

Cascade Natural Gas Corporation

Integrated Resource Plan Technical Advisory Group Meeting #2

Wednesday, July 19, 2017
Public Utility Commission of
Oregon
Salem, OR



Agenda

- **Introductions**
- **IRP Action Plan Update**
- **Distribution System Planning**
- **Current Supply Resources & Transportation Issues**
- **Alternative Resources**
- **Price Forecast**
- **Avoided Cost Calculation**
- **Planned Scenarios and Sensitivities**
- **Upcoming Schedule**
- **Questions**

IRP Action Plan Update

2014 IRP Action Item	Update
<p>1. Cascade will improve its demand forecast by developing a report to track the issuance of corrected bills and reclassifying therms from corrected bills to the month those therms were used. In its next IRP, Cascade will use its new Statistical Analysis Software (SAS) to test non-linear weather effects on natural gas, to perform analysis on potential serial correlation problems, and to create a time series autoregressive integrated moving average (ARIMA) model for customer forecasting.</p>	<p>As stated in TAG 1 Cascade now forecasts usage per customer by customer class. MDUR is in the process of developing the report to track the issuance of corrected bills and reclassifying therms for all of their LDCs. Cascade is currently using SAS for its statistical analysis to create an ARIMA model for customer forecasting. Cascade is exploring the possibility of expanding its software library to include R for auto ARIMA functionality and other uses.</p>
<p>2. Cascade will continue to monitor outside determinants of natural gas usage, such as legislative building code changes and electrical "Direct Use" campaigns as they are determined to significantly affect the Company's forecast.</p>	<p>Since the 2014 Action Plan, Cascade has monitored the following legislation, campaigns, and other external actions with the potential to influence natural gas use in the States of Washington and Oregon: - National standard practice manual, Portland renewable energy goals, gas to electric fuel switching, HB-2711 moratorium on hydraulic fracturing for oil and gas exploration and production, several Washington state bills on Carbon taxes, deep decarbonization, and the clean air rule.</p>
<p>3. Cascade will continue to monitor the effectiveness of the Oregon Public Purpose Fund to ensure the funds are adequate to capture significant portions of achievable therm savings in Oregon.</p>	<p>Since the 2014 IRP, Cascade has made two filings to increase its public purpose charge to ensure funding would be sufficient to acquire the therm savings target established in the IRP as a least cost resource: Advice No. O15-12-01 on December 11th, 2015 to increase its public purpose charge from 1.85% to 3.7% (reduced to 3.4% before Commission approval) and Advice No. O16-10-01 on October 31st, 2016, in which the Company asked to increase the Public Purpose Charge from 3.4% to 4.87%.</p>
<p>4. The company will continue to follow and analyze the impacts of the Western Climate Initiative and proposed carbon legislation at both the state and federal level as they pertain to natural gas conservation, as well as other such acts that may arise from these efforts. The company will continue to monitor the timing and the costs associated with carbon legislation and analyze the impacts on the company's overall portfolio costs. As specific carbon legislation is passed, the company will update its avoided cost calculations, conservation potential and make modifications to its DSM incentive programs as necessary.</p>	<p>The Company has continued to monitor the Western Climate Initiative and proposed carbon legislation since the 2014 Action Plan. While no significant action has been taken on the WCI with impacts to the Company, the Company is actively following the current legislation and is monitoring the potential impacts to portfolio costs.</p>

IRP Action Plan Update Cont'd

2014 IRP Action Item	Update
<p>5. The company will continue to monitor the cost effectiveness of existing conservation measures and emerging technologies to ensure that the current mix of measures included in the Washington Conservation program is appropriate. Areas for further analysis include the impacts associated with modifications to building codes along with the cost effectiveness of newer technologies such as the next generation of high efficiency water heaters (.70 EF) and high-efficiency hybrid heat pumps. The applicability of these measures within Cascade's service territory will be analyzed and the company's Conservation Incentive Program will be modified as necessary.</p>	<p>Cascade continually monitors the region and natural gas industry on currently available technology advancements as part of our Washington incentive programs. We reevaluate the portfolio cost-effectiveness paired with current technology and update install costs to maintain viability and as robust of a program as feasible. The Company is also engaged with the Northwest Energy Efficiency Alliance market transformation collaborative in coordination with other local utilities and the Energy Trust of Oregon as well as the Gas Technology Institute's emerging technology program to stay abreast of new technologies and opportunities for additions and changes to the Company's offerings.</p> <p>The Company also maintains a Trade Ally network for our Washington programs and routinely connects with local contractors to gauge availability of product and costs associated with installs of rebate eligible equipment and measures. The landscape is constantly evolving and Cascade works with its partners and local agencies and builders (including home builder associations) to track building code updates as well as changes to industry standards.</p>
<p>6. The Company will continue to monitor the potential reporting, administrative and potential financial impacts of long term resources as a result of concerns surrounding fracking. In particular we are awaiting the EPA to reveal the results of their current study in alleged water contamination found in Wyoming as a result of fracking activities.</p>	<p>In December 2016 the EPA published its final report on fracking. The comment period ended January 2017. Cascade is reviewing the final report and will provide a slide update at TAG 3.</p>

IRP Action Plan Update Cont'd

2014 IRP Action Item	Update
7. Cascade will continue to evaluate gas supply resources on an ongoing basis, including supplies of varying lengths (base, swing, peaking) and pricing alternatives. We will continue to analyze the uncertainties associated with supply and demand relationships.	On June 26th Cascade's Gas Supply Oversight Committee (GSOC) met and was provided an update on the 2017 portfolio procurement plan, which included recent market intelligence and updated pricing. In TAG 3 the company will discuss its supplies of varying lengths and pricing alternatives.
8. The Company will continue to monitor the proposed pipeline expansion projects to access more supplies out of the Rockies. As cost estimates change, the company will analyze those resources under consideration to determine if modifications to the preferred portfolio are necessary.	Cascade will be discussing all potential pipeline expansions during today's TAG meeting.
9. As part of the Cascade's risk management policy and implementation, the Company will report on the status of the UM 1720 as well as related risk management policy enhancements to Cascade's risk management policy, at the first Purchased Gas Adjustment (PGA) quarterly meeting with OPUC Staff in early 2017. This docket is the Commission's Investigation into Long Term Hedging Policy.	The first planned PGA quarterly meeting was postponed due to scheduling conflicts. Cascade provide an update during today's TAG meeting.
10. The Company will continue to explore options to incorporate biogas into its portfolio, as specific projects are identified in our service territory. Price, location and gas quality considerations of the biogas supply will be evaluated.	Cascade has filed a Biomethane Receipt Services (Schedule 800) in Oregon to establish biogas injection terms, conditions and gas quality requirements. Cascade continues to work with possible biomthane producers and evaluate those projects for possible future core supplies.
11. The Company will continue to monitor proposed LNG import facilities as information becomes available and will evaluate the various options that, if built, could result. Issues to monitor include specific cost, the availability of pipeline capacity and project timing.	After consultation with upstream pipelines, Cascade has determined that a pipeline expansion is a more prudent long-term solution.
12. The Company will continue to monitor the futures market for price trends and will evaluate the effectiveness of its risk management policy. Implementation of Dodd- Frank in the coming year raises potential administrative challenges from a reporting standpoint; additionally it is unknown how the costs associated with the use of clearinghouses might impact prices of natural gas in the future.	Cascade has updated its price forecast to modify its weights based on a backcast of the accuracy of its sources. At this time the price impacts of Dodd-Frank and hedging related dockets such as UM 1720 and UG-132019 continues to be unknown. The Company will continue to provide updates in coming TAG meetings.

Distribution System Planning

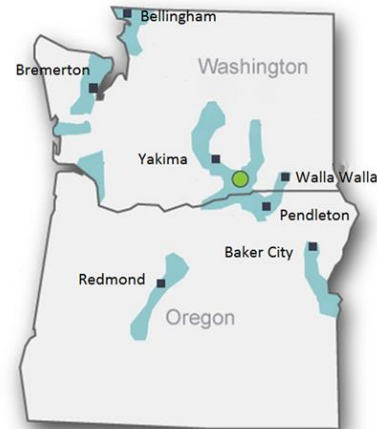
CHRIS BOLTON, ENGINEER II

TECHNICAL ADVISORY GROUP

JULY 19TH, 2017

Outline

- Company overview
- Network Design Fundamentals
- Interstate Pipeline Companies
- Software Technology
- Data Gathering
- Data Analysis
- System Enhancement Techniques
- Future Planning Process Flow
- Future Projects



CNGC 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

CNGC System Overview Cont'd

Facilities:

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

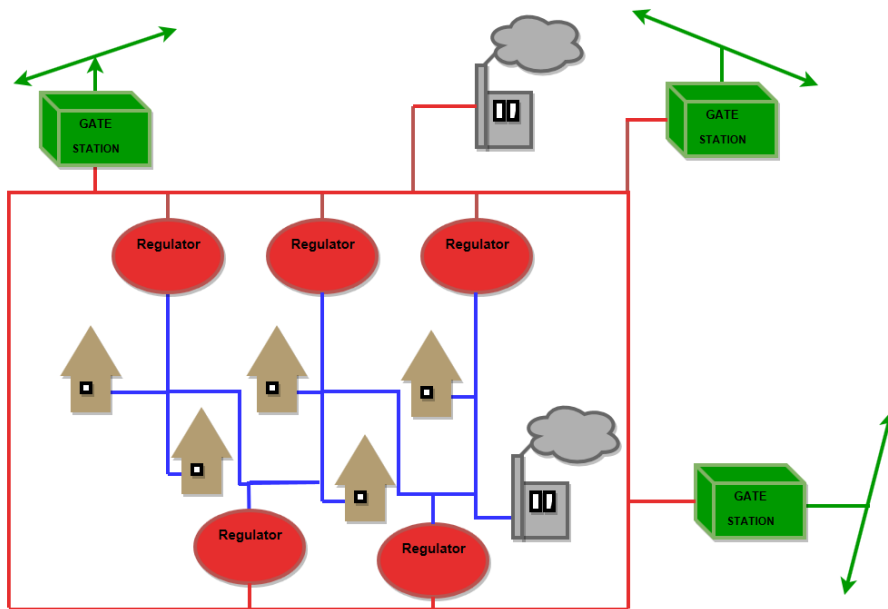


Where do we get our gas?



- Many interstate pipeline companies
- Williams Northwest Pipeline (Red)
- Transcanada Pipelines (Yellow)
- Enbridge Pipelines (Dark Blue)

Network Design Fundamentals

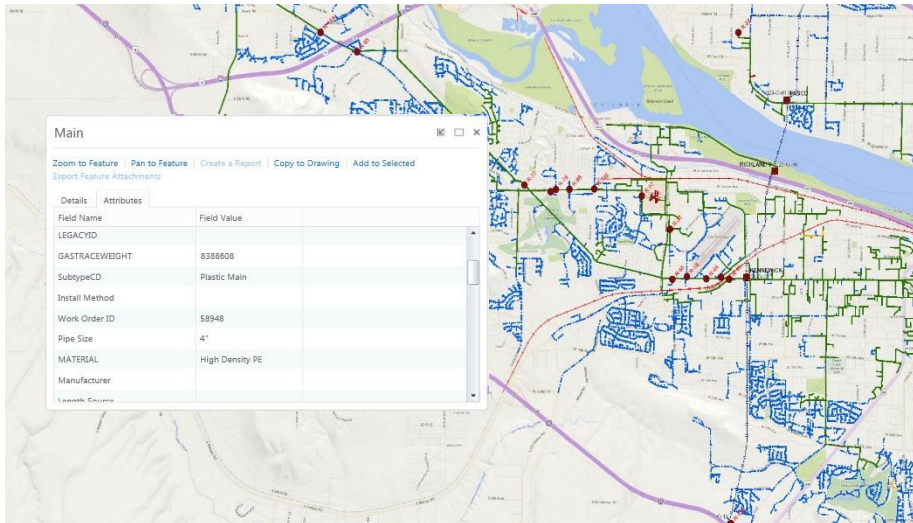


Keys:

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

GIS – Geographic Information System

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



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

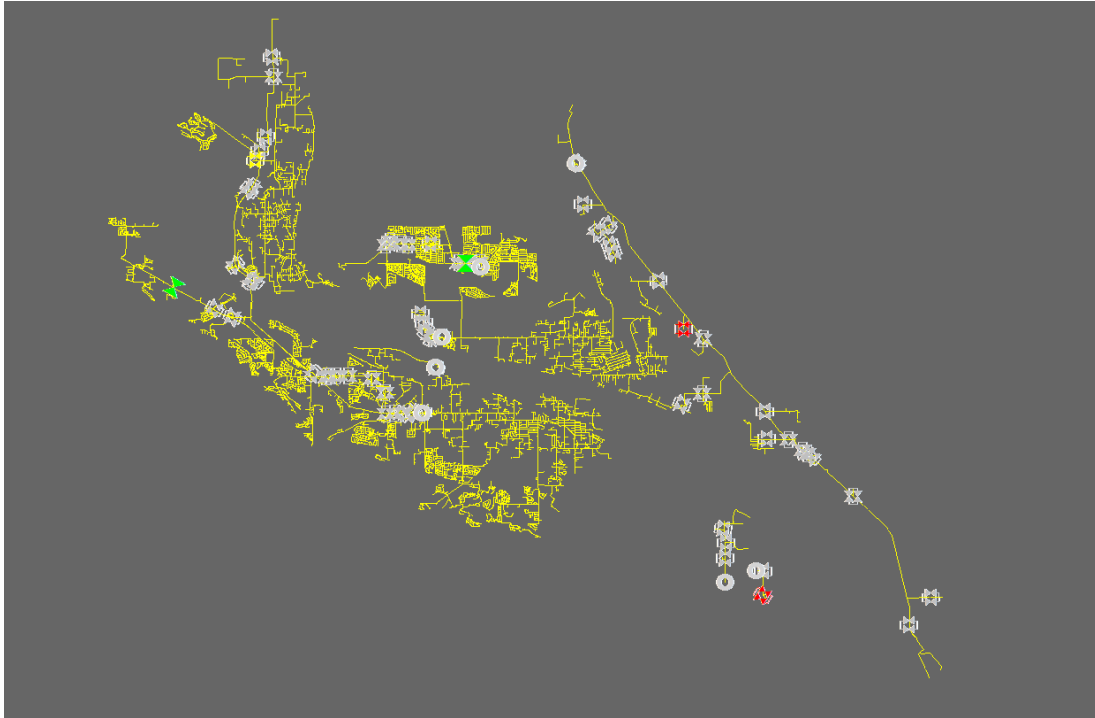
System Modeling

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

What is Synergi?

