2018 Avista Natural Gas IRP

Technical Advisory Committee Meeting
March 29, 2018
Spokane, WA
Agenda

- Introductions & Logistics
- Williams update
- TransCanada update
- Avista’s Supply Side Resources
- Distribution
- Renewable Natural Gas
- Power to Gas
- Initial sensitivity results & proposed scenarios

➤ Lunch will be around 12pm
2018 IRP Timeline

- **August 31, 2017** – Work Plan filed with WUTC
- **January through May 2018** – Technical Advisory Committee meetings. Meeting topics will include:
  - **TAC 1**: Thursday, January 25, 2018: TAC meeting expectations, review of 2016 IRP acknowledgement letters, customer forecast, and demand-side management (DSM) update.
  - **TAC 2**: Thursday, February 22, 2018: Weather analysis, environmental policies, market dynamics, price forecasts, cost of carbon.
  - **TAC 3**: Thursday, March 29, 2018: Distribution, supply-side resources overview, overview of the major interstate pipelines, RNG overview and future potential resources.
  - **TAC 4**: Thursday, May 10, 2018: DSM results, stochastic modeling and supply-side options, final portfolio results, and 2020 Action Items.
- **June 1, 2018** – Draft of IRP document to TAC
- **June 29, 2018** – Comments on draft due back to Avista
- **July 2018** – TAC final review meeting (if necessary)
- **August 31, 2018** – File finalized IRP document
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
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
Supply Diversity

Northwest Pipeline Supply Diversity

- Alberta
- Storage
- Domestic/Opal Prices
- British Columbia
- Alberta/Stanfield Prices
- British Columbia/Sumas Prices

Thru 12/31/17
Supply Diversity – South End

LA Plata B Compressor Thruput (3 years)

South Bound Flows

North Bound Flows

-200,000
-100,000
0
100,000
200,000
300,000
400,000

2015 2016 2017 Limit 2015a 2016a 2017a
Sumas South Historical

Chehalis Historical (Avg Dth/d)

- 2017
- Prior 10yr Avg
- Prior 5yr Avg
- Design Capacity
Stanfield West Historical

Roosevelt Historical (Avg Dth/d)

Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec

- 2017
- Prior 10yr Avg
- Prior 5yr Avg
- Dsgn Cap Incr
- Dsgn Cap Decr
Jackson Prairie Withdrawal Deliverability Curve

NOTE: Deliverability curve is based on a beginning seasonal quantity of 25.6 MMDth. Withdrawal capacity starts out at 1.2 MMDth/d and declines by 2 percent for each 1 percent the capacity drops below 60 percent.

Lowest point of deliverability during each of the last five heating seasons.

- March 19, 2016 – JP at 30% Capacity – 478,400 Dth/d Deliverability
- March 9, 2018 - JP at 26% Capacity – 430,560 Dth/d Deliverability
- March 9, 2017 - JP at 26% Capacity – 382,720 Dth/d Deliverability
- March 31, 2014 – JP at 22% Capacity – 287,040 Dth/d Deliverability

# of Days

0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 60 63

Jackson Prairie W/D Rights
Weather Forecast – February 26, 2014

February 26 forecast for March 1 through 3, 2014

Daily and Period Temperature Anomaly Key (F)

-36 -34 -32 -30 -28 -26 -24 -22 -20 -18 -16 -14 -12 -10 -8 -6 -4 -2 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36
### Base Tariff Rates

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<th>Service Description</th>
<th>Effective 12/31/2017</th>
<th>Effective 1/1/2018</th>
<th>Effective 10/1/2018</th>
<th>Comeback Rates Effective 1/1/2023</th>
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# Avista’s Net Effective Rate

## Net Effective Rate

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<tr>
<th>Contract</th>
<th>Daily Contract Demand</th>
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<th>Delivery</th>
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### Incremental CD through Segmentations to themselves

| Avista | 137286 | 9,211 | Starr Road | Coeur D'Alene | - | $ | - |

### Segmented Releases to Third Parties

| IGI | 110203 | 10,000 | Rockies | Idaho | 0.39294 | $(1,434,231) |
| 110192 | 10,000 | Rockies | Meridian/Boise | 0.39294 | $(1,434,231) |
| Clark PUD | 140788 | 2,841 | Stanfield | River Road | 0.39294 | $(407,465) |
| 140787 | 6,709 | Stanfield | River Road | 0.39294 | $(962,226) |
| 142230 | 17,394 | Sumas | River Road | 0.39294 | $(2,494,701) |
| Puget Sound | 141549 | 8,056 | Sumas | JP Delivery | 0.39294 | $(1,155,416) |
| | | | | | | $(7,888,271) |

### Net Effective Rate

| Net Effective Rate | 199,627 | 0.26655 | $19,421,783 |

## Peak Day Load Effective Rate

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<th>Daily Contract Demand</th>
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### Peak Day Effective Rate

| Peak Day Effective Rate | 293,450 | 0.19234 | $20,600,864 |
Avista’s Segmentation to Themselves

Incremental CD through Segmentation
Segment #1 9,211
Segment #2 9,211

Original Path
(R) Opal to (D) Spokane
9,211 Dth/d

Retained Segment 1
(R) Starr Road to (D) CDA
9,211 Dth/d

Retained Segment 2
(R) Rockies to (D) Spokane
9,211 Dth/d

Starr Road
CDA
Spokane
Rockies
Avista’s Segmented Release No. 1

Original Path
(R) Rockies to (D) Spokane
20,000 Dth/d

Retained Segment 1
(R) Stanfield to (D) Spokane
20,000 Dth/d

Released Segment 1
(R) Rockies to (D) Idaho
20,000 Dth/d

Annual Cost Savings
Segment #1 ~$3.0m
Avista’s Segmented Release No. 2

- **Released Segment 1**: (R) Rockies to (D) Spokane 20,000 Dth/d
- **Retained Segment 1**: (R) Stanfield to (D) Spokane 20,000 Dth/d
- **Released Segment 2**: (R) Stanfield to (D) River Road 10,000 Dth/d
- **Retained Segment 2**: (R) Palouse to (D) Lewiston 10,000 Dth/d
- **Original Path**: (R) Rockies to (D) Spokane 20,000 Dth/d

