

IS AFFORDABLE, RELIABLE ELECTRICITY IN JEOPARDY?  
& OTHER INTERESTING STUFF ABOUT ELECTRICITY

# EmPOWERed

**Rick Dunn, General Manager**

**September/October 2022**



# Welcome!

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*Is affordable, reliable  
electricity in jeopardy?*

**Join us at one of four  
community forums and learn:**

- How the power grid works
- The affects of aggressive clean energy policies
- How imposed restrictions on the hydrosystem and the possible removal of the Snake River dams would affect Benton PUD and its customers
- How affordable, reliable, environmentally-responsible electricity is essential for your health, safety and well-being

**EmPOWERing Our Community**

**September 14**

Blankslate  
804 Babs Avenue,  
Benton City 5:30 p.m.

**September 21**

Benton PUD Kennewick  
2721 W 10th Avenue  
5:30 p.m.

**September 28**

Benton PUD Kennewick  
2721 W 10th Avenue  
8:30 a.m.

**October 5**

Benton PUD Prosser  
250 N Gap Road  
5:30 p.m.



$$\text{Energy} = (\text{Politics} + \text{Emotion}) \times \text{Confusion}^2$$

3



climate crisis: inevitable, entrenched and irreversible



California Asks Residents To Avoid Charging Electric Vehicles Due To Blackout Risk Days After Unveiling New Gas Car Ban

By Ben Zeisloff Aug 31, 2022 DailyWire.com



David Paul Morris/Bloomberg via Getty Images



# Helping our customers make sense of things

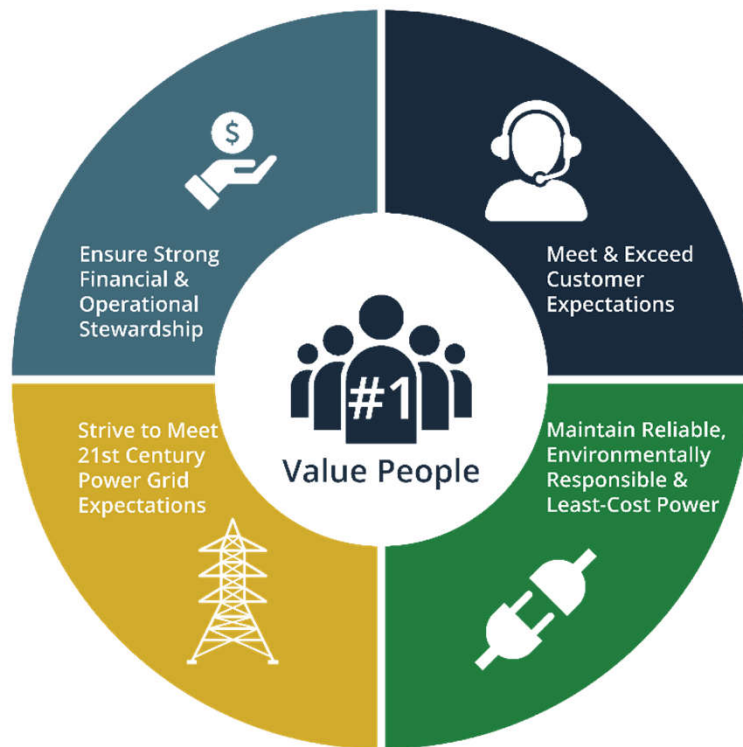
## EmPOWERed

- **Community education & outreach**
- **Increase electrical energy I.Q.**
  - ✓ **Employees**
  - ✓ **Customers**
  - ✓ **Schools**
  - ✓ **Civic organizations**





# Connecting with our Communities



## STRATEGIC INITIATIVES

- ✓ **Establish connections with our communities and schools** by finding ways to engage in community-support activities and educational opportunities
- ✓ Advocate for the preservation of the Federal Columbia River Power System and Columbia Generating Station through **active public engagement and education**
- ✓ Cultivate an “informed workforce” by delivering a program which educates employees on the utility business model, emerging issues and **empowers employees to become utility ambassadors in the community**

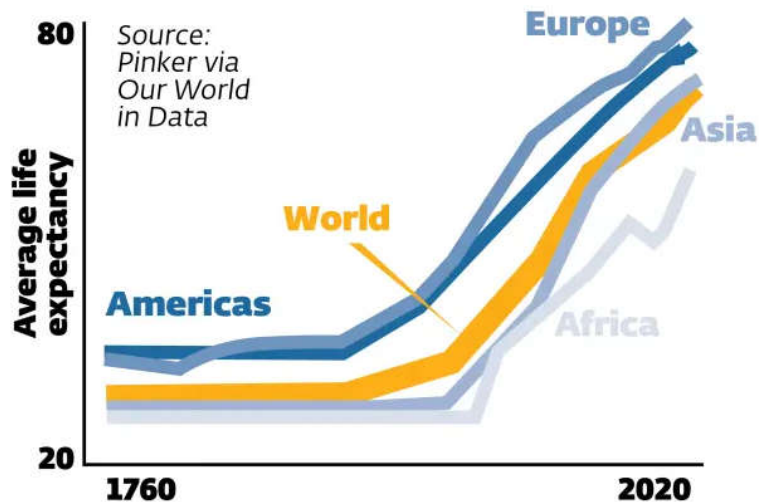
# Agenda

- 1) **Clean Energy & Washington State's Clean Energy Transformation Act (10 Minutes)** 1-35
- 2) **Global & U.S Energy, Electricity and CO2 Emissions (10 Minutes)** 36-57
- 3) **How the Power Grid Works (15 Minutes)** 58-88
- 4) **Hydropower & Benton PUD Electricity Supply Chain (15 Minutes)** 89-108
- 5) **Clean Energy Policies – Other Considerations (10 Minutes)** 109-119
- 6) **Capacity and Residential Demand Charges (15 Minutes)** 120-149
- 7) **Conclusions & Questions? (15 Minutes or as long as needed)** 150-153

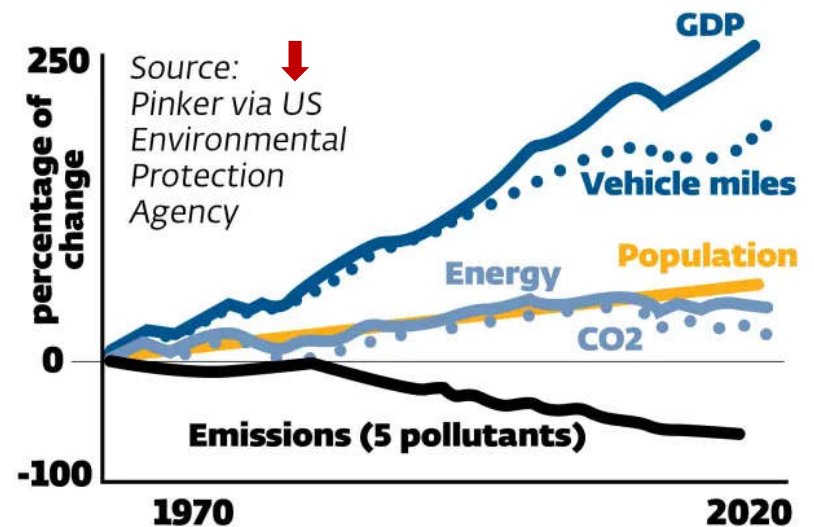
# It's a Great Time to be Alive!

“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



# Affordable & Reliable Energy is Key

**“Energy is the industry that powers every other industry. The lower cost energy is, the lower cost everything is.”**

Alex Epstein, Philosopher and Energy Expert

- ✓ Energy is the **capacity to do work**
  - “machine food” or “machine calories”
- ✓ Energy and Machines
  - “...amplify and expand our naturally meager productive ability...”
- ✓ Average U.S. person uses about **seventy-five times more “machine calories” than food calories**
- ✓ **Cost-effective and reliable energy** is the key to human flourishing
  - food, clothing, shelter, medical care, education, etc.

# Clean Energy Dominates Narrative

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- ✓ Carbon dioxide (and other) emissions are driving catastrophic climate change
- ✓ Rapid elimination of fossil-fuel use is the only answer for saving the planet (and humanity)
- ✓ Wind and solar power backed up by batteries (energy storage) are ready to save the day

# California 100% Clean Raised the Bar (Costs/Risks?)

10

California to rely on 100% clean electricity by 2045  
under bill signed by Gov. Jerry Brown



State Sen. Kevin de León (D-Los Angeles) holds up his environmental measure Senate Bill 100 after it was signed into law by Gov. Jerry Brown on Monday in Sacramento. (Rich Pedroncelli / Associated Press)

## California Issues First Rolling Blackouts Since 2001, As Heat Wave Bakes Western U.S.

Saturday, August 15, 2022

Nathan Rott / NPR



PHOTO BY MARCIO JOSE SANCHEZ AP



## To avoid blackouts, California may tap fossil fuel plants

By Kathleen Ronayne | AP  
June 30, 2022 at 9:03 p.m. EDT





# Texas Blackouts Raise Serious Questions

## Over reliance on Wind & Solar power?



- *All types of generation technologies failed.* All types of power plants were impacted by the winter storm. Certain power plants within each category of technologies (natural gas-fired power plants, coal power plants, nuclear reactors, wind generation, and solar generation facilities) failed to operate at their expected electricity generation output levels.

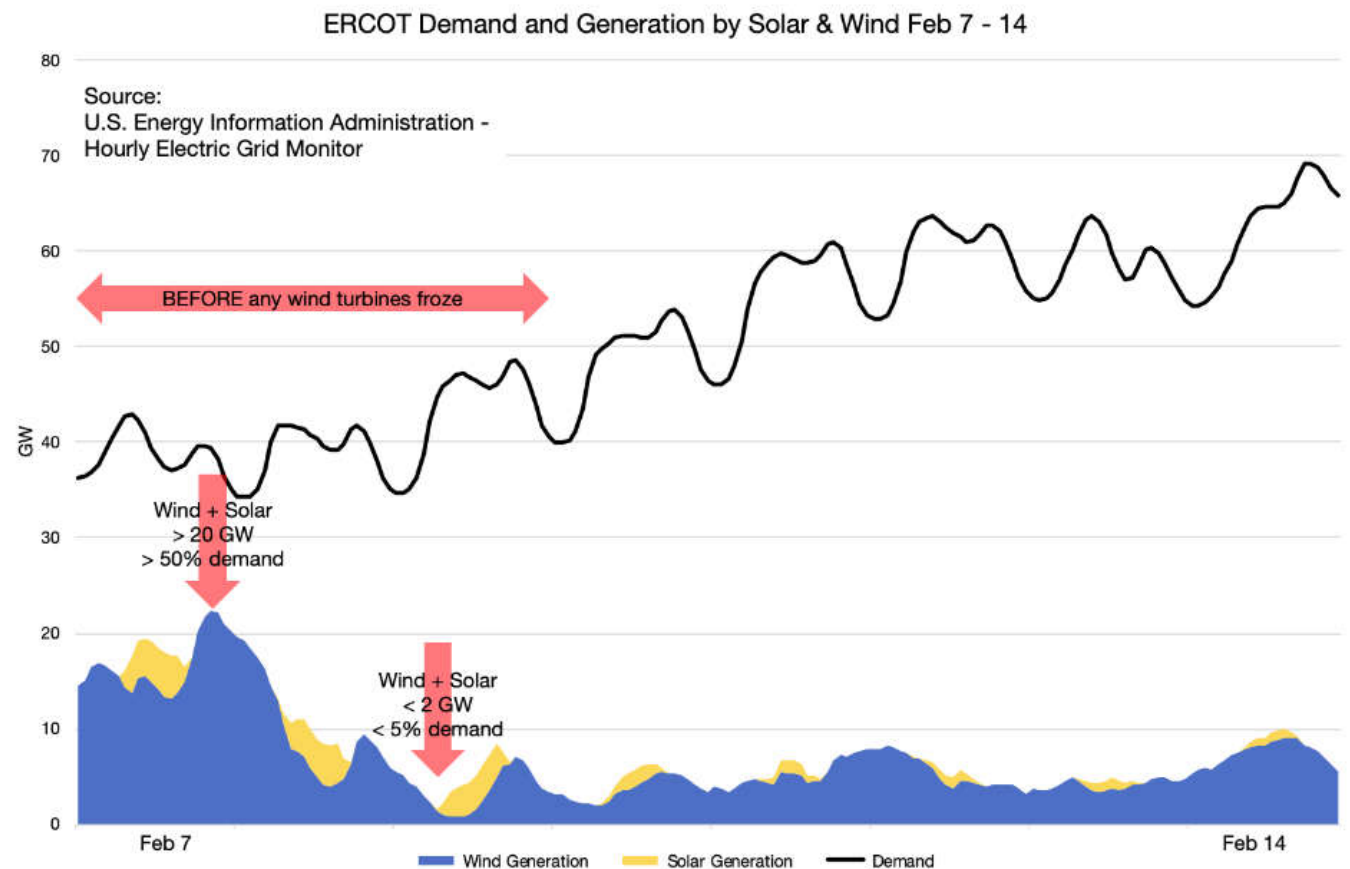
[https://www.puc.texas.gov/agency/resources/reports/UTAustin\\_\(2021\)\\_EventsFebruary2021TexasBlackout\\_\(002\)FINAL\\_07\\_12\\_21.pdf](https://www.puc.texas.gov/agency/resources/reports/UTAustin_(2021)_EventsFebruary2021TexasBlackout_(002)FINAL_07_12_21.pdf)



# Texas Blackouts Raise Serious Questions

***“Texas’s February 2021 disaster was caused by solar/wind disappearing and inadequate investment in reliable power plants and their weatherization.”***

Alex Epstein



# 100% Carbon-Free Electricity Club

## Expanding the '100 Percent' Club

Five states passed laws in 2021 that require a shift to 100 percent carbon-free electricity or net-zero emissions by mid-century. With the new additions, 11 states have these far-reaching climate laws, not including states that have set goals rather than requirements—like Maine and Nevada—and states that have taken action through executive orders rather than laws.

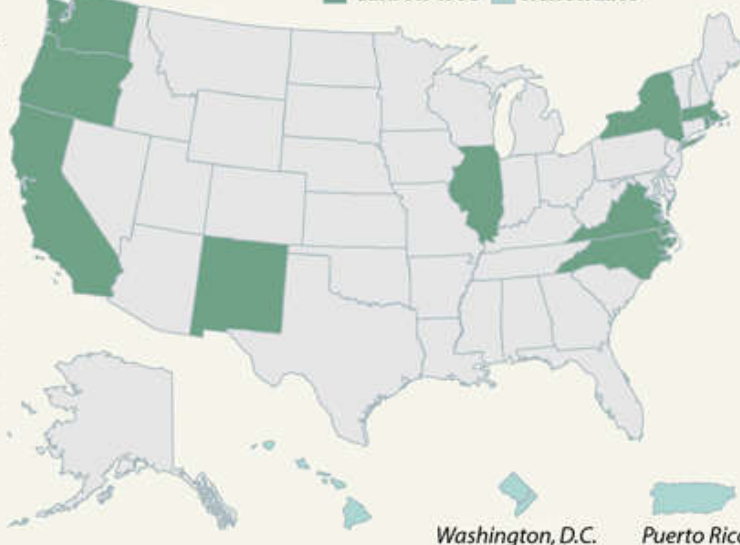
### 100 PERCENT REQUIREMENTS

	YEAR PASSED	TARGET YEAR
California	2018	2045
Hawaii	2015	2045
<b>Illinois</b>	<b>2021</b>	<b>2050*</b>
<b>Massachusetts</b>	<b>2021</b>	<b>2050</b>
New Mexico	2019	2050
New York	2019	2040
<b>North Carolina</b>	<b>2021</b>	<b>2050</b>
<b>Oregon</b>	<b>2021</b>	<b>2040</b>
<b>Rhode Island</b>	<b>2021</b>	<b>2050</b>
Virginia	2020	2050
Washington	2019	2045
Puerto Rico	2019	2050
Washington, D.C.	2019	2032

\*Illinois' law has a target year of 2045 for major energy provisions, but also lists 2050 as the final target year.

### ELECTRICITY GOALS

■ Carbon-free ■ Renewable



- Electricity represented **37% of total US energy** consumption in 2021
- Feasibility of converting all electricity to carbon-free & **decarbonizing the other 63%** of energy consumption?

SOURCES: Advanced Energy Economy; NRDC; ICN research

PAUL HORN / Inside Climate News



# WA Clean Energy Transformation Act (CETA)

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



2025  
NO COAL  
STANDARD



2030  
GHG NEUTRAL  
STANDARD



2045  
100% CLEAN  
STANDARD



**Wind, Solar etc. + Hydro & Nuclear Count**

# Washington Energy Strategy



<https://www.commerce.wa.gov/growing-the-economy/energy/2021-state-energy-strategy/>

**ELECTRICITY** at 16% of the state's emissions, must be 100% clean by 2030 and **by 2050 must roughly double** its output, while continuing to provide reliable power.

Energy equivalent to more than 10 CGS Nuclear Plants or 11x Lower Snake River Dams

**“avoid the worst impacts of climate change”**

**“rethink virtually every aspect of energy use in Washington”**

**Is there evidence (or logical argument) indicating rapid actions and sacrifices will make a national or global difference?**



## Electricity

Washington is on its way to eliminating greenhouse gas emissions from electricity with the implementation of the Clean Energy Transformation Act (CETA). Structural changes are needed to ensure the capacity to provide electricity to replace fossil fuels in transportation, buildings and industry.

- Invest in new transmission capacity and renewable generation, coordinating with other states.
- Develop distributed energy resources with smart grid capabilities and in consumer equipment to ensure reliability and flexibility.
- Strengthen market mechanisms to ensure resource adequacy and efficient electricity markets.

# CETA – Legislature Finds

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**RCW 19.405.010 Findings—Intent—2019 c 288.** (1) The legislature finds that Washington must address the impacts of climate change by leading the transition to a clean energy economy. One way in which Washington must lead this transition is by transforming its energy supply, modernizing its electricity system, and ensuring that the benefits of this transition are broadly shared throughout the state.

(2) With our wealth of carbon-free hydropower, Washington has some of the cleanest electricity in the United States. But electricity remains a large source of emissions in our state. We are at a critical juncture for transforming our electricity system. It is the policy of the state to eliminate coal-fired electricity, transition the state's electricity supply to one hundred percent carbon-neutral by 2030, and one hundred percent carbon-free by 2045. In implementing this chapter, the state must prioritize the maximization of family-wage job creation, seek to ensure that all customers are benefiting from the transition to a clean energy economy, and provide safeguards to ensure that the achievement of this policy does not impair the reliability of the electricity system or impose unreasonable costs on utility customers.

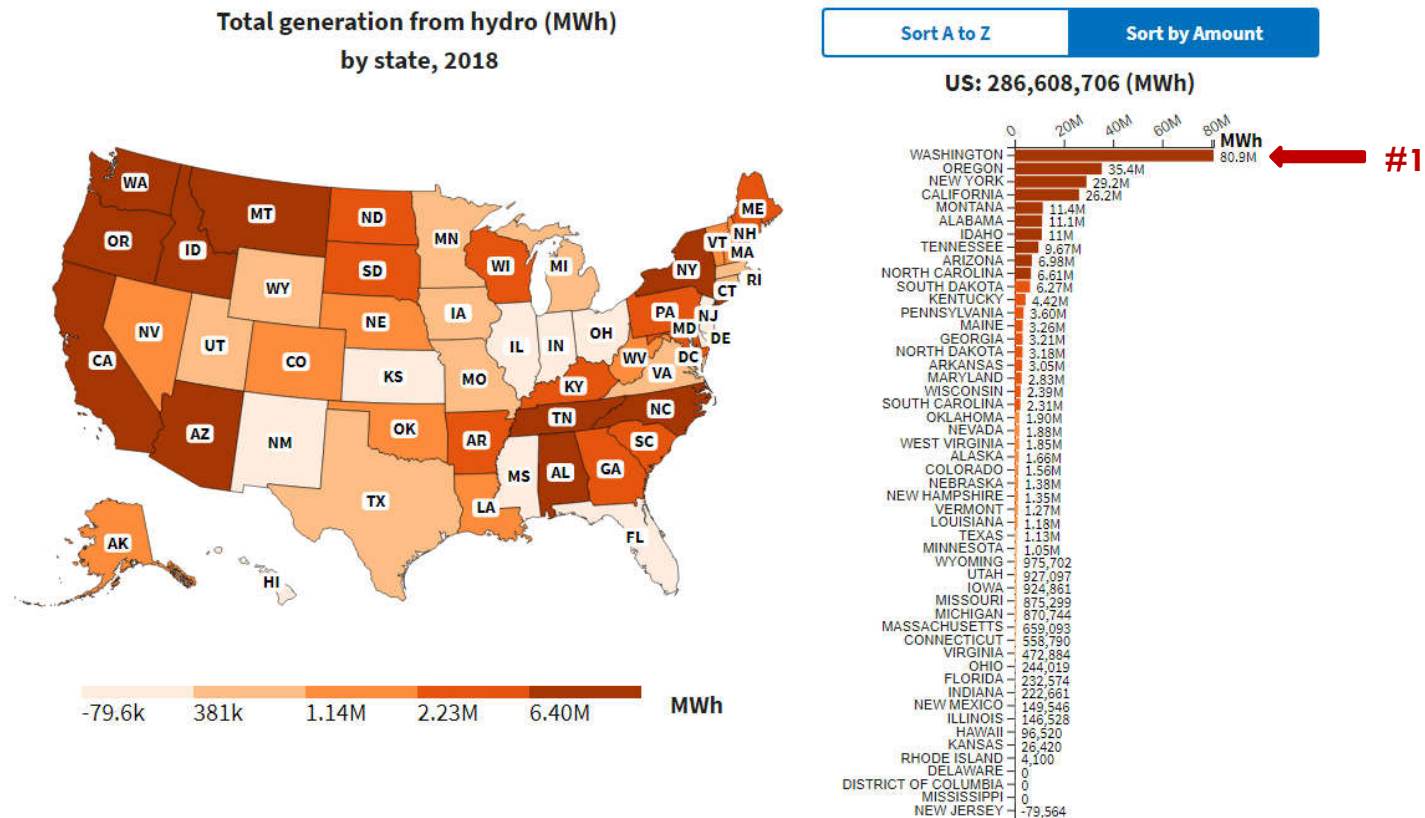
**Wait...I thought Washington had clean hydro power?**



# Washington Hydro is Nation Leading

Legislature finds: "...electricity remains a large source of emissions in our state."

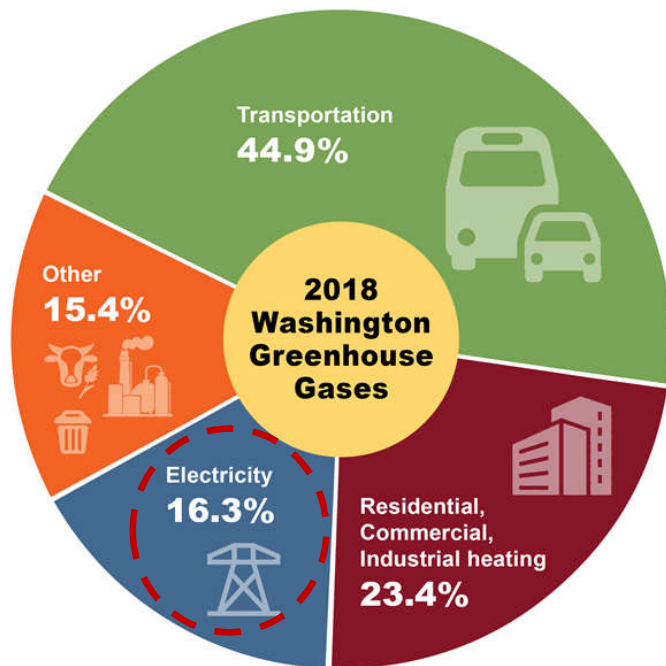
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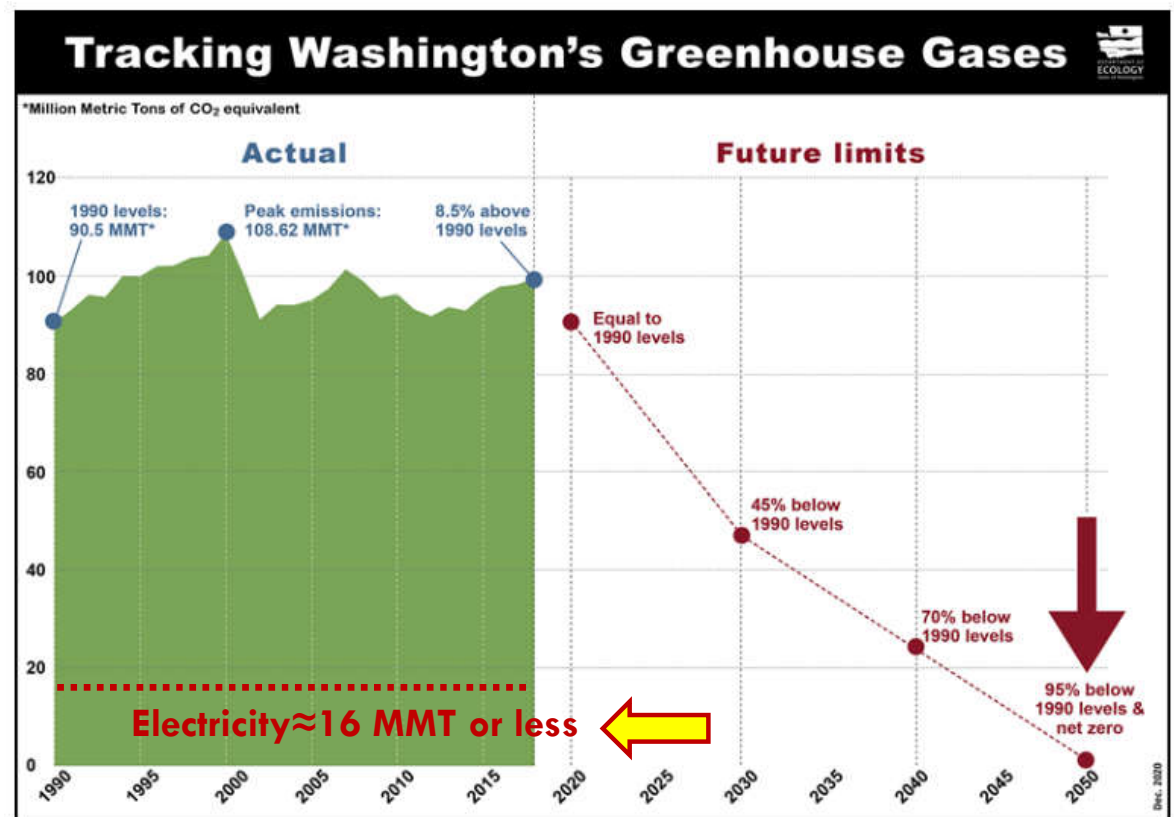
# Washington GHG Inventory

Legislature finds: "...electricity remains a large source of emissions in our state."

18



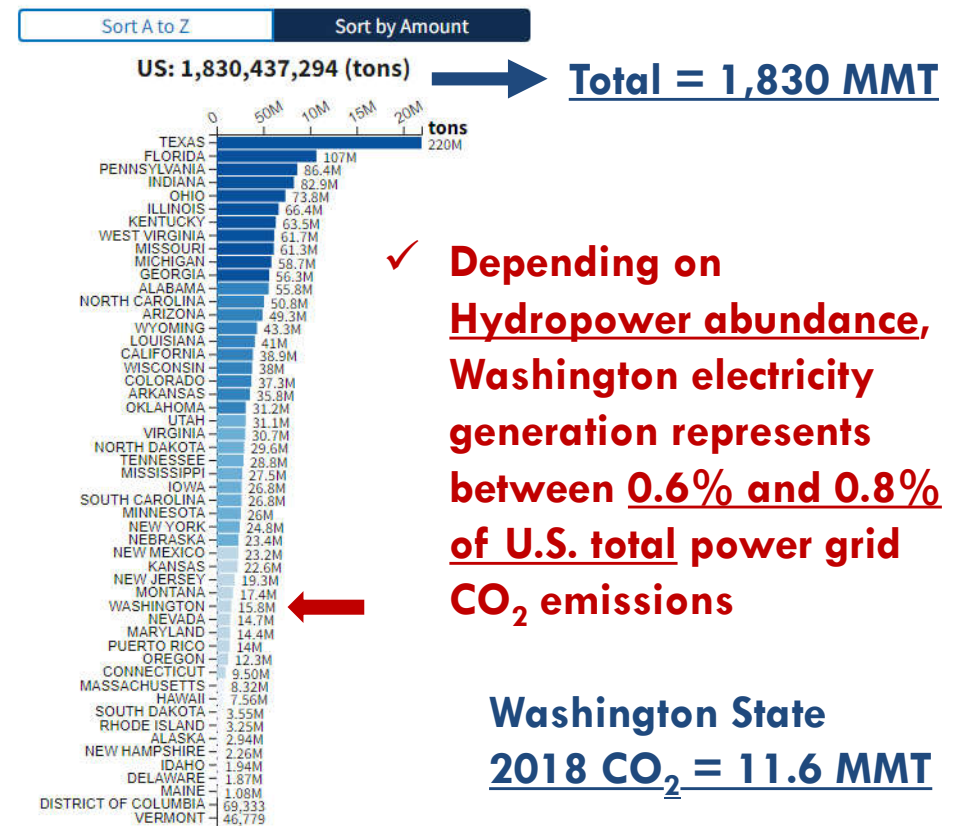
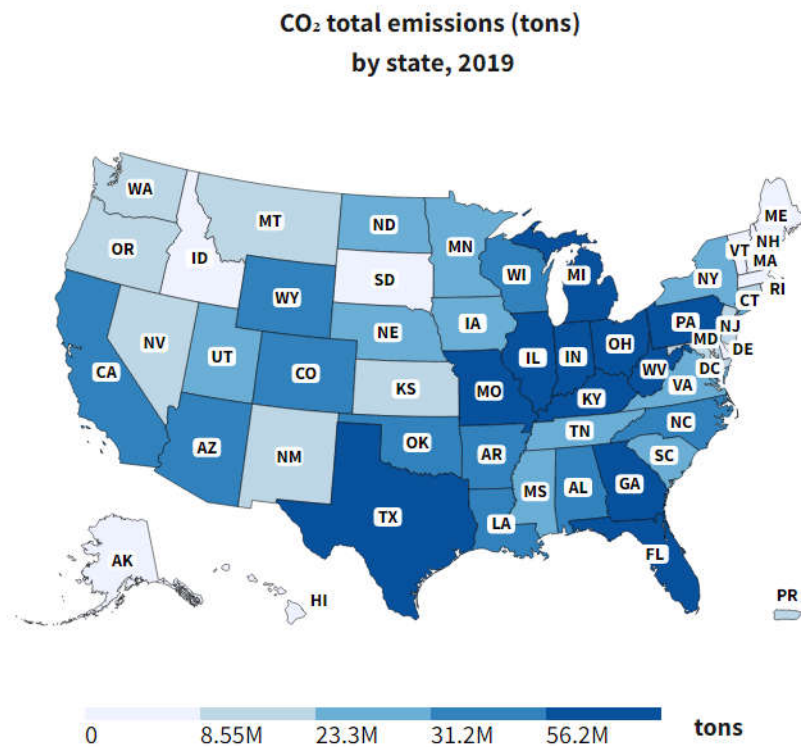
<https://ecology.wa.gov/Air-Climate/Climate-change/Tracking-greenhouse-gases/GHG-inventories>



# WA Grid CO<sub>2</sub> vs. Other States

Legislature finds: "...electricity remains a large source of emissions in our state."

19



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



# Washington State Electricity Sources

Legislature finds: "...electricity remains a large source of emissions in our state."

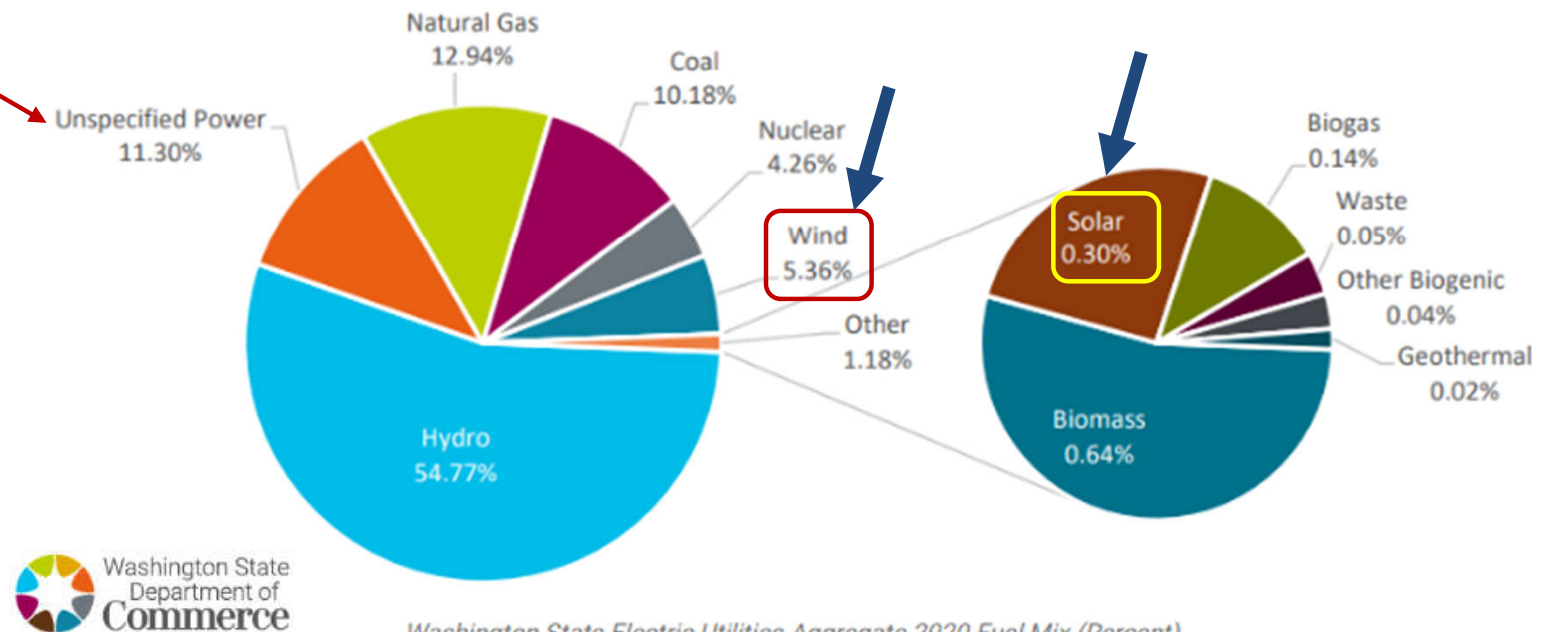
20

✓ Unspecified Power includes Large % of surplus hydro power sold in power market

✓ WA electricity is well over 60% hydropower

✓ +70% non-CO2 emitting

## Fuel Mix Disclosure

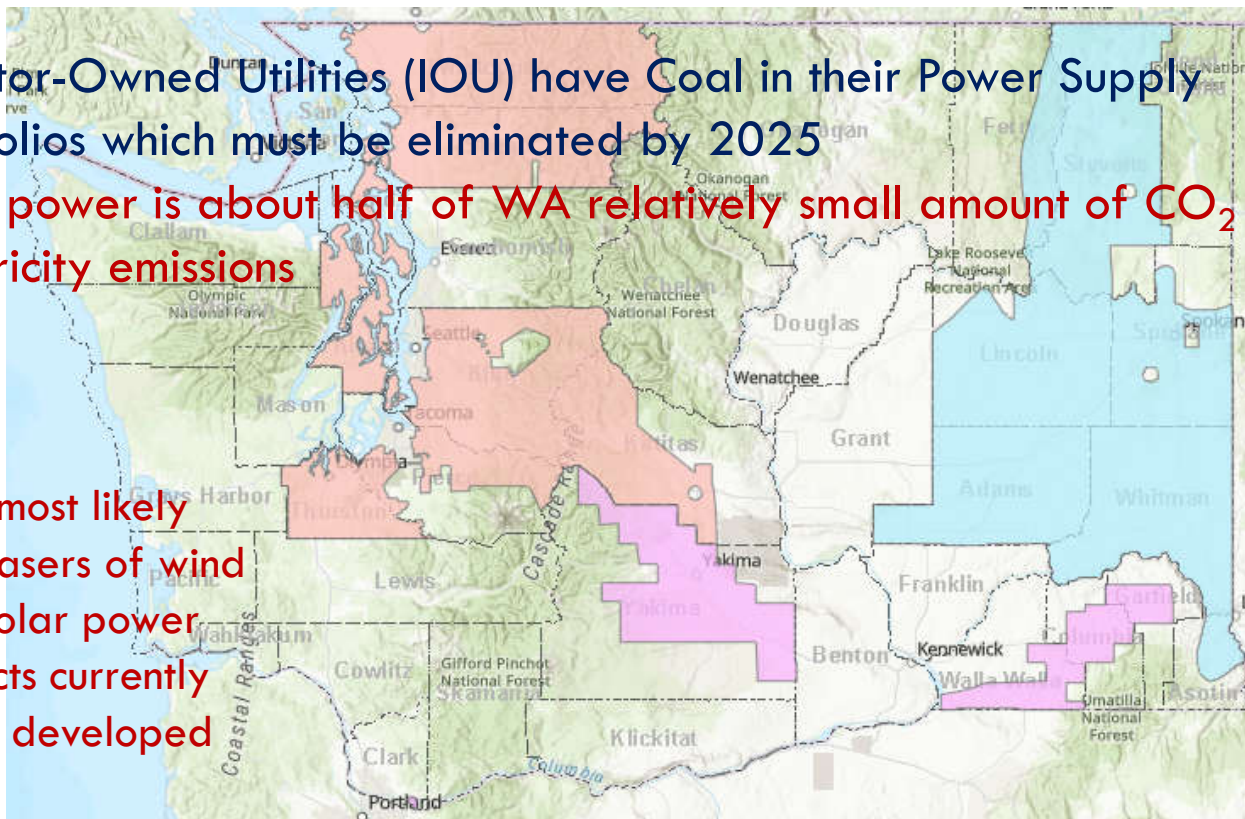


# Utilities in WA w/ Most CO<sub>2</sub> Emissions

Legislature finds: "...electricity remains a large source of emissions in our state."

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- ✓ Investor-Owned Utilities (IOU) have Coal in their Power Supply Portfolios which must be eliminated by 2025
- ✓ Coal power is about half of WA relatively small amount of CO<sub>2</sub> electricity emissions
- ✓ IOUs most likely purchasers of wind and solar power projects currently being developed



Avista Energy



A DIVISION OF PACIFICORP

PacifiCorp



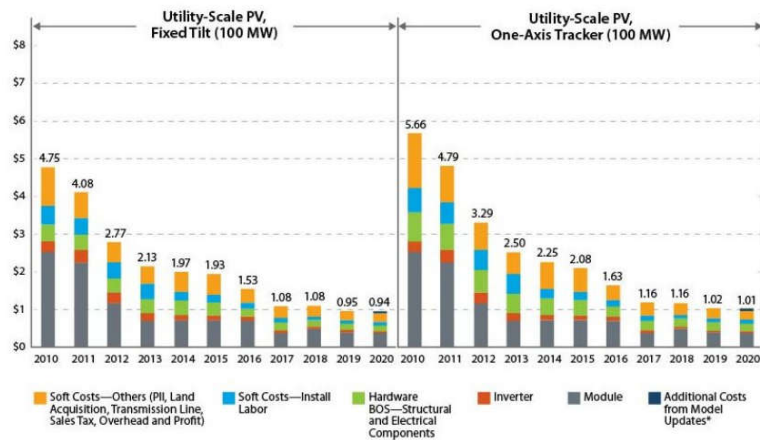
Puget Sound Energy

# CETA – Legislature Also Finds

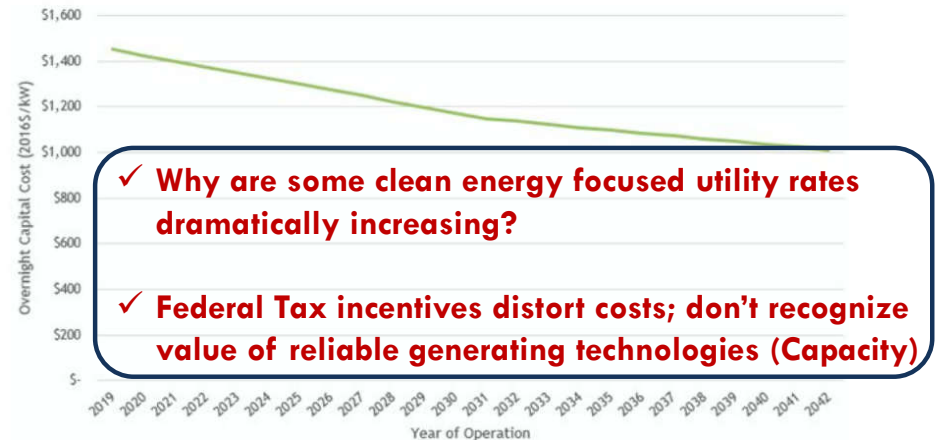
22

(3) The transition to one hundred percent clean energy is underway, but must happen faster than our current policies can deliver. Absent significant and swift reductions in greenhouse gas emissions, climate change poses immediate significant threats to our economy, health, safety, and national security. The **prices of clean energy technologies** continue to fall, and are, in many cases, **competitive or even cheaper than conventional energy sources.**

NREL Installed Utility-Scale PV Component Cost Reductions (\$/Wdc)



Onshore Wind – Capital Cost (2016\$/kW)



# Europe has already gone down wind/solar road

Legislature finds: “Clean energy technologies...competitive or even cheaper than conventional technologies”

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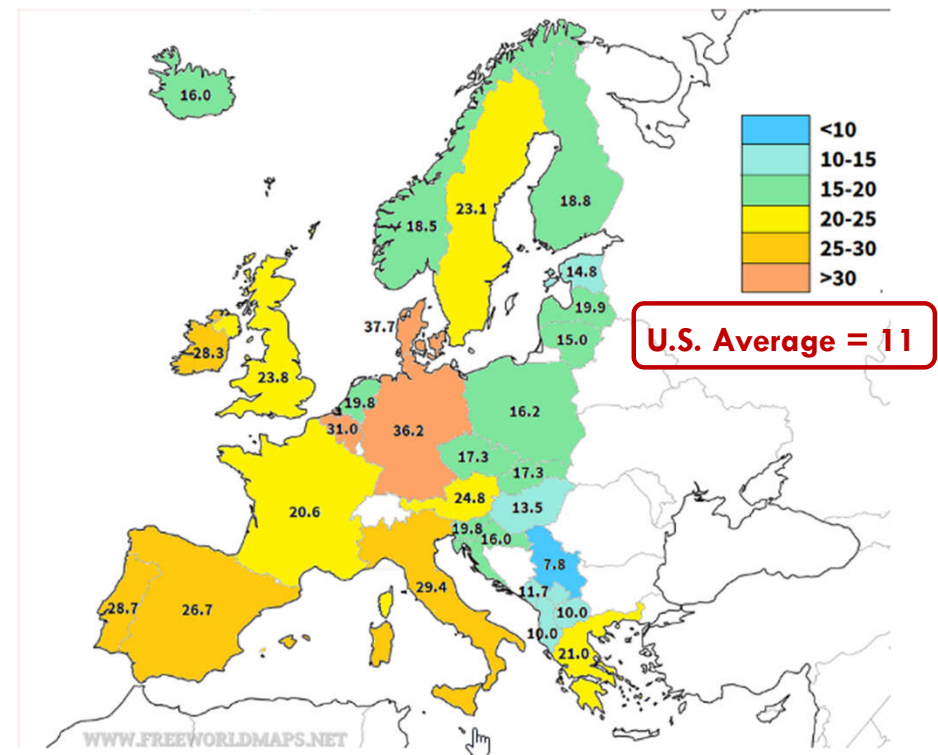
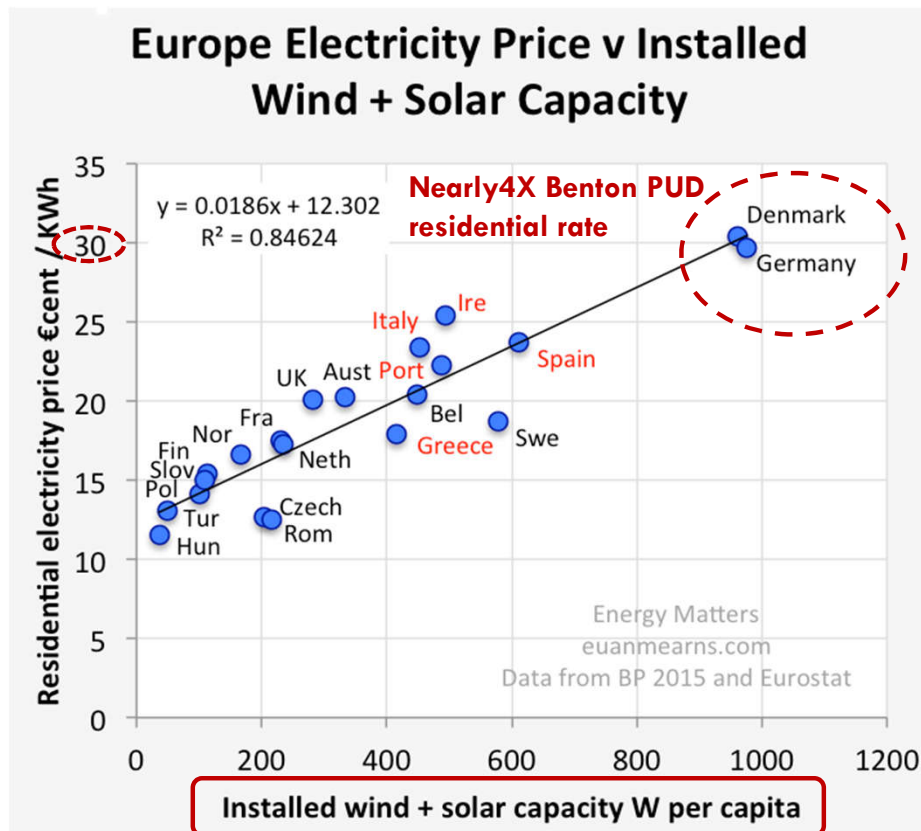


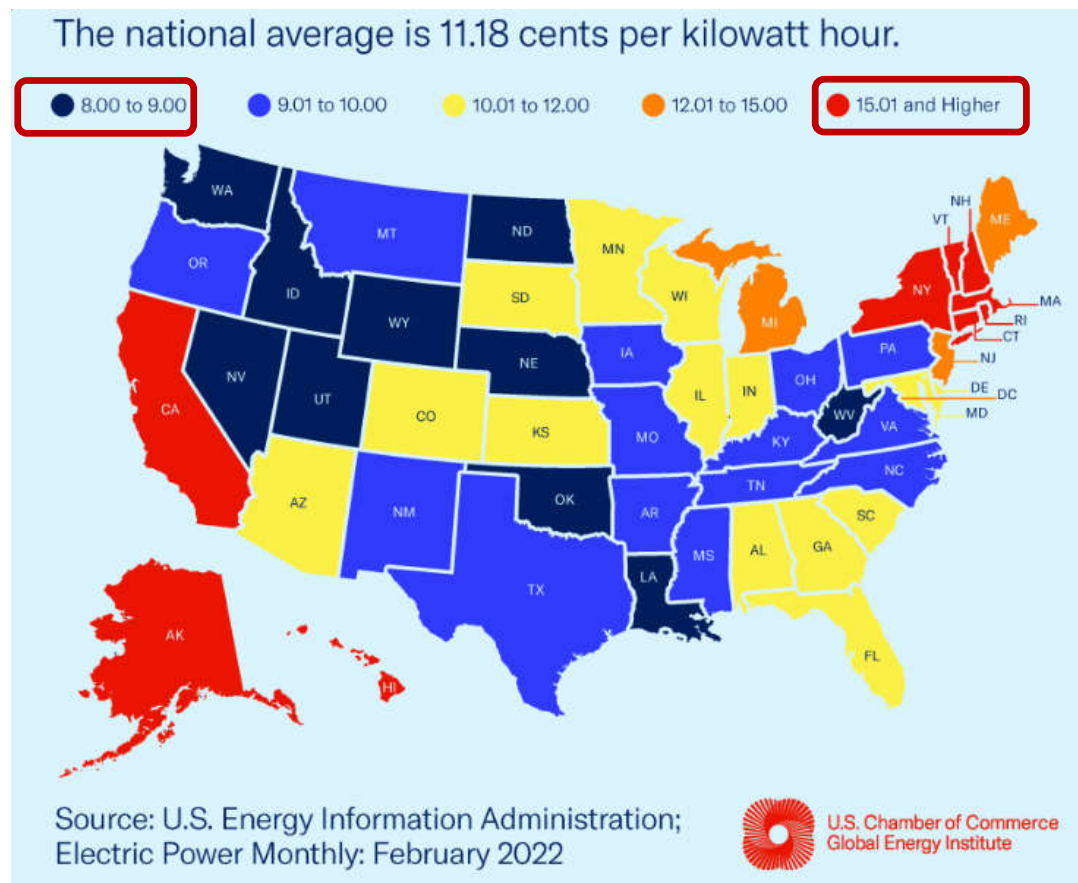
Figure 2: Average retail electricity prices in Europe in 2016, US cents/kWh



# 2021 Average U.S. Electricity Retail Prices

Legislature finds: “Clean energy technologies...competitive or even cheaper than conventional technologies”

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**There's an Old Saying:**  
**'As goes California, so goes the nation'**

**There needs to be a new category for California**  
**residential electricity prices soon to be >30 cents per kWh**

**Approaching what Germany & Denmark have realized**



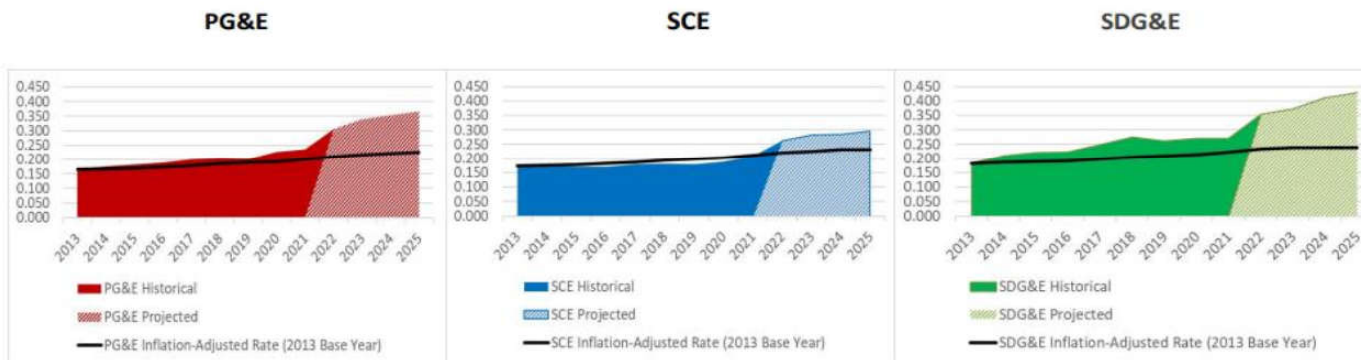
# Low-Cost Solar/Wind & Increasing Retail Rates?

