Cascade Natural Gas Corporation

2018 Integrated Resource Plan
Technical Advisory Group Meeting #2/#3

Thursday, July 12th , 2018

Seattle-Tacoma International Airport

Seattle, WA

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

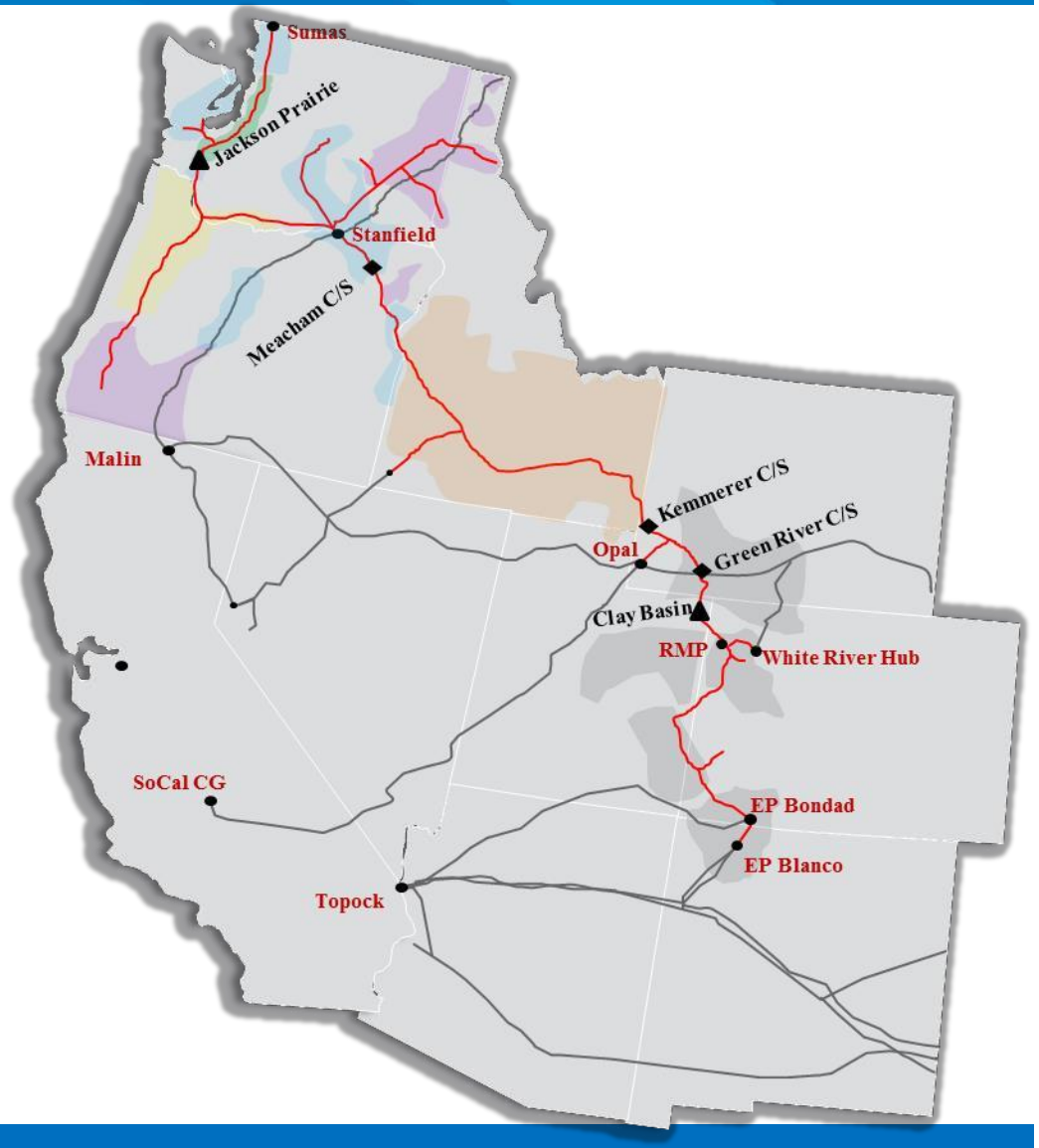
Williams WE MAKE ENERGY HAPPEN

Cascade's Northwest Pipeline Capacity

Laura Flanders / Mike Rasmuson

Northwest System – Strategically Located

- **Low-cost, primary service provider in the Pacific Northwest**
  - 3,900-mile system with 3.8 Bcf/d peak design capacity
  - ~120 Bcf of access to storage along pipeline, with high injection and deliverability capability in market area
  - Fully Contracted with > 9 year average contract life
- **Bi-directional design**
  - Provides flexibility (Rockies to market and Sumas to market)
  - Cheapest supply drives flow patterns
  - Provides operational efficiencies through displacement
- **Supply and market flexibility**
  - 65 receipt points totaling 11.6 Bcf/d of supply from Rockies, Sumas, WCSB, San Juan, emerging shales
  - 366 delivery points totaling 9.7 Bcf/d of delivery capacity
- **Solution oriented**
  - History of working with our customers both creatively and collaboratively to serve their needs



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Mastio Survey

> **Rated No. 2 in the Mega and Major Pipeline categories and No. 3 in the overall Interstate Pipeline category**

> **Northwest was ranked #1 in the following areas:**

- competitive rates
- diverse supply & markets
- likelihood to recommend

> **Northwest was ranked #2 in the following areas:**

- honest communications
- effectiveness of contract negotiations
- expertise of reps to solve your needs
- value received for the money paid
- flexibility of gas flows
- flexibility of transport options

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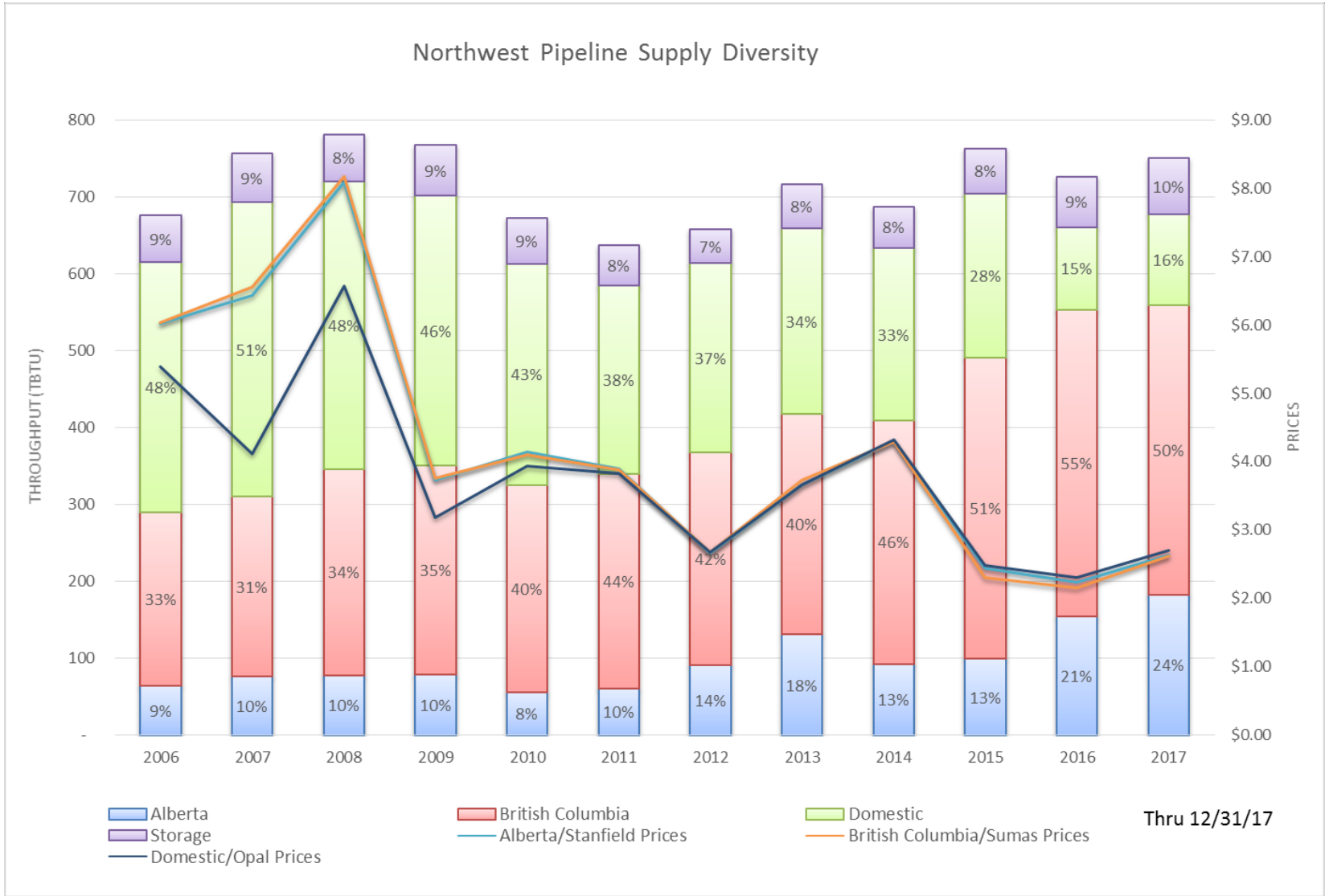
Supply Diversity



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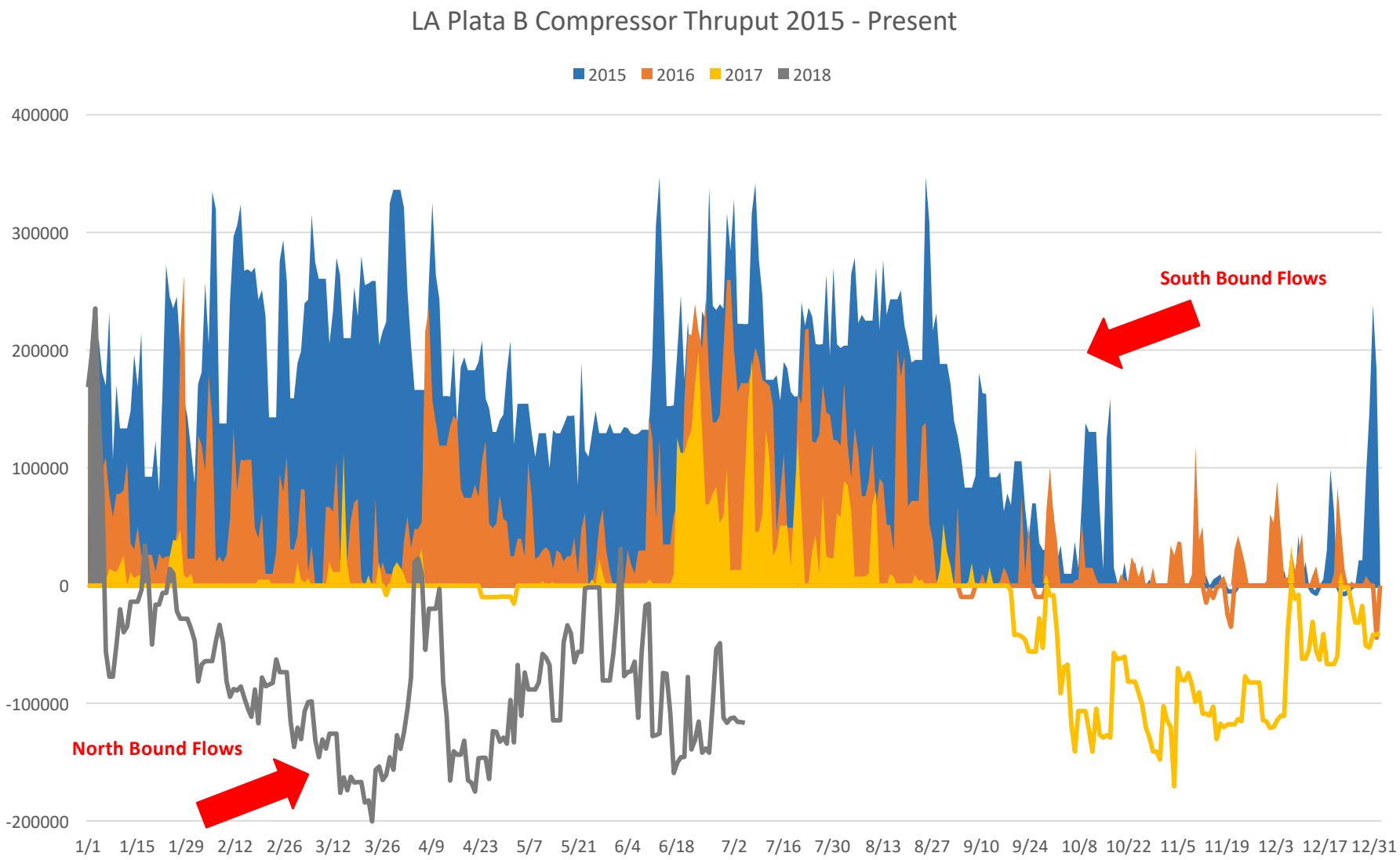
Supply Diversity – South End



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Tariff Rates

	Base Tariff Rates			
	Effective 12/31/2017	Effective 1/1/2018	Effective 10/1/2018	Comeback Rates Effective 1/1/2023
TF-1 Reservation (Large Customer)	0.41000	0.39294	0.39033	?
TF-1 Volumetric (Large Customer)	0.03000	0.00832	0.00832	?
Small Customer	0.72155	0.69427	0.69427	?

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Cascade's Excess MDDO's

> Cascade's contracts and excess MDDOs provide the flexibility to serve new incremental markets with minimal physical facilities added to the system

	100002 (TF-1)	100302 (TF-2)
Receipt Point MDQ	205,123	16,789
Delivery Point MDDOs	316,994	39,505
Excess MDDOs	111,871	22,716

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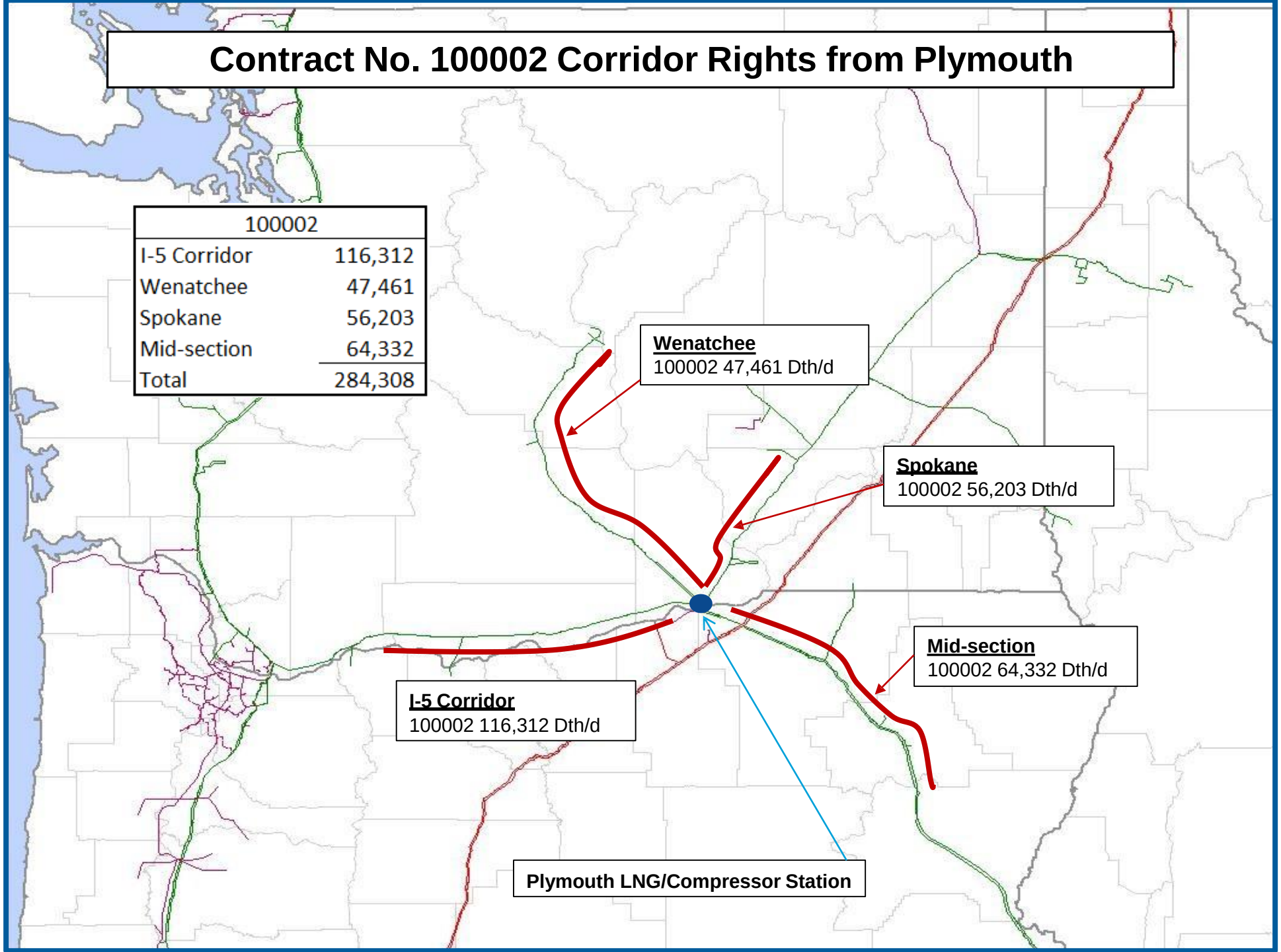
Contract No. 100002 Corridor Rights from Plymouth

100002	
I-5 Corridor	116,312
Wenatchee	47,461
Spokane	56,203
Mid-section	64,332
Total	284,308



Shelton Lateral Capacity Option

- **8,960 Dth/d of capacity is available or potentially available on the Shelton lateral to the Bremerton (Shelton) delivery point:**
  - 6,814 Dth/d of available capacity
  - 2,146 Dth/d of incremental capacity

- **The Bremerton (Shelton) delivery point will need to be modified to support the additional capacity at an estimated cost of ~$57,000**

- **The incremental lateral capacity would require minor facility modifications at an estimated cost of ~$14,000**
  - Northwest has estimated that it would cost over $20 million to expand the lateral if the capacity that is currently available is sold to a third party prior to Cascade acquiring this capacity

- **Cascade can acquire the lateral capacity along with Right of First Refusal (ROFR) by realigning capacity on Contract No. 139090 from Plymouth LNG to Bremerton (Shelton)**

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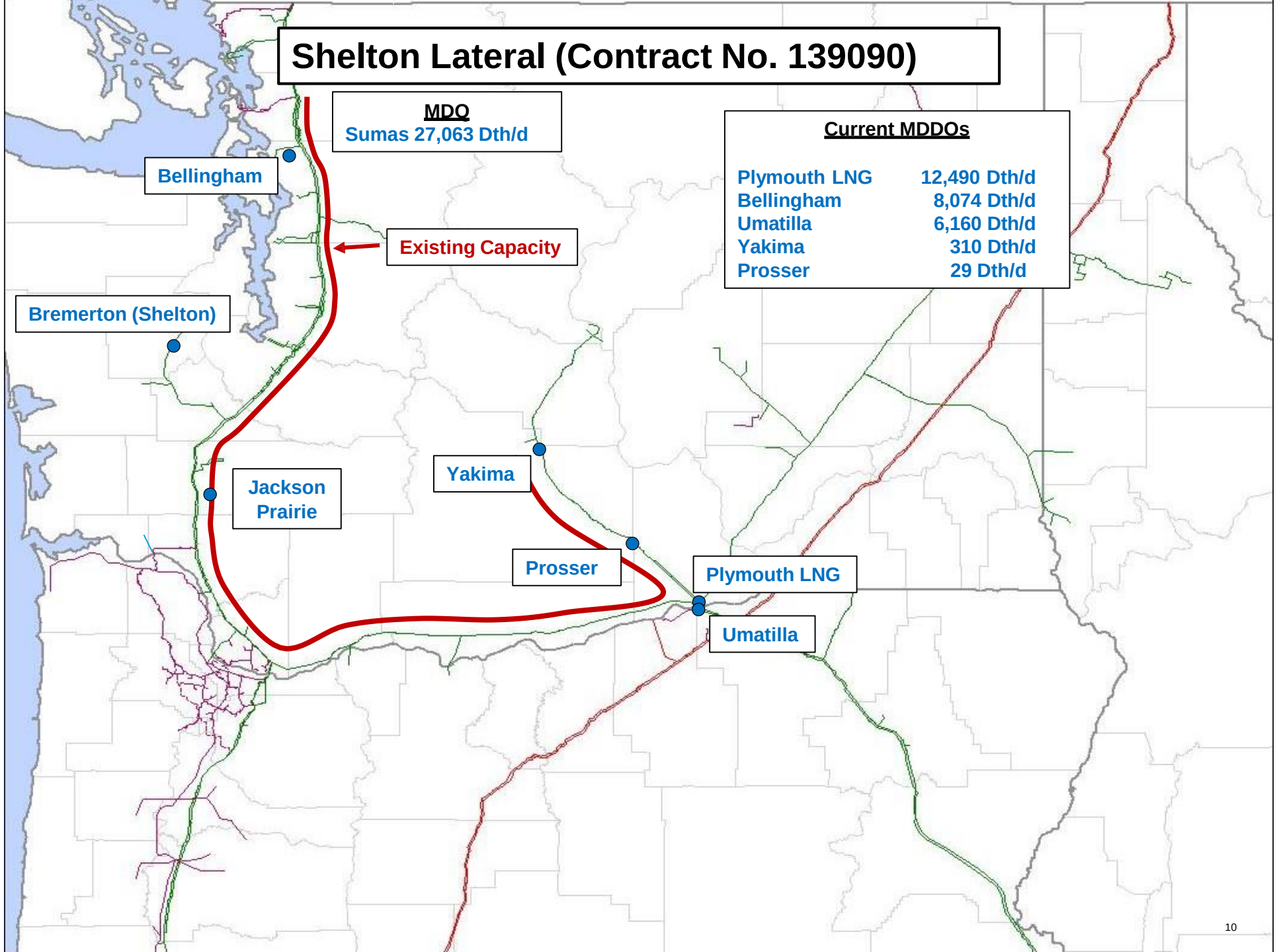
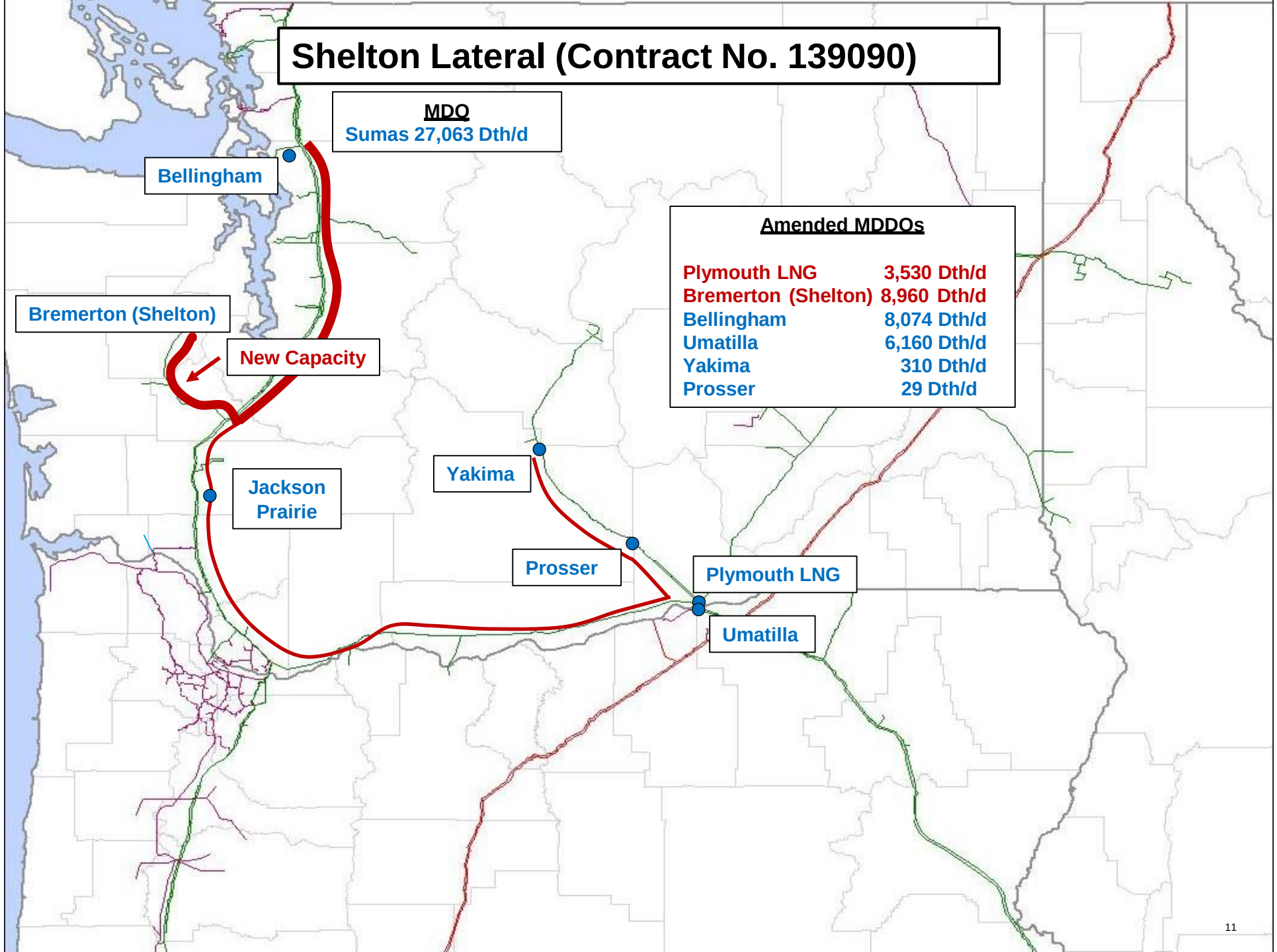
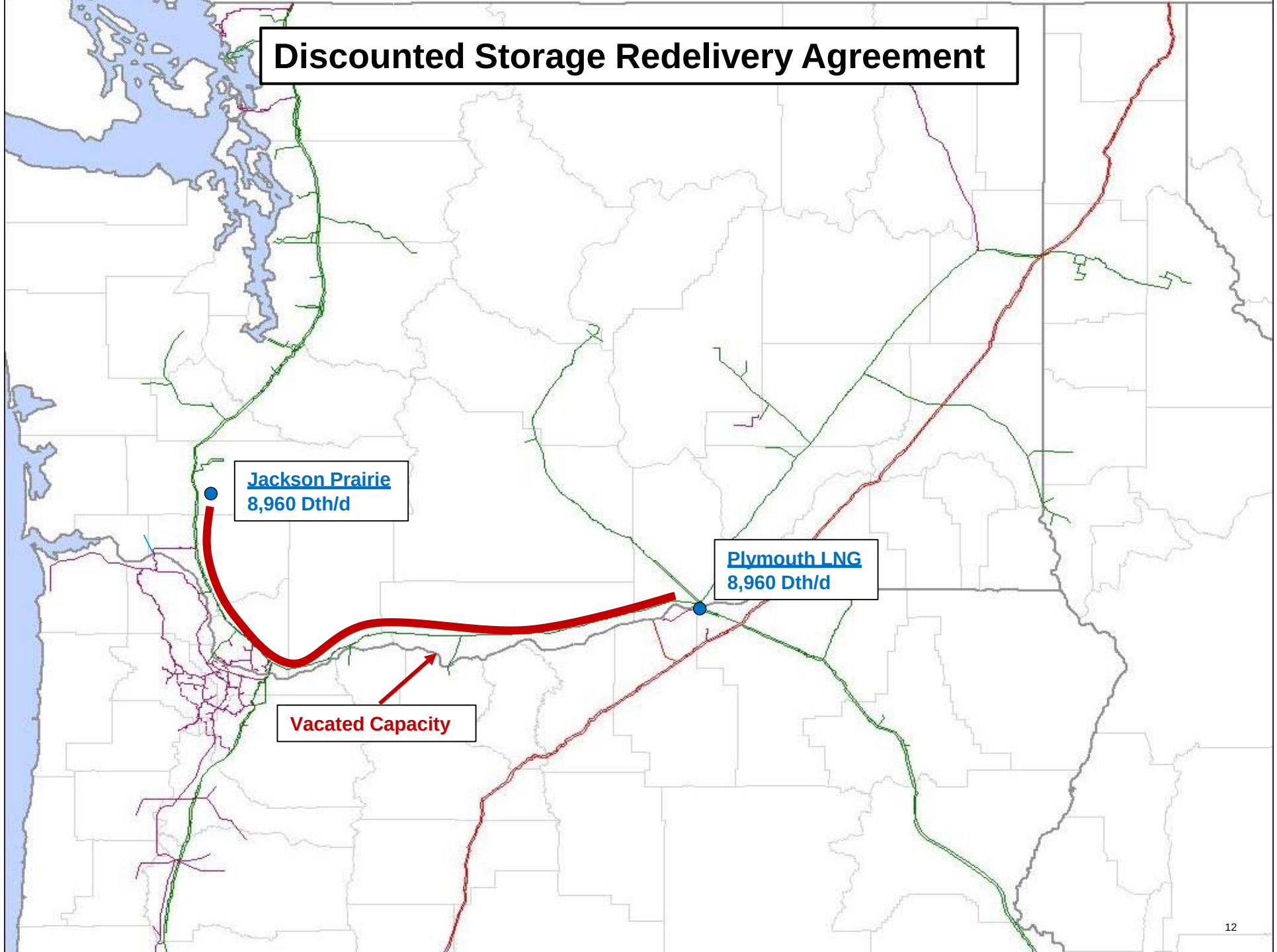

Shelton Lateral (Contract No. 139090)
MDQ
Sumas 27,063 Dth/d
Bellingham
Existing Capacity
Bremerton (Shelton)
Jackson Prairie
Yakima
Prosser
Plymouth LNG
Umatilla
Current MDDOs
Plymouth LNG 12,490 Dth/d
Bellingham 8,074 Dth/d
Umatilla 6,160 Dth/d
Yakima 310 Dth/d
Prosser 29 Dth/d


Shelton Lateral (Contract No. 139090)
MDQ
Sumas 27,063 Dth/d
Bellingham
Bremerton (Shelton)
New Capacity
Jackson Prairie
Yakima
Prosser
Plymouth LNG
Umatilla
Amended MDDOs
Plymouth LNG 3,530 Dth/d
Bremerton (Shelton) 8,960 Dth/d
Bellingham 8,074 Dth/d
Umatilla 6,160 Dth/d
Yakima 310 Dth/d
Prosser 29 Dth/d

Discounted Storage Redelivery Agreement



Discounted Storage Redelivery Agreement

- **By amending Cascade's Contract No. 139090 to the Shelton lateral, Cascade can acquire the vacated capacity from Jackson Prairie to Plymouth LNG through a discounted storage redelivery agreement**
  - Winter Rate – 100% of the maximum tariff rate from November – March of each year
  - Summer Rate – 0% of the maximum tariff rate from April – October
  - Primary Term End Date – October 31, 2034
- **The storage redelivery discount saves Cascade ~$750,000 annually compared to year-round max rate capacity**
- **Cascade has the option to lock in this discount capacity through October 31, 2052**
- **Cascade can utilize this capacity to provide the necessary mainline rights to serve a peak-day load on the Spokane and/or Wenatchee laterals**

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Spokane Lateral Realignment Option

- **Cascade could extend the Jackson Prairie storage redelivery capacity from Plymouth LNG up the Spokane lateral to Southridge through a hydraulic exchange**
  - The hydraulic exchange eliminates the need to install facilities on the Spokane lateral
- **The hydraulic exchange to accommodate an 8,960 Dth/d realignment from Plymouth LNG to Southridge requires 2,426 Dth/d be amended away from Moses Lake to Southridge on Contract No. 100002**
  - This hydraulic exchange creates an incremental 6,534 Dth/d of capacity on the Spokane lateral (8,960 Dth/d – 2,426 Dth/d) without having to install incremental facilities

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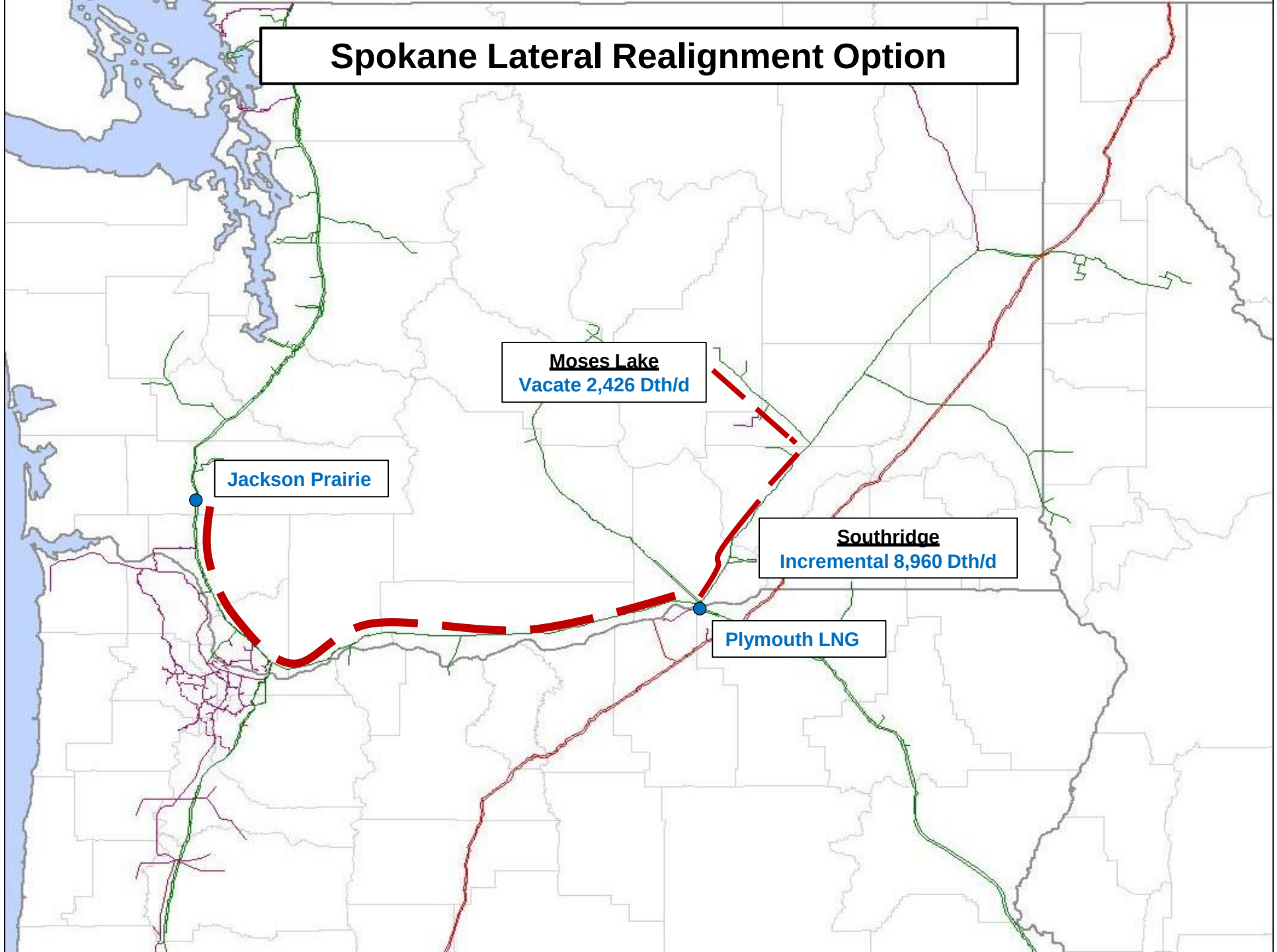
Spokane Lateral Realignment Option
Moses Lake
Vacate 2,426 Dth/d
Jackson Prairie
Southridge
Incremental 8,960 Dth/d
Plymouth LNG

Wenatchee Lateral Expansion Capacity

- **Alternatively, Cascade could extend a portion of the Jackson Prairie storage redelivery capacity from Plymouth LNG up the Wenatchee lateral to Yakima**
- **Pursuant to Cascade's 2012 IRP, Cascade has a capacity surplus to the end of the Wenatchee lateral and a capacity shortfall at Yakima**
- **By realigning the existing capacity on the lateral and utilizing the storage redelivery agreement to provide the mainline capacity, Northwest is able to drastically reduce the overall cost to expand this lateral, as illustrated below:**

Wenatchee Lateral Expansion

Capacity	Expansion Costs without Mainline Capacity and Realignments	Expansion Costs utilizing Storage Redelivery and Realignments /1	Cost Savings
6,000 Dth/d	56.3	29.3	27
4,000 Dth/d	43.6	17.8	25.8
2,000 Dth/d	27.5	13.9	13.6

/1 includes $.5 million attributable to the storage redelivery capacity.

