEW	ZILLAH (TOPPENISH)
2017	0.6%	1.4%	1.3%	1.2%	1.1%	0.7%	1.7%	1.4%	1.9%	0.8%	0.8%
2018	0.6%	1.4%	1.3%	1.2%	1.1%	0.7%	1.7%	1.3%	1.9%	0.8%	0.8%
2019	0.6%	1.4%	1.3%	1.2%	1.0%	0.7%	1.7%	1.3%	1.9%	0.8%	0.8%
2020	0.6%	1.3%	1.3%	1.2%	1.0%	0.7%	1.7%	1.3%	1.8%	0.8%	0.8%
2021	0.6%	1.3%	1.3%	1.2%	1.0%	0.7%	1.7%	1.3%	1.8%	0.7%	0.8%
2022	0.6%	1.3%	1.2%	1.2%	1.0%	0.7%	1.7%	1.2%	1.8%	0.7%	0.8%
2023	0.6%	1.3%	1.2%	1.2%	1.0%	0.7%	1.7%	1.2%	1.8%	0.7%	0.8%
2024	0.6%	1.3%	1.2%	1.2%	0.9%	0.7%	1.7%	1.2%	1.8%	0.7%	0.7%
2025	0.5%	1.3%	1.2%	1.2%	0.9%	0.6%	1.7%	1.2%	1.7%	0.7%	0.7%
2026	0.5%	1.3%	1.2%	1.1%	0.9%	0.6%	1.7%	1.2%	1.7%	0.7%	0.7%
2027	0.5%	1.3%	1.2%	1.1%	0.9%	0.6%	1.7%	1.2%	1.7%	0.7%	0.7%
2028	0.5%	1.3%	1.2%	1.1%	0.9%	0.6%	1.7%	1.2%	1.7%	0.7%	0.7%
2029	0.5%	1.3%	1.2%	1.1%	0.9%	0.6%	1.7%	1.2%	1.7%	0.7%	0.7%
2030	0.5%	1.3%	1.2%	1.1%	0.9%	0.6%	1.6%	1.2%	1.7%	0.7%	0.7%
2031	0.5%	1.2%	1.2%	1.1%	0.9%	0.6%	1.6%	1.1%	1.6%	0.6%	0.7%
2032	0.5%	1.2%	1.1%	1.1%	0.8%	0.5%	1.6%	1.1%	1.6%	0.6%	0.6%
2033	0.4%	1.2%	1.1%	1.1%	0.8%	0.5%	1.6%	1.1%	1.6%	0.6%	0.6%
2034	0.4%	1.2%	1.1%	1.0%	0.8%	0.5%	1.6%	1.1%	1.6%	0.6%	0.6%
2035	0.4%	1.2%	1.1%	1.0%	0.8%	0.5%	1.5%	1.1%	1.5%	0.5%	0.6%
2036	0.4%	1.2%	1.1%	1.0%	0.8%	0.4%	1.5%	1.0%	1.5%	0.5%	0.5%
Average Annual Growth	0.5%	1.3%	1.2%	1.1%	0.9%	0.6%	1.6%	1.2%	1.7%	0.7%	0.7%

DATA GATHERING (CONT.)

- PEAK HEATING DEGREE DAY (HDD) IN THE CNG DIFFERENT WEATHER ZONES
- USES HISTORICAL WEATHER DATA TO DETERMINE WHICH DEGREE DAY MATCHES WHICH ZONE.

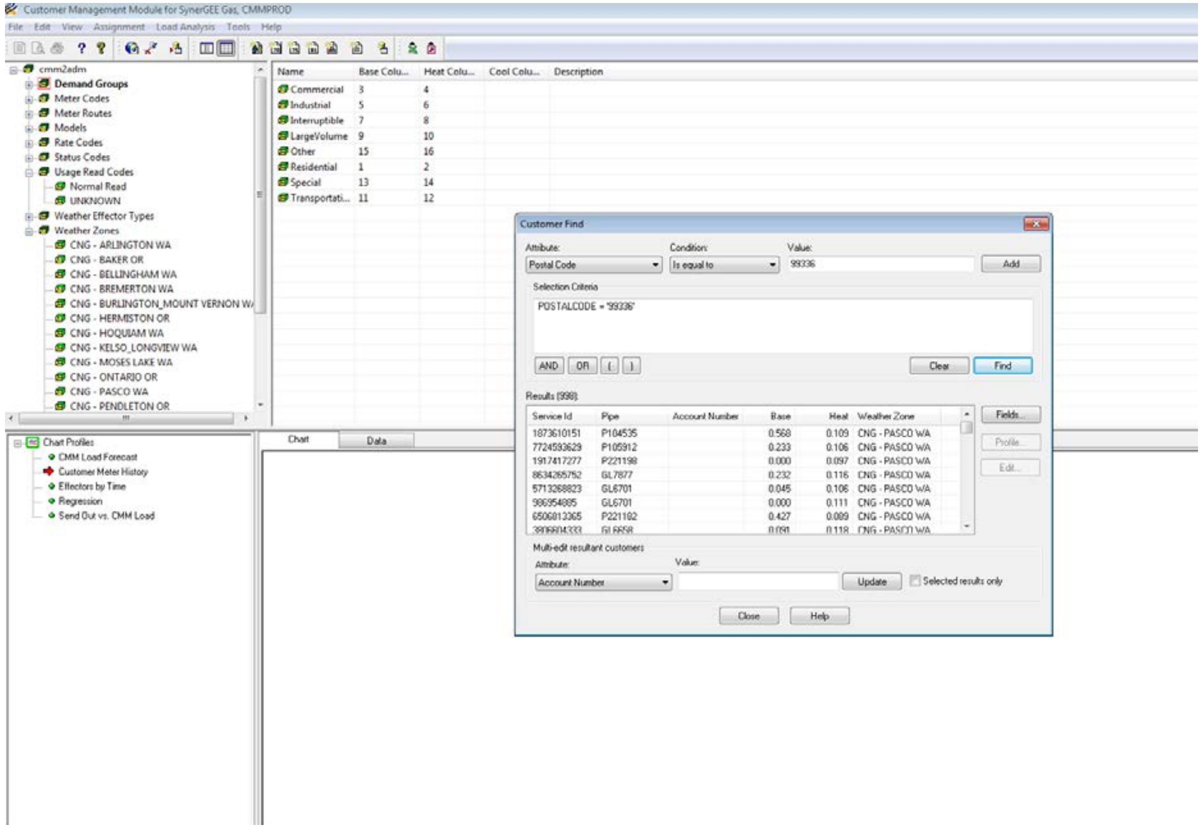
$$HDD = 60 - \frac{day\max + day\ min}{2}$$

CNG Weather Zones



System Peak Day	12/21/90
System Peak HDD	56
Zone 1	46
Zone 2	46
Zone 3	58
Zone 4	67
Zone 5	65
Zone 6	70.5
Zone 7	70.5

Customer Management Module (CMM)



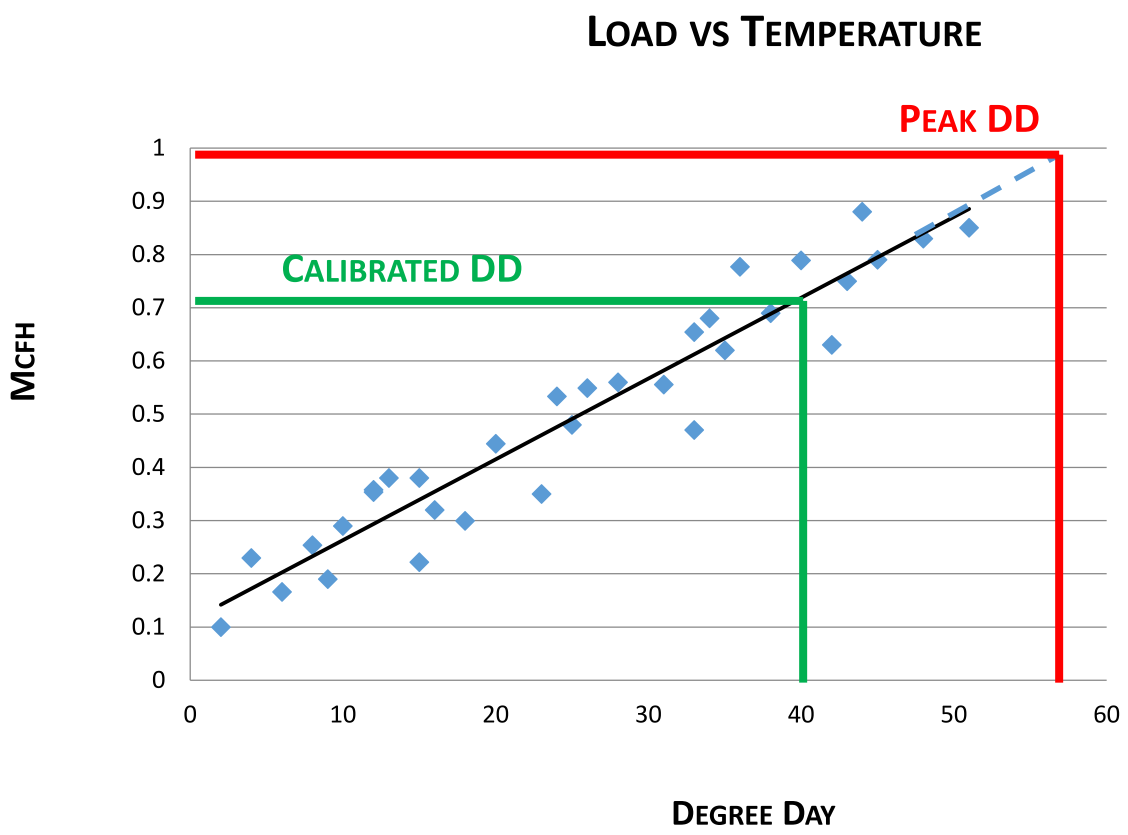
- Software that compiles data from CC&B, HDD, and/or growth studies to manage customer loads.
- Works directly with Synergi to input customer data and represent pressures and flows in the model.

CMM → Synergi

- Conversion can result in 3 model types:
  - Calibrated model – model to represent a specific date and time.
  - Design Day Model – Uses the peak HDD for selected areas to simulate a cold weather (worst case scenario).
  - Growth model - Uses design day model along with growth data to predict future projects.

CALIBRATED VS DEGREE DAY

- DIFFERENT LOADS WILL BE APPLIED TO EACH CUSTOMER



$y = 0.0152x + 0.1118$

HEAT BASE

40 DD = 0.72 MCFH

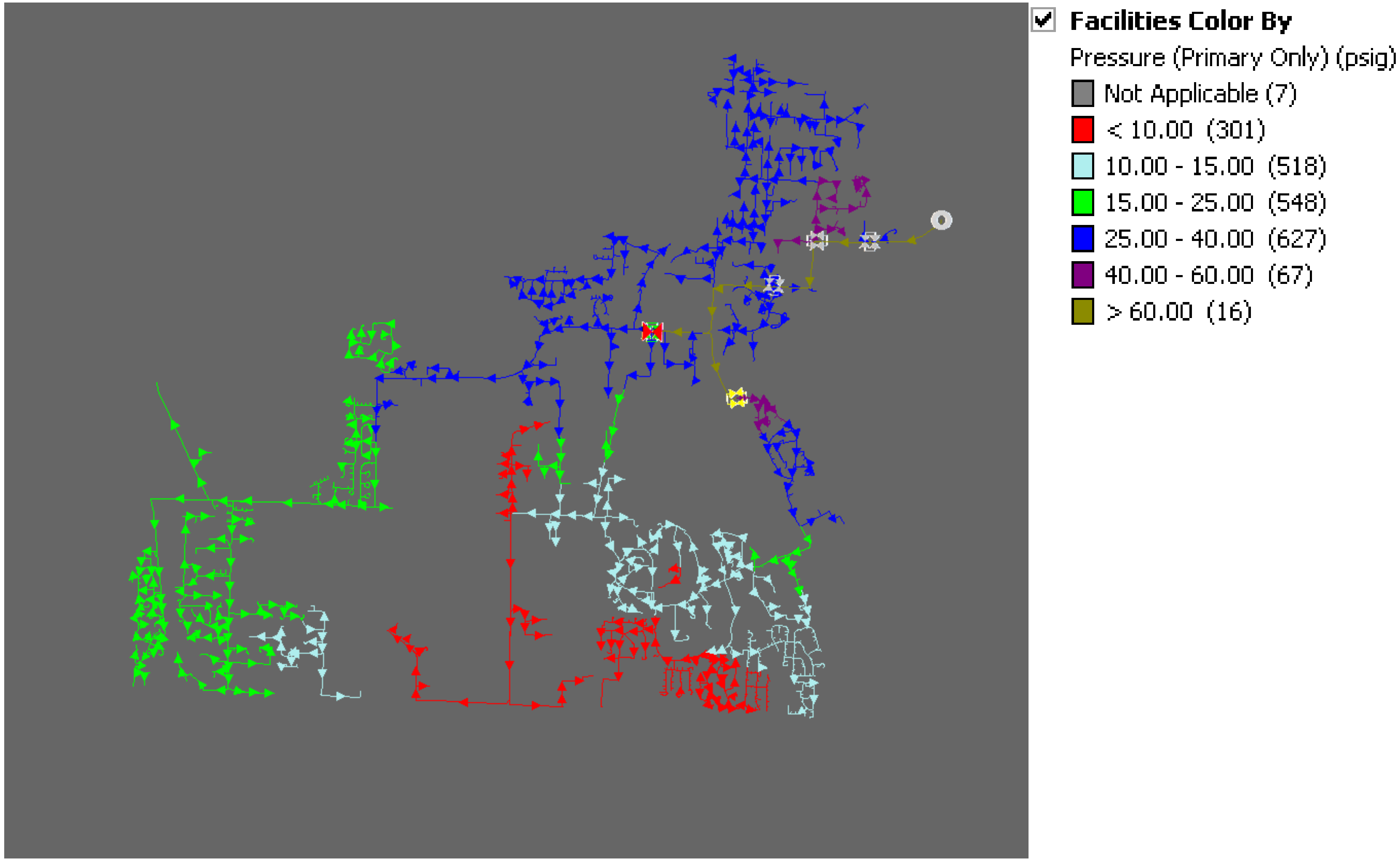
58 DD = 0.99 MCFH

System Modeling (cont.)

- All customers are loaded based upon base and heat trend.
- Growth model – works with design day model and customer growth numbers to simulate pressures and flows in the future.
- Benefits of the models:
  - Customer requests
  - Future planning
  - System reliability
  - Optimizing potential reinforcement

SYNERGI

- THEORETICAL LOW PRESSURE SCENARIO



CAPACITY ENHANCEMENT OPTIONS

- PIPES:
  - REPLACEMENTS
  - REINFORCEMENTS
  - LOOPS
- REGULATOR STATIONS
- COMPRESSORS

PIPE ENHANCEMENTS

PROS

- RELIABLE CAPACITY
- LOW MAINTENANCE
- PERMANENT

CONS

- CAN BE EXPENSIVE
- POTENTIAL LAND ACQUISITION/PERMITTING ISSUES

Reg Station Upgrades/Installs

Pros

- Adds source pressure to alternate system location
- Increases flow control
- Increases pressure control

Cons

- Long term regulator and valve maintenance
- High installation/fabrication costs
- Potential land acquisition issues

Compressor Stations

Pros

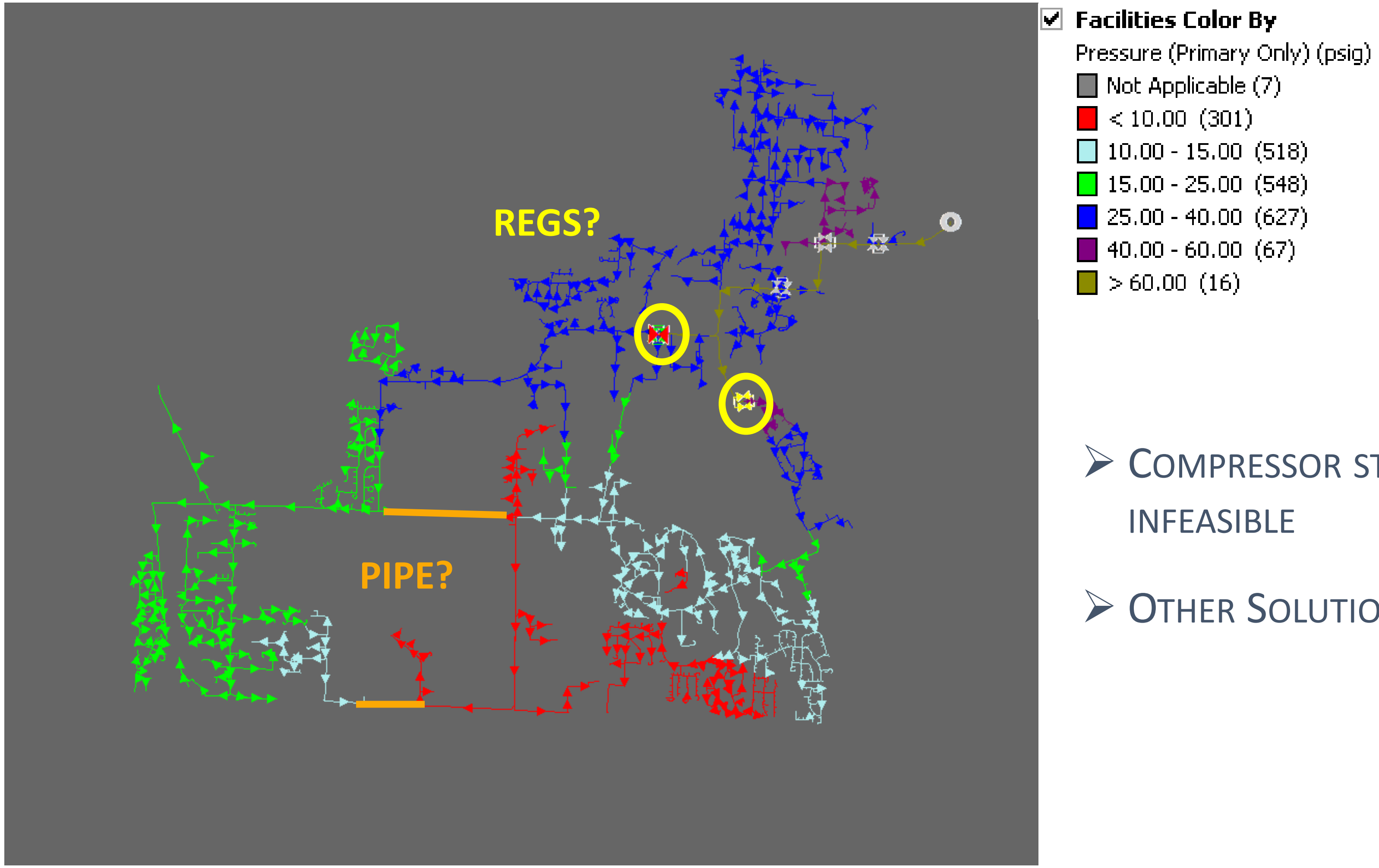
- Adding capacity at lower initial cost
- Less land required
- Situational operation

Cons

- Continuous maintenance/training
- Cost of fuel consumption
- Emissions/permitting
- Beneficial only on transmission type lines

SYNERGI

➢ LOW PRESSURE SCENARIO

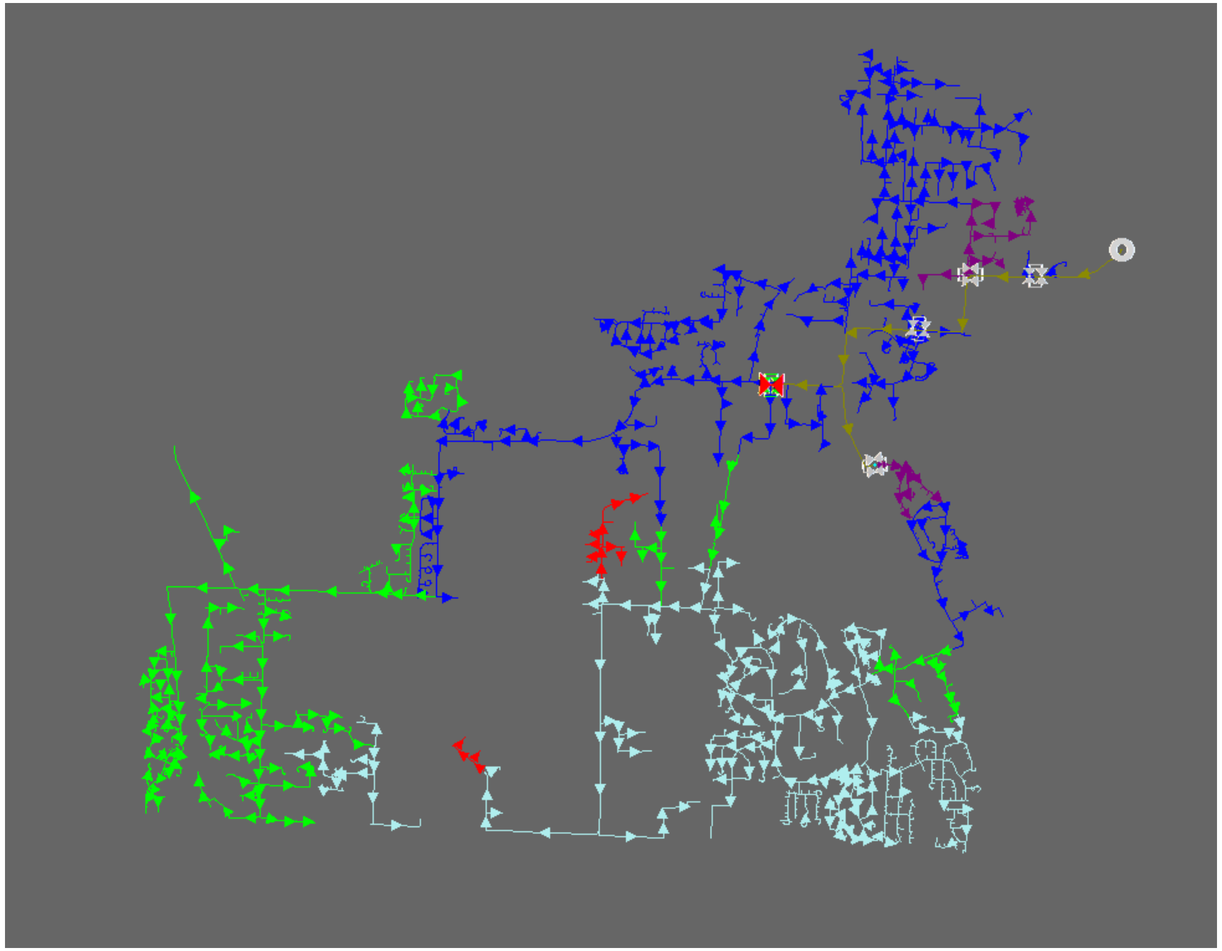


➢ COMPRESSOR STATION INFEASIBLE

➢ OTHER SOLUTIONS?

SYNERGI

➢ POSSIBLE SOLUTIONS – RAISING REG STATION SET POINTS



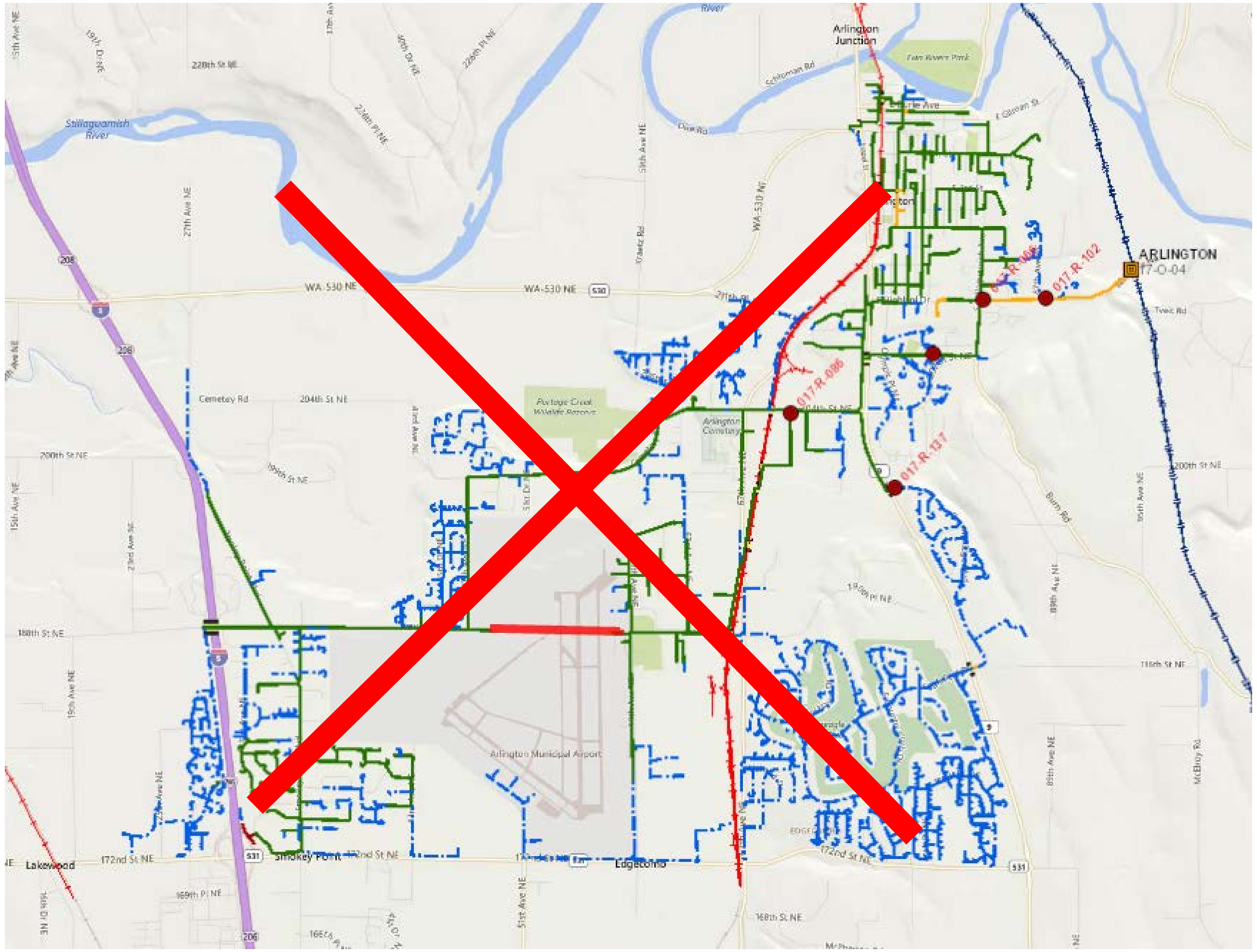
☑ **Facilities Color By**

Pressure (Primary Only) (psig)

- Not Applicable (7)
- < 10.00 (27)
- 10.00 - 15.00 (773)
- 15.00 - 25.00 (483)
- 25.00 - 40.00 (708)
- 40.00 - 60.00 (70)
- > 60.00 (16)

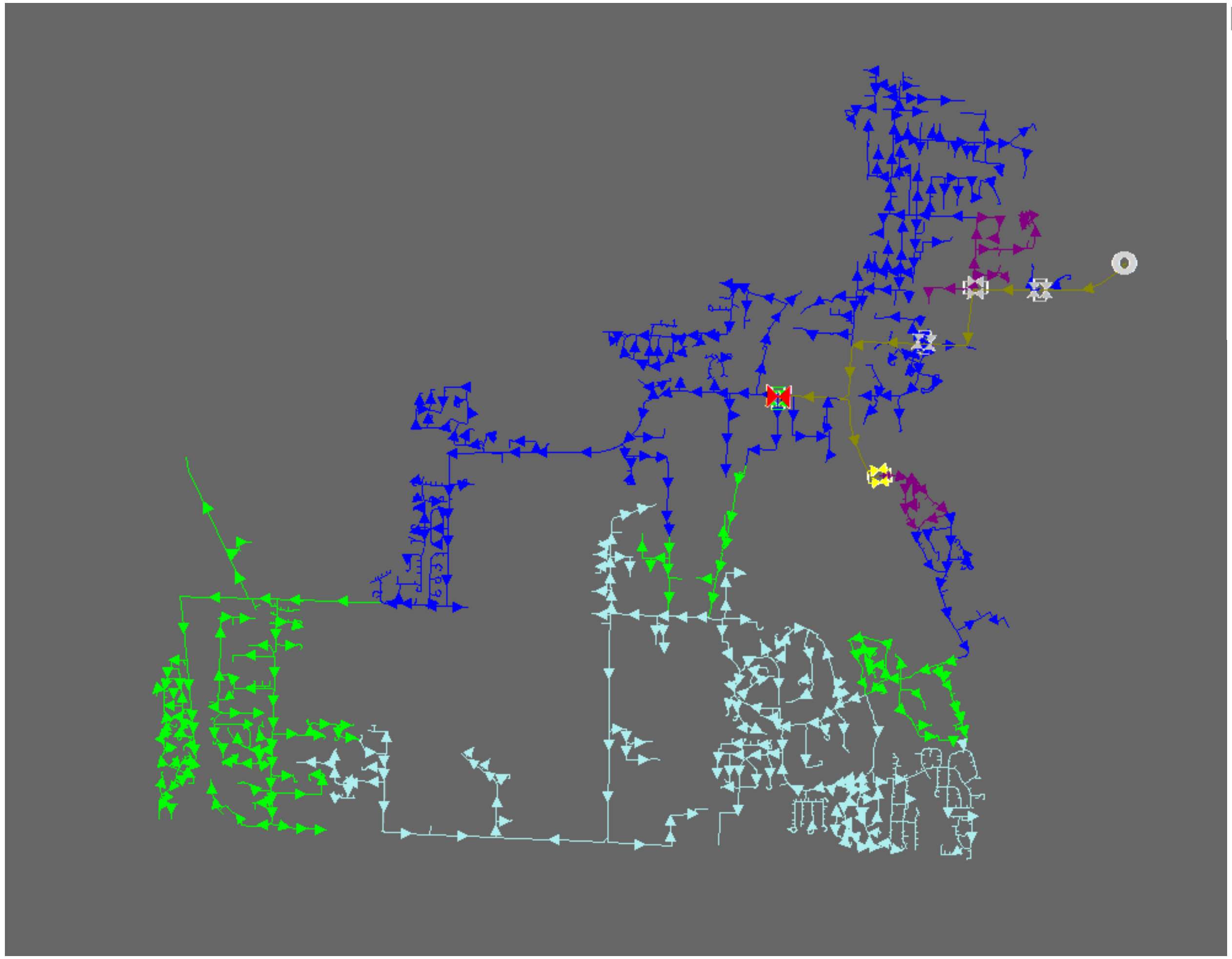
SYNERGI

➢ REINFORCEMENT OPTION #1



SYNERGI

➢ REINFORCEMENT OPTION #2

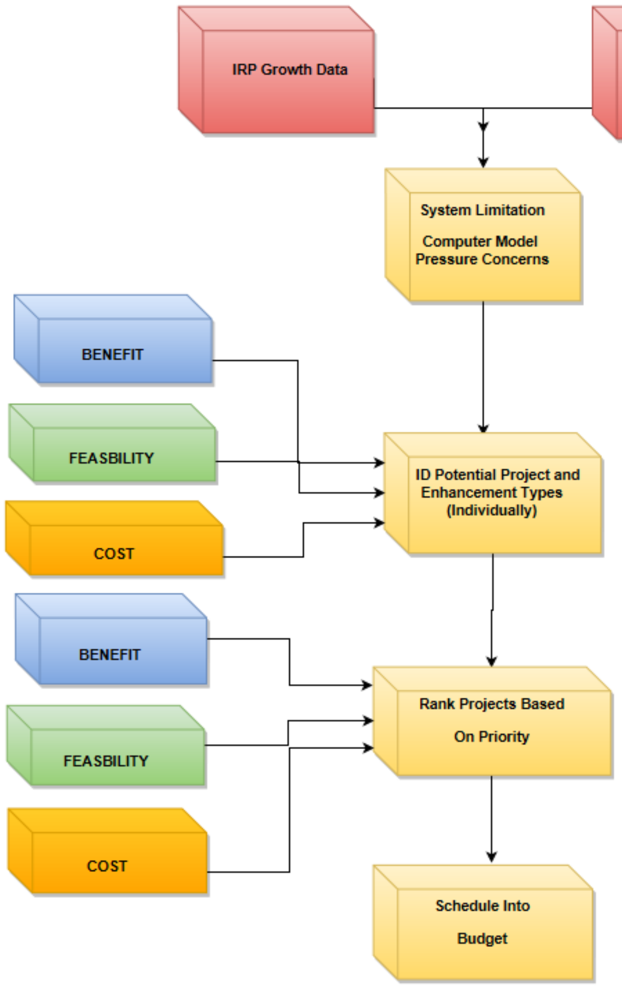


☑ **Facilities Color By**

Pressure (Primary Only) (psig)

- Not Applicable (8)
- < 10.00 (0)
- 10.00 - 15.00 (780)
- 15.00 - 25.00 (367)
- 25.00 - 40.00 (844)
- 40.00 - 60.00 (71)
- > 60.00 (16)

