Pacific NorthWest Economic Region

The Pacific Northwest Economic Region Presents:

REGIONAL ENERGY CEO ROUNDTABLE

Tuesday, August 17th | 8am-9:15am

Photo Courtesy of Montana Office of Tourism & Business Development

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Moderated by:

Bob Rowe
CEO
NorthWestern Energy

Arne Olson
Sr. Partner
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Mary Kipp
President & CEO
Puget Sound Energy

Nicole Kivisto
President & CEO Cascade
Natural Gas, MDU Utilities Group

Steve Wright
General Manager
Chelan PUD

David Anderson
President & CEO
NW Natural

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Energy+Environmental Economics

Climate Change and the Energy Transition: Our Energy Infrastructure at a Crossroads

PNWER Annual Summit Plenary Session: Overview of our Regional Infrastructure and Policy Landscape

August 17, 2021

Arne Olson, Senior Partner

Themes

- A changing climate is posing ***PROFOUND CHALLENGES*** to our ability to deliver reliable and affordable energy

- Responding to the physical and policy imperatives of climate change will require significant investment in our ***ENERGY INFRASTRUCTURE***

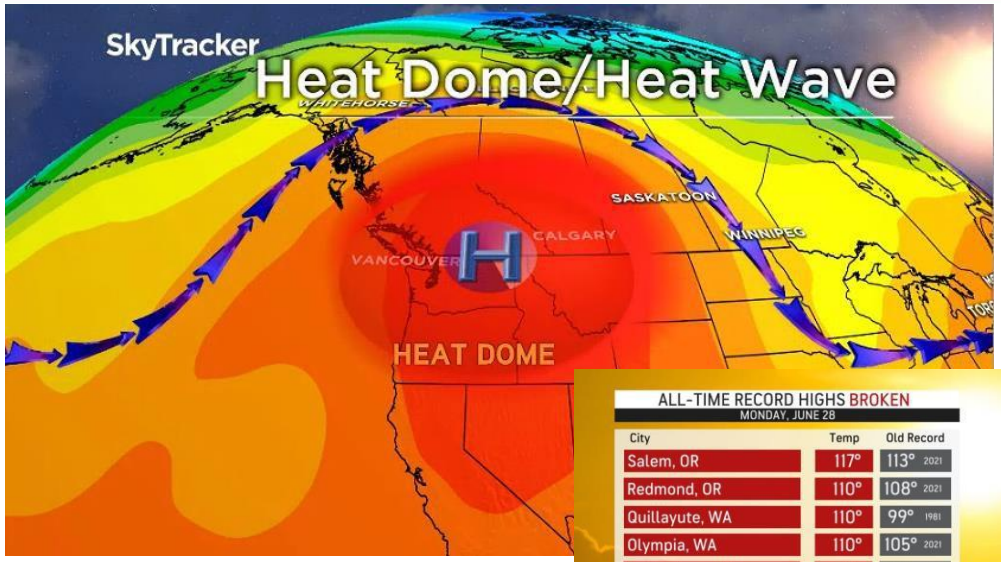
- Ensuring an ***ORDERLY, EQUITABLE TRANSITION*** toward clean energy systems will require proactive planning and regulation to preserve the public benefits provided by networked energy systems

The climate is transforming: key findings about possible climate futures from the 2021 IPCC report

1. **Global surface temperature will continue to increase until at least the mid-century** under all emissions scenarios considered. Global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in carbon dioxide (CO2) and other greenhouse gas emissions occur in the coming decades.
2. Many changes in the climate system become larger in direct relation to increasing global warming. They include **increases in the frequency and intensity of hot extremes**, marine heatwaves, and heavy precipitation, agricultural and ecological **droughts** in some regions, and proportion of intense tropical cyclones, as well as reductions in Arctic sea ice, **snow cover** and permafrost.
3. Continued global warming is projected to further intensify the global water cycle, including its variability, global monsoon precipitation and the **severity of wet and dry events**.
4. Under scenarios with increasing CO2 emissions, the ocean and land **carbon sinks are projected to be less effective** at slowing the accumulation of CO2 in the atmosphere.
5. Many changes due to past and future greenhouse gas emissions are **irreversible for centuries to millennia**, especially changes in the ocean, ice sheets and global sea level.

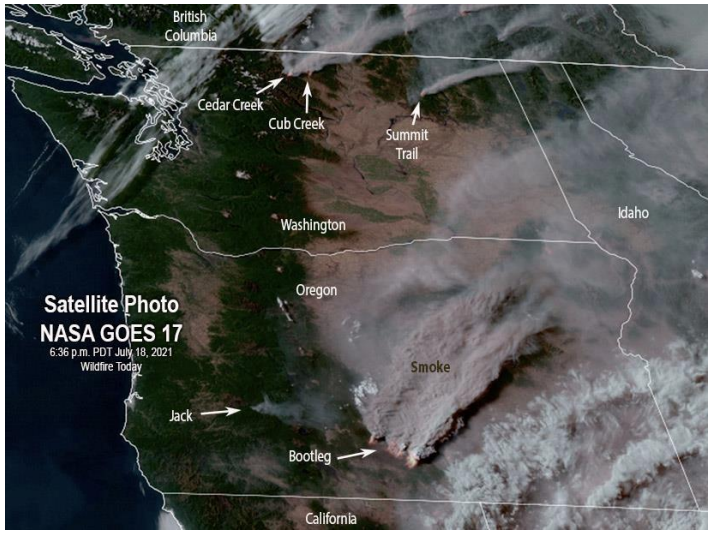
Intergovernmental Panel on Climate Change, Climate Change 2021: The Physical Science Basis
https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf

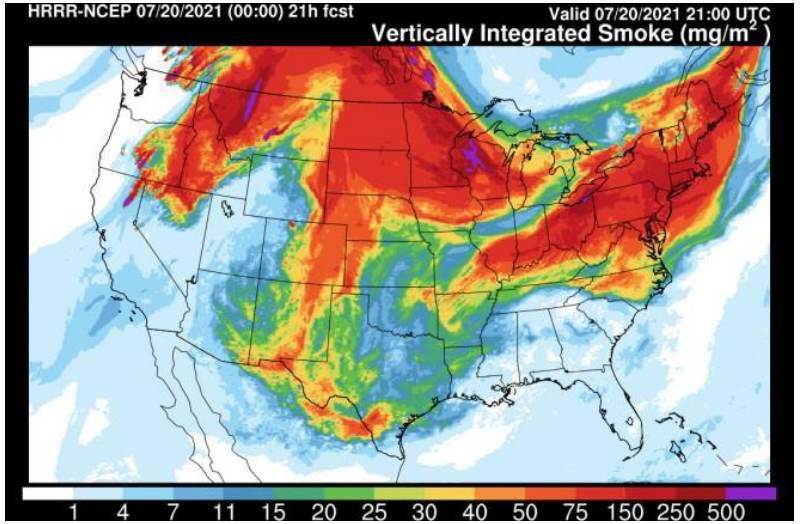
Climate impacts are happening close to home: extreme heat, drought, fires



ALL-TIME RECORD HIGHS BROKEN
MONDAY, JUNE 28

City	Temp	Old Record
Salem, OR	117°	113° 2021
Redmond, OR	110°	108° 2021
Quillayute, WA	110°	99° 1981
Olympia, WA	110°	105° 2021
Bellingham, WA	99°	96° 2009



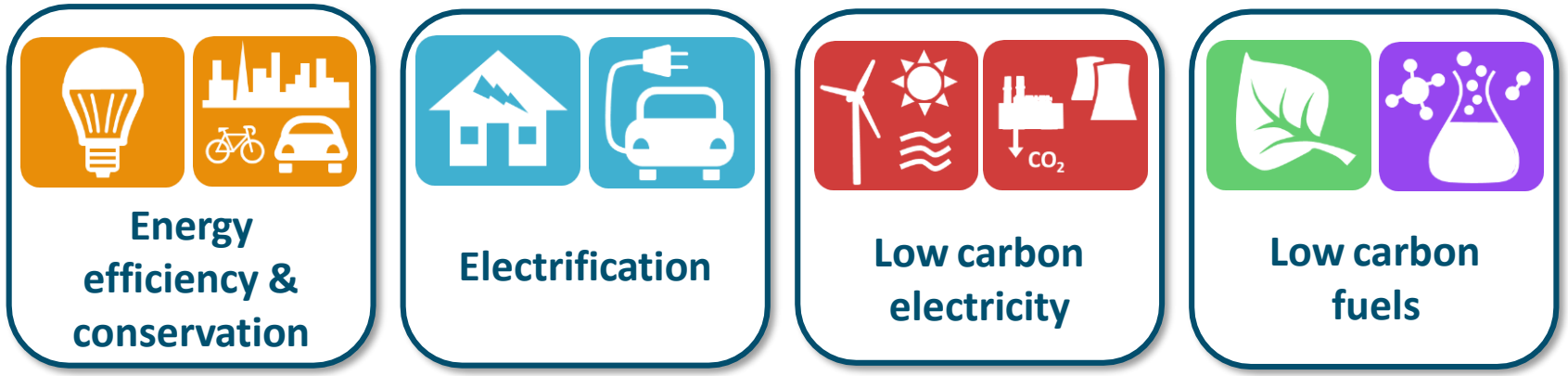


The policy landscape is transforming: clean energy goals are multiplying

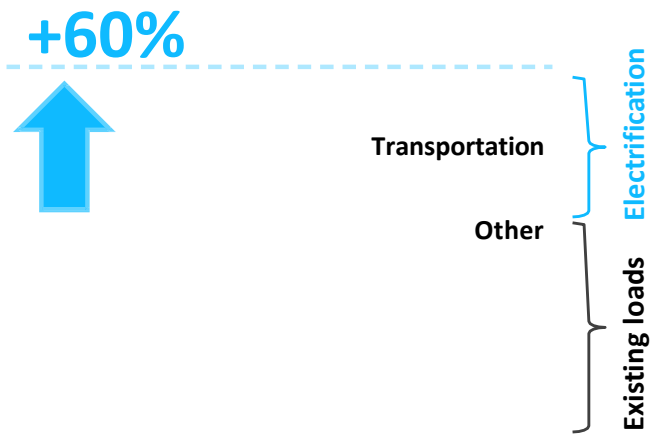
Most of the Pacific Northwest Region is now covered by some type of clean energy goal

Entity	Description
British Columbia	Climate Change Accountability Act (2007): Economy-wide, 40% reduction by 2030, 60% by 2040, 80% by 2050
Washington	Clean Energy Transformation Act (2019): Electricity only, no coal by 2025, carbon-neutral by 2030, 100% clean by 2045
Oregon	100% Clean Energy Bill (2021): Electricity only, 80% carbon reduction by 2030, 90% by 2045, 100% by 2040
Idaho Power	100% clean energy by 2045
Avista	Carbon neutral electricity by 2027, 100% clean energy by 2045
Puget Sound Energy	Beyond net-zero by 2045, which includes: a carbon neutral electric system by 2030 and 100% clean electricity by 2045.
NorthWestern	90% carbon reductions by 2045
Portland General Electric	80% carbon reduction by 2030, net zero carbon by 2040

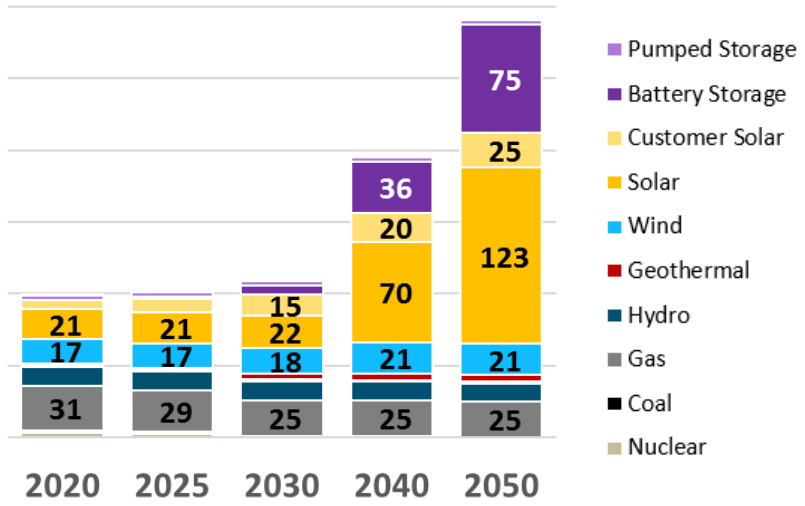
Meeting our energy and climate challenges will require a transition of our energy systems across four "pillars"



California Electric Loads under Deep Carbon Reductions



California Electric Resources under Deep Carbon Reductions



Electricity sector plays a key role in meeting societal carbon goals in all scenarios!

