Renewable Gas at NW Natural

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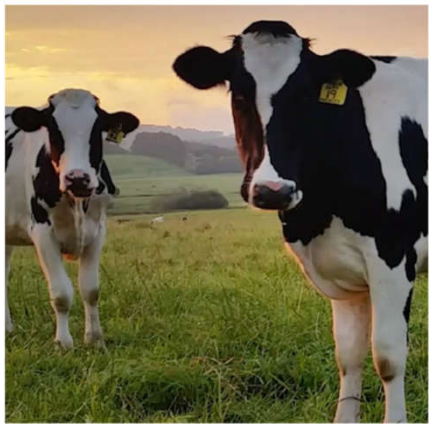
NW Natural®

NW Natural: A Brief 160-Year History

Manufactured gas for lighting and heat (1860s)

Network expands with arrival of Northwest pipeline (1950s)

Modernized system, decoupled rates, energy efficiency, Smart Energy (2000s)



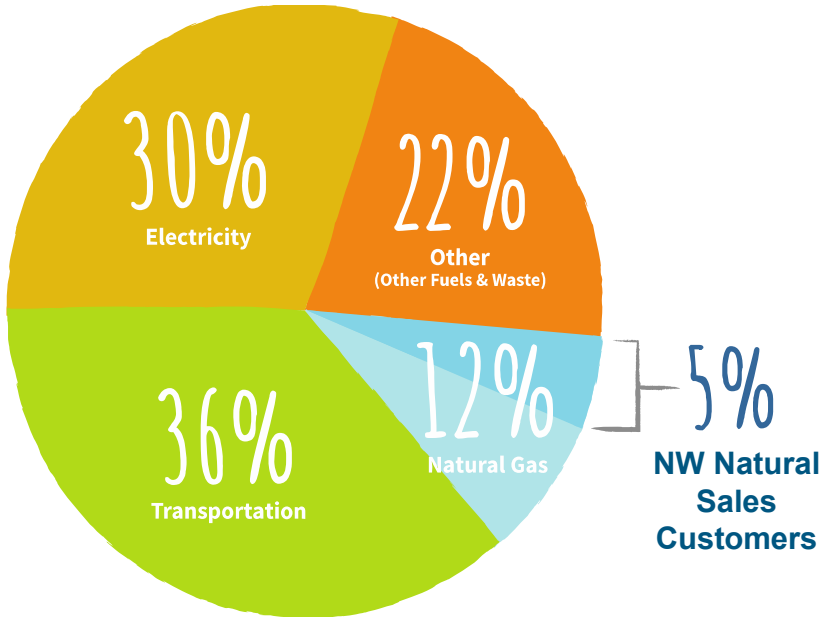
RNG and Renewable Hydrogen to Deeply Decarbonize (2017 and beyond)

Role of Our System Today

NW Natural's System

- Delivers more energy than any other utility in Oregon
- Heats 74% of residential square footage in the areas we serve
- Provides 90% of energy needs for our residential space and water heat customers on the coldest winter days
- One of the tightest, newest systems in the country

Oregon Greenhouse Gas Emissions



Source: ODEQ In-Boundary GHG Inventory 2015

NW NATURAL SERVES 2.5 MILLION PEOPLE IN 140 COMMUNITIES

Responding to the Climate Emergency

What is the goal?

- Emission reductions – as fast and affordably as possible

How are we driving to a lower carbon electric system?

- We didn’t say “cut the wires,” we set out to decarbonize what went over them

The same holds true for the gas delivery system

- We deliver energy through pipes, what goes through them will change

We’re committed to pursuing a 100% carbon neutral pipeline

- There is no technical barrier to getting there

What is Renewable Natural Gas?

RNG is *pipeline-quality gas* derived by cleaning up the biogases emitted as organic material chemically breaks down.

For NW Natural's system, RNG is:

- At least 97.3% methane
- At least 985 BTUs/SCF

Wastewater Treatment Plants

Municipal Solid Waste

Animal Manures

Landfills

Wood Waste/Residue

RNG Quality Specifications

Gas Quality Specifications for Biomethane and Interconnect Facility Settings

Parameter	Value Min	Value Max	Alarm Setting	Flare Setting	Re-instate
Methane %	97.3%		≤ 97.8%	< 97.3%	> 97.8%
Heating Value (BTU/Scf)	985	1115	≤ 990	< 985	> 990
Wobbe Number (BTU/Scf)	1290	1400			
Carbon Dioxide %		2.00%	≥ 1.8%	> 2%	< 1.8%
Nitrogen		2.00%	≥ 1.8%	> 2%	< 1.8%
Total Inerts + Oxygen %		2.70%	≥ 2.2%	> 2.7%	< 2.2%
Oxygen %		0.20%	≥ 0.18%	> 0.2%	< 0.18%
Hydrogen Sulfide (grain/100cf)		0.25	≥ 0.20	> 0.25	< 0.20
Total Sulfur (grain/100cf)		5.00	≥ 4.00	> 5.00	< 4.00
Siloxanes (grain/100cf)		0.019	≥ 0.015	> 0.019	< 0.015
Ammonia (grain/100cf)		5.00	≥ 4.00	> 5.00	< 4.00
Moisture (lb/MMcf)		7	≥ 4	> 7	< 4
Mercury		BDL	NA	Any	BDL
Temperature (°F)	35	120	≥ 115	> 120	< 115
Hydrocarbon Dew Point (°F)		15	≥ 10	> 15	< 10

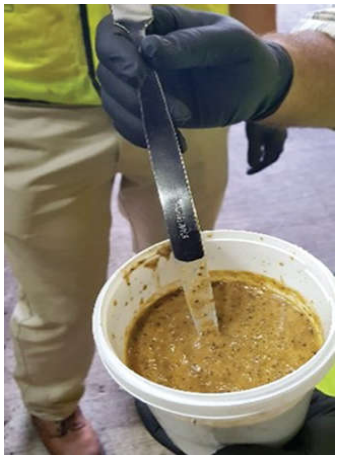
Why RNG?

