2020 Natural Gas IRP Schedule


TAC 2 (Dual Meeting with Power side): Thursday, August 6, 2020: Market Analysis, Price Forecasts, Cost Of Carbon, Environmental Policies
  • Demand Results and Forecasting – August 18, 2020

TAC 3: Wednesday, September 30, 2020: Distribution, Avista’s current supply-side resources overview, supply side resource options, renewable resources, Carbon cost, price elasticity, sensitivities and portfolio selection modeling.

TAC 4: Wednesday, November 18, 2020: CPA results from AEG & ETO, review assumptions and action items, final modeling results, portfolio risk analysis and 2020 Action Plan.
<table>
<thead>
<tr>
<th>Topic</th>
<th>Topic Length</th>
<th>Start Time</th>
<th>End Time</th>
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</thead>
<tbody>
<tr>
<td>Introductions/Agoenda</td>
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<tr>
<td>Avista and Carbon Reduction</td>
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<tr>
<td>Current Supply Side Resources</td>
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<tr>
<td><strong>BREAK</strong></td>
<td>15 minutes</td>
<td>10:15 AM</td>
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<tr>
<td>Renewable Natural Gas</td>
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<td>Hydrogen</td>
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<td><strong>LUNCH BREAK</strong></td>
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<td>Distribution</td>
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<td>Supply Side Resource Options</td>
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<tr>
<td>Carbon Costs/Price Elasticity</td>
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<td>3:00 PM</td>
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<tr>
<td>Sensitivities</td>
<td>30 minutes</td>
<td>3:00 PM</td>
<td>3:30 PM</td>
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Avista and Carbon Reduction

Jody Morehouse
Director – Natural Gas Supply
Planning for a Deeply Decarbonized Future

Active Energy Policy Environment

• Washington
  – Carbon reduction goal House Bill 2311
  – RNG/EE House Bill 1257

• Oregon:
  – RNG Senate Bill-98
  – Cap and Reduce Executive Order 20-04

*Focus on solutions that balance carbon reduction, affordability, and reliability*
Avista's Environmental Objectives

- Build further recognition of Avista’s continued commitment to environmental stewardship
- Acquire renewable supplies based on the demand of our customer base and/or policy direction
- Fully account for all costs of natural gas including carbon attributed to upstream emissions
- Continue to engage with state and local governments on all existing and future climate policy
- Increase understanding of how natural gas currently works as part of the energy ecosystem, ensuring that customers have choices for their energy needs that include access to reliable energy at affordable prices
- Demonstrate Avista’s leadership in responsibly managing a transition to a cleaner energy mix while being sensitive to customers’ and other stakeholders’ interests
Natural Gas is an Important Part of a Clean Energy Future

• In the right applications, **direct use of natural gas is best use**

• Natural gas generation provides **critical capacity** as renewables expand until utility-scale storage is cost effective and reliable

• **Full electrification can lead to unintended consequences:**
  - Creates new generation needs that may increase carbon footprint
  - Drives new investment in electric distribution, generation, and transmission infrastructure, causing bill pressure
  - Home and business conversion costs borne by customers

• Customers have paid for a vast pipeline infrastructure that can utilized for a cleaner future by **transitioning the fuel** and keeping the pipe

• A comprehensive view of the energy ecosystem leads to a **diversified approach to energy supply** that includes natural gas
Benefits of Natural Gas

• **For Customers.** Natural gas is affordable, resilient, and reliable.

• **For Society.** Natural gas is an abundant energy resource produced in North America, which helps lessen our dependency on foreign oil.

• **For Innovation.** Natural gas can play a supporting role in expanding the use of renewable energy sources.

• **For Environment.** Natural gas is the cleanest burning fossil fuel, so it helps reduce smog and greenhouse gas emissions.

• **For Economy.** Natural gas provides nearly a fourth of North America’s energy today.
Current Supply Side Resources

Justin Dorr
Resource Manager, Natural Gas Supply
Interstate Pipeline Resources

• The Integrated Resource Plan (IRP) brings together the various components necessary to ensure proper resource planning for reliable service to utility customers.

• One of the key components for natural gas service is interstate pipeline transportation. Low prices, firm supply and storage resources are meaningless to a utility customer without the ability to transport the gas reliably during cold weather events.

• Acquiring firm interstate pipeline transportation provides the most reliable delivery of supply.
Pipeline Contracting

Simply stated: The right to move (transport) a specified amount of gas from Point A to Point B
Contract Types

• Firm transport
  – Point A to Point B

• Alternate firm
  – Point C to Point D

• Seasonal firm
  – Point A to Point B but only in winter

• Interruptible
  – Maybe it flows, maybe it doesn’t
Avista's Transportation Contract Portfolio

Avista holds firm transportation capacity on 6 interstate pipelines:

<table>
<thead>
<tr>
<th>Pipeline</th>
<th>Expirations</th>
<th>Base Capacity Dth</th>
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<tbody>
<tr>
<td>Williams NWP</td>
<td>2025 – 2042 (2035)</td>
<td>290,000</td>
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<tr>
<td>Westcoast (Enbridge)</td>
<td>2026</td>
<td>10,000</td>
</tr>
<tr>
<td>TransCanada - NGTL</td>
<td>2024-2046</td>
<td>208,000</td>
</tr>
<tr>
<td>TransCanada - Foothills</td>
<td>2024-2046</td>
<td>204,000</td>
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<tr>
<td>TransCanada - GTN</td>
<td>2023-2028</td>
<td>210,000 164,000</td>
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<tr>
<td>TransCanada - Tuscarora</td>
<td>2023</td>
<td>200</td>
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Pipeline Overview
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
- 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
GTN Overview

- Transports WCSB and Rockies natural gas to Washington, Oregon and California
- Approximately 1,377 miles of pipeline
- Kingsgate best efforts receipt capability of approx. 2.87 Bcf/d and throughput capacity of approx. 2 Bcf/d through Station 14
- Deliveries of up to 1.5 Bcf/d to non-California Markets
- Concurrent transport expansions from NIT to Malin:
  - Tranche 1
    - 110 TJ/d (NGTL and FHBC), 100 MDth/d (GTN)
    - November 1, 2022 - Targeted in-service
  - Tranche 2
    - 175 TJ/d (NGTL and FHBC), 150 MDth/d (GTN)
    - November 1, 2023 - Targeted in-service
NGTL to Malin West Path expansion

