

Carbon-Free Electricity Policies Impacts & Perspectives

2024 EmPOWERING Our Community



Rick Dunn, General Manager/CEO

October 2024



RICKDUNN.SUBSTACK.COM

Sawing Off the Branch We're Sitting On and Deepening our Dependence on Northwest Hydro for 'Blackout Insurance'

Washington and Oregon have Teamed with the Federal Government to Undermine the Very Hydropower on Which 100% Clean Electricity Mandates were Based



Rick Dunn, P.E. - Pro Nuclear, Experience & Common Sense

By Rick Dunn

More than 'bumper sticker' clean energy policy information. Politicians are designing the power grid and we're heading for a cliff.

- ✓ ***Began Publishing November 2023***
- ✓ ***Optional & Free to Subscribe***
- ✓ ***Artistic Collaboration: Marjean Allen-Dunn***

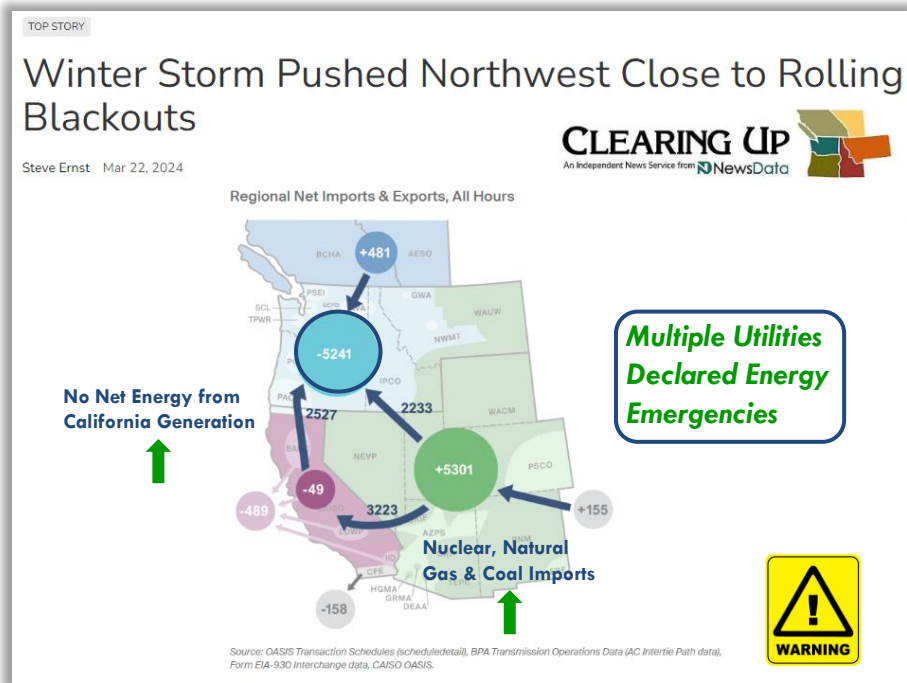
<https://rickdunn.substack.com/>

Agenda

1. **Northwest Close to Blackouts – How did we get here?**
2. **WA & OR Clean Energy Policies – Global & U.S. Perspectives**
3. **WA Energy Strategy – We're Coming for you Montana & Wyoming!**
4. **Where Do We Go from Here? – Near and Long Term**

Northwest Close to Blackouts

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January 12 – 16, 2024

- Northwest **Imported Electricity** for all 120 Hours of Cold Snap
 - Hydro **short on water**, natural gas **maxed out** & wind power collapsed to **zero**
 - +2,000 MW of **coal retirements** so far
 - Demand grew **2% to 6%** since December 2022 winter event
- Northwest electric **grid** & natural **gas** pipeline systems are at **immediate risk** with no margin for the unexpected

Northwest has Long Exported Electricity to California

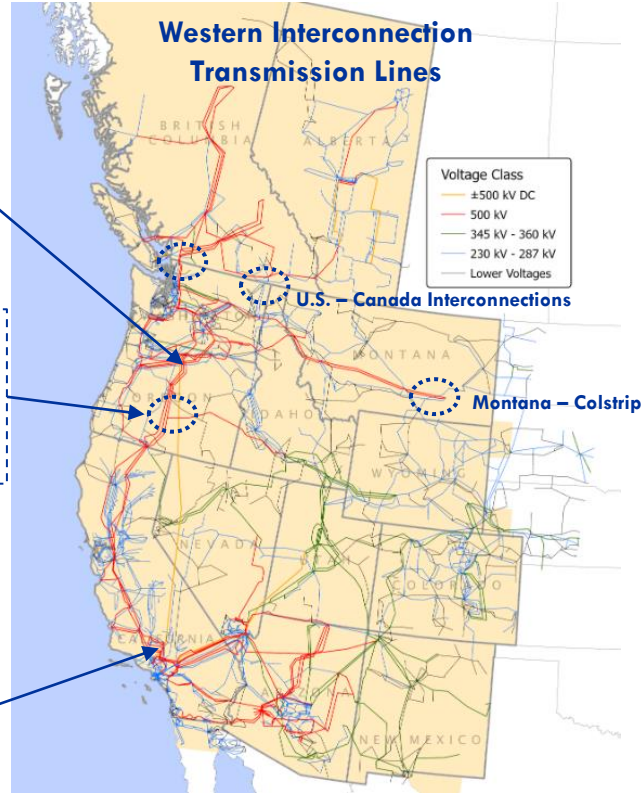
5

Pacific HVDC North Terminal near The Dalles



Pacific
DC & AC
Interties
8,000 MW

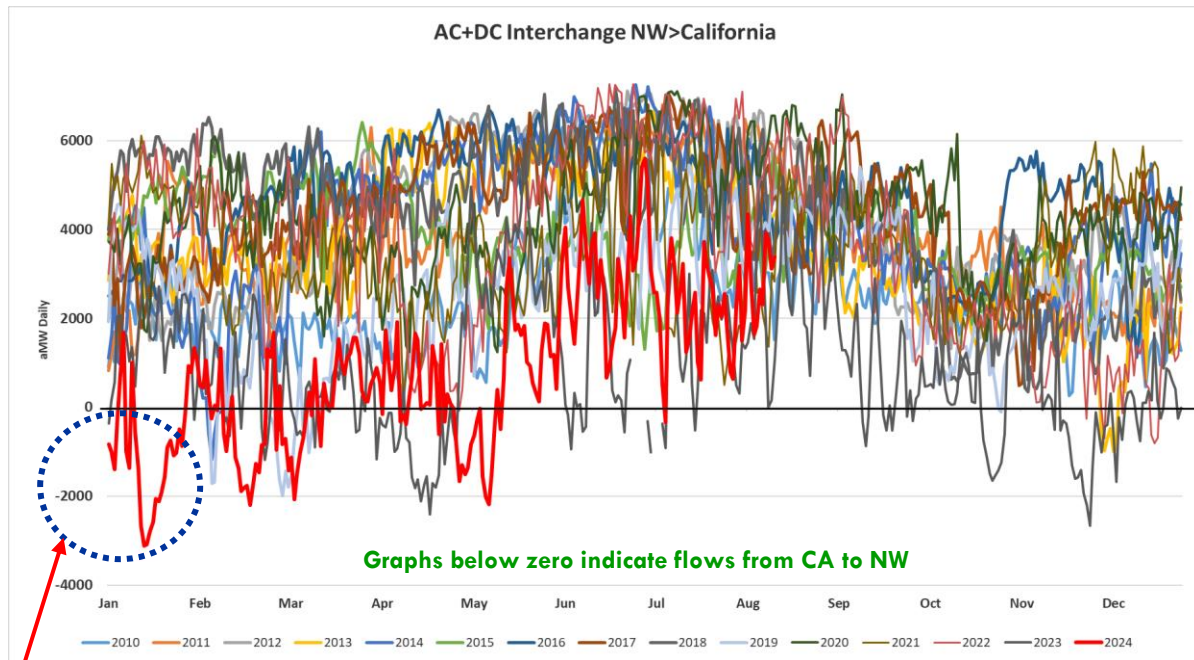
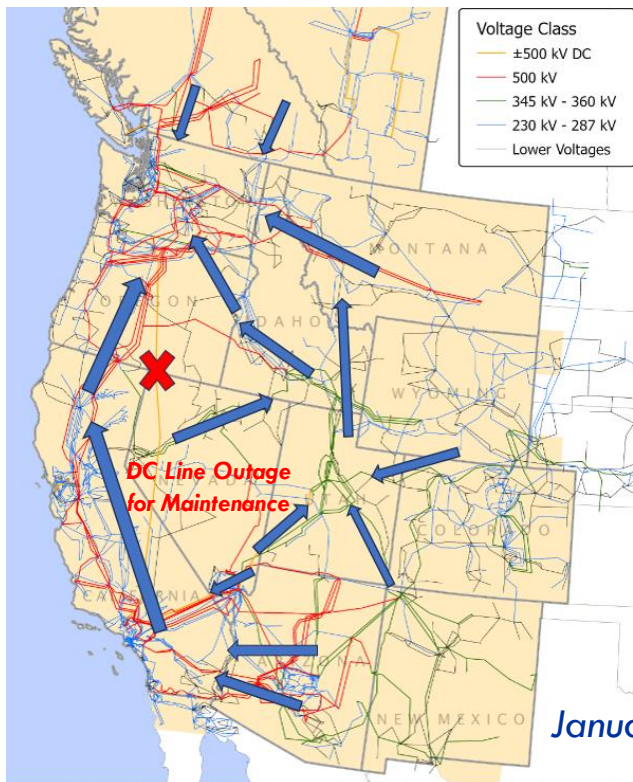
Pacific HVDC South Terminal near Los Angeles



- ✓ Pacific Interties went into service 1968 - 1970
- ✓ Path for Hydropower surpluses in the Northwest to flow to California
- ✓ High Voltage Direct Current (DC) allows more precise control of power flow and lower losses; but more complicated
- ✓ Canada & Montana Interconnections becoming more important

Northwest Beginning to Import Electricity via CA

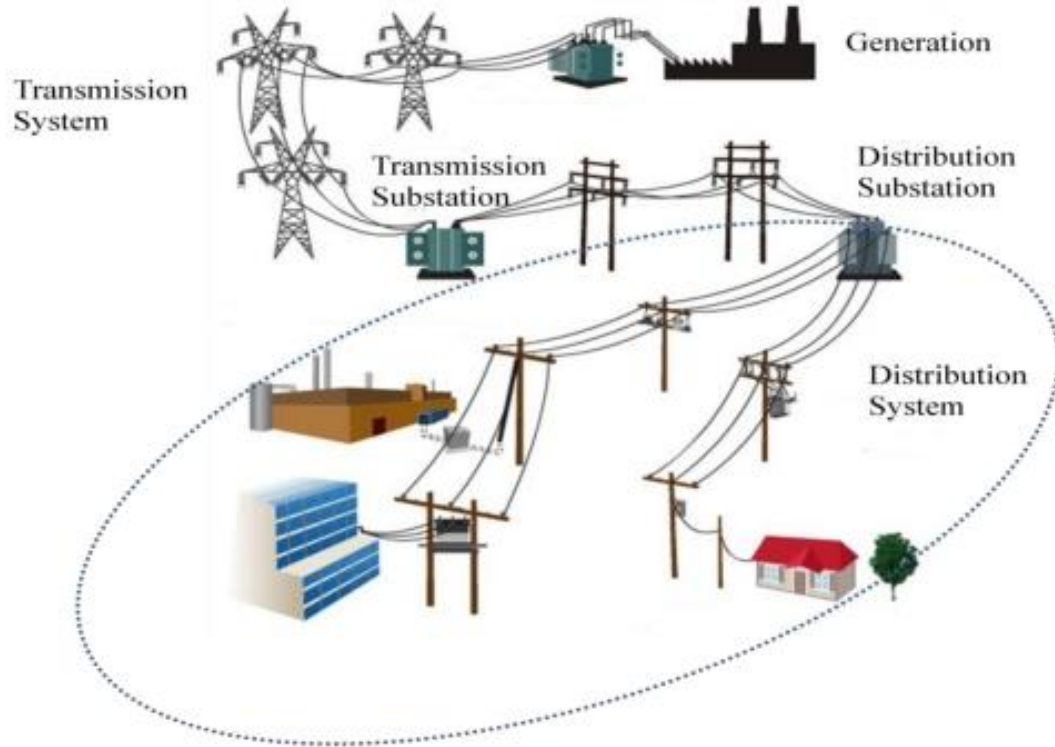
6



January 2024 Cold Weather Event

Power Grid Basics: A Service Like No Other!

7



Electricity is simultaneously:

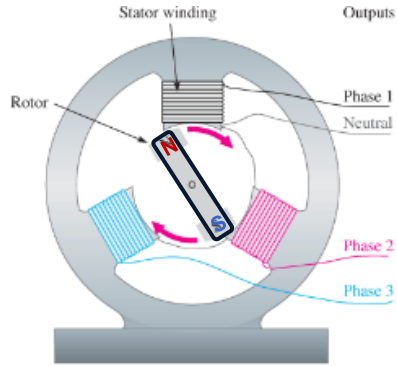
Produced

Delivered

Consumed

Alternating Current (AC) Electricity

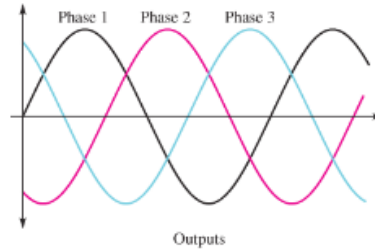
8



(a) Three-phase rotating-field generator

Rotating Magnetic Field

60 cycles per second sine waves



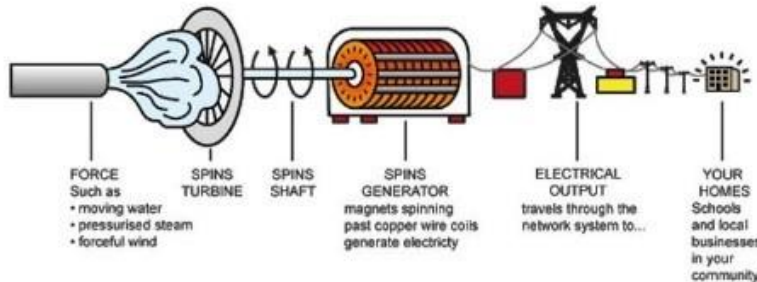
(b) Three-phase sine wave



Three-Phase Requires 3 Wires



Speed of rotation
precisely controlled

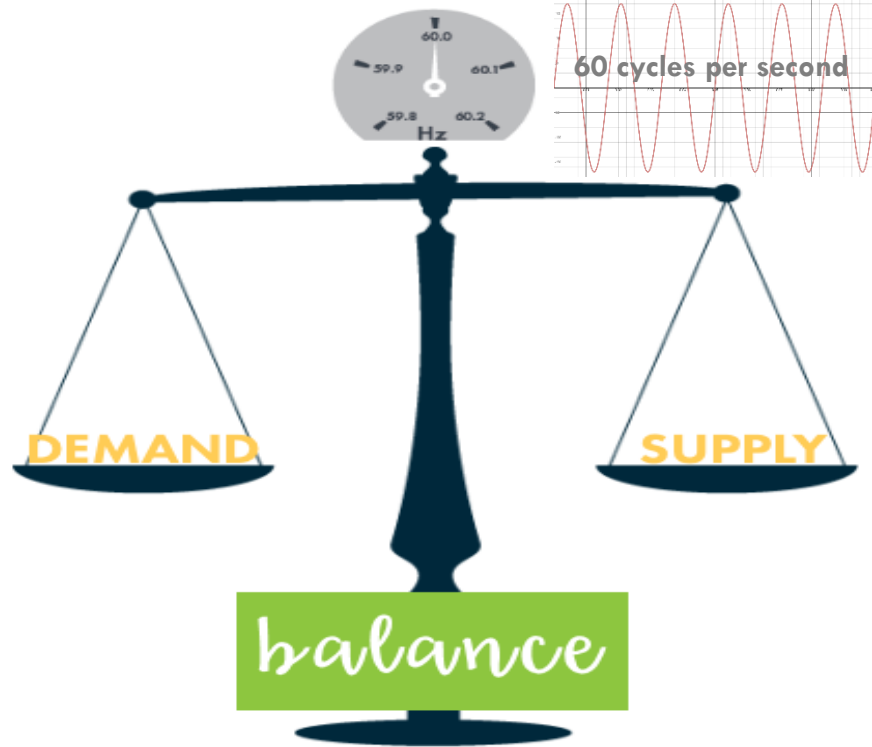


- ✓ All Generators must be **Synchronized**
- ✓ **Increasing** Demand Tends to **Decrease** Speed of Rotation
- ✓ **Decreasing** Demand tends to **Increase** Speed of Rotation

Demand/Supply Balancing: Physics

9

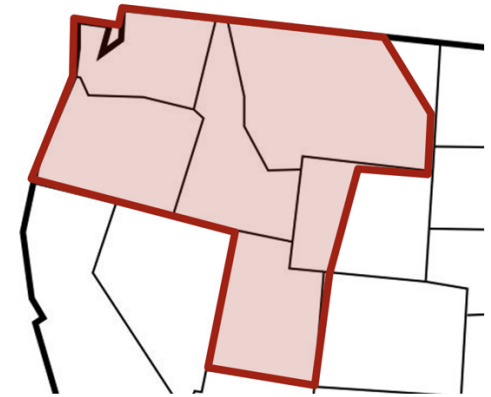
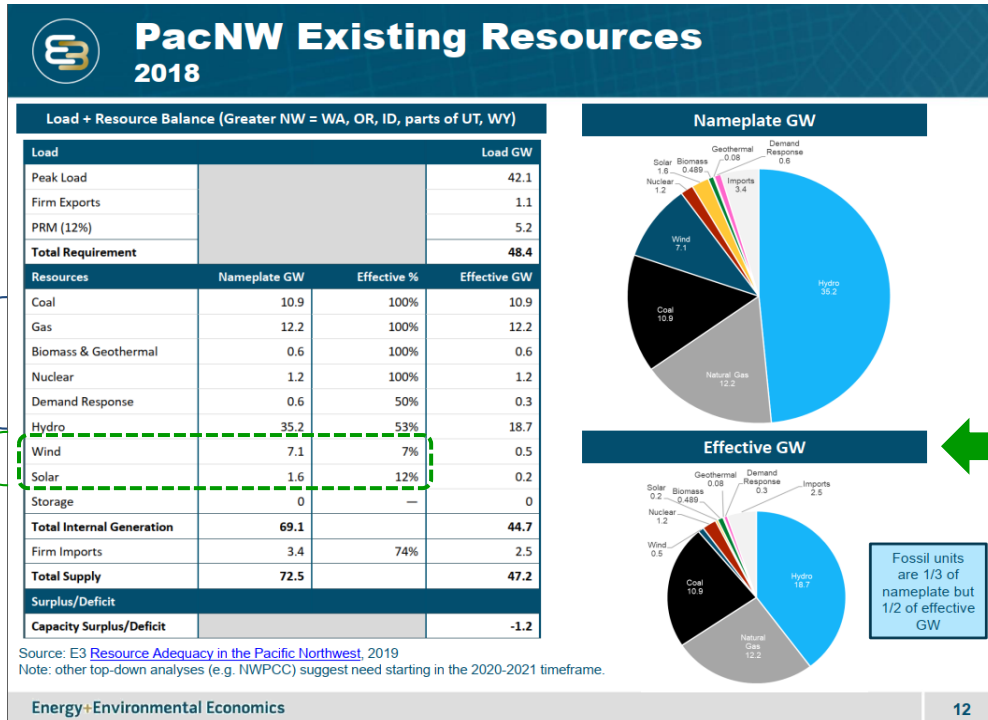
Electrical Demand and Supply Must Be Equal at All Times



- ✓ **'Cruise Control' set at 60**
 - *No over supply*
 - *No under supply*
- ✓ **The Laws of Power Grid Physics are Unforgiving**
- ✓ **Consequences of not maintaining supply & demand balance are blackouts**

Controllable Supply: Blackout Insurance

Effective Capacity = % of Installed Nameplate Generation that can be Counted on During Hours of Maximum Demand



Balancing Authority Areas include: Avista, Bonneville Power Administration, Chelan County PUD, Douglas County PUD, Grant County PUD, Idaho Power, NorthWestern Energy, PacifiCorp (East & West), Portland General Electric, Puget Sound Energy, Seattle City Light, Tacoma Power, Western Area Power Administration

Coal & Natural Gas

- ✓ 50% of Effective Capacity
- Hydro
- ✓ 40% of Effective Capacity

Controllable
High
Effective Capacity

Uncontrollable
Low
Effective Capacity

Source: E3 Resource Adequacy in the Pacific Northwest, 2019
Note: other top-down analyses (e.g. NWPCC) suggest need starting in the 2020-2021 timeframe.