Project Process Flow



Info & Data

Project & Schedules

CNG FUTURE PROJECTS

- EXAMPLE UPCOMING GROWTH PROJECTS

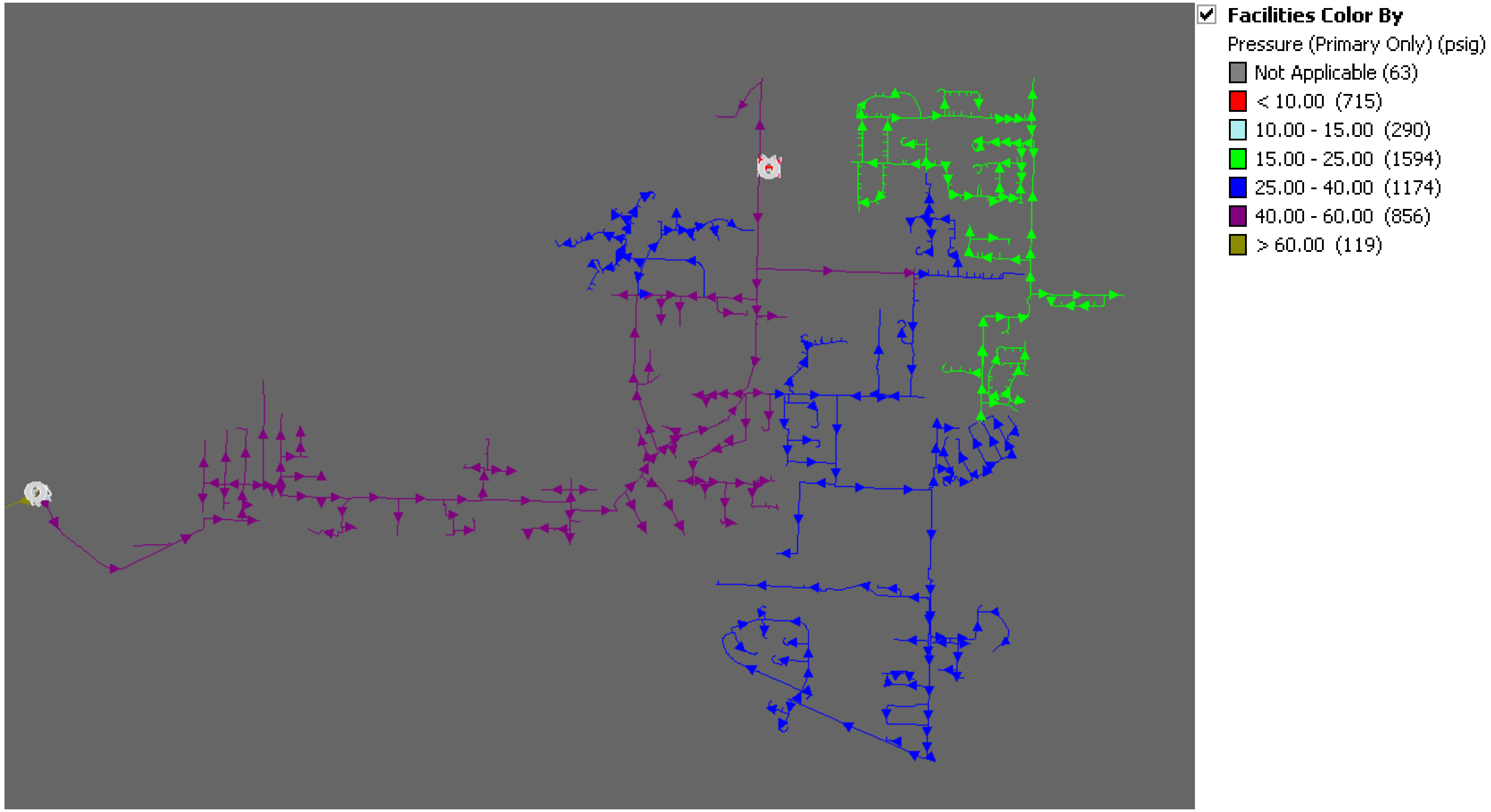
Location	2017	2018	2019
Stanwood 4” Reinforcement	$116,130		
Manchester 4” Reinforcement		$245,870	
South Walla Walla Gate & HP Line		$3,356,259	$2,190,610

STANWOOD 4" PE REINFORCEMENT

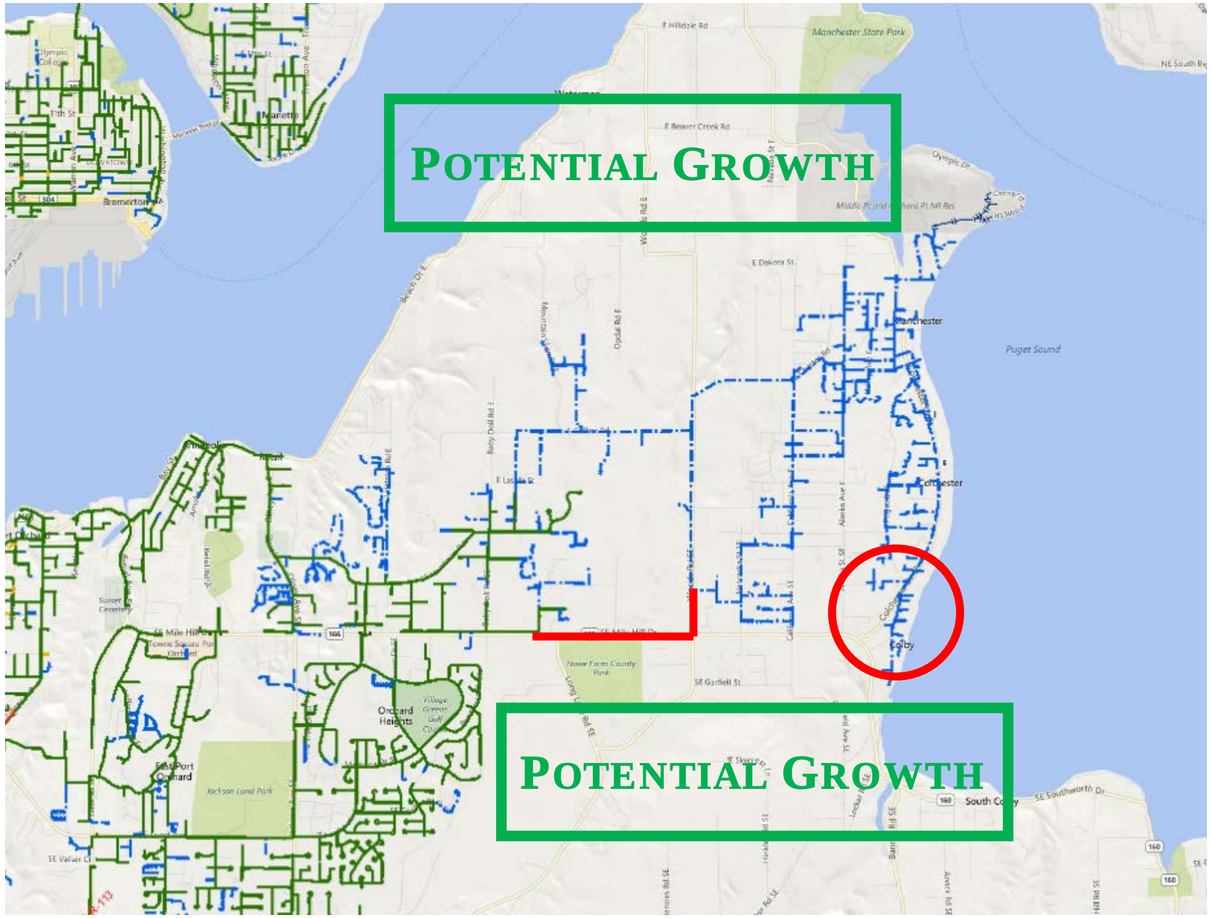
- 2017 PROJECT
- 1550' OF 4" PE
- ANTICIPATING LOW PRESSURE
- ALLOW FOR GROWTH TO THE NORTH AND EAST

STANWOOD 4" PE REINFORCEMENT

➢ DESIGN DAY PRESSURE BEFORE/AFTER



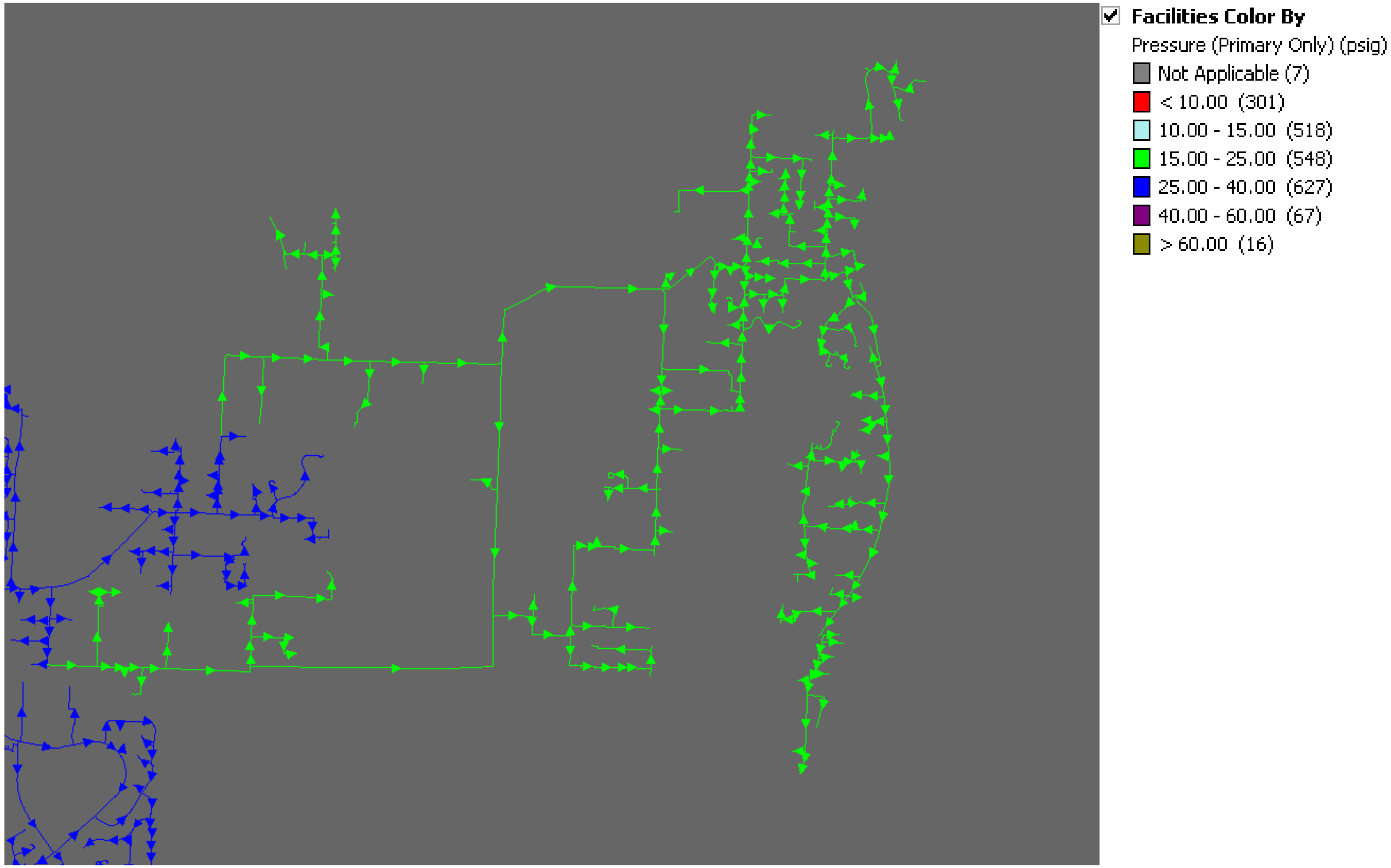
MANCHESTER 4" PE REINFORCEMENT



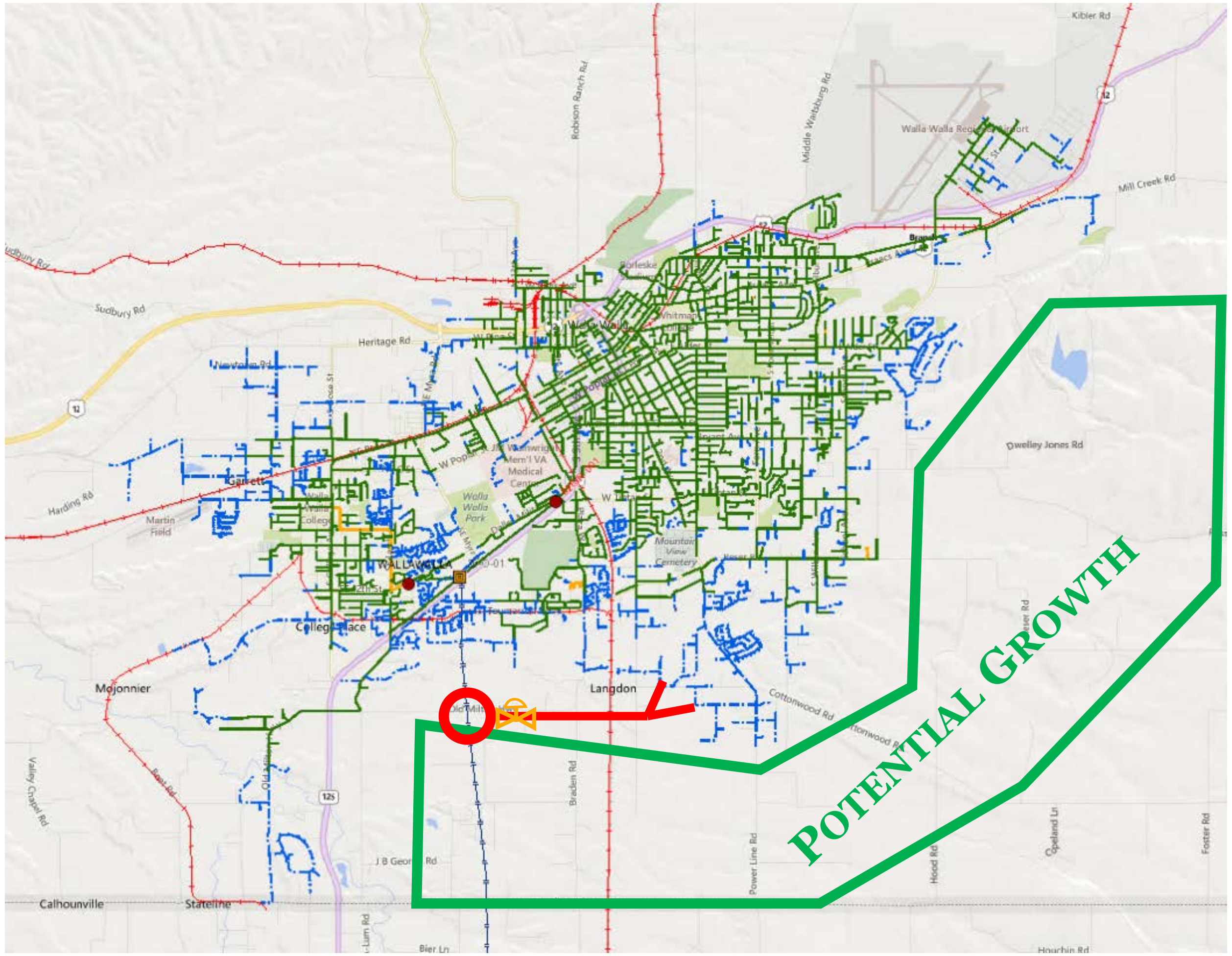
- 2018 PROJECT
- 5100' OF 4" PE
- LOW PRESSURE AT THE END OF SYSTEM
- ALLOW FOR GROWTH TO THE NORTH AND EAST

MANCHESTER 4” PE REINFORCEMENT

➢ DESIGN DAY PRESSURE BEFORE/AFTER



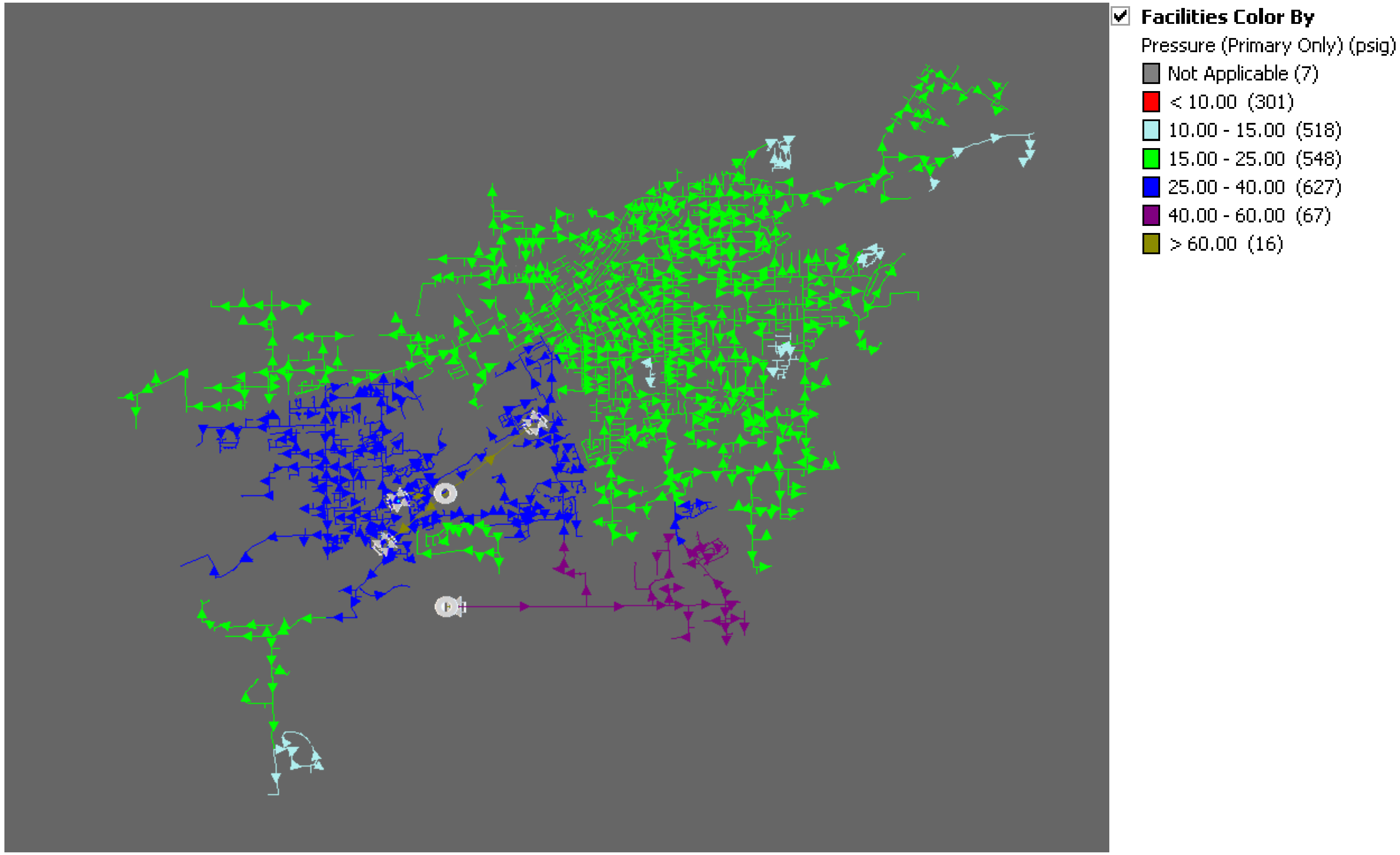
WALLA WALLA GATE & HP LINE



- 2018 AND 2019 PROJECT
- GROWTH NOTED IN SE WALLA WALLA
- UPGRADE WILL INTRODUCE MUCH MORE CAPACITY TO THE SYSTEM

Walla Walla Gate & HP Line

- Model pressure before/after project



Conclusion

- CNGC strives to use technology to gather data, analyze, plan, and design a reliable, safe and economical distribution system.

¿ QUESTIONS ?

Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

SENDOUT OPTIMIZATION MODELING

MARK SELLERS-VAUGHN, MANAGER RESOURCE PLANNING

BRIAN ROBERTSON, SENIOR RESOURCE PLANNING ANALYST

DEVIN MCGREAL, RESOURCE PLANNING ANALYST I

TECHNICAL ADVISORY GROUP

SEPTEMBER 15TH, 2016

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

SENDOUT model

- Cascade utilizes SENDOUT™ for resource optimization.
- This model 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.
- SENDOUT™ is very powerful and complex. It operates by combining a series of existing and potential demand side and supply side resources and optimizes their utilization at the lowest net present cost over the entire planning period for a given demand forecast.

SENDOUT model

- SENDOUT™ utilizes a linear programming approach.
- The model knows the exact load and price for every day of the planning period based on the analyst's input and can therefore minimize costs in a way that would not be possible in the real world.
- Therefore, it is important to acknowledge that linear programming analysis provides helpful but not perfect information to guide decisions.

Modeling Transportation In SENDOUT®

IS A BALANCING ACT OF REALITY AND SUBJECTIVE APPLICATION

- Start with a point in time look at each jurisdiction's resources.
- We start with the Nov16-Oct17 PGA portfolio.
- Contracts –Receipt and Delivery Points
- We start with current transport contracts, using centralized receipts and approx. 66 delivery locations.
- Rates
- Current contractual, with CPI increase every 3 years

- Contractual vs. Operational
- Contractual can be overly restrictive.
- Operational can be overly flexible.
- Incorporating operational realities into our modeling can defer the need to acquire new resources.
- Gas Supply's job is to get gas from the supply basin to the pipeline citygate.
- IRP focus is on the core.
- Operations job is to take gas from the pipeline gate to our customers.
- Operations focus is on the system, not just the core.
- Limiting factor is receipt quantity –how much can you bring into the system?

Modeling Challenges

- Supply needs to get gas to the citygate.
- Many of our transport agreements were entered into decades ago, based on demand projections at that point in time.
- Sum of receipt quantity and aggregated delivery quantity can help identify resource deficiency depending on how you allocate the rights.
- The aggregated look can mask individual city gate issues for looped sections, and the disaggregated look can create deficiencies where they don’t exist.
- In many cases operational capacity is greater than contracted.
- SENDOUT has perfect knowledge.

Supply Resource Optimization Process

Step 1: Resource Portfolio Selection

- run an optimization that includes a peak day, a peak week, and a peak heating season for *every* year in the planning horizon for each Scenario to ensure adequate resources are held to meet peak load

Step 2: Resource Portfolio Expected Costs

- optimize each portfolio from Step 1 under normal weather in each year to determine expected PVRR of each portfolio

Step 3: Resource Portfolio Stochastic Risk Assessment

- test the robustness of the expected resource choice from Step 2 by determining the PVRR of the portfolios from the previous steps under a wide slate of future environments that represent the uncertainty of natural gas prices, weather, and resource costs

Monte Carlo Stochastic Simulation Risk Analysis

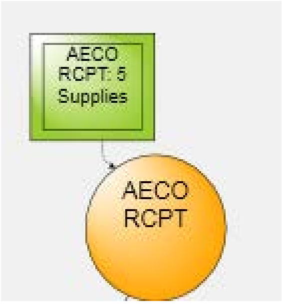
1. Two separate 100 draw simulations that need to be combined to evaluate total portfolio cost risk
2. Simulation 1: Variable Costs
   - Stochastic inputs: Gas Prices and Weather (Load)
   - After the simulation is complete (100 prices and weather futures are simulated), each portfolio is optimized (a daily dispatch cost minimization) for each of the simulation draw to determine PVRR
3. Simulation 2: Fixed Costs
   - Stochastic input: Supply resource option costs
   - After the simulation is complete and 100 different revenue requirement cost outcomes have been obtained, the total PVRR difference relative to the base case for each of the prospective resources is calculated for each simulation draw for all of the portfolios
4. Every PVRR outcome from the two simulation process is paired to determine the total portfolio PVRR for each Scenario under the same 10,000 prospective future environments

Base Case Sendout Inputs

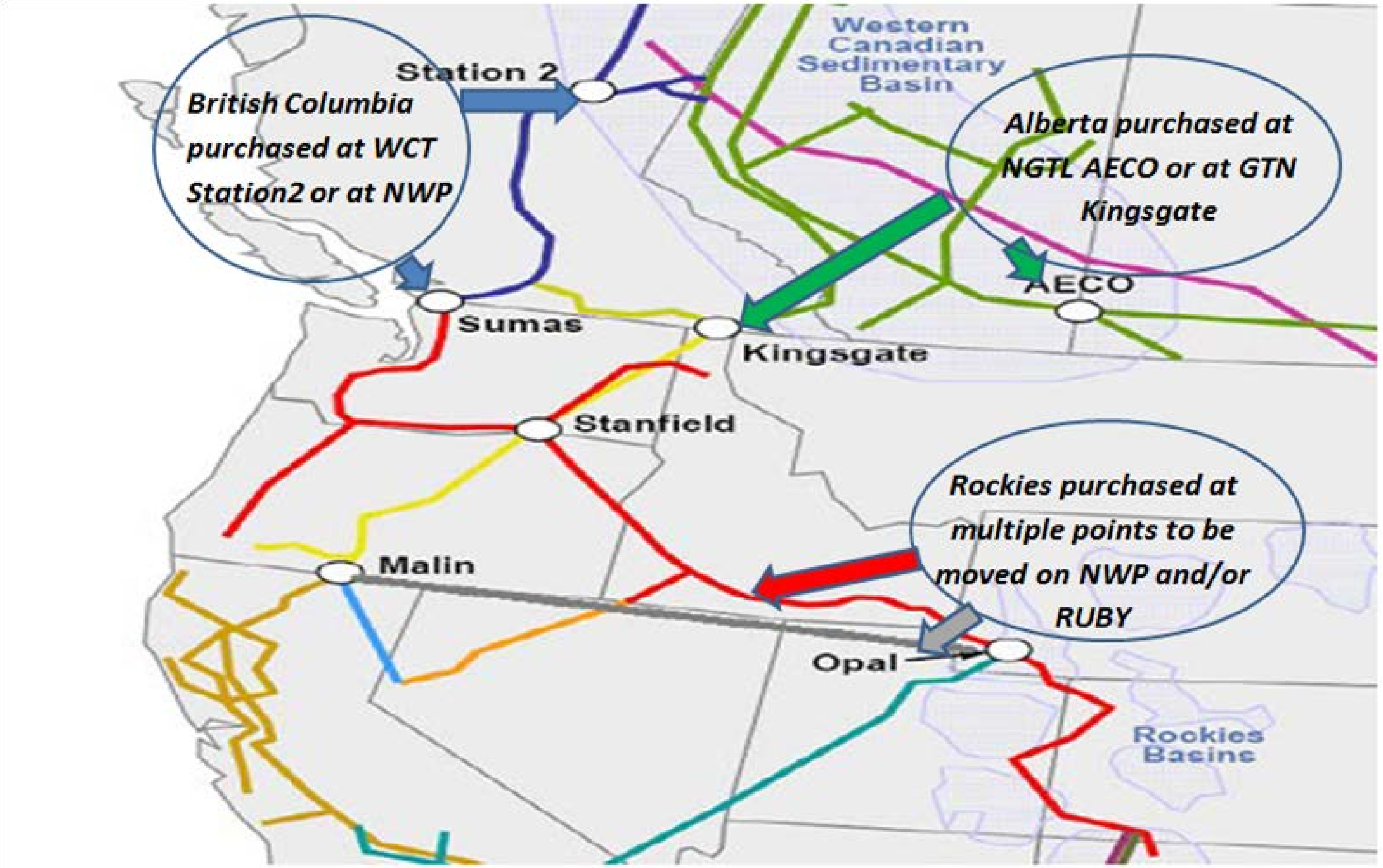
- Supply
- Storage
- Transportation
- Demand
- Price Forecast
- Weather

Supply

- Cascade can purchase gas at 3 markets; AECO, SUMAS, and OPAL.
- At each market Cascade can purchase gas at different locations along the pipeline.
- For the first year, Cascade uses all current contracts for Supply inputs.
- For years 2-20, Cascade uses Base, Fixed, Winter base, Summer and Winter day gas, and Peak day incremental supplies as inputs.
- The contracts for years 2-20 are renewed in November and April.



Supply


Station 2
British Columbia purchased at WCT Station2 or at NWP
Western Canadian Sedimentary Basin
Alberta purchased at NGTL AECO or at GTN Kingsgate
AECO
Sumas
Kingsgate
Stanfield
Rockies purchased at multiple points to be moved on NWP and/or RUBY
Malin
Opal
Rockies Basins

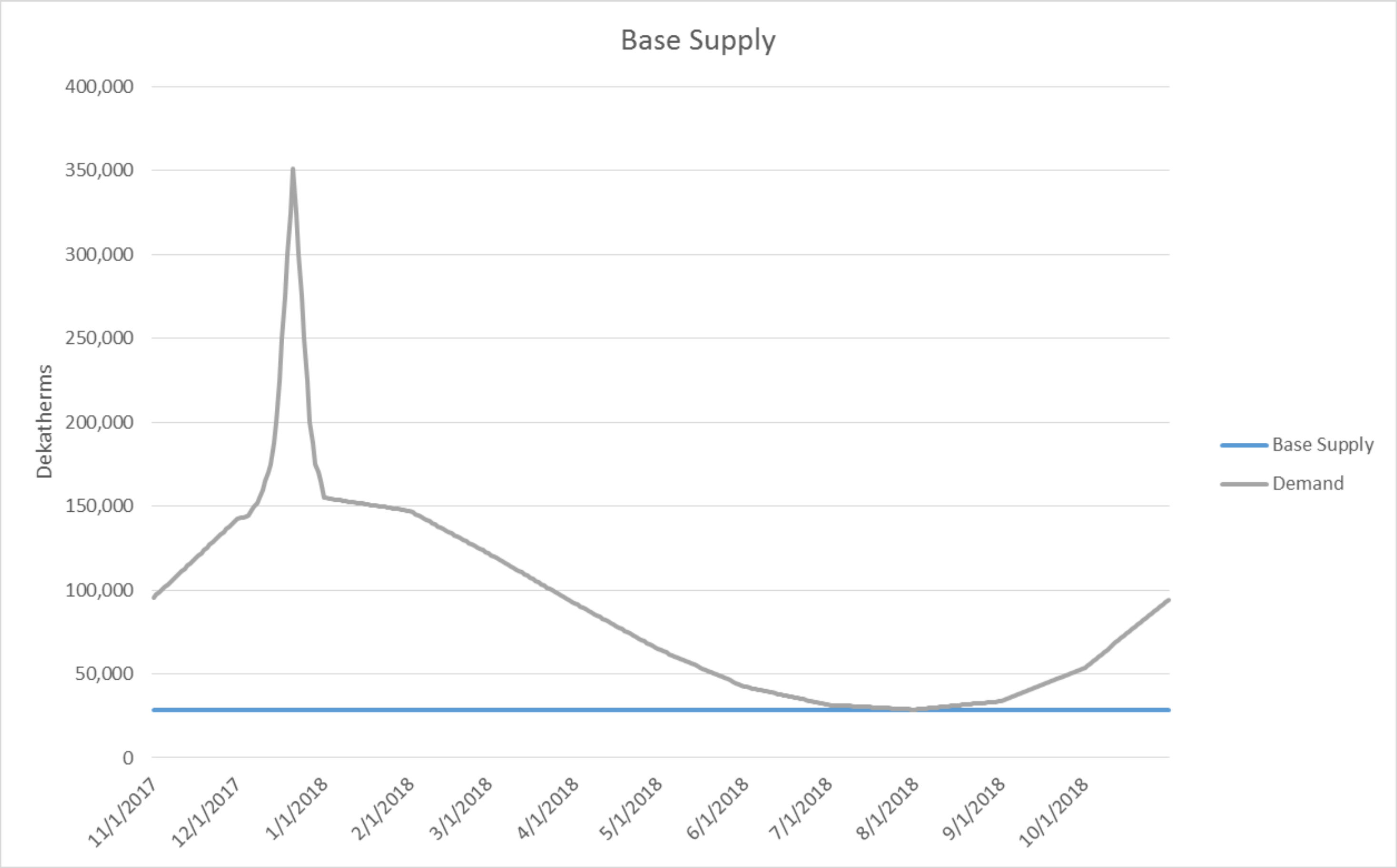
Supply Base and Fixed

- Supply Base and Fixed are the baseline supply contracts that are contracted every 12 months.
- A base contract has a basis rate. This is defined as the price of gas at a given market (ie, AECO base is the expected cost of gas at NYMEX plus the basis for AECO, for a given month).
- A fixed contract has a fixed rate.
- A penalty is applied to each contract when the contracted amount of gas is not taken for a day. This type of penalty forces these types of contracts to take the optimal amount of gas to serve the base demand.