**Annual Cost Savings**
- Segment #1 ~$3.0m
- Segment #2 ~$1.4m
Avista’s Segmented Release No. 3

Original Path
(R) Sumas to (D) Pullman
(6,000), Moscow (4,000), &
Coeur D’Alene (10,394)
20,394 Dth/d

Released Segment 3
(R) Sumas to (D) River Road
17,394 Dth/d

Retained Segment 3
(R) Starr Road to (D) CDA
10,394 Dth/d

Retained Segment 3
(R) Mollalla to (D) Pullman/ Moscow
10,000 Dth/d

Annual Cost Savings
Segment #1 ~$3.0m
Segment #2 ~$1.4m
Segment #3 ~$2.5m

Sumas Receipt
Coeur D’Alene
Pullman/ Moscow
Mollalla Receipt
River Road

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Avista’s Segmented Release No. 4

Original Path
(R) Sumas to (D) Spokane
8,056 Dth/d

Released Segment 4
(R) Sumas to (D) JP
8,056 Dth/d

Retained Segment 4
(R) JP to (D) Spokane
8,056 Dth/d

Sumas Receipt

JP Receipt

JP Delivery

Annual Cost Savings
Segment #1 ~$3.0m
Segment #2 ~$1.4m
Segment #3 ~$2.5m
Segment #4 ~$1.1m

Spokane
One Williams. One Mission.

Our Mission

- Operate safely in everything we do, every day.
- Execute on our commitments exceptionally well.
- Collaborate to rapidly deliver our best solutions.
- Grow our business, our people and our industry.
- Improve our operations and business performance continuously.

Our Vision

Be the premier provider of large-scale infrastructure connecting the growing supply of North American natural gas and natural gas products to growing global demand for clean fuels and feedstocks.
Firm Reliability

- 2014 – 99.9 percent
- 2015 – 100 percent
- 2016 – 99.9 percent
- 2017 – 100 percent

> To determine customer impact, firm reliability percentage is calculated on flows prior, during and after posted maintenance
Reliability and Integrity Programs

> Integrity Management
  – In-line Inspections
  – Requalifications
  – Cathodic Protection

> Geo Hazard
  – Strain Gauge
  – River Crossing
  – Land Movement

> Mainline Valve Automation
Integrity Management Program

> An Integrity Management Program based on an effective framework
  - Prevention, detection and remediation
  - Designed to address safety, reliability and compliance related risks in a comprehensive and systematic way
  - Plan maintenance focused on minimizing customer impacts

> Three major pipeline integrity recurring programs
  - Assessment Program
    - In-Line Inspection (smart pigging)
  - Department of Transportation Requalification Program
  - Cathodic Protection Program
Integrity Management Program (cont.)

Assessments

- In-Line Inspection Program (smart pigging)
  - The preferred assessment method to address most integrity threats
  - Means of complying with the Pipeline Safety Improvement Act (PSIA) of 2002
- Integrity Hydro-test
- Direct Assessments
Integrity Management Program (cont.)

In-Line Inspection (ILI) Program

> **Tools:**
  - Gauge plate pig
  - Cleaning pig
  - Geometry pig (dents, obstructions)
  - Magnetic Flux Leakage pig (MFL)

> **Specialty Tools**
  - Circumferential/Spiral Magnetic Flux Leakage Pig (CMFL)
  - ElectroMagnetic Acoustic Transducer (EMAT)
Integrity Management Program (cont.)

In-Line Inspection Program – Preparing the line for inspection

> Cleaning pig:
  • remove liquids and debris from line and prepares line for inspection

> Gauge Plate Pig:
  • inspect for obstructions such as severe dents or bends that could stop an instrumented tool
In-Line Inspection Program - Standard Instrumented In-line Inspection Tools

Geometry Tool:
- Locate and size dents, bends, ovality due to construction or third-party damage

> MFL Tool:
- inspect for internal/external corrosion or metal loss
In-Line Inspection Program - Specialty Tools

> **Circumferential/Spiral Magnetic Flux Leakage Pig (CMFL):**
  - Locate and size axially oriented anomalies

> **Electro Magnetic Acoustic Transducer (EMAT) Tool:**
  - Locate and size cracking including stress corrosion cracking (SCC)
Benefits of Utilizing ILI Technology for Integrity Assessment

- It can assess for anomalies for the entire length of a pipeline segment vs. just the HCA locations as a hydro test
- The line does not need to be taken out of service to complete the assessment
- It can find features that would not be found in a hydro test, (e.g. pending failures)
- Data can be compared against prior runs to determine if features are growing
Integrity Assessment Program

> Asset integrity
  - 3,201 (83.8%) miles of first time assessment
  - 177 (98.6%) miles of High Consequence Area (HCA) first time assessment
  - Reassess HCA's every 7 years
DOT Compliance Program

Department of Transportation Requalification Program

> Class location change based on population density and buildings near pipeline

> If class location changes, then either:
  - Reduce pressure
  - Perform a hydrostatic test
  - Replace pipeline
Cathodic Protection & Recoat Program

Purpose

• Protect the pipeline against corrosion
  – Williams uses impressed current systems to protect against corrosion
    • All current levels are evaluated annually

  – Coating protects against corrosion by providing a physical barrier from the elements as well as making the cathodic protection current more efficient
    • Recoat areas determined primarily by inline inspection run-to-run comparisons
Geologic Hazards Program

- Monitoring pipe strain at strategic locations
- Monitoring land movement in several ways