Legislature finds: “Clean energy technologies...competitive or even cheaper than conventional technologies”

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## Market Pressures - IOUs

### Projected Residential Rate Growth Expected for California IOUs (\$/kWh)



Rate increases  
to between  
\$0.30 to \$0.43  
per kWh

Nearly 5X Benton PUD  
residential rate

By 2030, bundled residential rates are forecasted to be approximately **40% (PG&E), 20% (SCE), and 70% (SDG&E) higher** than they would have been if 2013 rates for each IOU had grown at the rate of inflation.

Source: Randy Howard, General Manager, Northern California Power Agency

# CETA – Legislature Also Finds

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(4) The legislature finds that Washington can accomplish the goals of chapter 288, Laws of 2019 while: Promoting energy independence; creating high quality jobs in the clean energy sector; maximizing the value of hydropower, our principal renewable resource; continuing to encourage and provide incentives for clean alternative energy sources, including providing electricity for the transportation sector; maintaining safe and reliable electricity to all customers at stable and affordable rates; and protecting clean air and water in the Pacific Northwest. Clean energy creates more jobs per unit of energy produced than fossil fuel sources, so this transition will contribute to job growth in Washington while addressing our climate crisis head on. Our abundance of renewable energy and our strong clean technology sector make Washington well positioned to be at the forefront of the transition to one hundred percent clean electricity.

***“Our hydropower is like nowhere else in the country, and without it our 100% clean bragging rights would evaporate.”*** Rick Dunn

# Maximizing value of hydropower & dam breaching?

Legislature finds: “maximizing the value of hydropower, our principle renewable resource”

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## The Seattle Times

### Gov. Inslee, Sen. Murray pursue dam-breaching assessment on Lower Snake River

Oct. 23, 2021 at 7:00 am | Updated Oct. 26, 2021 at 2:37 pm



### White House weighs in on Lower Snake River dam breaching in unusual power play

July 12, 2022 at 6:00 am | Updated July 12, 2022 at 4:30 pm



**Between The Lines**  
Customer Newsletter • Summer 2022 • BentonPUD.org



**BENTON PUD**

No matter what some say,  
Snake dams are not easily replaceable

Message from  
the General Manager

I was honored to be an invited speaker for part of the Western Caucus Foundation (WCF) energy field tour across Central Washington and am grateful to Representative Dan Newhouse and his staff for extending the invitation.





# Energy Issues & Controversy Close to Home

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## Tri-City Herald

Tri-Cities region warned of possible rolling power blackouts during heat wave

BY ANNETTE CARY

UPDATED JUNE 28, 2021 5:20 PM



How you can prepare for a power outage and what to do once your power is out. BY ALYSSA HODENFIELD

**Tri-Cities Transmission Grid Needs Upgrades**

**Would be the Largest Wind Farm in WA State  
Who would it benefit?**



TRI-CITY REGIONAL  
CHAMBER OF COMMERCE

**HORSE HEAVEN WIND PROJECT  
PUBLIC OPINION SURVEY**



## Tri-City Herald

EDITORIALS

*Thanks Gov. Inslee and Sen. Murray for affirming the obvious in WA's Snake dam debate*

BY THE TRI-CITY HERALD EDITORIAL BOARD

UPDATED AUGUST 29, 2022 10:05 AM

**Tri-Cities is "Ground Zero" of Dam Breaching Debate**



# Benton PUD Good News! **Already Clean**

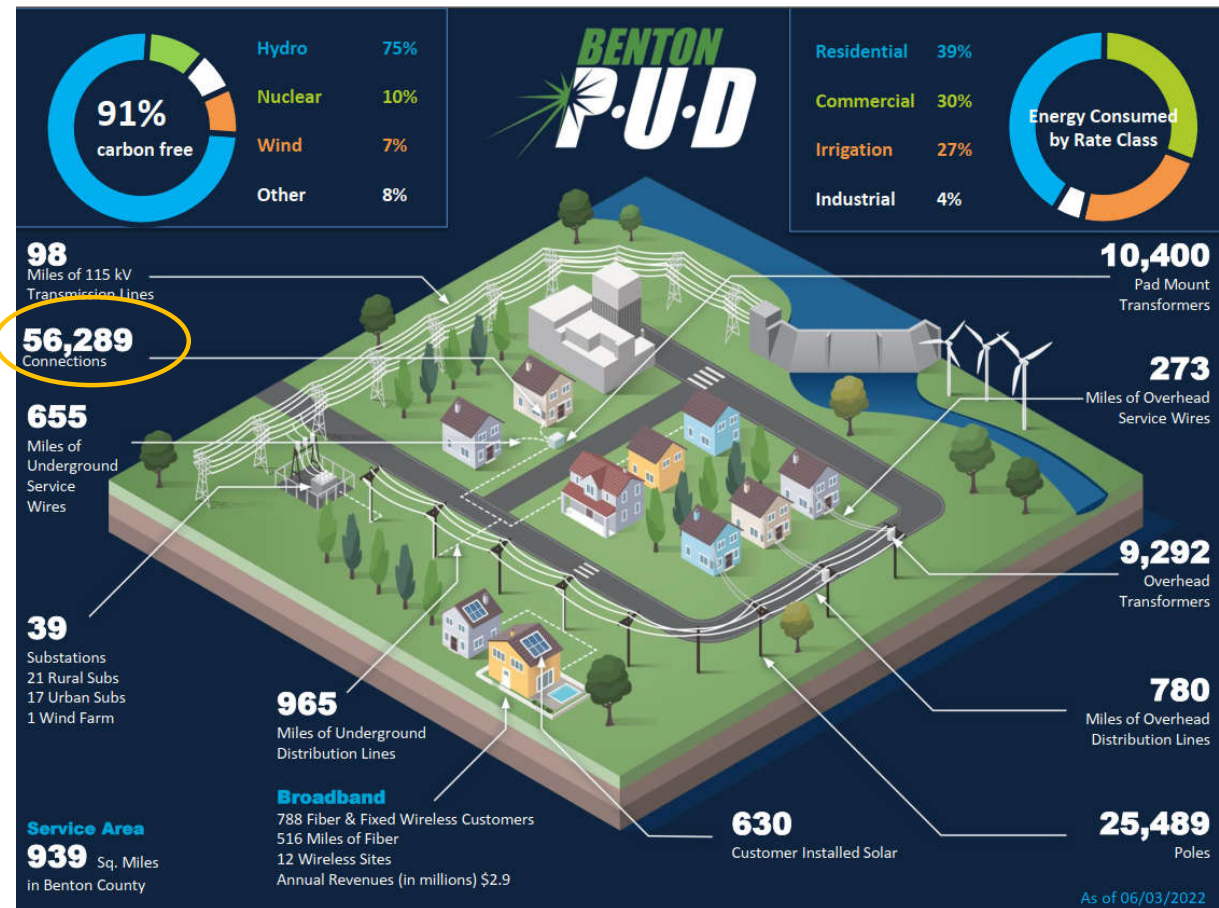
Legislature finds: "...electricity remains a large source of emissions in our state."

29

4-Year Average is  
**93% carbon free**



- Serving
- Kennewick
  - Finley
  - Benton City
  - Prosser





# Benton PUD Good News! Low Rates

## Average Retail Rates<sup>1</sup>

### 2020 Report on Average Revenue (Cents per kWh)<sup>2</sup>

	Residential	Commercial	Industrial	Total
Benton PUD	8.8	7.1	5.7	7.4
WA Publicly Owned	9.5	8.4	5.3	7.9
WA Investor Owned	10.4	10.0	7.8	10.0
WA Cooperatives	9.4	8.2	6.7	8.5
National Average	13.2	10.6	6.7	10.6
California	20.4	17.5	14.3	18.0

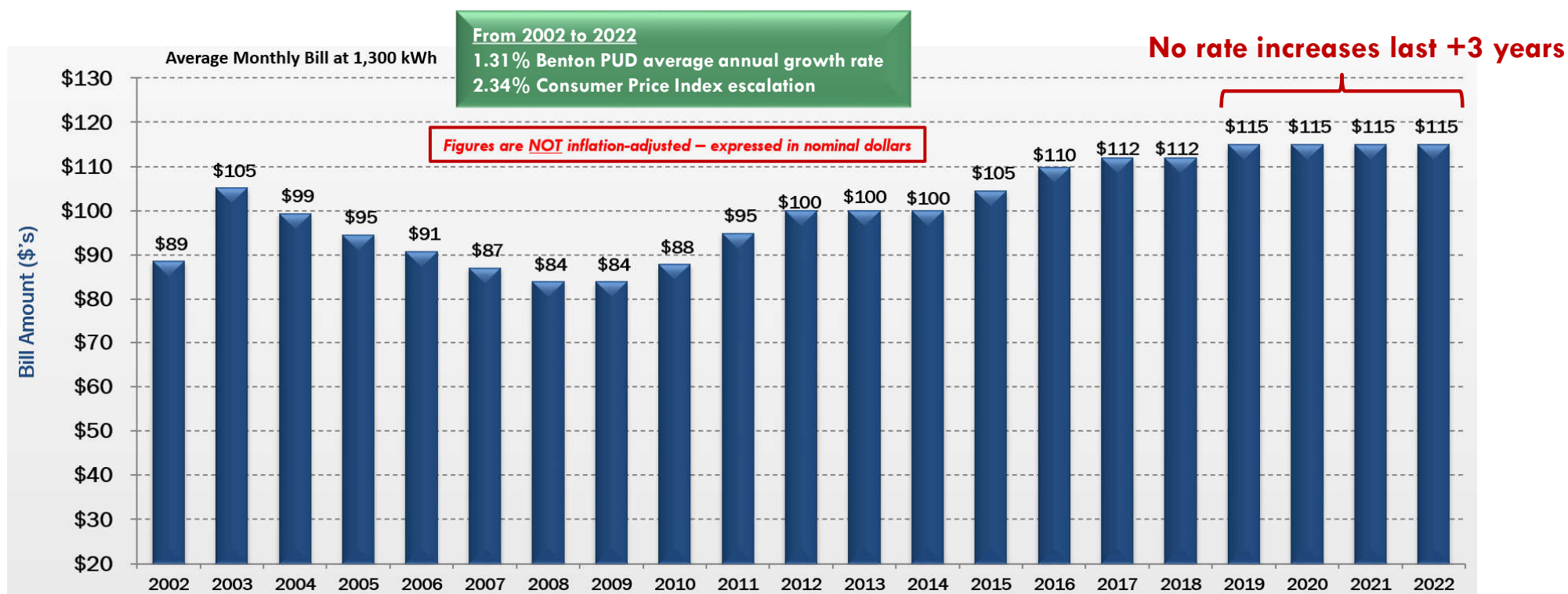


<sup>1</sup> Revenues - includes all charges to customer

<sup>2</sup> American Public Power Association

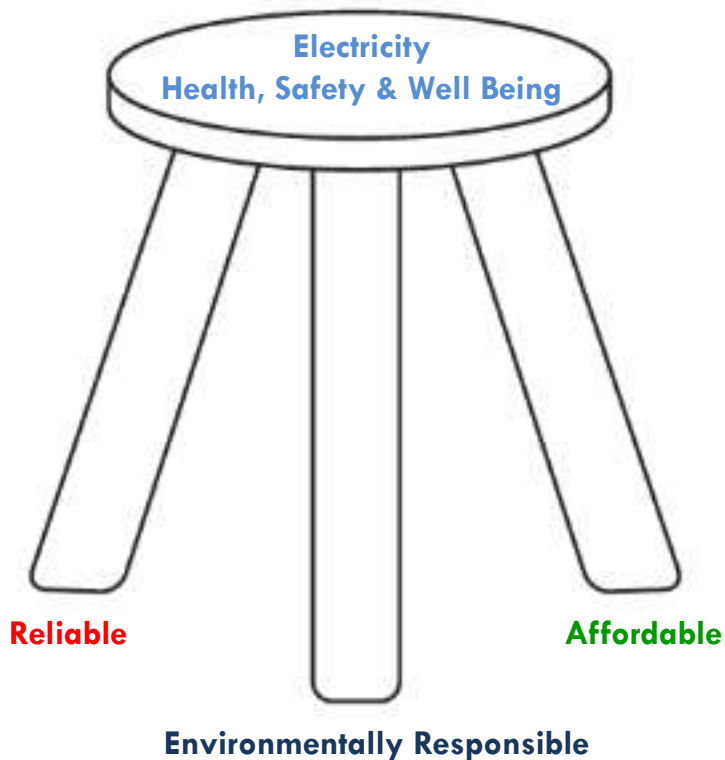
# Benton PUD Good News! Low Rates

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# What has Benton PUD concerned?

## Electric Utility Responsibilities



### ➤ Hydropower Erosion

- Increased spill & dam breaching
- Deepening dependence on hydro **Capacity** & flexibility
- Increasing drought plus cold/hot weather risks

### ➤ Generating Technology Prohibitions

- Coal-plant retirements & no new natural gas in WA/OR
- No firm plans to replace dependable (Effective) Capacity
- Increasing costs for **'Effective' Capacity**

### ➤ Strong Preferences for Low (Effective)-Capacity & Energy Dilute Wind/Solar

- Land use conflicts & long project lead times
- Unwarranted belief in battery (energy) storage readiness

### ➤ Increasing Risk of Blackouts in the Western Grid

- Anti fossil-fuel policies chills investments in new natural gas generation throughout the west

# “Capacity” and Why it’s Important

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- Capacity is the ability to produce a desired amount of electricity up to the maximum capability of the generator at any given point in time
  - Utilities need adequate total generation Capacity to meet continuously-varying electricity demand reliably over a broad range of conditions
  - The amount of generating Capacity that can be counted on during coldest & hottest days is referred to as ‘**Effective Capacity**’
- The consequences of inadequate Capacity are blackouts
  - Blackouts are inconvenient, expensive, and potentially life-threatening



# Capacity and Peak Demand in the News

## Wind and Solar Dependent Grids Struggle to Meet Peak Demand

### European Union Intends To 'Flatten The Curve' For Electricity Use

By Ben Zeisloft · Sep 7, 2022 DailyWire.com · f t



Thierry Monasse via Getty Images

European Commission President Ursula von der Leyen announced Wednesday that the European Union would propose a “mandatory target” for reducing electricity consumption during peak demand.



# Clean Energy Policies & Your Bill

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**BENTON PUD** 2721 W 10th Ave  
PO Box 6270  
Kennewick, WA 99336

Pay online or go paperless at  
[www.bentonpud.org](http://www.bentonpud.org)

Round Up Donation Year-to-Date \$169.09

4 1473

KENNEWICK WA 99336-9424

ACCOUNT INFORMATION  
Account: 08/23/2022  
Billing Date: 08/23/2022  
SUMMARY  
Total Previous Balance \$162.06  
Payments Received -\$162.06  
Balance Forward \$0.00  
New Charges Due 09/12/2022 \$170.08  
Total Amount Due \* \$170.08  
\* 1% late charge will be added if your payment is received after the due date.

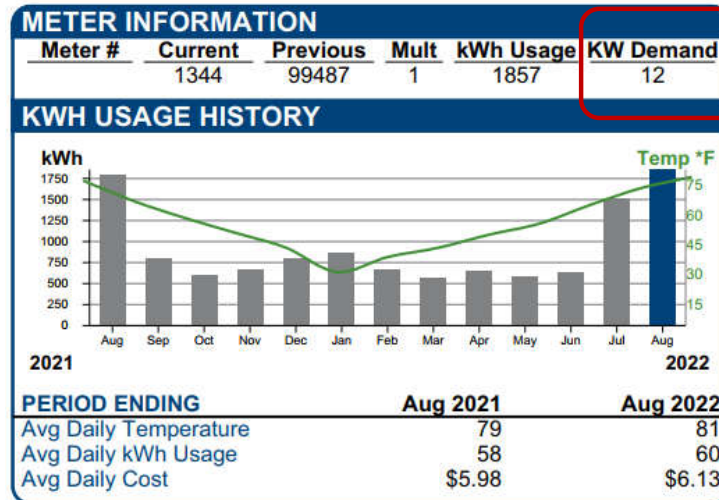
Autopay will be charged on 09/12/2022.

Funds for the amount due will be automatically withdrawn from or charged to your account. Do not send any payment.

**NEW CHARGES DETAIL**  
Service From 07/18/2022 - 08/18/2022  
Residential Services  
1,857 kWh @ 0.0739 \$137.23  
31 Days Daily System Charge \$19.53  
Kennewick City Tax \$13.32  
Subtotal New Charges \$170.08  
AutoPay Date 09/12/2022

**METER INFORMATION**  
Meter # 1344 Current 99487 Previous 1 Mult kWh Usage KW Demand  
1857 12

**KWH USAGE HISTORY**  
kWh Temp °F  
2021 2022  
Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug  
PERIOD ENDING Aug 2021 Aug 2022  
Avg Daily Temperature 79 81  
Avg Daily kWh Usage 58 60  
Avg Daily Cost \$5.98 \$6.13



Dependable  
Generating  
capacity  
**becoming  
scarcer &  
more costly**

• Maximum power demand KW (kilowatts)

• Customer KW Demand establishes

- ✓ **Capacity of power lines & equipment needed to prevent overloading**
- ✓ **Expense for Generating resources capable of meeting demand**

PLEASE RETURN THE BOTTOM PORTION WITH YOUR PAYMENT - MAKE YOUR CHECKS PAYABLE TO: BENTON PUD

**BENTON PUD** Kennewick Office 2721 W 10th Ave  
PO Box 6270  
Kennewick, WA 99336  
(509) 582-2175

Prosser Office 250 N Gap Road  
Prosser, WA 99350  
(509) 786-1841

Manage your account with SmartHub!  
♦ Make Payments, Go Paperless  
♦ Track Electric Usage  
♦ Report Outages  
Sign up at [BentonPUD.org](http://BentonPUD.org)

**AMOUNT DUE**  
ACCOUNT NUMBER  
Total Amount Due \$170.08  
New Charges Due Date 09/12/2022  
Helping Hands Donation \$  
Total Amount Enclosed \$ Autopay - Do Not Pay

BENTON PUD  
PO BOX 6270  
KENNEWICK WA 99336-0270

PAYMENT KIOSK  
BARCODE:

5120400655900000019006000019198062220220



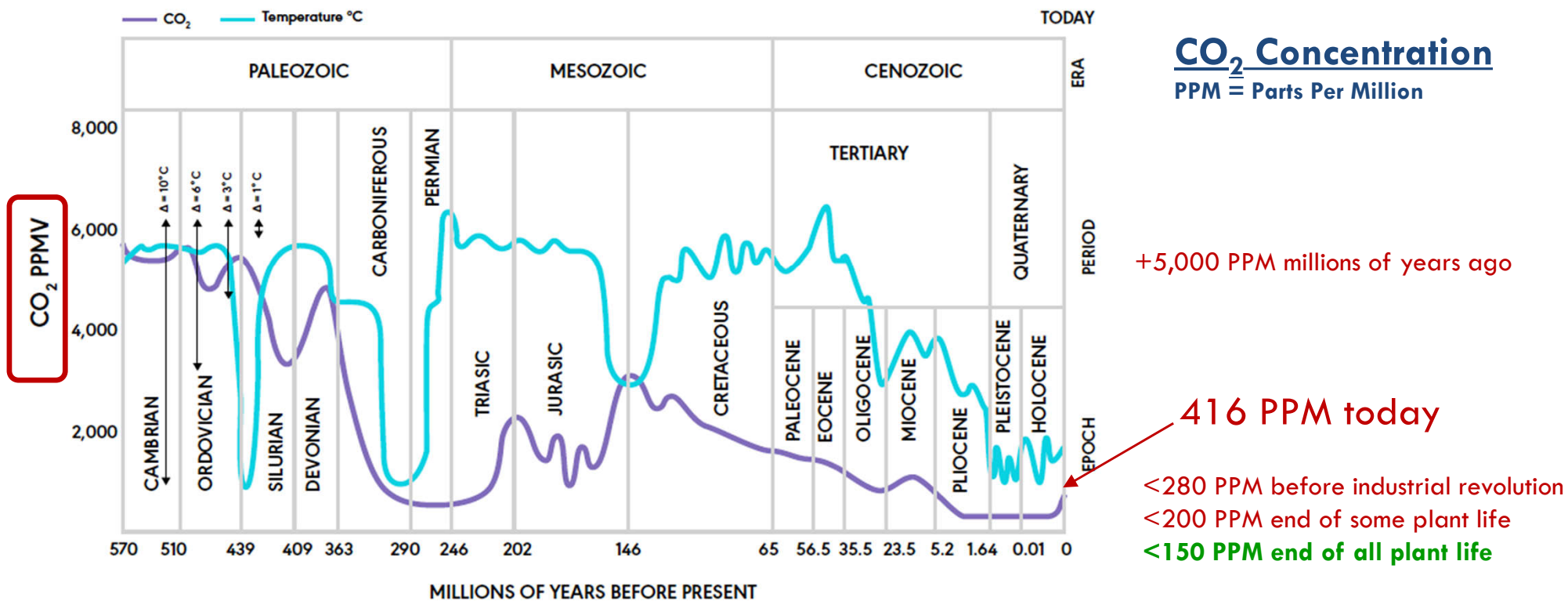
## Global & U.S Energy, Electricity and CO2 Emissions



# Global CO<sub>2</sub> Perspective

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Geological Timescale: Concentration of CO<sub>2</sub> and Temperature Fluctuations

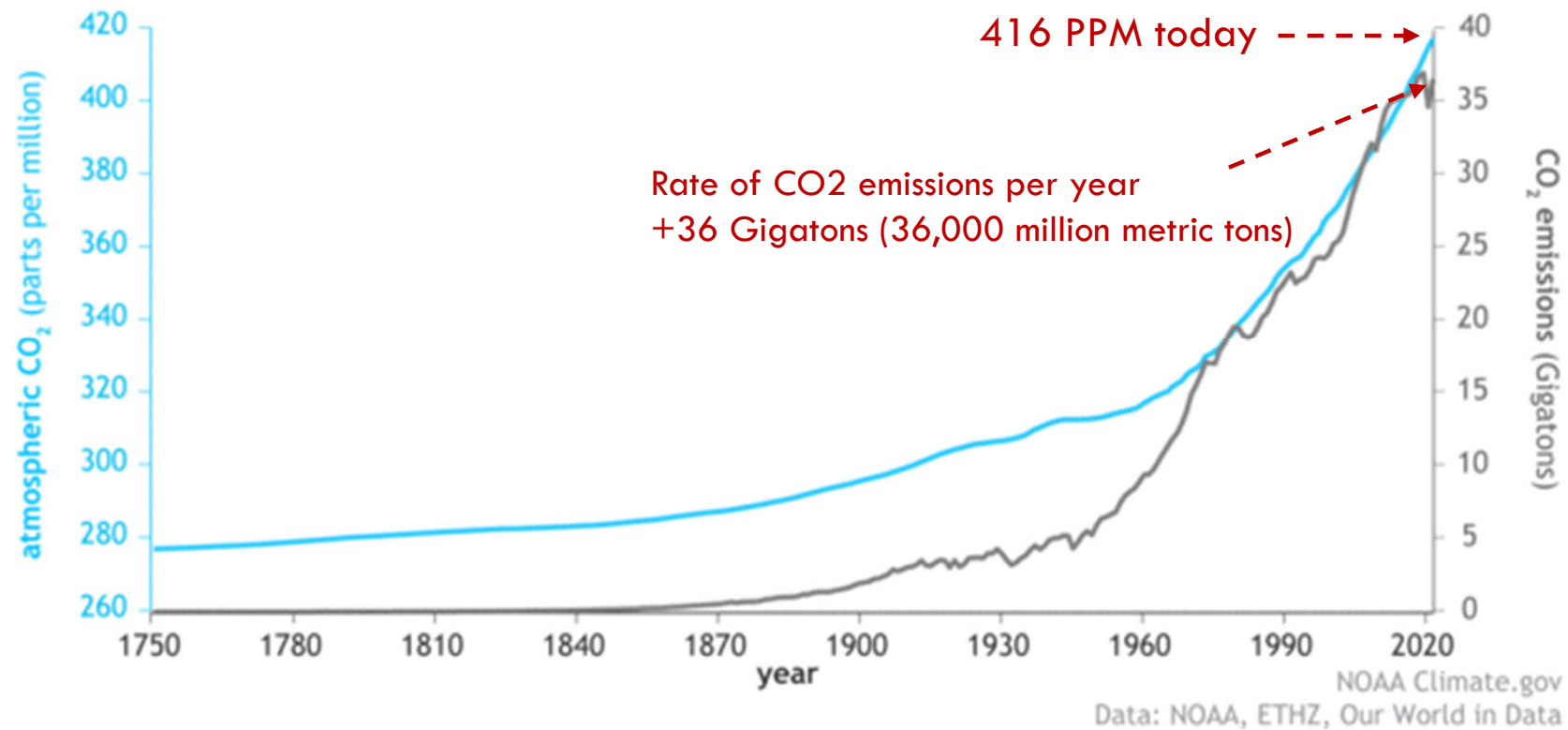




# Global CO<sub>2</sub> Perspective

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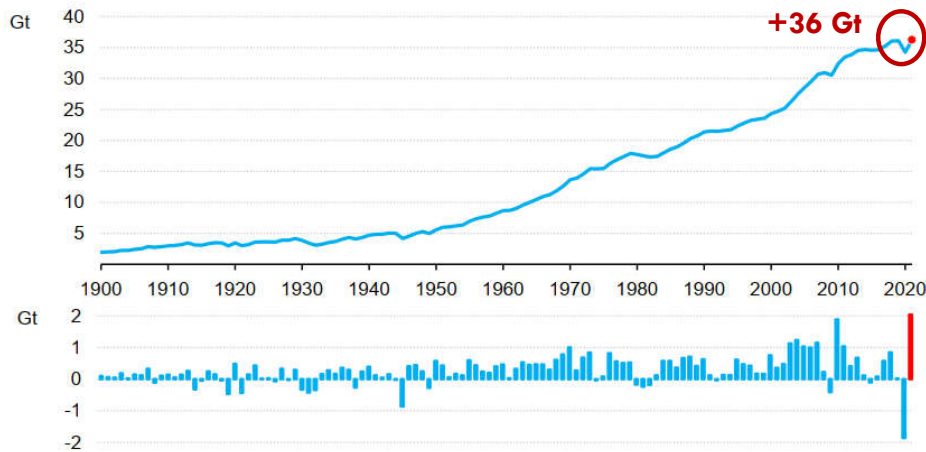
Atmospheric carbon dioxide amounts and annual emissions (1750-2021)



# Global CO<sub>2</sub> Emissions – Things to Consider

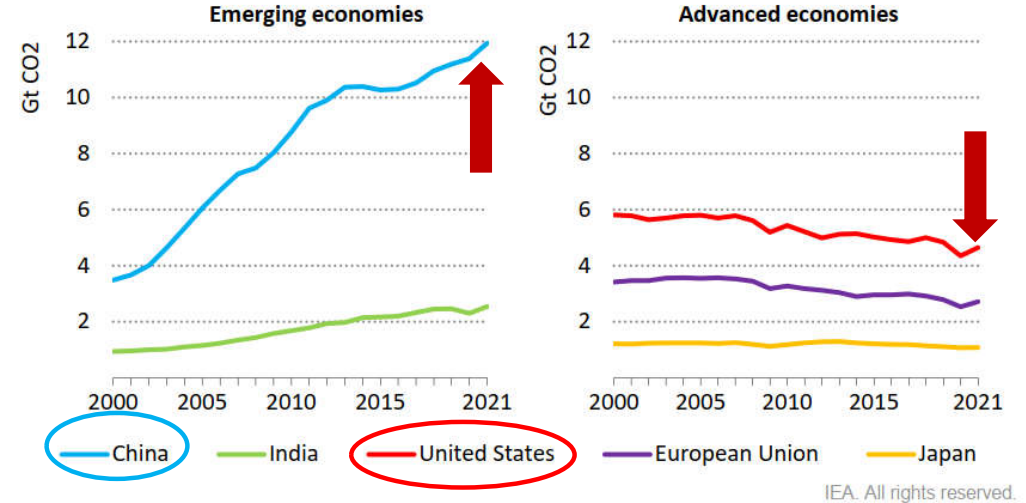
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**Figure 1** Total CO<sub>2</sub> emissions from energy combustion and industrial processes and their annual change, 1900-2021



**Then what about China and other developing nations?**

**Figure 5** CO<sub>2</sub> emissions in selected emerging and advanced economies, 2000-2021



ENERGY & ENVIRONMENT

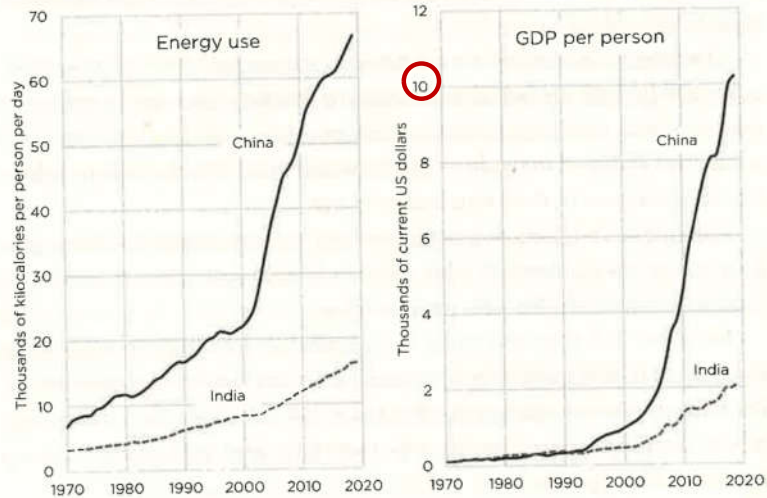
## Biden warns of 'existential' climate threat at Glasgow summit

BY MORGAN CHALFANT AND RACHEL FRAZIN - 11/01/21 11:52 AM ET

# Energy Use, Income & Life Expectancy Increasing

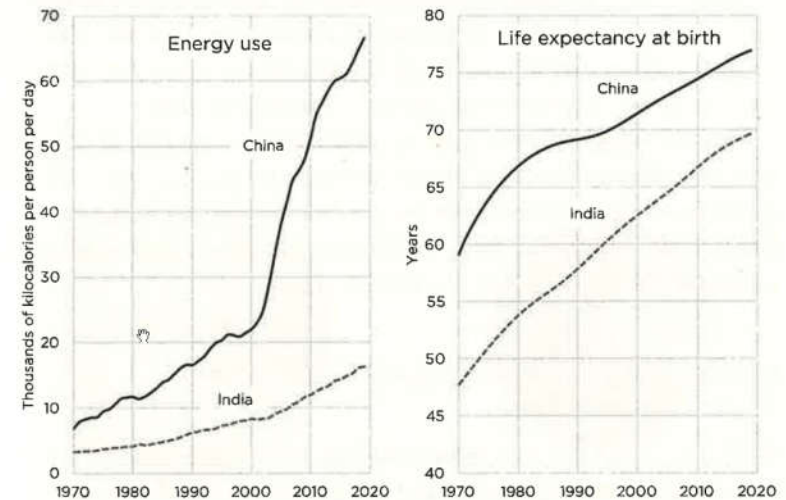
40

FIGURE 1.3 Energy Use and Income in China and India



Sources: BP Statistical Review of World Energy; World Bank Data

FIGURE 1.2 Energy Use and Life Expectancy in China and India



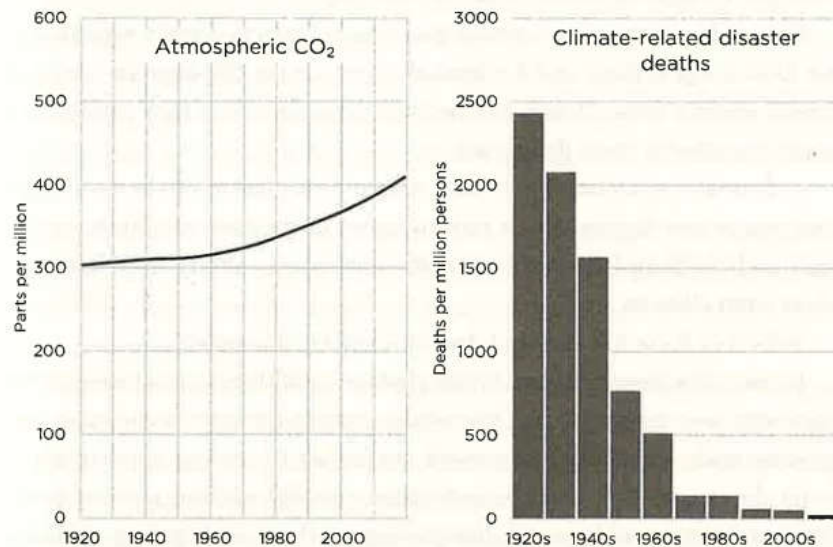
Sources: BP Statistical Review of World Energy; World Bank Data

**Note:** For comparison, United States GDP per person is between \$65k and \$70k

# Climate-Related Disaster Data Trending Down

41

FIGURE 2.2 More Fossil Fuel Use, Plummeting Climate-Related Disaster Deaths

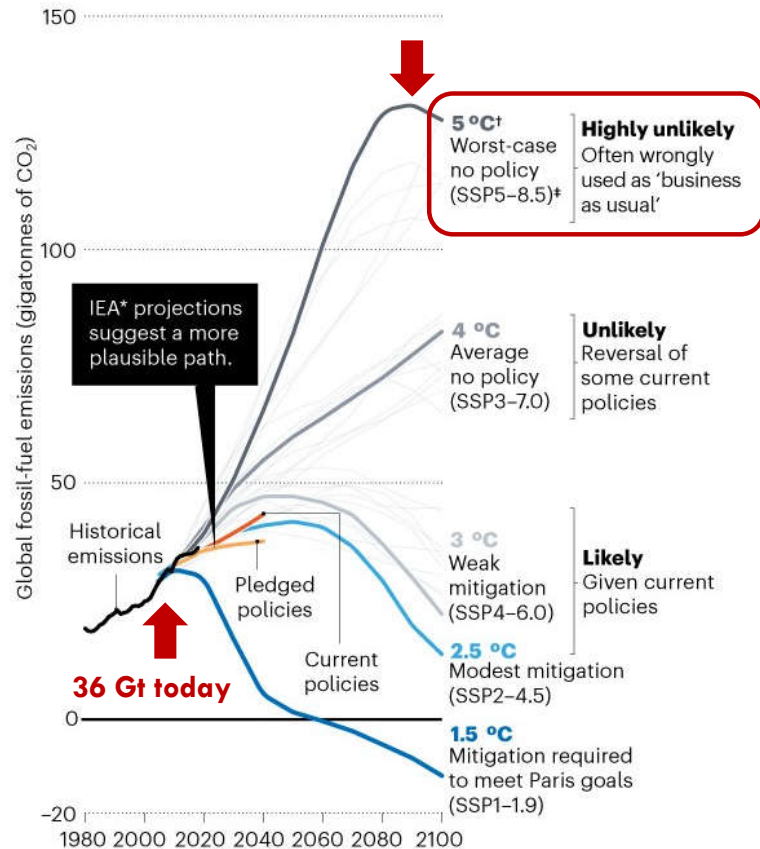


Sources: Scripps Institution of Oceanography; EM-DAT; World Bank Data; Maddison Project Database

- ✓ Rate of climate-related disaster deaths has fallen by 98% over the last century
  - Includes deaths from droughts, floods, storms, and extreme temperatures
- ✓ World life expectancy has increased from just over 30 years in 1900 to over 70 years today
- ✓ What is role of human innovation and adaptation to changes in climate?



# Worst-Case vs. Likely Scenarios



<https://www.nature.com/articles/d41586-020-00177-3>

COMMENT | 29 January 2020

## Emissions – the ‘business as usual’ story is misleading

Stop using the worst-case scenario for climate warming as the most likely outcome – more-realistic baselines make for better policy.

[Zeke Hausfather](#) & [Glen P. Peters](#)

Intergovernmental Panel on Climate Change (IPCC) Representative Concentration Pathways (RCPs)

RCP8.5 “... paints a dystopian future that is fossil-fuel intensive and excludes any climate mitigation policies, leading to nearly 5 °C of warming by the end of the century,”

“RCP8.5 was intended to explore an unlikely high-risk future. But it has been widely used by some experts, policymakers and the media as something else entirely: as a likely ‘business as usual’ outcome.”

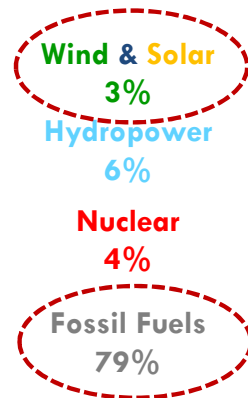
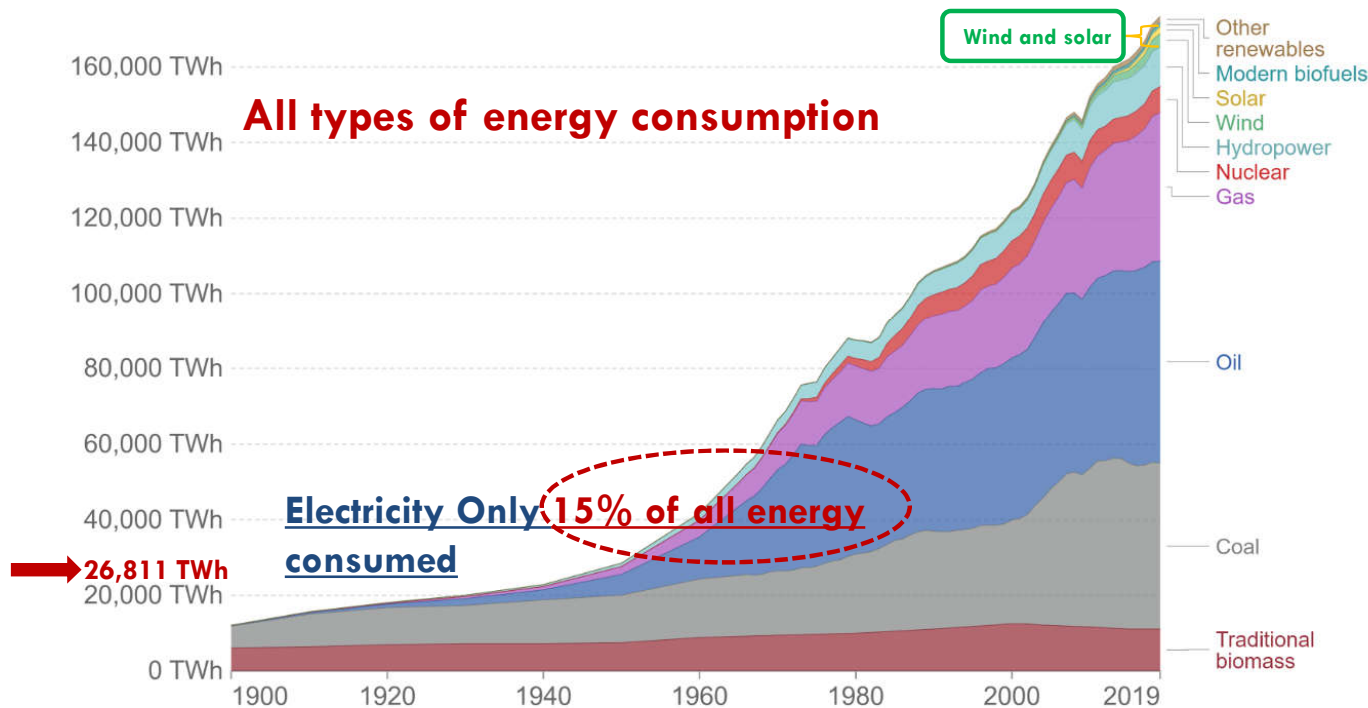
# Global Total Energy Consumption

## Global primary energy consumption by source

Primary energy is calculated based on the 'substitution method' which takes account of the inefficiencies in fossil fuel production by converting non-fossil energy into the energy inputs required if they had the same conversion losses as fossil fuels.

Our World  
in Data

✓ **Are Wind and solar power  
backed up by batteries ready to  
save the day?**



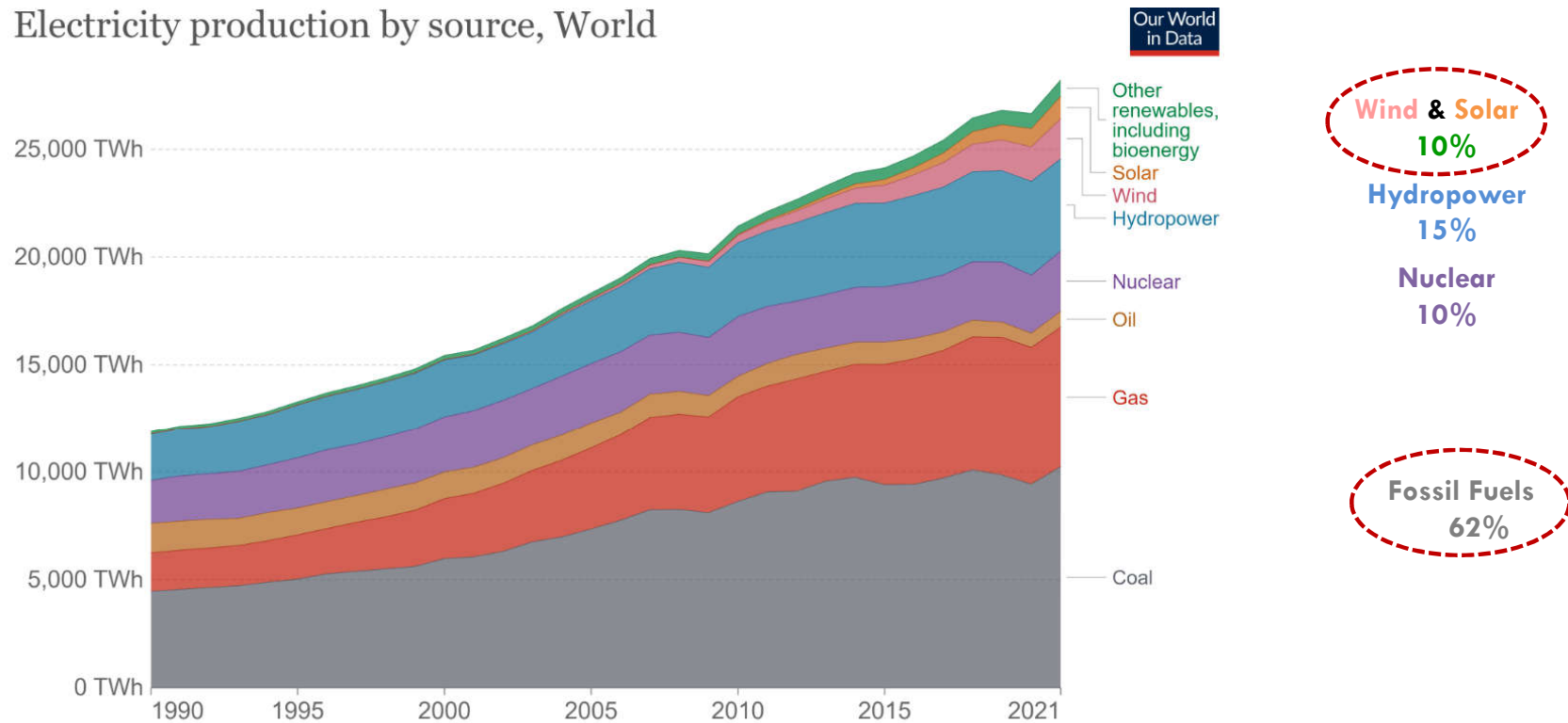
**As we think about “clean energy”  
Keep in mind in 2019 Electrical energy  
produced = 26,811 TWh**

Source: Vaclav Smil (2017) & BP Statistical Review of World Energy

OurWorldInData.org/energy • CC BY

# Global Electricity Production

Electricity production by source, World

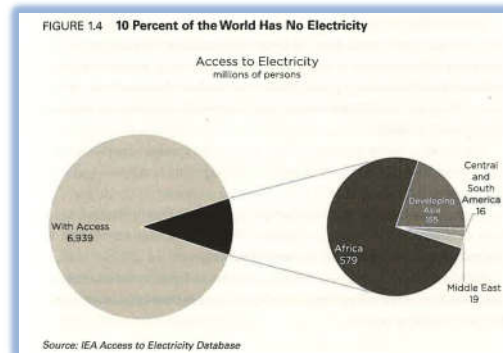


Source: Our World in Data based on BP Statistical Review of World Energy (2022) ; Our World in Data based on Ember's Global Electricity Review (2022) ; Our World in Data based on Ember's European Electricity Review (2022).

Note: 'Other renewables' includes biomass and waste, geothermal, wave and tidal.

OurWorldInData.org/energy • CC BY

# Energy Poverty: An Inconvenient Truth



- ✓ Almost 800 million people have no access to electricity
- ✓ Over 3 billion people use almost no energy, including electricity
  - Use less electricity than a typical American refrigerator
- ✓ Lack of access to affordable & reliable energy keeps people impoverished
  - Electricity means health, safety & wellbeing
  - No evidence impoverished world can “leapfrog” fossil-fuels with wind and solar power.