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Contract Consolidations

- **In exchange for the ROFR on the Shelton lateral along with the discounted JP storage redelivery capacity, Cascade will consolidate the following contracts with Contract No. 140047 that has a primary term of October 31, 2034**

Contract No.	Contract Demand	Evergreen	Notification	Current End Date
132329	5,000	U	5 years	1/31/2023
100064	1,078	U	5 years	3/31/2023
135558	25,400	U	5 years	4/30/2023

- **Northwest has provided Cascade with an option to lock in the storage redelivery agreement through October 31, 2052, by consolidating these three agreements and Contract No. 140047 on Contract No. 139090 that has a primary term end date of October 31, 2052**

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Summary

- **Cascade's contracts and excess MDDOs provide the flexibility to serve new incremental markets with minimal physical facilities added to the system**
- **Realigning capacity from Plymouth LNG to the Shelton lateral provides Cascade a unique opportunity to:**
  - acquire vintage capacity at a significant cost savings (estimated ~$71,000 for facility modifications verses ~$20 million to expand the lateral)
  - acquire a ROFR associated with the lateral capacity
- **Utilizing Cascade's flexibility on Contract No. 100002 provides them the ability to serve a peak-day load on the Spokane and/or Wenatchee laterals through a discounted storage redelivery agreement**
  - acquire capacity on the Spokane lateral with no additional costs
  - acquire capacity on the Wenatchee lateral by minimizing the cost to expand the lateral compared to a stand-a-lone expansion option

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TransCanada Update

J. Story – Director, NW Distribution markets

Cascade Natural Gas IRP Meeting

July 12, 2018

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In business to deliver

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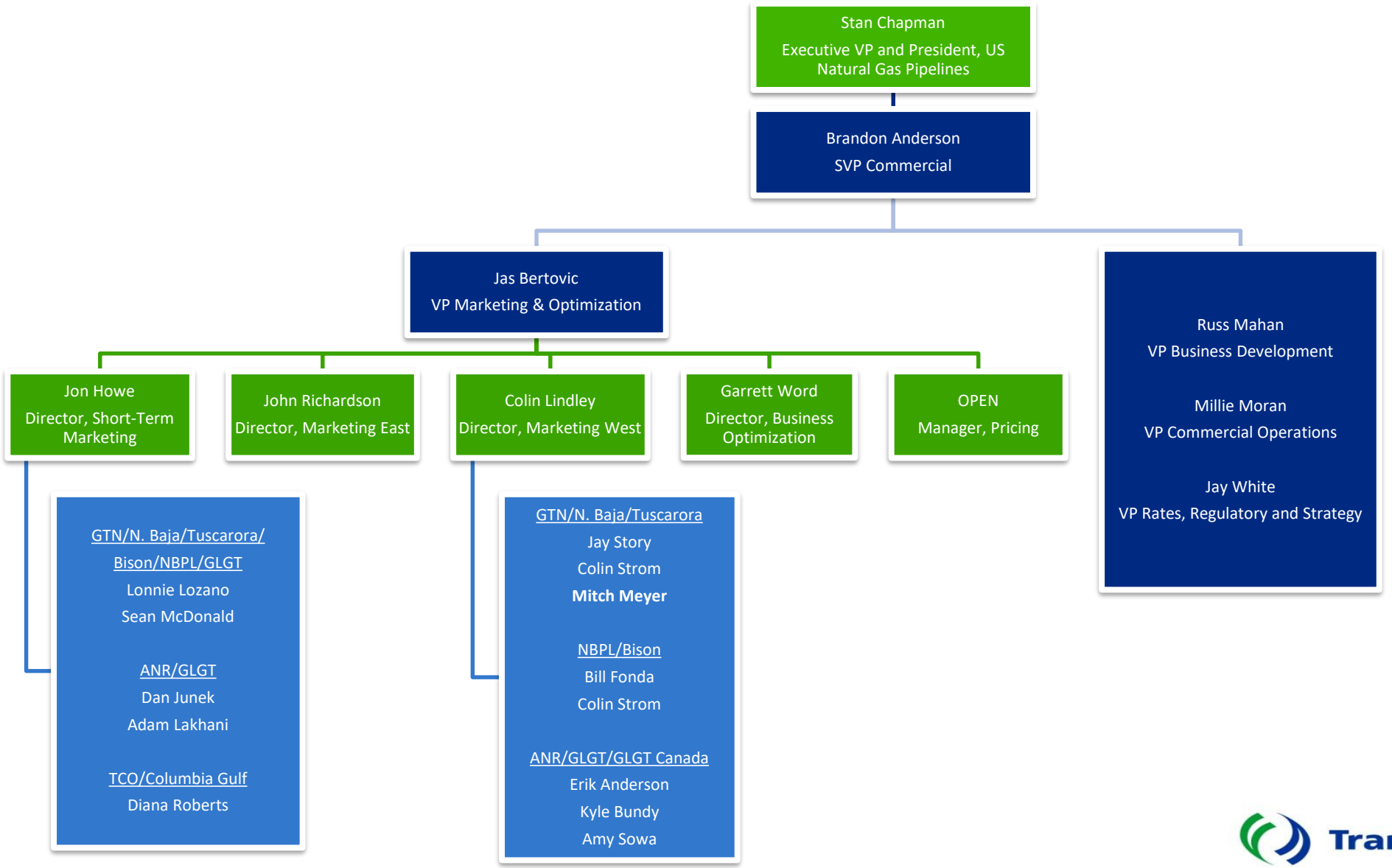
TransCanada U.S. Commercial Marketing & Optimization





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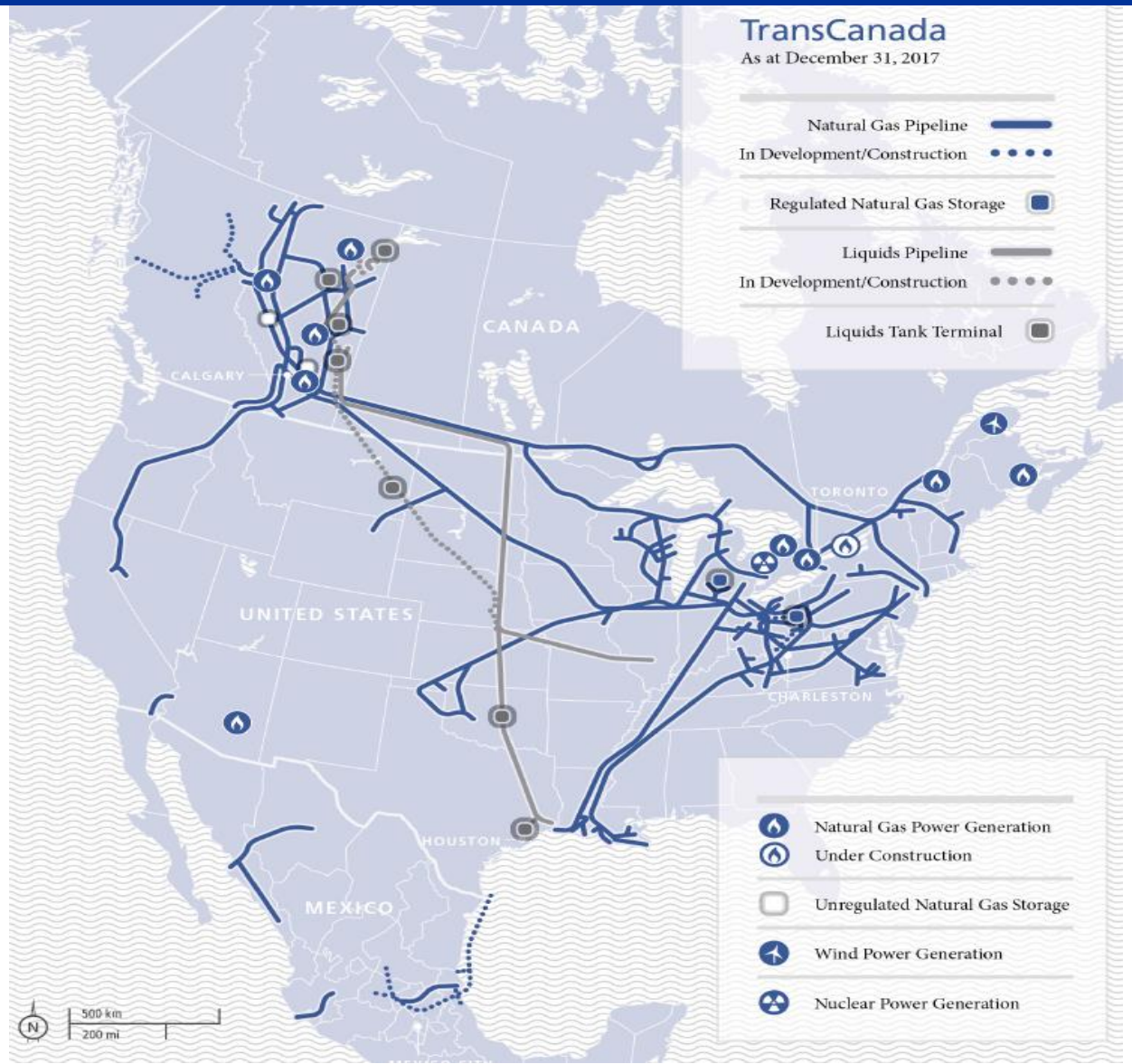

One of North America's Largest Natural Gas Pipeline Networks

- ~57,100 miles of pipeline
- ~653 Bcf of storage capacity
- ~23 Bcf/d or 25% of continental demand

Premier Liquids Pipeline System

- 3,000 miles of pipeline
- 555,000 b/d or 20% of Western Canadian exports

Large Private Sector Power Generator

- 11 power plants, 6,100 MW
- Primarily long-term contracted assets

Enterprise Value ~$100 billion*

*$CAD (2018)

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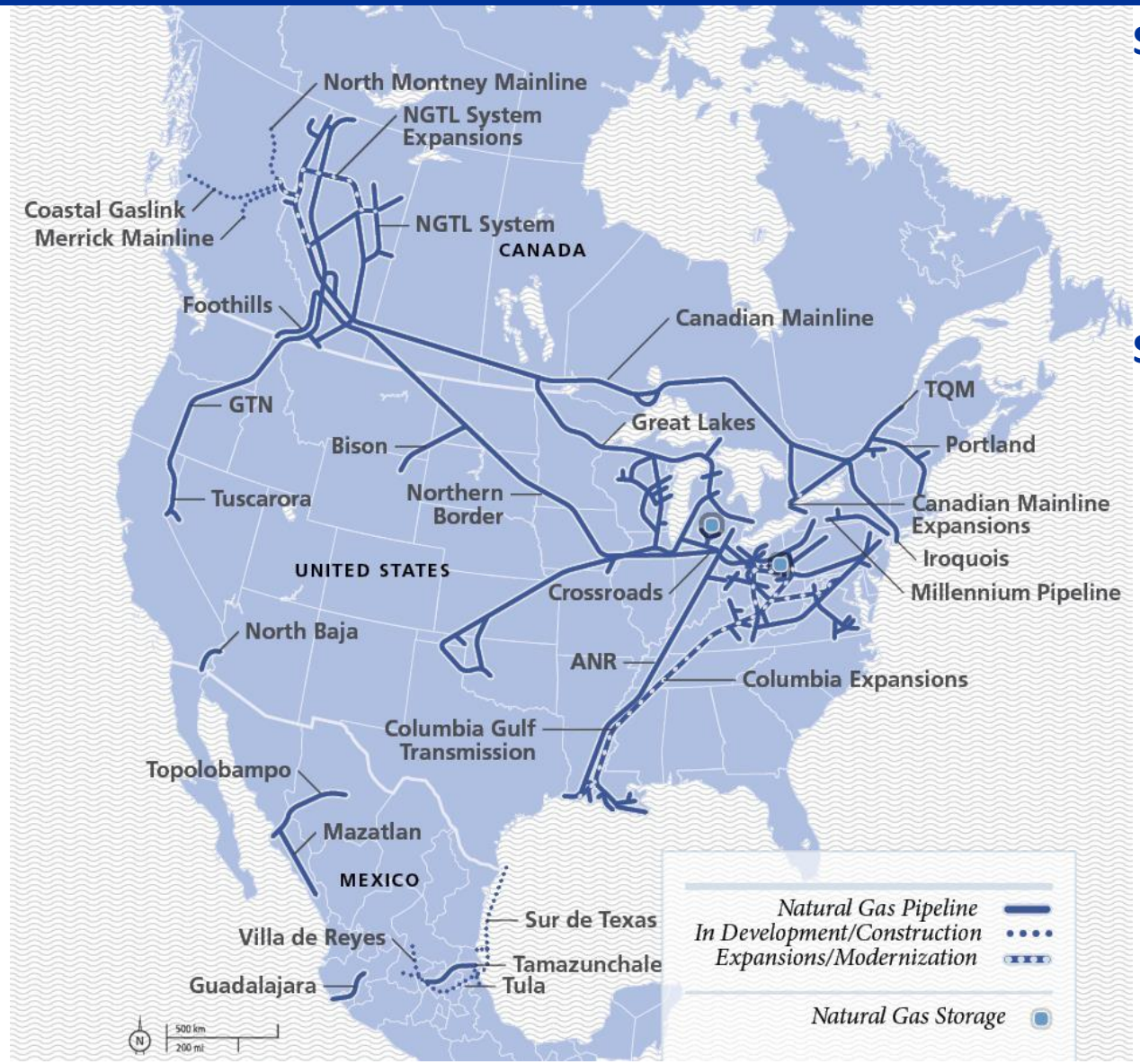
TransCanada's U.S. Pipeline Assets



Size and Scale

- ~31,000 miles of pipeline
- ~548 Bcf of storage capacity
- ~20% of all U.S. deliveries
- ~2,800 employees
- Assets across 37 states

Strategic Position

- Pre-eminent position in lowest cost supply basins
- Multiple access points to key trading and storage hubs in the Midwest
- Traditional LDC markets across U.S.
- LNG, power generation, and key interconnects
- Iroquois & PNGTS provide strategic connectivity in northeast
- ~40% of TransCanada EBITA from U.S. Gas by 2019

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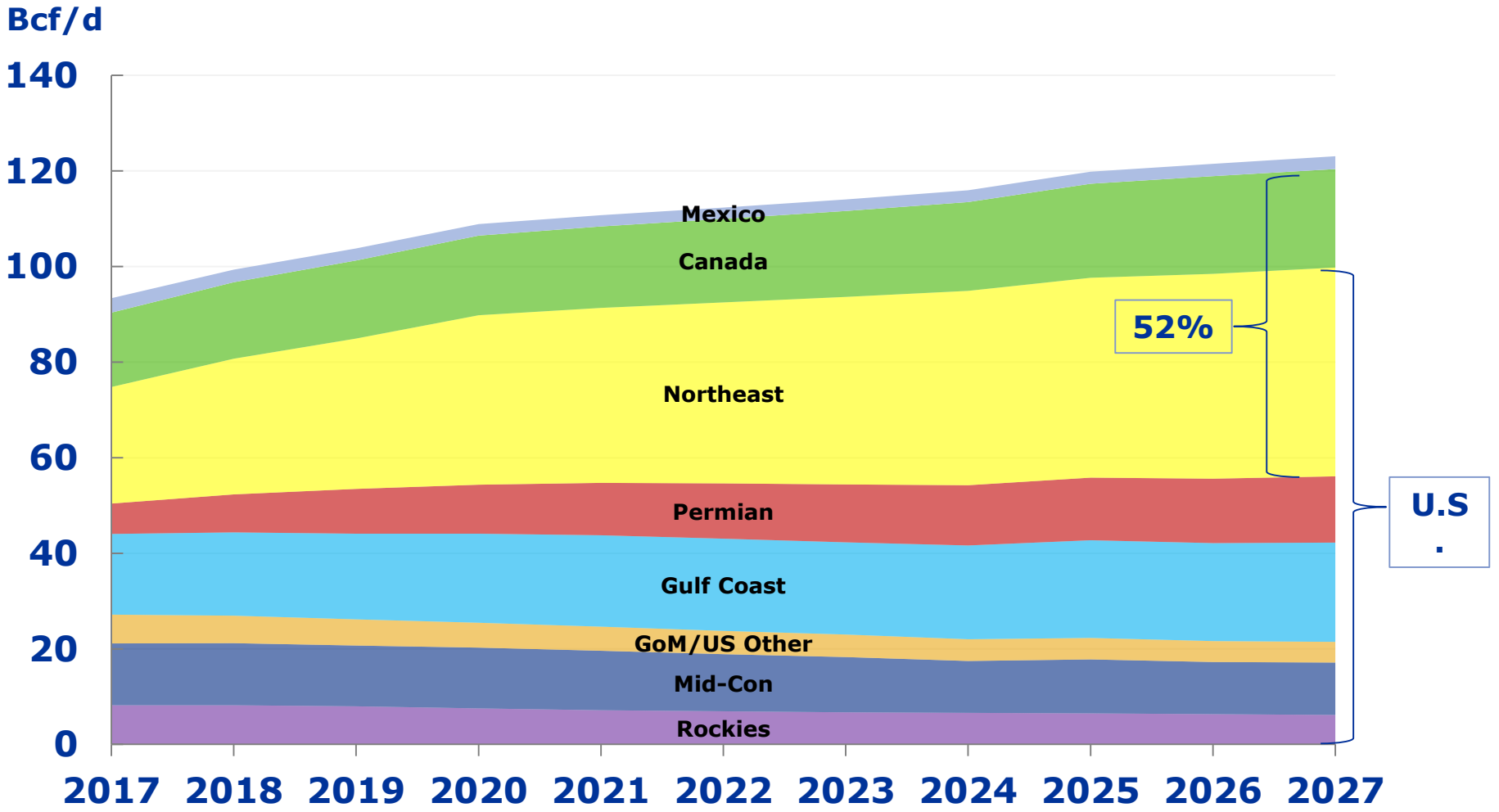
North American Supply



Appalachia and Canada will account for 52% of production by 2027

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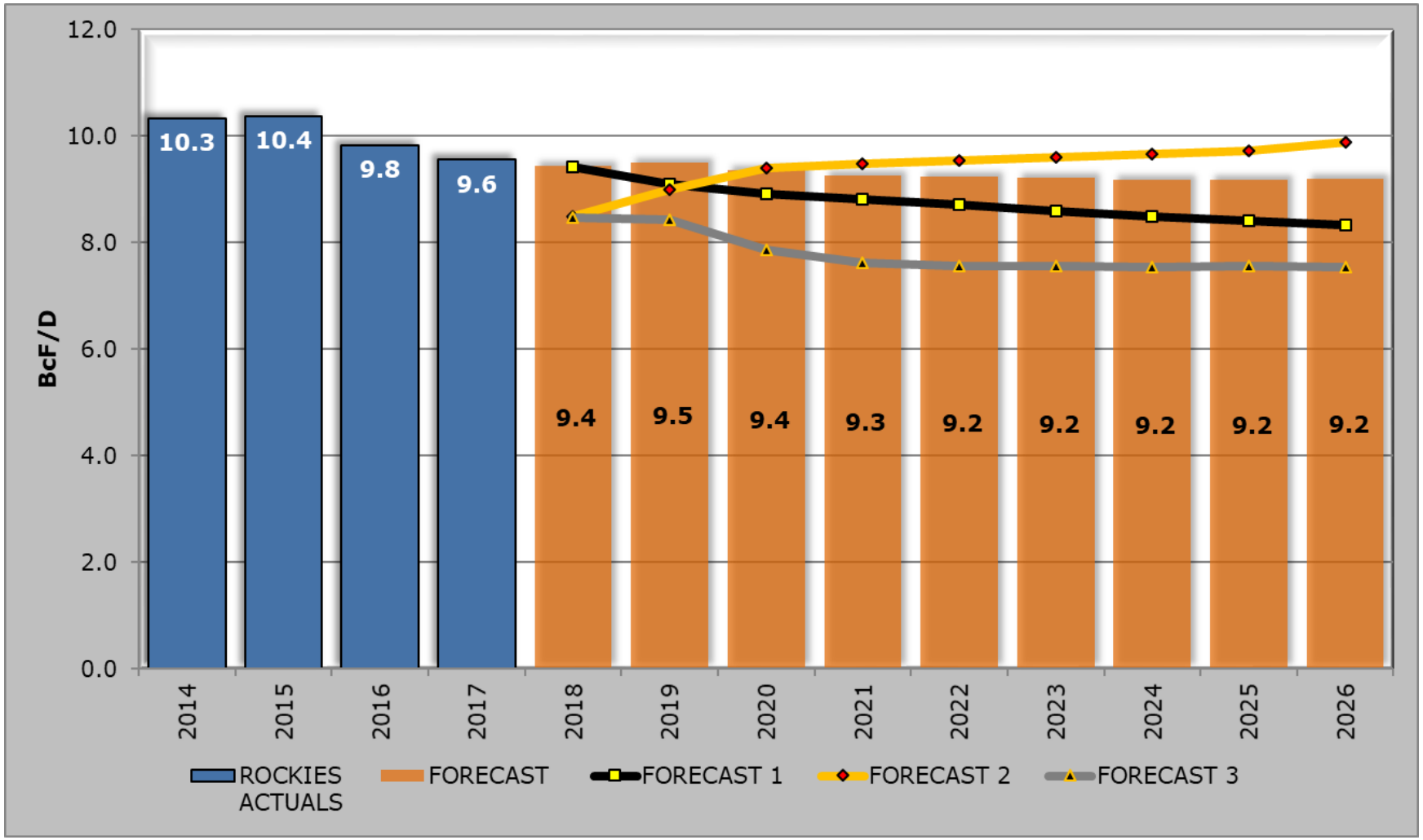
Rockies Production (Bcf/d)



***Source*: Point Logic Energy and Outside Consultants**

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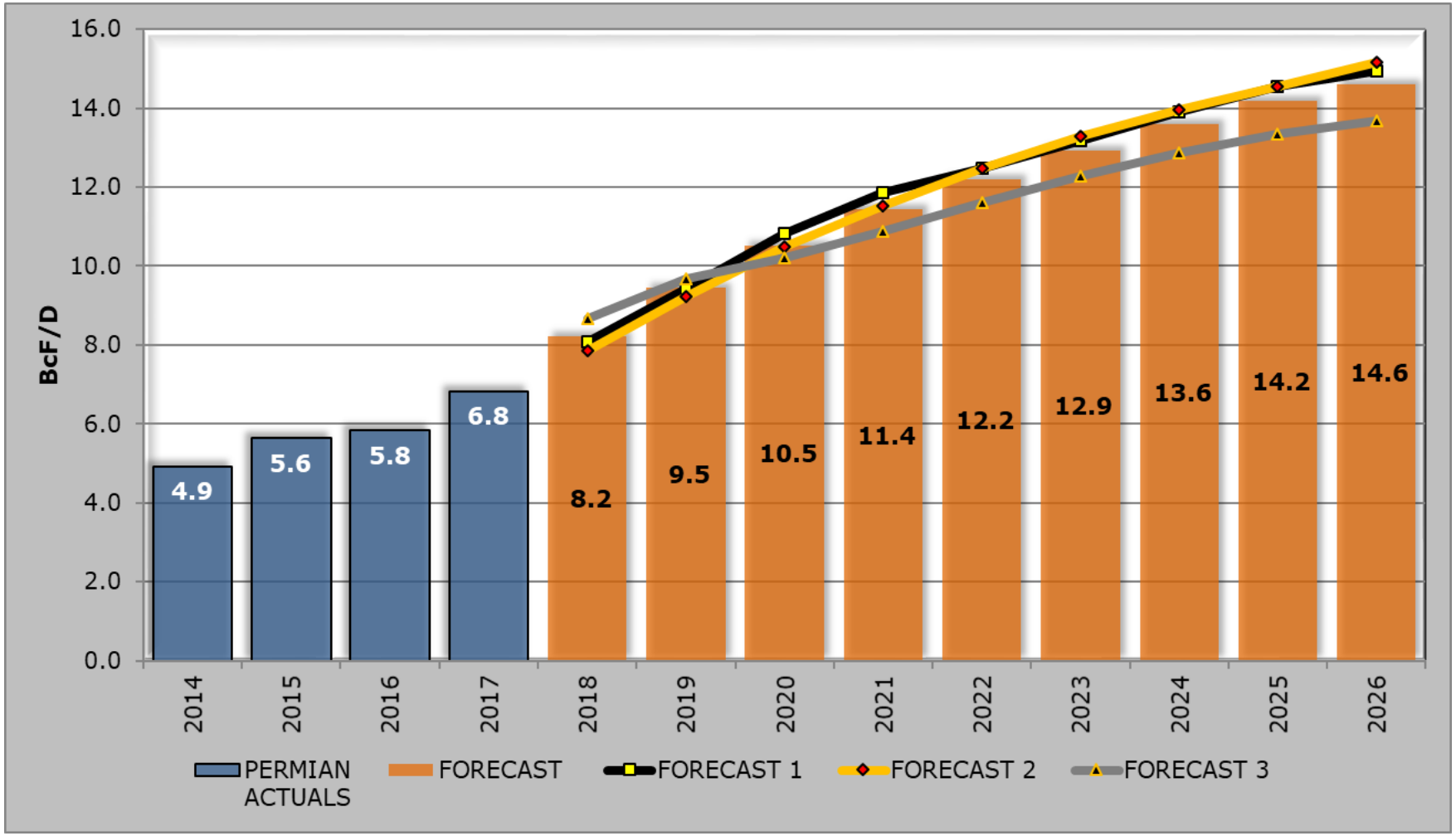
Permian Production (Bcf/d)



***Source*: Point Logic Energy and Outside Consultants**

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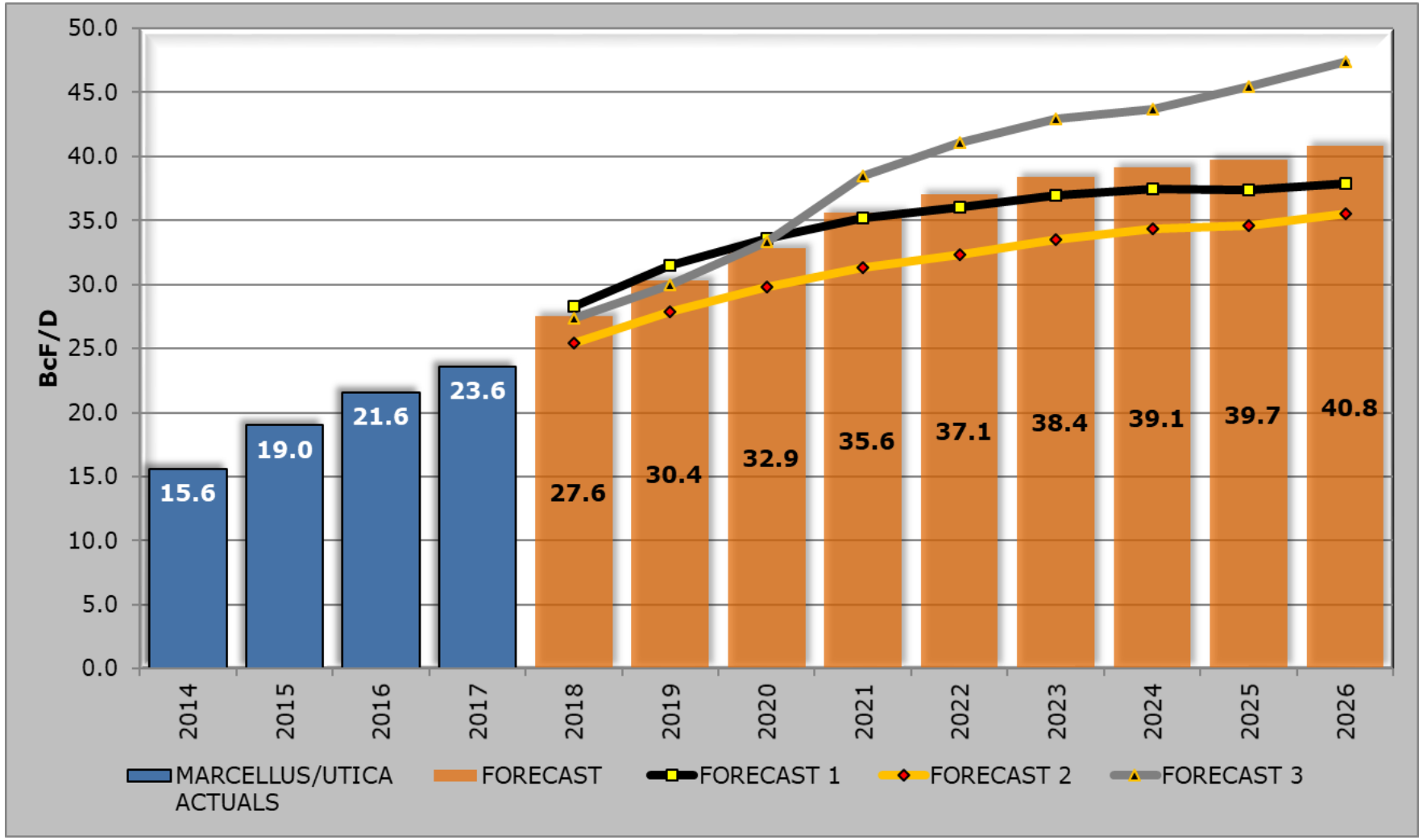
Marcellus & Utica Production (Bcf/d)



***Source*: Point Logic Energy and Outside Consultants**

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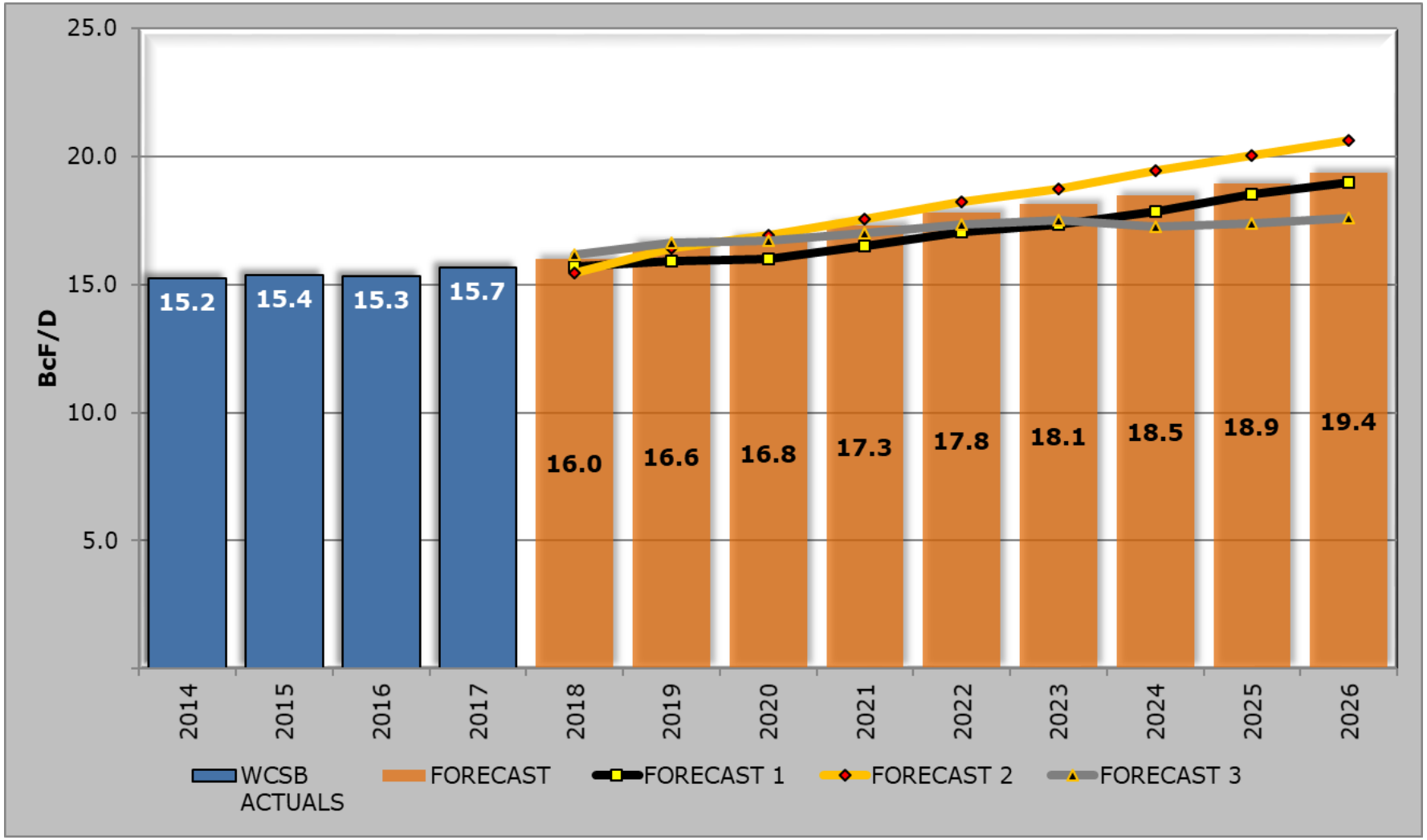
Western Canadian Production (Bcf/d)



***Source*: Point Logic Energy and Outside Consultants**

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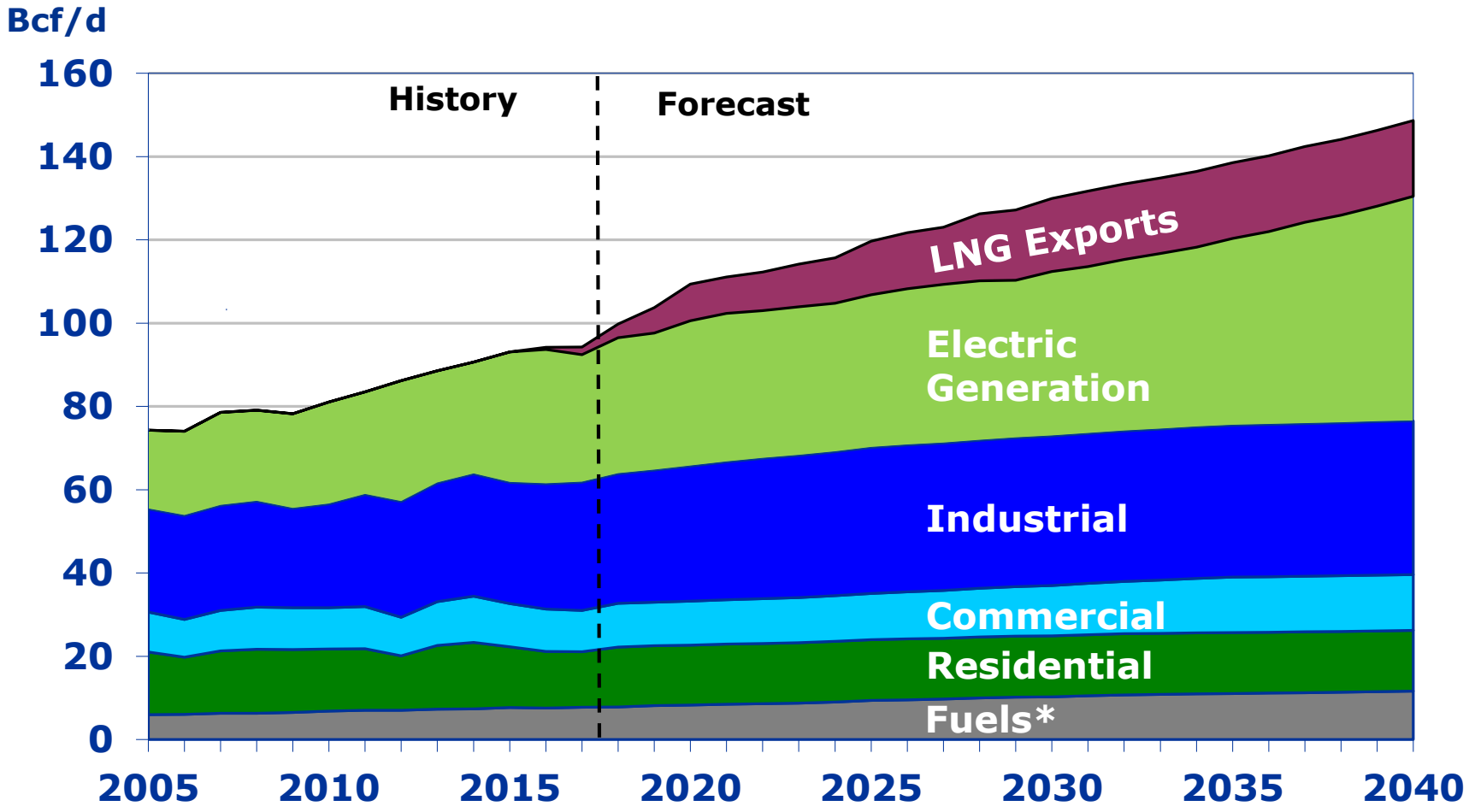
North American Natural Demand



Source: TransCanada
* Includes Lease, Plant, Pipeline & LNG Facility Fuels

29 Bcf/d of Demand Growth Over the Next Decade Driven by LNG Exports, Gas-fired Power Generation and Industrial Demand

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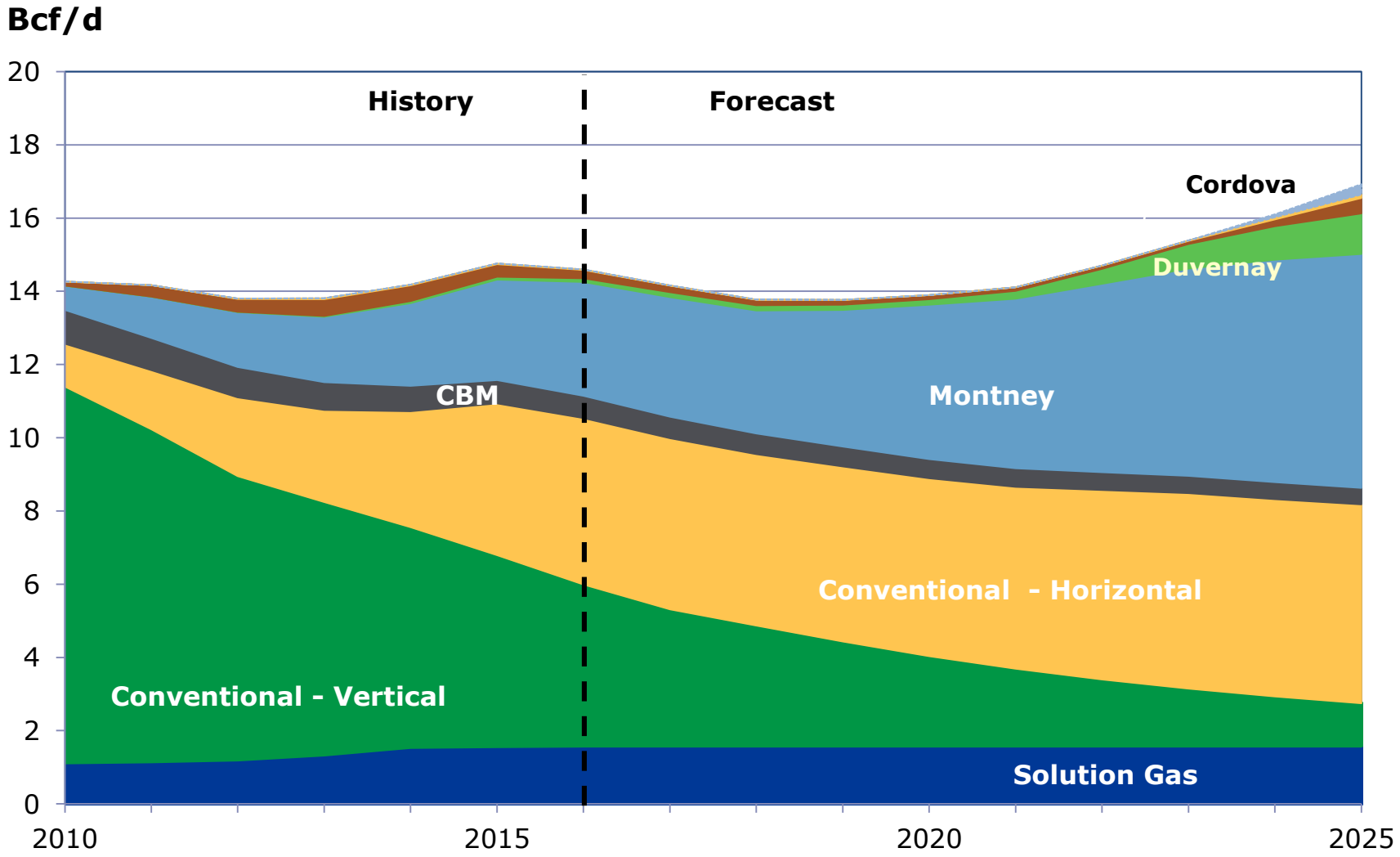
Western Canadian Sedimentary Basin Gas Supply



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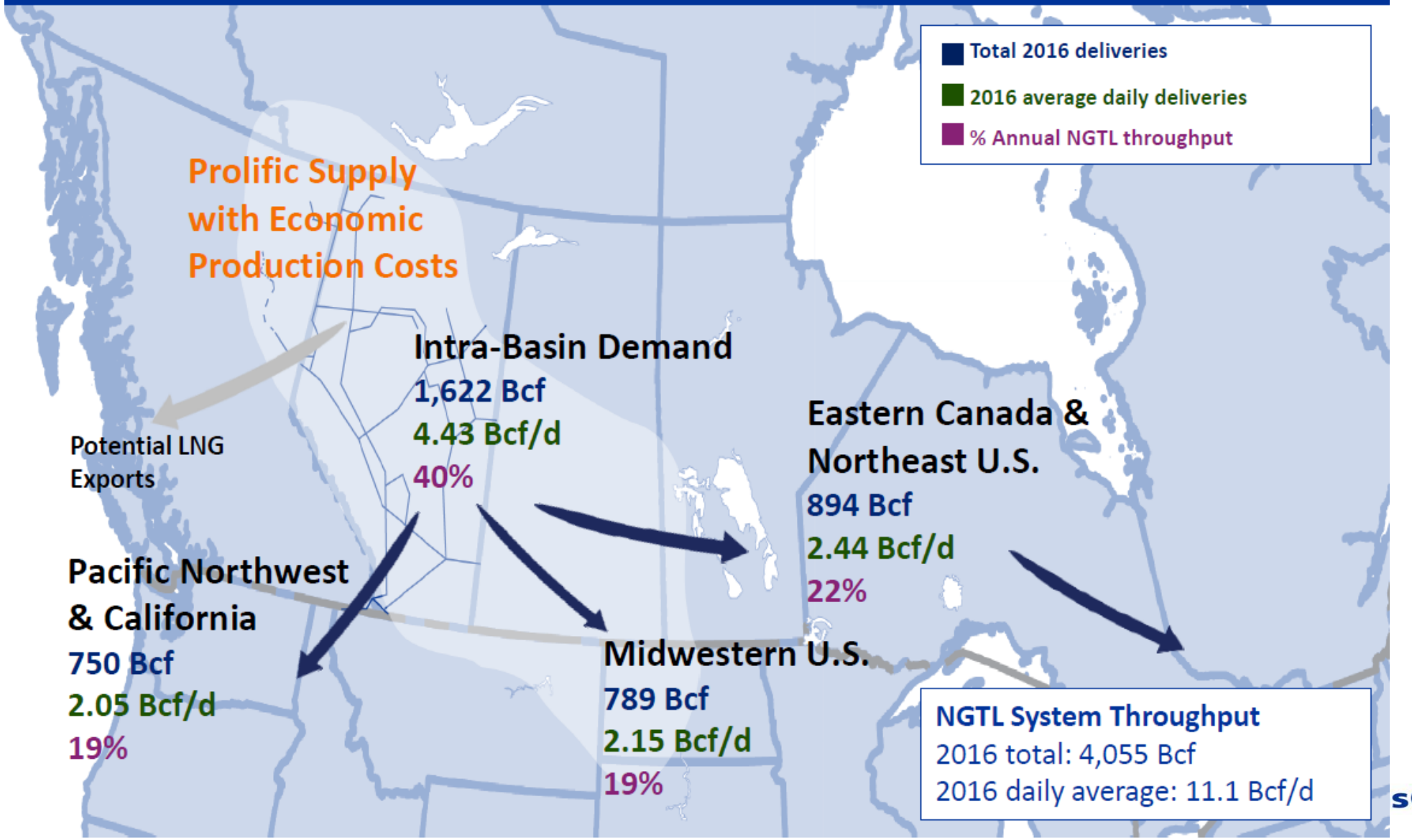
WCSB Production Seeking Markets