Strain Gauge  River Crossing  Land Movement
Reliability Programs

Northwest Geotechnical Monitoring

- Strain gauge database
- ILI strain analysis
- Inclinometers
- Aerial surveys
- River crossing monitoring program
- GIS geotechnical hazards database
- LIDAR data
The purpose of the program is to ensure that Northwest Pipeline is in compliance with the Department of Transportation required mainline valve spacing requirements.
Questions??
TransCanada Supply Update—J. Story
AVISTA – IRP/TAC Meeting
March 29, 2018
2017 Supply and Market Outlook

- North American Supply and Demand
- NGTL Expansions
- Impact on GTN Supply and Capacity
North American Supply
2017 TransCanada Outlook

Source: Wood Mackenzie
WCSB Production Seeking Markets

Prolific Supply with Economic Production Costs

Intra-Basin Demand
- 1,622 Bcf
- 4.43 Bcf/d
- 40%

Eastern Canada & Northeast U.S.
- 894 Bcf
- 2.44 Bcf/d
- 22%

Midwestern U.S.
- 789 Bcf
- 2.15 Bcf/d
- 19%

Pacific Northwest & California
- 750 Bcf
- 2.05 Bcf/d
- 19%

NGTL System Throughput
- 2016 total: 4,055 Bcf
- 2016 daily average: 11.1 Bcf/d
Western Canadian Sedimentary Basin Gas Supply

Bcf/d

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<th>History</th>
<th>Forecast</th>
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<td>Conventional - Horizontal</td>
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<tr>
<td>Solution Gas</td>
<td>Cordova</td>
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2010 2015 2020 2025
Western Canadian Production (Bcf)

Source: Wood Mackenzie
Western Canadian Sedimentary Basin

- WCSB:
  - Prolific and competitive resource
  - Economic production in Montney and Deep Basin resources

- NGTL System:
  - Dominant basin position, capturing 75% of WCSB production
  - Strongly connected to substantive supply and intra and ex-basin markets
  - Supply to GTN and Northern Border
  - 400+ Bcf of gas storage
  - 50+ Bcf/d of NIT trading liquidity
Evolving System Supply Distribution

- North of Bens Lake
- Peace River
- Central Area

2011:
- 35% 
- 60%
- 5%

2016:
- 24%
- 74%
- 2%

2021:
- >1%
- 15%
- 85%
**West Path**

- **James River By-Pass**
  - Open Seasons in 2015
  - Onstream June 2016
  - Pipeline modification Project
  - ~150 TJ/d of capacity
  - ABC Border Design Capability: ~2.2 Bcf/d

- **Sundre Crossover**
  - Open Seasons in January and June 2016
  - Onstream 2018
  - ~20km of NPS 42 pipeline loop of WAS Mainline
  - ABC Border Design Capability: ~2.45 Bcf/d
NGTL Mainline Expansions

2017 Expansions

Pipe
284 km of NPS 24-48

Compression
6 units for 113.5 MW

2018-19 Expansions

Pipe
267 km of NPS 36-42

Compression
8 units for 195 MW

Planned 2017 Facilities

Planned 2018-19 Facilities
2019/2020 West Path Expansion

AB-BC Border Expansion Capacity Open Season

Expansion Capacity: 408 TJ/d

Service Commencement Dates:
- Nov 2019: 120 TJ/d
- Jun 2020: 288 TJ/d

Bid Evaluation: Length of Requested Term

Minimum Term: 8 years

FT-D1 Pricing Discount: 10%

Closing Date: May 31, 2017

- Full alignment of TransCanada assets serving PacNW and Western states.
- Economic production from the WCSB resources is a good fit for Western US markets.
GTN Overview

- Positioned to serve markets throughout California, Nevada, and the Pacific Northwest
- Consists of 1,350 miles of pipeline
- Kingsgate best efforts receipt capability of approx. 2.87 Bcfd and throughput capability of approx. 2 Bcfd thru Sta. 14
- Deliveries of up to 1.5 Bcfd to non-California Markets
- Long-term contracts extending out as far as 2039
- Volume throughput continues to be strong and should continue to grow in 2018
- NGTL continues to address the export capability at ABC to bring into alignment with downstream systems
Demand Projections
Pacific Northwest & California

### PaCNW

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### CALIFORNIA

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NGTL West Path Expansion Summary

- **James River By-Pass**
  - ISD - June 2016
  - 150,000 Gj/d
  - A/BC Border Capability – 2.2 Bcf/d

- **Sundre Crossover**
  - ISD - April 2018
  - 245,000 Gj/d
  - A/BC Border Capability – 2.43 Bcf/d

- **Winchell Unite Addition**
  - ISD – November 2019
  - 120,000 Gj/d
  - Estimated A/BC Border Capability – 2.54 Bcf/d

- **West Path Expansion**
  - ISD – June 2020
  - 288,000 Gj/d
  - Estimated A/BC Border Capability – 2.81 Bcf/d
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 – 2.87 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

- **Remaining Available Capacity – Kingsgate to Malin Path**
  - 139,400 dth/d
  - Effective Date(s) – Any Date April 1, 2018 or Later
  - Unlimited Term
  - All Offered Capacity Awarded
• **Considerable Interest in Additional Kingsgate Sourced GTN Capacity**
  - GTN Exploring Expansion Options
    - “Market Pull” Required
    - Mainline
    - New Pipelines or Laterals – Trail West
  - ROFR Open Season Process
    - Contract Renewals
    - 2023 Contract Cliff

• **GTN Rate Case Update**
  - GTN Full Haul Rate Drops to $0.285 Effective 1/1/2020 thru 12/31/2021
    - Kingsgate to Stanfield - $0.146 Dth/d
    - Kingsgate to Spokane - $0.076 Dth/d
  - “Come Back” Provision Requires New Rates Effective 1/1/2022
    - Rate Case Preparation in 2021
    - Recent Contracting and Facility Upgrades will Impact Rates
NGTL and Foothills Pipelines Update
Avista - Supply Side Resources