Coal = 16% of U.S. Electricity

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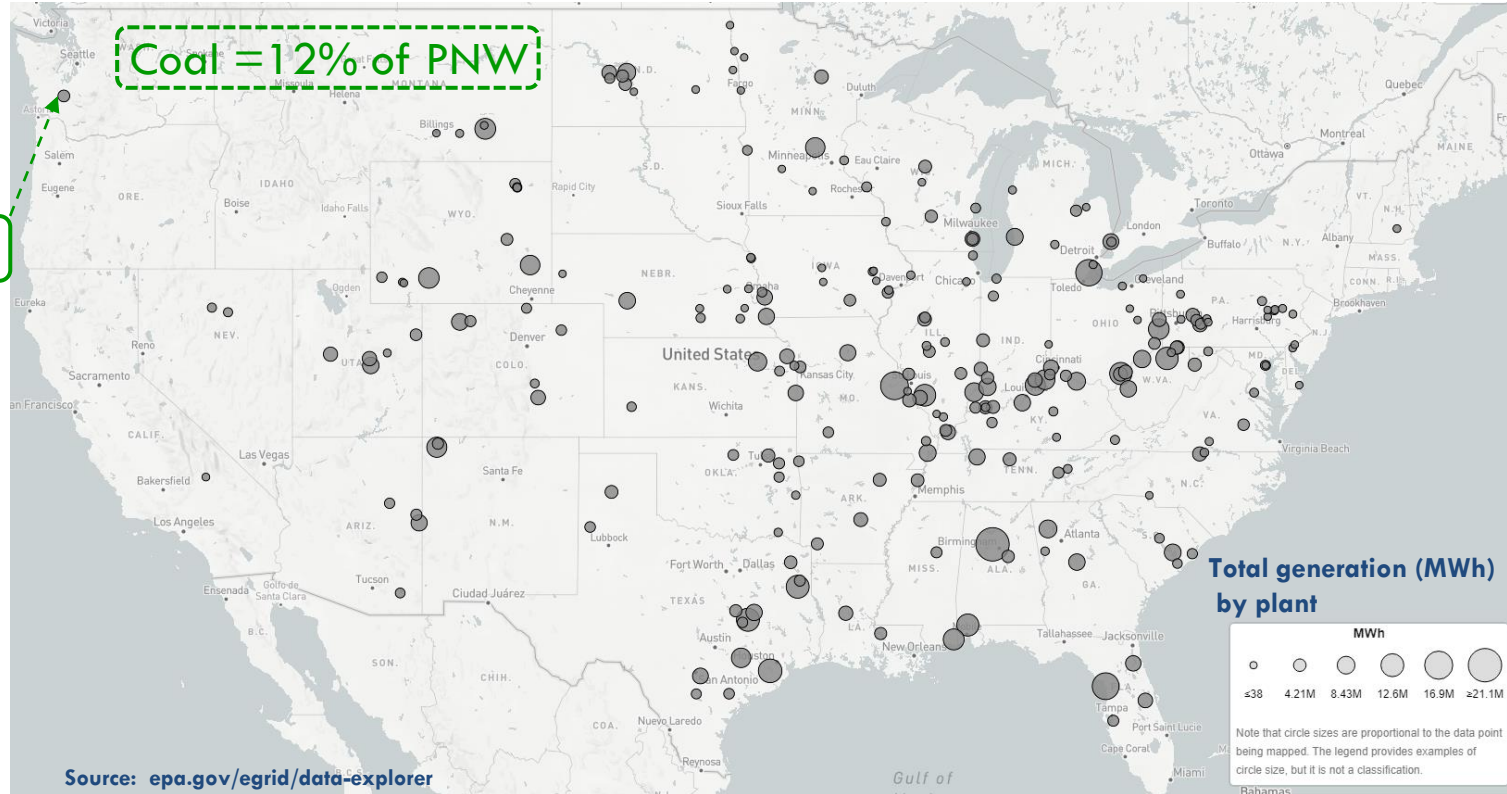
NW Coal Plant Closures

- 1) Colstrip(1) 716 MW in 2019
- 2) Centralia(1) 730 MW in 2020
- 3) Boardman 600 MW in 2020
- 4) Centralia(2) 730 MW in 2025

✓ 2,776 MW by 2025

✓ +3,000 MW more in ?

Coal = 12% of PNW



Natural Gas = 43% of U.S. Electricity

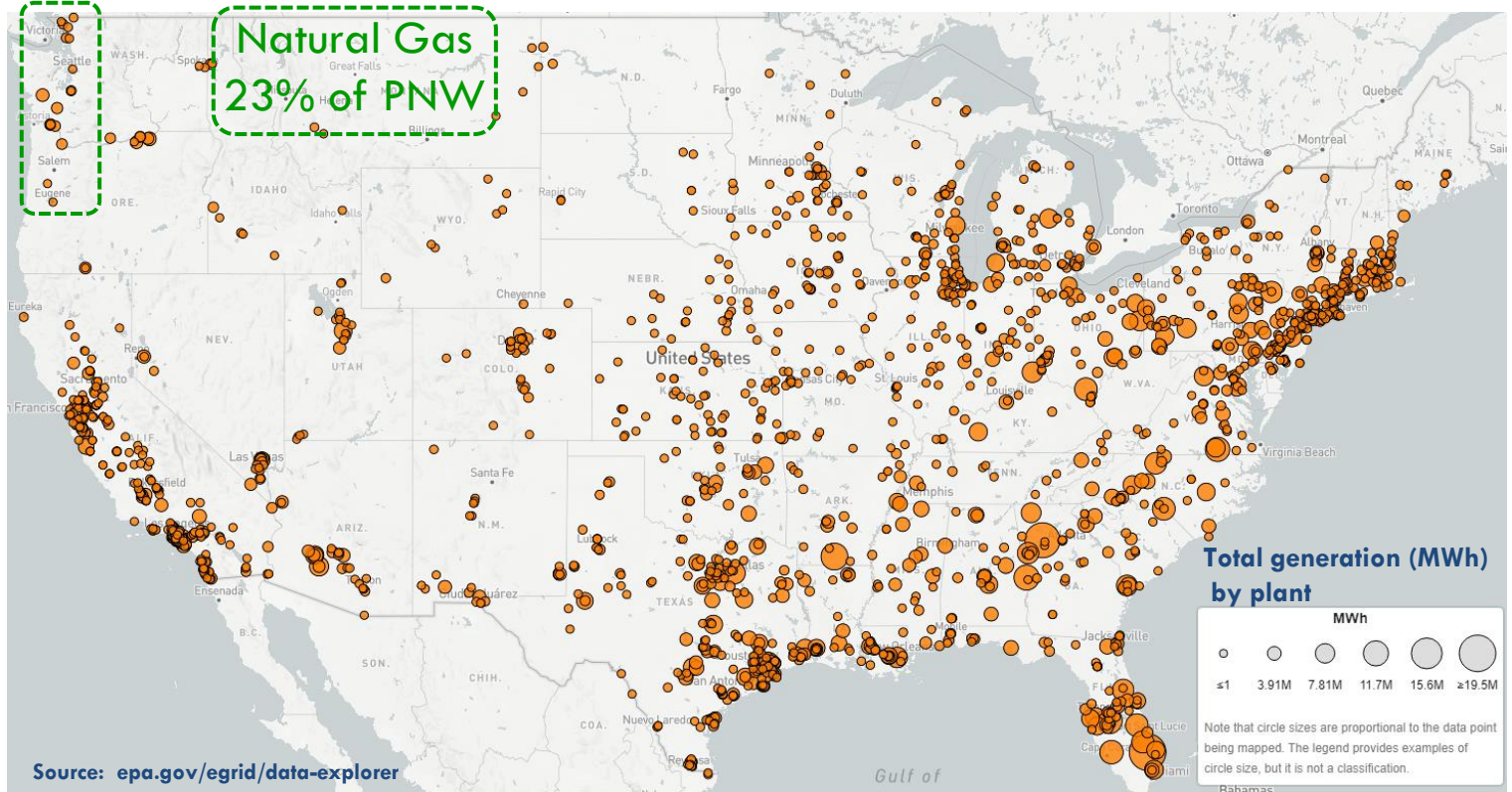
12

5,000 MW
Interstate-5
Population Centers

100% CO₂-Free
Policy Impacts?

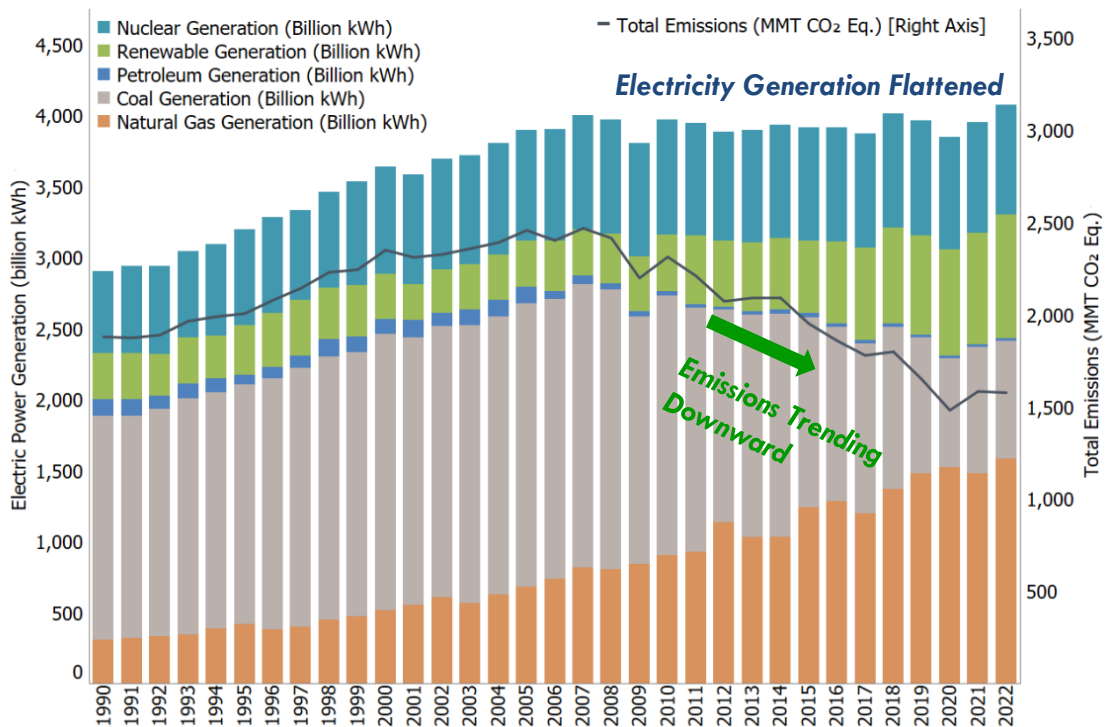
Controllable
&
Power/Energy
Dense

High MW/MWh
Per Acre



U.S. Electricity: Coal to Natural Gas Fuel Switching

Figure 2-8: Electric Power Generation (Billion kWh) and Emissions (MMT CO₂ Eq.)



36% CO₂ Reduction

Down 869 MMT since 2005

- **Natural Gas**
50 to 60% less CO₂ than Coal
- **Plus, Wind & Solar**

Hydropower = 5.7% of U.S. Electricity

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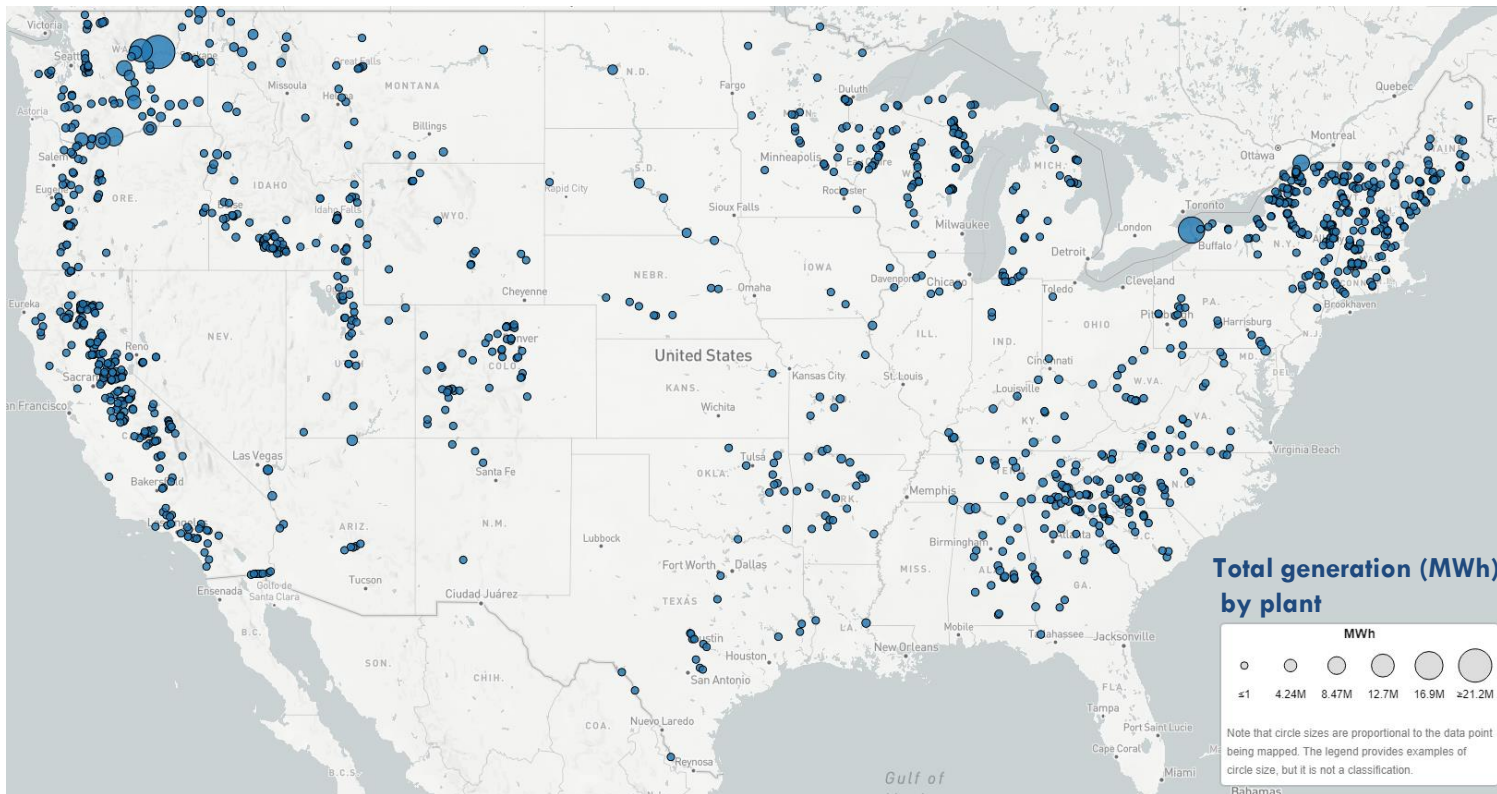
Northwest Hydropower
Like Nowhere Else:

Electricity Provided

✓ 50% of PNW Region

✓ 60% of Washington

Hydro-Based
100% CO₂-Free
Electricity **does**
not scale to the
rest of the U.S.