- Connecting WCSB supply to key North American markets
- Valued transport path for both Supply and End Use Shippers

Concurrent transport expansions from NIT to Malin:

**Tranche 1**
- 110 TJ/d (NGTL and FHBC), 100 MDth/d (GTN)
- November 1, 2022 - Targeted in-service

**Tranche 2**
- 175 TJ/d (NGTL and FHBC), 150 MDth/d (GTN)
- November 1, 2023 - Targeted in-service
- **Average** term of awarded capacity:
  - 31.3 years NGTL
  - 31.4 years Foothills BC

FOR DISCUSSION PURPOSES ONLY | SEPTEMBER 2020
WCSB gas is competitive in key markets, **Safety, Toll Competitiveness & Reliability** is Our Focus

**WCSB (77% TC Energy)**
- 15.6 Bcf/d supply
- 7.1 Bcf/d intra basin load
- 8.7 Bcf/d export
- 4 Bcf/d LNG projected

**Pacific**
- 8.3 Bcf/d market
- 2.2 Bcf/d via TC

**Chicago (Mid-West)**
- 12.7 Bcf/d end use market
- 1.6 Bcf/d from WCSB via TC

**U.S. Northeast**
- 6.9 Bcf/d market
- 0.7 Bcf/d via TC

**Eastern Canada**
- 4.2 Bcf/d market
- 2 Bcf/d from WCSB via TC

**NGTL System** provides access to **stable supply source** for WCSB end users and allows **unique opportunity** producers to compete in multiple export markets.
Storage – A valuable asset

- Peaking resource
- Improves reliability
- Enables capture of price spreads between time periods
- Enables efficient counter cyclical utilization of transportation (i.e. summer injections)
- May require transportation to service territory
- In-service territory storage offers most flexibility
Avista's Storage Resources

Washington and Idaho
Owned Jackson Prairie
• 7.7 Bcf of Capacity with approximately 346,000 Dth/d of deliverability

Oregon
Owned Jackson Prairie
• 823,000 Dth of Capacity with approximately 52,000 Dth/d of deliverability
Leased Jackson Prairie
• 95,565 Dth of Capacity with approximately 2,654 Dth/d of deliverability
The Facility

- Jackson Prairie is a series of deep, underground reservoirs – basically thick, porous sandstone deposits.
- The sand layers lie approximately 1,000 to 3,000 feet below the ground surface.
- Large compressors and pipelines are employed to both inject and withdraw natural gas at 54 wells spread across the 3,200 acre facility.
Renewable Natural Gas (RNG)

Michael Whitby, RNG Manager
Advancing RNG at Avista

Avista has been actively preparing to participate in RNG. The following topics covered in this section of the presentation are as follows:

- Renewable Natural Gas (RNG) Explained
- RNG – A Climate Change Solution
- Policy & Regulation
- Industry Reports
- Avista’s Commitment to Carbon Reduction
- Avista’s RNG Program & Team
- Program Considerations
- RNG Market Studies & Voluntary Customer Program
- Pipeline Safety & Interconnection Requirements
- Environmental Attribute Tracking & Banking
- RNG Production Technologies & Project Types
- RNG Opportunities and Challenges
- Cost Effectiveness Evaluation Methodology
Renewable Natural Gas (RNG) Explained

Renewable Natural Gas Explained
Renewable Natural Gas (RNG) is a non-fossil gas resource derived from various renewable waste stream sources including but not limited to landfills, wastewater treatment plants, food waste, and agriculture waste such as dairy farms, and other livestock farms. These feedstocks utilize anaerobic digestion to generate biogas, which in turn can be processed to meet pipeline quality RNG. Forest wood waste can also be converted to biogas via thermal gasification methods and made pipeline ready.

Viable feedstocks that are expected to continually operate and or expand will provide an opportunity for RNG to be produced in perpetuity, and shall serve to displace geologic gas volumes, and capture otherwise fugitive methane. As such, RNG can play an important role in decarbonizing our gas system through RNG customer programs and projects to reduce greenhouse gas (GHG) emissions, and the carbon footprint associated with geologic gas.

RNG is fully interchangeable with conventional natural gas and utilizes the existing natural gas distribution system network to seamlessly serve residential, commercial and industrial end users without any additional building improvements, equipment, or special equipment requirements.
RNG – A Climate Change Solution

Natural gas plays critical role for meeting aggressive green house gas (GHG) reductions goals, RNG even more so!

- Advantages of RNG
  - “De-carbonizes” gas stream
  - Gives customers another renewable choice
  - RNG is a strong pathway option for decarbonizing the thermal market
  - RNG utilizes existing infrastructure as it is fully interchangeable with conventional natural gas with no end user equipment modifications or replacement
  - RNG is a more economical solution than electrification which requires the procurement of added renewable electric resources, distribution system upgrades, and has a significant impact to end users due to the necessary replacement of building equipment and systems
  - In the right applications, **direct use of natural gas is best use**
  - Natural gas generation provides **critical capacity** as renewables expand until utility-scale storage is cost effective and reliable
Policy & Regulation:

**Washington HB 2580**
- RNG study requested by legislature from WA Department of Commerce & WSU Energy Program

**Washington HB 1257**
- Building efficiency bill that includes RNG
- Requires utilities to offer voluntary RNG programs/products to customers
- Allows utilities to invest in RNG projects and recover the costs

**Oregon SB 334**
- Directs the Oregon Department of Energy to conduct a biogas and renewable natural gas inventory and prepare a report

**Oregon SB 98 & AR 632 Rule Making**
- Final rules effective on July 17th 2020
- Allows investment recovery, percent of revenue requirement per year to be determined based on potential project costs & timing, pending petition to participate
- Allows investment in gas conditioning equipment without RFP process
Industry Reports:

Avista is familiar with these relevant industry reports and has utilized them to understand the RNG industry in general as well as the potential in Washington & Oregon.
Avista’s Commitment to Carbon Reduction

RNG is a Pathway to Decarbonizing the Natural Gas System

▪ By utilizing waste streams to create green fuel, RNG can play an important role in supporting Avista’s environmental strategy
▪ RNG provides Avista’s customers with a new environmentally friendly, low carbon fuel choice, delivered seamlessly via Avista’s existing natural gas system
Avista’s RNG Program & Team

Avista has been assessing and planning for RNG

- Program Manager in place
- Program Charter in place
- Program Execution Plan drafted
- Participation in the regulatory and rule making process in OR & WA, informal and formal
- Business Development efforts in pursuit of multiple RNG projects continues
- Business Cases developed for consideration in Avista’s five year capital planning cycle
- RNG Project accounting established
- Cross-functional team in place to support RNG:
  - Gas Engineering
  - Gas Supply
  - Legal
  - Governmental Affairs
  - Regulatory Affairs
  - Products & Services
Program Considerations

- Evaluate available RNG procurement options
- Pursue potential RNG development opportunities from local RNG feedstock resources under new legislation (Washington HB 1257 & Oregon SB 98)
- Develop an understanding of RNG development cost, cost recovery impacts to customers, resulting supply volumes and RNG costs
- Evaluate potential RNG customer market demands vs. supply
- Participation in rule making and policy:
  - Participation in HB 1257 Policy development
  - Participation in SB 98 Policy Rulemaking via AR 632 informal and formal
  - Cost recovery proposal led by NWGA with input from all four Washington LDC’s
  - Collaborative RNG Gas Quality Framework established across four WA LDC’s
RNG Market Studies & Voluntary Customer Program

- RNG Commercial Market Study completed in 2019
- RNG Residential Market Survey concluded in September 2020
  - Customers lack understanding of RNG since it is a new concept
  - Customers like the environmental aspects of RNG
  - Customers like to choose their level of participation to manage costs predictably
- Voluntary customer RNG program design will advance based on the studies above
- Estimate voluntary customer program demands
- RNG to be added to Avista’s renewables portfolio
Pipeline Safety & Interconnection Requirements

- Avista Gas Quality Specification developed
- Collaborative RNG Gas Quality Framework established across (4) WALDC’s
- Avista Interconnection Agreement template developed
- Avista Study Agreement and RNG Producer review process template developed
Environmental Attribute Tracking & Banking

Under OR SB 98 the M-RETS system has been selected to track RNG environmental attributes. Other jurisdictions including Washington may also select this system:

- 1 Renewable Thermal Certificate (RTC) = 1 Dekatherm (Dth) of RNG
- Transparent electronic certificate tracking
- Not a certification entity
RNG Production Technologies & Project Types

Avista is actively evaluating a handful of potential Anaerobic Digestion Projects throughout Washington and Oregon.

RNG Production Technologies

RNG Technologies:

- Conventional RNG: Amine scrub, membrane separation, water wash, PSA
- Hydrogen blending
RNG Opportunities & Challenges

California RNG market ($30+/Dth v. $2/Dth)
- Vehicle emission incentives shut-out other potential end users
- Producers see the pot of gold in Federal RIN & California LCFS markets
- RNG supplier cost volatility

Financing for producers
- RIN market is volatile
- No forward pricing for RNG RTC’s in carbon market
- Vehicle market may be approaching saturation in CA
- Environmental attribute value for local markets is undefined
RNG Opportunities & Challenges

Utility RNG Projects

- Feedstock owners can now partner with LDC’s to cultivate new RNG projects.
- Feedstock owners willingness to partner with the utility’s cost of service model. This is a foreign concept to feedstock owners that seek highest value for their biogas.
- LDC’s are credit worthy partners offering long term off-take contracts to feedstock owners.
- Each RNG project is unique with respect to capital development costs & resulting RNG costs.
- Each RNG project will vary in size, location and distance to interconnection pipeline, feedstock type, gas conditioning equipment and requirements and operating costs.
- Economies of scale – Low volume biogas opportunities face economic challenges.
- New RNG Projects can take 2-3 years to develop.
- Customers have paid for a vast pipeline infrastructure that can be utilized for a cleaner future by transitioning the fuel and keeping the pipe.
## RNG Opportunities & Challenges

### RNG $ per Dth/MMBtu

<table>
<thead>
<tr>
<th>Source: Promoting RNG in WA State</th>
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<tbody>
<tr>
<td><strong>Avista Owned and Operated</strong></td>
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<tr>
<td><strong>ID - WA 2035 Premium Estimate ($ / Dth)</strong></td>
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<tr>
<td>RNG - Landfills</td>
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<tr>
<td>RNG - Waste Water Treatment Plants (WWTP)</td>
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<tr>
<td>RNG - Agriculture Manure</td>
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<tr>
<td>RNG - Food Waste</td>
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### Graph

Source: Promoting RNG in WA State
RNG Opportunities & Challenges

Carbon Intensity will pay a role in how the environmental attributes / Renewable Thermal Certificate (RTC) values will be determined

<table>
<thead>
<tr>
<th>Fuel Pathway</th>
<th>Carbon Intensity gCO₂e MJ⁻¹</th>
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<tbody>
<tr>
<td>Diesel*</td>
<td>102.01</td>
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<tr>
<td>Gasoline*</td>
<td>99.78</td>
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<tr>
<td>Fossil CNG†</td>
<td>78.37</td>
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<tr>
<td>Landfill CNG†</td>
<td>46.42</td>
</tr>
<tr>
<td>WWTP CNG*</td>
<td>19.34</td>
</tr>
<tr>
<td>MSW CNG*</td>
<td>-22.93</td>
</tr>
<tr>
<td>Dairy CNG†</td>
<td>-276.24</td>
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*California Code of Regulation Title 17, §95488, Table 6. Carbon intensity for WWTP is the average of two WWTP pathways.
†California Code of Regulation Title 17, §95488, Table 7.
‡Method 2B Application CalBio LLC, Dallas Texas, Dairy Digester Biogas to CNG.
RNG Opportunities & Challenges