**Disproportionately impacts women and girls**

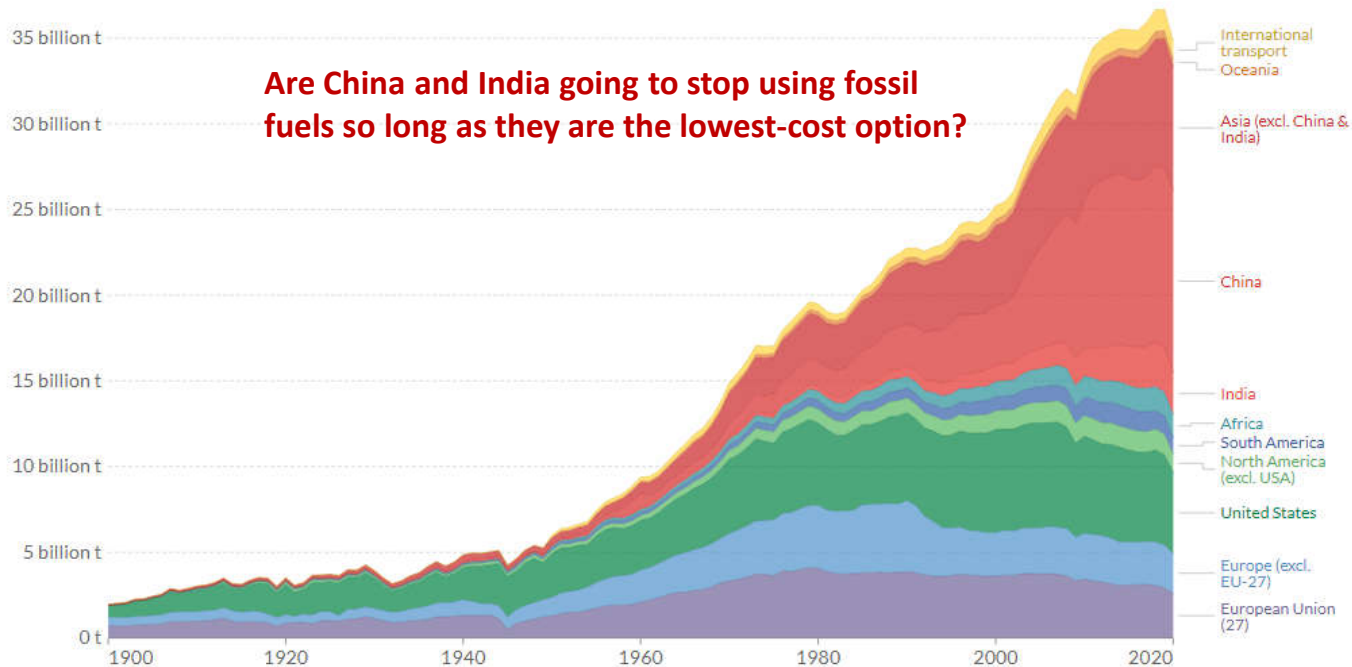


# Global CO<sub>2</sub> Emissions – Things to Consider

46

Annual CO<sub>2</sub> emissions from fossil fuels, by world region

□ Relative



Source: Global Carbon Project

Note: This measures CO<sub>2</sub> emissions from fossil fuels and cement production only – land use change is not included. 'Statistical differences' (included in the GCP dataset) are not included here.

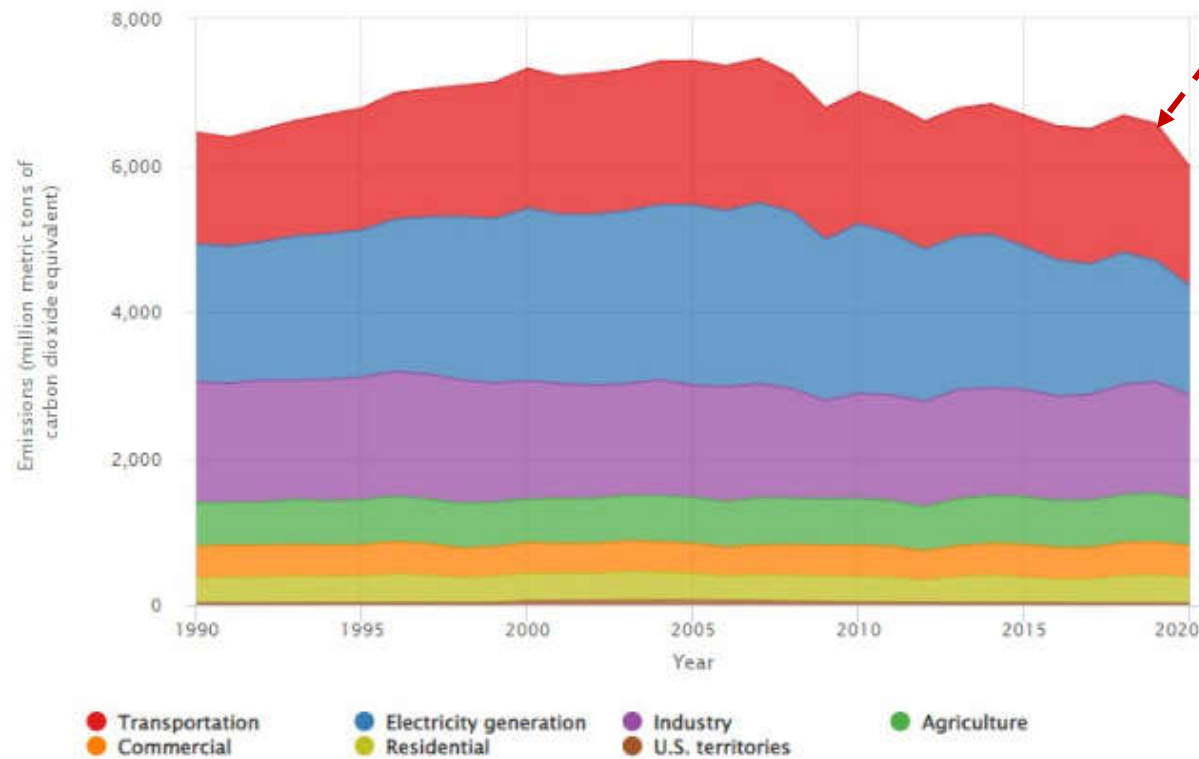
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions • CC BY

- Main reason global CO<sub>2</sub> emissions are rising is because billions of people in the **developing world are bringing themselves out of poverty** by using fossil fuels to power factories, farms, vehicles, and appliances.

Source: Alex Epstein Energy Talking Points

# U.S. Greenhouse Gas Emissions

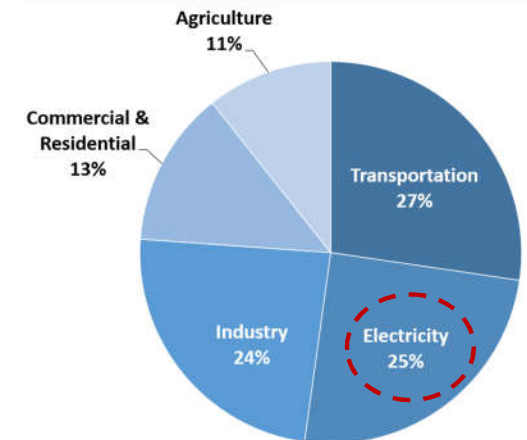
U.S. Greenhouse Gas Emissions by Economic Sector, 1990–2020



Source: U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2020.  
<https://www.epa.gov/gbgemissions/inventory-us-greenhouse-gas-emissions-and-sinks>

**1/6<sup>th</sup> of global total and falling**

Sources of U.S. Greenhouse Gas Emissions in 2020

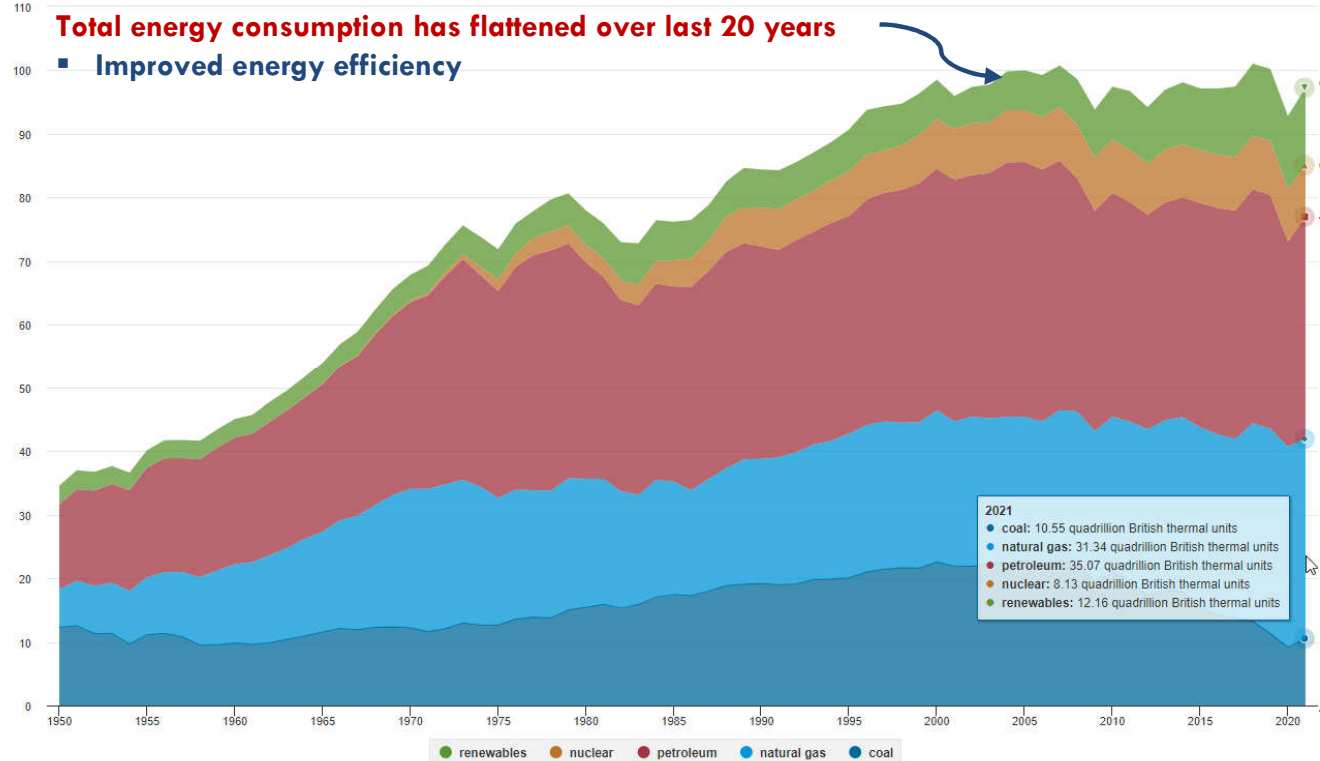


U.S. Environmental Protection Agency (2022). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2020

# United States Energy Consumption

U.S. primary energy consumption by major sources, 1950-2021

quadrillion British thermal units



## Consider scale of Energy Use

- 12% renewables now
  - Wind & Solar < 5%

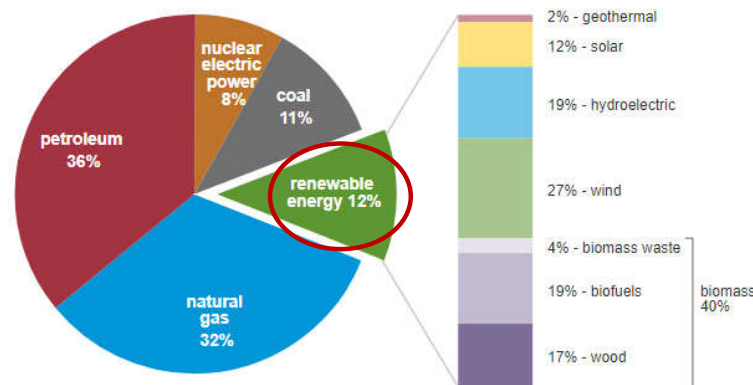
79% fossil fuels

# United States Energy Consumption

## U.S. primary energy consumption by energy source, 2021

total = 97.33 quadrillion  
British thermal units (Btu)

total = 12.16 quadrillion Btu



Data source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 1.3 and 10.1, April 2022, preliminary data  
Note: Sum of components may not equal 100% because of independent rounding.

There are five **energy-use sectors**, and the amounts—in quadrillion Btu (or *quads*)—of their primary energy consumption in 2021 were:

36.75 quads electric power	26.87 quads transportation	22.55 quads industrial	6.58 quads residential	4.58 quads commercial
----------------------------------	----------------------------------	------------------------------	------------------------------	-----------------------------

**Electricity is 37% of total energy consumption**

## Wind & Solar = 4.9% of Total Energy Consumption

- Wind = 3.4%
- Solar = 1.5%

## Fossil fuels = 79%

**Rapidly/completely replacing the 79% with the 5% (wind/solar)?**

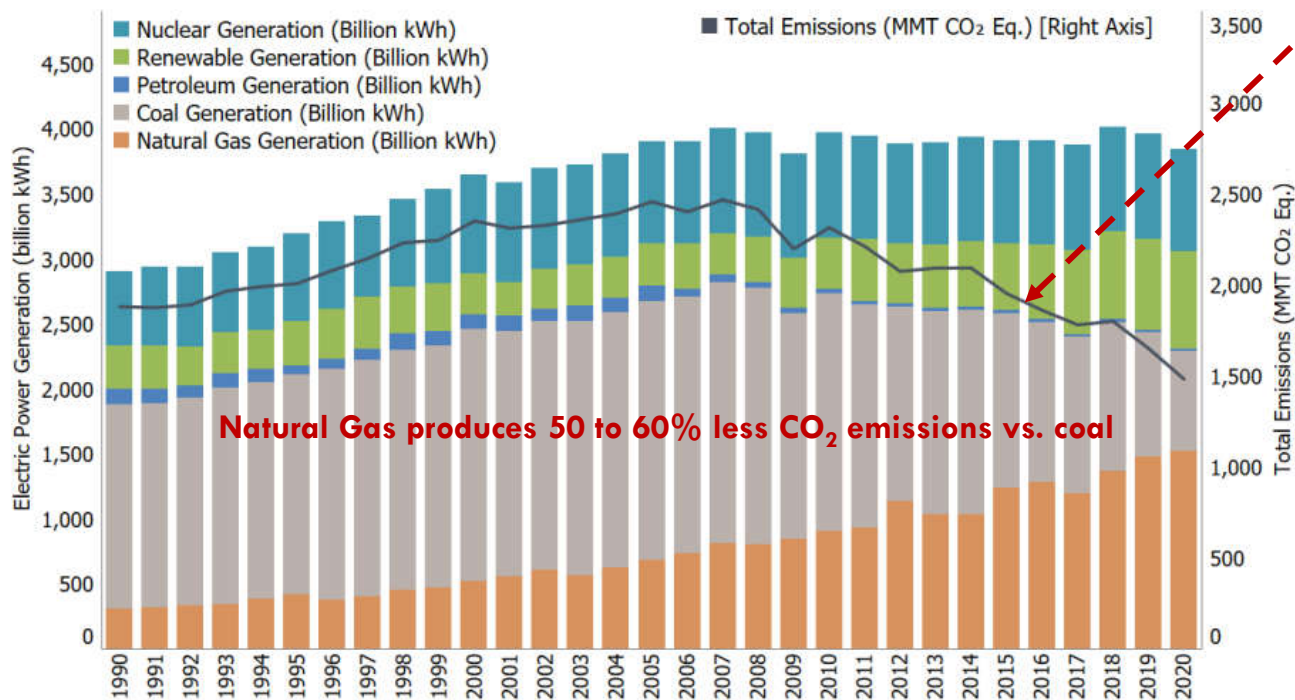
- Feasible? long permitting and development cycles
- Anti development environment exists in U.S.
- Land use impacts of mining and project development



# Electric Power Emissions Trending Down in U.S.

50

**Figure ES-7: Electric Power Generation and Emissions**

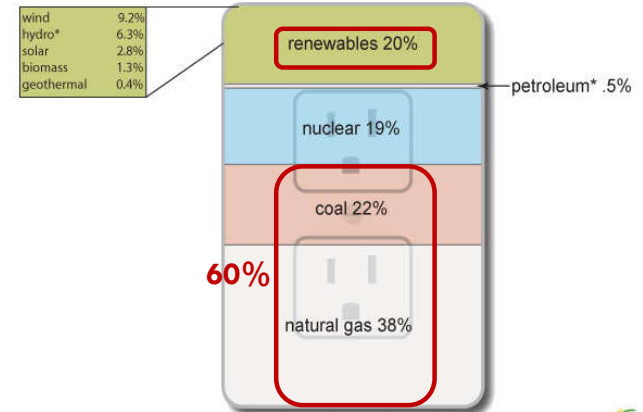


**Natural Gas produces 50 to 60% less CO<sub>2</sub> emissions vs. coal**

**Electric Power Emissions are trending down:**

- Natural Gas generation (38%) replacing Coal generation (22%) is biggest driver

**Sources of U.S. electricity generation, 2021**  
Total = 4.12 trillion kilowatthours



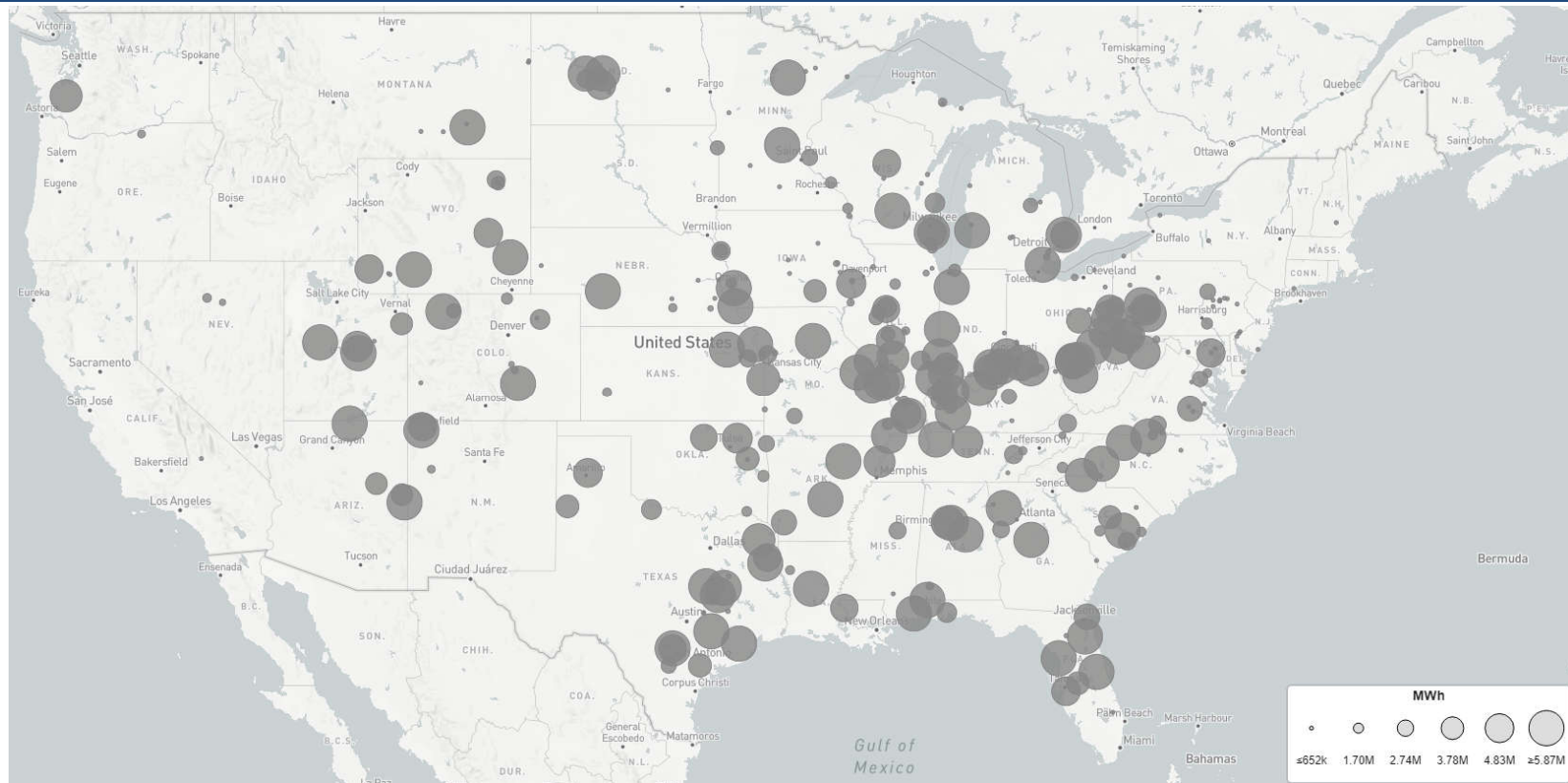
Source: U.S. Energy Information Administration, *Electric Power Monthly*, February 2022, preliminary data  
Note: Includes generation from power plants with at least 1,000 kilowatts of electric generation capacity (utility-scale).  
\*Hydro is conventional hydroelectric. \*Petroleum includes petroleum liquids, petroleum coke, other gases, hydroelectric pumped storage, and other sources.



<https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2020>

# Coal Plants: 22% of Electricity

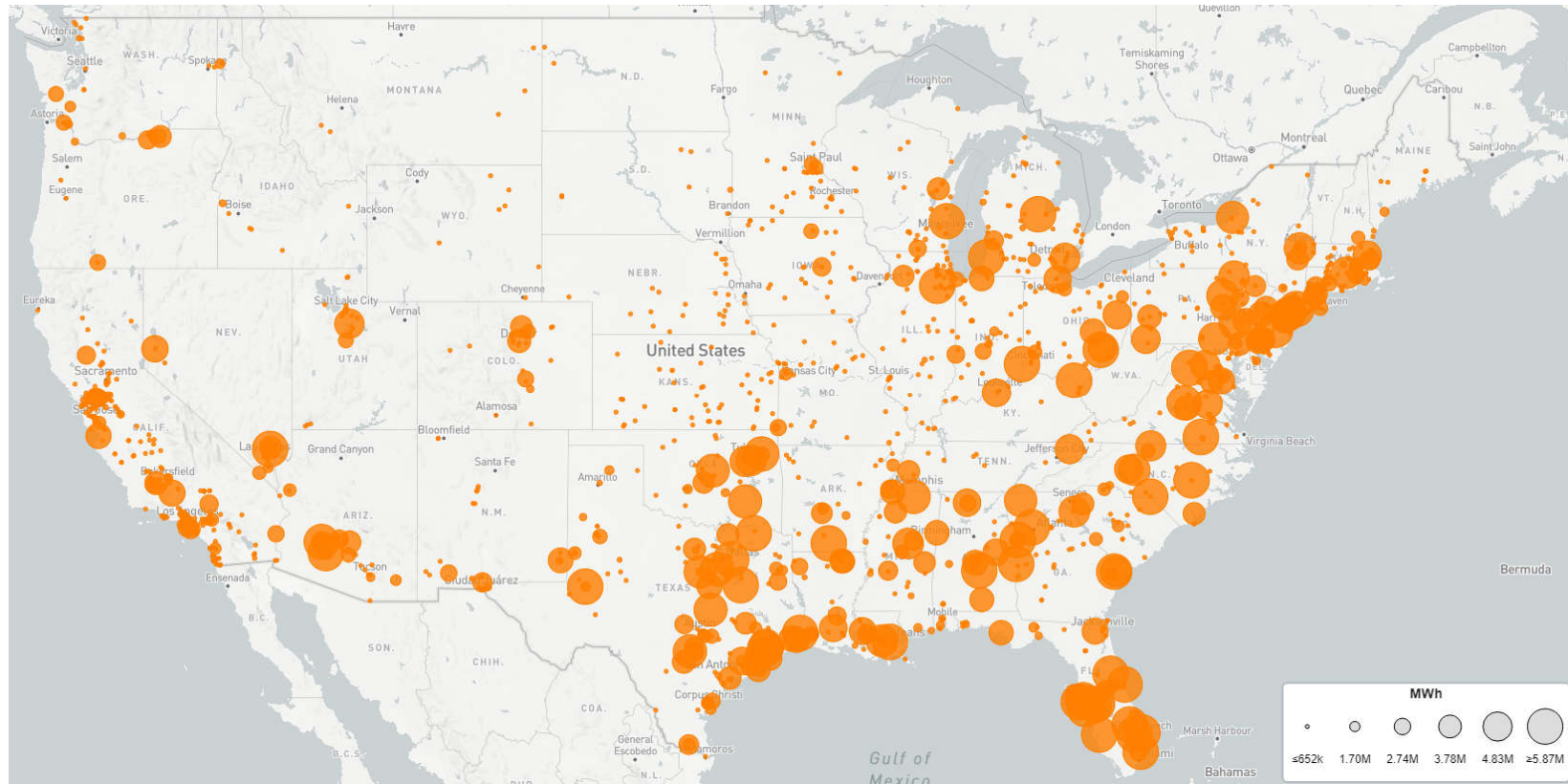
51



Source: [epa.gov/egrid/data-explorer](https://epa.gov/egrid/data-explorer) [2018 Energy (MWh)]

# Natural Gas Plants: 38% of Electricity

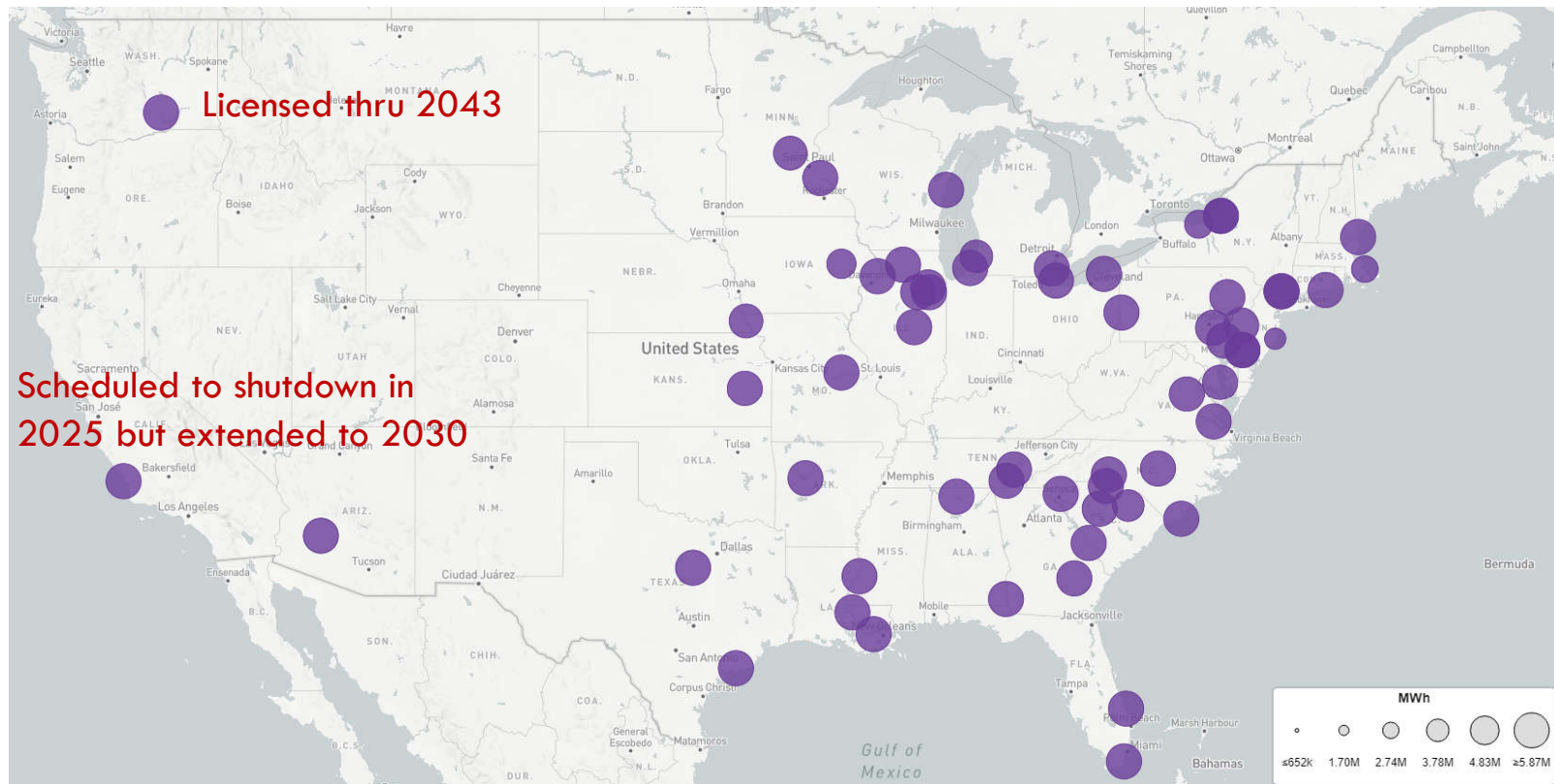
52



Source: [epa.gov/egrid/data-explorer](https://epa.gov/egrid/data-explorer) [2018 Energy (MWh)]

# Nuclear Plants: 19% of Electricity

53

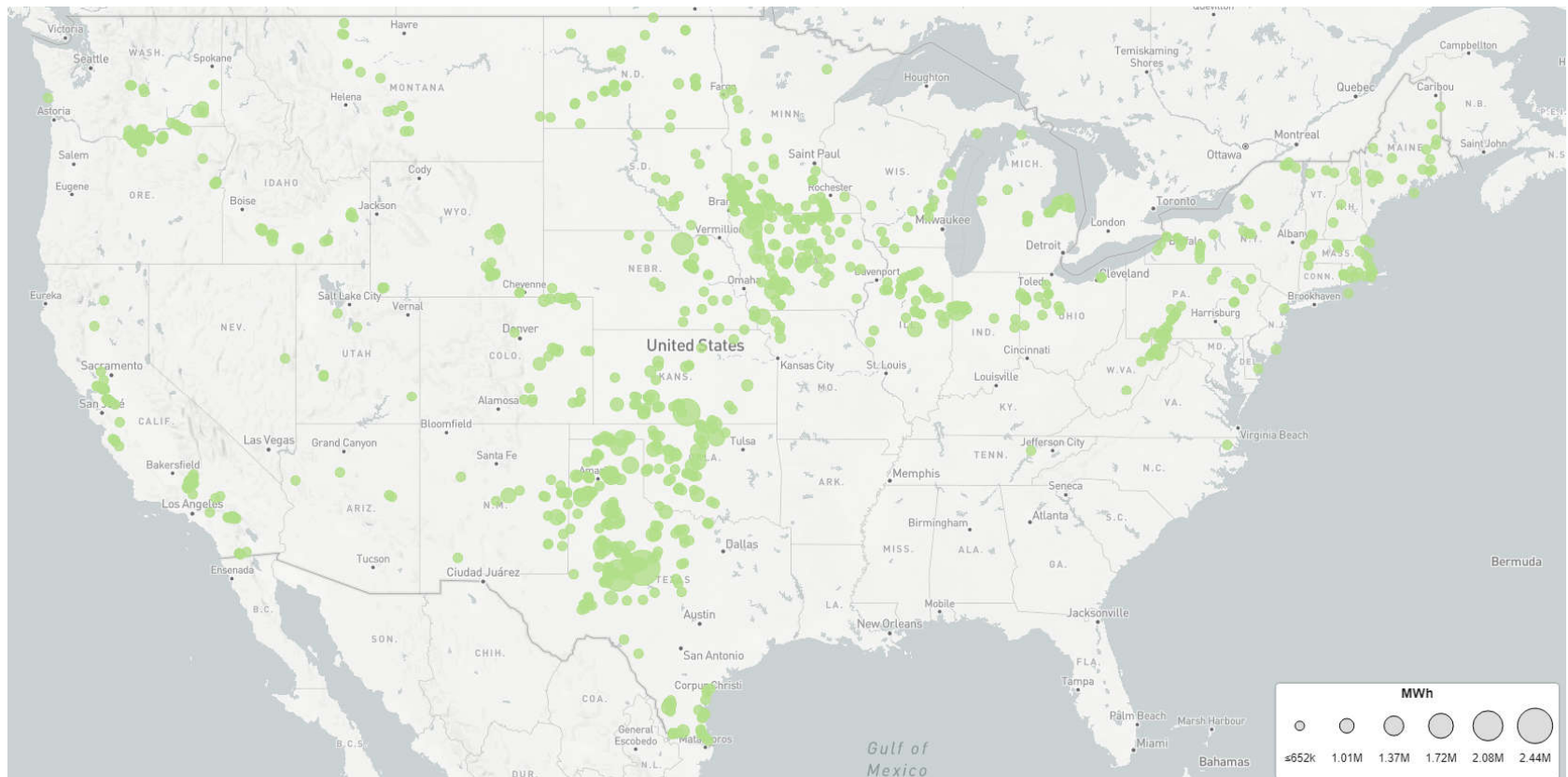


Source: [epa.gov/egrid/data-explorer](https://epa.gov/egrid/data-explorer) [2018 Energy (MWh)]



# Wind Generation: 9.2% of Electricity

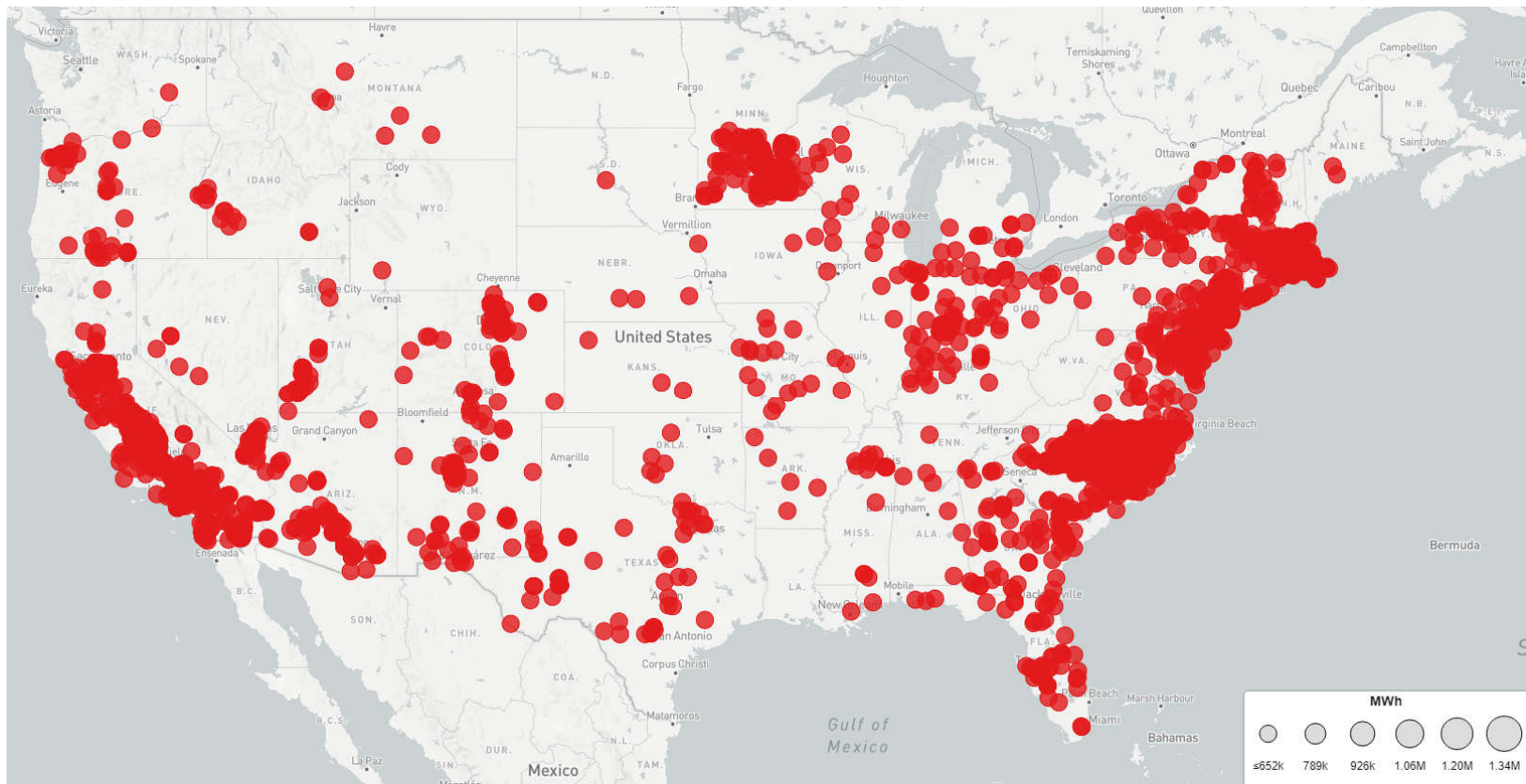
54



Source: [epa.gov/egrid/data-explorer](https://epa.gov/egrid/data-explorer) [2018 Energy (MWh)]

# Solar Generation: 2.8% of Electricity

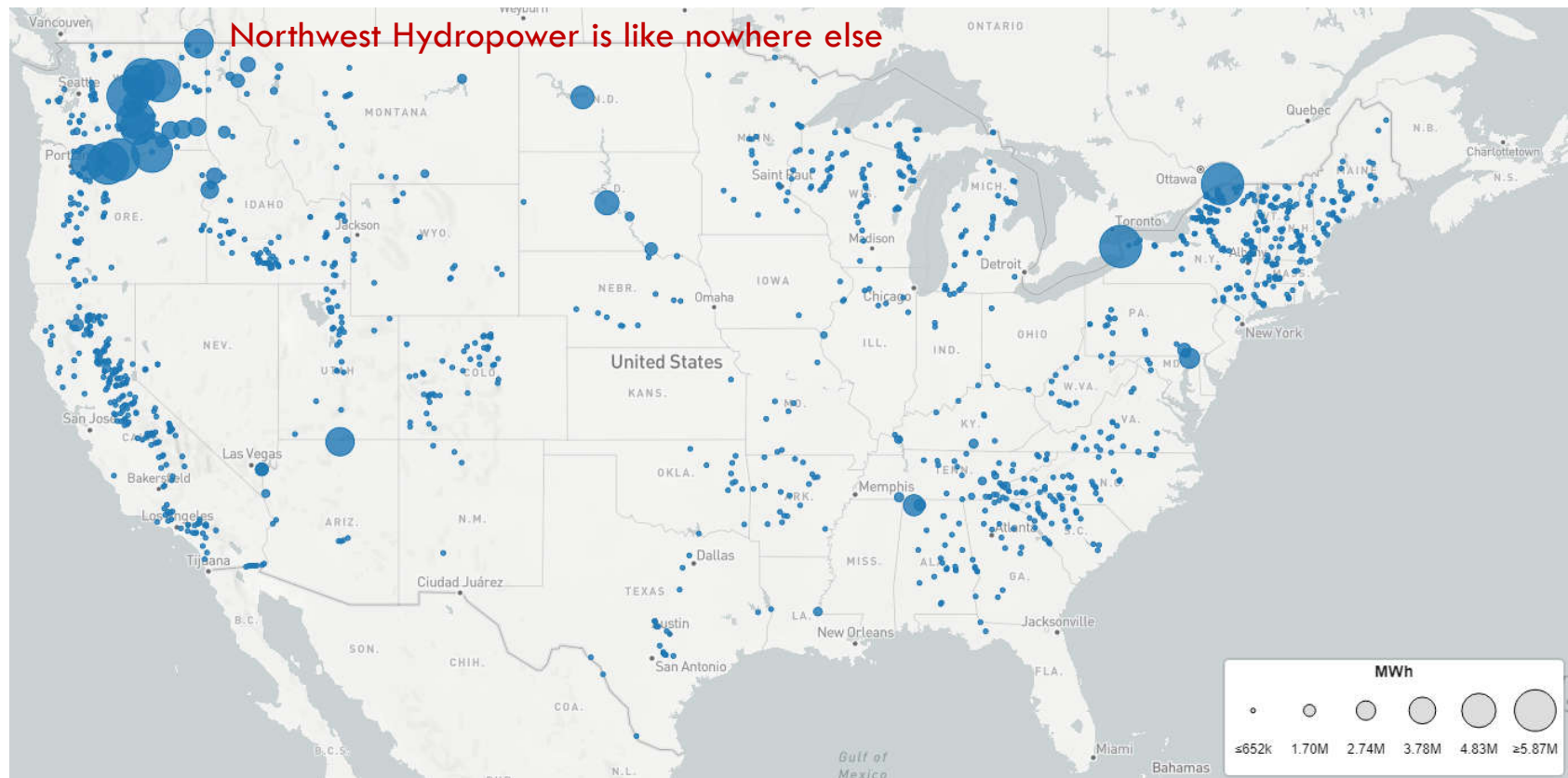
55



Source: [epa.gov/egrid/data-explorer](https://epa.gov/egrid/data-explorer) [2018 Energy (MWh)]

# Hydro Generation: 6.3% of Electricity

56

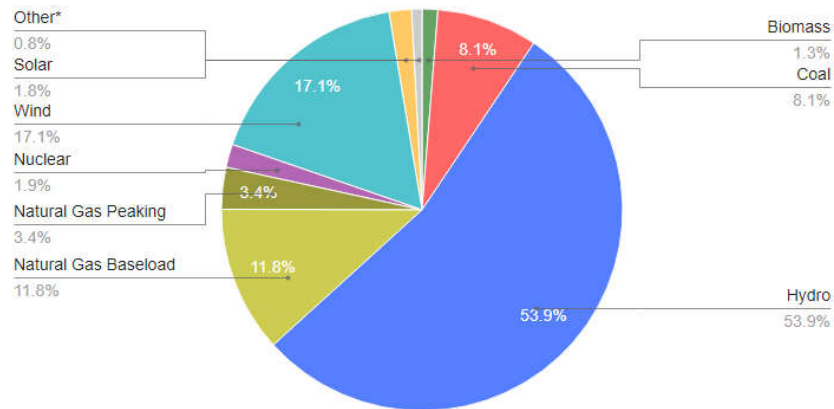


Source: [epa.gov/egrid/data-explorer](https://epa.gov/egrid/data-explorer) [2018 Energy (MWh)]

# Pacific Northwest Electricity Supply

## Nameplate Capacity

Pacific Northwest Generating Capacity: 64,340 mw\*

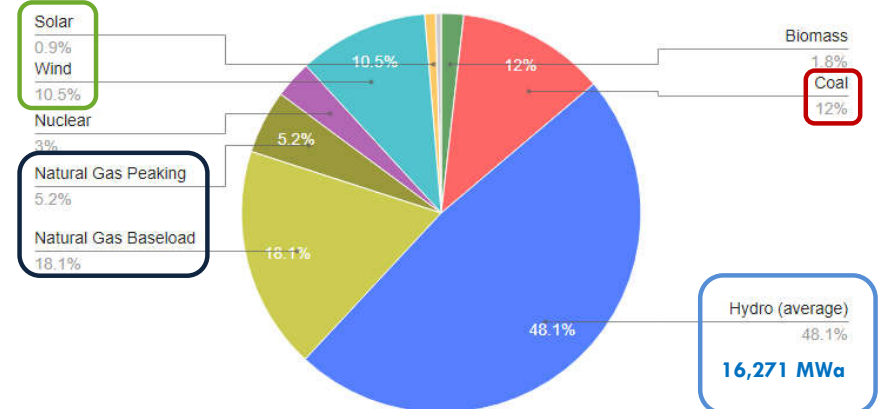


**Capacity** is essentially the 'horsepower' rating of power plants, or how much they are designed to produce at full load operation. Download chart as PNG

\* Other includes geothermal, petroleum, and solar

## Annual Energy Production

Pacific Northwest Generating Capacity: 33,828 MWa\*



**Capability** is the maximum amount of energy the plants are capable of producing over the course of an average year. Download chart as PNG

\* Other (yellow segment) includes geothermal, petroleum, and solar

Source: <https://www.nwcouncil.org/energy/energy-topics/power-supply>





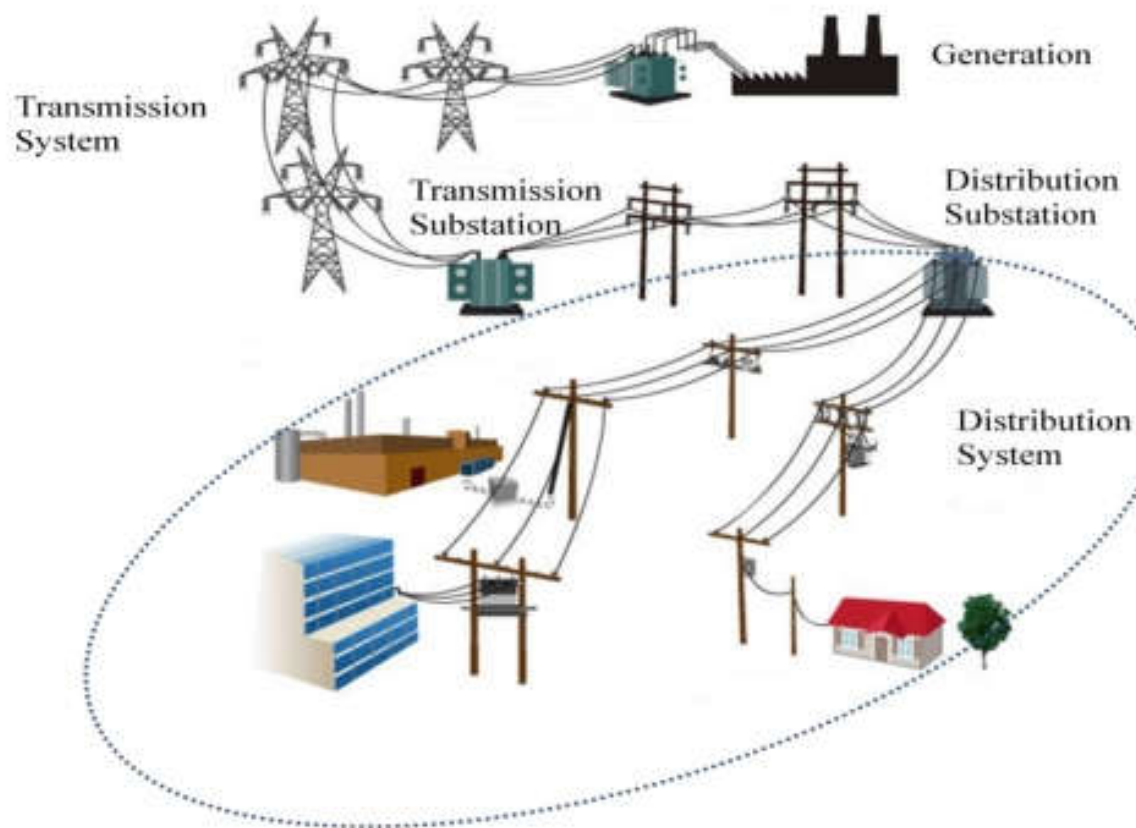
## How the Power Grid Works





# What does 'Effective' Capacity Look Like?

59



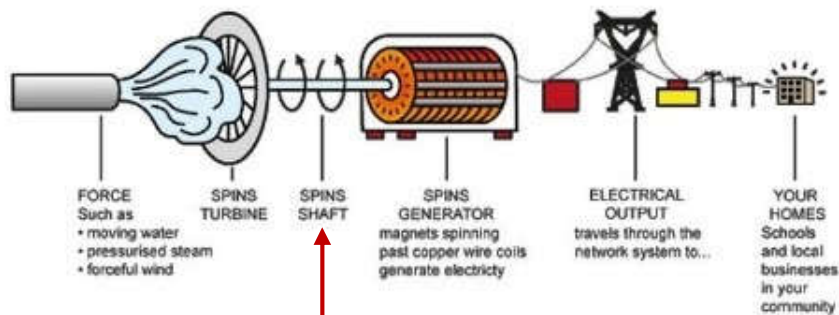
Electricity is simultaneously...