Source: epa.gov/egridd/data-explorer

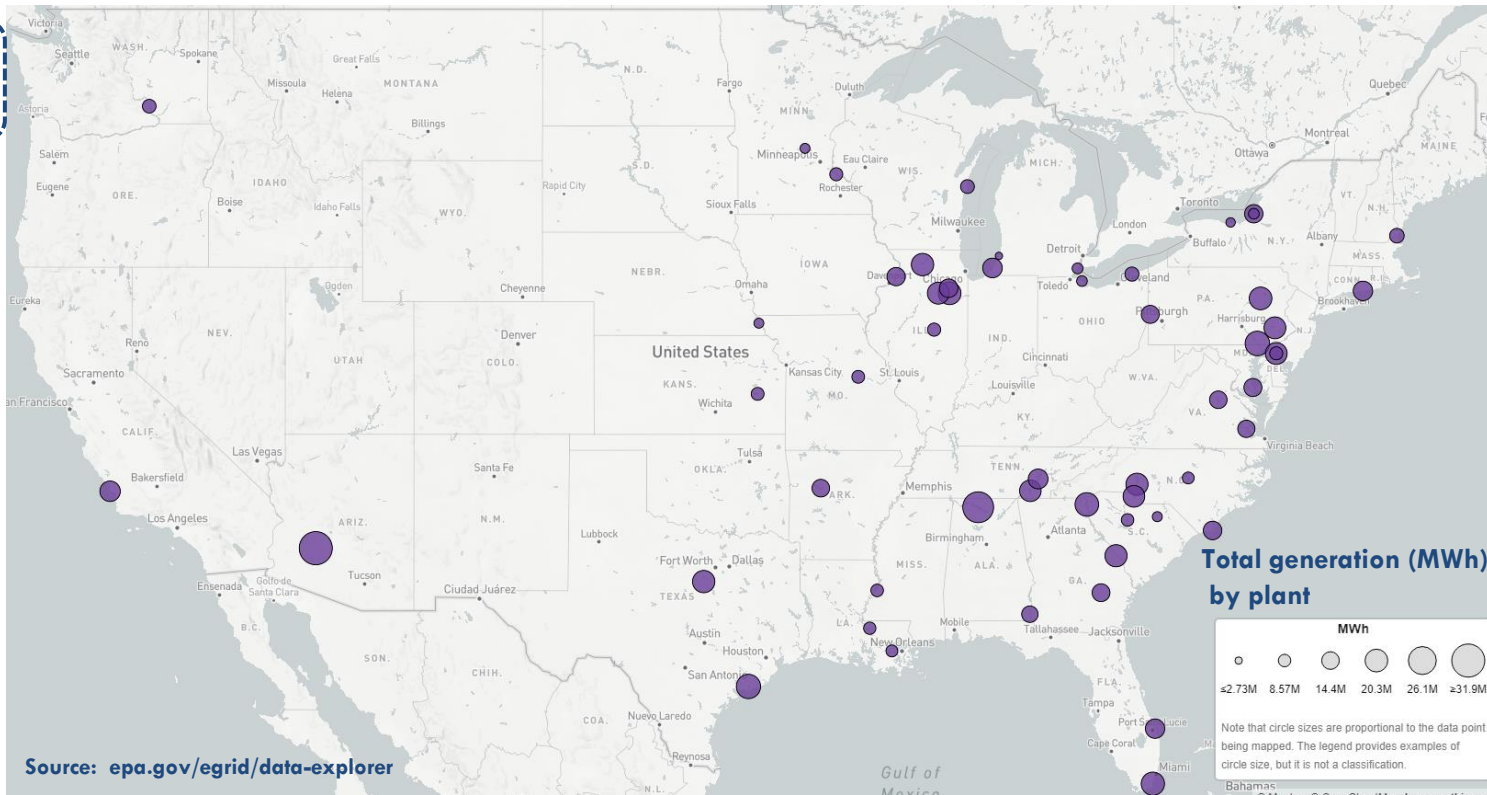
Nuclear = 18.6% of U.S. Electricity

15

Nuclear
3% of PNW

Controllable
&
Power/Energy
Dense

High MW/MWh
Per Acre



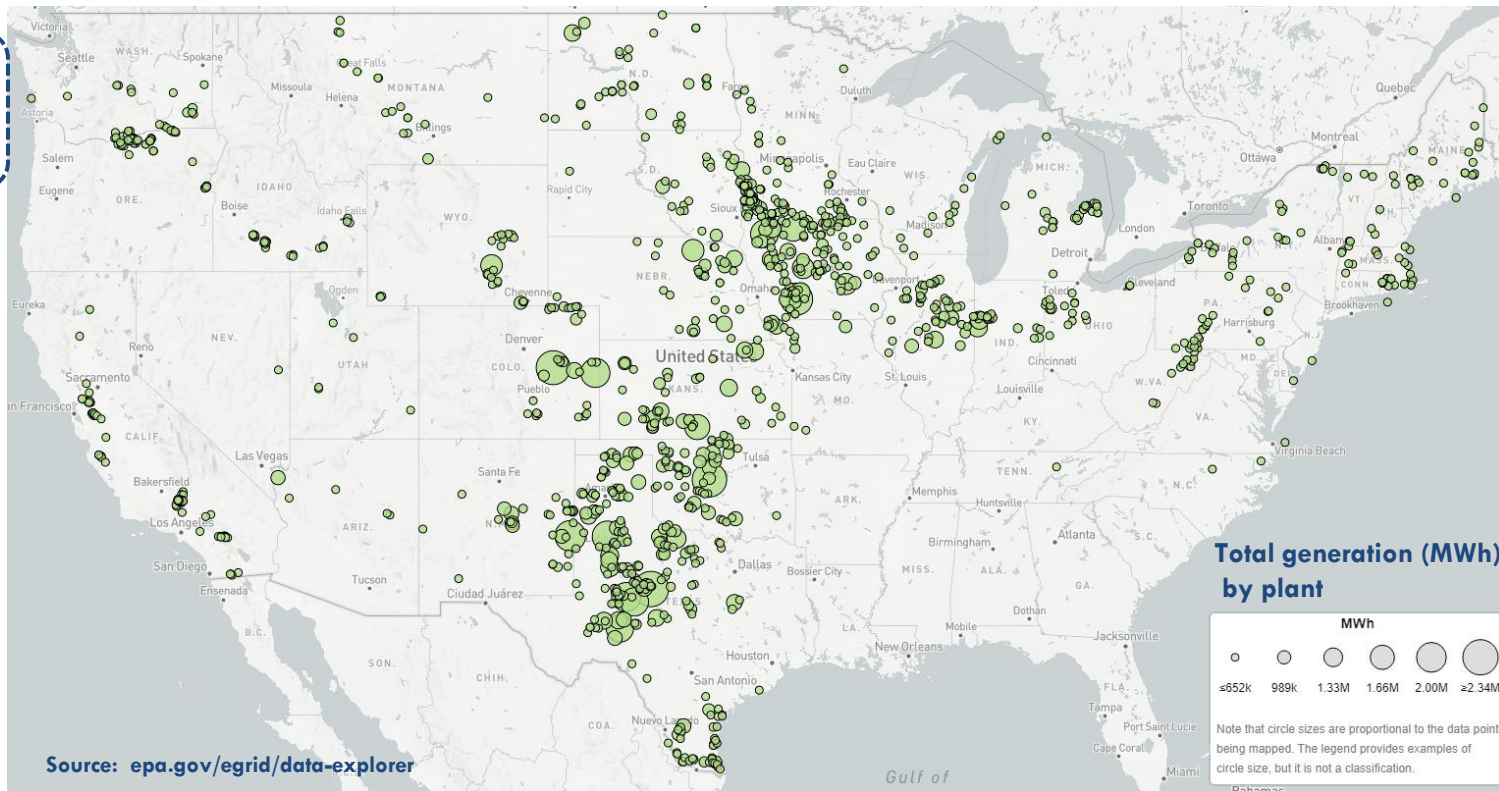
Wind = 10.2% of U.S. Electricity

16

Wind
10.5% of PNW

**Uncontrollable
&
Power/Energy
Dilute**

**Low MW/MWh
Per Acre**



Northwest Wind Power Effective Capacity

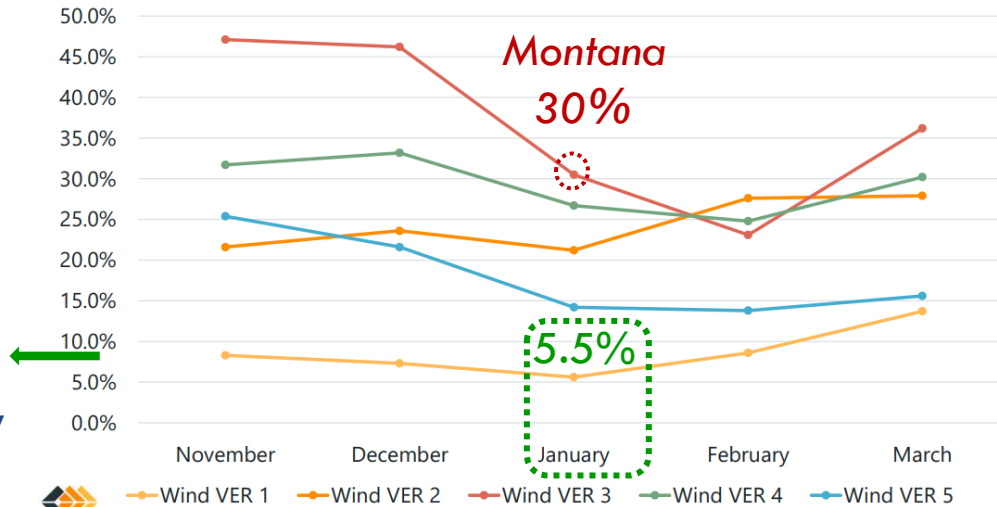
WIND ELCC - WINTER

Overbuild Factor

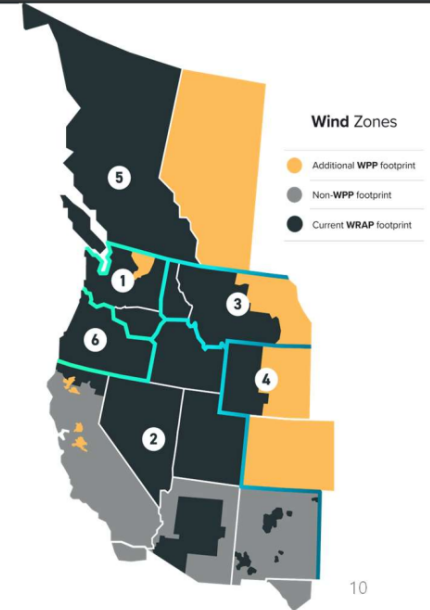
+18,000 MW
of Washington Wind

Replaces only
1,000 MW
of January
100% Effective Capacity

ELCC by VER Zone



ELCC = Effective Load Carrying Capability



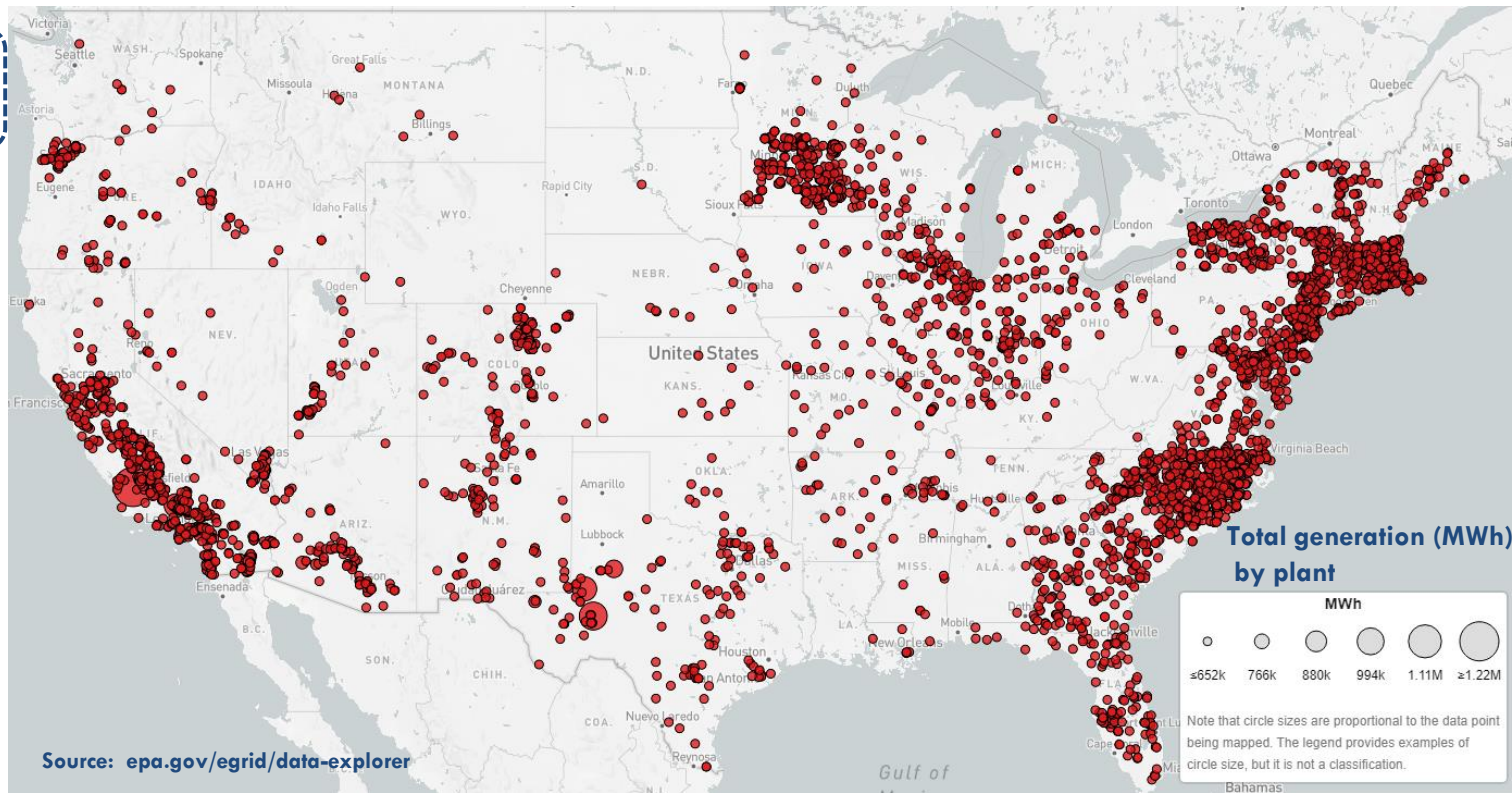
Solar = 3.9% of U.S. Electricity

18

Solar
0.9% of PNW

Uncontrollable
&
Power/Energy
Dilute

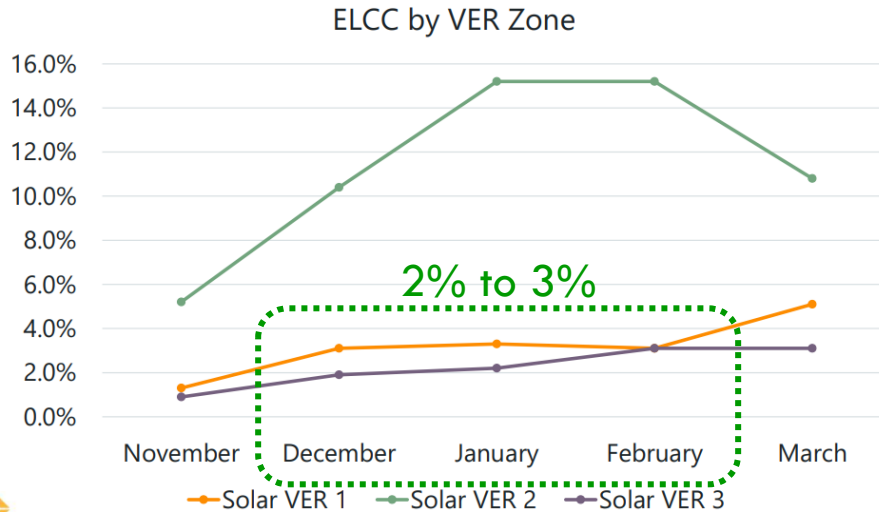
Low MW/MWh
Per Acre



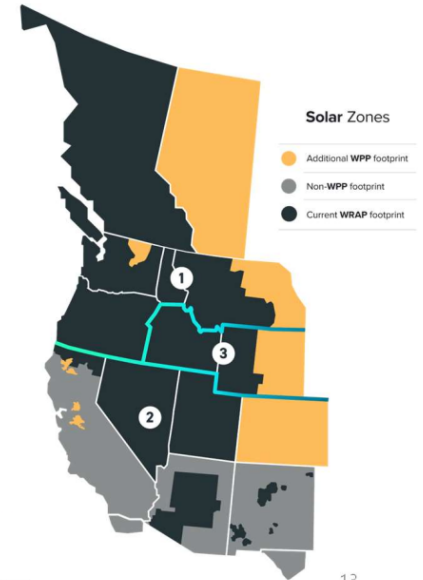
Northwest Solar Power Effective Capacity

