Appendix A

IRP Process

Draft 2018 WA IRP

Cascade Natural Gas Corporation

Integrated Resource Plan
Technical Advisory Group Meeting #1

March 15th 2018
SeaTac Airport
Seattle, WA

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Agenda

- Introductions
- About Cascade Natural Gas
- IRP Process
- Recap of latest CAG Meeting
- Best Practices Discussion
  - Load Forecast
  - Conservation
  - Carbon
  - Avoided Cost
  - Hedging
  - Stochastic Analysis Techniques
  - Renewables
  - Distribution System Planning
  - Additional Items
- 2018 WA IRP Timeline
- Next Steps

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A LITTLE HISTORY LESSON…

- Prior to 1955, natural gas was virtually unheard-of in the Pacific Northwest. Seeing an opportunity, Lester Pettit, Spencer Clark, and Stewart Matthews led a group of associates to form a company that would rise to the challenge. Cascade Natural Gas Corporation was incorporated January 2, 1953.
- In July 2007, Cascade was acquired by MDU Resources headquartered in Bismarck, ND.
  - Founded in 1924 as an electric utility in eastern Montana.
  - Core businesses are construction, utilities, and pipeline.
  - Approximately 9,600 employees, operating in 48 states.
  - Operates four utilities across eight states:
    - Montana-Dakota Utilities Co.
    - Great Plains Natural Gas Co.
    - Cascade Natural Gas Corporation
    - Intermountain Gas Co.

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AND TODAY WE ARE …

- Cascade Natural Gas Corp. serves 282,000 customers in 96 communities – 68 of which are in Washington and 28 in Oregon. Cascade's service areas are concentrated in western and south central Washington, and south central and eastern Oregon.

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

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Purpose of the IRP Process

Bruce Folsom

Bruce W Folsom Consulting LLC

March 15th, 2018

Purpose of the IRP

- The purpose of an IRP is to depict the <u>overall</u> company plan more <u>transparently</u> …
  - For immediately-contemplated actions (i.e., in the next two years),
  - To characterize emerging issues and related approaches for mitigation, if necessary, and
  - To outline the long-term direction a company is headed *vis-a-vis* the industry, including economic trends, industry structure (partners such as the pipeline(s) and their impact/actions), technology, customer usage, etc.

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IRP Objectives

- Present a transparent roadmap of the overall corporate plan per the previous slide
- Promote internal coordination
- Describe to key stakeholders and the public the complex utility system unique to the local distribution company and management decision-making processes
- Provide previews of future projects and issues which can lead to improved regulatory filings
- Meet regulatory requirements

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Benefits

- A company can describe its unique circumstances, opportunities and challenges over the planning horizon
- More specifically, while commissions do not approve the IRP—and, hence future actions—the description of potential actions generally provides for an improved process of future filings, because stakeholders have a basis, in advance, for what is driving those decisions

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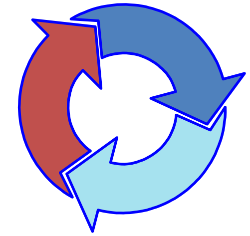
In Conclusion



- An IRP Provides an understanding of industry and utility-specific practices

- That the Commission acknowledges the plans, rather than approve them, does not lessen the process's regulatory importance

- The commitment from Cascade's senior leadership has been outstanding and recognized by stakeholders

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IRP Process

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Stakeholder Engagement Process

- Input and feedback from Cascade’s Technical Advisory Group (TAG) is an important resource to help ensure the IRP includes perspectives external to the Company and is responsive to stakeholders.
- Five TAG meetings will be held, with a potential sixth scheduled if needed.
- Multiple opportunities for public participation will be made available.

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Role of TAG Meetings in the IRP Process

- Cascade believes the TAG meetings are of significant value to the IRP process, and encourages as much active stakeholder participation as possible.
- Feedback from stakeholders is critical to the production of a document that clearly and effectively communicates the Company's plan to acquire the least cost mix of natural gas supply and conservation resources to serve forecasted demand.
- At the same time, Cascade will ultimately produce a plan that accounts for the challenges unique to its service area.

Meeting Principles

- This will be an effective TAG meeting if…
  - Start and end on time, with participants fully present;
  - Allow for open, inclusive and balanced participation and discussions;
  - Ask questions;
  - Slides are disseminated to stakeholders in advance, and reviewed by stakeholders prior to the meeting; and
  - Be clear about next steps and action items.
    - Deadlines to hit milestones are presented clearly, and respected by all parties.

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Importance of Milestones

- The IRP team plays an internal coordination role, assisting many departments working as one.
- This can be challenging, as each department has its own core function beyond the IRP.
- Milestones allow the Company to achieve this task while being respectful of each other's individual challenges and workload.
- The Company has critical milestones related to the completion of its load forecast, price forecast, avoided cost, and other critical processes. These often inform other parts of the IRP process, and must be met on time.

INTERNAL TEAM MEMBERS OF CNGC'S INTEGRATED RESOURCE PLAN:

LAST NAME	FIRST NAME	TITLE	COMPANY
Abrahamson	Jim	Manager, Conservation Policy	Cascade
Archer	Pam	Supervisor, Regulatory Affairs	Cascade
Bolton	Chris	Engineering II, Engineering	Cascade
Burin	Kary	Supervisor, Conservation	Cascade
Chiles	Mark	Vice President, Customer Service and Regulatory Affairs	Intermountain
Cooley	John	Manager, Industrial Services	Cascade
Cowlishaw	Monica	Manager, Conservation Programs	Cascade
Cunnington	Brian	Manager, Industrial Services	Cascade
Davis	Ashton	Resource Planning Analyst, Gas Supply	Cascade
Escobar	Michael	System Administrator	Cascade
Folsom	Bruce	Consultant	Bruce W Folsom Consulting LLC
Gross	Jennifer	Regulatory Analyst IV, Regulatory Affairs	Cascade
Krebsbach	Abbie	Director, Environmental	MDU

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INTERNAL TEAM MEMBERS OF CNGC'S INTEGRATED RESOURCE PLAN:

LAST NAME	FIRST NAME	TITLE	COMPANY
Martuscelli	Eric	Vice President, Operations	Cascade
McGreal	Devin	Resource Planning Analyst, Gas Supply	Cascade
Mellinger	Becky	Financial Analyst	Cascade
Morman	Bob	Director, Gas Supply Utility Group	MDU
Ogden	Jeremy	Director, Engineering	Cascade
Parvinen	Mike	Director, Regulatory Affairs	Cascade
Robbins	Chris	Manager, Gas Supply and Control- CNGC/IGC	Cascade/ Intermountain
Robertson	Brian	Sr Resource Planning Analyst, Gas Supply	Cascade
Sargent	Amanda	Conservation Analyst	Cascade
Sellers-Vaughn	Mark	Manager, Supply Resource Planning	Cascade
Senger	Garret	Executive Vice President, Regulatory, Customer Service, Gas Supply	MDU
Spector	Allison	Manager, Conservation Policy	Cascade
Stone	Carolyn	Gas Supply Analyst	Cascade
Tyssen	Nathan	Network Administrator	Cascade
Wood	Eric	Supervisor, Gas Supply	Cascade/ Intermountain

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Impact of U-161024

- On September 1st, 2016, the WUTC kicked off U-161024 to discuss potentially amending the IRP process.
- Cascade has been, and will continue to be, an active participant in all workshops related to this rulemaking.
- Open question: What are stakeholder expectations regarding U-161024 for Cascade's 2018 WA IRP?

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Recap of Conservation Advisory Group

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Last meeting 03/08/18

- Most recent discussions centered on the 2017 Conservation Potential Assessment and was proceeded by a training session on use of the Company's new Conservation Potential assessment tool – LoadMAP, developed by AEG.
- Therm savings accomplishments for 2017 were briefly discussed, and will officially be released as part of the Annual Conservation Report on June 1st to the Commission.

Best Practices Discussion

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Context

- Cascade is very proud of its acknowledged 2016 IRP, but recognizes the importance of continuing to improve and grow.
- To this end, Cascade has actively been engaged in following the IRPs of other regional LDCs. This includes reading their IRPs and attending their versions of TAG meetings.
  - The goal has been to learn IRP best practices across the industry, and take back applicable elements to include in our IRP.
  - In the spirit of this, Cascade encourages stakeholder to tell us if there is an element of another LDC's IRP that they believe is particularly well done.
  - As stated earlier, Cascade has its own unique challenges and demographics, and will produce an IRP specific to Cascade.
- Cascade encourages feedback on its proposed approach to the following IRP elements, either today or future TAG meetings.

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Load Forecast

- The Company currently utilizes an Autoregressive Integrated Moving Average (ARIMA) methodology with Fourier terms to predict customer count and usage.
- Cascade uses a 60 degree reference temperature to calculate HDDs.
- Multiple scenarios are analyzed such as high/low growth, warm/cold weather, peak day events, etc.
- Cascade has continued to evaluate other potential predictors such as housing starts, but have encountered the same problem as other regional LDCs related to the availability of data to accurately reflect its service area.

Customer Forecast

$$\alpha_0 + \alpha_1 Pop^{CG} + \alpha_2 Emp^{CG} + Fourier(k) + ARIMA \in (p,d,q)$$

- 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.

Use Per Customer Forecast

- $\text{Therms/C}^{CG,Class} = \alpha_0 + \alpha_1 HDD^{CG,\,M} + \alpha_2 I_w + \alpha_3 T + ARIMA \in (p,d,q)$
- 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; ARIMA$\in$(p,d,q) = Indicates that the model has p autoregressive terms, d difference terms, and q moving average terms.

Conservation

- The IRP team is an active participant in Cascade's Conservation Advisory Group (CAG).
- The Company will continue to integrate relevant aspects of the CAG meetings in its IRP process.
- As per the commitment the Company made in its 2016 Addendum to the IRP we are finalizing the CPA in Q1 and will include the full study in the 2018 IRP. In the DSM chapter we will also include a re-run of the model's potential based on updated inputs for 2018 and a recap of some of the elements contained within the Conservation Plan.

Carbon

- Cascade recognizes that there is a strong regional desire to reduce carbon emissions.
- The Company is paying close attention to various initiatives, including a Carbon Tax proposed by Governor Inslee.
- Cascade will follow the example of its regional LDCs and include an analysis of various carbon reduction scenarios in its 2018 IRP.

Avoided Cost

- Cascade has revamped its avoided cost formula to create a more transparent and intuitive final number.
- Cascade will be incorporating elements of other LDCs methodologies for distribution system and risk premium costs.
- Cascade is considering including these items in its 2018 IRP avoided cost, but encourages stakeholder feedback on this item.

Avoided Cost Formula

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

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_f = Incremental Fixed Transportation Costs
- TC_v = Variable Transportation Costs
- SC_f = Incremental Fixed Storage 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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Hedging

- Cascade has been an active participant in UG-132019, and has successfully included its hedging plan with its 2017 PGA filing.
- The Company is also engaged in discussions with potential consultants to review and recommend any changes to the plan as appropriate.
- The Company will continue to include its current hedging activity related to fixed price physicals in the 2018 IRP, and welcomes feedback as to what stakeholders would like to see in the IRP related to hedging.

Stochastic Analysis

- Cascade appreciated Staff feedback requesting further stochastic analysis in the Company's 2018 IRP.
- In the 2016 IRP, Cascade only ran stochastic analysis on the preferred deterministic portfolio.
- For the 2018 IRP, Cascade will perform Monte Carlo simulations on all potential portfolios before scenario and sensitivity testing.

Stochastic Analysis

- Cascade will stochastically test multiple portfolios in its 2018 IRP to capture the extrinsic value of all portfolios before selecting a candidate portfolio.
- This candidate portfolio will then be tested through stochastic scenario and sensitivity modeling.
- Cascade will compare the Value at Risk (VaR) of the candidate portfolio in each scenario/sensitivity to a VaR limit to ensure that the extrinsic risk of the portfolio is within tolerable levels.

Renewables

- Cascade is continuing to look at renewables as an option for long-term supplies.
- The Company has met with several biodigestor developers who are trying to capture value in the current RIN market. However, none of these have moved passed the discussion phase to date.
- In addition, Cascade has met with the City of Richland (WA) to discuss the possibility of capturing biogas from their landfill. They have hired a consultant to assess the feasibility of that project and will keep Cascade in the loop if that moves forward.

Distribution System Planning

- IRP process for distribution system planning includes a discussion of the distribution scenario process related to enhancements.
- Cascade will provide all planned WA projects under confidential treatment.
- Cascade encourages stakeholder feedback related to distribution system planning.

Additional Matters

- Cascade is always looking for ways to enhance the IRP, feedback related to any best practices would be greatly appreciated.

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2018 IRP Schedule

Date	Process Element	Location (Subject to change)
Thursday, March 8, 2018	TAG 1 slides distributed to stakeholders	
Thursday, March 15, 2018	**TAG 1: Process, Key Points, IRP Team, Timeline, Regional Market Outlook, Plan for dealing with issues raised in 2016 IRP, C.A.R.**	**Seattle-Tacoma Internation Airport Conference Center 9am-12pm**
Wednesday, May 16, 2018	TAG 2 slides distributed to stakeholders	
Wednesday, May 23, 2018	**TAG 2: Demand and Customer Forecast and Non-Core Outlook, Drilling down into segments of demand forecast. NWP/GTN Present Demand Taps.**	**Seattle-Tacoma Internation Airport Conference Center 9am-12pm**
Thursday, May 31, 2018	**2016 WA IRP 3rd Quarterly Update Filed**	
Thursday, June 28, 2018	TAG 3 slides distributed to stakeholders	
Thursday, July 12, 2018	**TAG 3: Distribution System Planning, Planned Scenarios and Sensitivities, Alternative Resources, Price Forecast, Avoided Costs. Current Supply Resources, Transport Issues.**	**Seattle-Tacoma Internation Airport Conference Center 9am-12pm**
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 Internation 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 Internation 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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Questions/Next Steps

- Review Plans for TAG 2 Discussion
  - Demand and Customer Forecast.
  - Non-Core Forecast.
  - NWP/GTN Pipeline Capacity Overview.
  - Next TAG is Wednesday, May 23rd at SeaTac Airport in Seattle, WA.

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Integrated Resource Plan
Technical Advisory Group Meeting #1

March 15th 2018
SeaTac Airport
Seattle, WA

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1st External WUTC Tag Meeting

Date & Time: 3/15/2018, 09:00 AM – 11:30 AM

Location: SeaTac Conference Center – Seoul Room

In attendance: Mark Sellers-Vaughn, Bruce Folsom, Brian Robertson, Devin McGreal, Ashton Davis, Chris Robbins, Monica Cowlishaw, Marty Saldivar, Karl Frankiewich, & Carolyn Stone.

Called in: Bob Morman, Dan Kirschner, Chris Bolton, Jennifer Gross & Garret Senger

Minutes by: Carolyn P Stone

Mark started the meeting by welcoming everyone to the 1st WUTC Tag Meeting of 2018. He said he was happy for everyone's participation! Mark proceeded with introductions both on phone and for those present. Mark thanked everyone for being there and went through the agenda items.

1. Identifying the elements of the IRP – structure
2. Identifying "hot button" issues
3. Best Practices
4. Renewables
5. Distribution System Planning
6. Additional items?
7. Timeline
8. Next Steps

Mark stated that there are a variety of people speaking this morning that will help explain how the IRP gets its "shape".

Mark asked Garret if he had any opening remarks. Garret stated that this is a step forward from previous filings and he is looking forward to the discussion.

Mark said there will be references to the 2014 IRP, but the focus today is on 2018's IRP. Mark further stated he does not expect a long meeting today.

1st Presentation – A Little History Lesson (Mark Sellers-Vaughn), Slide 3

- In 1953, CNGC was incorporated
- In July of 2007 CNGC was acquired by MDU
- CNGC serves 282,000 customers in 96 communities, 68 in WA, 28 in OR
- Cascade has a diverse distribution system – non-continuous service territory of 32,000 miles!

2nd Presentation – Purpose of the IRP Process (Bruce Folsom), Slide 5

- IRP provides an understanding of industry and utility practices.
- Bruce said the commitment from CNGC senior management has been outstanding!
- Bruce said CNGC is looking for best practices in regard to the IRP process
- Bruce pointed out that the resources analysts have been around a relatively short time but have really done a great job! Mark said Devin hasn't been here but 2 years!
- Bruce was hired to help using his years of experience. Bruce brought perspective and joy, encouragement and insight, plus the ability to work with many different types of people.

3rd Presentation – IRP Guidelines & Content (Mark Sellers-Vaughn), Slide 11

Slide #18 – Impact of U-161024

- This is the 2016 WUTC docket to amend the IRP process

Question: Mark asked what staff's expectations are for his group regarding this docket about the WUTC IRP?

Answer: Kyle said to follow the rules but no expectations, what came out yesterday may not apply today!

Question: Mark asked about the "Avoided Cost" discussion? He said Northwest Natural (NWN) is stretching the boundaries!

Answer: Kyle said using this TAG process to talk about Avoided Costs should be sufficient. He said retroactive application of guidelines is not in our plan!

- Mark went on to say that conversations are always welcome!
- He stated that the OPUC opened a docket for "Avoided Costs" and will be codified. It discusses distribution systems enhancements.
- Kyle said the WUTC does not have any new changes. The IRP rulemaking is done. They are drafting language for the PURPA and RFP's and we are trying to get rules finalized for…PURPA, Transmission & Distribution and RFP's. Kyle said the procedural piece is done "CR 102" and draft language to be released at the end of summer – then starts a 60-day block.
- Kyle stated that they are trying to use the IRP process to hash out proxy costs, then get WUTC input.
- Mark said we are eager to participate in that conversation!
- Kyle then gave those calling in to the meeting his contact information.

Question: Bruce said that CNGC is sensitive to what the other LDC's are doing. Does Staff work with NWN/PSE and is there interaction with Staff on their IRP's?
Answer: Yes, Kyle stated, we work with them. We cover for each other based on the demands on our time. There is a "cross—pollination" of ideas. NWN is doing interesting stuff. There is lots of interaction and then we report back to the team on it.

- Bruce commented that Staff picked one heck of a NEEAA meeting to attend, that was an amazing meeting he said!

Slide #21 – Context

- Mark said Cascade's 2016 IRP was acknowledged but they want to improve and grow.
- Attending the TAG meetings for other LDC's helps them to learn the IRP Best Practices in the industry. He encourages stakeholders to tell them what other LDC's do well

4th Presentation – Load Forecast (Ashton Davis) Slide 23

- The methodology used currently is called Autoregressive Integrated Moving Average (ARIMA)
- The model uses Citygate & class and goes through a stepwise regression. Population, employment, seasonality and multiple scenarios are used.
- Devin added that industrial and interruptible customers show seasonality. It doesn't always make sense, but things come up that may influence seasonality!

Question: Was this analysis done on Citygate?
Answer: Yes!

- Brian said this is above and beyond a "daily level", there is a weekend indicator and trend line

Question: Kyle said that NWN does a method like this but is trying to improve it. Do other IRP's use this as a common approach?
Answer: Some do

- Devin stated that the disaggregation of service area makes things complicated!
- Devin said sometimes doing the calculation at a "peak level" gives us granularity.

Slide #26 – Conservation

- The IRP team participates in CNGC's Conservation Advisory Group (CAG)
- Information on the CPA in Q1 will go into the IRP.

Question: Kyle asked what AEG is doing exactly?
Answer: Mark stated that they are writing the Conservation Potential Assessment (CPA) and that gives improved numbers from the 2016 IRP. They will rerun this in 2018. AEG has committed to get us the tools to do that!

Question: Kyle then asked if in 2020 will the team be consulting with AEG as needed?
Answer: Mark answered "Yes".

Slide #27 – Carbon

- CNGC recognizes that there is a strong regulatory desire to reduce carbon emissions and pays attention to initiatives.
- Cascade is following the example of regional LDC's and will include an analysis of various carbon reduction scenarios in the IRP.
- Devin said that the TAG process is not a one-way street. Other LDC's helped us with our stochastic analysis!

Question: Mark asked Kyle what Staff wants them to look at, among various stakeholders, regarding carbon analysis?
Answer: Kyle stated Commissioners are comparing notes. Closest standard is the "Social Cost of Carbon" At the moment using this for all 3 states!

Question: Mark asked Kyle how often do they give input?
Answer: In Portland and Seattle once per year, at either monthly or quarterly meetings. The first meeting was in Portland at the 1st half of 2017. This is fairly new for us, we are learning stuff!

- Devin said the team does a lot of scenarios with carbon analysis.
- AEG, he states is working with his group too.
- DSM can give us some inputs that help as well!

Question: Kyle asked does the model use low/medium/high carbon prices?
Answer: Devin said "Yes".

Question: Mark asked how would you introduce "Cap & Trade" into the model?
Answer: Kyle answered, "Shadow Prices".

- Kyle stated that it is expected by Staff that the base case will have carbon in it.
- Devin said they will look at the "social cost of carbon" to see if we are on the right track

5th Presentation – Avoided Cost (Devin McGreal), Slide 28

- Devin explained that there is a "revamped" avoided cost formula

- Devin said they will incorporate elements of what other LDC's are doing.
- They will incorporate the other LDC's ideas, but they want feedback!

Slide #29 – Avoided Cost Formula

- Devin briefly discussed the inputs of the avoided cost formula.
- Commodity Costs = The CNG price forecast for CNG is 20 years
- E_{adder} = Environmental adder is a constant 10%
- At least 2 are new for us, DSC – what the distribution system costs are and RP – Risk Premium (hedge analysis).
- Kyle mentioned "wrap up" slides and mentioned that NWN talked about it in their IRP.

Slide #30 – Hedging (Mark Sellers-Vaughn)

- Mark said CNGC has been actively participating in UG-132019 and included it's "Hedging Plan" with the 2017 PGA.
- Kyle stated that UG-132019 will prevail in Washington so it should be discussed in the IRP. Kyle said there should be more than 1 sentence in the IRP about this.
- Mark said CNGC has selected a consultant and they have been shadowing our process. He is looking forward to hearing feedback.
- We try to keep our system flexible and will do what Washington wants but be sure OPUC understands as well.
- Bruce said that when our policy on hedging comes out, any guidance and suggestions you can provide would help!
- Devin said they would like to see feedback on the length, depth and breadth of hedging section.

Page 31 – Stochastic Analysis

- The team is focused on this "holistically", i.e. what it can tell us about the uncertainty!
- In 2018 we ran a stochastic analysis on multiple portfolios to determine a candidate portfolio. To see what can be uncovered – something we weren't expecting? Large costs?
- In 2018 we will perform a "Monte Carlo" simulation on all potential portfolios before scenario/sensitivity testing.
- Value at Risk (VaR) is our main metric to quantify a good portfolio!
- We run 200 draws with the Monte Carlo – optimized in Send Out.
- This gives a total system cost and unserved demand – the 95th percentile….
- The candidate portfolio is then put through stochastic analysis, scenario & sensitivity testing so the risk is within tolerance levels.
- This will show the least cost and least risk portfolio!
- Kyle said that the Var is good, and he has seen it used in other IRP's too!

Question: Bruce asked what the amount of computing power and time was?
Answer: Devin said 1 draw takes 4 to 10 minutes so 200 takes 4 to 5 hours using each scenario/sensitivity. Then we decide if it worked right. The full process takes at least one month.

Question: Devin asked Kyle if there are any other "best practices" that you've seen related to stochastic analysis?
Answer: Kyle mentioned the 95% percentile and said he's seen this used by other utilities. He was curious why this was used? Devin said they run through types of data inputs in the stochastic analysis in the IRP. We use both deterministic and stochastic analysis in our model.

- Devin said we present deterministic and stochastic analysis but always looking for input. Our challenge is gas is the only resource!
- Bruce said that the PAC IRP is good. Stochastic analysis is "gold" to us. Keep feeding back to us on this!
- Devin went on to say we are proud of this IRP and hope to inspire other LDC's. We love the feedback!
- Kyle said on the electric side, PSE's 2017 IRP had heartburn over resource costs. He said it was contentious on oversight of inputs. There was good reason for confidentiality. It is critical that costs are accurate! They may have more experience for example.
- Kyle advised to make us **comfortable** with why you chose what you did!

6th Presentation – Renewables (Chris Robbins) Slide 33

- Renewables - Cascade looking at as option for long term supplies!
- How involved in this do we want to get is Cascade's challenge.
- 3rd party developers want on our system. We have discussed this and developing gas quality standards, but we can't get past the development stage!
- The utility investment – how to get the value of renewables to our customer!
- The costs and pricing are challenges
- Can consultant advise to make this happen asap?
- Developers - Rural outfits contact us. A landfill relocation to our system has been brought up, but this is not an easy option.

Question: Kyle asked what is in the IRP on this?
Answer: Is there a "green power" type option for gas?

- Devin said that NWP had an option
- Mike C said that NWN has green power in Linden
- Chris concurs but said what people are interested in could have a huge impact on customers cost-wise.

- Kyle said there is interest in new technology with renewables. Encourages IRP group to cover this topic and what your plans are for renewables.
- Kyle said…. show what you are doing to learn how this impacts your system in 20 years, customer base, service territories…? Stochastic analysis is too complex but a narrative on renewables in your territory would be good. Say what you are doing to say on the curve!
- Devin said they have it as an alternative resource in the IRP…the potential of it is in the IRP.

Slide #34 – Distribution System Planning (DSP)

- Mark said there is some level of introduction of system enhancements about growth in the IRP.
- He said there are some concerns with discussing our DSP costs and so will put in a confidential section of the IRP.

Slide #36 – 2018 IRP Schedule

- TAG #2, May 23rd at SEATAC including demand forecast
- TAG #3, July 12 – DSP, Alternative resources, Avoided Costs, transport issues
- TAG #4, Aug 16 – Carbon, Conservation
- TAG #5, Sep 18 – Final integrated results
- October 5, 2018 draft distributed
- December 5, 2018 IRP filing

- Mark said this is a high-level schedule! There will be an internal schedule. Everyone needs time to review the draft. We will give 1 month. We want feedback, so that's why we're giving you more time.
- Garret said that this is exciting and thanked the team. He said this is good information and provides a strong kick-off!
- Kyle warned the team that they will know he is new to this in seeing his comments and questions!
- Devin said all feedback drives the process!
- Mark said if there is anything we can do to help you, please let us know!

The meeting ended.

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®

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

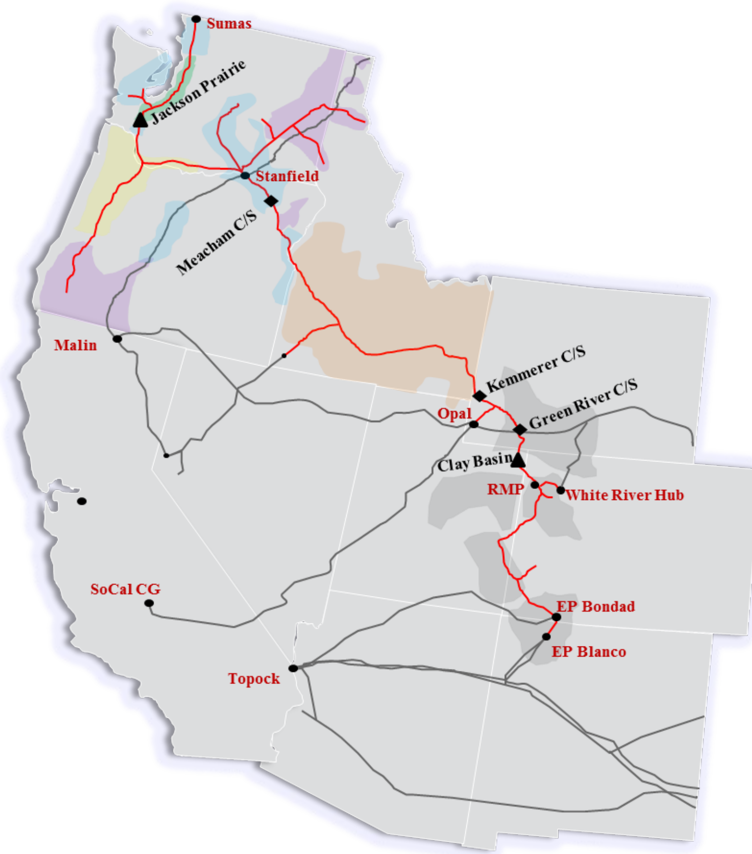
WE MAKE ENERGY HAPPEN

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

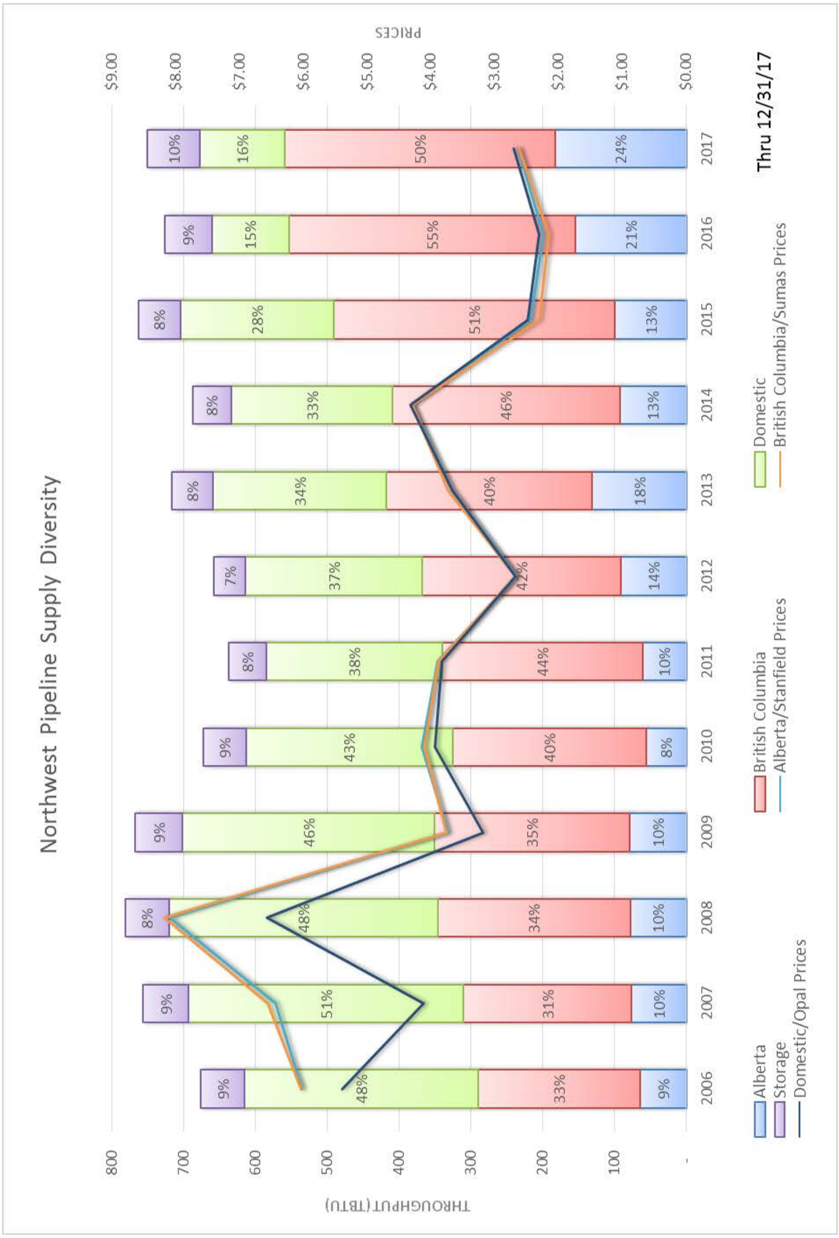


Mastio Survey

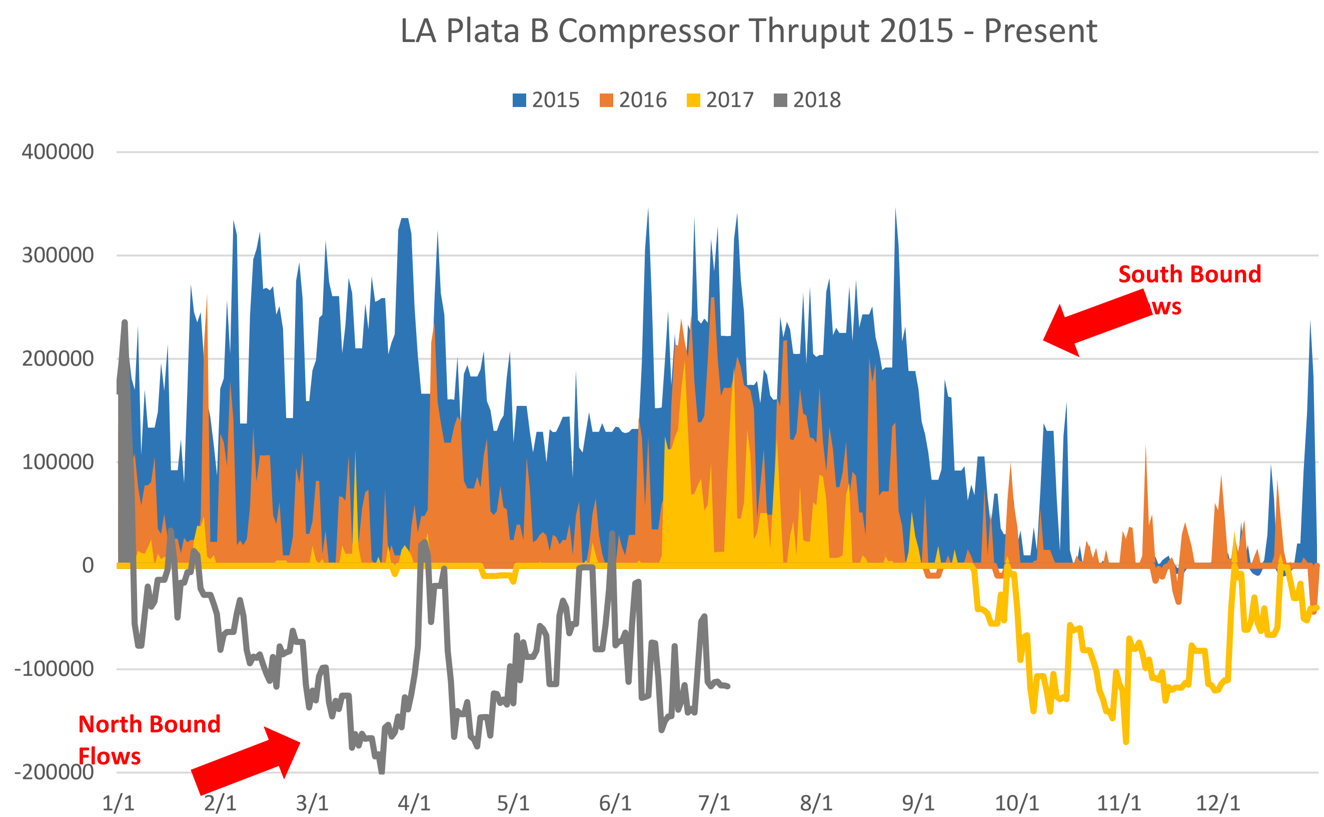
- **Rated No. 2 in the Mega and Major Pipeline categories and No. 3 in the overall Interstate Pipeline category**
- **Northwest was ranked #1 in the following areas:**
  - competitive rates
  - diverse supply & markets
  - likelihood to recommend
- **Northwest was ranked #2 in the following areas:**
  - 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

Williams

Supply Diversity



Supply Diversity – South End



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	?

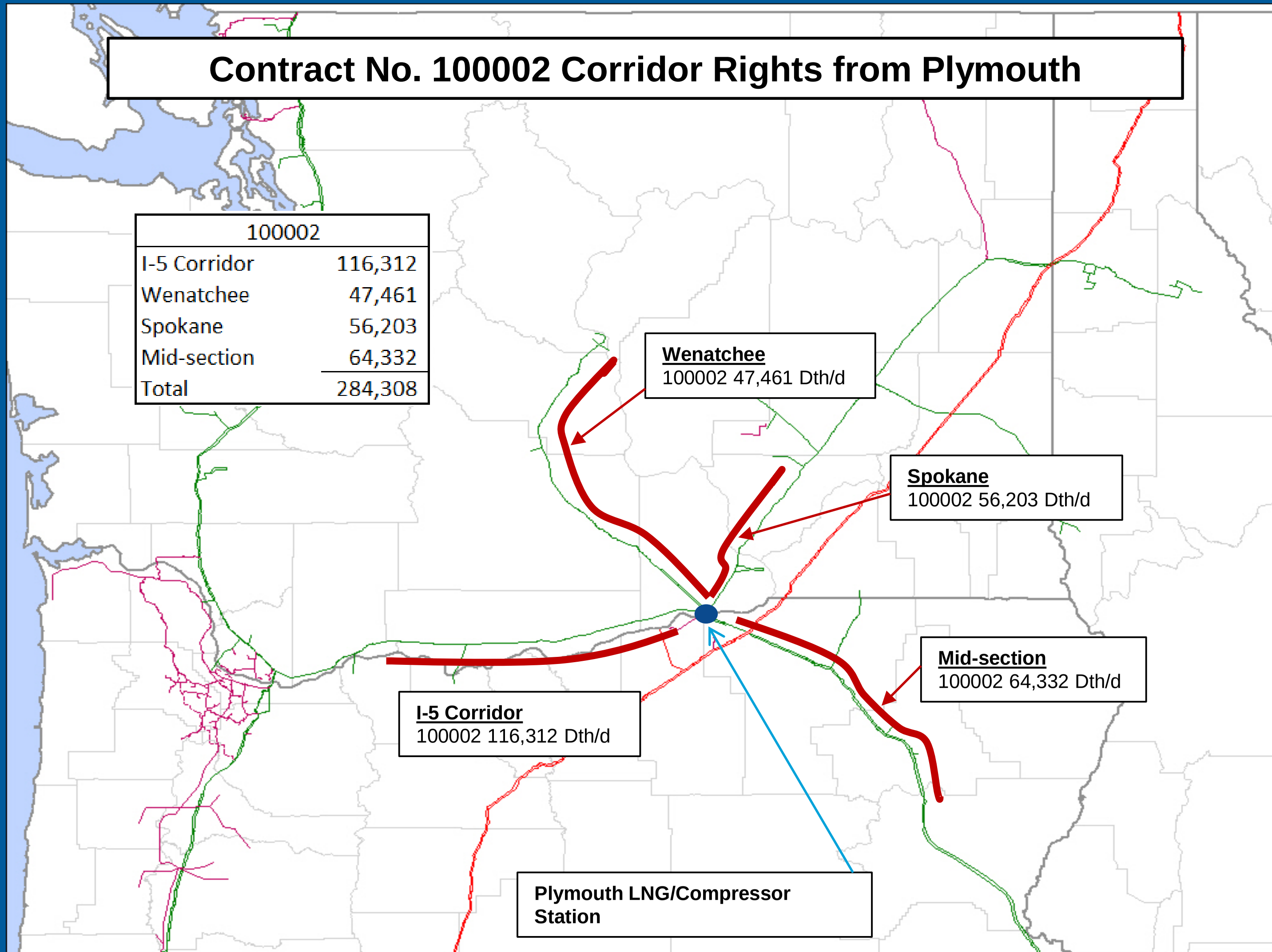
Cascade's Excess MDDO's

- 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

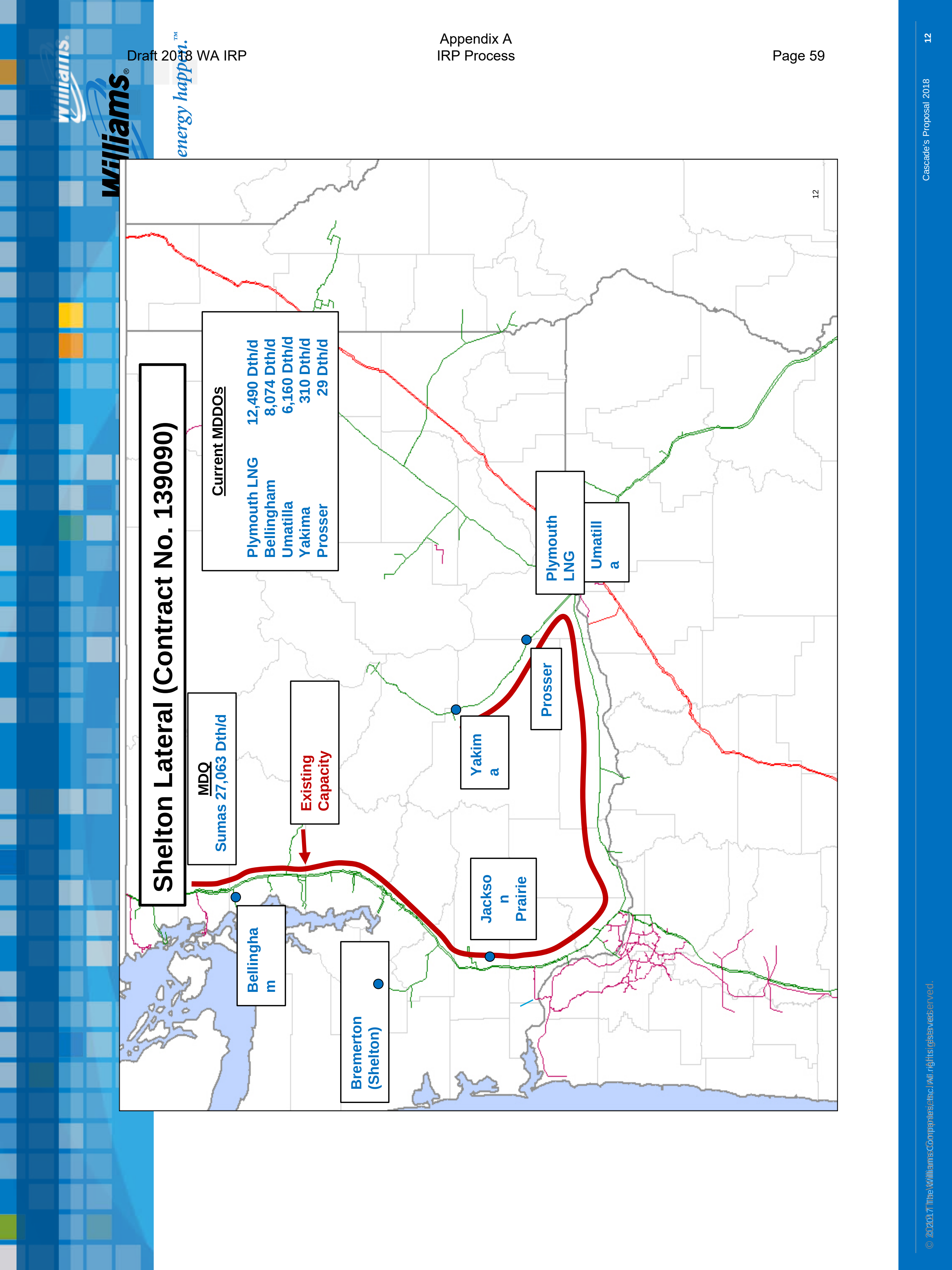
Contract No. 100002 Corridor Rights from Plymouth

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)**


Williams
energy happen.™
Shelton Lateral (Contract No. 139090)
MDQ
Sumas 27,063 Dth/d
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
Existing Capacity
Plymouth LNG
Umatill a
Prosser
Yakim a
Jackso n Prairie
Bellingha m
Bremerton (Shelton)
12
Cascade's Proposal 2018
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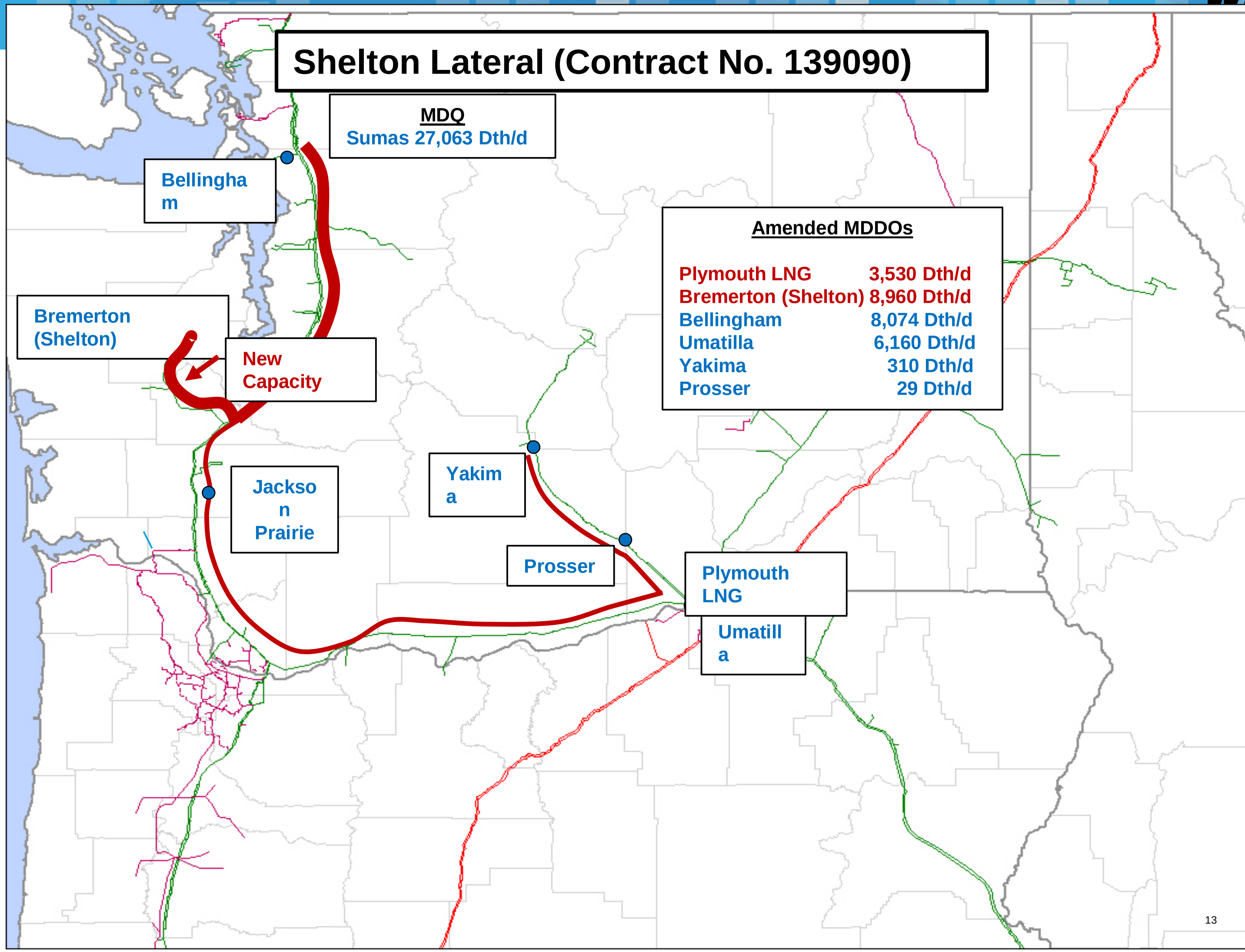
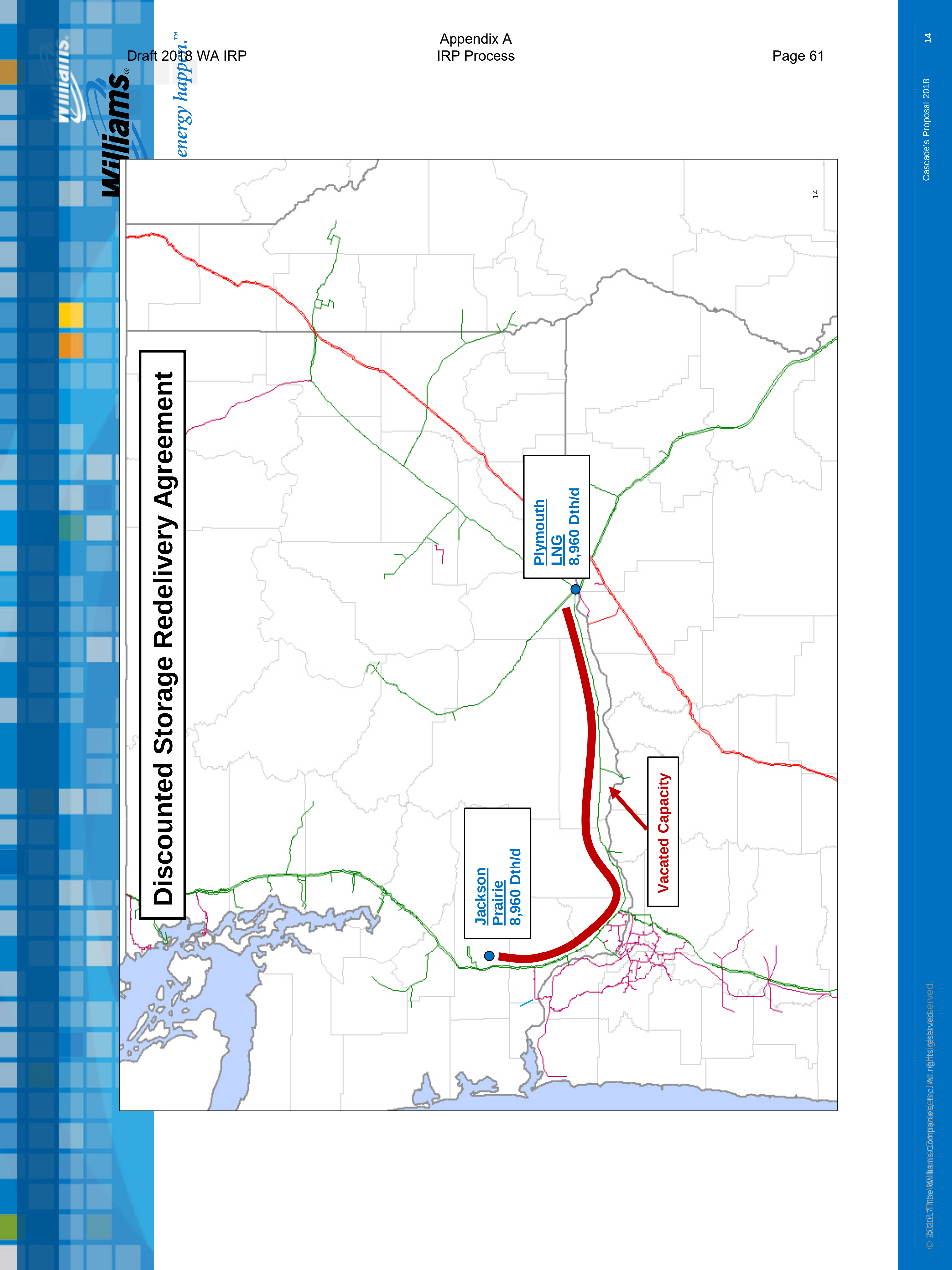
Williams® energy happen.™

Shelton Lateral (Contract No. 139090)




Williams
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Discounted Storage Redelivery Agreement
Plymouth LNG
8,960 Dth/d
Jackson Prairie
8,960 Dth/d
Vacated Capacity
Cascade's Proposal 2018
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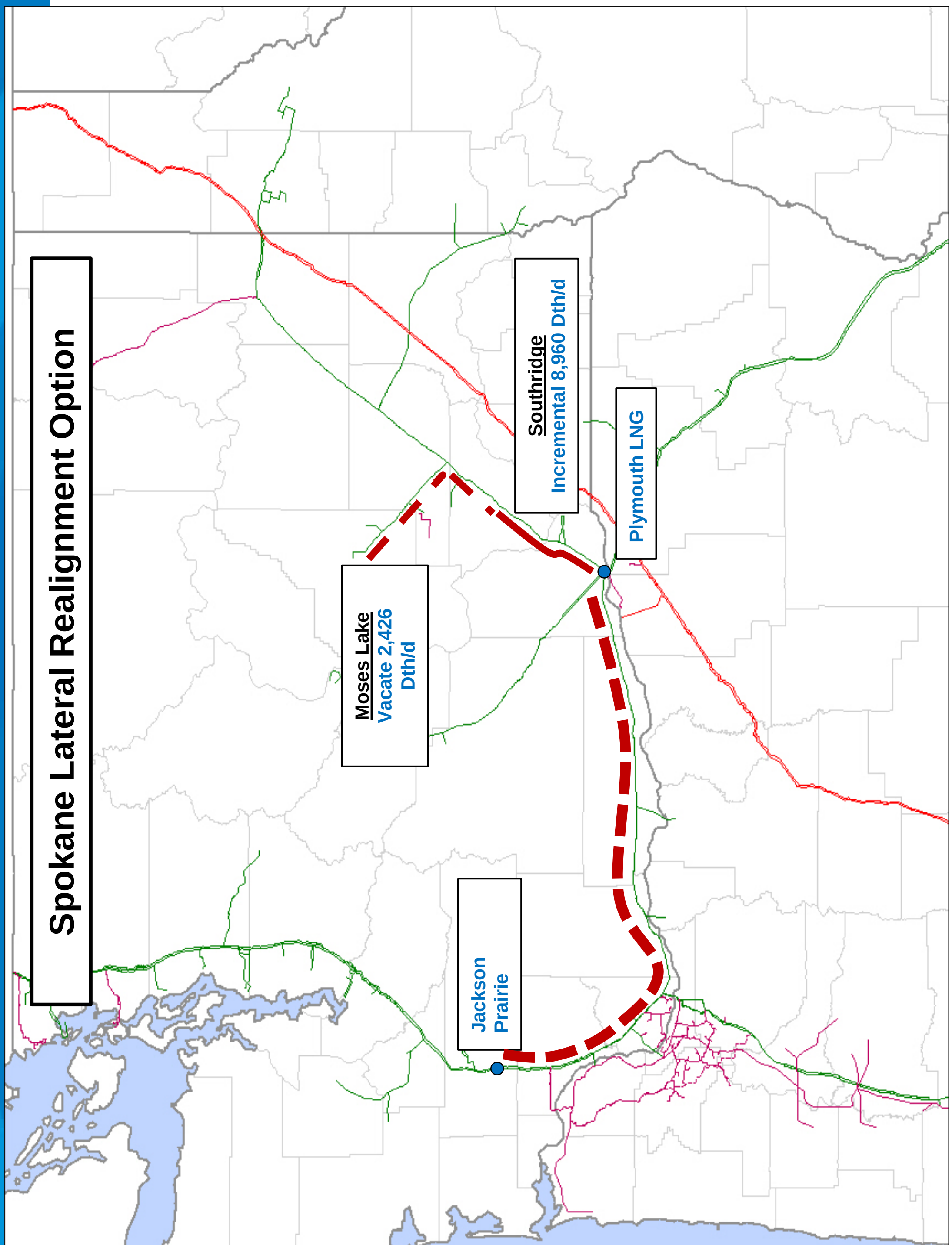
Discounted Storage Redelivery Agreement

- **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**

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


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

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.