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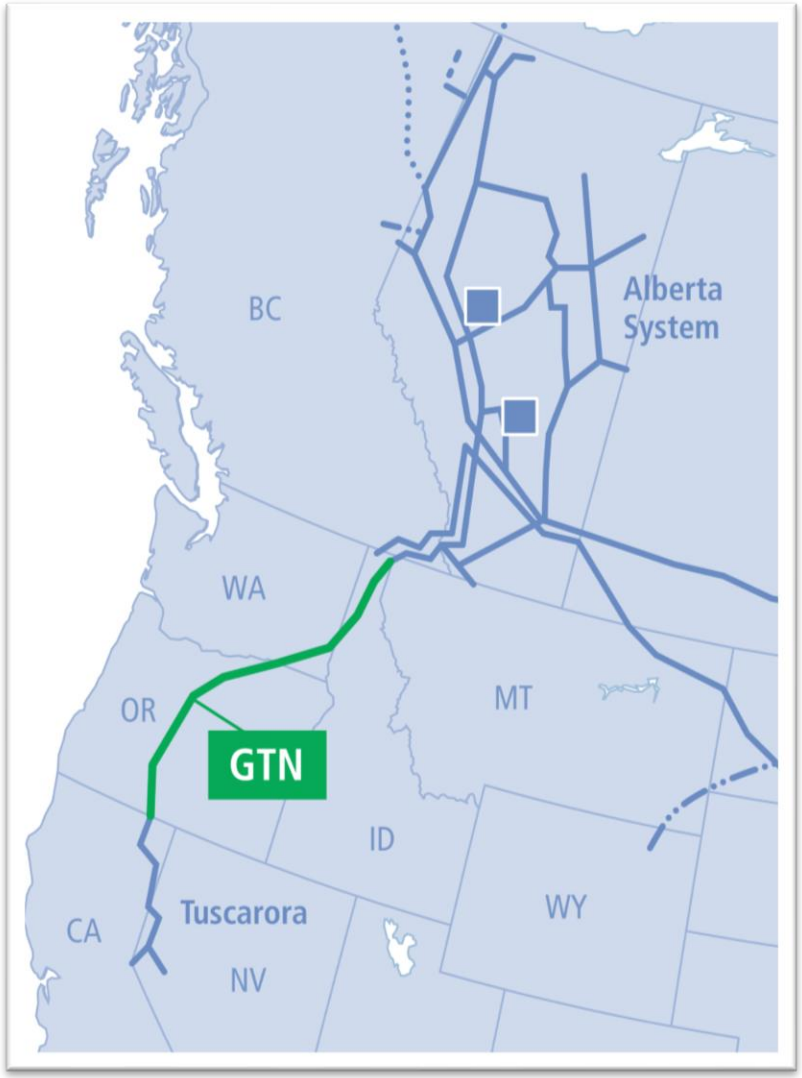
GTN Overview



- **Positioned to serve markets throughout California, Nevada, and the Pacific Northwest**
- **Consists of 1,350 miles of pipeline**
- **Long-term contracts extending out as far as 2039**
- **Volume throughput continues to be strong and should continue to grow**
- **NGTL continues to address the export capability at ABC to bring capacities into alignment**

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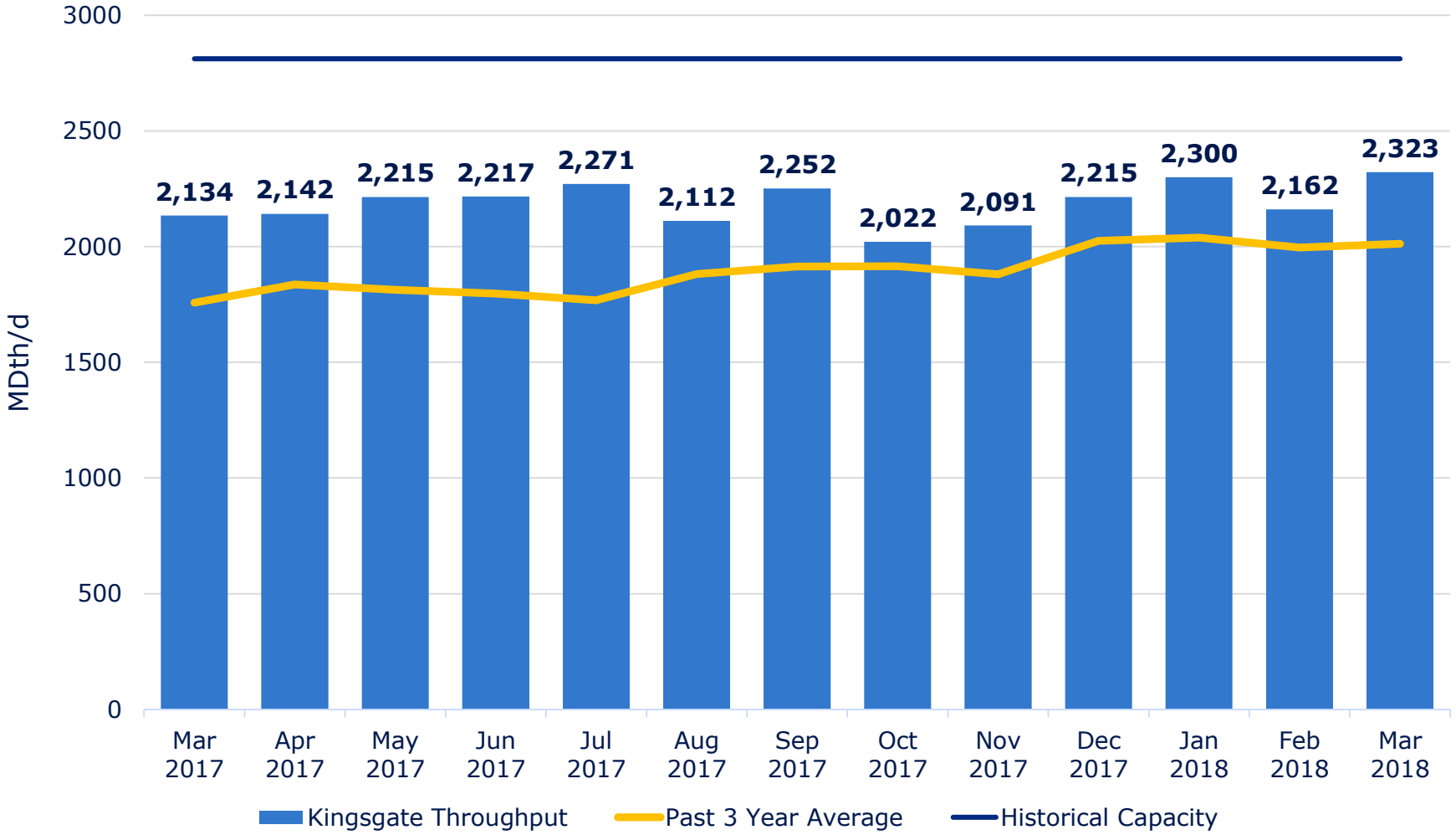
GTN System Throughput



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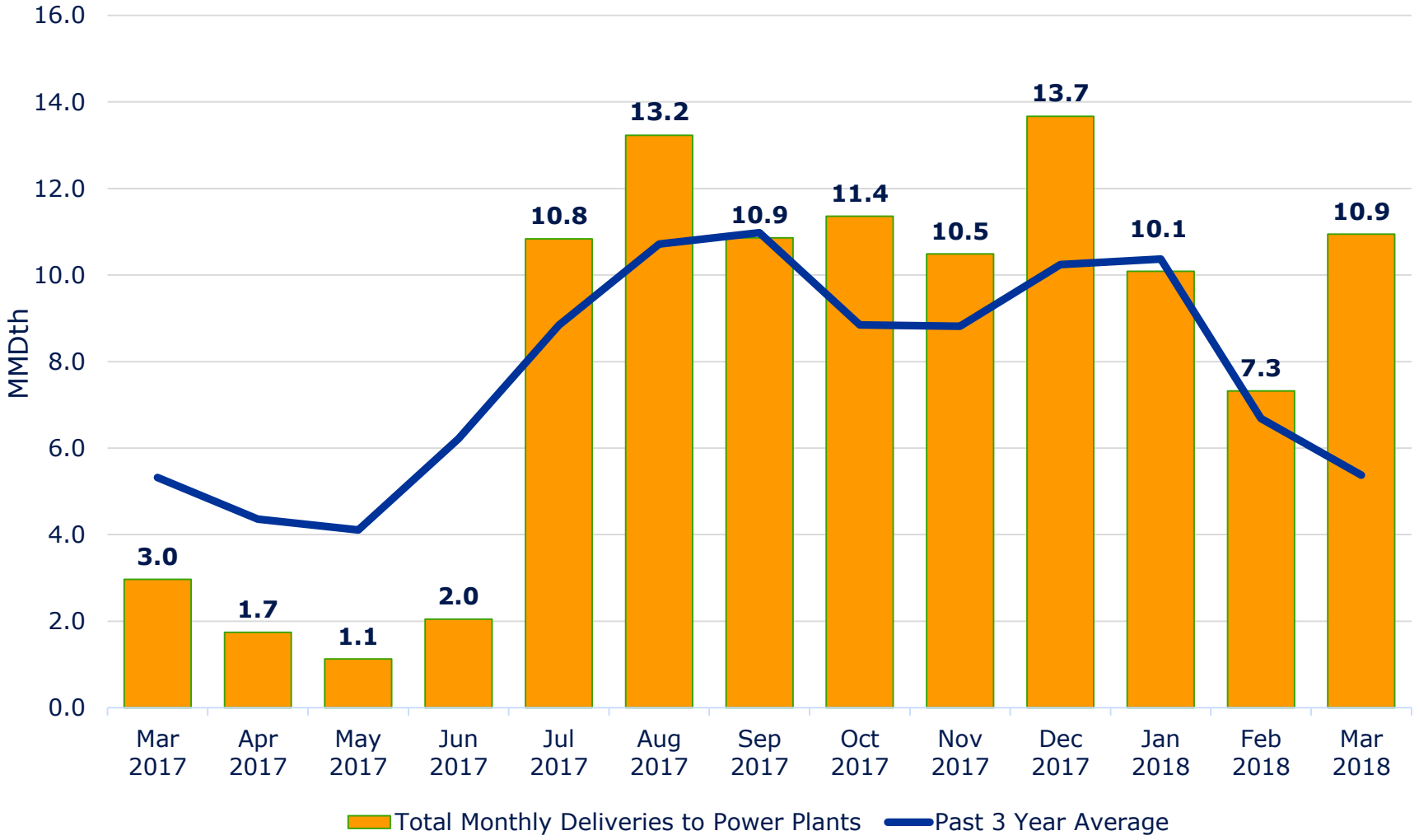
GTN Monthly Power Loads



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GTN
Potential Demand Projections



- **Northwest Innovation Works (NWIW)**
  - Developing a 10,000 metric tonne per day methanol plant in Kalama, WA
  - Other Pacific Northwest sites identified and under control of NWIW
  - In final phase of permitting at Kalama site
    - All state permits in hand, but pending Supplemental Environmental Impact Statement
    - Primarily focused on a life cycle analysis of greenhouse gas impacts
    - Expected completion of Supplemental EIS is September 2018
    - FID expected first half of 2019
    - COD mid to late 2022
- **Jordan Cove & Pacific Connector**
  - Developer has commercial agreements with Jera Co. Inc. (1.5+ mtpa) and Itochu Corp. (1.5 mtpa)
  - Submitted FERC 7c application September 21, 2017
  - 1 Bcf/d facility with final investment decision in the first half of 2019
  - Target in-service date is late 2022 for the pipeline and the end of 2023 for the LNG terminal
- **Trail West Pipeline**
  - Cross Cascades link to serve growing power/industrial demand along the I-5 corridor
  - Expansion up to approximately 750,000 Dth/d
  - Expected in service date of 2023

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NGTL West Path Expansion Summary

- **James River By-Pass**

  ISD - June 2016

  - 150,000 Gj/d
  - A/BC Border Capability – 2.2 Bcf/d
- **Sundre Crossover**
  - ISD - April 2018
    - 245,000 Gj/d
    - A/BC Border Capability – 2.43 Bcf/d
- **Winchell Unite Addition**
  - ISD – November 2019
    - 120,000 Gj/d
    - Estimated A/BC Border Capability – 2.54 Bcf/d
- **West Path Expansion**
  - ISD – June 2020
    - 288,000 Gj/d
    - Estimated A/BC Border Capability – 2.81 Bcf/d

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Impact on Kingsgate Supply

- **Total Available at Kingsgate May Vary Depending upon Foothills Markets and Fuel Usage**

- **Daily Kingsgate Supply Available estimated:**
  - Early 2018 2.33 Bcf/d*
  - November 2019 2.44 Bcf/d*
  - June 2020 2.71 Bcf/d*

*(estimates approx. 100,000dth/d scheduled on FTBC system)

- **Current GTN Kingsgate Receipt Capability:**
  - Best Efforts – 2.81 Bcf/d
  - Capability impacted by seasonal ambient temps and physical flow path

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Impact of Kingsgate Supply on GTN

- **Recent GTN Open Seasons to Contract Available Capacity**
  - Open Seasons Process Ran– December 2017 thru January 2018

- **Pre-arranged – Kingsgate to Malin Path**
  - 8 "Packages" totaling approx. 348,610 Dth/d
  - Contract Start Dates of Nov. 2019 and Nov. 2020
  - All contracted long-term
  - All Capacity Awarded to Pre-arranged Entities

- **Available Capacity Open Season – Kingsgate to Malin Path**
  - Total of 139,400 dth/d
  - Effective Date(s) – Any Date April 1, 2018 or Later
  - Unlimited Term
  - **All Offered Capacity Awarded and Contracted Long-term**
    - **Kingsgate to Malin 100% Contracted – January 1, 2021**

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Impact of Kingsgate Supply on GTN

- **Remaining GTN Kingsgate Sourced Available Capacity**
  - **Analyzing Shorter Path Capacity Availability**
    - Kingsgate to Points North of Stanfield
- **Availability of Non-Kingsgate Sourced Supply**
  - **Turquoise Flats to Stanfield**
    - 98,430 Dth/d Primary Firm Capacity
  - **Malin Sourced Displacement Capacity**
    - Availability Based Upon Daily North to South Transport

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Impact of Kingsgate Supply on GTN

- **Considerable Interest in Additional Kingsgate Sourced GTN Capacity**

  - **GTN Exploring Expansion Options**
    - Mainline – Compression Only and Compression plus Pipe Options
    - "Market Pull" Required
    - New Pipelines or Laterals – Trail West

  - **ROFR Open Season Process**
    - Contract Renewals
      - Term Extensions
      - Focus on Evergreen Provisions
      - Possible Open Seasons
    - 2023 Contract Cliff
      - Approx. 1 Bcf/d of Contract Expirations

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GTN Rates and Regulatory

- **GTN Rate Case Update**

  - **Uncontested Settlement Filed April 2015**
  - **Rates Lowered by 12.4% from Pre-settlement Rates**

  - **Further 8.1% Rate Reduction Effective 1/1/2020 thru 12/31/2021**
    - Kingsgate to Malin - $0.285/Dth/d
    - Kingsgate to Stanfield - $0.146 Dth/d
    - Kingsgate to Spokane - $0.076 Dth/d

  - **"Come Back" Provision Requires New Rates Effective 1/1/2022**

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GTN Rates and Regulatory

- **March 15, 2018 FERC Orders**
  - **Docket No. PL17-1**
    - Revised policy statement on treatment of Income taxes
      - MLPs can no longer recover an income tax allowance in cost-of-service rates
  - **Docket No. RM18-11**
    - Rate changes relating to Federal Income Tax Rate
    - Process to allow FERC to evaluate pipeline rates in light of Income Tax Rate Reduction
  - **Docket No. RM18-12**
    - Notice of Inquiry (NOI) regarding the effect of Tax Cuts and Jobs Act on Rates
    - FERC seeking comment on how to address changes relating to:
      - Accumulated Deferred Income Taxes
      - Bonus Depreciation

TransCanada

GTN Rates and Regulatory

- **GTN Considerations:**
  - **Recognizes the need to adjust rates to reflect lower federal income tax rate**
  - **GTN currently working through analysis and challenges due to current lack of clarity from FERC**
  - **GTN anticipates FERC producing a NOPR by the end of July – 2018**

TransCanada

Questions?

TransCanada
In business to deliver

Agenda

- Introductions
- NWP/GTN Presentations
- Demand and Customer Forecast
- Non-Core Outlook
- Drilling down into segments of demand forecast
- Distribution System Planning
- Current Supply Resources and Transport Issues
- Planned Scenarios and Sensitivities
- Alternative Resources
- Price Forecast
- Avoided Costs
- 2018 IRP Remaining Schedule

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NWP/GTN Presentations

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Demand Forecast

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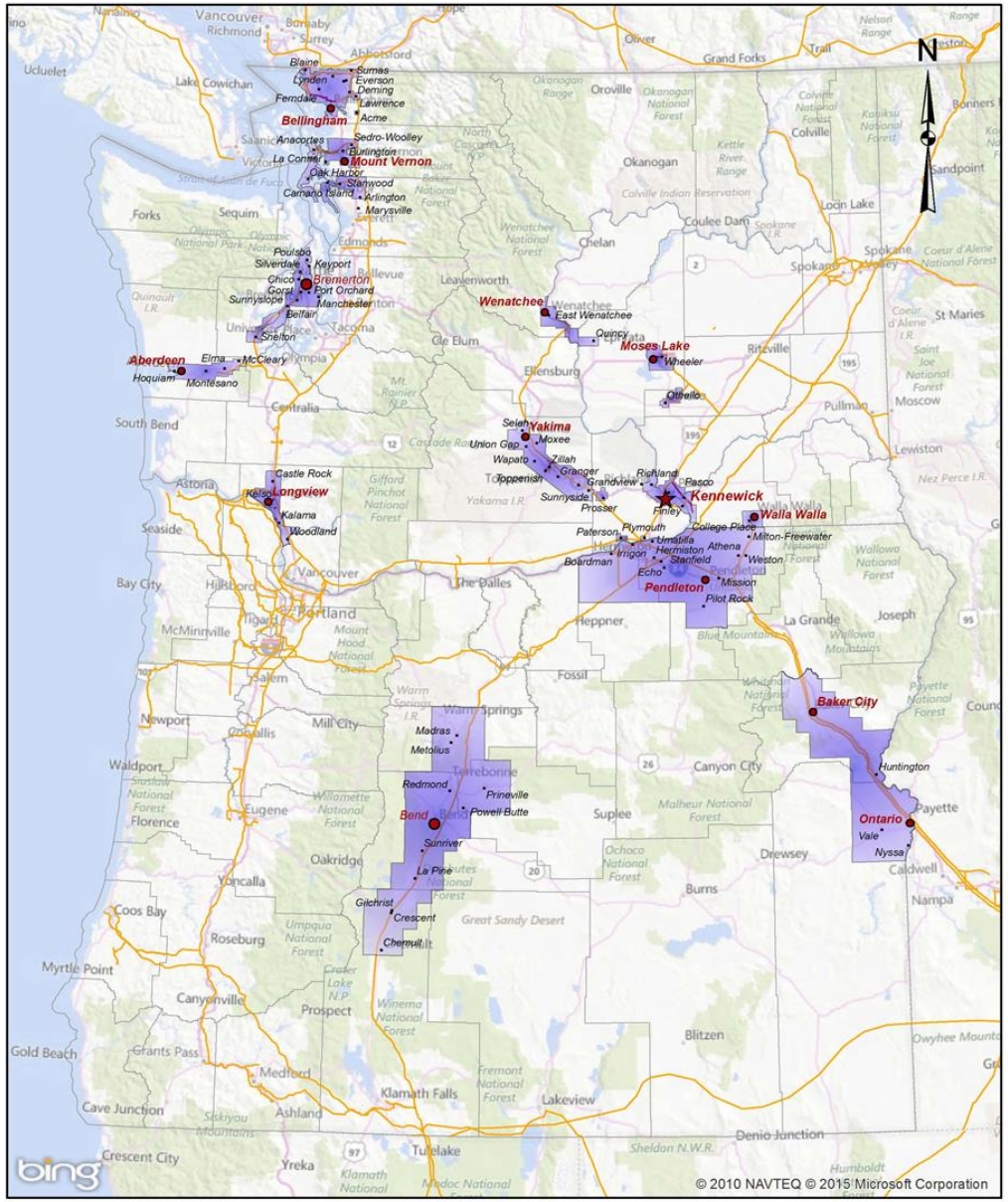

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Service Boundaries

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

Demand Forecast

- 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.
- Forecast demand at the citygate and citygate loop level.
- Forecast demand at the rate schedule level.

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Key Definitions

- AIC: The Akaike information criterion (AIC)
  - A measure of the relative quality of statistical models for a given set of data. Given a collection of models for the data, AIC estimates the quality of each model, relative to each of the other models. Hence, AIC provides a means for model selection.
- ARIMA: Auto-Regressive Integrated Moving Average
  - Type of model that is fitted to time series data.
  - When doing regressions using time series variables, it is common for the errors (or residuals) to have a time series structure. This could mean there is a predictable structure to the errors, meaning they can also be modeled. This is where the ARIMA term comes in.
- Define weather in terms of HDDs (Heating Degree Day)
- Citygate loops are a group of citygates that service a similar area that are forecasted together due to pipeline operations.

Key Assumptions

- Seven weather locations effectively cover Cascade's service territory.
- This forecast uses 30 years of recent weather history as the "normal" temperatures.
- Heating demand does not appreciatively start until average temps dip below 60° F, therefore a 60° F threshold is used.

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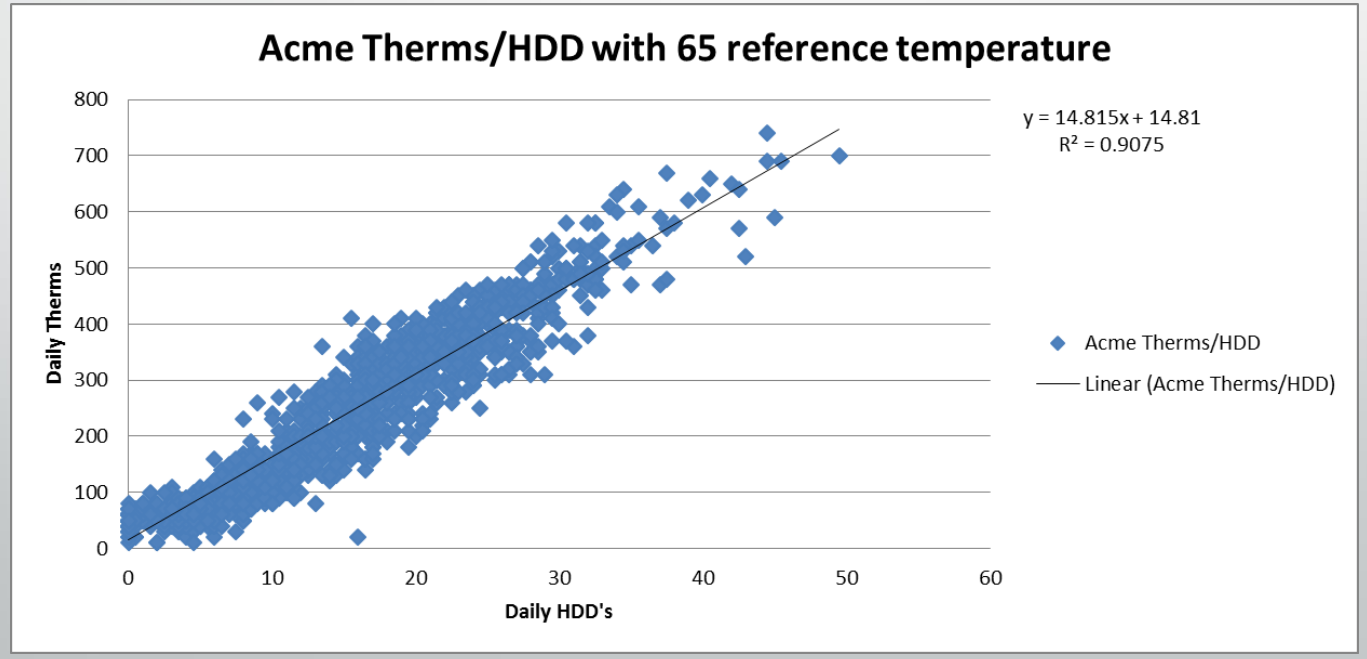
65 vs 60 HDD Threshold

- 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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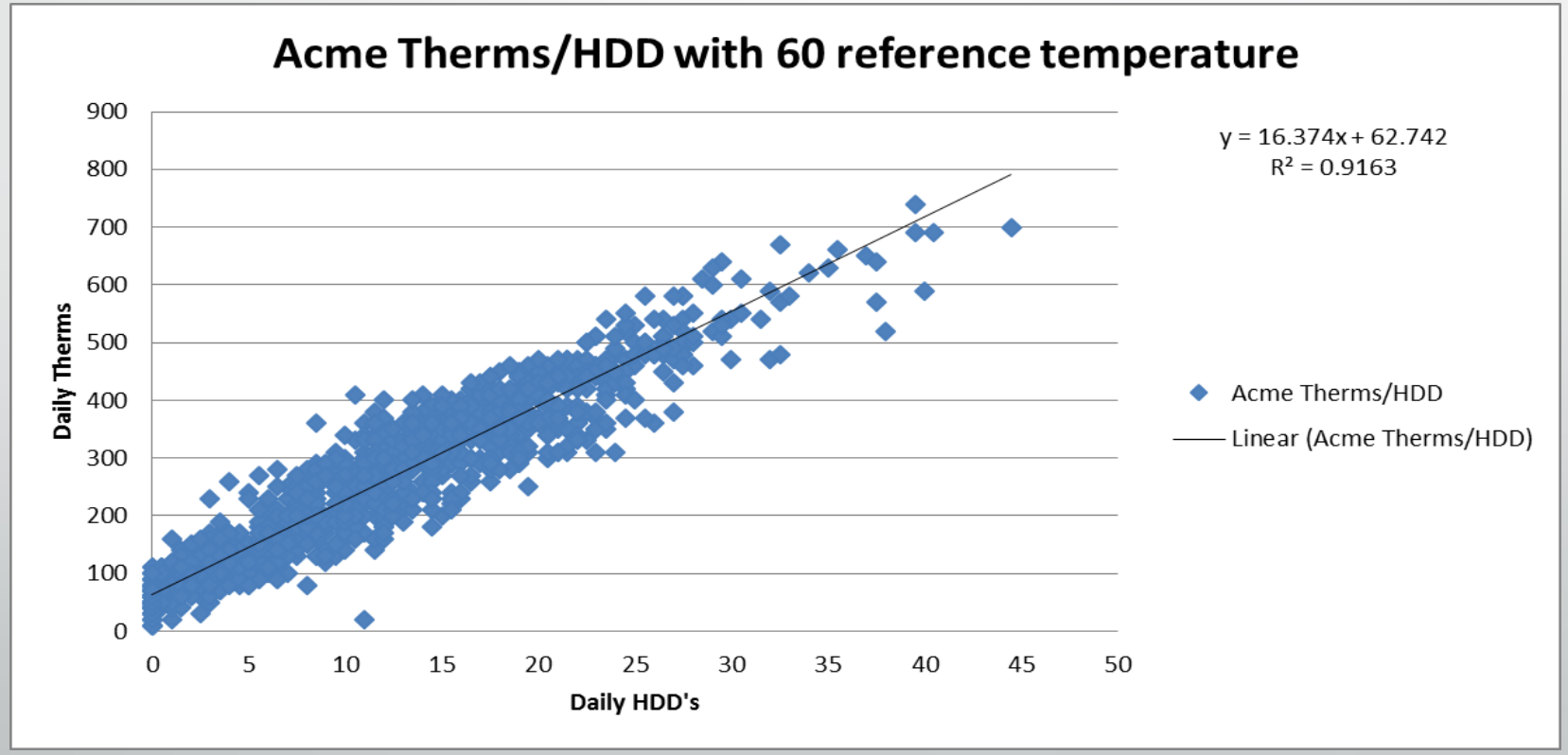
Acme Therms/HDD with 60 degree reference temperature



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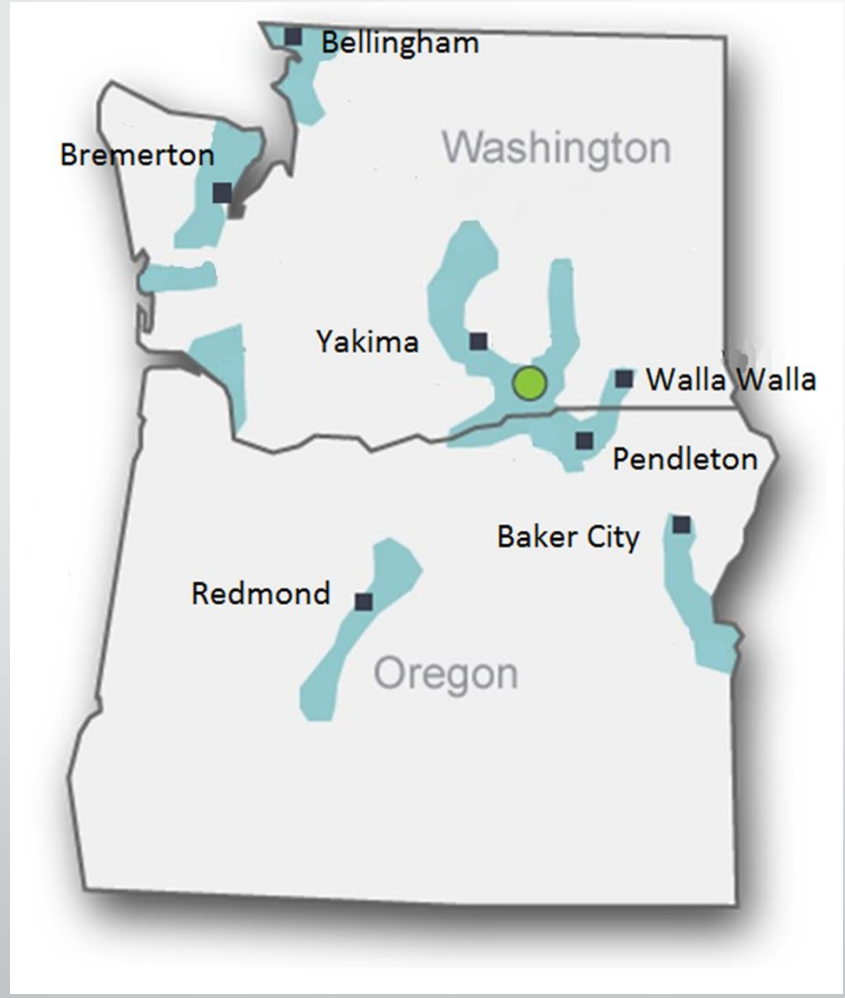
Weather Stations



- 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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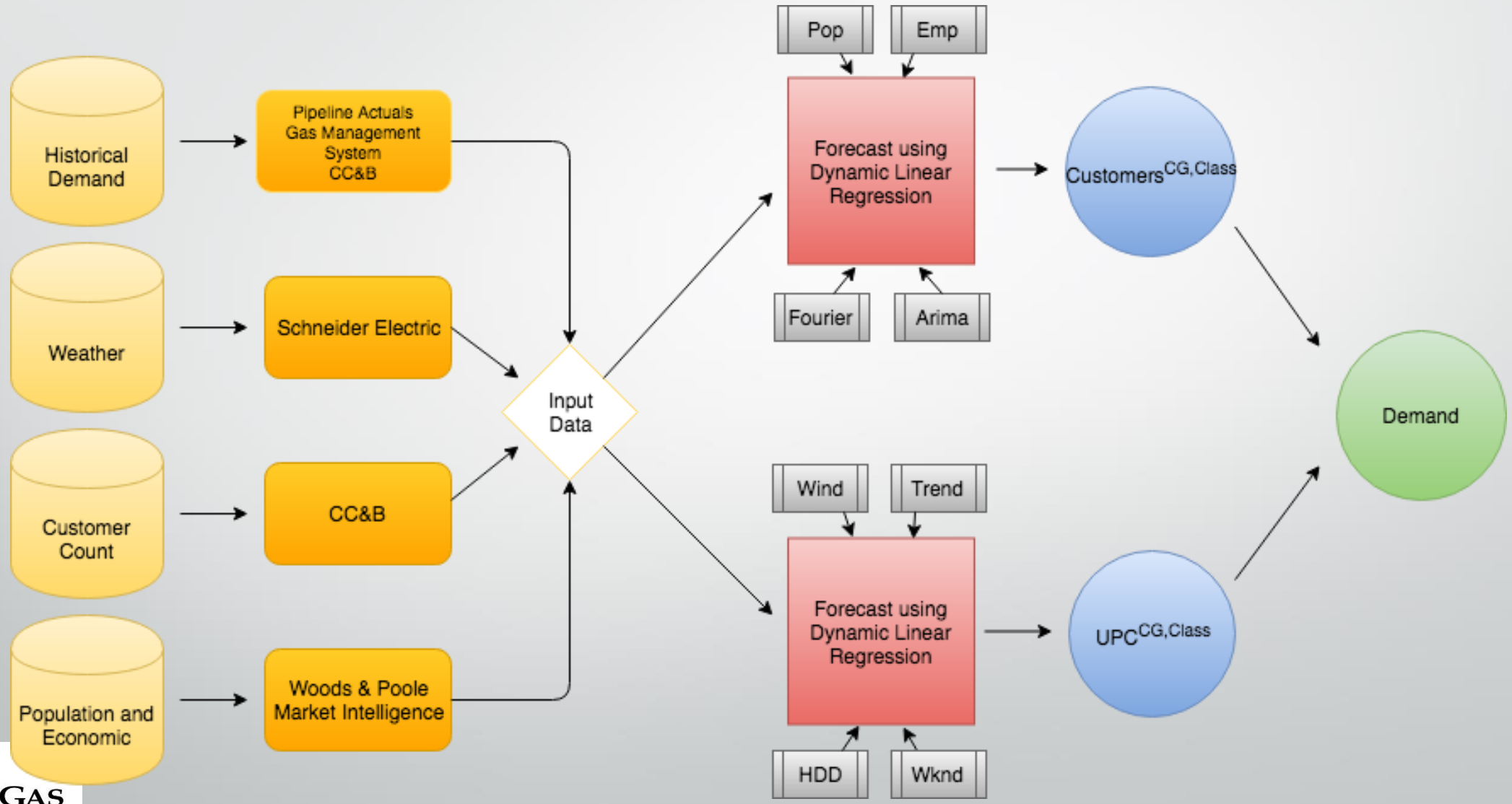
Process



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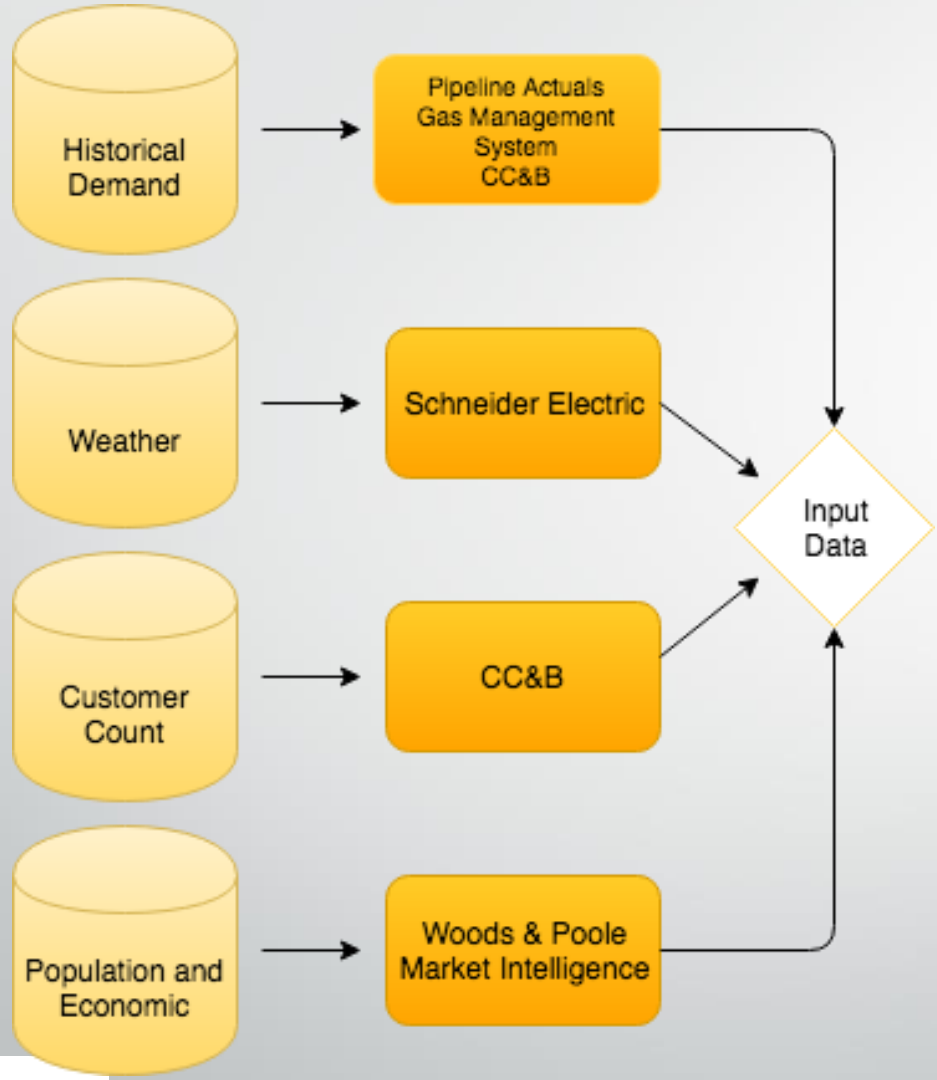
Inputs



- Cascade uses allocations to align data from various sources:
  - Pipeline actuals at Citygate level.
  - CC&B at town level.
  - Woods&Poole at county level.
- Market intelligence monthly.
- Unifying the inputs provides a consistent data format for analysis and forecasting.

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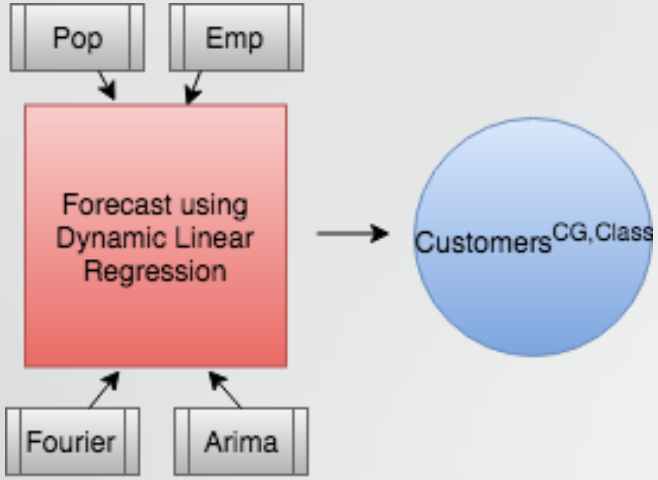

Customer Forecast

- $C^{CG,Class} = \alpha_0 + \alpha_1 Pop^{CG} + \alpha_2 Emp^{CG} + Fourier(k) + ARIMA \in (p,d,q)$
- Model Notes:
  - C = Customers; CG = Citygate; Class = Residential, Commercial, Industrial, or Interruptible; $ARIMA \in (p,d,q)$ = Indicates that the model has p autoregressive terms, d difference terms, and q moving average terms; Pop = Population; Emp = Employment; Fourier(k) = Captures seasonality of k number of seasons.