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

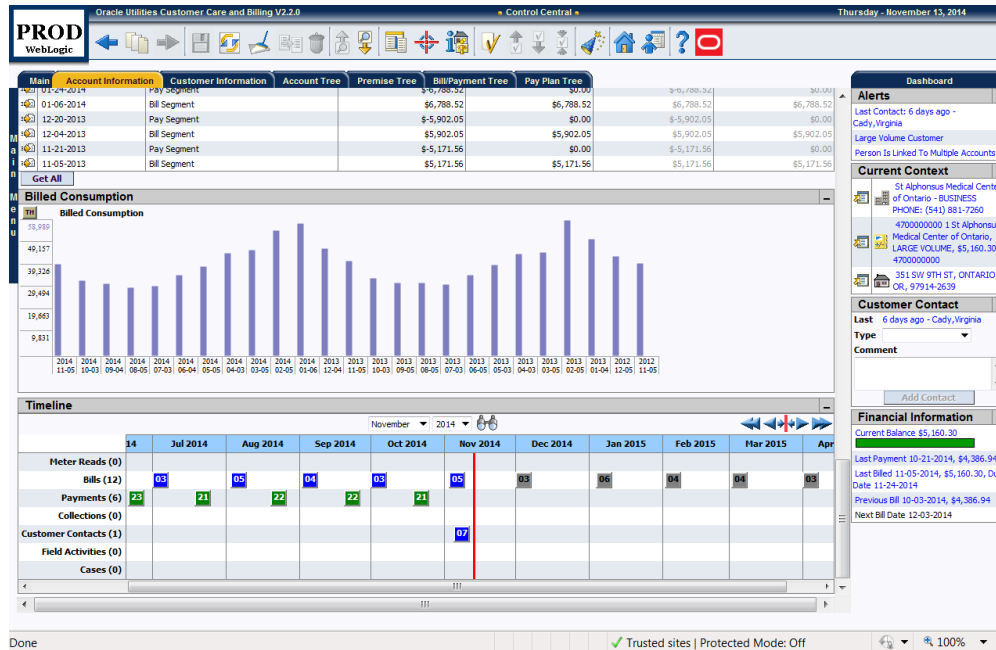
Model Example



How do we make this model accurate?

Data Gathering

- CC&B (customer billing data)



Data Gathering Cont'd

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

IGC +

CNGC -

Northwest Washington >

Central Washington >

Southwest Washington

Oregon >

MDU +

Data Legend +

✓ CNGC Southwest Washington Usage

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

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

List Grid A-Z

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

- SCADA Data : Real time and historical flow characteristics at specific locations in the system.

Data Gathering Cont'd

- IRP Customer Growth

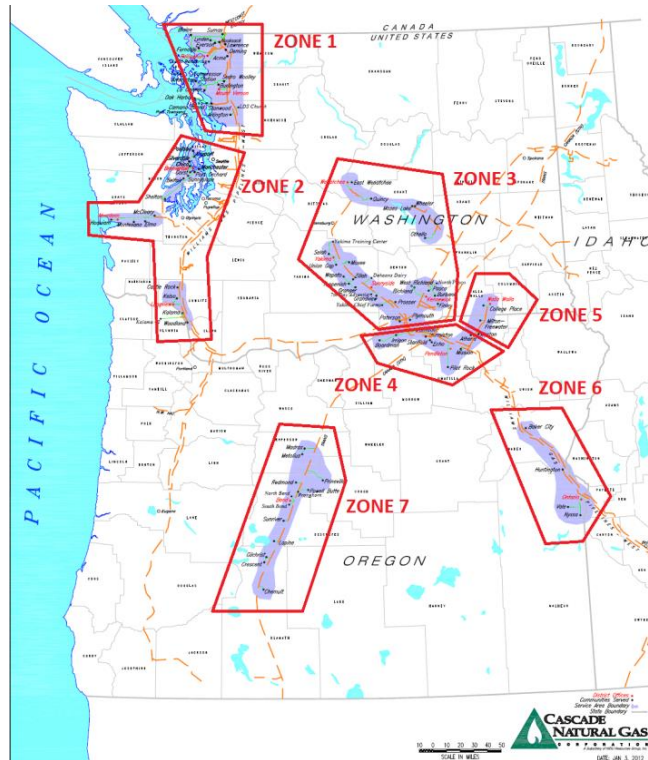
Year	Baker	Umatilla	Hermiston	Huntington	Milton-Freewater	Mission Tap	Pendleton	Prineville	Redmond	Pronghorn	Bend Loop
2018	0.77%	1.41%	1.28%	0.75%	1.15%	1.22%	1.31%	1.92%	2.45%	2.24%	2.46%
2019	0.78%	1.55%	1.38%	0.75%	1.21%	1.48%	1.40%	1.89%	2.42%	2.02%	2.44%
2020	0.78%	1.55%	1.45%	0.86%	1.27%	1.46%	1.48%	1.83%	2.39%	1.81%	2.42%
2021	0.78%	1.62%	1.52%	0.85%	1.42%	1.38%	1.54%	1.82%	2.40%	2.57%	2.40%
2022	0.79%	1.61%	1.57%	0.67%	1.38%	1.54%	1.61%	1.78%	2.36%	1.93%	2.38%
2023	0.80%	1.70%	1.64%	0.89%	1.43%	1.82%	1.66%	1.75%	2.35%	1.83%	2.36%
2024	0.80%	1.73%	1.68%	0.72%	1.55%	1.55%	1.71%	1.72%	2.32%	2.17%	2.34%
2025	0.80%	1.70%	1.73%	0.77%	1.59%	1.84%	1.76%	1.69%	2.31%	1.76%	2.32%
2026	0.80%	1.82%	1.78%	0.93%	1.59%	1.73%	1.81%	1.67%	2.28%	1.76%	2.30%
2027	0.81%	1.81%	1.81%	0.65%	1.54%	1.70%	1.85%	1.63%	2.25%	2.08%	2.28%
2028	0.81%	1.84%	1.86%	0.86%	1.70%	1.97%	1.89%	1.61%	2.24%	1.69%	2.25%
2029	0.81%	1.77%	1.90%	0.80%	1.75%	1.85%	1.92%	1.58%	2.20%	1.80%	2.23%
2030	0.82%	1.89%	1.92%	0.95%	1.70%	1.92%	1.95%	1.53%	2.18%	1.99%	2.21%
2031	0.82%	1.89%	1.95%	0.68%	1.78%	1.89%	1.98%	1.54%	2.16%	1.90%	2.17%
2032	0.81%	1.86%	1.97%	0.99%	1.77%	1.93%	2.00%	1.50%	2.11%	1.60%	2.13%
2033	0.81%	1.89%	1.98%	1.13%	1.79%	2.04%	2.02%	1.49%	2.08%	1.70%	2.10%
2034	0.82%	1.87%	2.01%	0.92%	1.80%	1.98%	2.03%	1.46%	2.06%	1.91%	2.07%
2035	0.81%	1.94%	2.01%	0.81%	1.96%	2.08%	2.05%	1.45%	2.02%	1.49%	2.04%
2036	0.81%	1.95%	2.03%	0.85%	1.91%	1.94%	2.06%	1.43%	1.99%	1.62%	2.01%
2037	0.80%	1.87%	2.05%	0.74%	1.91%	2.11%	2.06%	1.40%	1.97%	1.59%	1.98%
Average Annual Growth	0.80%	1.76%	1.77%	0.83%	1.61%	1.77%	1.80%	1.63%	2.23%	1.87%	2.25%

Data Gathering Cont'd

- Peak Heating Degree Day (HDD) in the different CNGC weather zones.
- Uses historical weather data to determine which degree day matches which zone.

Peak HDD = 60 - average daily temp

CNGC Weather Zones



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

Customer Management Module (CMM)

Name	Base Colu...	Heat Colu...	Cool Colu...	Description
Commercial	3	4		
Industrial	5	6		
Interruptible	7	8		
LargeVolume	9	10		
Other	15	16		
Residential	1	2		
Special	13	14		
Transportat...	11	12		

Service Id	Pipe	Account Number	Base	Heat	Weather Zone
1873618151	P104535		0.568	0.189	CNG - PASCO WA
772493929	P105912		0.233	0.186	CNG - PASCO WA
1911912277	P221189		0.890	0.087	CNG - PASCO WA
883426792	GL7677		0.232	0.116	CNG - PASCO WA
571326823	GL6701		0.645	0.186	CNG - PASCO WA
96056485	GL6701		0.890	0.111	CNG - PASCO WA
659681395	P221182		0.427	0.089	CNG - PASCO WA
389964133	GL 8699		0.891	0.118	CNG - PASCO WA

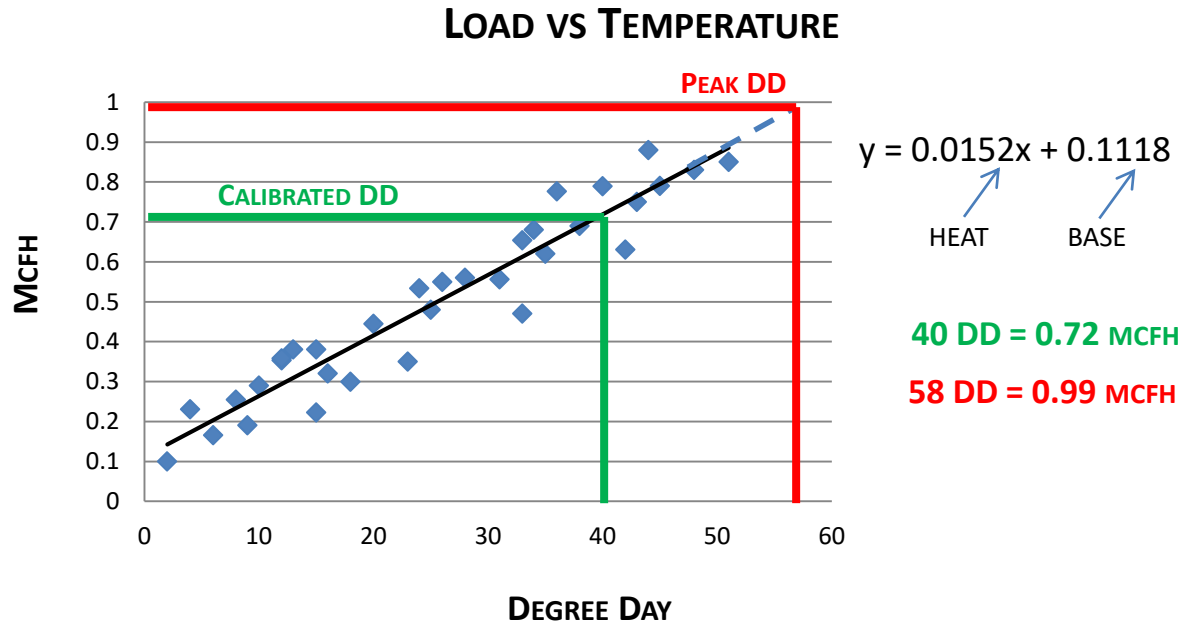
- Software that compiles data from CC&B, HDD, and/or growth studies to manage customer loads.
- Works directly with Synergi to input customer data and represent pressures and flows in the model.