Contract Consolidations

- To obtain the ROFR on the Shelton lateral along with the discounted JP storage redelivery capacity, Northwest is seeking to 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

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

TransCanada Update

J. Story – Director, NW Distribution markets

Cascade Natural Gas IRP Meeting

July 12, 2018

TransCanada
In business to deliver

Disclaimer: Forward Looking Information

This presentation includes certain forward looking information, including future oriented financial information or financial outlook, which is intended to help current and potential investors understand management's assessment of our future plans and financial outlook, and our future prospects overall. Statements that are forward-looking are based on certain assumptions and on what we know and expect today and generally include words like anticipate, expect, believe, may, will, should, estimate or other similar words.

Forward-looking statements do not guarantee future performance. Actual events and results could be significantly different because of assumptions, risks or uncertainties related to our business or events that happen after the date of this presentation. Our forward-looking information in this presentation includes statements related to: future dividend growth, the future growth of our core businesses.

Our forward looking information is based on certain key assumptions and is subject to risks and uncertainties, including but not limited to: our ability to successfully implement our strategic initiatives and whether they will yield the expected benefits, the operating performance of our pipeline and energy assets, economic and competitive conditions in North America and globally, the availability, demand for and price of energy commodities and changes in market commodity prices, the amount of capacity sold and rates achieved in our pipeline businesses, the amount of capacity payments and revenues we receive from our energy business, regulatory decisions and outcomes, outcomes of legal proceedings, including arbitration and insurance claims, performance and credit risk of our counterparties, changes in the political environment, changes in environmental and other laws and regulations, construction and completion of capital projects, labour, equipment and material costs, access to capital markets, interest, inflation, tax and foreign exchange rates, including the impact of U.S. tax reform legislation, weather, cyber security, technological developments and economic conditions in North America as well as globally. You can read more about these risks and others in our Fourth Quarter 2017 Financial Highlights release and 2017 Annual Report filed with Canadian securities regulators and the SEC and available at www.transcanada.com.

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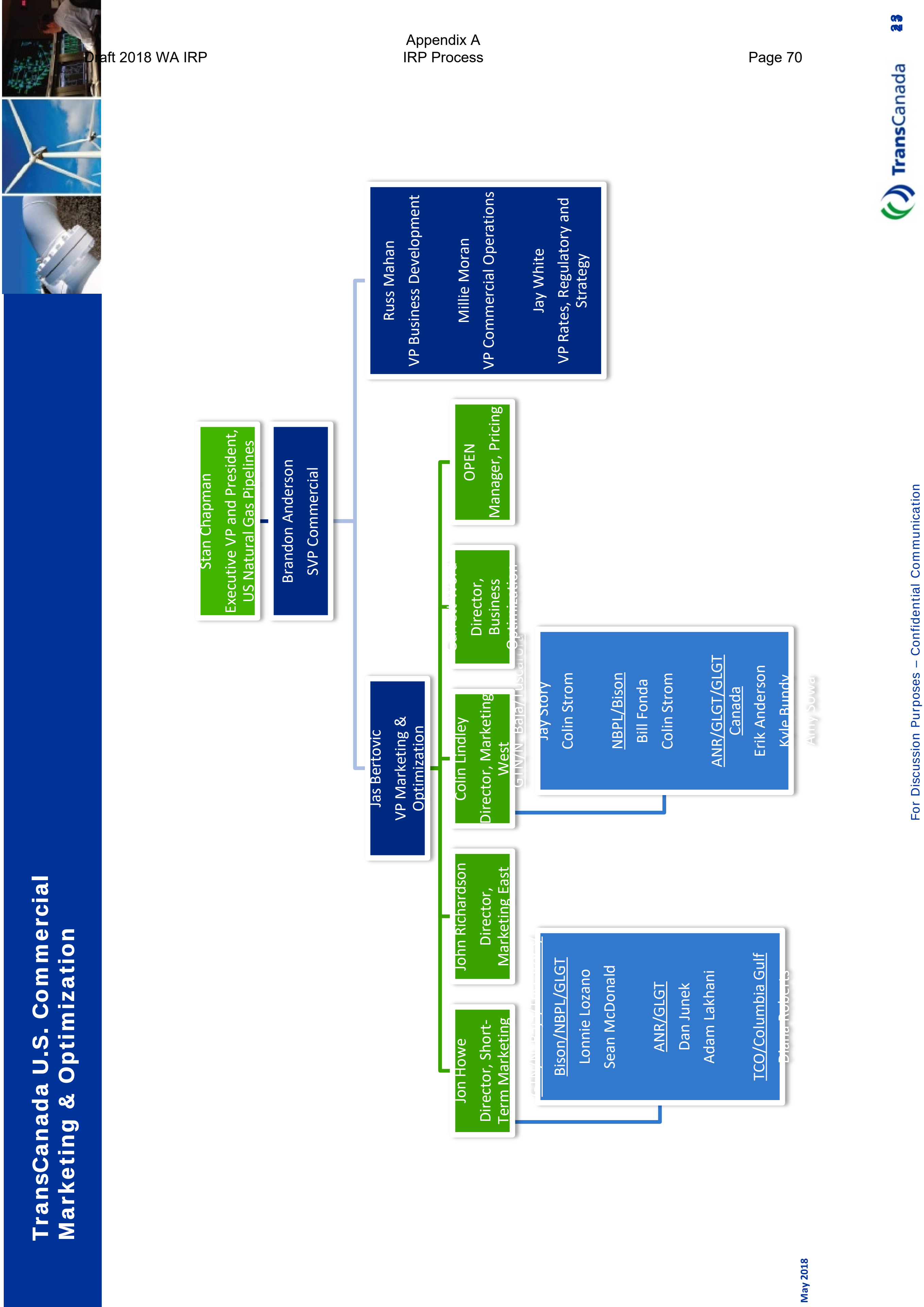
TransCanada U.S. Commercial Marketing & Optimization
Stan Chapman
Executive VP and President, US Natural Gas Pipelines
Brandon Anderson
SVP Commercial
Russ Mahan
VP Business Development
Millie Moran
VP Commercial Operations
Jay White
VP Rates, Regulatory and Strategy
Jas Bertovic
VP Marketing & Optimization
Jon Howe
Director, Short-Term Marketing
John Richardson
Director, Marketing East
Colin Lindley
Director, Marketing West
Director, Business Optimization
OPEN
Manager, Pricing
Bison/NBPL/GLGT
Lonnie Lozano
Sean McDonald
ANR/GLGT
Dan Junek
Adam Lakhani
TCO/Columbia Gulf
Jay Story
Colin Strom
NBPL/Bison
Bill Fonda
Colin Strom
ANR/GLGT/GLGT Canada
Erik Anderson
Kyle Bundy
May 2018
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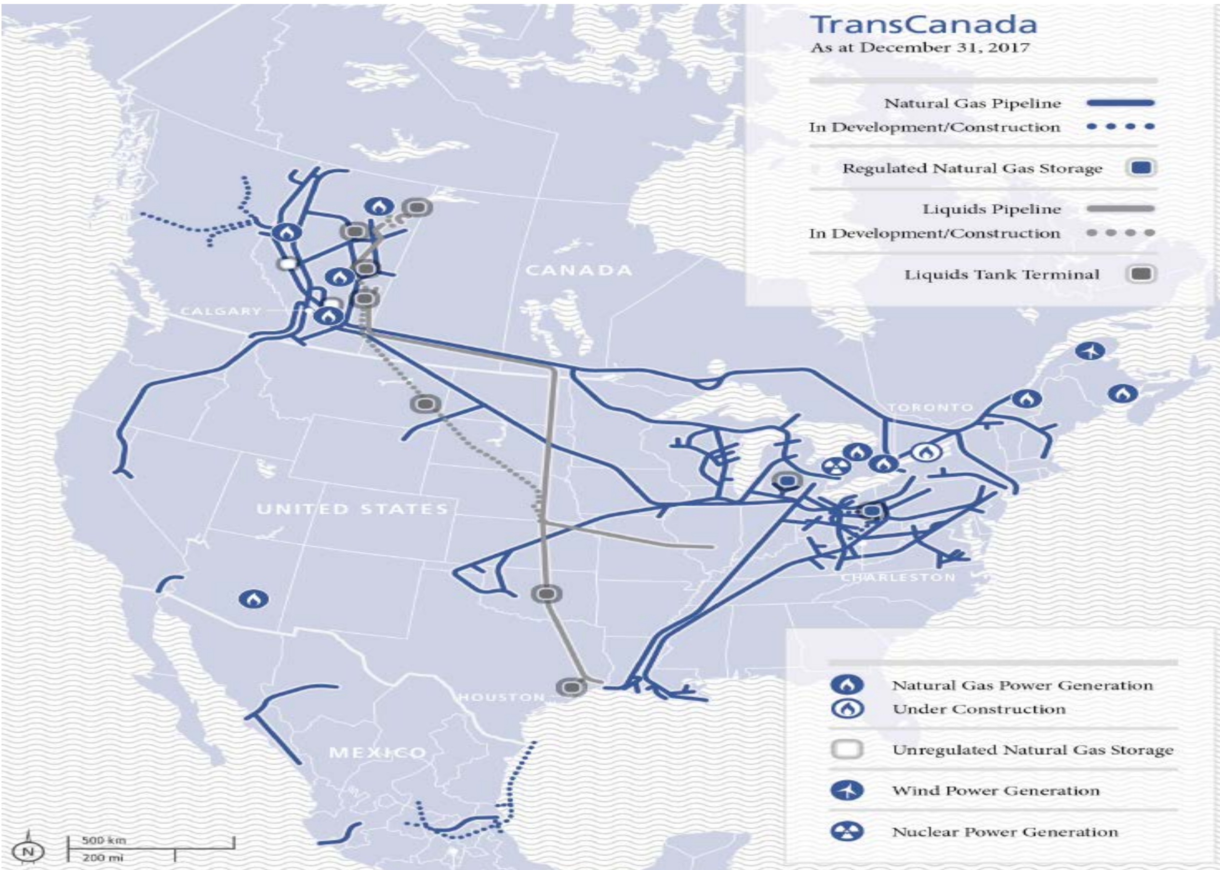
TransCanada Today



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

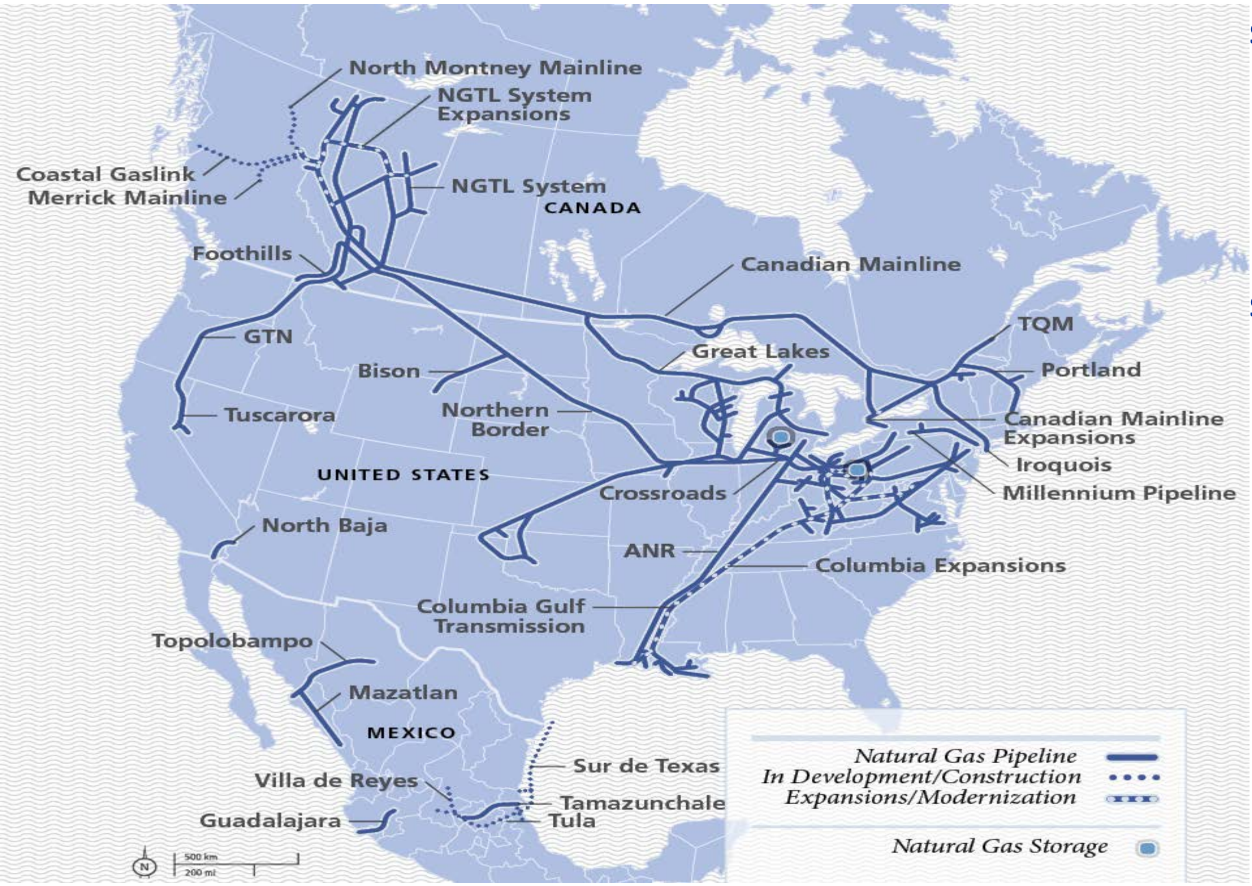
Premier Liquids Pipeline System
- 3,000 miles of pipeline
- 555,000 b/d or 20% of Western Canadian exports

Large Private Sector Power Generator
- 11 power plants, 6,100 MW
- Primarily long-term contracted assets

Enterprise Value ~$100 billion*

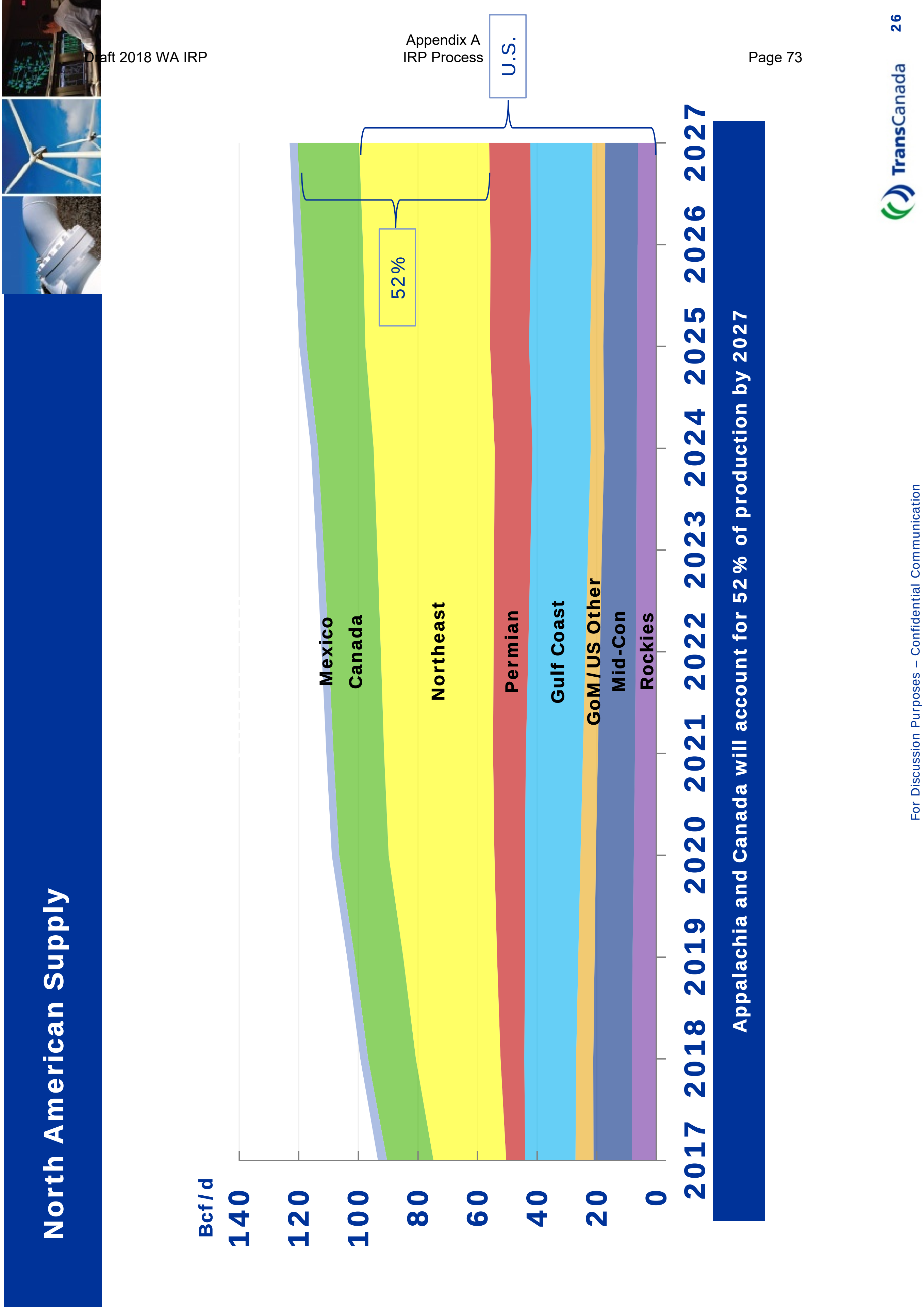
***$CAD (2018)**

TransCanada's U.S. Pipeline Assets

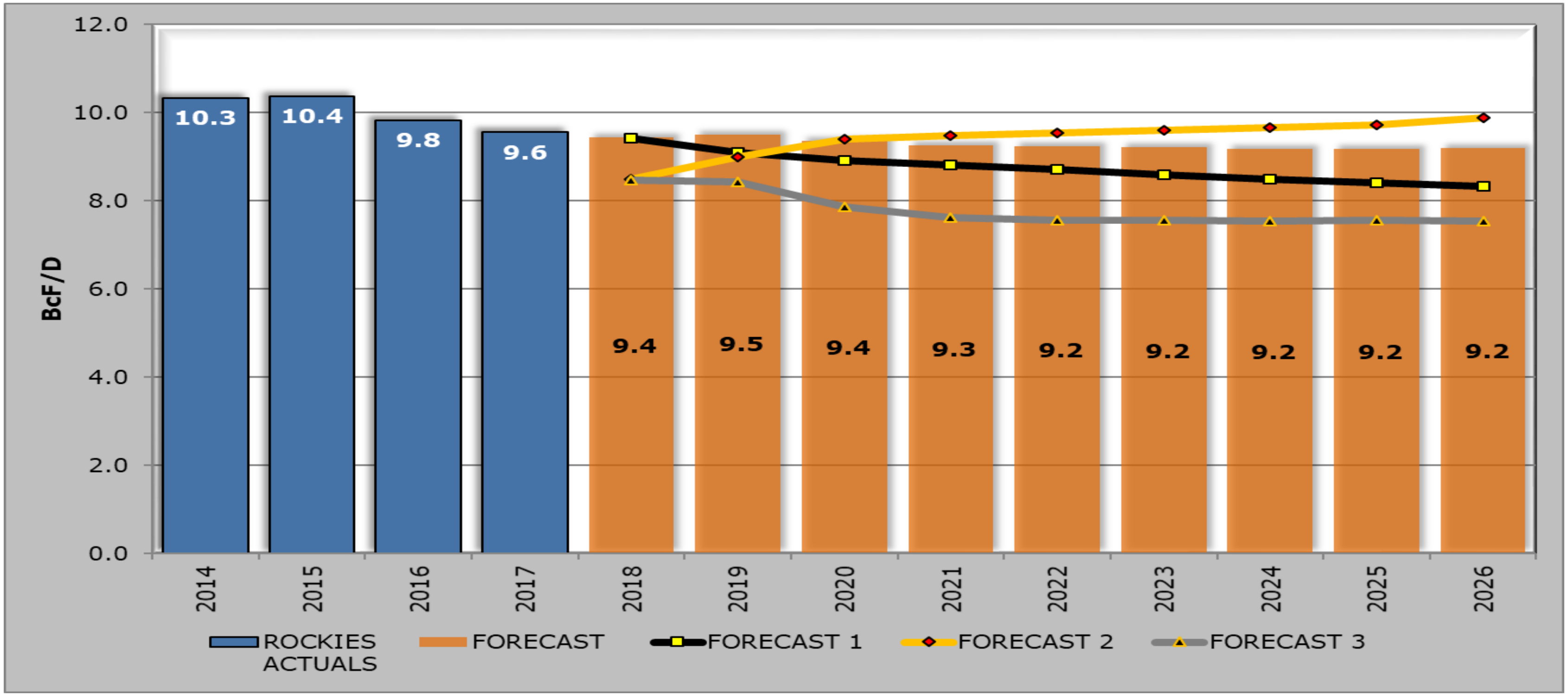


Size and Scale
- ~31,000 miles of pipeline
- ~548 Bcf of storage capacity
- ~20% of all U.S. deliveries
- ~2,800 employees
- Assets across 37 states

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

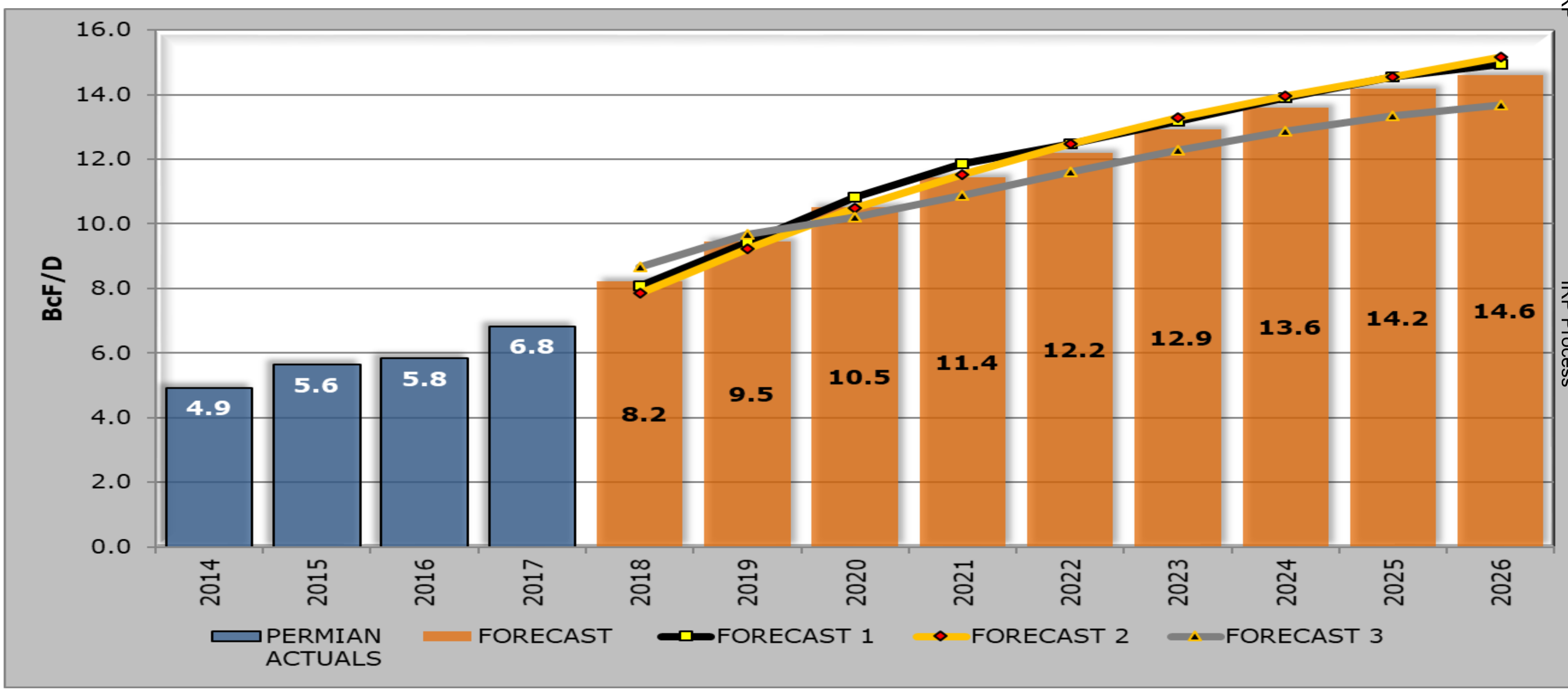

North American Supply
Bcf / d
140
120
100
80
60
40
20
0
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
Mexico
Canada
Northeast
Permian
Gulf Coast
GoM / US Other
Mid-Con
Rockies
52%
U.S.
Appalachia and Canada will account for 52% of production by 2027
TransCanada
26
For Discussion Purposes – Confidential Communication

Rockies Production (Bcf / d)



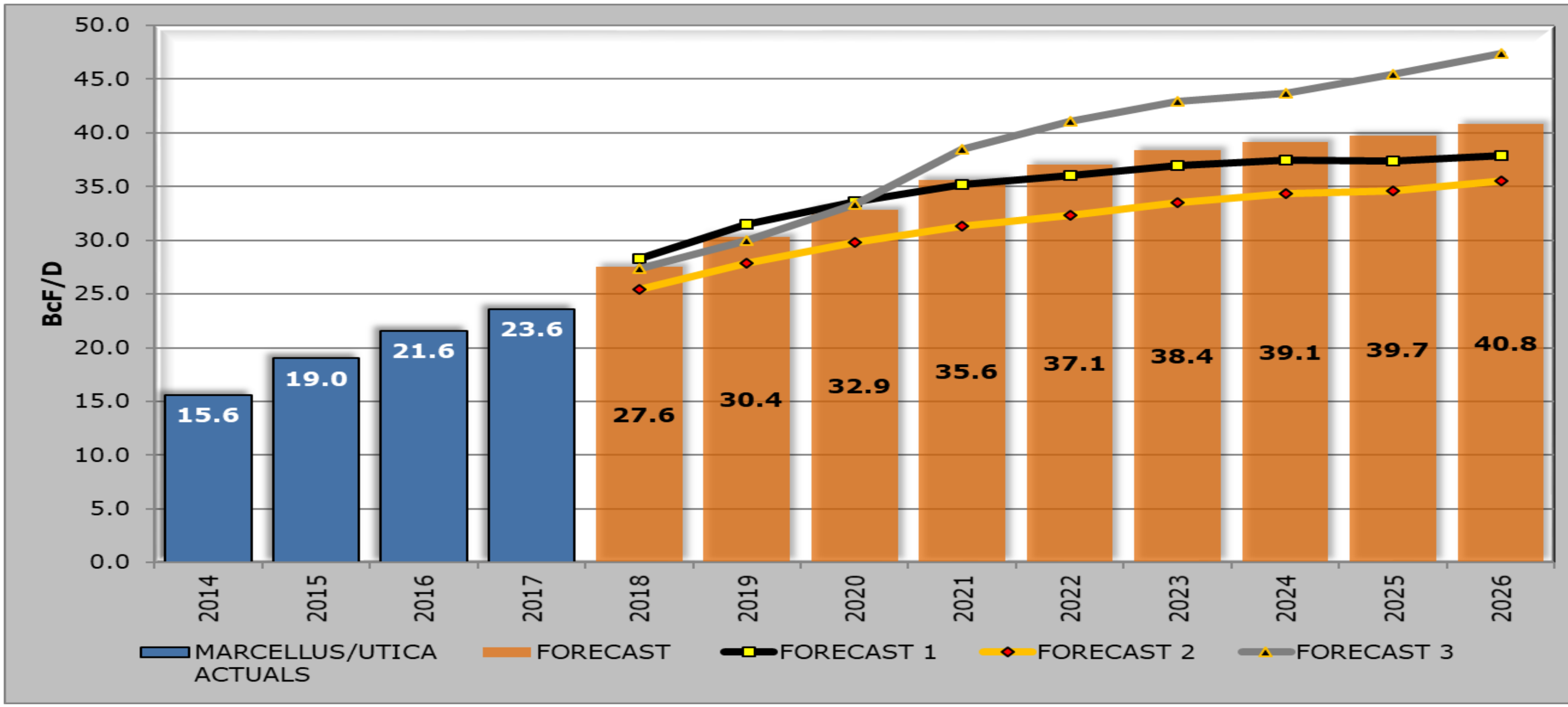
Source: Point Logic Energy and Outside Consultants

Permian Production (Bcf / d)



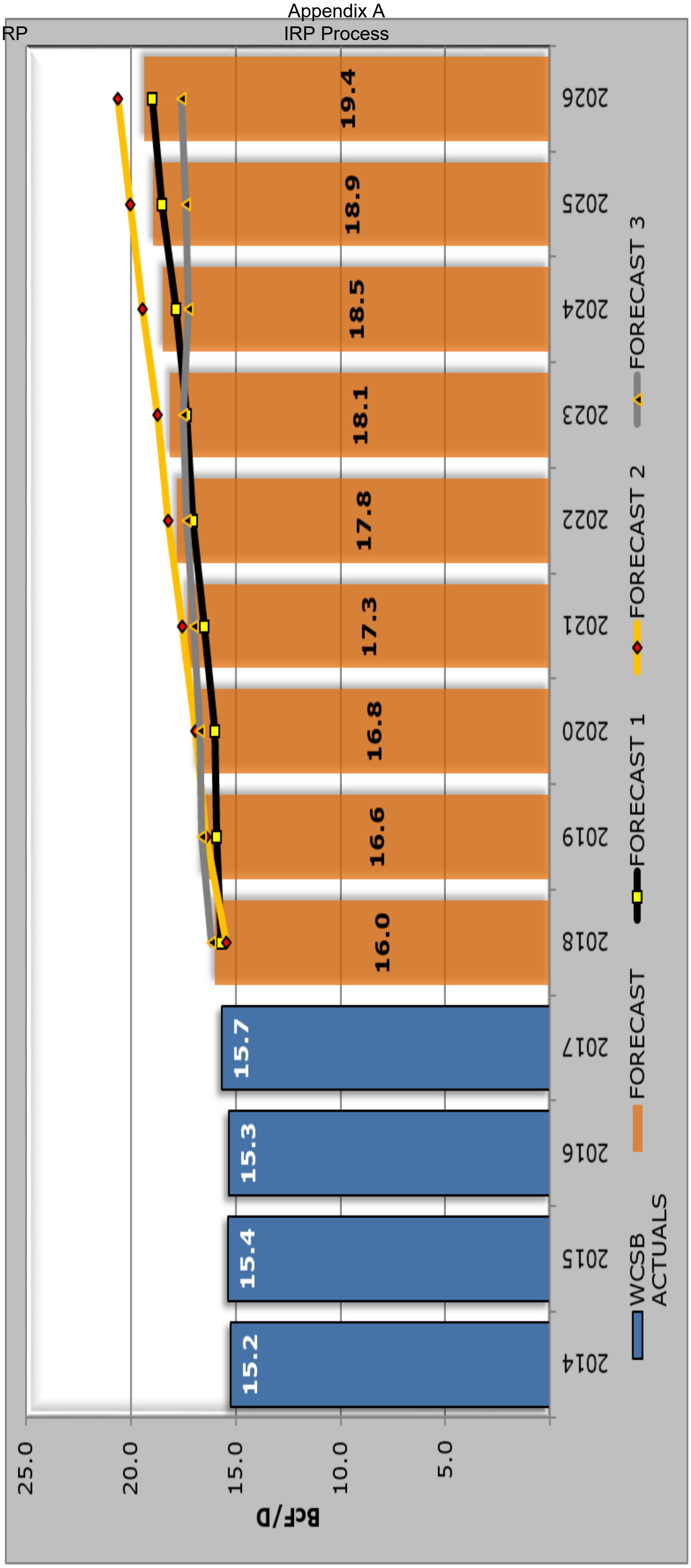
Source: Point Logic Energy and Outside Consultants

Marcellus & Utica Production (Bcf / d)



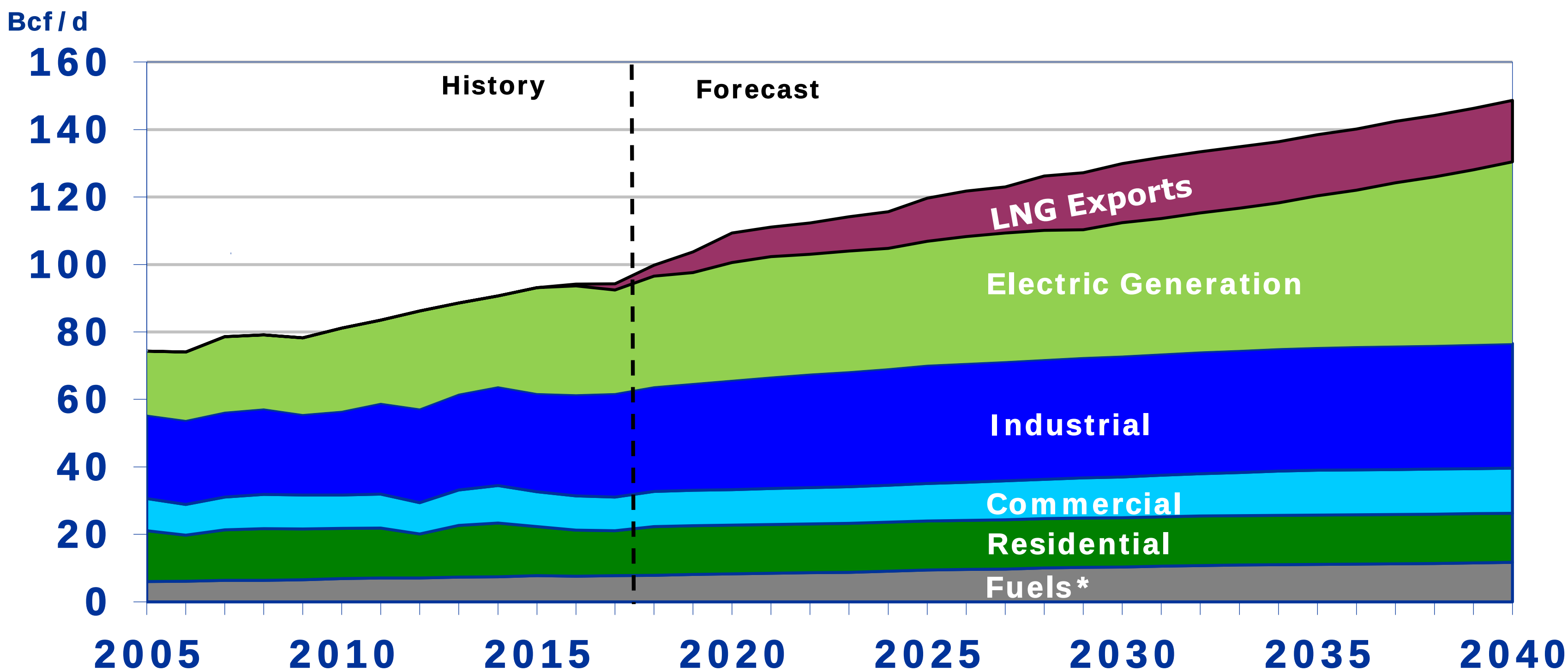
Source: Point Logic Energy and Outside Consultants

Western Canadian Production (Bcf / d)



Source: Point Logic Energy and Outside Consultants

North American Natural Demand

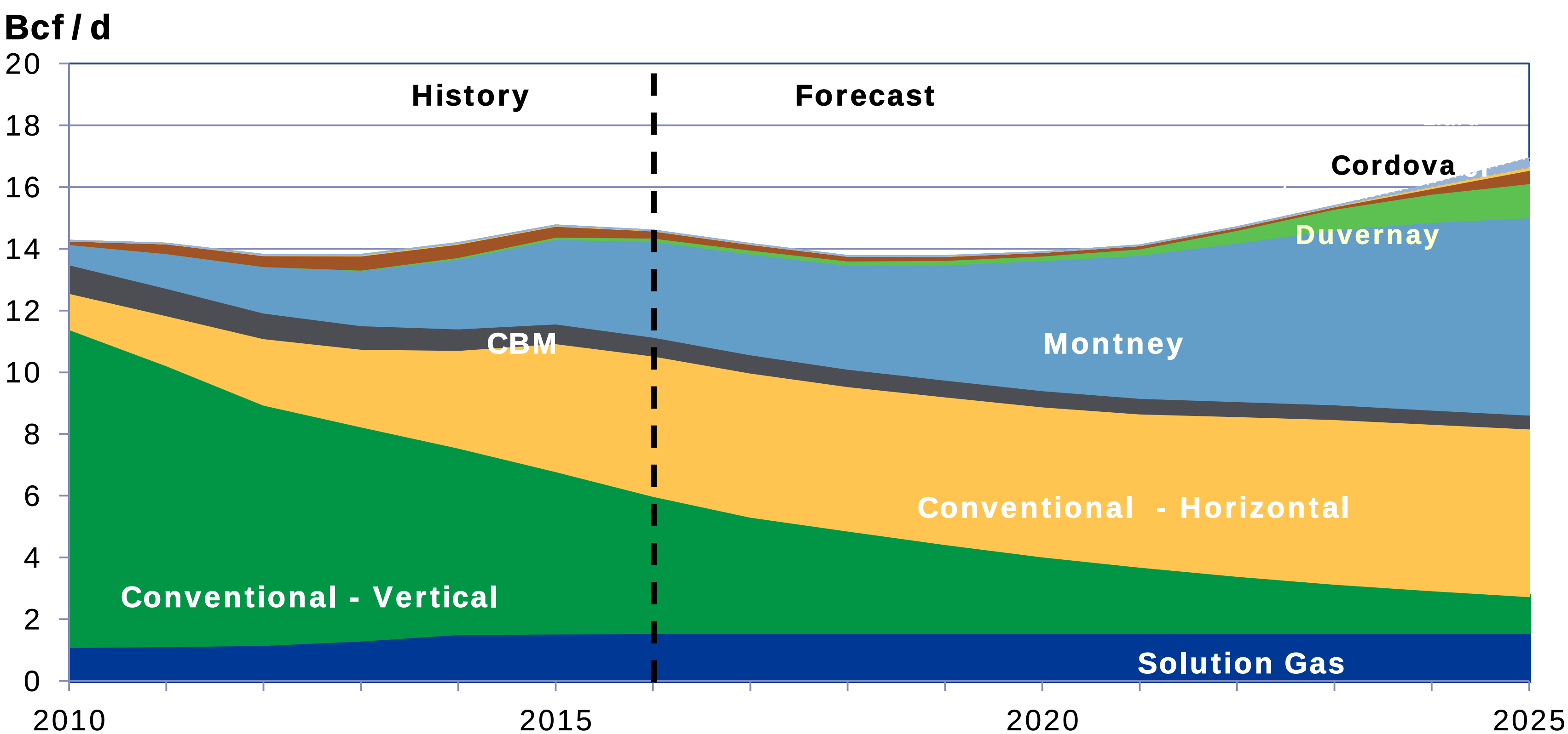


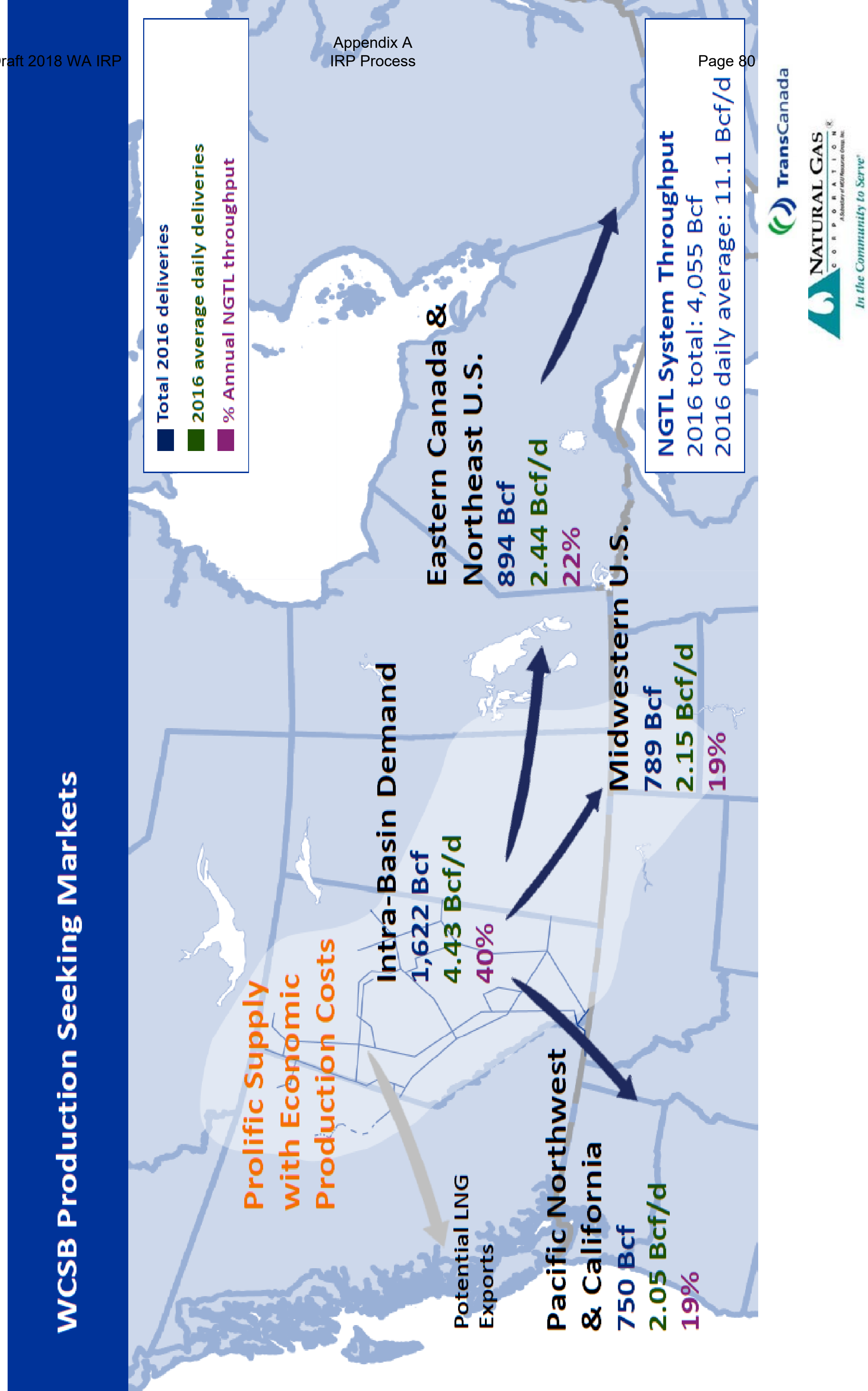
Source: TransCanada
* Includes Lease, Plant, Pipeline & LNG Facility Fuels

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

TransCanada

Western Canadian Sedimentary Basin Gas Supply




WCSB Production Seeking Markets
Total 2016 deliveries
2016 average daily deliveries
% Annual NGTL throughput
Prolific Supply with Economic Production Costs
Intra-Basin Demand
1,622 Bcf
4.43 Bcf/d
40%
Potential LNG Exports
Pacific Northwest & California
750 Bcf
2.05 Bcf/d
19%
Midwestern U.S.
789 Bcf
2.15 Bcf/d
19%
Eastern Canada & Northeast U.S.
894 Bcf
2.44 Bcf/d
22%
NGTL System Throughput
2016 total: 4,055 Bcf
2016 daily average: 11.1 Bcf/d
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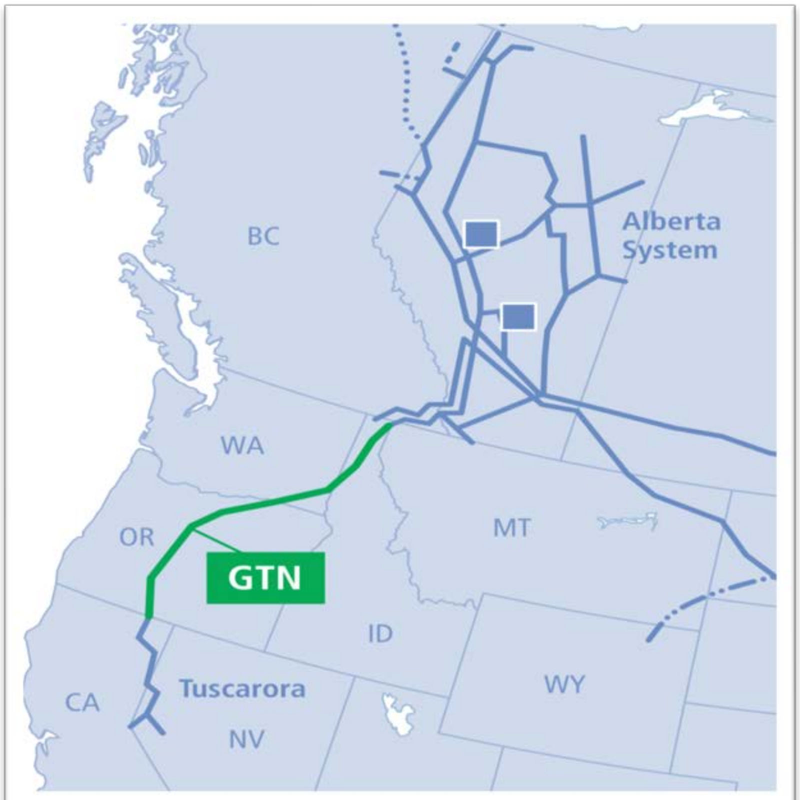
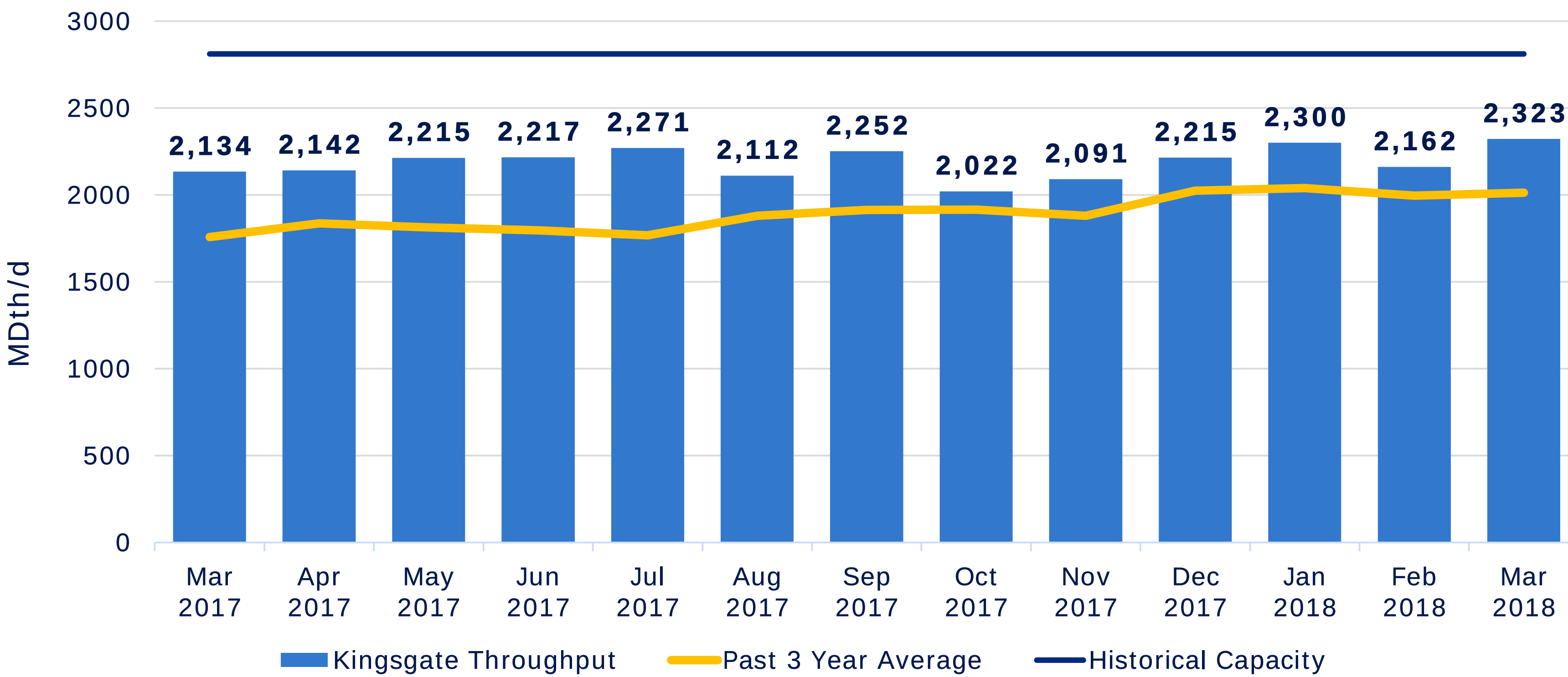
GTN Overview

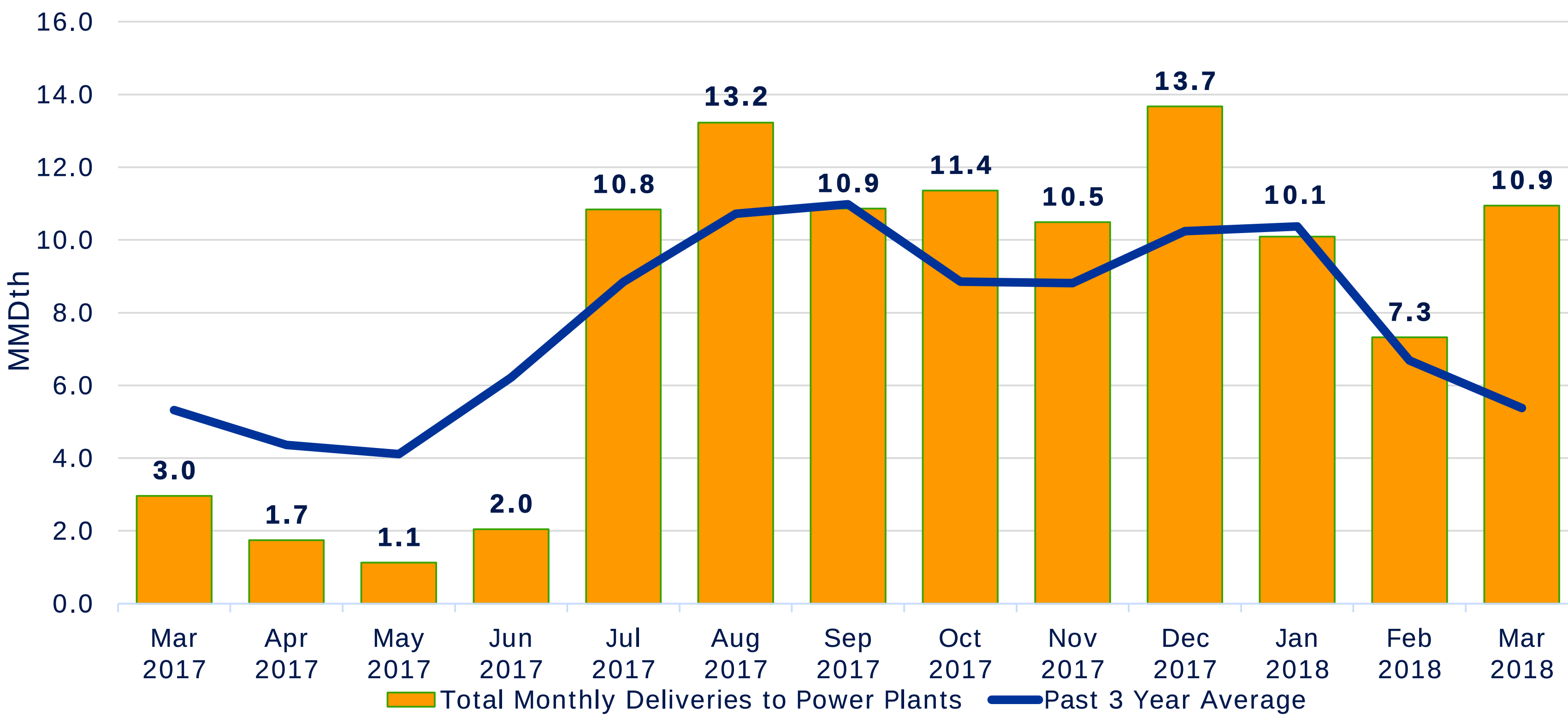


- Positioned to serve markets throughout California, Nevada, and the Pacific Northwest
- Consists of 1,350 miles of pipeline
- Long-term contracts extending out as far as 2039
- Volume throughput continues to be strong and should continue to grow
- NGTL continues to address the export capability at ABC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

GTN System Throughput



GTN Monthly Power Loads



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

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

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

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**

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

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

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**

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

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**

Questions?