***Produced***

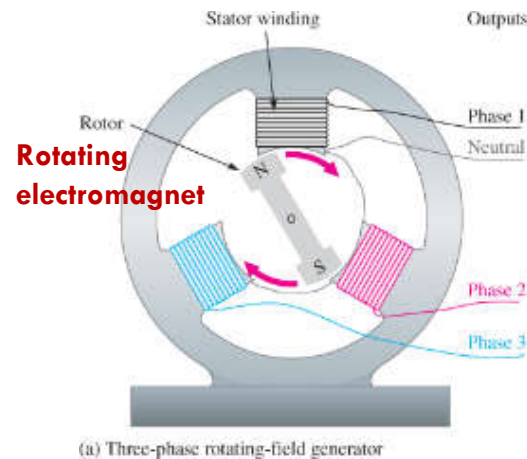
***Delivered***

***Consumed***

# Alternating Current (AC) Electricity



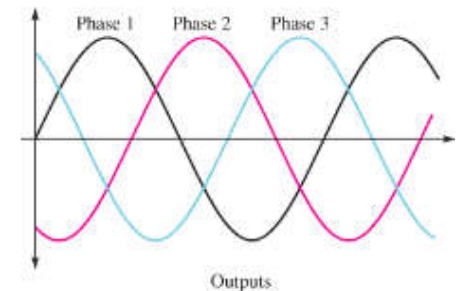
- ✓ **Speed precisely controlled to produce 60 cycles/second AC electricity**
- ✓ **Increased electricity demand tends to slow speed**
- ✓ **Need Generating technologies with 'cruise control' capabilities**



**This is why there are 3 wires**



**60 cycles per second sine waves**

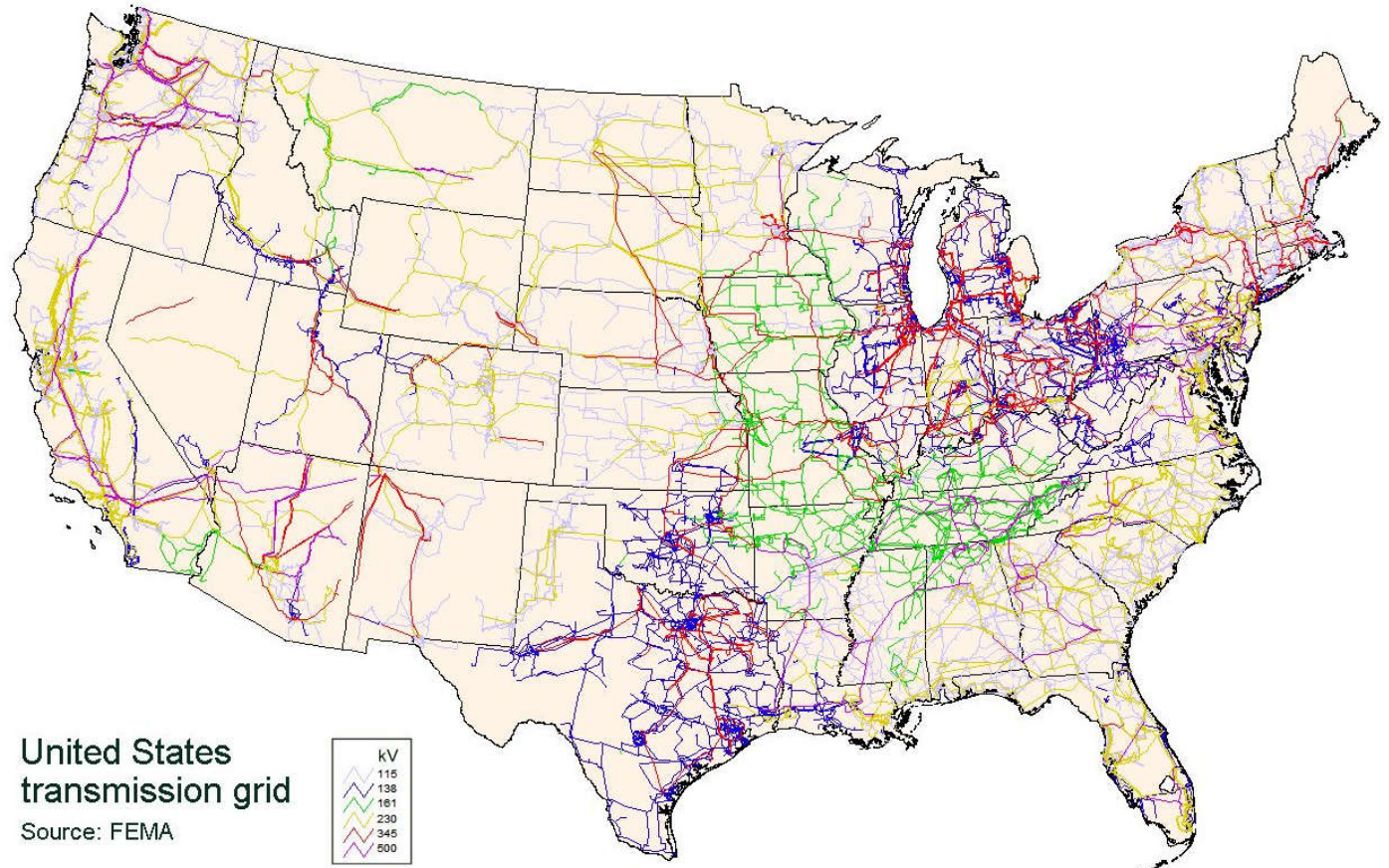


(b) Three-phase sine wave

# Interconnected Power Grid

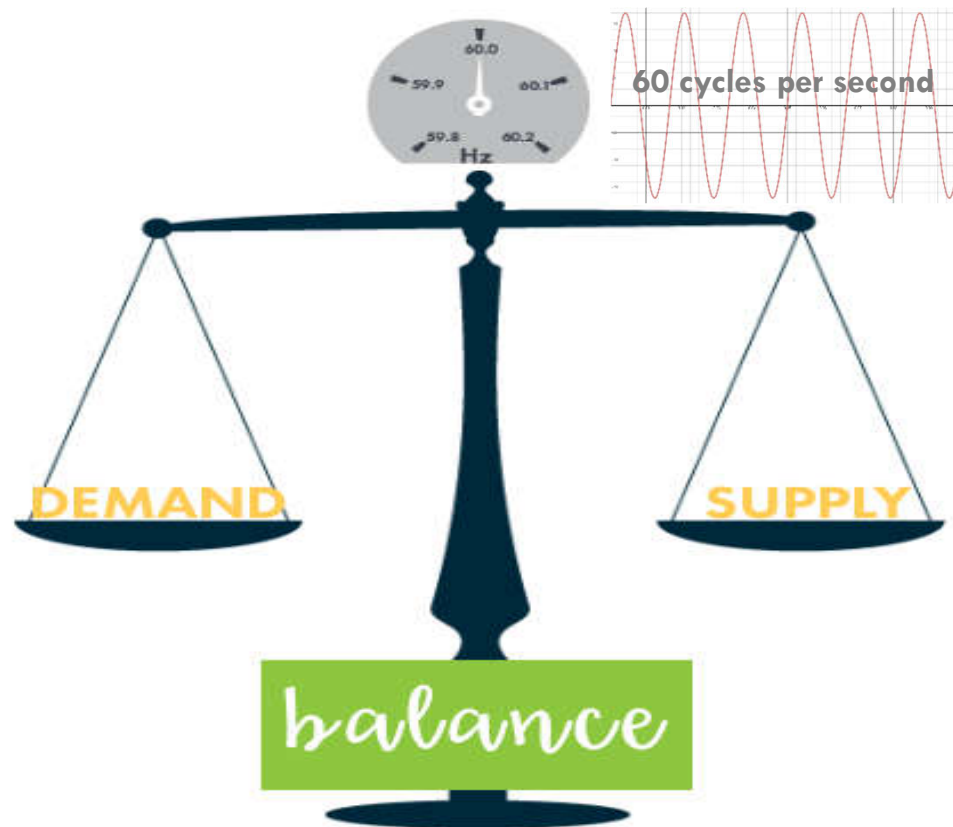
61

- ✓ Transmission lines operating at very high voltages (electrical pressure) move electricity from generating plants to population centers
- ✓ Power Grid named 20<sup>th</sup> Century's Greatest Achievement



# Demand/Supply Balancing: **Physics**

*Electrical Demand and Supply Must Be Equal at All Times*



- ✓ 'Cruise Control' set at 60
- ✓ The Laws of Power Grid physics are unforgiving
- ✓ Consequences of not maintaining supply & demand balance are blackouts



# Demand/Supply Balancing: Blackouts



NEWS

Where were you when the lights went out in 2003?

## Cascading blackouts

Dynamic supply and demand imbalances attributed to cascading failures, where the **failure of a few power grid components results in a “domino effect”** and causes large-scale loss of electricity.

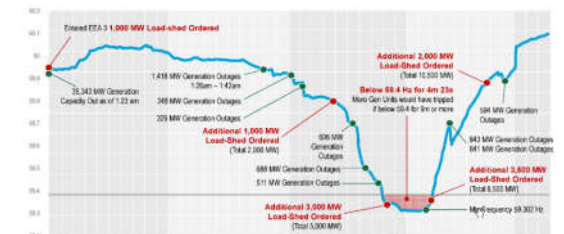
## Rolling blackouts

- When **demand is anticipated to be much higher than available supply** plus reserves (backup generation)
- Preemptive, targeted and temporary** to avoid possibility of more widespread outages and **serious equipment damage** that could result in more dangerous and prolonged blackouts

**Texas was “seconds and minutes” away from having blackouts for months, power grid official says**



Rapid Decrease in Generation Causes Frequency Drop

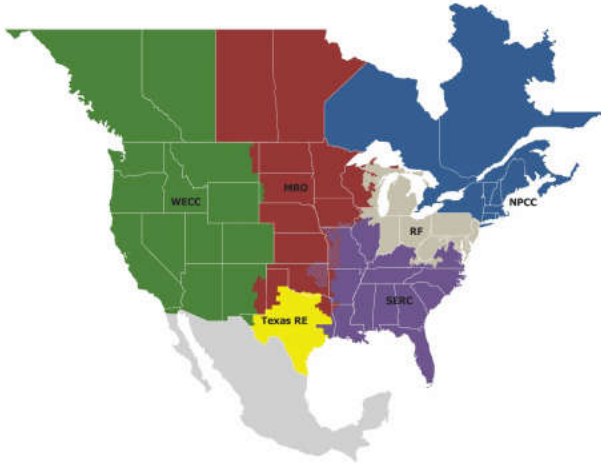


ercot

Figure 2.1. The ERCOT grid frequency during the critical time of load shedding and generation capacity outages on the morning of February 15, 2021 (ERCOT, 2021).



# Who is responsible for ensuring Generation Adequacy?



MRO	Midwest Reliability Organization
NPCC	Northeast Power Coordinating Council
RF	ReliabilityFirst
SERC	SERC Reliability Corporation
Texas RE	Texas Reliability Entity
WECC	Western Electricity Coordinating Council

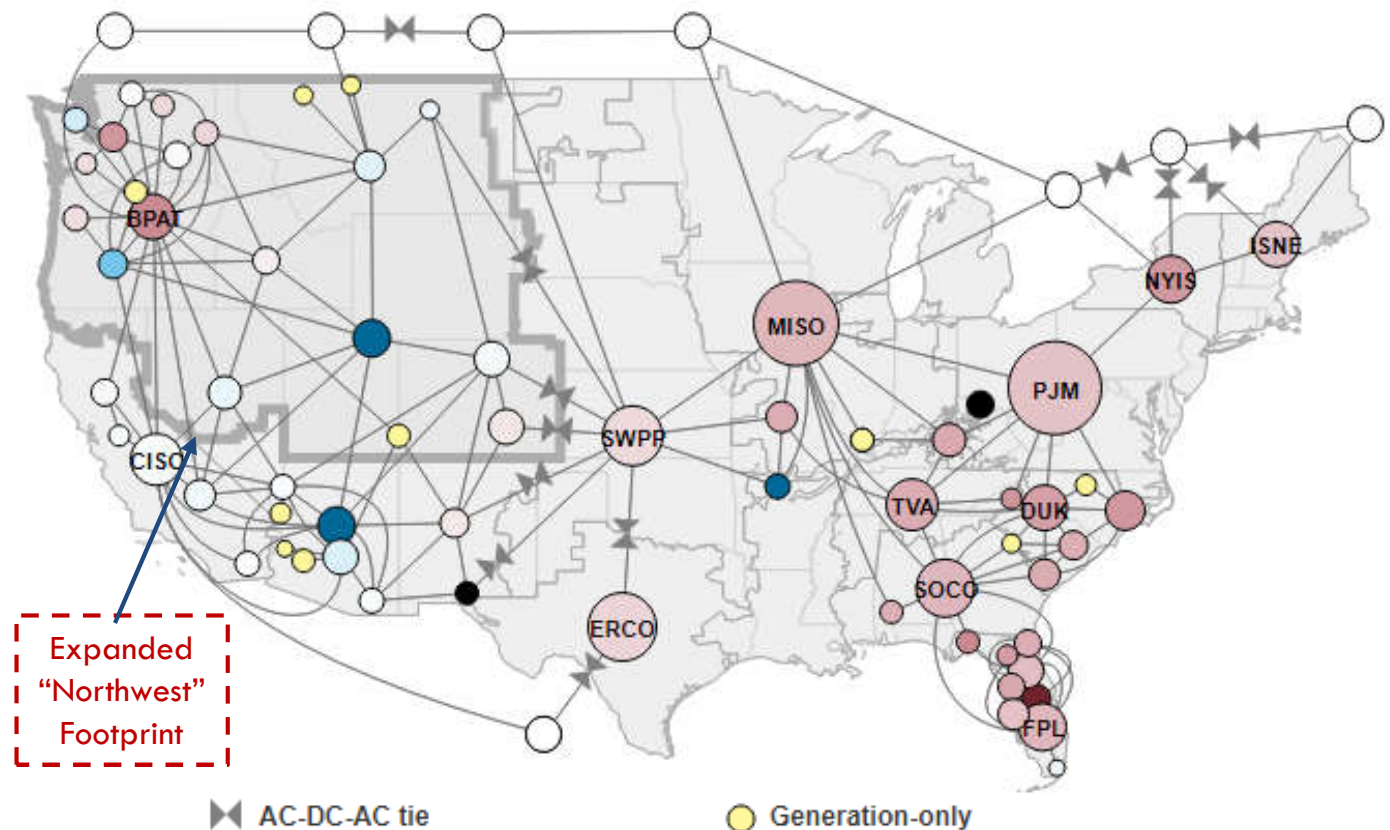
- NERC develops operating standards aimed at ensuring operational reliability
  - ▣ NERC publishes information on resource adequacy planning but does not have mandatory planning standards
- There is no mandatory or voluntary national standard for Resource Adequacy
- Each Balancing Authority establishes its own standard subject to oversight by state commissions or locally-elected boards
- Utilities, state commissions and local governing bodies are ultimately responsible for ensuring resource adequacy in their jurisdictions



# Balancing Authorities Share Capacity & Energy

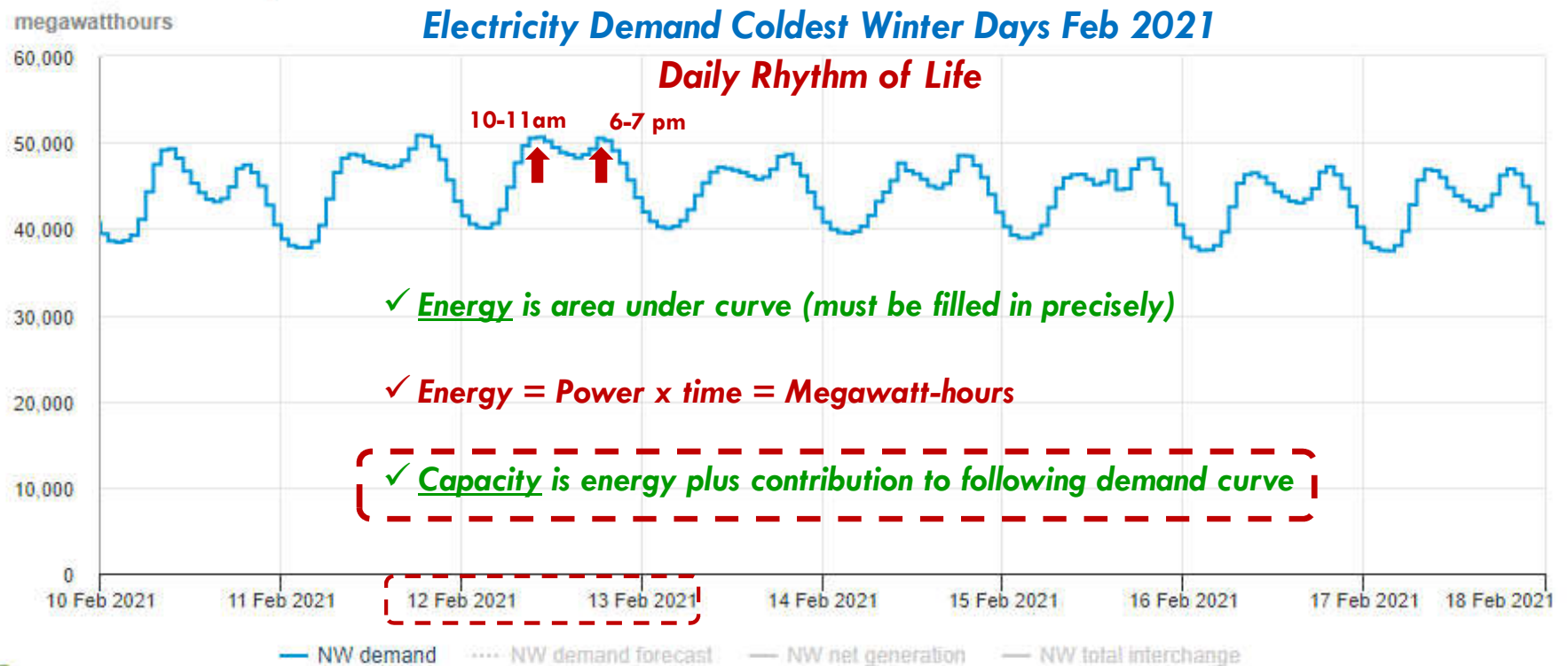
66

- ✓ **38 Balancing Area Authorities** in Western Power Grid
- ✓ High level of operational coordination
- ✓ Maintain demand (Load) & supply (Resource) balance through scheduled generation imports and exports



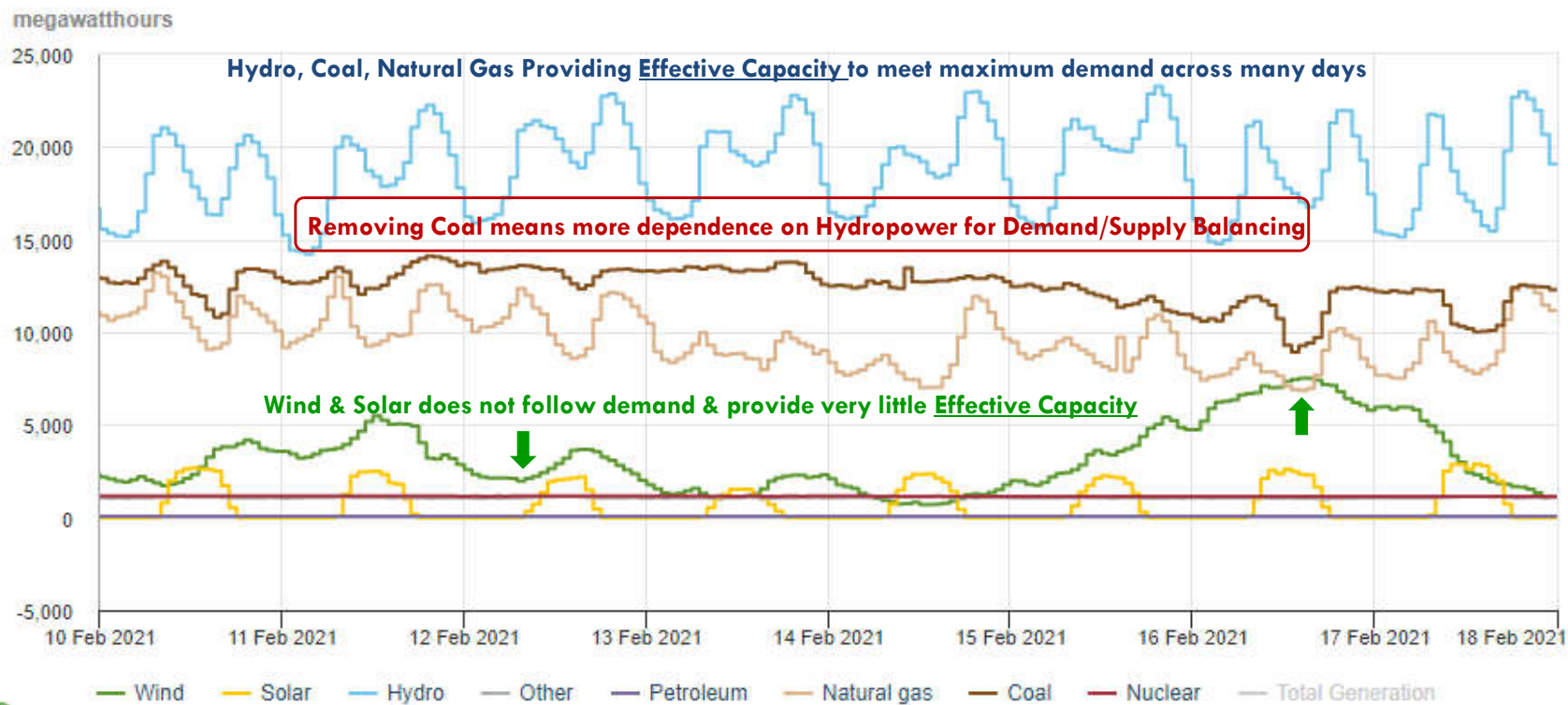
# Hydro Dominates Demand/Supply Balance in NW

Northwest (NW) region electricity overview (demand, forecast demand, net generation, and total interchange)  
2/10/2021 – 2/17/2021, Mountain Time



# Hydropower: Dominates Demand/Supply Balance in NW

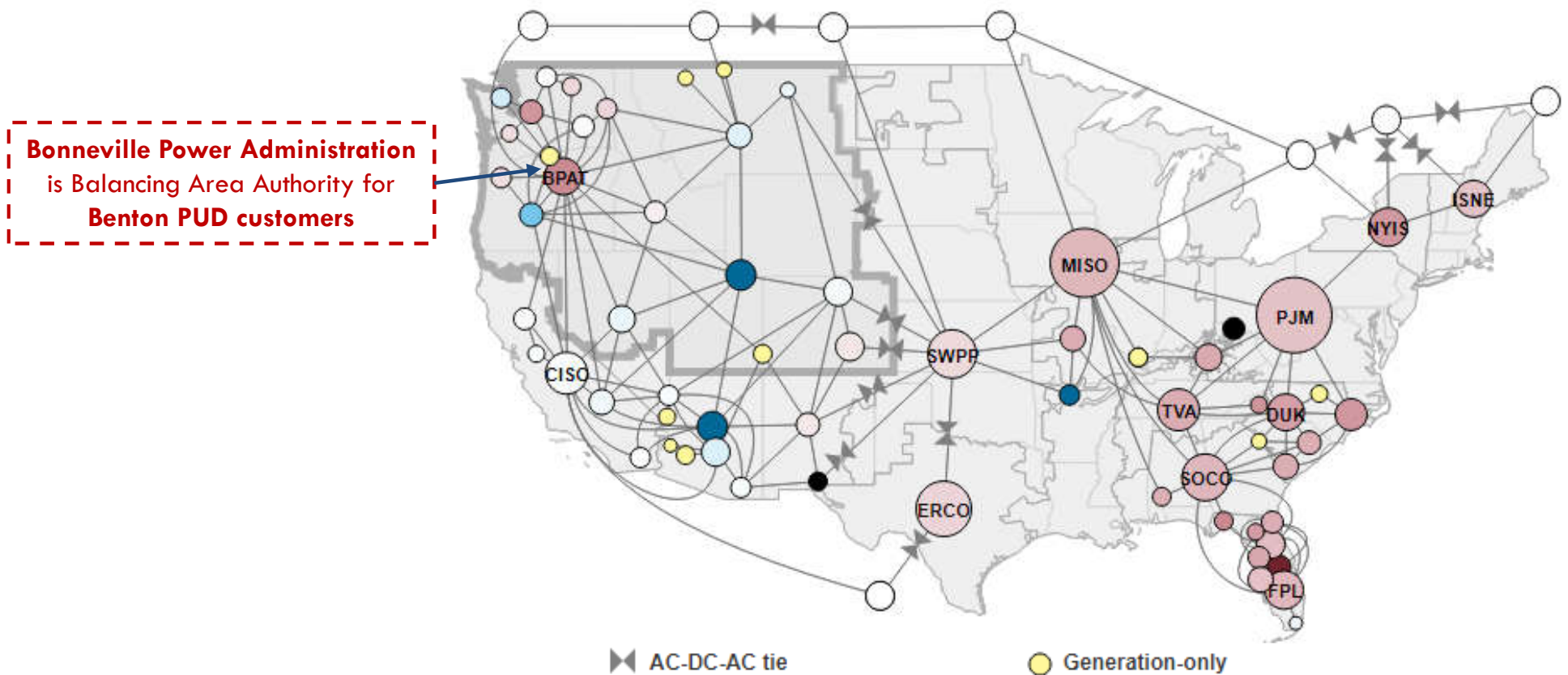
Northwest (NW) region electricity generation by energy source 2/10/2021 – 2/17/2021, Mountain Time





# Balancing Authorities Share Capacity & Energy

69

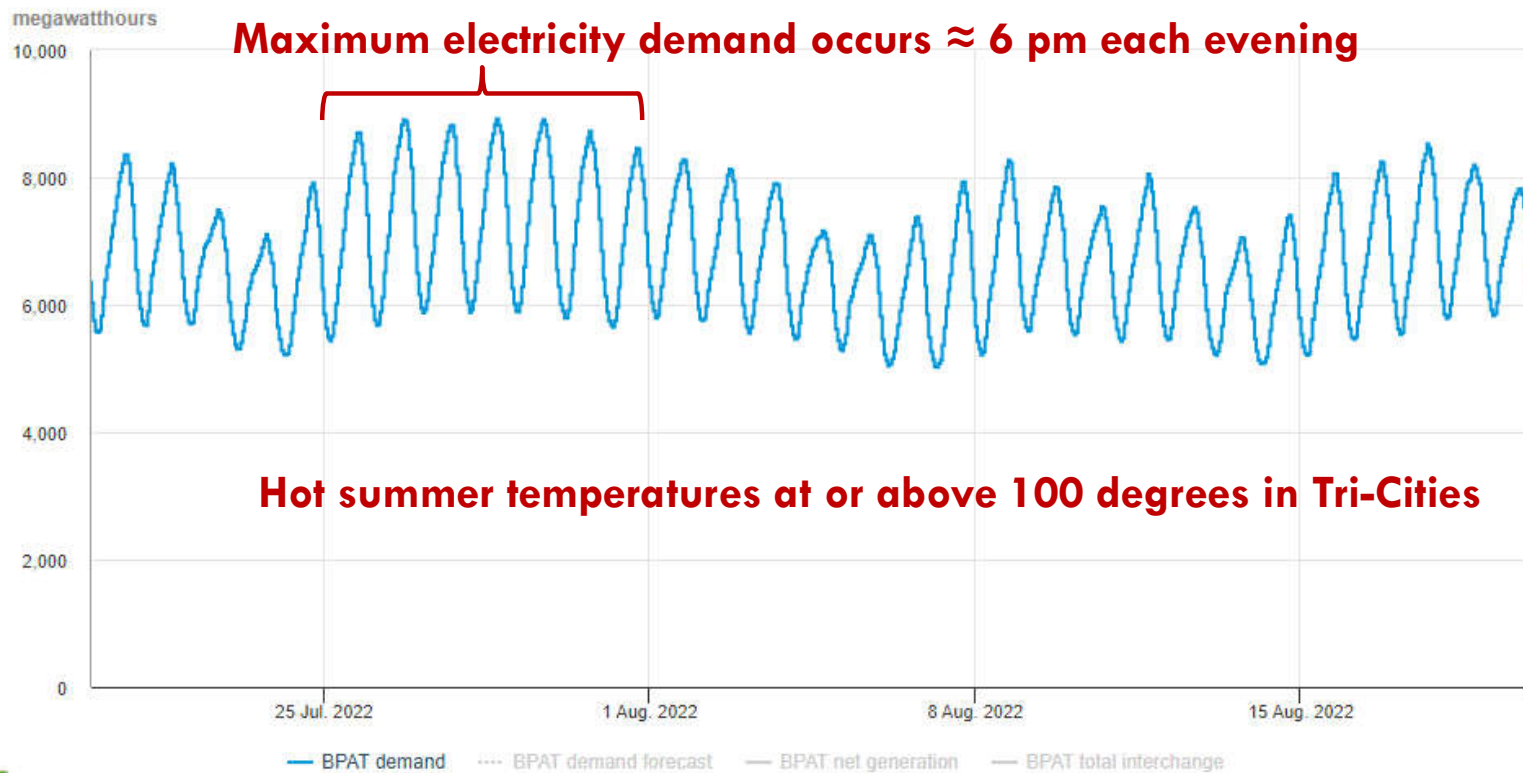


# Effective Capacity Matters – Hot Summer Days

Averages are the enemy of reliability planning

70

Bonneville Power Administration (BPAT) electricity overview (demand, forecast demand, net generation, and total interchange) 7/20/2022 – 8/19/2022, Pacific Time

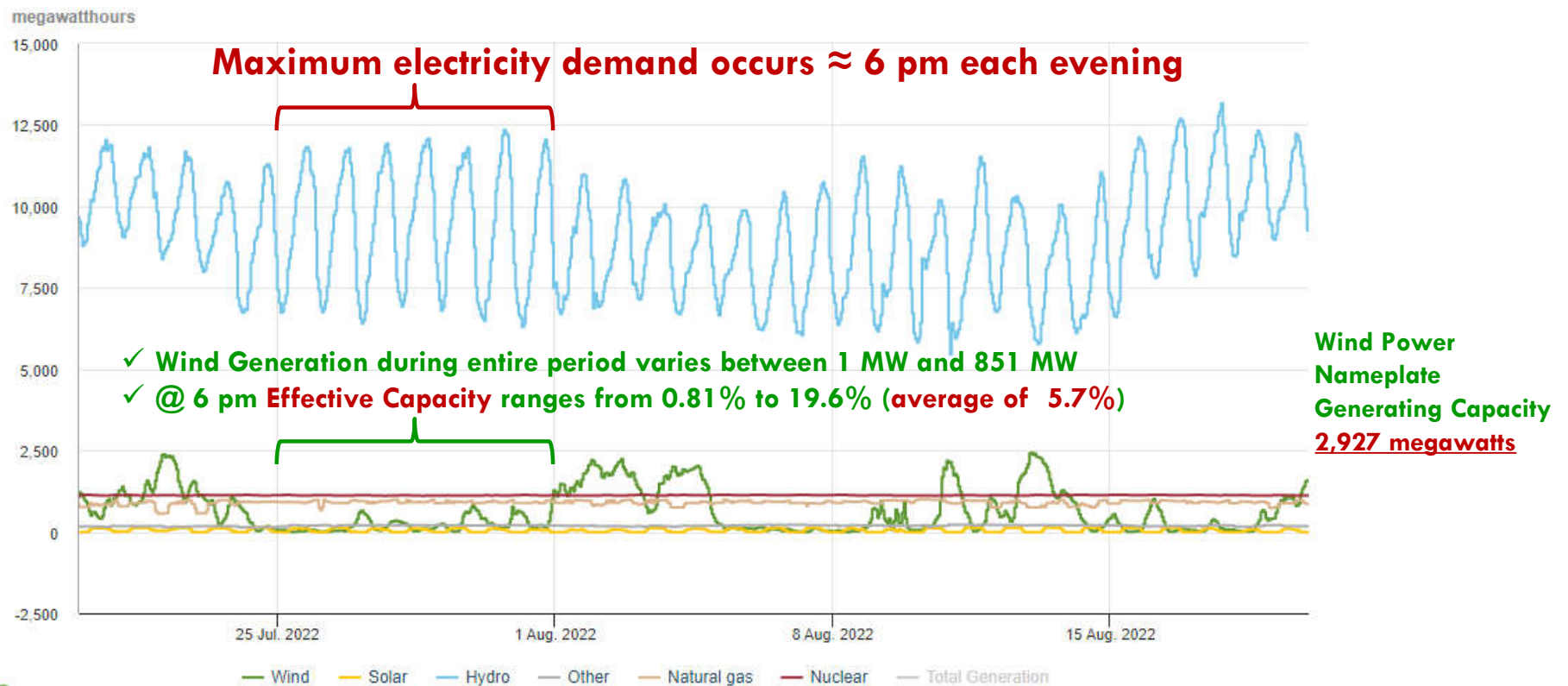


# Effective Capacity Matters – Hot Summer Days

Averages are the enemy of reliability planning

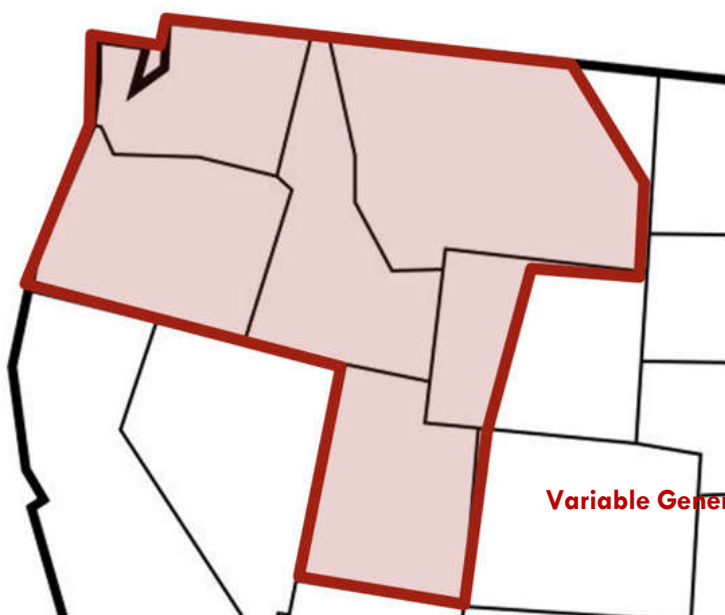
71

Bonneville Power Administration (BPAT) electricity generation by energy source 7/20/2022 – 8/19/2022, Pacific Time



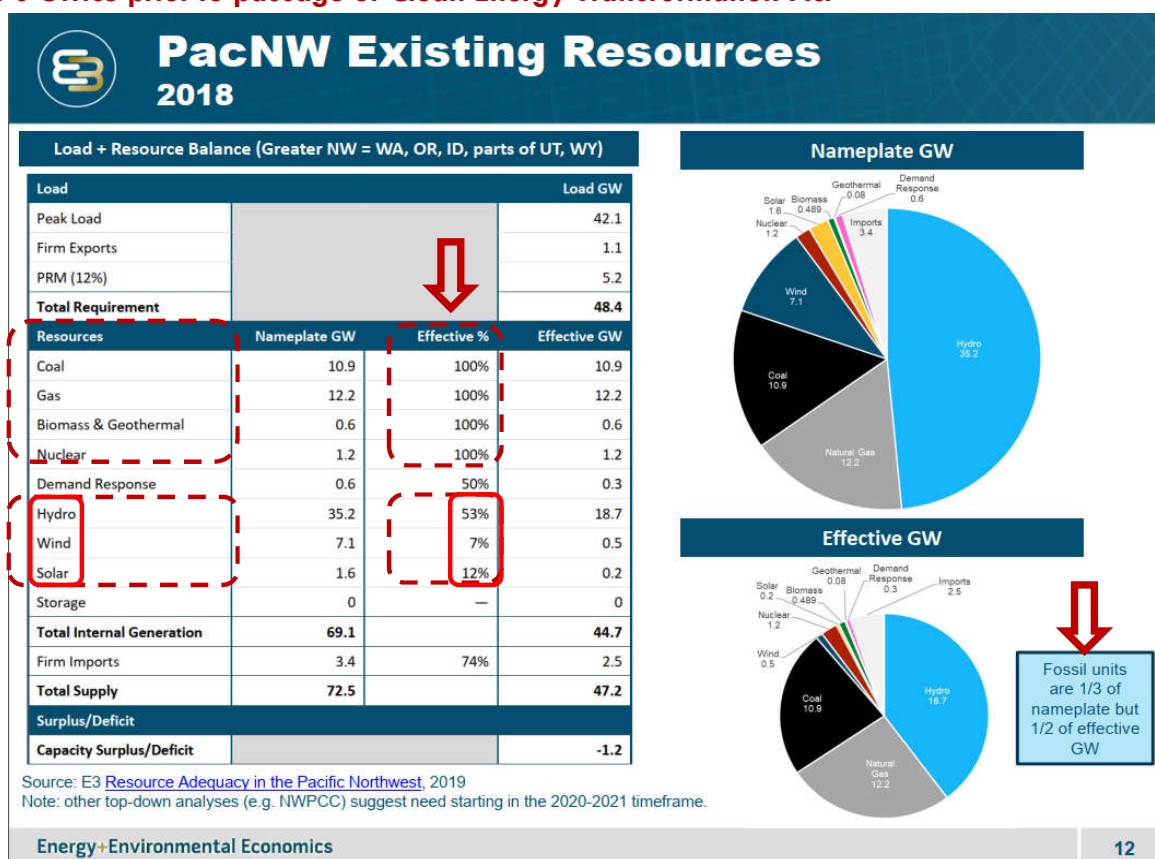
# “Effective” Capacity Resources in PNW

Study was provided to WA State Legislature & Governor's Office prior to passage of Clean Energy Transformation Act



Variable Generation

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



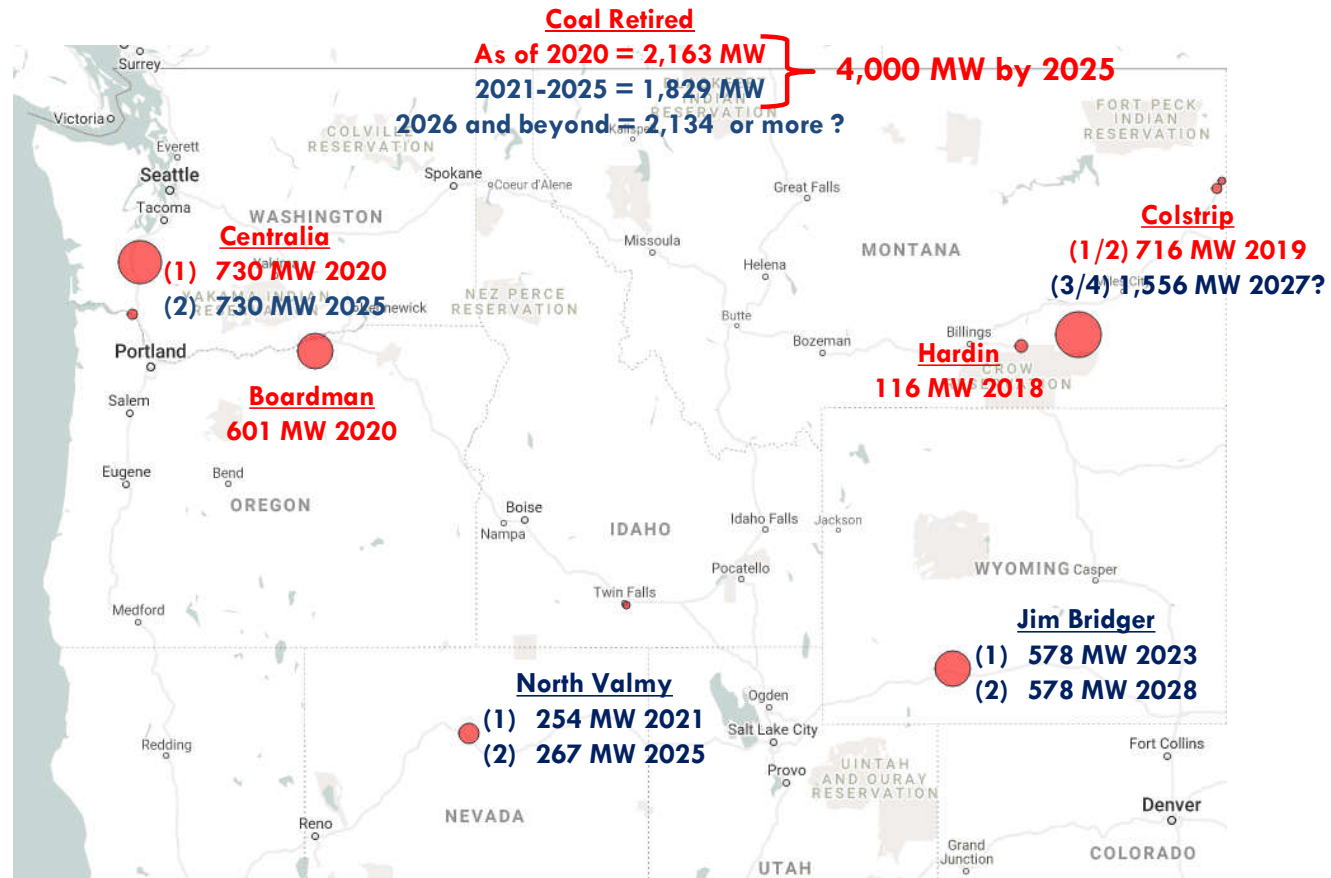
# Coal Retirements Reducing Effective Capacity

Plant Name	Capacity (MW) <sup>(1)</sup>	Retirement Year <sup>(2)</sup>
Hardin	116	2018
Colstrip (1) & (2)	716	2019
Centralia (1)	730	2020
Boardman	601	2020
North Valmy (1)	254	2021
Jim Bridger (1)	578	2023
Centralia Generation (2)	730	2025
North Valmy (2)	267	2025
Colstrip (3) & (4)	1,556	2027 (?)
Jim Bridger (2)	578	2028
<b>TOTAL</b>	<b>6,126</b>	

Notes:

(1) <https://www.nwcouncil.org/energy/energy-topics/power-supply/map-of-power-generation-in-the-northwest>

(2) Northwest Power and Conservation Council Pacific Northwest Power Supply Adequacy Assessment for 2024 (Assessment Update Figure 2)





# Northwest Grid Reliability Concerns

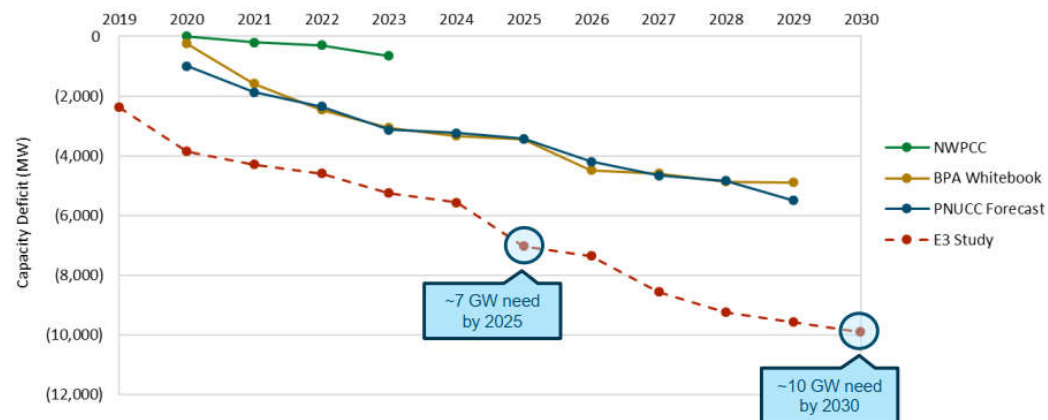
74

Study was provided to WA State Legislature & Governor's Office prior to passage of Clean Energy Transformation Act



## PacNW Near to Mid-Term Capacity Need Top-Down Forecast

- + Multiple regional assessments point to a near-term shortfall of winter-peaking physical capacity in the Northwest region
  - Shortfall grows to ~5,000-10,000 MW over next 10 years



- Key differences are driven by PRM requirements, capacity counting methodologies, and resource additions (see appendix for comparison of key assumptions).
- E3 and NWPC are truly "top-down" stochastic views, while PNUCC and BPA are closer to regional "bottom-up" analyses of utility IRPs.
- E3 study based on 2018 and 2030 RECAP LOLE modeling, shaped between those years based on forecasted coal-retirement schedules. This study updated previous analysis to include coal retirements from PacifiCorp's [2019 Draft IRP](#). E3's need does not incorporate any planned additions.

# Washington Chills Investment in new NG Capacity

75

## Clean Energy Transformation Act (CETA)



On May 7, 2019, Governor Jay Inslee signed into law the Clean Energy Transformation Act (CETA) ([E2SSB 5116, 2019](#)), which commits Washington to an electricity supply free of greenhouse gas emissions by 2045.

Effectively **eliminates investments in new dependable generation** (natural gas) by Washington utilities in the near/mid term

- **Social cost of greenhouse gas emissions** to be included by utilities in resource planning, evaluation, and selection

Cost adder for natural gas in 2019 dollars

- \$75/MT (adds  $\approx$  \$31/MWh for 2020)
- \$89/MT (adds  $\approx$  \$36/MWh for 2030)

- **Administrative penalties** for using fossil fuels

\$100 per MWh multiplied by:

- 1.5 for coal-fired plants
- 0.84 for gas-fired peaking power plants
- 0.60 for gas-fired combined-cycle plants
- Beginning in 2027, penalty adjusted for inflation

Reference:

Current wholesale price paid by Benton PUD for generation  $\approx$  \$35 per MWh

# Oregon Eliminates New/Expanded NG Capacity



## 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**
- Most ambitious timetable in the nation

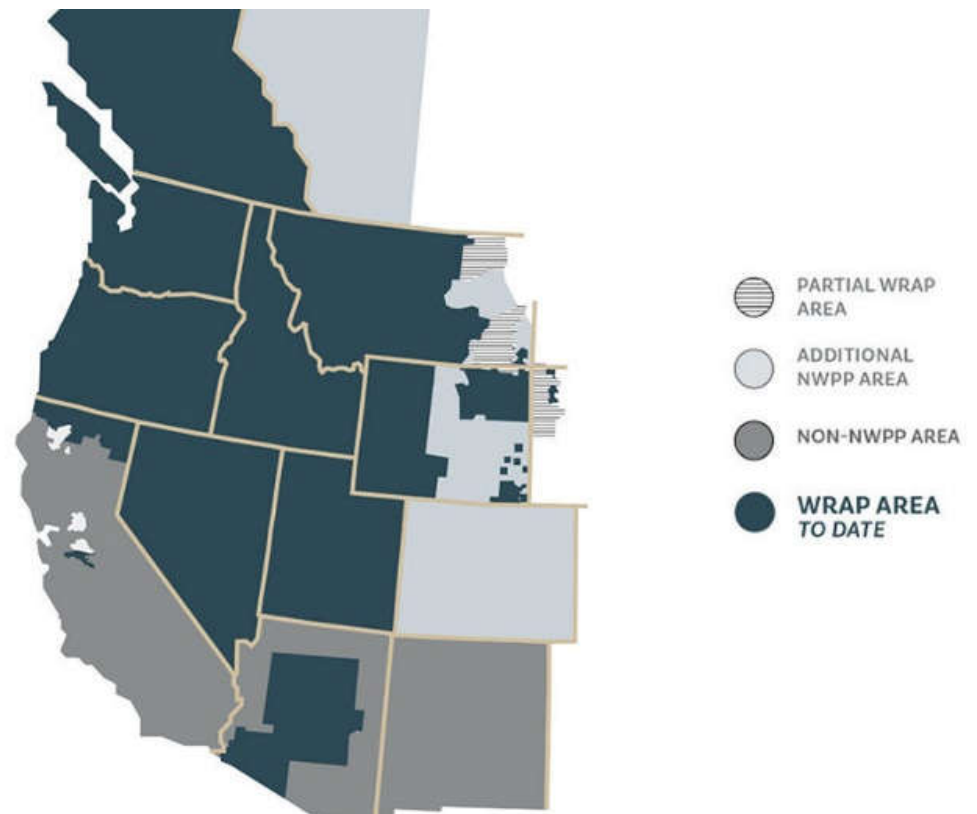
# Resource Adequacy in the West?