CMM → Synergi

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

Calibrated vs Degree Day

- Different loads will be applied to each customer

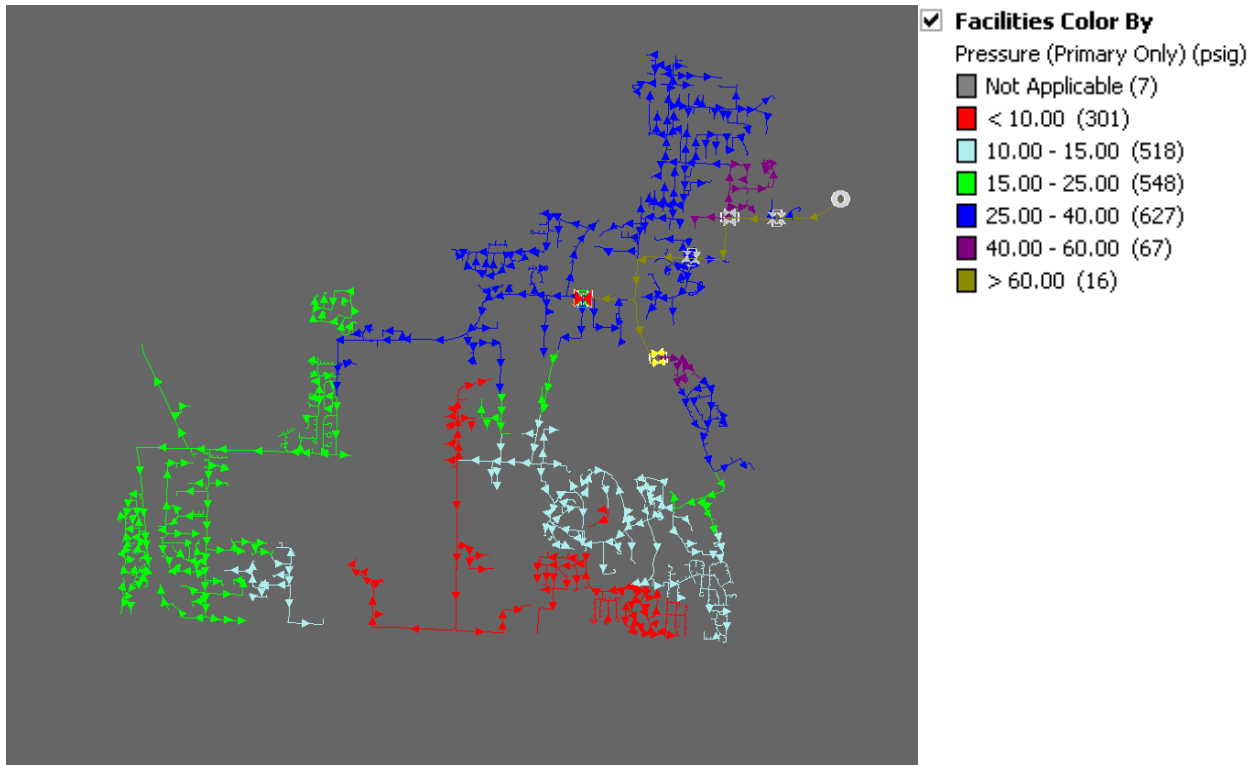


System Modeling Cont'd

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

Synergi

- Theoretical low pressure scenario



Capacity Enhancement Options

- Pipes:
 - Replacements
 - Reinforcements
 - Loops
- Regulator Stations
- Compressors

Pipe Enhancements

PROS

- Reliable capacity
- Low maintenance
- Permanent

CONS

- Can be expensive
- Potential land acquisition/permitting issues

Reg Station Upgrades/Installs

PROS

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

CONS

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

Compressor Stations

PROS

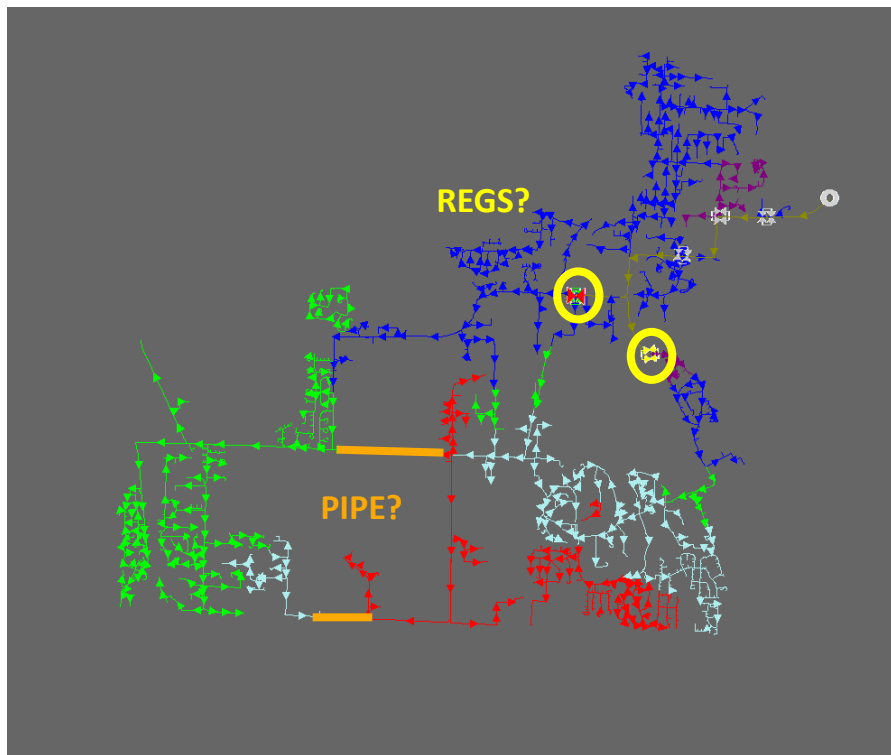
- Adding capacity at lower initial cost
- Less land required
- Situational operation

CONS

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

Synergi

- Low pressure scenario



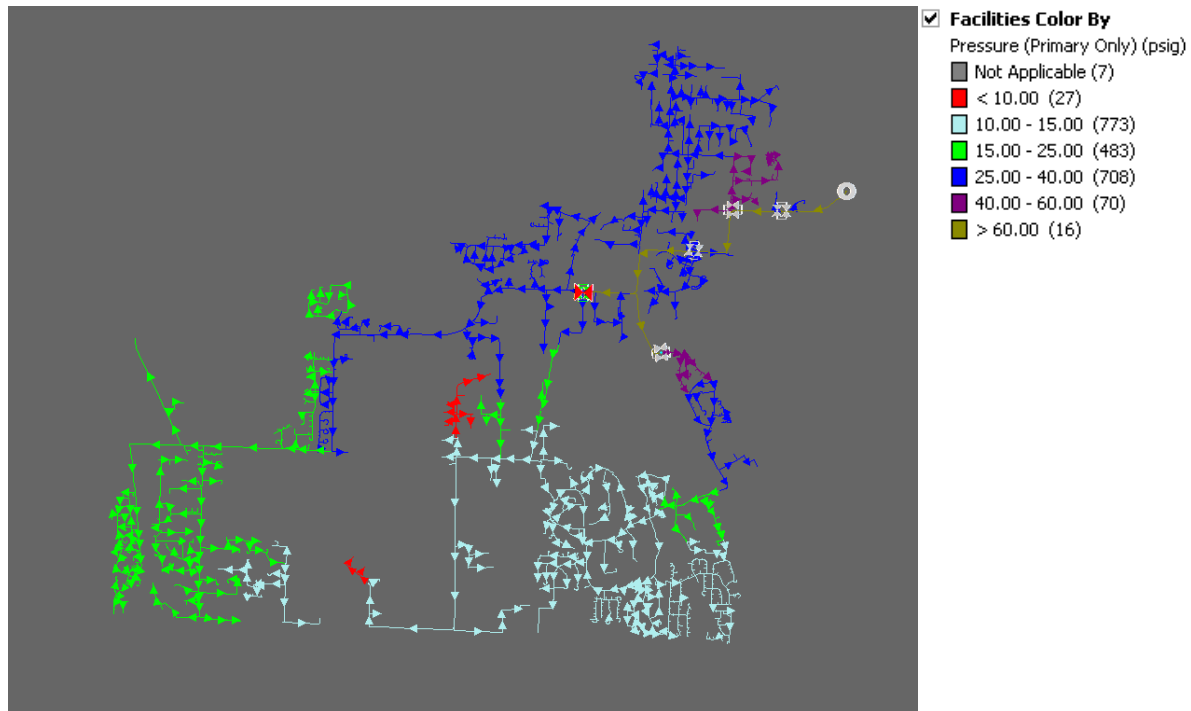
Facilities Color By
Pressure (Primary Only) (psig)

■	Not Applicable (7)
■	< 10.00 (301)
■	10.00 - 15.00 (518)
■	15.00 - 25.00 (548)
■	25.00 - 40.00 (627)
■	40.00 - 60.00 (67)
■	> 60.00 (16)

- Compressor station infeasible
- Other Solutions?

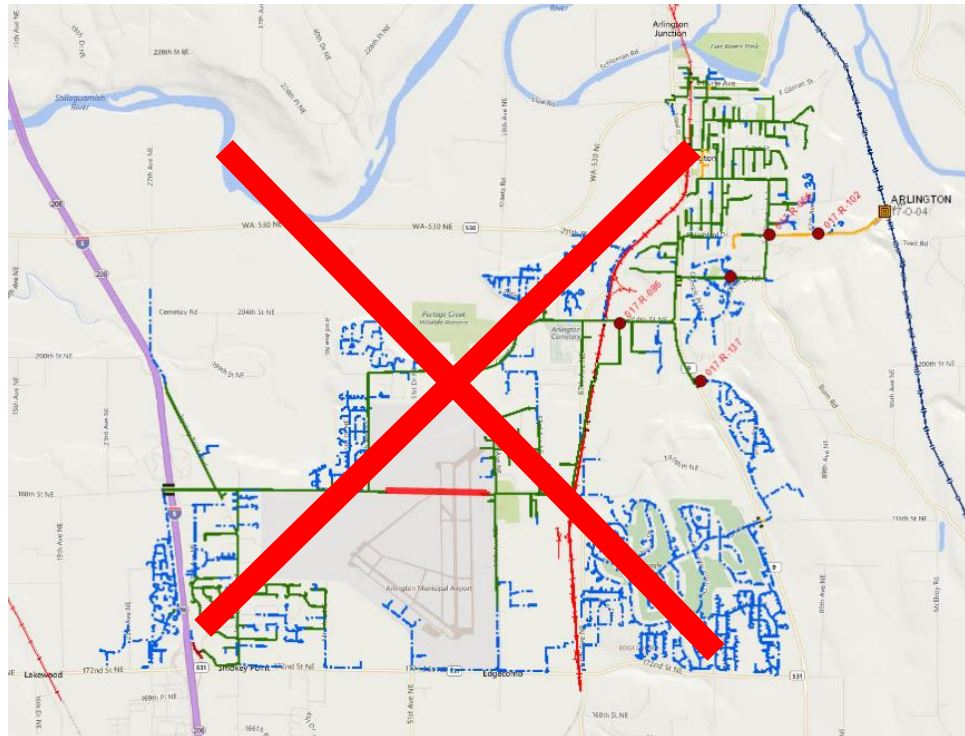
Synergi

- Possible solutions – raising reg station set points



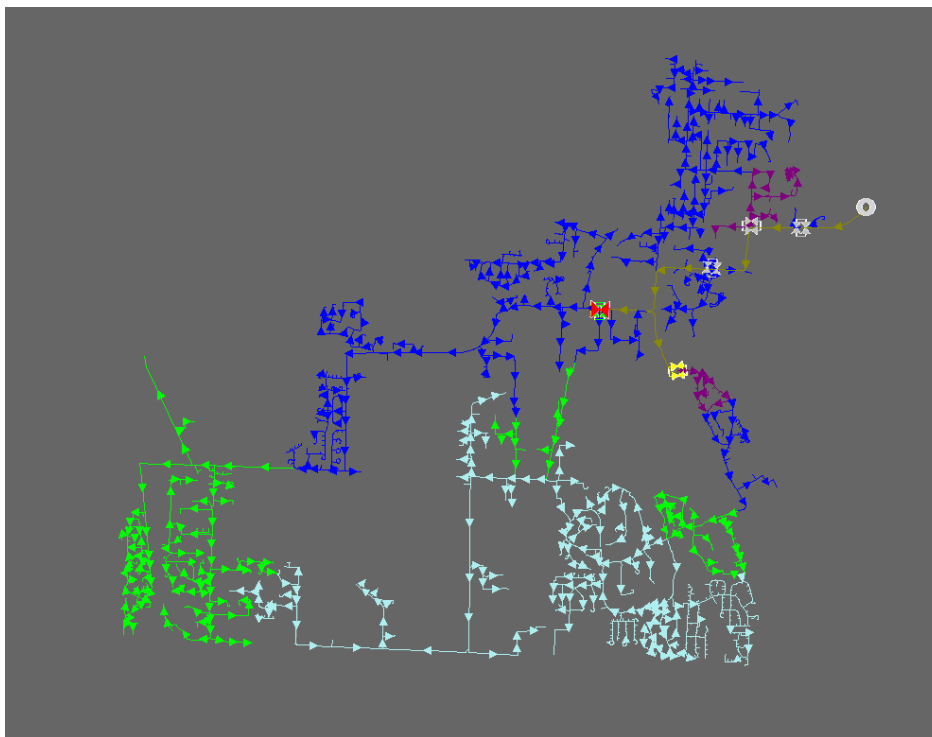
Synergi

- Reinforcement option #1



Synergi

- Reinforcement option #2

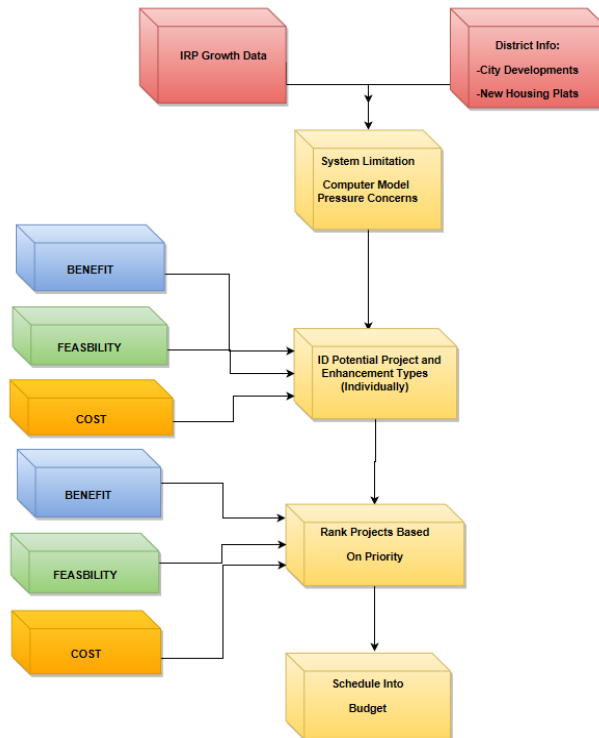


Facilities Color By
Pressure (Primary Only) (psig)