TransCanada
In business to deliver

Demand Forecast

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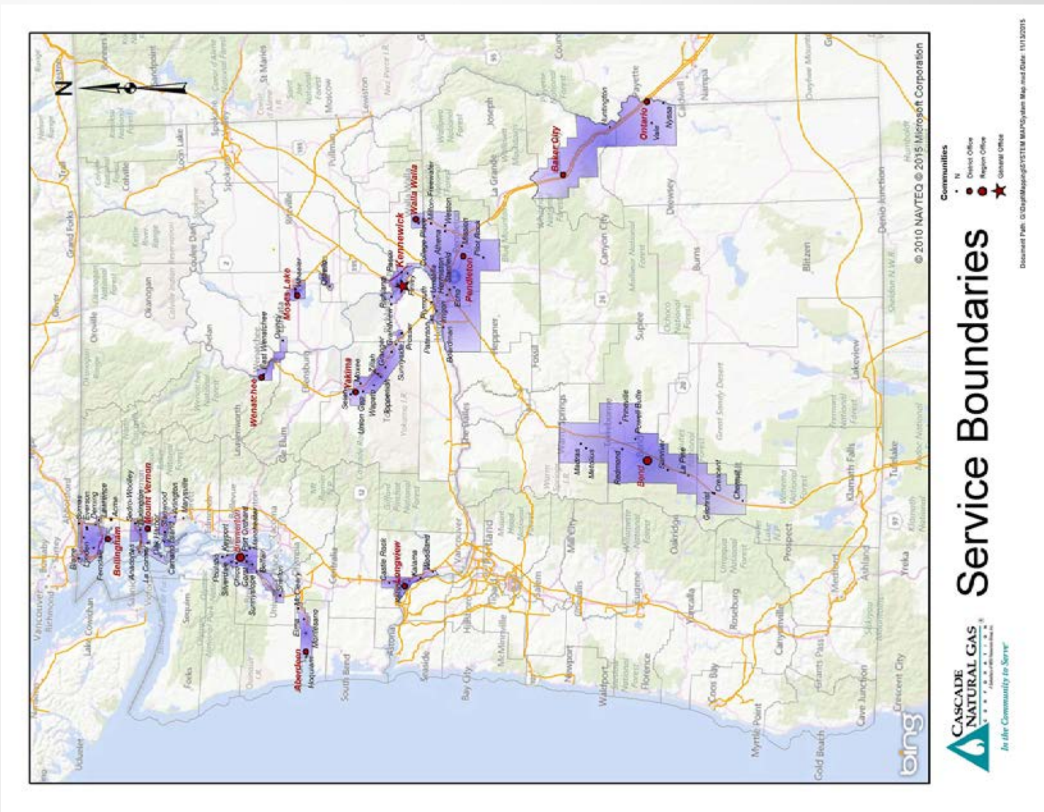

Service Boundaries
© 2010 NAVTEQ © 2015 Microsoft Corporation
Cascade Natural Gas
In the Community to Serve
Bellingham
Mount Vernon
Bremerton
Aberdeen
Longview
Wenatchee
Moses Lake
Yakima
Kennewick
Walla Walla
Pendleton
Baker City
Ontario
Bend

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.

Key Definitions

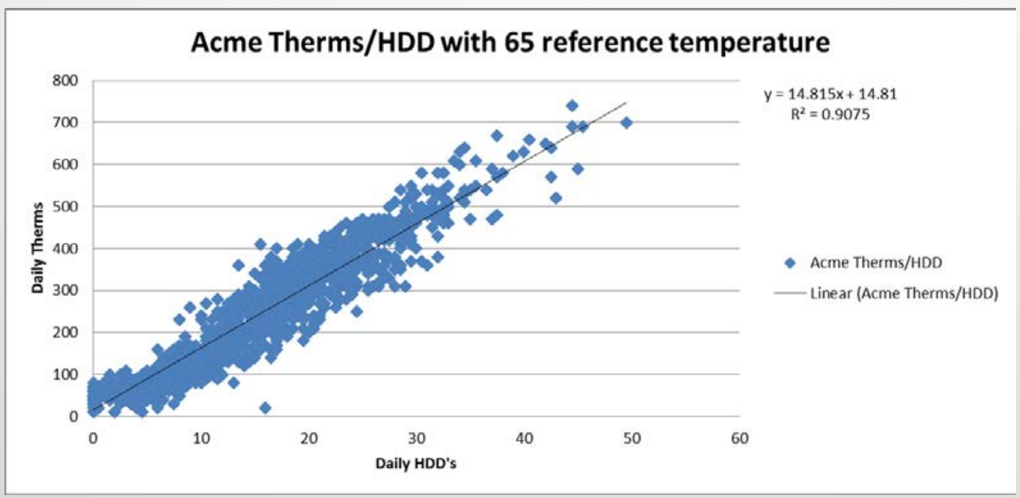
- AIC: The Akaike information criterion (AIC)
  - A measure of the relative quality of statistical models for a given set of data. Given a collection of models for the data, AIC estimates the quality of each model, relative to each of the other models. Hence, AIC provides a means for model selection.
- 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

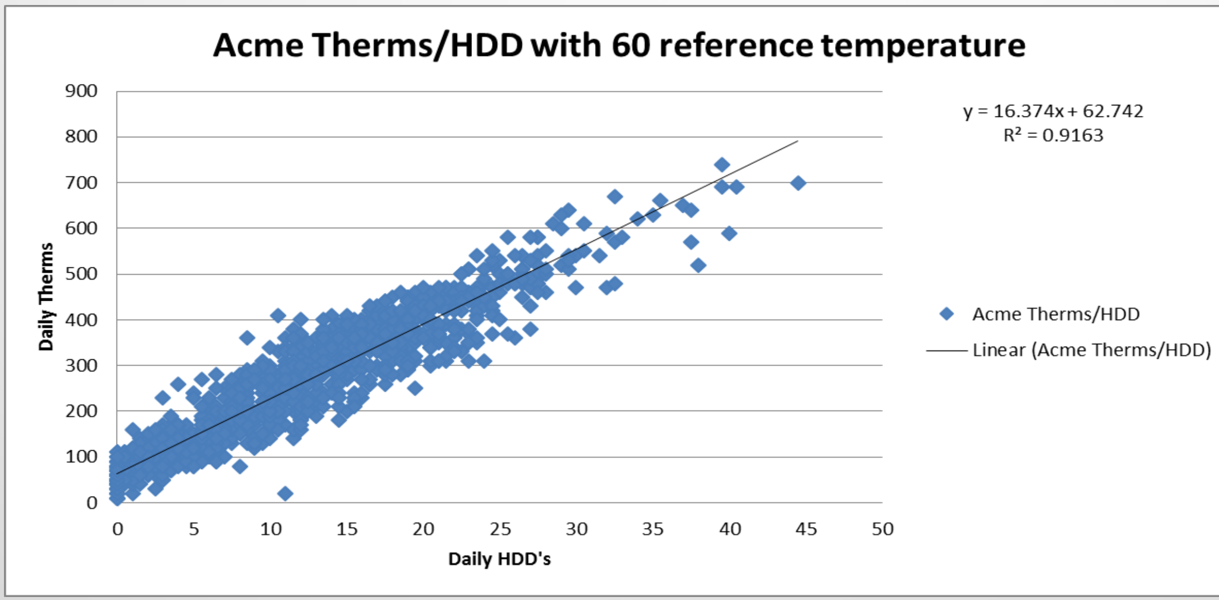
- Seven weather locations effectively cover Cascade's service territory.
- This forecast uses 30 years of recent weather history as the "normal" temperatures.
- Heating demand does not appreciatively start until average temps dip below 60° F, therefore a 60° F threshold is used.

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.



Acme Therms/HDD with 60 degree reference temperature



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Weather Stations

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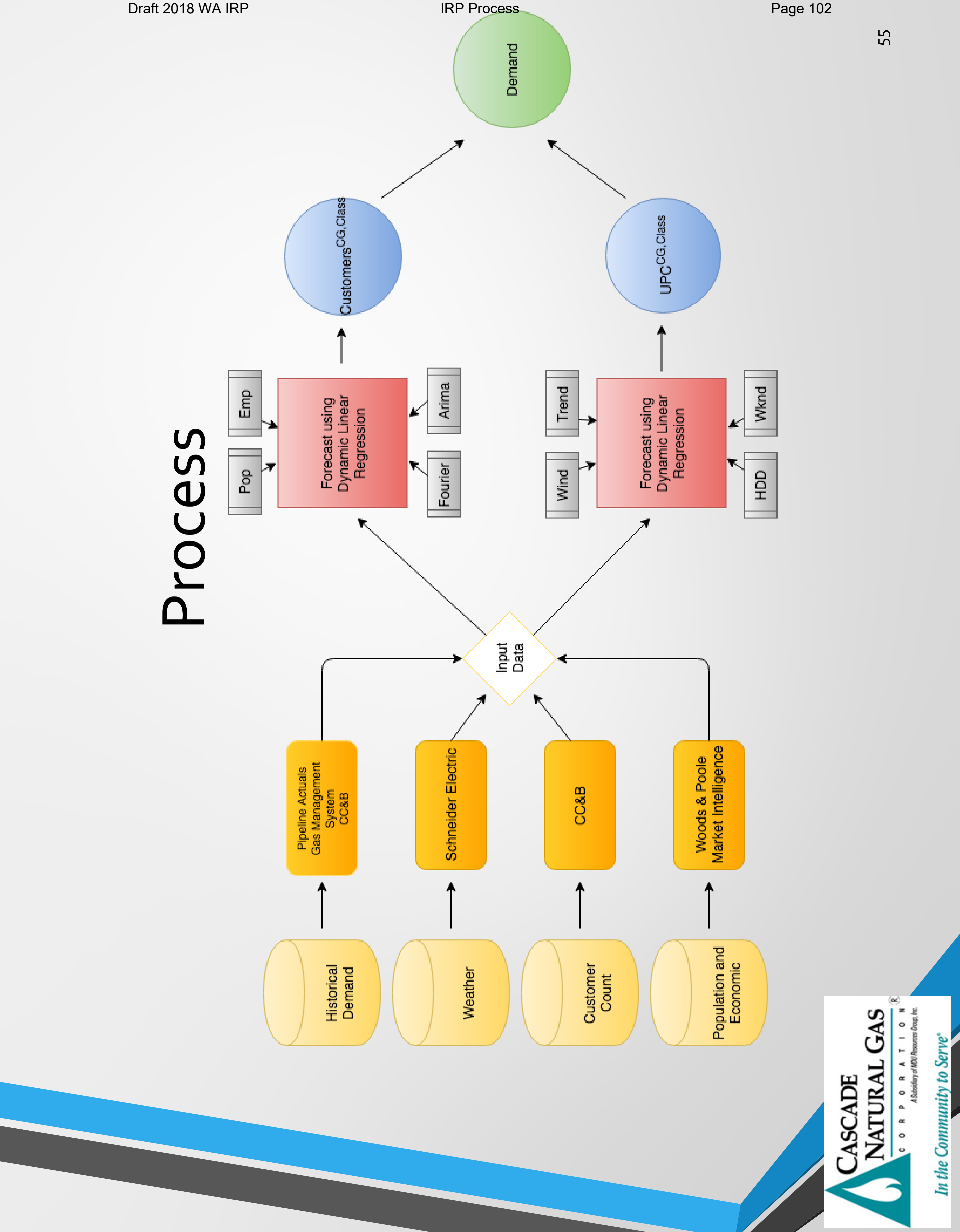
Process
55
Historical Demand
Weather
Customer Count
Population and Economic
Pipeline Actuals
Gas Management System
CC&B
Schneider Electric
CC&B
Woods & Poole
Market Intelligence
Input Data
Pop
Emp
Forecast using Dynamic Linear Regression
Fourier
Arima
Wind
Trend
Forecast using Dynamic Linear Regression
HDD
Wknd
Customers^{CG,Class}
UPC^{CG,Class}
Demand
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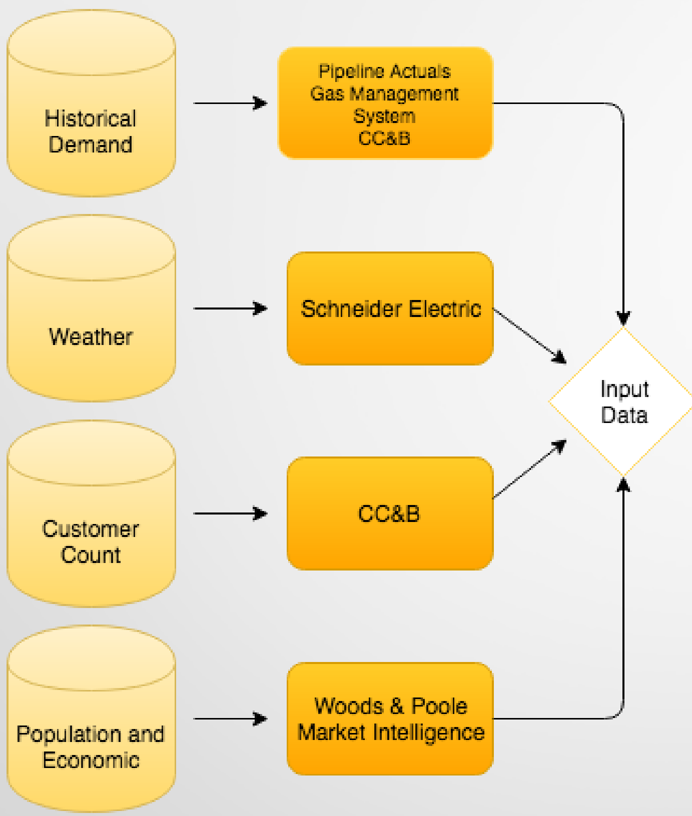
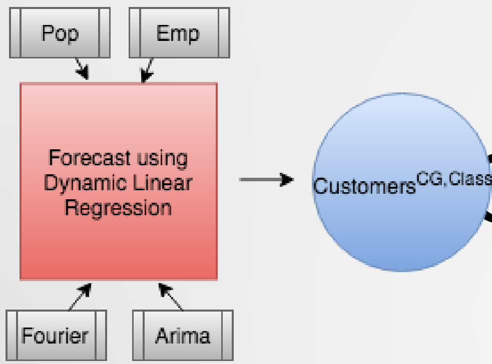
Inputs



- Pipeline actuals at Citygate level.
- CC&B at town level.
- Woods&Poole at county level.

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∈(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.

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

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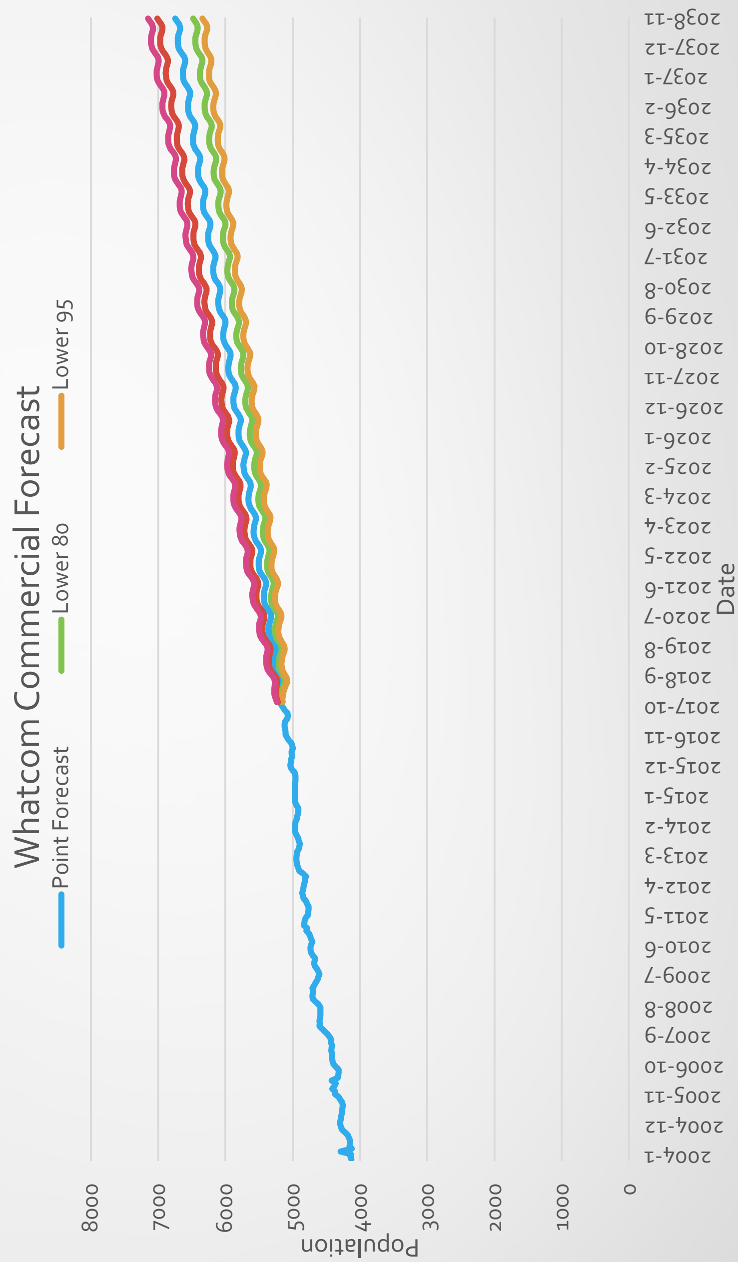
Customer Forecast



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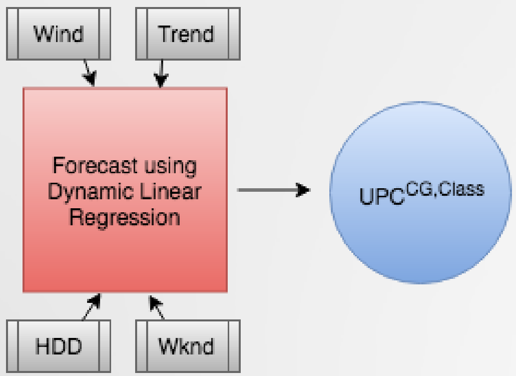
Use Per Customer Forecast



- 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.

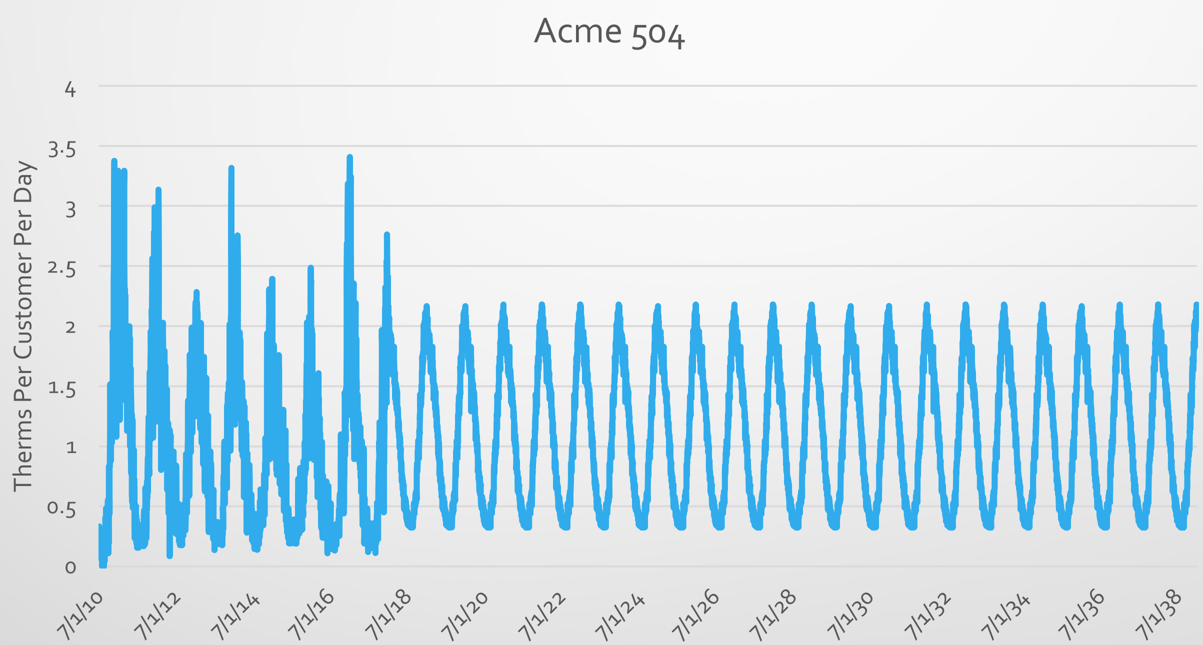
Citygate	date	weekend	trend		Cngwa502	Cngwa503	jan.hdd	dec.hdd	jan.wind	dec.wind
acme	10/3/2010	1	1	0	0.099243	0.538548	0	0	0	0
acme	10/4/2010	0	2	0	0.153376	0.832302	0	0	0	0
acme	10/5/2010	0	3	0	0.153376	0.832302	0	0	0	0
acme	10/6/2010	0	4	0	0.135331	0.734384	0	0	0	0
acme	10/7/2010	0	5	0	0.117287	0.636466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

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

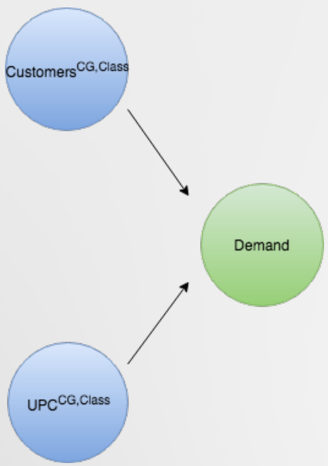
UPC Forecast Results

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

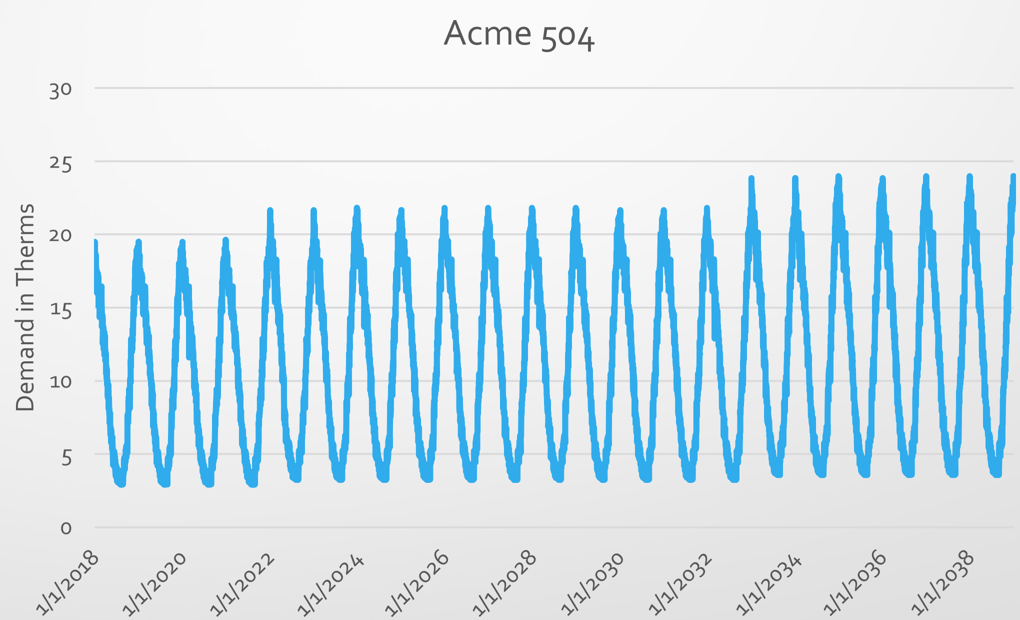


Final Demand Calculation



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



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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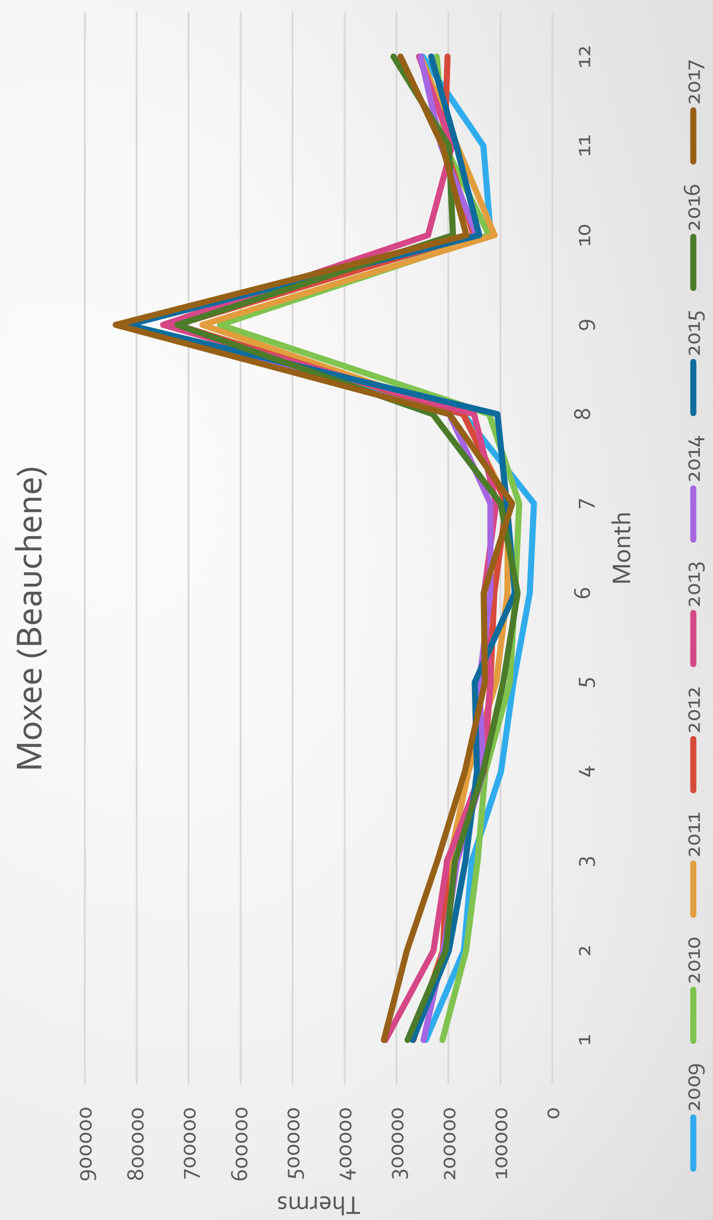
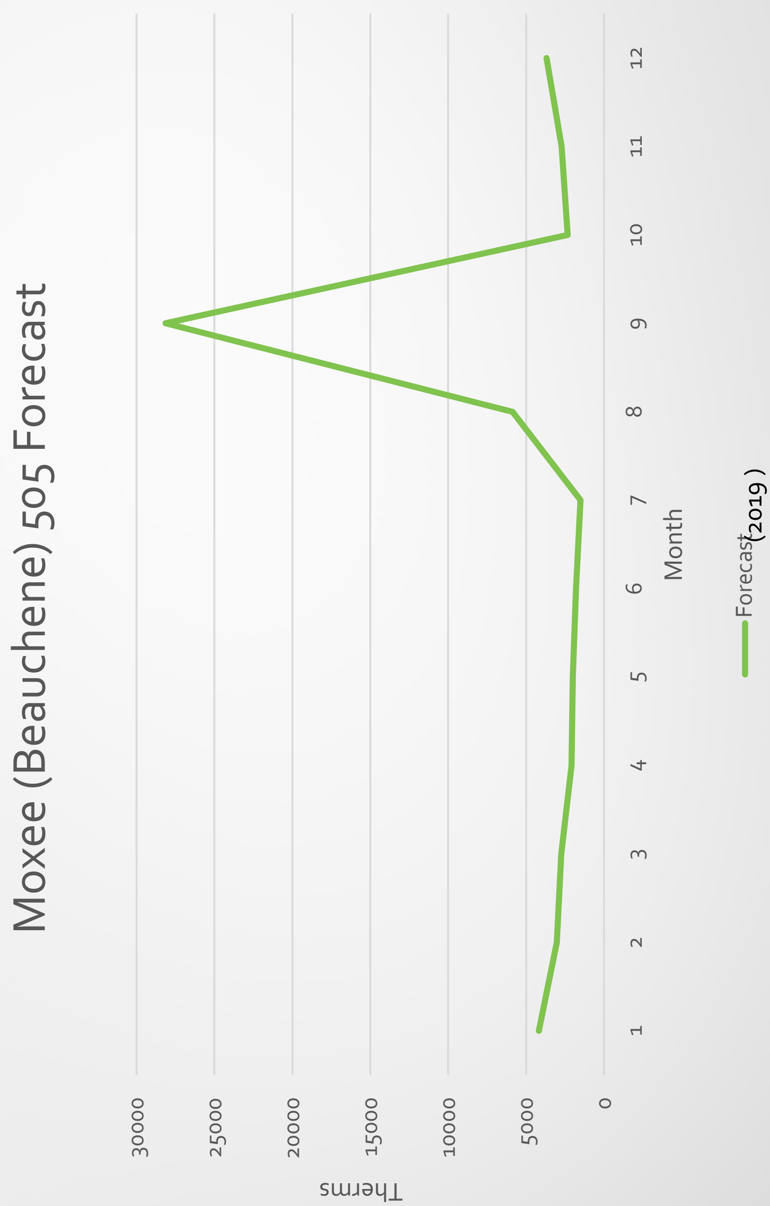
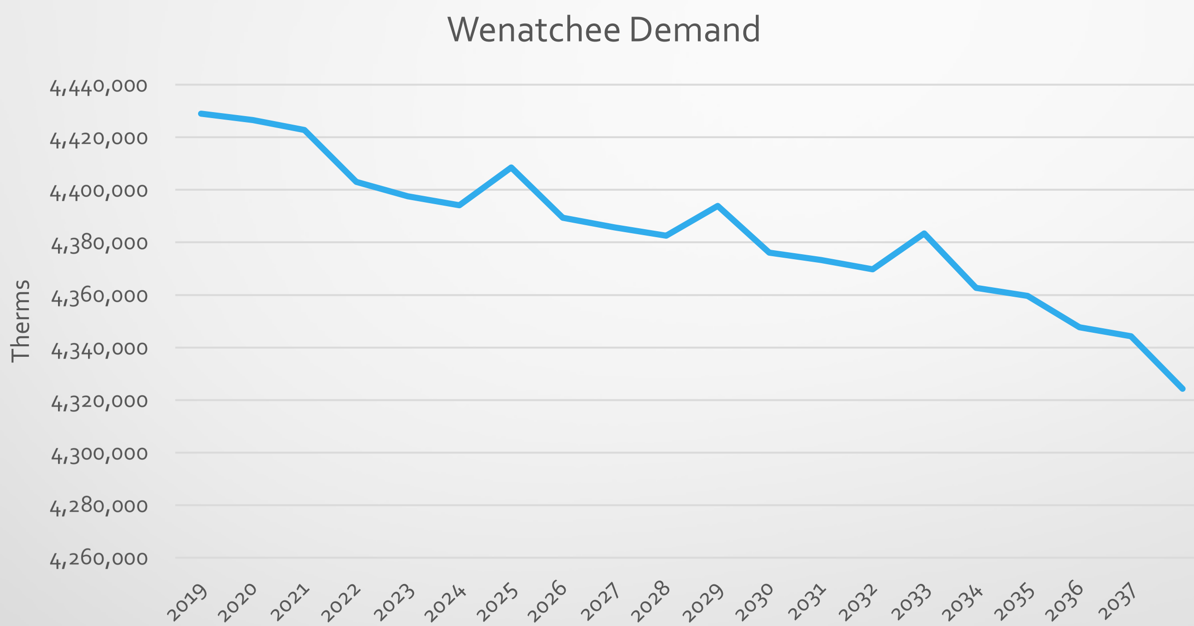
Moxee (Beauchene)



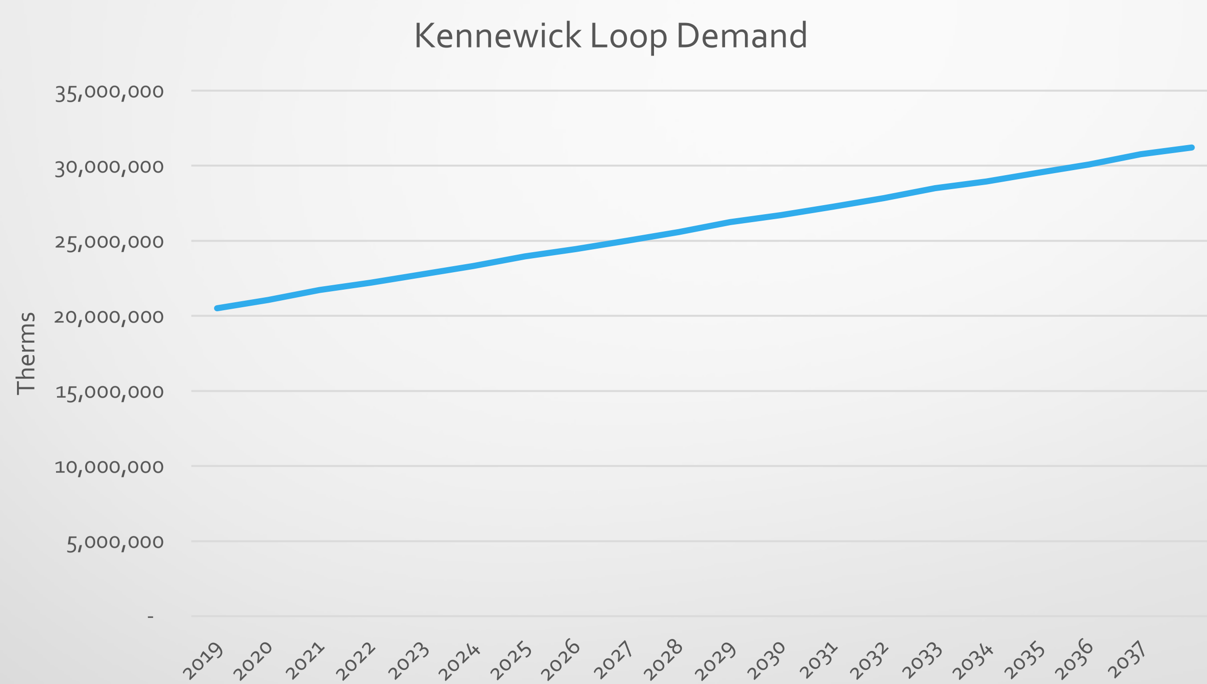

Moxee (Beauchene) 505 Forecast
Therms
30000
25000
20000
15000
10000
5000
0
1
2
3
4
5
6
7
8
9
10
11
12
Month
Forecast (2019)

Wenatchee Demand



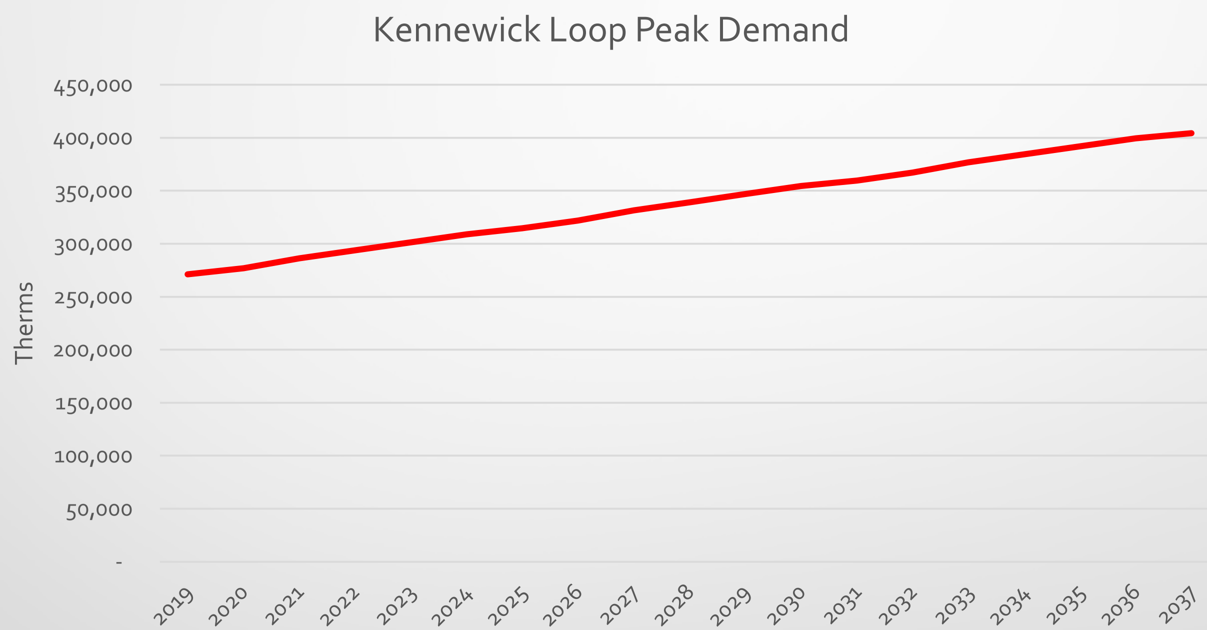

Wenatchee Peak Demand
Therms
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
-
2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037

Kennewick Loop Citygate



69

Kennewick Loop Citygate - Peak



- 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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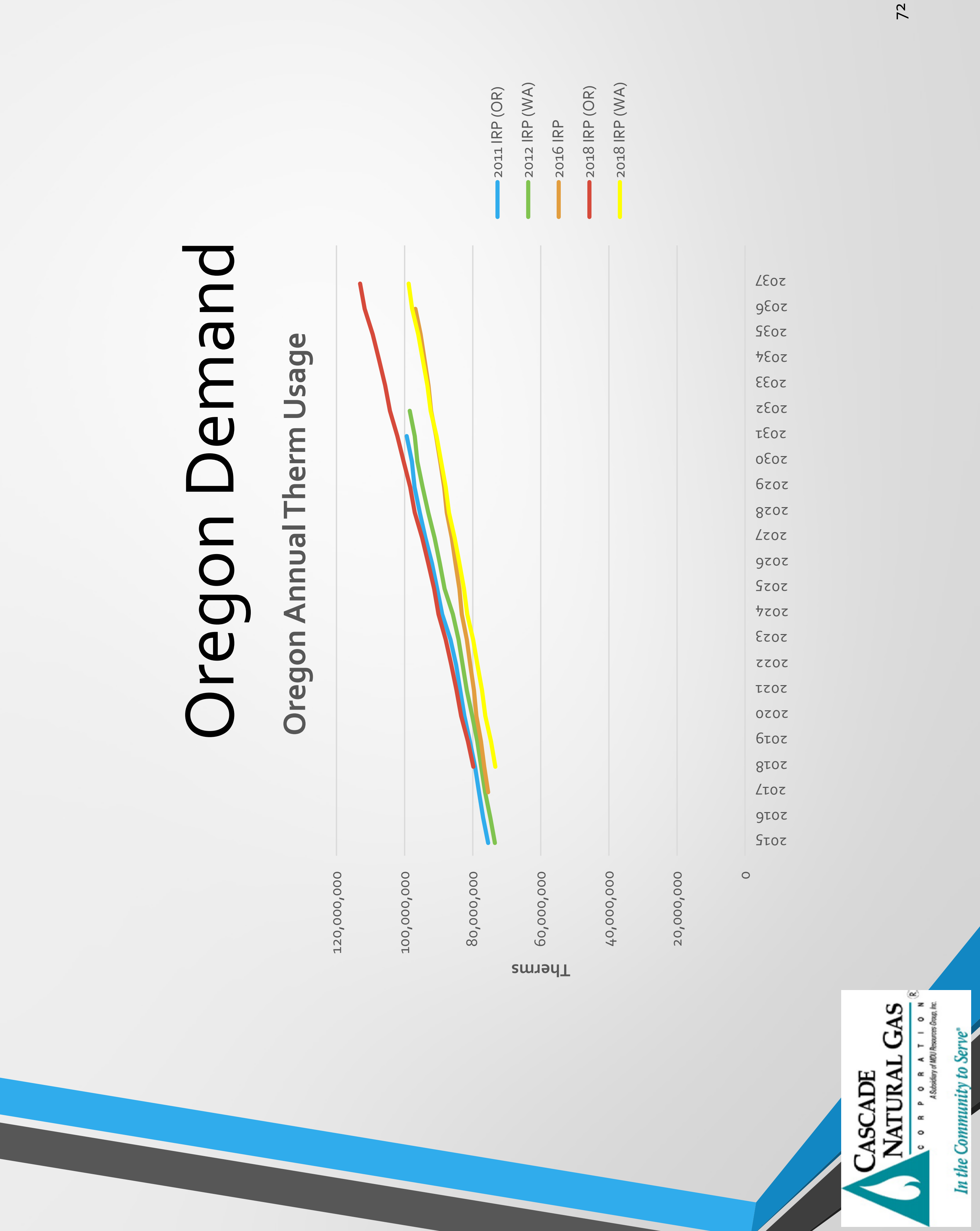
72
Oregon Demand
Oregon Annual Therm Usage
2011 IRP (OR)
2012 IRP (WA)
2016 IRP
2018 IRP (OR)
2018 IRP (WA)
Therms
120,000,000
100,000,000
80,000,000
60,000,000
40,000,000
20,000,000
0
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
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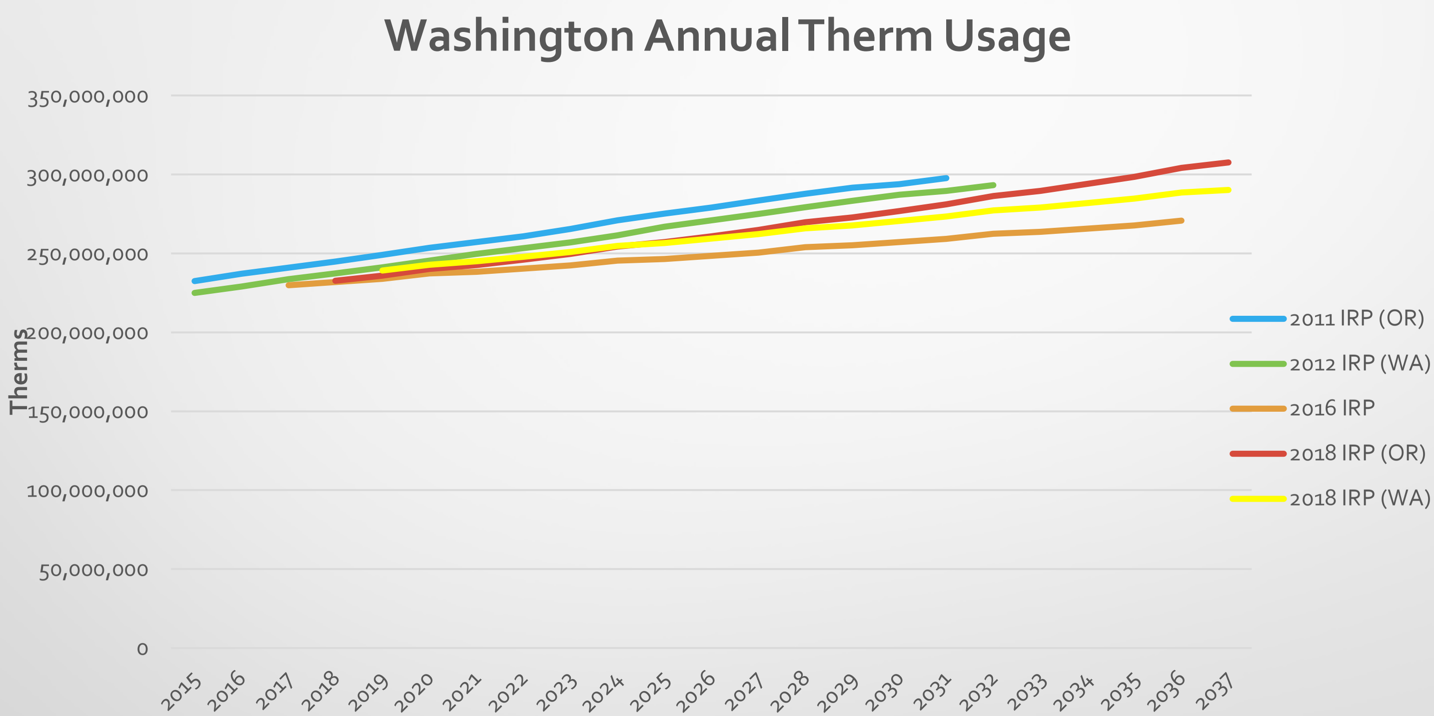
Washington Demand



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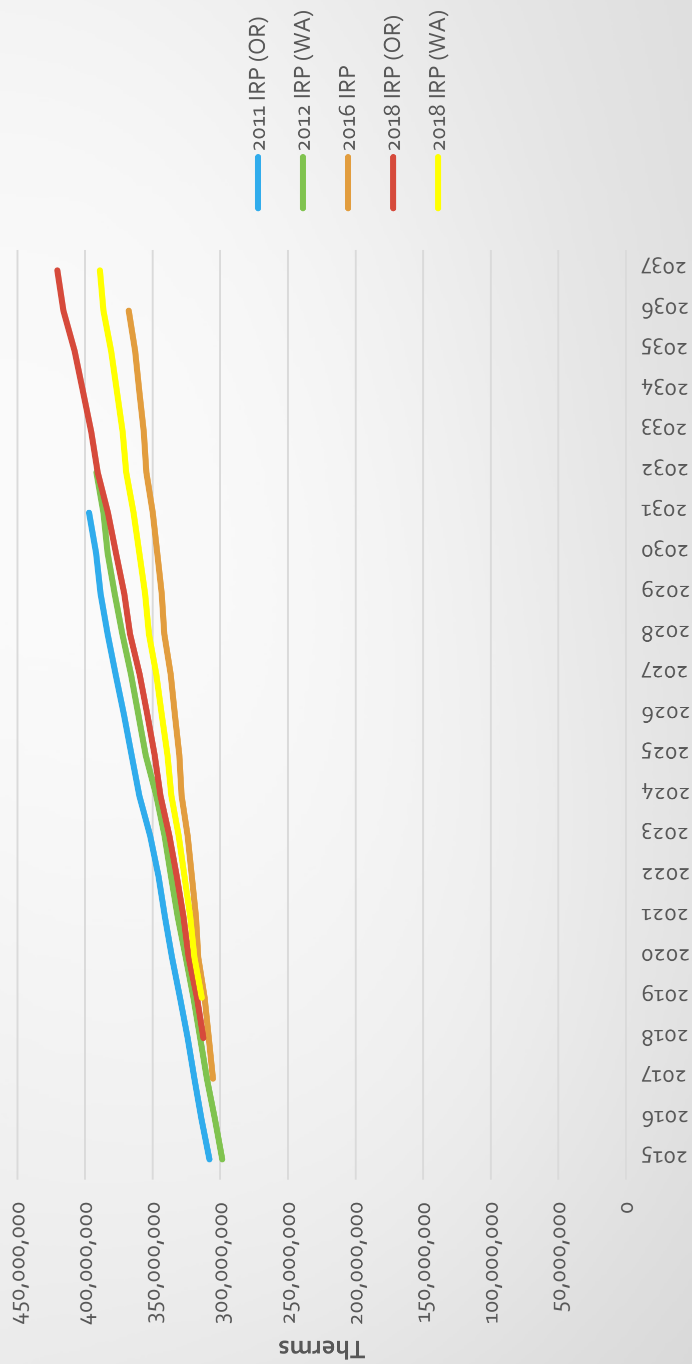
Total System Demand

Total System Annual Therm Usage



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Non-Core Outlook

Distribution System Planning

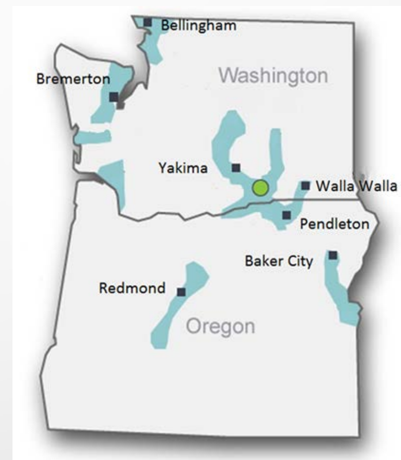
Chris Bolton, Engineer II

Technical Advisory Group

July 19th, 2017

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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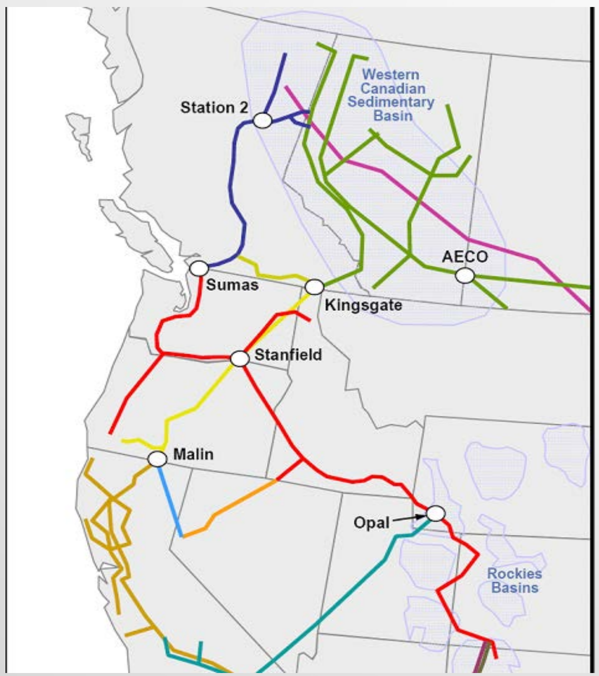
FACILITIES:

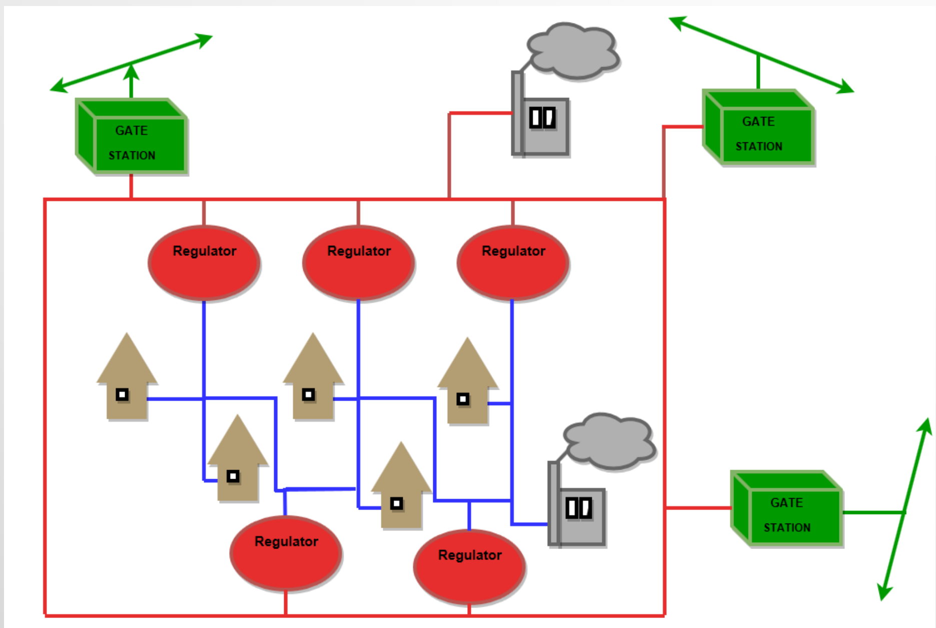
- REGULATOR STATIONS – OVER 700
- VALVES – OVER 1600
- ALSO OTHER EQUIPMENT SUCH AS HEATERS, ODORIZERS AND COMPRESSORS.

WHERE DO WE GET OUR GAS?



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

Network Design Fundamentals



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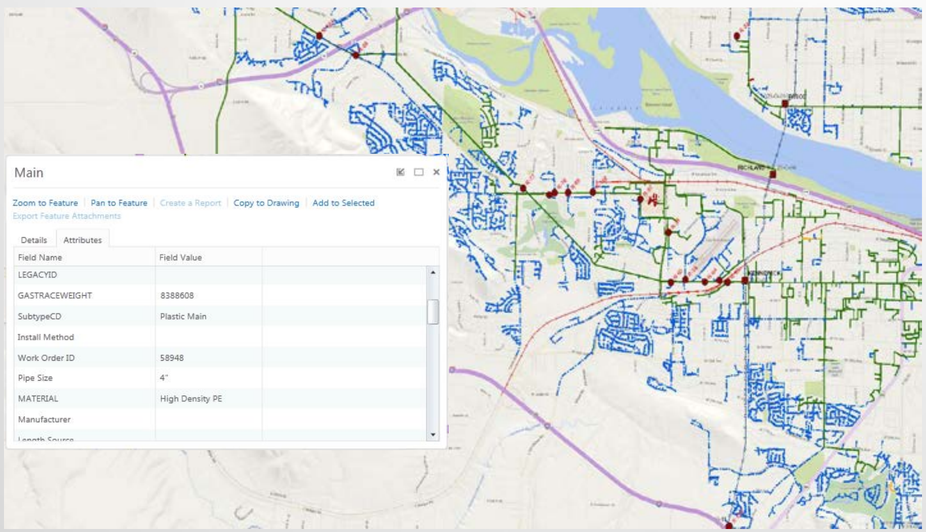
GIS – Geographic Information System

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



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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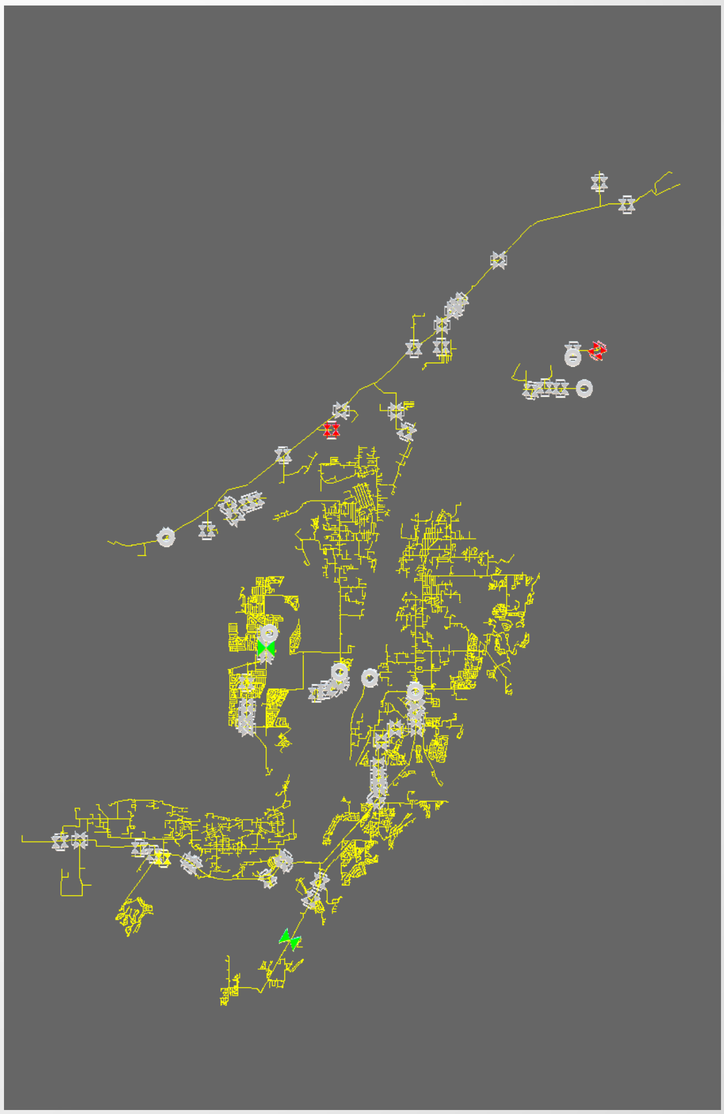
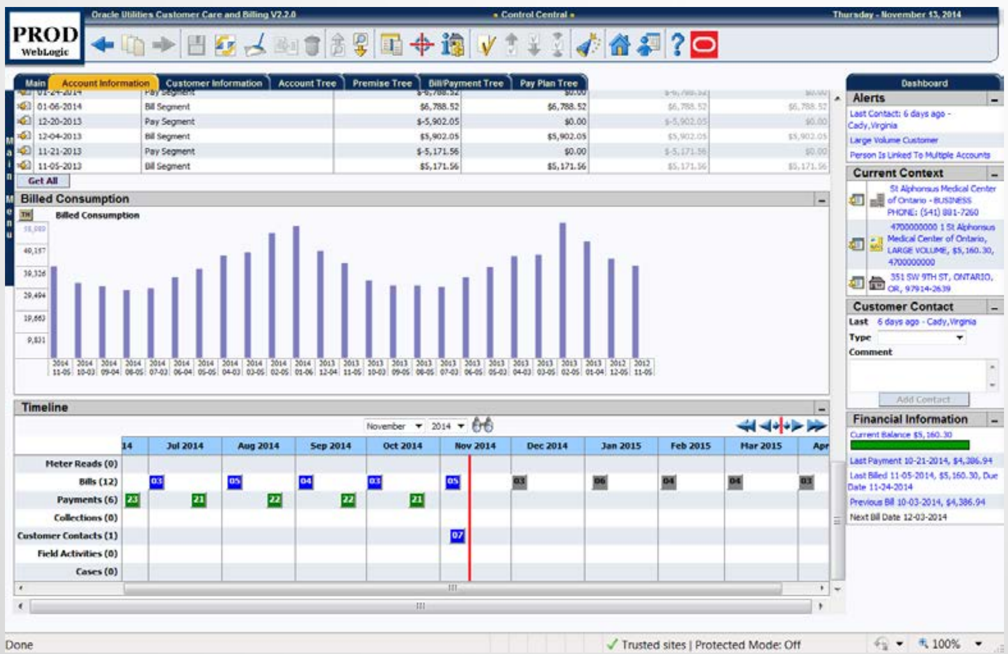
Model Ex.