Supply Example

	APR 2017	MAY 2017	JUN 2017
*Daily MDQ	3000	0	
*Daily Minimum Percent	100		
Annual Maximum			
Annual Minimum Percent			
Monthly Maximum			
Monthly Minimum Percent			
Seasonal Maximum			
Seasonal Minimum Percent			
Known Take			
*Rate - Commodity	4		
Rate - Dispatch			
Rate - Known Commodity Cost			
Rate - Other Variable 1			
Rate - Other Variable 2			
Rate - Penalty Annual			
Rate - Penalty Seasonal			
Rate - Penalty Monthly			
Rate - Penalty Daily	3.99		
Rate - D1			
Rate - D2			
Volume - D1 Volume			
Volume - D2 Volume			

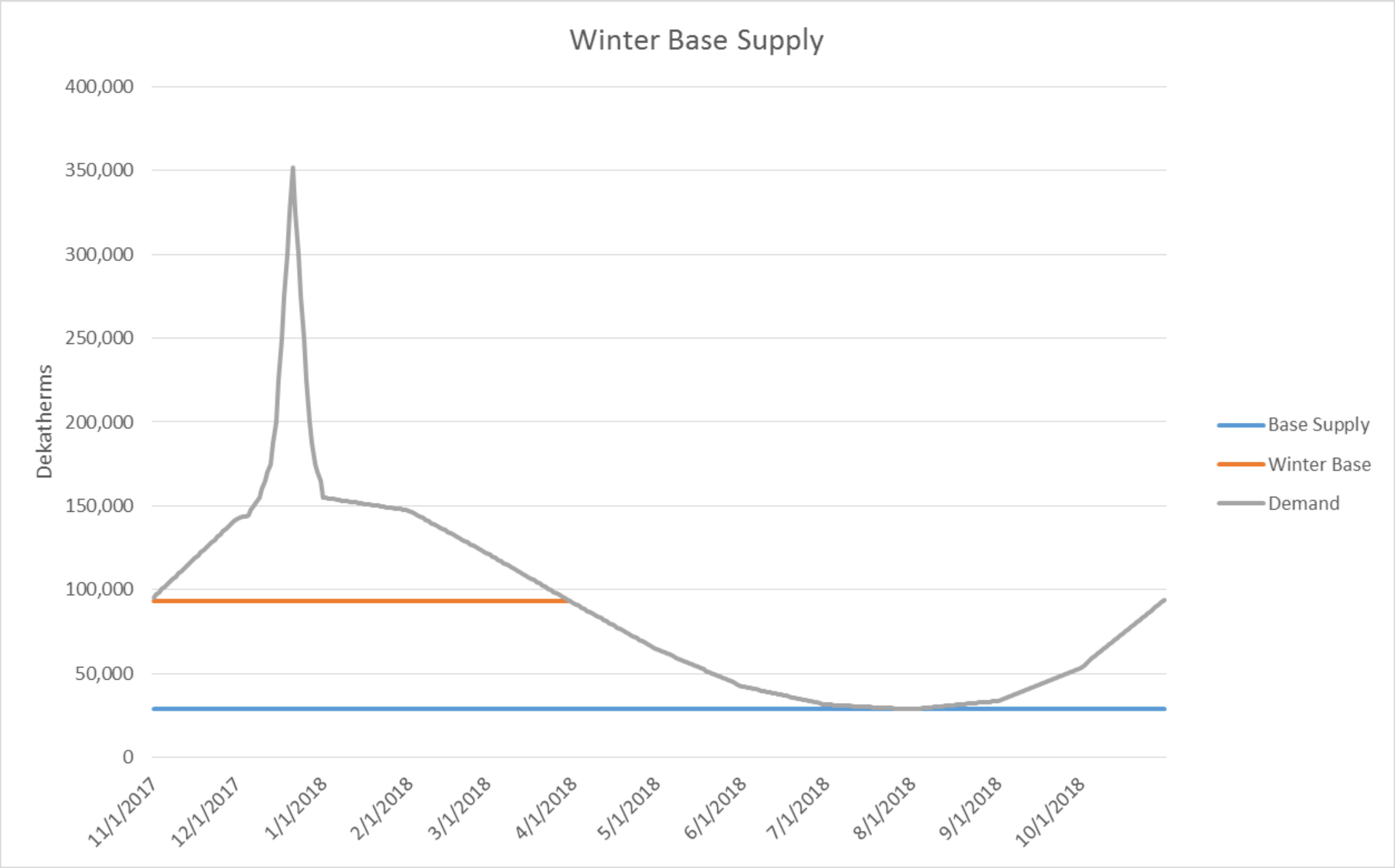
Base Supply cont'd



Winter base Supply

- Winter base supply is contracted supply with a premium charge that is slightly higher than base gas.
- The Maximum Daily Quantity (MDQ) is optimally set by SENDOUT.
- Winter supply is renewed every November and completes at the end of March.
- Winter Supply is additional baseline supply on top of the base or fixed supplies for the winter months.
- There is a penalty associated to this contract to force SENDOUT to take the optimal amount of additional winter base gas.

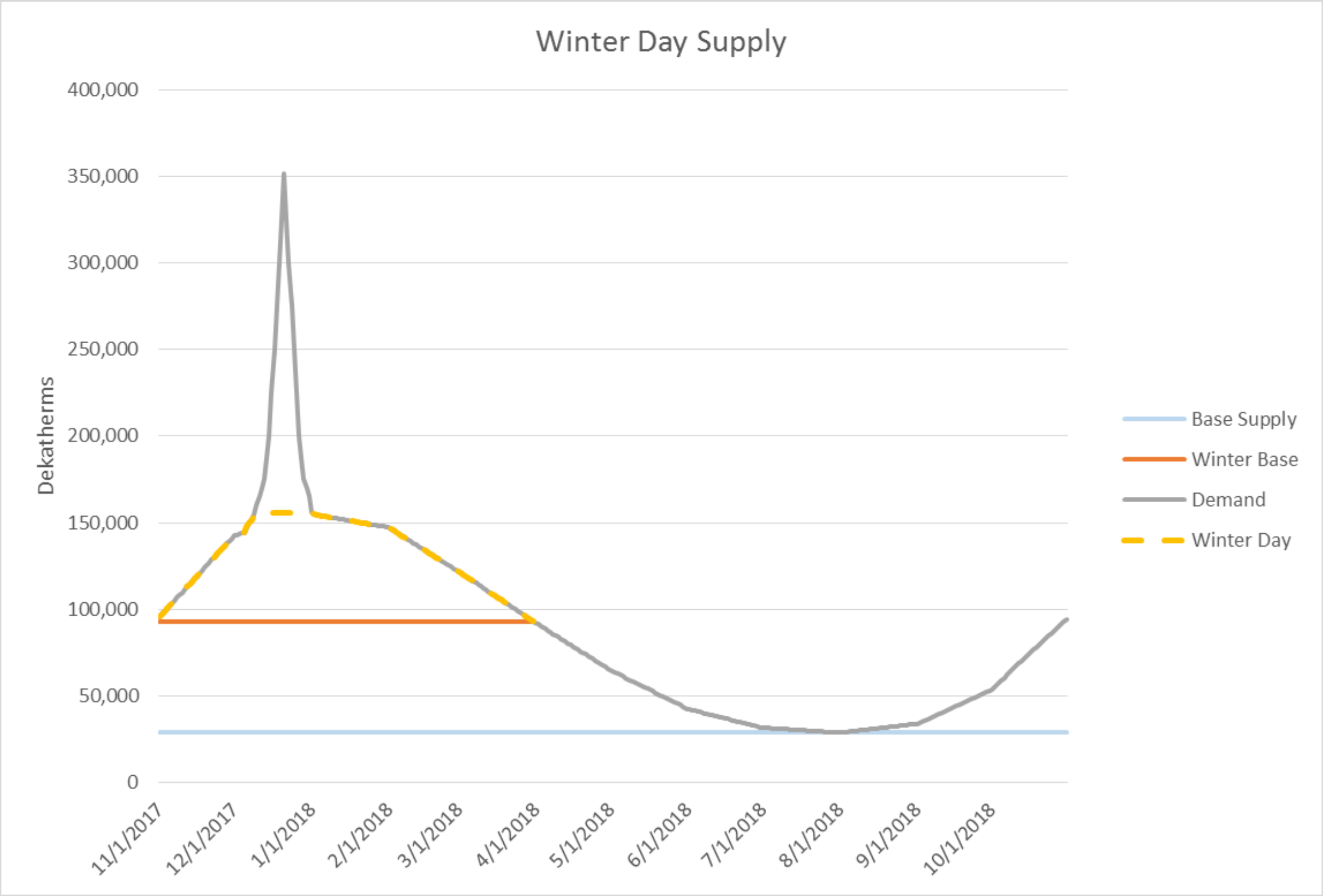
Winter base Supply cont'd



Day Supply (Winter)

- Winter Day supply is gas that is R-mixed at the beginning of November each year.
- The R-mix function takes into account the fixed and variable costs of a resource to determine the proper amount to take in a given period.
- Winter day gas has a MDQ cap but is not a must take supply.
- If a winter day supply has an MDQ of 10000 dth then it can take anywhere from 0 to 10000 dth's of gas on any given day in the winter.
- Winter day supply has a slightly higher premium than winter base supply and it can be contracted from November to April.

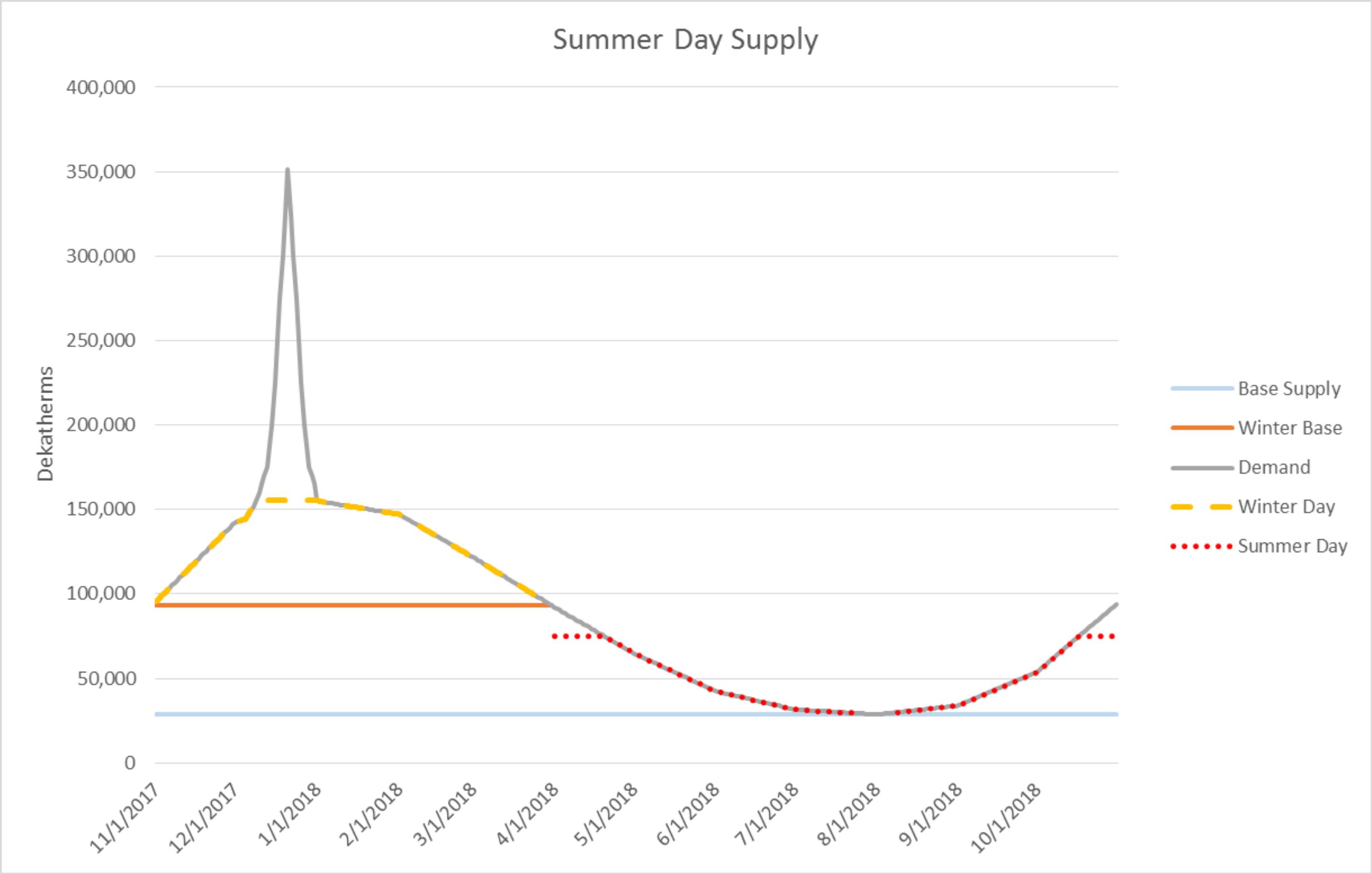
Day Supply (Winter) cont'd



Day Supply (Summer)

- Summer day supply is gas that is R-mixed at the beginning of April each year.
- Summer day gas has a MDQ cap but is not a must take supply.
- If a summer day supply has an MDQ of 10000 dth then it can take anywhere from 0 to 10000 dth's of gas on any given day in the summer.
- Summer day supply has a slightly lower cost than base supply and it can be contracted from April to November.

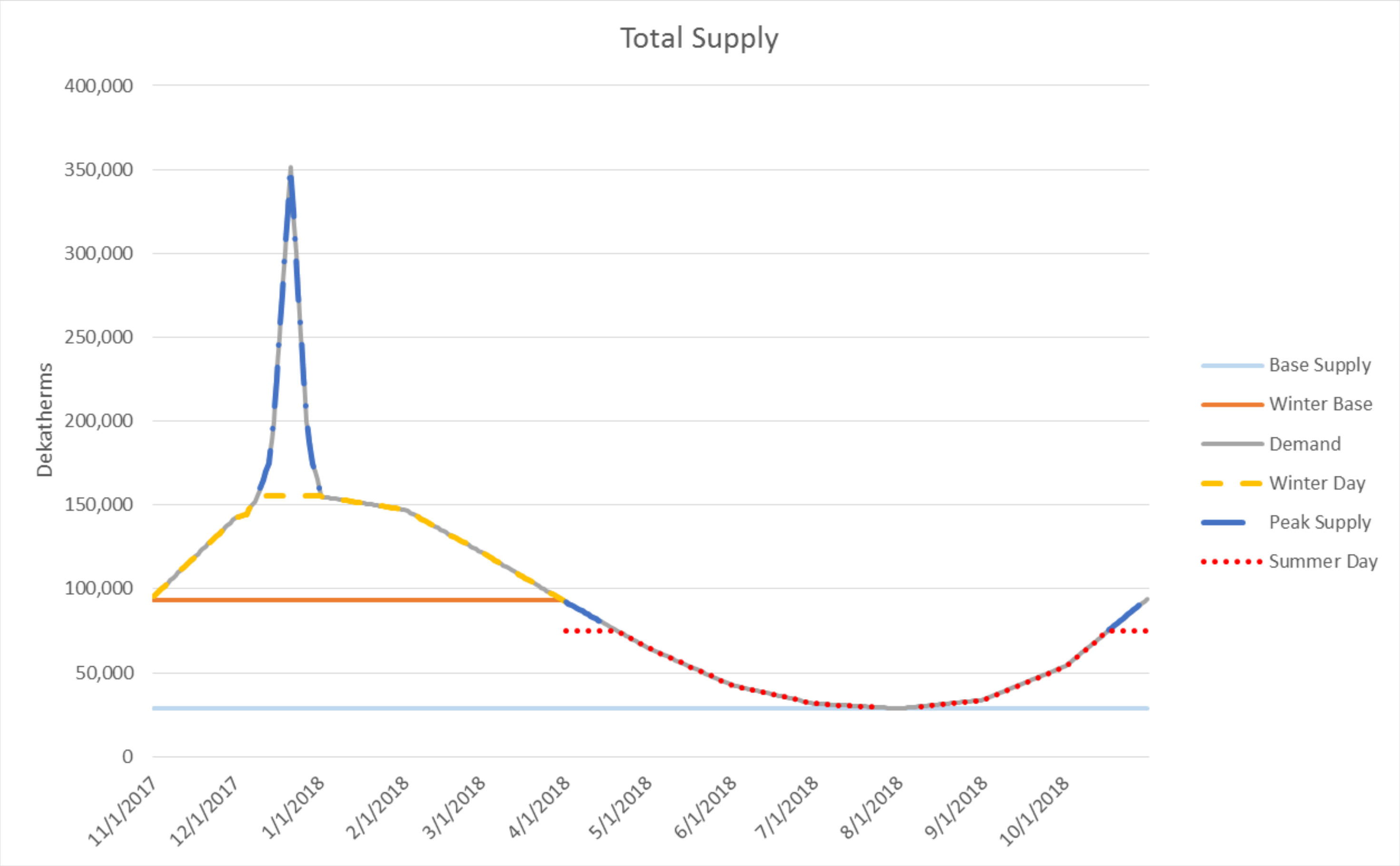
Day Supply (Summer)



Peak Supply

- Peak supply is gas purchased on high demand days where base, index, winter base, or day supply cannot accommodate.
- Peak supply has a slightly higher premium to buy than day supply.
- As long as Cascade has the transport capacity, we can purchase as much peak supply as needed to meet peak demand.

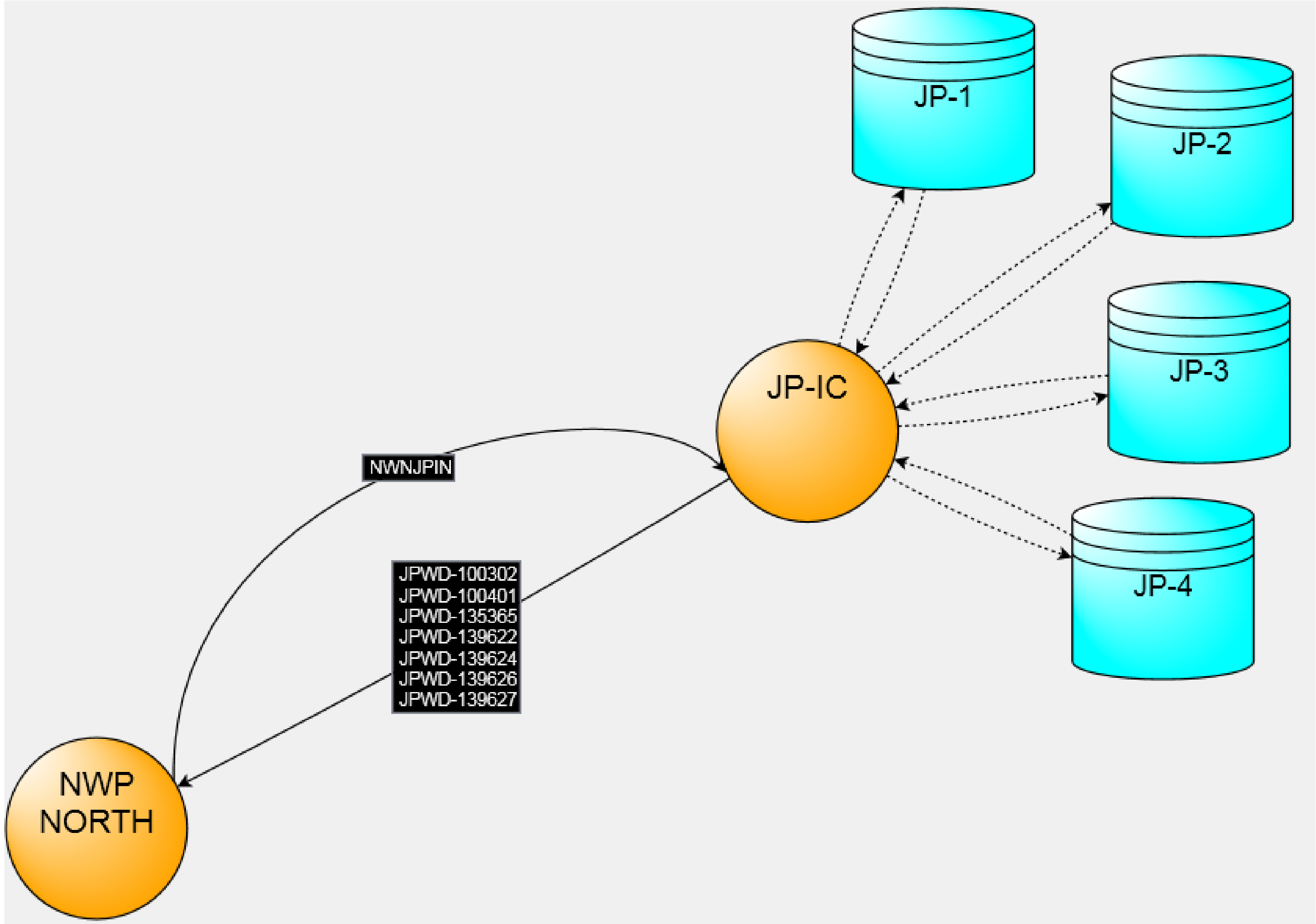
Total Supply



Storage

- Cascade leases storage at 2 locations: Jackson Prairie (JP) and Plymouth.
- Cascade has 4 storage contracts with JP and 2 contracts with Plymouth.
- Storage injections targets are set at 35% by the end of June, 80% by the end of August, and 100% by the end of September.
- These targets are set by our Gas Supply Oversight Committee.
- Cascade can withdrawal approximately 56,000 dth’s per day from JP and 78,000 dth’s per day from Plymouth for a total of approximately 134,000 dth’s per day.

Storage Example



Storage Example 2

	NOV 2016	DEC 2016	JAN 2017	FEB 2017	MAR 2017	APR 2017	MAY 2017	JUN 2017	JUL 2017	AUG 2017	SEP 2017
Process Indicator											
Inventory Maximum Physical Capacity	604351										
Inventory Minimum Physical Percent											
*Target Inv - End of Period Max Pct											
*Target Inv - End of Period Min Pct								35		80	100
*Inventory Adjustment - Value per Unit											
*Inventory Adjustment - Volume											
*Injection Daily MDQ	0					16789					
*Injection Daily Min Percent											
*Withdrawal Daily MDQ	16789					0					
*Withdrawal Daily Min Percent											
Fuel - Injection						.23					
Fuel - Withdrawal	.23										
Rate - Carry						0					
Rate - Injection											
Rate - Withdrawal											
Rate - Other Injection											
Rate - Other Withdrawal											
Rate - Volume Charge											
Rate - D1	.01558										
Rate - D2	.00057										
Volume - D1 Volume	16789										
Volume - D2 Volume											
Storage Ratchets Table	JP										
Starting Inv Layer 1 Value per Unit											
Starting Inv Layer 1 Volume	604351										
Energy Conversion Factor											
Injection Costing List - Transport											
Injection Costing List - Source											
Rate - Other Withdrawal 2											

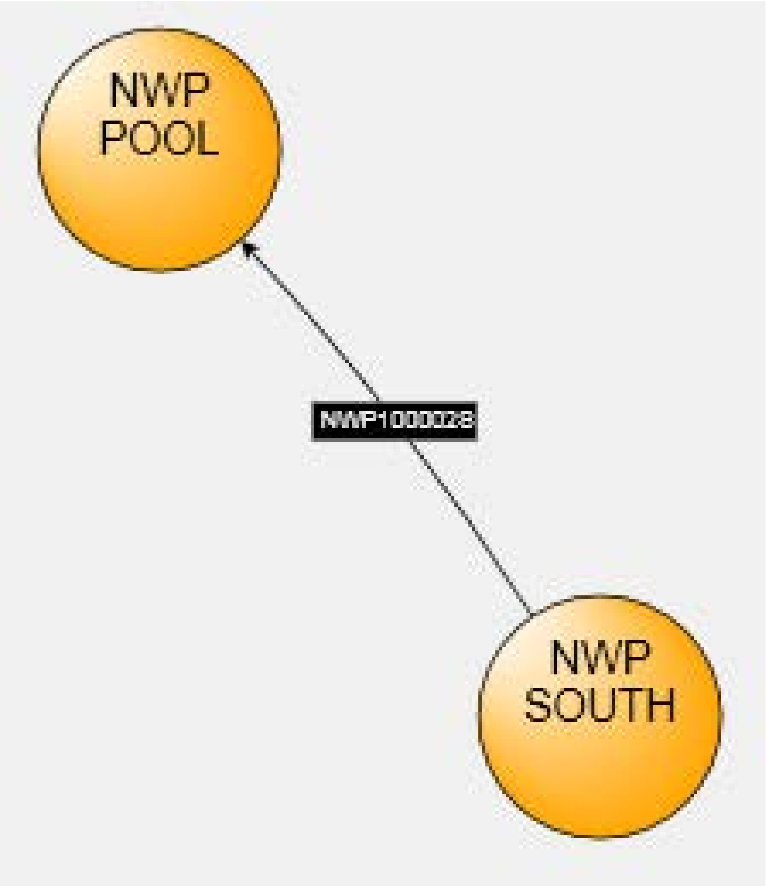
Transportation

- Transportation contracts are the means of how Cascade gets the gas from the supplier to the end user.
- Cascade has multiple types of transportation:
  - A single delivery point.
  - Multiple delivery points.
- The multiple delivery point contracts gives Cascade the flexibility to move the gas where it's most needed.
- On NWP, transportation goes to the zone level because MDDO's can be reallocated within a zone to the Citygate.
- On GTN, transportation goes to the Citygate level as MDDO's cannot be reallocated within the GTN zone.

Transportation cont'd

- Transportation has an MDQ, a D1 rate, a transportation rate, and a fuel loss percentage.
- A maximum delivery quantity (MDQ) which is the maximum amount of gas Cascade can move on the pipeline on a single day.
- A D1 rate which is the reservation rate to have the ability to move the MDQ amount on the pipeline.
- A transportation rate which is the rate per dekatherm that is actually moved on the pipeline.
- The fuel loss percentage is the statutory percent of gas based on the tariff from the pipeline that is lost and unaccounted for from the point of where the gas was purchased to the Citygate.

Transport Example



Transport Example

	JAN 2016	FEB 2016	MAR 2016
*Daily MDQ	313		
*Daily Minimum Percent			
Fuel	0.005		
Rate - Transportation	0.00801552		
Rate - Other Variable			
Rate - D1 Rate	0.25181398		
Rate - Other Fixed			
Rate - Dispatch			
Volume - D1			
Volume - Other Fixed			
Temp Cutoff Max Temperature			
Available % Below Min/Above Max			
Temp Cutoff Min Temperature			
Apply Temperature Cutoff			
Capacity Release - Revenue per Unit			
Capacity Release - Min Pct to Release			
Capacity Release - Max Pct to Release			
Capacity Release - Recall Indicator			
Capacity Release - Start\Stop Indicator			
Indicator - Report			
Indicator- Process			
Resource Mix Start\Stop Indicators			
Rmix MDQ Range Max			
Rmix MDQ Range Min			
Minimum Flow Incentive			
Monthly Max Volume			
Monthly Minimum Percent			
Annual Max Volume			
Annual Minimum Percent			
Seasonal Max Volume			
Seasonal Minimum Percent			

Delivery Rights vs Receipt Rights

- Cascade has more Delivery Rights than Receipt Rights.
- Approximately 457,000 Dth of Delivery Rights.
- Approximately 360,000 Dth of Receipt Rights.
- The excess Delivery Rights allow Cascade to be flexible with the 360,000 Dth of Receipt gas.