RNG RTC values within the utility construct cannot compete with the RNG values driven by the RFS RIN & LCFS markets

RIN = renewable identification number

Source: CARB

Source: EPA
**RNG Opportunities & Challenges**

WA RNG Report (HB 2580) – Utility’s have the opportunity to leverage the remaining RNG opportunities to decarbonize the natural gas system

*Released December 1, 2018*


<table>
<thead>
<tr>
<th>Existing Projects</th>
<th>Near Term Projects</th>
<th>Medium Term Projects</th>
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</thead>
<tbody>
<tr>
<td>Cedar Hills Landfill (King County)</td>
<td>Roosevelt Landfill (Republic Services) Klickitat County PUD</td>
<td>South Treatment Plant (King County) Puget Sound Energy</td>
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</tbody>
</table>

**Dth**

- 0
- 500,000
- 1,000,000
- 1,500,000
- 2,000,000
- 2,500,000

- Landfills
- Wastewater treatment plants
- Dairy digesters
- Municipal food waste digesters
- Food processing residuals
- Food processed at compost facilities
- Landfills
- Wastewater treatment plants
- Dairy digesters
- Municipal food waste digesters

*Released December 1, 2018*
Cost Effectiveness Evaluation Methodology

Developing the Methodology….a work in process

- Avista is creating a cost effectiveness evaluation methodology for evaluating RNG projects. The following slides are a snapshot of Avista’s work in progress.
- The methodology shown is derived from OPUC UM2030, also referenced in the OPUC SB 98 AR 632 Rulemaking
- The evaluation method shown herein is subject to input, refinement and reconsideration.
Hydrogen

Tom Pardee
Planning Manager, Natural Gas Supply
Hydrogen

• The energy factor of H2 Low Heating Value (LHV) is roughly equivalent to a gallon of gasoline or 114,000btu
  – This equates to 8.78 kg of H2LHV per Dth
• Most H2 is currently made from reforming natural gas
  – The energy can come from Nuclear (Pink), Renewables (Green) or Fossil fuels (Grey)
• High cost (currently) when compared to energy in a Dth combined with current prices of natural gas
• Hydrogen can only be stored in the pipeline as a % of gas or combined with a carbon source to produce methane.
• Hydrogen is lighter than air and diffuses rapidly (3.8x faster than natural gas) making it more difficult to contain
PtG Process

Source: http://www.europeanpowertogas.com/about/power-to-gas
Power to Gas

- Power to Gas (PtG) is a process using power to separate water into hydrogen and oxygen.
- Hydrogen can be stored, as a % of gas, in the existing gas grid or used in the mobility sector (blend up to 20%).
- PtG can help to balance excess power from intermittent sources like wind and solar.
- PtG can decarbonize the direct use of natural gas.
- PtG economics will advance as more renewables are added and the technology matures.
- Short term and seasonal energy storage.
- Stored in the existing gas pipeline.
PtG Benefits

Benefits

- Cleans up the grid using excess power
- Stores the energy for future use in the natural gas pipelines/infrastructure utilizing customer owned resources and are currently available
- Hydrogen is relatively safe as if it is released it quickly dilutes into a non-flammable concentration
Current Renewable Hydrogen Price estimates

Average – System Hydrogen costs

$ per MMBtu

2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040

*Assumes Avista owned resources
Distribution Overview

Terrence Browne
Sr. Gas Planning Engineer, Gas Engineering
Mission

- Using technology to plan and design a safe, reliable, and economical distribution system
Gas Distribution Planning

- Service Territory and Customers
- Scope of Gas Distribution Planning
- SynerGi Load Study Tool
- Planning Criteria
- Interpreting Results
- Long-term Planning Objectives
- Monitoring Our System
- Communicating Solutions
- Gate Station Capacity Review
- Project Examples
Service Territory and Customer Overview

- Serves electric and natural gas customers in eastern Washington and northern Idaho, and natural gas customers in southern and eastern Oregon
  - Population of service area 1.5 million
    - 385,000 electric customers
    - 360,000 natural gas customers
Our Planning Models

- 120 cities
- 40 load study models
5 Variables for Any Given Pipe

\[ P_{\text{up}} \quad Q \quad P_{\text{down}} \]

\[ L \quad D \]
Scope of Gas Distribution Planning

Supplier Pipeline

Gate Sta.

High Pressure Main

Reg.

Reg.

Reg.

Distribution Main and Services
Scope of Gas Distrib. Planning cont.
SynerGi (SynerGEE, Stoner) Load Study

- Simulate distribution behavior
- Identify low pressure areas
- Coordinate reinforcements with expansions
- Measure reliability
35 DD
30° F
Preparing a Load Study

- Estimating Customer Usage
- Creating a Pipeline Network
- Join Customer Loads to Pipes
- Convert to Load Study
Estimating Customer Usage

• Gathering Data
  – Days of service
  – Degree Days
  – Usage
  – Name, Address, Revenue Class, Rate Schedule…
Estimating Customer Usage cont.

- **Degree Days**
  - Heating (HDD)
  - Cooling (CDD)
- **Temperature - Usage Relationship**
  - Load vs. HDD’s
  - Base Load (constant)
  - Heat Load (variable)
  - High correlation with residential

<table>
<thead>
<tr>
<th>Avg. Daily Temperature ('Fahrenheit)</th>
<th>Heating Degree Days (HDD)</th>
<th>Cooling Degree Days (CDD)</th>
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</thead>
<tbody>
<tr>
<td>85</td>
<td>20</td>
<td></td>
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<tr>
<td>80</td>
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<td>80</td>
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</table>
$y = 0.0129x + 0.1175$

load vs. temperature graph with points indicating heat and base.
Creating a Pipeline Model

- **Elements**
  - Pipes, regulators, valves
  - Attributes: Length, internal diameter, roughness

- **Nodes**
  - Sources, usage points, pipe ends
  - Attributes: Flow, pressure
Balancing Model

- Simulate system for any temperature
  - HDD’s
- Solve for pressure at all nodes
Validating Model
Validating Model cont.
Validating Model cont.