Data Gathering

- CC&B (Customer Billing Data)



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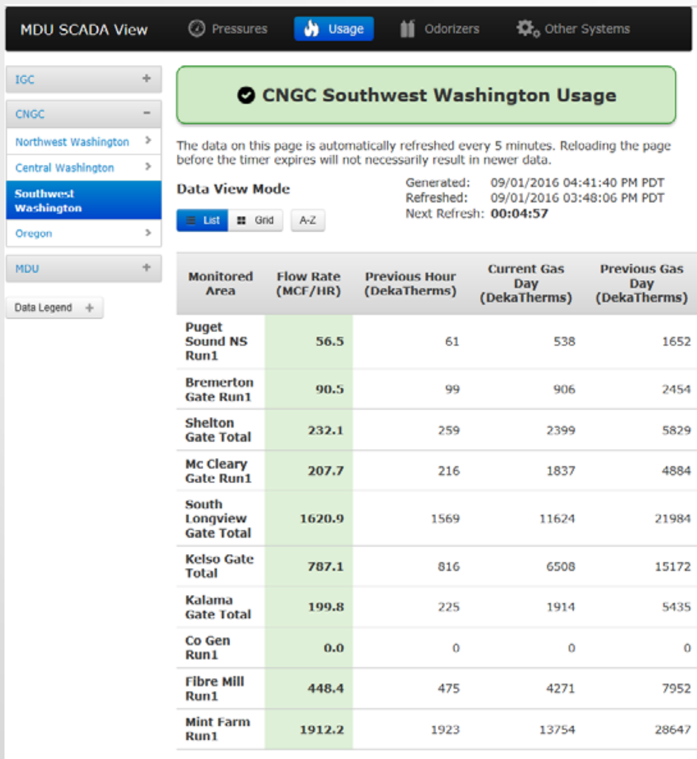
Data Gathering (cont.)



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

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

CNGC Southwest Washington Usage

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

Data View Mode List | Grid | A-Z

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

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

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

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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%

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.

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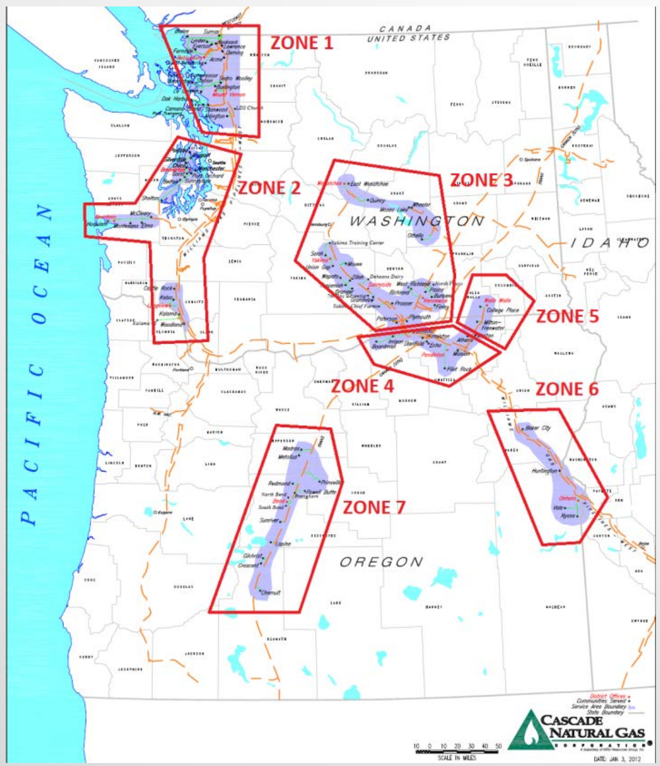
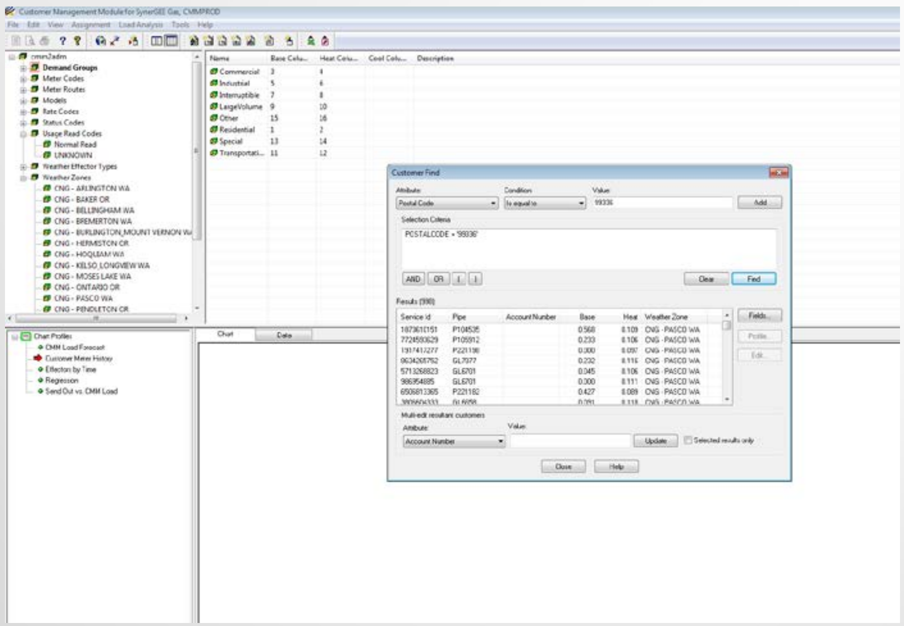
CNG WEATHER ZONES



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

Customer Management Module (CMM)



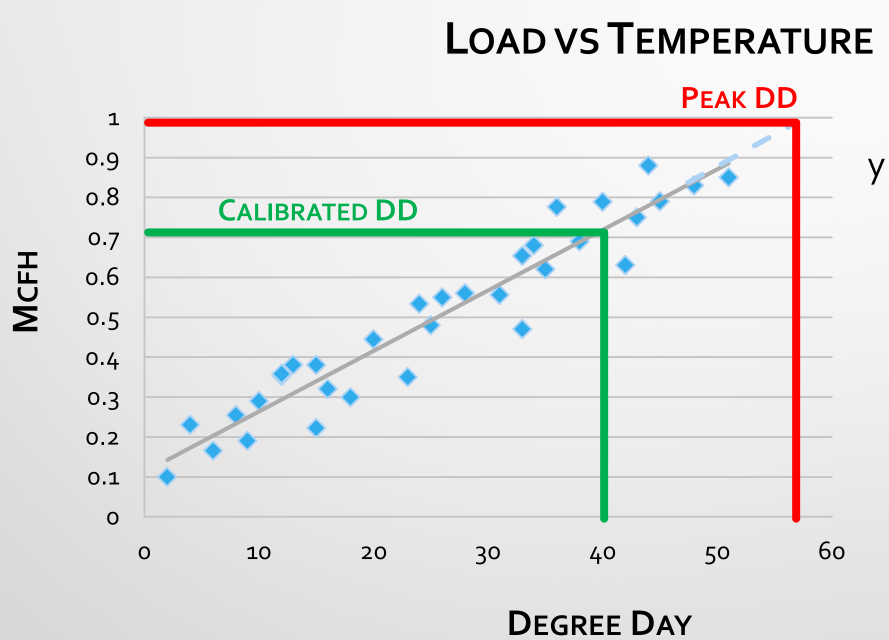
- Software that compiles data from CC&B, HDD, and/or growth studies to manage customer loads.
- Works directly with Synergi to input customer data and represent pressures and flows in the model.

CMM → Synergi

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

Calibrated vs Degree Day

- Different loads will be applied to each customer



y = 0.0152x + 0.1118

BASE

40 DD = 0.72 MCFH

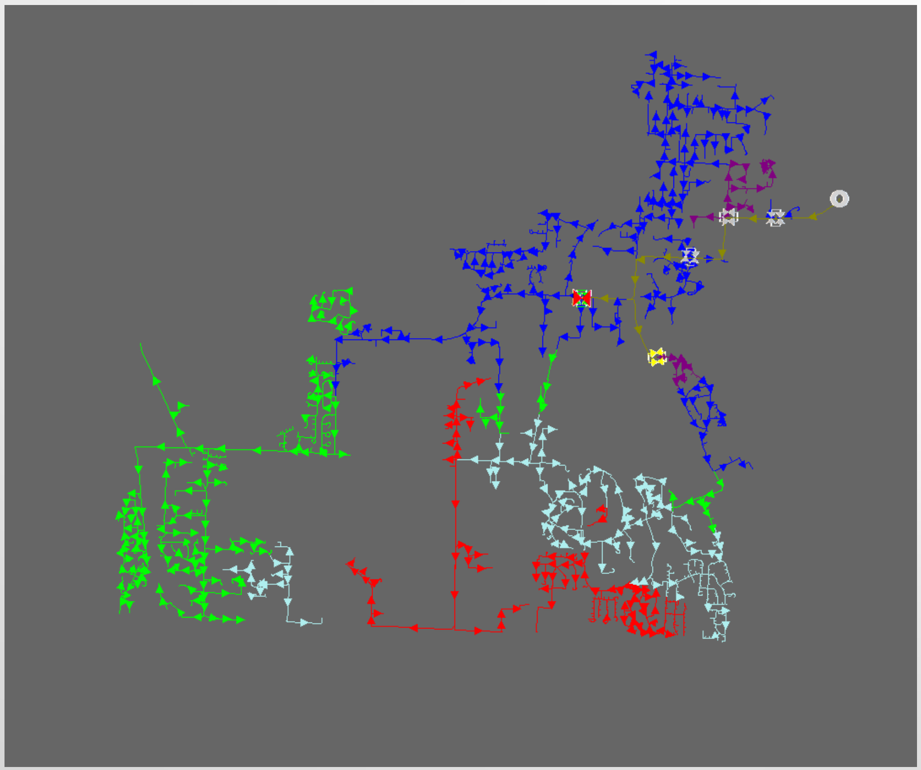
58 DD = 0.99 MCFH

System Modeling (cont.)

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

Synergi

- Theoretical low pressure scenario



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)

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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

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Compressor Stations

Pros

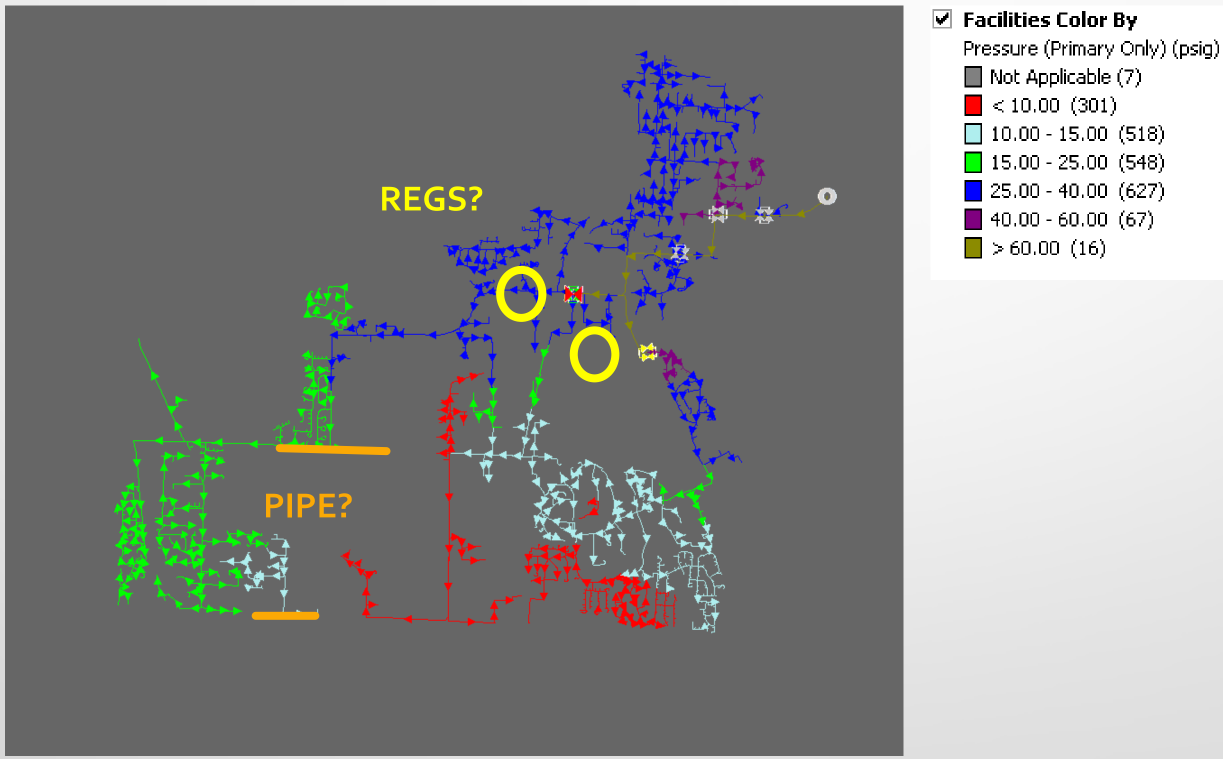
- Adding capacity at lower initial cost
- Less land required
- Situational operation

Cons

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

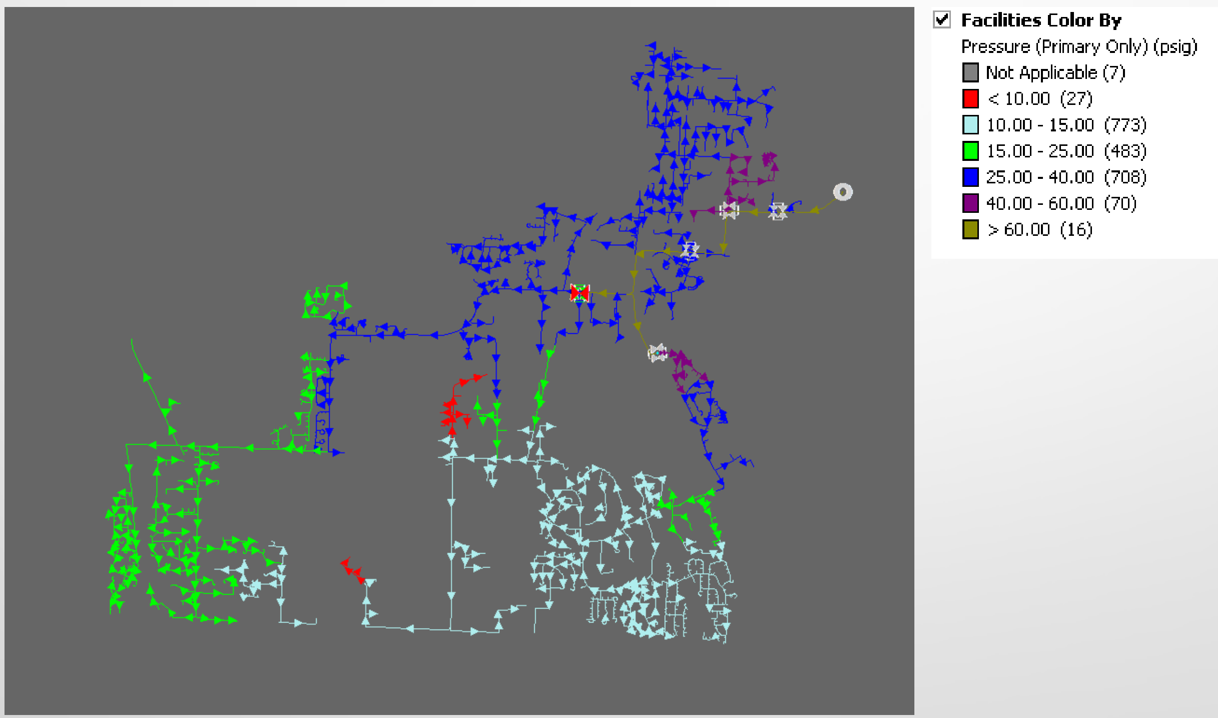
SYNERGI

- LOW PRESSURE SCENARIO



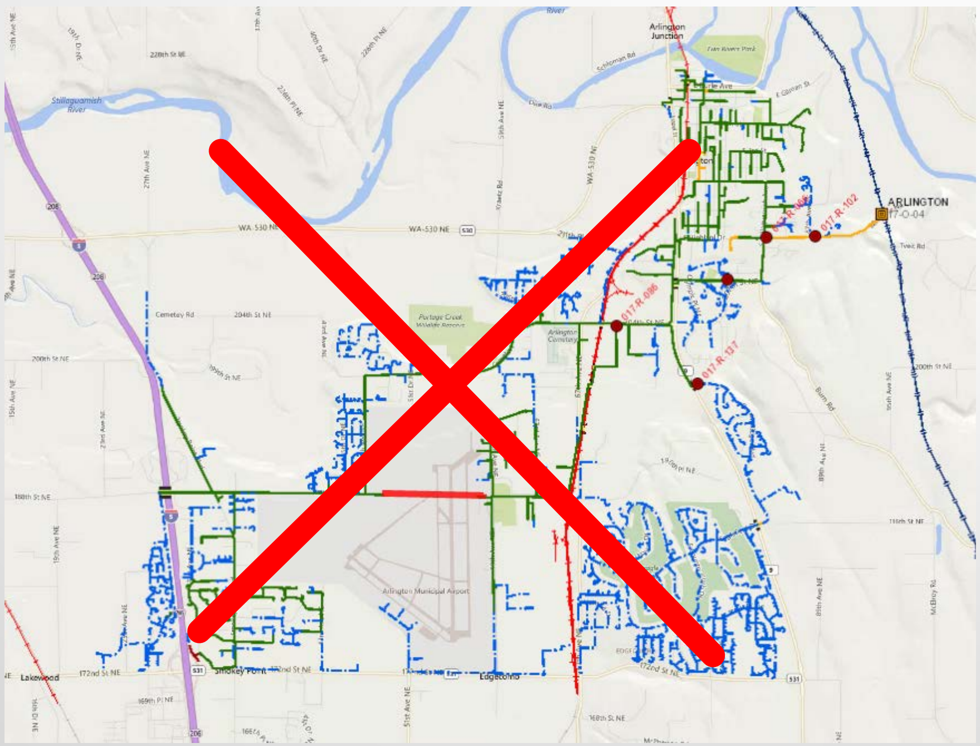
SYNERGI

- POSSIBLE SOLUTIONS – RAISING REG STATION SET POINTS



Synergi

- Reinforcement option #1



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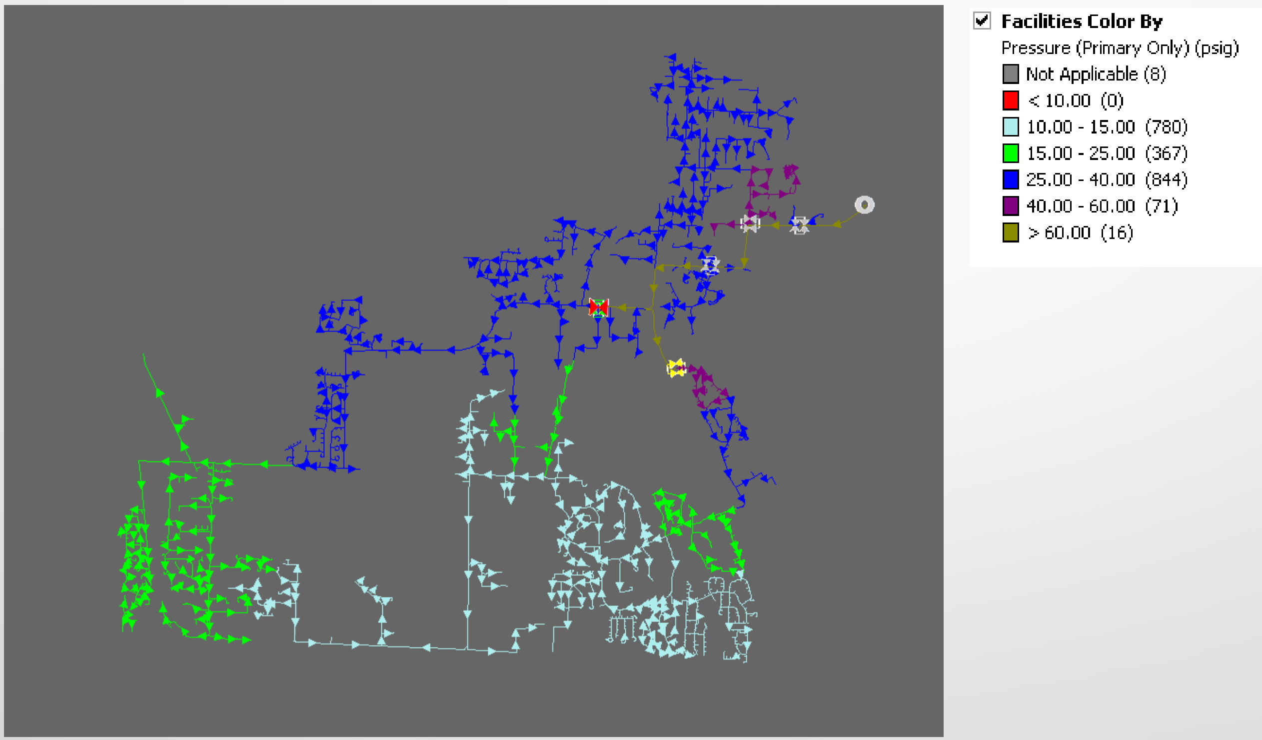
SYNERGI

- REINFORCEMENT OPTION #2



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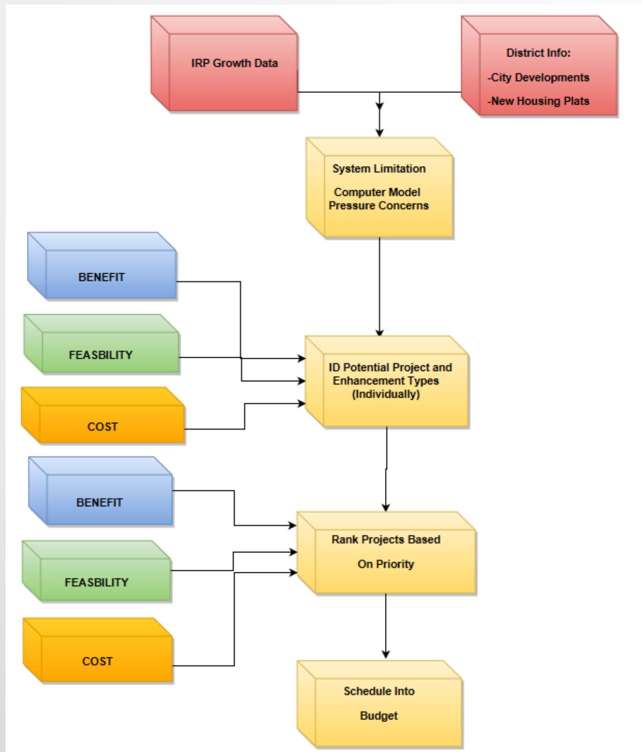
Project Process Flow



Project & Schedules

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

Conclusion

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

QUESTIONS ?

Cascade Gas Supply Overview

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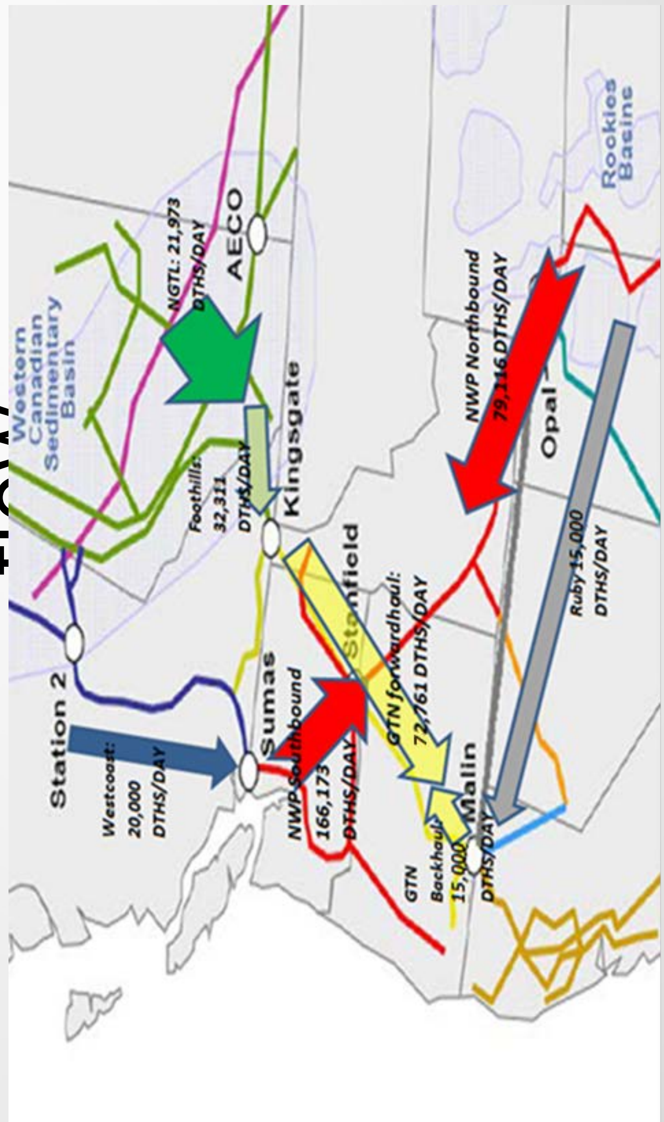
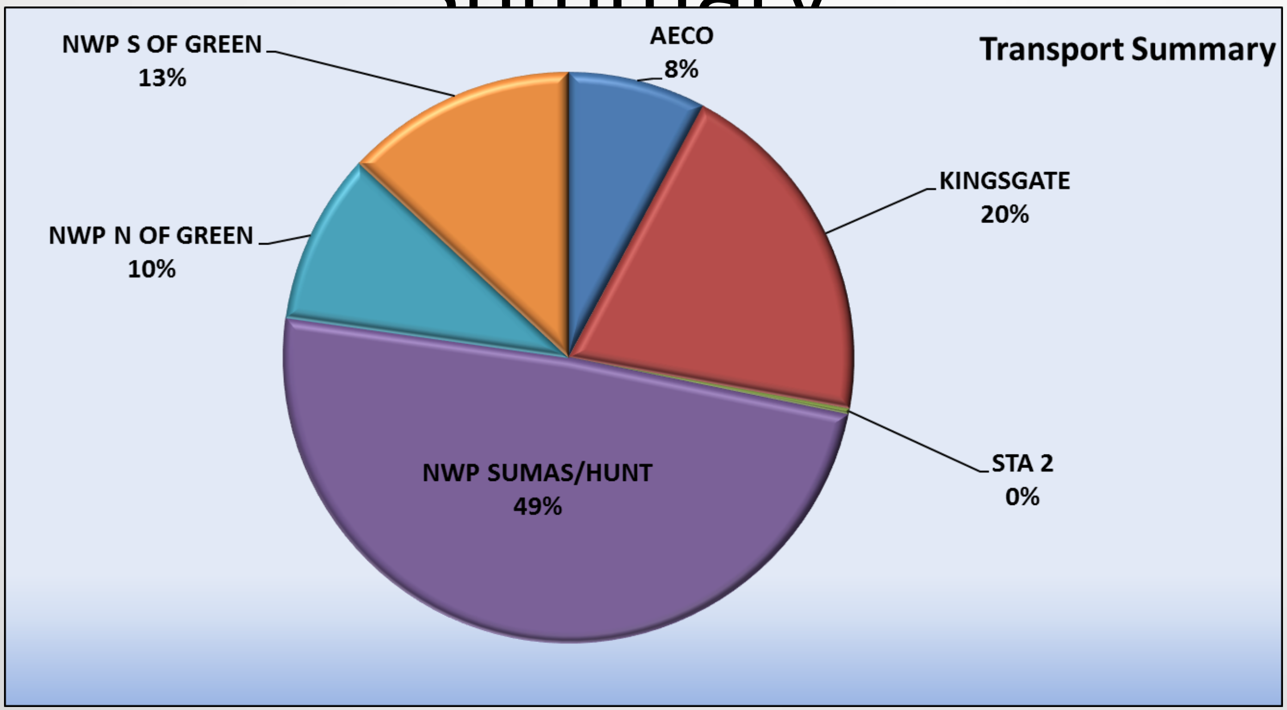
Pipeline transport flow



Transport Summary



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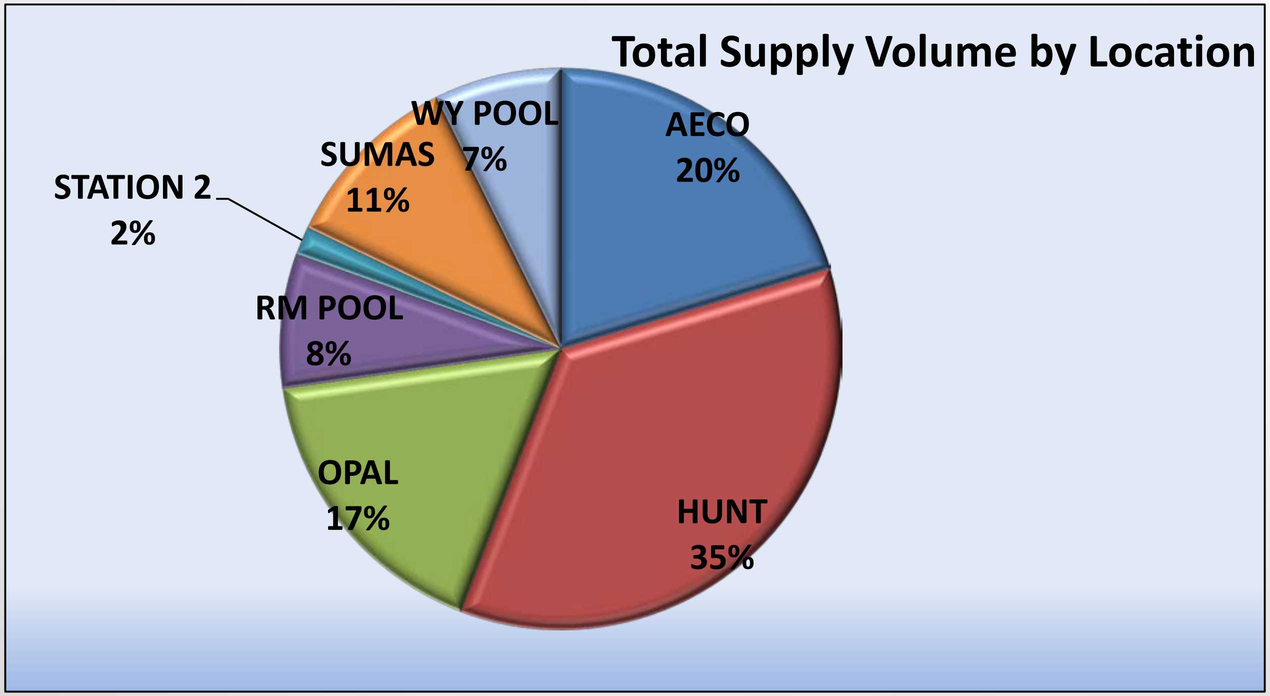
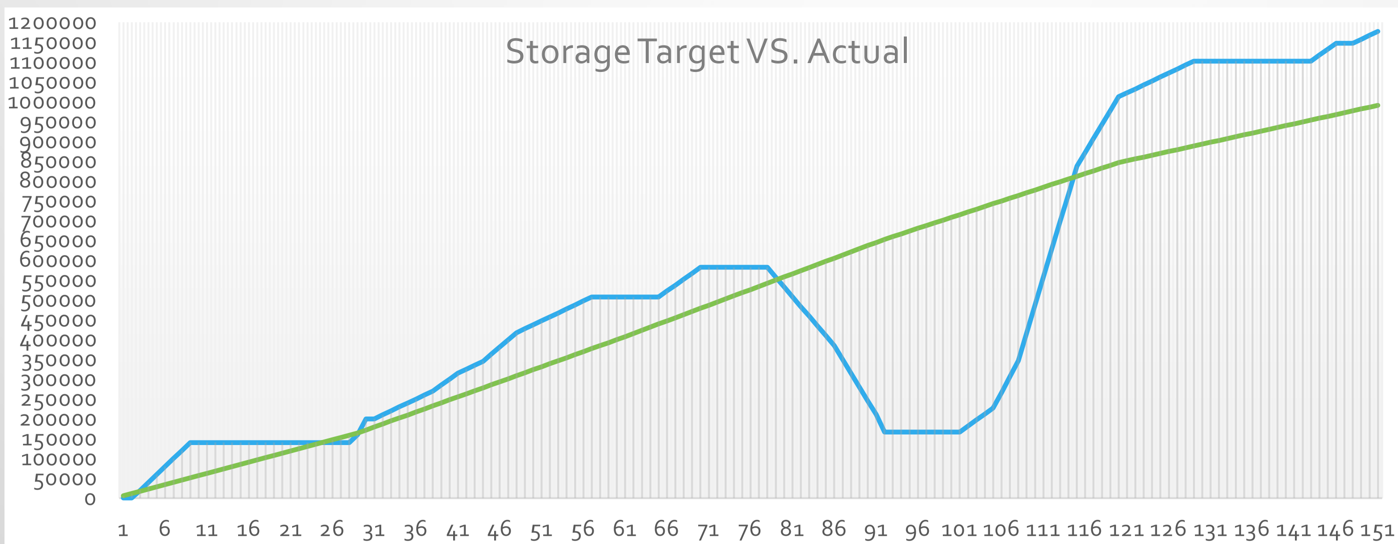
Supply Summary



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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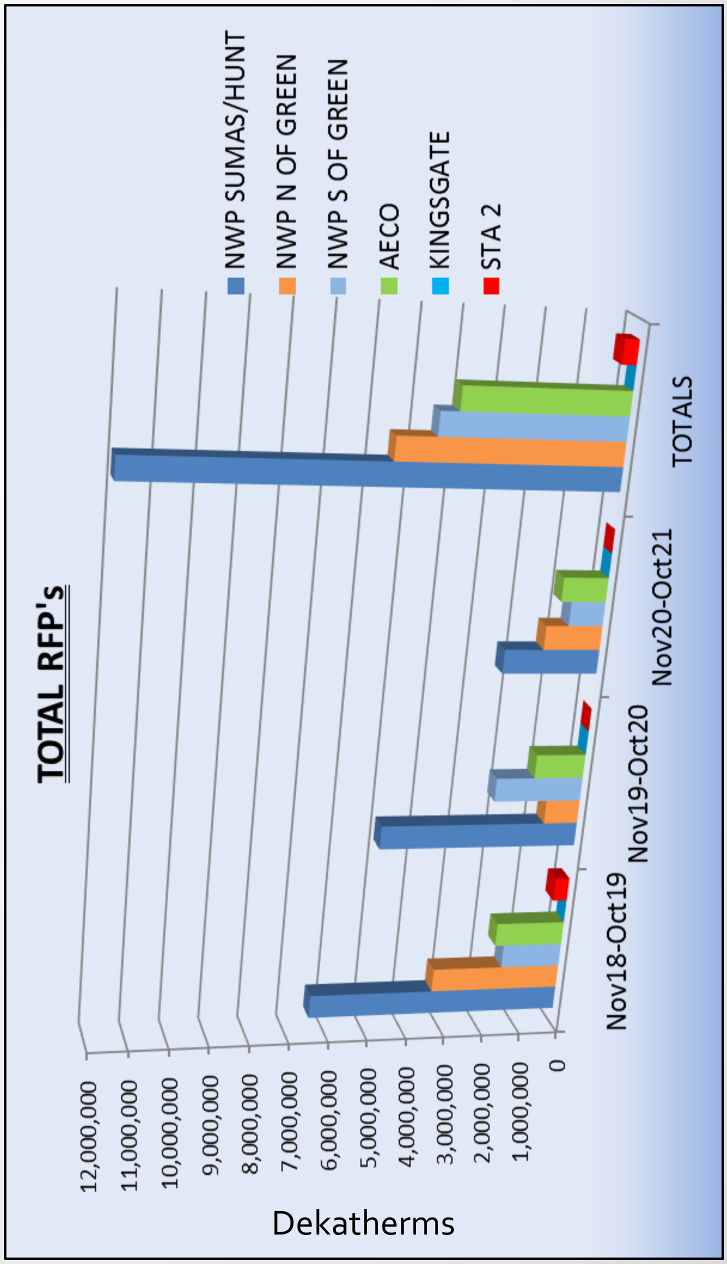
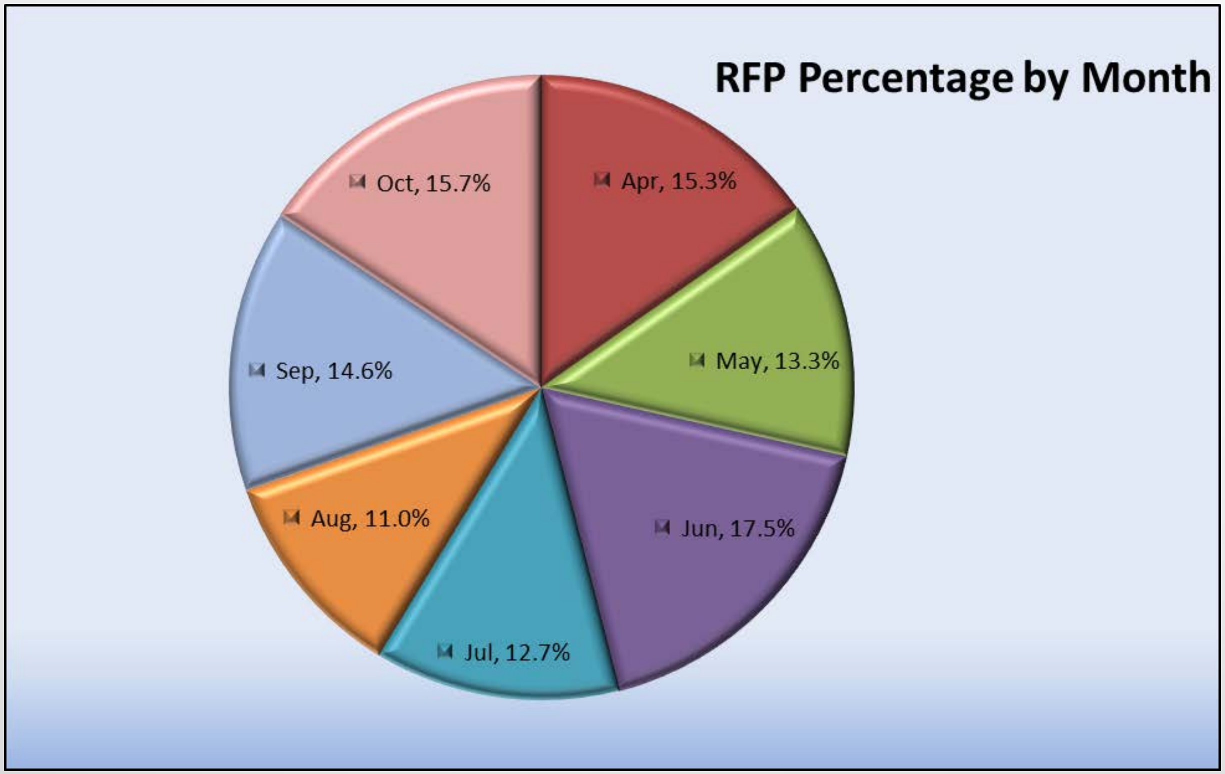
HIGHLIGHTS FOR THE 2017 PORTFOLIO DESIGN

- 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.

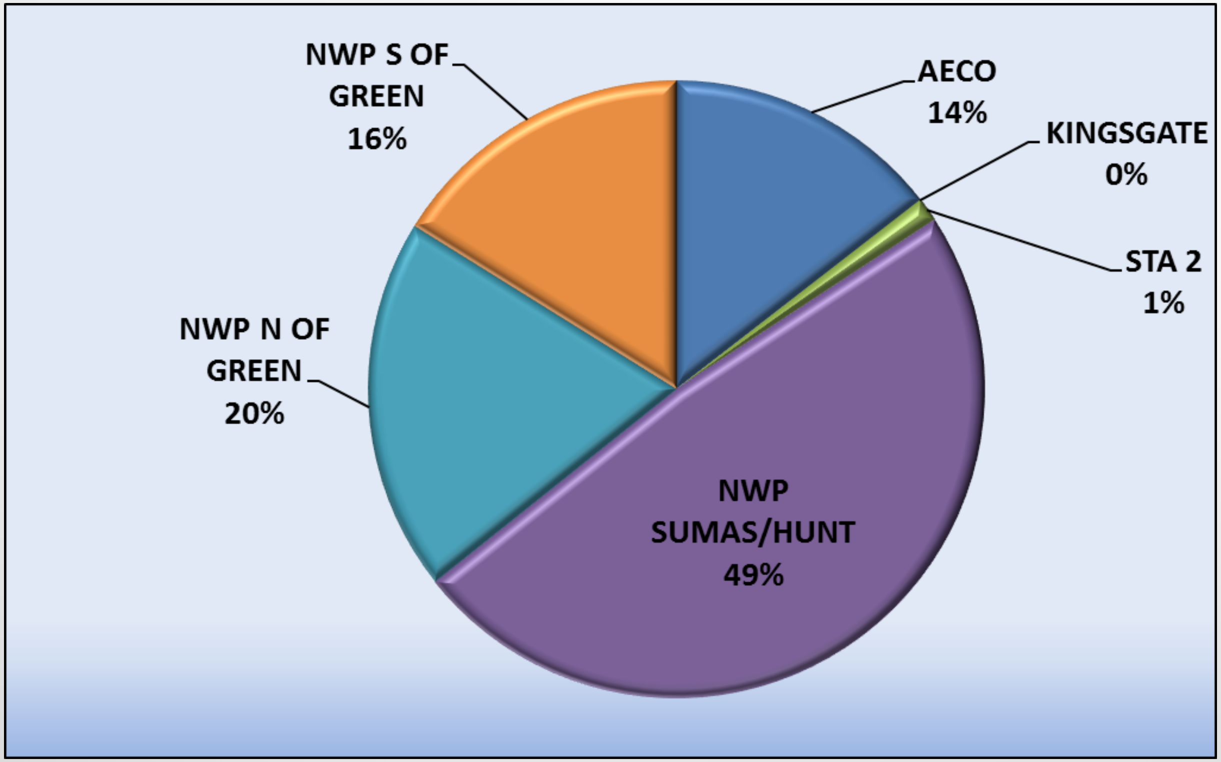
Total RFPs


TOTAL RFP's
Dekatherms
12,000,000
11,000,000
10,000,000
9,000,000
8,000,000
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
Nov18-Oct19
Nov19-Oct20
Nov20-Oct21
TOTALS
NWP SUMAS/HUNT
NWP N OF GREEN
NWP S OF GREEN
AECO
KINGSGATE
STA 2

RFP Percentage by Month



RFP Percentage By Basin



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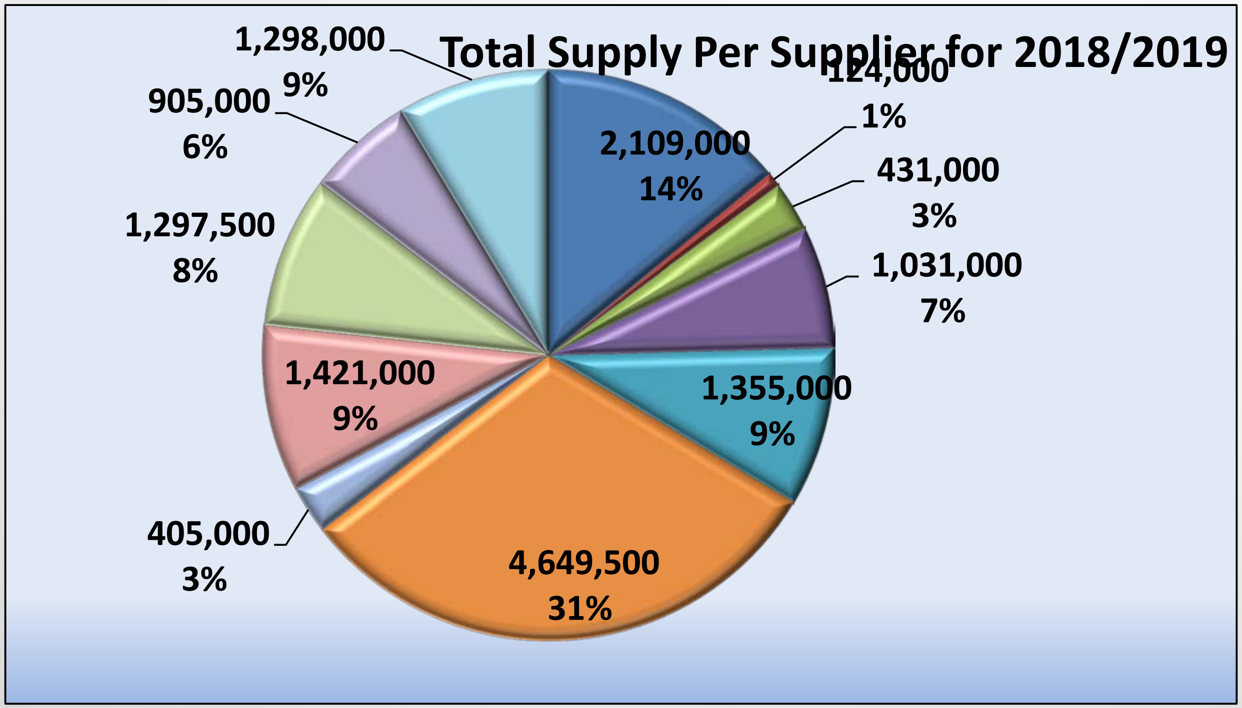
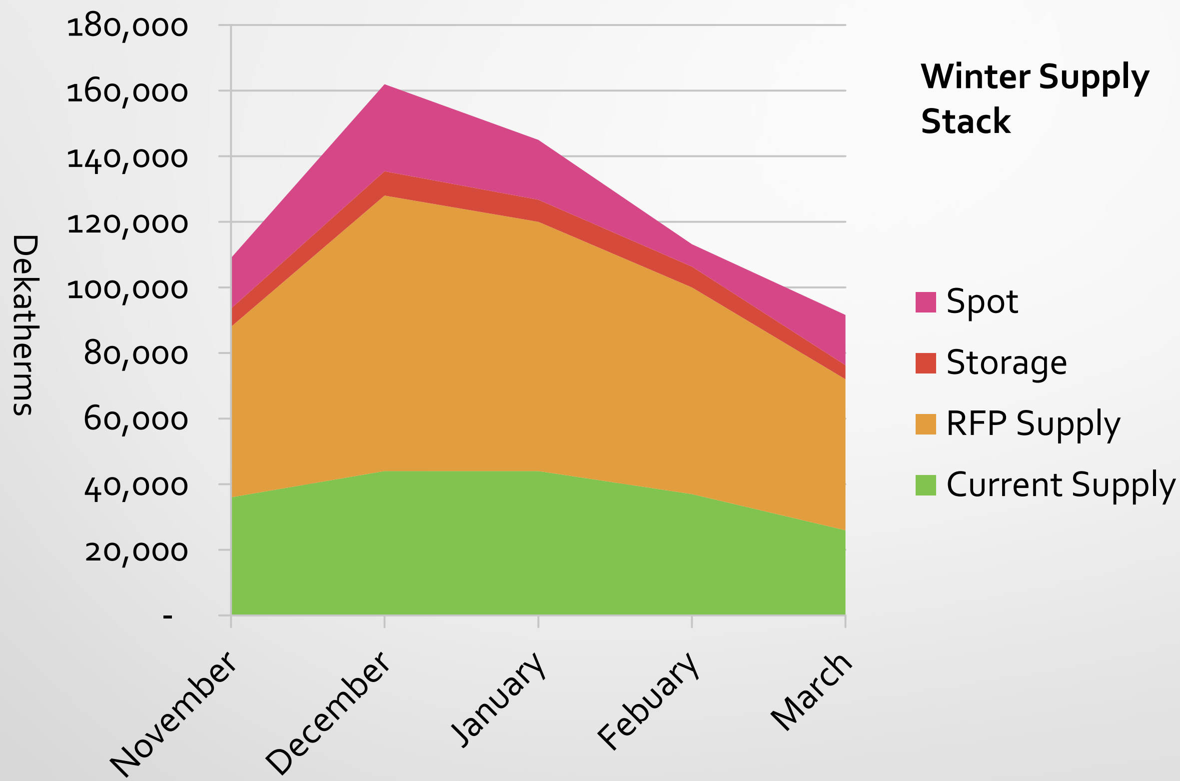
Current Supply Percentage by Supplier



Winter Supply Stack



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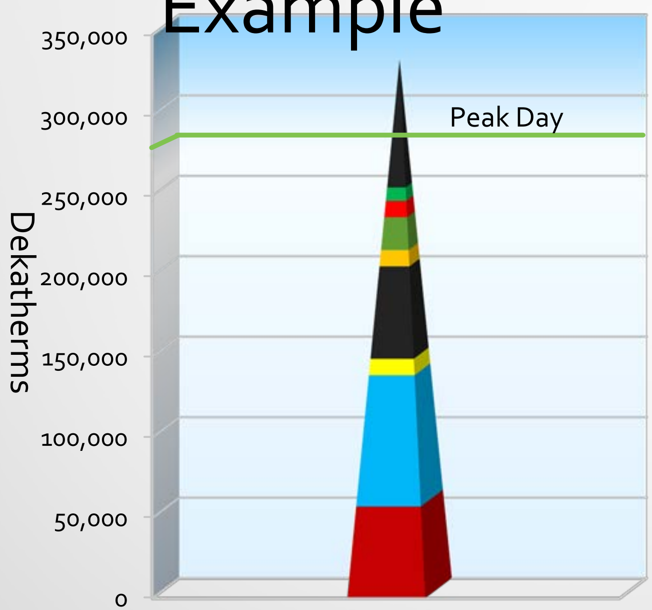
Peak Day Stack Example



Peak Day Stack

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	
56,000	

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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.