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



Project Process Flow



Info & Data



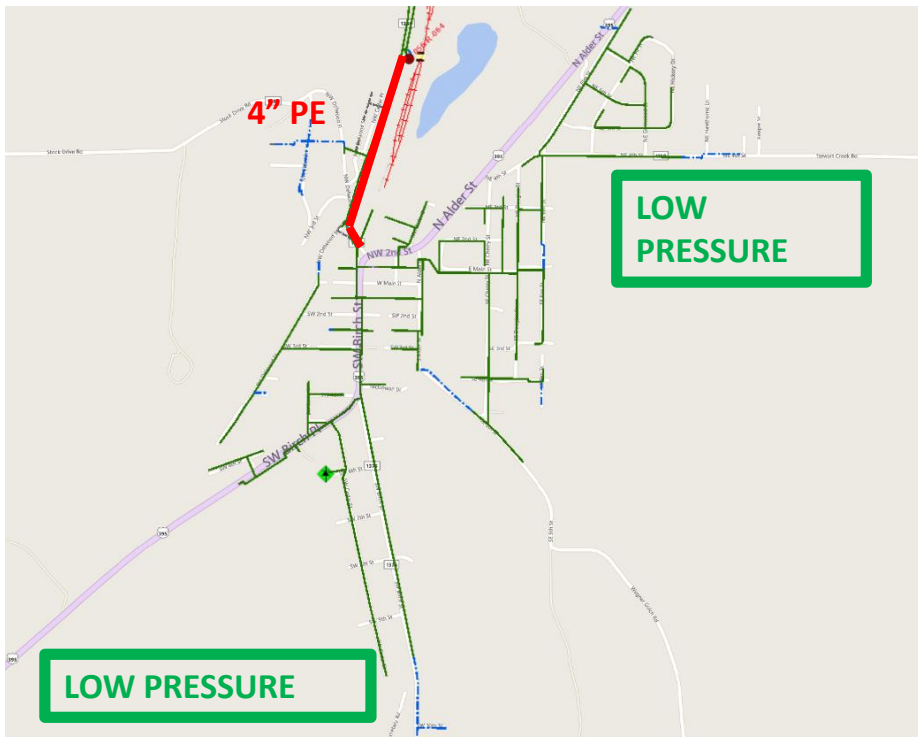
Project & Schedules

CNGC Future Projects

- Example upcoming growth projects

Location	2017	2018	2019
Pilot Rock 4" IP PE Reinforcement	\$ 219,566		
Bend 8" HP Steel Reinforcement		\$ 1,930,648	
Bend 4" IP PE Reinforcement			\$ 185,210

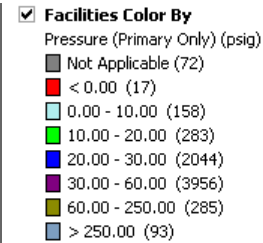
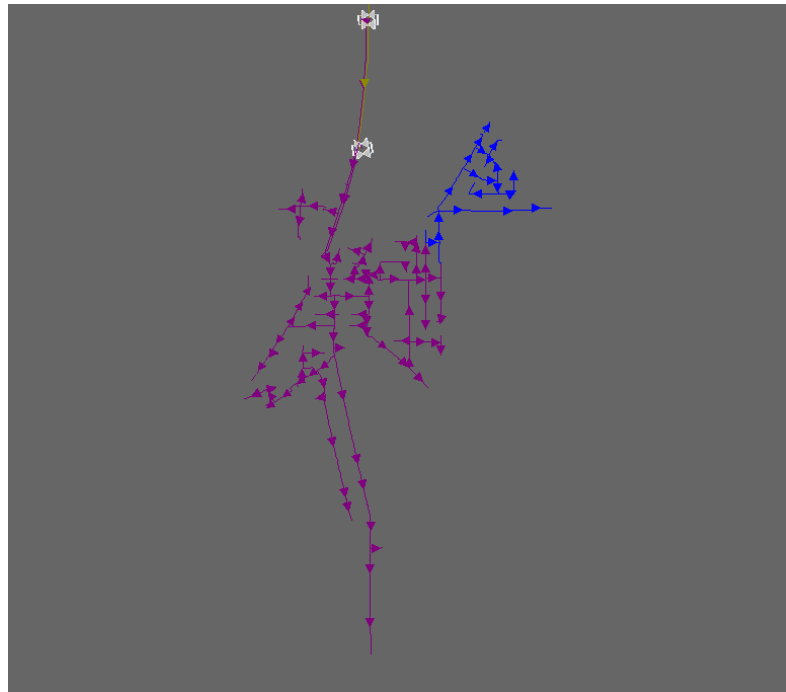
Pilot Rock 4" IP PE Reinforcement



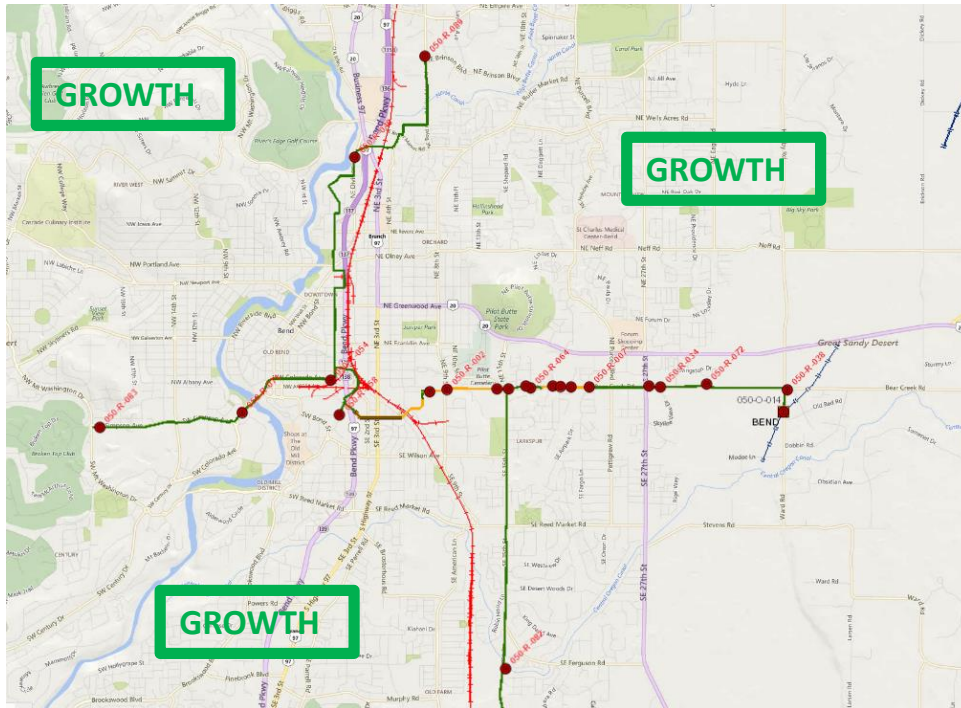
- 2017 project
- 1,950' of 4" PE
- Have experienced low pressure during peak heating
- Allow for growth in system

Pilot Rock 4" IP PE Reinforcement

- Design day pressure before/after



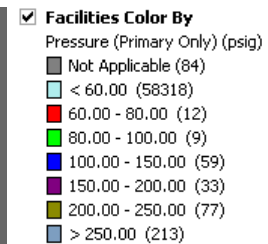
Bend 8" HP Steel Reinforcement



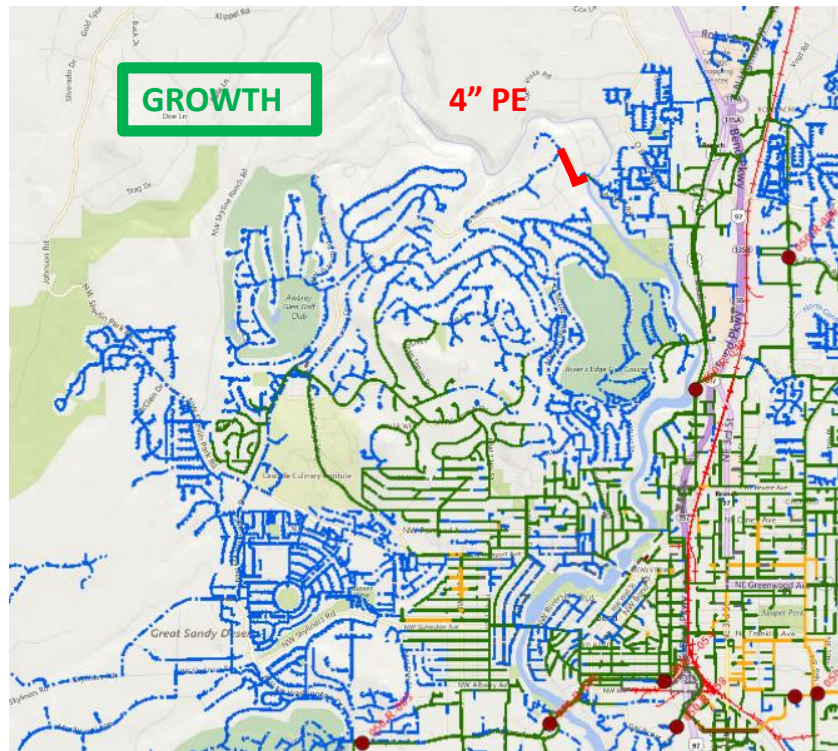
- 2018 project
- 6,400' of 8" HP Steel
- Pressure loss in high pressure lines
- Allow for growth in the entire district

Bend 8" HP Steel Reinforcement

- Design day pressure before/after



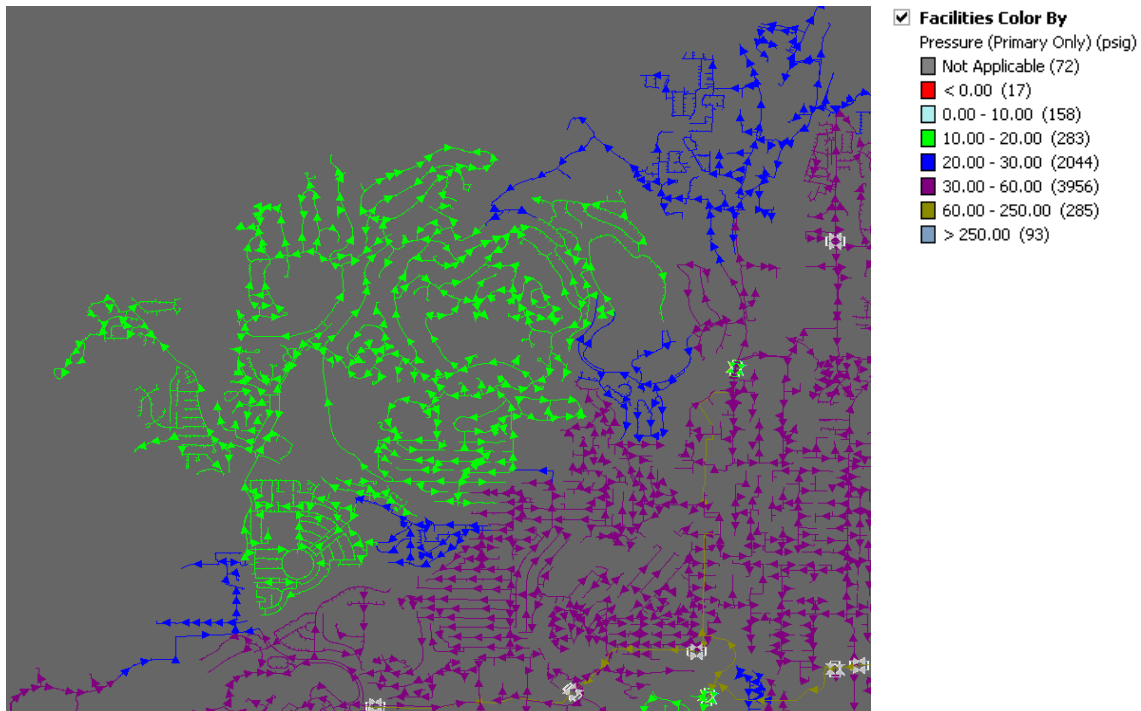
Bend 4" IP PE Reinforcement



- 2019 Project
- Growth all over the Bend Area
- Short reinforcement will enhance capacity to NW area