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Customer Forecast Inputs

County	Class	Year	Month	Count	Population	Employment	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Whatcom	Commercial	2004	1	4124	181.75	108.1	0	0	0	0	0	0	0	0	0	0	0
Whatcom	Commercial	2004	2	4139	181.75	108.1	1	0	0	0	0	0	0	0	0	0	0
Whatcom	Commercial	2004	3	4137	181.75	108.1	0	1	0	0	0	0	0	0	0	0	0
Whatcom	Commercial	2004	4	4288	181.75	108.1	0	0	1	0	0	0	0	0	0	0	0

Arima(1 1 0)(1 0 0) +

Xregs	AICc
Fourier	1505.389
Population + Fourier	1506.871
Employment + Fourier	1507.519
Employment	1562.932
Population	1566.24
Employment + Population + Fourier	1568.108
Arima Only	1597.354

← Arima(1 1 0)(1 0 0) + Fourier

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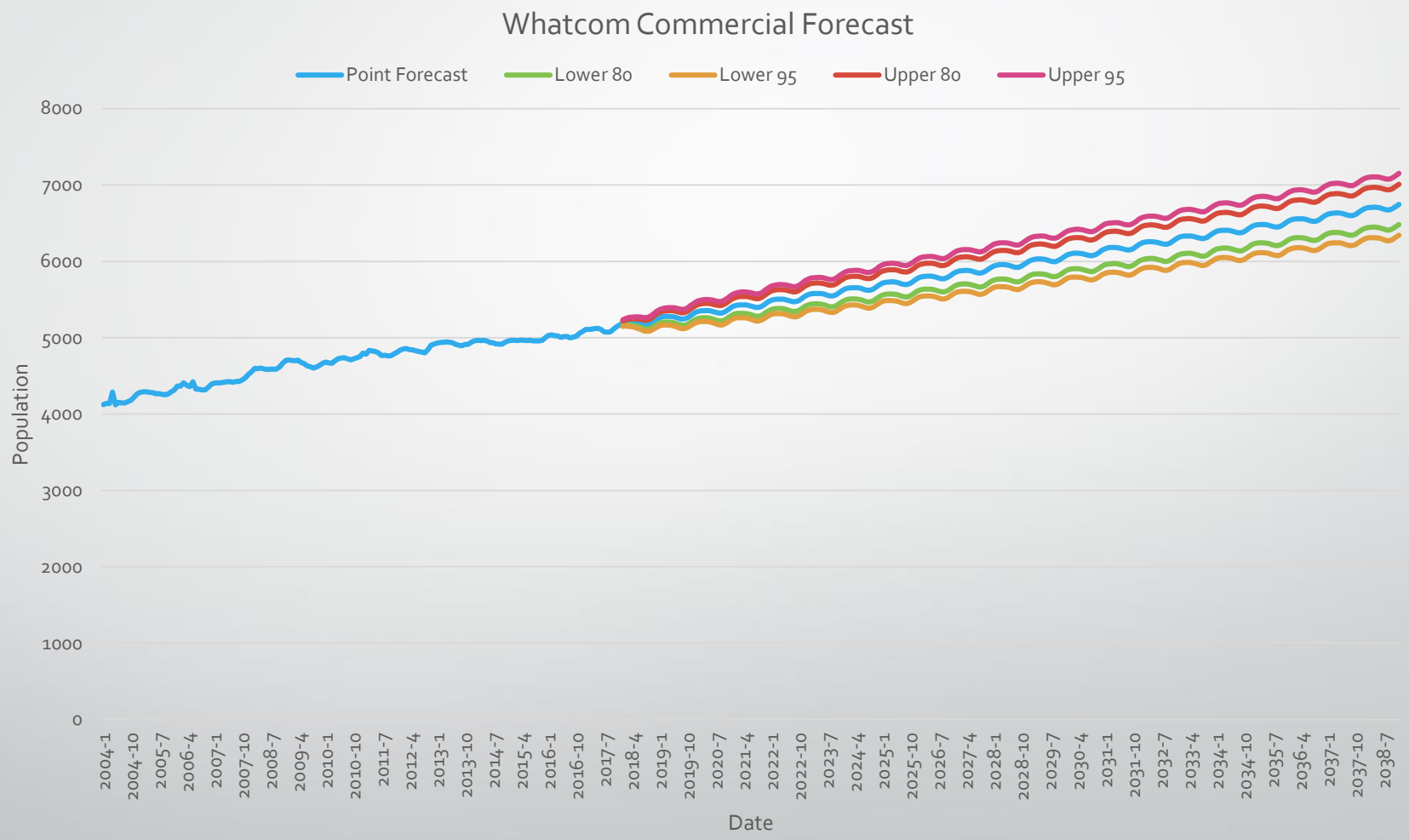
Customer Forecast

Arima(1 1 0)(1 0 0)
+ Fourier



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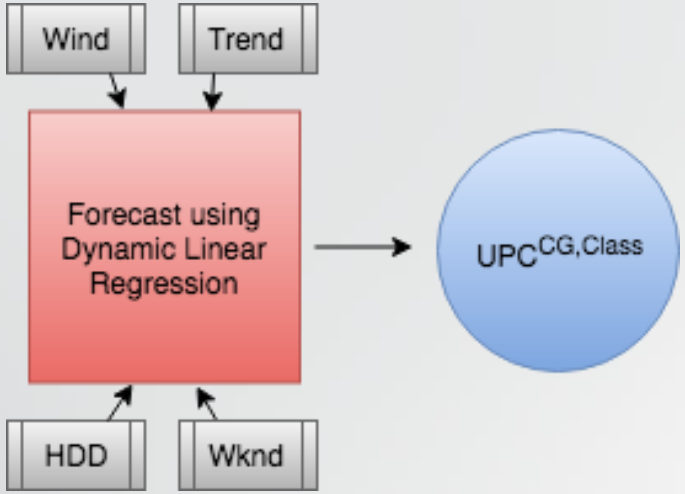

Use Per Customer Forecast

- $Therms/C^{CG,Class} = \alpha_0 + \alpha_1 HDD^{CG,M} + \alpha_2 I_w + \alpha_3 T + + \alpha_4 WIND^{CG,M}$
  Model Notes:
  - Therms/C = Therms per customer; CG = Citygate; Class = Residential, Commercial, Industrial, or Interruptible; HDD = Heating Degree Days; M= Month; I_w = Indicator Variable set to 1 if it is a weekend; T = Trend Variable increasing by 1 for each day forecasted; WIND = Daily average wind speed.

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Use Per Customer Forecast Inputs

Citygate	date	weekend	trend		Cngwa502	Cngwa503	jan.hdd	dec.hdd	jan.wind	dec.wind
acme	10/3/2010	1	1	0	0.099243	0.538548	0	0	0	0
acme	10/4/2010	0	2	0	0.153376	0.832302	0	0	0	0
acme	10/5/2010	0	3	0	0.153376	0.832302	0	0	0	0
acme	10/6/2010	0	4	0	0.135331	0.734384	0	0	0	0
acme	10/7/2010	0	5	0	0.117287	0.636466	0	0	0	0

$$\text{Acme 502} = \alpha_0 + \alpha_1 HDD^M + \alpha_2 I_w + \alpha_3 T + + \alpha_4 WIND^M$$
$$\text{Acme 503} = \alpha_0 + \alpha_1 HDD^M + \alpha_2 I_w + \alpha_3 T + + \alpha_4 WIND^M$$

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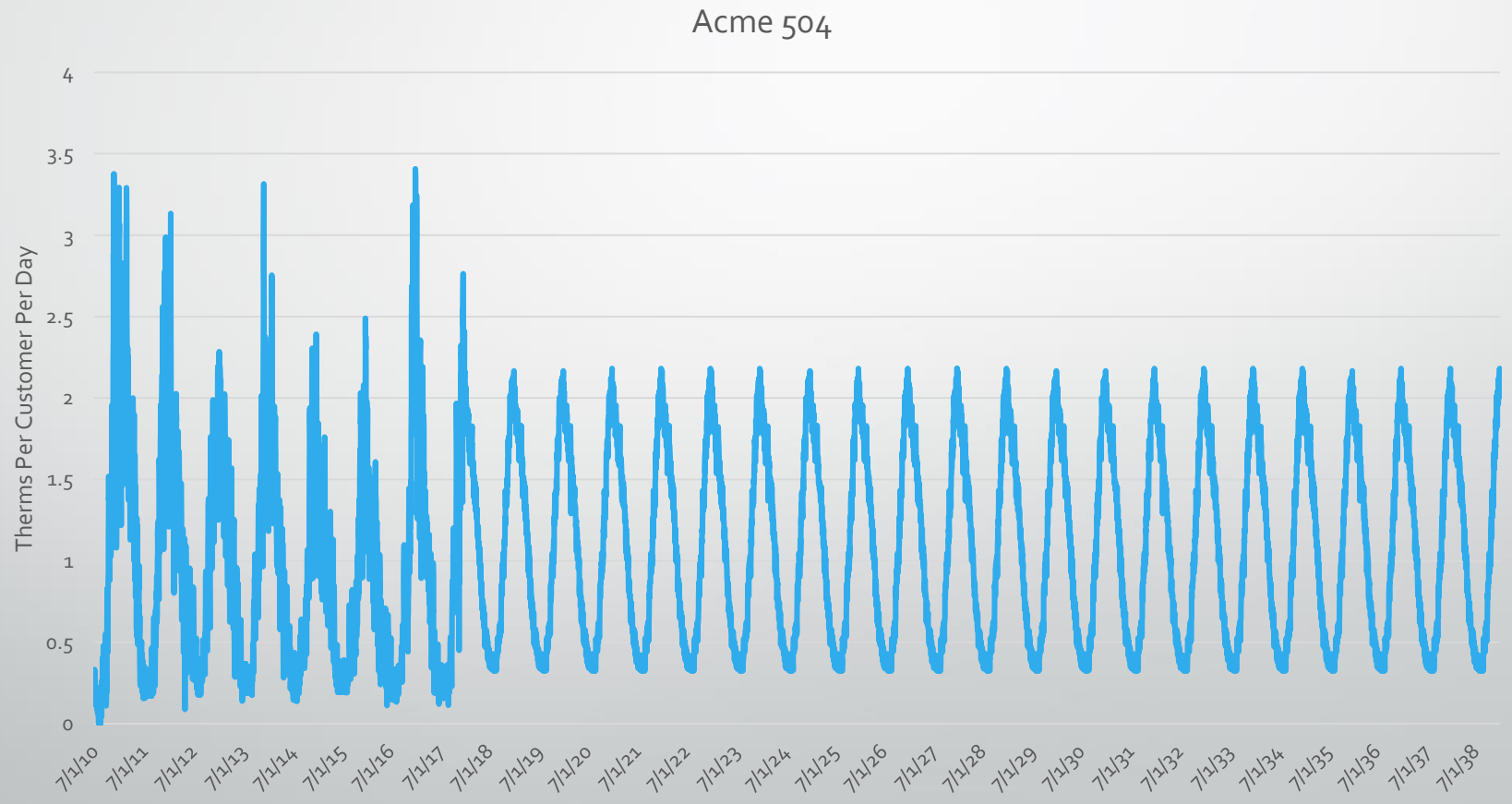
UPC Forecast Results

Intercept	weekend	trend	jan.hdd	feb.hdd	mar.hdd	apr.hdd	may.hdd	jun.hdd	jul.hdd	aug.hdd	sep.hdd	oct.hdd
0.402494	-0.07795	-8.01E-05	0.066535	0.063208	0.056673	0.059892	0.051729	0.050821	0.040756	0.002986	0.03954	0.05304

nov.hdd	dec.hdd	jan.wind	feb.wind	mar.wind	apr.wind	may.wind	jun.wind	jul.wind	aug.wind	sep.wind	oct.wind	nov.wind	dec.wind
0.062	0.070558	0.026064	0.021922	0.028022	0.015546	0.010411	0.00353	0.001301	1.25E-05	0.012483	0.021033	0.020635	0.016529



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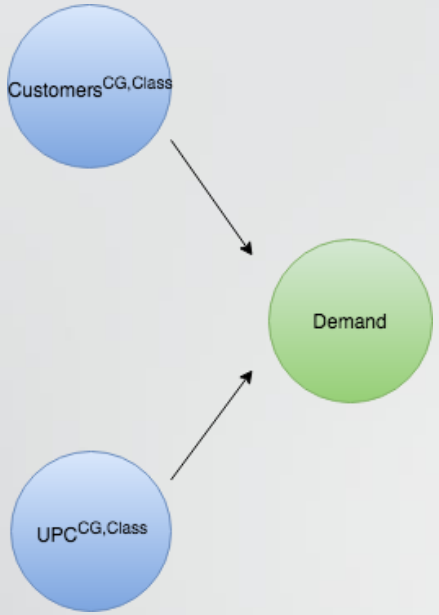
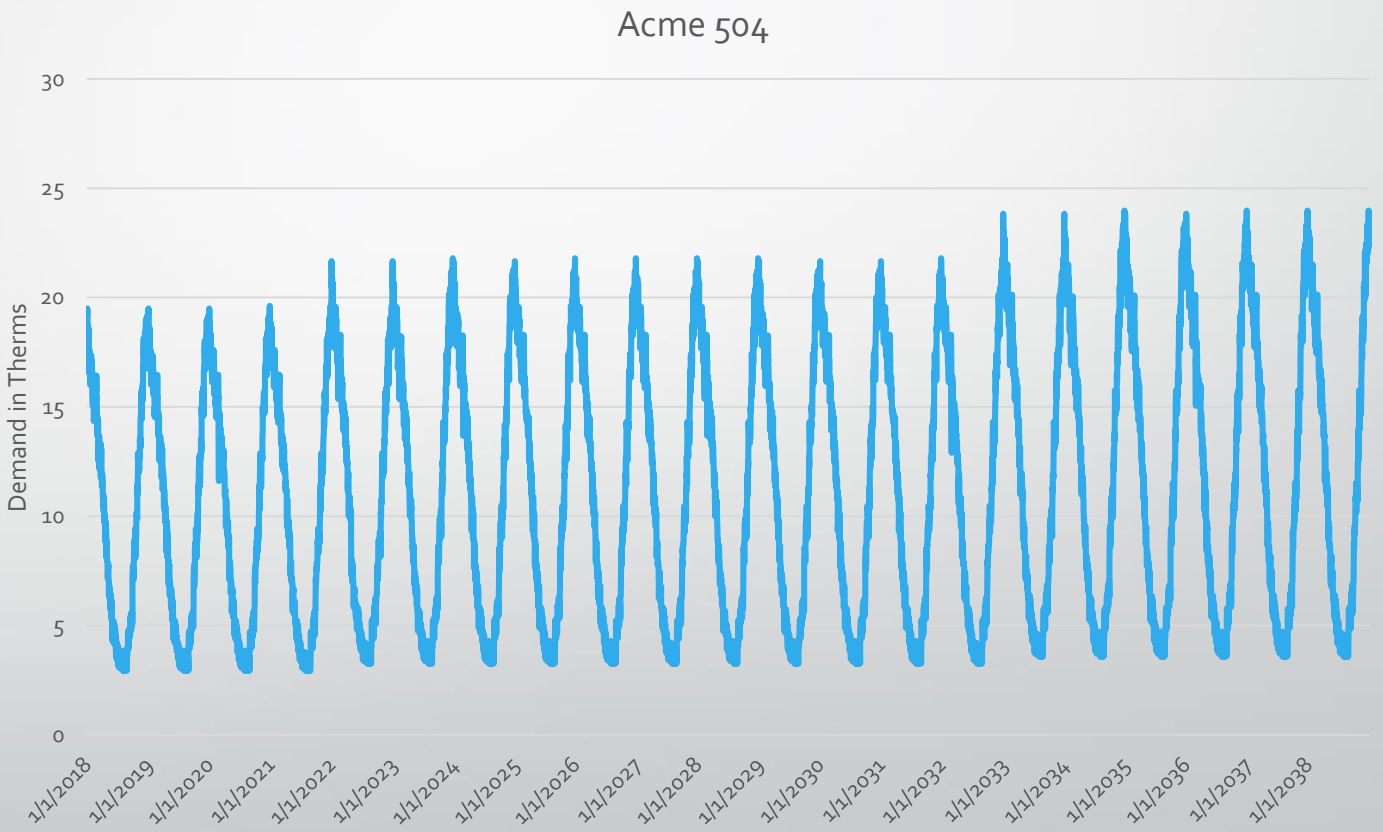
Final Demand Calculation



Acme 504

date	Point.Forecast	customers	demand
1/1/2018	2.056379237	9	18.50741
1/2/2018	2.07118369	9	18.64065
1/3/2018	2.166938889	9	19.50245
1/4/2018	2.042473345	9	18.38226
1/5/2018	2.083907812	9	18.75517
1/6/2018	2.013821654	9	18.12439



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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.
- Previously, demand was removed prior to running the use per customer vs. weather analysis.
- Now using monthly coefficients, Cascade can run the analysis while leaving the non-weather demand in.

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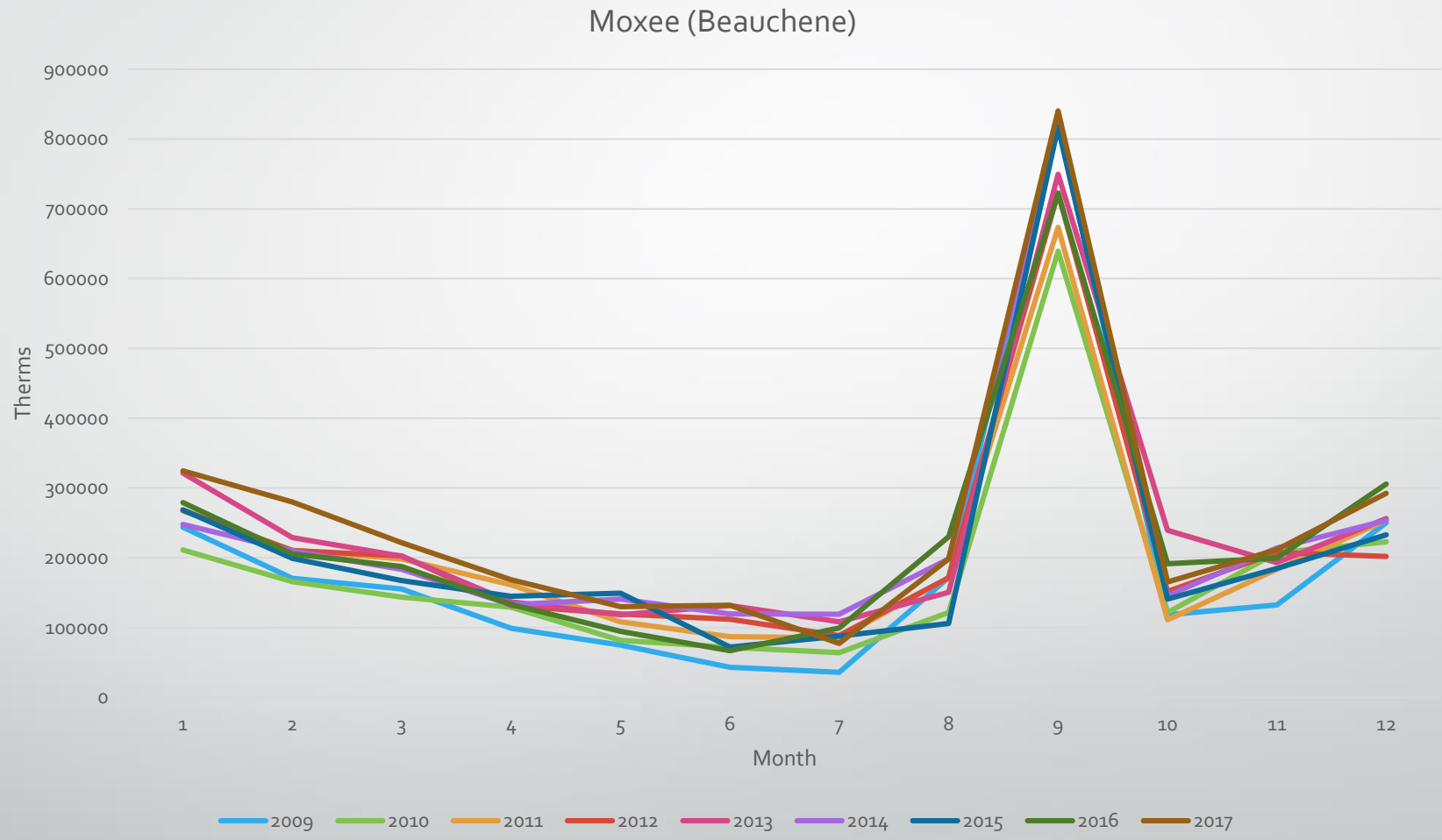
Moxee (Beauchene)



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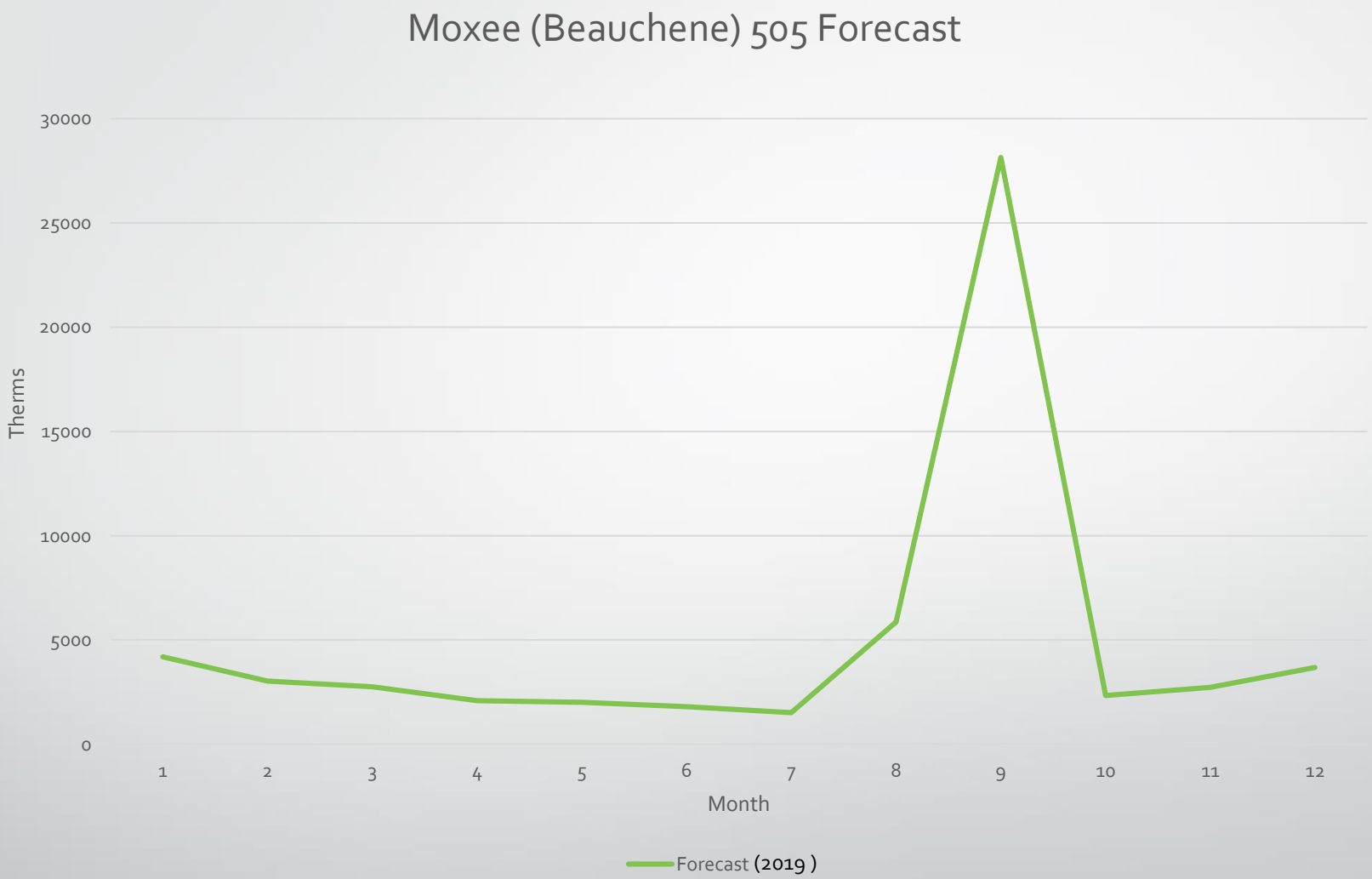

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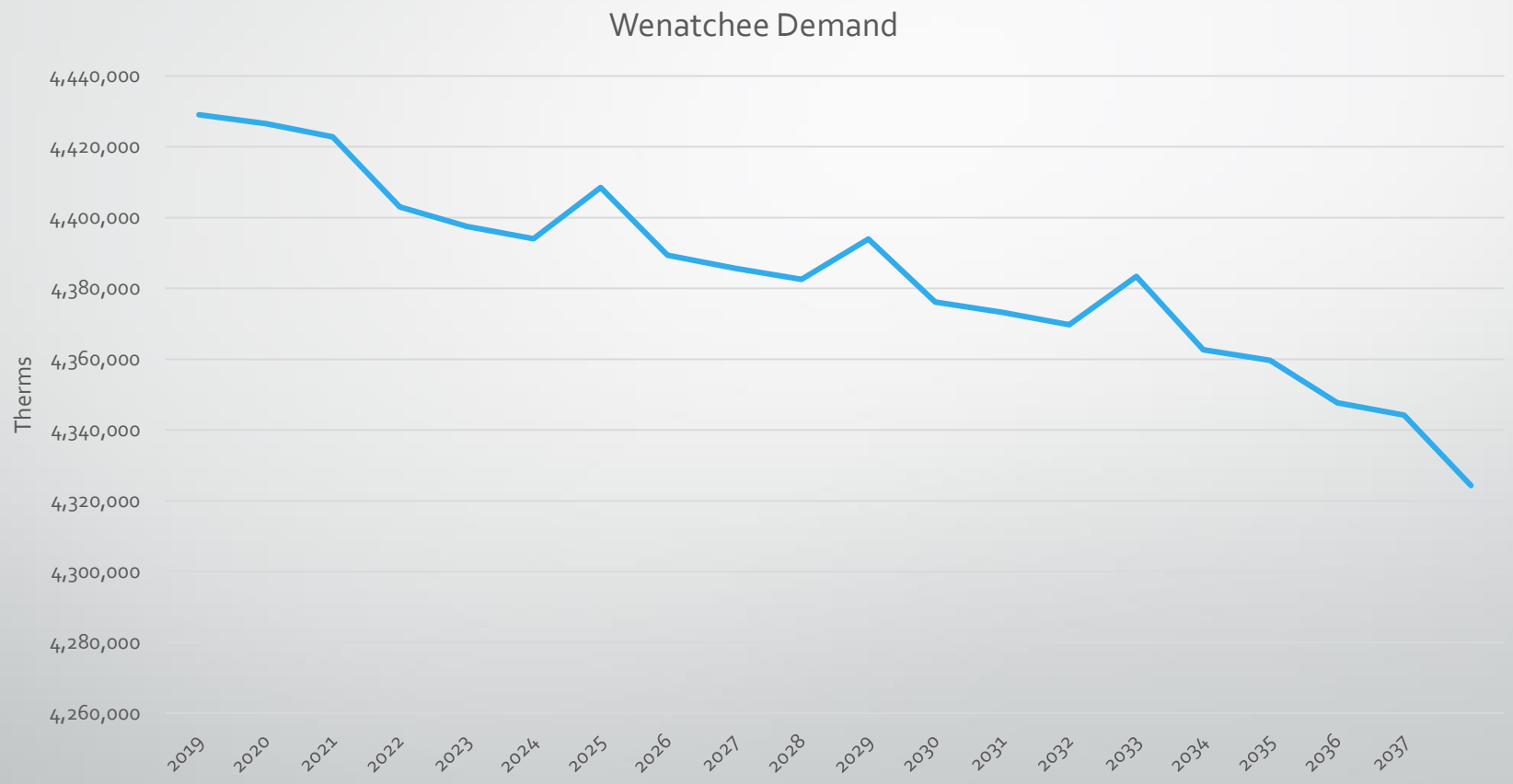
Wenatchee Demand



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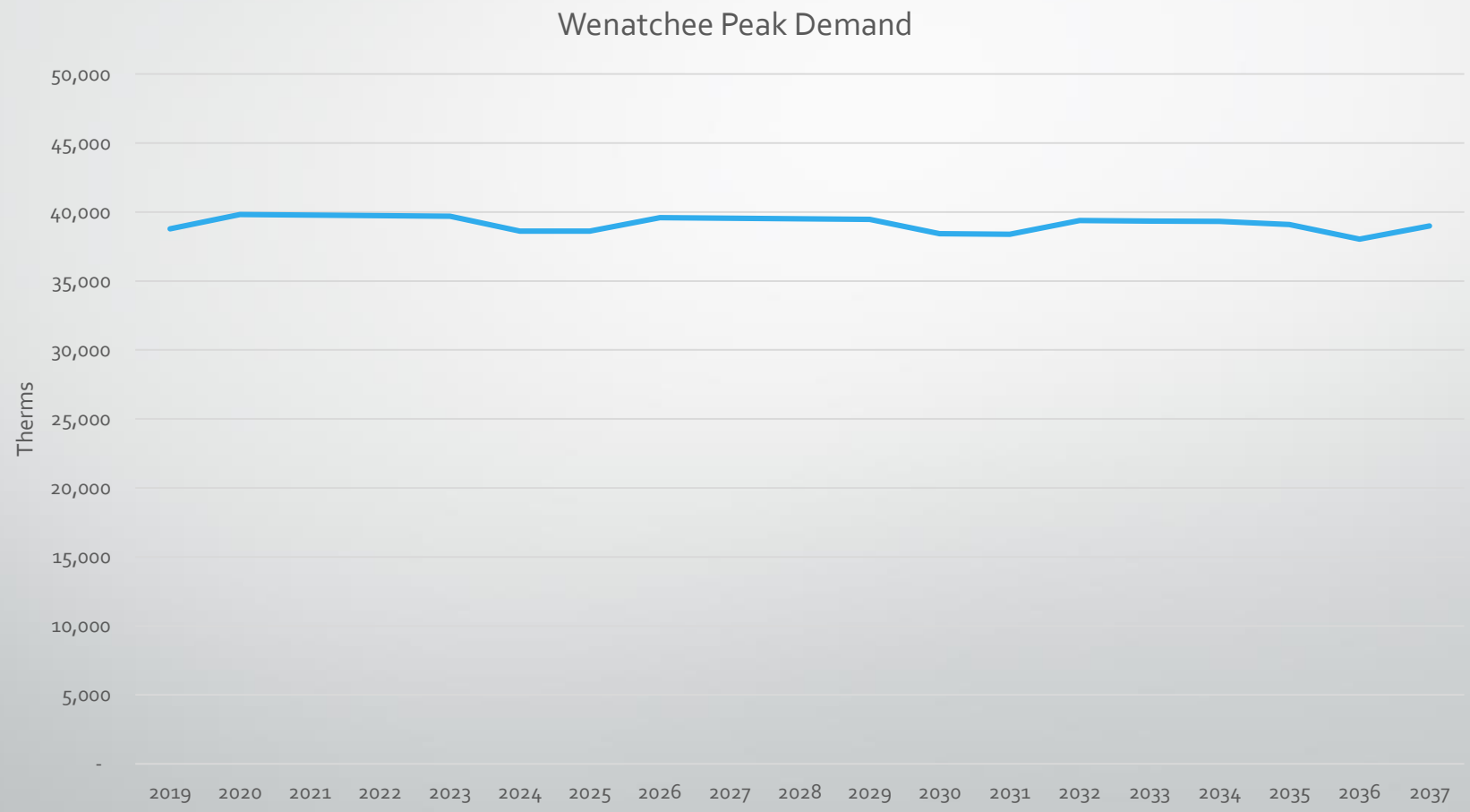
Wenatchee Demand - Peak



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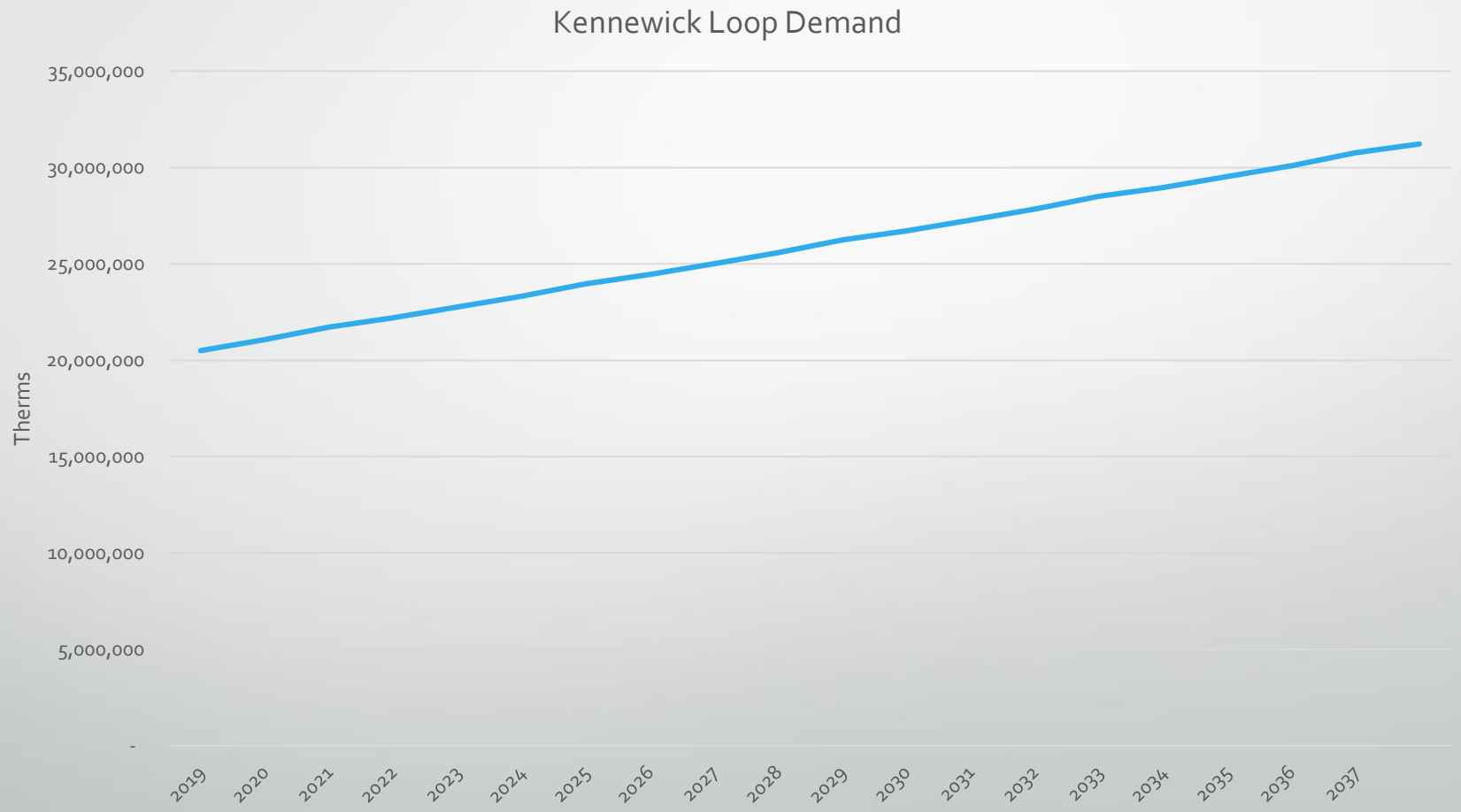
Kennewick Loop Citygate



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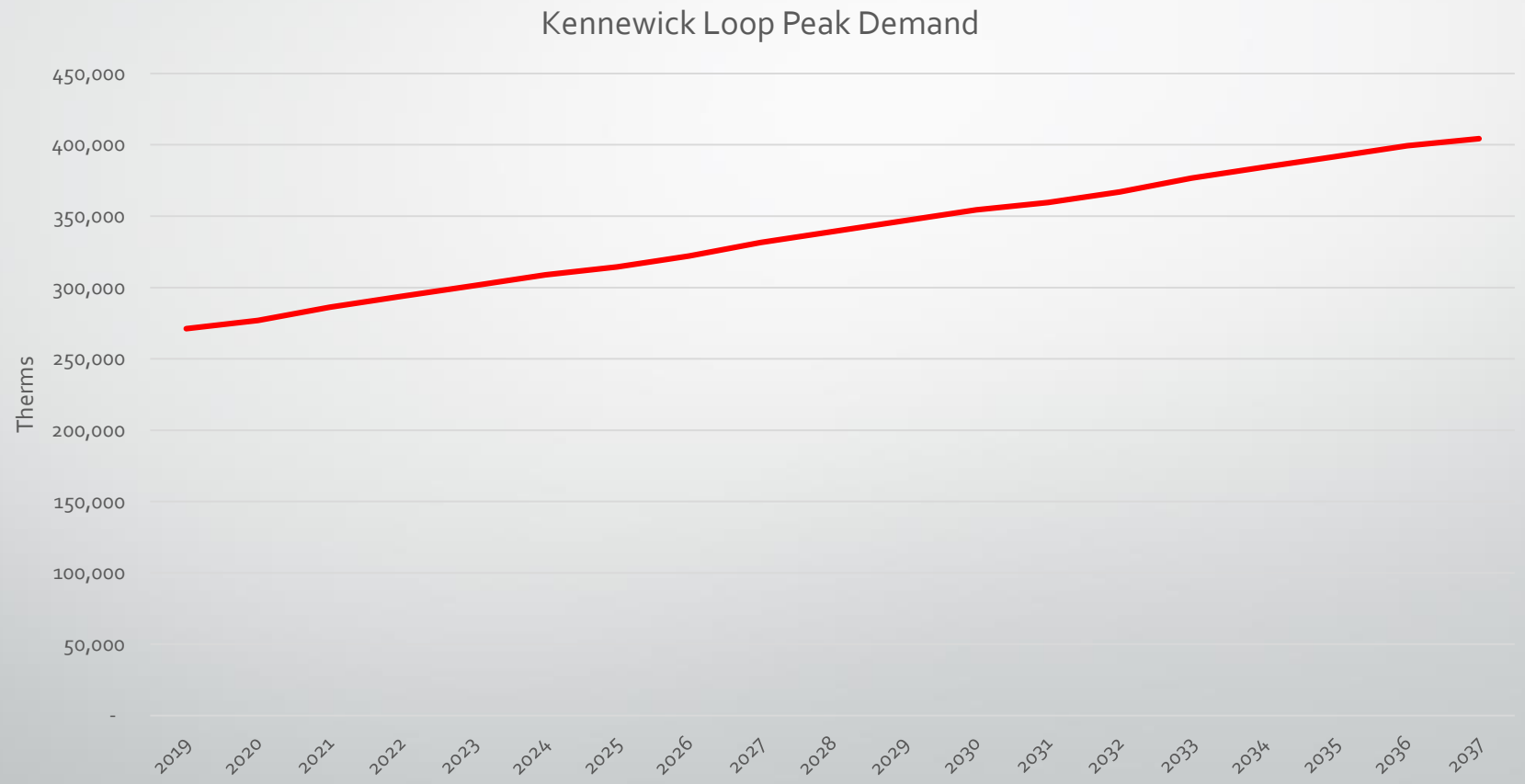
Kennewick Loop Citygate - Peak



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Kennewick Loop Citygate

- U.S. Census Bureau released the 2016 American Community Survey last year, revealing Pasco as Washington's fastest growing large city at a 12.3 percent growth rate.
- Pasco is considering the development of 1,600 acres of land in a plan that would provide for up to 8,300 homes.
- https://www.tri-cityherald.com/news/local/article205705534.html

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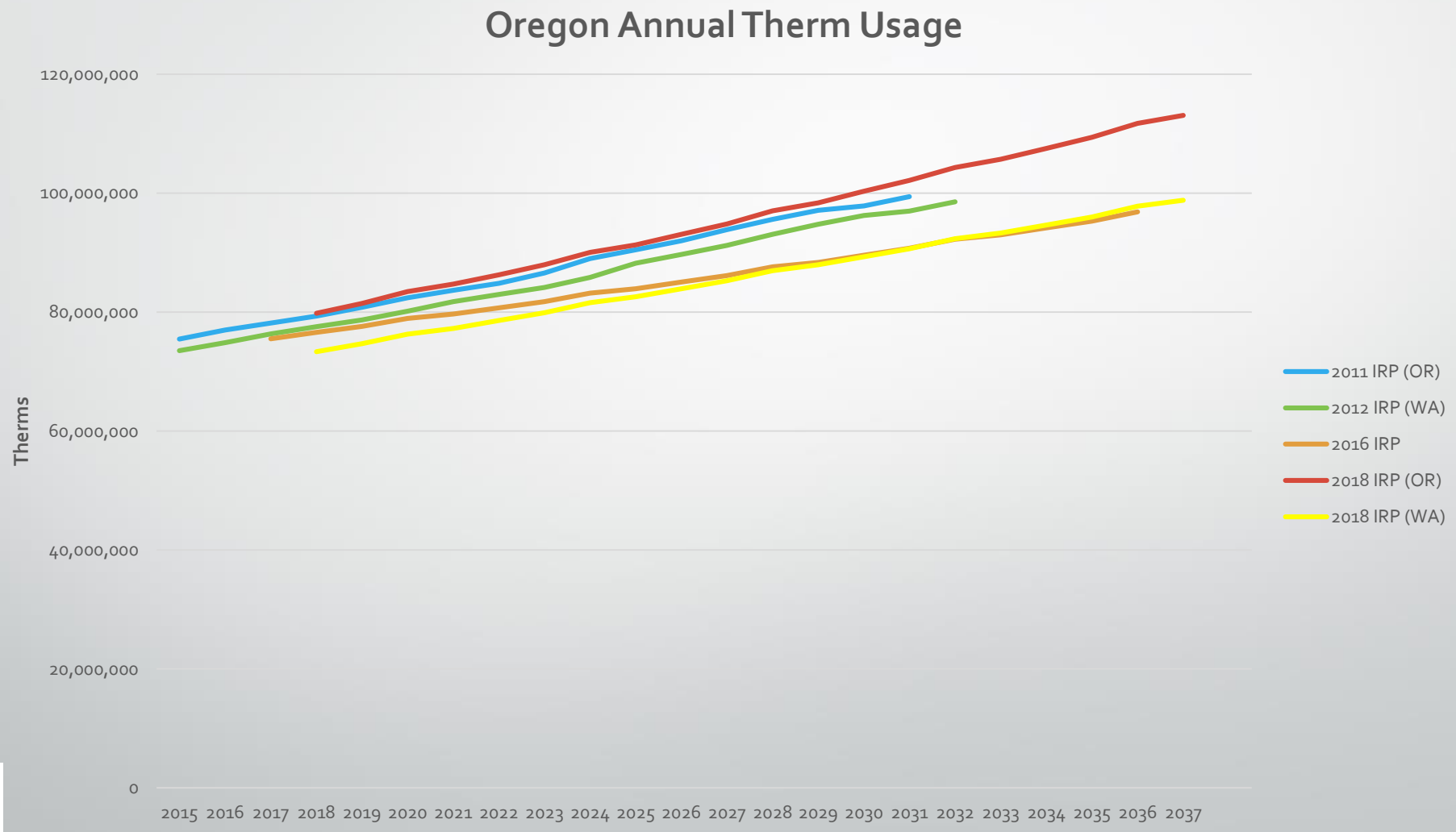
Oregon Demand