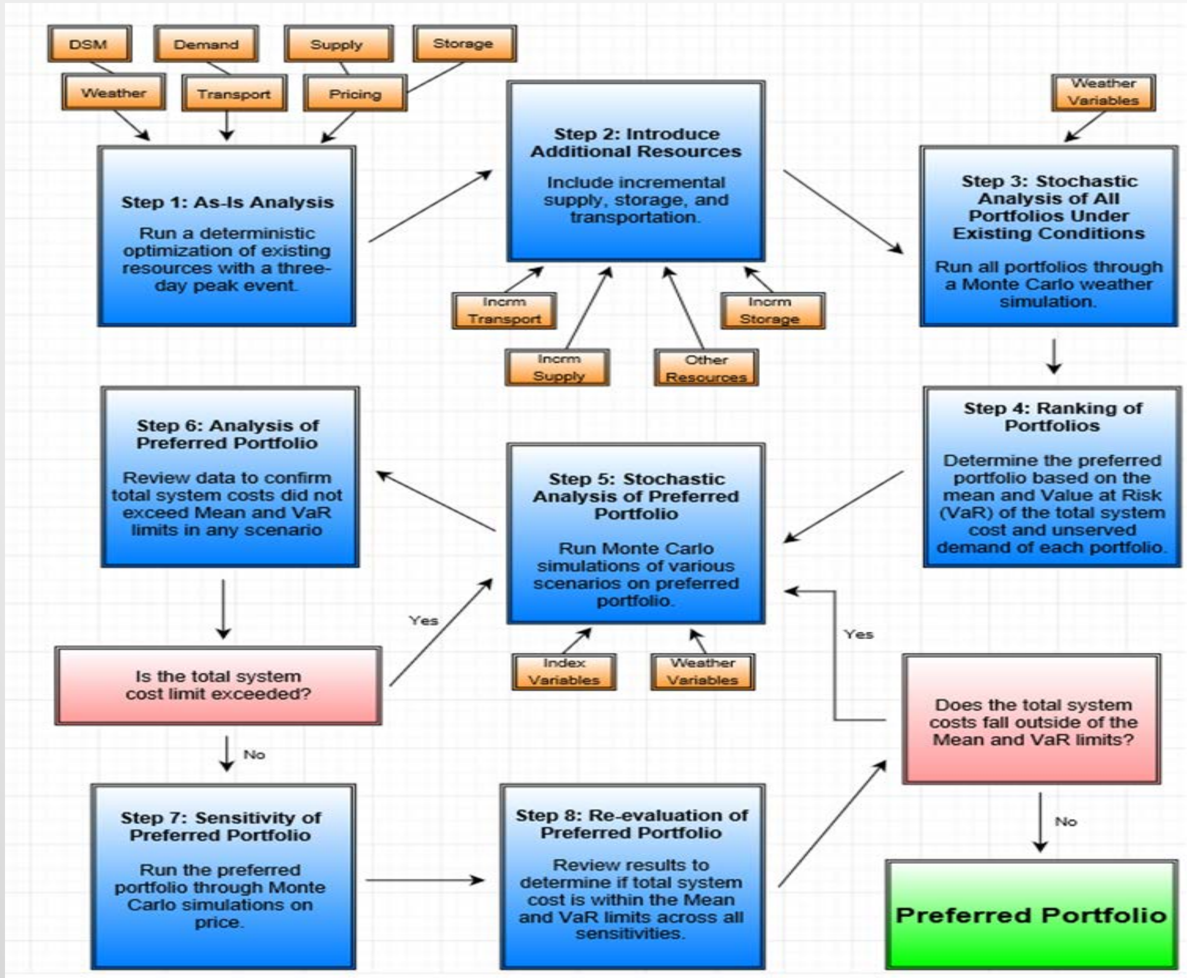
Supply Resource Optimization Process

- **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.

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



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?

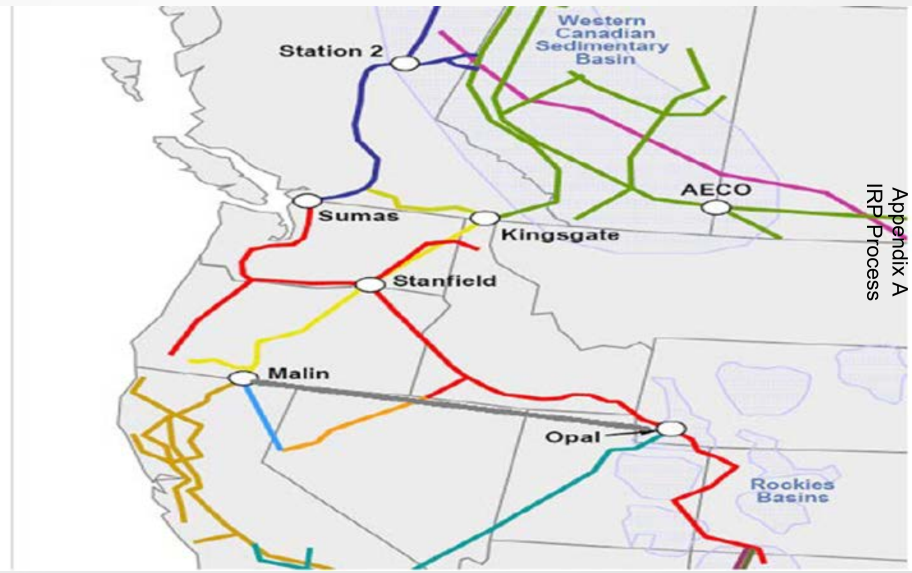
Scenarios and Sensitivities

- Scenario:
  - Change in projected demand
  - Change in availability of existing resources to serve demand
  - Change in availability of supply
- 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

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.		
	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***
Low Growth	***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.		
	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***
High Growth	***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 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.		
	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*
Limit Canada	*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.		
	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*
Limit Rockies	*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** **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 - JP	**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***

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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.		
	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*
No Storage - Ply	*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.		
	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*
No Storage - Both	*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		

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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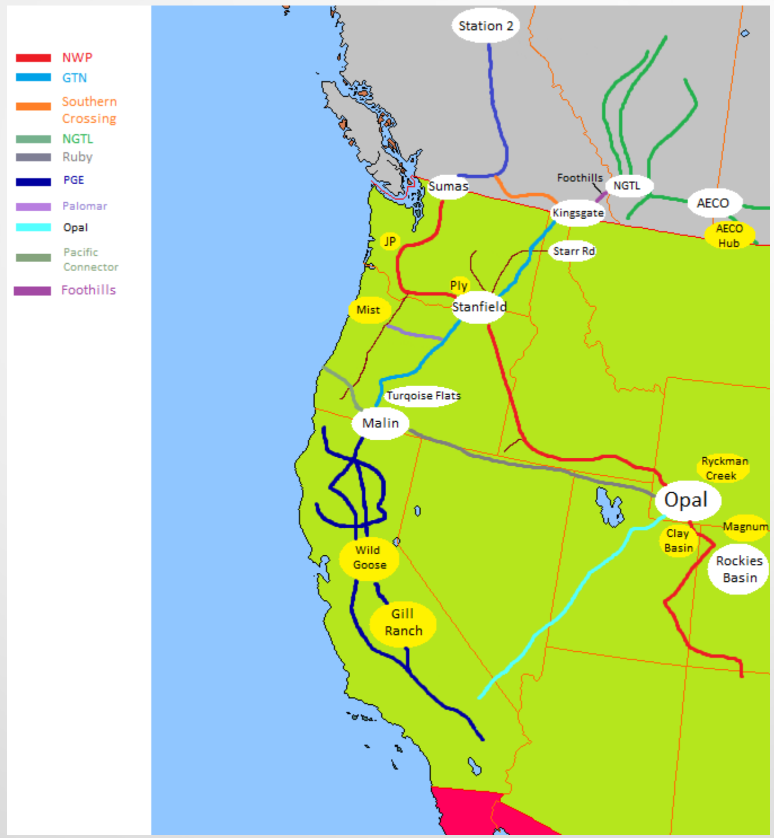
Alternative Resources

Major resource issues on the horizon

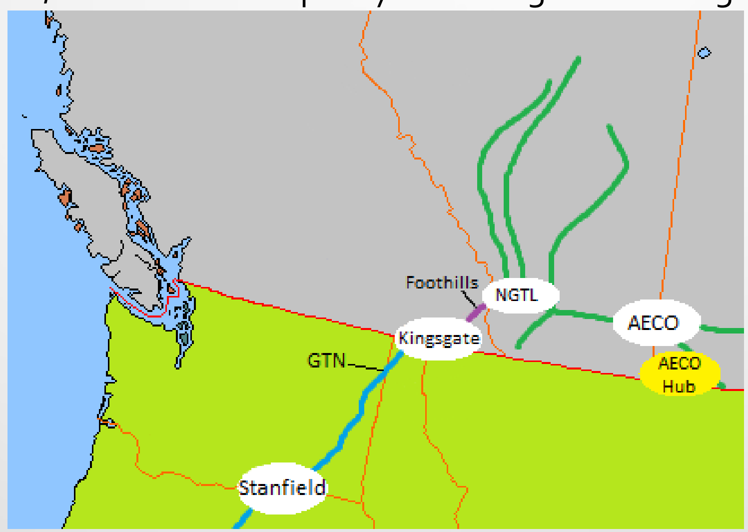
- Once a deficiency is identified, Cascade must analyze potential solutions to ensure service over the planning horizon.
- Conversations with partners at various pipelines, storage facilities, new supply sources.
- SENDOUT® is used to ultimately derive the optimal mix of resources, referred to as the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

Location of Current & Alternative Resources



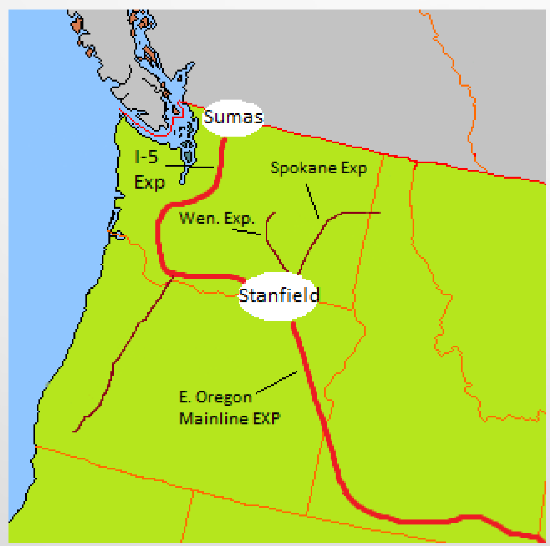
Incremental Transport – North to South

- 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 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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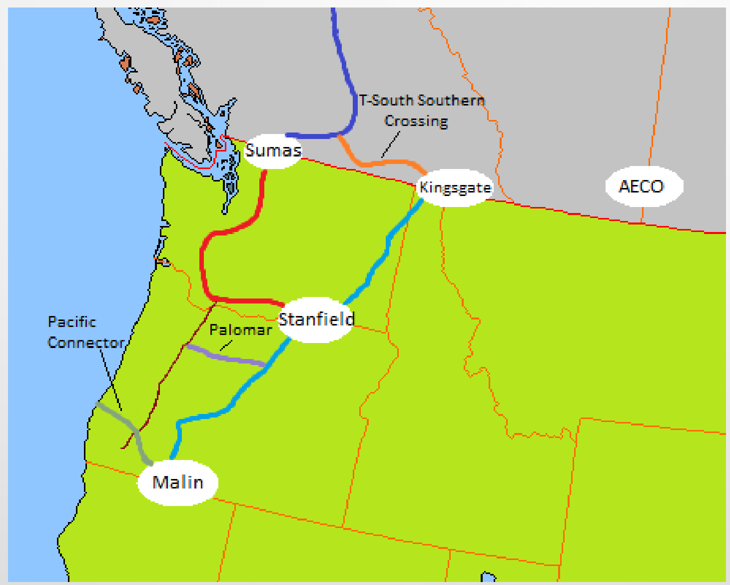
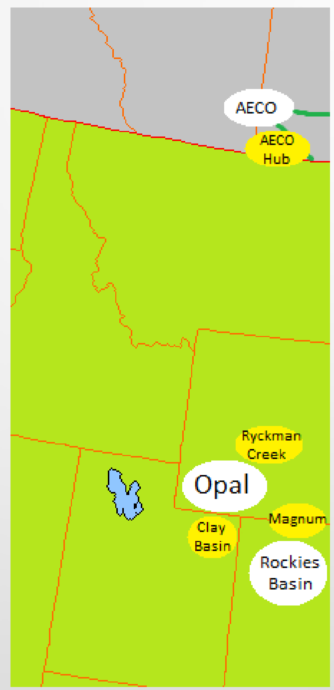
Incremental Transport – Bilateral

- 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



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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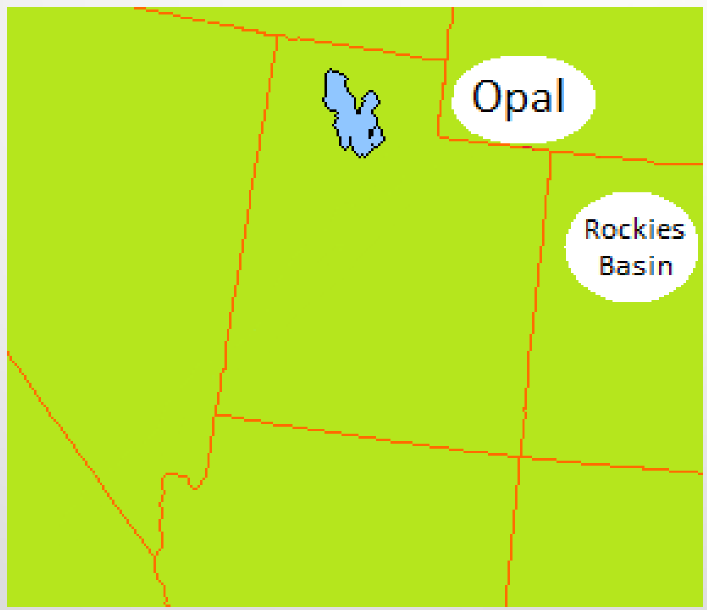
Incremental Supplies

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



Market Outlook and Long Range Price Forecast

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.

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.

	Weight		Interval
Rank (order of severity)	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.

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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

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.

- 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.

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

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

WUTC Tag Meeting 2 &3

Date & Time: 7/12/2018, 09:00 AM – 04:00 PM

Location: SeaTac Conference Center – Seoul Room

In attendance: Mark Sellers-Vaughn, Bruce Folsom, Brian Robertson, Devin McGreal, Ashton Davis, Eric Wood, Chris Bolton, Jay Story (GTN), Mike Rasmussen (NWP), Marty Saldivar (NWP), Laura Flanders (NWP), Karl Frankiewich, Andrew Rector, Cory Dahl (Washington State Attorney General's Office), & Carolyn Stone.

Called in: Scott Madison, Bob Morman, Chris Robbins, Jeremy Ogden, Mike Parvinen, Tom Pardee, Debra Reynolds, Amanda Sargent, Abigail Krebsbach, & Art Gelber (Gelber & Associates).

Minutes by: Carolyn P Stone

Mark began the meeting by welcoming everyone to the 2nd & 3rd WUTC Tag Meetings of 2018! Mark stated that there was a full agenda and questions, feedback, comments and concerns were very much appreciated! He asked attendees on the phone to please state their name before they speak. Mark asked Scott if he had any opening comments.

Scott thanked everyone for their participation. He stated that this is important for customers and stakeholders. He also thanked everyone for taking the time to be a part of the process and thanked the Resource Planning Team as well. Scott said he would not be on the call for the whole meeting.

Mark mentioned one item not on the Agenda. Art Gelber, of Gelber and Associates would introduce his firm and talk about the work his group is doing with CNGC towards a revised Hedging Policy, based on Docket 132019.

Bruce gave opening remarks as follows:

- The best way to influence the CNGC IRP will be in Tag's 2,3,4 & maybe 5.
- He asked stakeholders to know there is an open door to himself and the team.
- Interaction prior to making comments on the draft, before the demand forecast is done is very influential.

Brian then went over today's Agenda.

1st Presentation – Northwest (NWP) System Capacity (Mike Rasmussen)

Mike went on to present the "Shelton Lateral":

- Mike explained, there is 8,960 Dth of capacity available on the Shelton Lateral to the Bremerton delivery point - 6,814 available capacity and 2,146 incremental capacity!
- To get additional capacity NWP would have to expand the pipeline, costing $57K.
- We could install a press regulator for about $14K Mike said, but to expand the entire lateral would be up to $20m!
- Taking the short path to Plymouth – flow Plymouth to Shelton Lateral (new capacity).

Question: Kyle asked if there is growth at the Shelton Lateral?
Answer: Mark answered "yes", there is growth compared to the existing capacity. SENDOUT® Modeling will show what the best solution is. Devin said that the Shelton Lateral in the 2018 OPUC IRP came up as an option – but they are still modeling this. Mark said that the engineering group at CNGC distribution system work is minor combined with other solutions. It takes an entire corporation to address shortfalls!

- Capacity is remarketed to CNGC or another 3rd party and they are willing to discount Jackson Prairie (JP) to Plymouth!
- Amended contract #139090 so CNGC acquired vacated capacity from JP to Plymouth through a discounted storage redelivery agreement.
- CNGC has the option to lock in discounted capacity through 10/2052.

Mike then went on to present the Spokane Lateral:
- Extension of JP storage redelivery of capacity from Plymouth LNG up the Spokane Lateral to Southridge thru a "hydraulic exchange".
- Mike said, if you cut a straw shorter it increases pressure, but if the straw is 3 feet long you have lower pressure, so short haul gives more pressure! In this way we grow capacity without adding facilities!

Question: Andrew asked what the "short haul" refers to?
Answer: Mike said that Chehalis discharges pressure and the gas goes out, and as it goes down, it loses capacity and pressure and can't deliver as much. It is a pressure differential!

Question: Andrew asked if you are converting long-haul to short-haul?
Answer: Mike said that at the Moses Lake Lateral, there is excess capacity. Rights can be reserved there for free, but we don't need all those rights. It is a shortened path without putting any new facilities in. Plymouth to Southridge is where there is growth. We just changed where we deliver using transport contract #100002. This avoids both cost and environmental considerations!
Andrew said this brings 2,400 Dth's of gas. Mike added that the hydraulic equivalent (CD) is the same… shorter path.

Mike then went on to present the Wenatchee Lateral:

- NWP is working with CNGC because there is a need for capacity at Yakima. It is really shortened capacity that does not go to the end of the lateral. NWP must put in some facilities in Wenatchee, but it cuts the cost in half!

Question: Kyle asked if this flexibility is a function of their service area?
Answer: Mike answered "Yes!" Also, because of meter design, rights are "grandfathered" in. Today CNGC would have to pay for that flexibility!

- Mark stated that over the last several years, because of the creative solutions from NWP and GTN cascade has saved millions of dollars!

Question: Kyle asked, is the hardest part presenting this in your model?
Answer: Devin answered "Yes!"

2nd Presentation – TransCanada (TC) Update (Jay Story)

Jay Story is presenting today for GTN (Gas Transmission Northwest) and announced he is retiring after 36 years!

Potential Demand Projections: (slide #37)

1. Northwest Innovation Works: (NWIW)
   - Methanol plant in Kalama, WA, in final phase of permitting

2. Jordan Cove & PAC Connector:
   - PAC connects to RUBY & GTN to Coos Bay and build a power plant!
   - Jordan = Agreements with JERA and ITOCHU
   - Jordan is a large,1 Bcf facility but the pipeline has problems

3. Trail West Pipeline:
   - Cross cascades link to serve growth
   - Along I-5 corridor!
   - Up to 750K Dth
   - Service date of 2023
   - Used to be called "PALO"
   - Benefits both GTN and NWP (Mike said displacement use)

3rd Presentation - Demand Forecast (Ashton Davis), Slide #49

- 20-year outlook
- CORE demand and peak demand
- At the citygate (CG) level
- Use 211 different regressions

Key Definitions: (Slide #50)

- AIC is statistical measure to compare models
- ARIMA – Auto-Regression Integrated Moving Average – applies time to data
- HDDS – Weather defined
- Citygate loops – Group of DB's that service similar areas, forecasted together

Question: Andrew asked, “Do you use 1 rate schedule to forecast?”
Answer: Ashton said, “Aggregated Rate Schedules” are used.

Key Assumptions: (Slide #51)

- 7 weather locations
- 30 years weather history at “normal” temps
- 60º HDD used
    - Produces better results
    - R^2 is much higher

Question: Kyle asked if Schneider interpolates data?
Answer: Brian said they gather information from customers and other sources and “scrub” it. Brian said he can send Kyle the methodology. Andrew commented that these are good questions! Mark said his group will be responding to this tomorrow.

- Bruce commented, “Cascade is being modest!” The data is the best that fits the geographical area. He hopes this issue has been vetted by the TAG meetings fully. Mark said that he welcomes feedback even after the draft. If there is an additional TAG meeting or workshop needed they will have one. Mark said this has been an ongoing discussion with Staff for the past 2 years. It is important to the IRP and PGA and he is very glad to get concerns addressed. Bruce said he hopes that Staff can get behind this!

3rd Presentation – 2nd ½ - (Brian Robertson), Slide #72

- Forecast slightly lower from last year due to change in methodology
- Growth rate similar
- Washington demand slightly lower

Question: If all things were equal between OR and WA and they were on the same IRP cycle**,** would there be a different method for forecasting?
Answer: Brian said, “Not really”.

Non-Core Outlook: (Slide #75)

- Core = 300m Therms
- Non-core will include an outlook based on a 20-year plan. CG study will be in it.
- SENDOUT® includes non-core!
- More information will be included in TAG 5 on this.

4th Presentation – Distribution Planning (Chris Bolton), Slide #76

- Distribution System Planning works on what needs to be “in the ground” to serve customers!
- Bruce briefly discussed planning versus operations = they are related but different…it comes down to this – planning for peak and super peak days. Operations is different, it is making sure system is there to handle those peak days!
- Mark stated that the non-core forecast is for revenue, but engineering needs this forecast and that is why we work so closely with engineering. We have meetings together.

- Bruce says planners have always been right in the past.

Question: Kyle asked if this is using information on customer accounts and demographics per degree day?
Answer: Chris answered, "On an hourly level, yes!"

Synergi – Low Pressure Scenario: (Slide #99)
- Infeasible
- Other solutions?
- MAOP = can we raise the pressure?
- Put solutions into the Low-Pressure Scenario. Adequate pressure considered > 20 but depends on system.

5th Presentation – CNGC Gas Supply Overview: (Eric Wood)

Highlights for the 2017 Portfolio Design (PF): (Slide #112)
- Buying based on Year 1, 80% of Portfolio, Year 2, 40% and Year 3 20%
- Rolling physical hedge
- WUTC Hedging Policy – status quo until consultants help us form a "Hedge Plan"
- GSOC approves the PF design
- Forward curve relatively flat, even 5 years out!
- Annual load 30m Dth's, doesn't change that much
- Uses a 5-year rolling average
- Total RFP's planned Nov 18 forward

Question: Andrew said, looking at the graph, if I added it up I would get 80%?
Answer: Eric said you get 80% of total supply after you add in the 2 additional years.

Question: Andrew asked, the Nov 18 – Oct 19, 3-year cycle starts?
Answer: That's right. Starts in year 2016.

Question: Kyle asked if 2016 gas is purchased by 2017 and then in 2017 do you purchase more?
Answer: Mark said it is a "blended process". Eric layers on…Nov 20 – Oct 20 = 20% and Nov 19 – Oct 20 = 40%

Question: Is RFP a common method used to purchase?
Answer: Eric said his specific method is using TruMarx or "Comet" to purchase gas. He chooses terms, volume and price and puts that information in as an offer. Comet sends out an email to marketers and gives them the specifics and time to respond. Eric said he typically decides by price, sometimes by supplier (to promote diversity in suppliers).

6th Presentation – Planned Scenarios & Sensitivities (Brian Robertson)

SENDOUT® Model: (Slide #120)
- This model, Brian, said is used for resource optimization.
- It is powerful!
- This model permits development and analysis

Question: Andrew asked if this model has "perfect knowledge"?
Answer: Brian answered "Yes".

- Brian continued stating the model uses a "Linear" programming approach
- It is helpful but not perfect!

7th Presentation – Alternative Resources (Brian Robertson)

Location of Current & Alternative Resources: (Slide #138 thru #145)
- Incremental transport North to South
- Incremental transport - NWP
- Incremental transport South to North – GTN
- Incremental transport – Bilateral
- Incremental storage North & East
- Incremental storage South & West
- Incremental Supplies

8th Presentation – Market Outlook & Long-Range Price Forecast (Ashton Davis)

Long Range Market Outlook: (Slide #147)
- EIA Annual Energy Outlook (AEO), NG to lead power sector over next 20 + years
- CNGC Assigns a weight to each source to get Henry Hub (HH) price for 20-year planning
    - Wood Mackenzie
    - EIA
    - NPPC
    - Nymex HH

Price Forecast Weights: (Slide #151)
- SMAPE – Symmetric Mean Absolute Percentage to weights
    - Most aggressive
    - Most conservative

- SMAPE to Weights
    - Uses "Holt-Winters" smoothing

Question: Andrew said the most conservative approach is a "back cast" ...is it a conservative approach because it is lowest difference in error between two weights?
Answer: Ashton said because source 1 is more accurate, let's give source 1, 6%. Literature says weight them all the same – if you think you know about them, then go with the conservative approach. Devin added it is important how well you calculate error. We pick to best balance between each source. We use the best *bridging* of those two in calculating error!

9th Presentation – Avoided Cost Methodology & Calculation (Devin McGreal)

Methodology: (Slide #161)
- Distribution system cost – first time adding this!
- Weighted annual margin from our customers
- Distribution cost is weighted annual margin

- What we're allowed to make based on distribution system projects – Rate based = avoided distribution costs.
- Accounts for 10% of avoided cost calculation!
- We will get more in depth in on this at the next TAG meeting.
- Mark said for the Avoided Cost Docket in Oregon – we should have comments back by the next TAG.
- Kyle says Staff prefers consistency in methodology where possible while recognizing each system is different!

Methodology – Carbon: (Slide #162)

- Kyle said, compared with the other utilities, it would be helpful to know what is the rationale behind Avoided Costs. If we didn't have to serve 1/3 to CG for example, how much would that affect us?
- Devin said he does not want to talk about what other utilities do regarding avoided cost.
- Kyle said have all costs in the traditional model and breakdown what CNG pays for, that would help. There are so many moving pieces to this calculation…. other thoughts (to Andrew & Cory)?
- The more information the better!
- Devin said we will do a variety of scenarios with regards to methodology & carbon.

Brian Robertson then went over the 2018 IRP Remaining Schedule:

August 16	-	Next month's TAG meeting (TAG #4)
September 11	-	TAG #5 Slides distributed
September 18	-	TAG #5
October 5	-	Draft of 2018 IRP out
November 2	-	Comments due
November 14	-	TAG #6, if needed
December 14	-	IRP filing in Washington

Mark commented that Cascade is open to a workshop if needed. The meeting was adjourned.

Cascade Natural Gas Corporation

2018 Integrated Resource Plan
Technical Advisory Group Meeting #4

August 23rd, 2018

Seattle-Tacoma International Airport

Seattle, WA

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Agenda

- Introductions
- Safety Moment
- Organization Changes
- TAG 2/3 Recap
- Carbon Impacts
- Avoided Cost
- DSM Forecast
- Bio-Natural Gas
- Sendout Modeling
- Preliminary Resource Integration Results
- 2018 IRP Remaining Schedule
- Questions

TAG 2/3 Recap

- Cascade values and appreciates the feedback received from stakeholders.
- Responses to stakeholder questions were sent out with the slide deck.
- Additional questions?

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IRP Carbon Update and Assumptions

Devin McGreal
Andy McDonald

August 23rd, 2018

Topics to Cover Today

- Purpose
- Laying the Foundation
- Reducing Emissions
- The National Focus
- The Regional Focus
- Washington
- Oregon
- The Local Focus
- Types of CO_2 Adder Analyses
- Washington and Oregon Commission-Jurisdictional Planning Treatment
- Sensitivities and Impacts on Prices
- Proposed Direction
- Next Steps and Conclusion

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Purpose

- GHG Policy Update
  - Provide insight into current national, regional/state and local policy activities that inform Cascade Natural Gas Corporation's IRP process.
  - Provide discussion on Cascade's actions to reduce methane leaks and fugitive emissions while ensuring safe, reliable and economic service, and utilizing natural resources efficiently to minimize environmental impact.
- Carbon Modeling Assumptions
  - To explain Cascade's approach in determining range of carbon dioxide emissions values and assumptions for calculating inputs to project a 20 year avoided cost of natural gas, with associated two-year action items.

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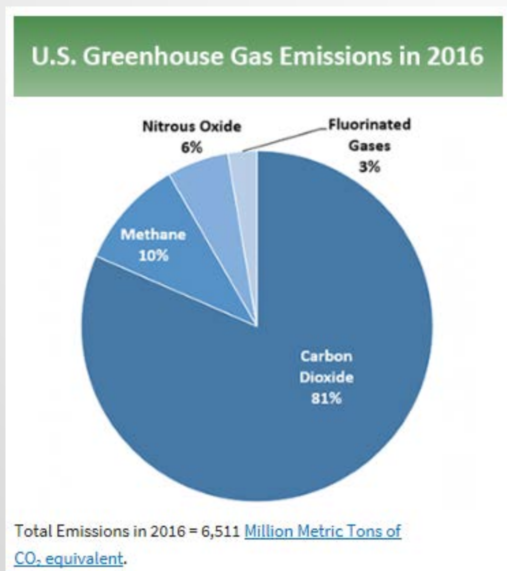
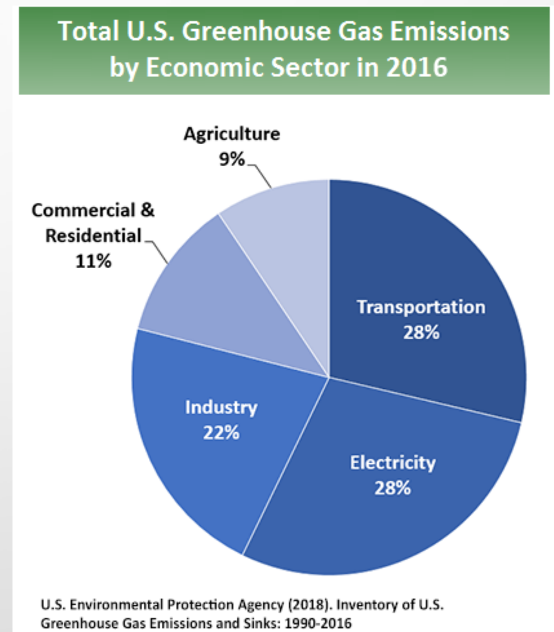
Laying the Foundation

- Carbon dioxide (CO_2) is the primary greenhouse gas (GHG) emitted through human activities. Methane is second.
- Main sources of United States GHGs emitted from human activities:





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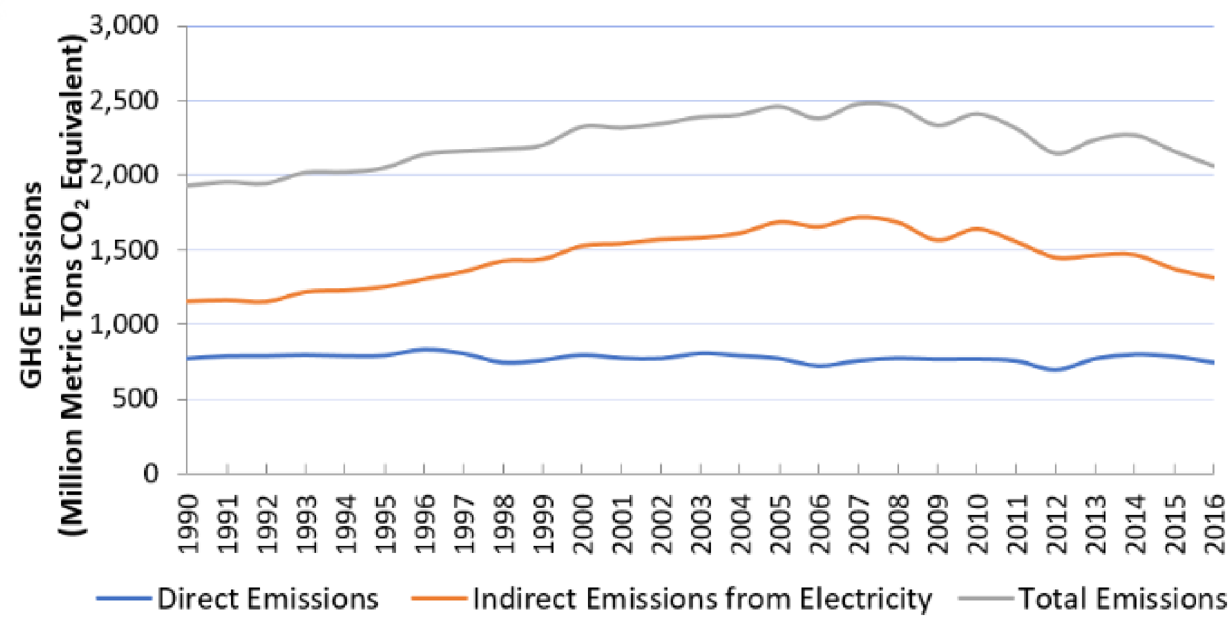
EPA Shows Decreasing Nationwide GHG Emissions Trends in Many Sectors

Greenhouse Gas Emissions from Homes and Businesses, 1990-2016



U.S. Environmental Protection Agency (2018). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016

All emission estimates from the [Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2016](#).

GHG Emissions from Natural

- Electric Generation Sector
  - Combustion emissions have dropped over time and transition to natural gas has helped achieve GHG reductions.
- Oil and Gas Production and Exploration, Transmission, and Storage Sector
  - Fugitive methane emissions and equipment/facility combustion emission.
  - Continued debate on contribution of these emissions and how to consider emissions in total energy supply chain since emissions studies vary.
  - Northwest Power & Conservation Council's 7th Power Plan (2016 version)

"…there is considerable uncertainty around such issues as whether its impacts compared to carbon dioxide are over or under-stated…and whether accounting for the methane emissions from coal production would also raise that fuel's full life-cycle climate impacts…"

"…will likely draw on gas production new wells which have lower fugitive emissions…"

"…unless new pipeline capacity is needed, fugitive emissions from pipeline leaks remain relatively constant…"

GHG Emissions from Natural Gas (cont.)

- Natural Gas Distribution Facility Emissions
  - Fugitive methane emissions from pipeline infrastructure and CO_2 emissions from combustion equipment
    - About 5 percent of oil and gas sector GHG emissions are from natural gas local distribution companies (based on EPA GHG inventory 2016 data)
    - About 0.5 percent of the total US GHG emissions from human activities are from natural gas local distribution companies (based on EPA GHG inventory 2016 data)
    - Cascade's annual facility emissions in Washington are about 27,000 metric tons of CO_2

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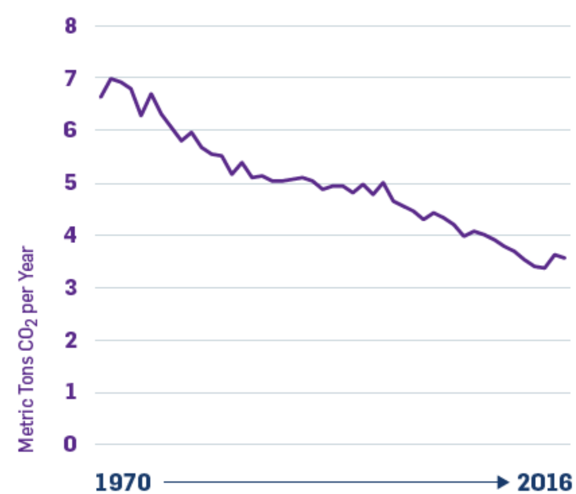
GHG Emissions from Natural Gas (cont.)

- Natural Gas Distribution <u>Customer</u> Emissions
  - Cascade's customers emit CO_2 emissions from the combustion of natural gas
  - Natural gas sales have increased overtime
  - Cascade's core customer emissions are in the range of about 2 to 2.5 million metric tons of CO_2 per year
  - Energy efficiency programs currently provide targeted emission reductions

Decreasing Trend for US Natural Gas Distribution Customer CO_2 Emissions

Residential Natural Gas Customers Have Led the Nation in Reducing Emissions for 40 Years

- Since 1970, gas utilities have added 30 million more residential customers with virtually no increases in emissions
- Utilities budgeted $1.5 billion in efficiency programs for 2018
- Utilities helped customers reduce 12.4 million metric tons of carbon dioxide emissions in 2016



Weather- Normalized CO_2 Emissions per Residential Natural Gas Customer

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Reducing Emissions

- Cascade has committed to GHG reductions from the following:
  - Methane fugitive emissions and leak reductions
    - Cascade became a founding member of EPA's Natural Gas Star Methane Challenge Program in March 2016
    - Participating in Excavation Damages Prevention
      - In 2014, created the Public Awareness position
      - Implemented a Damage Prevention Program
      - Actively participating in 811, Common Ground Alliance, local underground utility coordinating councils, and damage complaint programs in Washington and Oregon.
  - System Integrity Projects
    - From 2012-2018, nearly 91 miles of early vintage steel pipe, ranging from service lines up to 12-inch mains, have been replaced with new steel or polyethylene pipe.
    - Cascade is better positioned than most US utilities as it has no unprotected steel pipeline and none of the potentially leak-prone cast iron pipe seen elsewhere
- Streamlining emissions through demand management strategies including conservation and direct use

Reducing Emissions Through Energy Efficiency

- Cascade is dedicated to expanding its EE efforts
  - Increased conservation goals and targets
  - Residential program step increases
  - Commercial/Industrial program outreach & marketing
  - Regional collaborative approach to market transformation
  - Incorporation of NWPCC methodologies and regional technical forum
  - Emerging technology scanning and support
  - Supporting Wood Fireplace changeout programs
  - Coordination with state and local conservation initiatives

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GHG Policy Trends

- National Focus
  - Current administration has focused less on required emissions reductions
  - In June 2017, the US withdrew from the Paris Agreement on climate change
- Regional Focus
  - Some states have been adopting emissions reduction requirements in lieu of, or in addition to federal emission reduction requirements (ie. Washington, Oregon and California)
  - More state-level action, expected due to less national focus
- Local
  - Now seeing city-level action due to less national focus
  - Some cities committing to 100% renewable energy through goals and referendums
    - Ready for 100% Renewables Energy and Go 100% Renewable Energy list some of these local commitments

The National Focus

- EPA's Clean Power Plan (CPP)
  - Final CCP in August 2015 requiring state-specific reductions in CO2 emissions from electric sector and did not directly impact natural gas local distribution companies
  - Supreme Court granted stay of the CPP in February 2015 until DC Circuit Court of Appeals issues decision
  - Court has not issued a decision. Court has granted EPA's ongoing requests to hold the case in abeyance and for the abeyance to remain in place until 30 days after the conclusion of EPA's review and future rulemaking.
  - EPA proposed a "CPP Repeal" rule and requested comment in early 2018.
  - EPA's proposed "CPP Replacement" rule is currently being reviewed by Office of Management and Budget (OMB) and is expected to be published in the near future.
  - "CPP Replacement" rule is expected to limit GHG reductions to what is achievable "inside the fence" of a power plant facility.

The National Focus (con

- NSPS OOOOa – 40 CFR Part 60 Subpart OOOOa Standards of Performance for Crude Oil and Natural Gas Facilities
  - Reduces methane leaks at new, modified or reconstructed oil and oil and natural gas facilities.
  - Most natural gas local distribution companies are not significantly impacted by this rule.
- Market Choice Act
  - Proposed on July 23rd 2018 in the US House of Representatives as a national carbon tax of $24 per metric ton starting in 2020.
  - Unlikely to move past the House, but important to monitor.
- Vehicle Emissions Standards
  - EPA recently proposed a rule lessening the stringency of fuel economy standards for years 2012- 2026 new cars, SUVs and light duty trucks, citing concerns with maintaining the safety and affordability of vehicles, while also achieving lower pollution.

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The National Focus (con

- FERC Review of Pipeline Projects
  - *Sierra Club v. FERC*
    - On August 22, 2017 DC Circuit Court of Appeals held FERC is obligated to consider downstream GHG emissions
    - Remanded FERC's approval of the Southeast Market's Sabal Trail pipeline project for further review of downstream GHG emissions
    - No challenge was made to the US Supreme Court
    - Downstream GHG emissions were quantified, but FERC chose not to use Social Cost of Carbon in determining impacts
    - Permit was approved
  - FERC recently requested public input on implementing GHG/climate change impacts in their NEPA reviews

The Regional Focus

- The Northwest Power & Conservation Council (NWPCC or Council) recently published its 7th Power Plan
  - Most recent release May 2016
  - Significant discussion, analysis, and scenarios regarding CO_2 contained in Chapters 3 and 15
  - Next version draft expected October 2018, final mid-term report on January 2019
- Considerable prior regional collaboration regarding GHG
  - Such as the proposed cap and trade program of the Western Climate Initiative

Washington

- Clean Air Rule (CAR)
  - Washington Dept of Ecology issued final rule to reduce GHG emissions on September 15, 2016
  - Local distribution companies (LDC) would need to purchase emission reduction units ("ERUs") to demonstrate emissions reductions required by the rule considering LDC's obligation to serve customers
  - On September 27, 2016 and September 30, 2016, Cascade and three other natural gas distribution utilities jointly filed complaints in the United States District Court for the Eastern District of Washington and the State of Washington Thurston County Superior Court, respectively, challenging the legal underpinnings of CAR

Washington (cont.)

- Clean Air Rule (CAR) (cont.)
  - Natural gas utilities argued CAR should be invalidated due to:
    1. Ecology does not have authority to regulate non-emitting sources for their customers' emissions
    2. Ecology does not have authority to implement a program to limit statewide greenhouse gas emissions, particularly a trading program based on ERUs
  - On December 15, 2017, Thurston County Superior Court invalidated CAR and Ecology suspended rule requirements in late December 2017
  - On May 16, 2018, Ecology filed an appeal with the Supreme Court of Washington
  - Briefing is in progress. It is unknown when a decision on appeal will be issued, but is not expected before IRP filing

Washington (continued)

- Initiative 1631 (I-1631) – Washington Carbon Emissions Fee and Revenue Allocation Initiative
  - Charges a carbon tax of $15 per ton of carbon dioxide in 2020
  - Increases $2 per ton per year plus inflation
  - By 2030, price would be about $40 per ton and may increase further depending on whether the state is expected to meet its statutory greenhouse gas targets
  - By 2045, price would be about $85 per ton
- 2018 Legislation Considered but Not Passed
  - SB 6335 (Hobbs) $15 per ton in 2019, $25 per ton in 2024
  - SB 6096 (Ranker) $15 per ton in 2019 with $2.50 annual escalation until $30 per ton in 2025
  - SB 6203 (Inslee/Carlyle) $12 per ton in 2020 with $1.80 annual escalation and $30 per ton cap
- More legislation expected in 2019
- Significant other state policies with CO_2 impacts
  - SHB 2580 – Promoting Renewable Natural Gas
  - Electric Vehicle Action Plan
  - Potential Residential Energy Code Changes in 2019

Oregon

OREGON DEPARTMENT OF ENERGY

- Executive Order No. 17-20
  - Zero energy ready buildings & high performance energy targets for existing state buildings
  - Appliance efficiency standards review
  - ETO Pilot Programs
- SB344 – Inventory of Biogas and Renewable Natural Gas in Oregon
- 2018 Legislation Considered but Not Passed
  - GHG Cap and trade program bills – HB 4001, SB 1507
- Additional cap and trade proposals may be introduced in the 2019 legislative session
  - Joint Interim Committee on Carbon Reductions
- VW Settlement Funds
  - DEQ authorized to fund school bus projects
  - Treatment of at least 450 diesel powered buses
  - 20 buses qualified in CNGC service territory

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The Local Focus - City of Bellingham

- GHG Reduction and Renewables Energy Targets
  - Resolution passed by Bellingham City Council in March 2018
  - Renewables and emissions reduction targets updated to:
    - Reduce municipal greenhouse gas emissions to 85% below 2000 levels by 2030 and 100% below 2000 levels by 2050.
    - Reduce community emissions by 70% below 2000 levels by 2030 and 85% below 2000 levels by 2050.
    - Obtain all energy from renewable sources and remove use of fossil fuels
- Climate Action Task Force
  - City Council created task force to explore and recommend 100% renewable energy city targets by 2050, taking into account technology, feasibility, costs and other impacts, funding mechanisms, as well as possible accelerated targets.

The Local Focus - City of Bellingham (cont.)

City of Bellingham Climate Action Plan Webpage
https://www.cob.org/services/environment/climate/Pages/program.aspx

	2012 *Target*	2015 *Actual Emissions*	2020 *Target*	2030 *Target*	2050 *Target*
Municipal **reduction measures:** 3 completed, 20 long-term ongoing	-64% emissions from 2000 *exceeded (-69.5%)*	-68.3% from 2000	-70% from 2000	-85% from 2000	-100% from 2000
Community **reduction measures:** 5 completed, 43 long-term ongoing	-7% emissions from 2000 *exceeded (-17%)*	-10.4% from 2000	-28% from 2000	70% ~~-[illegible]%~~ from 2000	-85% from 2000

TABLE 1. *Municipal (city government operations) and community (within city limits) progress toward climate targets (which include green power purchases).*

The Local Focus – Whatcom County

- Whatcom County – committed to the "Ready for 100" campaign
  - "Ready for 100" campaign website states the following goals, but participants can target less stringent goals:
    - 100% renewable electricity by 2035
    - 100% renewable all other energy sectors by 2050
  - Whatcom County commits to:
    - 100% renewable electricity for county operations and larger Whatcom County community by 2035
    - Established commitments in ordinance

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The Local Focus - City of Bend

- Council Resolution 3044 passed by City of Bend in 2016
  - Established voluntary goals for City facilities and operations
    - 40% reduction of 2010 baseline year emissions by 2030
    - 70% reduction of 2010 baseline year emissions by 2050
    - May determine to use more recent years for baseline
  - May establish same voluntary goals community-wide
- Council Resolution 3099 created an ad hoc Climate Action Steering Committee (CASC)
    - Meeting in 2017-2019 to provide recommended action to City Council that encourage and incentivize voluntary efforts to reduce GHG emissions and fossil fuel use
  - Community Climate Action Plan (C-CAP)
    - CASC will recommend a set of strategies in the plan to guide both the City and the community in achieving the goals

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Types of CO_2 Adder Analys

- Cascade will be using the Social Cost of Carbon forecast with a 3% discount rate, from the Interagency Working Group on the Social Cost of Greenhouse Gases, as per guidance received from stakeholders in prior workshops.
- Other methodologies were considered, and may be modeled as sensitivity analyses:
  - I-1631 Ballot Initiative
  - Gov. Inslee proposed tax
  - House of Representatives Market Choice
  - Expected Value blend of multiple approaches?

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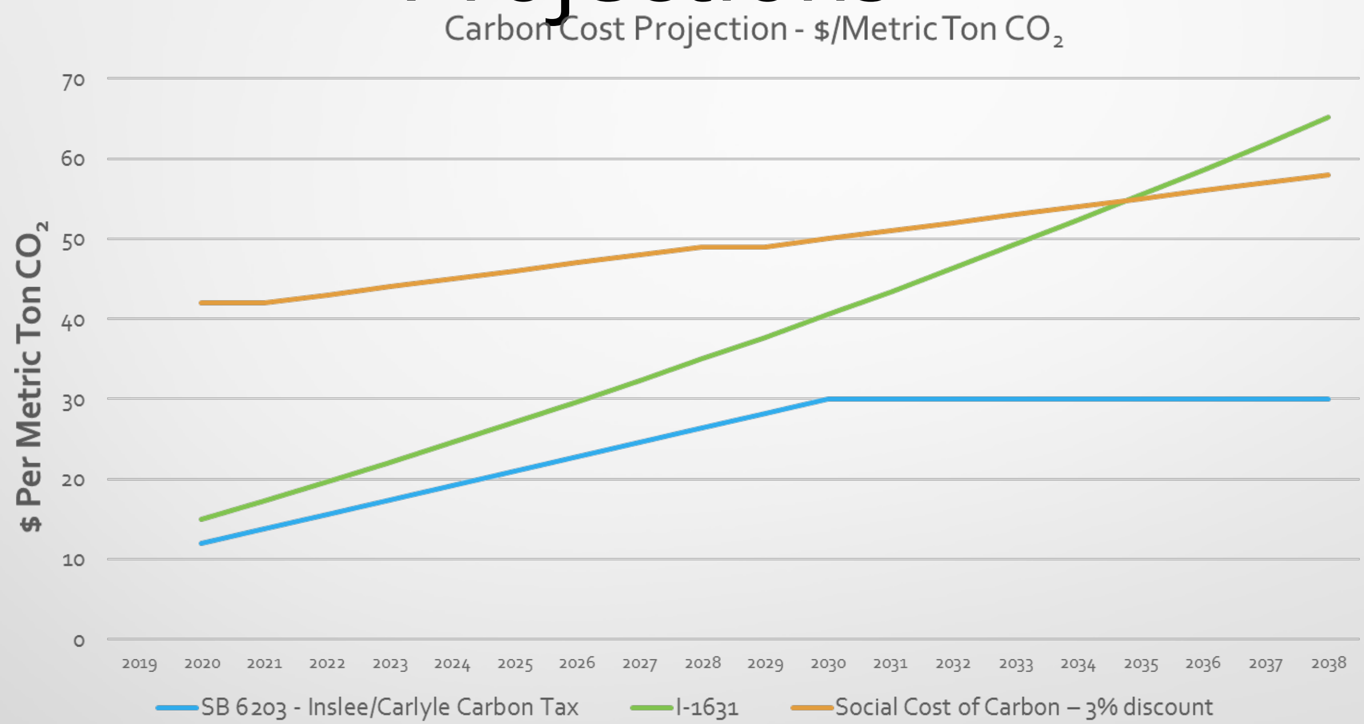
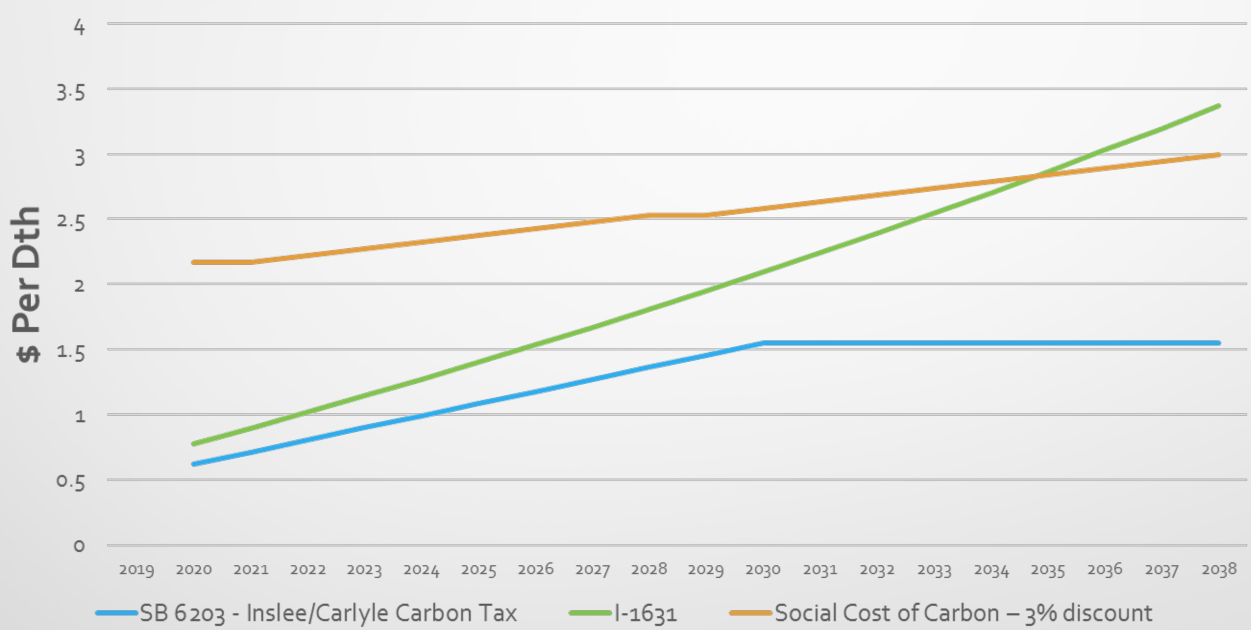
Comparing Carbon Cost Projections



Comparing Carbon Cost Projections

Carbon Cost Projection - $/Dth



Types of CO_2 Adder Analyses (cont.)

- Analysis of potential carbon futures will impact:
  - Timing and quantity of demand side resources
  - Total system costs of candidate portfolio under stochastic conditions
  - Timing and quantity of viability of renewable natural gas

- Three additional sensitivity analyses will be performed:
  - 0% Environmental Adder
  - 20% Environmental Adder
  - 30% Environmental Adder

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Washington and Oregon Commission-Jurisdictional Planning Treatment of CO_2 Emissions

- In their acknowledgment of many recent regional IRPs, the WUTC has indicated a strong desire for LDCs to use SCC as their baseline for carbon analysis
- Local Distribution Company acknowledgments:
  - PSE
    - UE-160918 and UG-160919
  - Pacific Power
    - UE-160353
  - Avista
    - UE-161036
- Cascade is not using ERU costs as a carbon adder due to Thurston County Court invalidating CAR

Next Steps and Conclusion

- Incorporate carbon planning assumptions into modeling
- Will provide a brief update of the modeling impacts at TAG 5
- Conclusion…
  - Regarding expectations, natural gas has a lesser impact on customers as compared to the electric utility industry
  - Cascade is paying close attention to National, Regional, and Local policies related to Carbon
  - Impact of ranges and sensitivity analyses will be presented to the TAG when modeling is performed

Questions…

…and thank you

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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.

- 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 for each of four climate zones.

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Avoided Cost Formula

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

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

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_F = Incremental Fixed Transportation Costs
- 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

Incremental Fixed Transportation Costs

- Cascade identifies when its shortfalls would begin in a pre-DSM environment and takes the simple average of all cost effective solutions for its fixed transportation costs.
- Only costs for incremental transportation is included because current fixed costs are not avoidable.
- These costs typically account for about 0-8% of avoided costs in a given year.

Variable Transportation Costs

- Cascade takes the simple average of current transportation costs pre-shortfalls, and the simple average of incremental transportation costs post shortfalls, for its variable transportation costs.
- Since variable costs are only charged on therms that flow through the upstream pipeline these are avoidable for existing contracts.
- These cost typically account for less then 1% of the avoided cost.

Storage Costs

- These would be the costs associated with a storage contract that would be used to solve for some or all of Cascade's peak day shortfalls, such as on system storage.
- Currently Cascade has no on system storage, such as Mist, and does not foresee on system storage as being part of the Company's preferred portfolio, so these costs are zero.

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Commodity Costs

- Commodity Costs are derived from Cascade's price forecast for the AECO, Rockies and Sumas basins.
- Cascade uses SENDOUT to calculate how each basin should be weighted in each climate zone.
- Avoided costs are run using peak pricing versus annual pricing.
- Commodity Costs are one of the major factors of Cascade's avoided cost calculation, accounting for 40-80% of the total avoided cost

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Carbon Tax

- New to this IRP in Washington, Cascade will be modeling the impact of a carbon tax by analyzing the impact of a number of actual proposed carbon futures.
- As per guidance from stakeholders in previous workshops, Cascade's base case carbon forecast will be based on the Social Cost of Carbon with a 3% discount rate.
- Using this forecast, these costs account for 0-45% of avoided costs.

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Environmental Adder

- Cascade modifies its commodity and carbon compliance costs by a 10% adder, as recommended by the NWPCC.
- There is some debate as to whether this is double counting the costs of the carbon compliance. Cascade will continue to use this adder but will look to the next power plan and regional best practices for guidance.