Eric Scott
Manager of Natural Gas Resources
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 rendered 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 Overview
Pipeline Overview
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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<tr>
<td>Williams NWP</td>
<td>2019 – 2042 (2035)</td>
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<td>Westcoast (Enbridge)</td>
<td>2026</td>
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<td>TransCanada - NGTL</td>
<td>2019-2028</td>
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<td>TransCanada - Foothills</td>
<td>2020-2028</td>
<td>204,000</td>
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<td>2023-2028</td>
<td>240,000 – 321,000</td>
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<td>166,000 – 212,000</td>
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<td>TransCanada - Tuscarora</td>
<td>2020</td>
<td>200</td>
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*Includes Thermal Transport
Contract Provisions - NWP

- Grandfathered Unilateral Evergreen (TF-1, TF-2, SGS-2F)
  - Roll-over 1 year
  - Shipper has sole option to extend or renew
- Standard Unilateral Evergreen
  - Roll-over 1 year
  - 5 year termination provision
- Standard Bilateral Evergreen
  - Either transporter OR shipper may terminate
- Right of First Refusal (ROFR)
  - Provides “last look”
Contract Provisions - GTN

• Unilateral Evergreen
  – Shipper alone may terminate contract
• Bilateral Evergreen
  – Either transporter OR shipper may terminate contract
• Right of First Refusal (ROFR)
  – Provides “last look”
Pipeline Contracting

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

A ➔ 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
Rate Design

• Postage stamp (NWP)
  – 1 mile or a thousand miles – same price
  – Plus variable

• Mileage (GTN)
  – Fee per mile
  – Plus variable
NWP Rate Case Settlement

• New rates in effect January 1, 2018
  – Good through September 30, 2018
• Rates further reduced October 1, 2018 – December 31, 2022
• Mandatory come-back – January 1, 2023
• No stay-out after October 2, 2018
GTN Rate Case Settlement

• New rates in effect January 1, 2016
  – Good through December 31, 2019
• Rates further reduced January 2020 – December 2021
• Mandatory come-back – January 1, 2022
• No stay-out
Pipeline Capacity – Segmented Releases Example
## Effective Rate - #100010

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<th>CD</th>
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<td>Sumas - Spokane</td>
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<tr>
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<td>(19,432 Dth)</td>
<td>$0.40</td>
<td>Sumas - Spokane</td>
<td>($2,837,000)</td>
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<td>-0-</td>
<td>Sipi - JP</td>
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<td>$2,837,000</td>
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</table>

**Northwest Pipeline Tariff Rate:**  $0.400  
**Effective rate – segmentation example:**  $0.133
Capacity Releases

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<th>Duration</th>
<th>Rate</th>
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<td>Annual</td>
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<td>Full rate</td>
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<tr>
<td>Long-term</td>
<td>1+ year – 31.5 years</td>
<td>Full rate</td>
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</tbody>
</table>

During 2017, AVA received $9.6mm in release “revenue”

Example:

AVA released 35,000 Dths/day at full tariff rate to Clark PUD until 10/31/2025 recapturing over $5.2mm annually all of which goes to customers.
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.
Jackson Prairie Interesting Energy Comparisons

1.2 Bcf per day (energy equivalent)

• 10 coal trains with 100 - 50 ton cars each
• 29 - 500 MW gas-fired power plants
• 13 Hanford-sized nuclear power plants
• 2 Grand Coulee-sized hydro plants (biggest in US)

46 Bcf of stored gas

• 12” pipeline 11,000,000 miles long (226,000 miles to the moon)
• 1,400 Safeco Fields (Baseball Stadiums)
• Average flow of the Columbia River for 2 days
• Cube - 3,550 feet on a side
Natural Gas Liquids - Extraction

- Gas from the Western Canadian Sedimentary Basin has many "liquids" that can be extracted and sold
- Nearly $2,100,000

<table>
<thead>
<tr>
<th>Natural Gas Liquid</th>
<th>Chemical Formula</th>
<th>Applications</th>
<th>End Use Products</th>
<th>Primary Sectors</th>
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</thead>
<tbody>
<tr>
<td>Ethane</td>
<td>C₂H₆</td>
<td>Ethylene for plastics production; petrochemical feedstock</td>
<td>Plastic bags; plastics; anti-freeze; detergent</td>
<td>Industrial</td>
</tr>
<tr>
<td>Propane</td>
<td>C₃H₈</td>
<td>Residential and commercial heating; cooking fuel; petrochemical feedstock</td>
<td>Home heating; small stoves and barbeques; LPG</td>
<td>Industrial, Residential, Commercial</td>
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<td>Butane</td>
<td>C₄H₁₀</td>
<td>Petrochemical feedstock; blending with propane or gasoline</td>
<td>Synthetic rubber for tires; LPG; lighter fuel</td>
<td>Industrial, Transportation</td>
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<tr>
<td>Isobutane</td>
<td>C₅H₁₂</td>
<td>Refinery feedstock; petrochemical feedstock</td>
<td>Alkylate for gasoline; aerosols; refrigerant</td>
<td>Industrial</td>
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<tr>
<td>Pentane</td>
<td>C₅H₁₂</td>
<td>Natural gasoline; blowing agent for polystyrene foam</td>
<td>Gasoline; polystyrene; solvent</td>
<td>Transportation</td>
</tr>
<tr>
<td>Pentanes Plus*</td>
<td>C₆H₁₄ and heavier</td>
<td>Blending with vehicle fuel; exported for bitumen production in oil sands</td>
<td>Gasoline; ethanol blends; oil sands production</td>
<td>Transportation</td>
</tr>
</tbody>
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Distribution System Planning

Terrence Browne PE,
Senior Gas Planning Engineer
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
• Historical Temperatures
• Monitoring Our System
• 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
    - 371,000 electric customers
    - 348,000 natural gas customers
Seasonal Demand Profiles

Washington/Idaho

Medford/Roseburg

Klamath Falls

LaGrande

[Graphs showing seasonal demand profiles for different regions with lines indicating residential, commercial, and industrial usage.]
Our Planning Models

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

- $P_{up}$
- $P_{down}$
- $Q$
- $L$
- $D$
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
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

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<th>Cooling Degree Days (CDD)</th>
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</table>
Load vs. Temperature

$y = 0.0129x + 0.1175$
Estimating Customer Usage cont.