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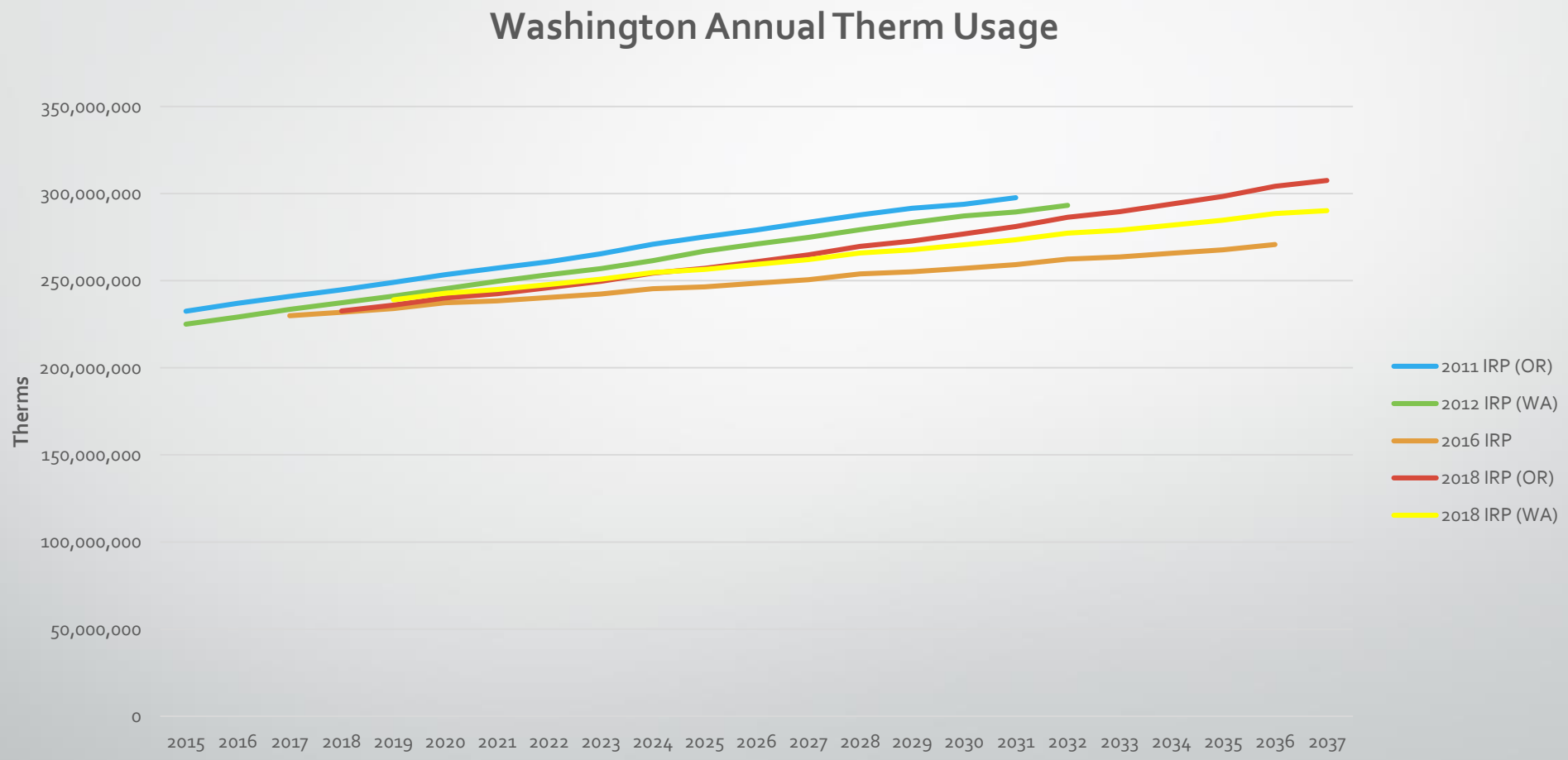
Washington Demand



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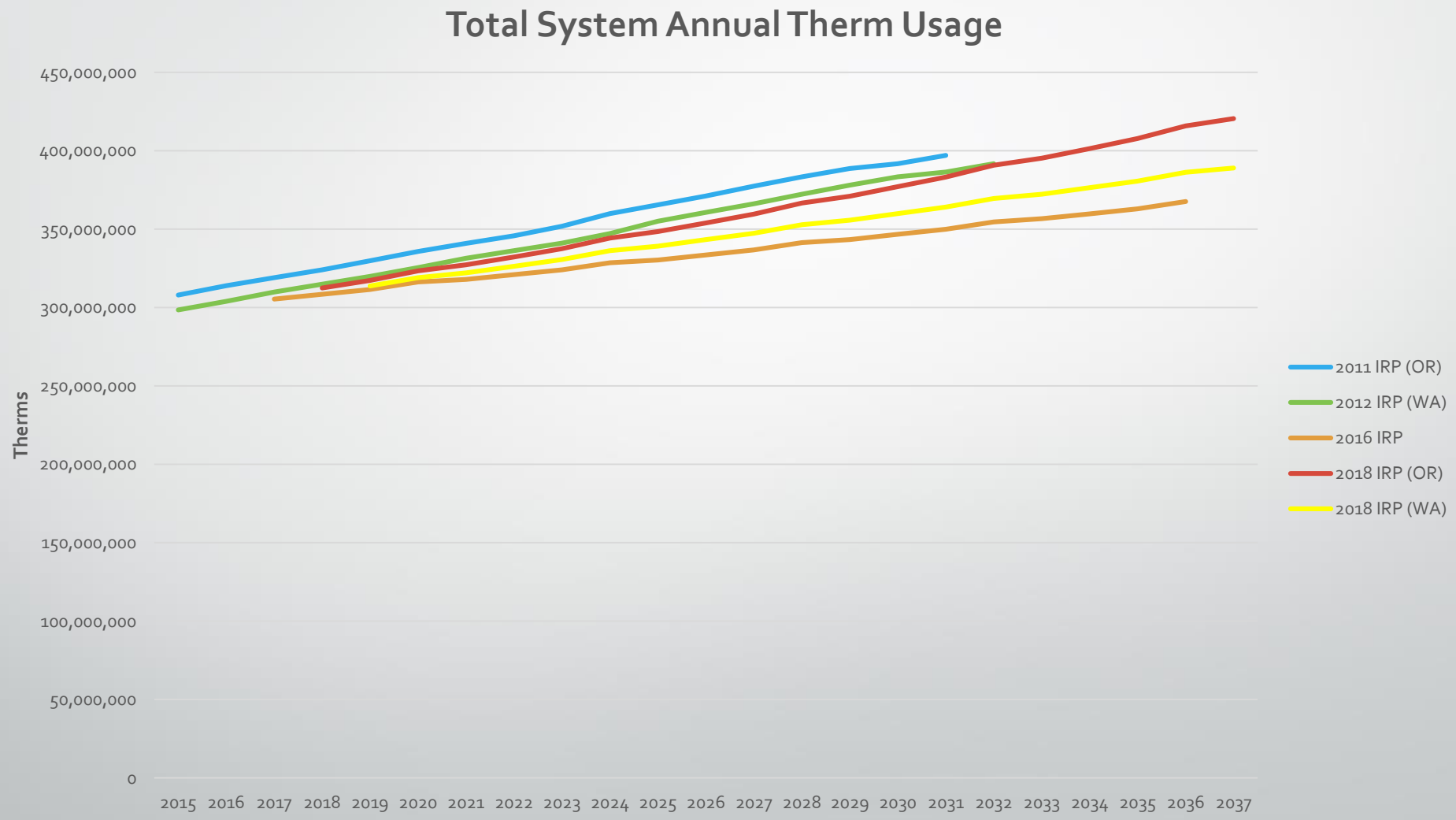
Total System Demand



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Non-Core Outlook

- As a new item for the 2018 IRP, Cascade will be including an outlook of its non-core demand over the 20-year planning horizon.
- This will be used in the Company's SENDOUT® modeling to test for physical capacity constraints at Cascade's citygates.
- For 2019, Cascade forecasts approximately 500 million therms of industrial transport load, and 220 million therms of electric generation in Washington.
- For 2019, Cascade forecasts approximately 60 million therms of industrial transport load, and 170 million therms of electric generation in Oregon.

Distribution System Planning

Chris Bolton, Engineer II

Technical Advisory Group

July 19th, 2017

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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

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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

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Facilities:

- Regulator stations – Over 700
- Valves – Over 1600
- Also other equipment such as heaters, odorizers and compressors.

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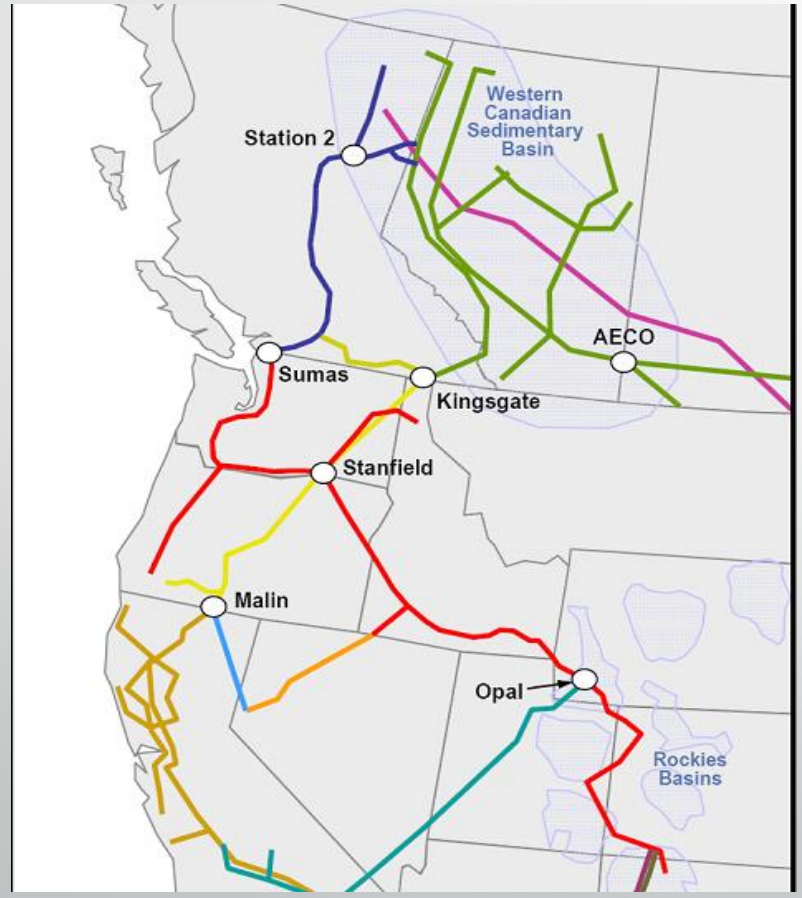
Where do we get our gas?



- Many interstate pipeline companies
- Williams Northwest Pipeline (red)
- Transcanada Pipelines (yellow)

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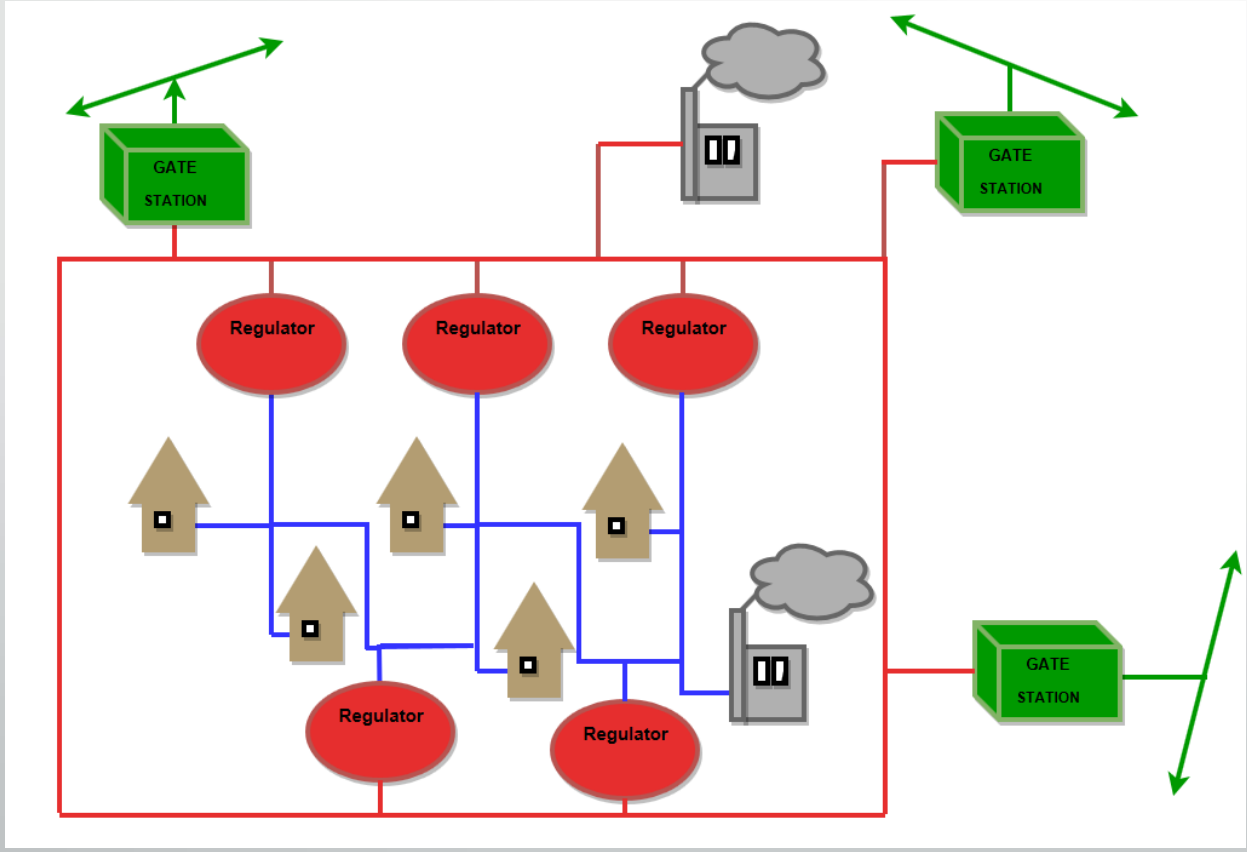
Network Design Fundamentals



Keys:

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

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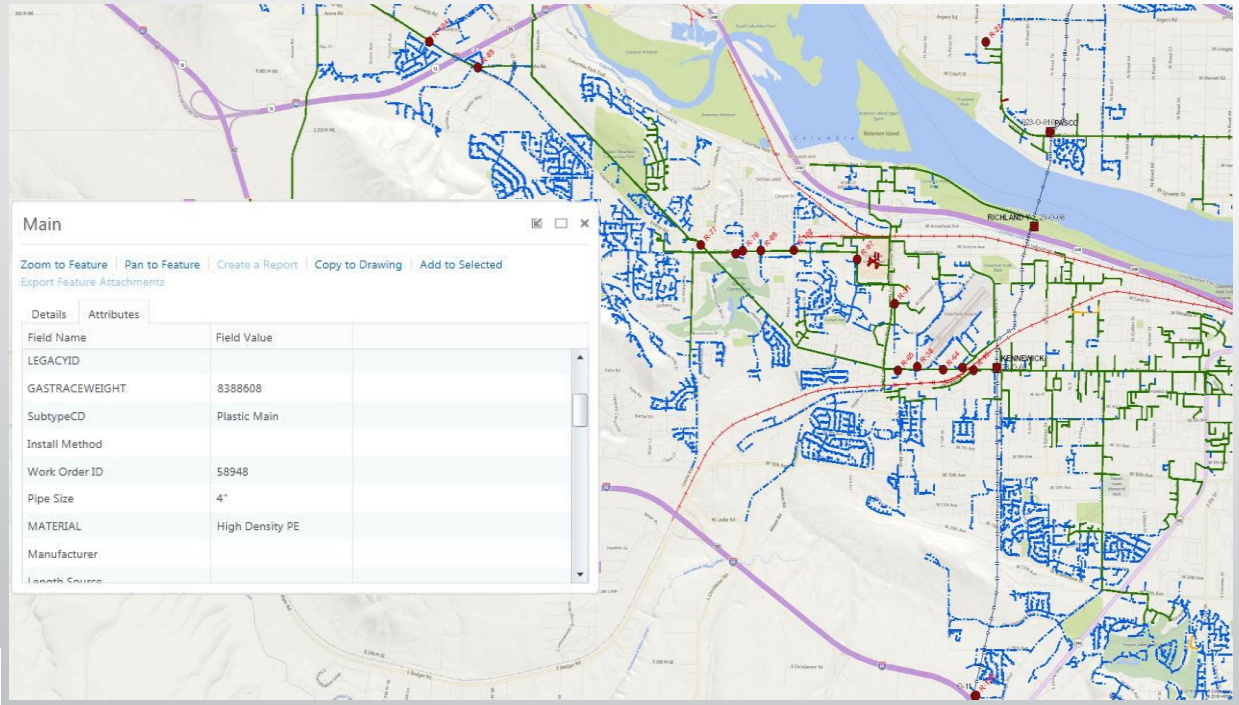
GIS – Geographic Information System

-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.....

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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.

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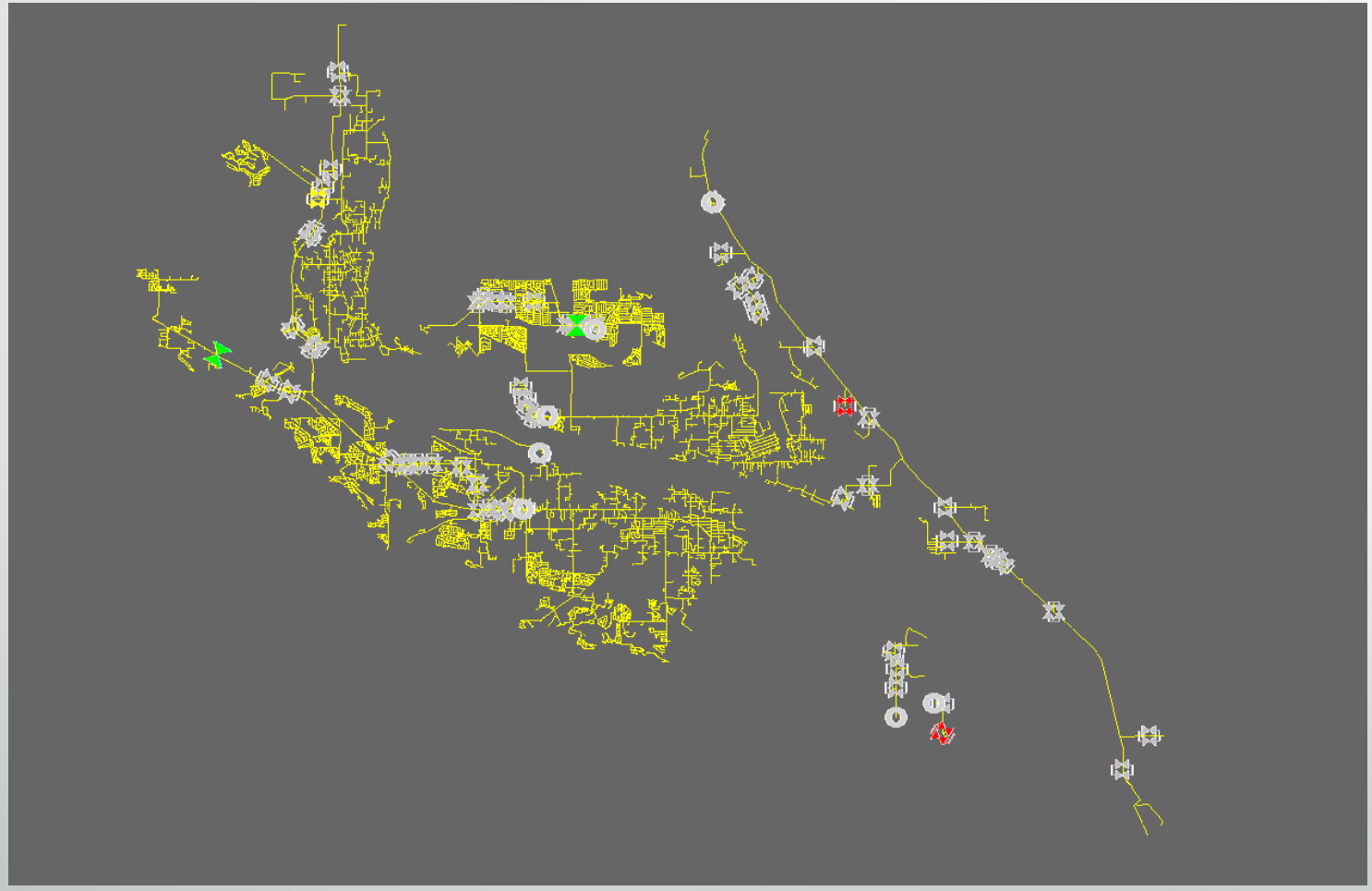
Model Ex.



HOW DO WE MAKE THIS MODEL ACCURATE?

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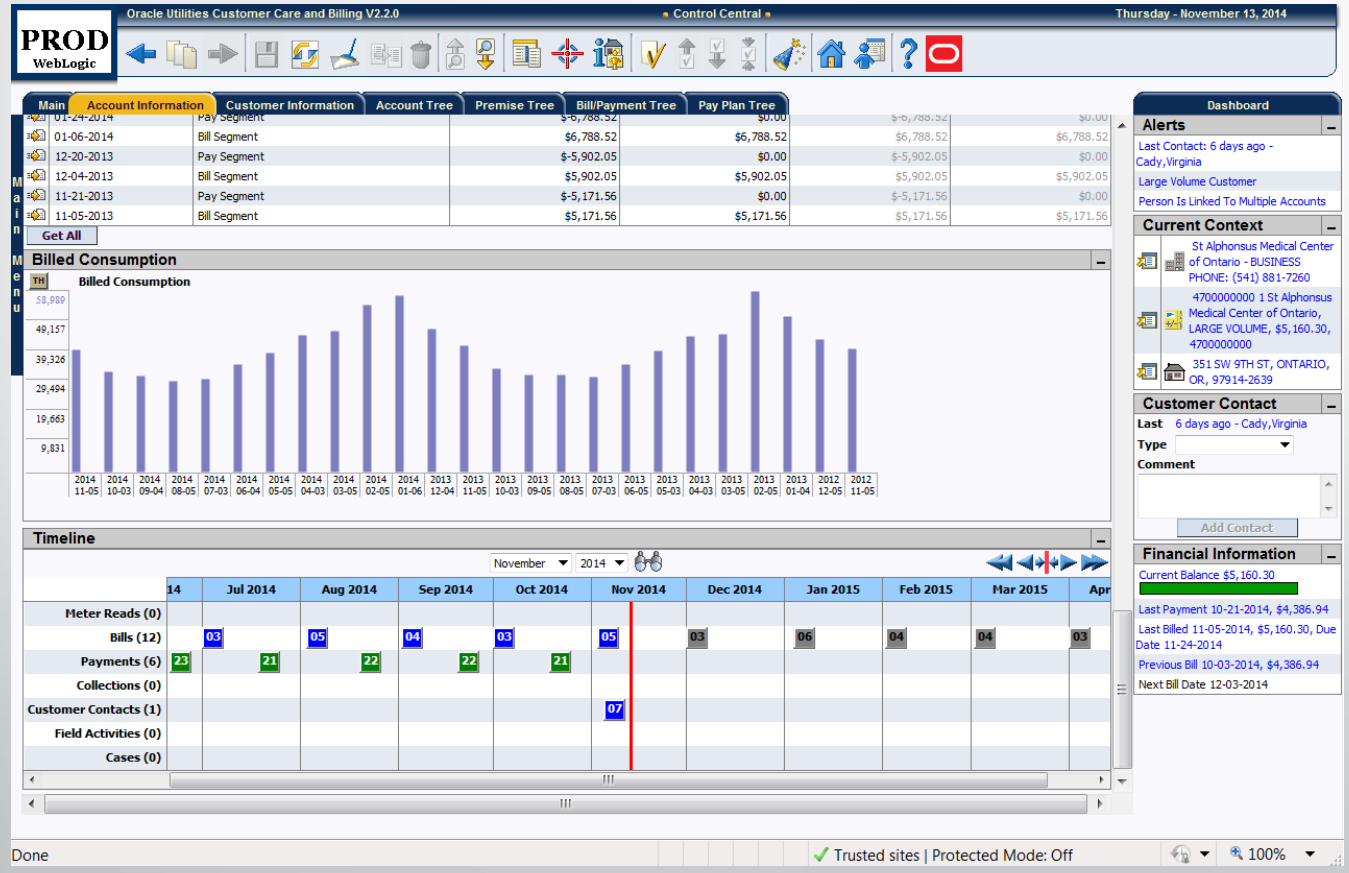
Data Gathering

- CC&B (customer billing data)



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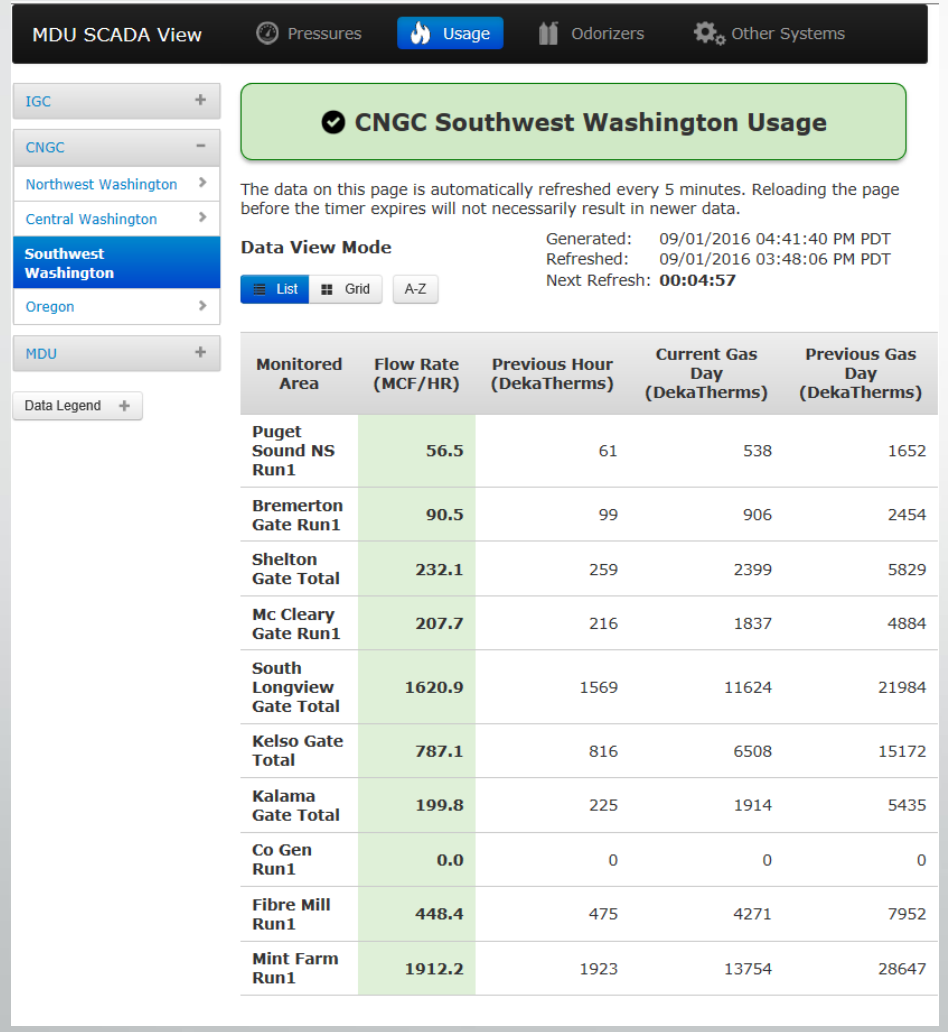
DATA GATHERING (CONT.)



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.

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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%

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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.

Peak HDD = 60 - average daily temp

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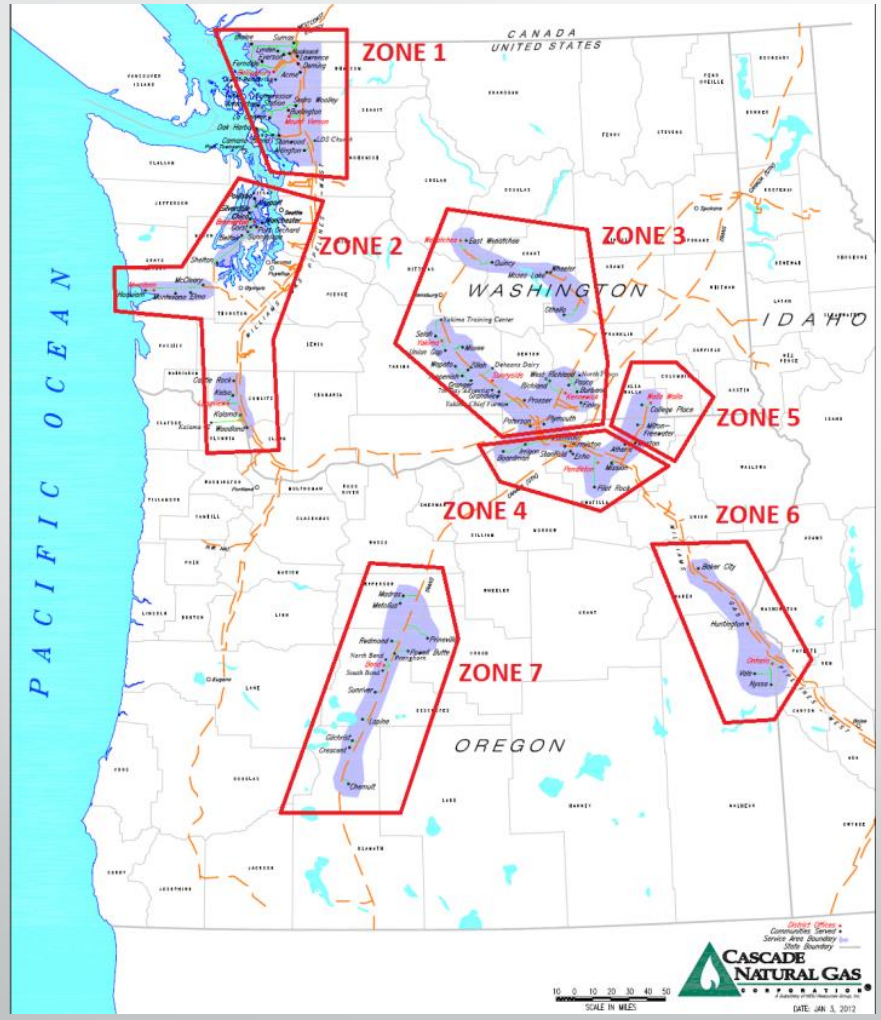
CNG Weather Zones



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

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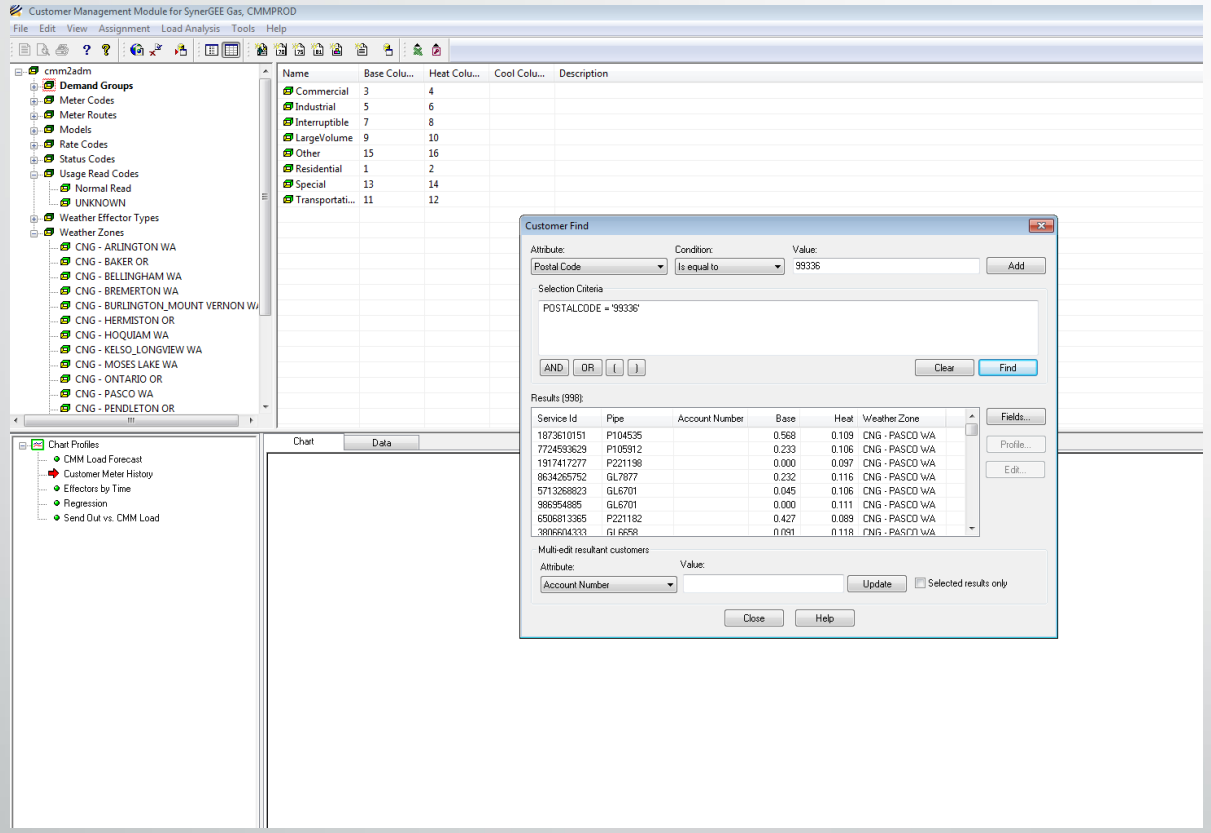
Customer Management Module (CMM)



- 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.

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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 EVENT (WORST CASE SCENARIO).
  - GROWTH MODEL - USES DESIGN DAY MODEL ALONG WITH GROWTH DATA TO PREDICT FUTURE PROJECTS.