Distribution System Costs

- New to this IRP cycle, Cascade will include avoided distribution system costs in its final calculation.
- These are calculated by taking Cascade's margin for each rate class, and deriving a one day system weighted margin figure, which is assumed to grow by inflation each year.
- These costs account for approximate 15-35% of Cascade's avoided cost

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Risk Premium

- Cascade's avoided cost formula allows for an additional adder to account for a premium associated with the uncertainty around the other factors of the avoided cost versus the relative certainty of energy efficiency programs.
- With gas prices so low and volatility very low, Cascade does not believe there is a material risk premium in this year's avoided cost calculation, so this factor is zero.

DSM FORECAST, 2018 IRP

TAG 4, Thursday, August 23rd, 2017

Monica Cowlishaw & Amanda Sargent

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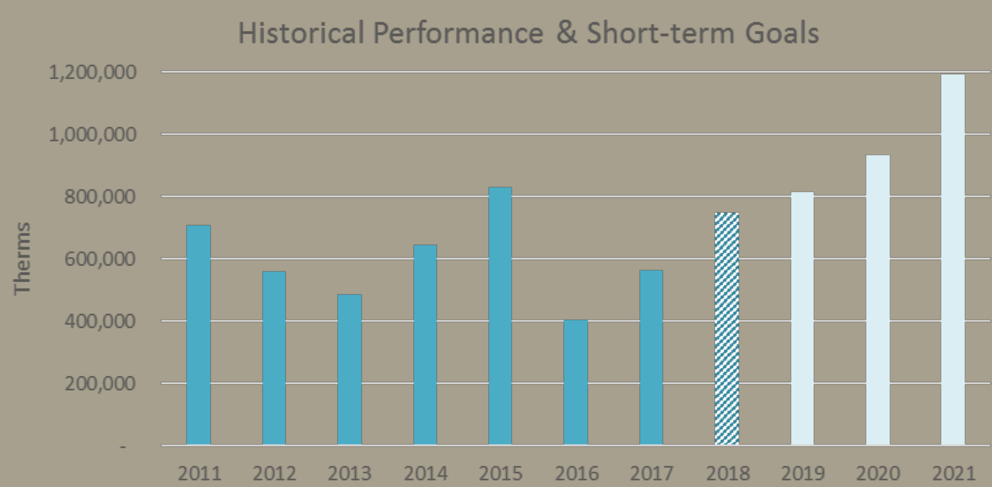
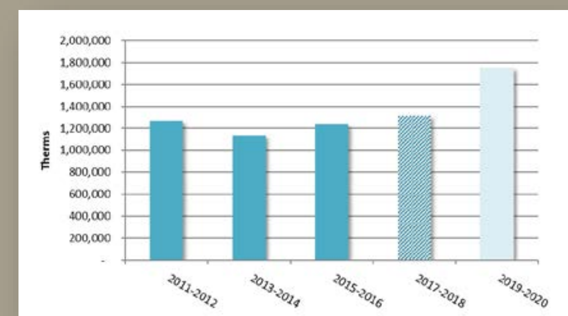
ELEMENTS OF THE DSM CHAPTER

- Overview
  - 2016 Deliverables
    - New Conservation Potential Assessment (included in Appendix)
    - NWPCC forecast methodology and ramp rate alignment
  - Historic Program Performance



← ANNUAL PERFORMANCE



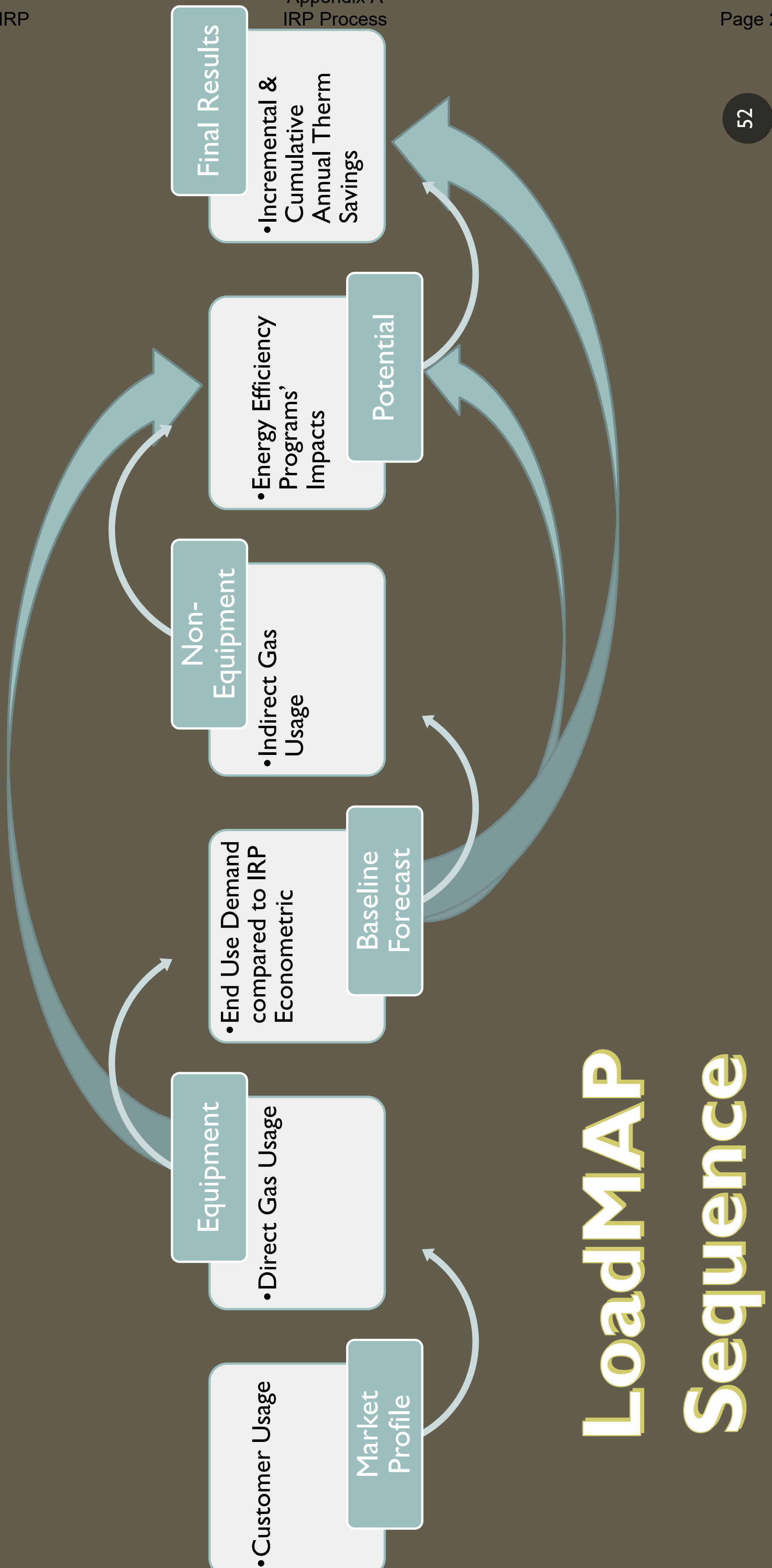
↑ BIENNIUM PERFORMANCE

ANNUAL SHORT TERM GOALS

	2018	2019	2020
C&I	328,807	415,266	479,323
RES	363,319	401,117	455,251

ELEMENTS OF THE DSM CHAPTER

- Conservation Planning
  - Prospective Portfolio Updates
  - Pathways to achieve 10 year goals
- Goals and Budget Estimates
- Benefit Cost Test Analysis
- 2018 Energy Efficiency Two Year Action Plan
  - Outreach & Messaging
    - Community Partnerships & Targeted Outreach


LoadMAP Sequence
Market Profile
•Customer Usage
Equipment
•Direct Gas Usage
Baseline Forecast
•End Use Demand compared to IRP Econometric
Non-Equipment
•Indirect Gas Usage
Potential
•Energy Efficiency Programs' Impacts
Final Results
•Incremental & Cumulative Annual Therm Savings
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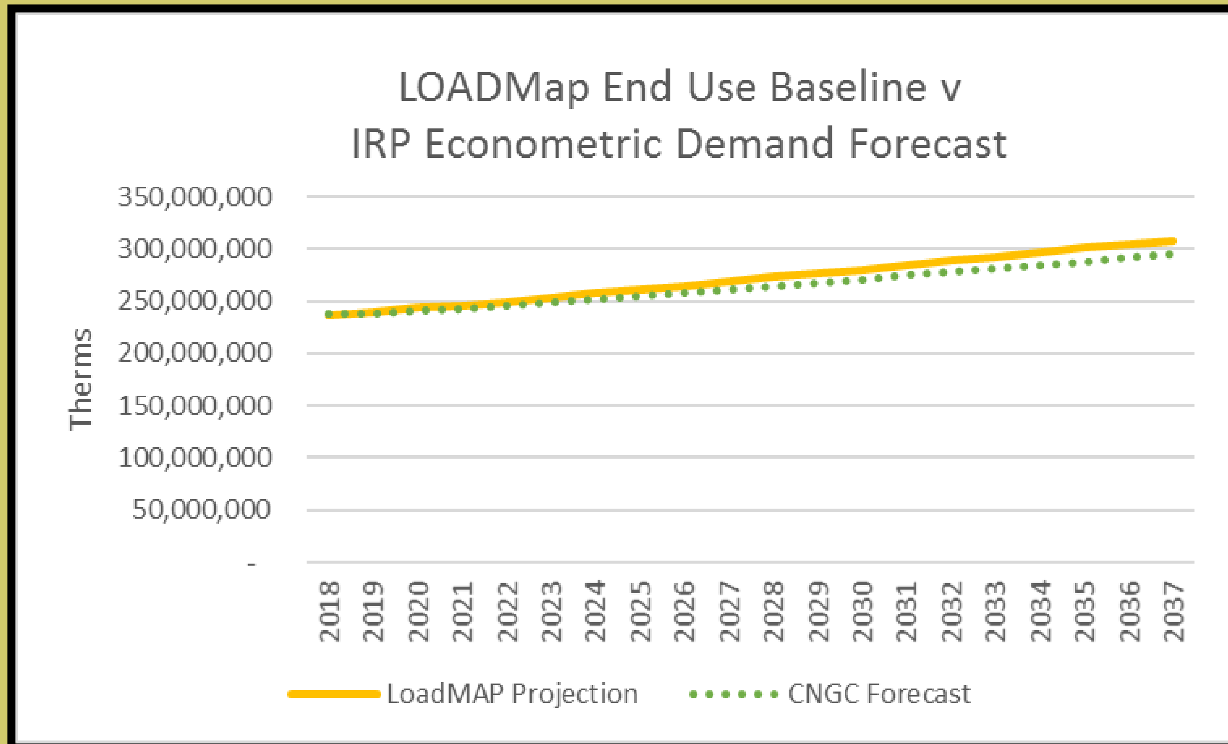

FORECAST COMPARISON

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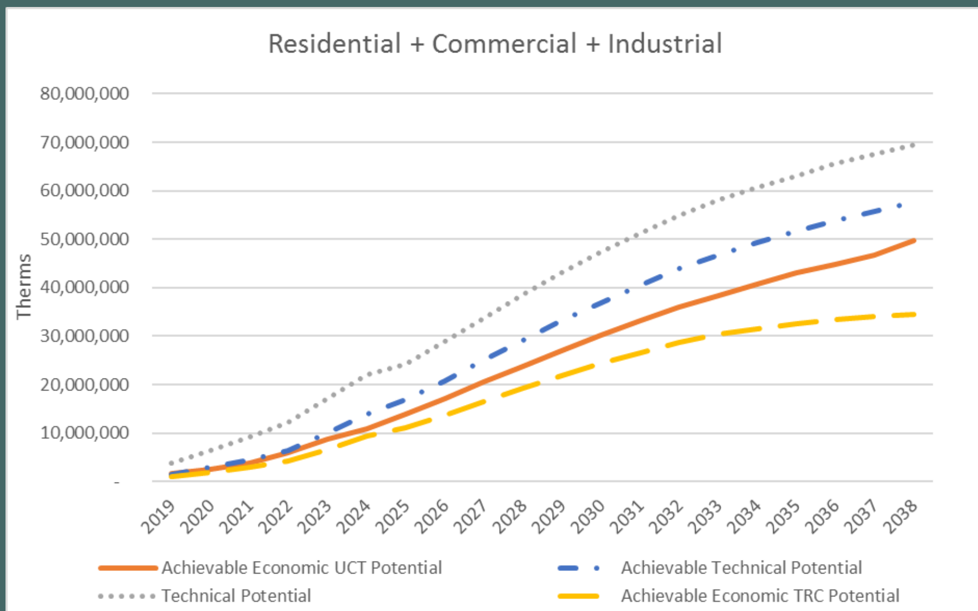
CUMULATIVE POTENTIAL DSM FORECAST



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COMMERCIAL & INDUSTRIAL

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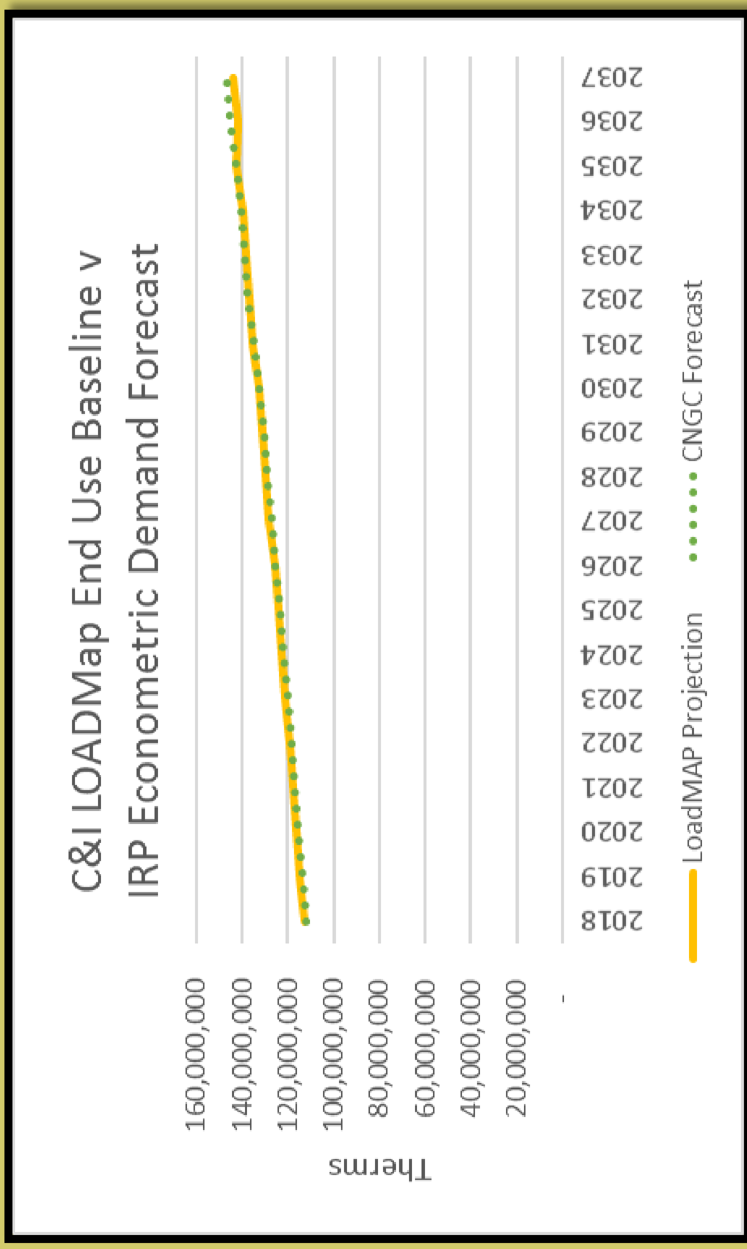
C&I BASELINE COMPARISON



COMMERCIAL FORECAST SUMMARY

Summary of Energy Savings (therms), Selected Years	2018	2019	2020	2022	2028	2038
Baseline Forecast (therms)	88,483,161	90,091,358	91,205,068	93,684,393	102,242,675	130,660,356
Potential Forecasts (therms)						
UCT Achievable Economic Potential	88,154,354	89,409,245	90,110,833	91,290,596	93,951,450	114,567,443
TRC Achievable Economic Potential	88,223,772	89,554,255	90,339,363	91,717,094	95,139,028	116,884,352
Achievable Technical Potential	87,647,752	88,409,501	88,628,509	88,886,010	89,630,200	109,456,837
Technical Potential	87,005,599	87,136,887	86,750,093	85,873,696	84,596,621	105,187,379
Cumulative Savings (therms)						
UCT Achievable Economic Potential	328,807	682,113	1,094,235	2,393,797	8,291,225	16,092,913
TRC Achievable Economic Potential	259,389	537,103	865,704	1,967,299	7,103,647	13,776,004
Achievable Technical Potential	835,409	1,681,857	2,576,558	4,798,383	12,612,475	21,203,518
Technical Potential	1,477,562	2,954,471	4,454,974	7,810,697	17,646,054	25,472,977
Energy Savings (% of Baseline)						
UCT Achievable Economic Potential	0.4%	0.8%	1.2%	2.6%	8.1%	12.3%
TRC Achievable Economic Potential	0.3%	0.6%	0.9%	2.1%	6.9%	10.5%
Achievable Technical Potential	0.9%	1.9%	2.8%	5.1%	12.3%	16.2%
Technical Potential	1.7%	3.3%	4.9%	8.3%	17.3%	19.5%
Incremental Savings (therms)						
UCT Achievable Economic Potential	328,807	354,891	415,598	825,719	1,104,473	888,630
TRC Achievable Economic Potential	259,389	278,779	330,974	717,786	963,972	775,707
Achievable Technical Potential	835,409	854,631	911,577	1,301,446	1,412,237	960,026
Technical Potential	1,477,562	1,488,445	1,523,723	1,876,154	1,691,119	1,158,787

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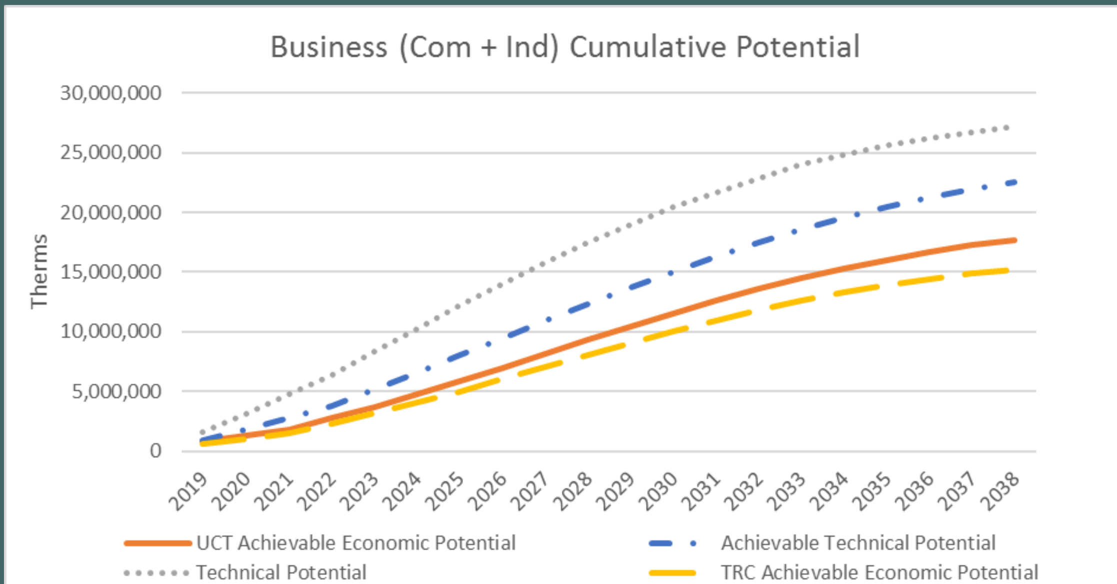
INDUSTRIAL FORECAST SUMMARY

Summary of Energy Savings (therms), Selected Years	2018	2019	2020	2022	2028
Baseline Forecast (mmTherms)	24,136,140	24,778,429	24,988,671	25,279,998	27,322,555
Potential Forecasts (mmTherms)					
UCT Achievable Economic Potential	24,076,166	24,658,182	24,804,912	24,914,869	26,304,750
TRC Achievable Economic Potential	24,079,851	24,666,546	24,818,858	24,941,526	26,372,329
Achievable Technical Potential	24,069,346	24,645,139	24,785,898	24,884,901	26,250,889
Technical Potential	24,042,048	24,592,175	24,708,611	24,755,724	25,992,179
Cumulative Savings (mmTherms)					
UCT Achievable Economic Potential	59,974	120,247	183,759	365,129	1,017,806
TRC Achievable Economic Potential	56,288	111,883	169,813	338,472	950,227
Achievable Technical Potential	66,794	133,290	202,773	395,097	1,071,667
Technical Potential	94,092	186,254	280,060	524,274	1,330,376
Energy Savings (% of Baseline)					
UCT Achievable Economic Potential	0.2%	0.5%	0.7%	1.4%	3.7%
TRC Achievable Economic Potential	0.2%	0.5%	0.7%	1.3%	3.5%
Achievable Technical Potential	0.3%	0.5%	0.8%	1.6%	3.9%
Technical Potential	0.4%	0.8%	1.1%	2.1%	4.9%
Incremental Savings (mmTherms)					
UCT Achievable Economic Potential	59,973.8	60,375.1	63,725.1	114,016.4	104,139.8
TRC Achievable Economic Potential	56,288.2	55,689.5	58,124.8	107,524.4	96,946.3
Achievable Technical Potential	66,793.8	66,647.5	69,798.9	119,530.7	108,159.3
Technical Potential	94,091.8	92,389.7	94,275.9	148,767.1	127,341.6

BUSINESS 20 YEAR DSM



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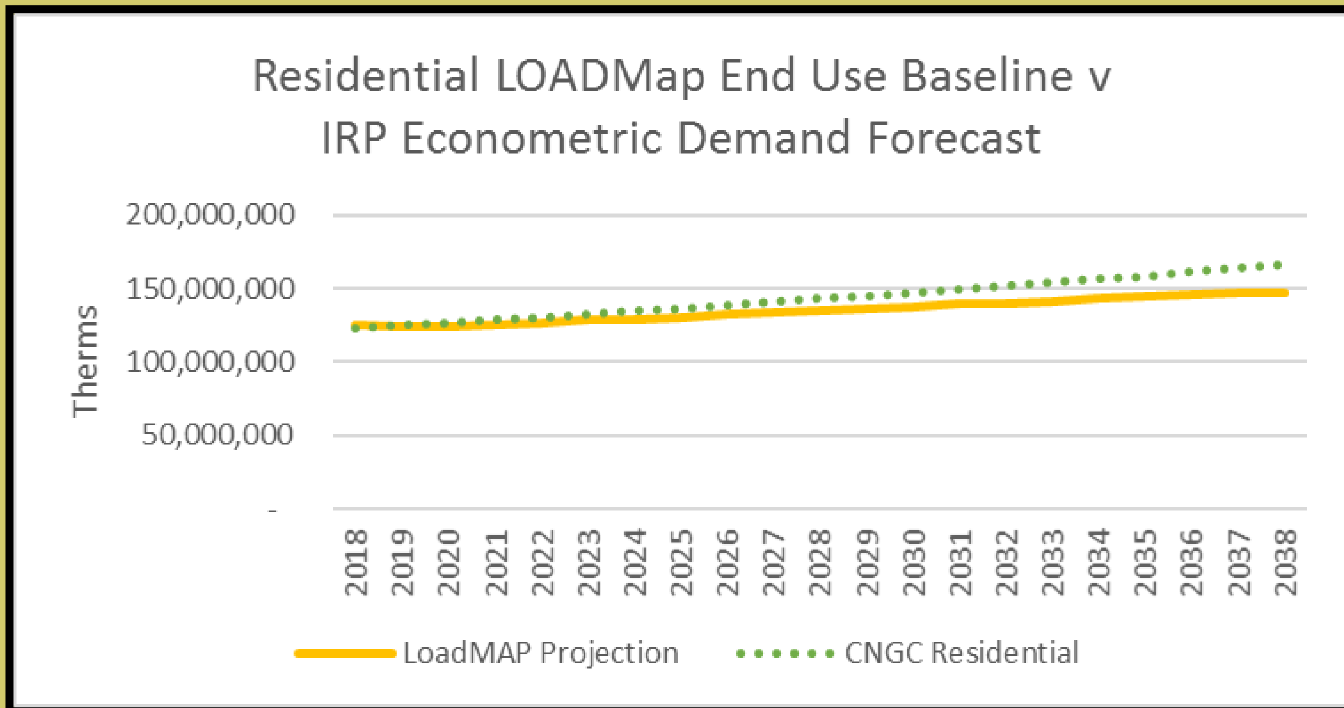
TOP TEN MEASURES

Measure
Boiler - AFUE 98%
Fryer - ENERGY STAR
Insulation - Roof/Ceiling - R-38
HVAC - Demand Controlled Ventilation - DCV enabled
Insulation - Wall Cavity - R-21
Gas Boiler - Insulate Steam Lines/Condensate Tank - Lines and condenstate tank
Water Heater - TE 0.94
Retrocommissioning - HVAC - Optimized HVAC flow and controls
Furnace - AFUE 95%
Space Heating - Heat Recovery Ventilator - HRV installed

RESIDENTIAL

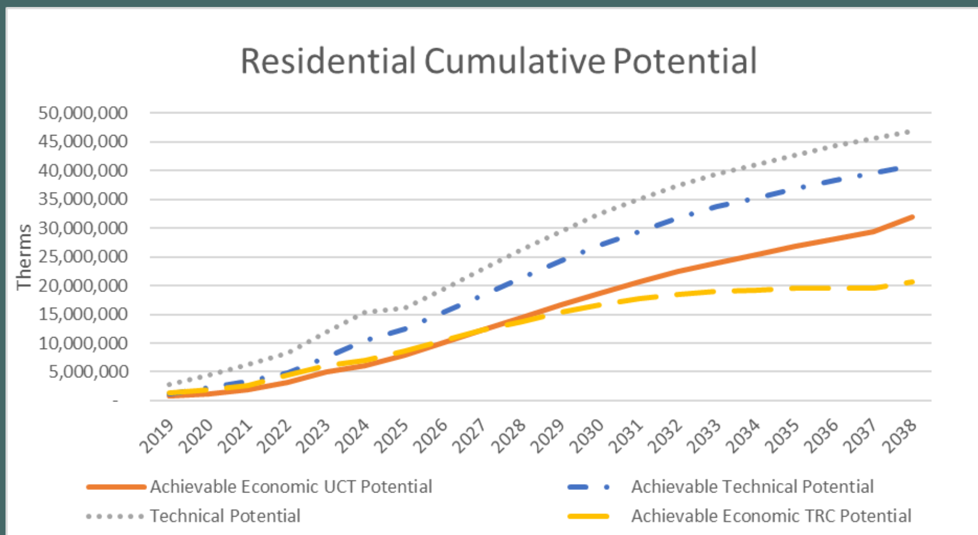


RESIDENTIAL BASELINE COMPARISON

FORECAST SUMMARY

Summary of Natural Gas Savings (therms), Selected Years	2018	2019	2020	2022	2028	2038
Baseline Forecast (therms)	125,132,034	123,592,607	124,383,336	126,802,750	134,762,905	147,070,239
Cumulative Savings (therms)						
UCT Achievable Economic Potential	401,017	794,418	1,250,899	3,234,259	14,448,057	45,729,170
Achievable Technical Potential	1,192,971	2,207,715	3,343,924	7,503,967	24,243,313	53,055,480
Technical Potential	2,876,398	4,540,572	6,282,242	11,862,187	29,429,050	61,341,343
Energy Savings (% of Baseline)						
UCT Achievable Economic Potential	0.3%	0.6%	1.0%	2.6%	10.7%	31.1%
Achievable Technical Potential	1.0%	1.8%	2.7%	5.9%	18.0%	36.1%
Technical Potential	2.3%	3.7%	5.1%	9.4%	21.8%	41.7%
Incremental Savings (therms)						
UCT Achievable Economic Potential	363,319	401,117	455,251	1,375,977	2,357,378	2,560,114
Achievable Technical Potential	1,075,090	1,039,784	1,137,091	2,825,441	3,257,000	2,504,871
Technical Potential	2,064,443	1,719,169	1,735,923	3,602,268	3,671,603	2,722,813

20 YEAR CUMULATIVE



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TOP TEN RESIDENTIAL MEASURES

Measure
Furnace - Direct Fuel - AFUE 95%
Insulation - Ceiling, Installation - R-38 (Retro only)
Built Green homes - Built Green spec (NC Only)
Insulation - Wall Cavity, Installation - R-11
Insulation - Floor/Crawlspace - R-30
Water Heater - Solar System - 40 sq ft supplemental solar system installed
Thermostat - Programmable - Programmed thermostat
Thermostat - Wi-Fi/Interactive - Interactive/learning thermostat (ie, NEST)
Fireplace - Tier 1 (70% FE Rating)
Water Heater > 55 gal. - Condensing (UEF 0.82)

QUESTIONS?

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Bio-Natural Gas

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Role of RNG in the IRP

- New to the 2018 WA IRP, Cascade will evaluate the potential of including Renewable Natural Gas (RNG) as a part of its preferred resource mix.
- Most of Cascade's discussions are preliminary, so modeling will mostly be used to determine optimal price points for certain projects under various scenarios and sensitivities.
- Currently Cascade is focused on two projects in WA: Biogas from the City of Richland Landfill and two bio digestors from Andgar in Bellingham.

City of Richland Landfill

- The city has hired a consultant to investigate the likelihood of pulling biogas from the Richland Landfill.
- The project is estimated to produce 504 dekatherms per day, and would connect to Cascade's North Richland distribution system.
- The developer is planning on keeping the environmental attributes (RINs) but have not had any further discussions on who would be using the physical gas.

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Andgar

- Developer that currently feeds an electric generation facility in the Bellingham area with two bio digesters.
- With the devaluation of REC's, Andgar is investigating re-routing their biogas into Cascade's North Whatcom distribution system and selling the environmental attributes into the open market.
- They have had some early discussions with Fortis BC and Cascade has also expressed interest in buying both the physical gas and environmental attributes.
- The project is estimated to produce 3,000 dekatherms per day. An estimate for an interconnect has been provided however, no further discussions has taken place.

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SENDOUT®
Optimization Modeling

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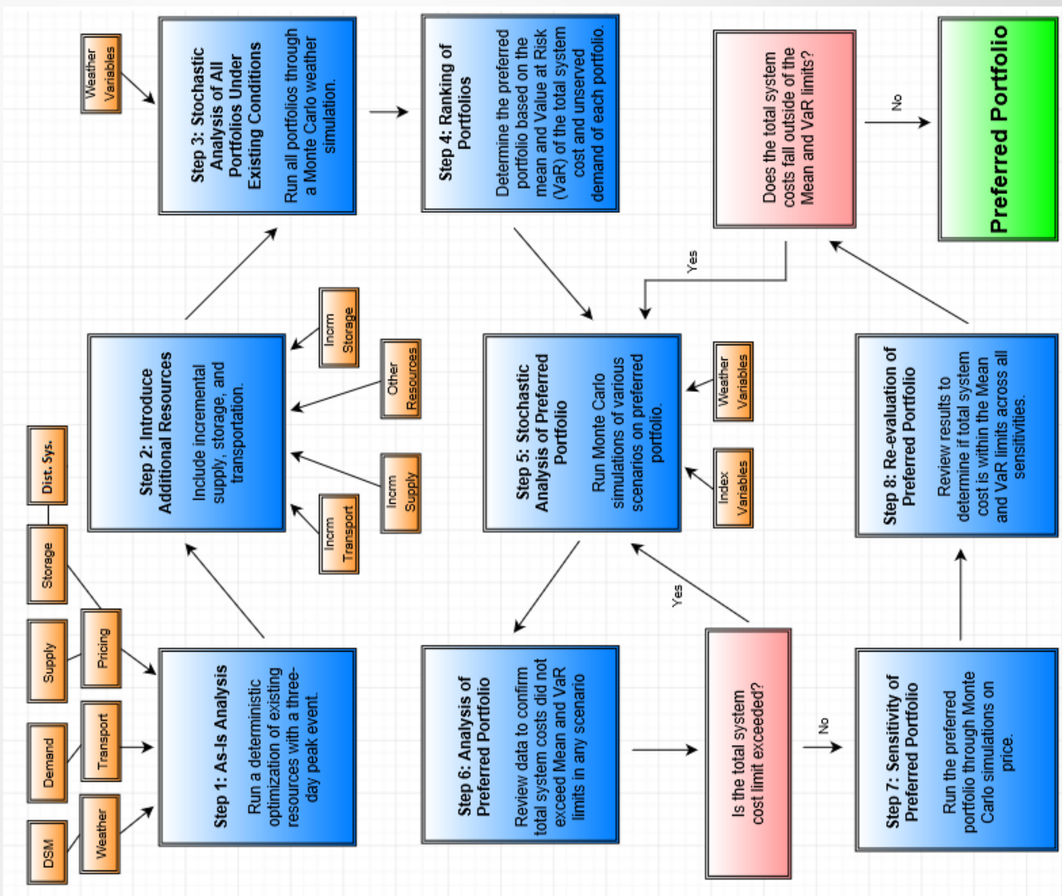
DSM
Demand
Supply
Storage
Dist. Sys.
Weather
Transport
Pricing
Step 1: As-Is Analysis
Run a deterministic optimization of existing resources with a three-day peak event.
Step 2: Introduce Additional Resources
Include incremental supply, storage, and transportation.
Incrm Transport
Incrm Supply
Other Resources
Incrm Storage
Weather Variables
Step 3: Stochastic Analysis of All Portfolios Under Existing Conditions
Run all portfolios through a Monte Carlo weather simulation.
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.
Step 5: Stochastic Analysis of Preferred Portfolio
Run Monte Carlo simulations of various scenarios on preferred portfolio.
Index Variables
Weather Variables
Step 6: Analysis of Preferred Portfolio
Review data to confirm total system costs did not exceed Mean and VaR limits in any scenario
Is the total system cost limit exceeded?
Yes
No
Step 7: Sensitivity of Preferred Portfolio
Run the preferred portfolio through Monte Carlo simulations on price.
Step 8: Re-evaluation of Preferred Portfolio
Review results to determine if total system cost is within the Mean and VaR limits across all sensitivities.
Does the total system costs fall outside of the Mean and VaR limits?
Yes
No
Preferred Portfolio

Base Case Sendout Inputs

- Supply
- Storage
- Transportation
- Constraints
- Demand
- Price Forecast
- Weather
- Distribution System

Supply

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

Supply Example

	JAN 2017	FEB 2017	MAR 2017	APR 2017	MAY 2017	JUN 2017	JUL 2017	AUG 2017	SEP 2017	Extension Option	Escalation Pattern	Monthly Multiplier	Index	Adder	Multiplier
*Daily MDQ	25000									Same					
*Daily Minimum Percent	100									Same					
Annual Maximum										Same					
Annual Minimum Percent										Same					
Monthly Maximum										Same					
Monthly Minimum Percent										Same					
Seasonal Maximum										Same					
Seasonal Minimum Percent										Same					
Known Take										Same					
*Rate - Commodity	2.5									Same	CPI				
Rate - Dispatch										Same					
Rate - Known Commodity Cost										Same					
Rate - Other Variable 1										Same					
Rate - Other Variable 2										Same					
Rate - Penalty Annual										Same					
Rate - Penalty Seasonal										Same					
Rate - Penalty Monthly										Same					
Rate - Penalty Daily	2.5									Same				-0.01	
Rate - D1										Same					
Rate - D2										Same					
Volume - D1 Volume										Same					
Volume - D2 Volume										Same					
Temp Cutoff Max Temperature										Same					
Available % Below Min/Above Max										Same					
Temp Cutoff Min Temperature										Same					
Apply Temperature Cutoff										Same					
Energy Conversion Factor										Same					
Process Indicator										Same					
Resource Mix Start\Stop Indicators	Start									Last Year					
Rmix MDQ Range Max	25000									Same					

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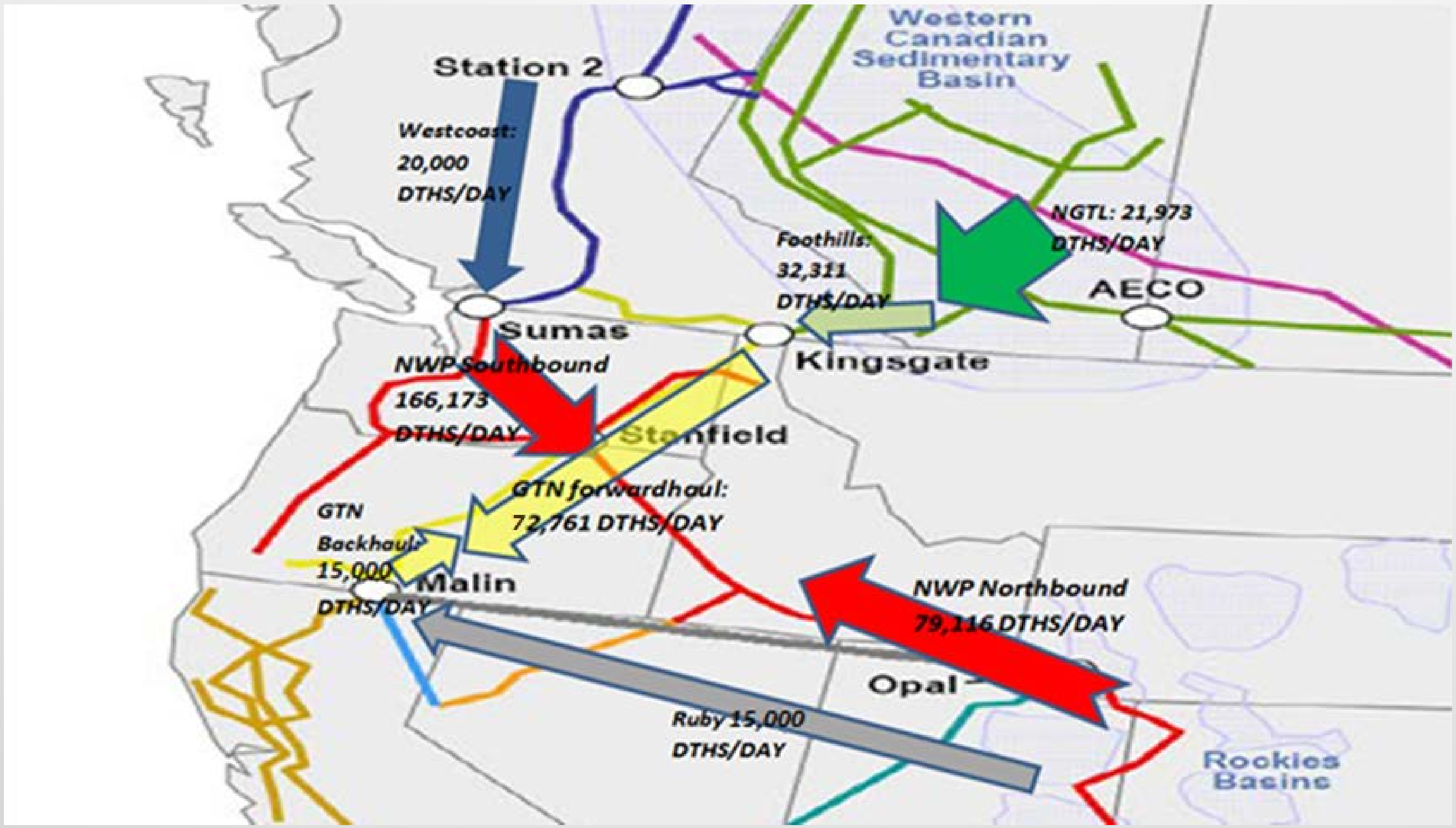
Supply


Station 2
Westcoast:
20,000
DTHS/DAY
Western Canadian Sedimentary Basin
Foothills:
32,311
DTHS/DAY
NGTL: 21,973
DTHS/DAY
AECO
Sumas
Kingsgate
NWP Southbound
166,173
DTHS/DAY
Stanfield
GTN forwardhaul:
72,761 DTHS/DAY
GTN
Backhaul:
15,000
DTHS/DAY
Malin
NWP Northbound
79,116 DTHS/DAY
Opal
Ruby 15,000
DTHS/DAY
Rockies Basins

Supply Base

- Supply Base is the baseline supply contracts that are entered into every 12 months.
- An index contract has a basis rate. This is defined as the floating price of gas at a given market (ie, AECO index is the forecasted cost of gas at NYMEX plus the basis for AECO, for a given month).
- A fixed contract has a fixed rate.
- A penalty is applied to each contract when the gas is not taken for a day. This forces SENDOUT® to only take the optimal amount of gas to serve the base demand.

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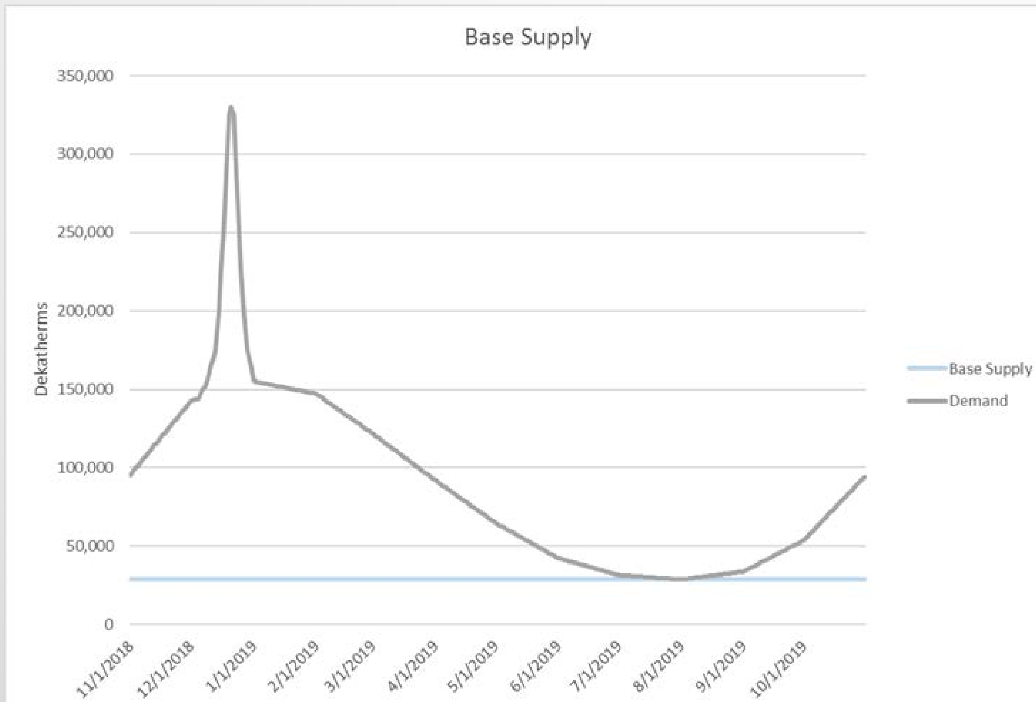
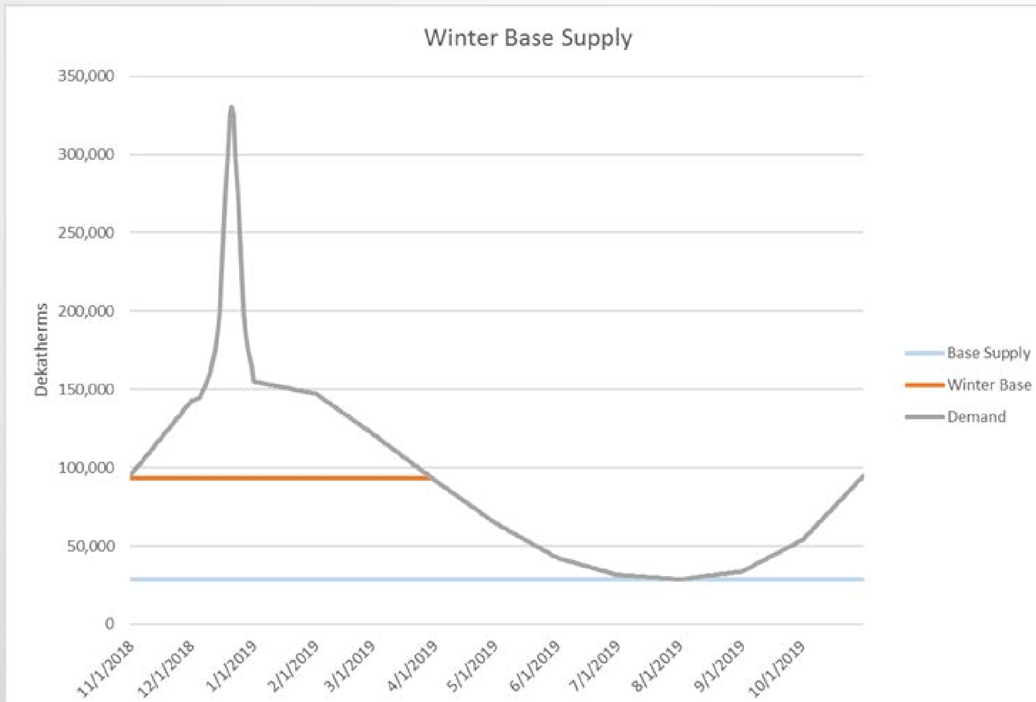
Base Supply cont'd



Winter base Supply

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

Winter base Supply cont'd



Day Supply (Winter)

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

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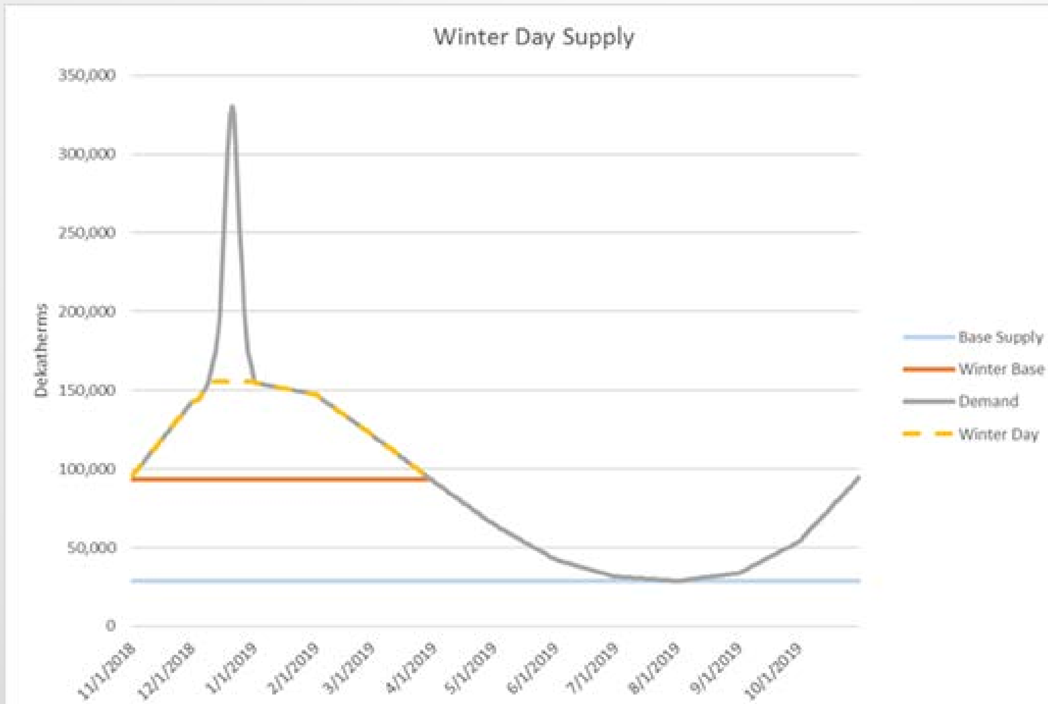
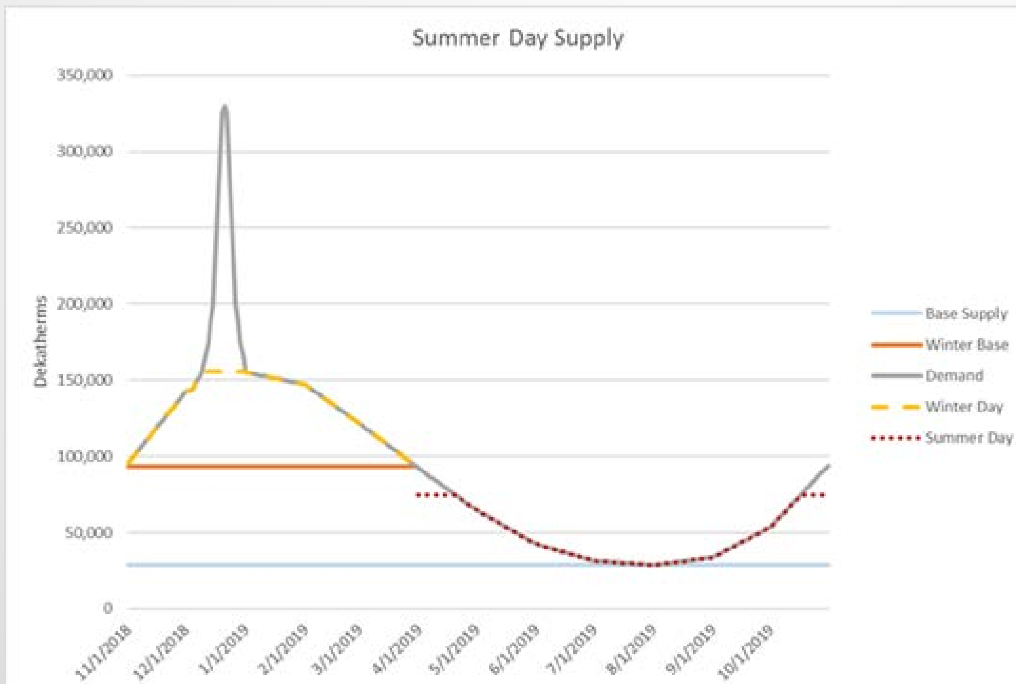
Day Supply (Winter) cont'd



Day Supply (Summer)

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

Day Supply (Summer)



Peak Supply

- Peak supply is gas purchased on high demand days where base, winter base, or day supply cannot accommodate.
- Peak supply has the highest premium to buy.
- As long as Cascade has the transport capacity or can utilize a third party's transport capacity, we can purchase as much peak supply as needed to meet peak demand.