- Simulate recorded condition
- Electronic Pressure Recorders
  - Do calculated results match *field* data?
- Gate Station Telemetry
  - Do calculated results match *source* data?
- Possible Errors
  - Missing pipe
  - Source pressure changed
  - Industrial loads
Planning Criteria

• Reliability during design HDD
  – Spokane 77 HDD (avg. daily temp. -12’ F)
  – Medford 54 HDD (avg. daily temp. 11’ F)
  – Klamath Falls 74 HDD (avg. daily temp. -9’ F)
  – La Grande 76 HDD (avg. daily temp. -11’ F)
  – Roseburg 51 HDD (avg. daily temp. 14’ F)

• Maintain minimum of 15 psig in system at all times
  – 5 psig in lower MAOP areas
35 DD
30° F
50 DD

15° F
65 DD
0°F
Interpreting Results

• Identify Low Pressure Areas
  – Number of feeds
  – Proximity to source

• Looking for Most Economical Solution
  – Length (minimize)
  – Construction obstacles (minimize)
  – Customer growth (maximize)
65 DD
0° F
Long-term Planning Objectives

- Future Growth/Expansion
- Design Day Conditions
- Facilitate Customer Installation Targets
Monitoring Our System

• Electronic Pressure Recorders
  • Daily Feedback
  • Real time if necessary
• Validates our Load Studies
Real-time Pressure & Flow Monitoring
ERX #007

West Medford 6 psig System
## 2019-2020 Winter

### Gas Load And Weather Forecast Report

**Date:** 01/08/2020

### Area: LAGRANDE

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**Average:** 208

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<td>36</td>
<td>27</td>
<td>33</td>
<td>18,079</td>
<td>7,682</td>
</tr>
</tbody>
</table>
What I do when “things” look bad?

1) Notify service area manager
2) Show where and at what temperature we think we’ll have low pressure
3) Identify possible solutions like:
   • Curtailing interruptible customers
   • Ask schools & businesses to voluntarily lower thermostats
   • Bring out CNG trailers
4) Continue to monitor forecast to see if temperatures improve or get worse
5) Share plan with Gas Controllers
6) Pray for warmer weather…
Communicating Solutions

Add 4"

Gas Planning Proposals
SIZE/NUMBER
2"
4"
6"
>6"

AVISTA
Gas Planning AOI

- Low pressure
- Future Growth
Solutions: long-term reinforcements

<table>
<thead>
<tr>
<th>State</th>
<th>Feet of pipe*</th>
<th>Estimated Cost $*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idaho</td>
<td>8,000</td>
<td>500,000</td>
</tr>
<tr>
<td>Oregon</td>
<td>22,000</td>
<td>1,600,000</td>
</tr>
<tr>
<td>Washington</td>
<td>70,000</td>
<td>4,900,000</td>
</tr>
</tbody>
</table>

*projects are subject to change and will be reviewed on a regular basis
Gate Station Capacity Review
Gate Station Capacity Review (example)

\[ y = 0.1278x + 3.5481 \]

\[ R^2 = 0.6484 \]

Daily Peak Flow (mcfh)

GTN Physical Capacity (31 mcfh)

Design Day Peak Flow (14.0 mcfh; 77 HDD)

Contractual Amount (21.9 mcfh, Diversity Factor = 1.5)

Linear (Daily Peak Flow (mcfh))

\[ y = 0.1278x + 3.5481 \]

\[ R^2 = 0.6484 \]

City Gate Station # X

77 HDD
Gate Station Capacity Review (example)

City Gate Station # Y

- **Daily Peak Flow (mcfh)**
- **NWP Physical Capacity** (206.0 mcfh, Diversity Factor = 1.44)
- **Design Day Peak Flow** (239.0 mcfh; 77 HDD)
- **Contractual Amount** (121.8 mcfh, Diversity Factor = 1.44)
- **Linear (Daily Peak Flow (mcfh))**
  \[ y = 2.1146x + 65.605 \]
  \[ R^2 = 0.6308 \]
Recent Projects and Examples
New Agri-Industrial Customer Service Request

Roseburg, OR
Agri-Industrial Customer Service Request

Roseburg, 54 HDD
Before Changes

Conditions:
• 21 Mcfh
• 15 psig
• year-round
  • 51 HDD

Facilities Color By:
Pressure (psig)

- 0.00
- 0.01 – 15.00
- 15.01 – 30.00
- 30.01 – 45.00
- 45.01 – 60.00
- > 60.01
Agri-Industrial Customer Service Request

Conditions:
- 21 Mcfh
- 15 psig
- year-round
  - 51 HDD
  - 47 HDD

Facilities Color By:
Pressure (psig)
- 0.00
- 0.01 – 15.00
- 15.01 – 30.00
- 30.01 – 45.00
- 45.01 – 60.00
- > 60.01

Roseburg, 54 HDD
With load added

Area drops to low pressure
Residential Development Service Request

Deer Park, WA
Residential Development Study

- Approximately 4,000 main lots
- 108 lots

- Approximately 2,500 main lots
- 72 lots
Residential Development Study

Facilities Color By: Pressure (psig)

- 0.00
- 0.01 – 15.00
- 15.01 – 30.00
- 30.01 – 45.00
- 45.01 – 60.00
- > 60.01

Inadequate Pressure (less than 15 psig)
Residential Development Study

Recommend: 250-300 2” PE

Acceptable Pressure (>15 psig)

Facilities Color By: Pressure (psig)
- 0.00
- 0.01 – 15.00
- 15.01 – 30.00
- 30.01 – 45.00
- 45.01 – 60.00
- > 60.01
Enbridge Pipeline Rupture Effect on distribution

Medford, OR
Enbridge Pipeline Rupture effect
Enbridge Pipeline Rupture effect
Enbridge Pipeline Rupture effect

Firm & Transport loads (100%) >> 45 HDD
Firm loads only (79%) >> 51 HDD
Questions and Discussion

Mission

*Using technology to plan and design a safe, reliable, and economical distribution system*
Unserved Demand and Supply Side Resource Options

Tom Pardee
Planning Manager, Natural Gas Supply
When unserved demand does show up……

There are a few questions we need to ask:

1. Why is the demand unserved?
2. What is the magnitude of the short? (i.e Are we 1 Dth or 1000 Dth’s short?)
3. What are my options to meet it?
When current resources don’t meet demand what could we consider?