SOLAR ELCC - WINTER

Northwest Solar
Extremely Low
Effective
Capacity in
Winter



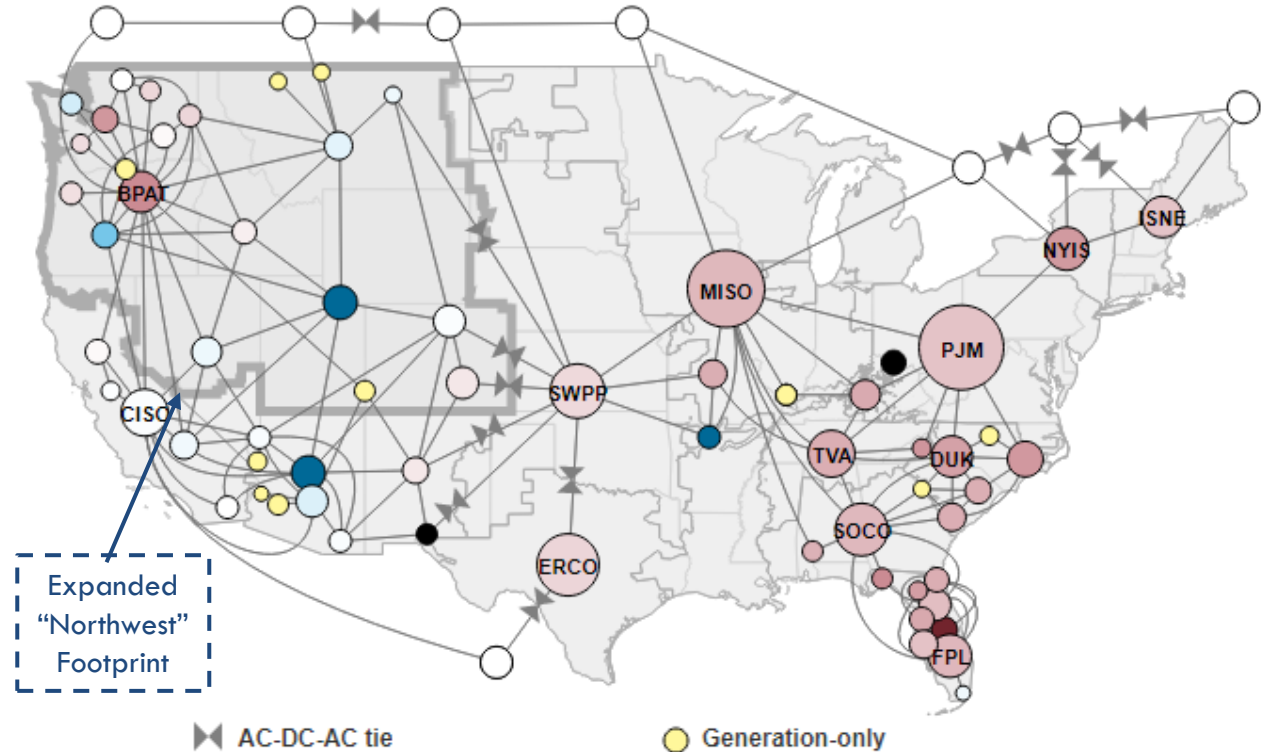
ELCC = Effective Load Carrying Capability



NW Supply & Demand Balancing: January 2024 Cold Snap

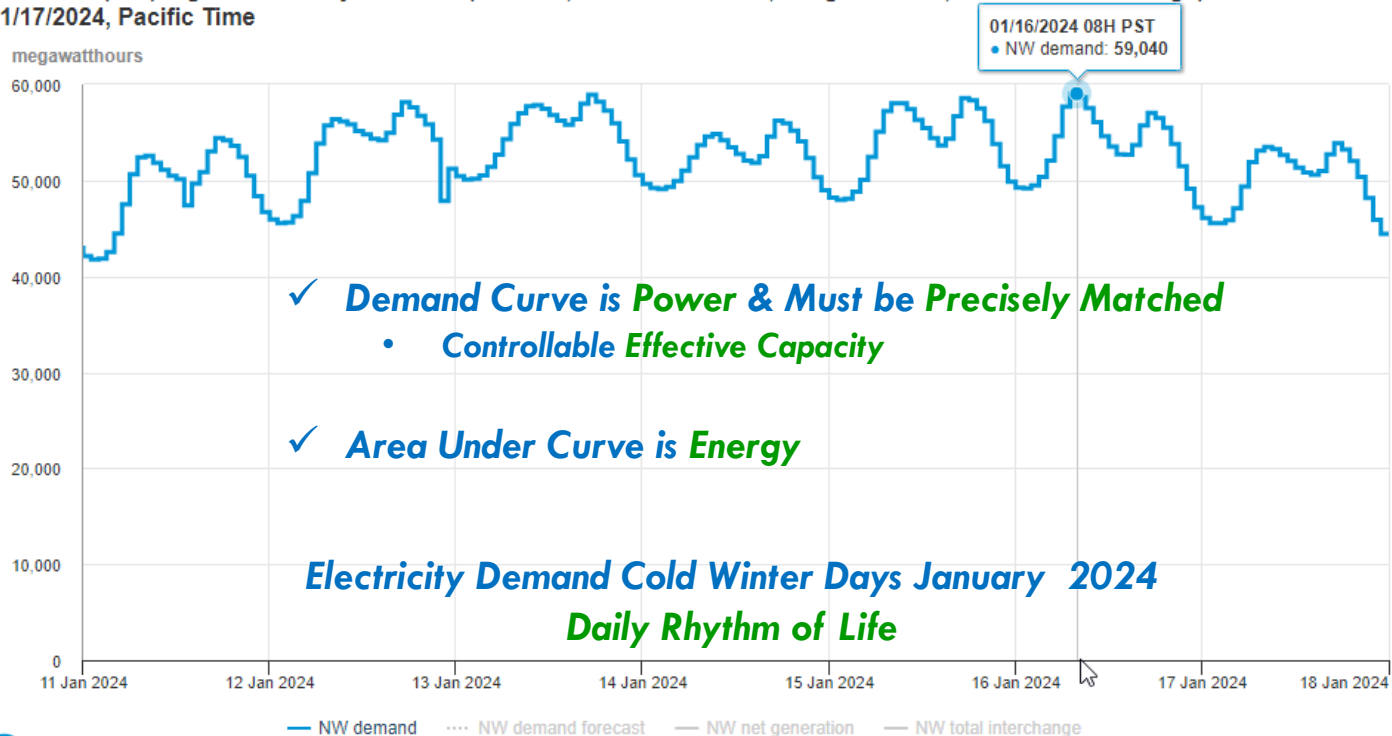
20

- ✓ **38 Balancing Area Authorities** in Western Power Grid
- ✓ **Maintain supply & demand balance** including scheduled generation imports and exports



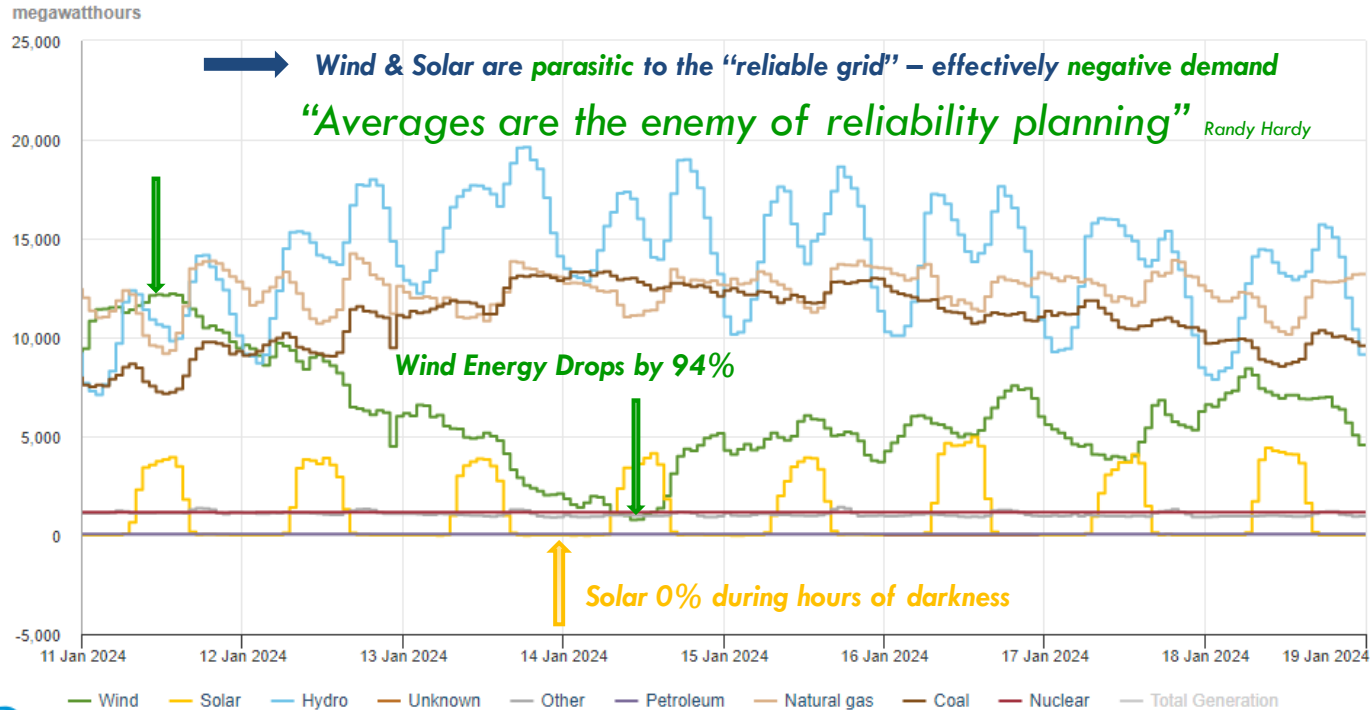
NW Electricity Demand: January 2024 Cold Snap

Northwest (NW) region electricity overview (demand, forecast demand, net generation, and total interchange) 1/11/2024 – 1/17/2024, Pacific Time



NW Electricity Supply: January 2024 Cold Snap

Northwest (NW) region electricity generation by energy source 1/11/2024 – 1/18/2024, Pacific Time



Future Concerns with Shutting Down Coal & No New Natural Gas

- More Dependence on Drought Susceptible Hydropower
- Ecological & Financial Costs to Overbuild Wind & Solar

• Increasingly Risky & Costly Probability Game

NW Hydro: Flexes Polar Vortex Muscle

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<https://rickdunn.substack.com/p/northwest-hydro-flexes-its-polar>

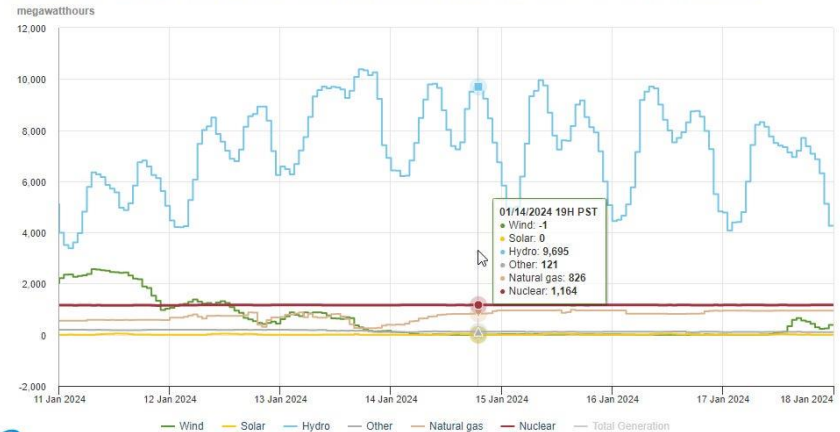
Northwest Hydro Flexes it's Polar-Vortex Muscle and 'Gone Went the Wind'

The question isn't, can you integrate tens-of-thousands of average megawatts of unreliable wind farms into the grid? The question is, should you?



RICK DUNN, P.E.
JAN 22, 2024

Bonneville Power Administration (BPAT) electricity generation by energy source 1/11/2024 – 1/17/2024, Pacific Time



eia Data source: U.S. Energy Information Administration



WA & OR Wind Power at Zero or Less During Coldest Temperatures

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WA Clean Energy Transformation Act (CETA)

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ENVIRONMENT
AMERICA

Washington state commits to 100% clean energy

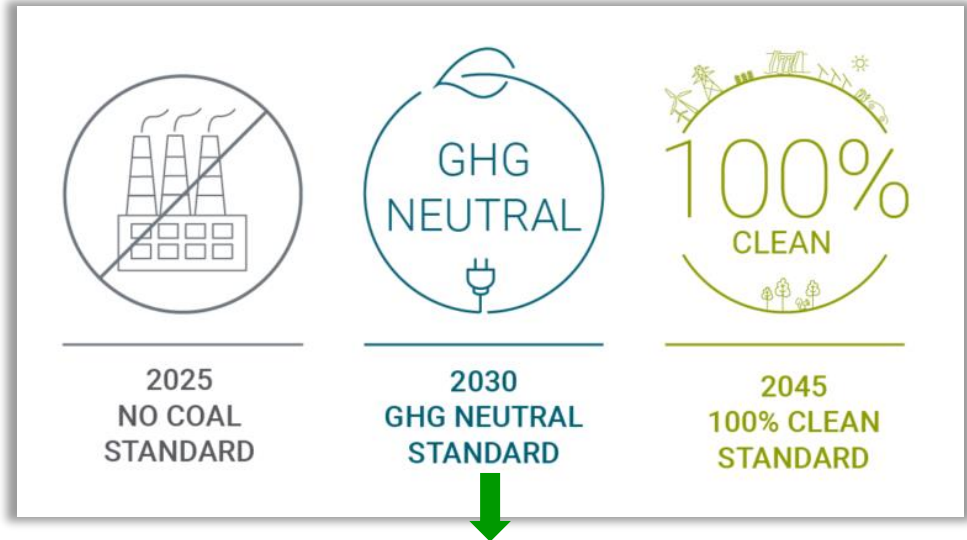
Washington is the latest state to go all-in on clean, carbon-free electricity.



Washington is the latest state to go all-in on clean, carbon-free electricity.

On May 7, Gov. Jay Inslee signed the 100% clean electricity bill into law,

CETA Requirements



- ✓ 20% of utility portfolio can be CO₂ emitting generation with offsets
- ✓ Has effectively *eliminated* investment in *new natural gas* generation so far

Oregon Clean Energy Bill

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Governor Kate Brown Signs Clean Energy Bills, Sets Goal for 100% Clean Energy by 2040

July 27, 2021

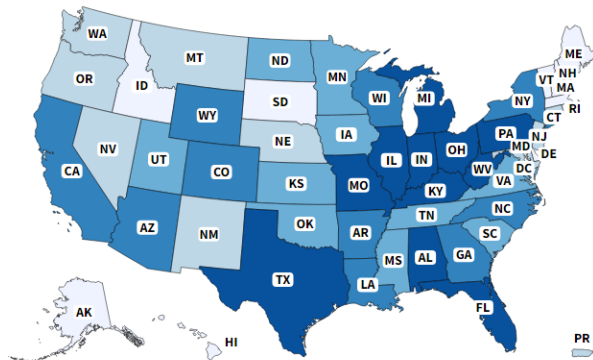
- Directs two largest utilities to deliver 100% clean electricity to customers by 2040
- Stairstep from 80% clean electricity by 2030, to 90% percent by 2035 and 100% by 2040
- **Prohibits** new or expanded natural gas-fired power plants in the state (*also illegal to build nuclear plants*)



- Most ambitious timetable in the nation

Washington & Oregon: What Dirty Energy Problem?

CO₂: total emissions (tons)
by state, 2022

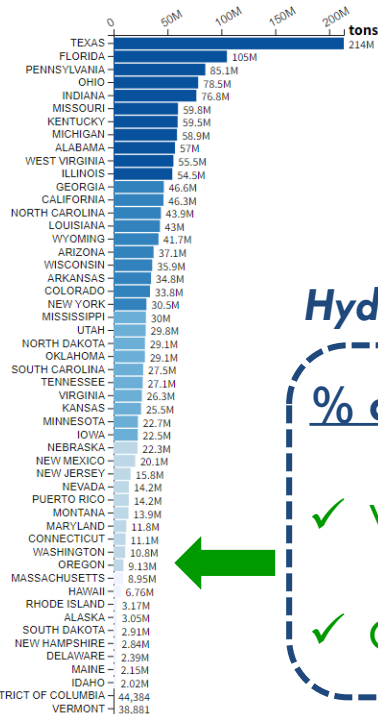


Trend, CO₂: total emissions (tons), by state, 2018–2022
Select a state in the map above or the graphs at the right to see its trend here.

Source: <https://www.epa.gov/egrid/data-explorer>

Sort A to Z Sort by Amount

US: 1,745,134,437 (tons)



Hydropower Like Nowhere Else

% of U.S. Total (1,745 MMT)

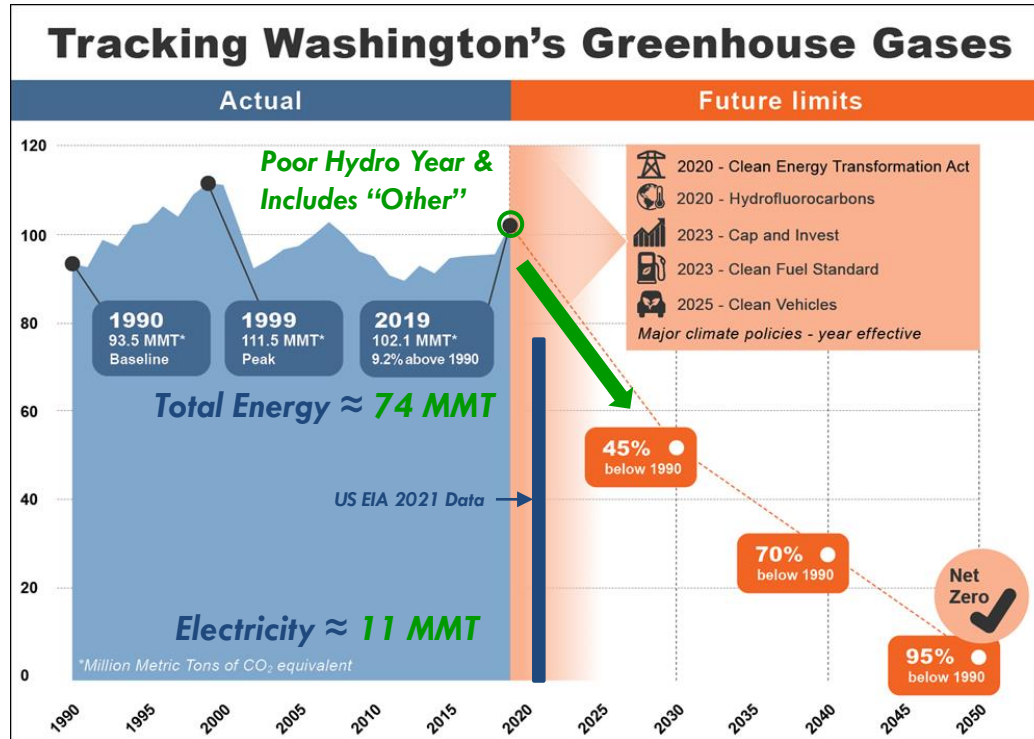
✓ WA = 10.8 MMT (0.62%)

✓ OR = 9.13 MMT (0.52%)



CO₂ Reductions: Local versus Global

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“...cuts are necessary to **prevent** the **worst effects of climate change** on our state’s coastlines, water supplies, forests, environment, and economy.”