Bend 4" IP PE Reinforcement

- Model pressure before/after project



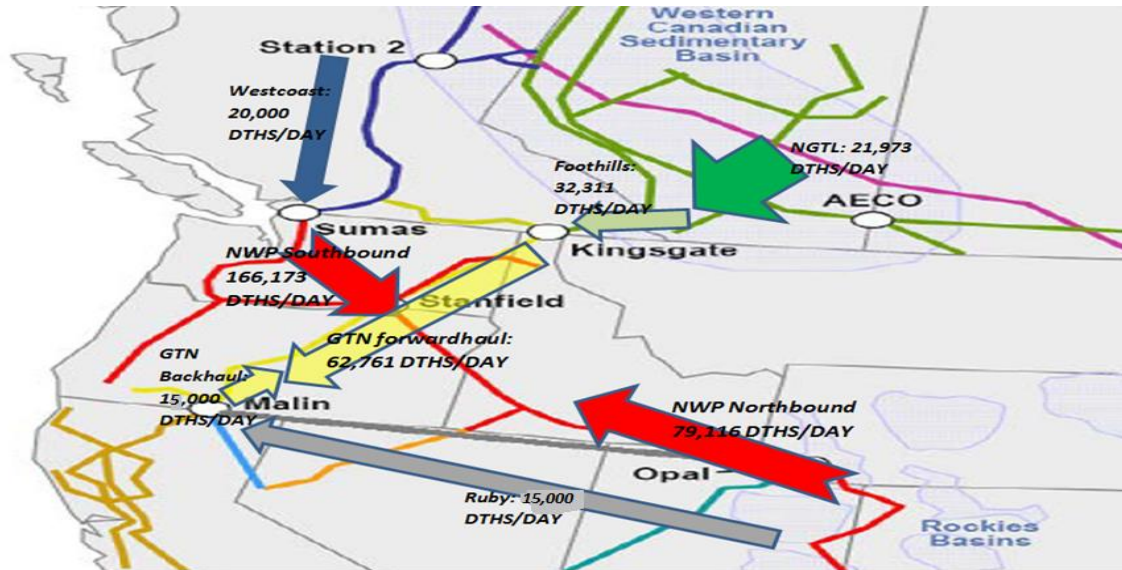
Conclusion

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

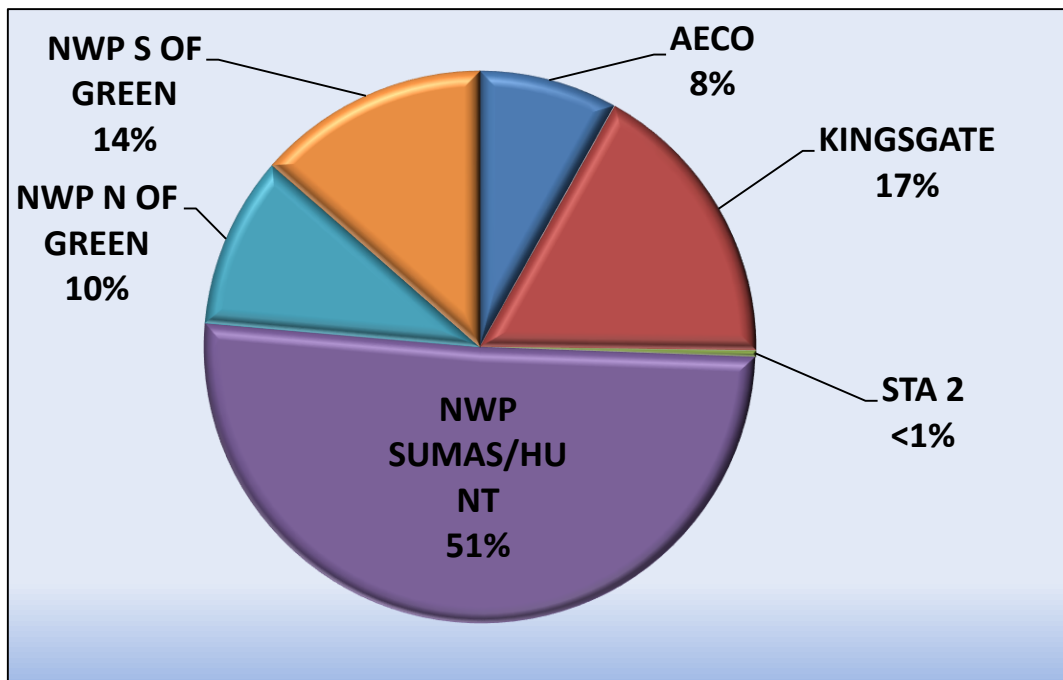
QUESTIONS?

Current Supply Resources & Transportation Issues

Pipeline transport flow



Transport Summary



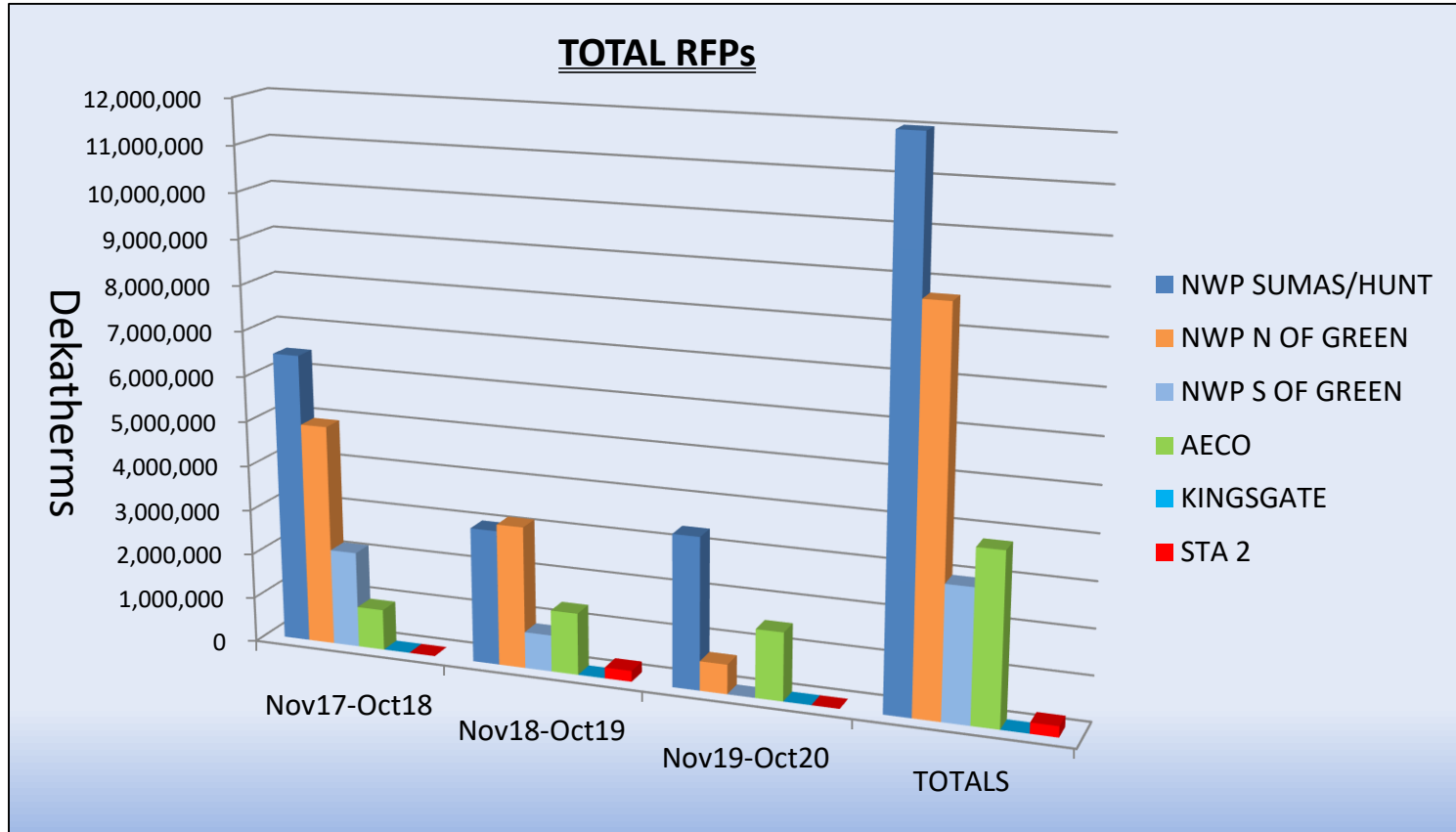
Storage Resources

- Jackson Prairie
 - 4 accounts with 1,235,593 dths capacity
 - CNGC cycled approximately 90% 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.

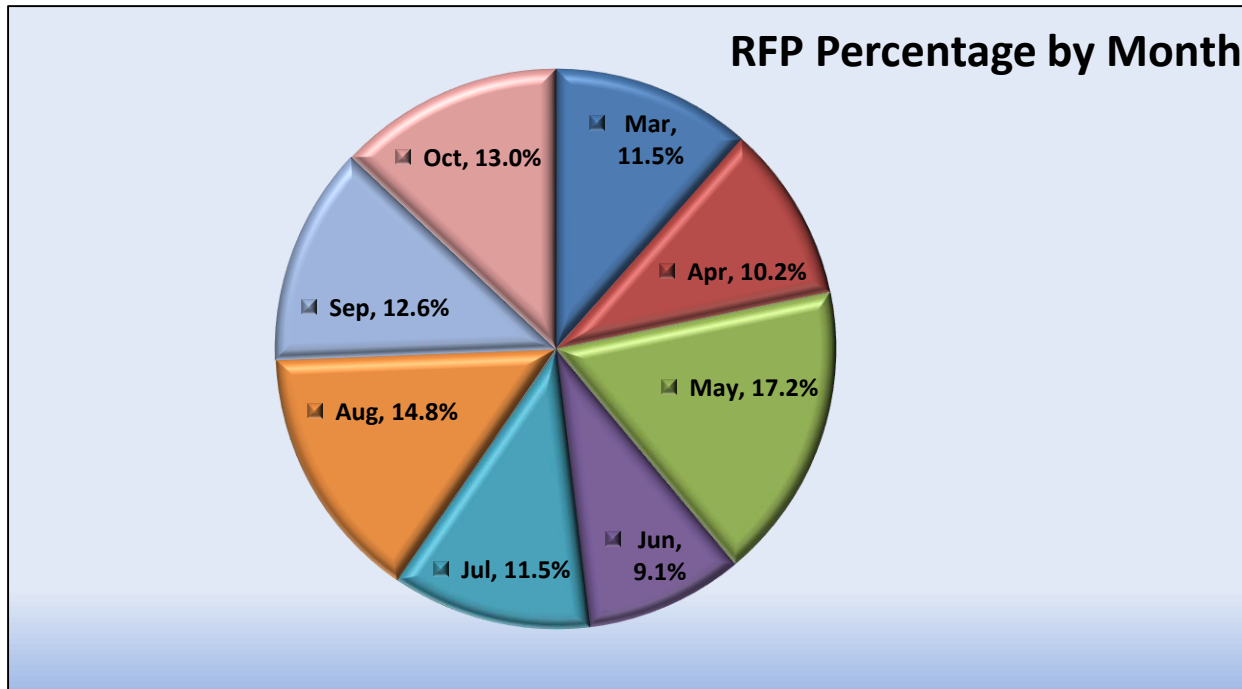
HIGHLIGHTS FOR THE 2017 PORTFOLIO DESIGN

- 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.