- RNG production turns costly waste products into revenue generators for cities and businesses
- RNG reduces CO_2 emissions, whether used directly in appliances or in vehicles
  - NW Natural assumes some future cost of carbon in all resource planning scenarios, and our customers desire renewable and lower carbon products
- Local RNG resources produce direct economic benefits
- On-system RNG potentially reduces infrastructure requirements and reduces pipeline capacity contracts

Eugene-Springfield Water Pollution Control Facility
Photo source City of Eugene

How is RNG Made (in Portland)?

Metro Commercial Food Waste



Food Waste Smoothie

Columbia Boulevard
Wastewater Treatment Plant

Columbia
Boulevard
Digesters

Conditioning Equipment and
Receipt Point

CNG Fueling Station and NWN
Distribution System

How is RNG Made?

Fats, Oils, and Greases (FOG) tanks at Gresham Wastewater Treatment Plant
Photo source NW Natural

How is RNG Made?

Rickreall Dairy's Manure Collection System

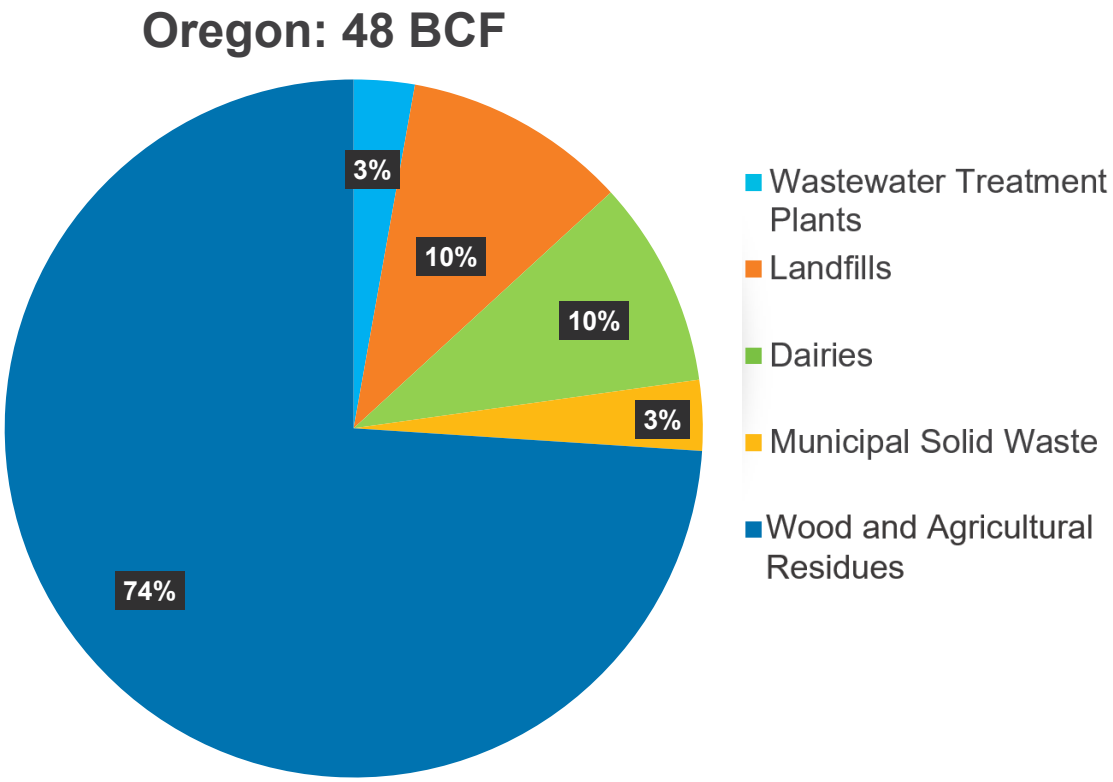
How is RNG Made?

Rickreall Dairy's Manure Lagoon

How is RNG Made?