- Transport capacity release recalls
- “Firm” backhauls
- Contract for existing available transportation
- Expansions of current pipelines
- Peaking arrangements with other utilities (swaps/mutual assistance agreements) or marketers
- In-service territory storage
- Satellite/Micro LNG (storage inside service territory)
- Large scale LNG with corresponding pipeline build into our service territory
- Structured products/exchange agreements delivered to city gates
- Biogas (assume it’s inside Avista’s distribution)
- Hydrogen blend (assume it’s inside Avista’s distribution)
- Avista distribution system enhancements
- Demand side management
New Resource Risk Considerations

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

• Availability
  – By Region – which region(s) can the resource be utilized?
  – Lead time considerations – when will it be available?
• Type of Resource
  – Peak vs. Base load
  – Firm or Non-Firm
  – “Lumpiness”
• Usefulness
  – Does it get the gas where we need it to be?
  – Last mile issues
• Cost
Regional Infrastructure – Potential Projects

1. Enbridge T-South expansion: addition of 190 million cubic feet per day (MMcf/d) of firm capacity.
2. FortisBC Southern Crossing expansion: addition of 300-400 MMcf/d of bidirectional capacity.
4. TC Energy Gas Transmission Northwest (GTN) Trail West/N-Max: addition of 500 MMcf/d capacity, expandable to 1,000 MMcf/d.
5. TC Energy other system enhancements: two projects to add a combined 525 MMcf/d of incremental firm transportation to the Alberta/BC export delivery point.
6. Pembina Pacific Connector Gas Pipeline (PCGP) Project: Addition of 1,000 MMcf/d capacity to serve proposed Cocos Bay LNG export facility.
## Supply Resources - Modeled

<table>
<thead>
<tr>
<th>Additional Resource</th>
<th>Size</th>
<th>Cost/Rates</th>
<th>Availability</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsubscribed GTN Capacity</td>
<td>Up to 50,000 Dth</td>
<td>GTN Rate</td>
<td>Now</td>
<td>Currently available unsubscribed capacity from Kingsgate to Spokane</td>
</tr>
<tr>
<td>Medford Lateral Exp</td>
<td>50,000 Dth / Day</td>
<td>$35M capital + GTN Rate</td>
<td>2022</td>
<td>Additional compression to facilitate more gas to flow from mainline GTN to Medford</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>166 Dth / Day</td>
<td>WA $48 / Dth, ID $40 / Dth, OR $46 / Dth</td>
<td>Varies</td>
<td>Cost estimates obtained from a consultant; levelized cost includes revenue requirements, expected carbon adder and assumed retail power rate</td>
</tr>
<tr>
<td>Renewable Natural Gas – Distributed Landfill</td>
<td>635 Dth / Day</td>
<td>WA $13 / Dth, ID $13 / Dth, OR $13 / Dth</td>
<td>Varies</td>
<td>Costs estimates obtained from a consultant for each specific type of RNG; levelized costs include revenue requirements, distribution costs, and projected carbon intensity adder/(savings). This cost also includes any incentives from bills such as Washington House Bill 2580 or Oregon Senate Bill 334</td>
</tr>
<tr>
<td>Renewable Natural Gas – Centralized Landfill</td>
<td>1,814 Dth / Day</td>
<td>WA $11 / Dth, ID $11 / Dth, OR $12 / Dth</td>
<td>Varies</td>
<td></td>
</tr>
<tr>
<td>Renewable Natural Gas – Dairy</td>
<td>635 Dth / Day</td>
<td>WA $34 / Dth, ID $39 / Dth, OR $33 / Dth</td>
<td>Varies</td>
<td></td>
</tr>
<tr>
<td>Renewable Natural Gas – Waste Water</td>
<td>513 Dth / Day</td>
<td>WA $19 / Dth, ID $18 / Dth, OR $19 / Dth</td>
<td>Varies</td>
<td></td>
</tr>
<tr>
<td>Renewable Natural Gas – Food Waste to (RNG)</td>
<td>298 Dth / Day</td>
<td>WA $38 / Dth, ID $39 / Dth, OR $38 / Dth</td>
<td>Varies</td>
<td></td>
</tr>
<tr>
<td>Plymouth LNG</td>
<td>241,700 Dth w/70,500 Dth deliverability</td>
<td>NWP Rate</td>
<td>Now</td>
<td>Provides for peaking services and alleviates the need for costly pipeline expansions</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pair with excess pipeline MDDO’s to create firm transport</td>
</tr>
</tbody>
</table>
## Future Supply Resources – Not Modeled
### Other Resources to Consider

<table>
<thead>
<tr>
<th>Additional Resource</th>
<th>Size</th>
<th>Cost/Rates</th>
<th>Availability</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Co. Owned LNG</td>
<td>600,000 Dth w/ 150,000 of deliverability</td>
<td>$75 Million plus $2 Million annual O&amp;M</td>
<td>2024</td>
<td>On site, in service territory liquefaction and vaporization facility</td>
</tr>
<tr>
<td>Various pipelines – Pacific Connector, Trails West, NWP Expansion, GTN Expansion, etc.</td>
<td>Varies</td>
<td>Precedent Agreement Rates</td>
<td>2022</td>
<td>Requires additional mainline capacity on NWPL or GTN to get to service territory</td>
</tr>
<tr>
<td>Large Scale LNG</td>
<td>Varies</td>
<td>Commodity less Fuel</td>
<td>2024</td>
<td>Speculative, needs pipeline transport</td>
</tr>
<tr>
<td>In Ground Storage</td>
<td>Varies</td>
<td>Varies</td>
<td>Varies</td>
<td>Requires additional mainline transport to get to service territory</td>
</tr>
</tbody>
</table>
Carbon Costs