- **Peaking Factor**
  - Peaking Factor = 6.25% of daily load
  - “Observed ratio” of greatest hourly flow to total daily flow at Gate Stations

- **Industrial Customers**
  - Model maximum hourly usage per Contractual Agreement
  - Firm Transportation customers only
  - Low Temperature-Usage correlation
Creating a Pipeline Model

- Elements
  - Pipes, regulators, valves
  - Attributes: Length, internal diameter, roughness
- Nodes
  - Sources, usage points, pipe ends
  - Attributes: Flow, pressure
### Attributes of Gas Pipes

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Join Customer Loads to a Model

- Residential and commercial loads are assigned to pipes
- Industrial or other large loads are assigned to nodes
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<th>Matched g</th>
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<th>House numb</th>
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Balancing Model

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

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

- Reliability during design HDD
  - Spokane 82 HDD
  - Medford 61 HDD
  - Klamath Falls 72 HDD
  - La Grande 74 HDD
  - Roseburg 55 HDD

- Maintain minimum of 15 psig in system at all times
  - 5 psig in lower MAOP areas
Planning Criteria

- Reliability during design HDD
  - Spokane **82 HDD** *(avg. daily temp. -17’ F)*
  - Medford **61 HDD** *(avg. daily temp. 4’ F)*
  - Klamath Falls **72 HDD** *(avg. daily temp. -7’ F)*
  - La Grande **74 HDD** *(avg. daily temp. -9’ F)*
  - Roseburg **55 HDD** *(avg. daily temp. 10’ F)*

- Maintain minimum of 15 psig in system at all times
  - 5 psig in lower MAOP areas
35 DD
30° 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)
Long-term Planning Objectives

• Future Growth/Expansion
• Design Day Conditions
• Facilitate Customer Installation Targets
Historical Temperatures
Historical Temperatures

- Spokane 82 HDD
  - 11/23/10: 64 HDD “Artic Blast”

- Medford 61 HDD

- Klamath Falls 72 HDD

- La Grande 74 HDD

- Roseburg 55 HDD
Historical Temperatures

- **Spokane 82 HDD**
  - 11/23/10: 64 HDD “Artic Blast”
  - 12/6/13 and 12/8/13: 58 HDD “Polar Vortex”

- **Medford 61 HDD**
  - 12/8/13: 52 HDD “Polar Vortex”

- **Klamath Falls 72 HDD**
  - 12/8/13: 72 HDD “Polar Vortex”

- **La Grande 74 HDD**
  - 12/8/13: 65 HDD “Polar Vortex”

- **Roseburg 55 HDD**
  - 12/8/13: 44 HDD “Polar Vortex”
Historical Temperatures

- **Spokane 82 HDD**
  - 11/23/10: 64 HDD “Artic Blast”
  - 12/6/13 and 12/8/13: 58 HDD “Polar Vortex”
  - 1/1/16: 55 HDD

- **Medford 61 HDD**
  - 12/8/13: 52 HDD “Polar Vortex”

- **Klamath Falls 72 HDD**
  - 12/8/13: 72 HDD “Polar Vortex”
  - 1/2/16: 62 HDD

- **La Grande 74 HDD**
  - 12/8/13: 65 HDD “Polar Vortex”

- **Roseburg 55 HDD**
  - 12/8/13: 44 HDD “Polar Vortex”
Historical Temperatures

- **Spokane 82 HDD**
  - 11/23/10: 64 HDD “Artic Blast”
  - 12/6/13 and 12/8/13: 58 HDD “Polar Vortex”
  - 1/1/16: 55 HDD
  - 1/5/17: 59 HDD

- **Medford 61 HDD**
  - 12/8/13: 52 HDD “Polar Vortex”
  - 1/5/17: 42 HDD

- **Klamath Falls 72 HDD**
  - 12/8/13: 72 HDD “Polar Vortex”
  - 1/2/16: 62 HDD
  - 1/5/17: 71 HDD

- **La Grande 74 HDD**
  - 12/8/13: 65 HDD “Polar Vortex”
  - 1/5/17: 65 HDD

- **Roseburg 55 HDD**
  - 12/8/13: 44 HDD “Polar Vortex”
  - 1/5/17: 38 HDD
Monitoring Our System

• Electronic Pressure Recorders
  • Daily Feedback
  • Real time if necessary

• Validates our Load Studies
Real-time Pressure & Flow Monitoring
ERX #015

Loon Lake, WA
ERX #007

West Medford 6 psig System
Solutions: short-term
Solutions: long-term

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<th>State</th>
<th>Feet of pipe</th>
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<td>62,300</td>
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<td>Washington</td>
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next 1-5 years
Gas Planning Layers

- Gas Planning Proposals
- Gas Planning AOI
Gas Planning Proposals

Add 4”
Gas Planning AOI
City Gate Station Capacity Review (example)

 GTN Physical Capacity
(31 mcfh)

 Design Day Peak Flow
(14.0 mcfh; 82 HDD)

 Contractual Amount
(21.9 mcfh, Diversity Factor = 1.5)

 Linear (Daily Peak Flow (mcfh))
y = 0.1278x + 3.5481
R² = 0.6484

Daily Peak Flow (mcfh)

Flow (mcfh) vs. HDD
Gate Station Capacity Review (example)