Fraser Valley Biogas
British Columbia –
Complete Mix Digester

Oregon RNG Technical Potential



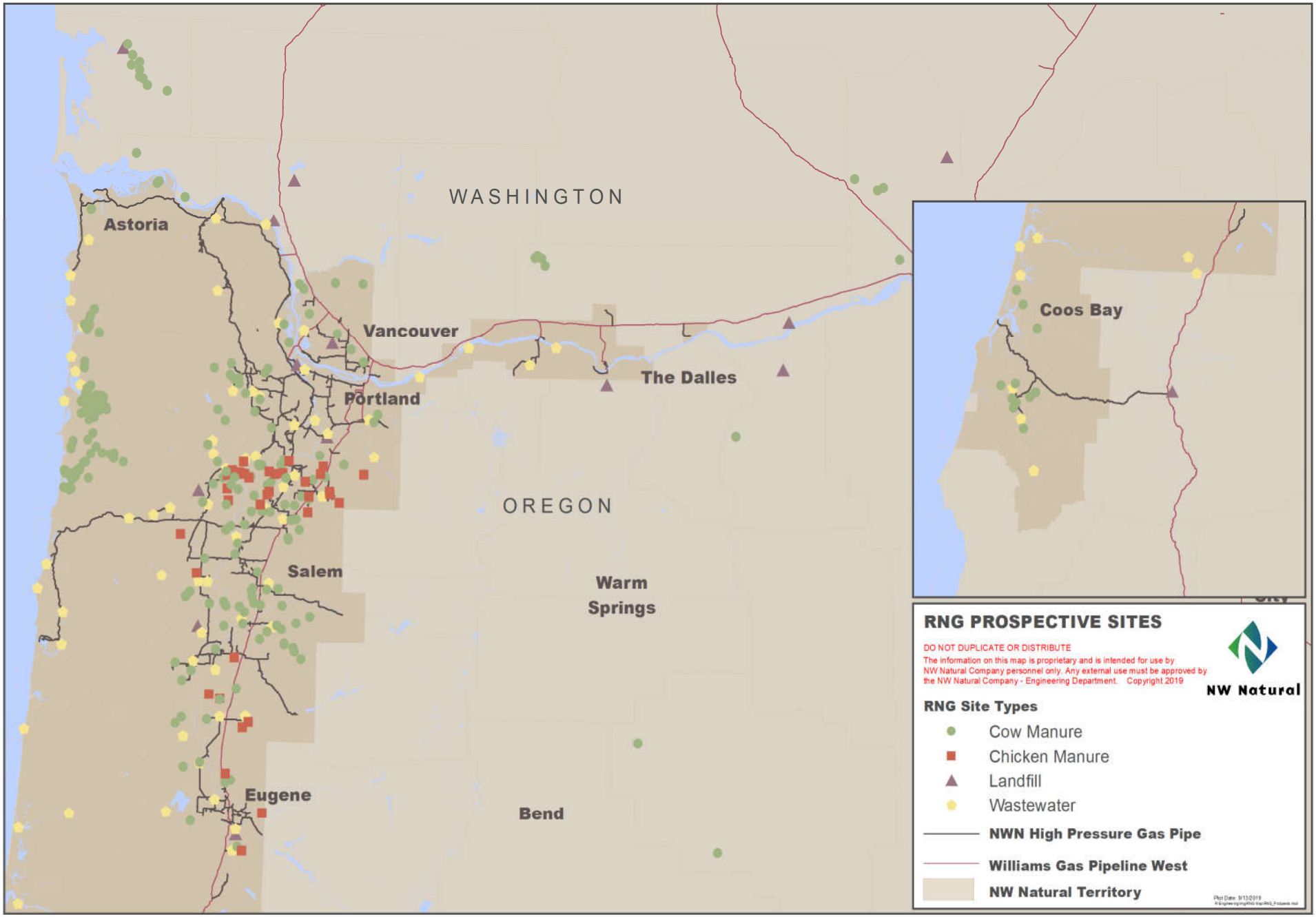
Total OR direct annual natural gas consumption:
236 BCF

Total OR direct annual natural gas consumption by residential sector:
48 BCF

Total NWN annual natural gas sales:
65 – 75 BCF

Source: Oregon Department of Energy: https://www.oregon.gov/energy/Data-and-Reports/Documents/2018-RNG-Inventory-Report.pdf

(1) "Wood and Agricultural Residues" is defined differently by different studies but generally includes urban waste wood, primary and secondary mill residues, and residues left after logging operations (e.g., trees cut or killed and left on the ground). It assumes a large amount (35%-50%) is left on the forest floor to "maintain ecological functions." Sources for data: https://www.nrel.gov/docs/fy14osti/60178.pdf#, NREL Bioenergy Database, U.S. EPA LMOP Database, Oregon DEQ Material Recovery and Waste Generation Survey, Oregon Department of Agriculture, and Oregon Department of Energy.


WASHINGTON
OREGON
Astoria
Vancouver
Portland
The Dalles
Salem
Warm Springs
Eugene
Bend
Coos Bay
RNG PROSPECTIVE SITES
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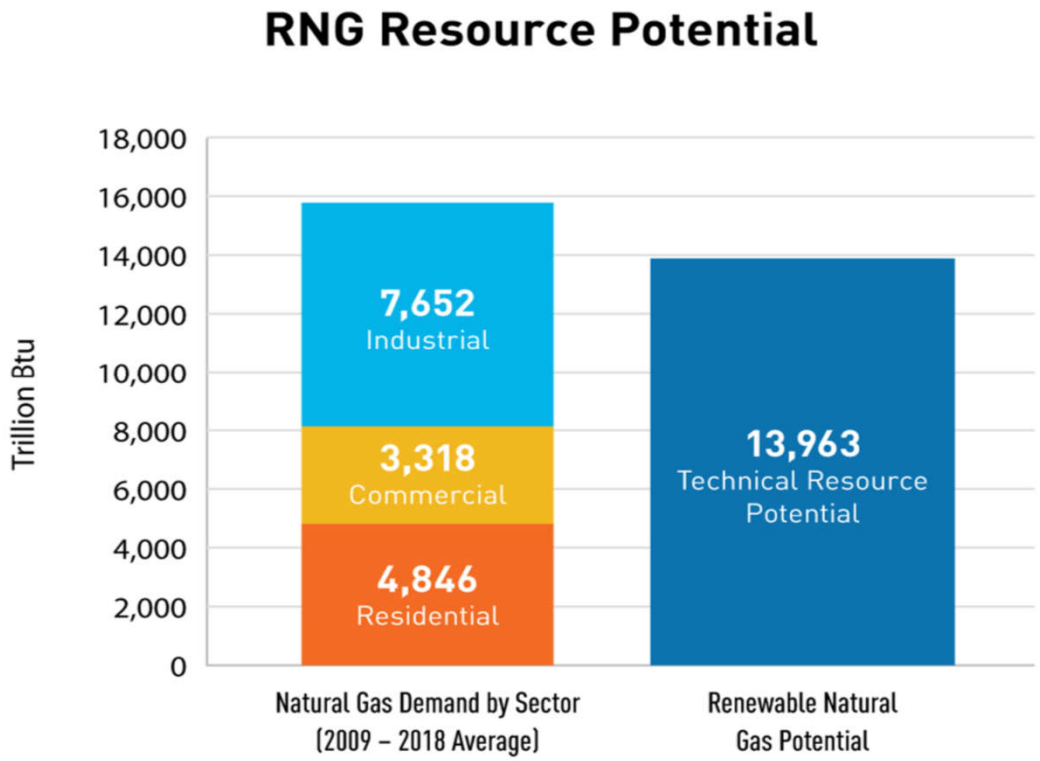
NW Natural
RNG Site Types
Cow Manure
Chicken Manure
Landfill
Wastewater
NWN High Pressure Gas Pipe
Williams Gas Pipeline West
NW Natural Territory