Climate change is posing multiple challenges to our Energy Infrastructure

- Keeping our communities and consumers ***SAFE*** is increasingly difficult with more extreme temperatures, storms and fires
- Providing ***RELIABLE*** energy service is complicated by both extreme weather and the transition to weather-dependent energy resources
- Keeping energy ***AFFORDABLE*** will be important to maintain our economic well-being and to facilitate the transition to electrified technologies
- A shift to more ***SUSTAINABLE*** energy sources is vital to limit future climate damage
- Ensuring ***EQUITABLE*** access to energy services will need to be a key priority as our energy systems transition

Electric sector “low-hanging fruit” is to rapidly scale up clean generating resources

+ **Invest in new and existing *CLEAN ELECTRICITY* generation**
  - Wind and solar power are low-cost and abundant in most places
  - Coal replaced with renewables and gas
  - Retain existing ***NUCLEAR*** and ***HYDRO***
  - Requires significant buildout of ***TRANSMISSION***

Significant GHG reductions can be achieved at relatively low cost in the Pacific Northwest

Image source: *Resource Adequacy in the Pacific Northwest (Various utilities, 2019)*

Maintaining reliable and affordable electricity will require continuing to invest in fossil fuel infrastructure

+ ***RESOURCE ADEQUACY*** **will be a significant challenge as coal is retired and more wind and solar are added**
  - ❑ Firm capacity resources are needed for periods when wind and solar energy are not available
  - ❑ Today there is no substitute for ***NATURAL GAS GENERATION***
  - ❑ A changing climate will amplify the challenge of maintaining reliable power supplies

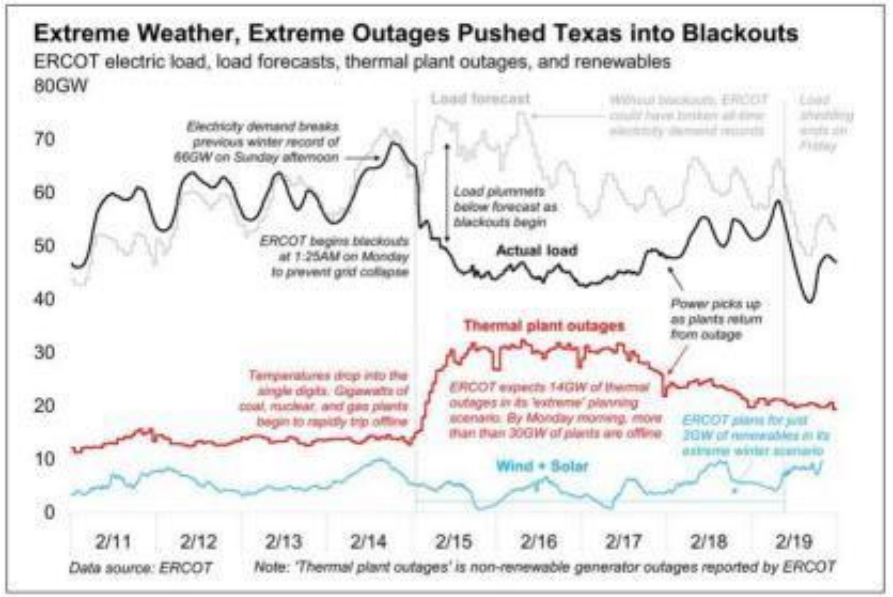
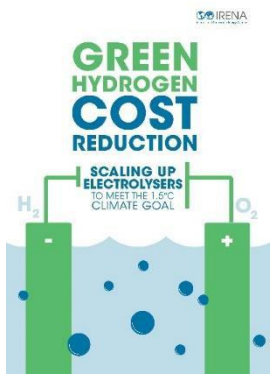
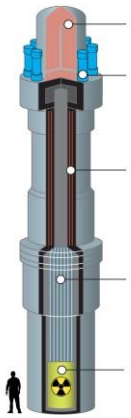
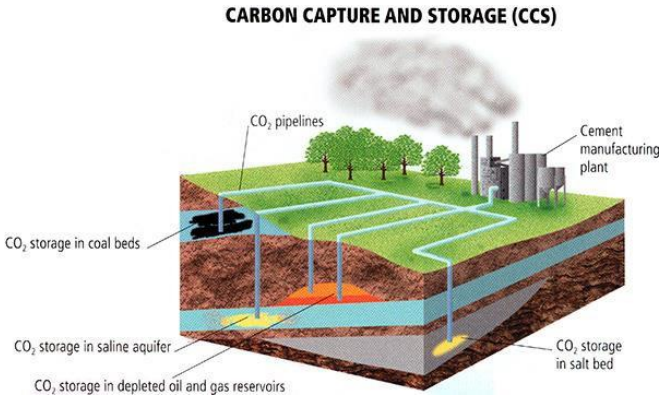


Figure 1. ERCOT data posted to Twitter by Brian Bartholomew (@BPBartholomew)

+ **Invest in R&D for *"CLEAN FIRM"* resources to eventually replace gas:**
  - ❑ New nuclear (e.g., Small Modular Reactors)
  - ❑ Fossil generation with carbon capture and sequestration
  - ❑ Very long-duration energy storage
  - ❑ Hydrogen or renewable natural gas