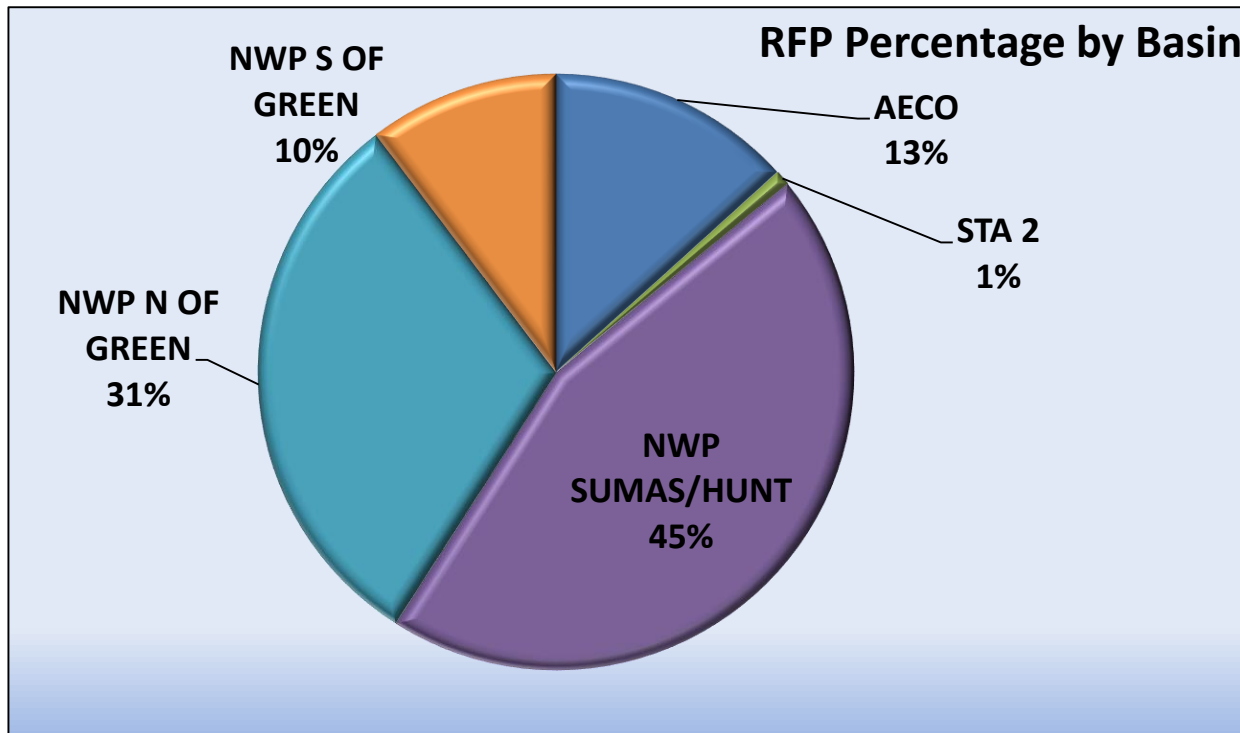
Total RFPs



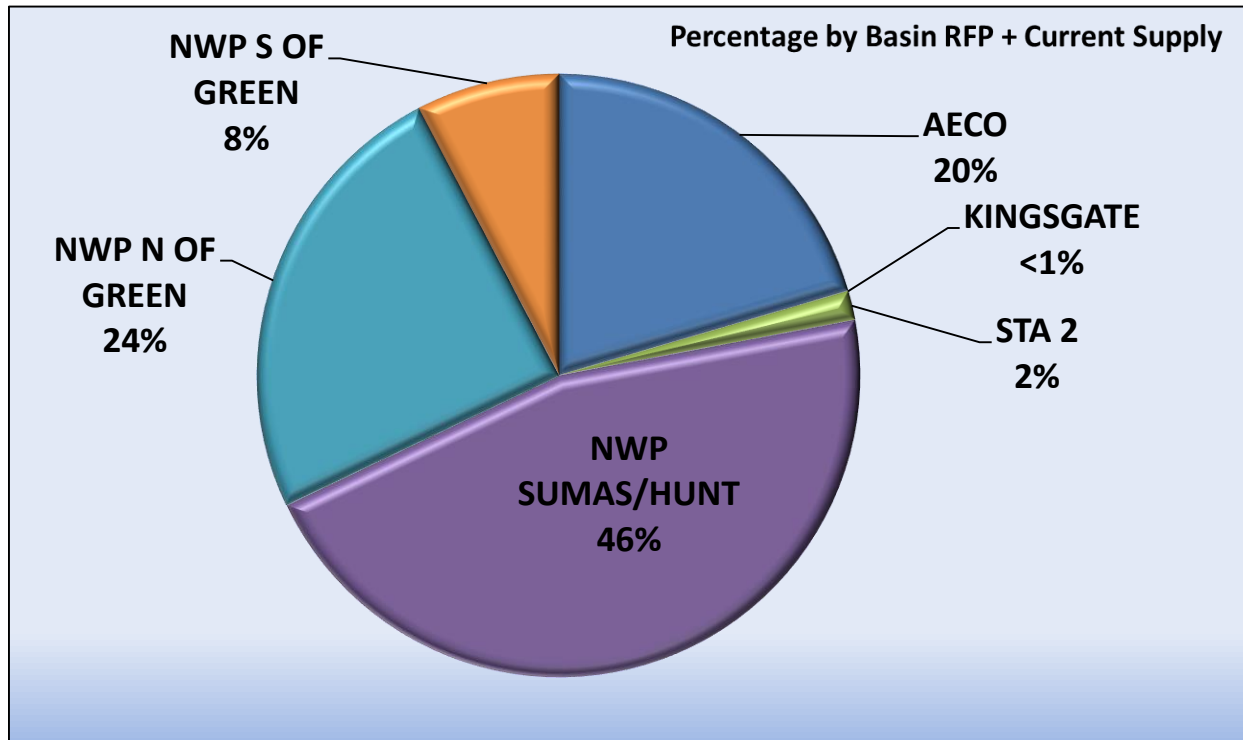
RFP Percentage by Month



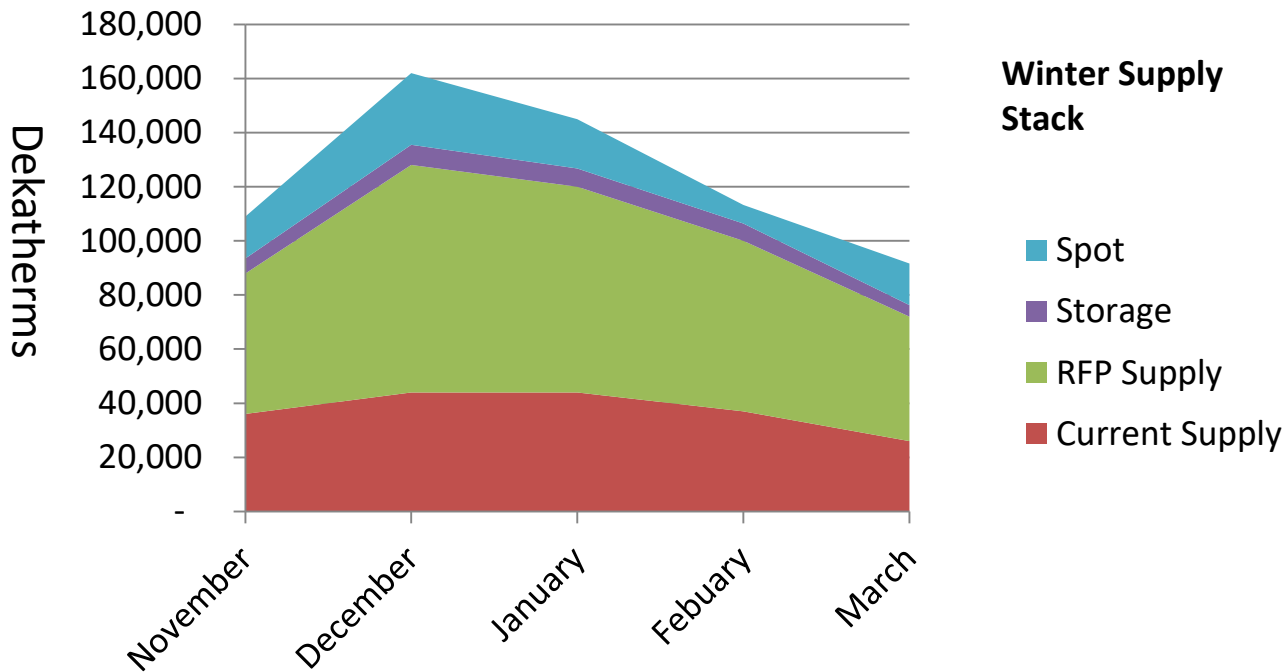
RFP Percentage By Basin



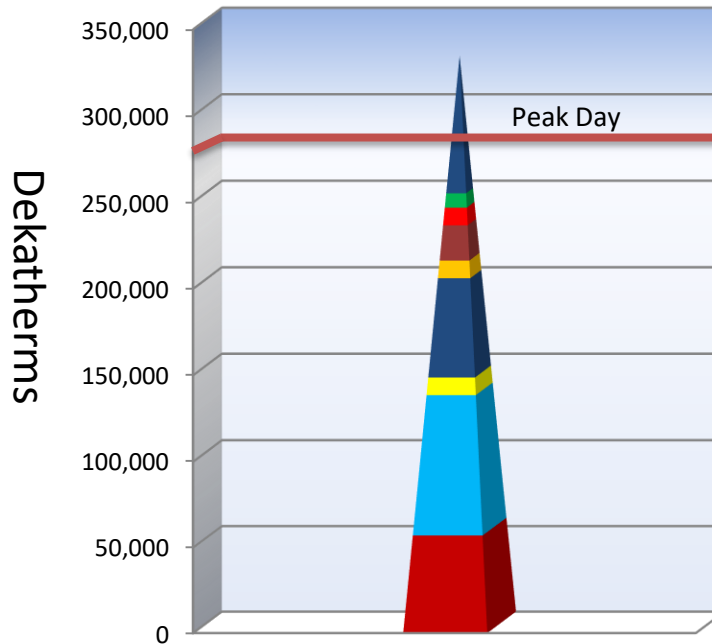
Percentage by Basin RFP + Current Supply



Winter Supply Stack



Peak Day Stack Example



Peak Day Stack Example

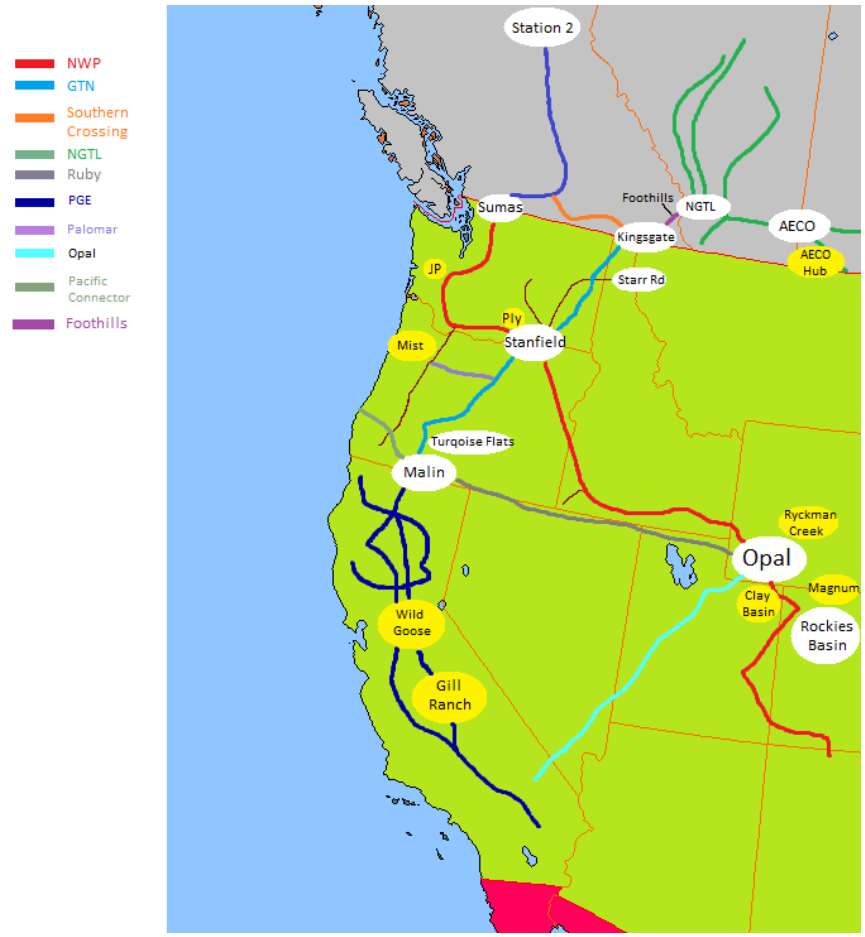
- 78,125** ■ LS Storage
- 8,156** ■ Pipeline Pack
- 10,000** ■ 3rd Party Citygate
- 20,000** ■ Peaking Deal
- 10,000** ■ Daily Spot Gas
- 56,366** ■ SGS Storage
- 10,000** ■ FOM Spot Gas
- 80,000** ■ RFP Supply
- 56,000** ■ Current Supply

Alternative Resources

Major Resource Issues on the Horizon

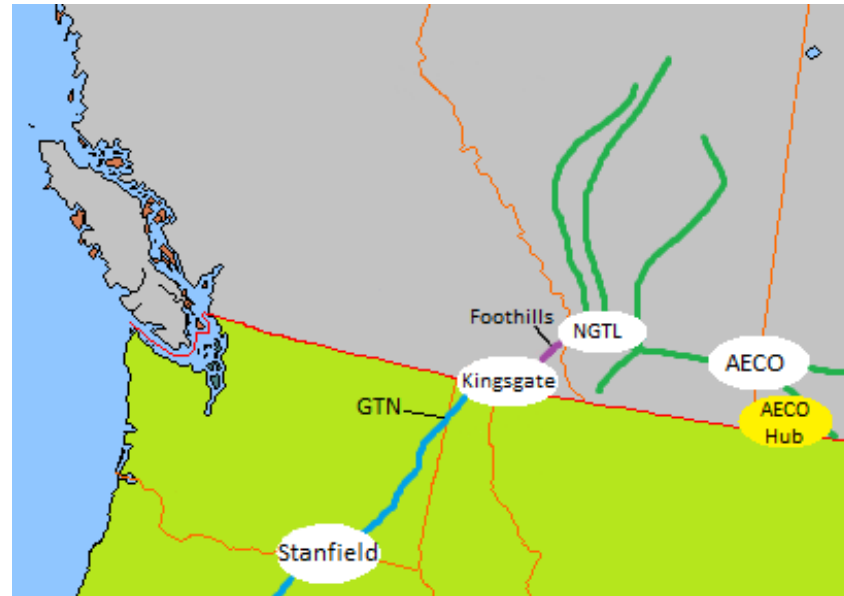
- Once a deficiency is identified, Cascade must analyze potential solutions to ensure service over the planning horizon.
- Conversations with partners at various pipelines, storage facilities, new supply sources.
- SENDOUT[®] is used to ultimately derive the optimal mix of resources, referred to as the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