Example of delivery right flexibility

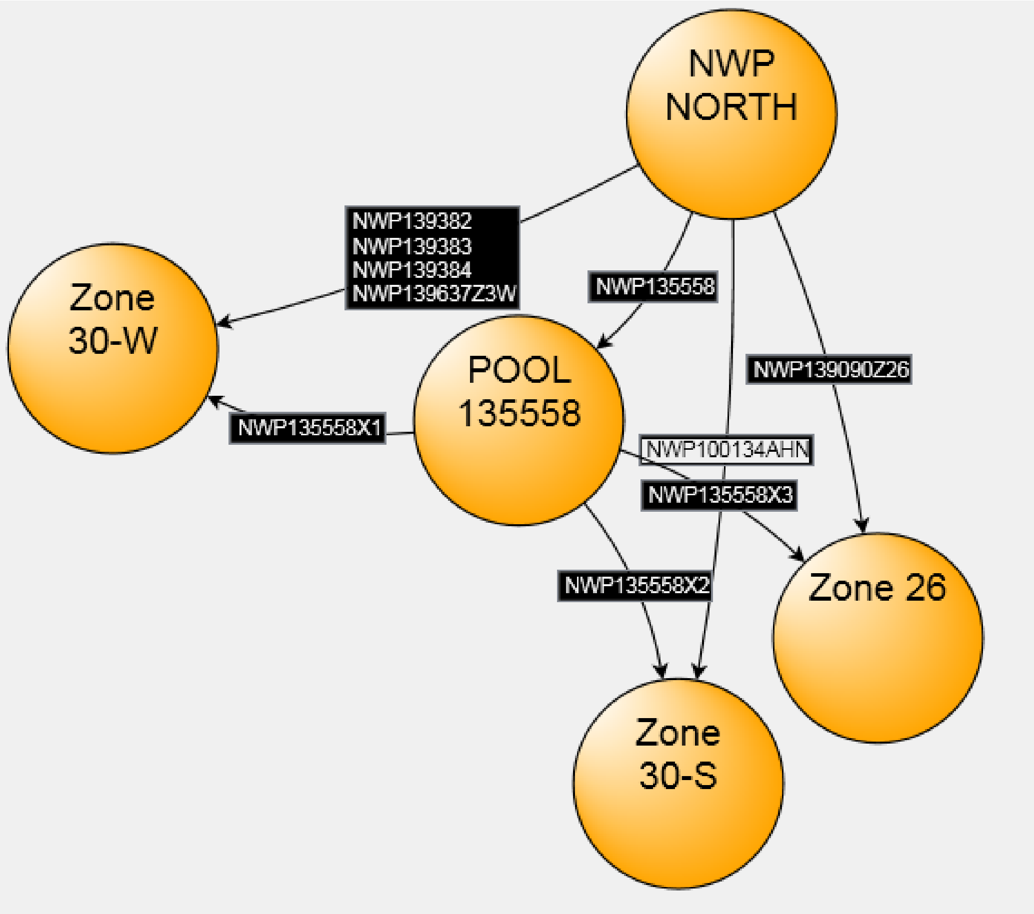
All of the following must be true

$X1 \leq 4\text{MDTs}$

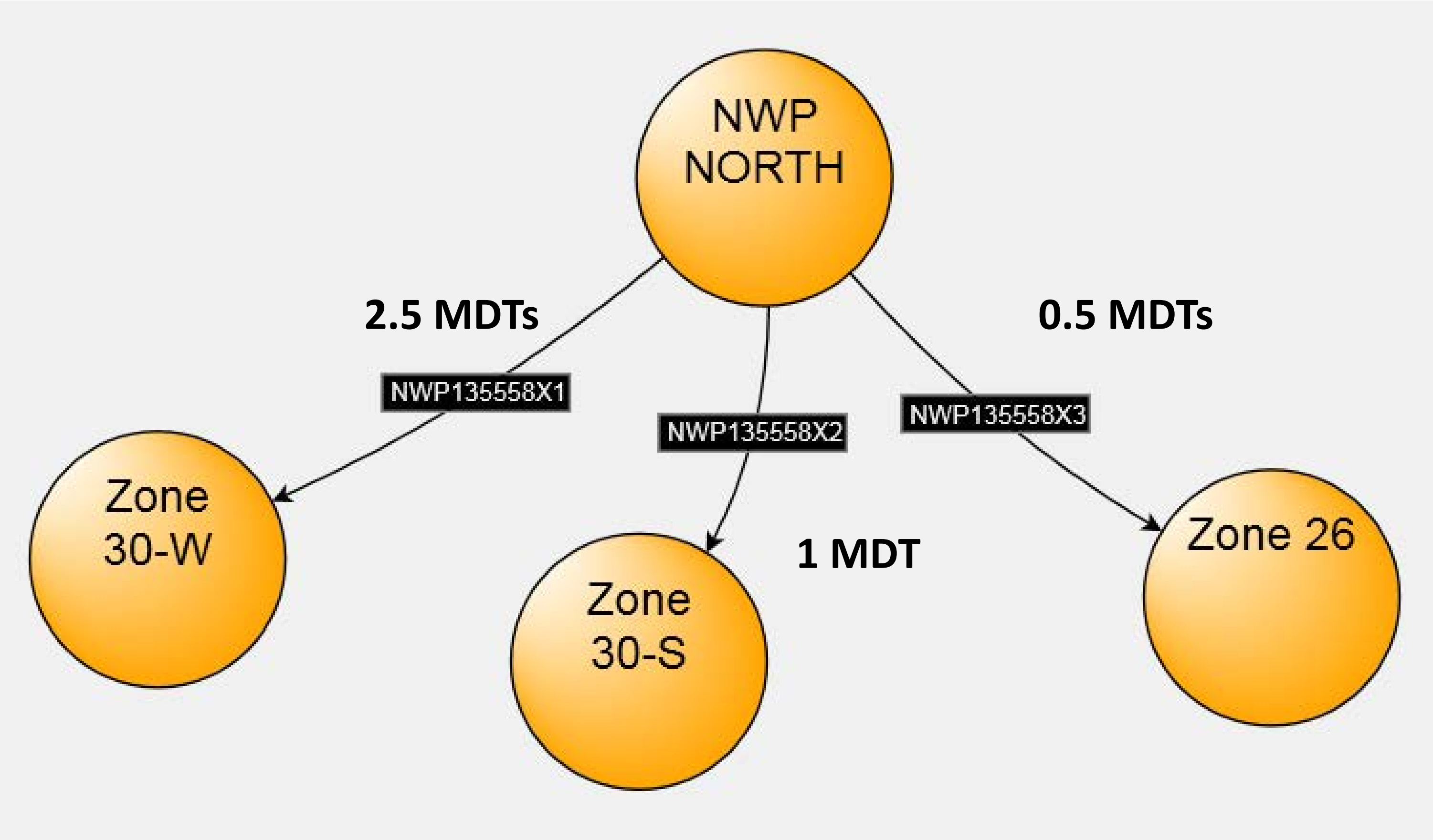
$X2 \leq 4\text{MDTs}$

$X3 \leq 4MDTs$

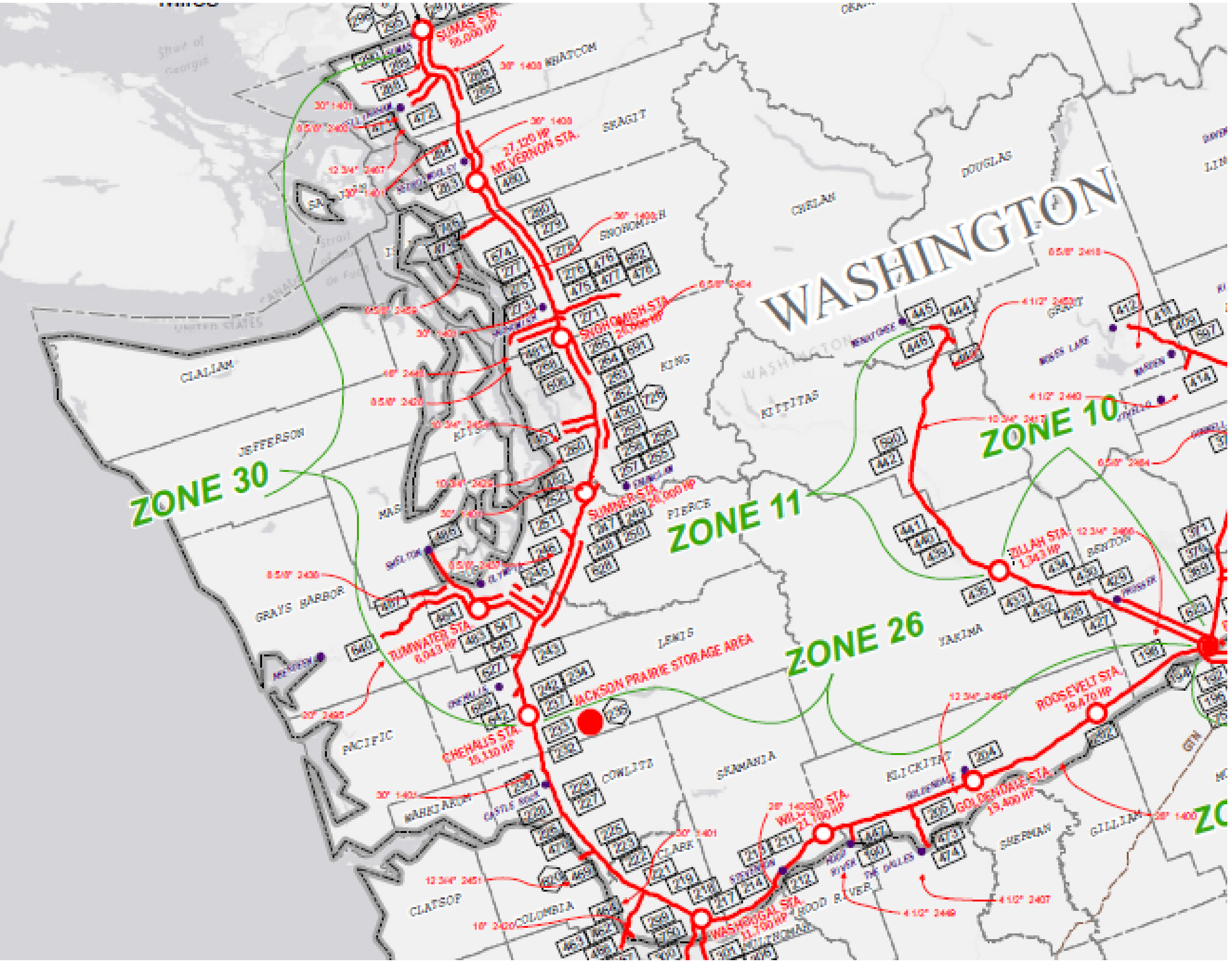
$X1 + X2 + X3 \leq 4MDTs$



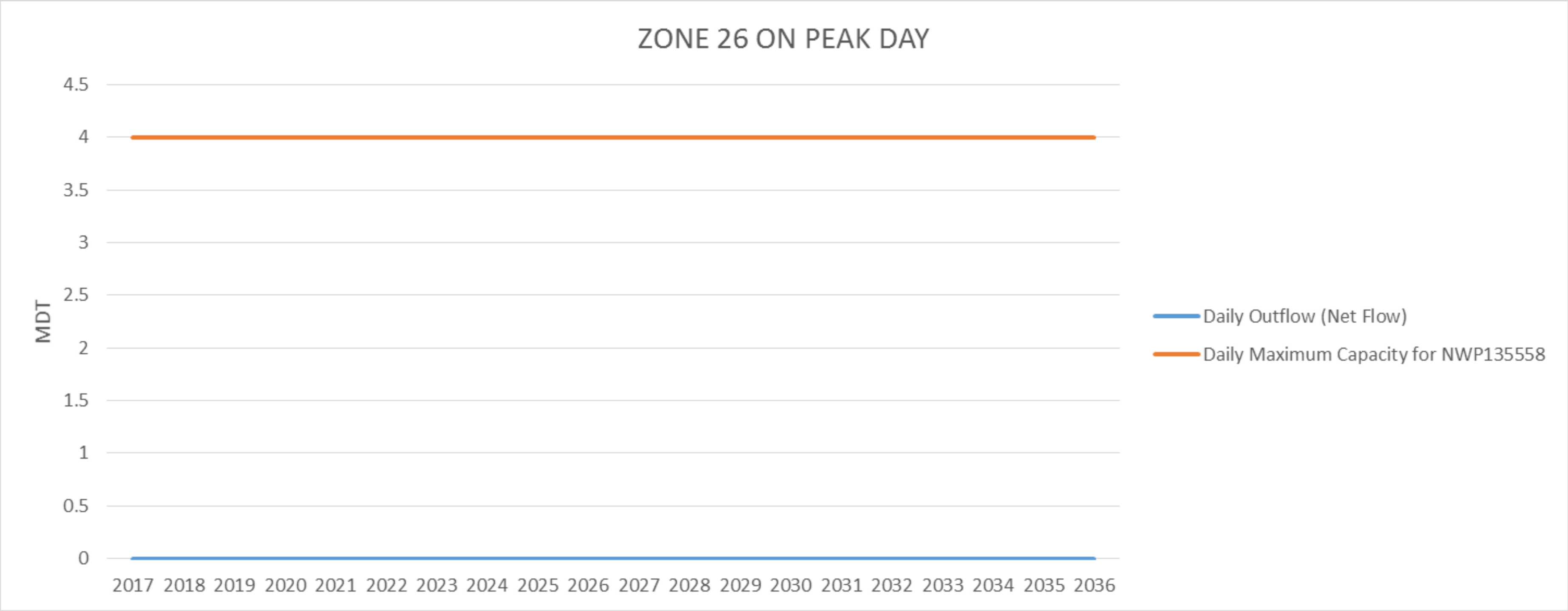
Example of delivery right inflexibility



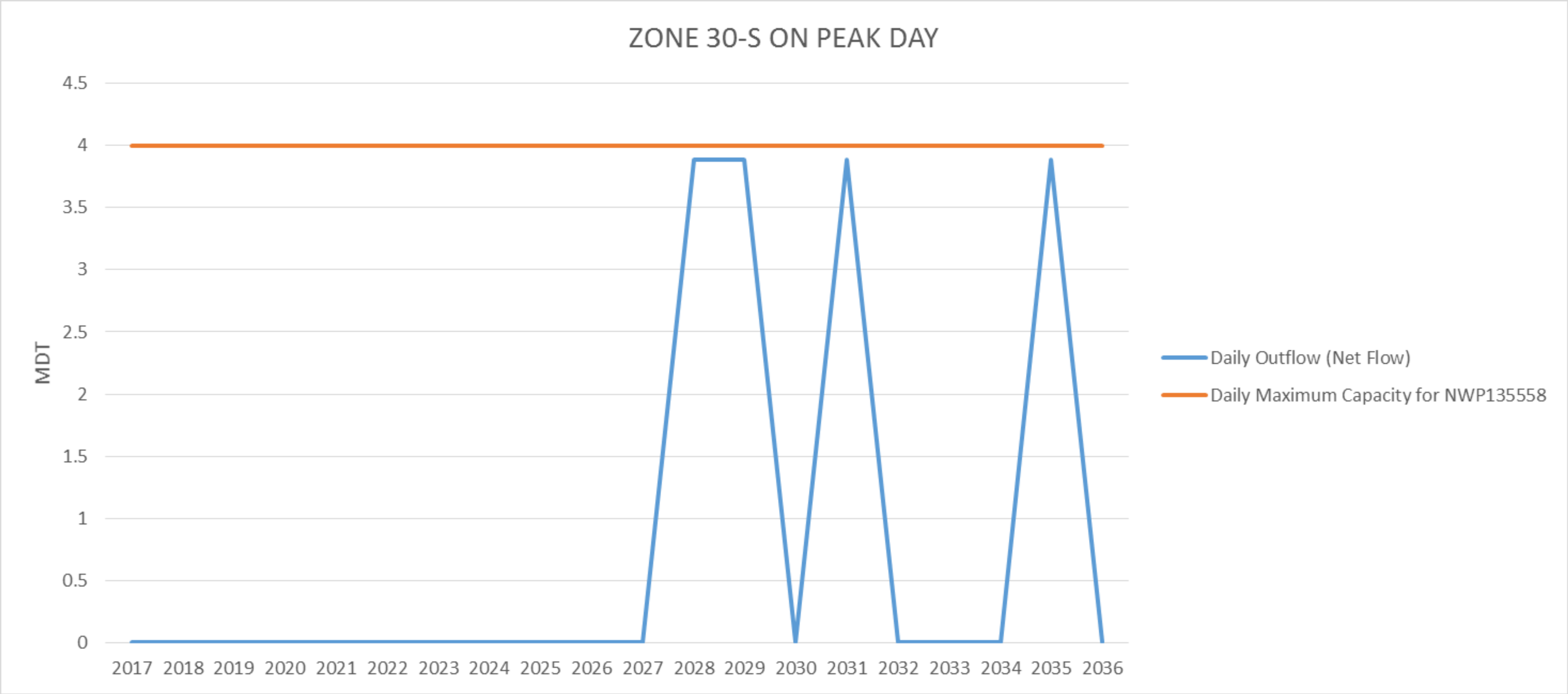
Location of Zones



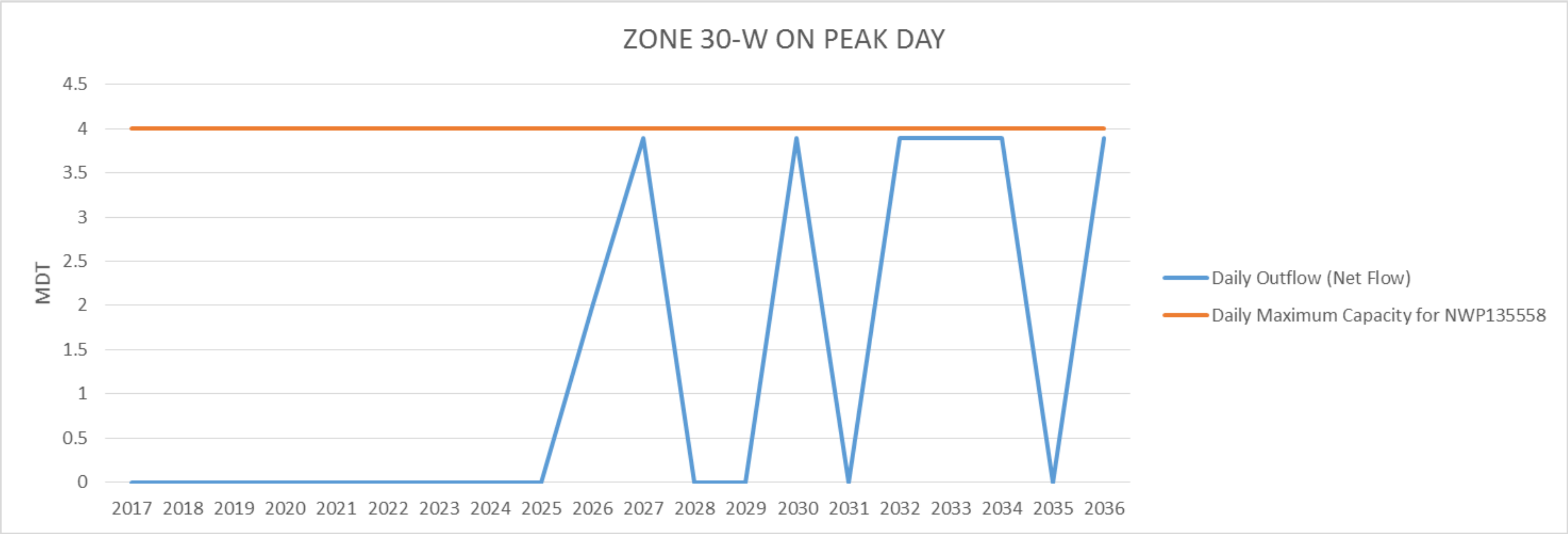
Zone 26 on Peak Day for Transport 135558



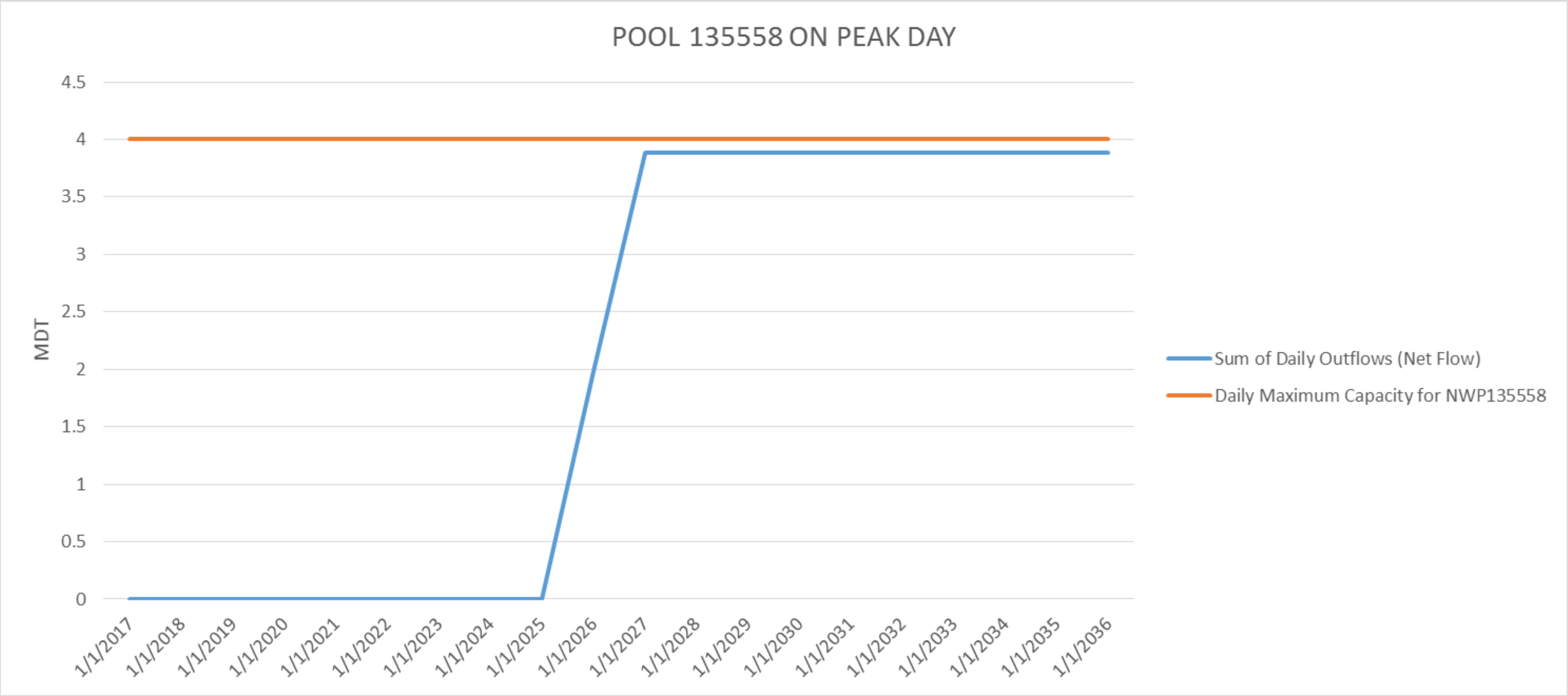
Zone 30-S on Peak Day for Transport 135558



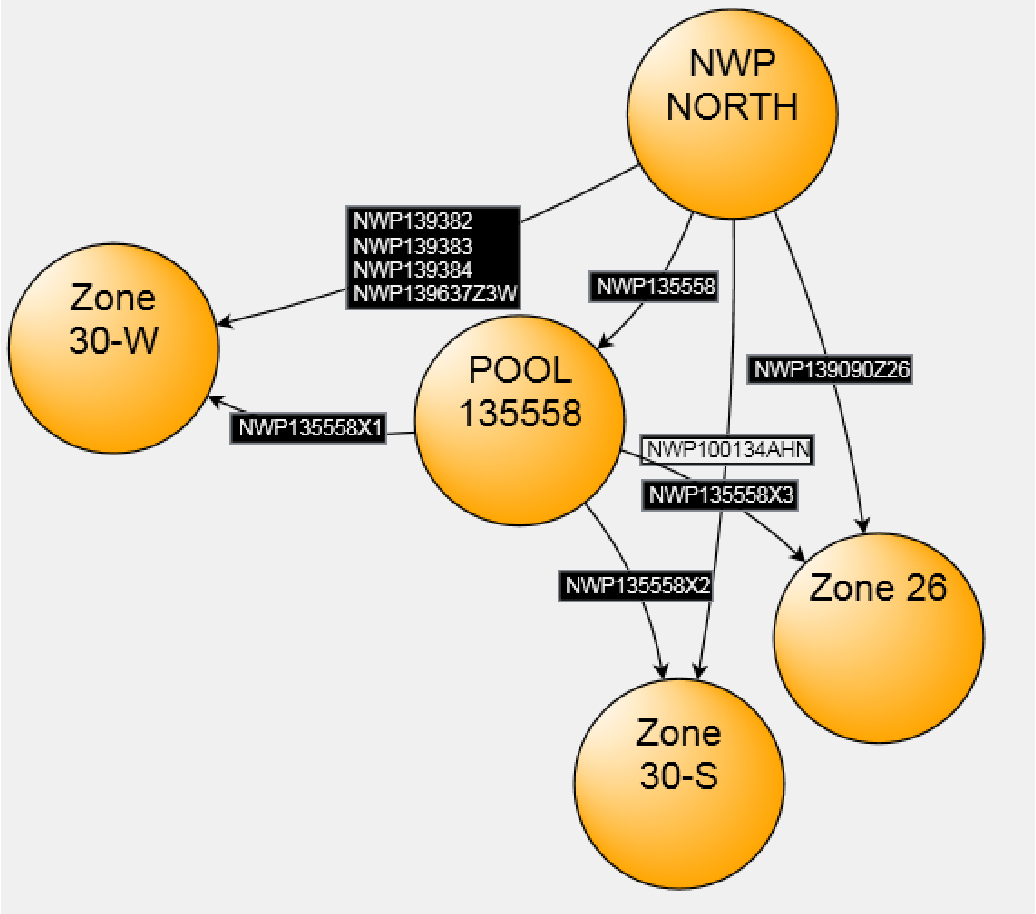
Zone 30-W on Peak Day for Transport 135558



Transport Contract 135558 on Peak Day



Example of delivery right flexibility



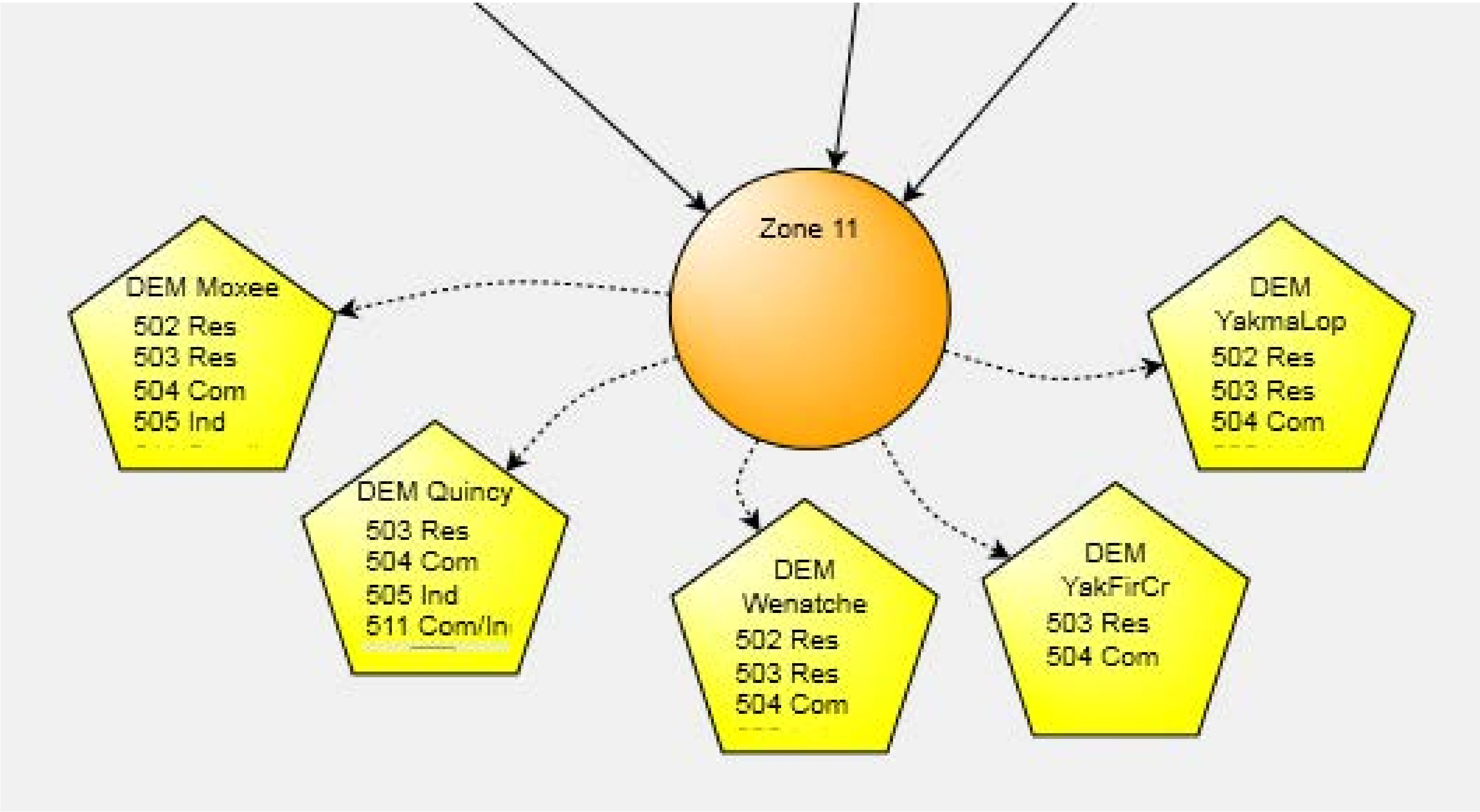
Demand Behind the Gate

- Cascade has strived over the last several years to make the IRP forecast and resource analysis to get to as granular a level as possible using the available data.
- Attempts to forecast demand behind the gate using existing forecasting methodology has been challenging.
- Customer billing data does not have daily meter reads for core customers making regression analysis on a use per HDD per customer difficult.
- Given Cascade is not a contiguous system, DSM by gate is currently is an ongoing complication
    - This year we have added the Climate Zone
    - Future IRPs will try and address the gate station level
- Some towns can be served by multiple pipelines and the mix can change over time.
- As part of the rate case settlement, Cascade is committed to performing a robust citygate study.

Demand

- Demand is forecasted at the Citygate level by rate schedule.
- For NWP, each Citygate's demand is associated with the zone.
- For GTN, each Citygate's demand is associated with it's respective Citygate interconnect.
- Demand Inputs
  - Forecast type (Monthly amount or Regressions)
  - Monthly projected customers for 20 years.
  - Regression coefficients if using the Regression forecast type.
  - If using a monthly number, it is the 2015 demand for that month with a growth factor.

Demand Example



Demand Example 2

	JAN 2016	FEB 2016	MAR 2016	APR 2016	MAY 2016	JUN 2016	JUL 2016
Forecast Method	Usage Fac						
Customers	24799.84312	24804.90431	24818.06341	24797.81864	24796.8064	24776.56163	24768.46372
*Demand - Daily							
Demand - Monthly Base							
Demand - Monthly Heat							
Demand - Monthly Total							
Demand - Percent Factor - non P non Q							
Demand - Percent Factor - non Q							
Usage Factors - Weekday Base	0.034631402						
Usage Factors - Weekday Heat	0.014867929						
Usage Factors - Weekend Base							
Usage Factors - Weekend Heat							
*Rate - Unserved Dispatch (Pri 1)							
*Rate - Unserved (Pri 2)							
*Rate - Revenue Variable (Pri 3)							
*Required Margin							
Rate - Revenue Fixed							
Determinant - Revenue Fixed							

Weather

- Weather inputs for SENDOUT include:
  - Monte Carlo
  - Historical
  - Normal
- Monte Carlo inputs include mean, standard deviation, max and minimum.
- Historical data is used to build weather profiles for Monte Carlo.
- Normal weather is the daily average of the 30-year most recent history (1986-2015).

Weather Example – Monte Carlo

	JAN 2014	FEB 2014	MAR 2014	APR 2014	MAY 2014	JUN 2014	JUL 2014
HDD Mean	1031.8	804.1	639.6	453.9	254.2	92.6	10.3
HDD Std Dev	145.4	133.1	84.4	93.0	72.2	40.4	15.2
HDD Distribution	Normal						
HDD Max	1291	1242	841	641	426	170	75
HDD Min	772	568	448	254	92	19	0
CDD Mean							
CDD Std Dev							
CDD Distribution							
CDD Max							
CDD Min							
Scaling Year	Best Match						

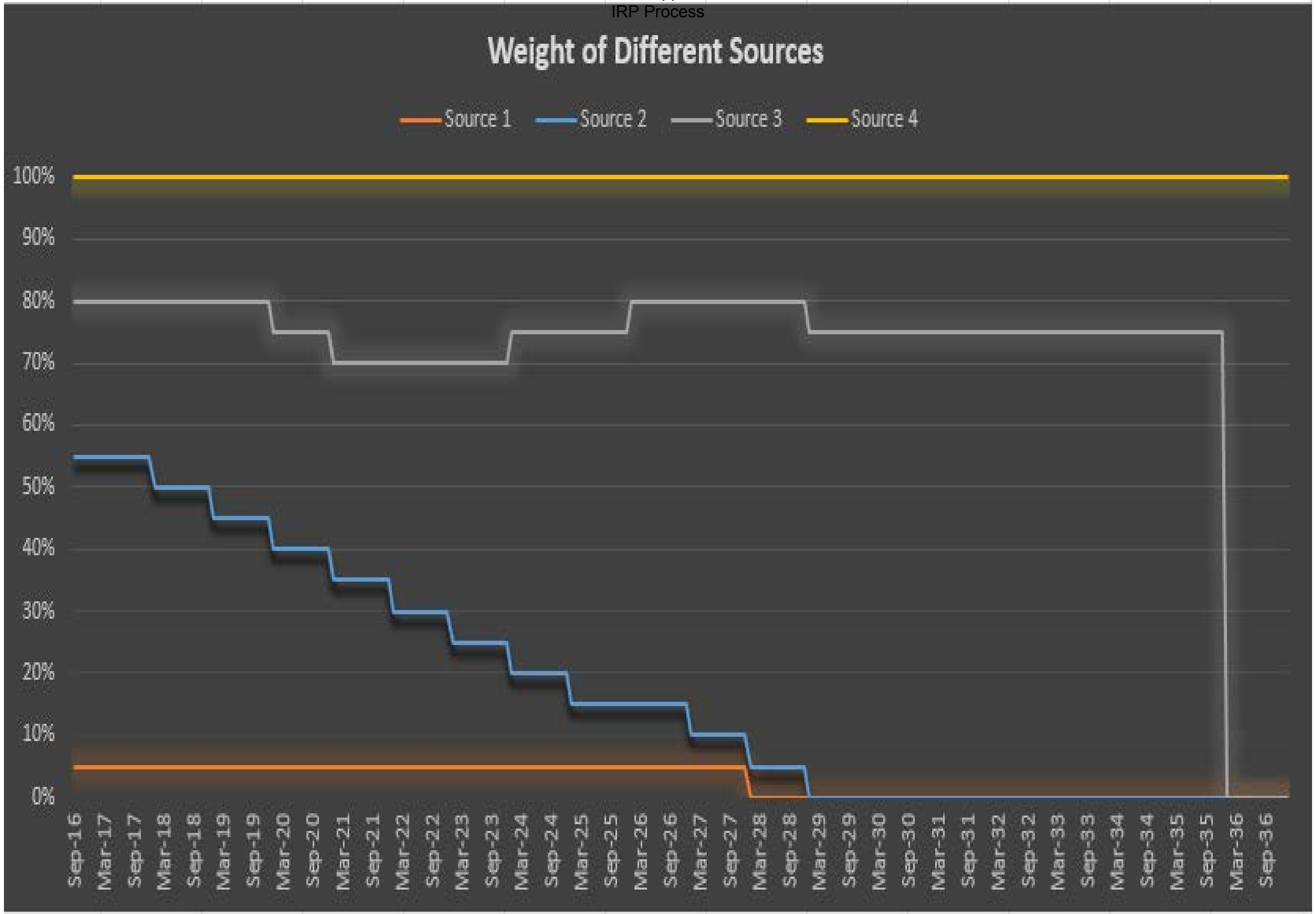
Long Range Price Forecast

- Cascade's long term planning price forecast is based on a blend of current market pricing along with long term fundamental price forecasts.
- The fundamental forecasts include Wood Mackenzie, the Energy Information Administration (EIA), the Northwest Power Planning Council, Bentek and the Financial Forecast Center's long term price forecasts.
- Market, particularly in near term is heavily influenced by Henry Hub prices.
- While not a guarantee of where the market will ultimately finish, Henry Hub NYMEX is the most current information that provides some direction as to future market prices.

Long Range Price Forecast

- Wood Mackenzie's long-term forecast is at a monthly level by basin. We use this to help shape the forecast's monthly basis pricing.
- We also rely on EIA's 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.
- We assign a weight to each source to develop the monthly Henry Hub price forecast for the 20 year planning horizon.
- Although it is impossible to accurately estimate the future, for trading purposes the most recent period has been the best indicator of the direction of the market. However, Cascade also considers other factors (historical constraints) which can lead to minor adjustments to the final long range forecast.