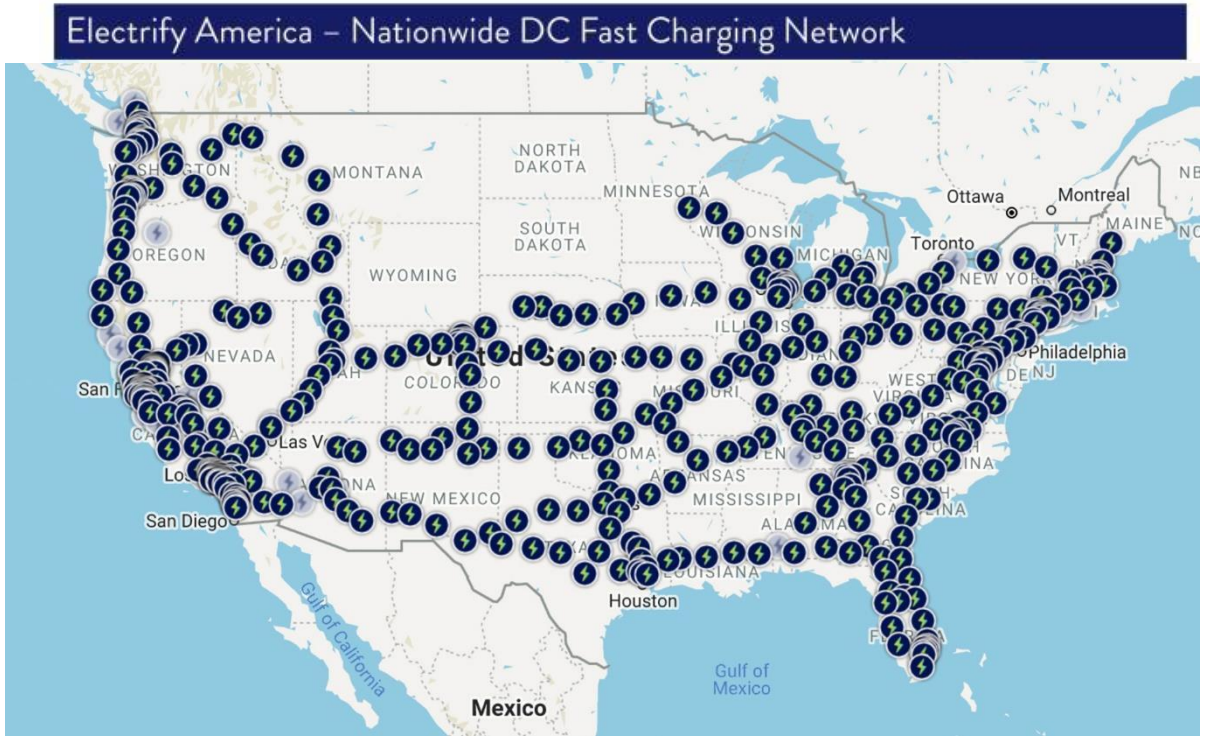


Transportation sector "low-hanging fruit" is electrification of light- and medium-duty vehicles

+ Accelerate adoption of light duty consumer ***ELECTRIC VEHICLES*** and short-haul truck fleets

+ Significant investment required to build out local and regional ***CHARGING NETWORKS***

+ Ensuring ***EQUITABLE ACCESS TO MOBILITY*** will require thoughtful and proactive regulation

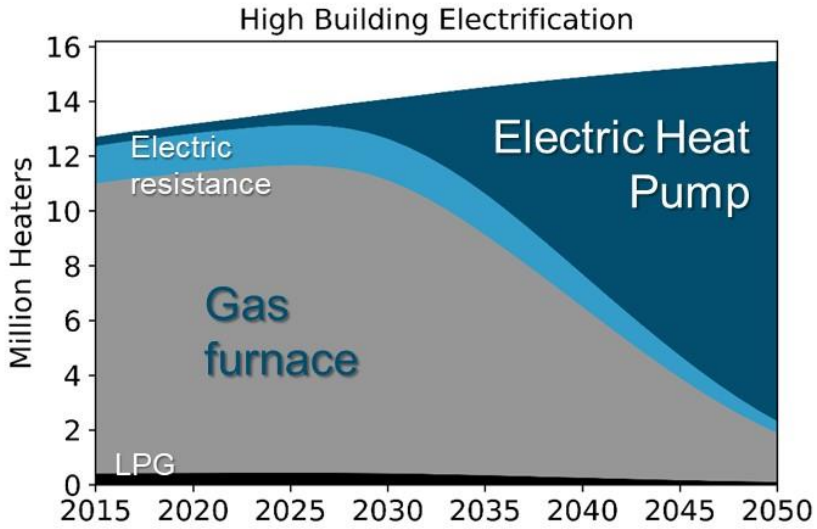


Building sector: managed transition toward electrification and lower-carbon fuels

+ **Encourage adoption of electric *HEAT PUMP* technologies for residential and small commercial buildings**

+ **Invest in clean alternatives to fossil gas such as *HYDROGEN* and *BIOMETHANE***

+ **Use proactive planning and regulation to manage an *ORDERLY AND EQUITABLE TRANSITION* of the natural gas business model**
  - ❑ Building electrification can have a significant impact on electricity system peak loads
  - ❑ Ensure equitable recovery of existing fixed costs during the transition



"S-shaped" adoption curves with stock rollover of long-lived equipment means policy action must start early

Themes

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Energy+Environmental Economics

Thank You!