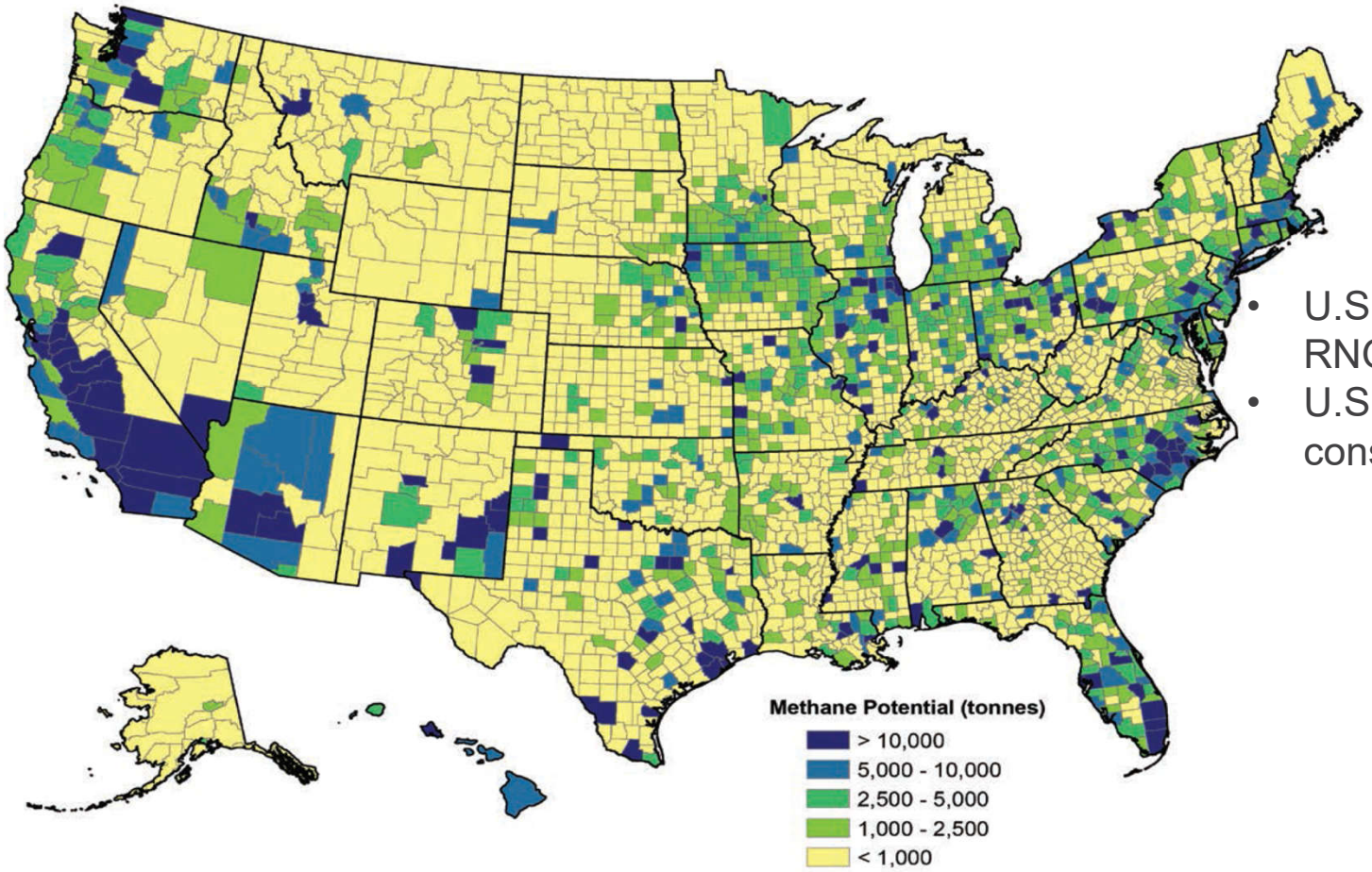
U.S. RNG Technical Potential



ICF national study shows renewable natural as technical potential is 88% of current direct use throughput.

Source: ICF, American Gas Foundation, Dec 2019

National RNG Potential



- U.S. annual technical RNG potential**: 4,200 BCF**
- U.S. annual natural gas consumption: **27,486 BCF**

Sources: https://www.nrel.gov/docs/fy14osti/60178.pdf#, NREL Bioenergy Database, USDA 2012 Forest Service's Timber Product Output database

Current U.S. RNG Projects

- Operational U.S. RNG projects: 102
- Total number of U.S. RNG projects has grown nearly 150% since 2014

Getting the Policy Right

- Until 2019: had to procure for our customers:
  - Least cost and least risk natural gas
- No Renewable Portfolio Standard for gas
- No tax or production incentives
- No feed-in-tariffs
- No funding via Energy Trust of Oregon for RNG production at our customers' sites

Oregon Senate Bill 98 (2019)