Location of Current & Alternative Resources



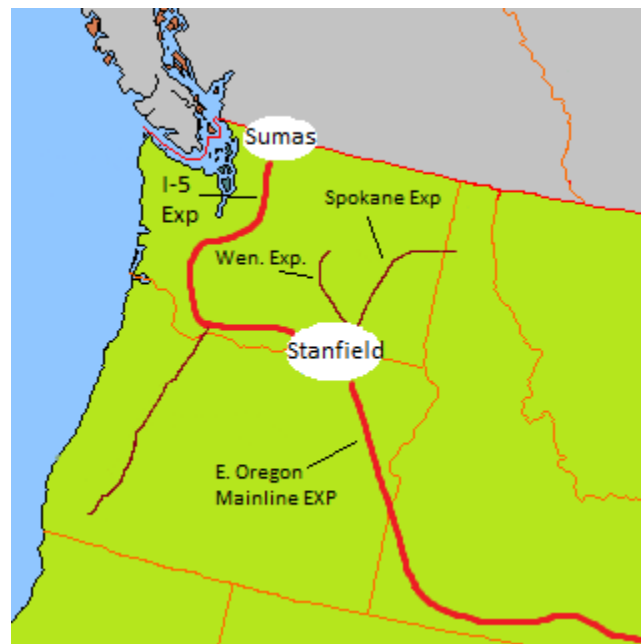
Incremental Transport – North to South

- 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



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



Incremental Transport – South to North

Incremental Opal– Additional capacity to move gas from Utah to Opal

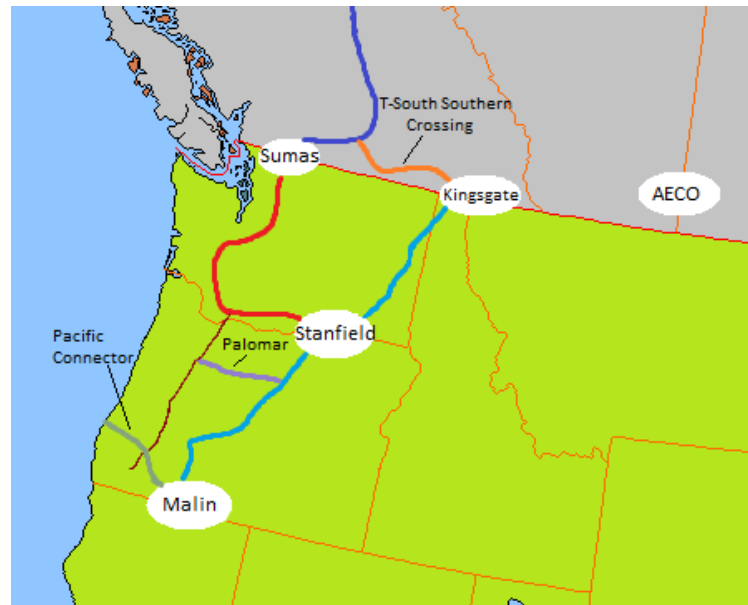
Incremental Ruby – Additional capacity to move gas from Rockies Basin to Turquoise Flats

Incremental GTN S/N – Additional capacity to move gas from Turquoise Flats to various citygates along GTN



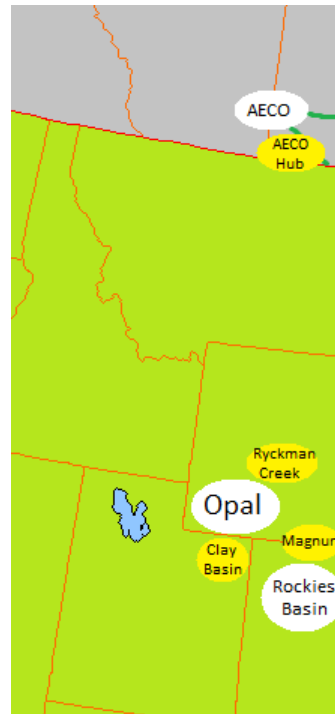
Incremental Transport – Bilateral

- 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



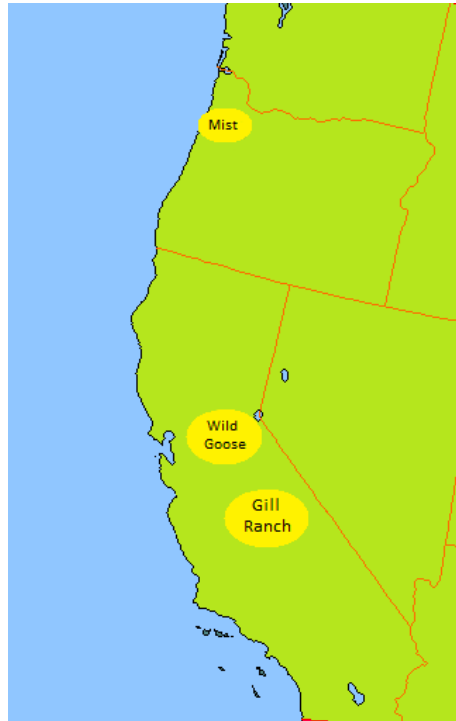
Incremental Storage - North and East

- 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, serving the system



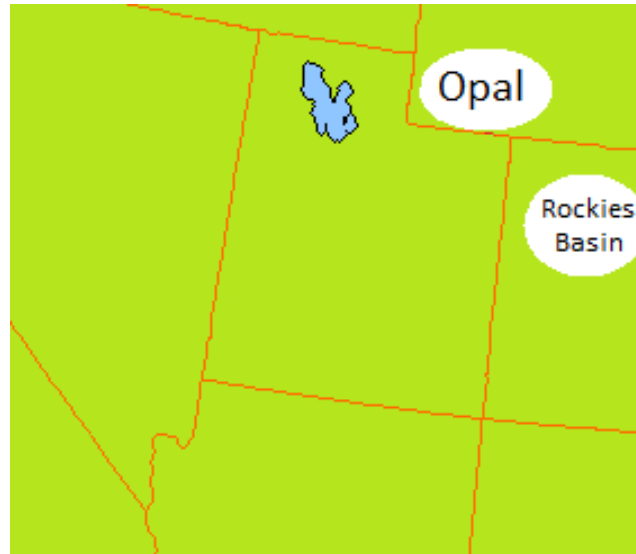
Incremental Storage - South and West

- 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



Incremental Supplies

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



Market Outlook and Long Range Price Forecast

Long Range Market Outlook

- According to the Energy Information Administration (EIA) 2017 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 grow the fastest.
- As expected, high natural gas consumption leads to a robust production forecast for natural gas.

Long Range Market Outlook Cont'd

- Like consumption, nonhydroelectric renewable energy shows a significant production growth projection.
- Global GDP growth looks strong, but Wood Mackenzie has identified three potential pitfalls that could lead to a loss of anywhere between \$2.2 trillion and \$3.6 trillion of potential global GDP growth by 2021.
- Wood Mackenzie projects in its 2017 first half North American highlight report that gas prices will remain above \$3/mmbtu.

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.

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.

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

Example of SMAPE Calculations by Source

	Source 1	Source 2	Source 3	Source 4
T+1	0.126033375	0.217301	0.1446299	0.152795
T+2	0.167033935	0.208055	0.1973402	0.193328
T+3	0.201221558	0.159752	0.1774237	0.180943
T+4	0.207867469	0.216499	0.0567454	0.206089
T+5	0.240209263	0.170581	0.0149917	0.203743
T+6	0.223763051	0.15863	0.0308552	0.178014
T+7	0.224086048	0.017803	0.160998	0.126166
T+8	0.173107419	0.108208	0.1654999	0.101882
T+9	0.22366183	0.182278	0.1409933	0.190653
T+10	0.197011026	0.171414	0.1373605	0.182815
T+11	0.232436816	0.198159	0.0881173	0.177821
T+12	0.235293955	0.064647	0.046813	0.169711

Example Weights Price Forecast For 2018

Date	Source 1	Source 2	Source 3	Source 4
18-Jan	7.443%	27.601%	51.155%	13.802%
18-Feb	4.103%	40.758%	43.028%	12.111%
18-Mar	4.142%	42.124%	38.518%	15.216%
18-Apr	4.619%	41.958%	37.283%	16.140%
18-May	5.469%	41.641%	36.015%	16.876%
18-Jun	5.248%	40.041%	37.548%	17.163%
18-Jul	3.654%	41.433%	39.335%	15.578%
18-Aug	3.970%	41.695%	38.973%	15.362%
18-Sep	3.324%	48.277%	34.266%	14.132%
18-Oct	4.354%	49.429%	31.572%	14.646%
18-Nov	4.459%	51.308%	29.570%	14.663%
18-Dec	5.599%	49.377%	29.287%	15.737%

Avoided Cost Methodology and Calculation

Avoided Cost Overview

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

Avoided Cost Formula

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

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

Where

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

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 taken from Cascade's 20-year price forecast.
- Risk Premium is the cost associated with hedging.
- Cascade does not include distribution system costs in its current avoided cost calculation, but is considering it for future iterations.

SENDOUT[®] Scenarios and Inputs

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 Transportation In SENDOUT® is a Balancing Act

- Start with a point in time look at each jurisdiction's resources
- Use the Nov17-Oct18 PGA portfolio
- Contracts –Receipt and Delivery Points
- We start with current transport contracts, using centralized receipts and approx. 66 delivery locations
- Rates - Current contractual, with CPI increase every 3 years
- Contractual vs. Operational
- Contractual can be overly restrictive
- Operational can be overly flexible
- Incorporating operational realities into our modeling can defer the need to acquire new resources.
- Gas Supply's job is to get gas from the supply basin to the pipeline citygate.
- IRP focus is on the core
- Operations job is to take gas from the pipeline gate to our customers.
- Operations focus is on the system, not just the core
- Limiting factor is receipt quantity –how much can you bring into the system?

Modeling Challenges

- Supply needs to get gas to the citygate.
- Many of 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
- **Step 3: Stochastic Analysis of All Resources Under Existing Conditions**
 - Run all current and incremental resources through a Monte Carlo weather simulation, using expected growth, supply and storage accessibility. Record the probability of each resource being selected
 - Derive a stochastic optimal portfolio for this scenario by inserting most selected resource one at a time until resource deficiencies are eliminated
 - Consider probability curves for amount, timing of resources when deriving optimal portfolio

Supply Resource Optimization Process Cont'd.

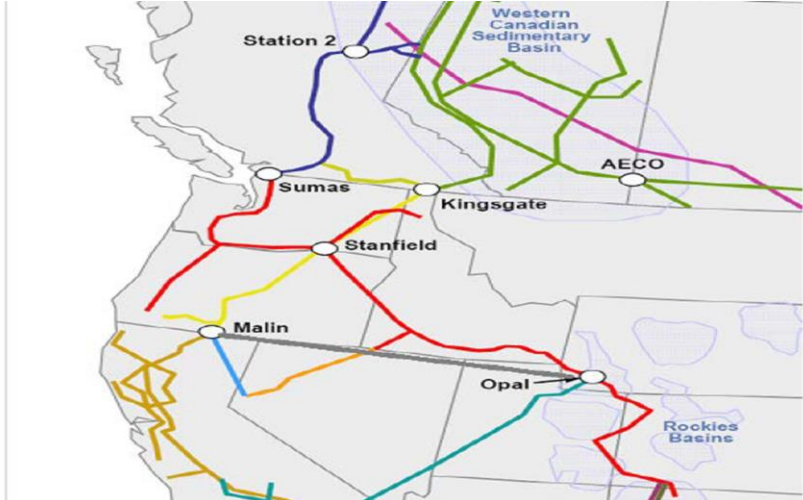
- **Step 4: Stochastic Analysis of All Scenarios**
 - Run Monte Carlo simulations on all scenarios, record optimal portfolio of each scenario.
- **Step 5: Selection of Preferred Portfolio**
 - Analyze the optimal portfolios of each scenario and rank portfolios. The preferred portfolio will be the best combination of cost and risk for Cascade and its customers.
- **Step 6: Sensitivity of Preferred Portfolio**
 - Run the preferred portfolio through Monte Carlo simulations on price. Review results to determine if total system cost is within a tolerable range across all sensitivities.
- **Step 7: Re-evaluation of Preferred Portfolio**
 - If the total system costs fall outside of a tolerable range in sensitivity analysis, select the next most optimal portfolio to run sensitivity analysis on. Repeat as needed.

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?