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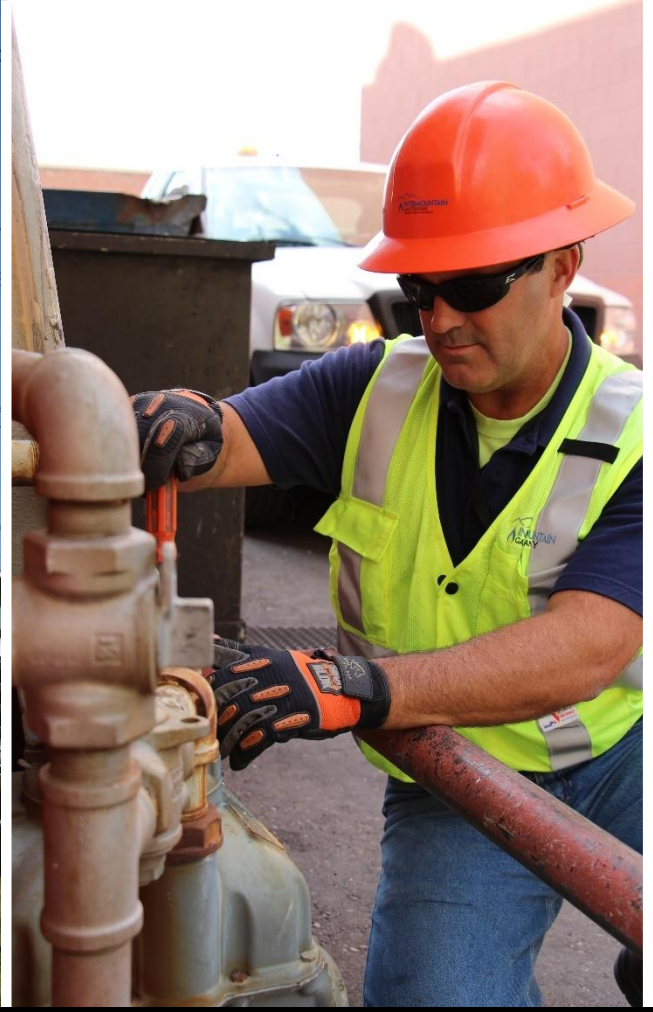
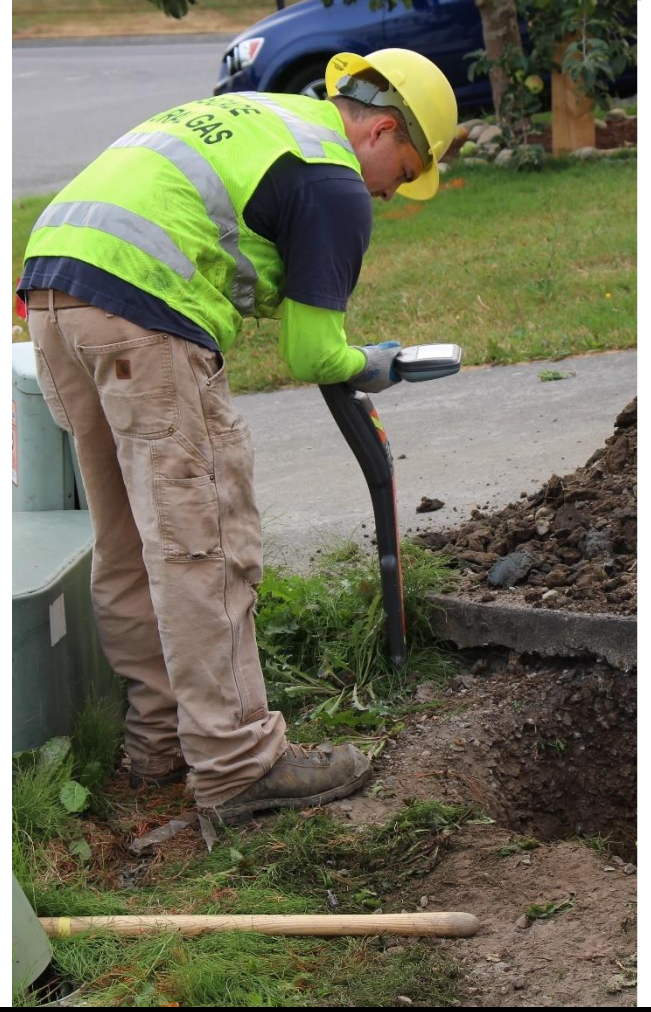