77

- ✓ Currently planning is “Balkanized”; but developing planning common standards



- ✓ Benton PUD has been a WRAP member during exploratory work
- ✓ Voluntary with Transition to binding program between summer 2025 to summer 2028



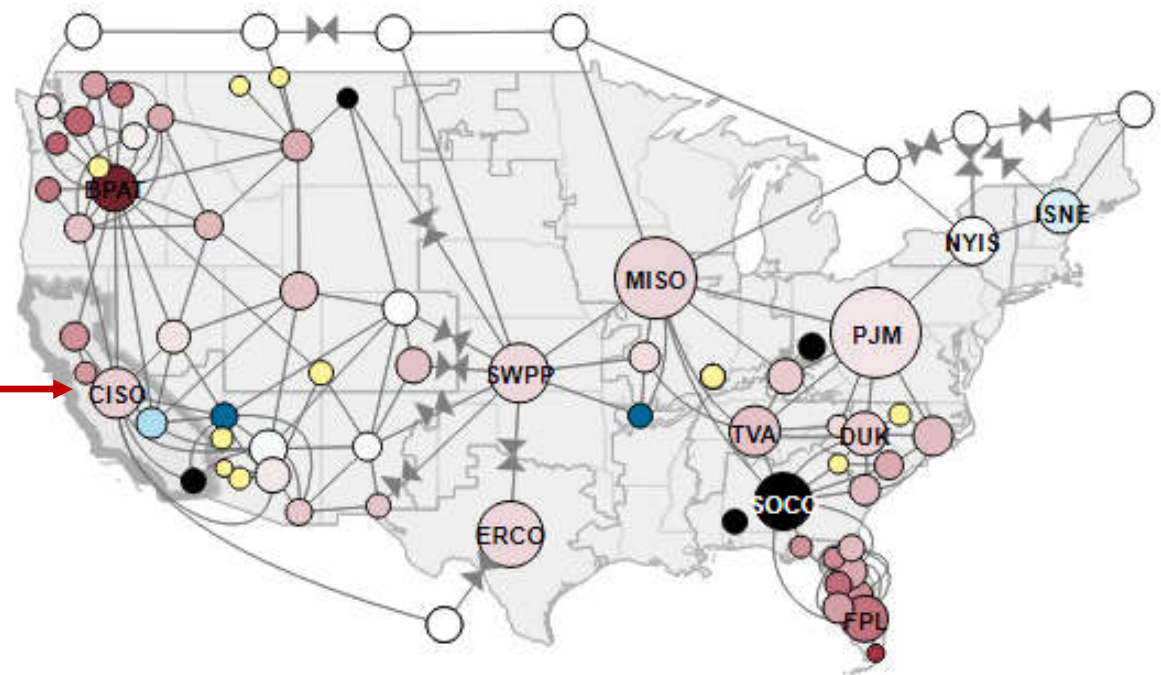
# California September 2022 Heat Wave & Power Grid Demand

78

## A CASE STUDY OF BALANCING POWER GRID RELIABILITY, COSTS & CO2 EMISSION REDUCIONS

### California Balancing Area Authorities

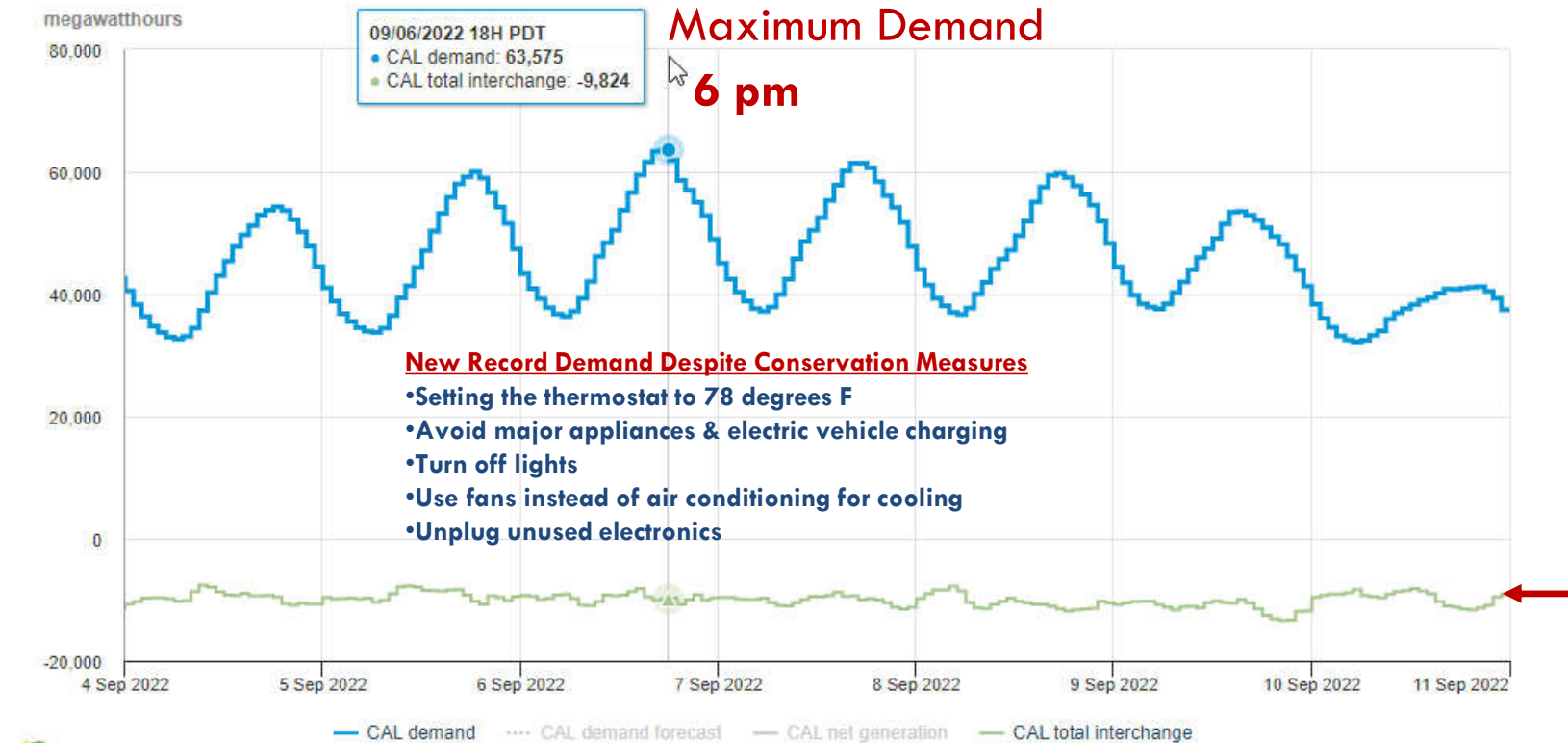
- ✓ California Independent System Operator (CISO)
- ✓ Los Angeles Dept. of Water and Power
- ✓ Balancing Authority of Northern California
- ✓ Turlock Irrigation District





# California Heat Wave & Grid Demand

California (CAL) region electricity overview (demand, forecast demand, net generation, and total interchange) 9/4/2022  
– 9/10/2022, Pacific Time



# Northwest has long exported electricity to California

Pacific HVDC North Terminal near The Dalles



Pacific  
DC & AC  
Interties  
8,000 MW

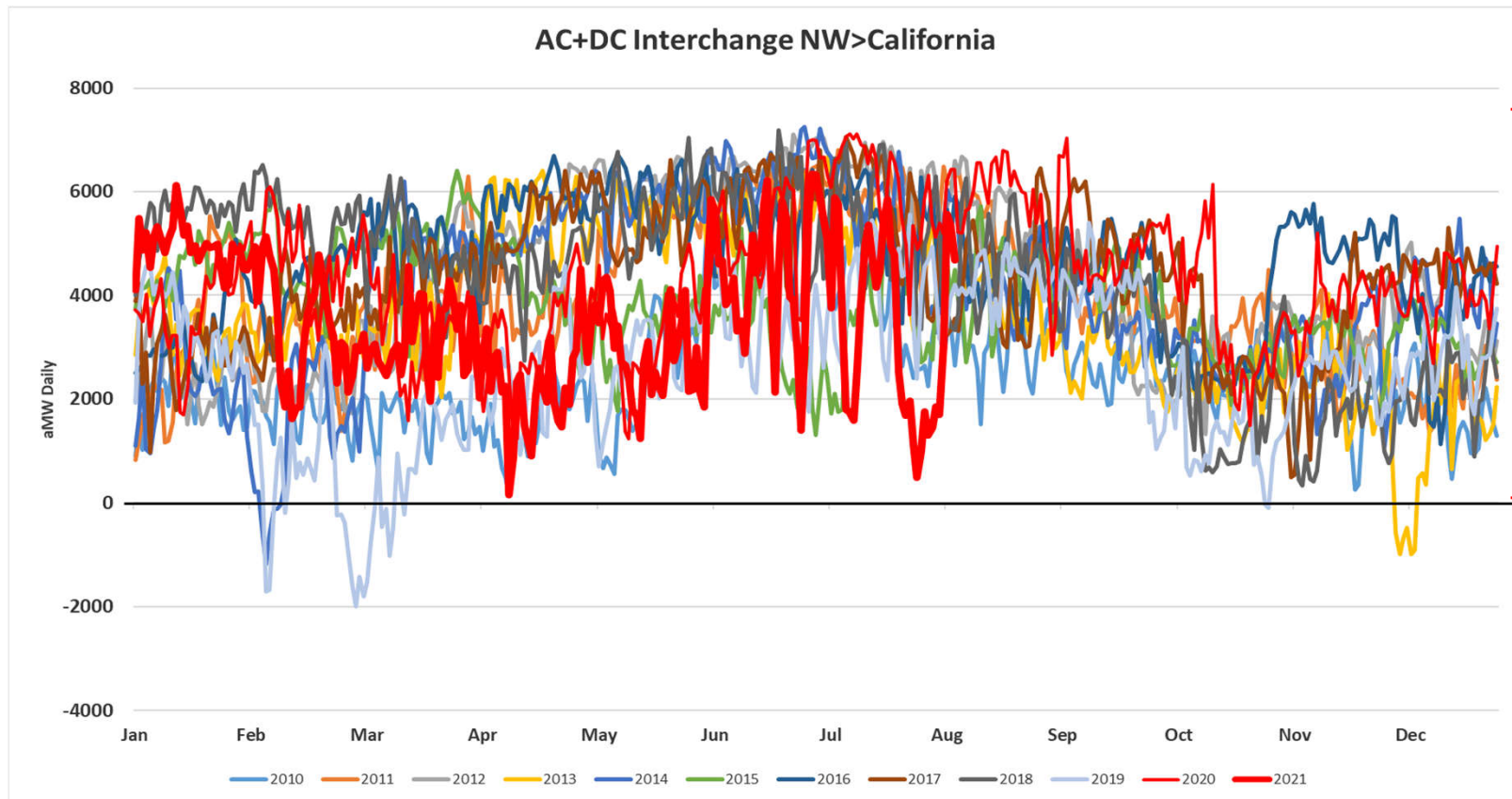
Pacific HVDC South Terminal near Los Angeles



- ✓ 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

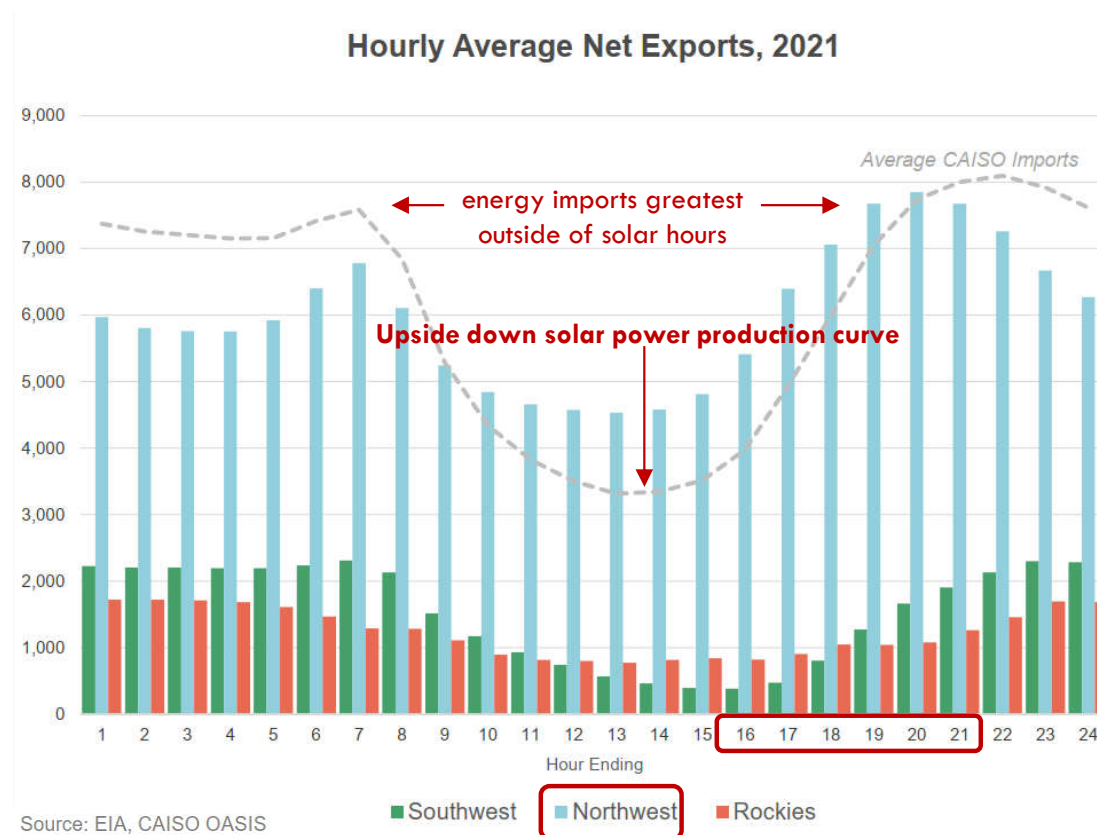
# California Imports A Lot of Electricity from NW

81



PNW exports  
to CA almost  
always

# California Relies on Electricity Imports



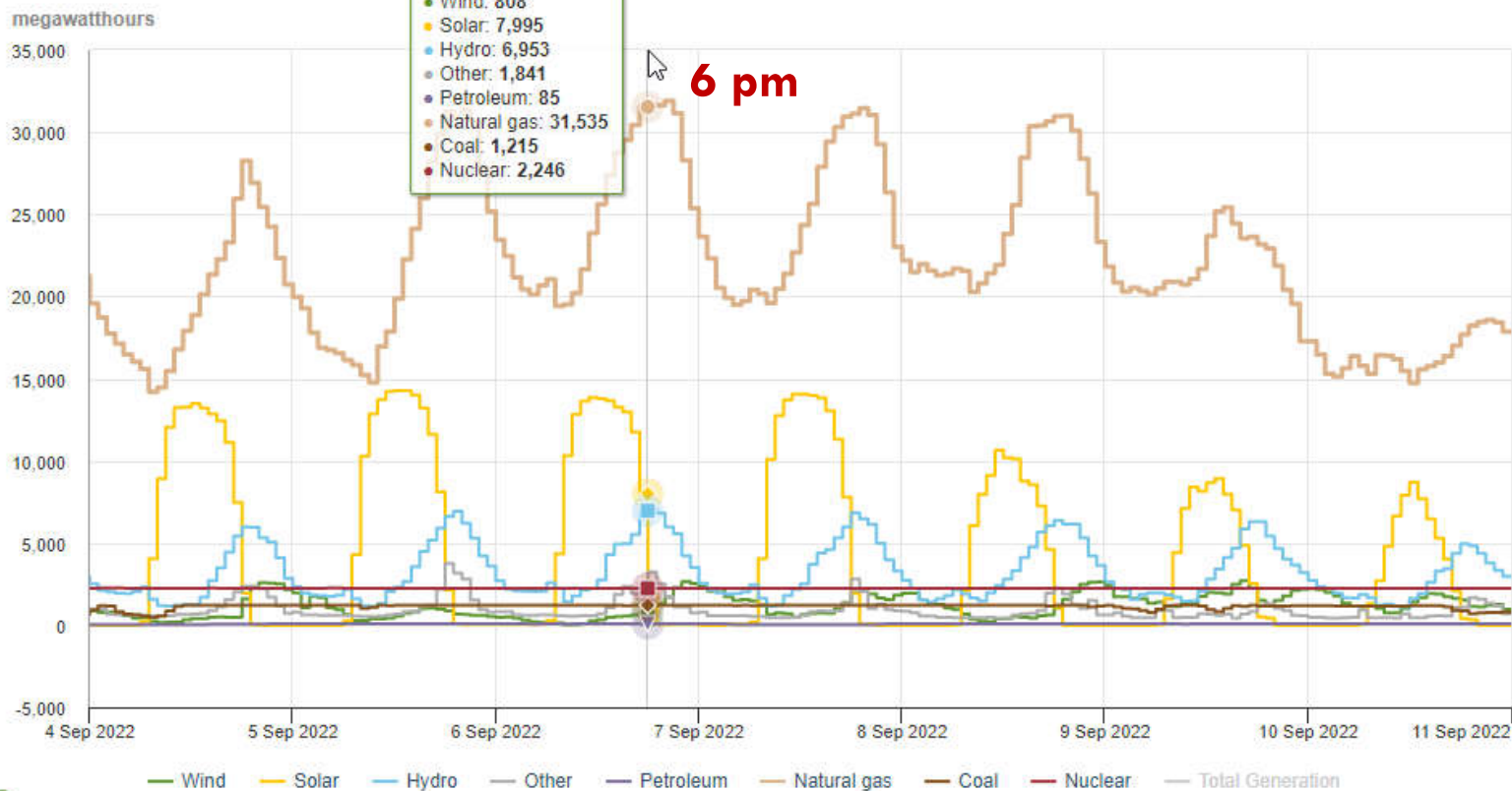
## CAISO Balancing Area Authority:

- ✓ In vast majority of hours California's CAISO balancing area authority is a purchaser and the rest of the west is a seller of wholesale electricity
- ✓ Northwest exports to CA during evening ramp: **+5,000 MW to +7,500 MW**



# CA Deeply Dependent on Natural Gas for Reliability

California (CAL) region electricity generation by source 9/4/2022 – 9/10/2022, Pacific Time



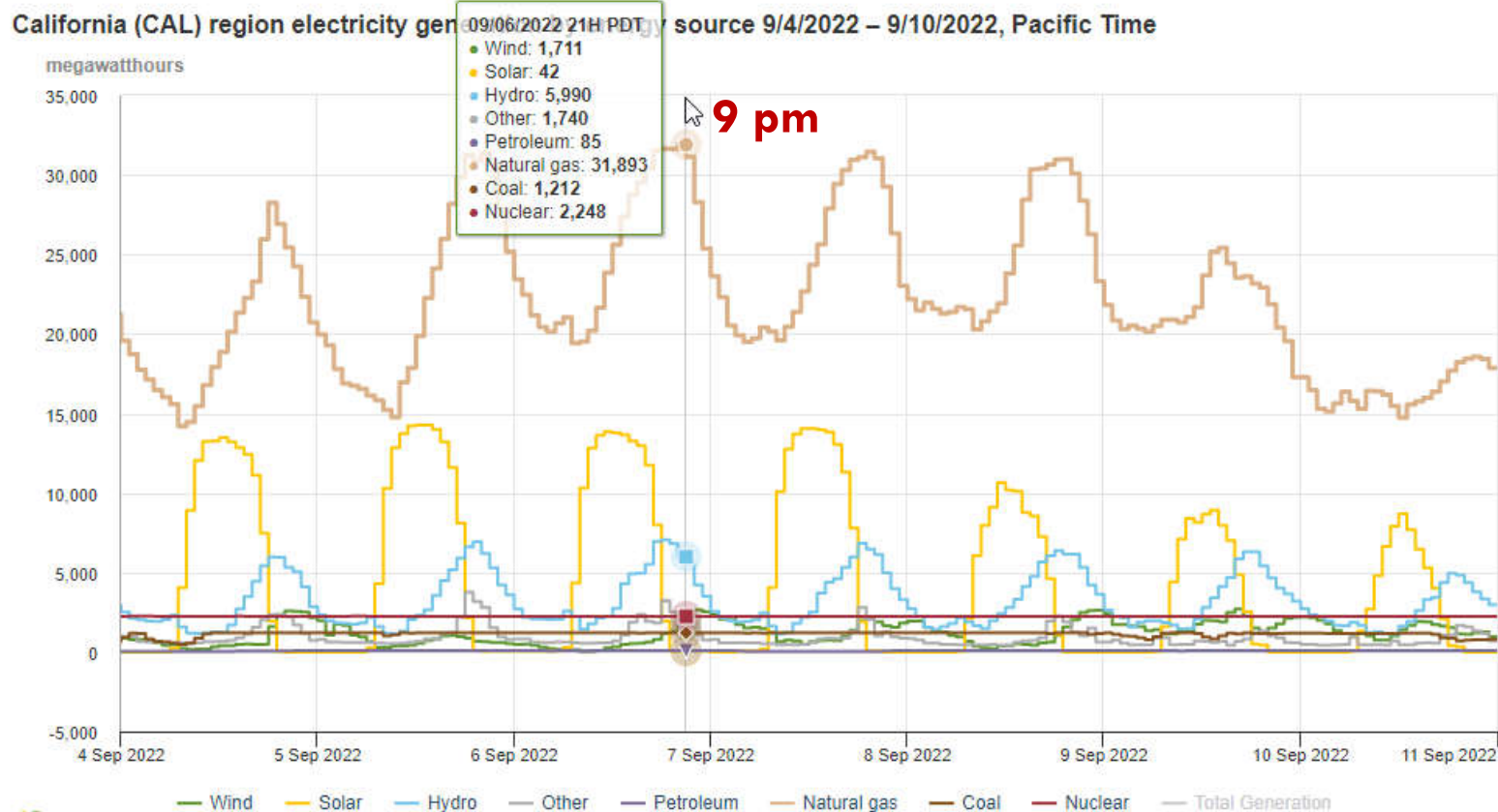
## On Day of Max Demand

- ✓ **Natural Gas** ramped up from 19,419 MW to 31,535 MW at 6 pm (50% of Demand)
- ✓ **Solar** dropped from 13,853 MW at Noon to 7,995 MW at 6 pm (12% of Demand)
- ✓ **Hydro** ramped up from 1,439 MW at 9 am to 6,953 MW at 6 pm (11% of Demand)



# Maximum Natural Gas 2 hours After Peak Demand

84

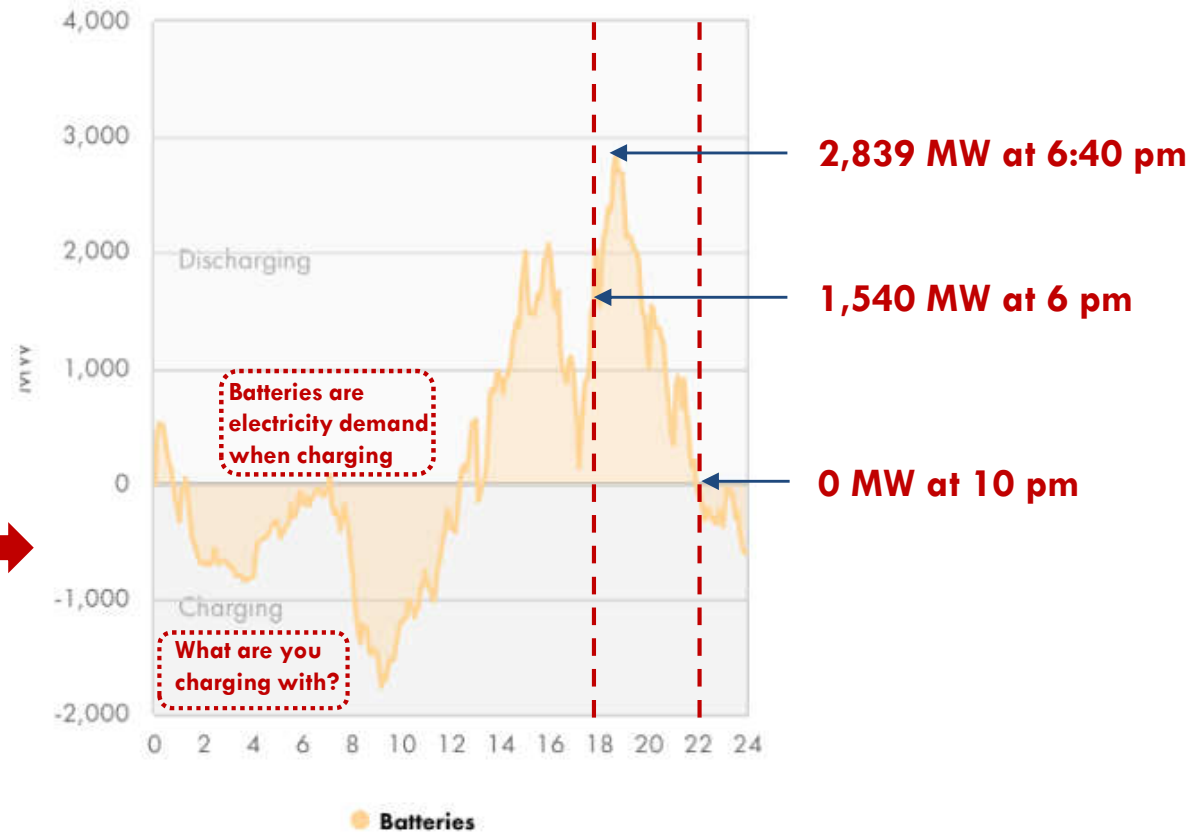
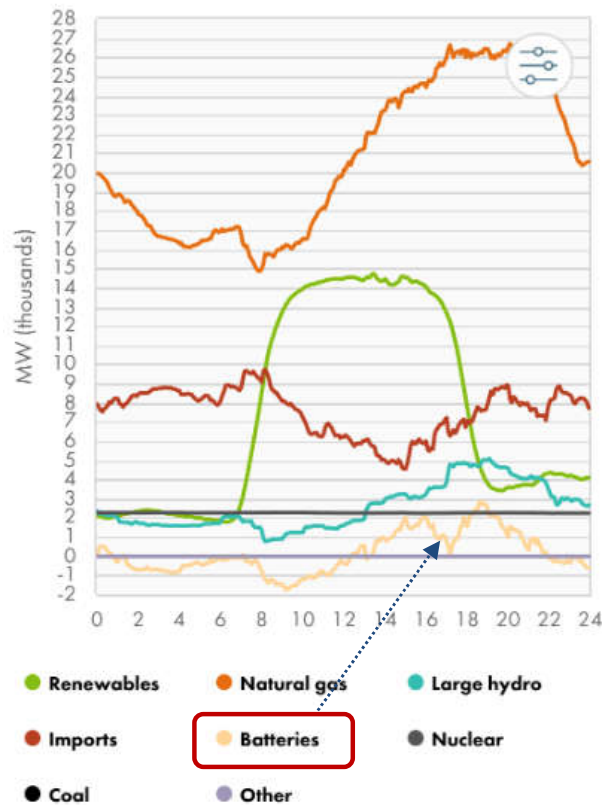


## On Day of Max Demand

- ✓ **Natural Gas** increased from 31,535 MW at 6 pm to 31,893 MW at 9 pm
- ✓ **Solar** dropped from 7,995 MW at 6 pm to 0 MW at 9 pm

# CAISO Batteries September 6th Peak Demand Event

85



# Capital Costs of Natural Gas, Wind & Solar



## Combined-cycle natural gas plants:

- \$1.1 billion per 1,000 MW
- 500 to >900 avg MW annually

## Simple-cycle peaking gas plants:

- \$130 million per 100 MW
- Used for peaking capacity only

*Fuel costs follow  
natural gas prices  
plus maintenance  
costs*



## Wind farms:

- \$2.0 billion per 1,000 MW
- 300 to 400 avg MW annually

## Solar farms:

- \$1.3 billion per 1,000 MW
- ≈310 avg MW annually E. Wash.

*No fuel costs and  
low maintenance  
costs*

Costs: U.S. EIA Northwest Power Pool

# Capital Costs of Grid Scale Batteries



## Lithium - Ion 4 hour:

- Based on NREL 2021 Report
- \$1.4 billion per 1,000 MW
- 4,000 MWh over a 4-hour period
- Lifetime 10-15 years or 3,000 cycles

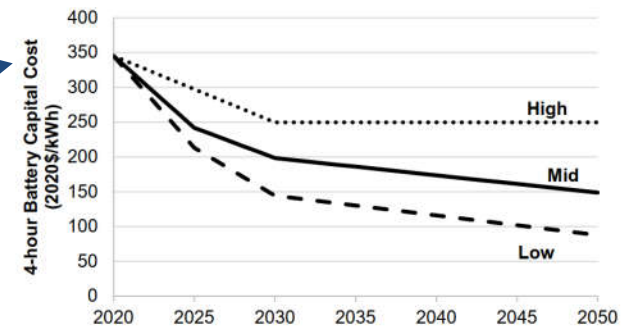


Figure ES-2. Battery cost projections for 4-hour lithium ion systems.



## WHAT ENERGY DO YOU CHARGE THE BATTERY WITH?

- Assuming Solar power and 95% efficient battery charging
- 4,210 MWh of energy to charge each cycle (daily)
- Requires 565 MW Solar @ 31% capacity factor
- \$1.3 billion per 1,000 MW
- \$735 Million for Solar

- **TOTAL COST OF SOLAR PLUS BATTERY = \$2.135 billion**
- **And that only gets you 4 hours; what about the rest of the night?**

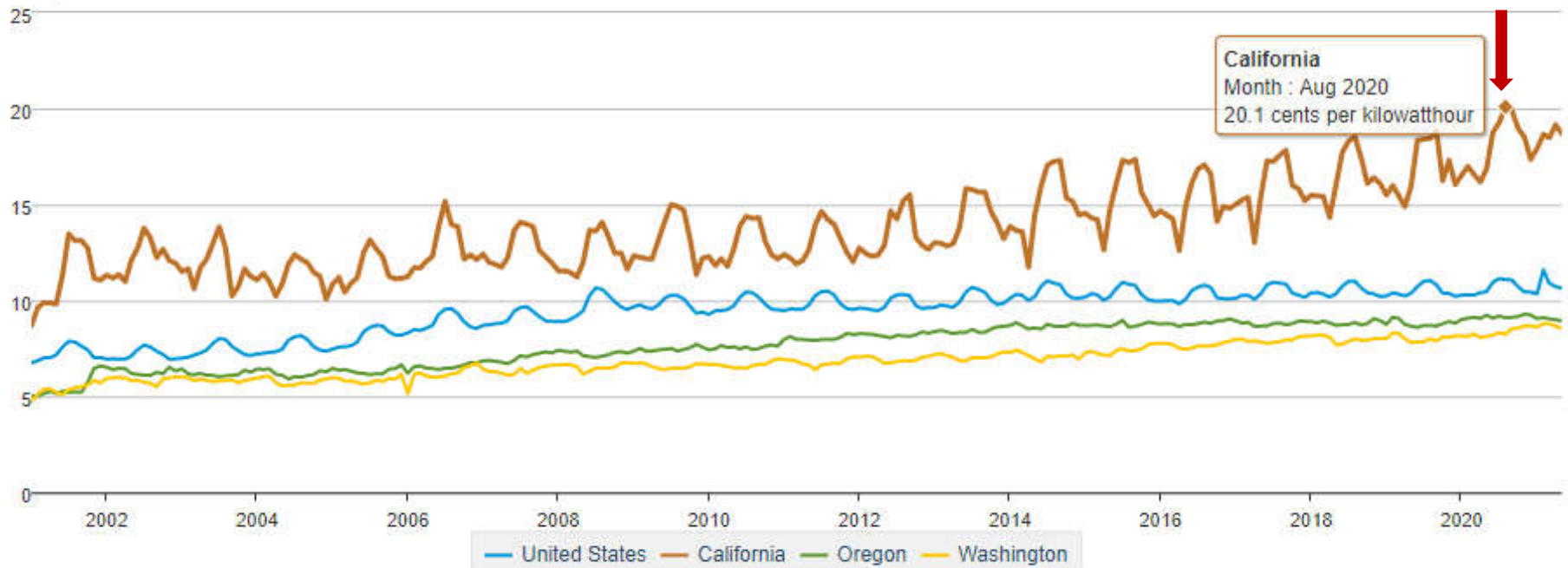
# Low-Cost Solar/Wind & Increasing Retail Rates?

Legislature finds: “Clean energy technologies...competitive or even cheaper than conventional technologies”

88

Average retail price of electricity **all sectors** monthly

cents per kilowatthour



Data source: U.S. Energy Information Administration





## Hydropower & Benton PUD Electricity Supply Chain

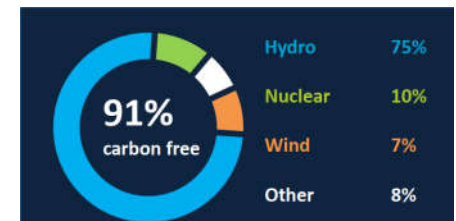
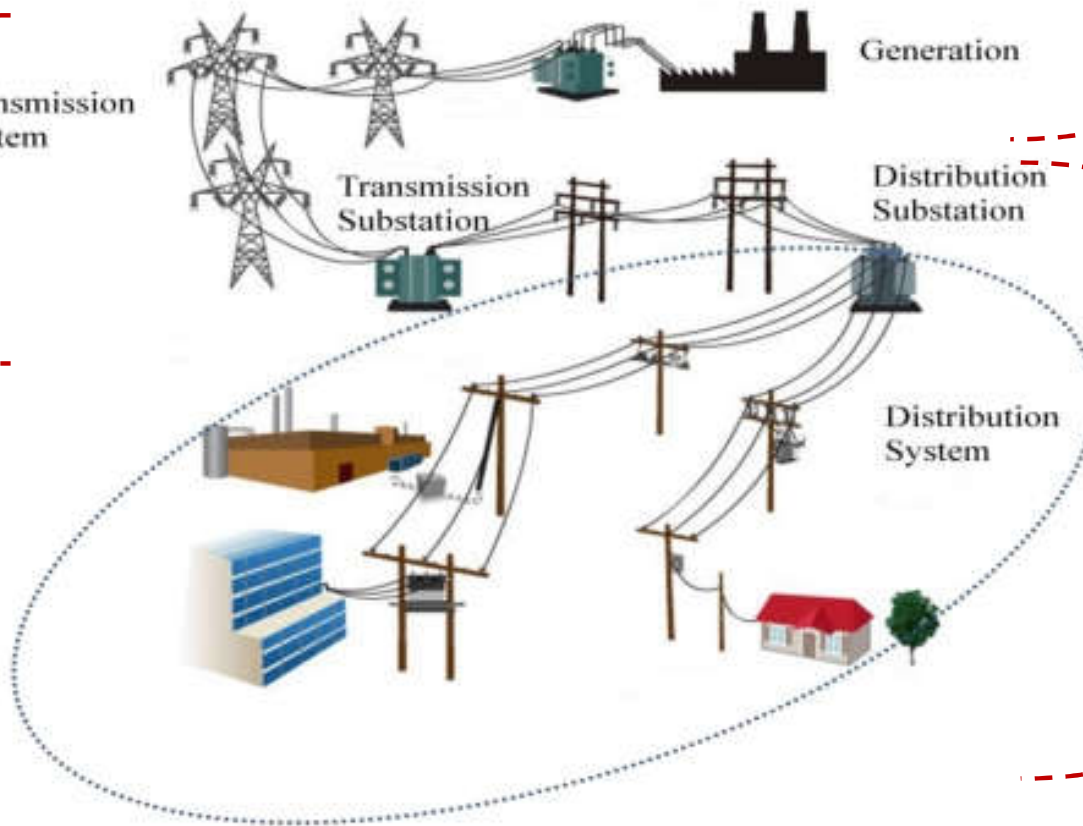


# Electricity Supply Chain: Consumer Owned Utilities

90



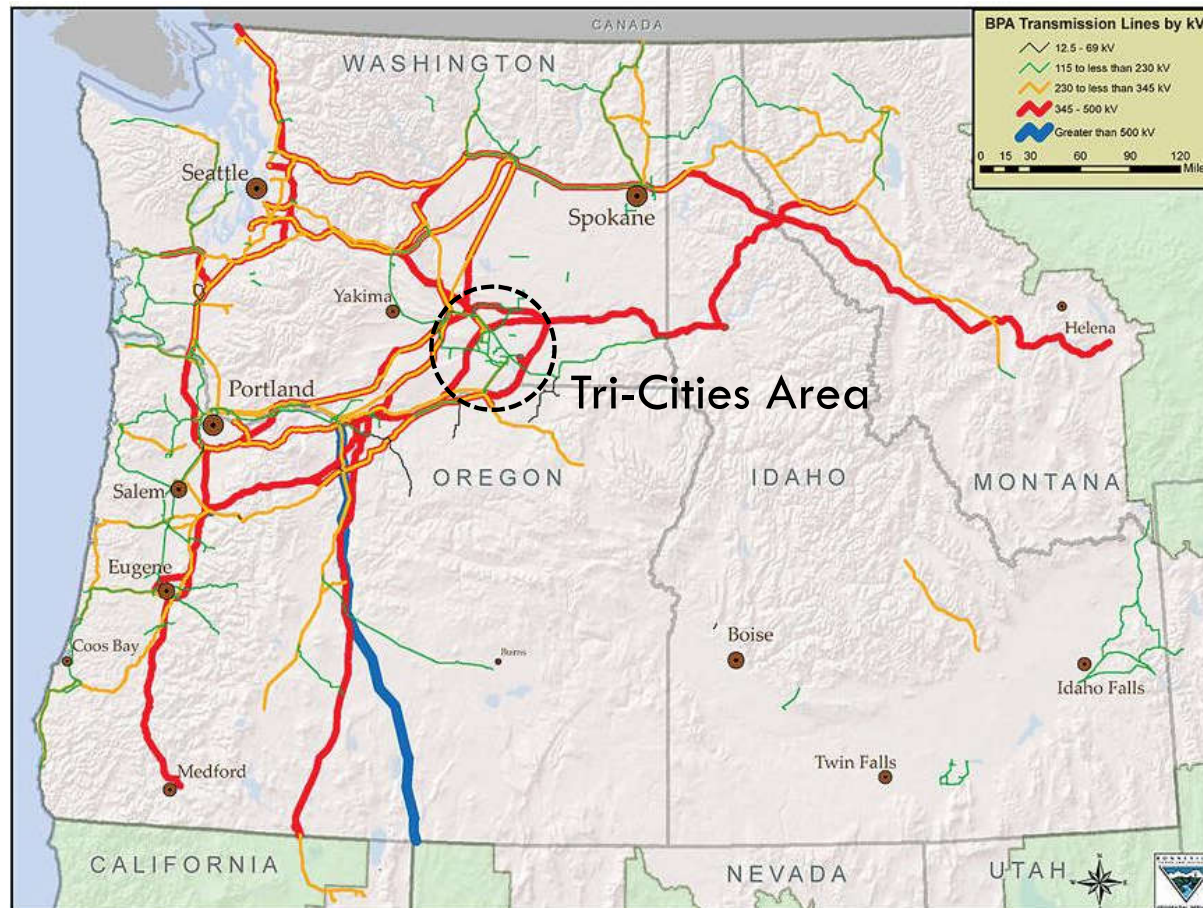
Transmission System



**One of 135 Preference Customers with Statutory Rights to Federal Hydropower**

# BPA Transmission Lines

91



## Transmission system

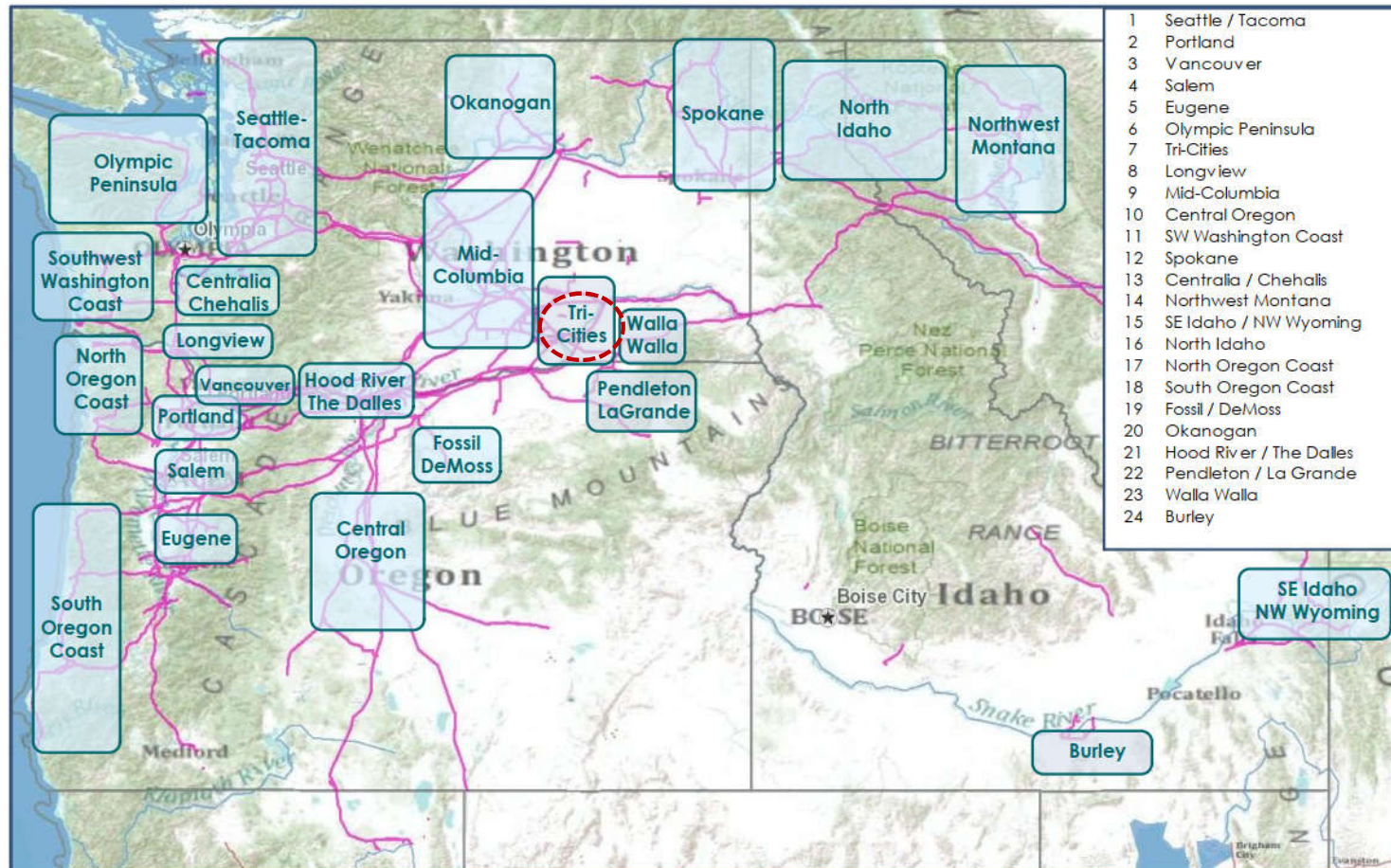
Operating voltage	Circuit miles
1,100 kV	1
1,000 kV	264 <sup>10</sup>
500 kV	4,860
345 kV	570
287 kV	229
230 kV	5,337
161 kV	119
138 kV	56
115 kV	3,440
below 115 kV	301
Total <sup>11</sup>	15,179

10/ BPA's portion of the PNW/PSW direct-current intertie. The total length of this line from The Dalles, Oregon, to Los Angeles, California is 846 miles.  
 11/ Total circuit miles as of February 2019.



# BPA Load Service Areas

92



# BPA Hydro: Firm Energy is Spoken For

93



**Federal power marketer for 31 hydroelectric dams and the Columbia Generating Station nuclear plant**



Projects	Nameplate MW	Highest Energy aMW	Average Energy aMW	Firm Energy aMW
Regulated Hydro (1)	21,409	10,326	8,110	5,961
Other Hydro	903	483	423	352
<b>TOTAL HYDRO</b>	<b>22,312</b>	<b>10,809</b>	<b>8,533</b>	<b>6,313</b>
CGS	1,169			994
Various Wind	0			34
Contracts	402			215
<b>TOTAL NON-HYDRO</b>	<b>1,571</b>			<b>1,243</b>

(1) Hydraulically coordinated to meet power and non-power requirements



# BPA Hydro: Foundational Public Power Resource

94



## Customers Consumer owned utilities

Cooperatives	54
Municipalities	42
Public utility districts	28
Federal agencies	7
Investor-owned utilities	6
Direct-service industries	1
Port districts	1
Tribal utilities	3
<b>Total</b>	<b>142</b>

✓ **135 Preference customers with statutory rights to Federal Hydropower**

✓ **Includes 127 Consumer Owned Utilities**



# BPA Hydro: Firm Energy is Spoken For

95

SONNEVILLE POWER ADMINISTRATION

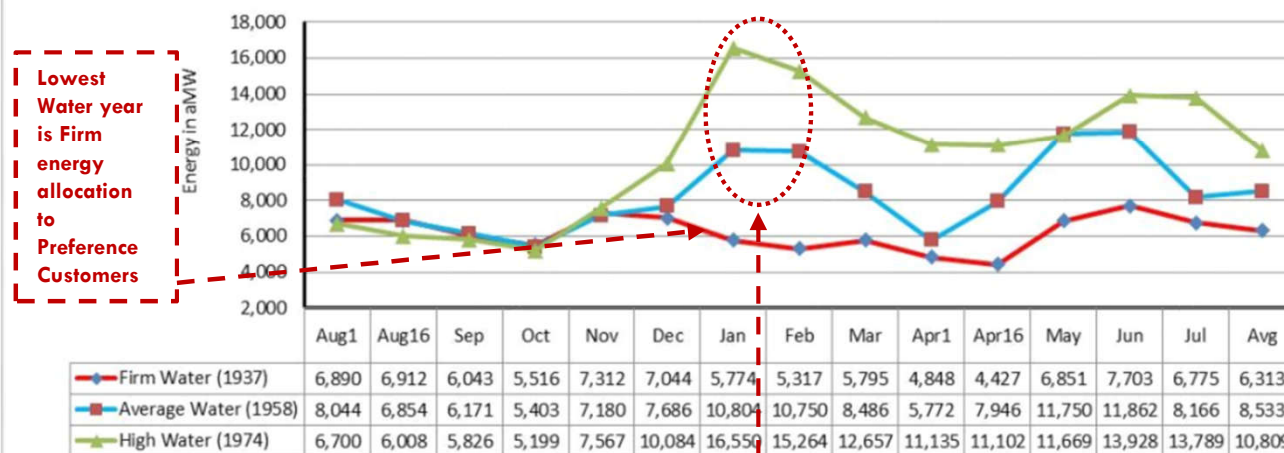
2022 Pacific Northwest  
Loads and Resources Study

July 2022



Table 2-9

Federal System  
Variability of Monthly Hydro Generation  
OY 2023  
Under Different Water Conditions



1. Firm energy already fully allocated to Preference Customers;  
**NO HYDRO LEFT FOR ECONOMIC DEVELOPMENT**

2. In **Average & High** water years, surplus hydropower is sold  
into power markets which **reduces costs** to Preference  
Customers

# BPA Hydro: Drought Year Capacity Deficits

96

SONNEVILLE POWER ADMINISTRATION

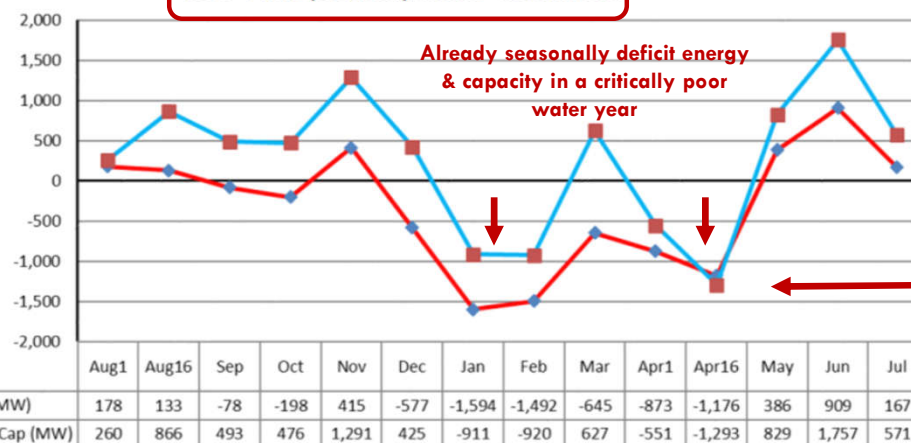
2022 Pacific Northwest  
Loads and Resources Study

July 2022



Table 2-16

Federal System  
Monthly Energy and 120-Hour Capacity Surplus/Deficit  
OY 2023  
1937-Firm (Critical) Water Conditions



BPA  
buys  
power in  
markets  
when  
short on  
supply

## 120-Hour Capacity

Average generation forecasts from the 6 highest heavy load hours per day, 5 days per week, for 4 weeks per month



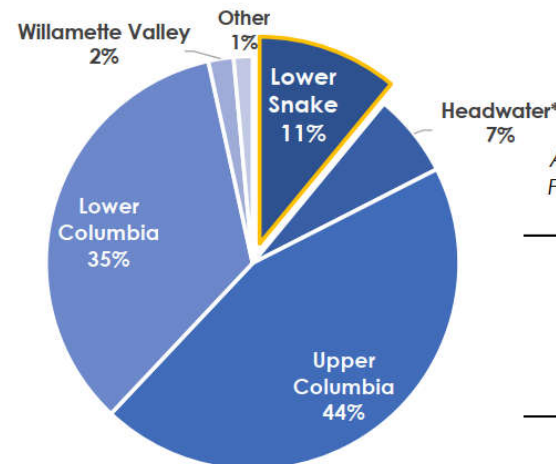
# Lower Snake River Dams: Energy & Capacity



## Lower Snake River Dams Provide Low Cost Energy and Capacity

The four Lower Snake River Dams (Lower Granite, Little Goose, Lower Monumental and Ice Harbor) have a **combined nameplate capacity of 3,033 MW**.

On average, the four projects generate **940 aMW**, which is about **11% of the Federal Columbia River Power System**.<sup>1</sup> The Lower Snake River Dams have a **levelized cost of generation of less than \$14/MWh**,<sup>2</sup> far below the Tier 1 rate of \$36/MWh or the price of market purchases and new renewable resources.





# LSRD: 11% of Energy w/ Blackout Insurance

98

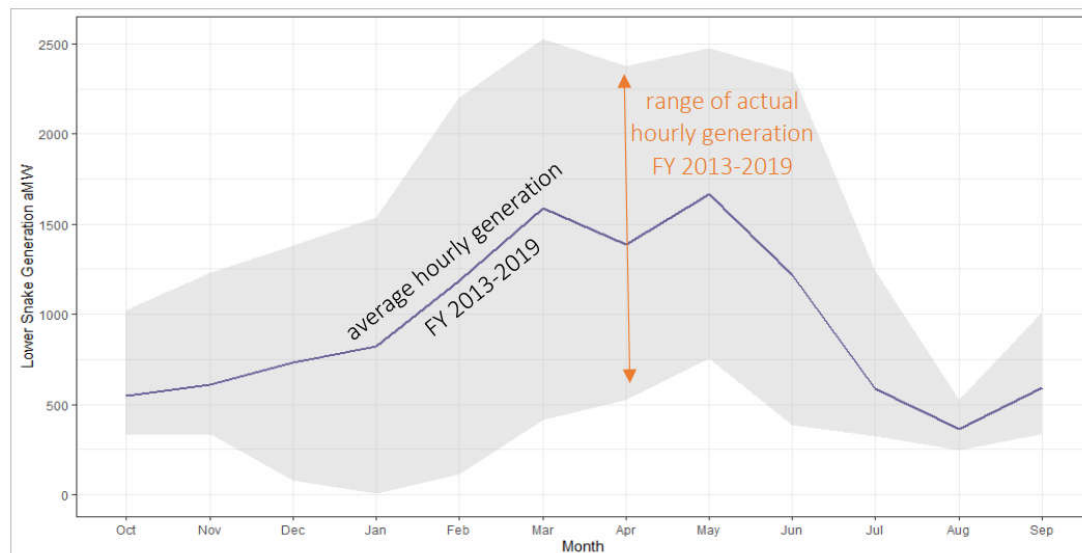
## AUTOMATIC GENERATION CONTROL ON FEDERAL DAMS



Automatic Generation Control allows federal hydro operators to use the lower Snake River dams to meet electricity demands minute-to-minute while using the Columbia River dams to support wind power. There are 31 federal dams in the Northwest; the 10 largest have AGC capability.