City Gate Station # Y

y = 2.1146x + 65.605
R² = 0.6308
Current Projects and Examples
Hayden Lake HighPressure Reinforcement

Coeur d’Alene, ID
Hayden Lake
Completed Proposal:
17,300' 6” HP steel
2 new regulator stations

Facilities Color By:
Internal Diameter (inches)
- < 1.900
- 1.900 – 2.800
- 2.800 – 3.670
- 3.670 – 5.400
- 5.400 – 7.900
- 7.900 – 10.000
- 10.000 – 12.000
- 12.000 – 13.000
- > 13.000
End of existing 6” HP

17,300’ of 6” Steel HP and two regulator stations

Tie-in to 4” IP Main

Tie-in to 4” IP Main
Before reinforcement
Hayden Lake HP Reinforcement

Before reinforcement

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
Completed Proposal:
17,300’ 6” HP steel
2 new regulator stations

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

Rathdrum
Post Falls
Coeur d’Alene
Completed Proposal:
17,300’ 6” HP steel
2 new regulator stations
Portable Pressure Monitor

Monitors the system pressure.
Hayden Lake Pressures Before & After

After Reinforcement

11 °F
43 psig

Before Reinforcement

12 °F
31 psig
Hayden Lake H.P. Reinforcement
East Medford H.P. Reinforcement

Medford, OR
Medford
Completed
Proposal:
16,000’ 12” HP steel

Facilities Color By:
Internal Diameter (inches)
- < 1.900
- 1.900 – 2.800
- 2.800 – 3.670
- 3.670 – 5.400
- 5.400 – 7.900
- 7.900 – 10.000
- 10.000 – 12.000
- 12.000 – 13.000
- > 13.000
Before reinforcement

End of HP Line 216 psig

270 psig

217 psig

280 psig

Facilities Color By:
Pressure (psig)

- 0.00 – 3.00
- 3.01 – 15.00
- 15.01 – 30.00
- 30.01 – 45.00
- 45.01 – 60.00
- > 60.01
Completed Proposal: 16,000’ 12” HP steel

After reinforcement

Facilities Color By:
Pressure (psig)

- 0.00 – 3.00
- 3.01 – 15.00
- 15.01 – 30.00
- 30.01 – 45.00
- 45.01 – 60.00
- > 60.01

Medford

281 psig

443 psig

282 psig

40 HDD
Medford HP Reinforcement

After reinforcement

277 psig

436 psig

278 psig

Facilities Color By:
Pressure (psig)
- 0.00 – 3.00
- 3.01 – 15.00
- 15.01 – 30.00
- 30.01 – 45.00
- 45.01 – 60.00
- > 60.01

Medford
Completed Proposal:
16,000’ 12” HP steel
East Medford H.P. Reinforcement
North Spokane H.P. Reinforcement

Spokane, WA
North Spokane
Completed Proposal:
11,500’ 8” HP steel
1 new regulator station

Facilities Color By:
Internal Diameter (inches)
- < 1.900
- 1.900 – 2.800
- 2.800 – 3.670
- 3.670 – 5.400
- 5.400 – 7.900
- 7.900 – 10.000
- 10.000 – 12.000
- 12.000 – 13.000
- > 13.000
North Spokane Proposed 6” route (approx. 2 miles)
North Spokane HP Reinforcement

Before reinforcement

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

20 HDD
North Spokane HP Reinforcement

After reinforcement

60 HDD

North Spokane
Completed Proposal:
11,500’ 8” HP steel
1 new regulator station
North Spokane HP Reinforcement

After reinforcement

77 HDD

North Spokane
Completed Proposal:
11,500’ 8” HP steel
1 new regulator station
North Spokane H.P. Reinforcement
Questions and Discussion

**Mission**

*Using technology to plan and design a safe, reliable, and economical distribution system*
What is Renewable Natural Gas (RNG)?
Why does RNG matter?

Carbon (CO₂) Emission Reduction

• Carbon reduction
  – LDC pathway to reduce emissions through “de-carbonized” gas stream
  – Can provide customers a new energy choice
  – Gives communities another means in meeting ambitious climate change commitments

• Renewable Fuel Standard (RFS) & Low Carbon Fuel Standards (LCFS)
  – Significant value for RNG in transportation sector in CA and OR

[Diagram showing Washington State GHG Targets: At 1990 levels, 25% below 1990 levels, 50% below 1990 levels. Under2 MOU Range of 2050 GHG Targets: 80% to 95% below 1990 levels. Source: State of Washington Deep Decarbonization Pathways Project 12/16/2016]
Other Benefits of RNG

Other

- Reduces waste remediation costs
- Reduces odors, water & air pollution, pathogens originating from waste streams
- Creates local jobs and generates revenue for cities and businesses
- New local sources for gas supply

“It reminds me of the Mr. Fusion Home Energy Reactor in the movie Back to the Future”
Dan Kirschner, NWGA Executive Director, on WA HB 2580 RNG Bill
Federal Renewable Fuel Standard Program

Mandates renewable fuel to replace % of petroleum-based transportation fuel

**Lifecycle Greenhouse Gas (GHG) Emissions**

GHG emissions must take into account direct and significant indirect emissions, including land use change.

- **Renewable Fuels**
  - 20% GHG reductions *

- **Advanced & Biodiesel Fuels**
  - 50% GHG reductions *

- **Cellulosic Fuels**
  - 60% GHG reductions *

* compared to a 2005 petroleum baseline

**D6**

**D4-D5**

**D3**

** D-codes are an approximation; actual code determined by EPA formula

Source: EIA
RFS and LCFS Effect on RNG Value

Estimated LCFS Incentives by Fuel Source (January 2017 Credit Prices)

RIN = renewable identification number

Source: CARB

D3 RIN: Value per Dth

Source: EPA
GHG CO₂ Reductions

Annual GHG Emissions from Appliances at a New Home

Source: AGA, MJB&A analysis
Potential RNG Production

Estimated methane generation potential for select biogas sources by county.