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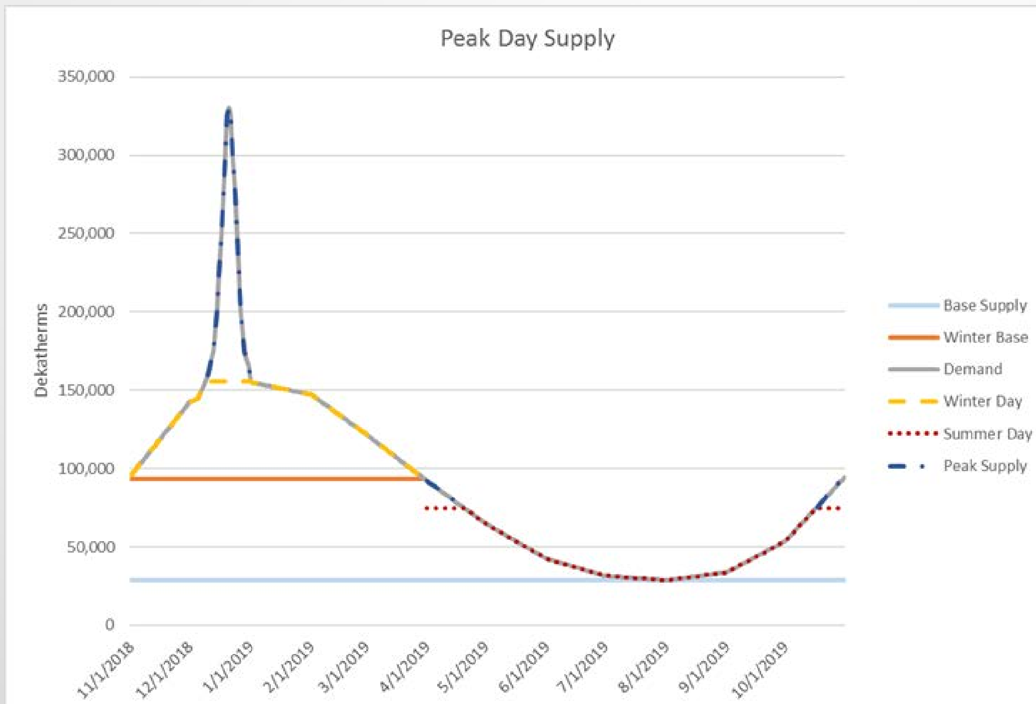
Total Supply



Storage

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

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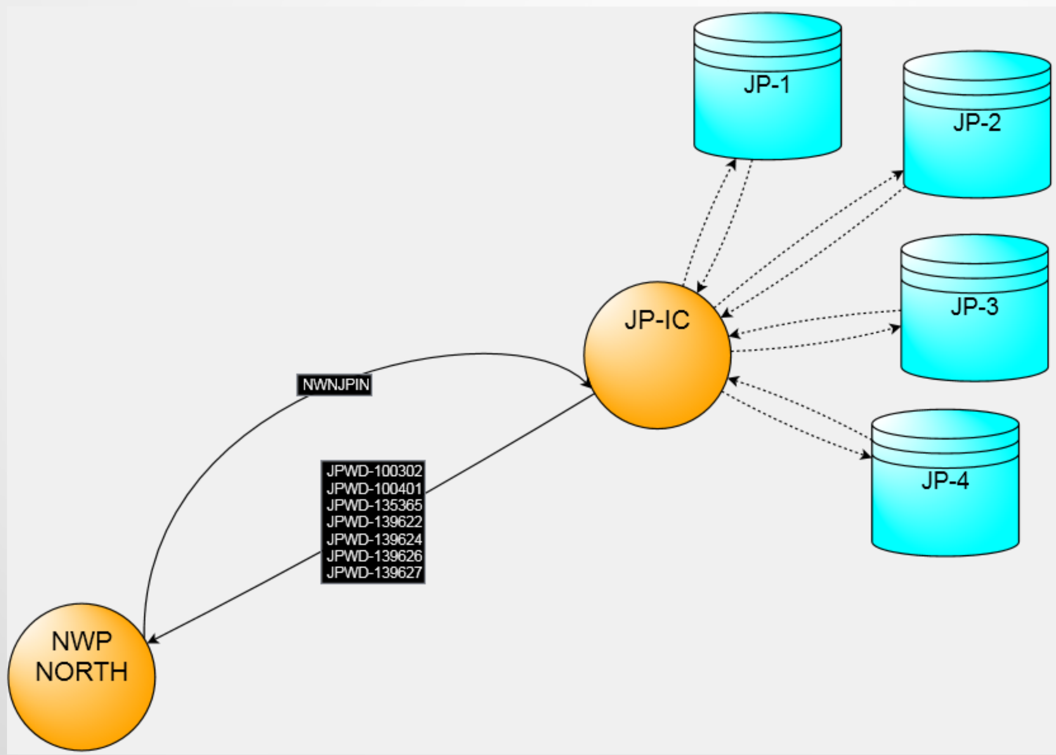
Storage Example



Storage Example 2

	JAN 2017	FEB 2017	MAR 2017	APR 2017	MAY 2017	JUN 2017	JUL 2017	AUG 2017	SEP 2017	Extension Option	Escalation Pattern	Monthly Multiplier
Process Indicator										Same		
Inventory Maximum Physical Capacity	604351									Same		
Inventory Minimum Physical Percent										Same		
*Target Inv - End of Period Max Pct										Same		
*Target Inv - End of Period Min Pct						35		80	100	First Year		
*Inventory Adjustment - Value per Unit										Same		
*Inventory Adjustment - Volume										Same		
*Injection Daily MDQ				16789						First Year		
*Injection Daily Min Percent										Same		
*Withdrawal Daily MDQ				0						Last Year		
*Withdrawal Daily Min Percent										Same		
Fuel - Injection	0.15									Same		
Fuel - Withdrawal	0.15									Same		
Rate - Carry										Same		
Rate - Injection										Same		
Rate - Withdrawal										Same		
Rate - Other Injection										Same		
Rate - Other Withdrawal										Same		
Rate - Volume Charge										Same		
Rate - D1	.01558									Same		DaysInMonth
Rate - D2	.00057									Same		DaysInMonth
Volume - D1 Volume	16789									Same		
Volume - D2 Volume										Same		
Storage Ratchets Table	JP									Same		
Starting Inv Layer 1 Value per Unit	3									Same		
Starting Inv Layer 1 Volume	604351									Same		
Energy Conversion Factor										Same		
Injection Costing List - Transport										Same		
Injection Costing List - Source										Same		

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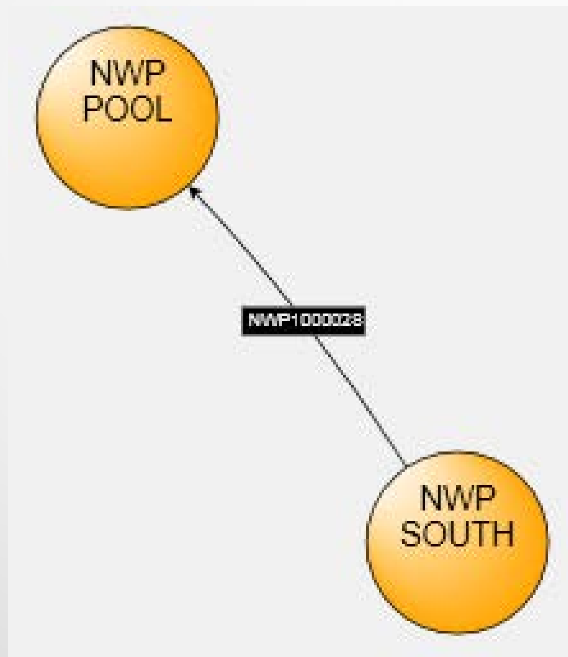
Transportation

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

Transportation cont'd

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

Transport Example



Transport Example

	JAN 2017	FEB 2017	MAR 2017	APR 2017	MAY 2017	JUN 2017	JUL 2017	AUG 2017	SEP 2017	Extension Option	Escalation Pattern	Monthly Multiplier
*Daily MDQ	116866									Same		
*Daily Minimum Percent										Same		
Fuel	1.28									Same		
Rate - Transportation	0.03									Same		
Rate - Other Variable										Same		
Rate - D1 Rate	0.39249									Same		DaysInMonth

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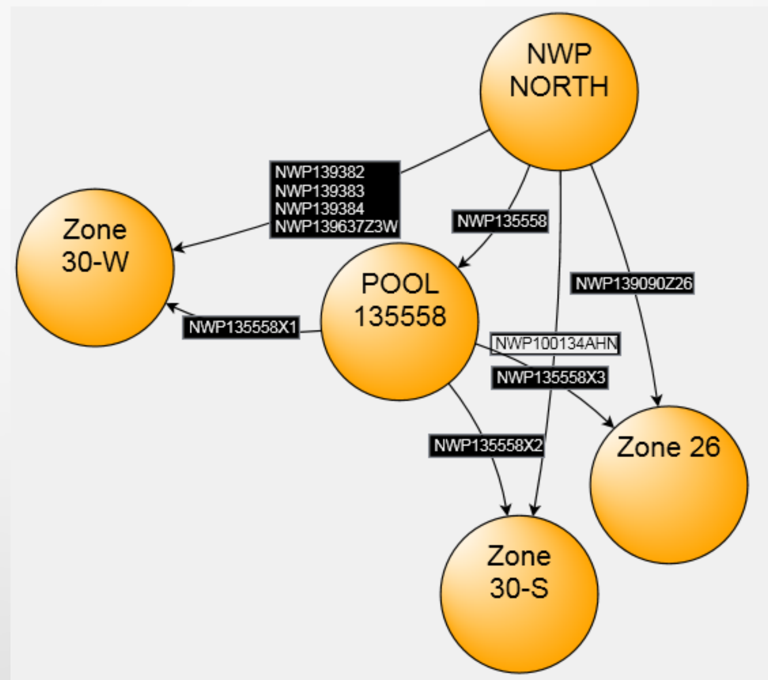
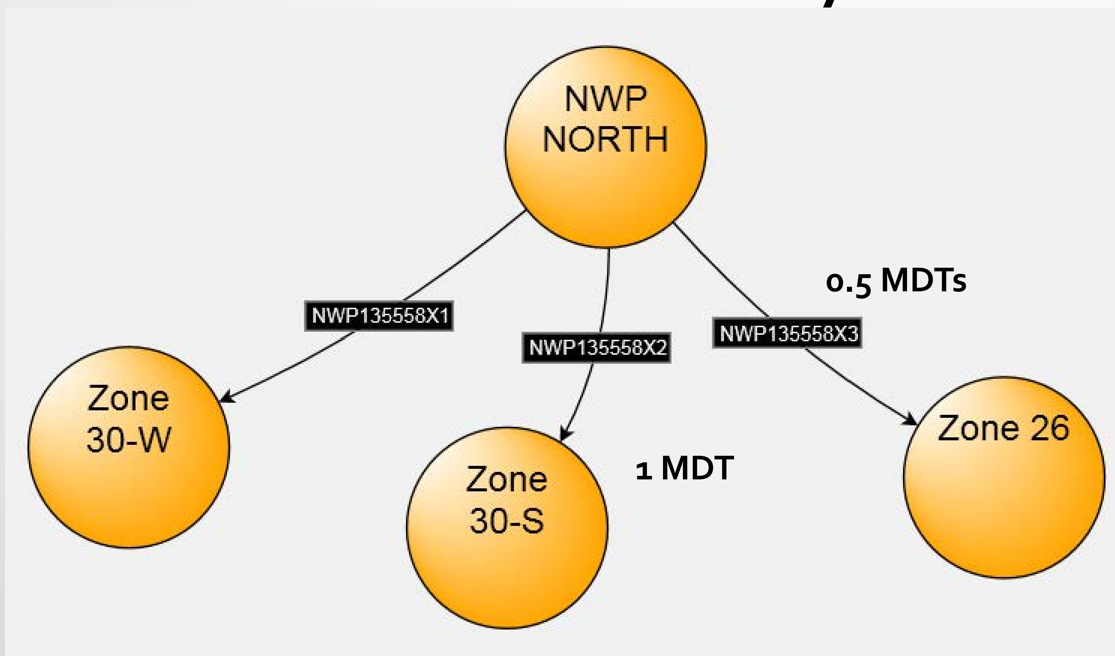
Delivery Rights vs Receipt Rights

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

Example of delivery right flexibility



Example of delivery right inflexibility



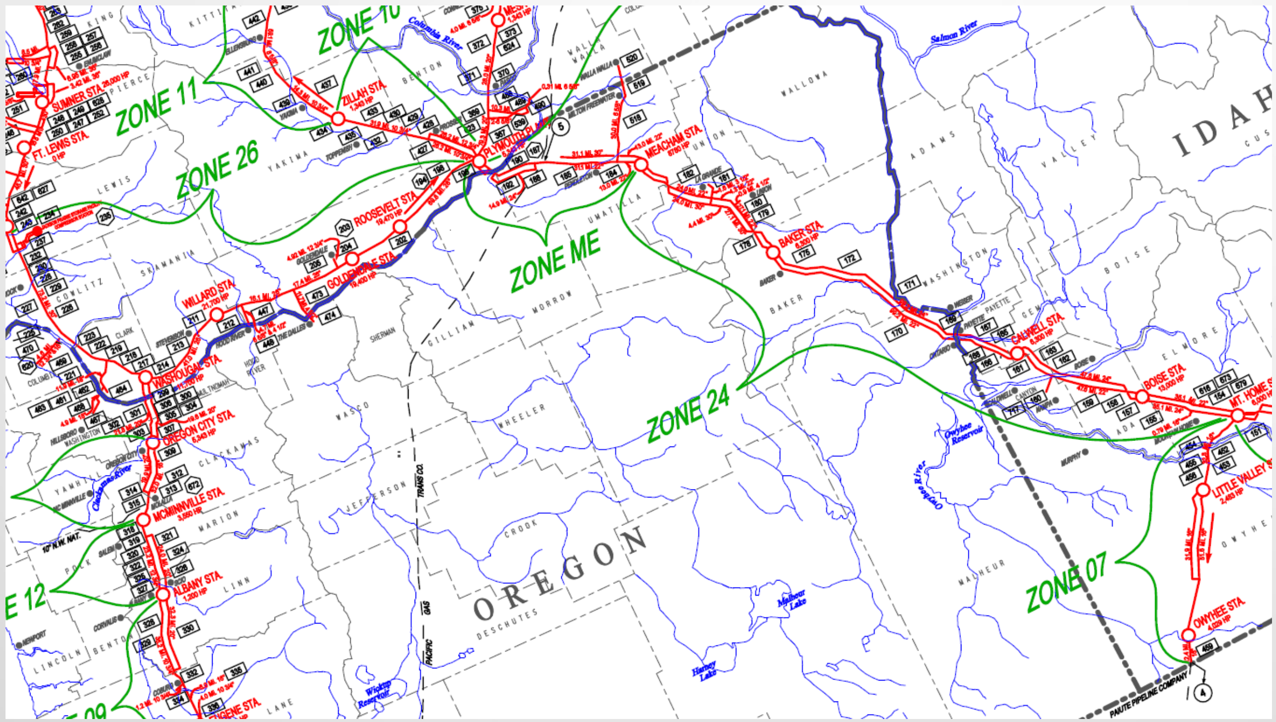
Transport Constraints

- To simplify modeling in SENDOUT®, the software allows the user to group multiple paths of one contract into a constraint group.
- This tells SENDOUT® to allow each path to take up to X Dekatherms, but not to exceed X Dekatherms for all paths of the contract.
- The analyst identifies which contracts should be in the group and assigns the contract MDQ for the constraint group.

Transport Constraints Example

	JAN 2017	FEB 2017	MAR 2017	APR 2017	MAY 2017	JUN 2017	JUL 2017	AUG 2017	SEP 2017	Extension Option
Annual Max										Same
Annual Min Percent										Same
Seasonal Max										Same
Seasonal Min Percent										Same
Monthly Max										Same
Monthly Min Percent										Same
*Daily Max	47603									Same
*Daily Min Percent										Same
Resource Mix Start\Stop Indicators										Same
RMIX MDQ Max										Same
RMIX MDQ Min										Same
Fixed Rate										Same
Demand Annual Max Percent										Same
Demand Annual Min Percent										Same
Demand Seasonal Max Percent										Same
Demand Seasonal Min Percent										Same
Demand Monthly Max Percent										Same
Demand Monthly Min Percent										Same
*Demand Daily Max Percent										Same
*Demand Daily Min Percent										Same

Location of Zones (Source: NWP)



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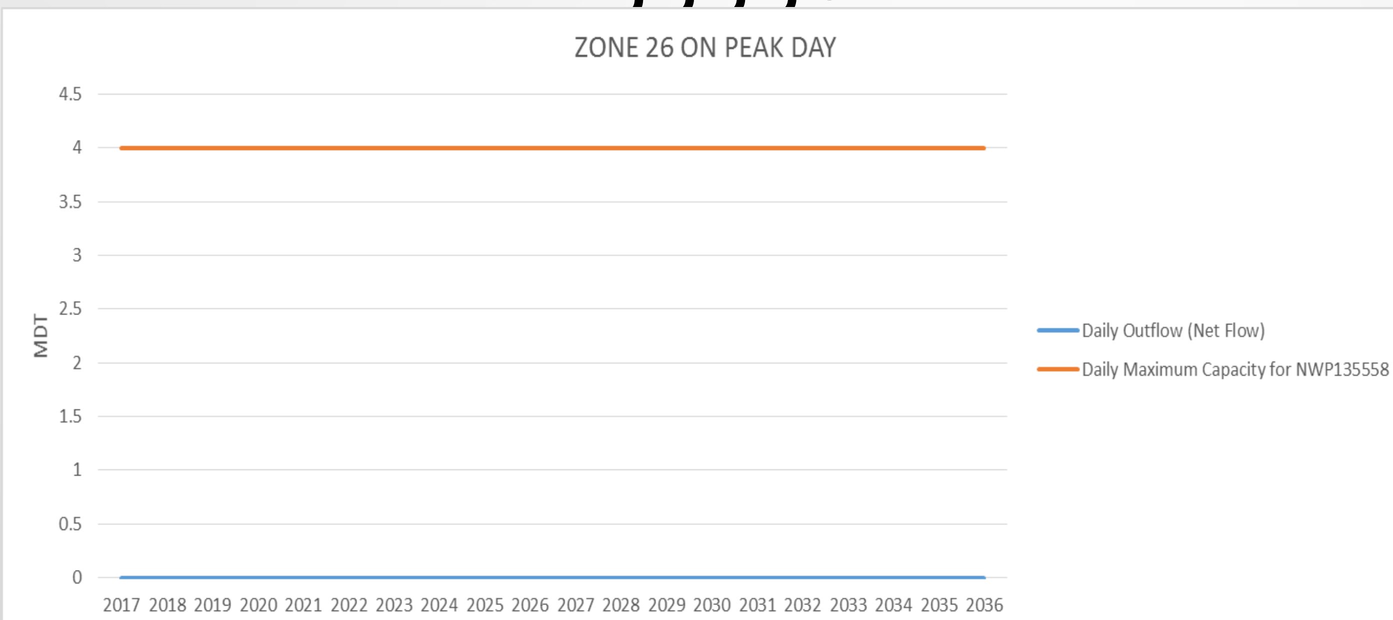
Zone 26 on Peak Day for Transport 135558



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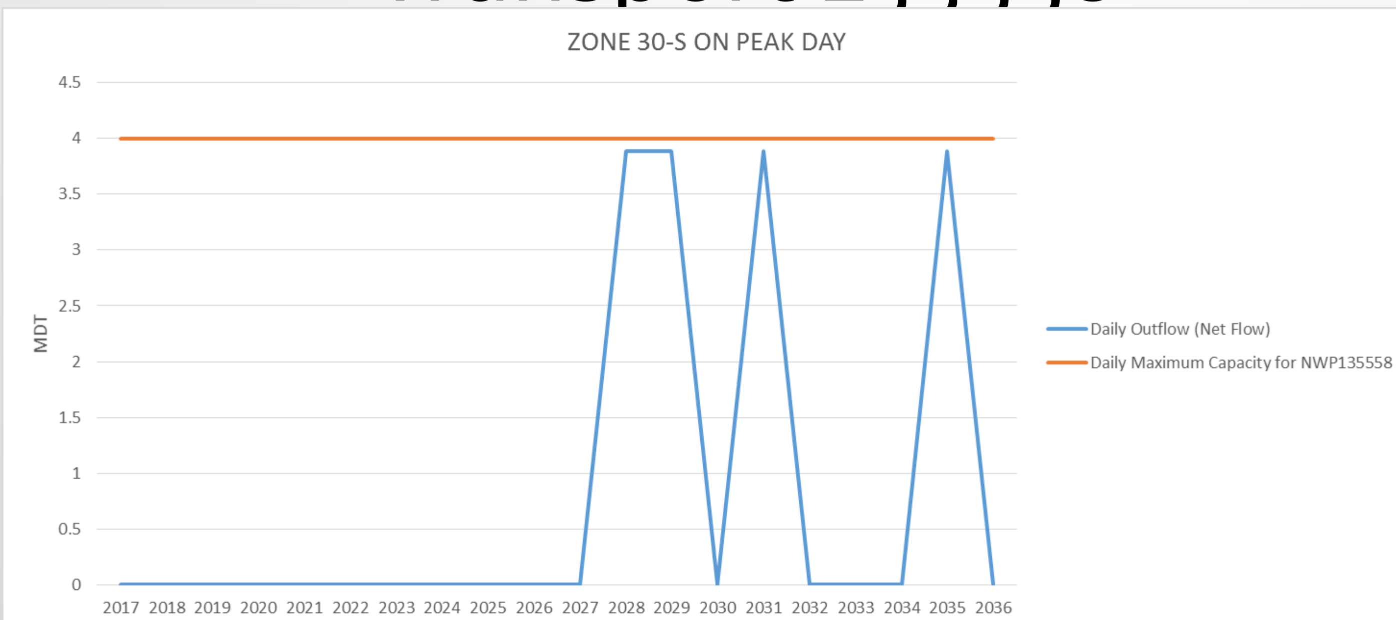
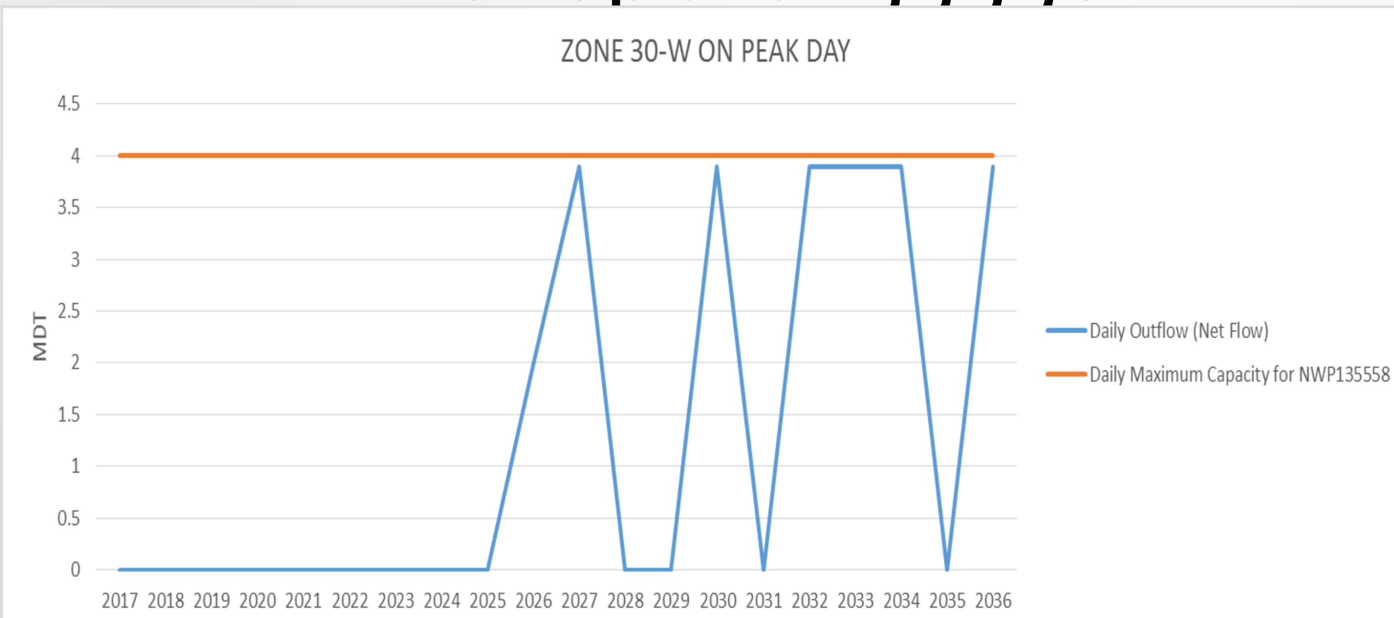
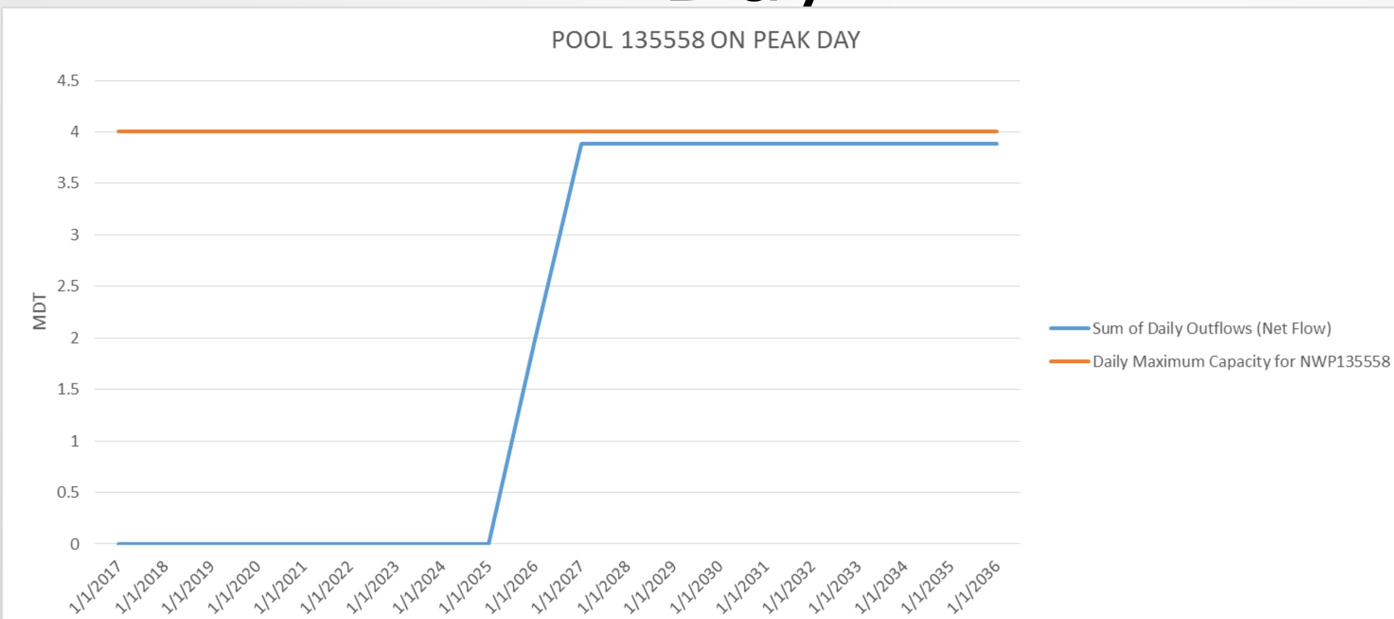
Zone 30-S on Peak Day for Transport 135558



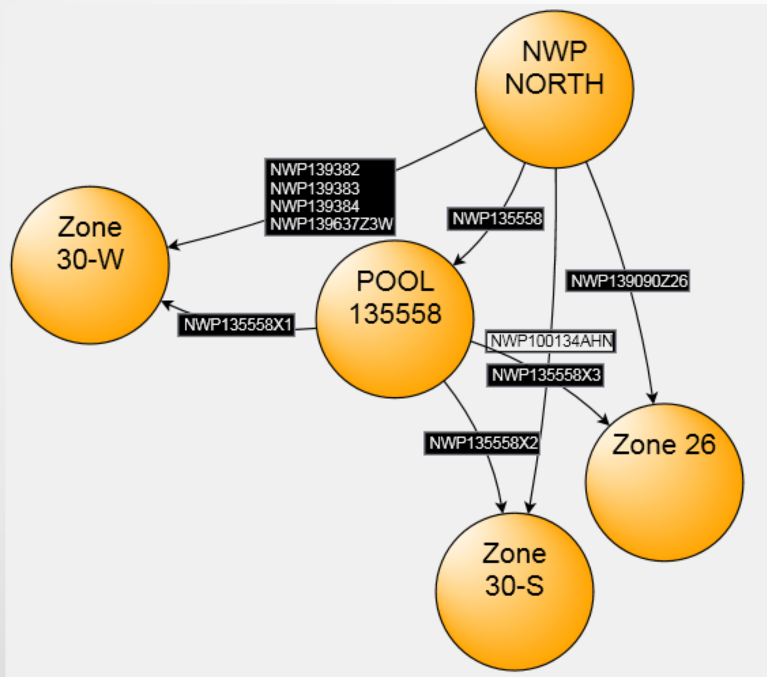
Zone 30-W on Peak Day for Transport 135558



Transport Contract 135558 on Peak Day



Example of delivery right flexibility



Demand Behind the Gate

- Cascade has strived over the last several years to enhance the IRP forecast and resource analysis to get to as granular a level as possible using the available data.
- Attempts to forecast demand behind the gate using existing forecasting methodology has been challenging.
- Customer billing data does not have daily meter reads for core customers making regression analysis on a use per HDD per customer difficult.
- Some towns can be served by multiple pipelines and the mix can change over time.

Demand

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

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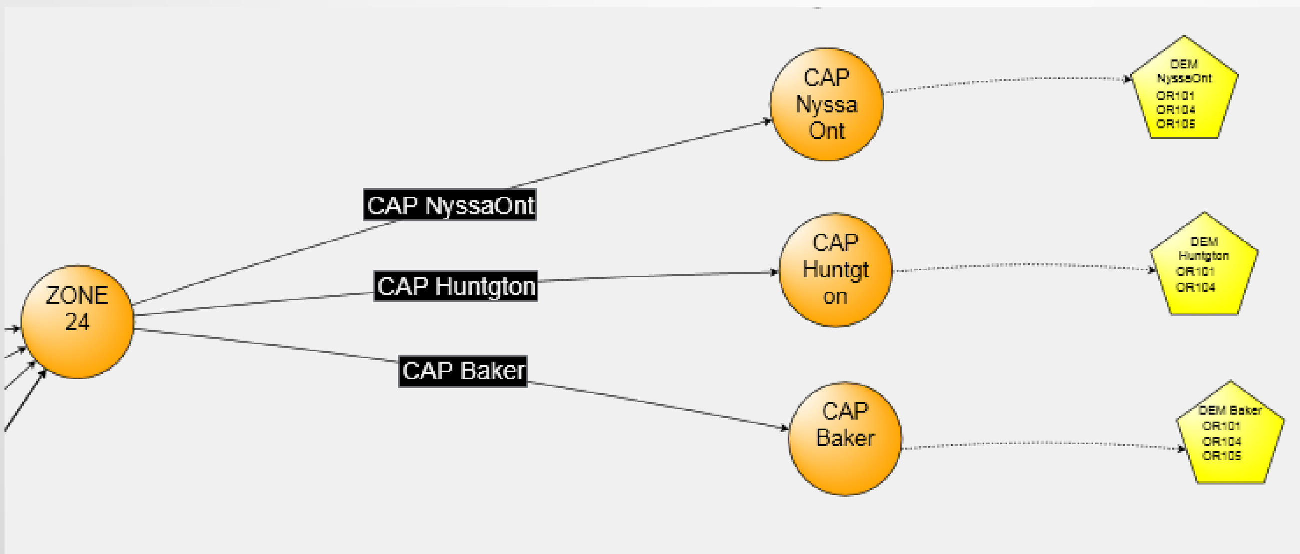
Demand Example



Demand Example 2

	JAN 2017	FEB 2017	MAR 2017	APR 2017	MAY 2017	JUN 2017	JUL 2017	AUG 2017	SEP 2017	Extension Option	Escalation Pattern	Monthly Multiplier	Index	Adder	Multiplier
Forecast Method	Usage Fac									Same					
Customers	28347	28386	28429	28435	28456	28442	28450	28469	28489	Same					
*Demand - Daily										Same					
Demand - Monthly Base										Same					
Demand - Monthly Heat										Same					
Demand - Monthly Total										Same					
Demand - Percent Factor - non P non Q										Same					
Demand - Percent Factor - non Q										Same					
Usage Factors - Weekday Base	0.1919	0.1659	0.1396	0.0979	0.0741	0.0625	0.0589	0.0581	0.06	First Year					
Usage Factors - Weekday Heat	0.007448									Same					
Usage Factors - Weekend Base	0.186298	0.160298	0.133998	0.092298	0.068498	0.056898	0.053298	0.052498	0.054398	First Year					
Usage Factors - Weekend Heat	0.007448									Same					
*Rate - Unserved Dispatch (Pri 1)										Same					
*Rate - Unserved (Pri 2)	960									Same					

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Weather

- Weather inputs for SENDOUT include:
  - Monte Carlo
  - Historical
  - Normal
- Monte Carlo inputs include mean, standard deviation, max, minimum, and distribution.
- Historical data is used to build weather profiles for Monte Carlo.
- Normal weather is the daily average of the 30-year most recent history (1988-2017).

Weather Example – Monte Carlo

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

Long Range Price Forecast

- Cascade's long-term planning price forecast is based on a blend of current market pricing along with long-term fundamental price forecasts.
- The fundamental forecasts include Wood Mackenzie, 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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Distribution System Planning in SENDOUT®

- New modeling technique in SENDOUT®.
- Models physical constraints at the citygate level.
- Does not impact the upstream modeling for core customers.
- Can show any citygate physical constraints over the next 20-years.
- Can be used to compare similar results from Engineering.
- Cascade has identified 5 citygates that need an upgrade in the next 1-2 years. 3 in Washington and 2 in Oregon:
  - Arlington, Walla Walla, Yakima, Bend, Prineville
- Cascade has also identified several other citygates which may need an upgrade in the next 2-5 years.

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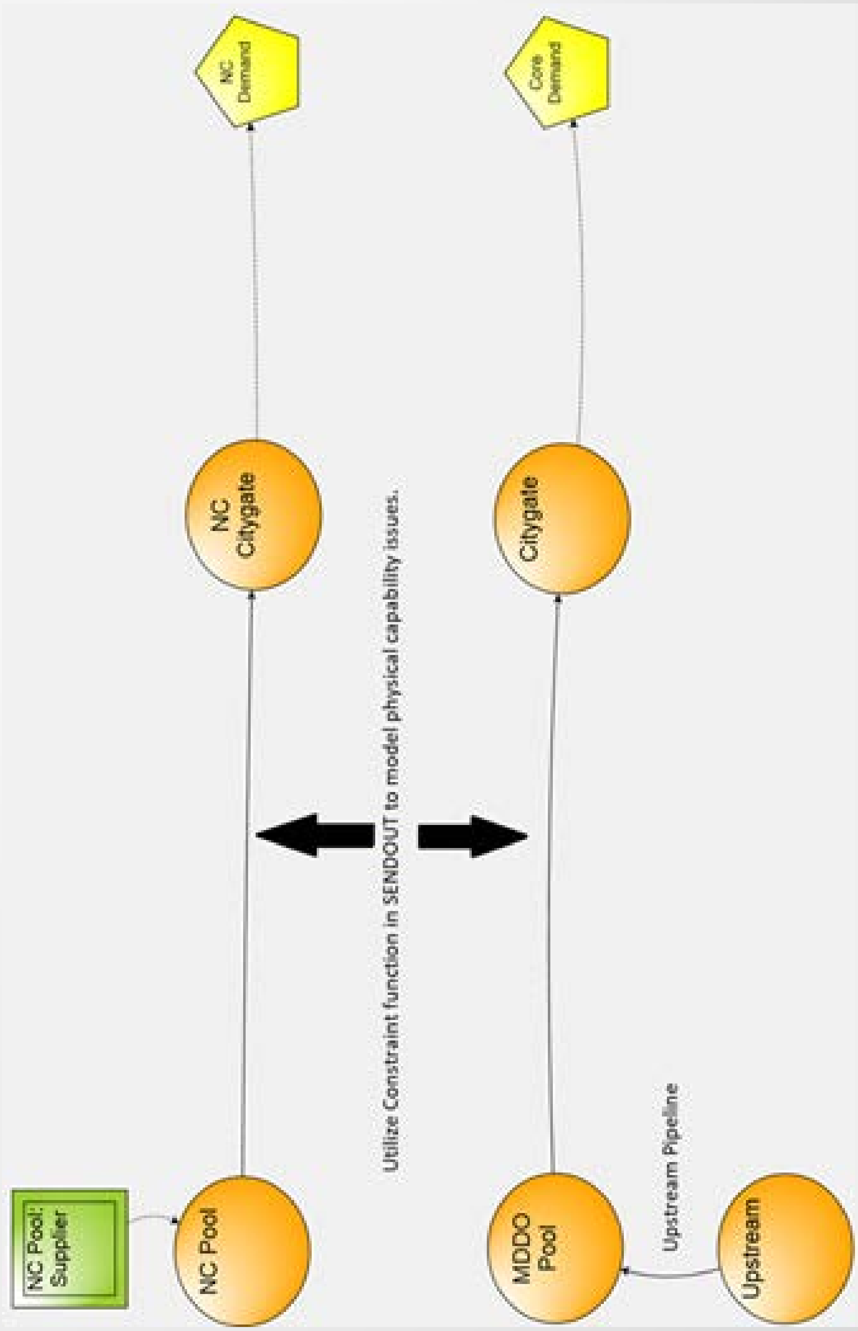

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Step 1: As-is Analysis

- Model Cascade's current system under expected conditions with a 3-day peak inserted each year.
- Record timing and location of potential shortfalls.
- Identifies the problems that incremental resources will solve for.

Step 2: Introduce Additional Resources

- Cascade uses it's market intelligence to identify potential solutions to shortfalls previously identified in the As-is.
- These can be in the form of incremental transport, incremental supplies, incremental storage, and other resources.
- Once included, Cascade runs the optimizer and records the timing and quantity of resources selected.
- This forms the deterministic preferred portfolio; one of six portfolios to be evaluated under stochastic conditions.
- The other 5 portfolios are derived by running the optimizer on a modified list of resource availability.

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Step 2: Introduce Additional Resources

- Deterministic Preferred Portfolio
- GTN Only Portfolio
- GTN + Storage Portfolio
- NWP Only Portfolio
- NWP + Storage Portfolio
- Storage Only

Step 3: Stochastic Analysis of All Portfolios Under Existing Conditions

- Each of the 6 portfolios is run through a Monte Carlo simulation on weather.
- Cascade records the mean and 95^{th} percentile value-at-risk (VaR) of the total system cost and unserved demand of each portfolio.
- This allows Cascade to evaluate the portfolios' intrinsic and extrinsic values.

Step 4: Ranking of Portfolios

- Portfolios are ranked primarily on unserved demand and secondarily on total system cost.
- Cascade uses regional best practices to weight the deterministic and stochastic components.
- Ultimately, the portfolio that performs best under expected conditions will be deemed the first candidate portfolio.

Step 5: Stochastic Analysis of Candidate Portfolio

- Cascade runs Monte Carlo analysis on the candidate portfolio under a variety of scenarios.
- Scenarios allow Cascade to evaluate a portfolio under a number of load impacting externalities.
- Cascade expects to run the simulations on both price and weather.
- Cascade records mean and VaR of total system cost under each scenario.

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Step 6: Analysis of Candidate Portfolio

- Cascade compares the 95^{th} percentile VaR under each scenario to a predetermined VaR limit.
  - The VaR limit is a risk and cost ceiling determined by Cascade's GSOC.
- If costs exceed the VaR limit in any scenario tested, Cascade may reject the candidate portfolio and begin testing the next ranking portfolio from step 4.
- If costs do not exceed the VaR limit, the candidate portfolio moves to sensitivity testing.

Step 7: Sensitivity Analysis of Candidate Portfolio

- Cascade runs Monte Carlo analysis on the candidate portfolio under a variety of sensitivities.
- Sensitivities allow Cascade to evaluate a portfolio under a number of price impacting externalities.
- Cascade expects to run the simulations on both price and weather.
- Cascade records mean and VaR of total system cost under each sensitivity.

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Step 8: Re-evaluation of Candidate Portfolio

- Cascade compares the 95th percentile VaR under each sensitivity to a predetermined VaR limit.
- If costs exceed the VaR limit in any sensitivity tested, Cascade may reject the candidate portfolio and begin testing the next ranking portfolio from step 4.
- If costs do not exceed the VaR limit, the candidate portfolio becomes Cascade's preferred portfolio.

Preliminary Resource Integration Results

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Preliminary Results

- Cascade has finalized its load forecast for the 2018 WA IRP.
- All of Cascade's existing resources have been run through SENDOUT® to complete the Company's As-is analysis as discussed in Step 1 of the Supply Resource Optimization Process.
  - Assuming contracts evergreen.
  - These preliminary results do not include the impacts of DSM as discussed earlier.
- Cascade has identified potential shortfalls in its GTN citygates starting in 2023.

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Discussion of Shortfalls

- Current modeling does not identify any shortfalls in Washington.
  - This assumes all deterministic conditions, and all contracts evergreening over the 20-year planning horizon.
- Cascade is running scenario and sensitivity analyses to evaluate the viability of options specific to Washington citygates, such as the Bremerton expansion.

Discussion of Shortfalls (cont.)

- Shortfalls in the citygates served by GTN are consistent with Cascade’s modeling in years past.
- Additionally, this is corroborated by Cascade’s market intelligence, which identifies Bend, OR as a major growth center on Cascade’s system.
- The next step is for Cascade to perform its Supply Resource Optimization Process which will determine the optimal solutions for any identified deterministic shortfalls.

Remaining Schedule

Date	Process Element	Location (Subject to change)
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 Internation 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	

ADDITIONAL QUESTIONS?

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Bruce Folsom - Consultant

Cascade Natural Gas Corporation

2018 Integrated Resource Plan

Technical Advisory Group Meeting #4

August 23rd, 2018

Seattle-Tacoma International Airport

Seattle, WA

Cascade 2018 IRP (UG-171186) TAG Meeting #4

Date & Time: 8/23/2018, 09:00 AM – 03:00 PM

Location: SeaTac Conference Center –Amsterdam Room

First	Last	Representing	Email	Participation Method
Kevin	Connell	CNGC	kevin.connell@mdu.com	In Person
Monica	Cowlishaw	CNGC	monica.cowlishaw@cngc.com	In Person
Corey	Dahl	Public Counsel	coreyd@attg.wa.gov	In Person
Ashton	Davis	CNGC	ashton.davis@cngc.com	In Person
Bruce	Folsom	Consultant	bruce.folsom@hotmail.com	In Person
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David	Nightingale	WUTC	dnight@ut.wa.gov	In Person
Mike	Parvinen	CNGC	michael.parvinen@cngc.com	In Person
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Chris	Robbins	CNGC	chris.robbins@cngc.com	In Person
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Eric	Wood	CNGC	Eric.Wood@cngc.com	Phone

Minutes by: Resource Planning Team

Brian began the meeting by welcoming everyone to the 4th WUTC Tag Meeting of 2018. He also provided safety instructions for those in the room. This was followed by introduction of participants in-person and on the phone.

Mark explained in addition to Scott Madison being the new senior executive responsible for the IRP. In addition, Mark introduced the new Director of Gas Supply, Kevin Connell. Kevin gave a brief overview of his decades of experience in Gas Supply related functions. Kevin thanked everyone for their participation. He stated that this is important for customers and stakeholders. He also thanked everyone for taking the time to be a part of the process and thanked the Resource Planning Team as well. Scott said he would not be on the call for the whole meeting.

Brian then went over today's Agenda.

TAG 2/3 Recap

-What is Satellite LNG? – Off system supply of liquified natural gas.
-Does this signal anything specific or out of the ordinary? Such as, the GH plant is increasing generation and could soon need that additional capacity or something? – We do not want to speak on behalf of Grays Harbor, but if they were to continue utilizing high levels of gas there is a risk of them wanting to acquire the Bremerton capacity
-Re: Supplemental workshop to discuss contracts versus actuals – We will be talking a lot about contract during this meeting, if there is still a need of clarification we would be happy to hold this workshop.
Re: Market intel - Can you please offer a quick reminder of how this information gets incorporated into the modeling? – Many elements of the market intel play a role in the IRP. The infrastructure section provides the RPT with insights into new resource alternative for Cascade to consider modeling, such as new storage or transportation projects. The regulatory/renewables sections make Cascade aware of carbon legislation to consider for modeling, such as the Market Choice proposal in the house of representatives that will be discussed shortly. These are just a few examples of the quantitative and qualitative impact of the market intel.

1st Presentation – IRP Carbon Update and Assumptions *(Abbie Krebsbach), Slide #4*

- GHG Policy Update
    - Provide insight into current national, regional/state and local policy activities that inform Cascade Natural Gas Corporation's IRP process.
    - Provide discussion on Cascade's actions to reduce methane leaks and fugitive emissions while ensuring safe, reliable and economic service, and utilizing natural resources efficiently to minimize environmental impact.
- Carbon Modeling Assumptions
    - To explain Cascade's approach in determining range of carbon dioxide emissions values and assumptions for calculating inputs to project a 20-year avoided cost of natural gas, with associated two-year action items.

Regarding laying the foundation: CNGC explained that this information is from 2016 data that EPA has published. In 2016, CO_2 accounted for about 81.6% of all U.S. greenhouse gas emissions from human activities, while methane emissions are second at 10%. The contribution of GHG emissions from US human activities that would be from our customers' consumption of natural gas we deliver is included within the residential and commercial, and industrial pie pieces shown here, but is not specifically broken out.

Much of the GHG reductions observed for energy delivery is due to the transition from coal-fired electric generation resources to lower emitting resources such as natural gas-fired and renewable electric generation resources. Energy efficiency programs have contributed to this downward trend as well. Washington shows decreasing emissions from review of EPA and EIA data, but no state charts were available to present.

Electric Generation - Power plants fueled by natural gas emit about half the CO2 emissions of coal plants, and natural gas fired-generation is better suited to provide ramping and intermittent dispatchable power for varied generation from increasing renewables on the grid. Washington has lower GHG emission from power plants than most states due to having so much hydropower, as well as other renewable generation and natural gas units available, but that can vary each year.

Oil & Gas Sector - Fugitive methane emissions can come from well/pipeline infrastructure and well completion processes, as well as CO2 emissions from natural gas flaring, compressor engines and other combustion equipment. There is continued debate on contribution of these emissions and how to consider emissions in total energy supply chain since emissions studies vary.

Northwest Power & Conservation Council's has included these statements and we'll continue to review new versions of the Power Plan when they are released – the next one is expected to be published in January 2019.

From our review of EPA GHG emissions reports in 2016, the oil and gas sector emitted about 9.5 percent of the total GHG emissions from all industries. (283 million metric tons of CO2 equivalent compared with total of 2,990 million metric tons of all industries).

Natural Gas Distribution – natural gas distribution company facility contribution to GHG emissions generally result from fugitive methane emissions/leaks from pipeline infrastructure, and from combustion of fuel in compressors. For instance, Cascade has one small natural gas-fired compressor station in Mt. Vernon. Normally, the majority of compressor stations that are in operation are owned and operated by transmission companies.

Depending on where you get your data, about 5% of O&G sector emissions are from natural gas distribution company infrastructure (EPA 2016 data shows 14 million metric tons of CO2 equivalent compared with total of 283 million metric tons for O&G and total of 2,990 million metric tons of all industries)

However, due to conservative methods in calculating and reporting emissions, it is likely that the natural gas distribution companies' contribution is lower than this.

Cascade is required to report facility emissions for the State of Washington and are about 27,000 metric tons of CO2 per year. Cascade's emission in Oregon are low and are not required to be reported to EPA or the State of Oregon.

Natural Gas Distribution Customers – CO2 emissions from customers' combustion of natural gas has increased due to low natural gas prices, increasing demand and steady economic growth. With that growth, emissions also increase from customers combustion of natural gas.

The total annual emissions from our core customers are in the range of 2 to 2.5 million metric tons of CO2 per year. Emissions from non-core customers have totaled in the range of about 800,000 tons per year, depending on the year.

Cascade's energy efficiency programs currently save about 40,000 to 80,000 dekatherms annually, slightly less than 5,000 metric tons of CO2 per year. More emission reductions will be realized as Cascade's programs mature and continue to grow.

What do you consider "customer" emissions? Does it mean the emissions from all the gas your customers consume? Yes, this means emissions from Cascade's core and non-core customers. Emissions are from the natural gas that Cascade sells.

Cascade has committed to methane fugitive emissions and leak reductions through the EPA's Natural Gas Star Methane Challenge Program.
Cascade became a founding member of that Program in March 2016 and is participating specifically in the Program's Excavation Damages Prevention segment.

Best management practices implemented for that program include reductions the company has realized in creating the Public Awareness position. In 2014, Cascade created the Public Awareness position to actively manage the Public Awareness Program and Damage Prevention Program. This person assists in providing community education and outreach opportunities, focusing on damage prevention and further reducing potential releases of methane from excavation damages.

Cascade is currently implementing a Damage Prevention Program that focuses on working with contractors or third parties that are repeat offenders. By identifying and reaching out to these third parties prior to work beginning on the respective project, we believe that we'll see a reduction in excavation damages throughout our service territory.

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

Cascade has also implemented pipeline replacement projects which have contributed to fugitive emissions reductions. Newer and more leak proof pipeline materials such as polyethylene and steel are used to replace older more leak-prone materials, methane leaks are reduced.
From 2012-2018, Cascade has replaced nearly 91 miles of early vintage steel pipe, ranging from service lines up to 12-inch mains, and have been replaced with new steel or polyethylene pipe.

Also, Cascade is better positioned than most US utilities as it has no unprotected steel pipeline and none of the potentially leak-prone cast iron pipe seen elsewhere. There are many utilities who still have cast iron pipe in their systems.

Cascade also encourages direct use of natural gas – especially as innovative gas solutions can maximize the efficient use of energy and offer customers more choice and improved affordability, reliability and comfort.

National policy trends we have seen in this administration is less focus on required emissions reductions. EPA is still funding its voluntary emissions reduction programs such as the Methane Challenge Program.

We see growing regional and state focus on adopting GHG emissions reductions or renewables mandates and studies through regulation or statute. We see this happening in Oregon, Washington and further south in California. We'll touch on what we see in Washington and Oregon in a few slides.

We see influence There are more cities across the US committing to emissions reductions and renewable energy through city goals and requirements vary – some goals are 2030 and some further out – ie. 2050. May include city infrastructure only, but some are community-wide. We will talk about a recent referendum in the City of Bellingham in a few slides.

The NSPS OOOOa Rule requires methane monitoring and leak repair at new oil and gas production facilities upstream of natural gas local distribution company facilities. EPA excluded local distribution company systems from the rule since LDC systems generally operate at lower pressures than interstate pipelines, and due to the downward trend of methane emissions from distribution company implementation of voluntary process improvements that have reduced fugitive emissions as mentioned before. Only oil and gas facilities upstream of LDC custody transfer meters are regulated by this rule.

The rule is in effect, and has been in the news over the past couple years due to EPA's continued re-evaluation and re-proposal of some of the monitoring and repair requirements and compliance deadlines. Environmental groups litigated EPA's approach to staying the compliance deadlines and rule is in effect.

An example of a recent federal legislative option to address GHGs is the proposed Market Choice bill in the US House. It includes a carbon tax provision for fossil fuels and applies an initial tax of $24 starting in 2020 and includes an annual inflation adder. Election year politics will make it difficult for bills addressing GHG emissions to pass. We will continue to monitor any potential congressional actions.

2nd Presentation – Avoided Cost (Devin McGreal), Slide #35

- 20-year price forecast
- Avoided cost is a 45-year outlook
- One for each weather zone
- More transparent and intuitive final number

Devin described each element of the avoided cost formula in detail. He discussed incremental fixed transportation costs, variable transportation costs, variable storage costs, commodity costs, carbon taxes, environmental adders, distribution system costs, and risk premium.

Devin confirmed that the four climate zones for avoided cost are Bellingham, Bremerton/Aberdeen/Longview, South Central WA, and Oregon

Devin confirmed the units for avoided cost are $/therm

What kind of cost effective solutions are looked at for transportation costs? – They are the average of any projects that would solve shortfalls in the most recent IRP

Is Cascade still using Social Cost of Carbon w/ 3% Discount Rate for its base case Carbon Analysis? – This is correct. The Company will also be modeling the impacts of several other potential carbon forecasts.

<u>3rd Presentation – DSM Forecast</u> (Monica Cowlishaw and Amanda Sargent), Slide #47

- New Conservation Potential Assessment
- Historical program performance
- Short term goals

LoadMAP Sequence: (Slide #52)
- Market profile
- Equipment
- Baseline Forecast
- Non-Equipment
- Potential
- Final Results

- Top Ten Measures reviewed

<u>4th Presentation – Bio-Natural Gas</u> (*Chris Robbins*), Slide #67

- Discussion of the role of RNG in the IRP
- Cascade will evaluate RNG potential as part of resource mix
- Two projects in focus currently, City of Richland Landfill and Andgar in Bellingham

<u>5th Presentation – SENDOUT® Optimization Modeling</u>: (Brian Robertson), Slide #71

- Review of Supply Resource Optimization Flow Chart
- Sendout Inputs review:
    - Supply, Storage, Transportation, Constraints, Demand, Price Forecast, Weather, and Distribution System.

Delivery Rights vs Receipt Rights: (Slide #94)
- Cascade has more delivery rights than receipt rights.
- Allows for flexibility.

Long Range Price Forecast: (Slide #111)
- Blend of current market pricing and long-term fundamental price forecasts
- Various sources of forecasts use different levels of time (e.g. monthly, annually…)

<u>6th Presentation – Preliminary Resource Integration Results:</u> (Ashton Davis), Slide #124

Preliminary Results: (Slide #125)
- Load forecast is finalized.
- Listed assumptions such as all contracts evergreen.
- Identified potential shortfalls in GTN citygates starting in 2023.
- Current modeling does not show Washington shortfalls.

Brian Robertson then went over the 2018 IRP Remaining Schedule:

September 11 - TAG #5 Slides distributed

September 18	-	TAG #5
October 5	-	Draft of 2018 IRP out
November 2	-	Comments due
November 14	-	TAG #6, if needed
December 14	-	IRP filing in Washington

Mark commented that Cascade is open to a workshop if needed. The meeting was adjourned.

Cascade Natural Gas Corporation

2018 Integrated Resource Plan
Technical Advisory Group Meeting #5

September 18th, 2018

Seattle-Tacoma International Airport

Seattle, WA

Agenda

- Introductions
- Safety Moment
- TAG 4 Recap
- Summary of Alternative Resources
- Components and Ranking of Candidate Portfolios
- New Stochastic Methodology
- Scenario and Sensitivity Results
- Preliminary Two-Year Action Plan
- 2018 IRP Remaining Schedule
- Questions

TAG 4 Recap

- Cascade values and appreciates the feedback received from stakeholders.
- Responses to stakeholder questions were sent out with the slide deck.
- Additional questions?