Source: BPA Fact Sheet March 2016

- ✓ 4 of 10 federal dams with automatic generation control
- ✓ Minute-to-Minute Demand/Supply Balancing
- ✓ 25% of BPA Operating Reserves (grid reliability & stability)
- ✓ Critical winter energy capability & voltage support on BPA transmission system

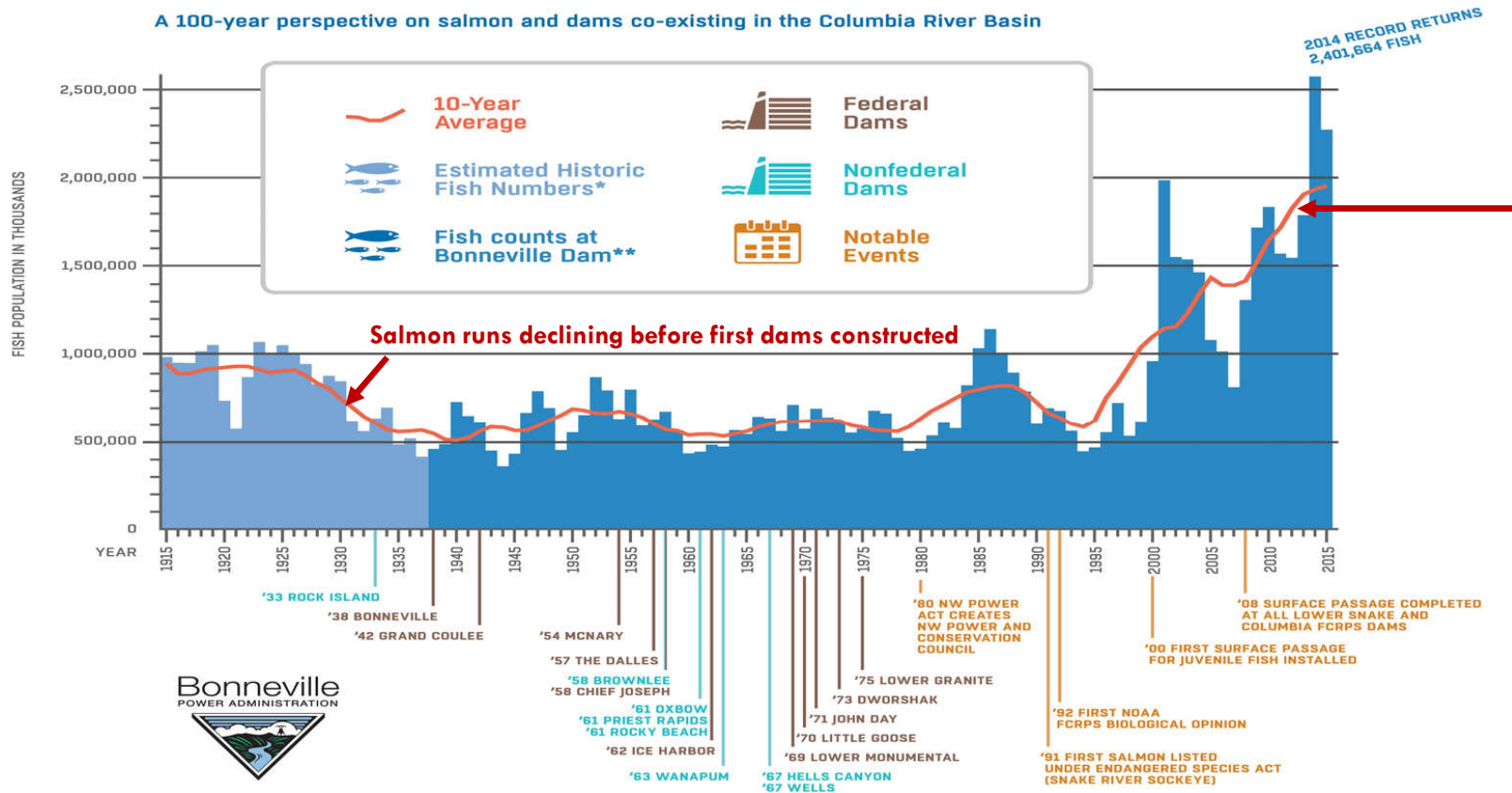


Source: [USACE Water Control Data](#)

# The Whole Dam Story

99

A 100-year perspective on salmon and dams co-existing in the Columbia River Basin



Salmon runs improving with investments and management of:

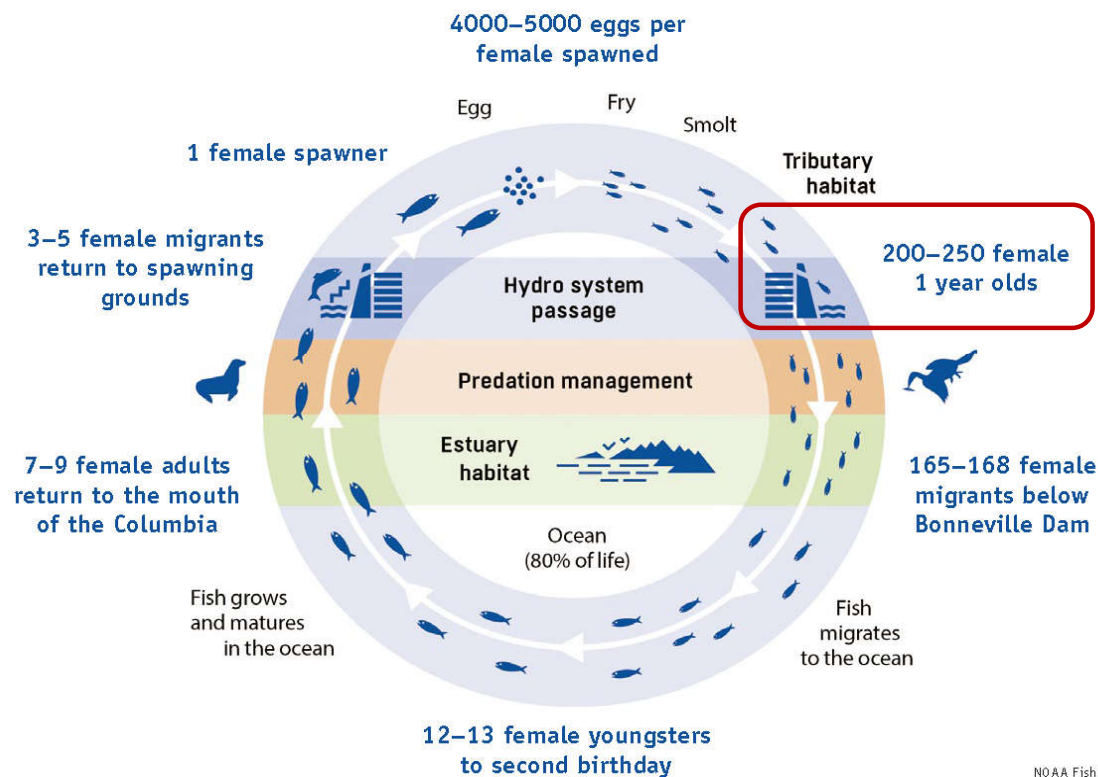
- ✓ Hydro
- ✓ Habitat
- ✓ Hatcheries
- ✓ Harvest

\*Salmon and steelhead returns pre-1938 assume a 75 percent harvest rate in the lower Columbia River—experts estimate anywhere from 50–85 percent based on catch at Astoria, Oregon.  
 \*\*Actual counts at the fish window at Bonneville Dam, 138 miles upriver from Astoria.

# Lower Snake River Dam Breaching

100

## Snake River Spring/Summer Chinook Life Cycle



- ✓ Smolt take 10 to 50 days to travel rivers and get to the estuary/ocean
- ✓ **Delayed mortality hypothesis** is driving calls for LSRD breaching w/o scientific evidence

7 July 2022

KINTAMA

p. 1/8.

**The Case for Snake River Dam Removal is Scientifically Dishonest**

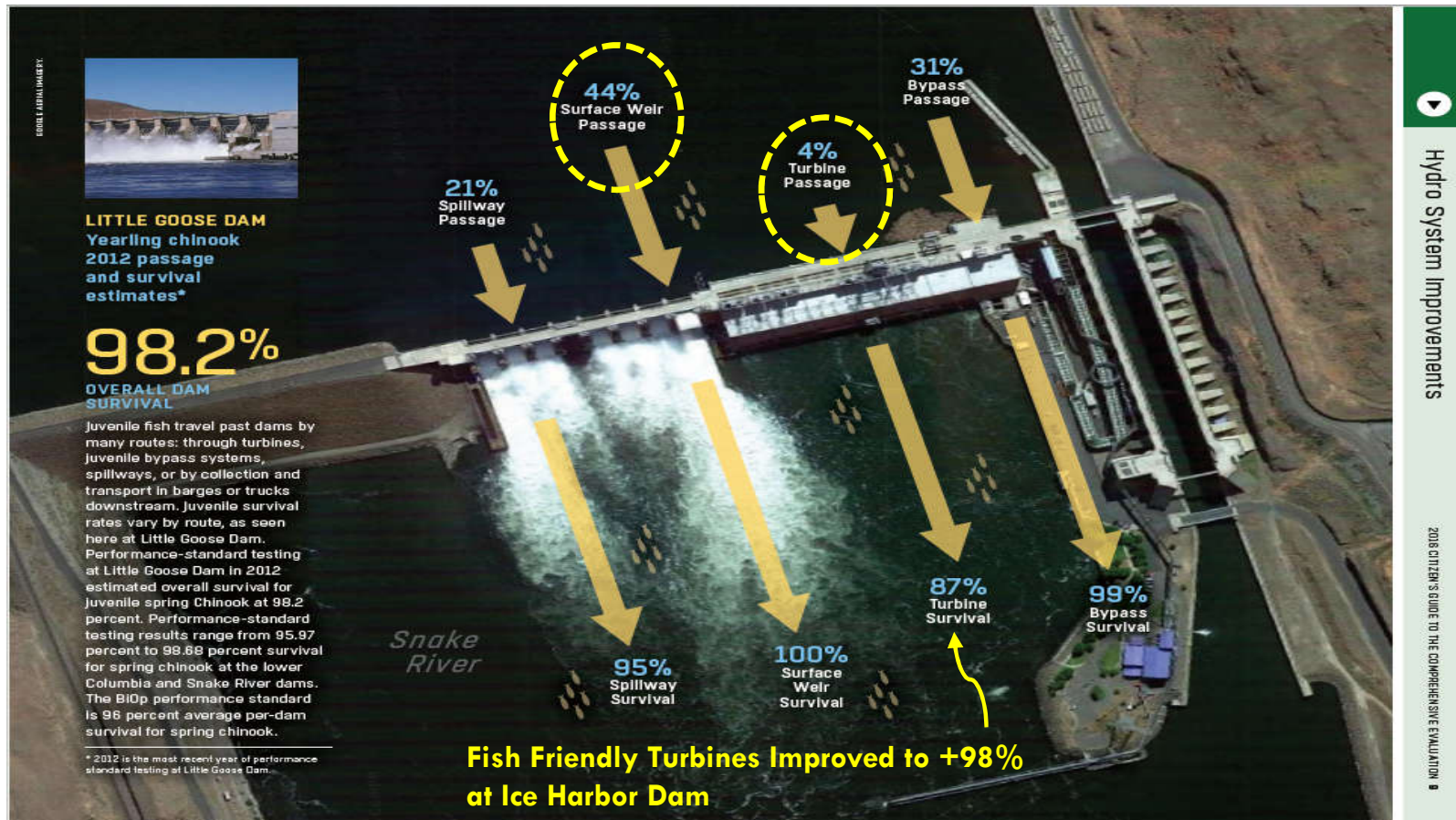
-David Welch, Ph.D. & President, Kintama Research Services.

*"If delayed mortality doesn't exist...then other approaches to getting more salmon should be considered".*

NOAA Fisheries

# Fish Bypass Technology Investments

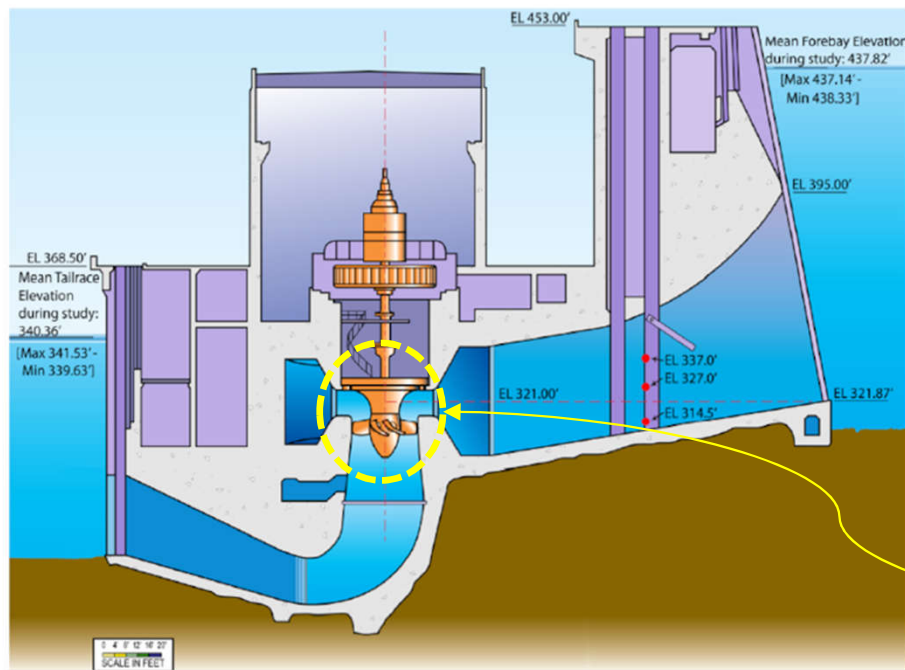
101





# Fish Friendly Turbine Design

102

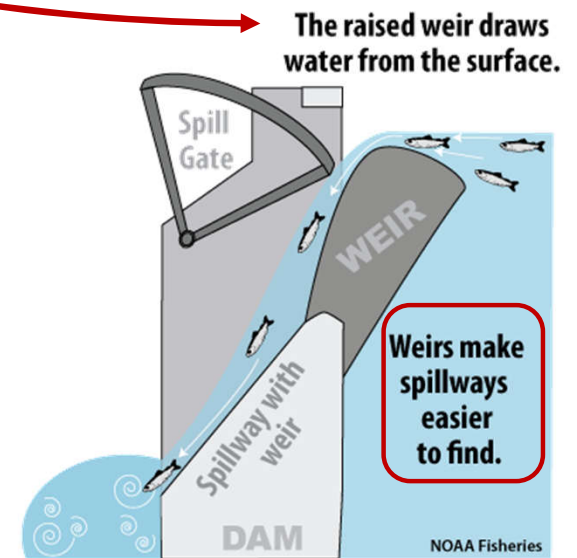
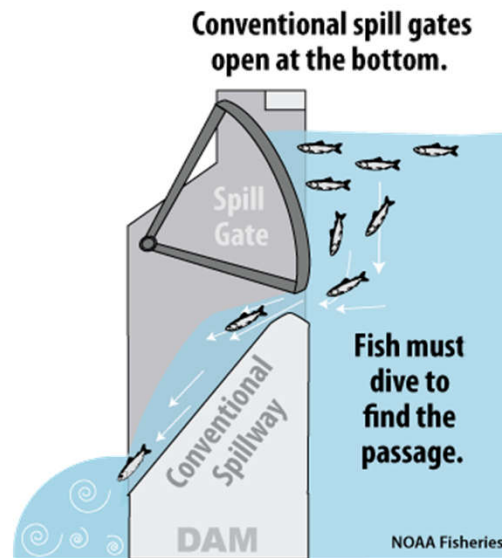
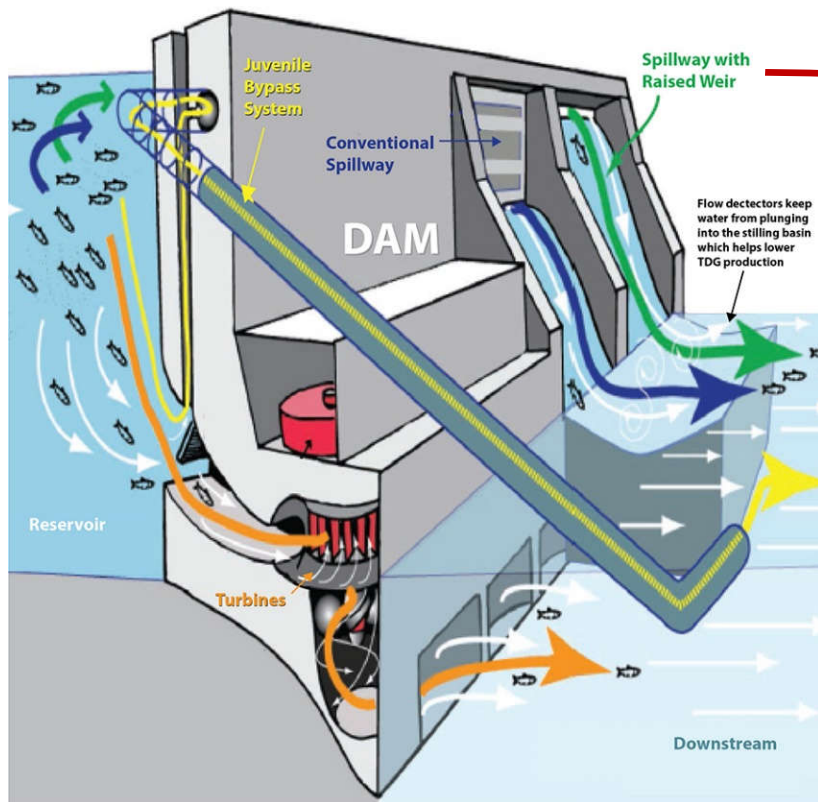


**"...biological testing using balloon tagged fish in October 2019 resulted in a 98.25% direct survival rate."**

<https://www.nwww.usace.army.mil/Media/News-Stories/Article/2991190/modernizing-hydropower-on-the-snake-river/>

# Raised Spillway Weirs

103

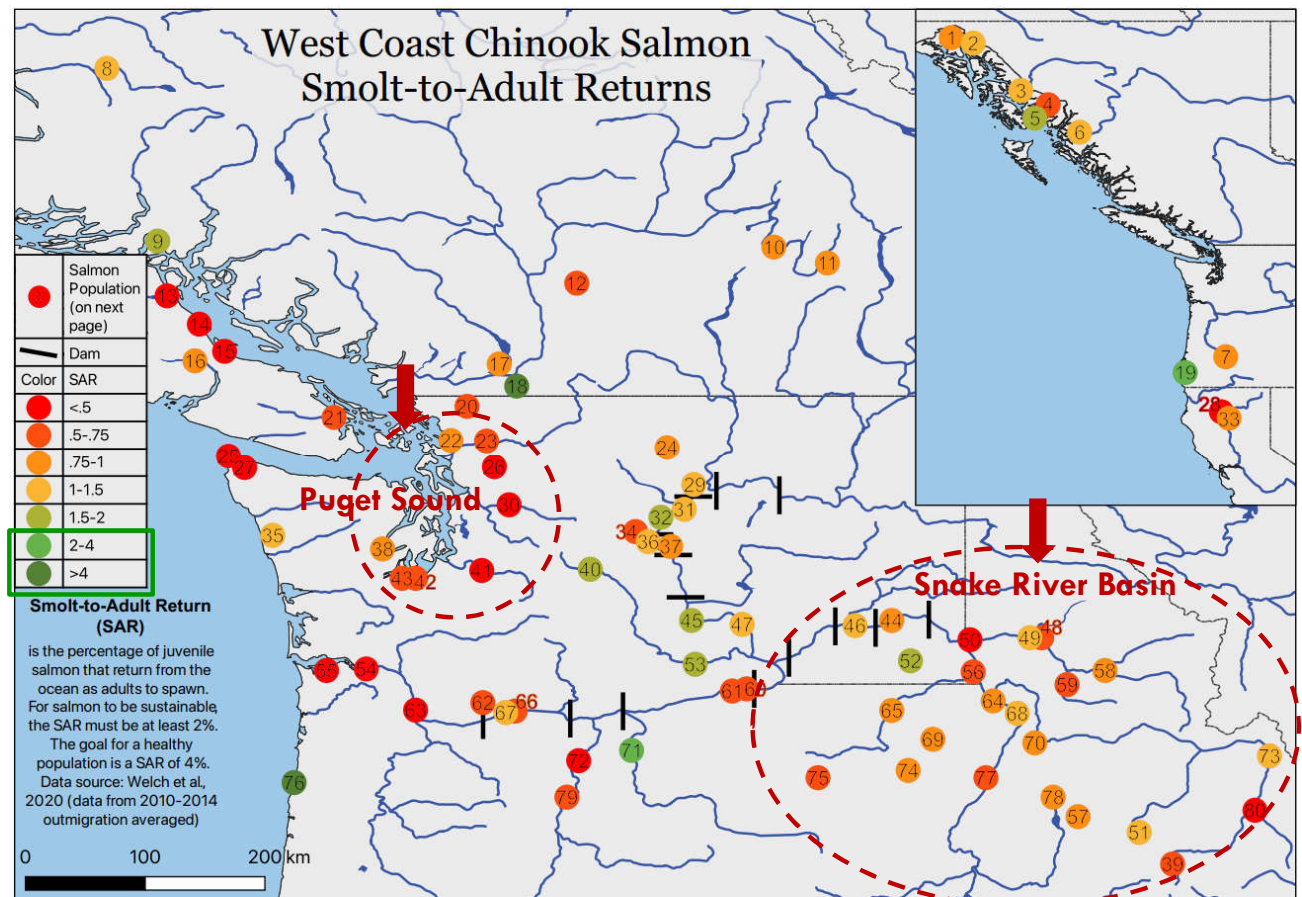


# West Coast Chinook Salmon Struggling

Whether river is dammed or not

104

**Smolt-to-Adult Return**  
Sustainable runs >2%





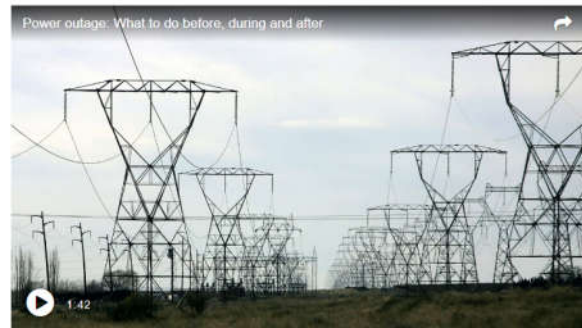
# Tri-Cities Area June 2021 Heat Dome Event

## Tri-City Herald

### Tri-Cities region warned of possible rolling power blackouts during heat wave

BY ANNETTE CARY

UPDATED JUNE 28, 2021 5:28 PM



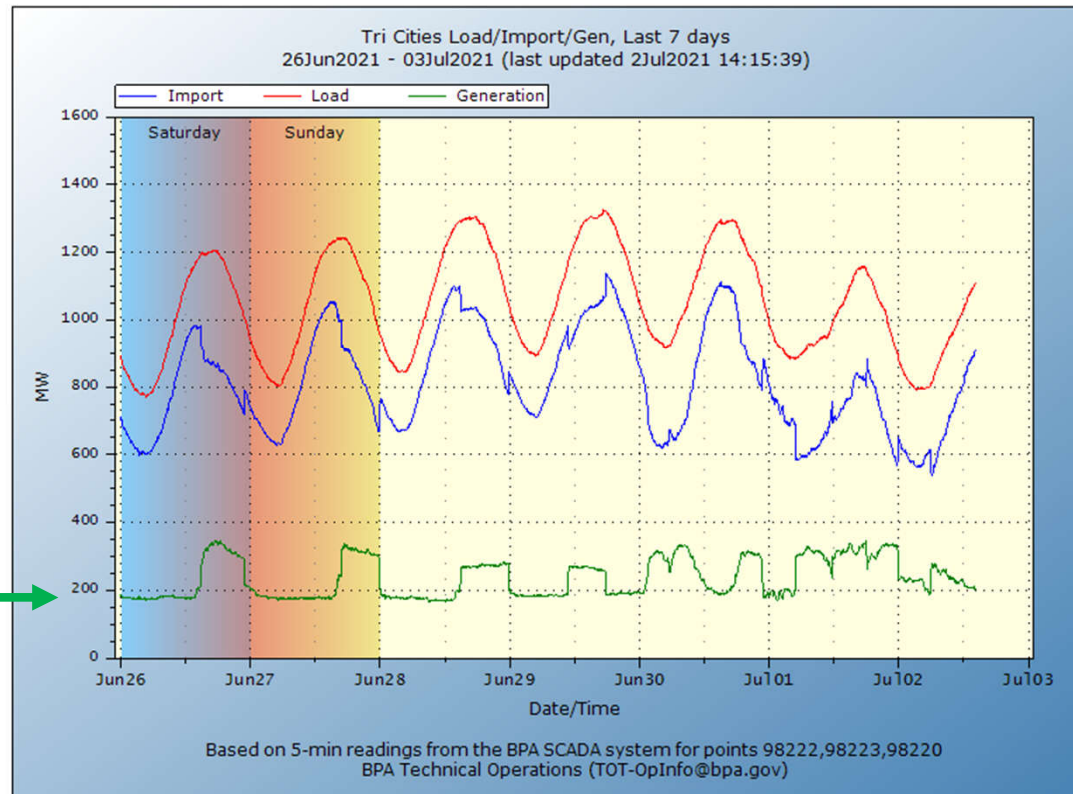
How you can prepare for a power outage and what to do once your power is out. BY ALYSSA HODENFIELD

**Snake River  
Ice Harbor Dam  
Critical to BPA  
Tri-Cities  
Transmission  
Operations**

### Tri-Cities Load/Imports/Generation MW

Data automatically refreshes every 5 minutes...

Download data (tab separated values)



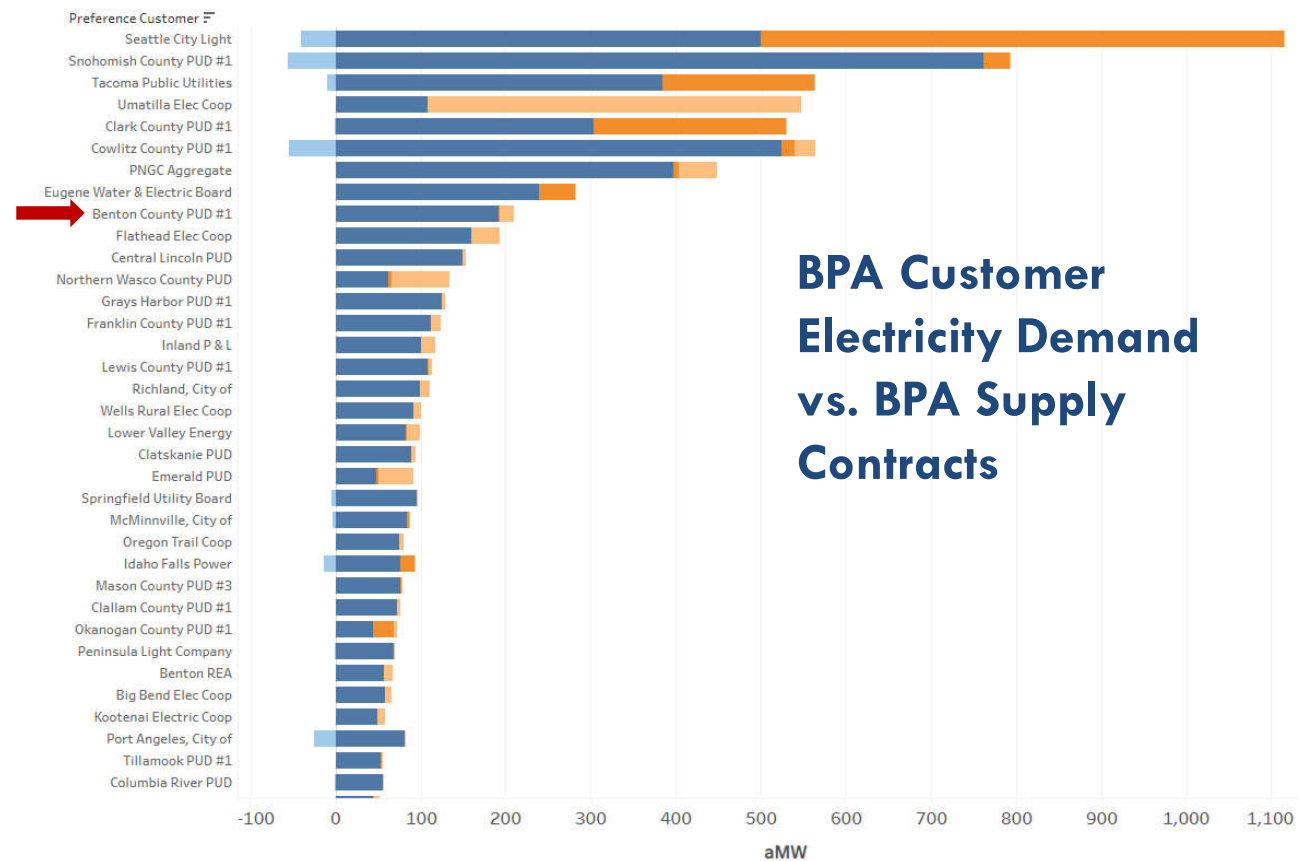


# Tri-Cities Area Utility Loads & BPA

106

Utility	2022 Annual aMW
Benton PUD	210
Franklin PUD	124
City of Richland	111
Benton REA	67
Big Bend Elec Coop	66
Columbia REA	42
<b>TOTALS</b>	<b>620</b>

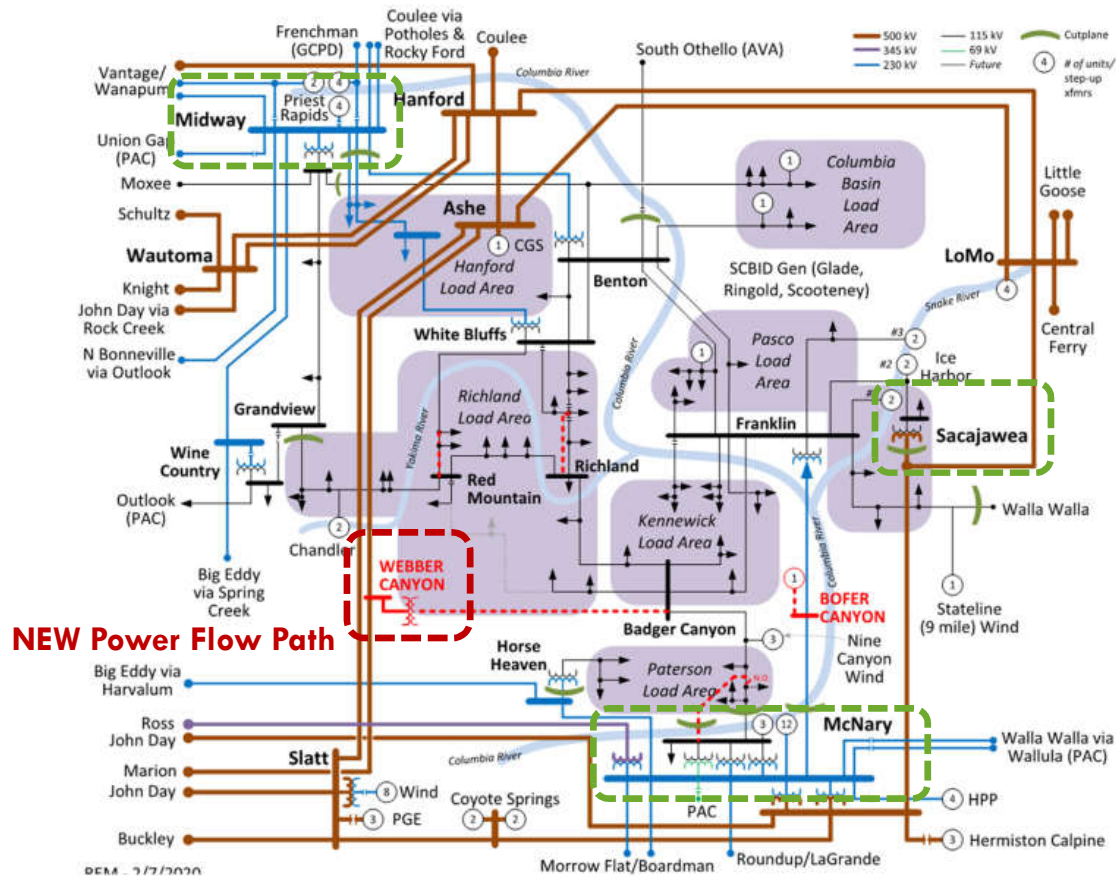
2022 Preference Customer Load Service Resource Breakdown



**BPA Customer Electricity Demand vs. BPA Supply Contracts**

# BPA Tri-Cities Area Grid Upgrades

107



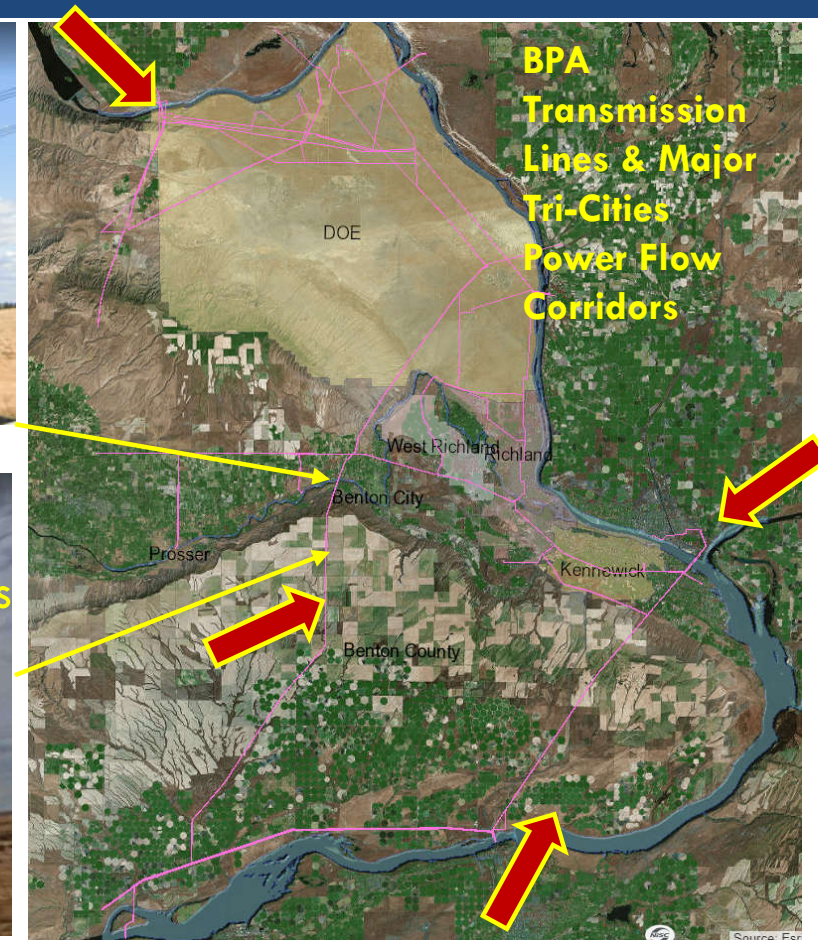
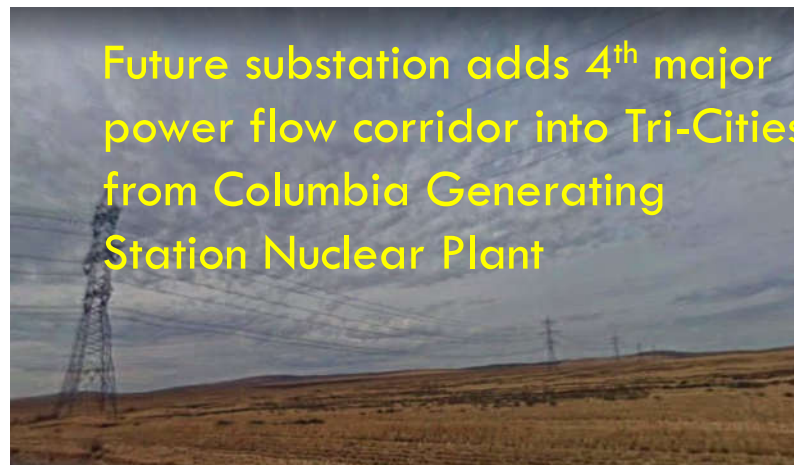
## TRI-CITIES AREA REINFORCEMENT

South Tri-Cities Reinforcement	\$80M	2025
McNary-Paterson Tap	\$5.2M	Mid 2023
Red Mountain-Horn Rapids 115 kV Line	\$3.6M	Fall 2023 or Spring 2024
Richland-Stevens Drive 115 kV Line	\$11M	2024

- ✓ 2021 Heat Dome Event Tri-Cities Area demand of 1,300 MW
- ✓ Increases BPA capacity in the area to 1,750 MW
- ✓ Adds 4<sup>th</sup> 500 kV Power Injection at new Webber Canyon Substation w/ electrons from Columbia Generating Station

# BPA Tri-Cities Area Grid Upgrades

108







## Clean Energy Policies – Other Considerations

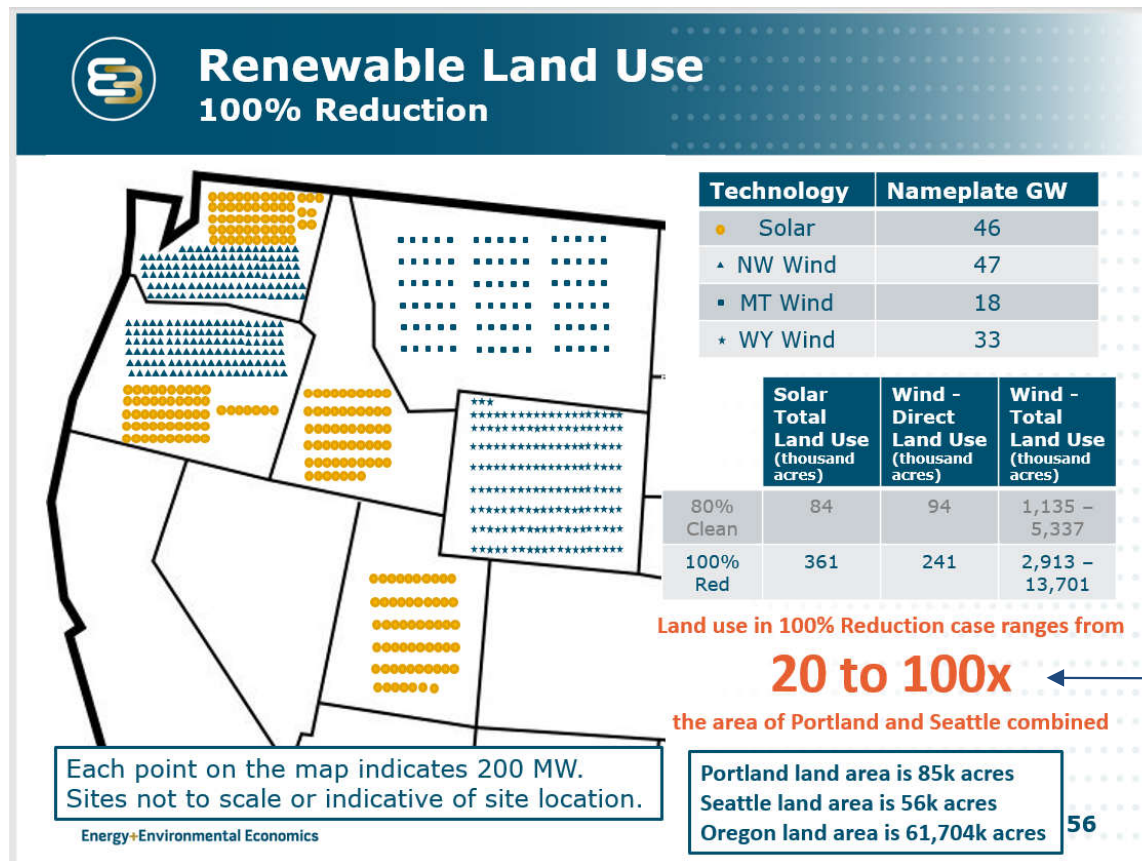




# Land Use Impacts of Wind & Solar

110

Study was provided to WA State Legislature & Governor's Office prior to passage of Clean Energy Transformation Act



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



Assumes 100% of Existing Hydropower stays in Place

# Transmission Line Development Friction

111



## CAISO Declares Emergency as Fire Derates Major Tx Lines

Jul 9, 2021 | Hudson Sangree and Robert Mullin

CAISO declared a Stage 2 emergency Friday as wildfire in Oregon nearly shut down a major transmission pathway between California and the Pacific Northwest.

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



- **Historical View:** Avoid building if at all possible
- **Current View:** Building more transmission lines is critical to clean energy future

- **Preemptive power line shutoffs and blackouts**

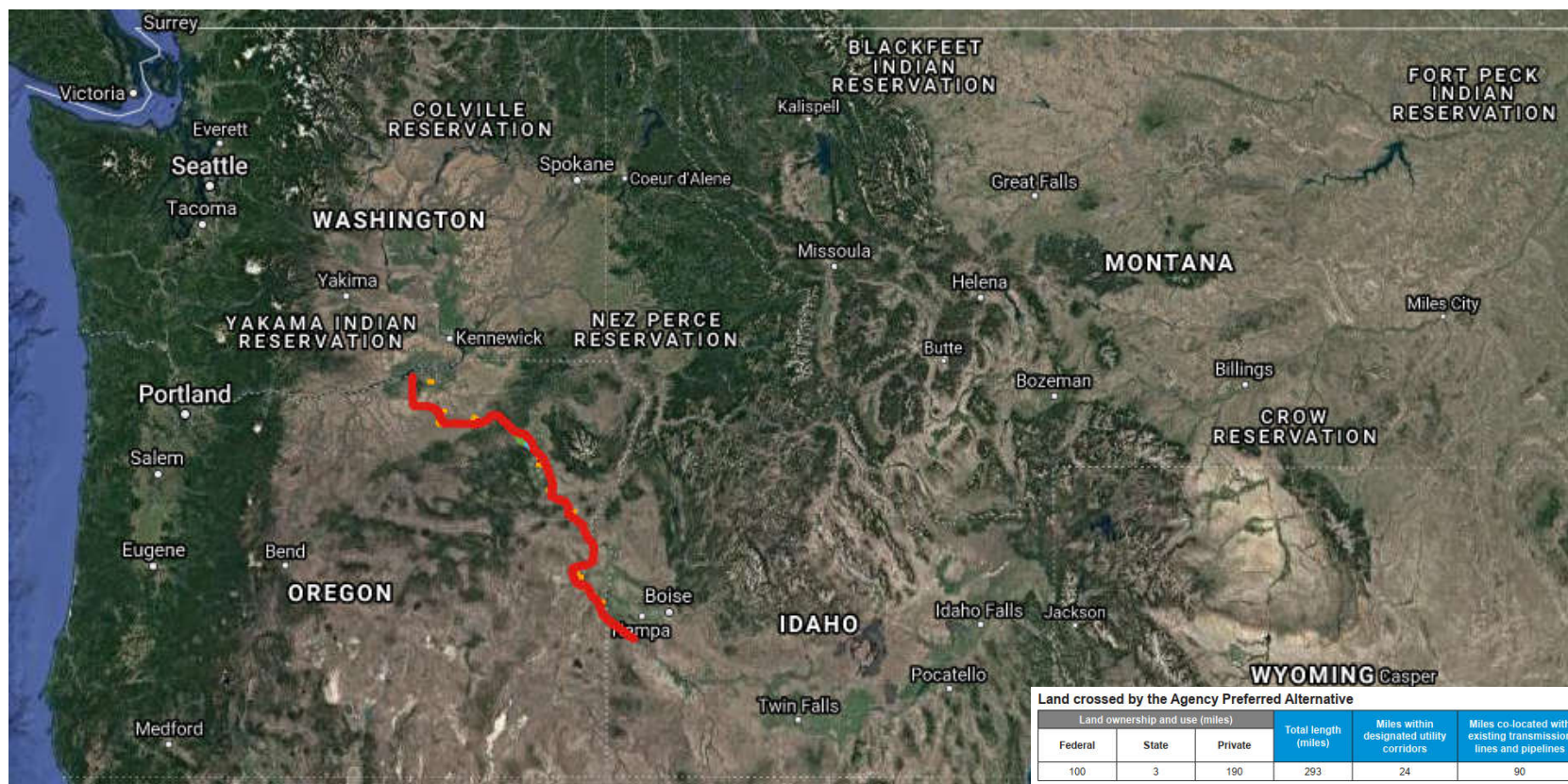
- **Increased utility legal and financial risks**

- **Dispersed wind and solar multiplies the needed transmission line corridors**
- **Rural and scenic areas will bear the burden**

- **Long lead times for permitting and construction (+20 years?)**

# Boardman-to-Hemingway 500 kV Line

112

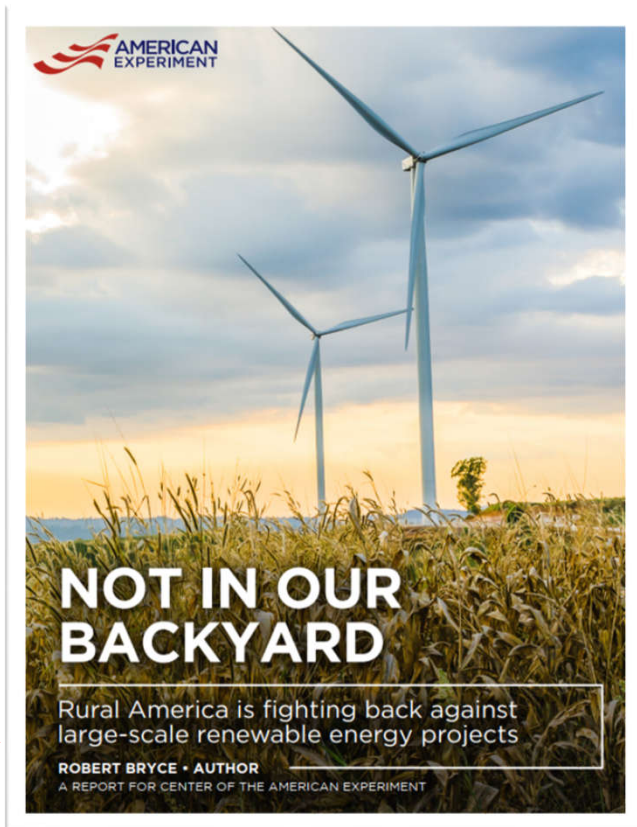


- 300 miles
- Need identified 2002
- Project defined 2006
- Complete by 2026?
- Raises serious questions about WA doubling electricity capacity and counting on Montana & Wyoming Wind & Solar
- Are MT and WY on board with WA strategy?



# Land-Use Conflicts

113



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

**Paving rural America with renewable energy will cost trillions of dollars, create visual blight on landscapes across the country, kill untold numbers of bats and birds, cause more negative human health impacts, and lead to more economic pain in rural America.**

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



# Policies in Conflict

114

## Los Angeles Times

CLIMATE & ENVIRONMENT



### How a federal agency is blocking America's largest wind farm



Road construction is underway for a giant wind farm at Phil Anschutz's Overland Trail Ranch in Wyoming. (Anschutz Corp.)