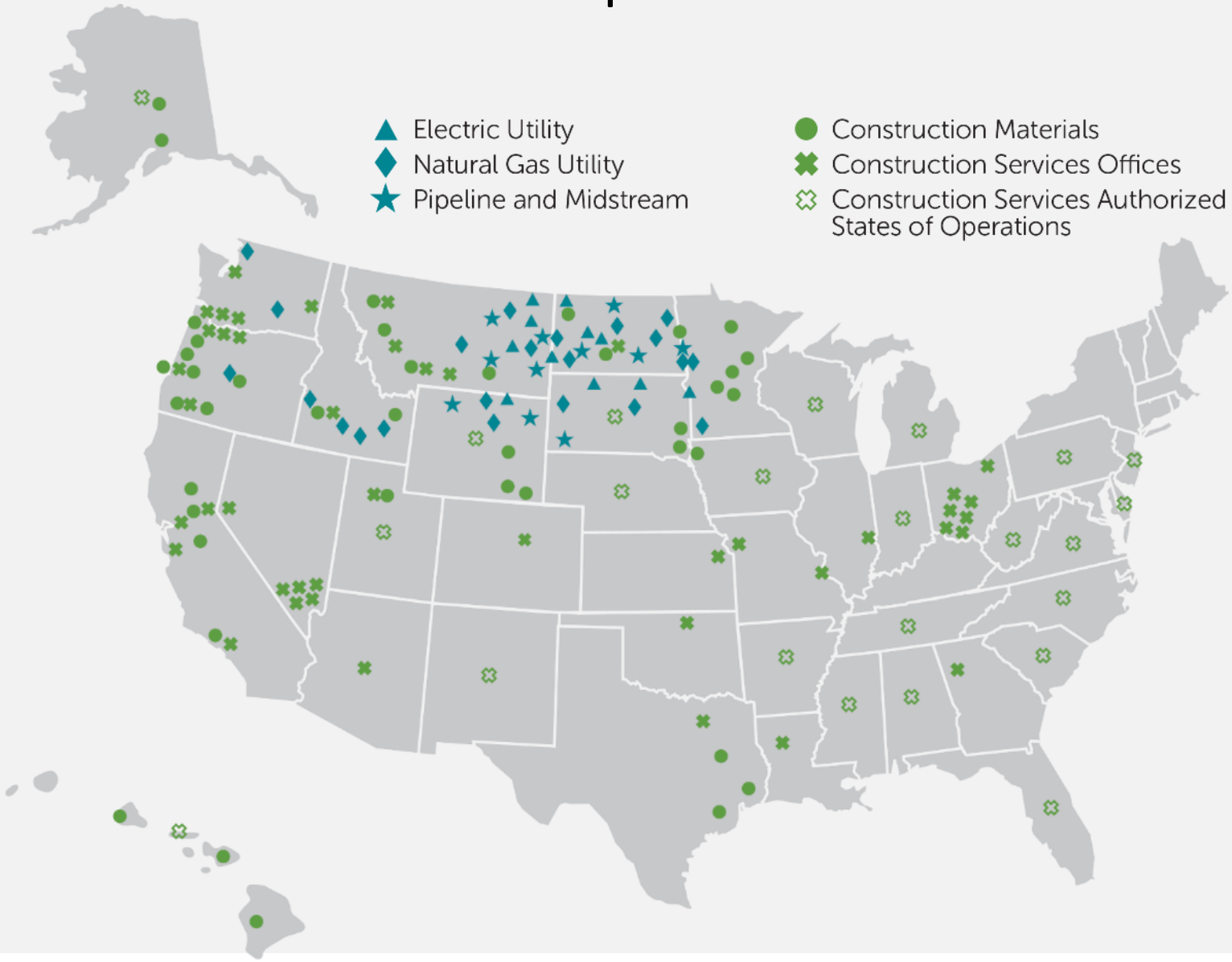

PNWER Annual Summit

Nicole Kivisto
President & CEO, MDU Utilities Group

Company overview

A strong infrastructure is the heart of the American economy. It is the natural gas and electricity that power business, industry and our daily lives. It is the pipes and wires that connect our homes, factories, offices and stores to bring them to life. It is the transportation network of roads, highways and airports that keeps our economy moving. **Infrastructure is our business, and we are Building a Strong America®.**

MDU Resources Group



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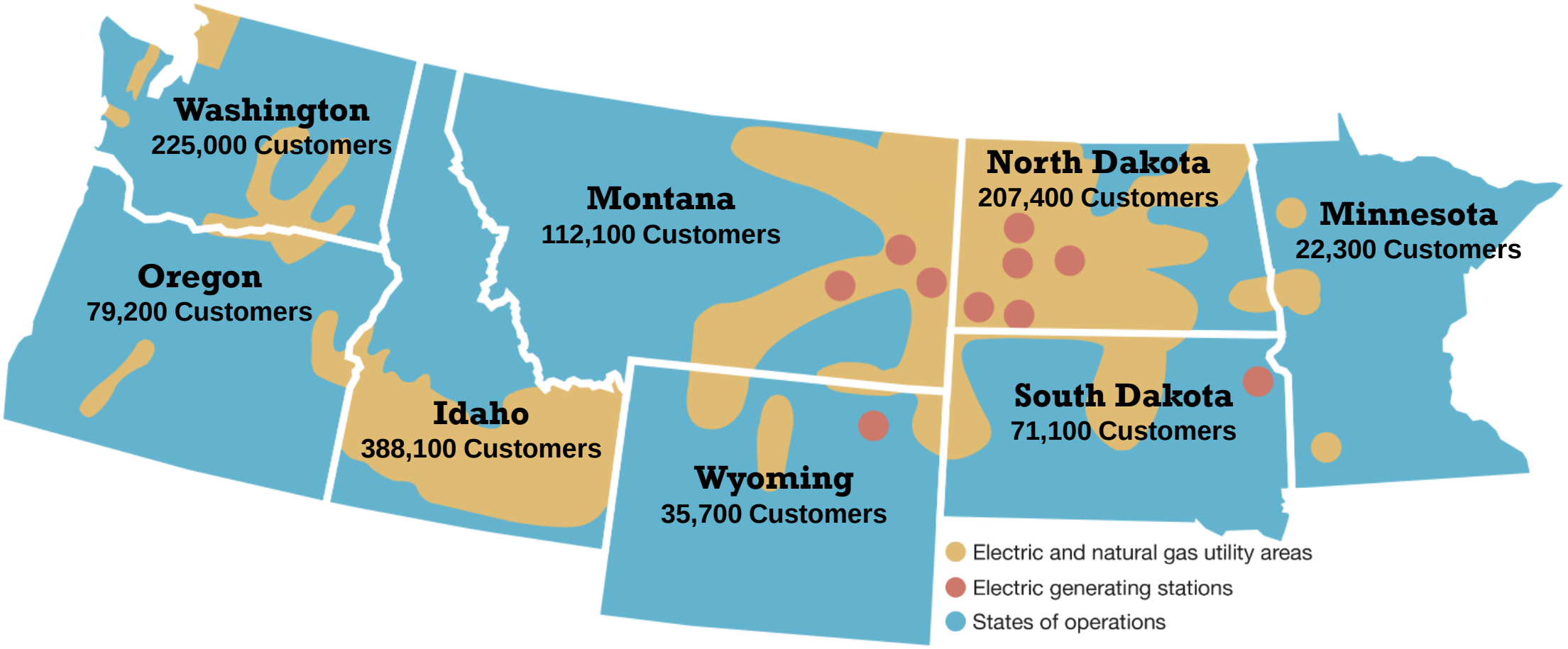
Customers by State



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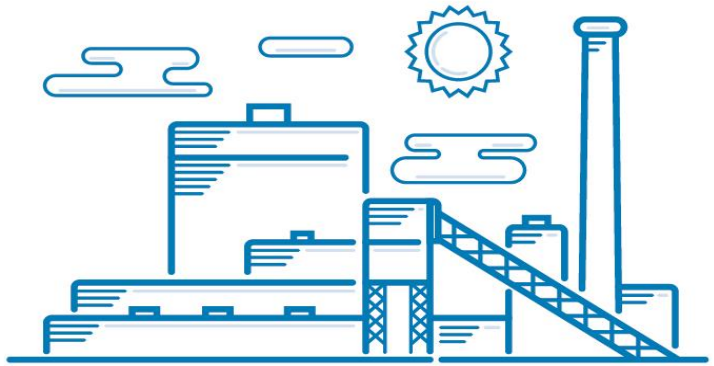
MDU ELECTRIC GENERATION OVERVIEW

TOTAL 756 MW



COAL-FIRED GENERATION

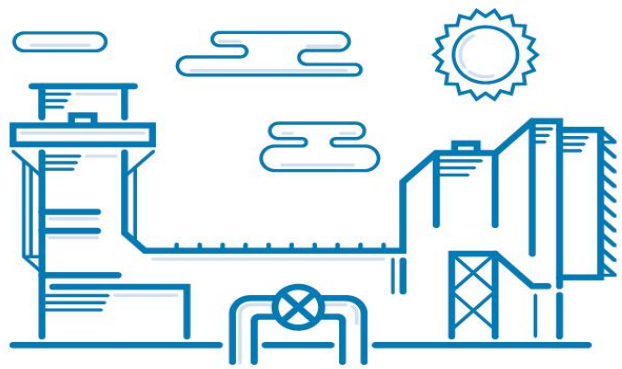
45% | 342 MW

Heskett 1&2 – Mandan, ND
- 25 MW unit 1 (1954) / 75 MW unit 2 (1963)