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
	<i>Incremental NGTL</i>	<i>Ryckman Crk Storage</i>	<i>Opal Incrm Supply</i>
	<i>Incremental GTN N-S</i>	<i>Gill Ranch Storage</i>	<i>BioNaturalGas</i>
	<i>NWP I-5 Mainline EXP</i>	<i>Mist Storage</i>	<i>Resource Mix - 3 Basins</i>
	<i>Incremental Ruby</i>	<i>Wild Goose Storage</i>	
	<i>NWP Wen lateral EXP</i>	<i>Aeco Hub Storage</i>	
	<i>Incremental Foothills</i>	<i>Magnum Storage</i>	
	<i>NWP Z20 lateral EXP</i>	<i>Clay Basin Storage</i>	
	<i>T-South-So Crossing</i>		
	<i>Trails West (Palomar)</i>		
	<i>NWP East OR Mainline EXP</i>		
	<i>Incremental GTN S-N</i>		
	<i>Incremental Enbridge</i>		
	<i>Pacific Connector</i>		



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

As-Is and Incremental 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.			
As Is	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
	<i>Incremental NGTL</i>	<i>Ryckman Crk Storage</i>	<i>Opal Incrm Supply</i>
	<i>Incremental GTN N-S</i>	<i>Gill Ranch Storage</i>	<i>BioNaturalGas</i>
	<i>NWP I-5 Mainline EXP</i>	<i>Mist Storage</i>	<i>Resource Mix - 3 Basins</i>
	<i>Incremental Ruby</i>	<i>Wild Goose Storage</i>	
	<i>NWP Wen lateral EXP</i>	<i>Aeco Hub Storage</i>	
	<i>Incremental Foothills</i>	<i>Magnum Storage</i>	
	<i>NWP Z20 lateral EXP</i>	<i>Clay Basin Storage</i>	
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	<i>Trails West (Palomar)</i>		
	<i>NWP East OR Mainline EXP</i>		
	<i>Incremental GTN S-N</i>		
	<i>Incremental Enbridge</i>		
	<i>Pacific Connector</i>		

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.			
Incr Storage	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
	<i>Incremental NGTL</i>	<i>Ryckman Crk Storage</i>	<i>Opal Incrm Supply</i>
	<i>Incremental GTN N-S</i>	<i>Gill Ranch Storage</i>	<i>BioNaturalGas</i>
	<i>NWP I-5 Mainline EXP</i>	<i>Mist Storage</i>	<i>Resource Mix - 3 Basins</i>
	<i>Incremental Ruby</i>	<i>Wild Goose Storage</i>	
	<i>NWP Wen lateral EXP</i>	<i>Aeco Hub Storage</i>	
	<i>Incremental Foothills</i>	<i>Magnum Storage</i>	
	<i>NWP Z20 lateral EXP</i>	<i>Clay Basin Storage</i>	
	<i>T-South-So Crossing</i>		
	<i>Trails West (Palomar)</i>		
	<i>NWP East OR Mainline EXP</i>		
	<i>Incremental GTN S-N</i>		
	<i>Incremental Enbridge</i>		
	<i>Pacific Connector</i>		

Incremental Transport and All in

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.			
Incr Transport	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
	<i>Incremental NGTL</i>	<i>Ryckman Crk Storage</i>	<i>Opal Incrm Supply</i>
	<i>Incremental GTN N-S</i>	<i>Gill Ranch Storage</i>	<i>BioNaturalGas</i>
	<i>NWP I-5 Mainline EXP</i>	<i>Mist Storage</i>	<i>Resource Mix - 3 Basins</i>
	<i>Incremental Ruby</i>	<i>Wild Goose Storage</i>	
	<i>NWP Wen lateral EXP</i>	<i>Aeco Hub Storage</i>	
	<i>Incremental Foothills</i>	<i>Magnum Storage</i>	
	<i>NWP Z20 lateral EXP</i>	<i>Clay Basin Storage</i>	
<i>T-South-So Crossing</i>			
<i>Trails West (Palomar)</i>			
<i>NWP East OR Mainline EXP</i>			
<i>Incremental GTN S-N</i>			
<i>Incremental Enbridge</i>			
<i>Pacific Connector</i>			

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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
	<i>Incremental NGTL</i>	<i>Ryckman Crk Storage</i>	<i>Opal Incrm Supply</i>
	<i>Incremental GTN N-S</i>	<i>Gill Ranch Storage</i>	<i>BioNaturalGas</i>
	<i>NWP I-5 Mainline EXP</i>	<i>Mist Storage</i>	<i>Resource Mix - 3 Basins</i>
	<i>Incremental Ruby</i>	<i>Wild Goose Storage</i>	
	<i>NWP Wen lateral EXP</i>	<i>Aeco Hub Storage</i>	
	<i>Incremental Foothills</i>	<i>Magnum Storage</i>	
	<i>NWP Z20 lateral EXP</i>	<i>Clay Basin Storage</i>	
<i>T-South-So Crossing</i>			
<i>Trails West (Palomar)</i>			
<i>NWP East OR Mainline EXP</i>			
<i>Incremental GTN S-N</i>			
<i>Incremental Enbridge</i>			
<i>Pacific Connector</i>			

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
	<i>Incremental NGTL</i>	<i>Ryckman Crk Storage</i>	<i>Opal Incrm Supply</i>
	<i>Incremental GTN N-S</i>	<i>Gill Ranch Storage</i>	<i>BioNaturalGas</i>
	<i>NWP I-5 Mainline EXP</i>	<i>Mist Storage</i>	<i>Resource Mix - 3 Basins</i>
	<i>Incremental Ruby</i>	<i>Wild Goose Storage</i>	
	<i>NWP Wen lateral EXP</i>	<i>Aeco Hub Storage</i>	
	<i>Incremental Foothills</i>	<i>Magnum Storage</i>	
	<i>NWP Z20 lateral EXP</i>	<i>Clay Basin Storage</i>	
	<i>T-South-So Crossing</i>		
<i>Trails West (Palomar)</i>			
<i>NWP East OR Mainline EXP</i>			
<i>Incremental GTN S-N</i>			
<i>Incremental Enbridge</i>			
<i>Pacific Connector</i>			

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
	<i>Incremental NGTL</i>	<i>Ryckman Crk Storage</i>	<i>Opal Incrm Supply</i>
	<i>Incremental GTN N-S</i>	<i>Gill Ranch Storage</i>	<i>BioNaturalGas</i>
	<i>NWP I-5 Mainline EXP</i>	<i>Mist Storage</i>	<i>Resource Mix - 3 Basins</i>
	<i>Incremental Ruby</i>	<i>Wild Goose Storage</i>	
	<i>NWP Wen lateral EXP</i>	<i>Aeco Hub Storage</i>	
	<i>Incremental Foothills</i>	<i>Magnum Storage</i>	
	<i>NWP Z20 lateral EXP</i>	<i>Clay Basin Storage</i>	
	<i>T-South-So Crossing</i>		
<i>Trails West (Palomar)</i>			
<i>NWP East OR Mainline EXP</i>			
<i>Incremental GTN S-N</i>			
<i>Incremental Enbridge</i>			
<i>Pacific Connector</i>			

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		

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
	<i>Incremental NGTL</i>	<i>Ryckman Crk Storage</i>	<i>Opal Incrm Supply</i>
	<i>Incremental GTN N-S</i>	<i>Gill Ranch Storage</i>	<i>BioNaturalGas</i>
	<i>NWP I-5 Mainline EXP</i>	<i>Mist Storage</i>	<i>Resource Mix - 3 Basins</i>
	<i>Incremental Ruby</i>	<i>Wild Goose Storage</i>	
	<i>NWP Wen lateral EXP</i>	<i>Aeco Hub Storage</i>	
	<i>Incremental Foothills</i>	<i>Magnum Storage</i>	
	<i>NWP Z20 lateral EXP</i>	<i>Clay Basin Storage</i>	
	<i>T-South-So Crossing</i>		
	<i>Trails West (Palomar)</i>		
	<i>NWP East OR Mainline EXP</i>		
	<i>Incremental GTN S-N</i>		
	<i>Incremental Enbridge</i>		
	<i>Pacific Connector</i>		

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
	<i>Incremental NGTL</i>	<i>Ryckman Crk Storage</i>	<i>Opal Incrm Supply</i>
	<i>Incremental GTN N-S</i>	<i>Gill Ranch Storage</i>	<i>BioNaturalGas</i>
	<i>NWP I-5 Mainline EXP</i>	<i>Mist Storage</i>	<i>Resource Mix - 3 Basins</i>
	<i>Incremental Ruby</i>	<i>Wild Goose Storage</i>	
	<i>NWP Wen lateral EXP</i>	<i>Aeco Hub Storage</i>	
	<i>Incremental Foothills</i>	<i>Magnum Storage</i>	
	<i>NWP Z20 lateral EXP</i>	<i>Clay Basin Storage</i>	
	<i>T-South-So Crossing</i>		
	<i>Trails West (Palomar)</i>		
	<i>NWP East OR Mainline EXP</i>		
	<i>Incremental GTN S-N</i>		
	<i>Incremental Enbridge</i>		
	<i>Pacific Connector</i>		

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
	<i>Incremental NGTL</i>	<i>Ryckman Crk Storage</i>	<i>Opal Incrm Supply</i>
	<i>Incremental GTN N-S</i>	<i>Gill Ranch Storage</i>	<i>BioNaturalGas</i>
	<i>NWP I-5 Mainline EXP</i>	<i>Mist Storage</i>	<i>Resource Mix - 3 Basins</i>
	<i>Incremental Ruby</i>	<i>Wild Goose Storage</i>	
	<i>NWP Wen lateral EXP</i>	<i>Aeco Hub Storage</i>	
	<i>Incremental Foothills</i>	<i>Magnum Storage</i>	
	<i>NWP Z20 lateral EXP</i>	<i>Clay Basin Storage</i>	
	<i>T-South-So Crossing</i>		
	<i>Trails West (Palomar)</i>		
	<i>NWP East OR Mainline EXP</i>		
	<i>Incremental GTN S-N</i>		
	<i>Incremental Enbridge</i>		
	<i>Pacific Connector</i>		

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
	<i>Incremental NGTL</i>	<i>Ryckman Crk Storage</i>	<i>Opal Incrm Supply</i>
	<i>Incremental GTN N-S</i>	<i>Gill Ranch Storage</i>	<i>BioNaturalGas</i>
	<i>NWP I-5 Mainline EXP</i>	<i>Mist Storage</i>	<i>Resource Mix - 3 Basins</i>
	<i>Incremental Ruby</i>	<i>Wild Goose Storage</i>	
	<i>NWP Wen lateral EXP</i>	<i>Aeco Hub Storage</i>	
	<i>Incremental Foothills</i>	<i>Magnum Storage</i>	
	<i>NWP Z20 lateral EXP</i>	<i>Clay Basin Storage</i>	
	<i>T-South-So Crossing</i>		
	<i>Trails West (Palomar)</i>		
	<i>NWP East OR Mainline EXP</i>		
	<i>Incremental GTN S-N</i>		
	<i>Incremental Enbridge</i>		
	<i>Pacific Connector</i>		

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
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	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
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	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		

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	JP1 JP2 JP3 JP4 PLY-1 PLY-2	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
	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	Ryckman Crk Storage Gill Ranch Storage Mist Storage Wild Goose Storage Aeco Hub Storage Magnum Storage Clay Basin Storage	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	JP1 JP2 JP3 JP4 PLY-1 PLY-2	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
	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	Ryckman Crk Storage Gill Ranch Storage Mist Storage Wild Goose Storage Aeco Hub Storage Magnum Storage Clay Basin Storage	Opal Incrm Supply BioNaturalGas Resource Mix - 3 Basins

Sensitivities Analyses

Sensitivities		Assumptions
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.
Carbon Adder	10%	Medium Load Growth, Average Weather with Peak Event, Medium Gas Price Environment with 10% 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
Per Ton	\$10	Medium Load Growth, Average Weather with Peak Event, Medium Gas Price Environment with \$10 per ton Carbon Tax
	\$20	Medium Load Growth, Average Weather with Peak Event, Medium Gas Price Environment with \$20 per ton Carbon Tax
	\$30	Medium Load Growth, Average Weather with Peak Event, Medium Gas Price Environment with \$30 per ton Carbon Tax

Additional Input From Stakeholders

Feedback on...

- Avoided cost methodology and calculations
- New price forecast weighting system
- New optimization process
- Clarification for scenarios versus sensitivities
- Risk analysis proposed, any additional analysis to be considered

2018 IRP Timeline

Date	Process Element	Location (Subject to change)
Friday, July 21, 2017	Citygate Update to CNGC Gas Supply Oversight Committee	
Wednesday, July 26, 2017	CAG Q3 Meeting	
Thursday, August 31, 2017	TAG 3 slides distributed to stakeholders	
Thursday, September 7, 2017	TAG 3 Carbon Impacts, Conservation(ETO), Preliminary Resource Integration Results, Proposed new 2 year Plan	Portland International Airport Conference Center 9am-3pm
Wednesday, October 4, 2017	CAG Q4 Meeting	
Wednesday, October 11, 2017	TAG 4 slides distributed to stakeholders	
Thursday, October 19, 2017	TAG 4: Final Integration Results, finalization of plan components	OPUC Offices Salem OR 9am-12pm
Monday, November 6, 2017	Draft of 2018 IRP distributed	
Tuesday, December 5, 2017	Comments due on draft from all stakeholders	
Wednesday, December 20, 2017	TAG 5, if needed	WebEx Only
Monday, January 22, 2018	Executive Summary Presentation to Senior Management	Kennewick, WebEx
Thursday, January 25, 2018	IRP filing in Oregon	

NEXT STEPS?

Cascade Natural Gas Corporation

Integrated Resource Plan Technical Advisory Group Meeting #2

Wednesday, July 19, 2017
Public Utility Commission of
Oregon
Salem, OR