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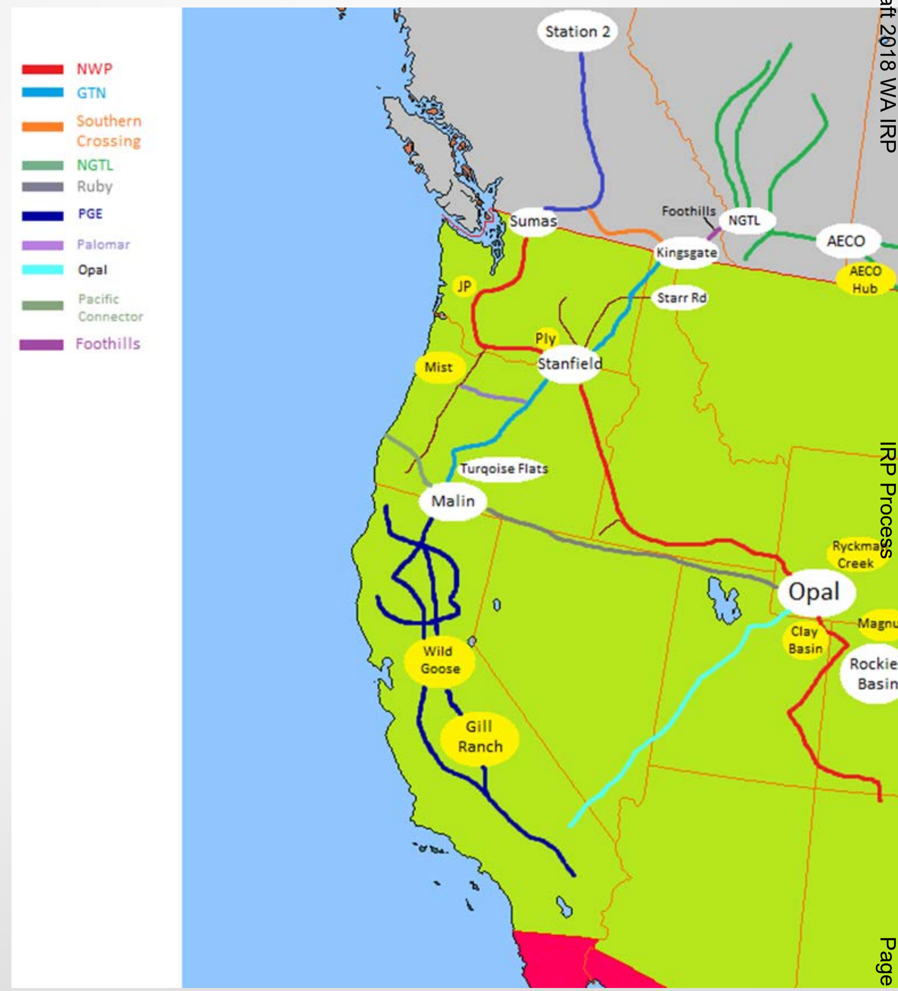
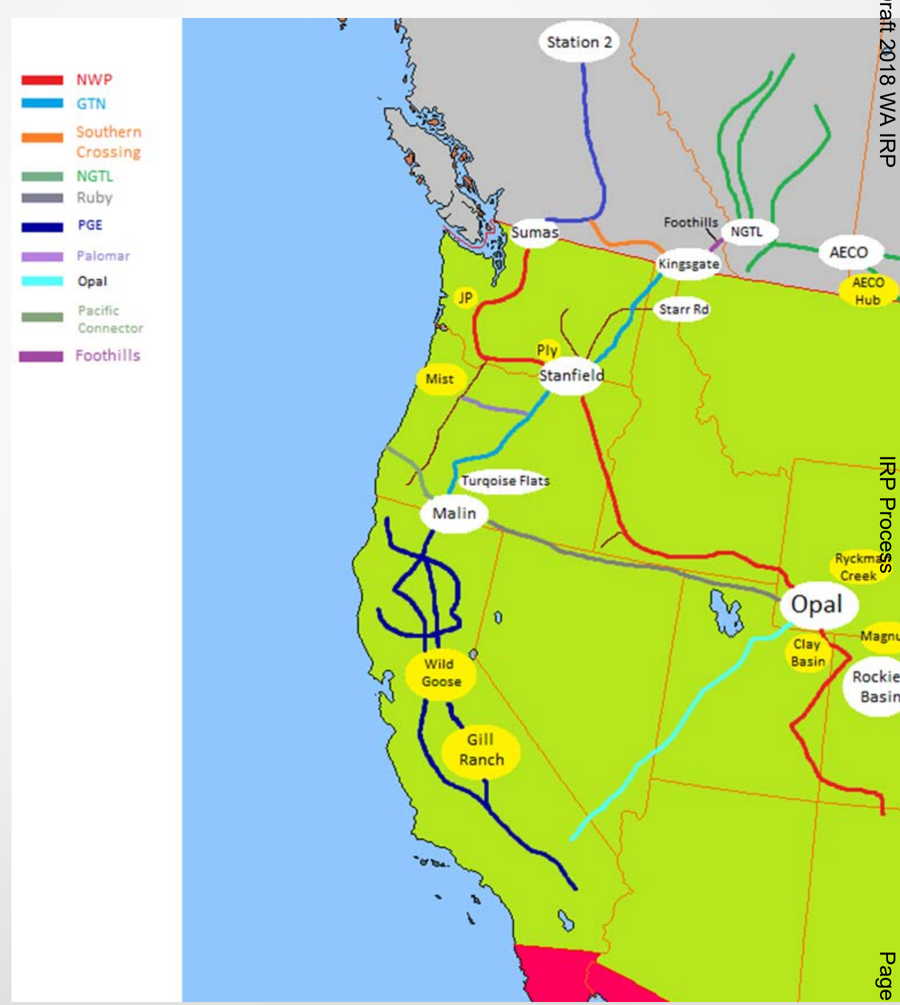
Summary of Additional Resources

Additional Potentia Resources

- Incremental Transport – North to South
- Incremental Transport – Northwest Pipeline
- Incremental Transport – South to North
- Incremental Transport – Bilateral



- Incremental Storage - North and East
- Incremental Storage - South and West
- Renewable Natural Gas



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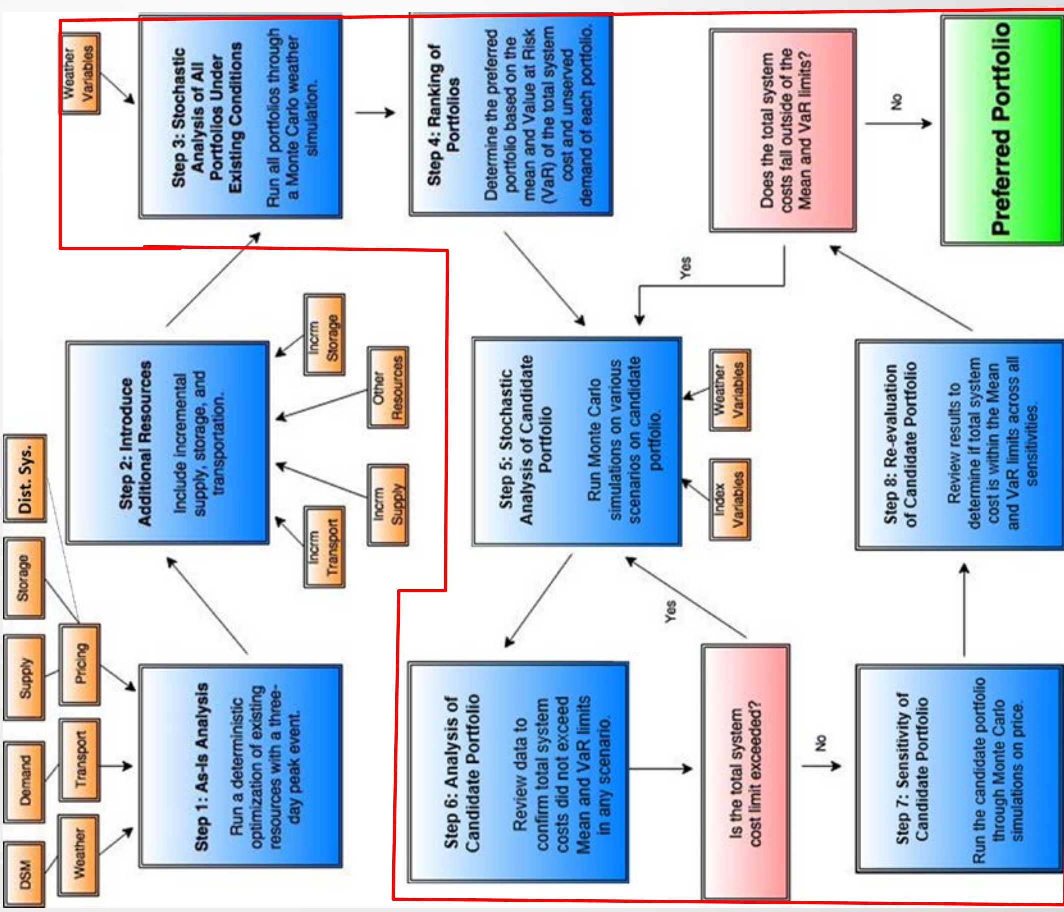
Components of Candidate Portfolios


DSM
Demand
Supply
Storage
Dist. Sys.
Weather
Transport
Pricing
Step 1: As-Is Analysis
Run a deterministic optimization of existing resources with a three-day peak event.
Step 2: Introduce Additional Resources
Include incremental supply, storage, and transportation.
Incrm Transport
Incrm Supply
Other Resources
Incrm Storage
Weather Variables
Step 3: Stochastic Analysis of All Portfolios Under Existing Conditions
Run all portfolios through a Monte Carlo weather simulation.
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.
Step 5: Stochastic Analysis of Candidate Portfolio
Run Monte Carlo simulations on various scenarios on candidate portfolio.
Index Variables
Weather Variables
Step 6: Analysis of Candidate Portfolio
Review data to confirm total system costs did not exceed Mean and VaR limits in any scenario.
Yes
Is the total system cost limit exceeded?
No
Step 7: Sensitivity of Candidate Portfolio
Run the candidate portfolio through Monte Carlo simulations on price.
Step 8: Re-evaluation of Candidate Portfolio
Review results to determine if total system cost is within the Mean and VaR limits across all sensitivities.
Does the total system costs fall outside of the Mean and VaR limits?
Yes
No
Preferred Portfolio

Recap – As-Is Shortfalls (Dth)

Zone GTN	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
	577	1,478	2,934	5,150	6,640	8,136	9,624	10,327
	2031	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**
	11,836	14,004	15,511	17,020	18,532	19,273	21,755	23,413

List of Candidate Portfolios

- All-In Portfolio
- GTN Only Portfolio
- GTN Plus Storage Portfolio
- NWP Only Portfolio
- NWP Plus Storage Portfolio
- Storage Only Portfolio

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All-In Portfolio

- Best deterministic mix of all alternative resources considered:
  - Incremental Transport – North to South
  - Incremental Transport – Northwest Pipeline
  - Incremental Transport – South to North
  - Incremental Transport – Bilateral
  - Incremental Storage – North and East
  - Incremental Storage – South and West

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All-In Portfolio – SENDOUT® Suggested Resource Mix

- Bremerton Shelton Realignment
- Incremental GTN Capacity From Stanfield – 8,369 Dth by 2028, 22,533 dth by 2038
- Incremental GTN Capacity From Kingsgate – 1,291 Dth by 2038
- Monitor Incremental Nova
- Spire (Formerly Ryckman Creek) Storage – 1,000 Dth in 2019

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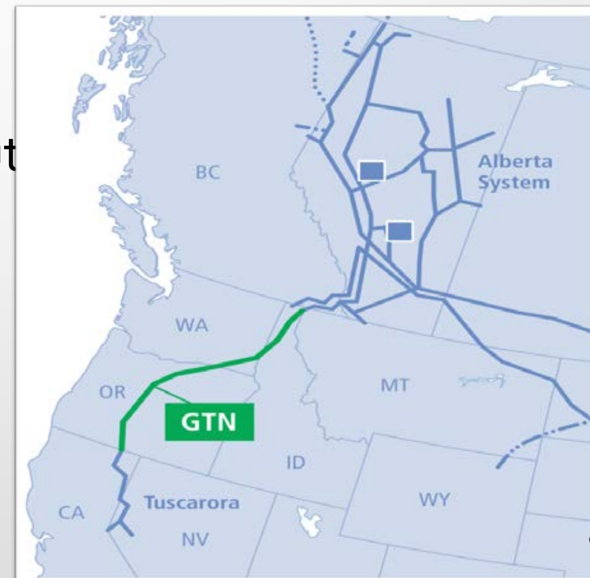
GTN Only Portfolio

- Best deterministic mix of all potential resources available on GTN:
  - Incremental Transport – North to South
  - Incremental Transport – South to North
  - Incremental Transport – Bilateral via Sout



GTN Only Portfolio – SENDOUT® Suggested Resource Mix

- Incremental GTN Capacity From Stanfield – 8,369 Dth by 2028, 12,115 dth by 2038
- Incremental GTN Capacity From Kingsgate – 3,380 Dth by 2038
- Incremental Nova – 11,710 Dth by 2038

GTN Plus Storage Portfolio

- Best deterministic mix of all potential resource available on GTN plus storage:
  - Incremental Transport – North to South on GTN
  - Incremental Transport – South to North on GTN
  - Incremental Transport – Bilateral via Southern Crossing
  - Incremental Storage – North and East
  - Incremental Storage – South and West

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GTN Plus Storage Portfolio – SENDOUT® Suggested Resource Mix

- Incremental GTN Capacity From Stanfield – 8,369 Dth by 2028, 12,115 dth by 2038
- Incremental GTN Capacity From Kingsgate – 3,380 Dth by 2038
- Incremental Nova – 11,710 Dth by 2038
- Spire Storage – 1,000 Dth in 2019

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NWP Only Portfolio

- Best deterministic mix of all potential resources available on NWP:
  - Incremental Transport – North to South
  - Incremental Transport – Northwest Pipeline
  - Incremental Transport – Bilateral via Trail West

NWP Only Portfolio – SENDOUT® Suggested Resource Mix

- Bremerton Shelton Realignment

NWP Plus Storage Portfolio

- Best deterministic mix of all potential resources available on NWP plus Storage:
  - Incremental Transport – North to South
  - Incremental Transport – Northwest Pipeline
  - Incremental Transport – Bilateral via Trail West
  - Incremental Storage – North and East
  - Incremental Storage – South and West

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NWP Plus Storage Portfolio – SENDOUT® Suggested Resource Mix

- Bremerton Shelton Realignment
- Spire Storage – 1,000 Dth in 2019

Storage Only Portfolio

- Best deterministic mix of all potential storage resources available:
  - Incremental Storage – North and East
  - Incremental Storage – South and West

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Storage Only Portfolio – SENDOUT® Suggested Resource Mix

- Spire Storage – 1,000 Dth in 2019

Summary of – SENDOUT® Suggested Resources by Portfolio

	All-In	NWP Only	NWP + Storage	GTN	GTN + Storage	Storage Only
Incremental NGTL						
Incremental Foothills						
Incremental GTN N/S						
I-5 Mainline Exp.						
Wenatchee Lateral Exp.						
Spokane Lateral Exp.						
Eastern OR Mainline Exp.						
Incremental Opal						
Incremental GTN S/N						
Incremental Ruby						
T-South Southern Crossing						
Trail West						
Pacific Connector						
Spire Storage						
AECO Hub Storage						
Clay Basin Storage						
Gill Ranch Storage						
Wild Goose Storage						
Mist Storage						

Legend	
	Selected resource for the portfolio
	Considered but not selected resource
	Not considered for the portfolio

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Methodology Behind Ranking of Portfolios

- New to the 2018 WA IRP, Cascade will be using deterministic results to identify the intrinsic value of a portfolio, and Value at Risk (VaR) analysis to capture the extrinsic value.
- Additionally, portfolios will be ranked primarily on their peak day unserved demand, and secondarily on their total system costs.
- Deterministic results are given 75% weight, and stochastic results 25% weight.

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Final Ranking of Portfolios

	Deterministic		Stochastic		Risk Adjusted Results	
Portfolio	Unserved Demand (MDT)	Total System Cost ($000)	Unserved Demand (MDT)	Total System Cost ($000)	Risk Adjusted Unserved Demand (MDT)	Risk Adjusted Total System Cost ($000)
All Resources	-	4,812,330	-	4,875,788	-	4,828,195
GTN Only + Storage	-	4,818,349	-	4,872,369	-	4,831,854
GTN Only	-	4,820,946	-	4,875,284	-	4,834,530
NWP Only + Storage	190	4,837,394	10	4,913,766	145	4,856,487
Storage Only	190	4,837,422	10	4,913,790	145	4,856,514
NWP Only	190	4,838,756	10	4,915,119	145	4,857,847

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Top Ranked Candidate Portfolio Components

- Bremerton Shelton Realignment
- Incremental GTN Capacity From Stanfield – 8,369 Dth by 2028, 22,533 dth by 2038
- Incremental GTN Capacity From Kingsgate – 1,291 Dth by 2038
- Monitor Incremental Nova

New Stochastic Methodology

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2016 IRP Methodology

- In previous IRPs, Cascade used the Monte Carlo functionality within SENDOUT® to run its stochastic analyses.
- SENDOUT® has computational limitations related to the number of draws it can perform, and the time it takes to complete those draws.
- For the 2018 IRP, Cascade has enhanced its methodology to allow for a more robust Monte Carlo simulation.

Cascade's New Methodology

- This year, Cascade will be performing a 10,000 draw Monte Carlo Simulation of weather and price using Excel and R.
- For each weather location Cascade records daily mean temperatures, standard deviations, and the largest 1 day jump to have historically occurred in that month.
- Cascade also records the correlations on a monthly level of each weather station to each other. This data is all loaded into R.

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Cascade’s New Methodology

- First, Cascade runs 1 draw of its Monte Carlo simulation for its first weather location.
- The normal random seed used each day for that draw is then run through a Cholesky decomposition matrix, which uses the correlations between each location to correlate the random variables for that first draw across all weather locations.
- This process is repeated 10,000 times, with the calculated HDDs from each draw stored in a separate matrix.

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Cholesky Decomposition Matrix - January

	Baker City	Bellingham	Bremerton	Pendleton	Redmond	Walla Walla	Yakima
Baker City	1						
Bellingham	0.6338301	0.7734723					
Bremerton	0.6584770	0.5837664	0.4749998				
Pendleton	0.7024465	0.3681832	0.0469737	0.6072920			
Redmond	0.7173640	0.3985243	0.1196151	0.2324631	0.5081539		
Walla Walla	0.7105065	0.3561187	0.0338146	0.5396395	0.0173972	0.2751418	
Yakima	0.6697351	0.3483110	0.0817184	0.3160165	-0.0036761	0.1685445	0.5432948

Cascade's New Methodology

- Cascade calculates a system weighted HDD for each draw, identifying the draw that results in the 99^{th} percentile of stochastic weather.
- The daily HDDs of each weather location in this draw are then loaded into SENDOUT®, which allows the Company to capture the costs and unserved demand of a given portfolio under extreme conditions.
- A similar process is undertaken for Monte Carlo simulations on price.

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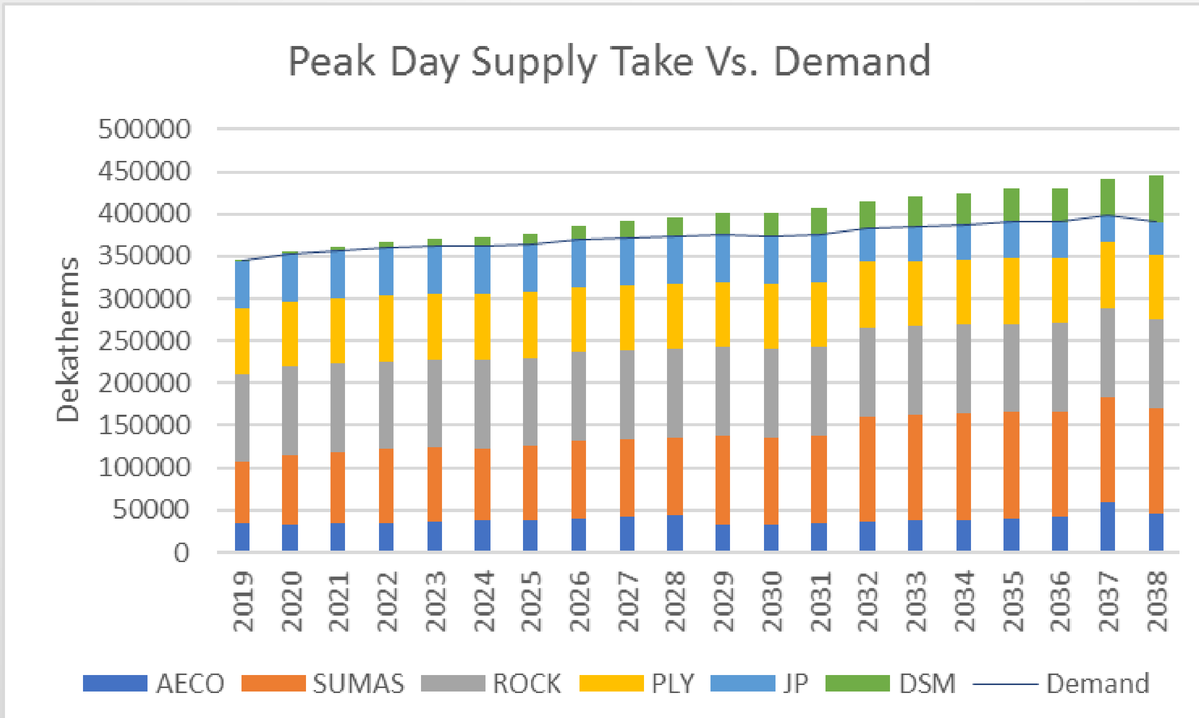
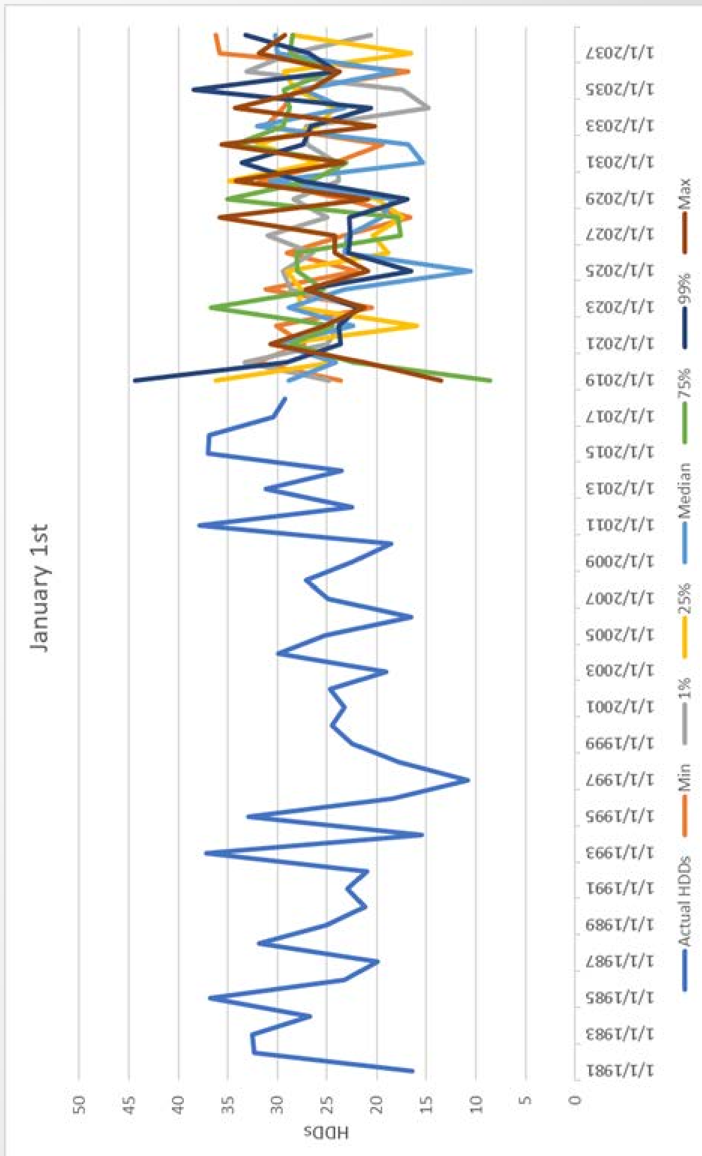
Scenario and Sensitivity Results

Peak Day Take Vs. Demand



HDD Draw Graph – January 1st



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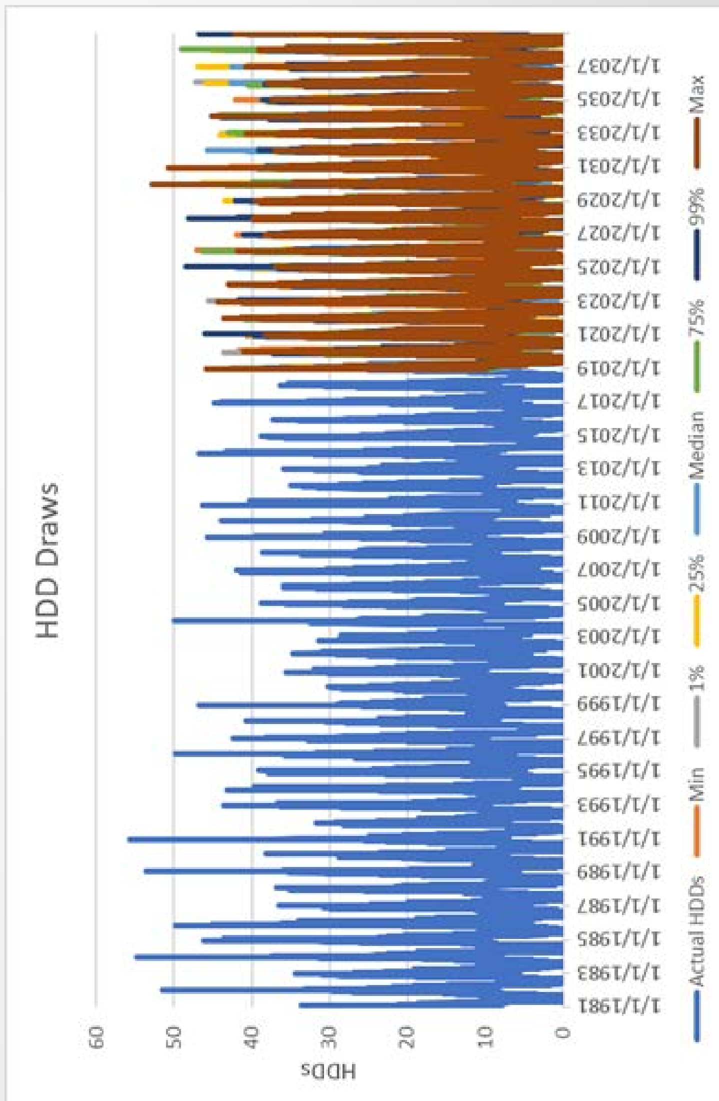
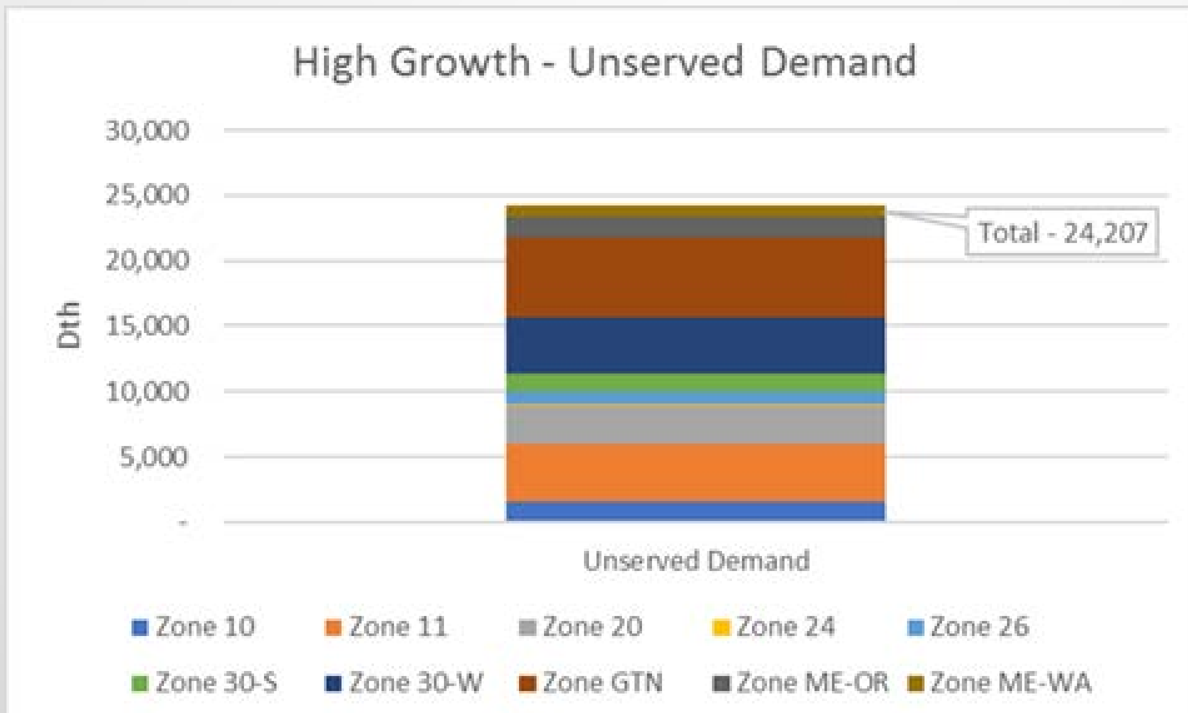
HDD Draw Graph – All Days



High Growth – Peak Day Unserved Demand



High Growth – Discussion

- In this scenario, the Company identifies minor potential shortfalls across its service area in 2038 under stochastic conditions.
- This does not invalidate the top ranked candidate portfolio, but provides a point of reference if weather and growth are unexpectedly high.
- Total system cost for this scenario was $5.23B, which does not exceed the VaR limit.

Carbon Sensitivity Discussion

- Cascade will include an analysis of three carbon sensitivities in its IRP, as discussed in TAG 4
  - I-1631 Ballot Initiative
  - SB 6203 – Inslee/Carlyle Carbon Tax
  - House of Representatives Market Choice
- Cascade's modeling has determined that its conservation programs are robust and comprehensive enough to meet projected DSM savings even at a lower than expected carbon future.

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Carbon Sensitivity Discussion

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  - House of Representatives Market Choice
- Cascade's modeling has determined that its conservation programs are robust and comprehensive enough to meet projected DSM savings even at a lower than expected carbon future.

Carbon Sensitivity Discussion

- **Residential**: Under all scenarios, there is a 5% decline in potential energy savings over the cumulative forecasts as well as in the short term with minimal differences between scenarios.
- **Commercial**: Under all scenarios, there was a 1-3% cumulative decline to potential energy savings and 3-6% in the short term. Commercial programs lost cost-effectiveness amongst all of the miscellaneous category of end uses, which include pool heaters.
- **Industrial**: All alternative carbon scenarios yielded the same results, reflecting an 8% decline in potential over the cumulative forecast and ~2% short term.

Changes to DSM forecast

The final DSM forecast reflects additional research into the feasibility of introducing new measures to the programs. This research will continue ahead of tariff filings. Other changes were made in consult with AEG. Below is a brief summary of the final DSM forecast by program:

Year	**2019**	**2020**	**2021**	**2026**	**2032**	**2038**
Residential	304,184	351,427	448,491	1,974,430	2,116,658	1,582,432
Com/Ind	370,587	437,271	513,429	1,122,763	1,082,389	884,551
Total	674,771	788,698	961,920	3,097,193	3,199,047	2,466,982

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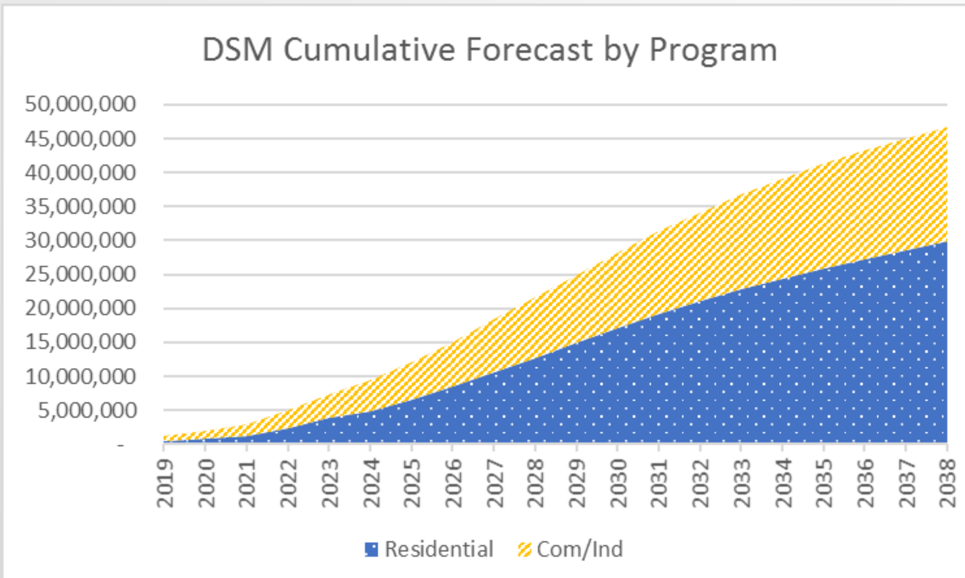
DSM Cumulative Forecast by Program



Scenario/Sensitivities versus Cost Limit

Scenario	TSC ($000)
VaR Limit	**6,035,244**
High Growth	5,255,008
Environmental Adder 30%	5,143,146
Environmental Adder 20%	5,060,205
No Alberta Supply	4,992,369
Price Forecast - High	4,978,170
Price Forecast - Low	4,873,367
No Rockies Supply	4,834,441
Expected Conditions	4,828,195
Environmental Adder 0%	4,765,309
Price Volatility - High	4,749,418
Low Growth	4,654,014
No BC Supply*	4,647,060

Conclusion

- Cascade has identified potential shortfalls at the gates served by GTN in Oregon, starting in 2023.
- The top ranking candidate portfolio included the Bremerton Shelton realignment, incremental capacity on GTN from both Kingsgate and Stanfield, and monitoring opportunities for incremental Nova capacity.
- Under expected conditions, this portfolio would eliminate the potential GTN.
- Additionally, this portfolio passes all scenario and sensitivity testing. It is Cascade's Preferred Portfolio.

Proposed Two-Year Action Plan

Environmental Policy

- Participate in City of Bellingham Climate Action Plan discussions.
- Participate on City of Bend Climate Action Steering Committee.
- Monitor service areas for potential GHG reduction goal development relating to energy delivery and supply.
- Monitor carbon pricing and policy developments nationally and statewide (i.e., WA ballot measure, WA CAR litigation, 2019 carbon tax or cap and trade bills, Market Choice, etc.).
- Monitor federal and state GHG regulation development for energy industry.
- Continuation of our current emission reduction and monitoring endeavors (i.e., Methane Challenge Program, Renewable Natural Gas studies).

DSM

- Perform continual technical review of new measures identified by the Applied Energy Group Conservation Potential Assessment as well as through participation in the Gas Technology Institute Emerging Technology workgroup for inclusion into the Energy Efficiency program portfolio.
  - This will allow the Company to determine whether the technology is available to installers within the CNGC service territory as well as enabling updates to incremental/install costs as applicable.
- Review and revise ramp rates within the LoadMAP model in compliance with best practices as recommended from the NWPCC and AEG, to align with measure maturity.
- Extend Northwest Energy Efficiency Alliance membership into cycle 6 (2020-2024) and elevate CNGC's participation to equal status with electric and dual fuel utilities on the Board of Directors allowing regional natural gas market transformation efforts to grow.
  - Fully engage in NEEA's Next Step Homes program starting in 2019 to support our expanding residential builder outreach efforts and participation.

DSM (Continued)

- Expand Commercial/Industrial program outreach and customer engagement.
- Enhanced Trade Ally engagement:
  - Drive commercial Trade Ally participation through the commercial program with the primary objective being to make the incentive program a simple part of the install process for all Trade Allies in our network installing in commercial/industrial properties and second, to increase the network where gaps exist.
  - Provide CNGC Sponsored TA training for underperforming measures including air sealing and potential duct sealing if added to the portfolio.
  - Expand a Point of Sale offering to residential Trade Allies to remove upfront cost barriers for customers to install higher-efficiency upgrades.
- Explore geographic pilots and efforts for specific offerings to underperforming areas within the service territory – for example in Zone 2 (Aberdeen, Longview, etc.).

Gas Supply

- Cascade will continue working with Gelber & Associates on a Hedging plan that will comply with the Docket UG-132019.
- By year end 2018, make a recommendation to GSOC regarding the volume and timing of acquiring incremental GTN capacity.

Avoided Cost

- Implement a risk premium, if appropriate, based on guidance from WUTC and from the UM 1893/ AR 621 rulemaking in Oregon.

Distribution System Planning

- Cascade has identified engineering projects to be put into the IRP. The projects as well as the costs will be provided in the draft IRP under confidential treatment.

Remaining Schedule

Date	Process Element	Location
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	

ADDITIONAL QUESTIONS?

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Bruce Folsom - Consultant

Cascade Natural Gas Corporation

2018 Integrated Resource Plan
Technical Advisory Group Meeting #5

September 18th, 2018

Seattle-Tacoma International Airport

Seattle, WA

WUTC Tag Meeting #5

Date & Time: 9/18/2018, 09:00 AM – 12:15 PM

Location: SeaTac Conference Center – Seoul Room

In attendance: Mark Sellers-Vaughn, Brian Robertson, Devin McGreal, Ashton Davis, Kyle Frankiewich, Andrew Rector & Carolyn Stone.

Called in: Bruce Folsom, Bob Morman, Amanda Sargent, Monica Cowlishaw, Eric Wood, Cory Dahl (Washington State Attorney General's Office)

Minutes by: Carolyn P Stone

Brian went over the Agenda for this meeting and went through introductions.

Tag 4 Recap, *Agenda item #3*

- Mark stated that feedback on the IRP has been very good. There are some tweaks needing done. Mark thanked Staff for their input!

***Presentation #1* - Summary of Additional Potential Resources** (Mark Sellers-Vaughn)

Question: Andrew asked about the GTN North to South transportation?
Answer: Mark and Brian both answered that this is a "bi-directional" transport which requires use of RUBY pipeline. This is incremental transportation, north to south, King to Malin and using NOVA/Foothills transmission.

Question: Kyle asked if you have to use Malin to get the gas transported?
Answer: Mark said we use Incremental NWP, north to south or south to north. Eric stated that transporting to Malin directly would use a higher pricing structure. King to Malin destination is California, so prices would be higher than at Sumas. We transport via RUBY to Malin to Turquoise Flats. Mark said CNGC has not recently been purchasing gas at Malin, but has in the past. Incremental transport bilateral = WCT to King, Trail west, this is the "lavender" line on the graph on Slide #5.

- Devin gave an update on proposals, the Bremerton/Shelton proposal Is still being modeled. During the next few weeks he said they will present results.
- Mark remarked that it appears the Shelton proposal makes sense!

Question: Kyle asked if the GSOC makes the decision on proposals?

Answer: Mark said it will be presented to GSOC, they will ask questions and then yes, they make the final decision.

- Mark commented that GSOC often will need to make quick decisions. This is a unique portion of our system, timing, complications in process, non-conforming agreements… decision…if it won't have to go through FERC.

Question: Andrew asked, "What non-confirming agreements?"
Answer: Mark explained that it has to do with how the pipeline posts capacity. There is a "Confidentiality Agreement" in place with PSE. In this case, it wouldn't get posted so it NWP must go to FERC to say that not posting it won't harm others in the market. It took a while to figure this out!

Question: Kyle asked if CNGC would get an "approval" or not?
Answer: Mark said it is not an approval, it is more a "non-action" or "statement". Kyle remarked, then we need to get this. Mark said we already have it!

Additional Potential Resources, Slide #6 (Brian Robertson)
- Brian explained, this slide shows incremental storage including Jackson Prairie, Plymouth, Mist and AECO Hub.
- South and west shows Wild Goose, Gill Ranch (modeling shows this CA transport is high $).
- Clay Basin, Spire (previously Ryckman Creek), and Magnum.

***Presentation #2*, Components of Candidate Portfolios** (Ashton Davis)

- Ashton introduced Slide #8 as the "Resource Optimization Process Flow".
- The area in red, Ashton said, is where we are focusing
- Steps 5,6,7 & 8 identify the preferred portfolio…Devin stated portfolios are still "candidates" though, until they go through the full process!

Question: Andrew asked the definition of VaR?
Answer: Devin said VaR means "Value at Risk". It is a risk analysis to put a tangible number to the most you could lose during a given time frame. This is a way to say in extreme conditions, what is the worst-case scenario?

Recap – As-is Shortfalls (Dth), Slide #9, (Ashton Davis)
- Ashton said at the last TAG meeting, there were GTN shortfalls. Citygates on GTN are in Oregon.
- Devin added that there are no shortfalls in Washington. Brian interjected stating the Zone 30-S and the Bremerton (Shelton) deal were still being analyzed.
- Mark stated that CNGC's system is geographically diverse – we have more delivery rights than receipt rights! We are assuming how gas will flow on peak day but can't guess how bi-directional gas will flow on NWP. The Bremerton/Shelton gives us capacity that is not used, but could be a shortfall if someone else picks up that capacity! Still fine-tuning portions of this. Part of the Portfolio's purpose is to fix an overall issue.
- Devin said, at a certain point, we will identify shortfalls, but modeling can do more than that! Modeling gives price spread information which helps bring down cost.

List of Candidate Portfolios, Slide #10 (Ashton Davis)

- There are 6 candidate portfolios:
  - o All-In, NWP transportation only, NWP + Storage, GTN transportation only, GTN + Storage, and Storage only.

All-In Portfolio, Slide 11 (Ashton Davis)

- Ashton said, the All-In Portfolio is the best deterministic mix of all alternative resources. We throw it all in and it gives us the best selection of solutions.

All-In Portfolio – SENDOUT Suggested Resource Mix, Slide #12 (Devin McGreal)

- Incremental GTN capacity from Stanfield…
- Incremental GTN capacity from Kingsgate…
- Monitor Incremental NOVA (until 2038, when we will add capacity in)
- Spire, 1,000 Dth in 2019

Question: Andrew asked about "monitoring"?
Answer: Devin and Ashton said keeping availability and pricing in mind. Mark said we monitor it per Staff…. NOVA and Malin particularly because of the shortfall.

- Devin asked why the capacity to Stanfield is so attractive… Mark said because GTN has mileage based transport rates. The Bremerton/Shelton proposal puts the shortfall closer to the Citygate. If there is a shorter way to go, we get a discount from Stanfield to Bend to Madras with the Bremerton/Shelton possibility!
- Kyle recalled that in the NWP proposal at the last Tag meeting, NWP brought this point up. This "sweetened" the deal. Mark said NWP would prefer we use them rather than us picking up additional RUBY capacity!
- Ashton said the selected "Spire" (formerly Ryckman Creek) has reliability issues. Ryckman Creek went through multiple bankruptcies, etc.

Question: Kyle send SENDOUT is deterministic and resource optimistic…?
Answer: Ashton said "Yes"! There is no way for SENDOUT to quantify reliability!

- Devin said that Spire will be under new management now and it will be explored further. CNGC may talk to the new management.
- Mark said they may give them more consideration in the Portfolio!

Question: Andrew asked… in 2019, hypothetically if you decide Spire is not a good idea, where would you get the extra 1K dth's?
Answer: Devin said, the 1,000 is a max # per day storage capacity, but not really needed. The 1,000 dth's do not solve a shortfall.

GTN Only Portfolio, Slide 13 (Ashton Davis)

- The next portfolios are not as robust as the "All-In", which is based on the best deterministic mix
- Devin said it gives you a reference point, i.e. what if something happens at NWP for example. We can then refer back to the 2018 IRP, so all Portfolios are very important!

Question: Kyle asked are the Portfolios now realistic options or "sky is falling" type?

Answer: Devin said 1. In a perfect world, we would do an All-In" gas and "All-In" Solar, but we have gas only. We used the same method previously and no feedback from Staff. Mark added that it is considered "best practice" at this point. This is not an emergency preparedness plan! However, we probably should be thinking about such things as terrorist attacks, etc.

- Devin reminded attendees that in the GTN only Portfolio, we are keeping all the NWP contracts. These are only ***incremental*** resources! This gives us real, tangible results. The All-In Portfolio will have NWP/GTN solutions, then we run through stochastic modeling and then it could show one of them is too expensive.
- Ashton said if we get better at quantifying risk, the Portfolios could get a lot more interesting!

Question: Kyle asked if getting more stochastic analysis numbers would make modeling more accurate?

Answer: Ashton "Yes!" Using deterministic results, the All-In" is as the top candidate Portfolio because it is fully served and the least cost option.

GTN Only Portfolio – SENDOUT Suggested Resource Mix, Slide #14 (Ashton Davis?)
- In the GTN Portfolio, we are hiding all NWP incremental resource
- It said to increase GTN from Stanfield capacity by 2,038
- It said to increase from Kingsgate
- Requests incremental NOVA

NWP Only Portfolio, Slide #17 (Ashton Davis)
- Bremerton Shelton realignment, shortfalls are on GTN mostly!

NWP Only Plus Storage Portfolio, Slide #19 (Ashton Davis)
- Incremental NWP North to South!

NWP Plus Storage Portfolio – SENDOUT Suggested Resource Mix - Slide #20 (Ashton Davis)
- Bremerton Shelton realignment
- Spire storage – 1,000 Dth

Storage Only Portfolio, Slide #21, (Ashton Davis)
- Spire, 1000 in 2019

Summary of – SENDOUT Suggested Resources by Portfolio, Slide 23, (Ashton Davis)
- Red boxes are not considered for Portfolio
- Yellow are considered but not selected by SENDOUT
- Green are selected resources for the Portfolio

Question: Devin asked Staff if this format works?

Answer: Andrew replied that it seems OK to him.

Question: Andrew asked…just to clarify, red falls outside of Portfolio?

Answer: Devin said "Yes".

Question: Kyle said red shows deterministic limitations on the Portfolio?

Answer: Devin said "Yes".

- Kyle remarked that this is clear, we want to do analysis to determine resources that make sense. This is consistent and clear!

Question: Kyle asked about a "piece of the puzzle" – how you made decisions on what resources to limit or choose…. trying to think, if this is the scenario – buys only GTN, no NWP, this wouldn't occur….?

Answer: Ashton says it boils down to a "gas only" solution. If you want some other competitive Portfolio let us know…where resources compete. We are wide open to suggestions!

Question: Kyle asked could you do all storage with needed capacity to get to the storage?

Answer: Devin said, the storage option includes transportation, but no other options.

Question: Kyle said if you make available storage in California but with no transport, then will it not work?

Answer: Devin said, Gill Ranch for example, we can buy storage capacity then put it on transport to get to the storage. Mark said we want to avoid arbitrariness, if 20K GTN capacity, then we determine Portfolio, it feels too arbitrary. We try to take the "arbitrariness" out!

Methodology Behind Ranking of Portfolios, Slide #24, (Ashton Davis)

1. Combination of deterministic results to identify the intrinsic value of the Portfolio and VaR analysis, to capture the extrinsic dollar value. For example, if you are thinking of going to college, what are the intrinsic and extrinsic values associated?
2. Ranked on peak day unserved demand and on total system costs.
3. Deterministic results, given 75% weight and stochastic results, 25% weight.

Final Ranking of Portfolios, Slide #25 (Ashton Davis)

- Risk-Adjusted results based on the 75/25 split.
- Deterministic, Stochastic, then Risk-Adjusted results.
- These numbers in MDT (Mega Dth's) and dollars in billions ($000)

Top Ranked Candidate Portfolio Components, Slide 26 (Ashton Davis)

1. Bremerton Shelton realignment
2. Incremental GTN capacity from Stanfield
3. Incremental GTN capacity from Kingsgate
4. Monitor incremental NOVA

Question: Carolyn asked how often the SENDOUT and stochastic modeling is done?

Answer: Brian said it is run for every IRP, or again if changes occur.

- Brian stated that "Step 4" is where we rank them, and there is lots of analysis including with Spire and without Spire.
- Kyle stated, if removing Spire is a management decision, what's preventing it from being included as a "continue exploring" item. If it is cost effective, you would need an explanation to Commissioners why not? Answer "not yet" so future needs are better understood. Continued analysis of Spire sounds good.

- Mark said we can add this to GSOC in the last section of the Alternative Resources portion. Put up analysis of Spire or other options…?

<u>Presentation #3</u>**<u>, New Stochastic Methodology</u>** (Ashton Davis)

- Ashton said in previous IRP's they used Monte Carlo IN SENDOUT and it took days! In 2018 using R for the Monte Carlo simulation.
- Devin said it doesn't need to run 10K runs. We can do stochastic analysis outside of SENDOUT on only what we need!
- Ashton aid CNGC is doing 10K Monte Carlo simulation of weather and prices using R.
- Brian said in the past they only ran 200 draws, this is exponentially more!

Cascade's new Methodology, Slide #30 (Ashton Davis)

1. We run 1 draw of Monte Carlo simulation for the first weather location**.**
2. Random seed is used each day for draw, then run thru "Cholesky Decomposition Matrix" (CDM). This is commonly used with Monte Carlo simulations. The Monte Carlo generates up correlated numbers, the CDM shows their correlation: Gives new weather profile – more realistic! Helps to give the 10K valuable draws!

Question: Andrew said it is not clear how the CDM figures the right numbers?
Answer: Ashton said Historical values.

Question: Kyle said it shows the magnitude of the correlation?
Answer: Devin answered "Yes!"

<u>Presentation #4</u>**<u>, Scenario and Sensitivity Results</u>** (Devin McGreal)

Peak Day Take Vs. Demand, Slide #34 (Devin McGreal)

- Devin said this shows how the top candidate Portfolio gets its gas!

HDD Draw Graph – January 1st, Slide #35 (Devin McGreal)

- How resources of stochastic analysis work
- Shows the noise we want to capture!

Question: Kyle asked what sort of system weighting is used?
Answer: Devin said all 7 weather locations are assigned a weight. Brian said we take the demographics and increase by 1 HDD to see how it impacts demand. It increases total demand.

Question: Kyle asked if correlated and separate HDD's and turn into 1 system HDD? Do we know system wide? Could it be a mismatch? Is HDD a good proxy of revenue/cost requirements?
Answer: Devin said it does. If you have a draw of the highest HDD's, you will have to buy supply and increase costs more than for 1 peak event.

High Growth – Peak Day Unserved Demand, Slide #37 (Devin McGreal)

- 99 Percentile of weather
- In 2038, a large peak event!

- Potential unserved demand

Question: Question was asked, are you not planning for uncertain demand?
Answer: Devin said the scenarios = demand impacting externalities, the sensitivity includes mostly price forecasts. We don't plan for this, we use it as a tool. We would want to know what total system costs are in this scenario.

High Growth Discussion, Slide #38, (Devin McGreal)
- Major shortfalls in 2038
- Does not invalidate ranked Portfolio!
- The low growth scenario was brought up and Brian said that is usually "ho hum", but if we do an expected low growth scenario that might push back as a shortfall and this is important information to keep in mind!

Carbon Sensitivity Discussion, Slide #39, (Devin McGreal)
- There are 3 different carbon sensitivities:
    - I-1631 Ballot
    - SB 6203 Carbon Tax
    - House of Rep Market Choice
- Model shows that conservative program is robust and comprehensive so will meet DSM savings at a lower than expected carbon future.
- Amanda said at 1% and 3% over long term in her analysis – over full-time horizon not a meaningful difference!

Change to DSM Forecast Discussion, (Devin McGreal)
- DSM feasibility of new measures to programs, the #'s will be in the IRP. We consult with Applied Energy Group (AEG).

Scenario/Sensitivity vs Cost Limit, Slide #42, (Devin McGreal)
- 1.2X total system cost
- Any show an extremely high cost?
- VaR limit is manager set
- No method to fully set VaR limit
- At what point are you at risk? …$6,035,244,000!
- High growth, high cost as expected

Question: Staff asked…BC Supply looks better for us…why?
Answer: Devin said there is a lot of unserved demand in this scenario. If any kind of catastrophe – confirms no other solution. *Unserved* shows *not served* by SENDOUT model.

Conclusion, Slide #43 (all)
- Identified shortfalls in GTN start in 2023 in the top-ranking Portfolio
- Under expected conditions this Portfolio eliminates GTN
- This Portfolio passes all scenario and sensitivity testing.
- This is Cascade's preferred Portfolio

Question: Carolyn asked if the decision to use this Portfolio is by GSOC?

Answer: Mark said the decision first goes thru Chris & Eric and himself then to Kevin Connell, then if Kevin OK's it, it is presented to GSOC for final decision.

Question: Andrew asked if all the analysis is done?
Answer: Mark replied that a little still needs done and double checking. Because our system is so unique you almost have to go through this line by line…i.e. does it make logical sense, can it flow operationally…is it realistic…can you really do it??

***Presentation #5*, Proposed Two-Year Action Plan** (Devin McGreal)

Environmental Policy, Slide #45 (Brian Robertson)

- Participation in environmental discussions and on committees
- Monitor service areas
- Monitor carbon pricing and policy development (WA ballot, carton tax, "Market Choice")
- Monitor federal and state Green House Gas (GHG) regulation
- Monitor current emission reduction & monitor endeavors (methane & renewable gas studies)
- Monica said they are keeping us much more aware of what is out there. We are keeping an eye on it and what we see, we take back to the Resource Planning team!
- Amanda said that for Bellingham regarding equipment to add to the Portfolio, we've been considering it and offering rebates.
- Devin said, that would change the DSM numbers.

DSM, Slide #46 (Brian Robertson)

- Brian said technical review of new measures
- Amanda said NEAA Board Meeting last Thursday voted to be on board – moving along with a 2-year plan. This is the 1st step to increasing our engagement with Jim Snyder with the Commission. We will continue!

Question: Carolyn asked if DSM is included in the Portfolio analysis?
Answer: Devin said it IS input as free supply, though it is not "free", it acts to decrement demand…. we can add a dotted line to graph to show this!

DSM (Continued), Slide #47 (Brian Robertson)

- Kyle encouraged company and staff to tie these two pieces together! Closing the loop on this…i.e. "We said in IRP we would do this and this is how we will do it," ...connecting things would help!
- Monica said we do include it, but we will expand on it from a strategic perspective.

Gas Supply, Slide #48 (Brian Robertson)

- Hedging Plan Docket – UG 132019, in 2018 make a recommendation
- Add in monitor Spire & NOVA!

Avoided Cost, Slide #49 (Brian Robertson)

- Implementation of a risk premium

Question: Staff asked about "rulemaking on Avoided Cost in Oregon"?

Answer: Devin said we are required to file Avoided Cost with the commission for approval, so working with the LDC's together on one format. After approval in middle of next year, the subcommittee will talk about the components of the Avoided Cost calculation.

- We are open to a Risk Premium
- A/R 621 workshop is in July, feedback about risk premium will happen then.
- Regional "Best Practices", should be put in next IRP.

Question: Andrew asked of the Avoided Cost calculation is different between WUTC & OPUC?
Answer: Devin answered that the cost of gas would be the major change.

- Kyle said he is encouraged to hear that OR has a more robust system than we do. The original intent of bringing up Avoided Costs was to figure formatting and presentation and where it came from, what it means and get it on 1 page. I don't see a reason not to do this. If OR is happy then we would be hard pressed to not use it.
- Devin said Stakeholders originally found it not transparent. The purpose is to make it so!

Question: Carolyn asked, will it be easy to get the LDC's together on this format?
Answer: Mark said we have already had meetings and it is not easy.

Distribution System Planning, Slide #50 (Brian Robertson)

- Engineering projects to be put into the IRP

Question: Brian asked Staff if anything is missing?
Answer: Andrew said we will let you know.

Remaining Schedule, Slide #51 (Brian Robertson)

- Brian went over the remining schedule for the IRP, stating that there can be a Tag #6 if stakeholders want one.
- The Final IRP is due on December 14th in Washington!

Additional Questions, Slide #52 (Ashton Davis)

- Ashton went over the contact information on this slide.
- Mark asked Cory, on the phone if he had any questions.
- Cory said he did not right now.

Mark closed the meeting saying thank you to everyone for their participation and attendance. Mark said that 2018's IRP should be a step above the 2016 IRP based on your input!

Mark asked if Bruce had any comments:
Bruce said: 1) It is so gratifying to see the advanced tools the Resource Planning group is using in just 2 short years!
2) It is also gratifying to see the stakeholder engagement. This is quality. It is so good to see involvement, asking questions and gaining understanding!

The meeting was adjourned at 12:15 PM.