Coyote Station – Beulah, ND
- 107 MW of 427 MW plant (1981)

Big Stone Station – Big Stone City, SD
- 108 MW of 475 MW plant (1975)

WyGen III – Gillett, WY (Non-Miso)
- 27 MW of 110 MW (2010)



NATURAL GAS-FIRED GENERATION

27% | 204 MW

Heskett 3 – Mandan, ND
- 88 MW

Glendive 2 – Glendive, MT
- 40 MW

Glendive 1 – Glendive, MT
- 34 MW

Miles City – Miles City, MT
- 23 MW

Lewis & Clark 2 – Sidney, MT
- 19MW

RENEWABLE GENERATION

28% | 210 MW

Thunder Spirit Wind 1 & 2 – Hettinger, ND
- 155.5 MW

Diamond Willow Wind – Baker, MT
- 30 MW

Cedar Hills Wind – Rhame, ND
- 19.5 MW

Glen Ullin Waste Heat (from pipeline compressor)– Glen Ullin, ND
- 5.3 MW

Other
Portable Diesel Generation
- Two units – each 2 mw

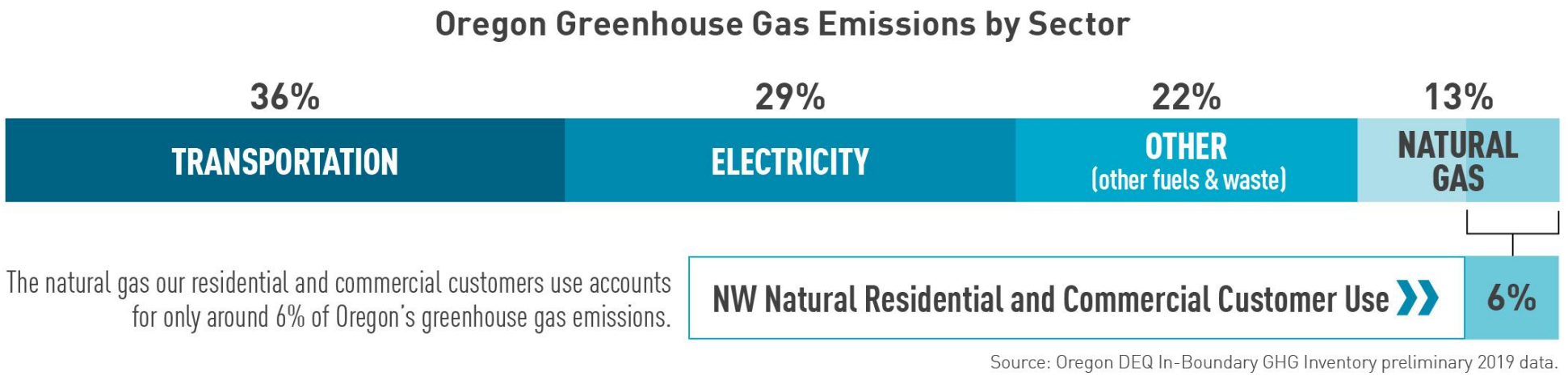
PNWER

David Anderson, President & CEO

NW Natural®

Role of Our System Today

- **Serves 2.5 million people** in Oregon and Southwest Washington
- **Delivers more energy** than any other utility in Oregon
- **Heats 74%** of residential square footage in the areas we serve
- **Meets 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
- Our customers' emissions **account for just 6%** of Oregon's total GHG emissions