Most aggressive RNG policy in the country

- Utility can purchase renewable natural gas and hydrogen for all customers as part of resource mix
- Enables the utility to play a role in developing RNG & make long-term contracts for renewable supply
- Sets a spending limit to protect customers – 5% of Revenue Requirement can be spent annually on incremental cost of RNG
- Rulemaking scheduled to be complete in summer of 2020

Oregon Senate Bill 98

- Large gas utilities may procure RNG for sales customers, up to established volumetric targets:

S.B. 98 Targets	
Year	Percentage of sales volume
2020 - 2024	5%
2025 - 2029	10%
2030 - 2034	15%
2035 - 2039	20%
2040 - 2044	25%
2045 - 2050	30%

Current RNG Interconnects

Project	Feedstock	% of Our Sales Volume
City of Portland	Wastewater	0.50
Eugene-Springfield	Wastewater	0.13
Shell New Energies	Agricultural Waste	1.30

- RNG may be procured via supply contracts, capital investments in projects, or a combination of both, from inside or outside Oregon

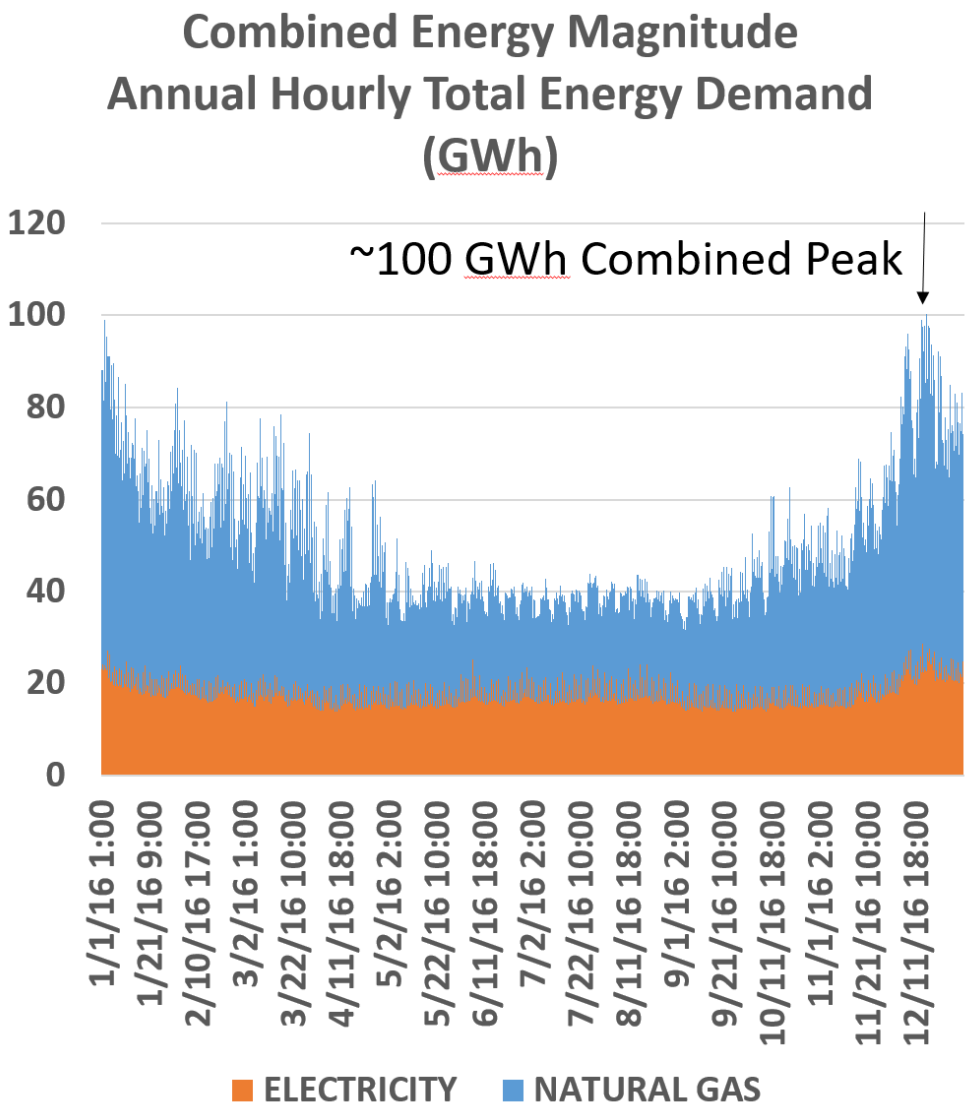
Washington House Bill 1257

- Natural gas utilities may procure RNG for sales customers, with a rate impact cap of 5% bill increase
- Natural gas utilities must offer all customers a voluntary RNG tariff

How Does RNG Fit Into the Bigger Energy Picture?

- Uses existing infrastructure
- Captures existing methane that is entering the atmosphere
- Continues to meet the energy needs that are hard or expensive to electrify
- Utilizes existing equipment
- Provides steady heat supply that is not season- or time-of-day-dependent

Pacific NW: Concurrent Electric and Gas System Peaks



- Pacific NW: winter peaking by a large margin
- Gas system delivers the bulk of the space heating on any given cold day
- This is before we electrify transportation

Analysis by University of California-Irvine (Advanced Power and Energy Program)

Pacific NW: Concurrent Electric and Gas System Peaks

Why is peak capacity so important for energy system planning?