Year	Source 2	Source 1	Source 3	Source 4
2017	50.000%	5.000%	25.000%	20.000%
2018	45.000%	5.000%	30.000%	20.000%
2019	40.000%	5.000%	35.000%	20.000%
2020	35.000%	5.000%	35.000%	25.000%
2021	30.000%	5.000%	35.000%	30.000%
2022	25.000%	5.000%	40.000%	30.000%
2023	20.000%	5.000%	45.000%	30.000%
2024	15.000%	5.000%	55.000%	25.000%
2025	10.000%	5.000%	60.000%	25.000%
2026	10.000%	5.000%	65.000%	20.000%
2027	5.000%	5.000%	70.000%	20.000%
2028	5.000%	0.000%	75.000%	20.000%
2029	0.000%	0.000%	75.000%	25.000%
2030	0.000%	0.000%	75.000%	25.000%
2031	0.000%	0.000%	75.000%	25.000%
2032	0.000%	0.000%	75.000%	25.000%
2033	0.000%	0.000%	75.000%	25.000%
2034	0.000%	0.000%	75.000%	25.000%
2035	0.000%	0.000%	75.000%	25.000%
2036	0.000%	0.000%	0.000%	100.000%


Weight of Different Sources
Source 1
Source 2
Source 3
Source 4
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Sep-16
Mar-17
Sep-17
Mar-18
Sep-18
Mar-19
Sep-19
Mar-20
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Mar-21
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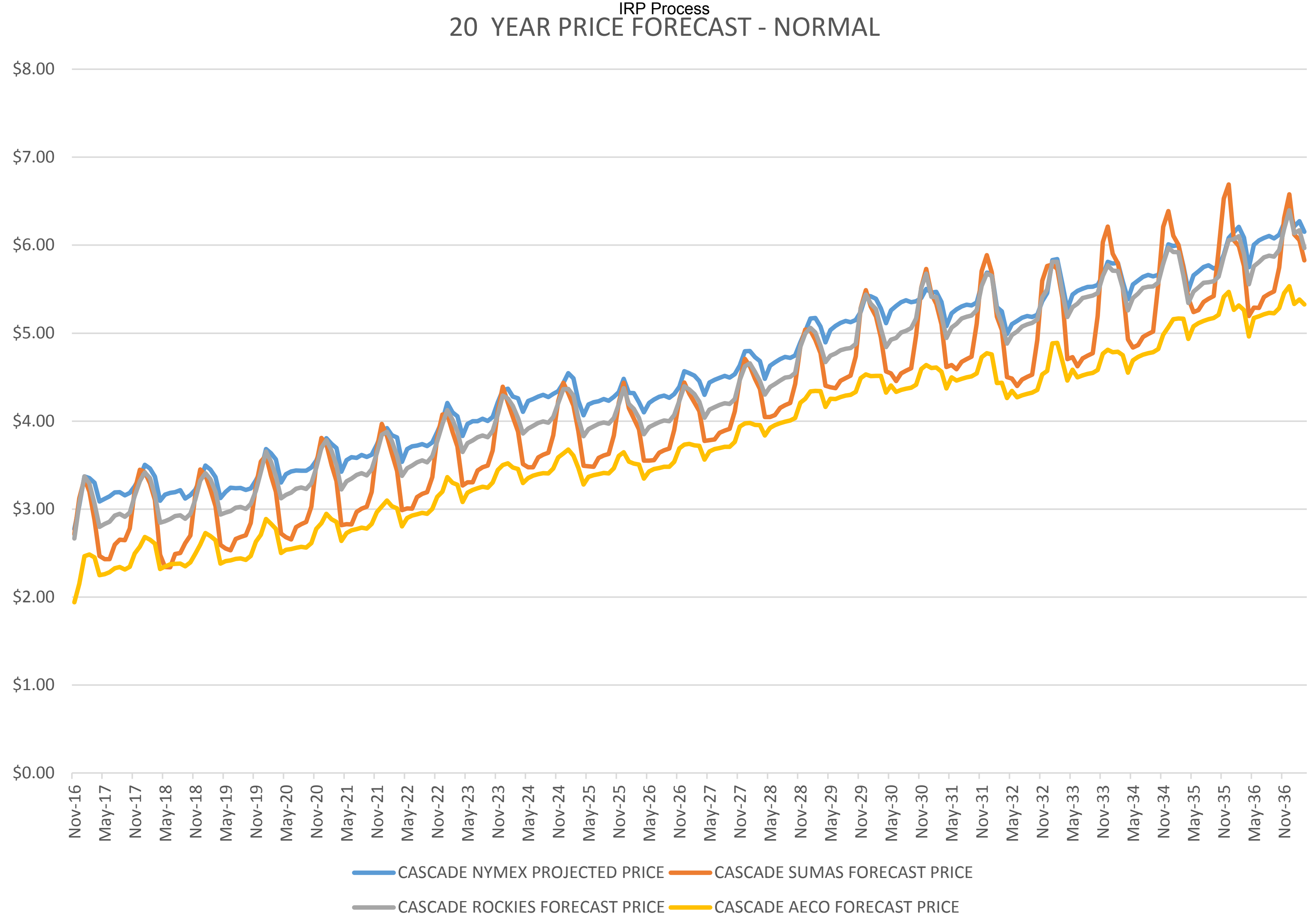
Sep-35
Mar-36
Sep-36


20 YEAR PRICE FORECAST - NORMAL
$8.00
$7.00
$6.00
$5.00
$4.00
$3.00
$2.00
$1.00
$0.00
Nov-16
May-17
Nov-17
May-18
Nov-18
May-19
Nov-19
May-20
Nov-20
May-21
Nov-21
May-22
Nov-22
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May-35
Nov-35
May-36
Nov-36
CASCADE NYMEX PROJECTED PRICE
CASCADE SUMAS FORECAST PRICE
CASCADE ROCKIES FORECAST PRICE
CASCADE AECO FORECAST PRICE

Major resource issues on the horizon

- **Addition alternatives to be considered during IRP process**
  - **NWP I-5 Expansion**
  - **Realignment of MDDOs to citygates**
  - **Palomar/Cross Cascades**
  - **Pacific Connector**
  - **Incremental Nova**
  - **Incremental Foothills**
  - **Incremental GTN (north to south)**
  - **Biofuel**
  - **Satellite LNG**
  - **Mist Storage**
  - **AECO Storage**
  - **Wild Goose Storage**
  - **Gill Ranch Storage**
  - **Ryckman Creek Storage**

- Began discussions with Niska Partners to gather information to model AECO Hub Storage in the 2016 IRP. In addition, we will be considering Wild Goose, Gill Ranch, Mist and Ryckman Creek storage.

- Working with GTN to develop a narrative to explain how our long path capacity can be used to meet peak day shortfalls.

SENSITIVITIES ANALYSES

Scenario Name	Key Assumptions
High Growth	Strong Economic Growth result in High Load growth, Average Weather, Medium Gas Prices.
Low Growth	Economic Conditions result in Low Load growth, Average Weather, Medium Gas Prices.
Environmental Externalities Carbon 1	Medium Load Growth, Average Weather, Assumes Carbon Adder Implemented in 2018 for CO2 emissions at $10/ton with adder increasing annually by 3% plus CPI (Consumer Price Index).
Environmental Externalities Carbon 2	Medium Load Growth, Average Weather, Assumes Carbon Adder Implemented in 2016 for CO2 emissions at $20/ton with adder increasing annually by 3% plus CPI (Consumer Price Index).
Environmental Externalities Carbon 3	Medium Load Growth, Average Weather, Assumes Carbon Adder Implemented in 2017 for CO2 emissions at $30/ton with adder increasing annually by 3% plus CPI (Consumer Price Index).

Supply Side Alternatives Modeled

Resource	Scenario Considered
Conventional Gas Supply Contracts with annual, seasonal or winter only characteristics delivered to Northwest Pipeline & GTN Systems	All
Conventional Gas Supply Peaking Contracts Delivered to Northwest Pipeline & GTN Systems	All
Gas Supply Peaking Contract delivered to Cascade's citygates	All
Incremental Storage Delivered to Northwest Pipeline and GTN systems	All
Satellite LNG Storage within Cascade's distribution system	All
Additional Pipeline Capacity secured through medium--long term capacity agreements	All

Avoided Cost Overview

- As part of the IRP process, Cascade calculates a 20-year forecast and 45 years of avoided costs.
- The avoided cost is an estimated cost to serve the next unit of demand with a supply side resource option at a point in time. This incremental cost to serve represents the cost that could be avoided through energy conservation.
- The avoided cost forecast can be used as a guideline for comparing energy conservation with the cost of acquiring and transporting natural gas to meet demand.
- Cascade evaluates the impact that a range of environmental externalities, including CO2 emission prices, would have on the avoided costs in terms of cost adders and supply costs.
- We produce an expected avoided cost case based on the medium forecast (base case) peak day.

Costs included in the avoided cost calculation

- The long term gas price forecast compiled from a consultant's gas price forecast (which is the majority of the cost);
- A price for carbon included in the gas price forecast, which has been embedded by price forecast consultant
- Gas storage variable and fixed costs
- Upstream variable and fixed transmission costs;
- Peak related on-system transmission costs; and
- A 10 percent adder for unidentified environmental benefits, as recommended by the Northwest Power and Conservation Council ("NWPCC").

Avoided Costs by Conservation Zone (9/14/2016 draft 2016 IRP), cost per therm

		Zone 1 Avoided		Zone 2 Avoided		Zone 3 Avoided
2016	$	0.331007	$	0.332405	$	0.333519
2017	$	0.376641	$	0.378231	$	0.379499
2018	$	0.374966	$	0.376549	$	0.377812
2019	$	0.386840	$	0.388473	$	0.389776
2020	$	0.406234	$	0.407949	$	0.409317
2021	$	0.426303	$	0.428103	$	0.429538
2022	$	0.458433	$	0.460368	$	0.461912
2023	$	0.496455	$	0.498551	$	0.500223
2024	$	0.520204	$	0.522401	$	0.524152
2025	$	0.525322	$	0.527539	$	0.529308
2026	$	0.547107	$	0.549417	$	0.551259
2027	$	0.582635	$	0.585095	$	0.587057
2028	$	0.617658	$	0.620266	$	0.622345
2029	$	0.648015	$	0.650751	$	0.652933
2030	$	0.668615	$	0.671438	$	0.673689
2031	$	0.669892	$	0.672720	$	0.674976
2032	$	0.663548	$	0.666349	$	0.668583
2033	$	0.705535	$	0.708514	$	0.710889
2034	$	0.722589	$	0.725640	$	0.728073
2035	$	0.750226	$	0.753394	$	0.755919
2036	$	0.761681	$	0.764896	$	0.767461

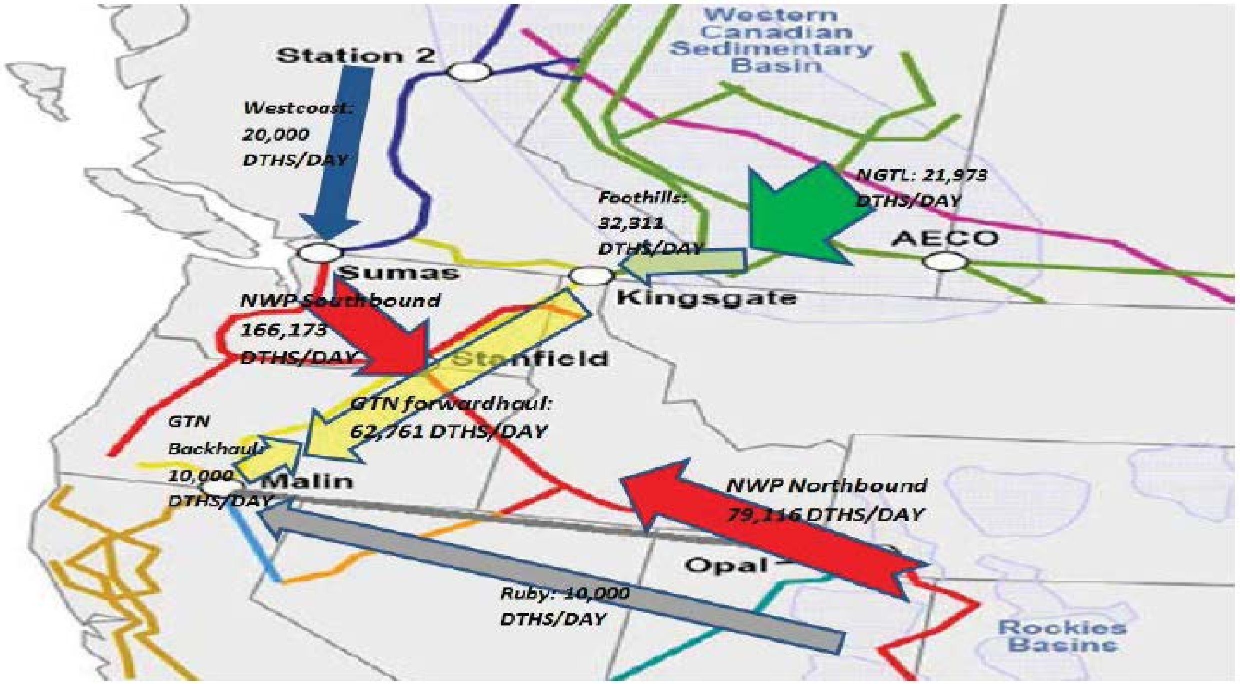
SYSTEM AVOIDED COSTS LAYERS (dollars in therms)

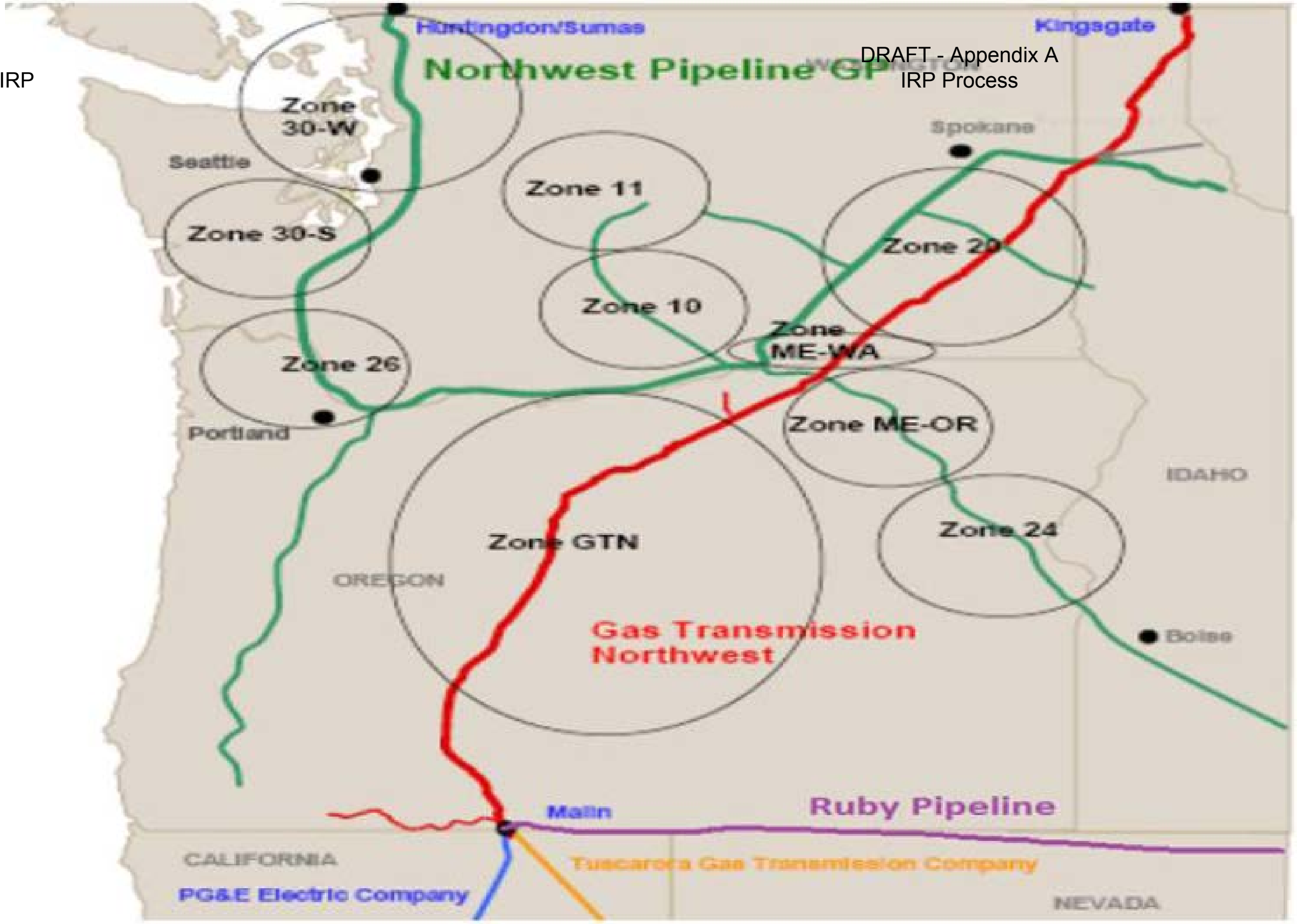
	Commodity	Transport Fixed	Transport Commodity	Storage Fixed	Storage Commodity	Total Avoided Cost
2016	0.236034111	$ 0.086348	$ 0.001661	$ 0.008725	$ 0.000811	$ 0.333579
2017	0.248988859	$ 0.115504	$ 0.002221	$ 0.011671	$ 0.001085	$ 0.379470
2018	0.251545028	$ 0.111764	$ 0.002149	$ 0.011293	$ 0.001050	$ 0.377801
2019	0.25866501	$ 0.116048	$ 0.002232	$ 0.011726	$ 0.001090	$ 0.389760
2020	0.274609258	$ 0.119244	$ 0.002293	$ 0.012049	$ 0.001120	$ 0.409316
2021	0.288511716	$ 0.124839	$ 0.002401	$ 0.012614	$ 0.001173	$ 0.429538
2022	0.301883742	$ 0.141623	$ 0.002724	$ 0.014310	$ 0.001330	$ 0.461870
2023	0.32780844	$ 0.152588	$ 0.002935	$ 0.015418	$ 0.001433	$ 0.500182
2024	0.341904823	$ 0.161284	$ 0.003102	$ 0.016296	$ 0.001515	$ 0.524102
2025	0.343585078	$ 0.164353	$ 0.003161	$ 0.016606	$ 0.001544	$ 0.529249
2026	0.344992909	$ 0.182479	$ 0.003509	$ 0.018438	$ 0.001714	$ 0.551133
2027	0.364226364	$ 0.197121	$ 0.003791	$ 0.019917	$ 0.001852	$ 0.586907
2028	0.389918307	$ 0.205625	$ 0.003955	$ 0.020777	$ 0.001931	$ 0.622206
2029	0.42189893	$ 0.204442	$ 0.003932	$ 0.020657	$ 0.001920	$ 0.652850
2030	0.437462807	$ 0.209045	$ 0.004020	$ 0.021122	$ 0.001964	$ 0.673614
2031	0.448043057	$ 0.200861	$ 0.003863	$ 0.020295	$ 0.001887	$ 0.674949
2032	0.437720131	$ 0.204314	$ 0.003929	$ 0.020644	$ 0.001919	$ 0.668527
2033	0.463291109	$ 0.219116	$ 0.004214	$ 0.022140	$ 0.002058	$ 0.710819
2034	0.475820954	$ 0.223240	$ 0.004293	$ 0.022556	$ 0.002097	$ 0.728007
2035	0.500991107	$ 0.225637	$ 0.004339	$ 0.022799	$ 0.002119	$ 0.755886
2036	0.509989669	$ 0.227894	$ 0.004383	$ 0.023027	$ 0.002141	$ 0.767434

POTENTIAL ADDITIONAL PIPELINE TRANSPORT RESOURCES

Model Name	Start Date	End Date	Daily MDQ	Description	Cost Dths	Lead Time	Pipeline	VARIABLE < $.10	FUEL < 3%
Incremental NOVA-Foothills-GTN	2018	OPEN	Approx 16,000 dths/day ea pipeline	AECO NIT, Foothills to Kingsgate	NOVA, Foothills, GTN (blended; approx $0.35)	>2 years	NOVA, Foothills, GTN	YES	YES
Incremental NWP	2019	OPEN	Appoximately 15,000 dhts/day	Sumas to WA and OR citygates	NWP Rate between X2 and X3	> 3years	NWP	YES	YES
Incremental RUBY	2019	OPEN	Appoximately 15,000 dhts/day	Ryckman to Malin	Variable up to $1.14	> 3years	RUBY	YES	YES
New CALIFORNIA TRANSPORT	2019	OPEN	Appoximately 15,000 dhts/day	CGT to Malin	$1.68	> 3years	CGT	YES	YES
New Southern Crossing	2018	OPEN	VARIABLE	Huntingdon/Kingsgate	$0.45 to 0.47	> 3 years	SPECTRA, SO-XING, SOXING KNG	YES	YES

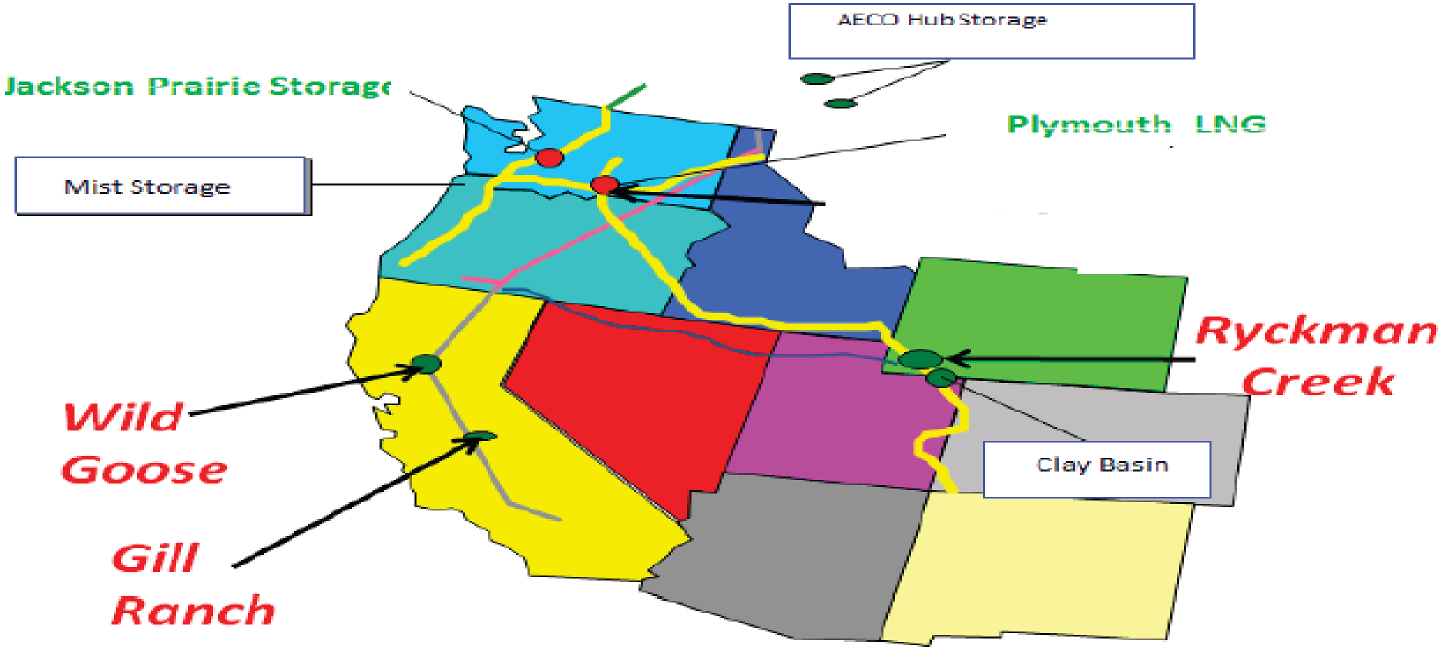
EXAMPLE OF POSSIBLE CNGC WINTER TRANSPORT CAPACITY FLOW



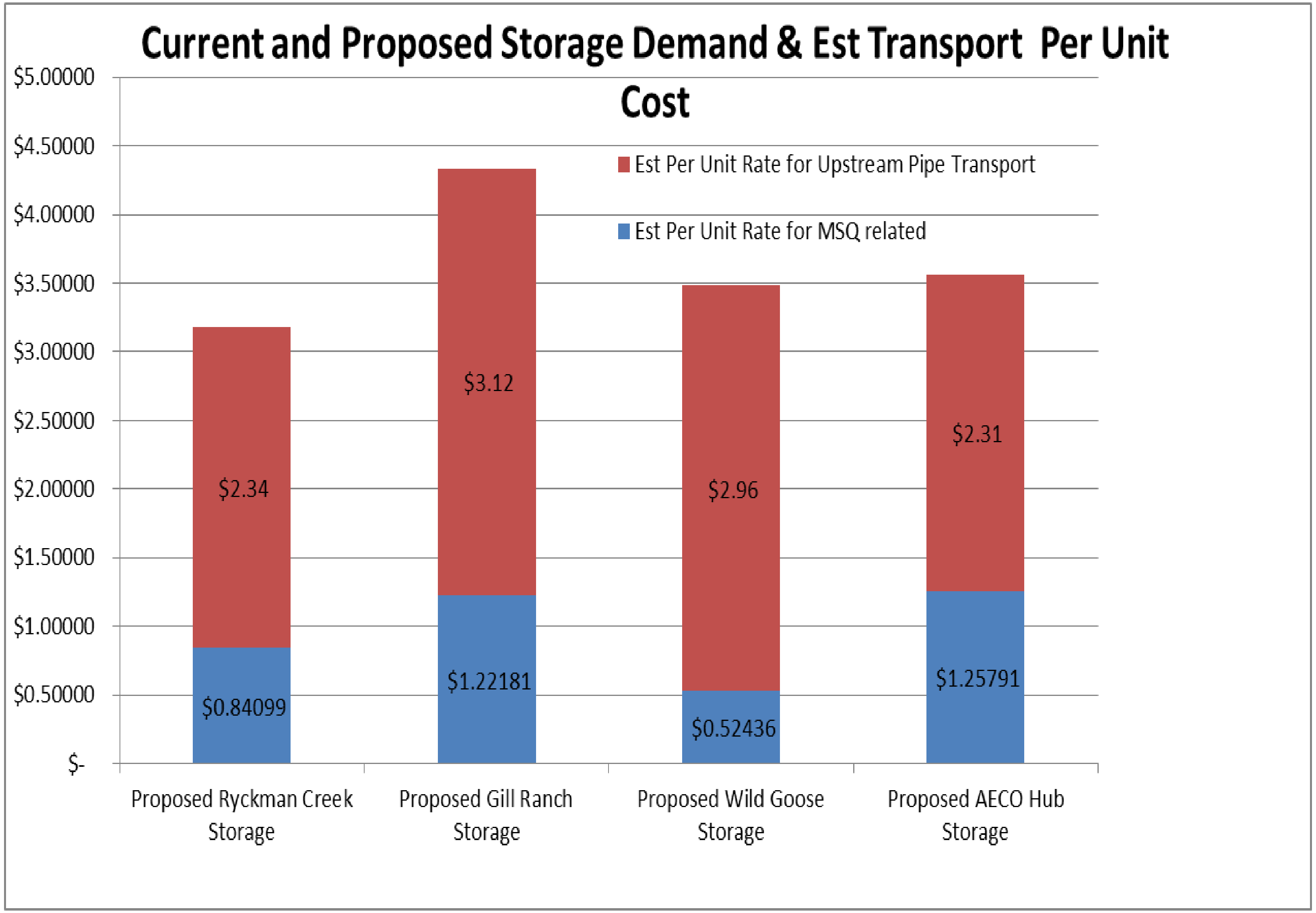


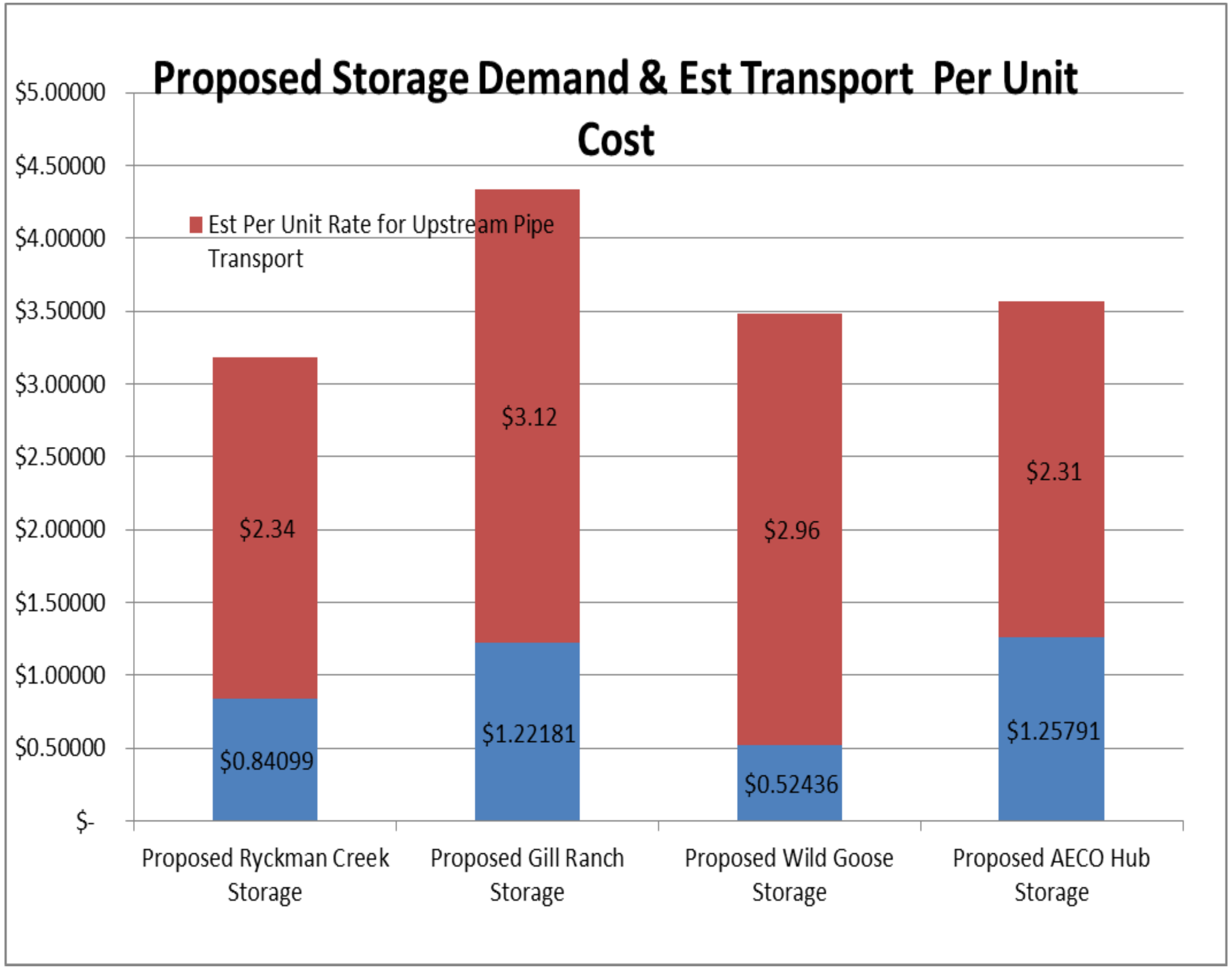
MODEL NAME	CONTRACT LOCATION TYPE	PIPELINE	PRICE TYPE	XPIRY DATE	OTHER COMMENTS	PRICE OR INDEX BASIS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
SAT LNG 30-S	Satellite LNG Zone 30-S	CNG	NYMEX		RUN AT VARIABLE VOLUMES UP TO THE AMOUNT		1,000	1,000	1,000								1,000	1,000
SAT LNG OR	Satellite LNG Zone Oregon	CNG	NYMEX		RUN AT VARIABLE VOLUMES UP TO THE AMOUNT		1,000	1,000	1,000								1,000	1,000

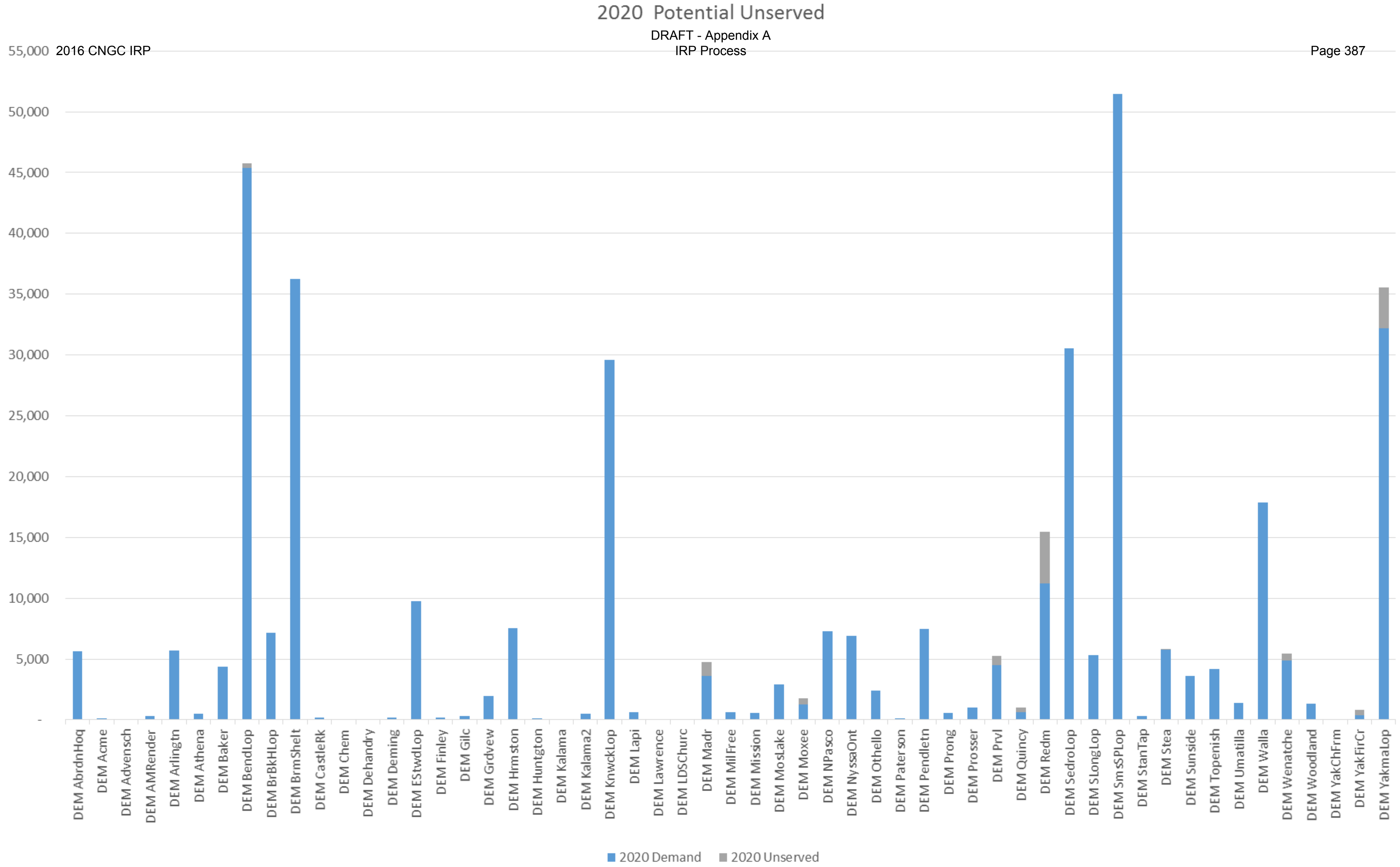
Regional Storage

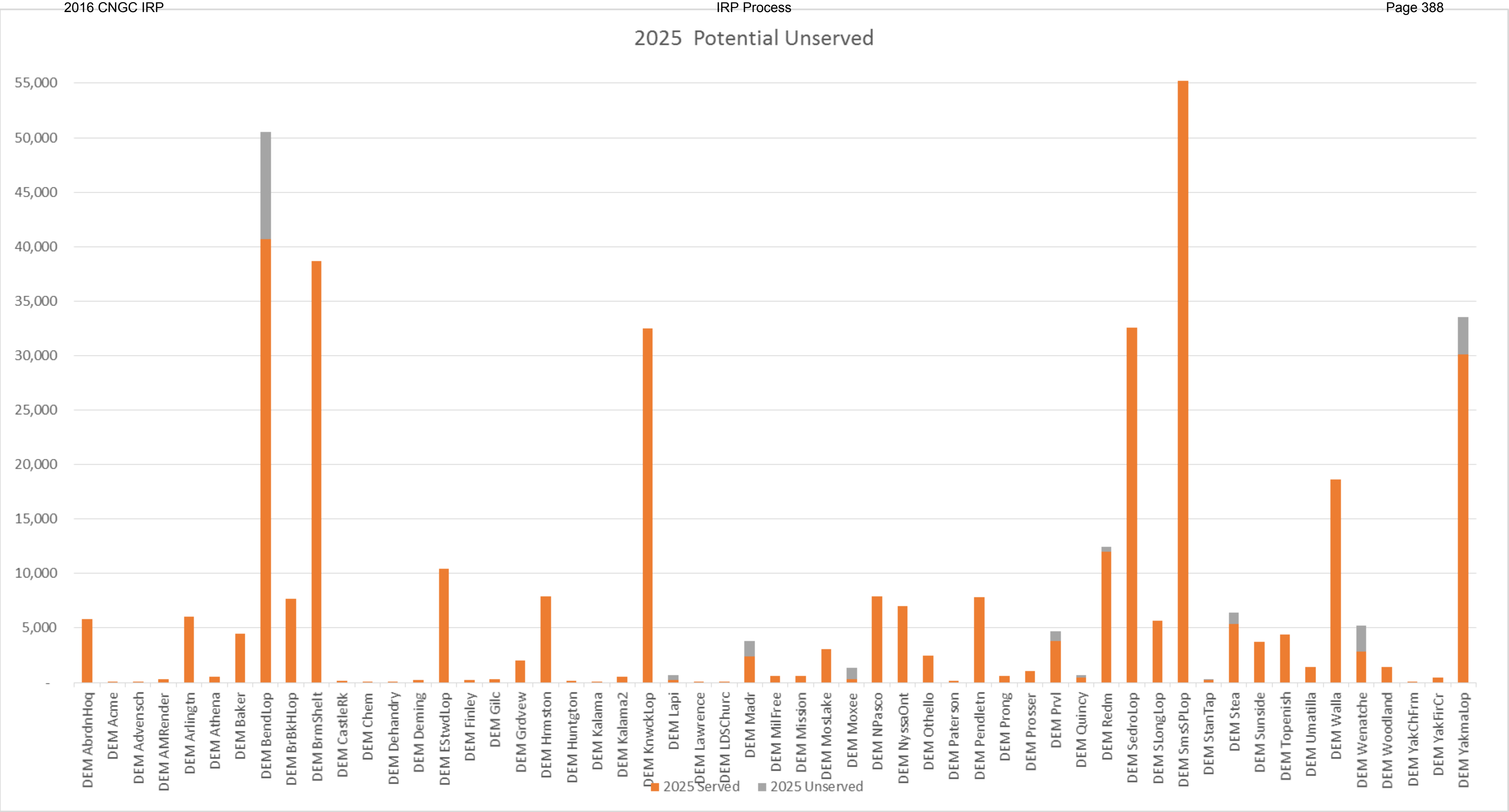


Storage Account	MSQ (Maximum Storage Quantity) or Working Inventory	Estimated Annual MSQ Demand Costs	Est Per Unit Rate for MSQ related	Est Daily Charges	Avg Daily MSQ Unit Rate of Services	Transport	Incremental Transport Needed	Total Transport Needed to cycle storage once	Est Per Unit Rate for Upstream Pipe Transport	Storage Associated MSQ Charges	Totals
Proposed Ryckman Creek Storage	350,000	$ 294,348	$ 0.84099	$ 806	$ 0.00230	15,000	Ruby, GTN	$ 818,208	$ 2.34	$0.84099	$ 3.18
Proposed Gill Ranch Storage	350,000	$ 427,634	$ 1.22181	$ 1,172	$ 0.00335	15,000	PG&E, GTN	$ 1,090,536	$ 3.12	$1.22181	$ 4.34
Proposed Wild Goose Storage	350,000	$ 183,526	$ 0.52436	$ 503	$ 0.00144	15,000	PG&E GTN	$ 1,036,778	$ 2.96	$0.52436	$ 3.49
Proposed AECO Hub Storage	350,000	$ 440,270	$ 1.25791	$ 1,206	$ 0.00345	15,000	NWP, GTN	$ 807,000	$ 2.31	$1.25791	$ 3.56