Table: Estimated Methane Generation Potential for Select Biogas Sources in the United States

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<td>Animal manure</td>
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<td>IIC organic waste</td>
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<td><strong>Total</strong></td>
<td><strong>7,857,449</strong></td>
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* Includes candidate landfills only as defined by the EPA's Landfill Methane Outreach Program.

About 420 Bcf
RNG Projects in North America

- Approx. 120 RNG projects in North America
- 13 of these are located in the Pacific Northwest
Oregon SB 344 DOE RNG Update

As a means toward feasible reductions in greenhouse gas emissions, committee to provide recommendations to ODOE regarding:

• Development of an inventory of RNG resources
• Characterization of the opportunities
• Identify barriers to production and utilization
• Policies to promote RNG and remove barriers
• Report due by September 2018
Washington SB 2580 RNG Bill

• Requires the Washington State University Extension Energy Program and the Department of Commerce, in consultation with the Utilities and Transportation Commission, to submit recommendations on how to promote the sustainable development of RNG to the Governor and the Legislature by September 1, 2018

  “Governor Inslee and Department of Commerce were pleased to request this bill, which received near unanimous, bipartisan support from the Legislature,” said Peter Moulton, Energy Policy Section Manager, Washington Department of Commerce.

• Requires the Department of Commerce, in consultation with natural gas utilities and other state agencies, to explore the development of voluntary gas quality standards for the injection of RNG into the state’s natural gas pipeline systems

• Reinstate and expand incentives in order to stimulate investment in biogas capture and conditioning, compression, nutrient recovery, and use of RNG for heating, electricity generation and transportation fuel
Oregon and Washington RNG Studies

Source: ODOE RNG Feb. 22, 2018 Presentation

Figure 4. Washington Landfills and Major Natural Gas Pipelines

Regional RNG Policies

- California SB 1383: Goal to reduce the economic uncertainty associated with RNG. Requires LDCs to interconnect at least five dairy projects to the natural gas pipeline system by January 1, 2018.
  - Allows LDCs to recover the costs associated with projects
- British Columbia Green House Gas Reduction Regulation
  - Allows for 5% RNG on LDC system
  - Allows LDCs to invest and recover costs associated with projects
Are Avista customers interested in RNG?

- Rogue Disposal
- Rogue Valley Transit
- Southern Oregon University
- City of Medford
- City of Ashland

- US Postal Service
- United Parcel Service
- DSU Peterbilt
- Butler Ford

Source: Interest expressed through Rogue Valley Clean Cities Coalition per Dry Creek Landfill
What are the challenges & barriers?

• California RNG market ($30/Dth v. $2/Dth)
  – Vehicle emission incentives shut-out other potential end users
  – RIN market is volatile
  – No forward pricing for RNG RINs in carbon market
  – RFS future beyond 2022 uncertain
  – Vehicle market may be approaching saturation in CA
  – Too expensive for LDCs to purchase; LDCs could produce RNG cheaper

• Financing for producers challenging
  – Future RNG value unknown
  – Producer/LDC partnerships for product

• Policies for LDC cost recovery or purchase of not least cost fuel source
Next Steps for RNG

• Model various RNG scenarios for 2018 IRP
• Participate in ODOE SB 344 Advisory Council
• Support efforts with WSU and WA SB 2580
• Evaluate customer interest in RNG products
• Evaluate potential RNG projects in Avista service territory
Power to Gas

Tom Pardee
Manager of Natural Gas Planning
Power to Gas

- Power to Gas (PtG) is a process using power to separate water into hydrogen and oxygen.
- Both hydrogen and methane 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.

https://youtu.be/lQWIubQyaao
PtG Process

Source: http://www.europeanpowertogas.com/about/power-to-gas
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 H2_{LHV} per Dth
• Most H2 is currently made from reforming natural gas
• The US Department of Energy expects that over the long term the production of hydrogen will be increased with production from renewables
Water Electrolysis for PtG

- Water electrolysis is a mature and well understood technology with 3 different types of electrolysis technologies in these PtG processes
  - Alkaline electrolysis (AEL)
    - Most mature and well understood technology
    - Best when coupled with an intermittent power supply
  - Polymer electrolyte membrane (PEM)
    - Fast cold start with a high purity of H2
    - Limited Life expectancy
  - Solid oxide electrolysis (SOEC)
    - High electrical efficiency
    - Currently not as stable when paired with intermittent power supply
PtG Comparison

Benefits

• Cleans up the grid using excess power
• Stores the energy for future use
• Hydrogen is relatively safe as if it is released it quickly dilutes into a non-flammable concentration

Obstacles

• 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 though this is primarily cause by end-use restrictive conditions
  – Risks increase significantly if over 50% mix
• Hydrogen is lighter than air and diffuses rapidly (3.8x faster than natural gas) making it more difficult to contain
Continued R&D is needed to reduce H₂ production & delivery costs.
Next Steps

• Model at an estimated rate of $4 per kg of H2 based on DOE technical target by 2020
  – This is the untaxed cost of hydrogen produced, delivered, and dispensed to the vehicle
    • It does not include off-board cooling or regeneration of chemical hydrogen storage materials
      – Source: https://www.energy.gov/eere/fuelcells/doe-technical-targets-onboard-hydrogen-storage-light-duty-vehicles

• Look for a consultant or ways to more accurately estimate the cost of H2 in Avista’s territory
Initial Results and Proposed Scenarios