Extreme weather example, January 2017:

- The region's electric system experienced the largest peak in recent years during the 7am hour with a load of less than **30 gigawatts.**

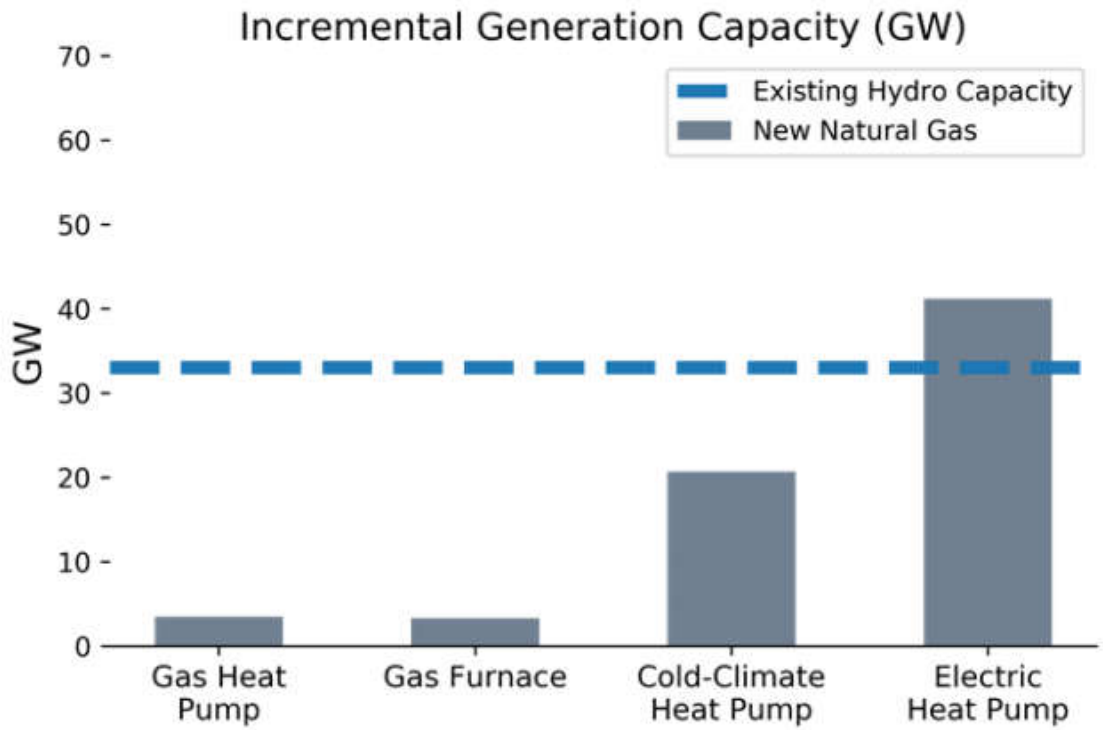
- During the same hour, the direct use of natural gas system in the Northwest also experienced its largest peak in recent years, and delivered about 1.8 million therms of natural gas to homes and businesses, which is equal to **53 gigawatts.**

The natural gas system in the Northwest can deliver 98 gigawatts of energy on peak

- 3 times the current electric generating fleet that serves the region
- Roughly 100x the delivery capability of utility scale battery storage in the United States

Pacific NW: Coincident Peaks

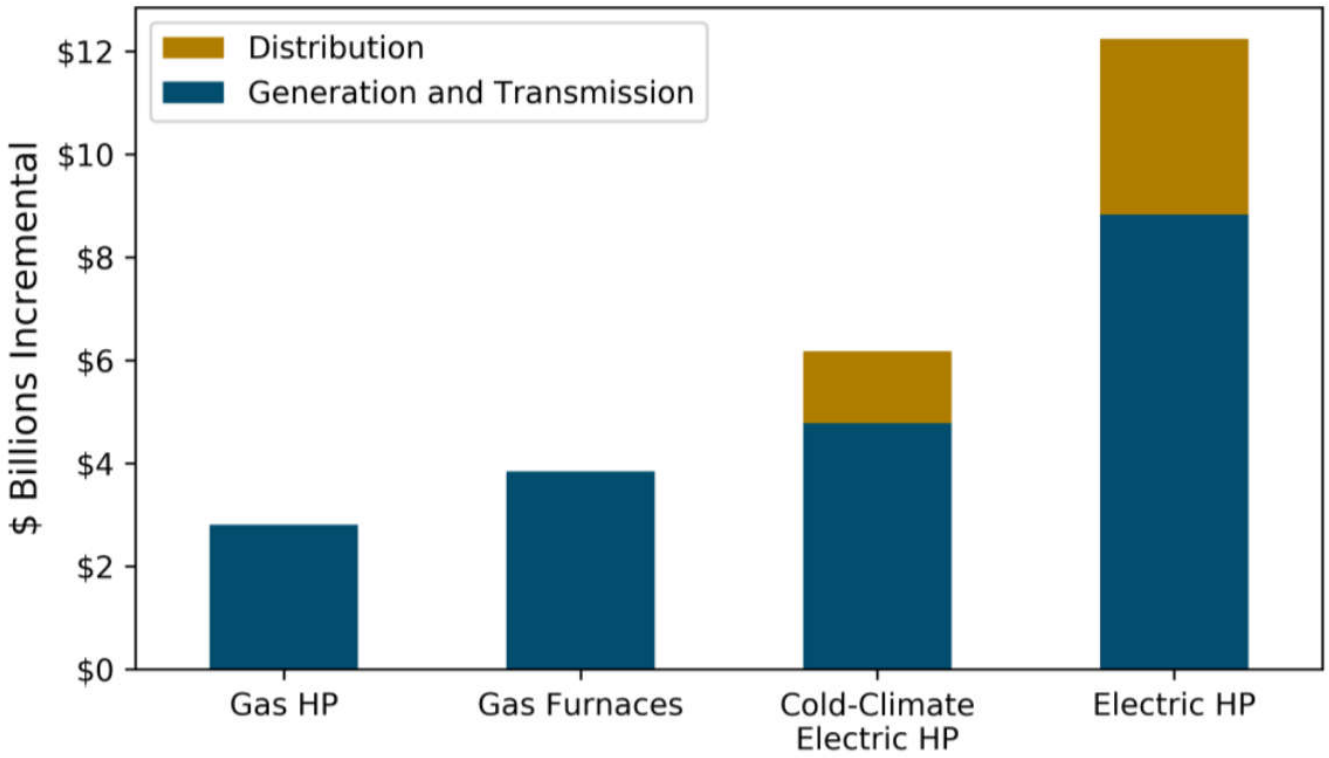
Figure 4. 2050 new firm natural gas capacity build by scenario, compared to existing regional hydroelectric capacity (gigawatts)