Current and Proposed Storage Demand & Est Transport Per Unit Cost
Est Per Unit Rate for Upstream Pipe Transport
Est Per Unit Rate for MSQ related
$5.00000
$4.50000
$4.00000
$3.50000
$3.00000
$2.50000
$2.00000
$1.50000
$1.00000
$0.50000
$-
$2.34
$0.84099
$3.12
$1.22181
$2.96
$0.52436
$2.31
$1.25791
Proposed Ryckman Creek Storage
Proposed Gill Ranch Storage
Proposed Wild Goose Storage
Proposed AECO Hub Storage


Proposed Storage Demand & Est Transport Per Unit Cost
$5.00000
$4.50000
$4.00000
$3.50000
$3.00000
$2.50000
$2.00000
$1.50000
$1.00000
$0.50000
$-
Est Per Unit Rate for Upstream Pipe Transport
$2.34
$0.84099
$3.12
$1.22181
$2.96
$0.52436
$2.31
$1.25791
Proposed Ryckman Creek Storage
Proposed Gill Ranch Storage
Proposed Wild Goose Storage
Proposed AECO Hub Storage


2020 Potential Unserved
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
-
DEM AbrdnHoq
DEM Acme
DEM Advensch
DEM AMRender
DEM Arlingtn
DEM Athena
DEM Baker
DEM BendLop
DEM BrBkHLop
DEM BrmShelt
DEM CastleRk
DEM Chem
DEM Dehandry
DEM Deming
DEM EStwdLop
DEM Finley
DEM Gilc
DEM Grdvew
DEM Hrmston
DEM Huntgton
DEM Kalama
DEM Kalama2
DEM KnwckLop
DEM Lapi
DEM Lawrence
DEM LDSChurc
DEM Madr
DEM MilFree
DEM Mission
DEM MosLake
DEM Moxee
DEM NPasco
DEM NyssaOnt
DEM Othello
DEM Paterson
DEM Pendletn
DEM Prong
DEM Prosser
DEM Prvl
DEM Quincy
DEM Redm
DEM SedroLop
DEM SLongLop
DEM SmsSPLop
DEM StanTap
DEM Stea
DEM Sunside
DEM Topenish
DEM Umatilla
DEM Walla
DEM Wenatche
DEM Woodland
DEM YakChFrm
DEM YakFirCr
DEM YakmaLop
2020 Demand
2020 Unserved


2025 Potential Unserved
55,000
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DEM AbrdnHoq
DEM Acme
DEM Advensch
DEM AMRender
DEM Arlingtn
DEM Athena
DEM Baker
DEM BendLop
DEM BrBkHLop
DEM BrmShelt
DEM CastleRk
DEM Chem
DEM Dehandry
DEM Deming
DEM EStwdLop
DEM Finley
DEM Gilc
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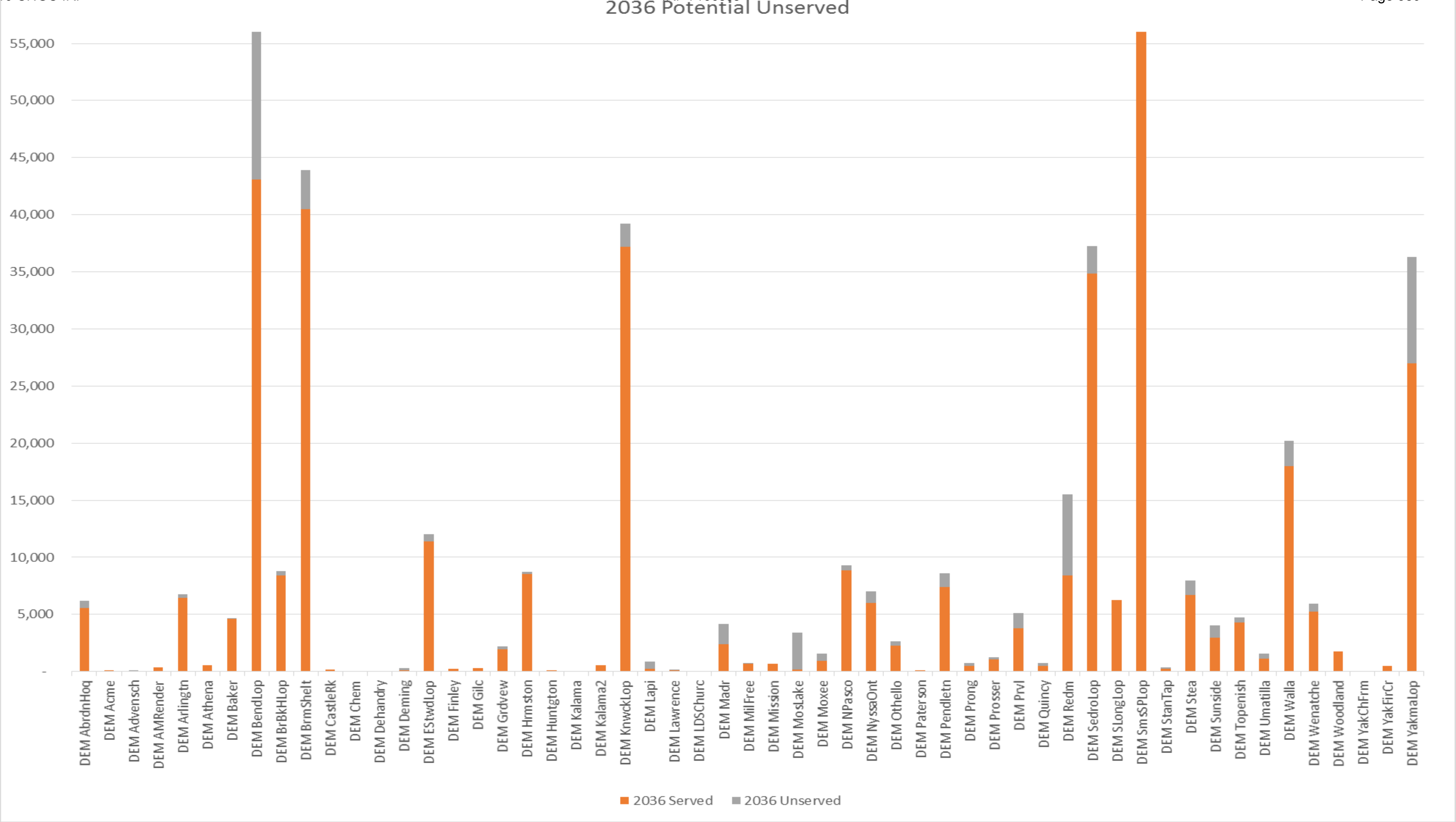
DEM Huntgton
DEM Kalama
DEM Kalama2
DEM KnwckLop
DEM Lapi
DEM Lawrence
DEM LDSChurc
DEM Madr
DEM MilFree
DEM Mission
DEM MosLake
DEM Moxee
DEM NPasco
DEM NyssaOnt
DEM Othello
DEM Paterson
DEM Pendletn
DEM Prong
DEM Prosser
DEM Prvl
DEM Quincy
DEM Redm
DEM SedroLop
DEM SLongLop
DEM SmSPLop
DEM StanTap
DEM Stea
DEM Sunside
DEM Topenish
DEM Umatilla
DEM Walla
DEM Wenatche
DEM Woodland
DEM YakChFrm
DEM YakFirCr
DEM YakmaLop
2025 Served
2025 Unserved


2036 Potential Unserved
55,000
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15,000
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DEM AbrdnHoq
DEM Acme
DEM Advensch
DEM AMRender
DEM Arlingtn
DEM Athena
DEM Baker
DEM BendLop
DEM BrBkHLop
DEM BrmShelt
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DEM Hrmston
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DEM LDSChurc
DEM Madr
DEM MilFree
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DEM NPasco
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DEM Prong
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DEM Quincy
DEM Redm
DEM SedroLop
DEM SLongLop
DEM SmSPLop
DEM StanTap
DEM Stea
DEM Sunside
DEM Topenish
DEM Umatilla
DEM Walla
DEM Wenatche
DEM Woodland
DEM YakChFrm
DEM YakFirCr
DEM YakmaLop
2036 Served
2036 Unserved

Net Present Value of 20 Year Portfolio

	NPV 20 Year Portoflio (Cost ins $000s)	Averge Cost per Therm
Basecase Scenario	3,881,261	0.38122561
High Load Growth	4,509,405	0.41553591
Low Load Growth	3,863,334	0.40028689
Environmental Externalities Case 1	3,989,232	0.4422217
Environmental Externalities Case 2	4,444,650	0.44663668

Preliminary Scenario NPV

SCENARIO	NPV IN $000	AvgCost per Therm
Base Case	$ 3,881,261	0.381225608
Incremental NWP and TCPL transport		
Ryckman Creek Storage	$ 3,901,832	$ 0.429031
Incremental NWP	$ 4,035,736	$ 0.440697
AECO Hub Storage	$ 4,075,324	$ 0.447559
Incremental TCPL	$ 4,075,324	$ 0.450187
Incremental Ruby	$ 4,230,575	$ 0.458614
Wild Goose Storage	$ 4,438,028	$ 0.459377
Gill Ranch Storage	$ 4,482,857	$ 0.463189

2016 IRP Timeline

Friday, October 07, 2016	**TAG 5: Final Integration Results, finalization of plan components**	**Seattle Airport Conference Center**
Monday, October 17, 2016	Draft of 2016 IRP distributed	Kennewick, WebEx
Monday, November 07, 2016	Comments due on draft from all stakeholders	
Thursday, November 17, 2016	TAG 6, if needed	Seattle Airport Conference Center
Wednesday, November 23, 2016	Final IRP goes to press	
Thursday, December 01, 2016	Executive Summary Presentation to Senior Management	Kennewick, WebEx
Wednesday, December 14, 2016	IRP filing in Washington	

NEXT STEPS?

Cascade Natural Gas Corporation

Integrated Resource Plan
Technical Advisory Group Meeting #4

Thursday, September 15th, 2016

Seattle-Tacoma International Airport
Conference Center

Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve

4th External TAG Meeting

Date & time: 09/14/2016, 09:00 AM – 12:20 PM

Location: Seattle Airport Conference Center

Presenters: Mark Sellers-Vaughn, Chris Bolton, Brian Robertson & Devin McGreal

In attendance: Mark Sellers-Vaughn, Brian Robertson, Devin McGreal, Chris Bolton, Chris Robbins,

Called in: Bob Morman, Garret Senger, Mike Parvinen, Pam Archer, Eric Wood, Carolyn Stone, Laura Flanders - NWP, Chad Luginbill, Josh Romine, Mark Chiles, Deborah Reynolds, Jeremy Twitchell – WUTC, Jim Abrahamson, Alison Spector, Tom Pardee, Cooper Wright – WUTC,

Minutes by: Carolyn P Stone

Mark began the meeting by welcoming everyone. Mark then went over some safety items for those attending the meeting in person and today's the Agenda.

Brian Robertson then discussed Cascade's New IRP Webpage, see link below:

https://www.cngc.com/rates-services/rates-tariffs/integrated-resource-plan

Presentation #1 – Chris Bolton
Distribution System Planning

- Chris started by going over his presentation outline then did a CNG distribution system overview. Chris stated that there are many factors that go into planning any changes to the current system or adding a new station. For example, you must be aware of residential development growth or additions.
- Chris explained that the Geographic Information System (GIS) helps engineering look at what is currently in place and helps them create system "models". Using GIS and other input data they can create their models using a program called "Synergi". Slide #12 shows a model.
- Data is gathered from many sources. CC&B gives customer billing information, showing "usage". Resource Planning provided growth and historical weather data. SCADA data provides historical flow. Peak Heating Degree Day is calculated as follows HDD = 60 - day max + day min/2, then they matches weather data to zones.
- Loads are applied to each customer on Page #20, 40 DD is load. The Peak design day model gives peak load, 58 DD. Synergi compiles customer data, pressures and flows. The model has many benefits in planning and optimization.

  Question: Mark asked if most LDC's use Synergi?
  Answer: Yes!

- Chris stated that all customer data is loaded based on trend. IRP growth data helps to predict next year's load growth. The model shows the worst case scenario.
- Next few slides show the PROS and CONS of various enhancements and upgrades. There are many CONS associated with replacement of a Compressor Station. Chris stated CNG only has 1 and upgrading this wouldn't increase capacity!
- On Page 31 shows the Project Process Flow from data inputs to considerations & plans to schedules.
- On Page 33 there is an area of potential growth in the NE and shows the Stanwood Project.
- On Page 37, the Walla Walla project shows potential growth in the SE. This upgrade will add capacity!

Presentation #2 – Mark Sellers-Vaughn
Sendout Optimization Modeling

- Mark started out by stating that Brian Robertson and Devin McGreal have had the monumental task of modeling in Sendout. They started from scratch and there is quite a bit more to do. Our ABP Vendor was very helpful also! KUDOs were also given to Mark for his work on the IRP. It is a huge project and everyone is impressed with where we are at this time.

- Mark stated that the Sendout is optimization modeling using base case scenarios.

- Brian Robertson continued stating the model includes transport and storage contract information. It uses linear programming. It is a good tool to use but not the final answer! It is very powerful and complex.

  - They started by using the PGA portfolio data
  - There are 66 delivery locations
  - Transportation contracts & rates are included
  - Includes rates
  - Contractual information can be overly restrictive
  - Operational can be overly flexible!

Modeling Challenges, Page 44:

- We have more delivery rights than receipt rights!
- Sendout has perfect knowledge

Question: What does that mean "Perfect Knowledge"?
Answer: It means that Sendout has complete knowledge of data but we have to apply our knowledge of the "real world" in order to make good decisions!

Page 45, Monte Carlo Simulations

- Mark reminds that there are 200 simulations, 100 of each are combined, using variable & Fixed costs
- Mark also stated that this piece of Sendout is not yet completed. It won't be until the end of the month and is to be presented at TAG #5.

Question: Have you found that there is a correlation between weather and price?
Answer: Generally, we don't see this correlation.

Page 47, Base Case Inputs

- Supply (from AECO, Sumas, PAL, uses current, 1st year contracts)
- Storage
- Transport
- Demand
- Price Forecast
- Weather – Normal

Page 50, Supply Base & Fixed:

Question: How many times have we contracted for peak day resources?
Answer: For peak days we either use contracts designated as peak day supply OR storage.

Page 63, Storage

- This page shows a storage example from the Sendout. JP has 4 contracts and Plymouth 2
- Storage targets are:
  - 35% for the end of June
  - 80% end of August
  - 100% at the end of September
- Northwest Pipeline tariff requires the above breakdown
- Information that is PUBLIC is shown only

Page 68, Delivery Rights vs Receipt Rights

- Cascade has more delivery rights than receipt rights, 457K Dth f Delivery Rights and 360K Dth of Receipt rights. Page 69 shows the flexibility we have because of the increased Delivery Rights. Page 70 shows the inflexibility with Delivery Rights using CNG's NWP contract #135558.

Question: What is the value of getting more granular from Gate Station to Climate Zone?
Answer: To help avoid future costs and pressure problems.

Question: Is the analysis disaggregated such that the City gates are not serving multiple communities?
Answer: It is set up as a "Demand Center"

Page 81, Weather

Question: Why did you pick "normal" weather data to use?
Answer: We will get an explanation of the reason for this for you.

Page 88, Major Resource issues on the Horizon

NWP limitations…

Question: Is the NWP I-5 expansion off the table?
Answer: The naming convention of this project has changed but it is NOT off the table.

Currently there is nothing concrete in the works for Biofuel at this time.
We are still considering storage options.

Question: Ryckman Creek?

Answer: Still considering it.

Page 91, Avoided Cost Overview (costs avoided via conservation)

- Costs include the long term gas price forecast
- The above, is the majority of costs!
- There is a 10% adder for environmental benefits.
- Carbon price
- Storage variable/fixed costs
- Transmission costs

Question: The Washington State Dept. of Ecology issued a new carbon rule. This could create obligations for the future. Should it be factored into this calculation?
Answer: Mark stated that it could be a big deal.

Question: How would we model it?
Answer: Factor CO^2 into Avoided Costs. In the sensitivities analysis (page 89) we pick that up a bit…

Question (directed to Staff): What is your comfort level in modeling the new carbon rule?
Answer (from Staff): Don't sweat it too badly. In the future you can model this more accurately.

- Mark stated that the tight timing for the IRP won't allow us to do this right now.
- It might be put into the "Clean Power Plan". It directly affects power.
- It begins in 2017, 7% per year 2017, 2018 & 2019
- The first demonstration of compliance has to happen in 2020.
- It could be litigated!

Question: At least we should acknowledge the rule is in place and posit some assumptions or impact?
Answer: We will put it into future IRP's

Question: Should we create a supplemental filing?
Answer: It doesn't really have an impact. The Carbon cap reflects costs for emissions. Costs to the customer – they will pay for emissions. Avoided costs and conservation costs will increase.

Page 94, System Avoided Costs Layers (dollars in therms)

- Avoided costs are still subject to change depending on when we lock in storage & transport.

- Monica Cowlishaw stated that she will use the numbers she has now to run the TeaPOT model.

Page 98, Current & Proposed Storage Demand & EST Transport Per Unit Cost

- Mark states that Ryckman looks the most attractive here!

Page 100, 2020 Potential Unserved

Question: Is it possible to highlight the Washington points on this chart?
Answer: YES!

Page 104, Preliminary Scenario NPV

- 3.8 billion over 20 years!
  - Includes some combination of NWP & GTN
  - Includes a portion of Ryckman Storage
  - Options of transport but none clearly stand out
  - Some concerns as follows:
    - Ryckman would primarily be used to Oregon's benefit.
    - Ryckman has reliability concerns. We need to address whether to decide for Oregon now or wait until the Oregon IRP?

Question: What are the implications??
Answer: The model wants Rickman, NWP & GTM, 100m over 20 years! California transport will be needed for using Ryckman. The Base Case assumes Ryckman Creek, NWP & GTN.

Question: What about the expansions cost?
Answer: The cost is reasonable to the rate payer. Is resource reasonableness outside of cost?

Question: If just considering cost, then the answer is obvious? Is the opportunity closed?
Answer: Mark states that credibility of the party is at issue. Senior management (GSOC) has a cautious viewpoint! Washington would end up paying for it.

Question: The IRP gives indication to a likely direction but doesn't hold you to that option?
Answer: Yes, senior management makes a reasonable decision. If the Commissioners agree, then OK. If you don't look at all the factors in this choice you could be penalized!

Questions & Discussion: Mark states that if we were to mention the subject to Oregon we could do so in a conceptual viewpoint. Right now we have an aggressive timeline. We don't want to expose ourselves to issues that will come back to "bite" us later. Mark asks for another day to do additional work on the additional resources. The draft is due on Saturday. We could include NWP and GTN in our preliminary scenario and put in draft that we are talking about the NEXT resource.
Answer: Mark states that is already identified.

- Garret stated he liked the discussion today and will be at TAG #5.

- Mark thanks everyone and said the new guidance is extremely helpful!!

Cascade Natural Gas Corporation

Integrated Resource Plan
Technical Advisory Group Meeting #5

Friday, October 14th 2016

CNGC Headquarters

Via WebEx

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

AGENDA

- Safety and housekeeping items
- Introductions
- Model Selection and Explanation of Resources Taken
- Monte Carlo Discussion
- Results
- Action Plan
- 2016 IRP Timeline
- Adjournment

Current Resources

- Our current resources models our system over a 20 year period which includes:
  - Current Supply Sources.
  - Current Storage.
  - Current Transport – Note: for modeling purposes we assume all existing transportation contracts will be renewed if they expire over the 20 year time horizon.
- This run allows the company to see what the model does without the alternative resources attached. It sets a bench mark to test the validity of the information (for instance comparing first year system cost to the most recent PGA).

Types of Supply - Summary

- Base – Can be listed as “Base” or “Fixed” this is an annual supply that we must take if we contract it.
- Winter – This is another supply that we must take, but is only available during the winter season (November-March).
- Day Gas – Can be broken down by winter and summer day gas. We only have to take what we need of this type of gas, and because it is more flexible, it is more expensive than Base or Winter gas.
- Peak – Used to serve demand when all other options are exhausted. It is also the most expensive type of gas.

KEY ELEMENTS IN SENDOUT SCENARIO

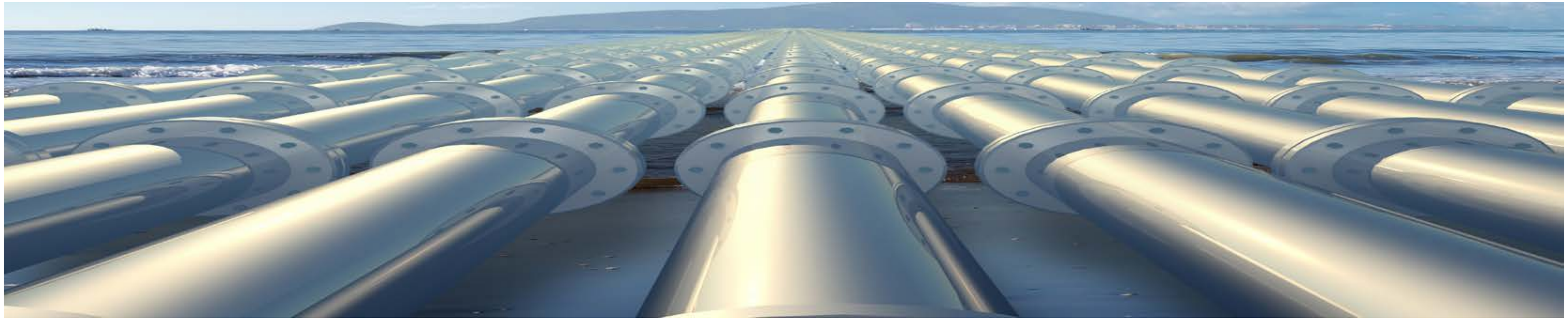
Current Station2	JP1	AECO Base/Fixed, Winter, Day W/S, Peak
Current NOVA	JP2	SUMAS Base/Fixed, Winter, Day W/S, Peak
Current GTN	JP3	ROCKIES Base/Fixed, Winter, Day W/S, Pea
Current NWP	JP4	HUNT Base/Fixed, Winter, Day W/S
Current Foothills	PLY-1	KINGSGATE BASE
Current Ruby	PLY-2	OPAL BASE
		KERN WINTER
		STAT2 BASE
Incremental NOVA	*Ryckman Crk Storage*	*Kern Incrm Supply*
Incremental GTN	*Gill Ranch Storage*	*BioNatualGas*
NWP I-5 EXP	*Mist Storage*	*Satellite LNG*
Incremental Ruby	*Wild Goose Storage*	*Resource Mix - 3 Basins*
NWP Wen EXP	*Aeco Hub Storage*	
Incremental Foothills		
NWP Z20 EXP		
Incremental GTN STARRD		
T-South-So Crossing		
TRAIL MAX/N-MAX		
NWP East OR EXP		
Incremental GTN S-N		
Pacific Connector		

Assumptions

- Incremental Transport
- Incremental Storage
- All In
- Expected Case

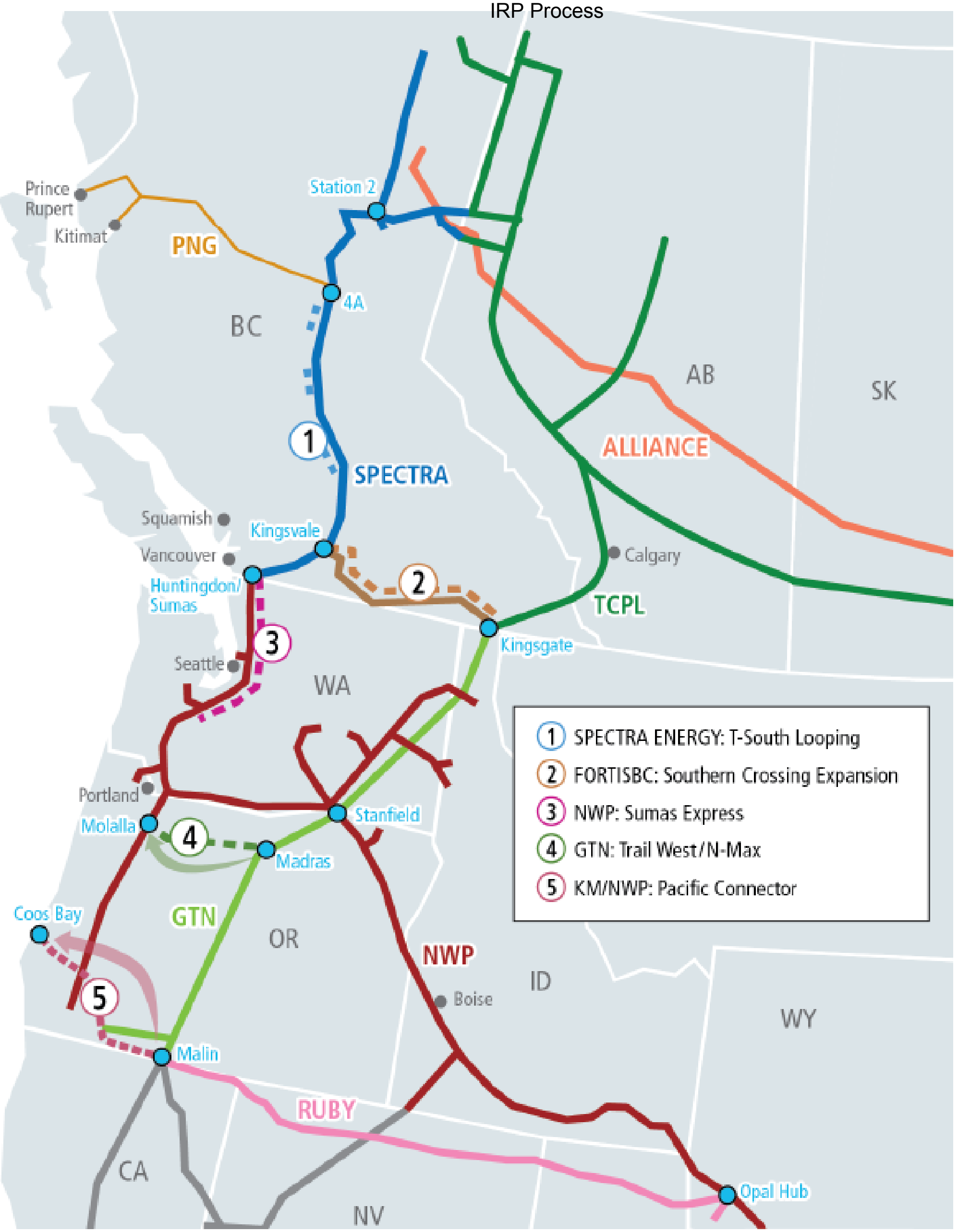
Incremental Transport

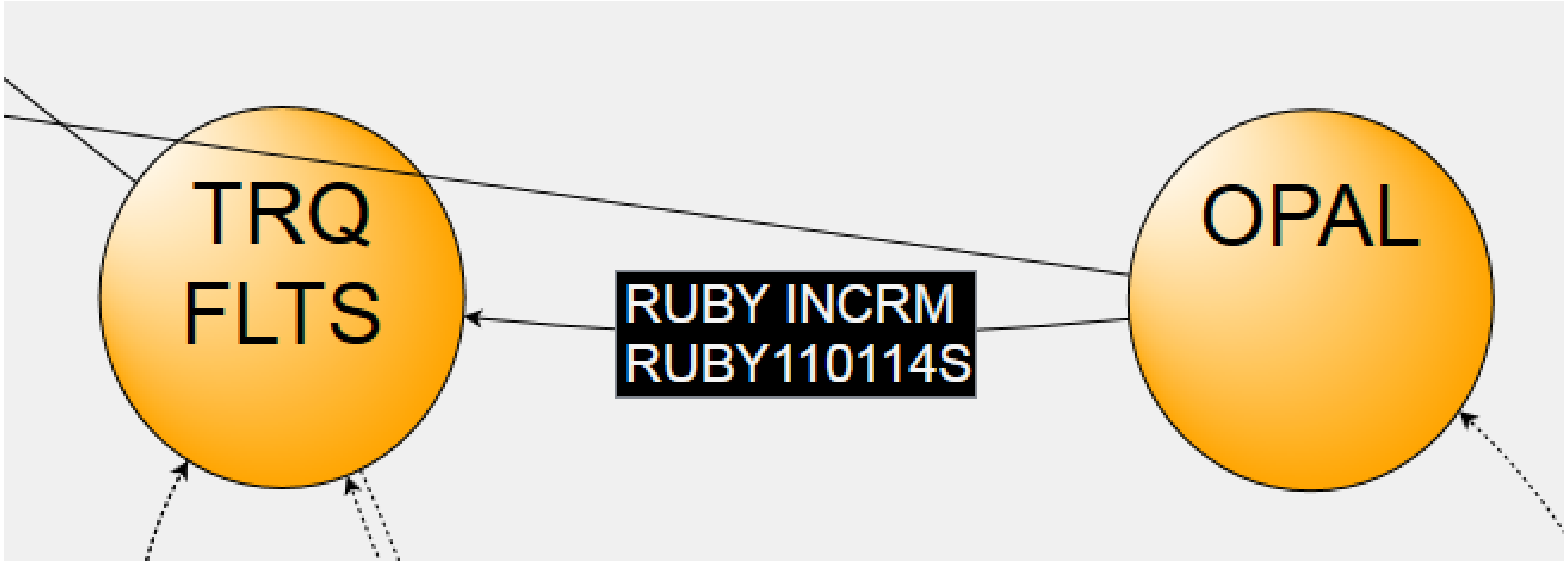
- Incremental Transport is tested next as it was our belief that this was the main shortfall.
- All Incremental Transports began on Nov. 2017 Except:
  - NWP East OR which begins Nov 2021.
  - I-5 Expansion begins Nov 2020, with realignment of MDDOs to 30-W starting Nov 2017.
- Anticipate rates will be negotiated, however we will provide incremental transport rates under confidential treatment.
- Transport is only sized once over the simulation.