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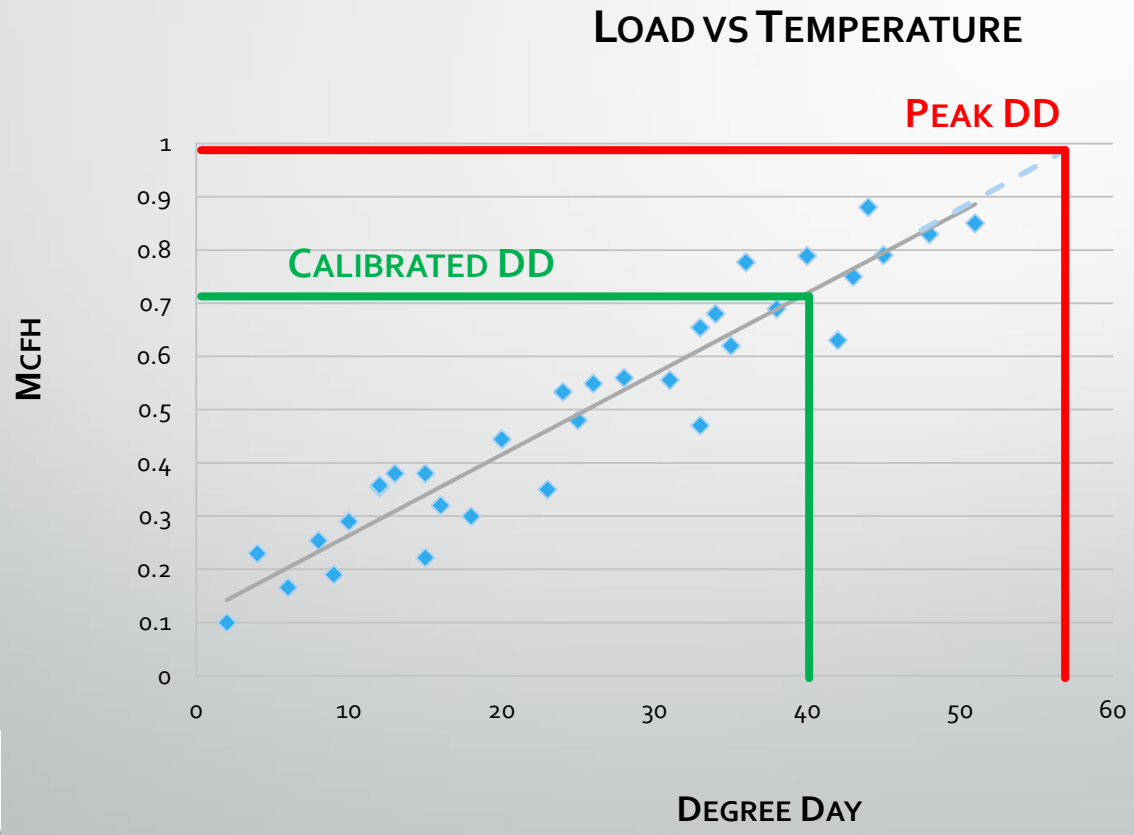
Calibrated vs Degree Day

- 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

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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

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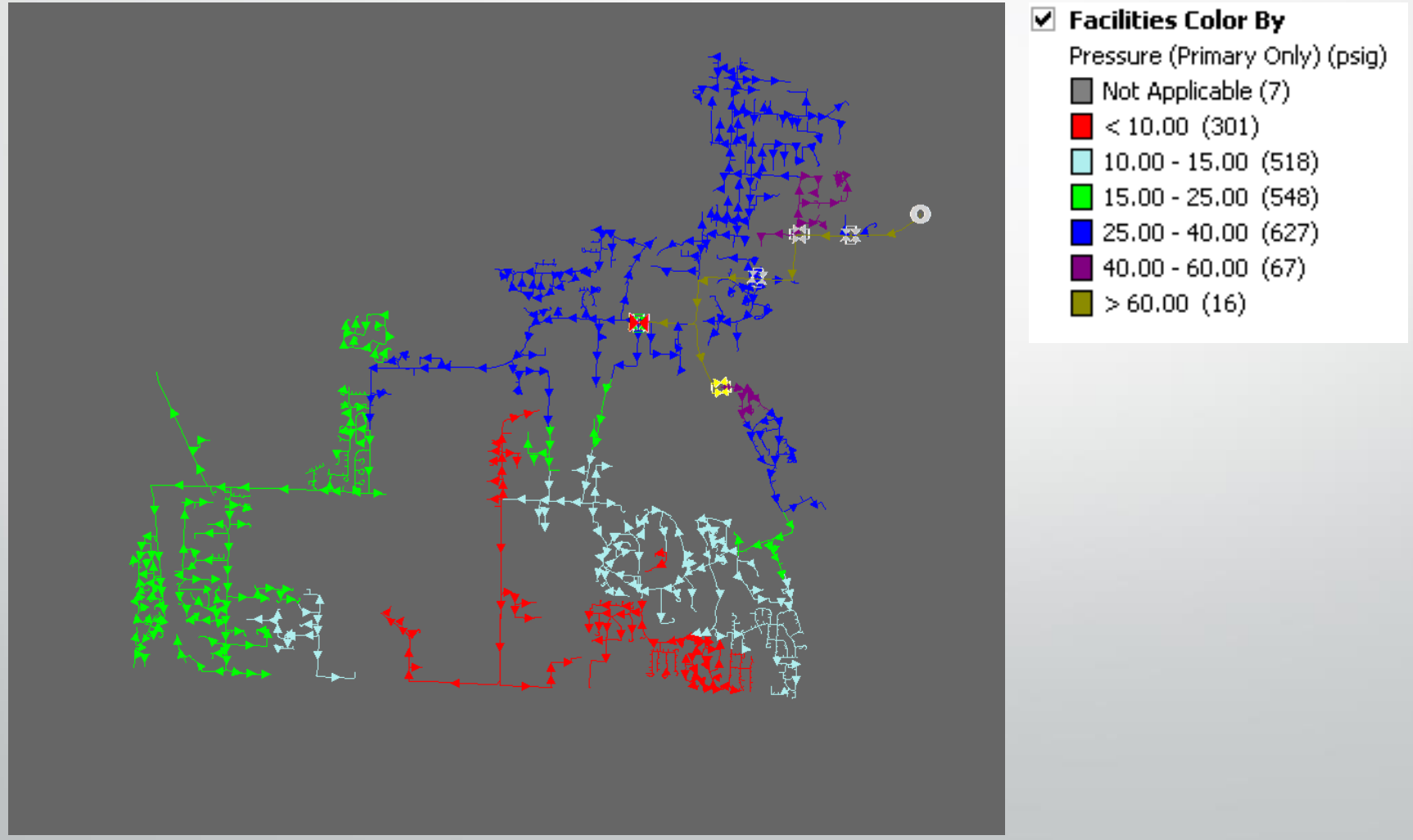
SYNERGI

- THEORETICAL LOW PRESSURE SCENARIO



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Capacity Enhancement Options

- Pipes:
  - replacements
  - reinforcements
  - loops
- Regulator Stations
- Compressors

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Pipe Enhancements

Pros

- Reliable capacity
- Low maintenance
- Permanent

Cons

- Can be expensive
- Potential land acquisition/permitting issues

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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

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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

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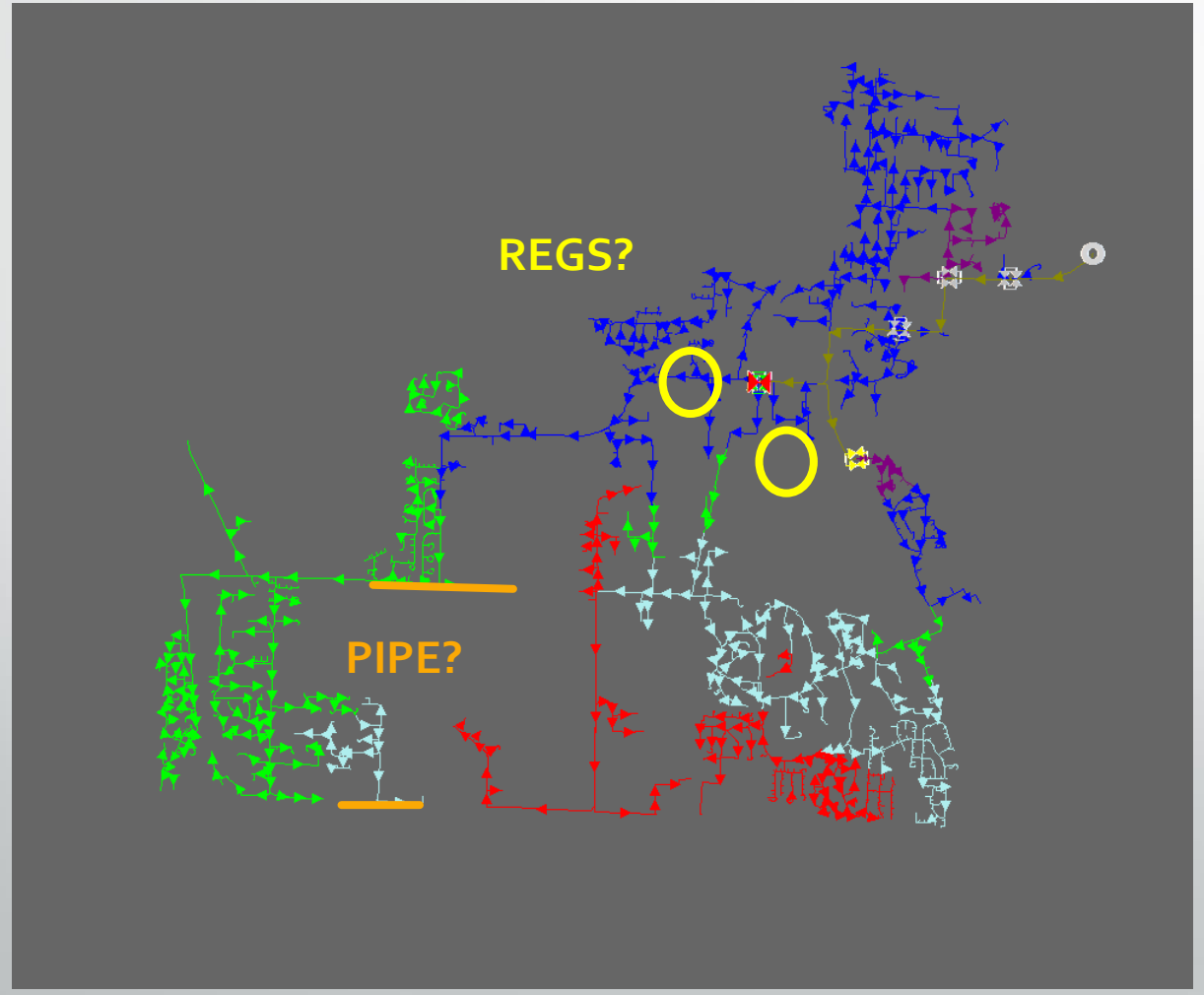
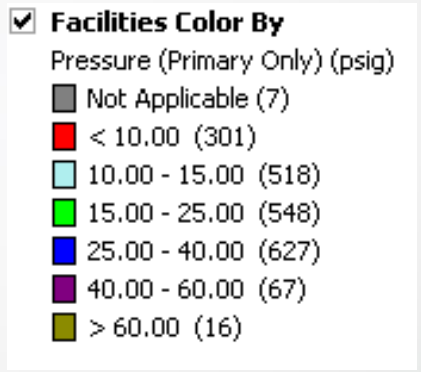
SYNERGI

- LOW PRESSURE SCENARIO





- COMPRESSOR STATION INFEASIBLE
- OTHER SOLUTIONS?

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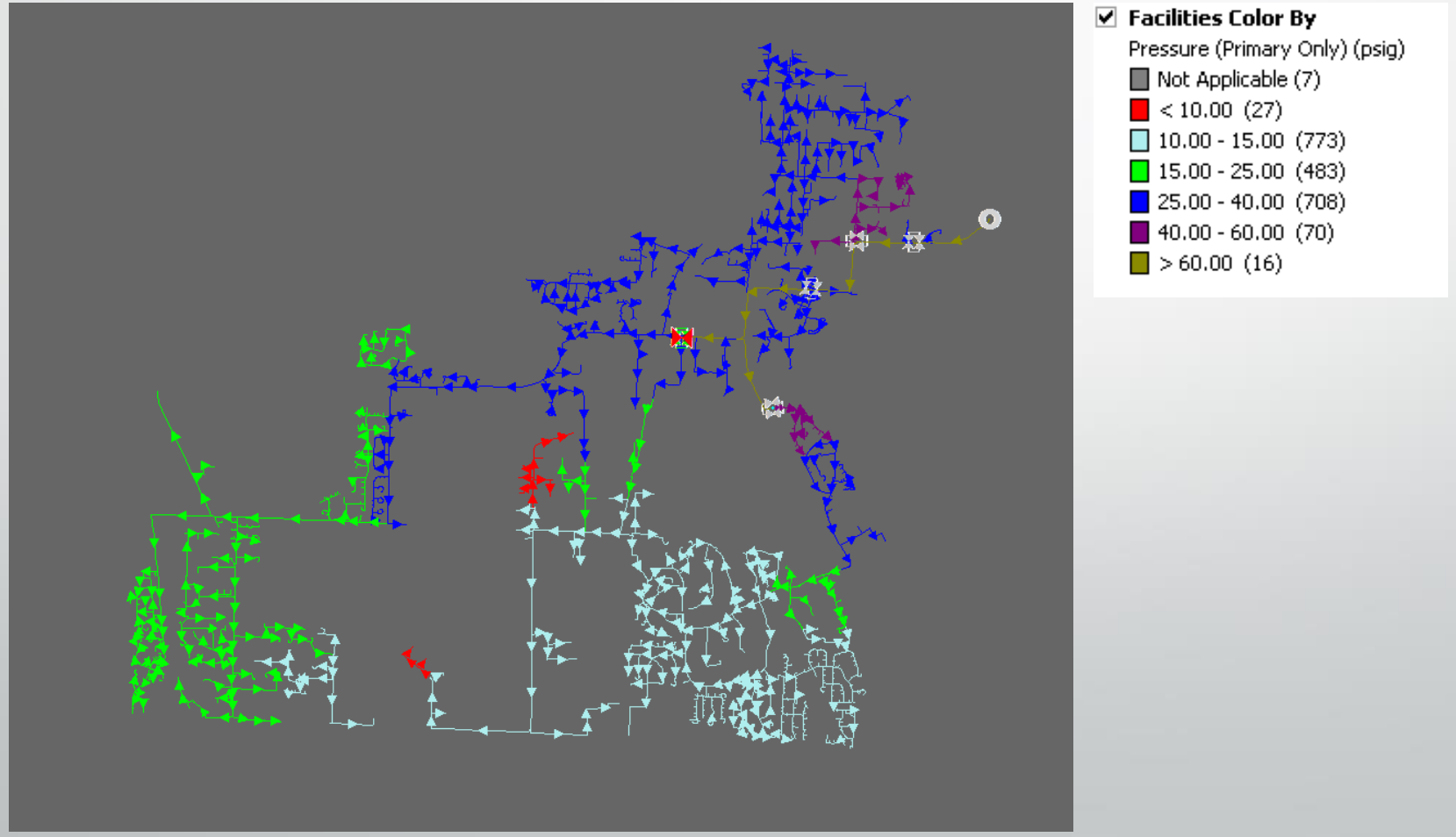
SYNERGI

- POSSIBLE SOLUTIONS – RAISING REG STATION SET POINTS



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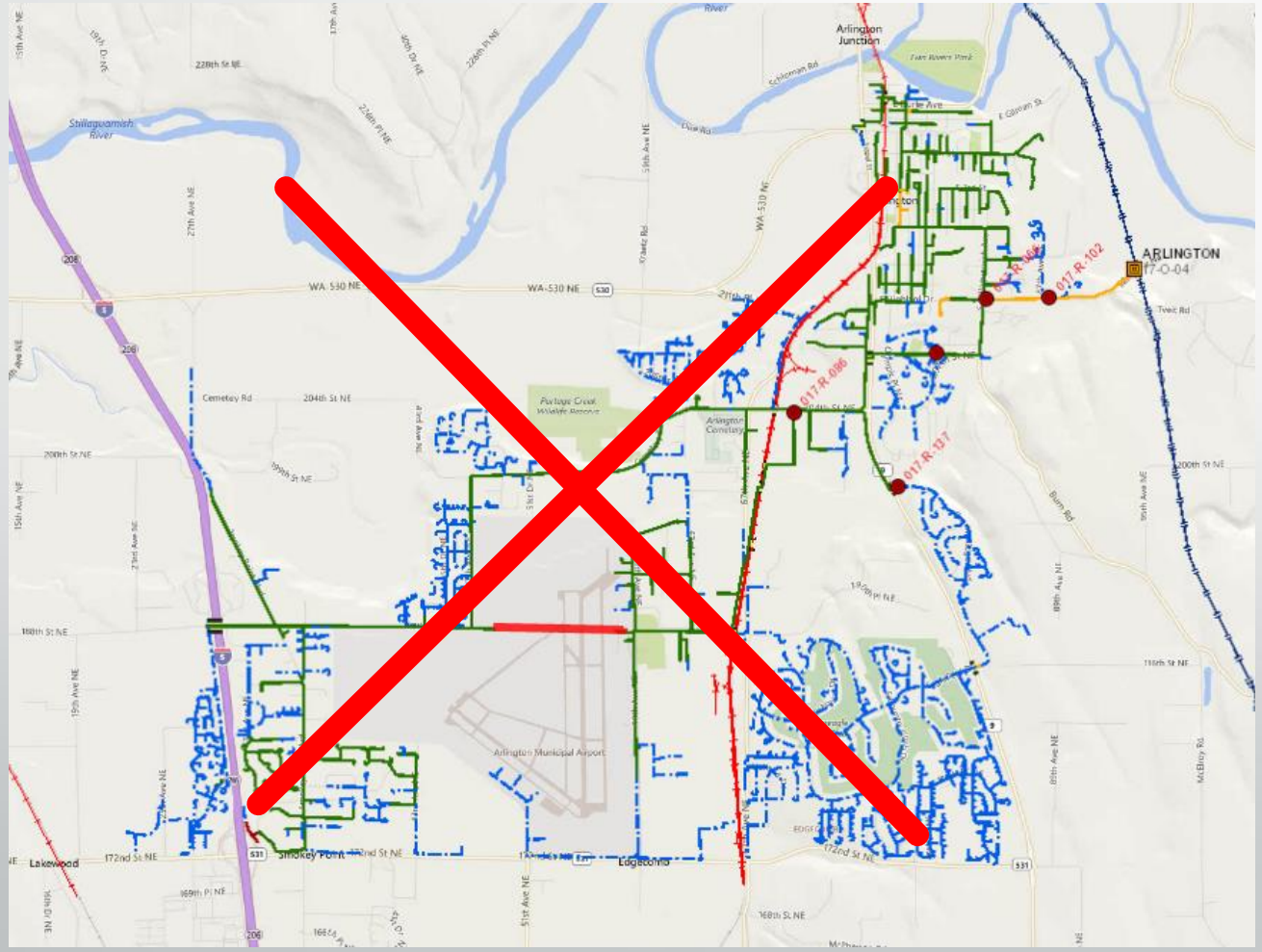
SYNERGI

- REINFORCEMENT OPTION #1



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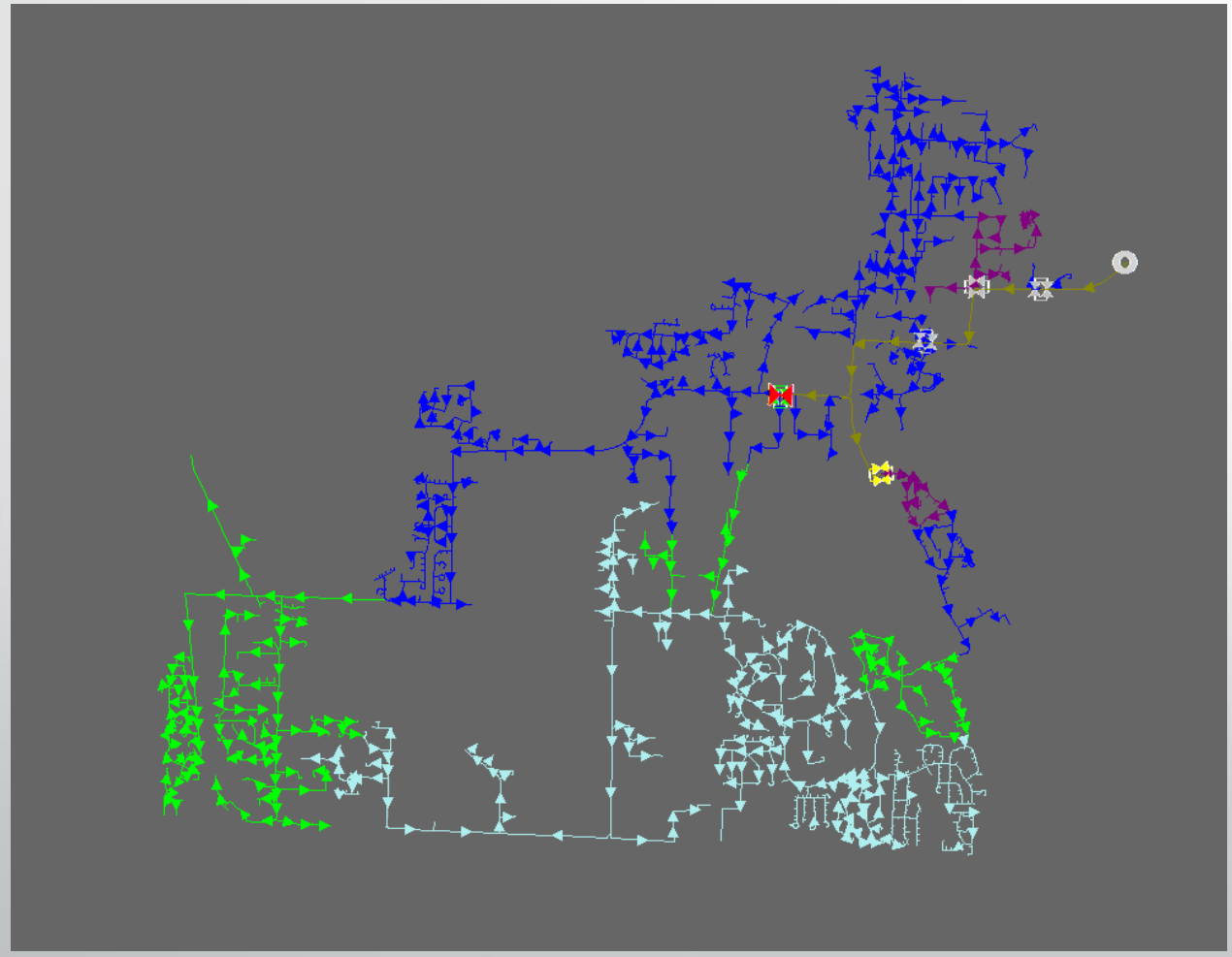
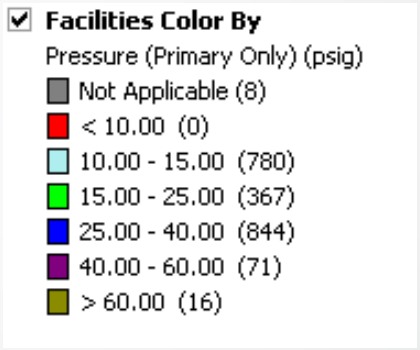
SYNERGI

- REINFORCEMENT OPTION #2





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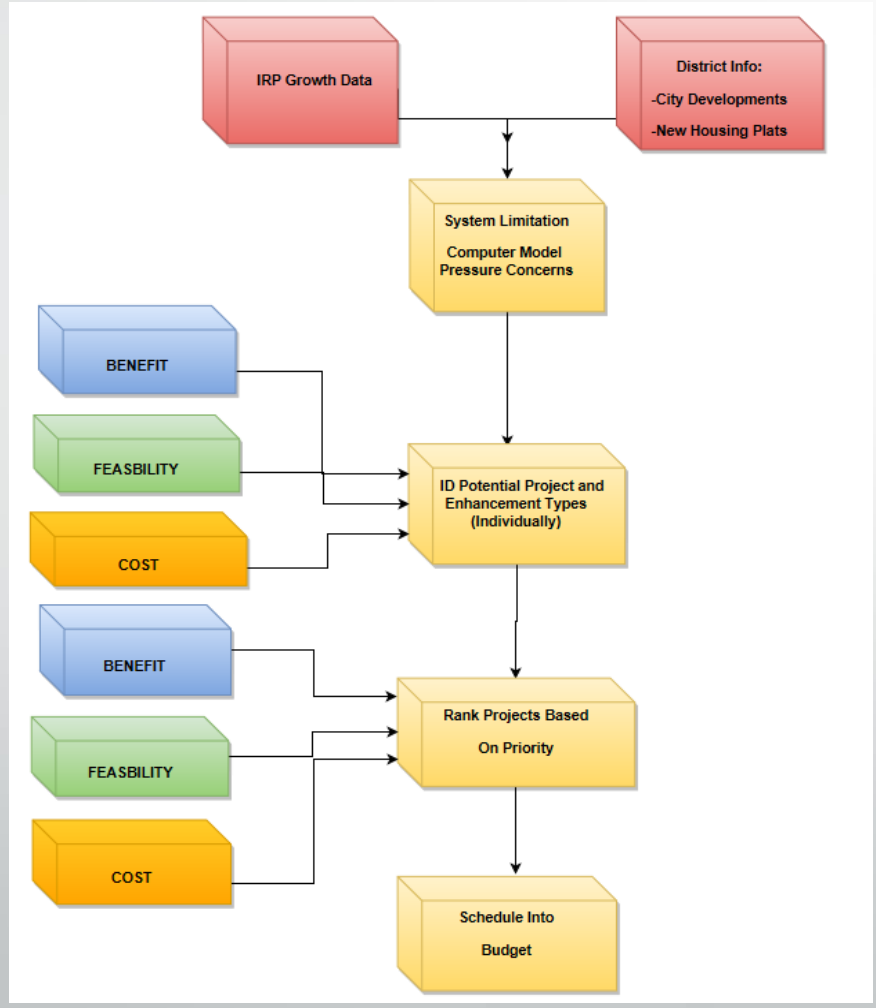
Project Process Flow



Info & Data

Project & Schedules

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CNG Future Projects

- Example upcoming growth projects

Location	2019	2020	2021
Burlington 4” PE Reinforcement	$ 676,507		
8” HP Yakima Reinforcement		$ 1,781,770	
Bellingham 6” PE Reinforcement			$ 1,733,876

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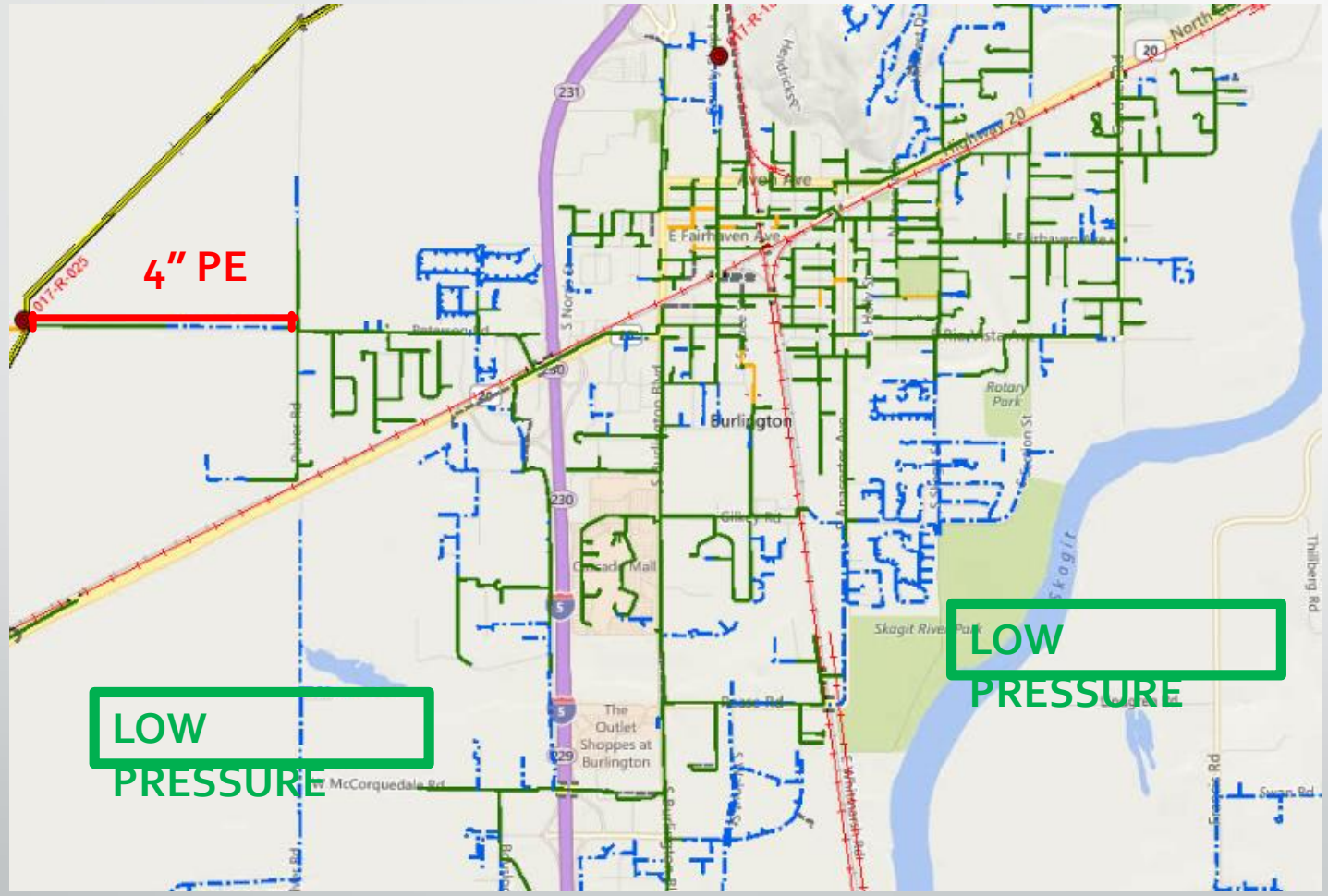
BURLINGTON 4" IP PE REINFORCEMENT



- 2019 PROJECT
- 4,000' OF 4" PE
- HAVE EXPERIENCED LOW PRESSURE DURING PEAK HEATING
- ALLOW FOR GROWTH IN SYSTEM

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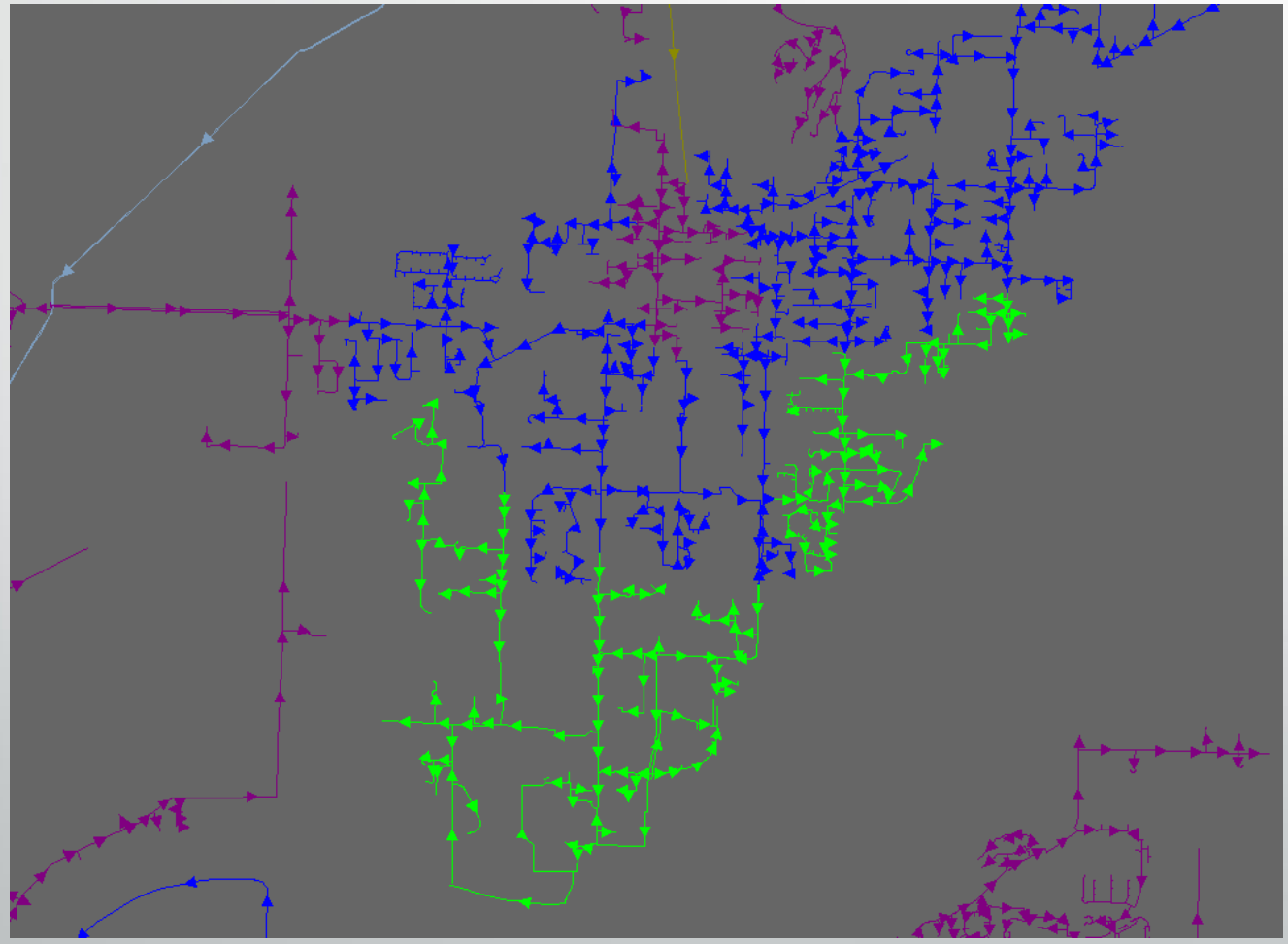
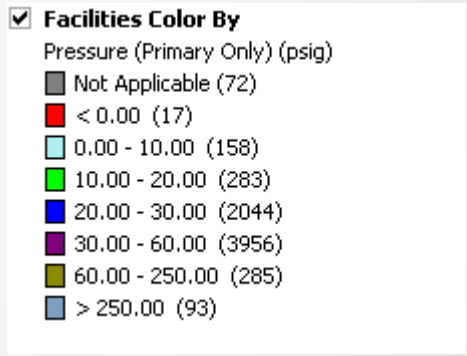
Burlington 4" IP PE Reinforcement

- Design day pressure before/after





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Conclusion

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

QUESTIONS ?

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Cascade Gas Supply Overview

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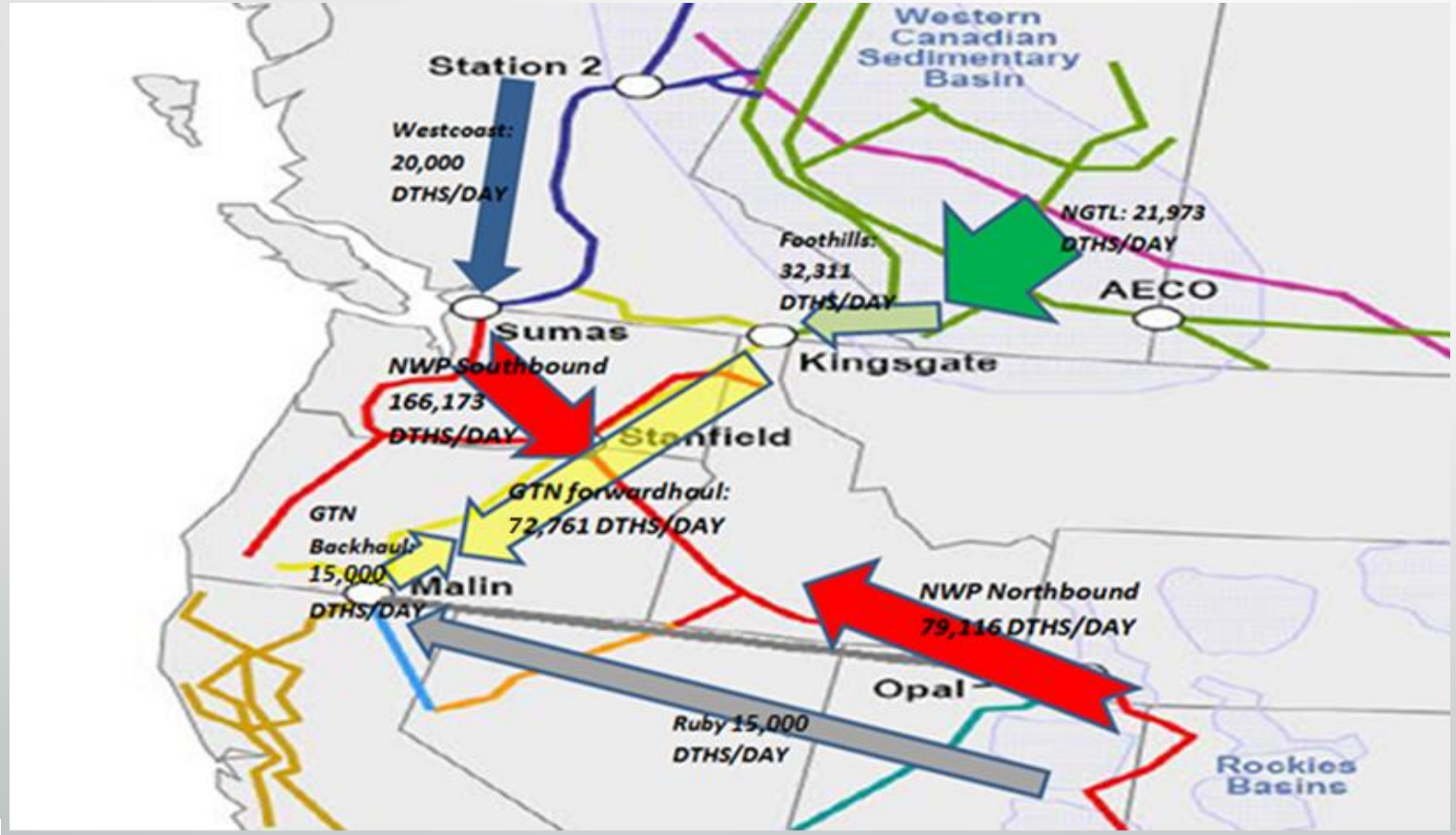
Pipeline transport flow



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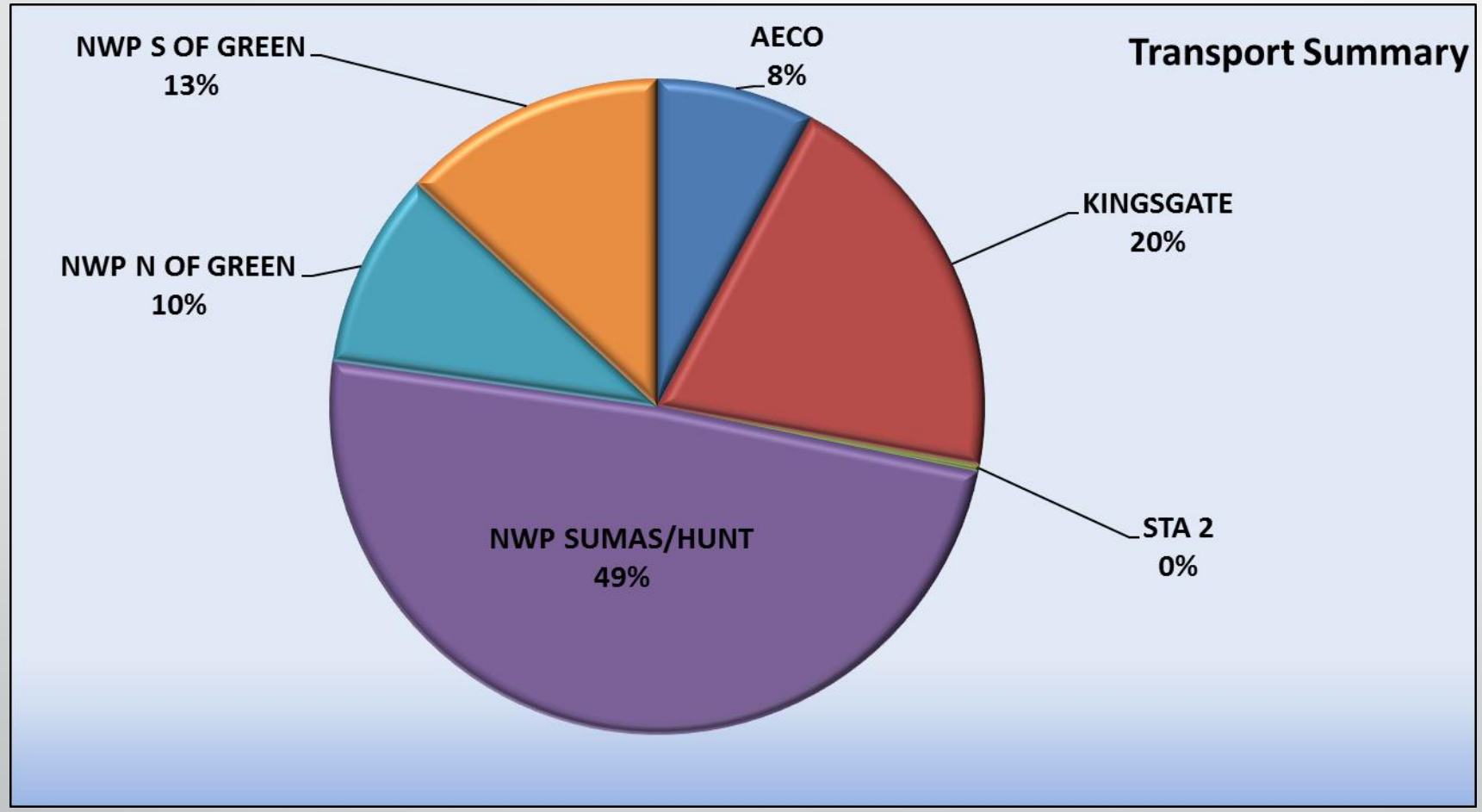
Transport Summary



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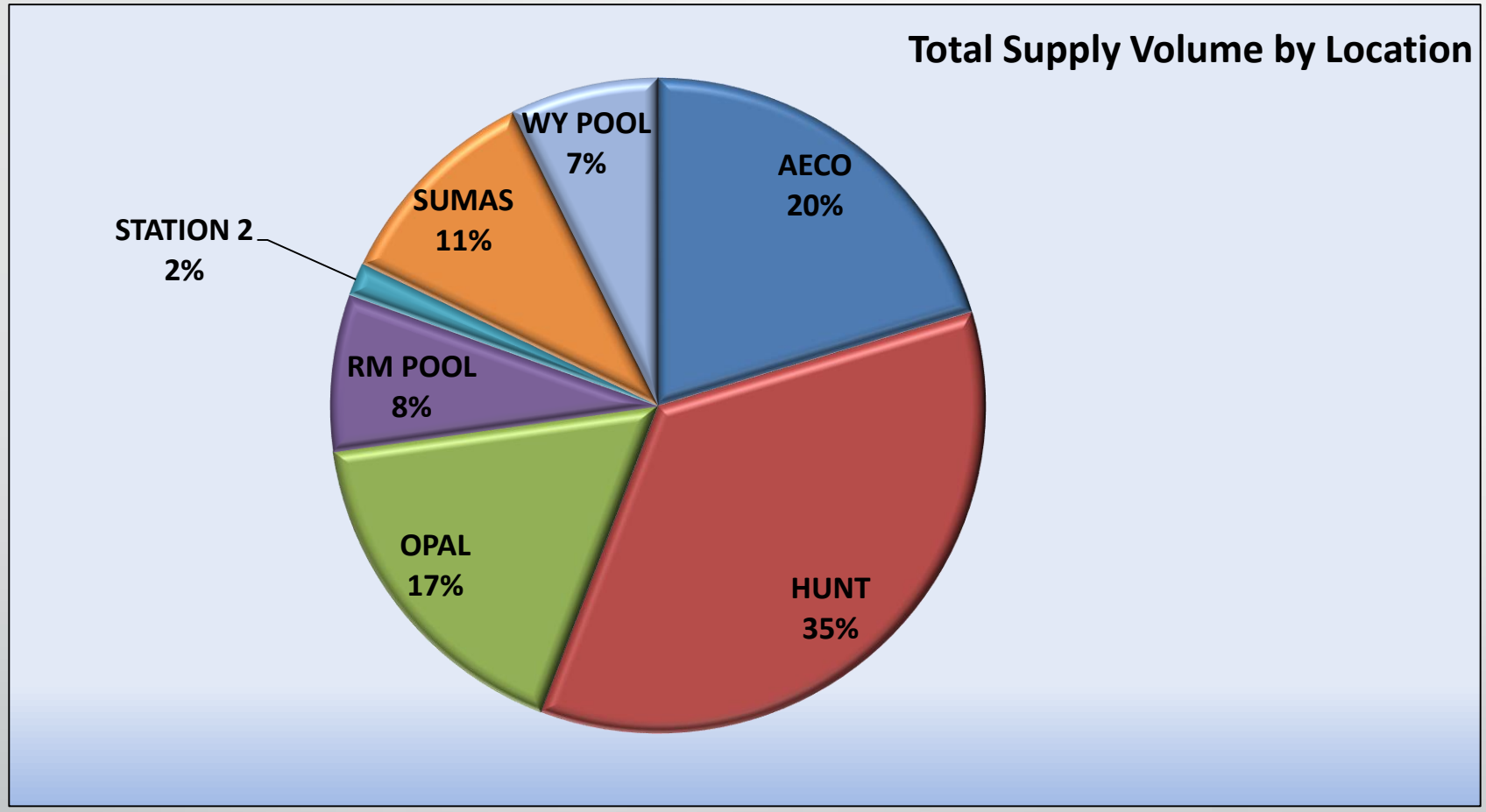
Supply Summary



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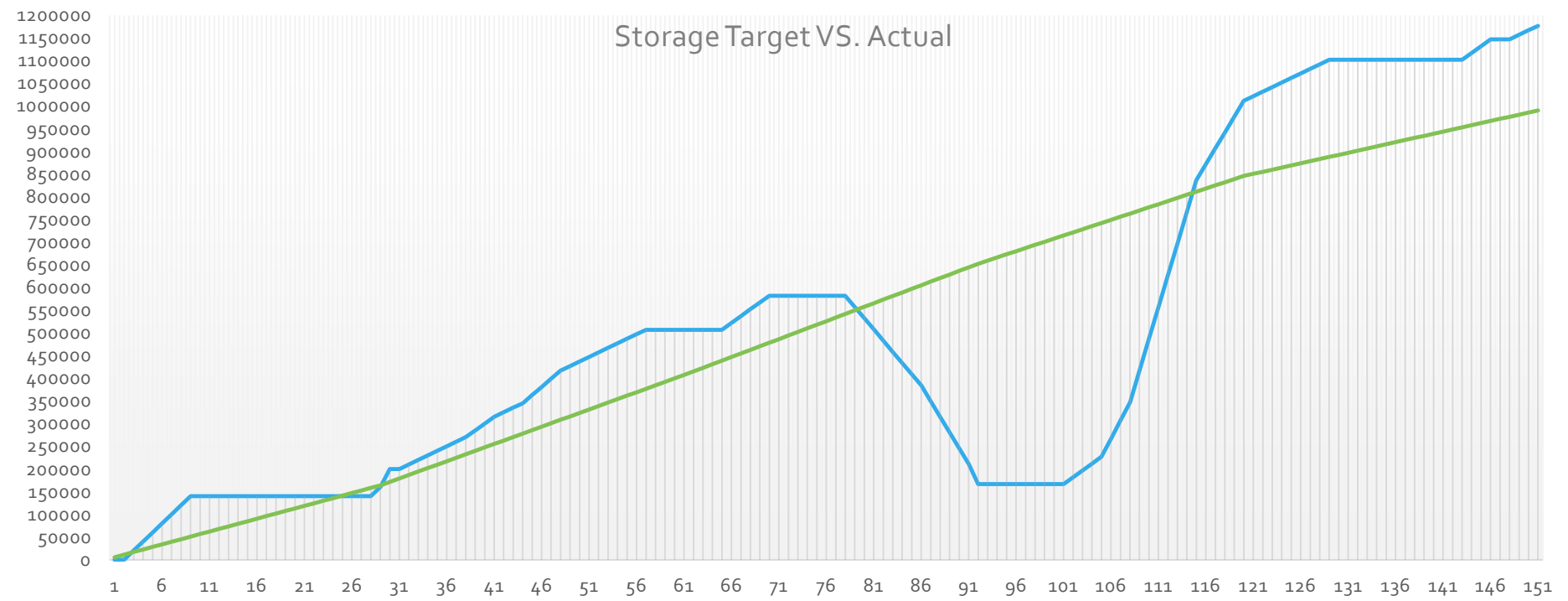
Storage Resources

- Jackson Prairie
  - 4 accounts with 1,235,593 dths capacity
  - CNGC cycled approximately 95% of Jackson Prairie storage over the past winter season
  - CNGC targets cycling Jackson Prairie
- Plymouth
  - 2 accounts with 662,200 dths capacity
  - New account of 100,000 dths added for the 2016/2017 season
  - In addition to above we acquired TF-2 (Firm Redelivery Transportation) of 10,675 dths
  - CNGC remains committed to using Plymouth as a peaking resource

2017/2018 Storage Use



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HIGHLIGHTS FOR THE 2017 PORTFOLIO DESIGN

- PORTFOLIO PROCUREMENT DESIGN BASED ON A DECLINING PERCENTAGE EACH YEAR, ACCORDINGLY: Year 1: Approximately 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
- 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.
  - Due to new WUTC hedging policy, may need to consider puts, calls, or financial derivatives to address fixed-priced physicals that may become "out of the money"
  - Hedging may need to be more flexible as policy develops
- CNGC's Gas Supply Oversight Committee (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.