Source: E3 2018: https://www.ethree.com/wp-content/uploads/2018/11/E3_Pacific_Northwest_Pathways_to_2050.pdf

What is the Goal?

Figure 30: RESOLVE Costs, Including a Distribution Adder



Source: E3 2018: https://www.ethree.com/wp-content/uploads/2018/11/E3_Pacific_Northwest_Pathways_to_2050.pdf

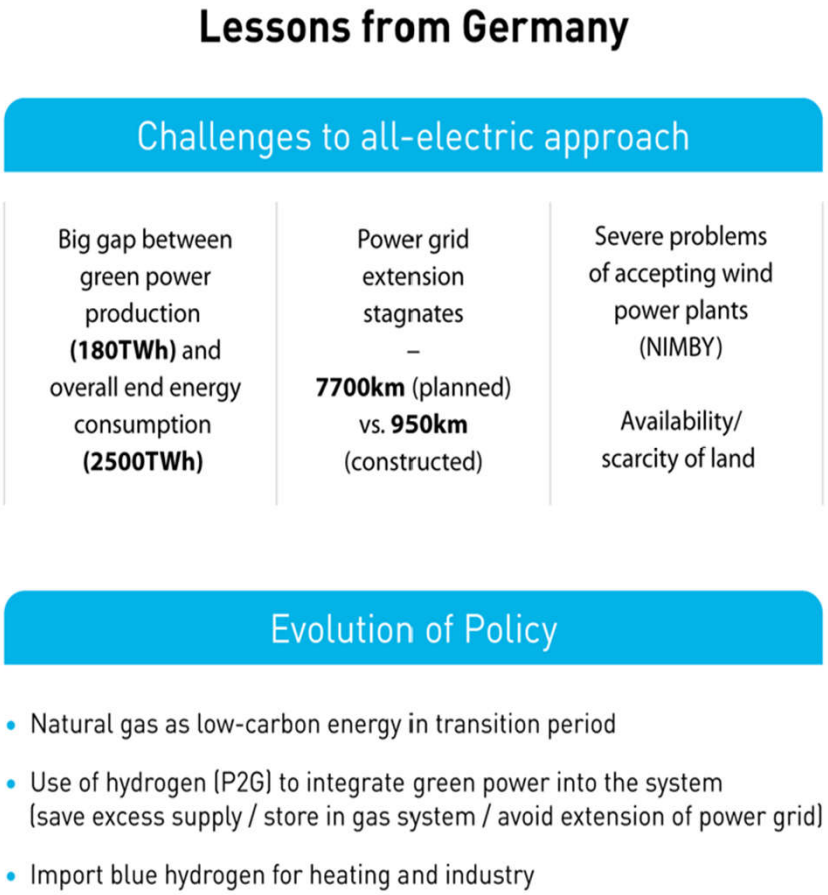
Germany's Experience

Started down an all-electrification path:

- From 2010 to 2019, spent billions on subsidies and infrastructure – and have substantially increased electric renewables to about 40%
- **Yet no emission reductions in 9 years - why?**
  - Moving away from nuclear and increasing reliance on coal
  - Can't meet energy system demands with electric renewables

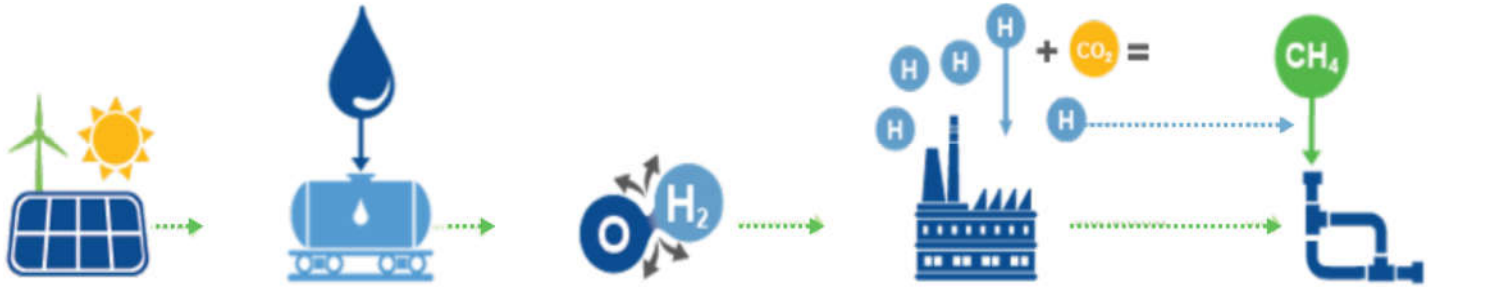
Lessons for the Northwest?