KEY ELEMENTS IN SENDOUT SCENARIO

Current Station2	**JP1**	**AECO Base/Fixed, Winter, Day W/S, Peak**
Current NOVA	**JP2**	**SUMAS Base/Fixed, Winter, Day W/S, Peak**
Current GTN	**JP3**	**ROCKIES Base/Fixed, Winter, Day W/S, Pea**
Current NWP	**JP4**	**HUNT Base/Fixed, Winter, Day W/S**
Current Foothills	**PLY-1**	**KINGSGATE BASE**
Current Ruby	**PLY-2**	**OPAL BASE**
		KERN WINTER
		STAT2 BASE
Incremental NOVA	***Ryckman Crk Storage***	***Kern Incrm Supply***
Incremental GTN	***Gill Ranch Storage***	***BioNatualGas***
NWP I-5 EXP	***Mist Storage***	***Satellite LNG***
Incremental Ruby	***Wild Goose Storage***	***Resource Mix - 3 Basins***
NWP Wen EXP	***Aeco Hub Storage***	
Incremental Foothills		
NWP Z20 EXP		
Incremental GTN STARRD		
T-South-So Crossing		
TRAIL MAX/N-MAX		
NWP East OR EXP		
Incremental GTN S-N		
Pacific Connector		


Prince Rupert
Kitimat
PNG
Station 2
4A
BC
AB
SK
ALLIANCE
1
SPECTRA
Squamish
Kingsvale
Vancouver
Huntingdon/ Sumas
2
Calgary
TCPL
Kingsgate
3
Seattle
WA
Portland
Molalla
4
Madras
Stanfield
GTN
OR
Coos Bay
5
NWP
Boise
ID
WY
Malin
RUBY
CA
NV
Opal Hub
1 SPECTRA ENERGY: T-South Looping
2 FORTISBC: Southern Crossing Expansion
3 NWP: Sumas Express
4 GTN: Trail West/N-Max
5 KM/NWP: Pacific Connector


TRQ
FLTS
RUBY INCRM
RUBY110114S
OPAL

Incremental Storage

- We model 4 different potential storage facilities to check for potential price opportunities, as well as to meet load.
- All storages are modeled to begin in April 2018.
- Anticipate rates will be negotiated, however we will provide incremental storage rates under confidential treatment.
- Storage is only sized once over the simulation.

KEY ELEMENTS IN SENDOUT SCENARIO

Current Station2	**JP1**	**AECO Base/Fixed, Winter, Day W/S, Peak**
Current NOVA	**JP2**	**SUMAS Base/Fixed, Winter, Day W/S, Peak**
Current GTN	**JP3**	**ROCKIES Base/Fixed, Winter, Day W/S, Pea**
Current NWP	**JP4**	**HUNT Base/Fixed, Winter, Day W/S**
Current Foothills	**PLY-1**	**KINGSGATE BASE**
Current Ruby	**PLY-2**	**OPAL BASE**
		KERN WINTER
		STAT2 BASE
Incremental NOVA	***Ryckman Crk Storage***	***Kern Incrm Supply***
Incremental GTN	***Gill Ranch Storage***	***BioNatualGas***
NWP I-5 EXP	***Mist Storage***	***Satellite LNG***
Incremental Ruby	***Wild Goose Storage***	***Resource Mix - 3 Basins***
NWP Wen EXP	***Aeco Hub Storage***	
Incremental Foothills		
NWP Z20 EXP		
Incremental GTN STARRD		
T-South-So Crossing		
TRAIL MAX/N-MAX		
NWP East OR EXP		
Incremental GTN S-N		
Pacific Connector		

All In Scenario

- In addition to Incremental Transport and Storage, we include:
  - Yakima satellite LNG Facility to serve additional unserved demand.
  - Opal Incremental Supply to see if it would interact with storage.
- This scenario serves as the foundation for us to see what resources are taken to meet system demand with the least cost mix of natural gas supply and conservation.[1]

1 WAC Rule 480-90-238

KEY ELEMENTS IN SENDOUT SCENARIO

Current Station2	**JP1**	**AECO Base/Fixed, Winter, Day W/S, Peak**
Current NOVA	**JP2**	**SUMAS Base/Fixed, Winter, Day W/S, Peak**
Current GTN	**JP3**	**ROCKIES Base/Fixed, Winter, Day W/S, Pea**
Current NWP	**JP4**	**HUNT Base/Fixed, Winter, Day W/S**
Current Foothills	**PLY-1**	**KINGSGATE BASE**
Current Ruby	**PLY-2**	**OPAL BASE**
		KERN WINTER
		STAT2 BASE
Incremental NOVA	***Ryckman Crk Storage***	***Kern Incrm Supply***
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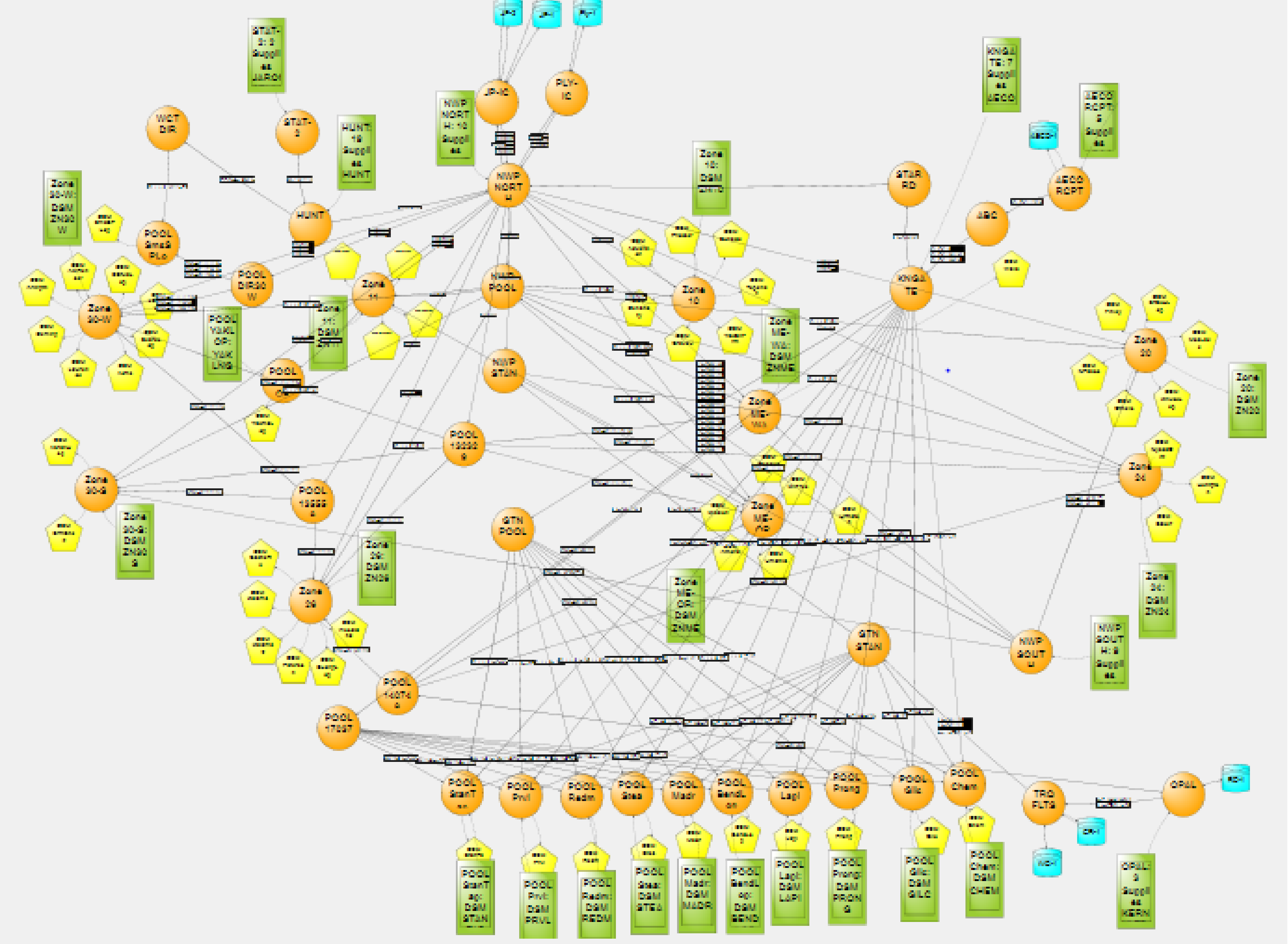
NWP I-5 EXP	***Mist Storage***	***Satellite LNG***
Incremental Ruby	***Wild Goose Storage***	***Resource Mix - 3 Basins***
NWP Wen EXP	***Aeco Hub Storage***	
Incremental Foothills		
NWP Z20 EXP		
Incremental GTN STARRD		
T-South-So Crossing		
TRAIL MAX/N-MAX		
NWP East OR EXP		
Incremental GTN S-N		
Pacific Connector		


HUNT
NWP STAN
GTN POOL
GTN STAN
ABC
OPAL
POOL 17537

Expected Scenario

- Re-Run the optimization removing the resources SENDOUT does not select in the All-In case.
  - Allows us to confirm that removing these resources does not impact the amount of served demand.
  - Removes fixed costs associated with the resources not taken to provide a true total system cost.

KEY ELEMENTS IN SENDOUT SCENARIO

Current Station2	**JP1**	**AECO Base/Fixed, Winter, Day W/S, Peak**
Current NOVA	**JP2**	**SUMAS Base/Fixed, Winter, Day W/S, Peak**
Current GTN	**JP3**	**ROCKIES Base/Fixed, Winter, Day W/S, Pea**
Current NWP	**JP4**	**HUNT Base/Fixed, Winter, Day W/S**
Current Foothills	**PLY-1**	**KINGSGATE BASE**
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Incremental Ruby	***Wild Goose Storage***	***Resource Mix - 3 Basins***
NWP Wen EXP	***Aeco Hub Storage***	
Incremental Foothills		
NWP Z20 EXP		
Incremental GTN STARRD		
T-South-So Crossing		
TRAIL MAX/N-MAX		
NWP East OR EXP		
Incremental GTN S-N		
Pacific Connector		

Total System Costs ($000)

Scenario	Total System Cost	Average Cost/Served Therm
As-Is	4,213,446	0.5951053
Incremental Transport	4,085,782	0.5766252
Incremental Storage	4,085,782	0.5766252
All In	4,085,939	0.5766167
Expected Case	4,073,121	0.5748078

Alternative Resources Selected

- Transport:
  - Incremental GTN – Allows us to continue to serve customers as we grow in Citygates that are fed by our GTN capacity, specifically around Bend, Oregon where we expect shortfalls.
  - I-5 Expansion – Allows us to continue to serve customers as we grow around the I-5 corridor, specifically in the Sumas area.
  - Wenatchee Expansion – Allows us to continue to serve customers as we grow in Central Washington.
  - Spokane Expansion – Allows us to continue to serve customers as we grow in Eastern Washington.
  - Incremental Starr Road – Allows us the flexibility to move gas off of GTN and onto NWP through Starr Road when needed, displacing potential incremental NWP capacity.
  - Eastern Oregon Expansion – Allows us to move gas from NWP to serve Eastern Oregon.

Alternative Resources Selected

- Supply:
  - Yakima Satellite LNG Plant – Allows us the opportunity to serve demand in a cost effective way directly to Yakima, WA without new transport, which in turn helps increase served demand system wide through a displacement of Maximum Daily Delivery Obligations (MDDOs) among existing contracts.

Alternative Resources Not Selected

- Transport
  - Incremental NOVA/Foothills – There is currently no incremental NOVA capacity available. In addition, SENDOUT did not believe there was a cost effective opportunity presented by moving gas along these contracts to Kingsgate versus buying gas at Kingsgate directly.
  - Incremental Ruby / Turquoise Flats – SENDOUT determined it was more cost effective to use incremental transport along GTN to serve the incremental demand these contracts would serve.
- Storage
  - Ryckman Creek, Gill Ranch, Wild Goose, AECO Hub – No incremental storage taken – None of the storage facilities modeled were cost effective, or led to an increase in served demand.

Alternative Resources Not Selected

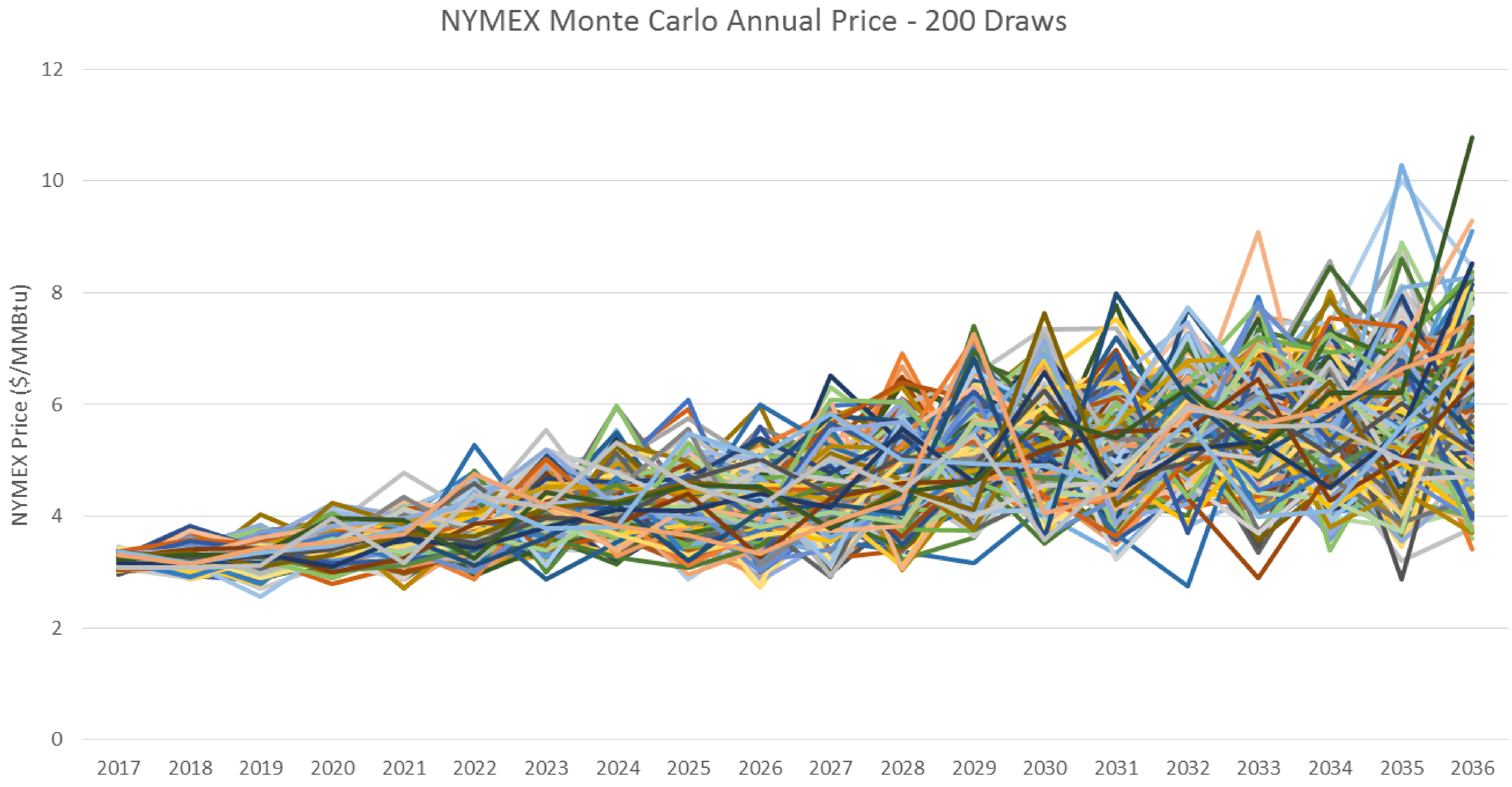
- Supply
  - Opal Incremental – Since SENDOUT determined it was best to serve increasing demand through a GTN Expansion, there was no need to purchase additional gas to move along Ruby.

Monte Carlo Simulations

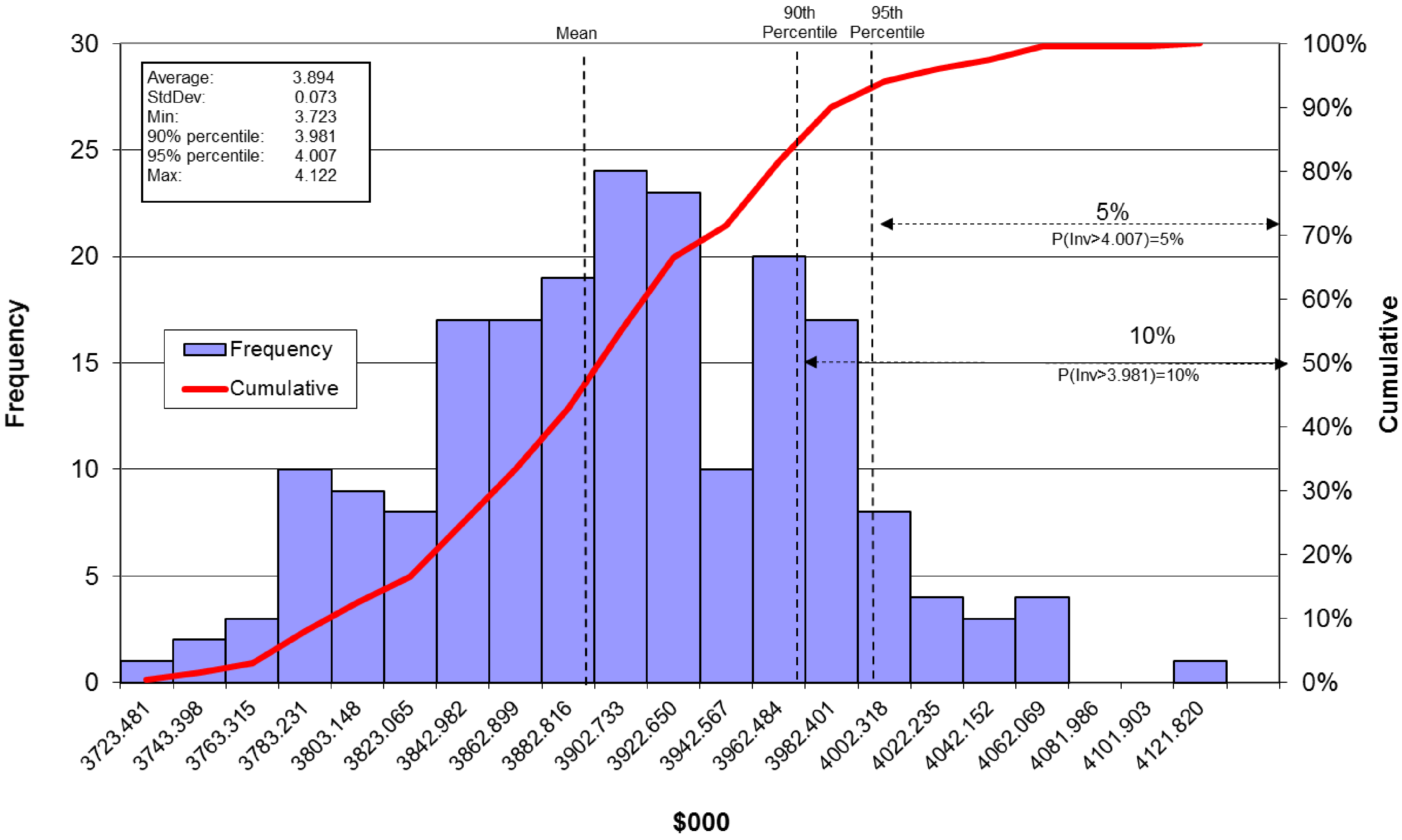
- Monte Carlo – NYMEX price
- Monte Carlo – Weather
- Why not Monte Carlo on both together?
- Results

Monte Carlo – NYMEX Price

- Using our 20 year price forecast as the mean value for the NYMEX market, we had SENDOUT run 200 simulations to stress test our expected case over a variety of different scenarios.
- We also modeled how our expected case would fare with 5 difference assumptions: Low Growth, High Growth, a 10% Carbon Adder, a 20% Carbon Adder, and a 30% Carbon adder.
- This ensures that our expected resource portfolio is still the optimal choice even in extreme pricing situations.


NYMEX Monte Carlo Annual Price - 200 Draws
NYMEX Price ($/MMBtu)
0
2
4
6
8
10
12
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036

Total System Cost w/ Expected Customer Growth



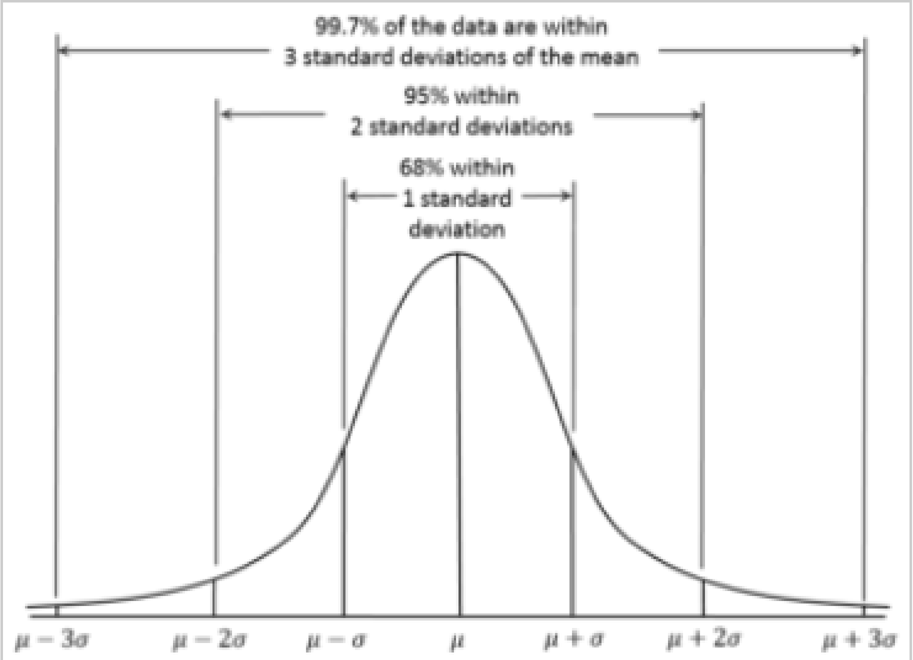
Monte Carlo – Weather

- Using historical weather, we had SENDOUT run 200 simulations to stress test our expected case over a variety of different scenarios.
- We also modeled how our expected case would fare with 5 difference assumptions: Low Growth, High Growth, a 10% Carbon Adder, a 20% Carbon Adder, and a 30% Carbon adder.
- This ensures that our expected resource portfolio is still the optimal choice even in extreme weather situations.

Monte Carlo Weather – Normal Distribution

	JAN 2014	FEB 2014	MAR 2014	APR 2014	MAY 2014	JUN 2014	JUL 2014
HDD Mean	1031.8	804.1	639.6	453.9	254.2	92.6	10.3
HDD Std Dev	145.4	133.1	84.4	93.0	72.2	40.4	15.2
HDD Distribution	Normal						
HDD Max	1291	1242	841	641	426	170	75
HDD Min	772	568	448	254	92	19	0
CDD Mean							
CDD Std Dev							
CDD Distribution							
CDD Max							
CDD Min							
Scaling Year	Best Match						

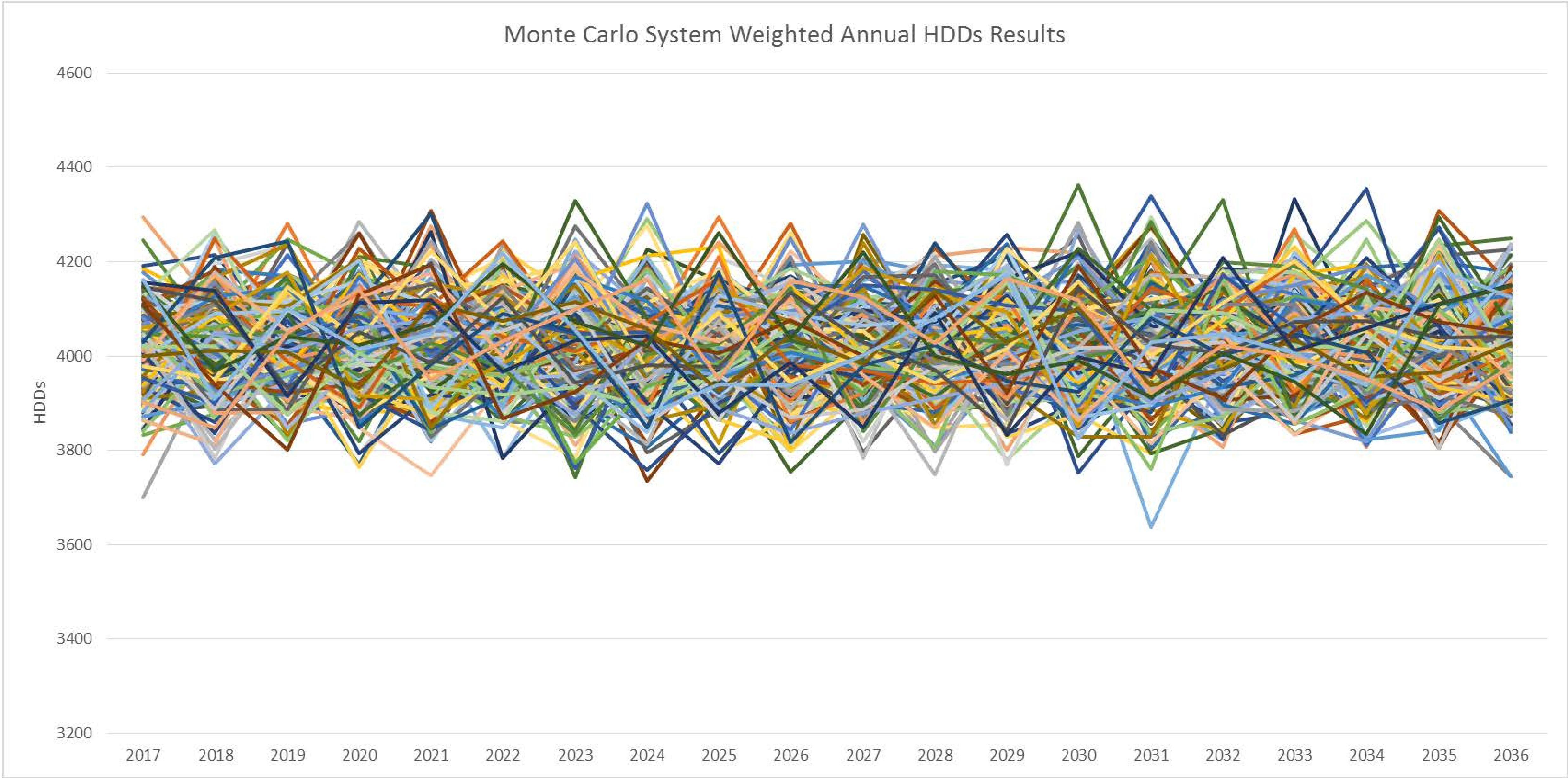
- When following a normal distribution your data will follow the 68%, 95%, 99.7% rule like in the below diagram.

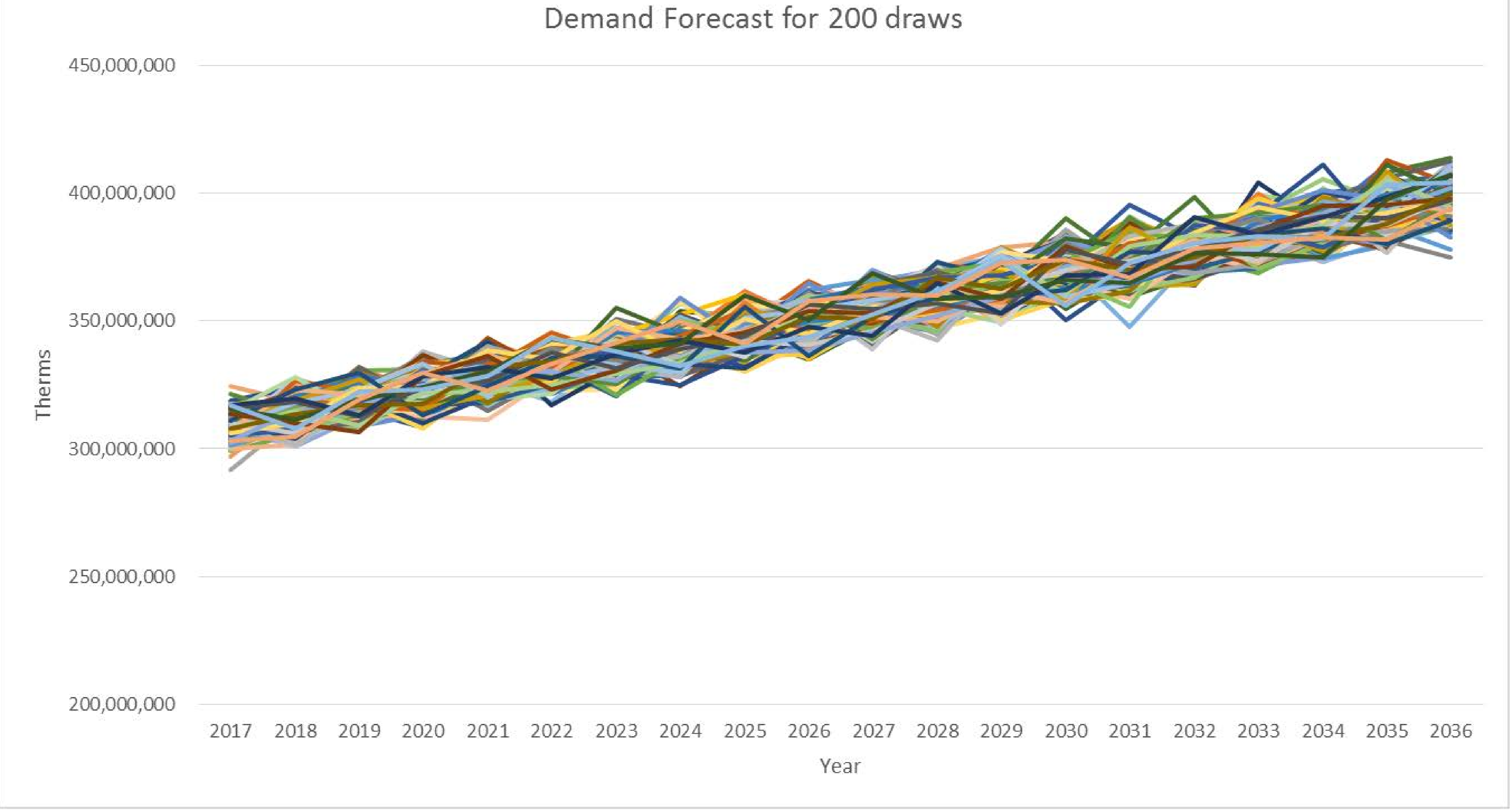


For the normal distribution, the values less than one standard deviation away from the mean account for 68.27% of the set; while two standard deviations from the mean account for 95.45%; and three standard deviations account for 99.73%.