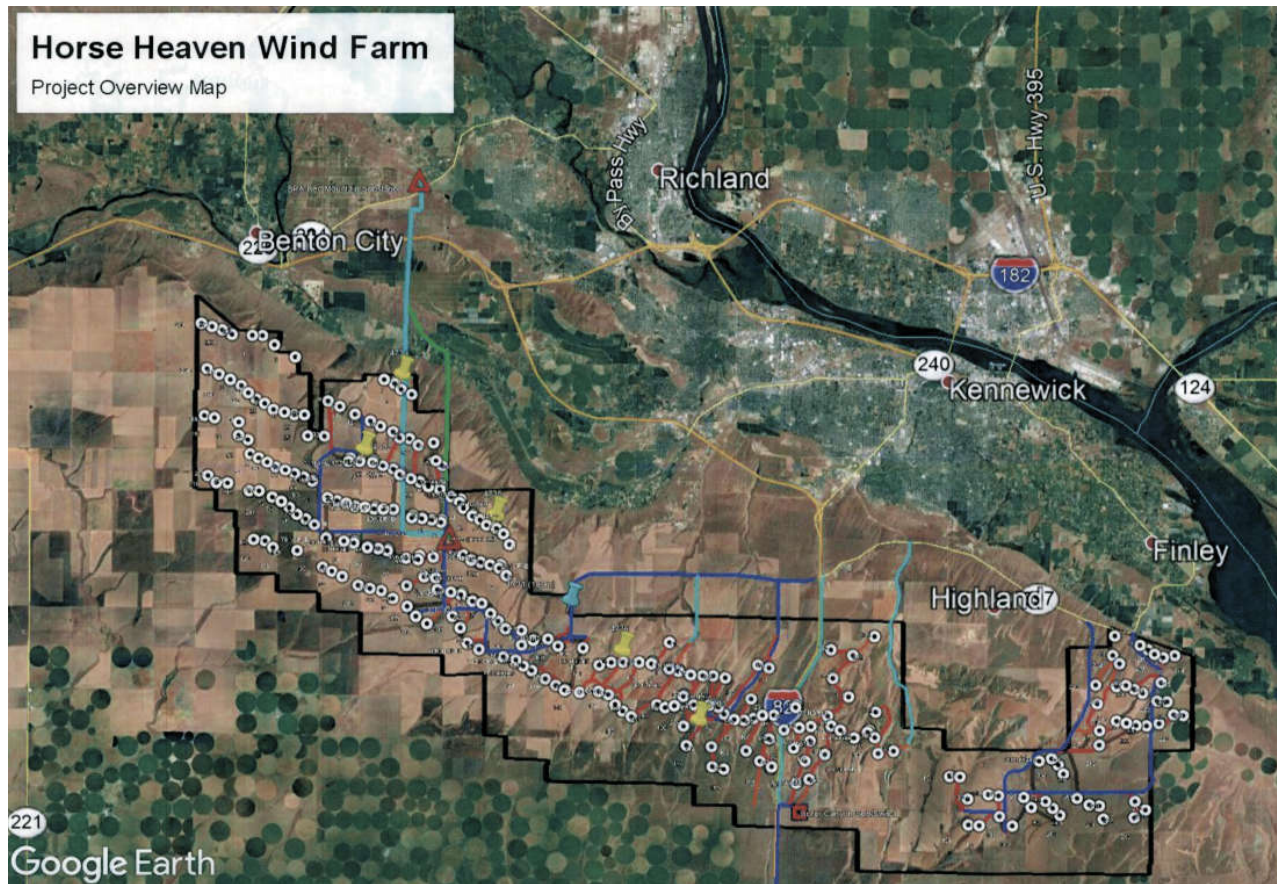
That's right: Even as President Biden urges Congress to fund a rapid buildout of clean energy infrastructure to fight climate change, an arm of his administration is helping to block the country's largest renewable power project.

"We've got a policy priority of increased renewable energy, and we have a policy priority of increased conservation. Those two are going to continue to butt heads," he said. "We have to find ways to resolve those conflicts."

Renewables vs. Conservation

# Benton County Wind Farm: A WA Case Study

115



- 850 MW Wind Project
- Benton County
- 244 Wind Turbines
- Up to 600 feet tall
- 72,428 acres (113 square miles)
- **Developer using EFSEC process to gain Governor Inslee's approval**
- **Overwhelming local opposition**

# Benton County Wind Farm: A Case Study

116

Deserts and arid lands are habitats too . . . for animals & people



State of Washington

DEPARTMENT OF FISH AND WILDLIFE

Pasco District Office, Habitat Program • 2620 North Commercial Avenue, Pasco, WA 99301

*“These areas, as well as the entire Horse Heaven Hills ridgeline, are used seasonally and year-round by a variety of avian species, some of which are State, Priority, Candidate, and Threatened Species. In fact, the entire Horse Heaven Hills ridgeline is an important area for avian species and other wildlife, including reintroduced Pronghorn antelope. It is a strategic location that provides suitable habitat for a variety of native plant and wildlife species and has been recognized as such through a variety of scientifically validated stakeholder publications.”*



# Unspoken Environmental Costs

## 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, 2016 6:45 pm ET



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

**IEA estimates need to increase the supply of minerals such as lithium, graphite, nickel, and rare earths by 4,200%, 2,500%, 1,900%, and 700%, respectively, by 2040.**

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



Source: <https://www.prageru.com/video/whats-wrong-with-wind-and-solar/>

- ✓ We should at least be talking about this
- ✓ Is social cost of carbon the only environmental cost worth considering?
- ✓ Are there stricter limits we should be putting on wind/solar development?

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.



# Power/Energy Density Matters to the Environment

118

**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 NuScale Small Modular Reactor Complex = 0.05 square miles of land

# Next Generation Nuclear



Advanced  
Reactor  
Demonstration  
Program

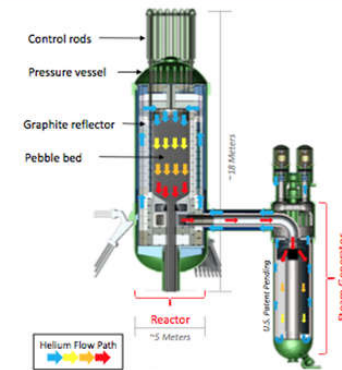
ARDP Grant  
Recipient #1

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

4/12/2021  
NEWS RELEASE



## The Xe-100 Reactor Cannot Melt Down



- Xe-100 Reactor Benefits**
- Helium transports heat from the reactor to the steam generator; no cooling fluid required
  - Reactor core design eliminates the possibility of meltdown
  - On-line refueling allows for continuous operations
  - Able to quickly respond to energy demands
  - Used fuel is proliferation resistant

© 2015 X Energy, LLC

Nuclear Energy. Reimagined.

7

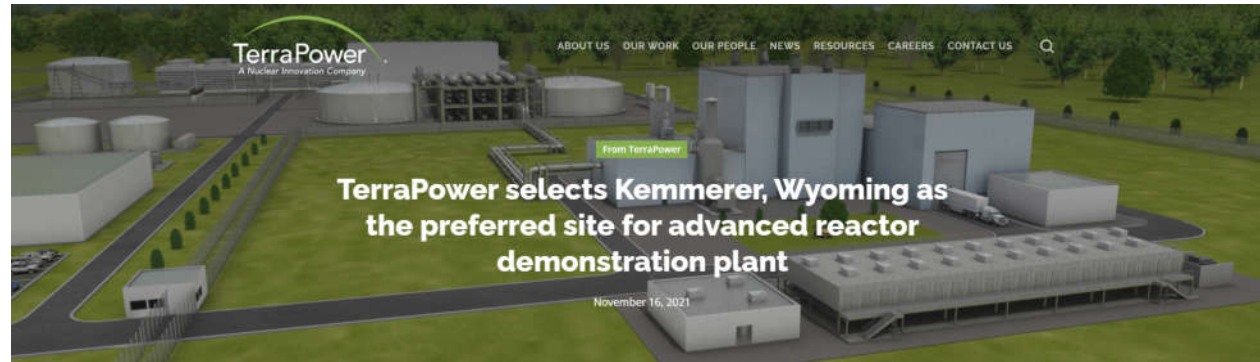
## Bill Gates and Warren Buffett to build new kind of nuclear reactor in Wyoming

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



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

ARDP Grant  
Recipient #2






## Benton PUD Capacity and Residential Demand Charges





PLEASE RETURN THE BOTTOM PORTION WITH YOUR PAYMENT • MAKE YOUR CHECKS PAYABLE TO: BENTON PUD

	<b>Kennecworth Office</b> 2721 W 10th Ave P.O. Box 6270 Benton, WA 99306 (509) 582-2175	<b>Prosser Office</b> 250 N Gap Road Prosser, WA 99350 (509) 786-1841	<b>AMOUNT DUE</b> <b>ACCOUNT NUMBER</b> Total Amount Due <b>\$170.08</b> New Charges Due Date <b>09/12/2022</b>
	Manage your account with SmartHub! ♦ Make Payments, Go Paperless ♦ Track Electric Usage ♦ Report Outages <a href="http://BentonPUD.org">Sign up at BentonPUD.org</a>		<b>Helping Hands Donation</b> \$ <b>Total Amount Enclosed</b> \$ <b>Autopay - Do Not Pay</b>



BENTON PUD  
 PO BOX 6270  
 KENNECKWICK WA 99336-0270      6



512040066559000000190800001919606220220

NEW CHARGES DETAIL	
Service From 07/18/2022 - 08/18/2022	
Residential Services	
1,857 kWh @ 0.0739	\$137.23
31 Days Daily System Charge	\$19.53
Kennewick City Tax	\$13.32
<b>Subtotal New Charges</b>	<b>\$170.08</b>
AutoPay Date 09/12/2022	

**METER INFORMATION**

Meter #	Current	Previous	Mult	kWh Usage	KW Demand
	1344	99487	1	1857	12

**KWH USAGE HISTORY**

Month	kWh Usage	Temp °F
Aug 2021	1750	75
Sep	750	65
Oct	600	55
Nov	700	50
Dec	750	45
Jan	850	35
Feb	700	40
Mar	600	45
Apr	700	50
May	600	55
Jun	650	60
Jul	1400	65
Aug 2022	1750	75

**PERIOD ENDING**

	Aug 2021	Aug 2022
Avg Daily Temperature	79	81
Avg Daily kWh Usage	58	60
Avg Daily Cost	\$5.98	\$6.13

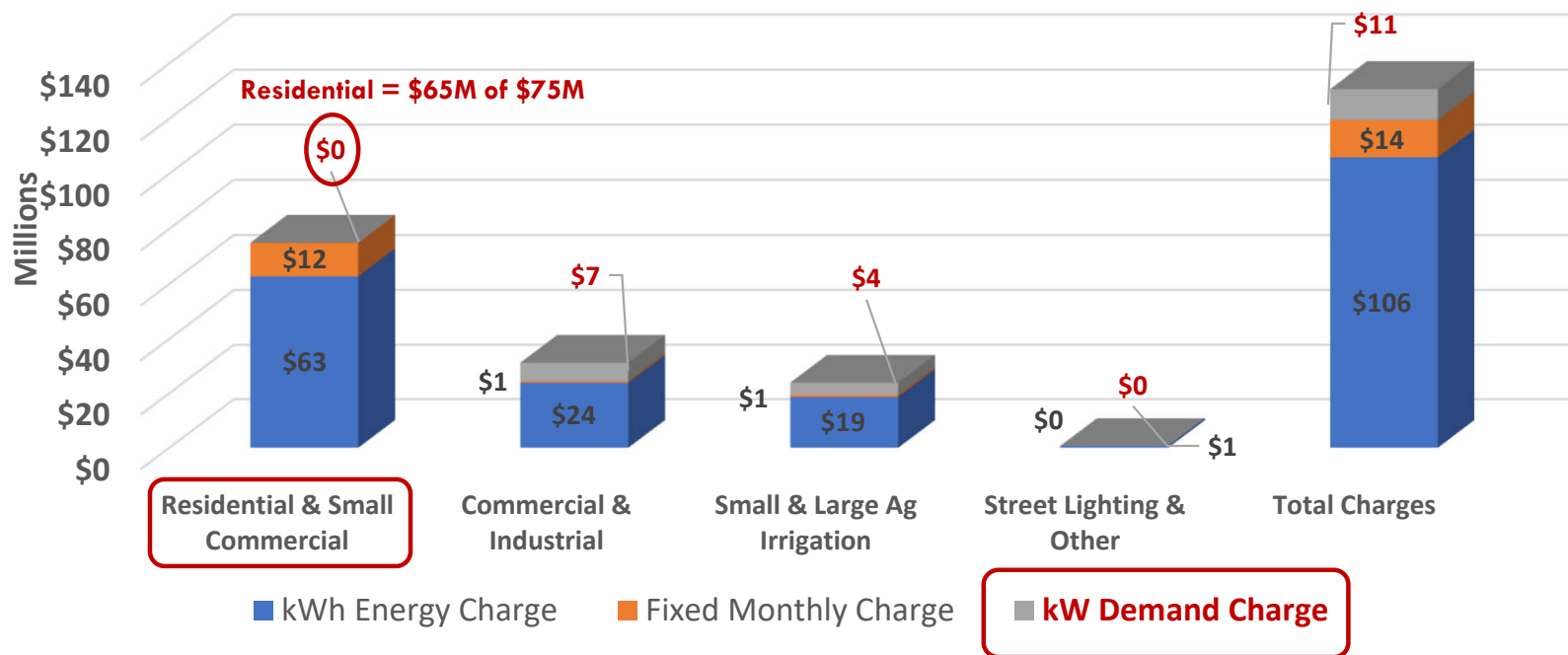
- **Energy Consumption in kWh is the dominant billing component**
- **Currently no charge based on individual residential customer KW Demand**
- **Maximum power demand KW (kilowatts)**
- **Establishes Capacity of power lines & equipment needed to prevent overloading**
- **Measured as maximum average energy used over a half-hour period in billing cycle (would be one-hour period with proposed residential demand charge).**



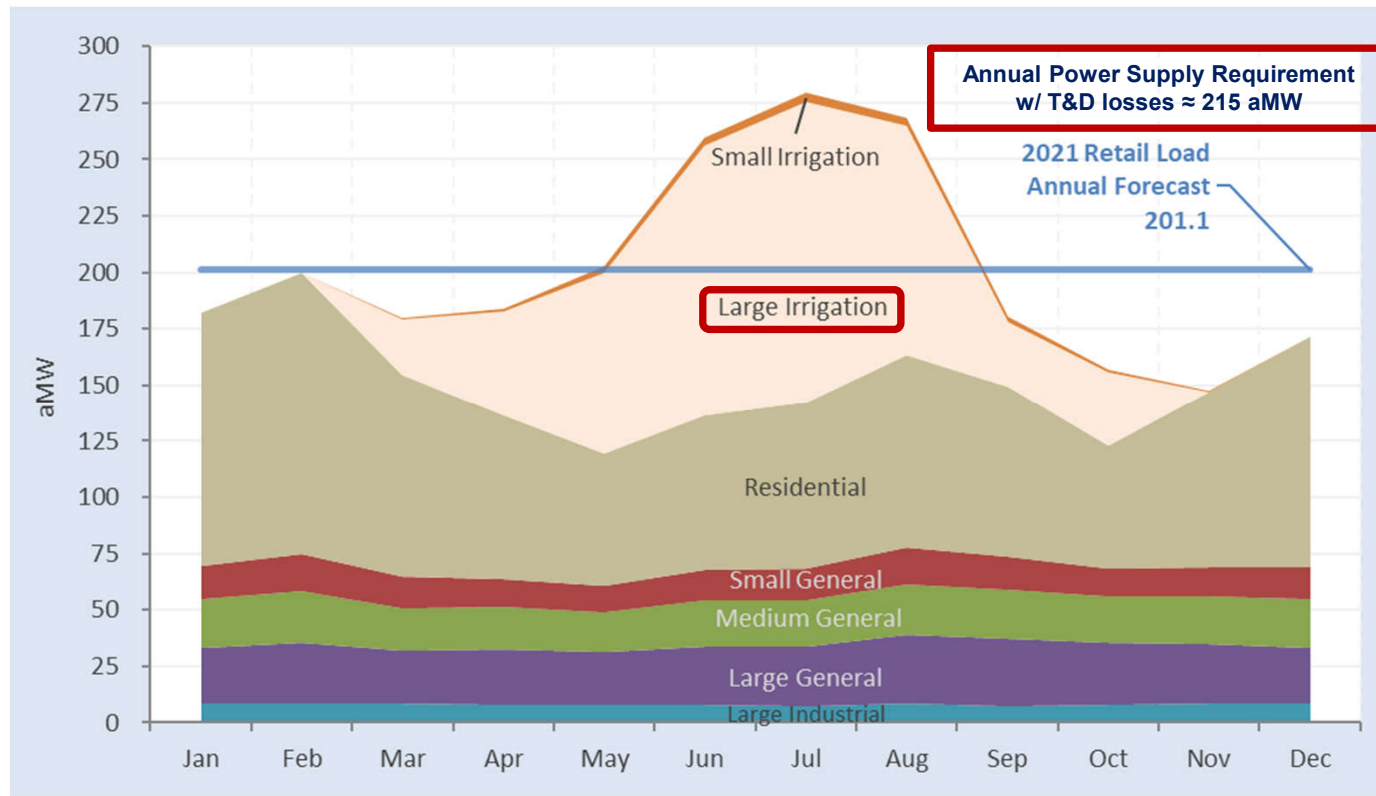
# Benton PUD Existing Capacity Charge Revenues

122

## Total Benton PUD Customer Revenues by Type of Charge



## Retail Load Shape – Very Summer “Peaking”



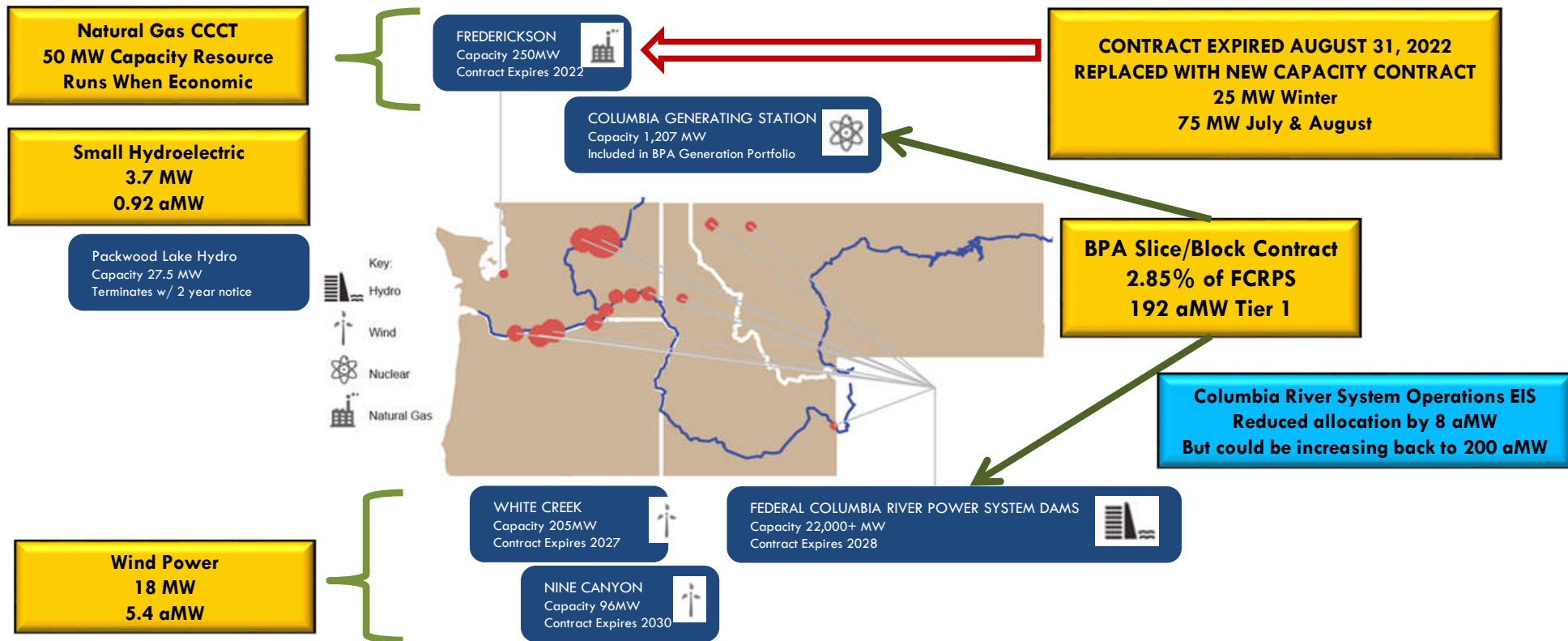
### System Peak Hourly Load

**Summer: 490 MW (2021)**

**Winter: 371 MW (2017)**



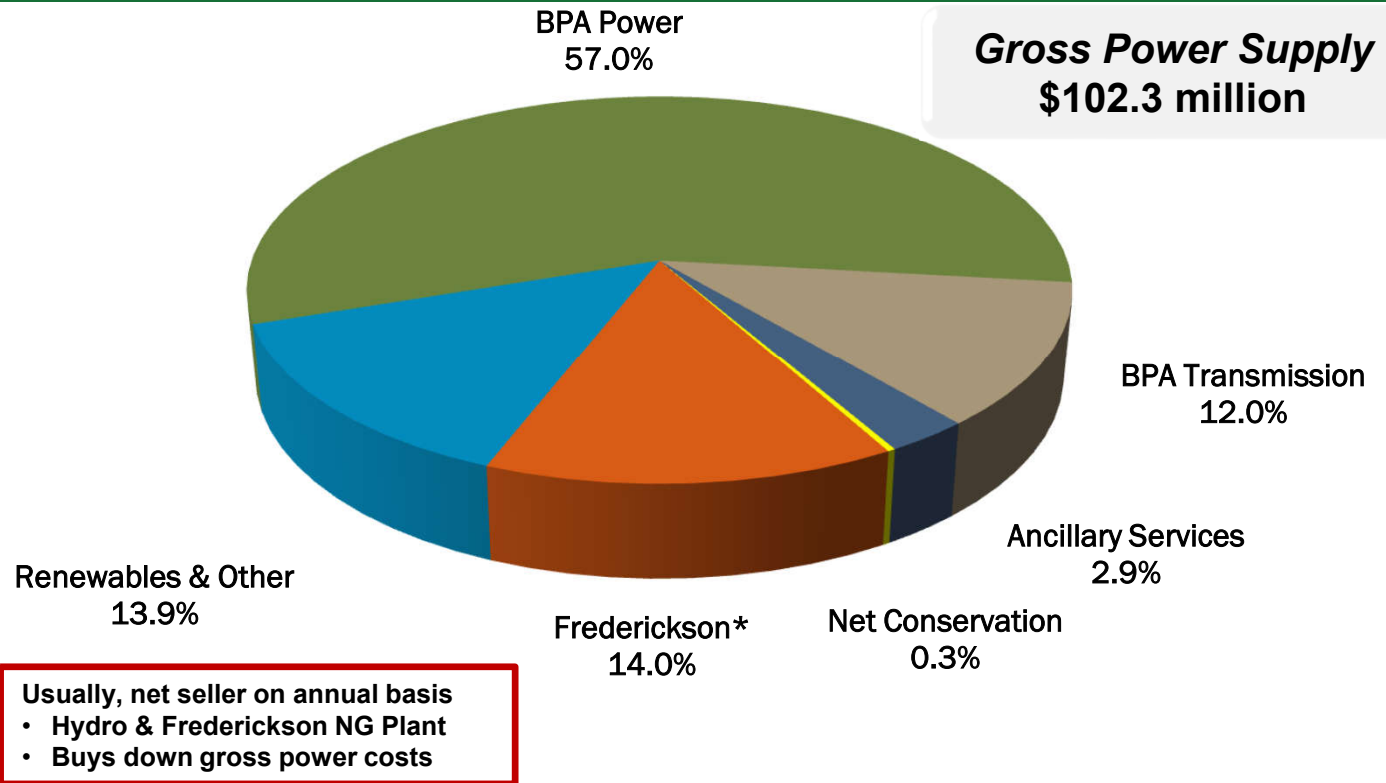
# BPU Generation Resources



# 2022 Power Supply Budget

125

Description	Amount
BPA Power	\$58.3
BPA Transmission	12.3
Gross Fredrickson*	14.3
Renewables & Other	14.2
Ancillary & Net Conservation	2.9
<b>Gross Power Supply</b>	<b>\$102.3</b>
<b>Less: Secondary Market Sales</b>	<b>(21.1)</b>
<b>Less: Transmission Sales</b>	<b>(1.1)</b>
<b>Net Power Expense</b>	<b>\$80.1</b>



\* Gross cost excludes the estimated secondary market sales from Frederickson (energy & gas) of \$13.2 million resulting in net Frederickson costs of \$4.1 million, which is 5.0% of net power expense.



# Benton PUD Hydro & Nuclear Supply/Demand

126

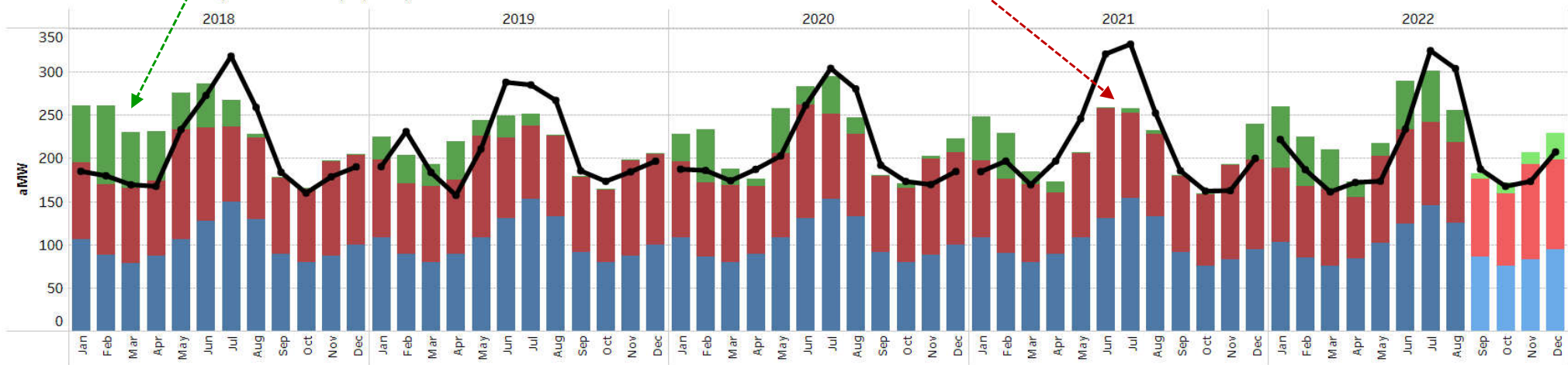
Some years/months we have more energy than we need

Seller in regional power market

Some years/months we have less energy than we need

Buyer in regional power market

Load vs. BPA Resources (Forecast as of 09/01/2022)

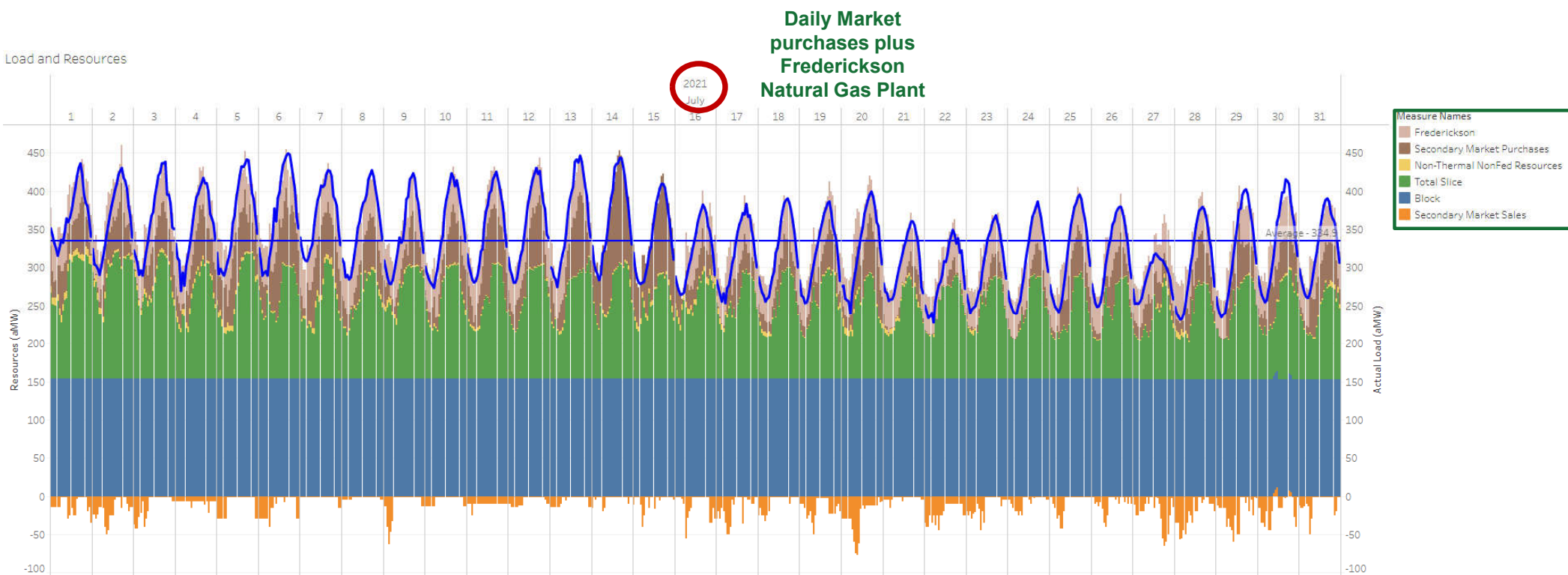


Note: Benton PUD actual and forecasted load includes transmission losses. Forecasted deficits are typically covered through the use of financial hedges approved by the Risk Management Committee members and the physical deficit is covered with Day Ahead and Real-time purchases made by The Energy Authority (TEA).

- Above Critical Slice
- Critical Slice
- Block
- Forecast Above Critical ...
- Forecast Critical Slice
- Forecast Block
- Load (Actual & Forecast)

# BPUD Reliance on Power Market Purchases

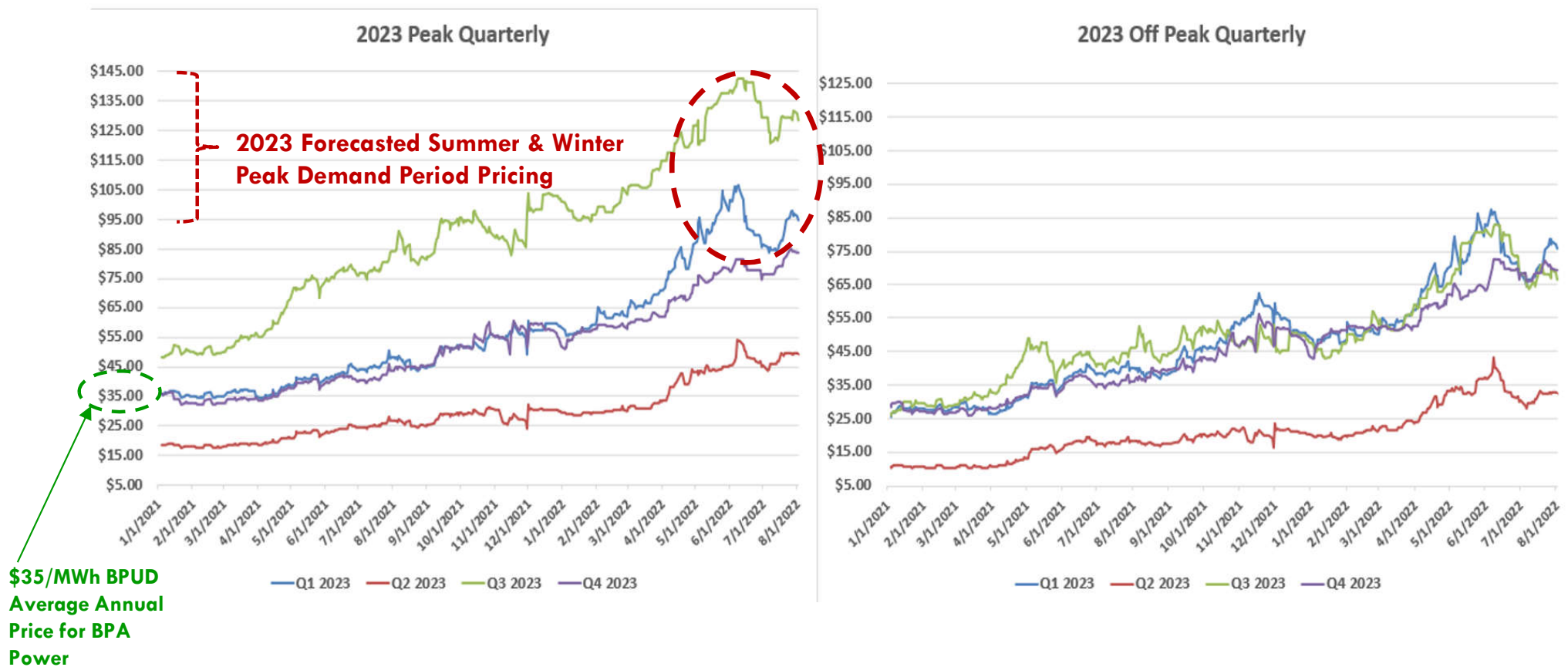
127



**We need dependable seasonal generating Capacity we know will be available for the hours, days and weeks we need it.**

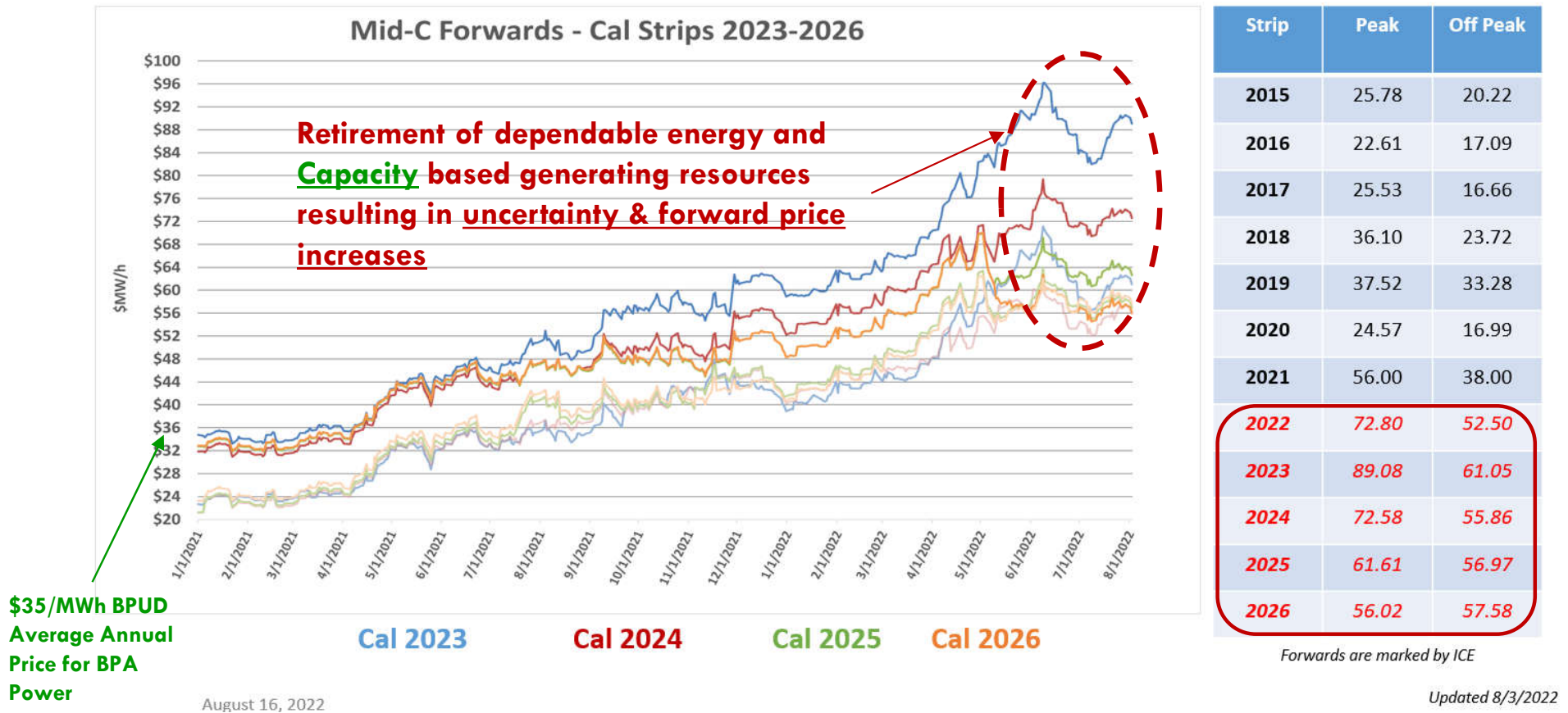
# Market Purchases: Future Seasonal Prices Going Up

128



# Market Purchases: Future Annual Prices Going Up

129

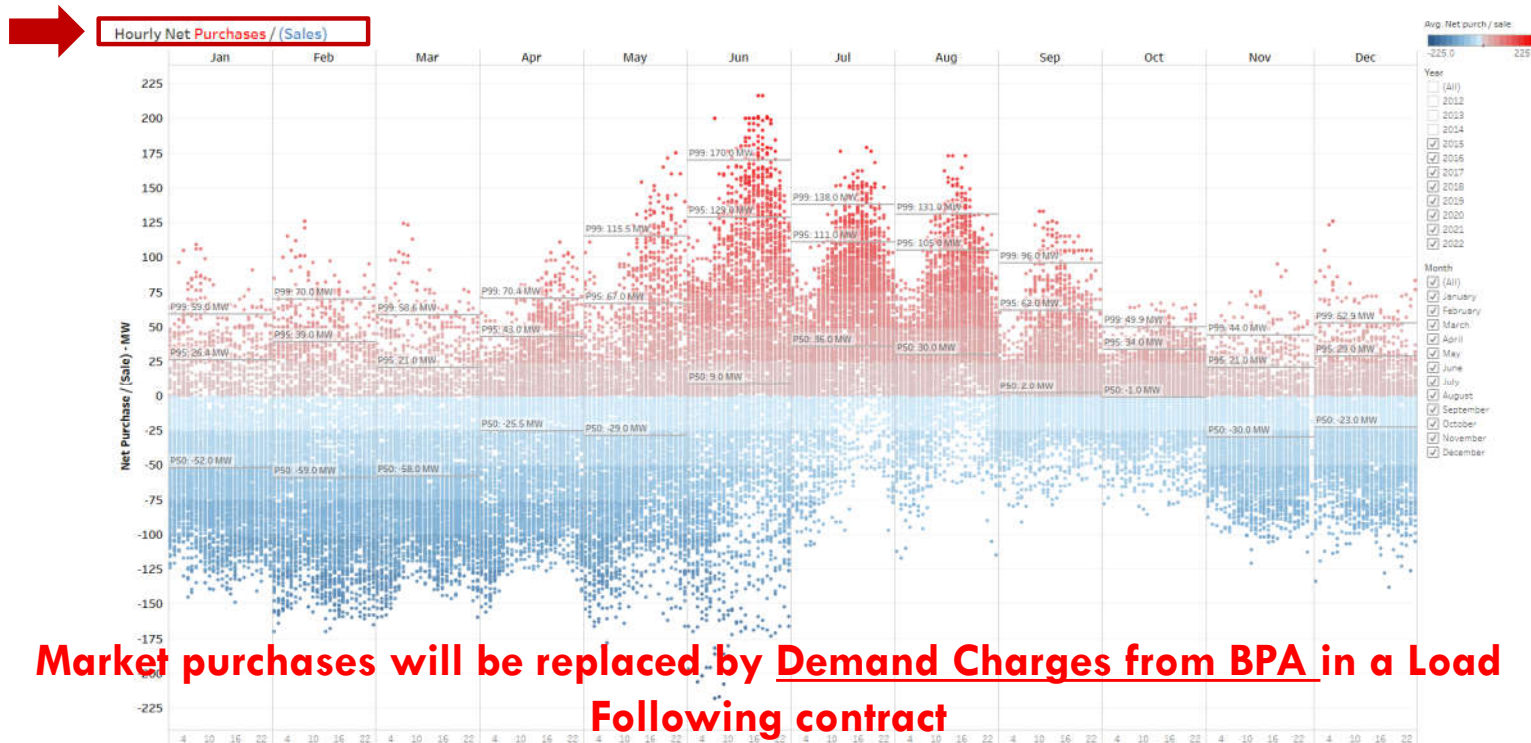




# Benton PUD Possible BPA Contract Conversion

130

***Benton PUD is very concerned about the future availability and price of dependable generating Capacity for purchase in power markets***

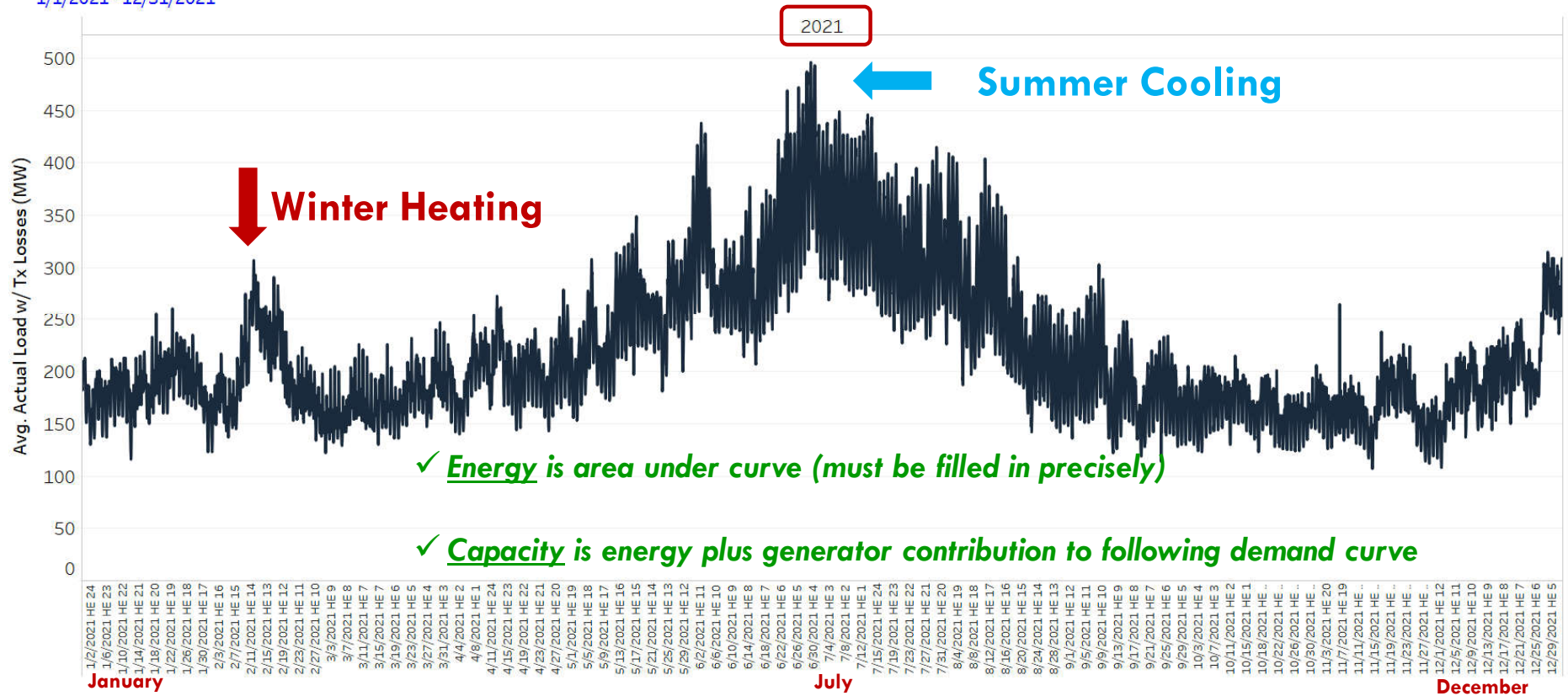


- ✓ Existing BPA Slice/Block contract requires market purchase and sales to balance loads & resources
- ✓ Increasing power market volatility and costs
- ✓ Asked for and offered option to convert to BPA Load Following as early as October 2023
- ✓ Final Decision Expected September or early October of this year