Kaylene Schultz
Natural Gas Analyst
First Year Peak Demand Unserved Washington

| Year | Reference | Reference Plus Peak | Low Cust Growth | High Cust Growth | DSM Case | Peak Plus DSM Case | Demand Destruction Ref Case | Demand Destruction Ref Plus Peak Case | Alternate UPC (2-Year) | Alternate UPC (5-Year) | Expected Elasticity | Low Prices | High Prices | Carbon Legislation - Low | Carbon Legislation - Expected | Carbon Legislation - High |
|------|-----------|---------------------|----------------|-----------------|----------|-------------------|-----------------------------|--------------------------------|-------------------------------|---------------------|---------------------|------------------|-----------|------------|--------------------------|--------------------------|---------------------|
| 2017 |           |                     |                |                 |          |                   |                             |                                |                               |                     |                      |                  |           |            |                          |                          |                    |
| 2018 |           |                     |                |                 |          |                   |                             |                                |                               |                     |                      |                  |           |            |                          |                          |                    |
| 2019 |           |                     |                |                 |          |                   |                             |                                |                               |                     |                      |                  |           |            |                          |                          |                    |
| 2020 |           |                     |                |                 |          |                   |                             |                                |                               |                     |                      |                  |           |            |                          |                          |                    |
| 2021 |           |                     |                |                 |          |                   |                             |                                |                               |                     |                      |                  |           |            |                          |                          |                    |
| 2022 |           |                     |                |                 |          |                   |                             |                                |                               |                     |                      |                  |           |            |                          |                          |                    |
| 2023 |           |                     |                |                 |          |                   |                             |                                |                               |                     |                      |                  |           |            |                          |                          |                    |
| 2024 |           |                     |                |                 |          |                   |                             |                                |                               |                     |                      |                  |           |            |                          |                          |                    |
| 2025 |           |                     |                |                 |          |                   |                             |                                |                               |                     |                      |                  |           |            |                          |                          |                    |
| 2026 |           |                     |                |                 |          |                   |                             |                                |                               |                     |                      |                  |           |            |                          |                          |                    |
| 2027 |           |                     |                |                 |          |                   |                             |                                |                               |                     |                      |                  |           |            |                          |                          |                    |
| 2028 |           |                     |                |                 |          |                   |                             |                                |                               |                     |                      |                  |           |            |                          |                          |                    |
| 2029 |           |                     |                |                 |          |                   |                             |                                |                               |                     |                      |                  |           |            |                          |                          |                    |
| 2030 |           |                     |                |                 |          |                   |                             |                                |                               |                     |                      |                  |           |            |                          |                          |                    |
| 2031 |           |                     |                |                 |          |                   |                             |                                |                               |                     |                      |                  |           |            |                          |                          |                    |
| 2032 |           |                     |                |                 |          |                   |                             |                                |                               |                     |                      |                  |           |            |                          |                          |                    |
| 2033 |           |                     |                |                 |          |                   |                             |                                |                               |                     |                      |                  |           |            |                          |                          |                    |
| 2034 |           |                     |                |                 |          |                   |                             |                                |                               |                     |                      |                  |           |            |                          |                          |                    |
| 2035 |           |                     |                |                 |          |                   |                             |                                |                               |                     |                      |                  |           |            |                          |                          |                    |
| 2036 |           |                     |                |                 |          |                   |                             |                                |                               |                     |                      |                  |           |            |                          |                          |                    |
| 2037 |           |                     |                |                 |          |                   |                             |                                |                               |                     |                      |                  |           |            |                          |                          |                    |
First Year Peak Demand Unserved Idaho

First Year Peak Demand Not Met with Existing Resources
Sensitivity Comparisons - ID

- Reference
- Reference Plus Peak
- Low Cust Growth
- High Cust Growth
- Alternate Weather Std
- DSM Case
- Peak Plus DSM Case
- Demand Destruction Ref Case
- Demand Destruction Ref Plus Peak Case
- Alternate UPC (2-Year)
- Alternate UPC (5-Year)
- Expected Elasticity
- Low Prices
- High Prices
- Carbon Legislation - Low
- Carbon Legislation - Expected
- Carbon Legislation - High
First Year Peak Demand Unserved Medford

First Year Peak Demand Not Met with Existing Resources
Sensitivity Comparisons - Medford
First Year Peak Demand Unserved
Roseburg

First Year Peak Demand Not Met with Existing Resources
Sensitivity Comparisons - Roseburg
First Year Peak Demand Unserved
Klamath Falls

First Year Peak Demand Not Met with Existing Resources
Sensitivity Comparisons - Klamath Falls
First Year Peak Demand Unserved

La Grande

First Year Peak Demand Not Met with Existing Resources
Sensitivity Comparisons - La Grande

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<th>Year</th>
<th>Reference</th>
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<th>Alternate Weather Std</th>
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*Assumes average yearly reduction starting in 2018 to achieve 2050 target of 80% below 1990 emissions
# 2018 Proposed Scenarios

<table>
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<tr>
<th>Proposed Scenarios</th>
<th>Input Assumptions</th>
<th>Expected Case</th>
<th>Cold Day 20yr Weather Std</th>
<th>Average Case</th>
<th>Low Growth &amp; High Prices</th>
<th>Demand Destruction</th>
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<td>Customer Growth Rate</td>
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<td>Use per Customer</td>
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<td>Weather Planning Standard</td>
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<td>20 year average</td>
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<td>Carbon Legislation ($/Metric Ton)</td>
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2018 IRP Timeline

• **August 31, 2017** – Work Plan filed with WUTC

• **January through May 2018** – Technical Advisory Committee meetings. Meeting topics will include:
  – TAC 3: Thursday, March 29, 2018: Distribution, supply-side resources overview, overview of the major interstate pipelines, RNG overview and future potential resources.
  – TAC 4: Thursday, May 10, 2018: DSM results, stochastic modeling and supply-side options, final portfolio results, and 2020 Action Items.

• **June 1, 2018** – Draft of IRP document to TAC

• **June 29, 2018** – Comments on draft due back to Avista

• **July 2018** – TAC final review meeting (if necessary)

• **August 31, 2018** – File finalized IRP document
Questions?