Tom Pardee
Planning Manager, Natural Gas Supply
Cost of Carbon and Sendout

- Monthly costs are loaded into SENDOUT
- These costs will differ based on the requirements or an expected program type by state
- These costs are input at the transportation level in order to correctly account for the cost of carbon in each area regardless of supply basin
Social Cost of Carbon

- Social cost of carbon dioxide in 2007 dollars using the 2.5% discount rate, listed in table 2, [technical support document](#): Technical update of the social cost of carbon for regulatory impact analysis under Executive Order No. 12866, published by the interagency working group on social cost of greenhouse gases of the United States government, August 2016.
Social cost of carbon dioxide in 2007 dollars using the 2.5% discount rate, listed in table 2, technical support document: Technical update of the social cost of carbon for regulatory impact analysis under Executive Order No. 12866, published by the interagency working group on social cost of greenhouse gases of the United States government, August 2016.

- Adjust to 2019$ using Bureau of Economics GDP
- Adjust to Nominal $ using 2.11% annual inflation rate
Oregon – Carbon adder

*Modeled as an expected cost of California’s cap and trade program
High Carbon Scenario - SCC @ 95% @ 3%

- EPA - Social Cost of Carbon
- Adjust to 2019$ using Bureau of Economics GDP
- Adjust to Nominal $ using 2.11% annual inflation rate
Carbon Costs

Levelized Cost per MTCO2e

- OR Cap and Trade: $44.92
- WA SCC: $113.75
- High Carbon Price: $234.45
- Low Carbon Price: $0
Expected Case
Cost of Carbon by State - Summary

- **Washington** - Social cost of carbon @ 2.5% discount rate;
  - upstream emissions associated with natural gas drilling and transportation of natural gas to its end use.
- **Oregon** is based off a Wood Mackenzie estimate for Cap and Trade
- **Idaho** - carbon prices will not be included
Price Elasticity

Tom Pardee
Planning Manager, Natural Gas Supply
Price Elasticity

Price elasticity is a method used by economists to measure how supply or demand changes based on changes in price.

\[
\text{Price Elasticity of Demand} = \frac{\% \text{ Change in Quantity Demanded}}{\% \text{ Change in Price}}
\]
Price Elasticity Factors Defined

• Price elasticity is usually expressed as a numerical factor that defines the relationship of a consumer’s consumption change in response to price change.

• Typically, the factor is a negative number as consumers normally reduce their consumption in response to higher prices or will increase their consumption in response to lower prices.
  • For example, a price elasticity factor of -0.081 means:
    • A 10% price increase will prompt a 0.81% consumption decrease
    • A 10% price decrease will prompt a 0.81%
    • consumption increase
Summary

• The elasticity as measured in the Medford and Roseburg areas will be used for the entire system as estimated elasticity.
• 0.81% decrease only for each price rise of 10%
• This elasticity is measured through heat coefficients and annual price changes
Sensitivities

Michael Brutocao
Analyst, Natural Gas Supply
## Sensitivities Summary

<table>
<thead>
<tr>
<th>Influence Type</th>
<th>Sensitivity</th>
<th>Customer Growth Rate</th>
<th>Use per Customer</th>
<th>Weather</th>
<th>Demand Side Management</th>
<th>Prices</th>
<th>Elasticity</th>
<th>First Year System Unserved</th>
<th>Location Unserved</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEMAND INFLUENCING - DIRECT</td>
<td>Reference</td>
<td>Reference</td>
<td>3 Year Historical</td>
<td>20 Year Average</td>
<td>Planning Standard</td>
<td>None</td>
<td>Expected</td>
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<td>2035</td>
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<td></td>
<td>Reference Plus Peak</td>
<td>Low Growth</td>
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<td></td>
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<td>Low Cust</td>
<td>High Growth</td>
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<td>2029</td>
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<td>High Cust</td>
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<td>2035</td>
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<td></td>
<td>Alternate Weather Standard</td>
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<td>80% below 1990 emissions – OR/WA only</td>
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<td>2 Year use per customer Alternate</td>
<td>Reference</td>
<td>2 Year Historical</td>
<td>Planning Standard</td>
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<td>None</td>
<td>2035</td>
<td>Washington</td>
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<td>5 Year use per customer Alternate</td>
<td>Reference</td>
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<td>Washington</td>
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<td>JP Outage Only (0% capacity)</td>
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<td>JP Outage Only (50% capacity)</td>
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## Sensitivities Summary (Continued)