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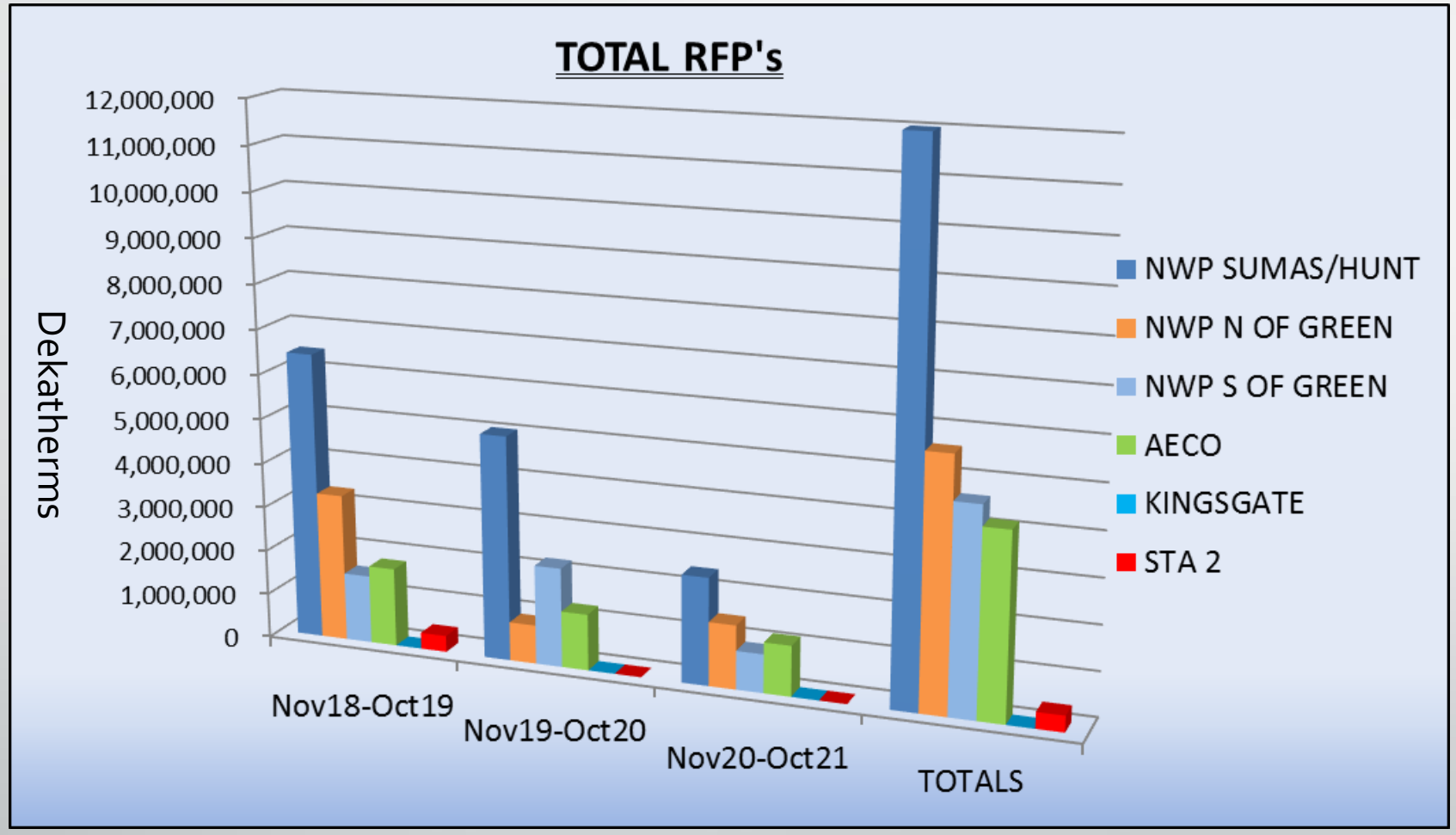
Total RFPs



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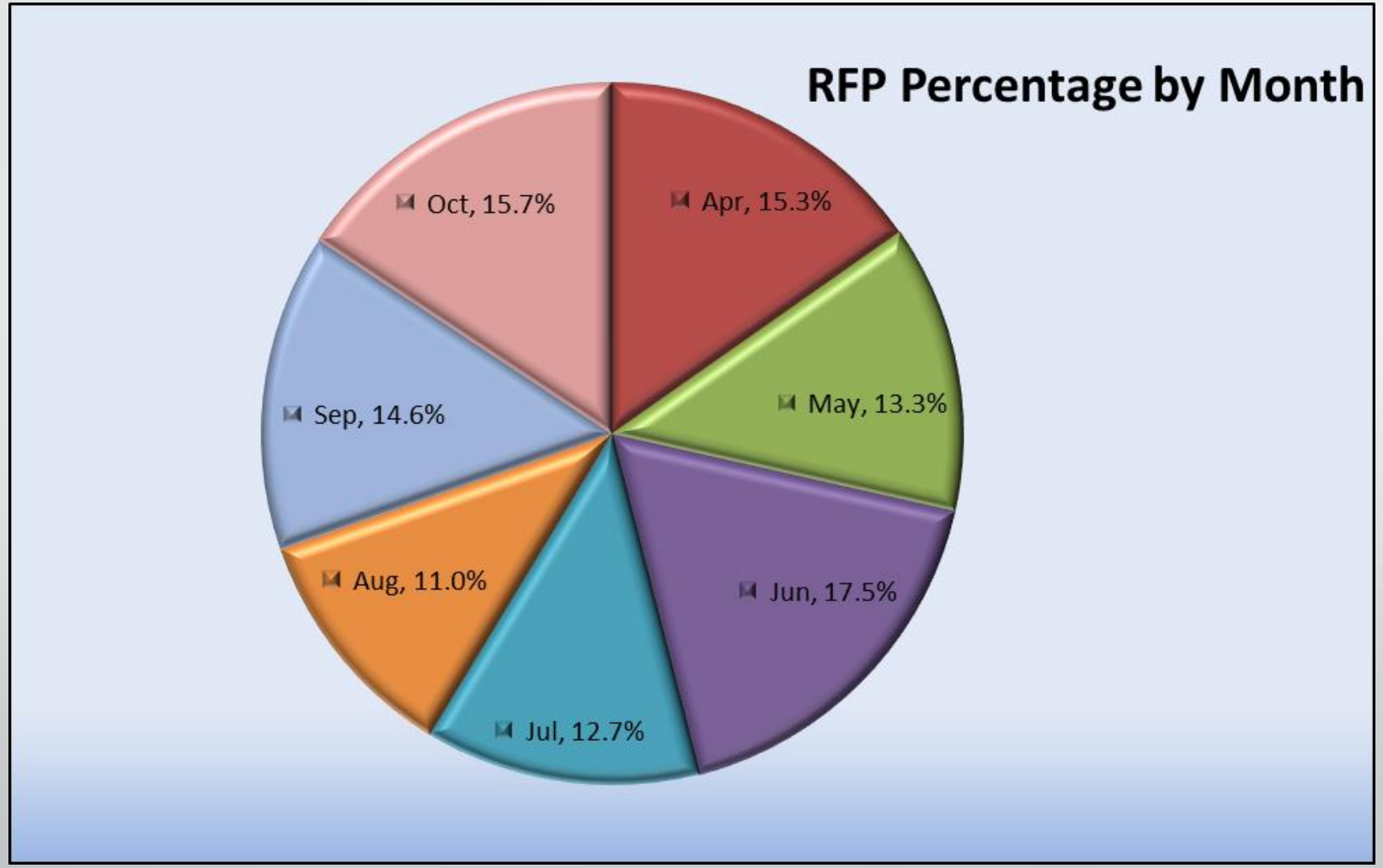
RFP Percentage by Month



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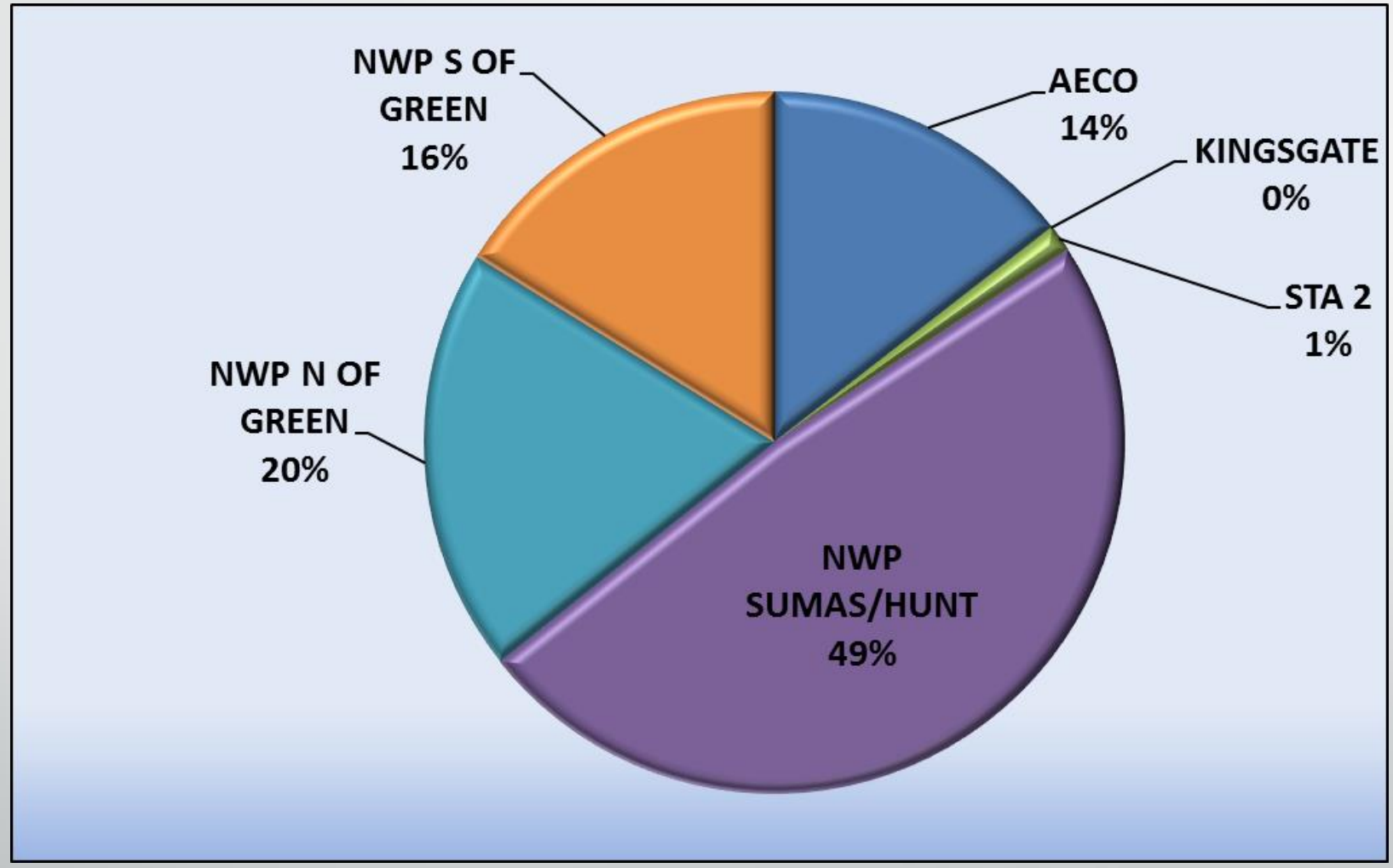
RFP Percentage By Basin



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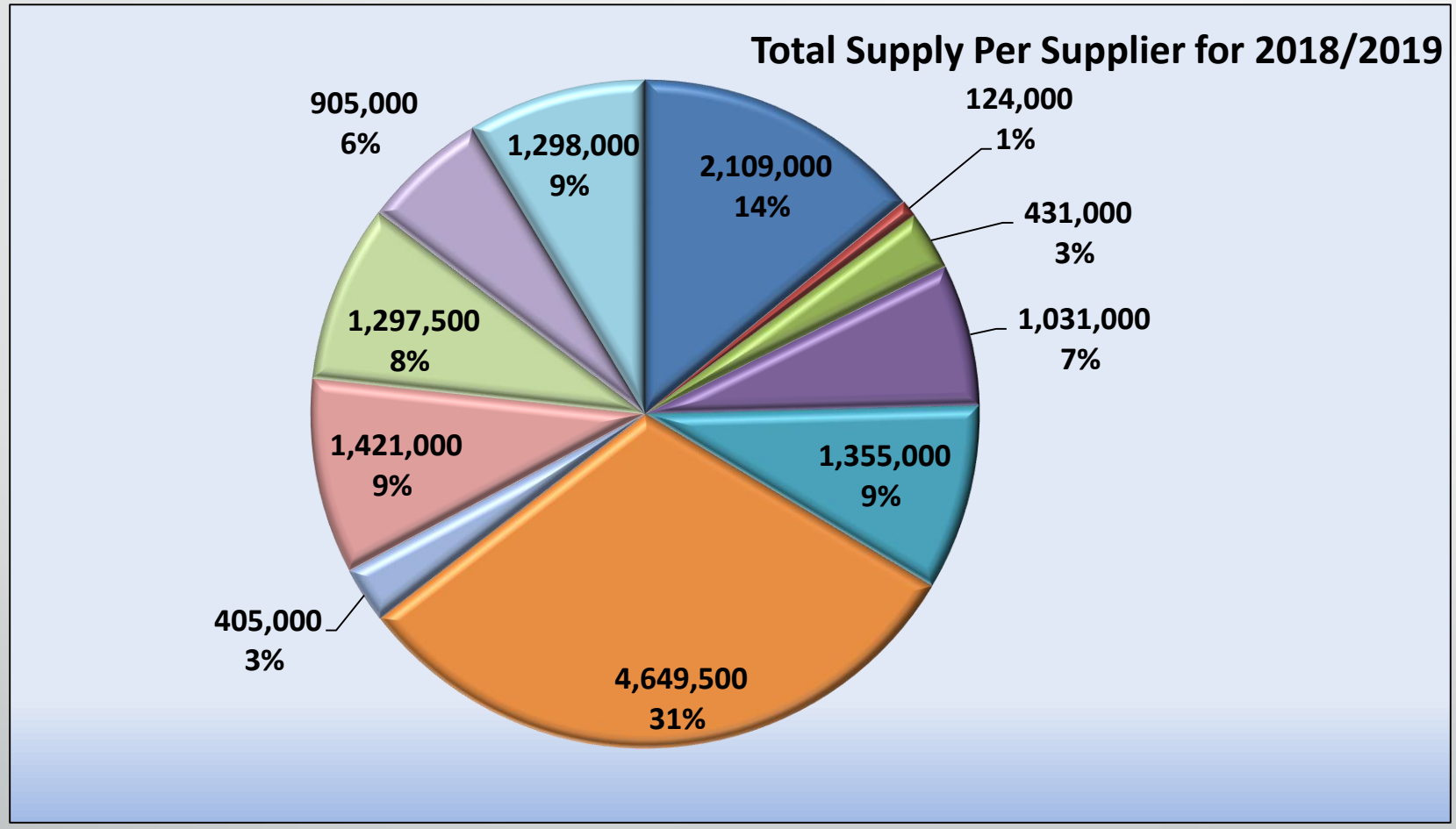
Current Supply Percentage by Supplier



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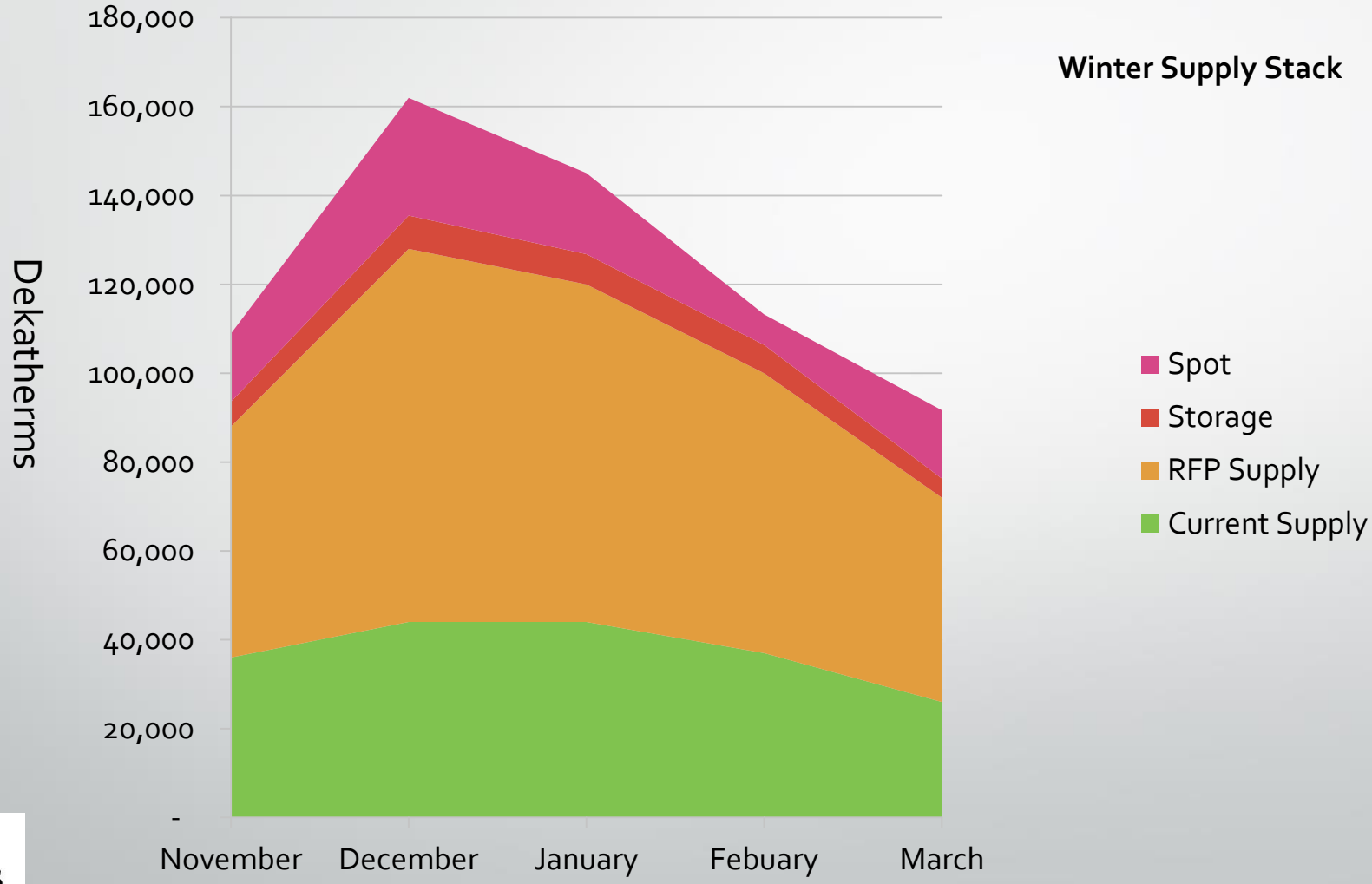
Winter Supply Stack



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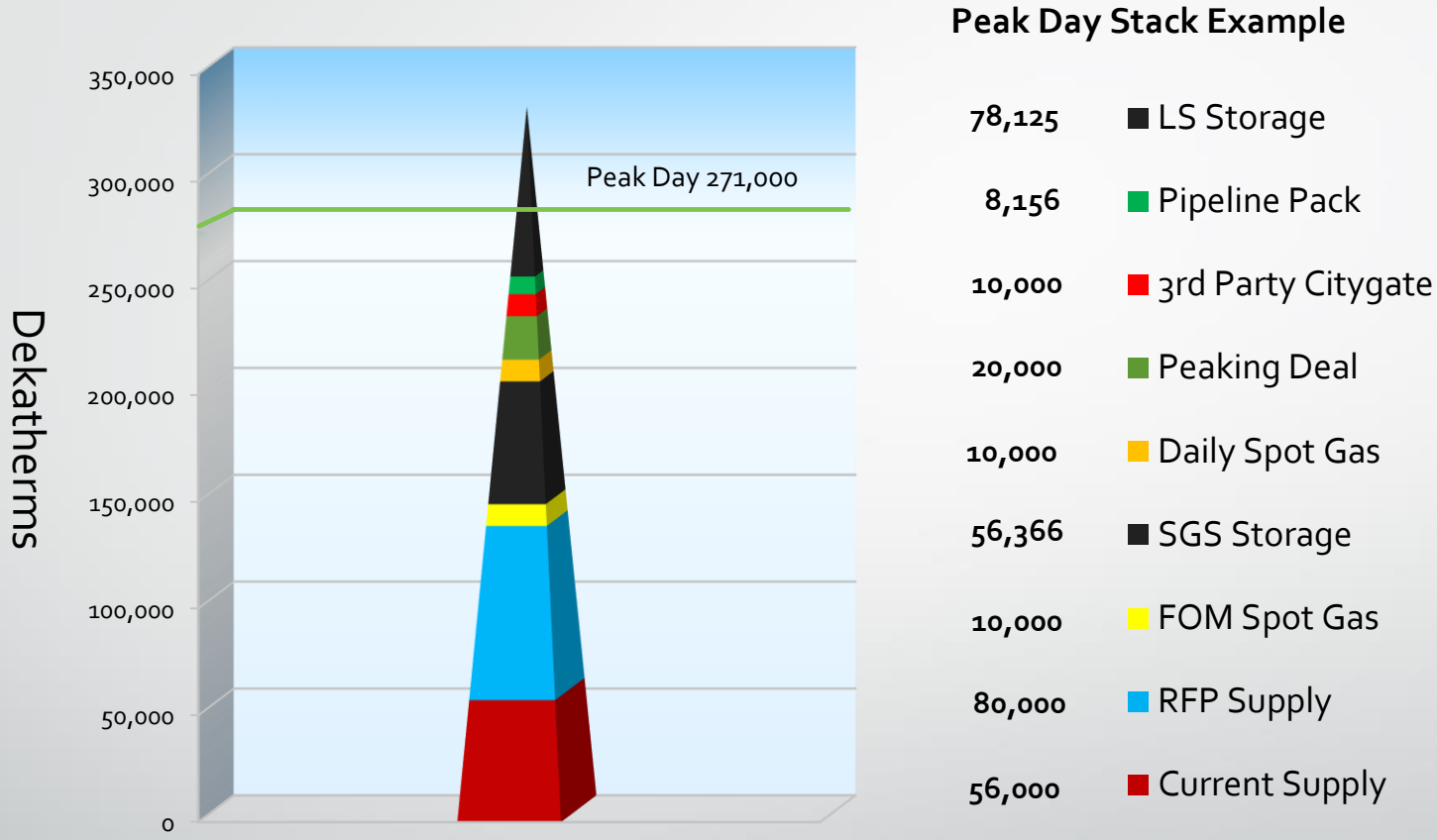
Peak Day Stack Example



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

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Planned Scenarios and Sensitivities

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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 Cont'd

- 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 Challenges

- Supply needs to get gas to the citygate.
- Many of Cascade's 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 rights are allocated.
- The aggregated look can mask individual citygate 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: As-Is Analysis**
  - Run a deterministic optimization of existing resources with a three-day peak event to uncover timing and quantity of resource deficiencies.
- **Step 2: Introduce Additional Resources**
  - Include incremental supply, storage, and transportation to derive a deterministic optimal portfolio, additional portfolios.
- **Step 3: Stochastic Analysis of All Portfolios Under Existing Conditions**
  - Run all portfolios through a Monte Carlo weather simulation, using expected growth, supply and storage accessibility. Record the probability distributions of total system costs for each portfolio.
- **Step 4: Ranking of Portfolios**
  - Determine the preferred portfolio based on the mean and Value at Risk (VaR) of the total system cost and unserved demand of each portfolio. This resource mix will be the best combination of cost and risk for Cascade and its customers.

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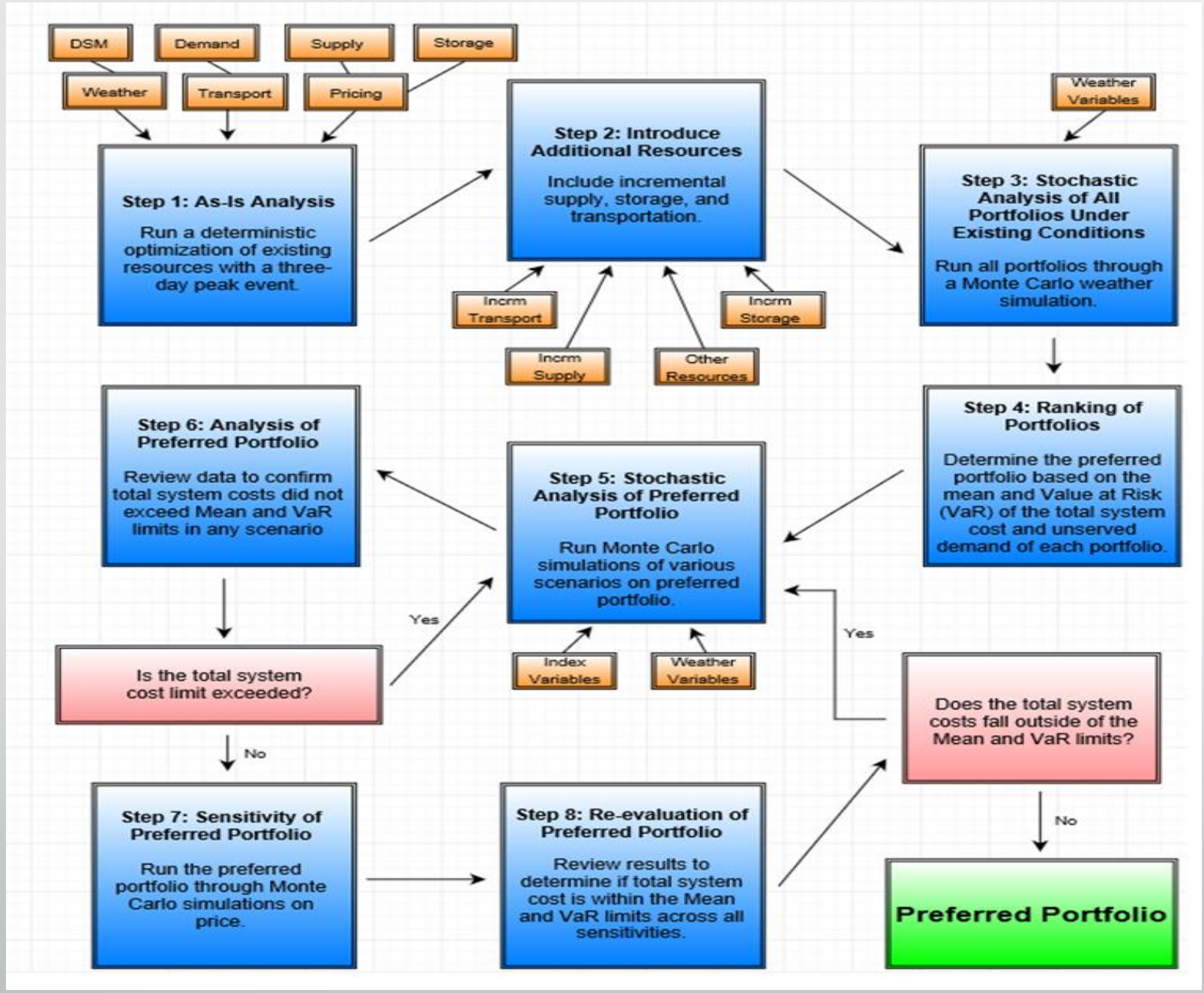
Supply Resource Optimization Process (Cont'd)

- **Step 5: Stochastic Analysis of Preferred Portfolio**
  - Run Monte Carlo simulations of various scenarios on preferred portfolio; comparing Mean and VaR to a managerial limit.
- **Step 6: Analysis of Preferred Portfolio**
  - Review data to confirm total system costs did not exceed Mean and VaR limits in any scenario. If limit is exceeded, repeat step 5 with next highest ranked portfolio.
- **Step 7: Sensitivity of Preferred Portfolio**
  - Run the preferred portfolio through Monte Carlo simulations on price. Review results to determine if total system cost is within the Mean and VaR limits across all sensitivities.
- **Step 8: Re-evaluation of Preferred Portfolio**
  - If the total system costs fall outside of the Mean and VaR limits in sensitivity analysis, select the next most optimal portfolio to run scenario and sensitivity analysis on. Repeat as needed.



Supply Resource Optimization Process Flow Chart

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Additional Preferred Portfolio Considerations

- Does it get supply to the citygate?
- Is it reliable?
- 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 or peaking resource?
- How many dekatherms are needed?
- 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?

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Scenarios and Sensitivities

- Scenario:
  - Change in projected demand
  - Change in availability of existing resources to serve demand
  - Change in availability of supply
- Sensitivity:
  - Change in price forecast
  - Change in environmental adder
  - Change in carbon forecast

Both carry the same importance, failure to pass either of them can lead to a portfolio being rejected

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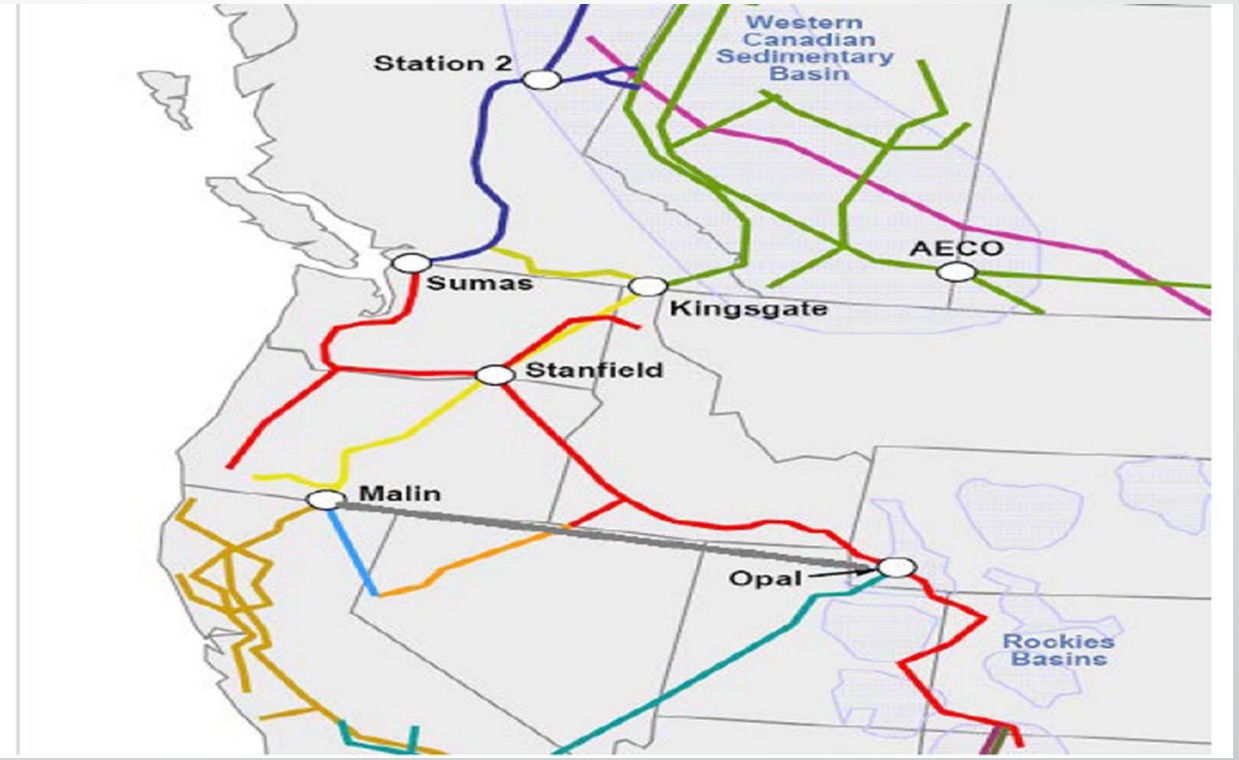
All In Case

	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. All items in BLUE mean those elements were dampened in the scenario.		
All In	**Current Station2**	**JP1**	**AECO Base/Fixed, Winter, Day W/S, Peak**
	Current NGTL	**JP2**	**SUMAS Base/Fixed, Winter, Day W/S, Peak**
	Current GTN	**JP3**	**ROCKIES Base/Fixed, Winter, Day W/S, Peak**
	Current NWP	**JP4**	**HUNT Base/Fixed, Winter, Day W/S**
	Current Foothills	**PLY-1**	**KINGSGATE Base**
	Current Ruby	**PLY-2**	**OPAL Base**
			STAT2 Base
	Incremental NGTL	***Ryckman Crk Storage***	***Opal Incrm Supply***
	Incremental GTN N-S	***Gill Ranch Storage***	***BioNaturalGas***
	NWP I-5 Mainline EXP	***Mist Storage***	***Resource Mix - 3 Basins***
	Incremental Ruby	***Wild Goose Storage***	
	NWP Wen lateral EXP	***Aeco Hub Storage***	
	Incremental Foothills	***Magnum Storage***	
	NWP Z20 lateral EXP	***Clay Basin Storage***	
	T-South-So Crossing		
	Trails West (Palomar)		
	NWP East OR Mainline EXP		
	Incremental GTN S-N		
	Incremental Enbridge		
	Pacific Connector		



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

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Low Growth and High Growth

	KEY ELEMENTS IN SENDOUT SCENARIO		
	Low 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. All items in BLUE mean those elements were dampened in the scenario.		
Low Growth	**Current Station2**	**JP1**	**AECO Base/Fixed, Winter, Day W/S, Peak**
	Current NGTL	**JP2**	**SUMAS Base/Fixed, Winter, Day W/S, Peak**
	Current GTN	**JP3**	**ROCKIES Base/Fixed, Winter, Day W/S, Peak**
	Current NWP	**JP4**	**HUNT Base/Fixed, Winter, Day W/S**
	Current Foothills	**PLY-1**	**KINGSGATE Base**
	Current Ruby	**PLY-2**	**OPAL Base**
			STAT2 Base
	Incremental NGTL	***Ryckman Crk Storage***	***Opal Incrm Supply***
	Incremental GTN N-S	***Gill Ranch Storage***	***BioNaturalGas***
	NWP I-5 Mainline EXP	***Mist Storage***	***Resource Mix - 3 Basins***
	Incremental Ruby	***Wild Goose Storage***	
	NWP Wen lateral EXP	***Aeco Hub Storage***	
	Incremental Foothills	***Magnum Storage***	
	NWP Z20 lateral EXP	***Clay Basin Storage***	
	T-South-So Crossing		
	Trails West (Palomar)		
	NWP East OR Mainline EXP		
	Incremental GTN S-N		
	Incremental Enbridge		
	Pacific Connector		

	KEY ELEMENTS IN SENDOUT SCENARIO		
	High 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. All items in BLUE mean those elements were dampened in the scenario.		
High Growth	**Current Station2**	**JP1**	**AECO Base/Fixed, Winter, Day W/S, Peak**
	Current NGTL	**JP2**	**SUMAS Base/Fixed, Winter, Day W/S, Peak**
	Current GTN	**JP3**	**ROCKIES Base/Fixed, Winter, Day W/S, Peak**
	Current NWP	**JP4**	**HUNT Base/Fixed, Winter, Day W/S**
	Current Foothills	**PLY-1**	**KINGSGATE Base**
	Current Ruby	**PLY-2**	**OPAL Base**
			STAT2 Base
	Incremental NGTL	***Ryckman Crk Storage***	***Opal Incrm Supply***
	Incremental GTN N-S	***Gill Ranch Storage***	***BioNaturalGas***
	NWP I-5 Mainline EXP	***Mist Storage***	***Resource Mix - 3 Basins***
	Incremental Ruby	***Wild Goose Storage***	
	NWP Wen lateral EXP	***Aeco Hub Storage***	
	Incremental Foothills	***Magnum Storage***	
	NWP Z20 lateral EXP	***Clay Basin Storage***	
	T-South-So Crossing		
	Trails West (Palomar)		
	NWP East OR Mainline EXP		
	Incremental GTN S-N		
	Incremental Enbridge		
	Pacific Connector		

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Limit BC and Limit Alberta

	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. All items in BLUE mean those elements were dampened in the scenario.		
Limit BC	**Current Station2**	**JP1**	**AECO Base/Fixed, Winter, Day W/S, Peak**
	Current NGTL	**JP2**	**SUMAS Base/Fixed, Winter, Day W/S, Peak**
	Current GTN	**JP3**	**ROCKIES Base/Fixed, Winter, Day W/S, Peak**
	Current NWP	**JP4**	**HUNT Base/Fixed, Winter, Day W/S**
	Current Foothills	**PLY-1**	**KINGSGATE Base**
	Current Ruby	**PLY-2**	**OPAL Base**
			STAT2 Base
	Incremental NGTL	***Ryckman Crk Storage***	***Opal Incrm Supply***
	Incremental GTN N-S	***Gill Ranch Storage***	***BioNaturalGas***
	NWP I-5 Mainline EXP	***Mist Storage***	***Resource Mix - 3 Basins***
	Incremental Ruby	***Wild Goose Storage***	
	NWP Wen lateral EXP	***Aeco Hub Storage***	
	Incremental Foothills	***Magnum Storage***	
	NWP Z20 lateral EXP	***Clay Basin Storage***	
	T-South-So Crossing		
	Trails West (Palomar)		
	NWP East OR Mainline EXP		
	Incremental GTN S-N		
	Incremental Enbridge		
	Pacific Connector		