What the rest of the **world** is doing **matters & says something**

- **Extent & rate of CO₂ reductions**
 - ✓ **Virtue signaling vs. global impacts**

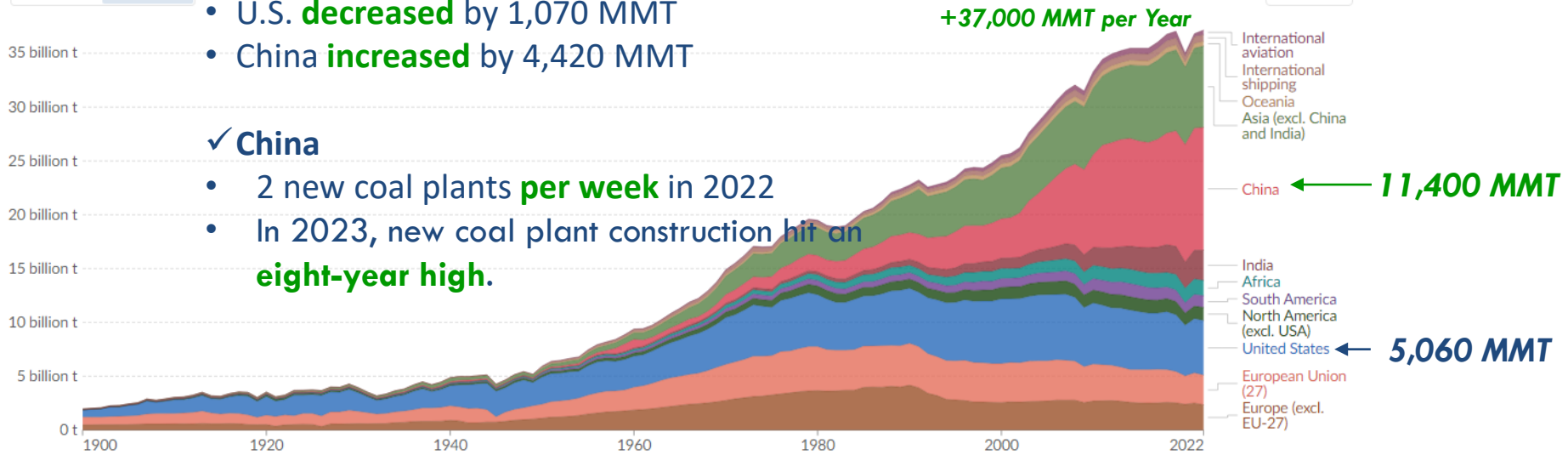
- **Bending the Curve vs. Going Over a Cliff**
 - ✓ **Grid Reliability Risk**
 - ✓ **Increasing Energy Rates**
 - ✓ **Land-use Impacts**

As We Push Grid to Blackout: Global CO₂ Emissions Rise

Annual CO₂ emissions by world region

Emissions from fossil fuels and industry are included, but not land-use change emissions. International aviation and shipping are included as separate entities, as they are not included in any country's emissions.

Table Chart



✓ Since 2007

- U.S. **decreased** by 1,070 MMT
- China **increased** by 4,420 MMT

✓ China

- 2 new coal plants **per week** in 2022
- In 2023, new coal plant construction hit an **eight-year high.**

Rapid Global “Energy Transition” ?

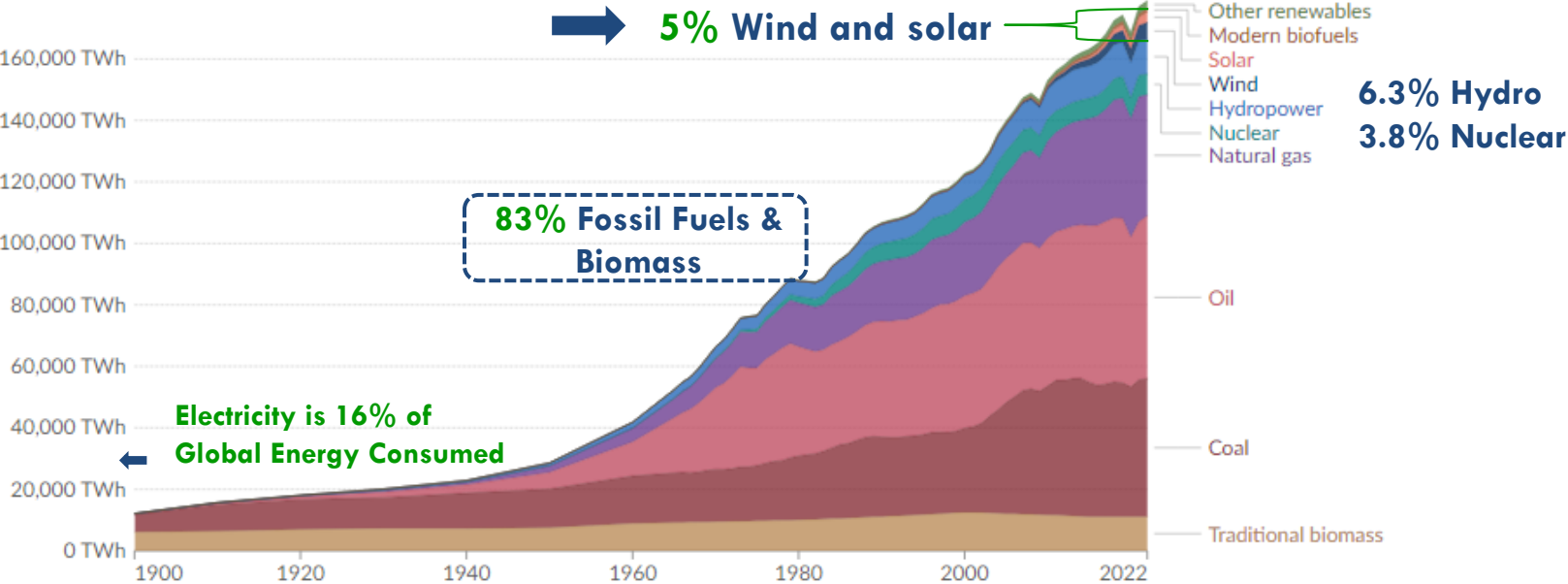
Global primary energy consumption by source

Primary energy is based on the substitution method and measured in terawatt-hours.



Table Chart

Settings



Source: <https://ourworldindata.org/energy-production-consumption>

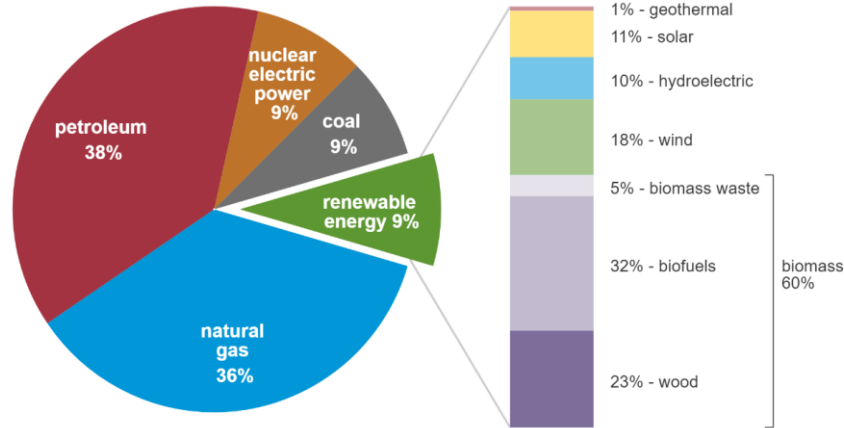
U.S. Total Energy Consumption in 2023

31

U.S. primary energy consumption by energy source, 2023

total = 93.59 quadrillion
British thermal units

total = 8.24 quadrillion British thermal units



Data source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 1.3 and 10.1, April 2024, preliminary data



Note: Sum of components may not equal 100% because of independent rounding.

□ Fossil fuels = 83%

□ Wind & Solar = 2.6% ←

▣ Hydro = 0.9%

▣ Total Renewables = 9%

□ Nuclear = 9%

□ Electricity Represents 34% of total U.S. Energy

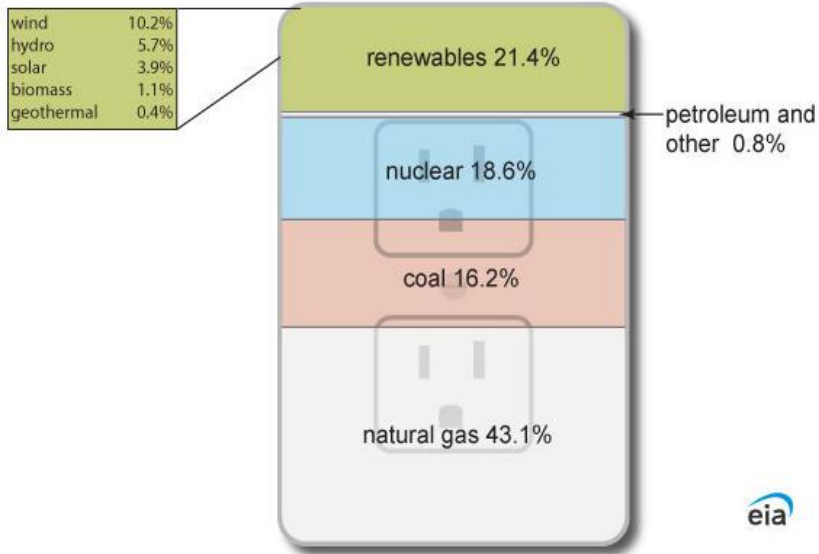
Wind was $18\% \times 9\% = 1.62\%$ & Solar was $11\% \times 9\% = 0.99\%$

Wind & Solar combined were 2.6% of U.S. primary energy consumption in 2023

U.S. Electricity Generation

32

Sources of U.S. electricity generation, 2023
Total = 4.18 trillion kilowatthours



Source: <https://www.eia.gov/energyexplained/electricity/>



□ Fossil Fuels = 60%

□ Renewables = 21.4%

□ Wind & Solar = 14.1% ← 84%
New Generation Under Development

□ Hydro = 5.7%

□ Nuclear = 18.6%

□ 39% Non-CO₂ Emitting

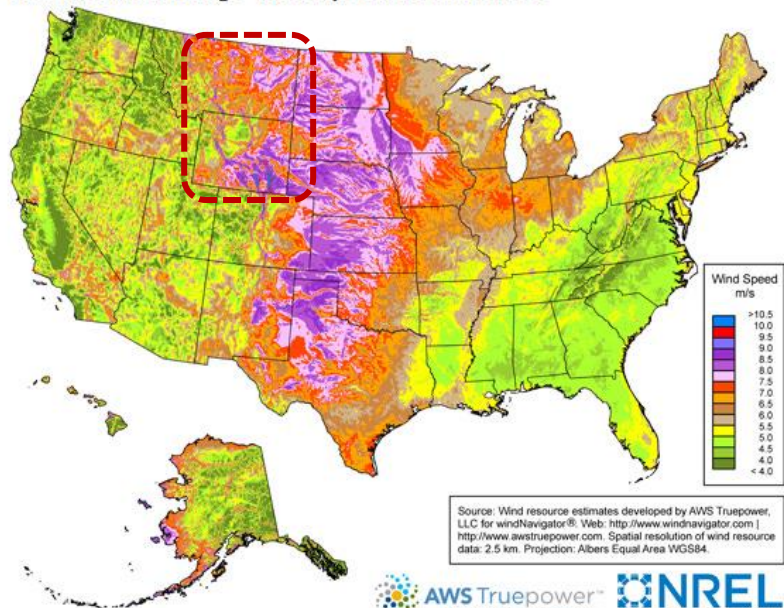
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We're Coming for You MT & WY!

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U.S. annual average wind speed at 80 meters



Washington State Energy Strategy

+10,000 aMW = 10 x Columbia Generating Station Nuclear Plant

Decarbonizing the Electricity Sector

97%
growth in electricity end use demand by 2050

43% of electricity imported by 2050

36% from WY & MT wind

ELECTRICITY EMISSIONS INTENSITY

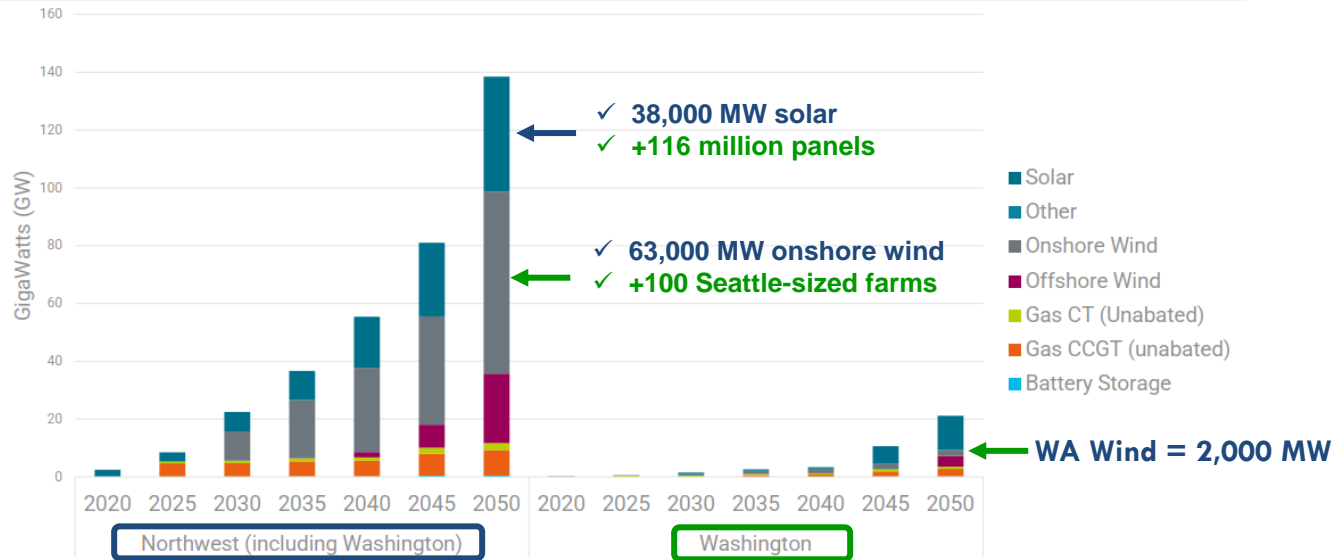


- Double end use electricity load by 2050
 - ✓ Electricity to displace fuels in transportation, industry, buildings
 - ✓ Hydrogen electrolysis and electric boilers as flexible demand resources
- Invest in new transmission capacity and renewable generation, coordinating with other states
- Develop distributed energy resources with smart grid capabilities to ensure reliability and flexibility
- Strengthen market mechanisms to ensure resource adequacy and efficient electricity markets.
 - ✓ Coordination with other states and federal government

WA Energy Strategy: Everywhere but Here

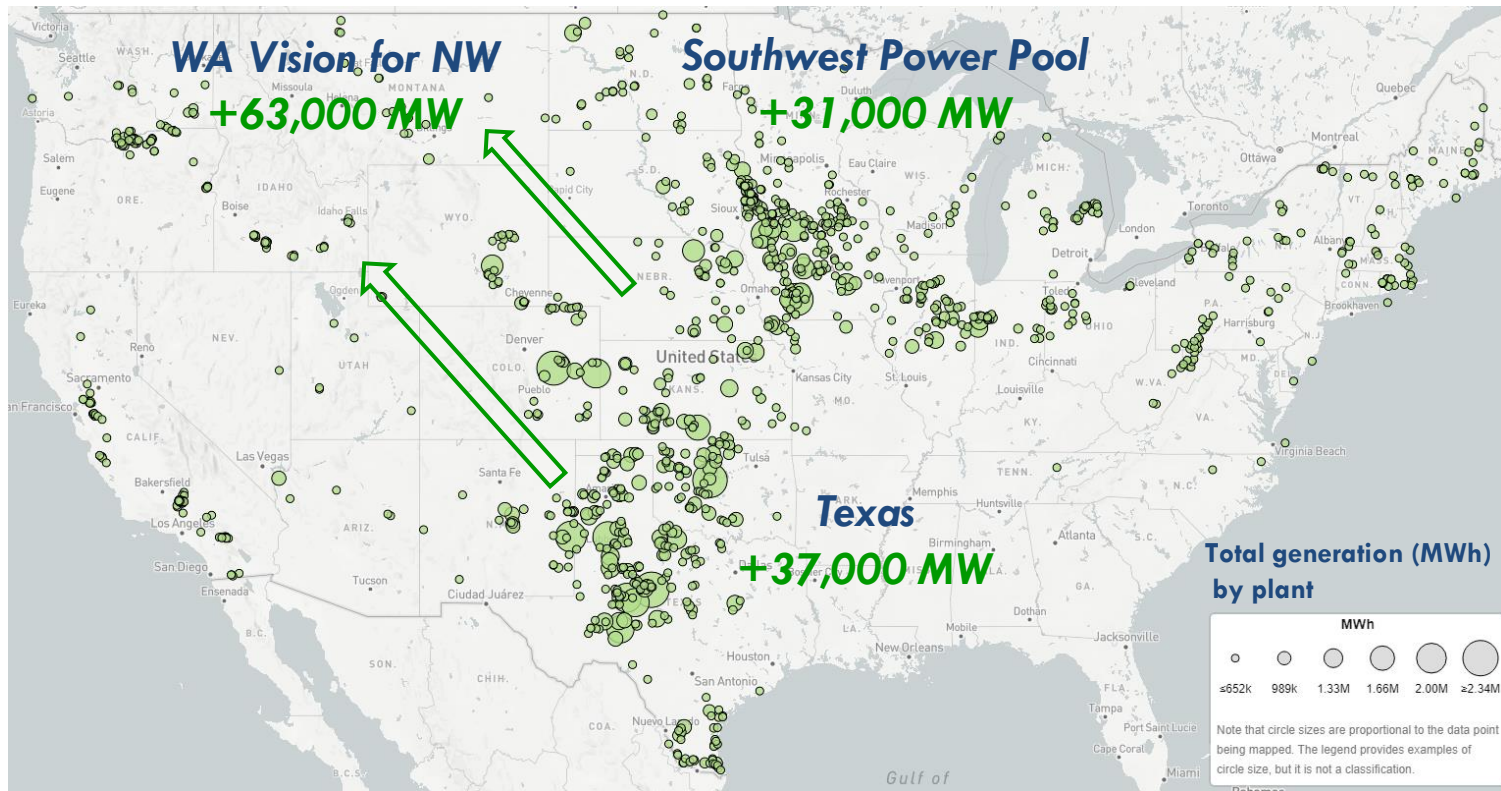
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2021 State Energy Strategy Electric capacity additions – electrification scenario