- Already facing significant electric system capacity constraints (as coal plants close)
- In Oregon, roughly half of natural gas attributed to energy use in the state is for power generation
- Driving more peak/winter heating to the electric system will exacerbate that issue – and require more fossil generation for reliability



Power to Gas

Excess wind, solar, or hydro converted to renewable hydrogen for use in our pipeline system



excess renewable energy > goes through electrolysis > which splits the molecule > blends hydrogen directly into pipeline or methanate with waste carbon > can be used immediately or stored seasonally for future use

100+ projects in Europe

3 projects in North America

Germany - Power to Gas

- Hydrogen pilot: City of Mainz, Germany
- Supplied by onsite wind and excess from grid – hydrogen injected to gas system and trucked off for vehicles (including city fleet of hydrogen buses)
- NWN envisions first pilot in Eugene

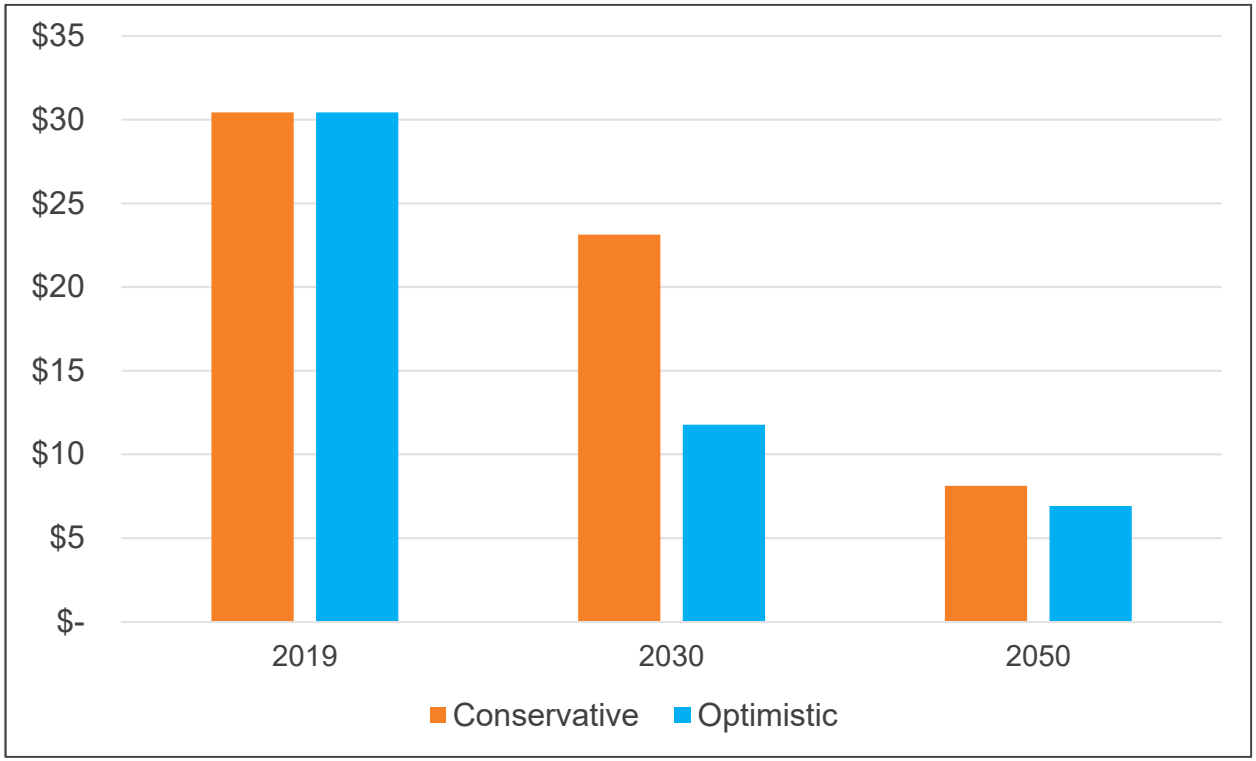
Power to Gas

- First pilot project in Eugene
- Partners:
  - Eugene Water and Electric Board
  - Bonneville Environmental Foundation
  - Air Products
- 2MW project will utilize excess/low value renewable electricity from EWEB to generate hydrogen via electrolysis
  - Inject portion of hydrogen into NWN pipeline to blend with natural gas
  - Sell portion of hydrogen to existing hydrogen customers

Renewable Hydrogen Markets

Cost of Hydrogen from Renewable Electricity

($/mmbtu-equivalent)



- Significant declines expected in capital costs
- Strong growth in European markets
- Growing demand in onsite industrial usage
- Expected increase in curtailed and low-cost renewable electricity

Source: Bloomberg New Energy Finance

Hydrogen as a Seasonal Energy Storage Medium

Problem: Seasonal renewable energy storage

One solution: pumped hydro

- Proposed **$2 billion** pumped hydro project near John Day Dam
- Could provide about **15,000 megawatt hours per year of storage**

Other solutions using existing gas infrastructure?

- NW Natural storage provides the equivalent of 4.7 million megawatt hours of storage – ***300x*** **the amount of that project**
- Can store renewable natural gas and blended / methanated renewable hydrogen
- Installing a Power to Gas facility to produce hydrogen with the same capacity as the pumped hydro project estimated at approx. **$360 million**[1]
- Thinking innovatively about gas system dramatically increases decarbonization options

[1]Using USDOE 2020 electrolyzer cost forecasts

RNG and Hydrogen: 2020

- Moving forward on pilot power-to-gas hydrogen project in Eugene with Eugene Water and Electric Board
- Expect finalized rules from both Oregon PUC and Washington UTC in 2020 on RNG procurement, cost recovery, and voluntary tariffs for customers
- Currently evaluating many RNG purchase options and plan to begin purchasing RNG in 2020
- Implementing lessons learned in Europe and partnering with other utilities around questions on hydrogen injection – developing internal and external hydrogen roadmaps

Thank you

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