	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. All items in BLUE mean those elements were dampened in the scenario.		
Limit Alberta	**Current Station2**	**JP1**	**AECO Base/Fixed, Winter, Day W/S, Peak**
	Current NGTL	**JP2**	**SUMAS Base/Fixed, Winter, Day W/S, Peak**
	Current GTN	**JP3**	**ROCKIES Base/Fixed, Winter, Day W/S, Peak**
	Current NWP	**JP4**	**HUNT Base/Fixed, Winter, Day W/S**
	Current Foothills	**PLY-1**	**KINGSGATE Base**
	Current Ruby	**PLY-2**	**OPAL Base**
			STAT2 Base
	Incremental NGTL	***Ryckman Crk Storage***	***Opal Incrm Supply***
	Incremental GTN N-S	***Gill Ranch Storage***	***BioNaturalGas***
	NWP I-5 Mainline EXP	***Mist Storage***	***Resource Mix - 3 Basins***
	Incremental Ruby	***Wild Goose Storage***	
	NWP Wen lateral EXP	***Aeco Hub Storage***	
	Incremental Foothills	***Magnum Storage***	
	NWP Z20 lateral EXP	***Clay Basin Storage***	
	T-South-So Crossing		
	Trails West (Palomar)		
	NWP East OR Mainline EXP		
	Incremental GTN S-N		
	Incremental Enbridge		
	Pacific Connector		

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Limit Canada and Limit Rockies

	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. All items in BLUE mean those elements were dampened in the scenario.		
Limit Canada	**Current Station2**	**JP1**	**AECO Base/Fixed, Winter, Day W/S, Peak**
	Current NGTL	**JP2**	**SUMAS Base/Fixed, Winter, Day W/S, Peak**
	Current GTN	**JP3**	**ROCKIES Base/Fixed, Winter, Day W/S, Peak**
	Current NWP	**JP4**	**HUNT Base/Fixed, Winter, Day W/S**
	Current Foothills	**PLY-1**	**KINGSGATE Base**
	Current Ruby	**PLY-2**	**OPAL Base**
			STAT2 Base
	Incremental NGTL	***Ryckman Crk Storage***	***Opal Incrm Supply***
	Incremental GTN N-S	***Gill Ranch Storage***	***BioNaturalGas***
	NWP I-5 Mainline EXP	***Mist Storage***	***Resource Mix - 3 Basins***
	Incremental Ruby	***Wild Goose Storage***	
	NWP Wen lateral EXP	***Aeco Hub Storage***	
	Incremental Foothills	***Magnum Storage***	
	NWP Z20 lateral EXP	***Clay Basin Storage***	
	T-South-So Crossing		
	Trails West (Palomar)		
	NWP East OR Mainline EXP		
	Incremental GTN S-N		
	Incremental Enbridge		
	Pacific Connector		

	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. All items in BLUE mean those elements were dampened in the scenario.		
Limit Rockies	**Current Station2**	**JP1**	**AECO Base/Fixed, Winter, Day W/S, Peak**
	Current NGTL	**JP2**	**SUMAS Base/Fixed, Winter, Day W/S, Peak**
	Current GTN	**JP3**	**ROCKIES Base/Fixed, Winter, Day W/S, Peak**
	Current NWP	**JP4**	**HUNT Base/Fixed, Winter, Day W/S**
	Current Foothills	**PLY-1**	**KINGSGATE Base**
	Current Ruby	**PLY-2**	**OPAL Base**
			STAT2 Base
	Incremental NGTL	***Ryckman Crk Storage***	***Opal Incrm Supply***
	Incremental GTN N-S	***Gill Ranch Storage***	***BioNaturalGas***
	NWP I-5 Mainline EXP	***Mist Storage***	***Resource Mix - 3 Basins***
	Incremental Ruby	***Wild Goose Storage***	
	NWP Wen lateral EXP	***Aeco Hub Storage***	
	Incremental Foothills	***Magnum Storage***	
	NWP Z20 lateral EXP	***Clay Basin Storage***	
	T-South-So Crossing		
	Trails West (Palomar)		
	NWP East OR Mainline EXP		
	Incremental GTN S-N		
	Incremental Enbridge		
	Pacific Connector		

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Limit JP and Limit Ply Storage

	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. All items in BLUE mean those elements were dampened in the scenario.		
Limit Storage - JP	Current Station2	JP1	AECO Base/Fixed, Winter, Day W/S, Peak
	Current NGTL	JP2	SUMAS Base/Fixed, Winter, Day W/S, Peak
	Current GTN	JP3	ROCKIES Base/Fixed, Winter, Day W/S, Peak
	Current NWP	JP4	HUNT Base/Fixed, Winter, Day W/S
	Current Foothills	PLY-1	KINGSGATE Base
	Current Ruby	PLY-2	OPAL Base
			STAT2 Base
	Incremental NGTL	*Ryckman Crk Storage*	*Opal Incrm Supply*
	Incremental GTN N-S	*Gill Ranch Storage*	*BioNaturalGas*
	NWP I-5 Mainline EXP	*Mist Storage*	*Resource Mix - 3 Basins*
	Incremental Ruby	*Wild Goose Storage*	
	NWP Wen lateral EXP	*Aeco Hub Storage*	
	Incremental Foothills	*Magnum Storage*	
	NWP Z20 lateral EXP	*Clay Basin Storage*	
	T-South-So Crossing		
	Trails West (Palomar)		
	NWP East OR Mainline EXP		
	Incremental GTN S-N		
	Incremental Enbridge		
	Pacific Connector		

	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. All items in BLUE mean those elements were dampened in the scenario.		
Limit Storage - Ply	Current Station2	JP1	AECO Base/Fixed, Winter, Day W/S, Peak
	Current NGTL	JP2	SUMAS Base/Fixed, Winter, Day W/S, Peak
	Current GTN	JP3	ROCKIES Base/Fixed, Winter, Day W/S, Peak
	Current NWP	JP4	HUNT Base/Fixed, Winter, Day W/S
	Current Foothills	PLY-1	KINGSGATE Base
	Current Ruby	PLY-2	OPAL Base
			STAT2 Base
	Incremental NGTL	*Ryckman Crk Storage*	*Opal Incrm Supply*
	Incremental GTN N-S	*Gill Ranch Storage*	*BioNaturalGas*
	NWP I-5 Mainline EXP	*Mist Storage*	*Resource Mix - 3 Basins*
	Incremental Ruby	*Wild Goose Storage*	
	NWP Wen lateral EXP	*Aeco Hub Storage*	
	Incremental Foothills	*Magnum Storage*	
	NWP Z20 lateral EXP	*Clay Basin Storage*	
	T-South-So Crossing		
	Trails West (Palomar)		
	NWP East OR Mainline EXP		
	Incremental GTN S-N		
	Incremental Enbridge		
	Pacific Connector		

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Limit Both Storage and No JP

	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. All items in BLUE mean those elements were dampened in the scenario.		
Limit Storage - Both	Current Station2	JP1	AECO Base/Fixed, Winter, Day W/S, Peak
	Current NGTL	JP2	SUMAS Base/Fixed, Winter, Day W/S, Peak
	Current GTN	JP3	ROCKIES Base/Fixed, Winter, Day W/S, Peak
	Current NWP	JP4	HUNT Base/Fixed, Winter, Day W/S
	Current Foothills	PLY-1	KINGSGATE Base
	Current Ruby	PLY-2	OPAL Base
			STAT2 Base
	Incremental NGTL	*Ryckman Crk Storage*	*Opal Incrm Supply*
	Incremental GTN N-S	*Gill Ranch Storage*	*BioNaturalGas*
	NWP I-5 Mainline EXP	*Mist Storage*	*Resource Mix - 3 Basins*
	Incremental Ruby	*Wild Goose Storage*	
	NWP Wen lateral EXP	*Aeco Hub Storage*	
	Incremental Foothills	*Magnum Storage*	
	NWP Z20 lateral EXP	*Clay Basin Storage*	
	T-South-So Crossing		
	Trails West (Palomar)		
	NWP East OR Mainline EXP		
	Incremental GTN S-N		
	Incremental Enbridge		
	Pacific Connector		

	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. All items in BLUE mean those elements were dampened in the scenario.		
No Storage - JP	Current Station2	JP1	AECO Base/Fixed, Winter, Day W/S, Peak
	Current NGTL	JP2	SUMAS Base/Fixed, Winter, Day W/S, Peak
	Current GTN	JP3	ROCKIES Base/Fixed, Winter, Day W/S, Peak
	Current NWP	JP4	HUNT Base/Fixed, Winter, Day W/S
	Current Foothills	PLY-1	KINGSGATE Base
	Current Ruby	PLY-2	OPAL Base
			STAT2 Base
	Incremental NGTL	*Ryckman Crk Storage*	*Opal Incrm Supply*
	Incremental GTN N-S	*Gill Ranch Storage*	*BioNaturalGas*
	NWP I-5 Mainline EXP	*Mist Storage*	*Resource Mix - 3 Basins*
	Incremental Ruby	*Wild Goose Storage*	
	NWP Wen lateral EXP	*Aeco Hub Storage*	
	Incremental Foothills	*Magnum Storage*	
	NWP Z20 lateral EXP	*Clay Basin Storage*	
	T-South-So Crossing		
	Trails West (Palomar)		
	NWP East OR Mainline EXP		
	Incremental GTN S-N		
	Incremental Enbridge		
	Pacific Connector		

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No Ply Storage and No Storage

	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. All items in BLUE mean those elements were dampened in the scenario.		
No Storage - Ply	**Current Station2** **Current NGTL** **Current GTN** **Current NWP** **Current Foothills** **Current Ruby** ***Incremental NGTL*** ***Incremental GTN N-S*** ***NWP I-5 Mainline EXP*** ***Incremental Ruby*** ***NWP Wen lateral EXP*** ***Incremental Foothills*** ***NWP Z20 lateral EXP*** ***T-South-So Crossing*** ***Trails West (Palomar)*** ***NWP East OR Mainline EXP*** ***Incremental GTN S-N*** ***Incremental Enbridge*** ***Pacific Connector***	**JP1** **JP2** **JP3** **JP4** **PLY-1** **PLY-2** ***Ryckman Crk Storage*** ***Gill Ranch Storage*** ***Mist Storage*** ***Wild Goose Storage*** ***Aeco Hub Storage*** ***Magnum Storage*** ***Clay Basin Storage***	**AECO Base/Fixed, Winter, Day W/S, Peak** **SUMAS Base/Fixed, Winter, Day W/S, Peak** **ROCKIES Base/Fixed, Winter, Day W/S, Peak** **HUNT Base/Fixed, Winter, Day W/S** **KINGSGATE Base** **OPAL Base** **STAT2 Base** ***Opal Incrm Supply*** ***BioNaturalGas*** ***Resource Mix - 3 Basins***

	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. All items in BLUE mean those elements were dampened in the scenario.		
No Storage - Both	**Current Station2** **Current NGTL** **Current GTN** **Current NWP** **Current Foothills** **Current Ruby** ***Incremental NGTL*** ***Incremental GTN N-S*** ***NWP I-5 Mainline EXP*** ***Incremental Ruby*** ***NWP Wen lateral EXP*** ***Incremental Foothills*** ***NWP Z20 lateral EXP*** ***T-South-So Crossing*** ***Trails West (Palomar)*** ***NWP East OR Mainline EXP*** ***Incremental GTN S-N*** ***Incremental Enbridge*** ***Pacific Connector***	**JP1** **JP2** **JP3** **JP4** **PLY-1** **PLY-2** ***Ryckman Crk Storage*** ***Gill Ranch Storage*** ***Mist Storage*** ***Wild Goose Storage*** ***Aeco Hub Storage*** ***Magnum Storage*** ***Clay Basin Storage***	**AECO Base/Fixed, Winter, Day W/S, Peak** **SUMAS Base/Fixed, Winter, Day W/S, Peak** **ROCKIES Base/Fixed, Winter, Day W/S, Peak** **HUNT Base/Fixed, Winter, Day W/S** **KINGSGATE Base** **OPAL Base** **STAT2 Base** ***Opal Incrm Supply*** ***BioNaturalGas*** ***Resource Mix - 3 Basins***

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Sensitivities Analyses

Sensitivities		Assumpitons
Price	High	Medium Load Growth, Average Weather with Peak Event, High Gas Price Environment
	Low	Medium Load Growth, Average Weather with Peak Event, Low Gas Price Environment
Env. Adder	0%	Medium Load Growth, Average Weather with Peak Event, Medium Gas Price Environment with No Adder for Unknown Regulatory Impacts
	20%	Medium Load Growth, Average Weather with Peak Event, Medium Gas Price Environment with 20% Adder for Unknown Regulatory Impacts
	30%	Medium Load Growth, Average Weather with Peak Event, Medium Gas Price Environment with 30% Adder for Unknown Regulatory Impacts
Carbon Adder	Various	Medium Load Growth, Average Weather with Peak Event, Medium Gas Price Environment with Various Potential Carbon Futures Modeled

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Alternative Resources

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Major resource issues on the horizon

- Once a deficiency is identified, Cascade must analyze potential solutions to ensure service over the planning horizon.
- Conversations with partners at various pipelines, storage facilities, new supply sources.
- SENDOUT® is used to ultimately derive the optimal mix of resources, referred to as the "preferred portfolio."

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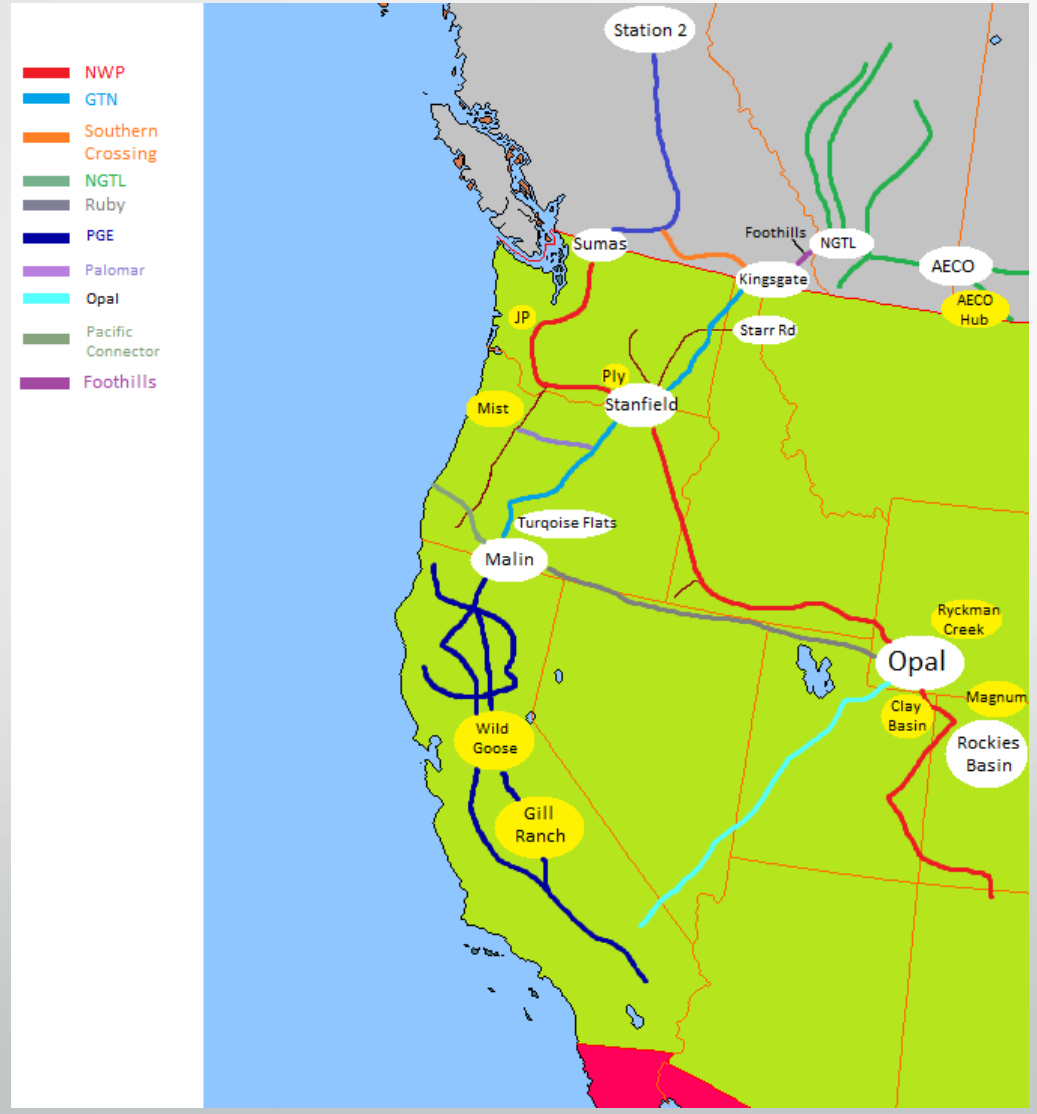
Location of Current & Alternative Resources



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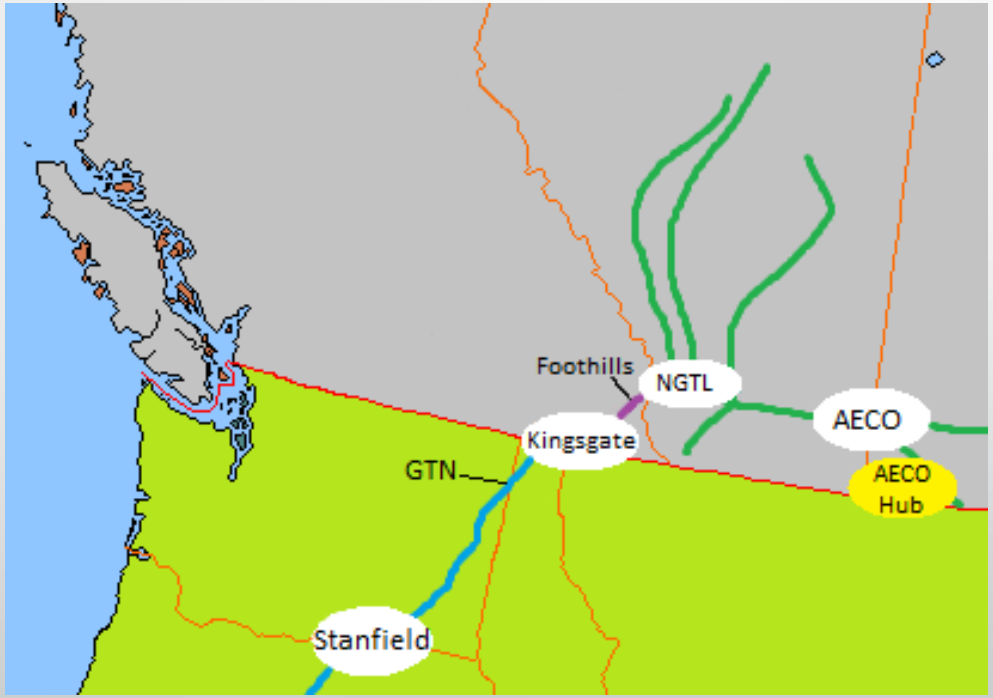
Incremental Transport – North to South

- Incremental NGTL – Additional capacity to move gas from AECO basin to Alberta/BC border
- Incremental Foothills – Additional capacity to move gas from Alberta/BC border to Kingsgate
- Incremental GTN N/S – Additional capacity to move gas from Kingsgate to various citygates along GTN



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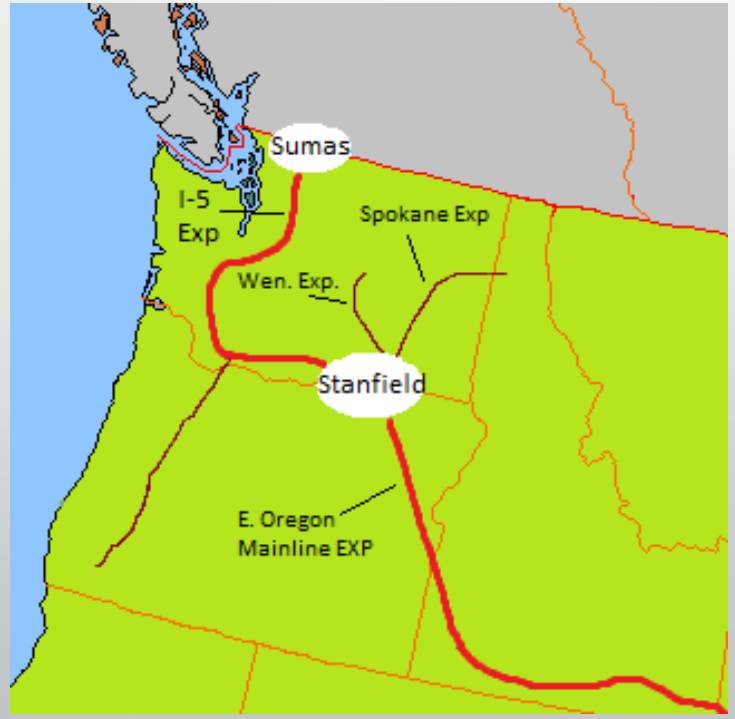
Incremental Transport – Northwest Pipeline

- I-5 Mainline Expansion – Additional capacity to move gas along I-5 corridor in western Washington
- Wenatchee Lateral Expansion – Additional capacity to move gas along Wenatchee Lateral to central Washington
- Spokane Lateral Expansion – Additional capacity to move gas along Spokane Lateral to eastern Washington
- Eastern Oregon Mainline Expansion – Additional capacity to move gas along Eastern Oregon Lateral to Oregon citygates



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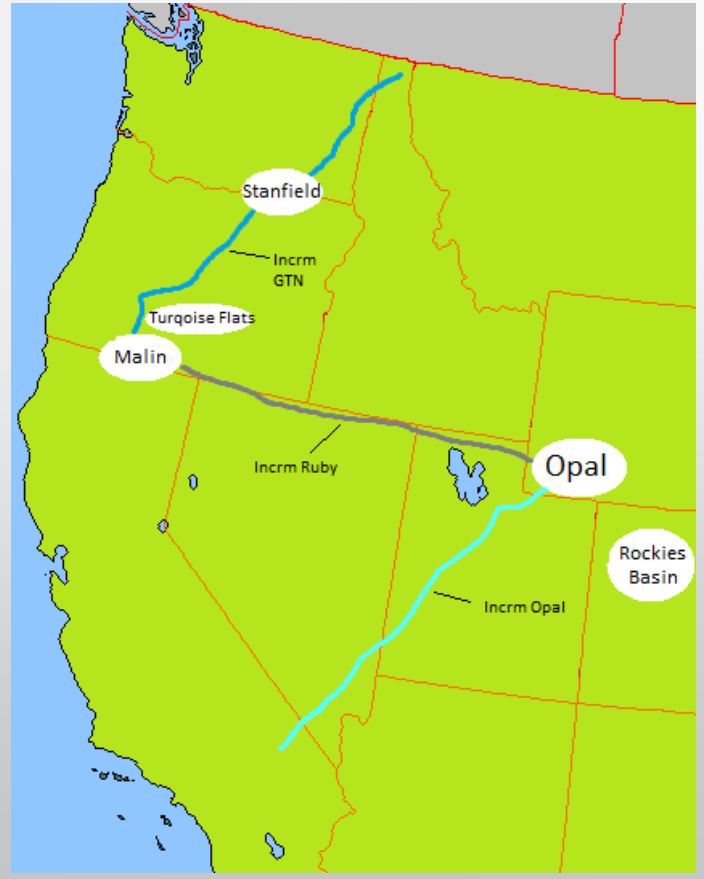
Incremental Transport – South to North

- Incremental Opal– Additional capacity to move gas from Utah to Opal
- Incremental GTN S/N – Additional capacity to move gas from Turquois Flats to various citygates along GTN
- Incremental Ruby – Additional capacity to move gas from Rockies Basin to Turquoise Flats



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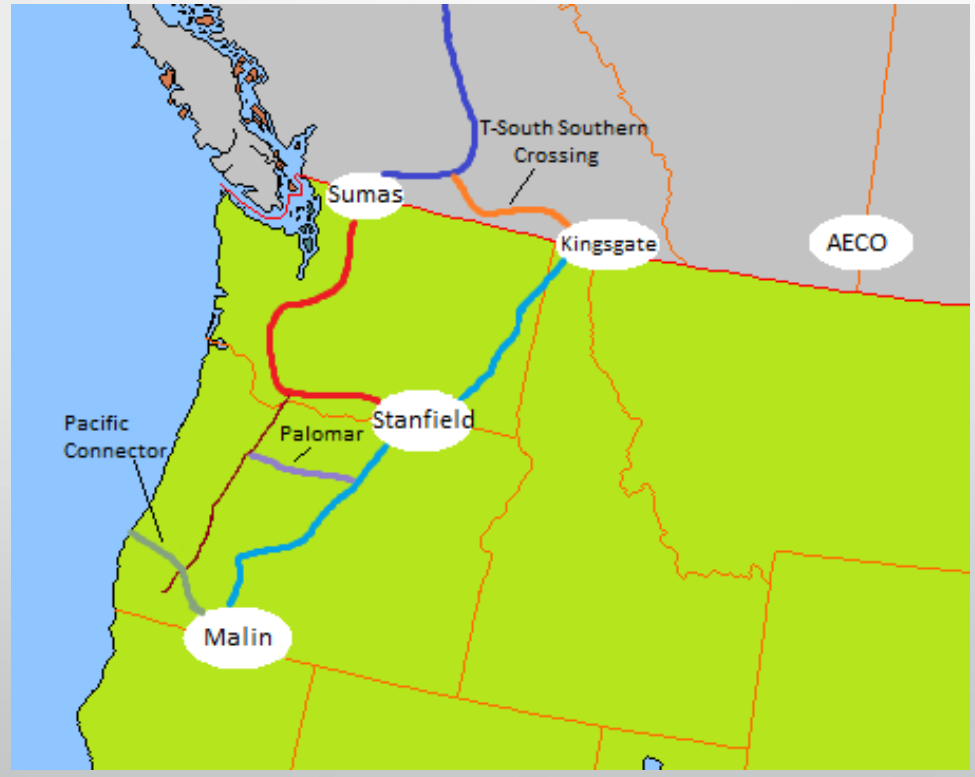
Incremental Transport – Bilateral

- T-South Southern Crossing – Price arbitrage opportunity to move gas between Sumas and AECO basins bilaterally
- Trails West (Palomar) – Additional capacity to move Rockies gas to the I-5 corridor
- Pacific Connector – Pipeline that will feed LNG facility on Oregon coast, increasing liquidity at Malin



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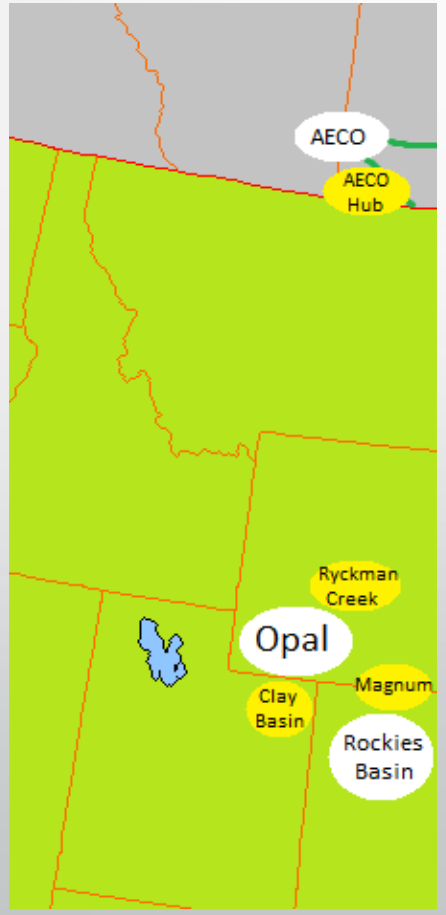
Incremental Storage - North and East

- Ryckman Creek Storage – Additional storage in southwest Wyoming serving the system, primarily Oregon
- Magnum Storage – Additional storage near Rocky Mountains, serving the system, primarily Oregon
- AECO Hub Storage – Additional storage near AECO Hub, serving the system
- Clay Basin Storage – Additional storage near Opal



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Incremental Storage - South and West

- Gill Ranch Storage – Additional storage in central California, serving the system, primarily Oregon
- Mist Storage – Additional storage in northern Oregon, serving the system, primarily Washington
- Wild Goose Storage – Additional storage in northern California, serving the system, primarily Oregon

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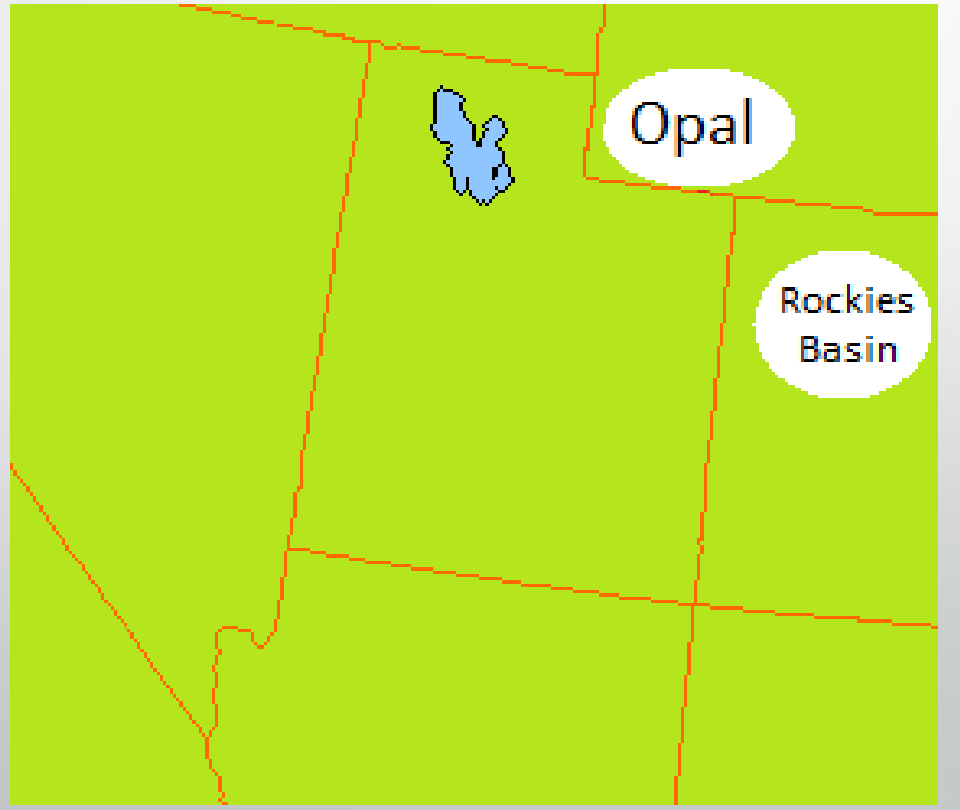
Incremental Supplies

- Incremental Opal Supply – Additional supply around the Rockies Basin
- Renewable Natural Gas – Incremental biogas supply directly to distribution system



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Market Outlook and Long Range Price Forecast

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Long Range Market Outlook

- According to the Energy Information Administration (EIA) 2018 Annual Energy Outlook (AEO), Natural Gas is projected to lead the power sector in gross energy consumption over the next 20+ years.
- On a percentage basis, renewable energy is forecasted to grows the fastest.
- As expected, high natural gas consumption leads to a robust production forecast for natural gas.

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Long Range Market Outlook Cont'd

- Like consumption, nonhydroelectric renewable energy shows a significant production growth projection.
- In the EIA Reference case, the natural gas spot prices at Henry Hub rise because of a high sensitivity to domestic resource and technology assumptions
- Reference case prices rise modestly out to 2050 despite technological advances supporting production. This is primarily due to domestic and export market demand growth.

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, EIA, the Northwest Power Planning Council (NPPC), Bentek and the Financial Forecast Center's long term price forecasts.
- 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.
- Wood Mackenzie's long-term forecast is at a monthly level by basin. Cascade uses this to help shape the forecast's monthly basis pricing.
- The Company also relies 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.

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Long Range Price Forecast Cont'd

- CNGC assigns 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.

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Price Forecast Weights

- Considerations in weight assignments
  - Cascade has modified its weighting system based on a backcast of the symmetric mean absolute percentage error (SMAPE) of its sources since 2010
    - Wood Mackenzie (monthly, covers all basins)
    - EIA (industry barometer, annual long term)
    - NPPC (regional perspective, but recognize it is also a blend)
    - NYMEX Henry Hub
  - EIA is the only source who produces a forecast after 2036
    - EIA typically forecasts higher than most other sources, so their forecast needs to be normalized based on their average error
  - Some sources produce forecasts daily, while others are far less frequent
    - Cascade uses an age dampening mechanism to account for this in its price forecast, reducing the impact of forecasts that do not account for more current market information

SMAPE to Weights

- Cascade uses the inverse of the SMAPEs of each source, which are then smoothed using Holt-Winters smoothing.

Rank (order of severity)	Weight		Interval
	Source 1	Source 2	
MSE	0.605111033	0.394888967	0.210222067
MAE	0.563119545	0.436880455	0.12623909
MAPE	0.562986465	0.437013535	0.12597293
RMSE	0.553149363	0.446850637	0.106298727
MAAPE	0.546818641	0.453181359	0.093637282
SMAPE	0.546045931	0.453954069	0.092091861

Example of SMAPE Calculations by Source

	Source 1	Source 2	Source 3	Source 4
T+1	0.11476063	0.217300759	0.100303147	0.150149419
T+2	0.155600954	0.208054622	0.210782631	0.183031285
T+3	0.180080034	0.159751563	0.211083367	0.188603149
T+4	0.180885987	0.216499212	0.116823262	0.205636302
T+5	0.204540958	0.17058102	0.13103414	0.227583943
T+6	0.205116131	0.158629542	0.123911318	0.235010724
T+7	0.193435025	0.017802511	0.087262544	0.218316379
T+8	0.153245566	0.108208036	0.125836311	0.150703308
T+9	0.19521638	0.182278012	0.083976291	0.212140322
T+10	0.173129437	0.171413928	0.100741558	0.172400617
T+11	0.209019609	0.19815898	0.159935388	0.180704729
T+12	0.206179306	0.064646764	0.09191201	0.176900657

Price Forecast Weights

- In Months T+1 to T+15, Cascade uses NYMEX Forward pricing for all locations exclusively
  - For short term forecasting, the marketplace is ideal because forward prices should reflect all current events that impact the forecast (weather, storage, etc.)
  - Long term forecasting is more concerned about the fundamental market intelligence, which is reflected in the analysis of Cascade's sources
- Months T+16 to T +36 are used to interpolate the weights from exclusively NYMEX to the weights calculated from each source's SMAPE.
- Months T + 37 onward use the age dampened weights of each source.

Example Weights Price Forecast For 2018 IRP (Not Interpolated)

	Source 1	Source 2	Source 3	Source 4
Sep-19	100.000%	0.000%	0.000%	0.000%
Oct-19	54.262%	3.158%	29.499%	13.081%
Nov-19	53.482%	2.979%	29.580%	13.958%
Dec-19	56.356%	3.281%	28.405%	11.958%
Jan-20	53.575%	2.902%	30.386%	13.136%
Feb-20	52.953%	2.898%	32.206%	11.942%
Mar-20	45.974%	2.150%	37.449%	14.427%
Apr-20	47.706%	2.341%	36.448%	13.506%
May-20	45.855%	2.069%	37.275%	14.801%
Jun-20	48.808%	2.335%	34.192%	14.664%
Jul-20	47.119%	2.073%	34.166%	16.642%
Aug-20	49.281%	2.280%	31.641%	16.799%
Sep-20	46.078%	1.964%	32.449%	19.508%
Oct-20	45.998%	1.952%	33.741%	18.310%
Nov-20	43.825%	1.679%	33.020%	21.475%
Dec-20	43.206%	1.597%	35.140%	20.057%
Jan-21	41.838%	1.376%	34.029%	22.757%
Feb-21	42.092%	1.394%	34.187%	22.328%
Mar-21	40.542%	1.256%	34.439%	23.764%
Apr-21	40.662%	1.267%	34.702%	23.368%
May-21	39.420%	1.140%	35.021%	24.419%
Jun-21	40.747%	1.244%	33.998%	24.011%
Jul-21	42.113%	1.332%	31.951%	24.603%

Example Weights Price Forecast For 2018 IRP (Interpolated)

	Source 1	Source 2	Source 3	Source 4
Sep-19	100.000%	0.000%	0.000%	0.000%
Oct-19	97.369%	0.182%	1.697%	0.753%
Nov-19	94.738%	0.337%	3.346%	1.579%
Dec-19	92.106%	0.593%	5.137%	2.163%
Jan-20	89.475%	0.658%	6.889%	2.978%
Feb-20	86.844%	0.810%	9.006%	3.340%
Mar-20	84.213%	0.628%	10.943%	4.216%
Apr-20	81.581%	0.824%	12.837%	4.757%
May-20	78.950%	0.804%	14.491%	5.754%
Jun-20	76.319%	1.080%	15.817%	6.784%
Jul-20	73.688%	1.031%	17.000%	8.281%
Aug-20	71.056%	1.301%	18.056%	9.587%
Sep-20	68.425%	1.150%	19.001%	11.423%
Oct-20	65.794%	1.236%	21.372%	11.598%
Nov-20	63.163%	1.101%	21.654%	14.083%
Dec-20	60.531%	1.109%	24.420%	13.939%
Jan-21	57.900%	0.996%	24.631%	16.472%
Feb-21	55.269%	1.076%	26.408%	17.247%
Mar-21	52.638%	1.000%	27.433%	18.929%
Apr-21	50.006%	1.068%	29.237%	19.688%
May-21	47.375%	0.990%	30.422%	21.213%
Jun-21	44.744%	1.160%	31.705%	22.391%
Jul-21	42.113%	1.332%	31.951%	24.603%

Avoided Cost Methodology and Calculation

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Avoided Cost Overview

- As part of the IRP process, Cascade produces a 20-year price 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.

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Avoided Cost Overview

- For the 2018 IRP, Cascade has revamped its avoided cost formula to create a more transparent and intuitive final number.
- Cascade evaluates the impact that a range of environmental externalities, including CO_2 emission prices, would have on the avoided costs in terms of cost adders and supply costs.
- The Company produces an expected avoided cost case based on peak day.

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Avoided Cost Formula

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

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

Where

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

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Methodology

- Transportation costs are pulled directly from the major pipelines that Cascade utilizes (NWP, GTN, Enbridge, Ruby, Nova Gas Transmission (NGTL) and Foothills).
- Storage costs come from the two major storage facilities that Cascade utilizes (Jackson Prairie and Plymouth).
- Commodity Costs are take from Cascade's 20-year price forecast.
- Risk Premium is the cost associated with hedging.
- Distribution System Costs only look at costs associated with growth. Pipeline integrity cannot be avoided.

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Methodology - Carbon

- Modeling carbon compliance costs is a challenge because the future of carbon is uncertain.
- As discussed during scenarios and sensitivities Cascade will model the impact of a variety of potential carbon pathways.
- Based on guidance from stakeholders, Cascade will be using the Social Cost of Carbon (SCC) 3% discount rate forecast for this IRP cycle.

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2018 IRP Remaining Schedule

Date	Process Element	Location (Subject to change)
Thursday, August 9, 2018	TAG 4 slides distributed to stakeholders	
Thursday, August 16, 2018	**TAG 4 Carbon Impacts, Conservation, Bio-Natural Gas, Preliminary Resource Integration Results, Proposed new 2 year Plan.**	**Seattle-Tacoma International Airport Conference Center 9am-3pm**
Tuesday, September 11, 2018	TAG 5 slides distributed to stakeholders	
Tuesday, September 18, 2018	**TAG 5: Final Integration Results, finalization of plan components.**	**Seattle-Tacoma International Airport Conference Center 9am-12pm**
Friday, October 5, 2018	Draft of 2018 IRP distributed	
Friday, November 2, 2018	Comments due on draft from all stakeholders	
Wednesday, November 14, 2018	TAG 6, if needed	WebEx Only
Friday, December 14, 2018	IRP filing in Washington	

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ADDITIONAL QUESTIONS?

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Cascade Natural Gas Corporation

2018 Integrated Resource Plan
Technical Advisory Group Meeting #2/#3

Thursday, July 12th , 2018

Seattle-Tacoma International Airport

Seattle, WA

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