# Total Hourly Electricity Demand Curve

## Benton PUD Load

1/1/2021 - 12/31/2021



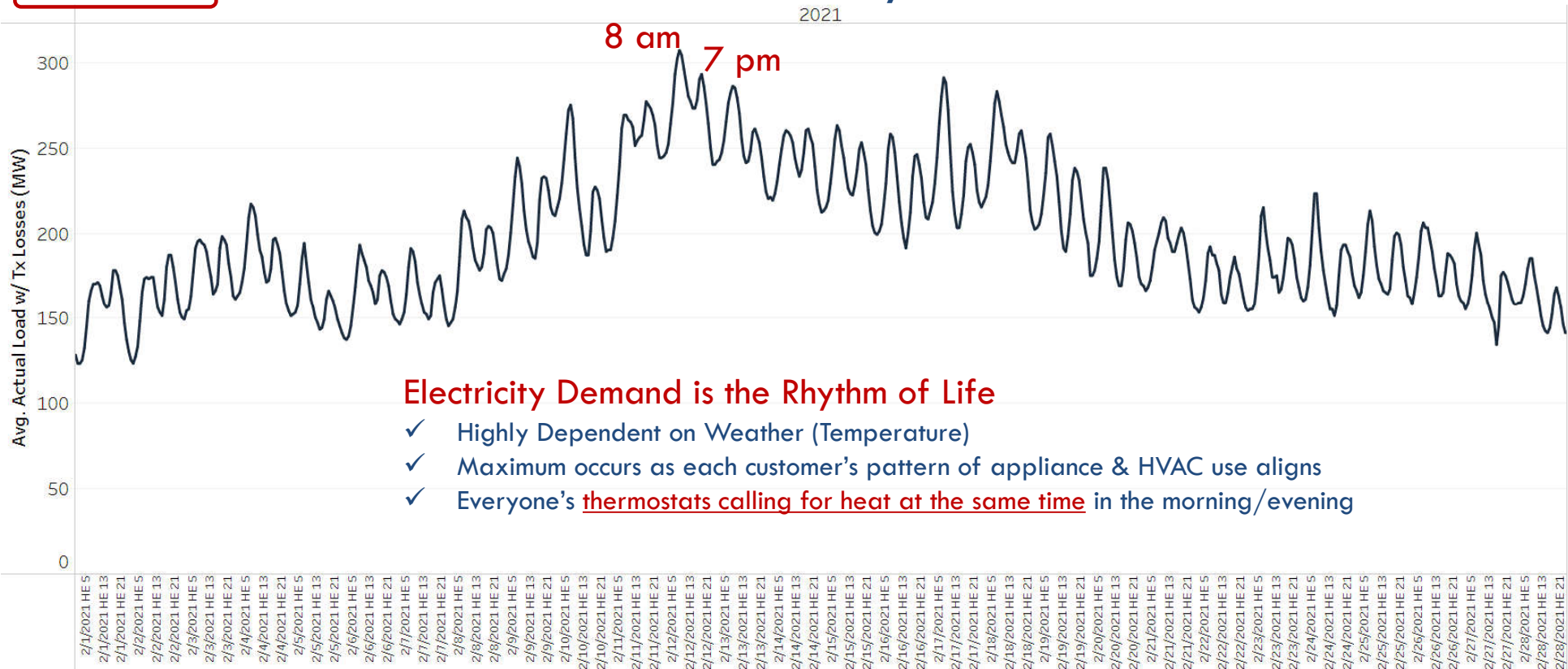
# Winter Electricity Demand Curve

## Benton PUD Load

2/1/2021 - 2/28/2021

February

2021



# Summer Electricity Demand Curve

## Benton PUD Load

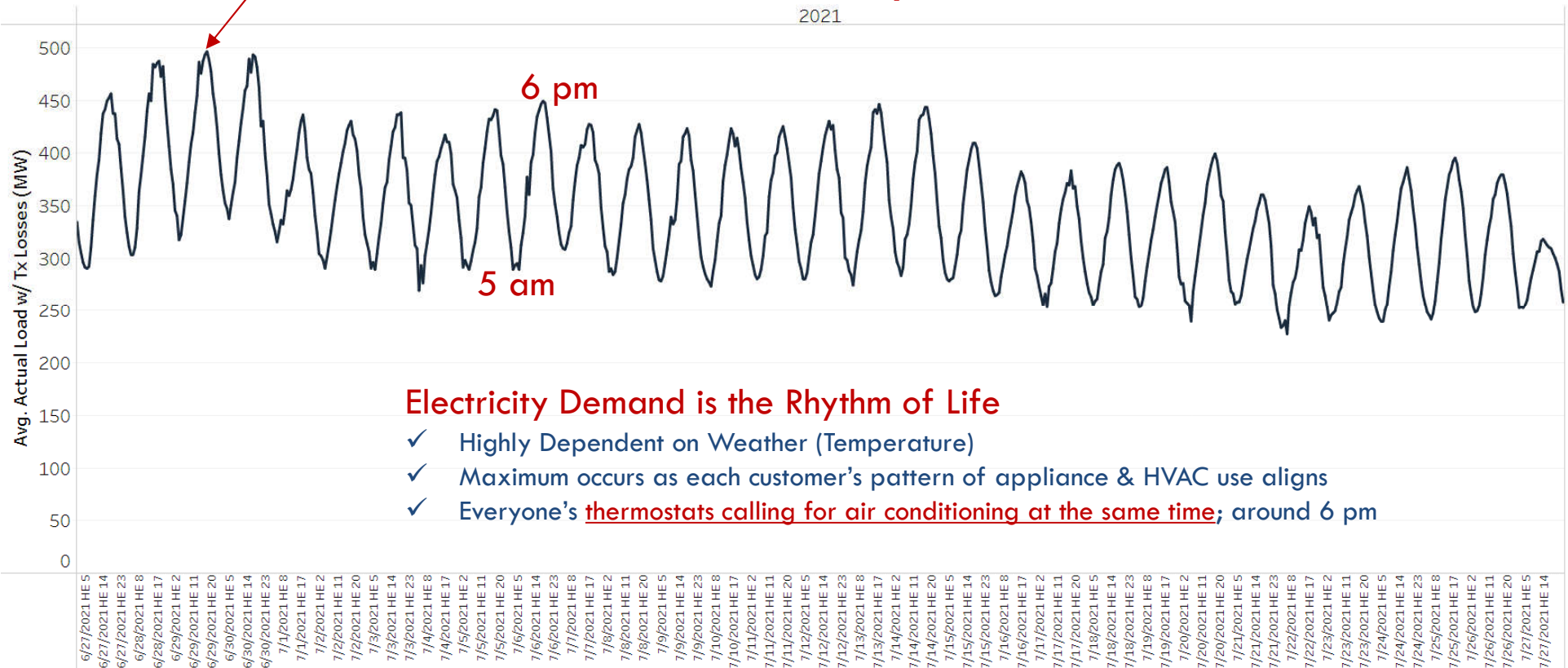
6/27/2021 - 7/27/2021

Heat Dome Event 115°

New Record Maximum Demand

June - July

2021





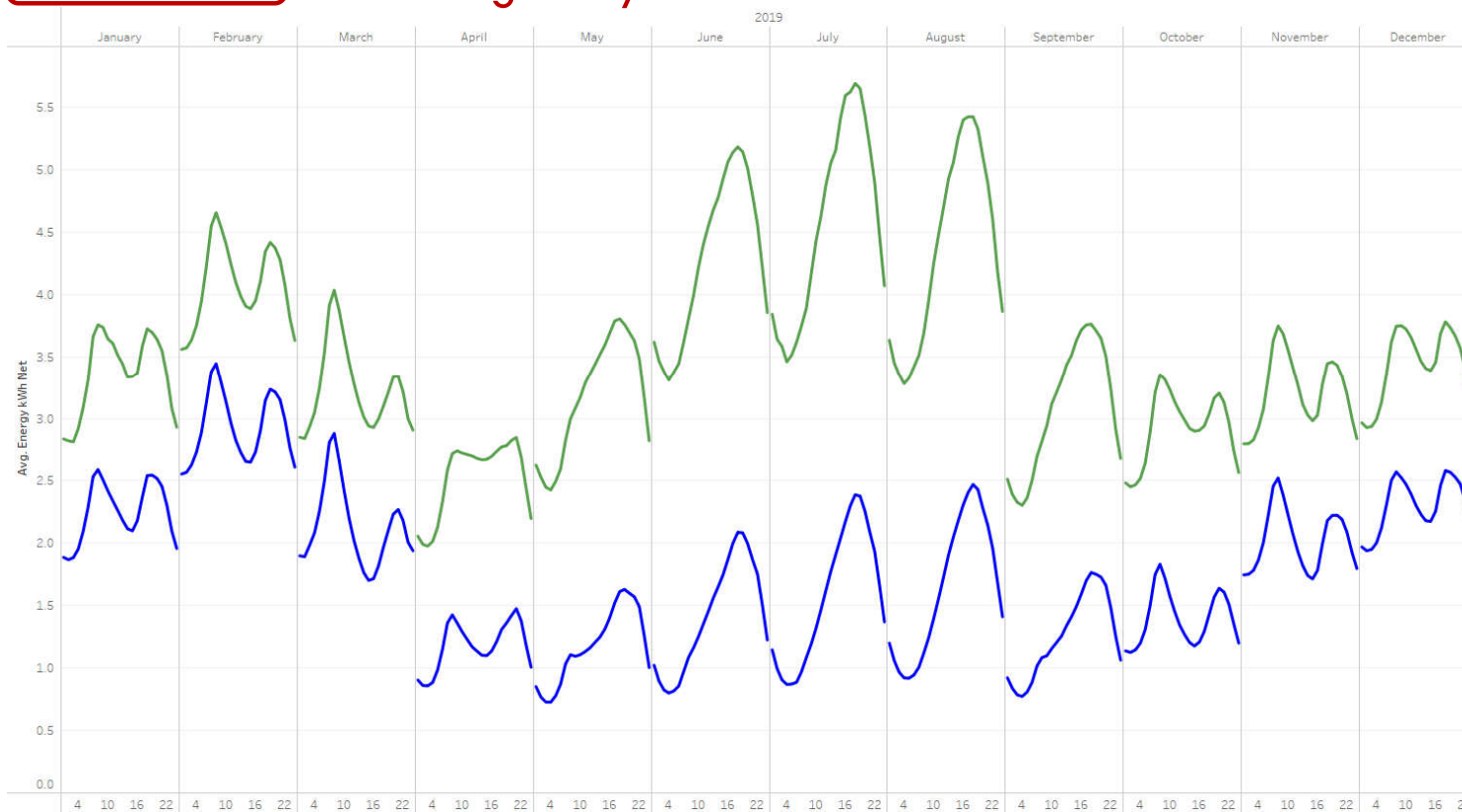
# Residential Drives Demand Curve

134

Average Hourly Load

All Classes versus Residential

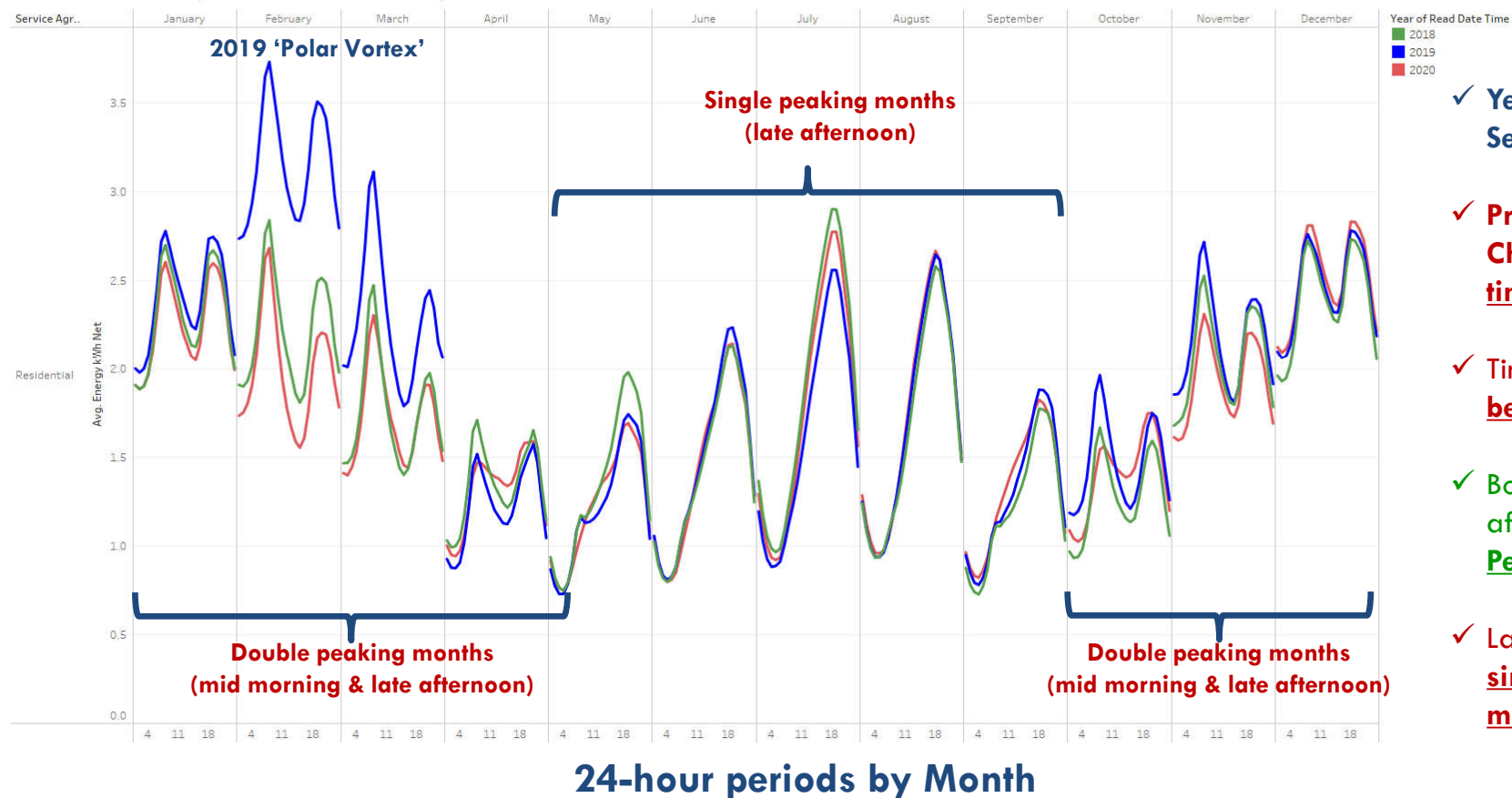
## Average Day Customer Demand Curve



- ✓ Residential is the Major Contributor to Total System Peak Demand
- ✓ Currently no proportionate charge for residential customers contributing most to Peak Demand

# Residential Demand Curve Predictable

Average Hourly Load (Customer Class: Residential)



✓ Year-to-Year Seasonal Patterns

✓ Proposed Demand Charges would be time-of-day based

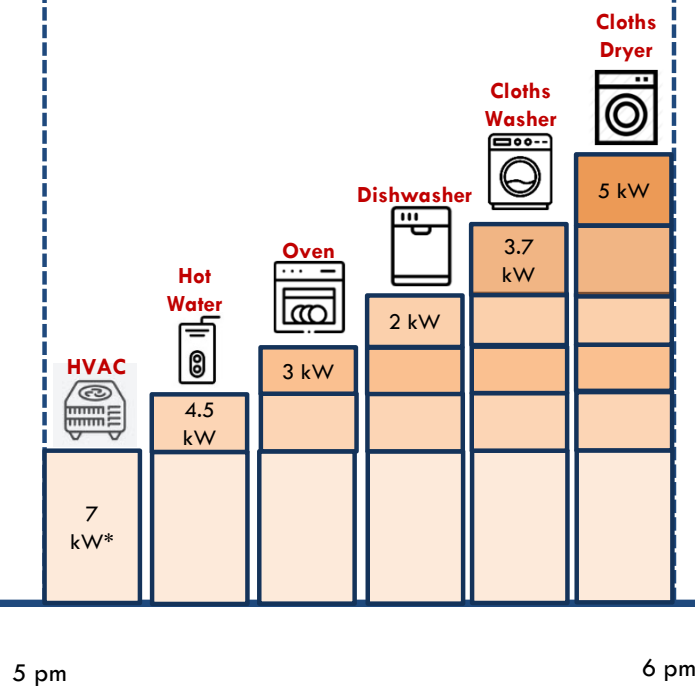
✓ Time-of-day would be fixed periods

✓ Both morning and late afternoon in Double Peaking Months

✓ Late Afternoon in single peaking months

# What Drives Residential kW Demand Curve?

Summer and Winter evening peaks typically occur between 5-8pm when customers run several appliances. While each appliance does not run at full capacity 100% of the time during a period, together they contribute to utility total system peak demand for electricity.

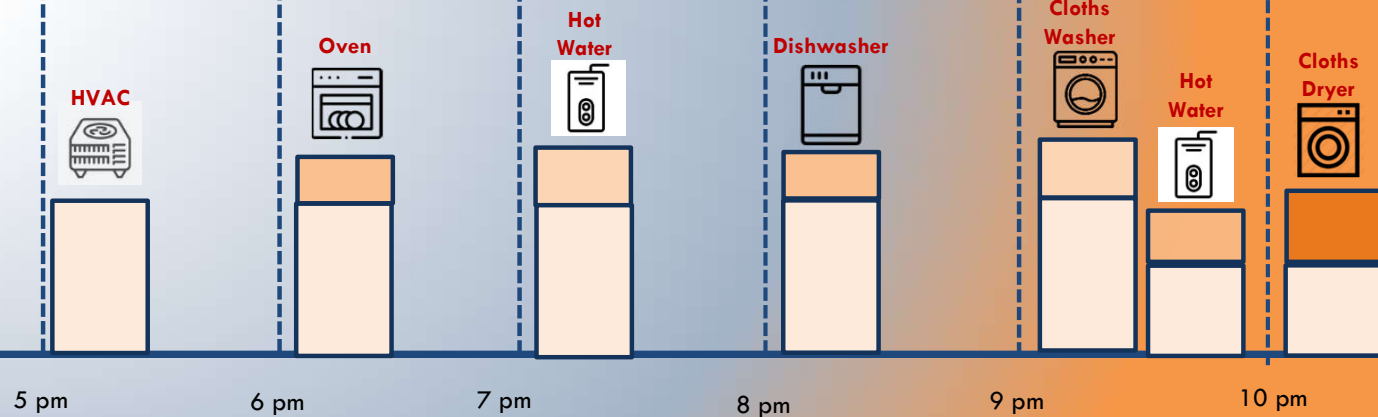


Potential for large demand if all appliances running at the same time

\*Can range from 3 kW for A/C to 10 kW for heat

# Customers Can Control Demand Curve

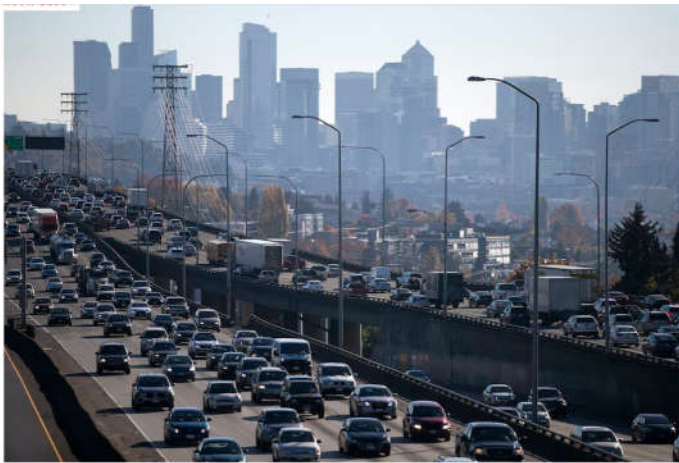
By spreading out appliance use a customer can significantly reduce peak electricity demand





# Electric Vehicle Charging: Increasing Electricity Demand

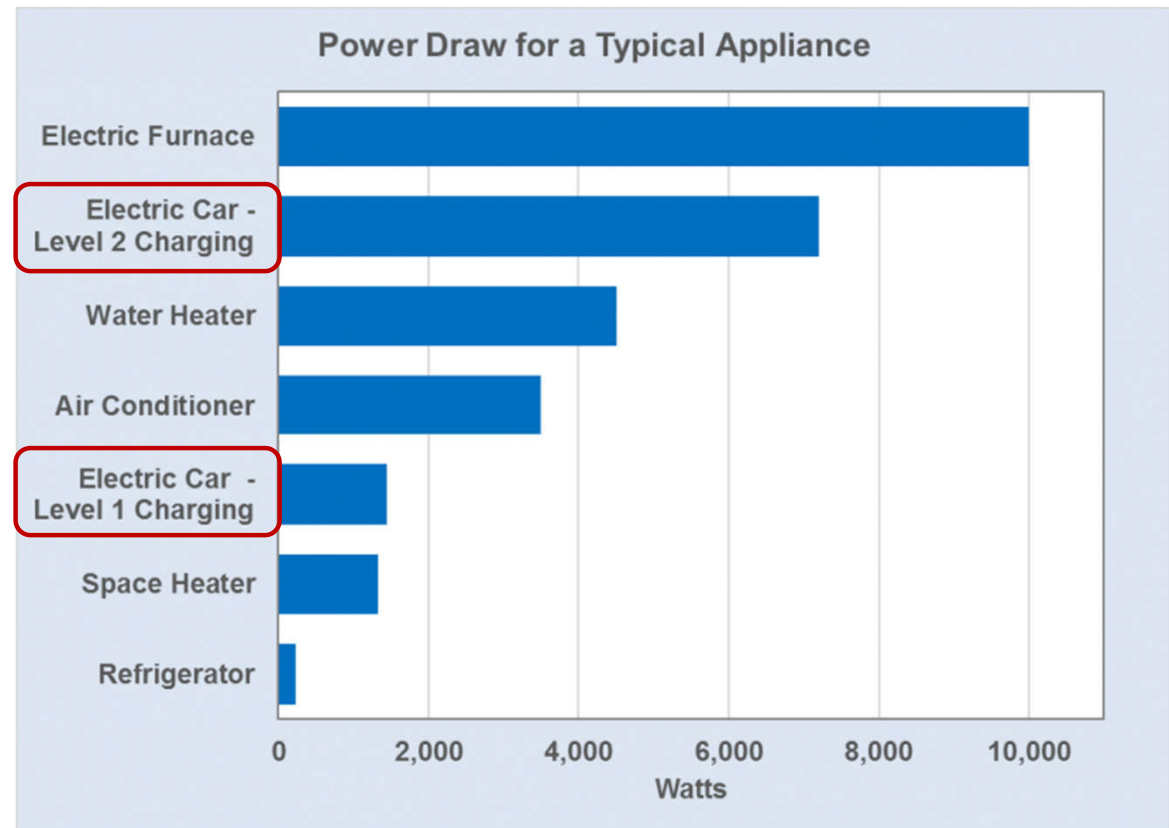
138



Traffic roils along Interstate 5 near Northeast 45th Street, on Friday, Oct. 27, 2017, in Seattle.







CREDIT: KUHN PHOTO/MEGAN FARMER

**Washington to phase out new gasoline-powered cars by 2035**



# Electric Vehicle Charging: Increasing Electricity Demand

139

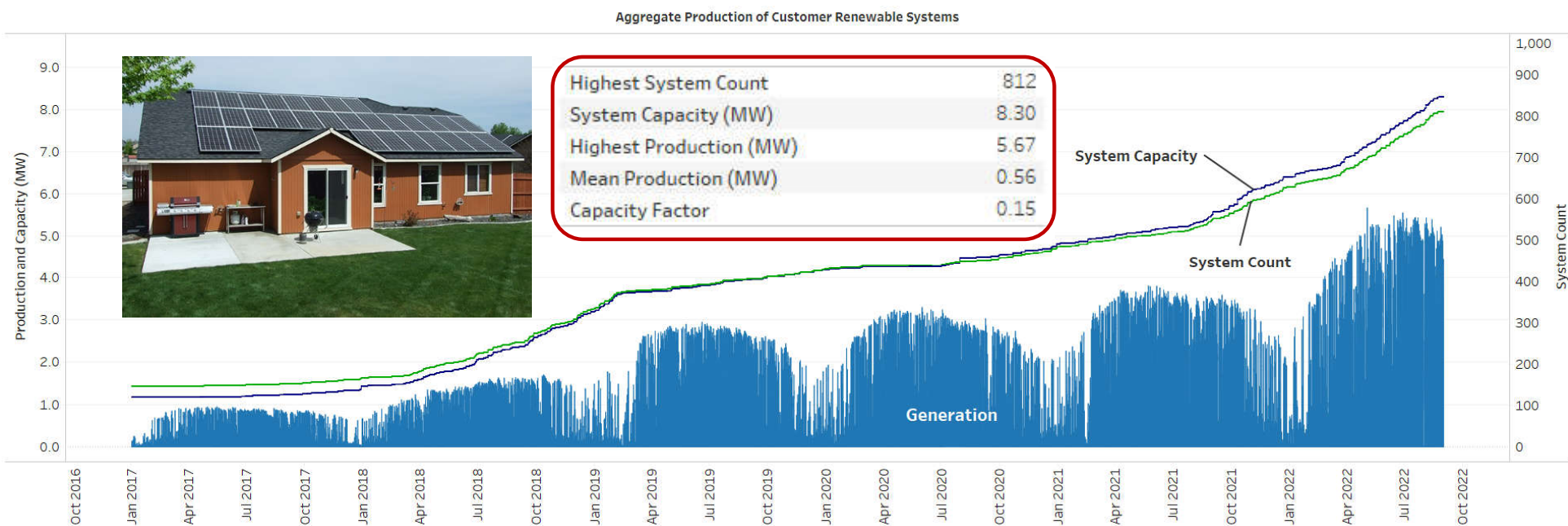
	Vehicle Type	Efficiency (kWh/mi)	Range (mi)	Battery Size (kWh)	Charge Rate (kW)
 	Class 1 Passenger Car & Small SUV	0.25-0.35	150-350	40-100	<div>Level 2: 7-11 kW</div> <div>DCFC: 50-350 kW</div>
	Class 1 & 2 Pickup Trucks and Large SUV	0.4-0.6	100-300	100-200	<div>Level 2: 11-19.2 kW</div> <div>DCFC: 150-350 kW</div>
	Class 2/3 Light Duty Vehicles	0.5-1	120-150	67-140	<div>Level 2: 19.2 kW</div> <div>DCFC: 50-150 kW</div>
	Class 3-5 Buses/Utility Vehicles	1-1.5	105-205	110-230	<div>Level 2: 13-19.2 kW</div> <div>DCFC: 50-150 kW</div>
	Class 6-8 Bucket Trucks	2-4	~90 (With Aux Power)	250-350	<div>Level 2: 19.2 kW</div> <div>DCFC: 150 kW</div>
	Class 6-8 Trucks/Tractor Trailers	2+	125-250	230-500	<div>Level 2: 19.2 kW</div> <div>DCFC: 50-250 -&gt; 1MW+ in the future</div>

Typical Peak Residential Demand ~ 5-7kW

Typical Depot: ~20-100kVa (Lighting/HVAC loads)

# Do Solar Customers Contribute to Peak Demand?

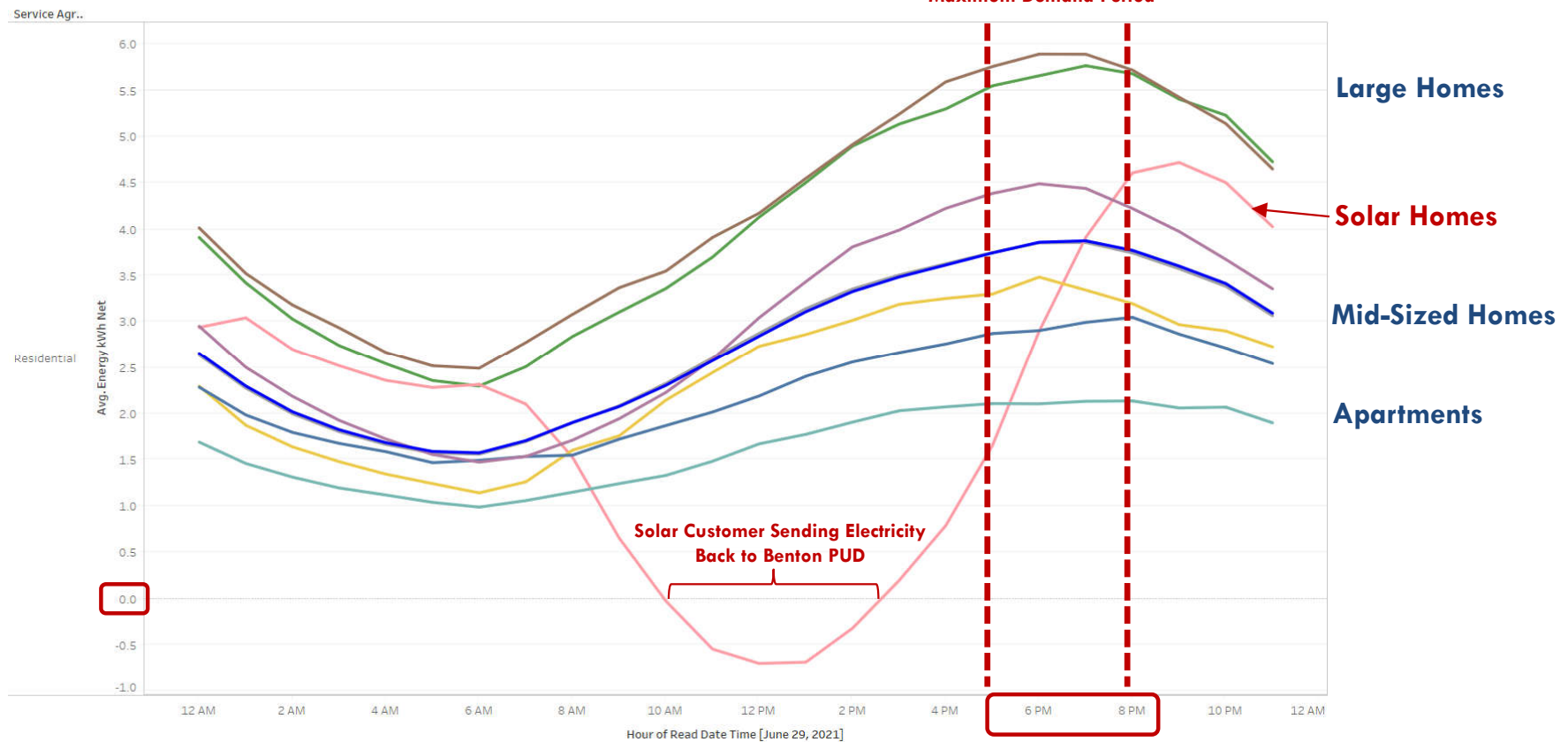
140



# Residential kW Demand - Summer Hours

141

Average Hourly Load by Day by Segmentation (Customer Class: Residential)

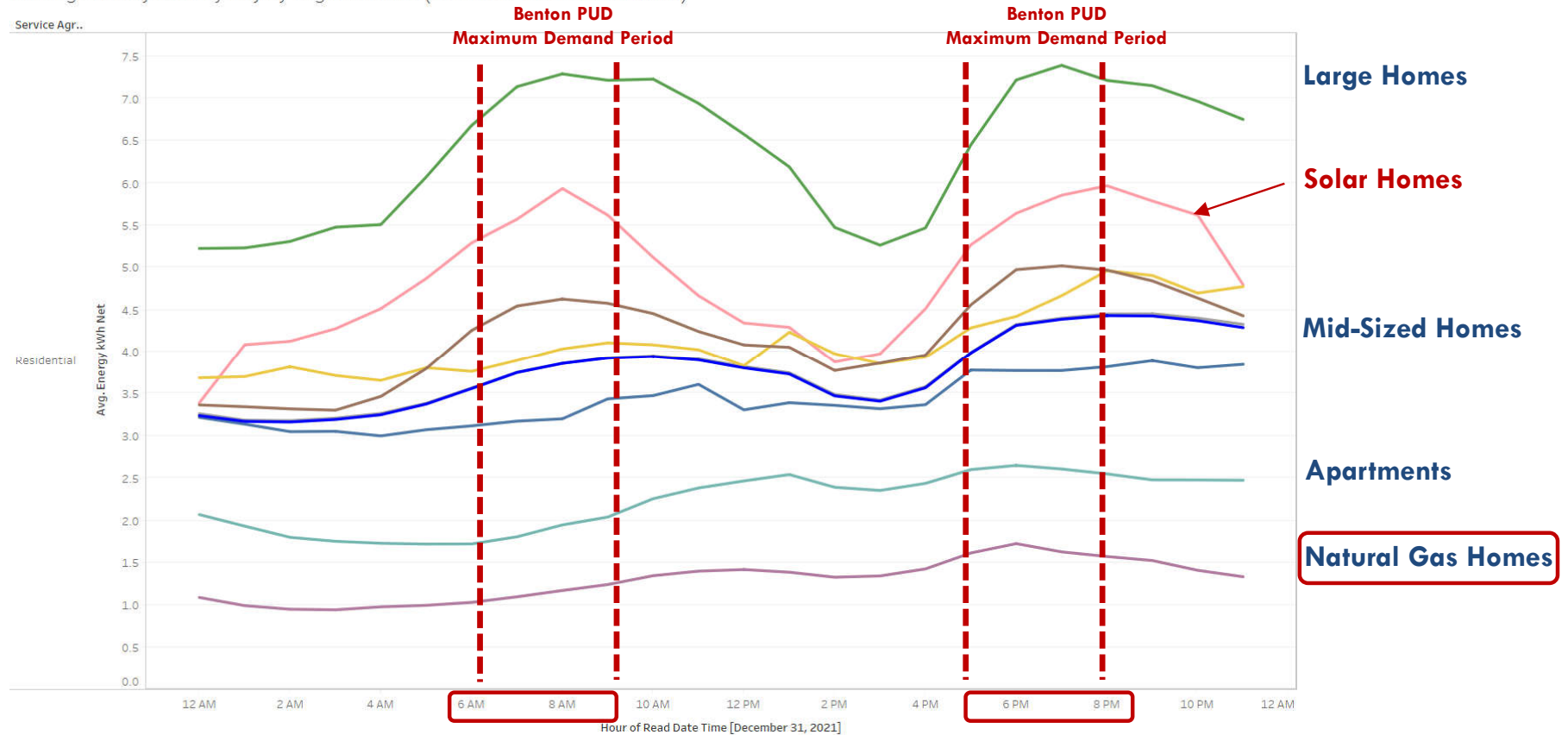




# Residential kW Demand - Winter Hours

142

Average Hourly Load by Day by Segmentation (Customer Class: Residential)



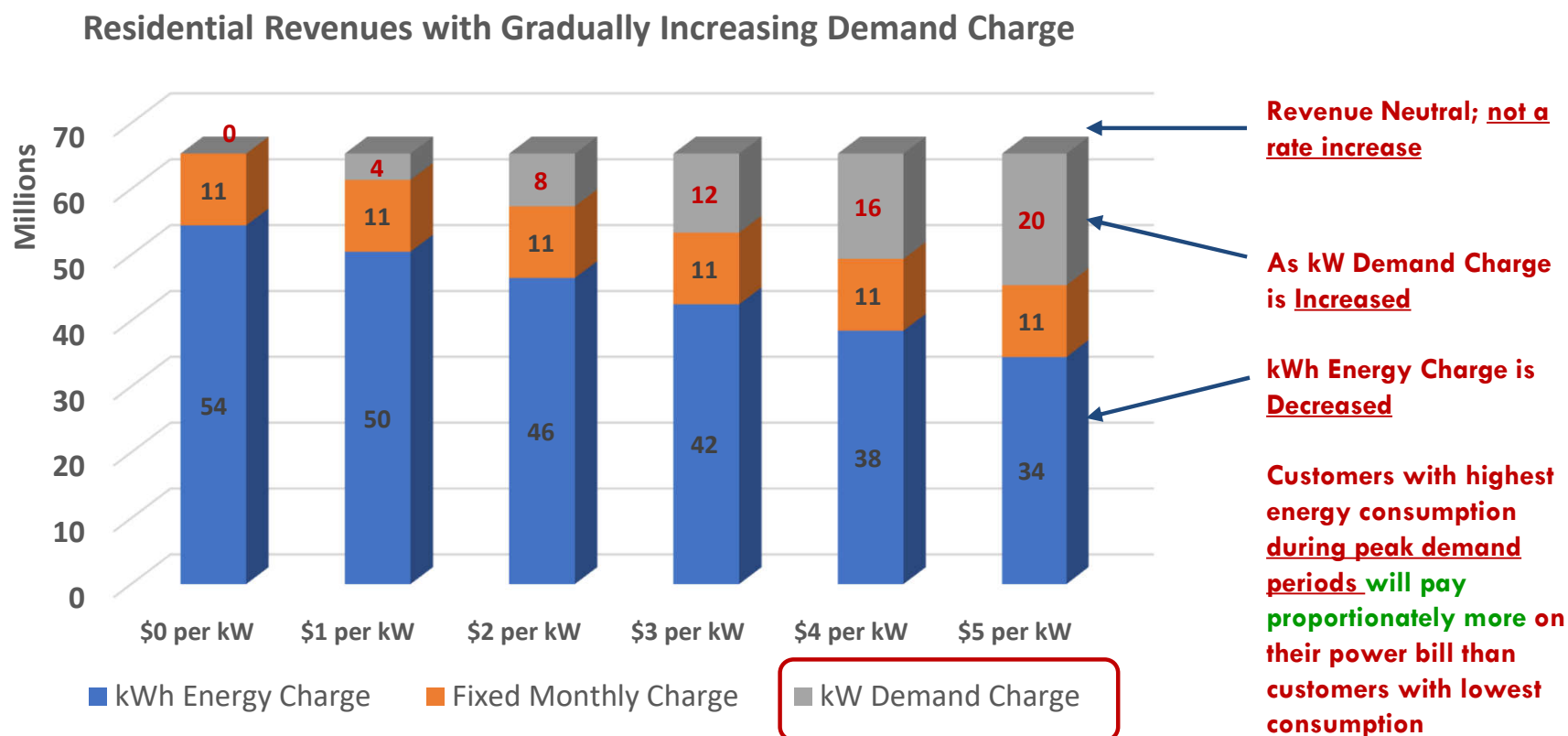
# Residential Demand Charge Recommendation

143

- Staff's Recommendation to our Board of Commissioners
  - ▣ Implement Residential Demand Rate October 2023
  - ▣ Do it by being revenue neutral
    - Decrease energy rate so total projected revenue is unchanged
  - ▣ Time of Day based (demand would be measured within peak hours)
    - Example:
      - 6-9am and 5-8pm (October – April)
      - 5-8pm (May – September)
    - Provides flexibility for customers
  - ▣ Start small and use gradualism
    - Start with \$1 per kW charge (with decrease in energy rate)
    - Gradually move toward Cost-of-Service Analysis level (~\$5 per kW) with increases annually

# Residential Demand Charge Recommendation

144

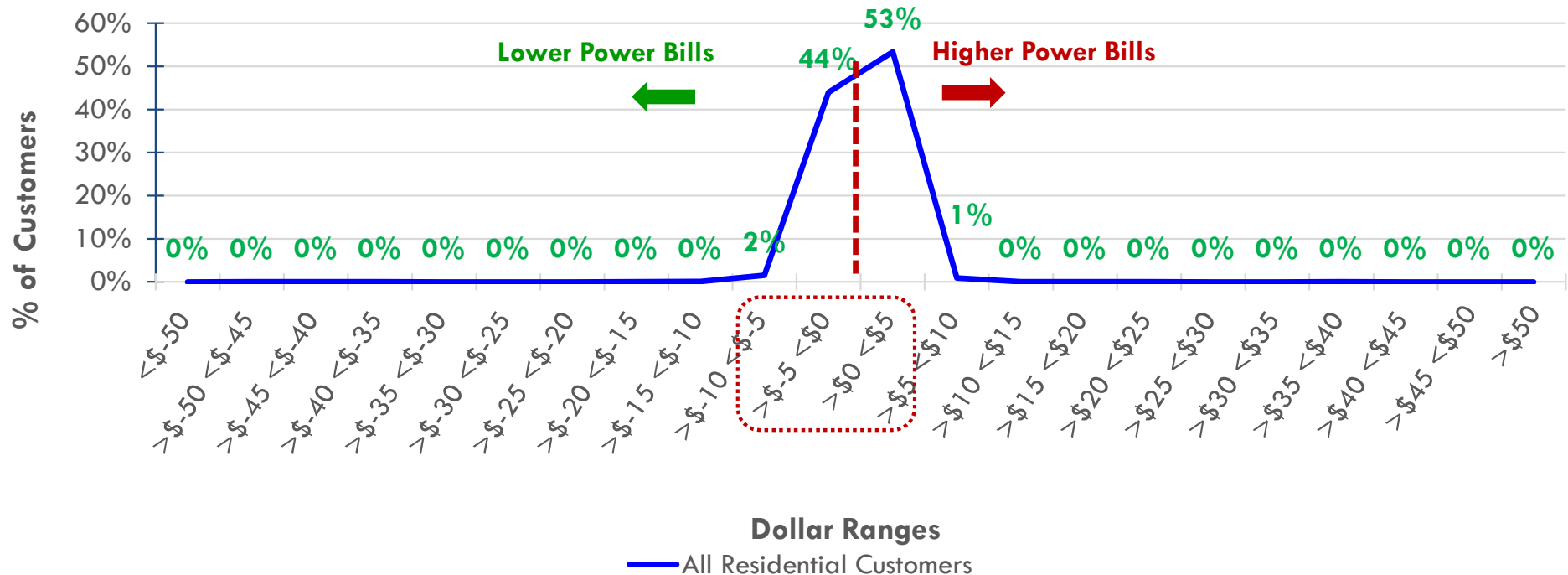


# Residential Bill Decreases/Increases

With \$1 per KW Demand Charge and kWh Charge Reduced from \$0.0739 to \$0.0688 per kwh

145

Average Monthly Dollar Impacts  
(All Customers vs Customer Segments)



\*Estimated rates for analysis purposes only. Assumes no change from current Daily System Rate.

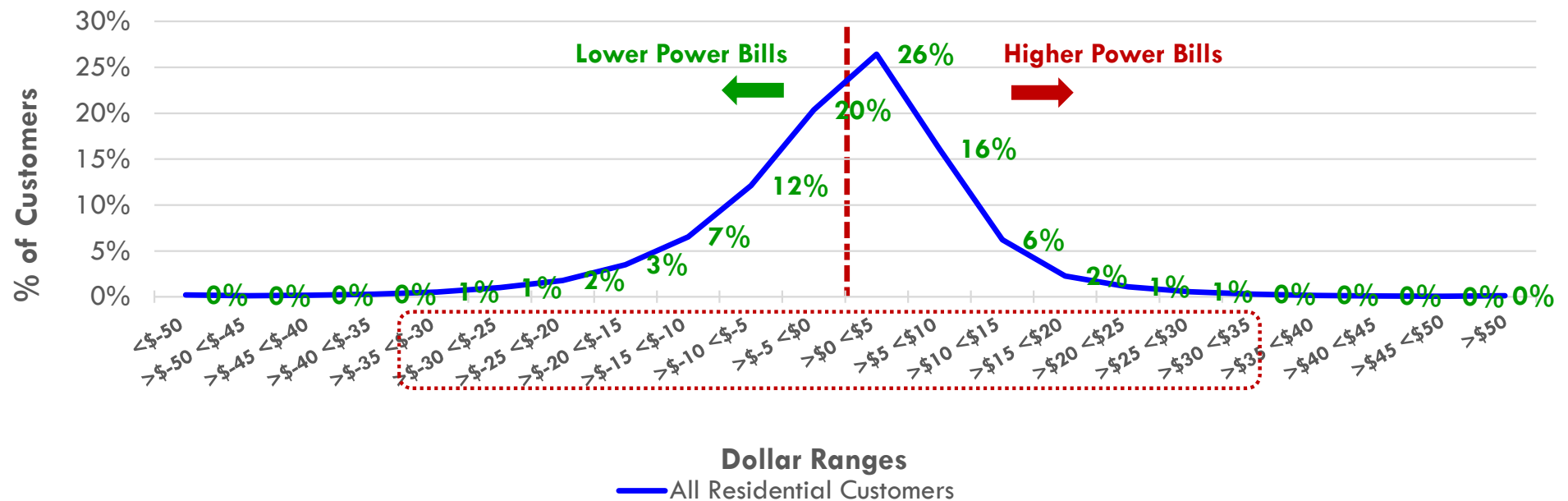


# Residential Bill Decreases/Increases

With \$5 per KW Demand Charge and kWh Charge Reduced from \$0.0739 to \$0.0487 per kwh

146

Average Monthly Dollar Impacts  
(All Customers vs Customer Segments)



\*Estimated rates for analysis purposes only. Assumes no change from current Daily System Rate.

# Benton PUD Customer SmartHub

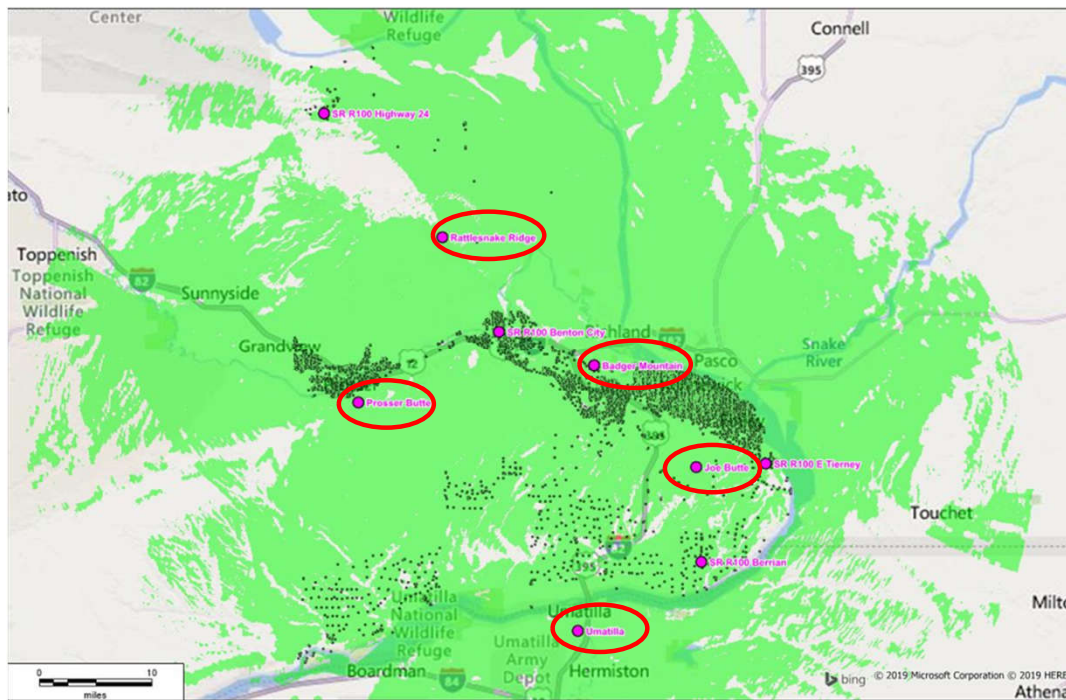
147



- **Enables Customers to:**
  - ▣ **Manage energy usage and demand**
  - ▣ See detailed usage profile (curve)
  - ▣ Set alerts when usage exceeds limits set by the customer
  - ▣ Understand usage patterns
  - ▣ Make decisions on how to use electricity more efficiently

# Smart Grid @ BPUD: Advanced Meters

148



This propagation study is based on actual information provided by the utility pertaining to meter type, Smart point Location, potential antennae height on structure, structure height, and structure location. Any changes, deletions and/or additions that are not provided to the design engineers during the creation of this design may result in a study that does not correlate to actual field conditions.

## FlexNet Design Propagation Analysis

8071 - BENTON PUD - AM  
Kennewick, WA

RF Engineer: Jon Jobe  
Date: 09/10/2019

### Proposed Site Details

Total Site Locations: 9  
Total Base station Counts: 9  
M400B2 = 4  
M400D = 1  
R100 Collector = 4

### Design Factors

Flex Net Version: V1  
Modulation: FSK7HR  
Endpoint Type: Electric  
Smart point Location: Outside  
Attenuation: 0 dB

	Count	%
Total Endpoints Covered	52,924	99.57%
Total Endpoints Analyzed	53,143	

### LEGEND

- Area of Coverage
- Site Location
- Endpoint Location

**sensus**  
a xylem brand

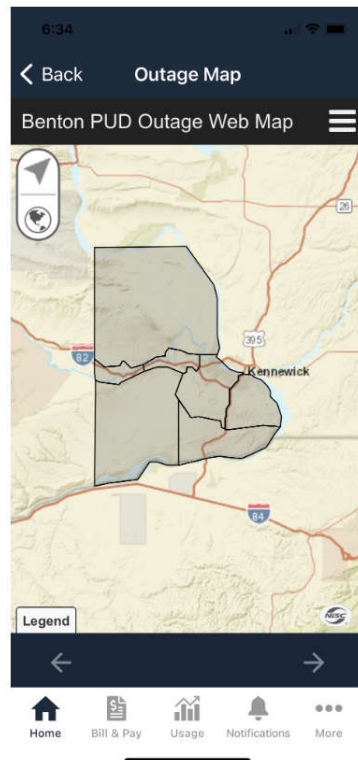


- ✓ Energy Use Data on Short Time Intervals
- ✓ Remote Service Connection & Disconnection
- ✓ On-Demand Reads
- ✓ Service Theft and Tamper Detection
- ✓ Power Quality Monitoring
- ✓ Outage Detection and Reporting

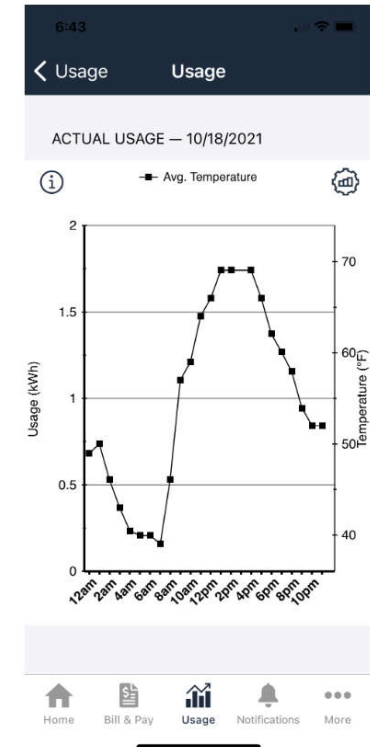
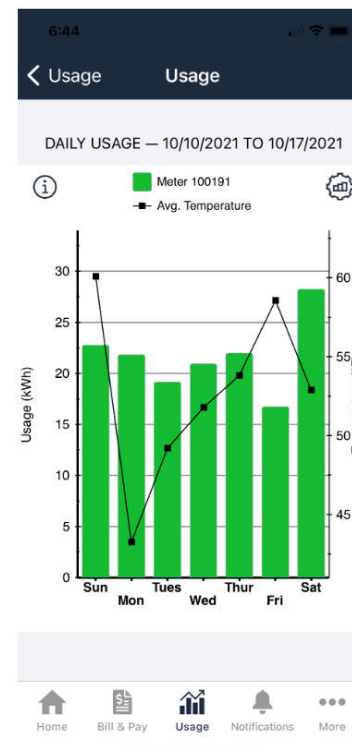
# SmartHub App Features

149

## Outage Status



## Customer Usage Profiles and Notifications





# Benton PUD Key Positions

150

- **Keep hydro in place:** continue investments in **H**ydro, **H**abitat, **H**atcheries and **H**arvest
- Build some **new natural gas power plants** to replace coal (**Would require CETA changes**)
- **Cap wind and solar** development (eliminate in some areas)
- Support development of **advanced nuclear power**
  - Large amounts of reliable (always on) and non-emitting energy on a small footprint
  - Reduced need for long-distance transmission lines
    - **Ultimately could be built near population centers**
  - Responsive to strong push for electrification of transportation and natural-gas end uses
  - **Export technology to other nations** (true global leadership)

# QUESTIONS?

151



# Top 10 Takeaways

152

- 1) Hydropower is the foundation of Washington's low cost and clean electricity which represents less than 16 million metric tons (MMT) of the nation's 1,800 MMT of electricity emissions
- 2) Fossil fuels represent 79% of total energy consumption globally and in the U.S. and abandoning them rapidly is not a credible or realistic plan
- 3) Wind and solar provide only 3% and 5% of total global and US energy consumed respectively
- 4) Natural gas power generation produces 50% to 60% less CO2 emissions than coal allowing electricity emissions in the U.S. to drop significantly over the past two decades
- 5) Coal plant retirements in the northwest without plans for building new dependable capacity like what is provided by natural gas could jeopardize power grid reliability in drought years coinciding with cold/hot weather extremes

# Top 10 Takeaways

153

- 6) Wind and solar power are energy-dilute and material intensive requiring vast areas of land for development and mining (in an anti-development era)
- 7) Wind and solar power cannot provide dependable and effective capacity needed to balance power grid demand and supply requiring massive and costly overbuilds to squeeze out capacity contributions
- 8) Dependable and effective generating capacity is 'King' and is expected to be scarcer in the near to midterm (need to prepare to pay more)
- 9) Over 22,000 megawatts of northwest hydropower capacity are the foundation of Washington's 100% clean electricity law and sets the northwest apart from California which depends on over 30,000 megawatts of natural gas generating capacity to avoid blackouts
- 10) Advanced nuclear power could provide common ground for reducing carbon emissions while maintaining reliable power grids in the U.S. and throughout the world