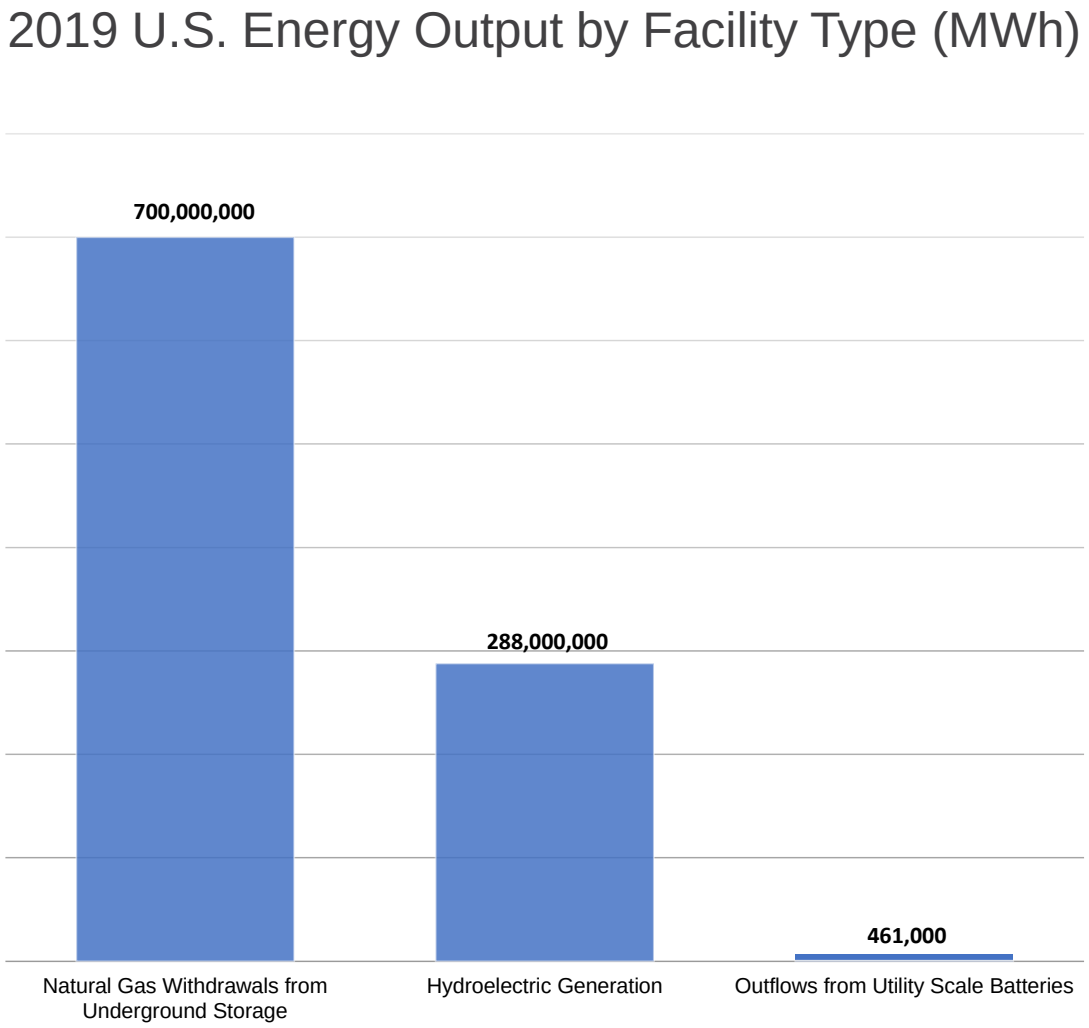


The Future of the Gas System

A decarbonizing network:

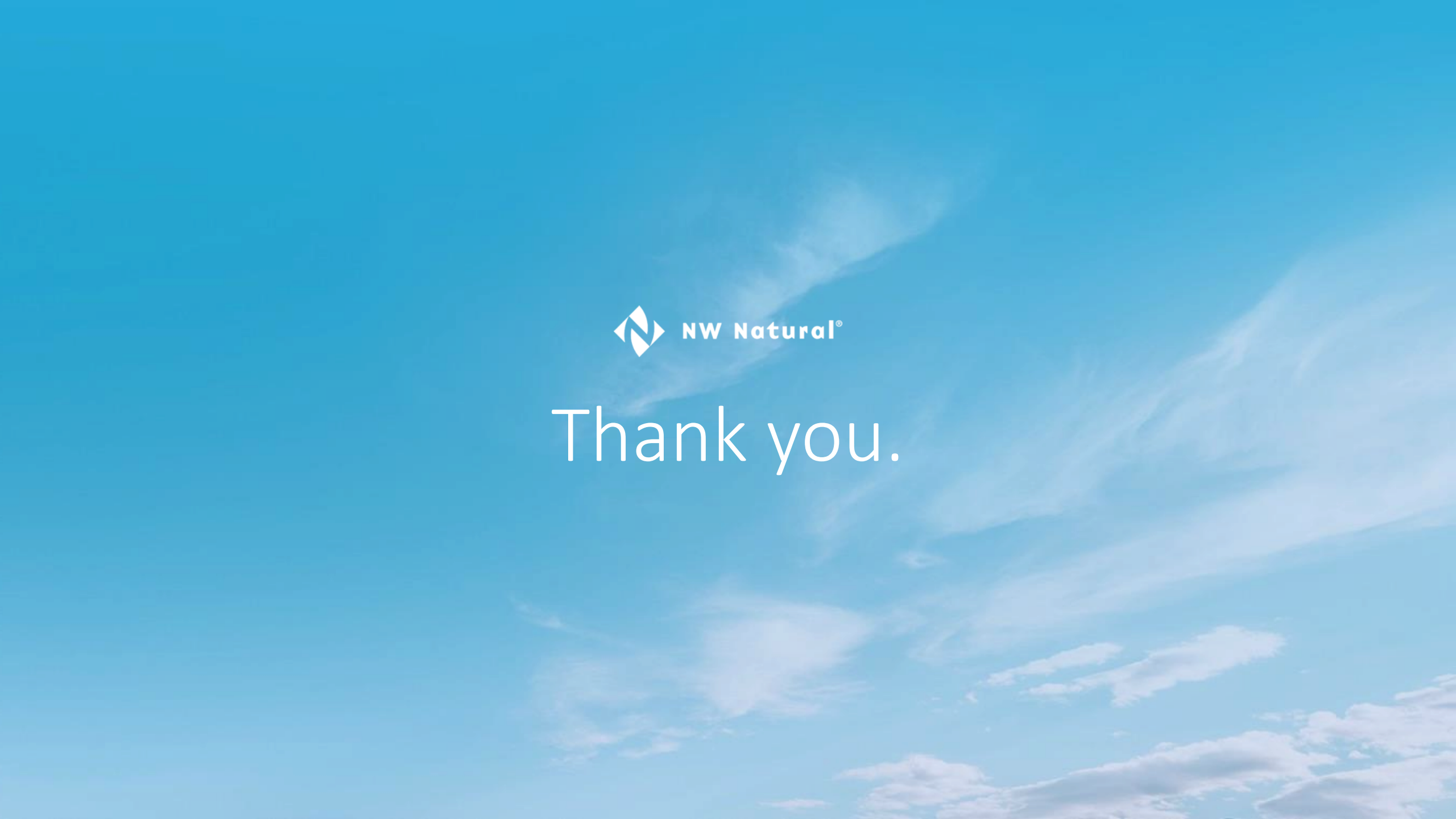
- Deep energy efficiency
- Renewable natural gas
- Clean hydrogen
  - ✓ Blended
  - ✓ Methanated
  - ✓ 100% H2

Gas System: Flexible, Long-Duration Renewable Storage



- Gas system has 2.5 times the energy of hydro facilities and about 1,500 times the energy delivered from current large-scale utility batteries
- Existing facilities can be used to store renewable natural gas and methanated hydrogen
- NWN's Mist storage can hold 6 million MWh of energy that can be delivered whenever needed
- To replicate that with a Li-ion battery, that's $2 trillion at today's prices[5]

1. Source: EIA Weekly Natural Gas Storage Report - Withdrawals are calculated and aggregated from a weekly regional report. This understates the total volumes withdrawals if data was available for daily withdrawals from individual storage facility.
2. To convert natural gas volumes to MWh for comparison, this figures uses a national average heat content of 1036 btu/cf and a direct energy conversion of 0.29307 MWh/MMBtu.
3. Source: EIA 923 Form – Hydroelectric and battery generation are pulled from generator level data identified with prime movers "HY" and "BA", respectively. Net generation is aggregated for hydroelectric generators and gross generation is aggregated for batteries.
4. The figure for hydroelectric generation is the total net generation from hydroelectric facilities and does not distinguish between what can and cannot be stored.
5. https://www.nrel.gov/docs/fy19osti/73222.pdf


NW Natural®
Thank you.