Washington's Vision for the Northwest

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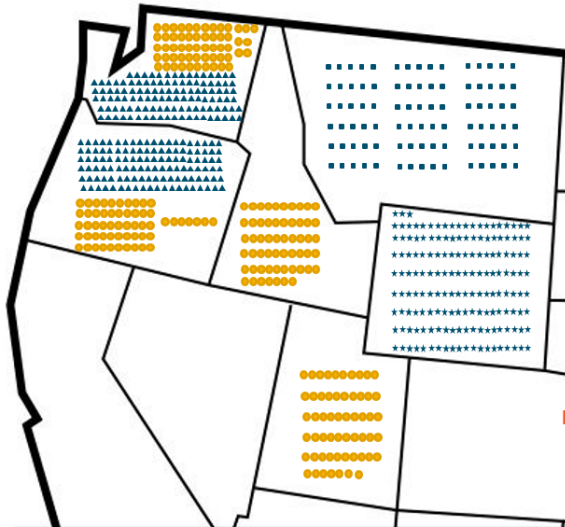


Source: epa.gov/egriddata-explorer

Wind & Solar: Land Use Impacts



Renewable Land Use 100% Reduction



Technology	Nameplate GW
● Solar	46
▲ NW Wind	47
■ MT Wind	18
★ WY Wind	33

	Solar Total Land Use (thousand acres)	Wind - Direct Land Use (thousand acres)	Wind - Total Land Use (thousand acres)
80% Clean	84	94	1,135 - 5,337
100% Red	361	241	2,913 - 13,701

Land use in 100% Reduction case ranges from **20 to 100x** the area of Portland and Seattle combined

Portland land area is 85k acres
Seattle land area is 56k acres
Oregon land area is 61,704k acres

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Transmission Lines Needed to Bring Wind and Solar Power to Population Centers



Assumes 100% of Existing Hydropower stays in Place

Each point on the map indicates 200 MW. Sites not to scale or indicative of site location.

Energy+Environmental Economics

Transmission Lines: Development & Operations Friction

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- ✓ High up front capital costs & long siting, permitting & construction **lead times**
 - 15 years or more not uncommon
- ✓ Wildfire **legal and financial risks**
 - Risk mitigation includes **preemptive shutoffs** and **blackouts**



WIRE
PG&E exits bankruptcy, but long-term wildfire risk could put it 'back in the soup'



PacifiCorp: Wildfire Insurance Costs Pose 'Material Threat' to Financial Stability

CLEARING UP • September 8, 2023



Boardman-to-Hemingway: Tx Line Case Study



- 300 miles
- Need identified 2002
- 1,000 MW Capacity
- Project defined 2006
- Complete by 2026?

- Raises serious questions about WA doubling electricity capacity and counting on Montana & Wyoming Wind & Solar



Land-Use Conflicts: Development Friction



Land-use conflicts are a key issue today and those conflicts are already proving to be the limiting factor in the growth of renewables.



ROBERT BRYCE

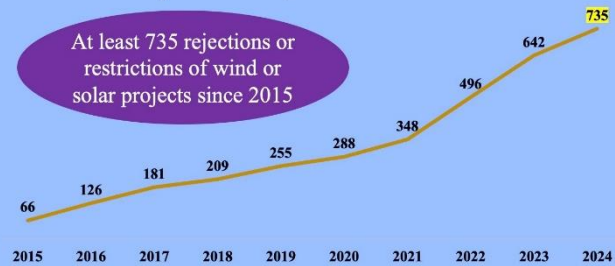
Tally Of US Wind & Solar Rejections Hits 735

What the media, and academics, won't tell you about the raging backlash in rural America against Big Wind and Big Solar, in 10 charts

SEP 22, 2024

Cumulative US Wind & Solar Rejections, 2015 To 2024

At least 735 rejections or restrictions of wind or solar projects since 2015



Source: Renewable Rejection Database

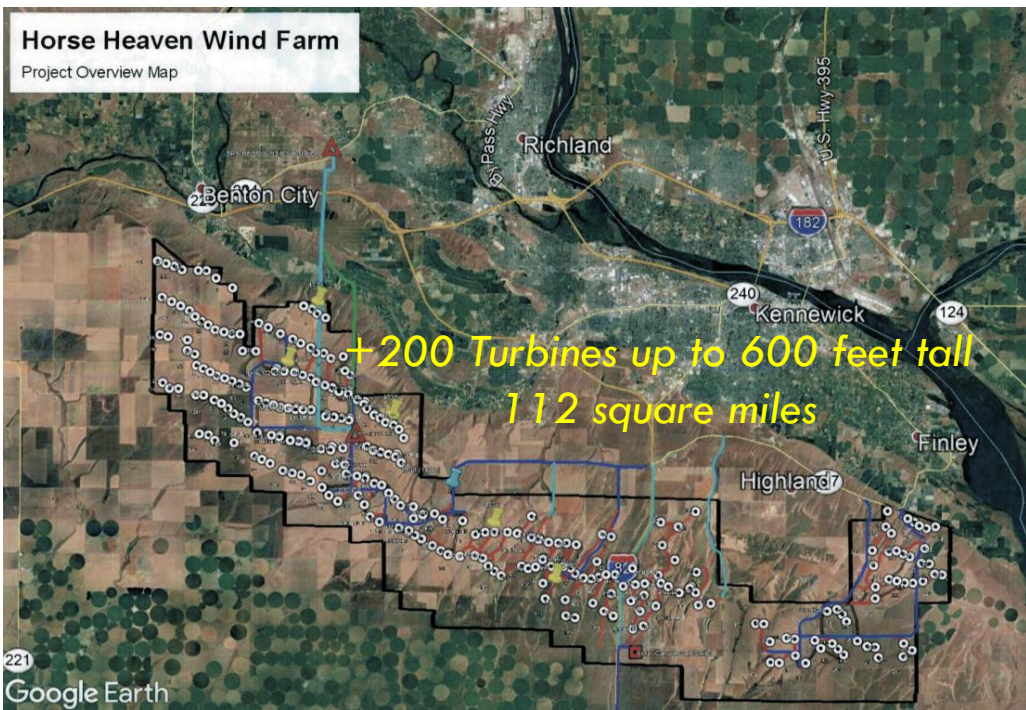
© Robert Bryce

[Tally Of US Wind & Solar Rejections Hits 735 - Robert Bryce \(substack.com\)](https://www.substack.com/p/tally-of-us-wind-solar-rejections-hits-735)

Source: <https://www.americanexperiment.org/reports/not-in-our-backyard>

Not-In-My-Backyard: NIMBY Case Study

“communities and community members must have a seat at the table in designing programs and selecting projects.” WA 2021 State Energy Strategy



Benton County, Washington

- ✓ Local Electricity > 95% CO₂ Free Today
- ✓ Developer bypassing “locals” using State EFSEC

850 MW Nameplate
280 avg MW

47 MW
January
Effective Capacity
Contribution



Demonstrating the Landscape-Scale Impact of One Proposed Windfarm in a Rural County

Endangered Species: Just Another NIMBY



Washington Department of
FISH & WILDLIFE

Ferruginous hawk (*Buteo regalis*)



Photo by Brett Billings - U.S. Fish and Wildlife Service



A species native to the State of Washington that is seriously threatened with extinction throughout all or a significant portion of its range within the state.

Category:

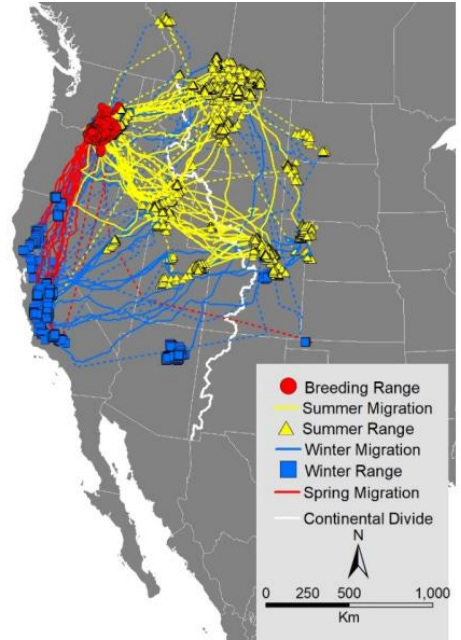
Ecosystem:

State status: [Endangered](#)

Vulnerability to climate change ([More details](#))

Low	Low-Moderate	Moderate	Moderate-High	High
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Nowhere to Hide



Washington Department of Fish & Wildlife has identified “**collision with wind turbines**” as one of several direct sources of mortality

Figure 4. Year-round migration patterns of adult Ferruginous Hawks breeding in shrubsteppe west of the Continental Divide and tracked ≤6yr with satellite telemetry.

Inflaming the Rural/Urban Divide: “Green Tyranny”

43

Bold Action or Green Tyranny?

How Jay Inslee's Energy Policy Delusions and Hypocrisy are Inflaming the Urban-Rural Political Divide and Ignoring the Plight of an Endangered Species



RICK DUNN, P.E.
JUN 03, 2024



“You’ve got to break a few eggs to make an omelette”.

Step 1

Replace Environmentalism with Climatedism
Wrecking the Planet to “Save It”

Step 2

Regulatory Reforms

Eminent Domain on Steroids



Step 3

Push the Grid to a Reliability Cliff

More wind & solar over a bigger area ... and fast!

Step 4

Propaganda

Our “bold actions” will change the future of the planet & there’s no price too high for others to pay

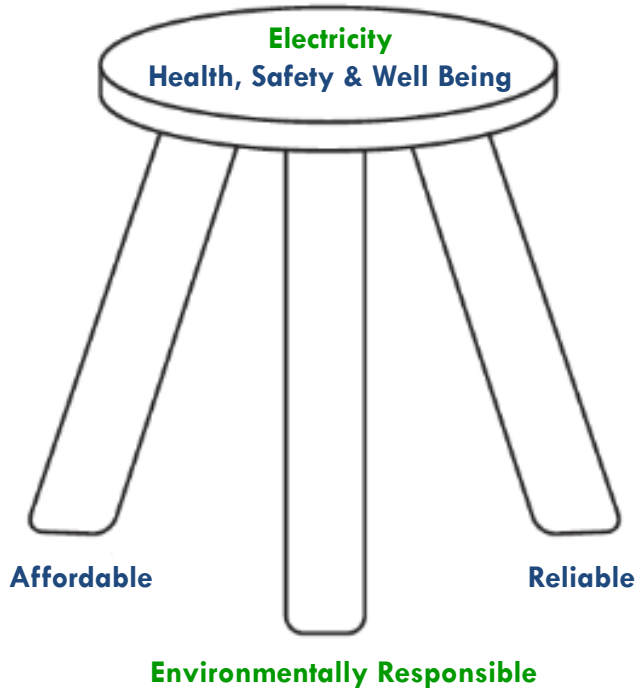
<https://rickdunn.substack.com/p/bold-action-or-green-tyranny>

Agenda

1. Northwest Close to Blackouts – How did we get here?
2. WA & OR Clean Energy Policies – Global & U.S. Perspectives
3. WA Energy Strategy – We're Coming for you Montana & Wyoming!
4. **Where Do We Go from Here? – Near and Long Term**

NW Utility Balancing Act: **Becoming Increasingly Difficult**

45



- Hydropower Erosion
 - ▣ Increased spill & threats of dam breaching



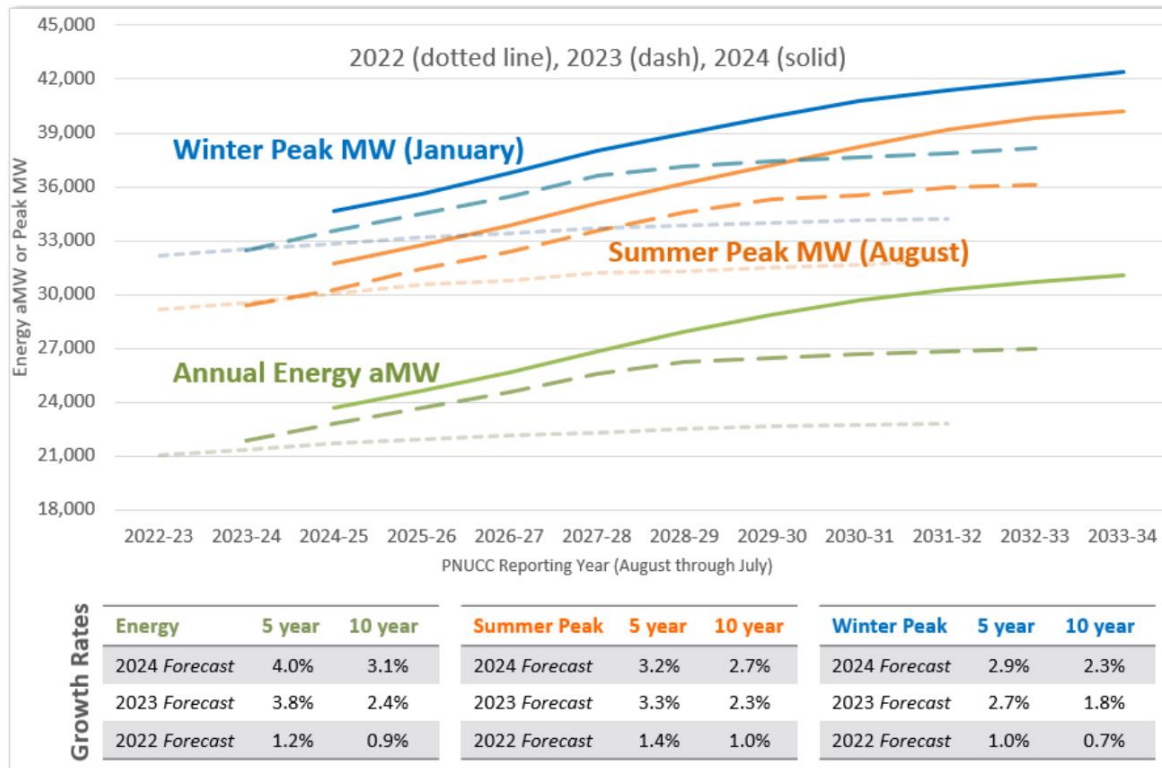
- Eliminating CO₂ valued above all factors
 - ▣ Coal-plant retirements & no new natural gas in WA & OR

- Wind & Solar: Weather Dependent & Energy Dilute
 - ▣ Located remotely from population centers & require vast swaths of land due to need for extreme overbuild

- Increasing **Costs** & Risk of **Blackouts**



Northwest Demand +30% in 10 Years



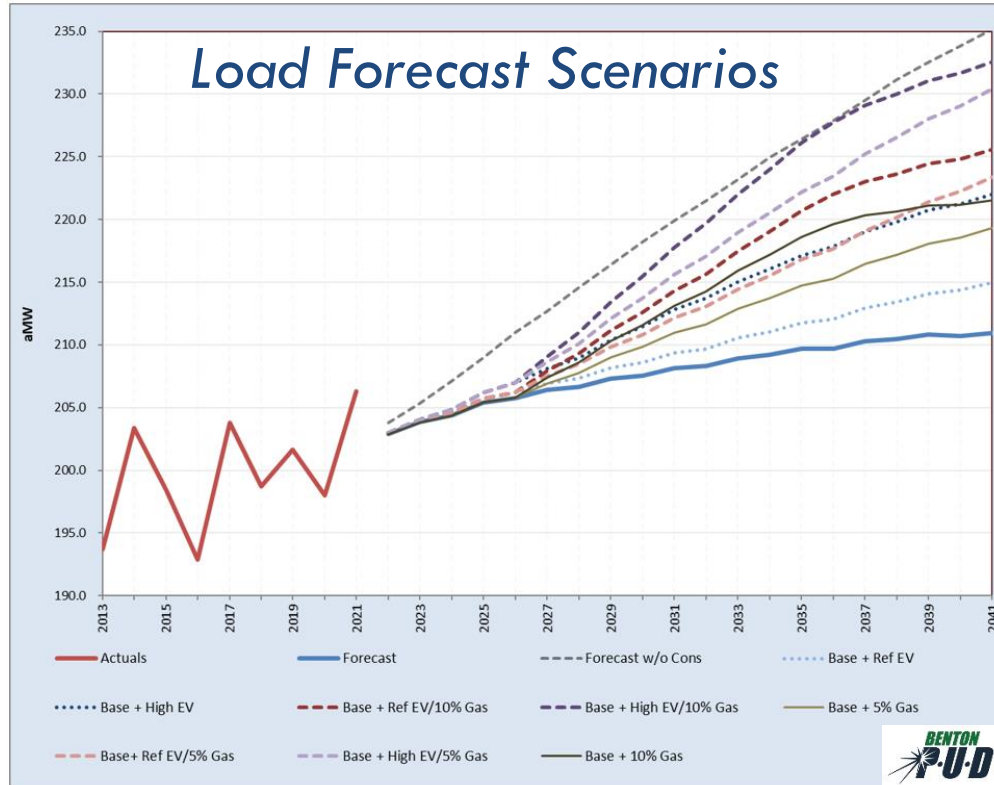
May 2024

✓ Winter & Summer **Firm Peak** Requirements

➤ Could Increase Nearly **10,000 MW** in 10 yrs

Utility Forecasts: Highly Uncertain

47



← High Electrification

Which is it?