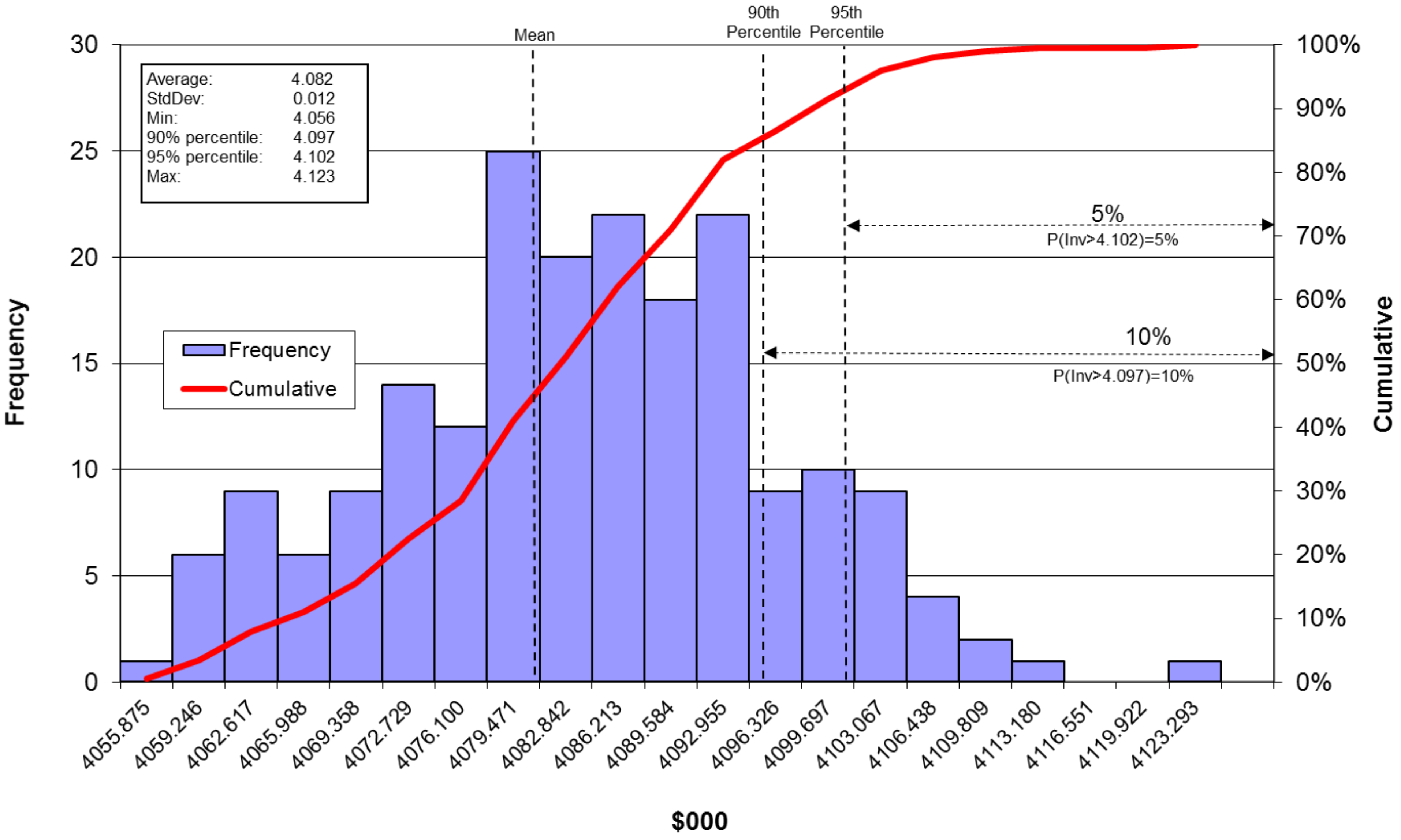
- To build our monthly inputs for SENDOUT we analyze our 30 data samples for each weather location which are the monthly HDD totals for the years 1986-2015. After getting the Mean and standard deviation we can compute how many data samples fall within each range of standard deviations.

	All Months Combined
Within 1 Std Dev	69%
Within 2 Std Dev	96%
Within 3 Std Dev	99.4%


Monte Carlo System Weighted Annual HDDs Results
HDDs
4600
4400
4200
4000
3800
3600
3400
3200
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036


Demand Forecast for 200 draws
450,000,000
400,000,000
350,000,000
300,000,000
250,000,000
200,000,000
Therms
2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036
Year

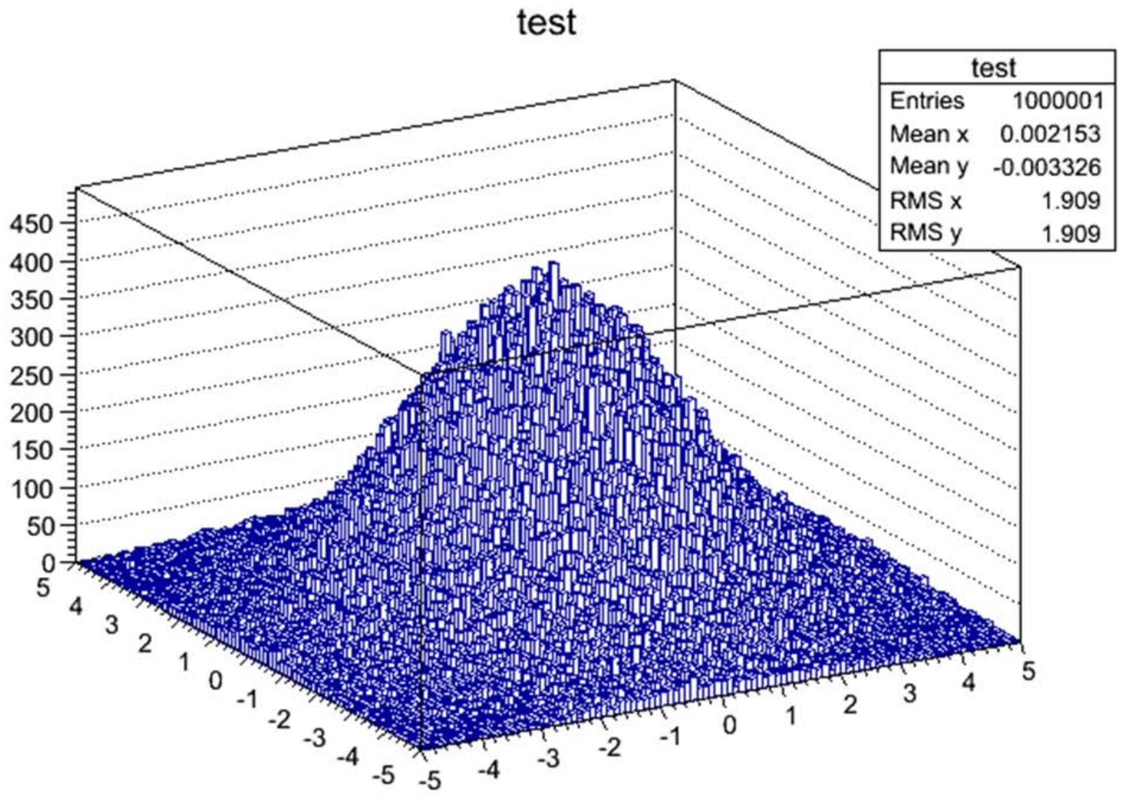
Total System Cost w/ expected customer growth



- What happens when we look at drawing on both price and weather at the same time?

  - We can imagine a 3 dimensional histogram, instead of the 2 dimensional histograms on the previous pages. Filling this in takes many more draws.

  - 200 draws of weather on the X axis and 200 draws of price on the Y axis might need 200 x 200 = 40,000 draws to fill in a histogram like this…

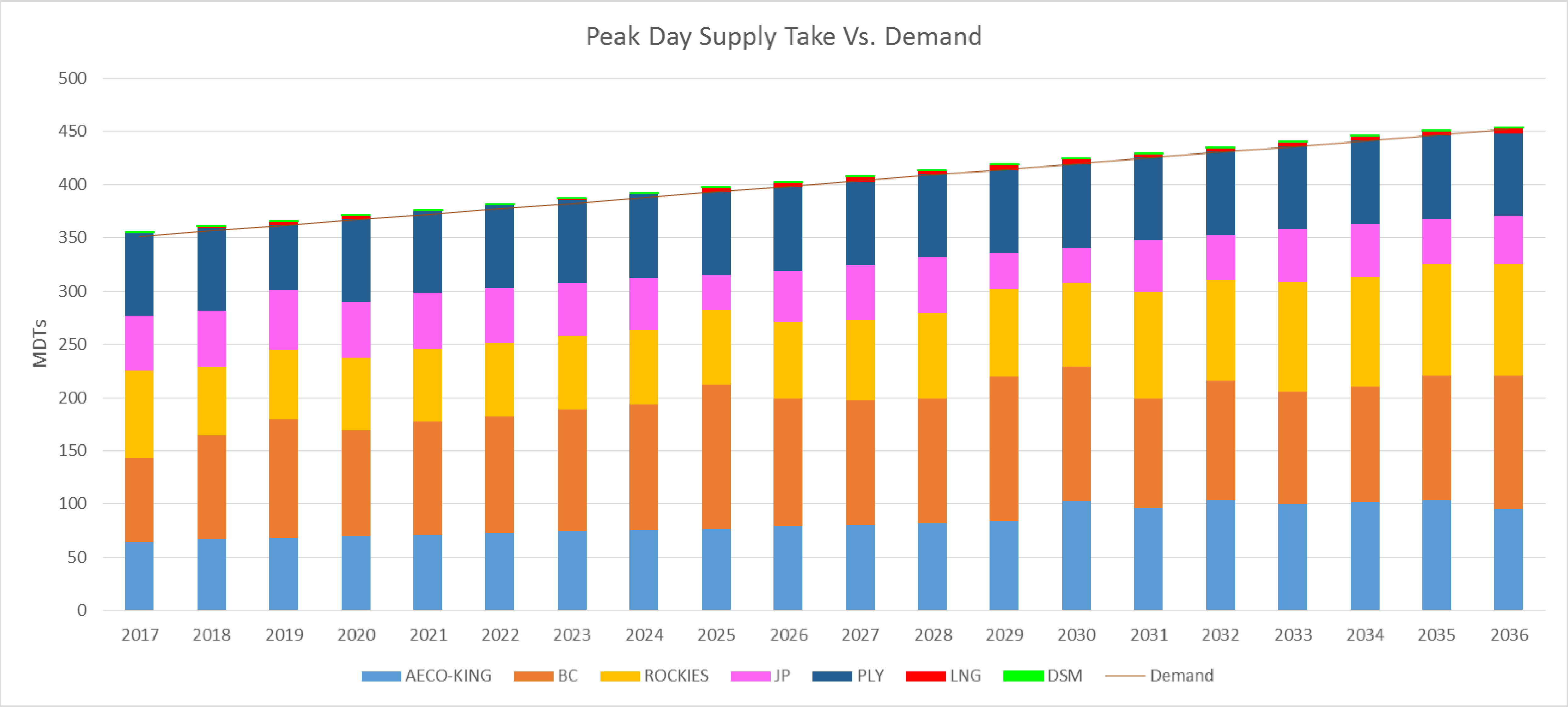


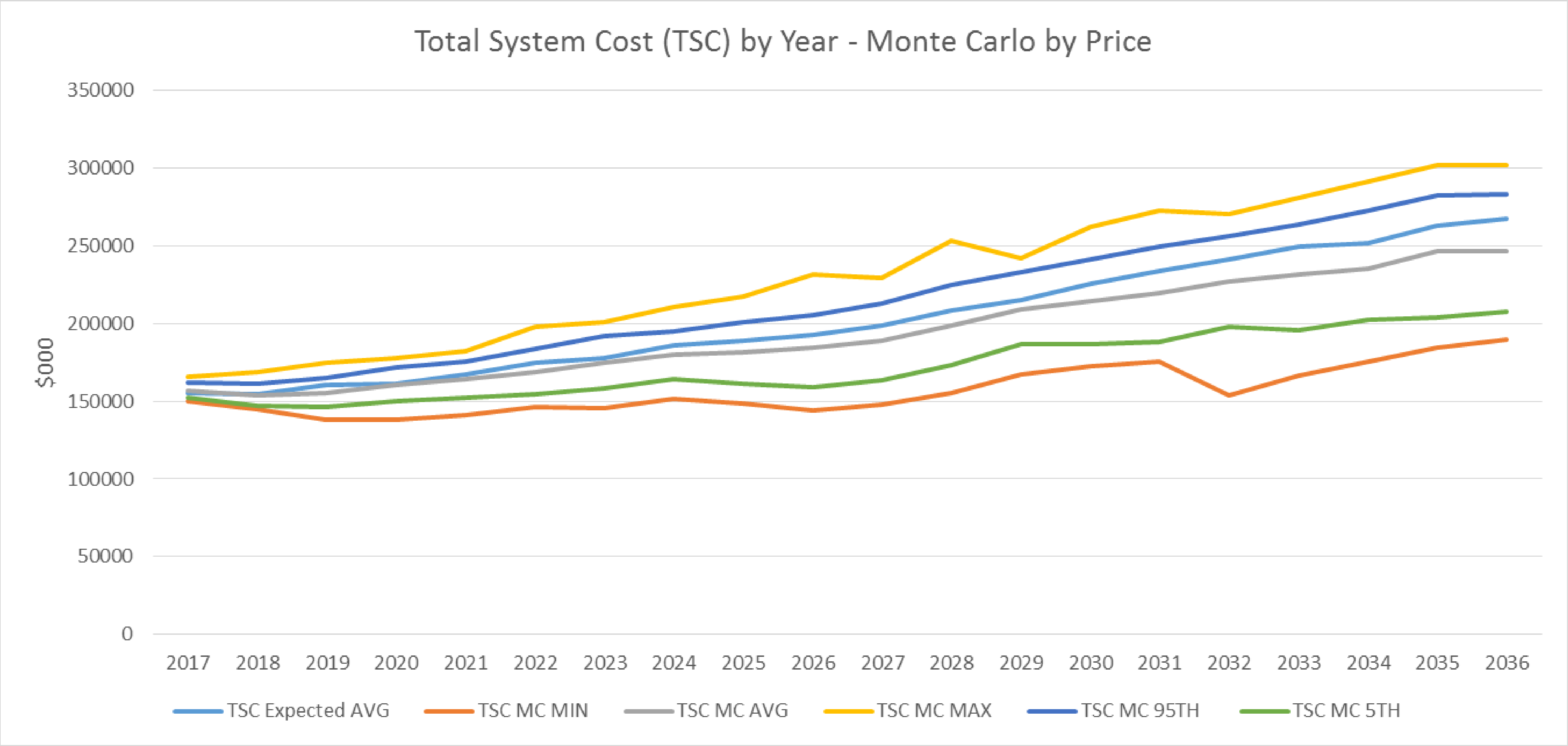
Rmix Decision - Storage

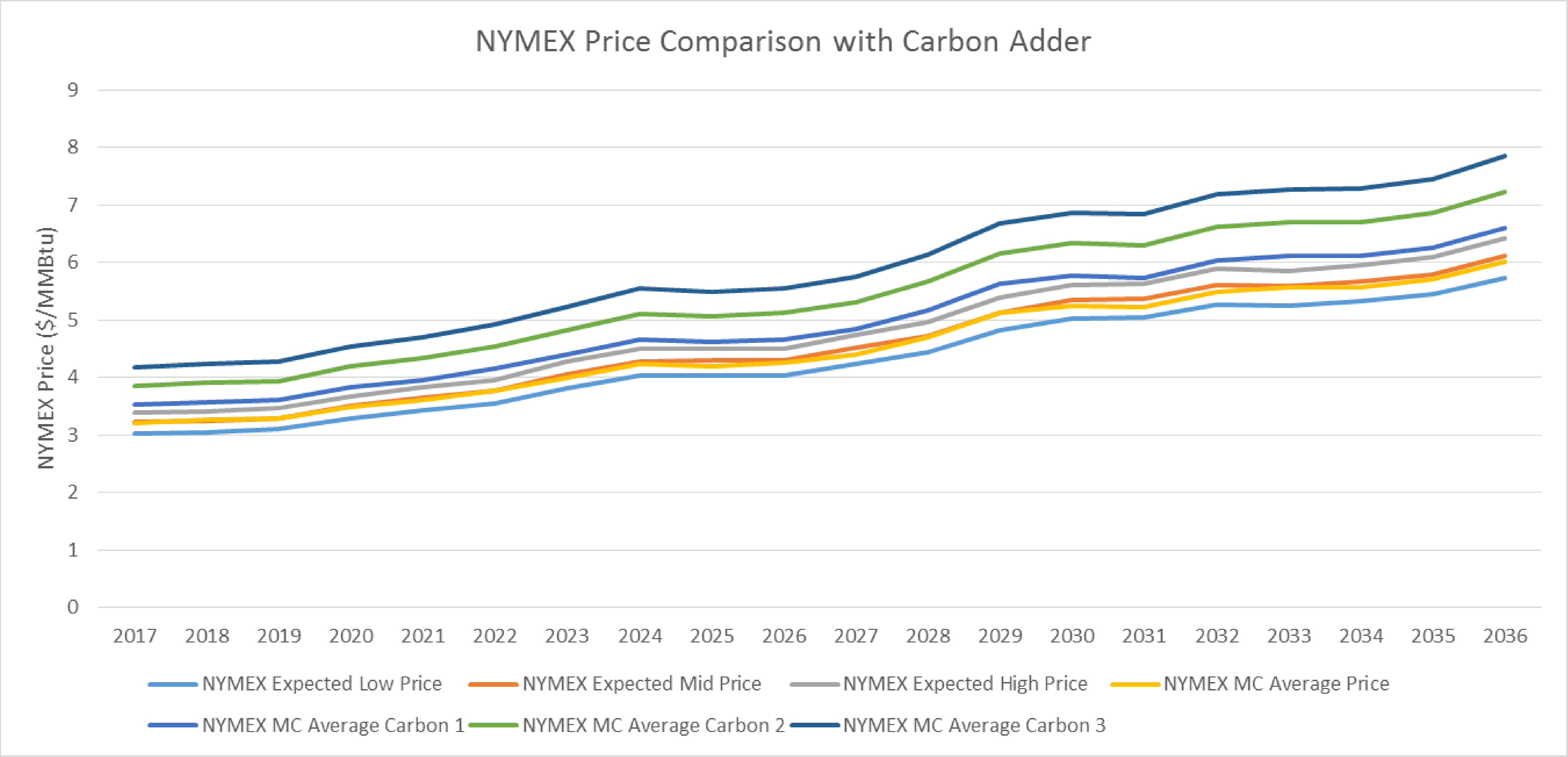
Storage	Start Date	End Date	Min Level	Max Level	Result MDQ	Inventory
AECO-1	APR 2018	MAR 2037	0	INF	0.00	0
GR-1	APR 2018	MAR 2037	0	INF	0.00	0
RC-1	APR 2018	MAR 2037	0	INF	0.00	0
WG-1	APR 2018	MAR 2037	0	INF	0.00	0

Rmix Decision - Transport

Contract	Start Date	End Date	Min Level	Max Level	Result MDQ
BNDLOP INCRM	NOV 2016	OCT 2026	0.00	INF	4.13
BNDLOP INCRM	NOV 2026	MAR 2037	0.00	INF	17.12
CHEM INCRM	NOV 2016	OCT 2026	0.00	INF	0.00
CHEM INCRM	NOV 2026	MAR 2037	0.00	INF	0.00
GILC INCRM	NOV 2016	OCT 2026	0.00	INF	0.00
GILC INCRM	NOV 2026	MAR 2037	0.00	INF	0.00
LAPI INCRM	NOV 2016	OCT 2026	0.00	INF	0.14
LAPI INCRM	NOV 2026	MAR 2037	0.00	INF	0.18
MADR INCRM	NOV 2016	OCT 2026	0.00	INF	1.37
MADR INCRM	NOV 2026	MAR 2037	0.00	INF	1.75
MDDO SmsSPLo	NOV 2016	MAR 2037	0.00	INF	48.50
MDDO YAKLOP	NOV 2017	MAR 2037	0.00	INF	32.59
PRONG INCR	NOV 2016	OCT 2026	0.00	INF	0.18
PRONG INCR	NOV 2026	MAR 2037	0.00	INF	0.75
PRVL INCRM	NOV 2016	OCT 2026	0.00	INF	0.91
PRVL INCRM	NOV 2026	MAR 2037	0.00	INF	1.31
REDM INCRM	NOV 2016	OCT 2026	0.00	INF	7.27
REDM INCRM	NOV 2026	MAR 2037	0.00	INF	12.09
RUBY BendLop	NOV 2016	MAR 2037	0.00	INF	14.49
RUBY Chem	NOV 2016	MAR 2037	0.00	INF	0.00
RUBY Gilc	NOV 2016	MAR 2037	0.00	INF	0.00
RUBY Lapi	NOV 2016	MAR 2037	0.00	INF	0.65
RUBY Madr	NOV 2016	MAR 2037	0.00	INF	1.48
RUBY Prong	NOV 2016	MAR 2037	0.00	INF	0.64
RUBY Prvl	NOV 2016	MAR 2037	0.00	INF	1.13
RUBY Redm	NOV 2016	MAR 2037	0.00	INF	7.28
RUBY StanTap	NOV 2016	MAR 2037	0.00	INF	0.09
RUBY Stea	NOV 2016	MAR 2037	0.00	INF	4.39
SPOK EXT	NOV 2017	MAR 2037	0.00	INF	5.65
STAN EXP 24	NOV 2021	MAR 2037	0.00	INF	6.76
STAN EXP MEW	NOV 2021	MAR 2037	0.00	INF	6.36
STEA INCRM	NOV 2016	OCT 2026	0.00	INF	0.00
STEA INCRM	NOV 2026	MAR 2037	0.00	INF	0.00
STNTAP INCRM	NOV 2016	OCT 2026	0.00	INF	0.08
STNTAP INCRM	NOV 2026	MAR 2037	0.00	INF	0.11
STRRD INCRM	NOV 2016	OCT 2026	0.00	INF	5.96
STRRD INCRM	NOV 2026	MAR 2037	0.00	INF	9.33
WEN EXP Z10	NOV 2017	MAR 2037	0.00	6.00	0.00
WEN EXP Z11	NOV 2017	MAR 2037	0.00	6.00	5.81


Peak Day Supply Take Vs. Demand
MDTs
500
450
400
350
300
250
200
150
100
50
0
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
AECO-KING
BC
ROCKIES
JP
PLY
LNG
DSM
Demand


Total System Cost (TSC) by Year - Monte Carlo by Price
$000
350000
300000
250000
200000
150000
100000
50000
0
2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036
TSC Expected AVG
TSC MC MIN
TSC MC AVG
TSC MC MAX
TSC MC 95TH
TSC MC 5TH


NYMEX Price Comparison with Carbon Adder
NYMEX Price ($/MMBtu)
0
1
2
3
4
5
6
7
8
9
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
NYMEX Expected Low Price
NYMEX Expected Mid Price
NYMEX Expected High Price
NYMEX MC Average Price
NYMEX MC Average Carbon 1
NYMEX MC Average Carbon 2
NYMEX MC Average Carbon 3

Action Plan

Functional Area	Anticipated Action	Timing
Demand Forecast	Expanding forecasting to non-linear regressions using SAS	Beginning 2016 for 2018 IRP
Demand Forecast	Consider the new weather normalization model in the forecast	Begin in 2016 for 2018 IRP
Demand Forecast	Cascade will work on gathering growth information from other locations to compare with Woods & Poole. Also include analysis of State Economist Report	Begin in 2017 for inclusion in 2018 IRP
DSM	Investigate incorporating distribution system costs into the avoided cost calculation	Begin in 2017 for inclusion in 2018 IRP
DSM	As specific carbon legislation is passed, the company will update its avoided cost calculations, conservation potential and make modifications to its DSM incentive programs as necessary.	Consider in 2017 for possible modification in the 2018 IRP

Action Plan – Cont.

Functional Area	Anticipated Action	Timing
Environmental, DSM, Demand Forecast	The Washington State Dept. of Ecology issued a new carbon rule. Will need to consider IRP implications	Begin in 2017 for inclusion in 2018 IRP
Supply Resources	Negotiate with TransCanada for the needed incremental GTN capacity for November 2017	Complete by June 2017, with a November 2018 in-service date
Supply Resources	Work with NWP to define what delivery rights can be modified to meet potential shortfalls	Complete assessment by July 2017
Supply Resources	Work with NWP and potentially other regional LDCs to determine if a combination of I-5, Wenatchee, etc. expansion or segmentation can address shortfalls and regional infrastructure concerns.	Complete assessment by July 2017
Distribution System Planning, Resource Planning, Gas Supply	Incorporate the citygate study into the IRP.	Begin in 2016, complete in early 2017 for inclusion in IRP
Distribution System Planning, Gas Supply, Operations, Others	Use the results of the Study to confirm aligning of alternative resources, specifically satellite LNG	Confirm that satellite LNG is proper solution by July 2017;
Distribution System Planning, Gas Supply, Operations, Others	Upon confirmation of need to for satellite LNG, proceed with implementation of facility	Begins no later than July 2017, for potential in service date of November 2018

2016 IRP Timeline

Date	Process Element	Location (Subject to change)
Monday, October 17, 2016	Draft of 2016 IRP distributed	Via email and posted on cngc.com webpage
Monday, November 07, 2016	Comments due on draft from all stakeholders	
Thursday, November 17, 2016	TAG 6, if needed	Kennewick, WebEx
Wednesday, November 23, 2016	Final IRP goes to press	
Thursday, December 01, 2016	Executive Summary Presentation to Senior Management	Kennewick, WebEx
Wednesday, December 14, 2016	IRP filing in Washington	

NEXT STEPS?

Cascade Natural Gas Corporation

Integrated Resource Plan
Technical Advisory Group Meeting #5

Friday, October 14th 2016

CNGC Headquarters

Via WebEx

In the Community to Serve®

5th External TAG Meeting

Date & time: 10/14/2016, 09:00 AM – 10:30 PM

Location: WebEx from Kennewick GO

Presenters: Mark Sellers-Vaughn, Brian Robertson & Devin McGreal

In attendance: Mark Sellers-Vaughn, Brian Robertson, Devin McGreal, Carolyn Stone, Mike Parvinen, Mike Clapp & Jennifer Gross.

Called in: Bob Morman, Garret Senger, Eric Wood, Laura Flanders - NWP, Mark Chiles, Tom Pardee – Avista, Ed Finklea - NWIGU, Amanda Sargent, Sheila McElhinney, Kary Burin, Kathi Scanlan, Chris McGuire, Monica Cowlishaw & Bruce Folsom.

Minutes by: Carolyn P Stone

Mark began the meeting by welcoming everyone. Mark then had Brian Robertson show the exits for safety purposes to those attendees at Kennewick GO.

Mark announced that the meeting would last about 90 minutes and asked everyone for any opening remarks. Garret Senger stated that there has been unbelievable work to get this IRP out in such a short time span and thanks the IRP team. Bob Morman stated that this was a monumental task and also thanks for CNG crew. Both were looking forward to today's presentation.

Mark went over the meeting agenda:

In today's meeting we will state what the deliverable is for Monday in regards to the draft and stated they may need to clarify a few things with regards to the deterministic & Monte Carlo model runs. Mark ends by asking those on the phone to identify themselves before they speak.

Presentation #1 – Devin McGreal
Current Resources

- Devin started out by stating that "current resources" are the resources used in the model runs as well as those resources that are NOT being used and why.
- Slide #4 - Devin explained the types of supplies:
  - Base – fixed supplies we must take.
  - Winter Supply – Must be taken in winter only.
  - Day Gas – Used on peak days and the most costly supply.
- Slide #5 – Shows the Key Elements matrix. Devin reminds that the elements highlighted in red are excluded resources.
- Slide #7 – Most incremental transport begins in November of 2017.
- Slide #8 – Mark went over the resources shown in red & explanations why not in used in model:
  - **T-South-So Crossing** – Crosses south of BC & Alberta…Alberta to Sumas, this requires expansion to NWP and shows no significant advantage to CNG. There is some potential in the future for this resource.

- **Trail Max/N-Max** – This goes from Opal using GTN from Madras to Malallo. Mark explained CNG would need additional transport, so this option doesn't benefit us.
- **Pacific Connector** – This is associated with the Jordan Cove project. Goes from Malin to NWP at Grant's Pass. There has been opposition to the project, but it's not a done deal yet. This is a supply resource possibility in the future.
- **Ryckman Creek Storage –** Requires incremental capacity at Ruby. There are reliability issues including accidents and financial issues. Even the cost is prohibitive due to transport upstream and downstream in Oregon.
- **Gill Ranch Storage** – This storage is in California and would require transport on California's system. The cost from California to Malin would be high.
- **Mist Storage** – This is used primarily for PGE. There is no supply available that is cost effective for CNG.
- **AECO Hub Storage –** This goes from NOVA to GTN. It is a good price but is constrained and flow subject to interruption. Firm OUT only, non-firm IN.

- Slide #9 is an "expansions" graph, showing the path for each resource mentioned above.
- Slide #10 shows how the incremental transport looks in Sendout.
- Slide #11 discusses modeling of incremental storage.
  - Incremental transport cheaper than picking up additional storage

Question: Kathi Scanlan asked if Cascade is going to provide descriptions of these resource not modelled for the IRP filing.
Answer: Mark said "yes".

- Slide #13 – All in Scenario includes the Yakima LNG satellite facility & OPAL incremental supply.
  - It does not include BioNatural Gas, as there is nothing available to the CORE at this time. We talked about ALL scenarios.
- Slide #15 – "Impact Slide" showing our system modeled. Mark said he has been told that this scenario is one of the most complicated to try.
- Slide #16 – Expected Scenario removes the resources SENDOUT does not like. This rank orders the scenario to see if the expected IS the lowest cost option!
- Slide #18 shows the 5 scenarios ranked.
  - Mark mentioned that we they removed fixed costs, the Average cost went down. The Expected Case is the lowest cost scenario realizing that Sendout has perfect information.

Question: Ed Finklea asked if the average cost includes commodity.
Answer: Yes. This is the "All In" cost to the CityGate.

Slide #19 – Alternative Resources Selected:

Question: Carolyn Stone asked when you say that the model "doesn't take" the resource, what exactly does that mean?
Answer: Devin said the model selects resources as to what it considers optimal. If the model doesn't use the resource in its results then it doesn't consider that optimal.

- Slide #20 - Sendout "likes" the Yakima LNG Satellite plant
- Slide #21 & 22 – Alternative Resources NOT Selected, OPAL incremental was not used.

Presentation #2 – Brian Robertson

Monte Carlo (MC) Simulations

Brian explains that the Monte Carlo simulations use expected weather and expected growth as stress tests on the Sendout model results.

- Slide #25 shows the MC annual Price at 200 draws using Nymex
- Slide #26 shows the total system cost with expected customer growth. The Standard Deviation (STD) varies more here than with weather.

Question: Ed Finklea asked if the IRP group is stating that there is more price uncertainty than weather uncertainty.
Answer: Mark answered "yes essentially"!

- Slide #27 – Historical weather data is used with the same assumptions for extreme weather
- Slide #30 – Every historical months HDD was compiled into 30 data points for every weather station, which follows closely to a normal distribution!
- Slide #31 – HDD results using 200 draws
- Slide #32 – Demand Forecast – note the low demand for year 2031.
- Slide #33 - The mean is close to the "deterministic" model's mean.
- Slide #34 - Monte Carlo Price & Weather at the same time would take 40,000 draws to calculate, which would take 100 days to run the model....
- Slide #35 – Shows the Resource Mix (R-Mix) decision for storage – None of these options taken!
- Slide #37 – Shows the Peak Day supply taken vs demand. Shows each demand increment and what resource is used to provide supply.
- Slide #38 – Total System Cost (TSC) by year
  - The yellow line is the max
  - Grey line is the MC average
  - Light Blue is the deterministic run
- Slide #39 – Price comparison with a Carbon Adder
  - The Orange line is the Expected mid-price
  - Taken from a 20 year price forecast
  - Using an average of 200 runs

Presentation #3 – Mark Sellers-Vaughn

Action Plan

Mark went over Slide #40, Action Plan

Question: Which case will be at in the Monday draft?
Answer: In general we will grow into the resources. In 2021 for example the scenario shows that we are 17K Dth short at Bend, Wenatchee short 5,800 Dth, Bellingham 24Deth and SE Oregon 6300 Dth's. The worst case scenario happens in 2026.

Question: Mark asked Kathi Scanlan if the next IRP due date is due 2 years from filing date?
Answer: Yes

Question: Mark asked Mike Parvinen if there will be a new weather normalization model for the rate case. Mark wants to consider it for the next IRP
Answer: Mike said they are gathering intelligence now.

Question: Jennifer Gross asked if the Demand Side Management section shows distribution planning and avoided costs by zone.

Answer: Mark said yes, it is a challenge though because CNG's system is so spread out.

- Monica Cowlishaw discussed the "Collaborative Effort, $15m over 5 years toward developing high efficiency Natural Gas. She referenced including rooftops & heat pump water heaters will offer savings in the future. CNG will continue to be involved in this effort.

- Slide #41- Mark stated that a generalized "Carbon Rule" will be in the IRP as the other LDC's have done.
  - Mark stated that the LDC's will be working as a group to approach the pipeline together. This will provide cost effectiveness and clarification as well as consistency.
  - The City Gate study will be in the IRP showing CORE & Non-Core but we are interested only in CORE.
  - In 2017 we identify the need for the satellite LNG. Discussions and studies with other departments will be needed to confirm this need.

Question: Chris McGuire said he was confused about the Monte Carlo simulation. He said the presentation showed shocks of weather and price only used to test the deterministic model. Shouldn't other portfolio options be used to test…how do you know the expected is still considered the "optimal"?

Answer: Devin McGreal answered by stating that the tests confirm no dramatic demand or price like some large quantity of unserved demand, for example.

Chris went on to say that the statement he heard today was that you've proven the choice by Sendout is an "acceptable" option, not necessarily optimal. Chris encourages the team to use the Monte Carlo as a tool for both the average expected portfolio cost as well as the spread of outcomes (expected volatility/risk). He cautions the team to be careful with the language used in the IRP. Mark thanked Chris! Mark then stated that he will look for comments on the draft.

- Slide #42 – 2016 IRP Timeline - Mark reiterated that we have had a tight aggressive timeline. He states we will file the Draft 2016 IRP on Monday. The time of day is unknown. The Draft filing will be done electronically, via Email. It will be posted in the IRP CNG Website (this posting may happen on Tuesday but the official filing will happen Monday).

Question: Mark asks Kathi Scanlan if the electronic filing is OK.

Answer: Kathy said "yes".

- Mark stated that they may make some hard copies.
- Comments are due by NOVEMBER 7 end of day!!
- The IRP goes to press on November 23rd
- There will be a presentation of the Executive Summary to Executive Management
- Official filing will be done on December 14th in Washington.
- Mark then asked if the group had any final questions or comments.

Bruce Folsom commented that a lot of work has been put into this document and on an incredibly aggressive schedule!! **Nice job to the IRP team at CNG!!!**

Question: Laura Flanders asked what the plans were for the LDC's group to meet with pipelines, as mentioned earlier.

Answer: Mark said they will be getting in touch with the pipelines in the coming weeks.

THANK YOU TO EVERYONE FROM THE IRP TEAM!