<table>
<thead>
<tr>
<th>Influence Type</th>
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<th>Elasticity</th>
<th>First Year System Unserved</th>
<th>Location Unserved</th>
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<tr>
<td></td>
<td>Carbon Cost - High (SCC 95% at 3%)</td>
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<td>Carbon Cost - Expected (SCC 2.5% (WA) &amp; Cap&amp;Red (OR))</td>
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<td>Carbon Cost - Low $0</td>
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<td>EMISSIONS INFLUENCING</td>
<td>High Upstream Emissions 2.47% leakage (EDF study)</td>
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<td></td>
<td>Expected Upstream Emissions (0.79% leakage)</td>
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<td>Expected</td>
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<td>Expected Global Warming Potential (20 Years)</td>
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<td>Expected</td>
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</table>
### First Year Peak Demand Unserved (11/1/2020 – 10/31/2040)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Washington</th>
<th>Idaho</th>
<th>La Grande</th>
<th>Medford</th>
<th>Klam Falls</th>
<th>Roseburg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference Plus Peak</td>
<td>2035</td>
<td>2039</td>
<td></td>
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</tr>
<tr>
<td>High Customer Growth</td>
<td>2029</td>
<td>2038</td>
<td>2035</td>
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<tr>
<td>Alternate Weather Standard</td>
<td>2035</td>
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<td>Reference Plus Peak Plus DSM</td>
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<tr>
<td>2-yr Use Per Customer</td>
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<td>5-yr Use Per Customer</td>
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<tr>
<td>Outage (JP - 0%)</td>
<td>2021</td>
<td>2022</td>
<td>2028</td>
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<tr>
<td>Outage (JP - 50%)</td>
<td>2021</td>
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<tr>
<td>Outage (AECO - 0%)</td>
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<tr>
<td>Outage (AECO - 50%)</td>
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<td>2028</td>
<td></td>
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<tr>
<td>Outage (Sumas - 0%)</td>
<td>2026</td>
<td>2021</td>
<td>2020</td>
<td></td>
<td>2032</td>
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<tr>
<td>Outage (Sumas - 50%)</td>
<td>2025</td>
<td>2038</td>
<td>2035</td>
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<tr>
<td>Outage (Rockies - 0%)</td>
<td>2021</td>
<td>2023</td>
<td>2020</td>
<td>2031</td>
<td>2033</td>
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<tr>
<td>Outage (Rockies - 50%)</td>
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<td>2039</td>
<td>2025</td>
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<tr>
<td>Outage (NWP - 0%)</td>
<td>2020</td>
<td>2020</td>
<td>2020</td>
<td>2021</td>
<td>2028</td>
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<tr>
<td>Outage (NWP - 50%)</td>
<td>2020</td>
<td>2023</td>
<td>2020</td>
<td>2029</td>
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<td>Outage (GTN - 0%)</td>
<td>2020</td>
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<td>2026</td>
<td>2020</td>
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<tr>
<td>Outage (GTN - 50%)</td>
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<td>2028</td>
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</tbody>
</table>

*Sensitivities not listed above have no unserved demand.*
Demand Sensitivities: Weather

- Reference Plus Peak
- Alternate Weather Standard
- Reference
Demand Sensitivities: 80% Below 1990 Emissions

MDth

- Reference Plus Peak
- 80% Below 1990 Emissions

45% Below 1990 MTCO2e Emissions

80% Below 1990 MTCO2e Emissions
Demand Sensitivities: Demand Side Management
Demand Sensitivities: Use Per Customer
Demand Sensitivities: Customer Growth
Demand Sensitivities: Price and Carbon Elasticities
Demand Sensitivities: Price (with Elasticities)
Demand Sensitivities: Carbon (with Elasticities)
Demand Sensitivities: Upstream Emissions (with Elasticities)

- No Upstream Emissions
- Carbon Cost - Expected
- Expected Upstream Emissions
- High Upstream Emissions
Demand Sensitivities: GWP (with Elasticities)
Sensitivities, Scenarios, Portfolios

Core Cases

Price Forecast

Demand and Supply Side Sensitivities

Optimize Resource Portfolios

Stochastic Cost/Risk Analysis By Resource

Preferred Resource Strategy

Highest Performing Portfolios selection
## Proposed Scenarios

<table>
<thead>
<tr>
<th>INPUT ASSUMPTIONS</th>
<th>Expected Case</th>
<th>Average Case</th>
<th>Low Growth &amp; High Prices</th>
<th>Carbon Reduction</th>
<th>High Growth &amp; Low Prices</th>
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<tbody>
<tr>
<td>Customer Growth Rate</td>
<td>Reference Case Cust Growth Rates</td>
<td>Low Growth Rate</td>
<td>Reference Case Cust Growth Rates</td>
<td>High Growth Rate</td>
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<tr>
<td>Use per Customer</td>
<td>Reference Case Cust Growth Rates</td>
<td>Low Growth Rate</td>
<td>Reference Case Cust Growth Rates</td>
<td>High Growth Rate</td>
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<tr>
<td>Demand Side Management</td>
<td>Expected Case GPA</td>
<td>High Prices DSM</td>
<td>Low Prices DSM</td>
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<tr>
<td>Weather Planning Standard</td>
<td>99% probability of coldest in 30 years</td>
<td>20 year average</td>
<td>99% probability of coldest in 30 years</td>
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<tr>
<td>Prices</td>
<td>Carbon Legislation ($/Metric Ton)</td>
<td>SCC @ 2.5% WA; Cap and Trade forecast - OR; NO Carbon adder in ID</td>
<td>Carbon Cost - High (SCC 95% at 3%); NO Carbon adder in ID</td>
<td>SCC @ 2.5% WA; Cap and Trade forecast - OR; NO Carbon adder in ID</td>
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<tr>
<td>GWP</td>
<td>100-Year GWP</td>
<td>Expected Case GPA</td>
<td>High Prices DSM</td>
<td>Low Prices DSM</td>
<td></td>
</tr>
</tbody>
</table>

### Results

**First Gas Year Unserved**
- Washington
- Idaho
- Medford
- Roseburg
- Klamath
- La Grande

**Scenario Summary**
- Most aggressive peak planning case utilizing Average Case assumptions as a starting point and layering in peak day 99% probability. The likelihood of occurrence is low.
- Case most representative of our average (budget, PGA, rate case) planning criteria.
- Stagnant growth assumptions in order to evaluate if a shortage does occur. Not likely to occur.
- Reduction of the use of natural gas to 80% below 1990 targets in OR and WA by 2050. The case assumes the overall reduction is an average goal before applying figures like elasticity and DSM.
- Aggressive growth assumptions in order to evaluate when our earliest resource shortage could occur. Not likely to occur.

*1,000 Draws per scenario will be run stochastically*
2020 Natural Gas IRP Schedule


TAC 2 (Dual Meeting with Power side): Thursday, August 6, 2020: Market Analysis, Price Forecasts, Cost Of Carbon, Environmental Policies
• Demand Results and Forecasting – August 18, 2020

TAC 3: Wednesday, September 30, 2020: Distribution, Avista’s current supply-side resources overview, supply side resource options, renewable resources, Carbon cost, price elasticity, sensitivities and portfolio selection modeling.

TAC 4: Wednesday, November 18, 2020: CPA results from AEG & ETO, review assumptions and action items, final modeling results, portfolio risk analysis and 2020 Action Plan.