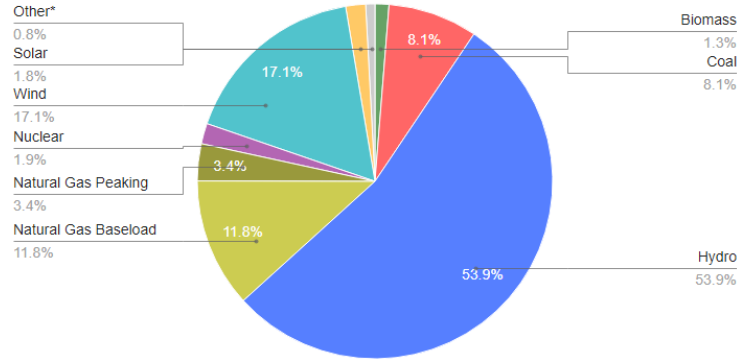
← Status Quo

- ✓ What about **Data Centers & other Electricity Intensive Loads?**
- ✓ Drives need for **scalable, rapidly deployable, CO₂-free, & reliable generation**

Pacific Northwest Generating Capacity Now & Possible Future

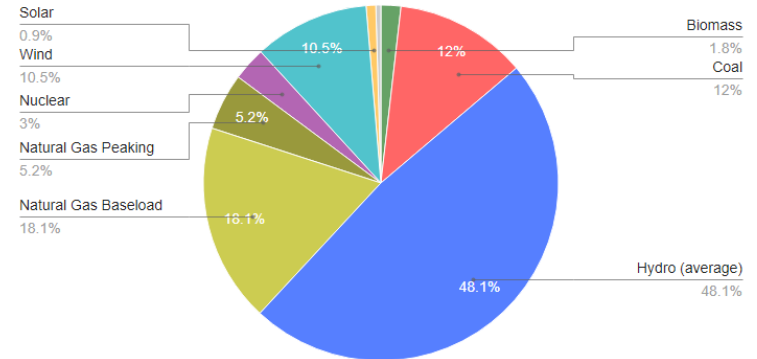
Nameplate Capacity

Pacific Northwest Generating Capacity: 64,340 mw*



Average Year Energy

Pacific Northwest Generating Capability: 33,828 MWh*



Unprecedented Development in an **Anti-Development Era**

✓ In **25 years** construct **+28,000 aMW**

✓ = **100 years** of Hydro, Natural Gas & Coal Development

WA & OR Vision

Eliminate
Natural Gas & Coal
-12,000 aMW

x2 Electrification
+16,000 aMW

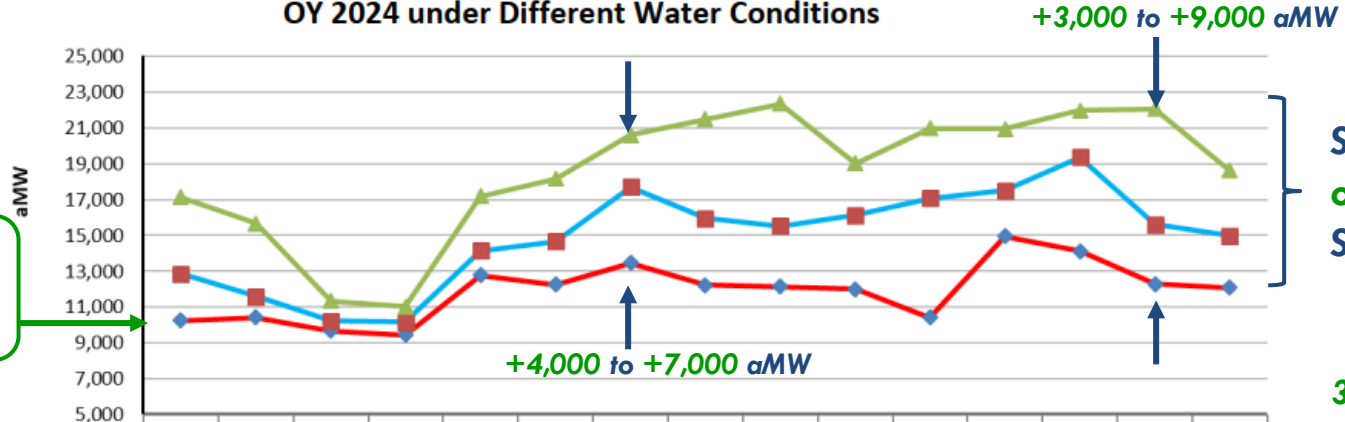
	Average MW	Capacity Factor
Hydro	16,271	47%
Natural Gas	7,882	80%
Coal	4,059	78%
Wind	3,552	32%
Solar	304	26%

PNW Hydro is Great! But Highly Variable

Table 3-5

PNW Region
 Variability of Monthly Hydro Generation
 OY 2024 under Different Water Conditions

Firm Generation Spoken For



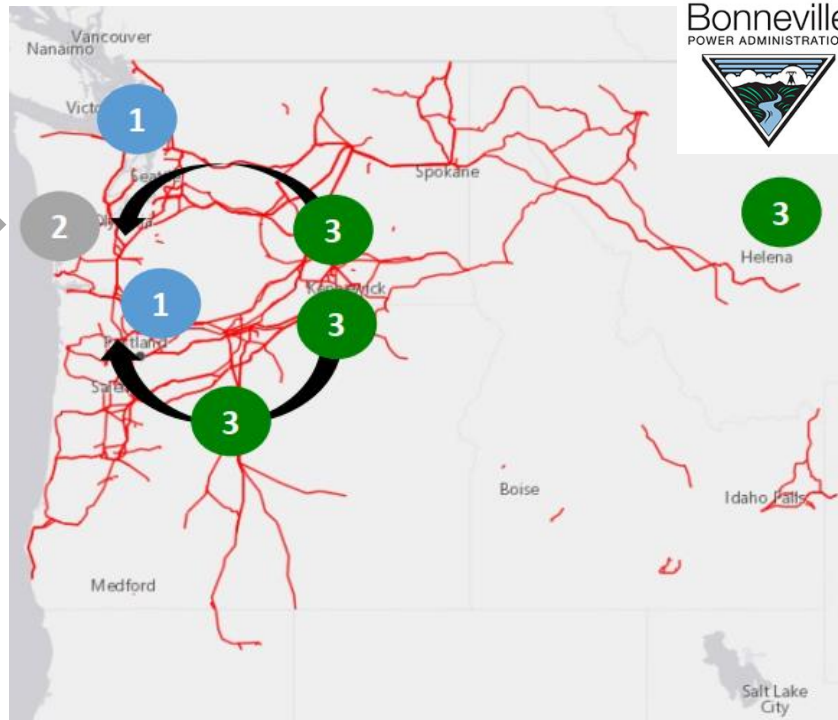
Surplus May or May Not Show Up

3 to 9 X CGS Nuclear Plant In Some Months

	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
◆ Firm Water (P10)	10,268	10,424	9,680	9,468	12,772	12,264	13,459	12,220	12,157	12,010	10,436	14,953	14,121	12,294	12,081
■ Median Water (P50)	12,868	11,591	10,237	10,180	14,150	14,681	17,712	15,952	15,523	16,130	17,067	17,499	19,372	15,600	14,970
▲ High Water (P90)	17,128	15,680	11,353	11,036	17,178	18,161	20,582	21,478	22,334	19,026	20,956	20,936	21,970	22,056	18,617

BPA Transmission Lines: Critical to All Utilities

50



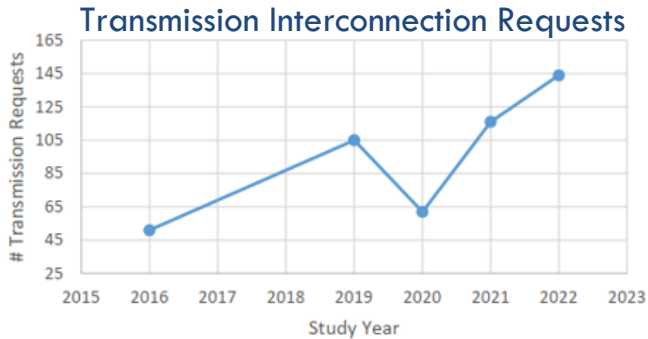
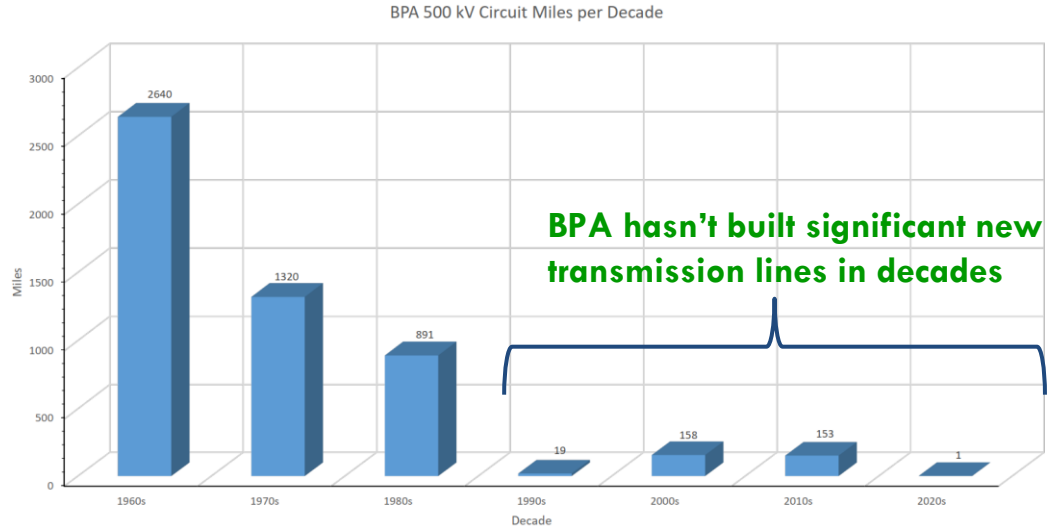
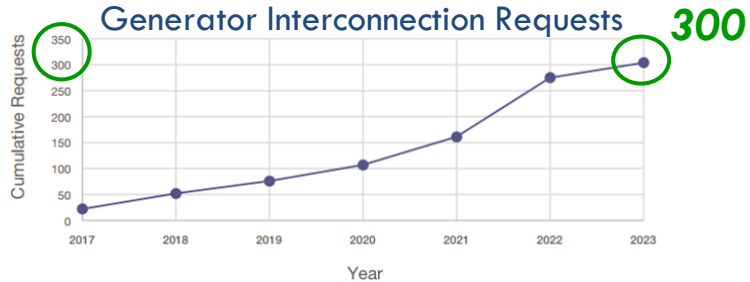
BPA Owns & Operates 75% of NW Grid

The following factors:

1. Load growth in Portland and Seattle – driven by high tech industry, transportation and building electrification
2. Reduced operation of 4.5 GW of carbon emitting generators on the west side along the I5 corridor
3. Replacement wind and solar resources are located east of the Cascades

Will increase flows on cross-Cascades transmission paths and throughout the load centers

BPA Transmission: Interconnection Frenzy



CLEARING UP
An Independent News Service from NewsData

TOP STORY

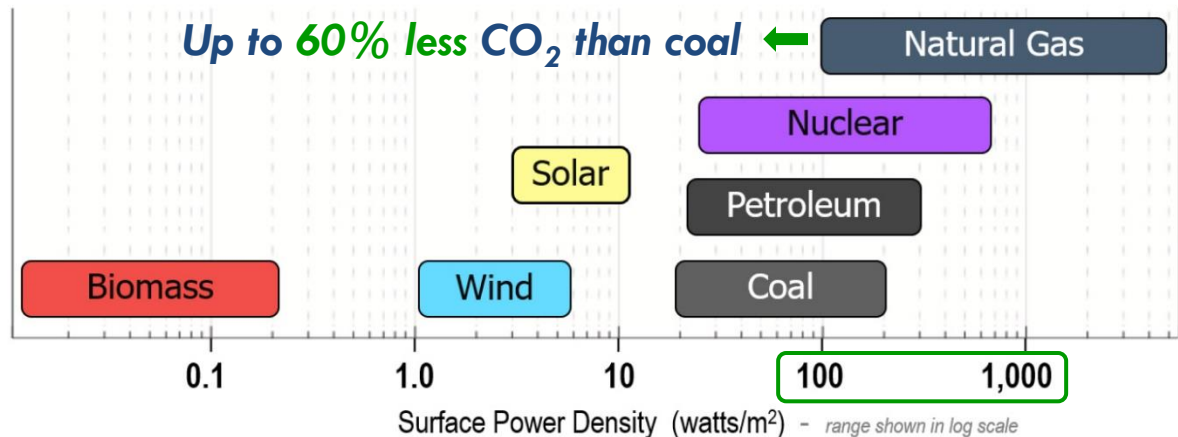
BPA Transmission Expansion Study Hits a 'Brick Wall'

Steve Ernst Mar 1, 2024

Land-Use vs. CO₂ Footprint: Finding Common Ground

52

Surface Power Density - Sources of Electrical Power Generation



(image source: Ecotech Advisors, Inc. Only renewable energy sources that are site agnostic are considered. Data source: "The spatial extent of renewable and non-renewable power generation: A review and meta-analysis of power densities and their application in the U.S." (John van Zalk & Paul Behrens, 2018))

What if we built:

- ✓ As Little **Transmission** as Absolutely Necessary
- ✓ **Reliable Generation Plants**

- **Small-footprint**
- **Low or no-CO₂**

- **Closer to where people live** ←

- ✓ Natural gas is **100 to 1,000 X** more power dense than wind and solar
- ✓ New nuclear with **safety perimeter at fence line** will increase power density

Land-Use vs. CO₂ Footprint: Finding Common Ground

53



An artist's rendering of NuScale Power's small modular nuclear reactor plant. Photo courtesy of NuScale



Energy contained in a
gummy bear pellet of
uranium fuel

= **2,000 pounds** of coal

Small Footprint Nuclear: Long-Term Solution

54

If reducing carbon dioxide emissions is the goal, policymakers must consider the options that are scalable, affordable, and have small footprints.

There is no viable pathway toward running our economy solely on renewables. Therefore, policymakers must be considering the energy sources that are low- or no-carbon, and are affordable and scalable. That means using more natural gas and nuclear energy.

Source: <https://www.americanexperiment.org/reports/not-in-our-backyard>



An artist's rendering of a NuScale SMR site. Courtesy: NuScale Power

✓ 1,000 aMW of wind power = 500 to 1,000 square miles of land

✓ 720 MW Small Modular Reactor Complex = 0.05 square miles of land ←

New Nuclear: Gaining Momentum



ARDP

Advanced
Reactor
Demonstration
Program

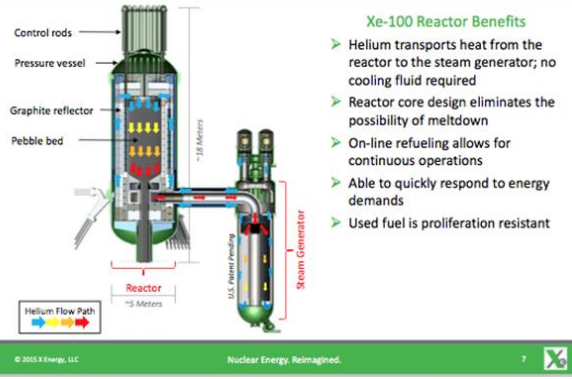
~~ARDP Grant
Recipient #1~~

Energy Northwest, Grant County PUD and X-energy announce TRi Energy Partnership

4/1/2021
NEWS RELEASE



The Xe-100 Reactor Cannot Melt Down



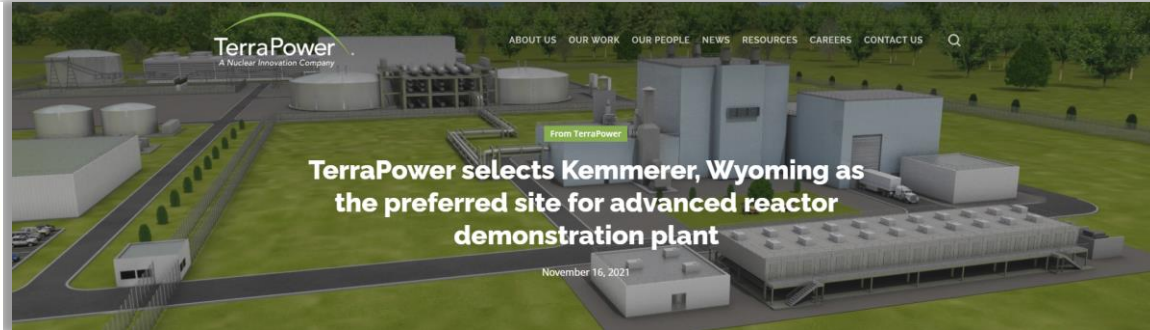
Bill Gates and Warren Buffett to build new kind of nuclear reactor in Wyoming

The project in Wyoming - the country's top coal-producing state - is a small advanced reactor with salt-based storage that could boost output

ARDP Grant
Recipient #2



Warren Buffett's Pacific Corp and Bill Gates's TerraPower have joined forces on a plan to launch an advanced Natrum nuclear reactor in Wyoming. Photograph: Jason Lee/Reuters



New Nuclear: Gaining Momentum

56

ARDP Grant **New Recipient #1**
Breaking Ground in 2026
“completed by end of decade”

Nuclear

X-Energy, Dow Unveil Texas Site for ARDP Nuclear Demonstration

X-energy and Dow will site a proposed four-unit 320-MWe Xe-100 advanced nuclear reactor facility at Union Carbide Corp. Seadrift Operations, a sprawling Dow chemical materials manufacturing site in Seadrift, Calhoun County, Texas.



ARDP Grant Recipient #2
Breaking Ground Now
2030 Operational Goal



Amazon Steps Up for Site-1 SMR!

57

*4 Modules Initially with up to 12 Total
80 Megawatts per Module*

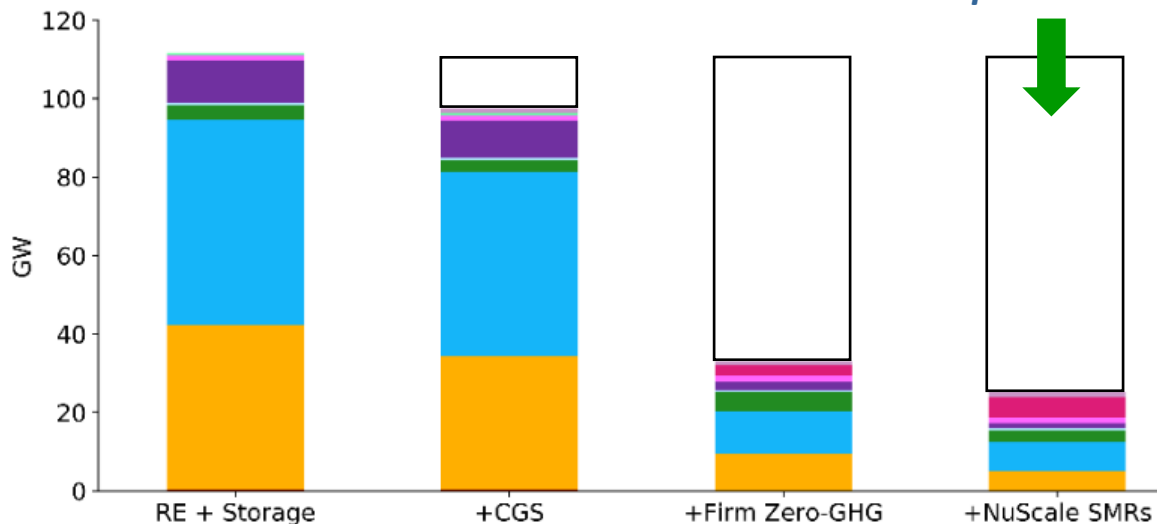


- ✓ Original **ARDP** Grant #1, now **DOE Loan** Program Office
- ✓ Amazon to purchase first **4 modules**
- ✓ Energy Northwest has option to build additional **8 modules**
- ✓ Additional power available to **Amazon and northwest utilities**

Benefits of zero-emitting firm capacity at 100% GHG reductions

*Avoids 80 to 150
Seattle-Sized Wind
Farms & 112 M
solar panels*

100% GHG Reduction Portfolios



Adding	Avoids
+1.2 GW CGS	-9.5 GW Storage
+5.3 GW SMRs	-44.8 GW Wind
	-37 GW Solar
+6.5 GW Firm	-91 GW Non-firm
<p>CGS + NuScale SMRs reduce system costs by almost \$8B per year relative to RE + Storage</p>	

Data Centers: Need Baseload Generation Now

59



Big Tech's "Dirty Little Secret"
Natural Gas Power + Renewable Energy Certificates
"Greenwashing"

<https://rickdunn.substack.com/p/wind-and-solar-green-industry-fantasyland>

Wind & Solar 'Green Industry' Fantasyland #1

How 'Big Tech's' 100% renewable deception, detached from reality politicians, and the legacy of Northwest hydropower are fueling false hopes of industrial development in Washington and Oregon.



RICK DUNN, PE.
FEB 25, 2024

MARKETS BUSINESS INVESTING TECH POLITICS VIDEO INVESTING CLUB PRO LIVESTREAM

AI could drive a natural gas boom as power companies face surging electricity demand



PUBLISHED SUN, MAY 5 2024 4:53 AM EDT | UPDATED SUN, MAY 5 2024 12:00 PM EDT

Spencer Kimball
@SPENCERKIMBALL

SHARE f X in

Driving Nuclear Renaissance

AWS acquires Talen's nuclear data center campus in Pennsylvania

Cloud company pays \$650 million – plans 960MW campus

March 04, 2024 By: Dan Swinhoe Have your say

MARKETS BUSINESS INVESTING TECH POLITICS VIDEO INVESTING CLUB PRO LIVESTREAM

Constellation Energy to restart Three Mile Island nuclear plant, sell the power to Microsoft for AI

PUBLISHED FRI, SEP 20 2024 7:22 AM EDT | UPDATED 2 HOURS AGO

Spencer Kimball
@SPENCERKIMBALL

SHARE f X in

Capital Costs: Low & No-CO₂ Emissions Generation

60



Combined-Cycle Natural Gas

\$1.2 billion per 1,000 MW

Wind

\$2.3 billion per 1,000 MW

Solar:

\$1.4 billion per 1,000 MW

Lithium-Ion Batteries

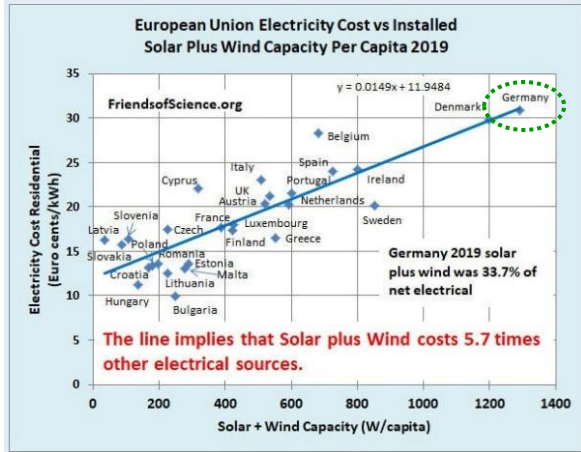
\$1.3 billion per 1,000 MW

- ✓ 4-hour Discharge Duration
- ✓ Increases Effective Capacity
- ✓ Risk of Multi-day Energy Drain

High Capital \$ Due to Overbuild

Wind & Solar Grid Costs: Cautionary Tale from Germany

61



□ Residential/Industrial Avg. ¢ per kWh



□ Germany: 40/26.4

□ +39% wind& solar annual electricity

□ De-industrialization is occurring



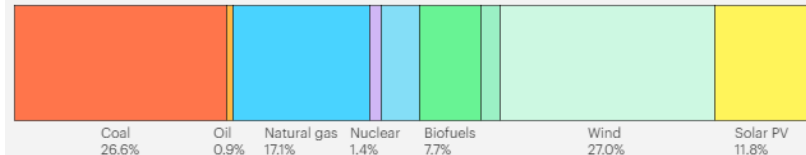
Germany leads on:

- ✓ concentration of **wind & solar** per capita
- ✓ Highest **priced** electricity

Energy mix

Electricity generation mix, Germany, 2023

Total energy supply Production Electricity Consumption



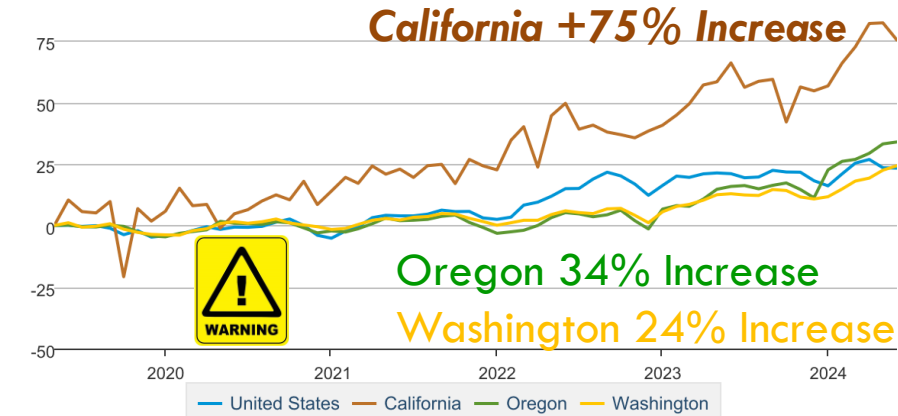
<https://www.iea.org/countries/germany>

WA & OR Residential Rates Increasing

West Coast Residential Rate Increases Since May 2019

Average retail price of electricity, residential, monthly

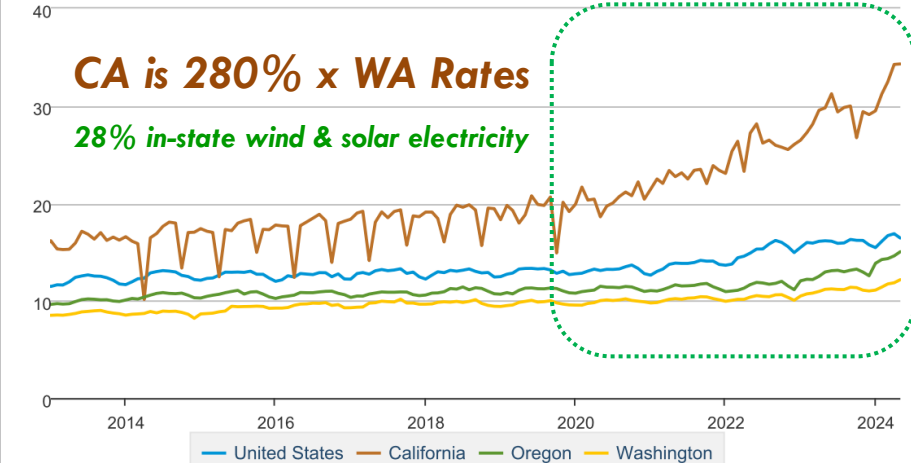
Percent Indexed to May 2019 as percent



Data source: U.S. Energy Information Administration

Average retail price of electricity, residential, monthly

cents per kilowatt-hour



Data source: U.S. Energy Information Administration

WA/OR/CA = 12¢/15¢/34¢ per kWh

Unspoken Environmental Costs: Cradle-to-Grave

If You Want 'Renewable Energy,' Get Ready to Dig



Building one wind turbine requires 900 tons of steel, 2,500 tons of concrete and 45 tons of plastic.

By Mark P. Mills
Aug 5, 2019 9:45 pm ET



Wind turbines in Palm Springs, Calif., July 13, 2017. PHOTO: PAUL BUCK/EUROPEAN PRESSPHOTO AGENCY

ARGUMENT

The Limits of Clean Energy

If the world isn't careful, renewable energy could become as destructive as fossil fuels.

BY JASON HICKEL | SEPTEMBER 6, 2019, 8:51 AM

INVESTING

The battery decade: How energy storage could revolutionize industries in the next 10 years

PUBLISHED MON, DEC 30 2019-11:55 AM EST | UPDATED MON, DEC 30 2019-3:25 PM EST



WIRED on Energy

The spiralling environmental cost of our lithium battery addiction

As the world scrambles to replace fossil fuels with clean energy, the environmental impact of finding all the lithium required could become a major issue in its own right



✓ All energy conversion technologies involve **Environmental Tradeoffs**

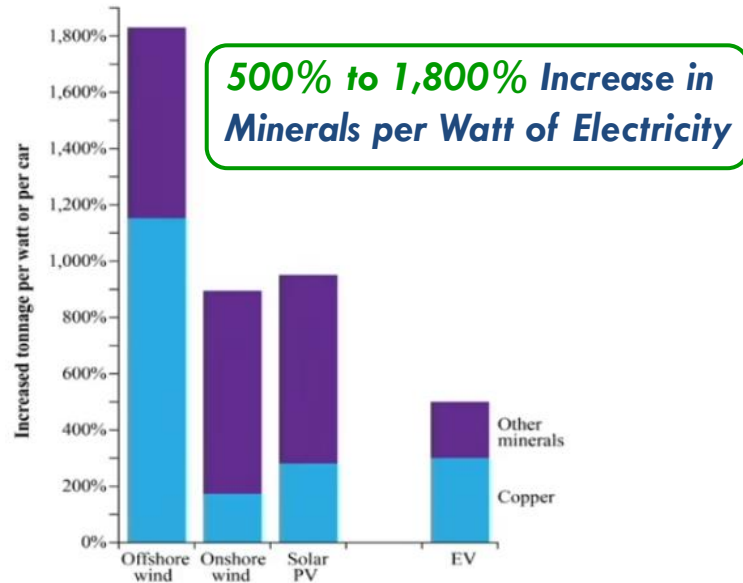
✓ Social **cost of carbon** should not be the only environmental metric

Wind & Solar: Land & Mineral Intensive

64

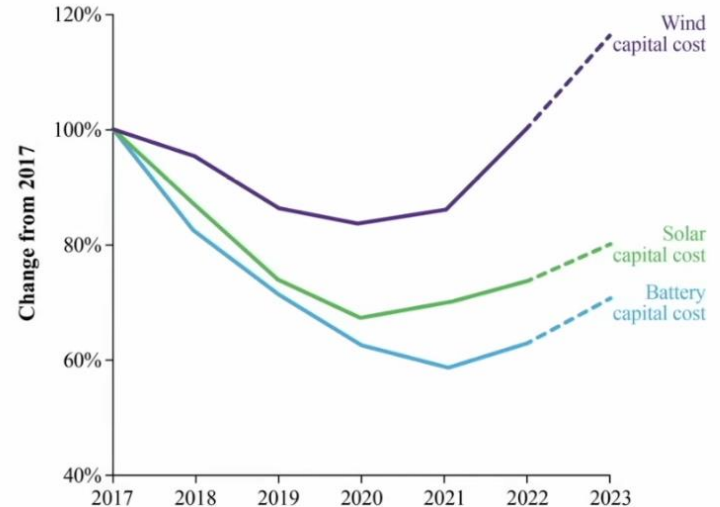
State Of Reality: *Minerals*

Transition possibilities distill to the future of mining



Green Machines Costs *Rising*

Material inputs ~70% cost solar module, battery



Energy Transition: Mining Reality Check

65

Environment Energy

3 minute read · January 26, 2022 1:48 PM PST · Last Updated a year ago

Biden administration kills Antofagasta's Minnesota copper project

By Ernest Scheyder



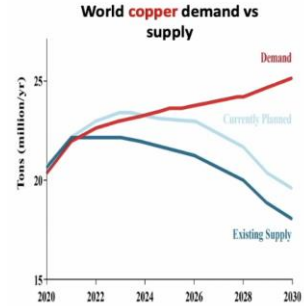
16 years to bring new mine into operation



The Future of Copper
Will the looming supply gap short-circuit the energy transition?

IEA: 100s of New Mines Needed, Soon

“Will the looming [copper] supply gap short-circuit the energy transition?”
S&P Global



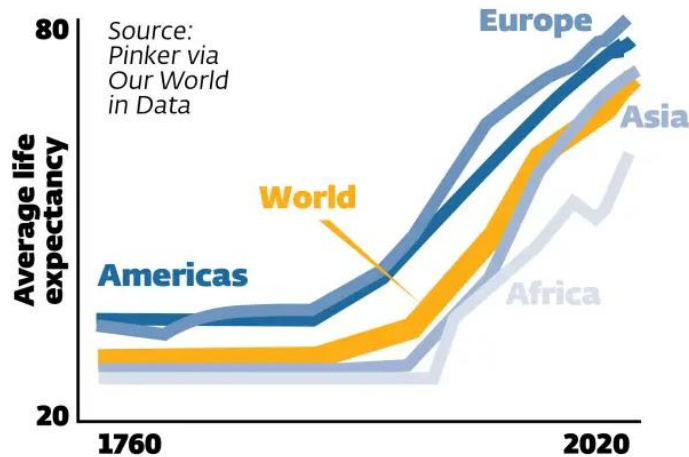
Mining critically needed and OK as long as it's somewhere else

Conclusions: *It's a Great Time to be Alive!*

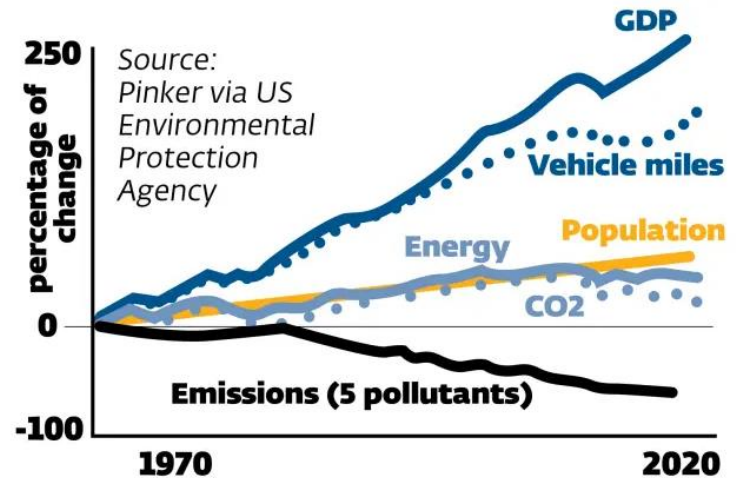
66

“We live **longer**, healthier, safer, **wealthier**, freer, more peaceful and more stimulating lives than those who came before us.”

Steven Pinker, Harvard Psychologist



We are living longer



Nature is rebounding

Conclusions: *Ideas Worth Considering*

67

- ✓ **Be wary of *climate catastrophizing* as the basis for energy policies**
 - Panicked energy strategies are *force feeding* inherently deficient wind & solar
 - Need intellectually honest life-cycle *cost-versus-benefit* analysis; financial & ecological
 - Environmental *virtue signaling* versus real global impacts

- ✓ **Data shows *bending* global CO₂ emissions & concentration *curves* is likely a longer-term prospect**
 - Energy poverty is *human poverty*; we need more global energy, not less
 - Greenhouse effect *saturates* with increasing CO₂ concentration

- ✓ **“*All of the above*” sounds nice but . . .**
 - Overbuilding wind, solar & batteries diverts *intellectual & financial* capital from reliable solutions

- ✓ **How about “*always the best*” reliable, small-footprint, low or no CO₂ technologies**

Can We Please Find **Common Ground**

68

Natural-Gas-to-Nuclear (**N2N**) is worth considering



RICKDUNN.SUBSTACK.COM

Tilting at Windmills and the Great Northwest Land Grab

Small modular nuclear technology offers something weather dependent and land hungry wind and solar cannot provide - scalability closer to urban areas where most electricity is used.



RICKDUNN.SUBSTACK.COM

The Increasingly Precarious Northwest Utility Balancing Act

Why small-footprint, scalable, and reliable natural gas and nuclear power are critical to the Northwest grid of the future - It's the Math Stupid!

*“How about an energy future of abundance and **human flourishing**, not one based on unprecedented **land grabs**, intermittency, variability, and scarcity.”*

*“I know it might seem like a long shot, but we must create a **“safe space” for natural gas** to be put back on the table in Washington and Oregon.”*