Northwest **Power** and **Conservation** Council

April 2, 2024

MEMORANDUM

TO: **Council Members**

FROM: **Elizabeth Osborne**

SUBJECT: **Clean Energy Transition and Innovation Panel**

BACKGROUND:

Presenters: Sonia Aggarwal, Chief Executive Officer, Energy Innovation Policy and Technology, LLC
Angela Becker-Dippmann, Director of the Energy & Environment Directorate's Program Development Office, Pacific Northwest National Laboratory
Josh Jacobs, Vice President, Clean Energy Strategy and Planning, Puget Sound Energy

Summary: With rapidly increasing loads, state and national emission reduction commitments, and the growing role of low-cost, intermittent resources on the grid, the power system faces unprecedented challenges. As we prepare for the next planning cycle, we face unusually large uncertainties about load growth, resource availability, and extreme weather. The energy industry has historically seen relatively low rates of investment in research and development and technology innovation and therefore relatively slow technology transition. However, public, private, and academic focus on accelerating technology research, commercialization, and deployment have increased very rapidly to address these challenges. It is critical for the Council to assess this shifting landscape and the foreseeable changes in demand, supply, and energy system configuration over the approaching planning horizon. Staff update the Council regularly on specific technology

developments; this will be an opportunity to look at the bigger picture of energy system innovation with specific reference to our central regional challenges.

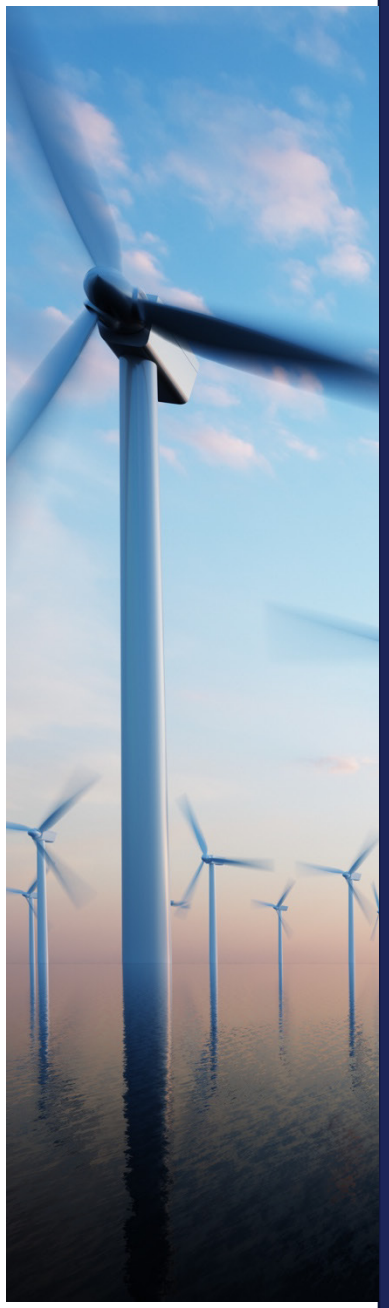
Speakers will discuss several key questions: What are some of the emerging innovations that will help us ensure resource adequacy under these changing conditions? What energy supply innovations can help us meet the growing need for both clean energy and flexible capacity? We have a lot of experience with demand side energy resources, but how can we deploy demand side strategies to meet the growing need for capacity resources? What resources and incentives are available to help the region develop and deploy needed energy infrastructure while minimizing costs to ratepayers? These challenges play out in unique ways in the Northwest, but they are also national and global challenges. Our panelists are familiar with the global, national, state, and local contexts in which we tackle these challenges to inform our Northwest response as we prepare for a new power planning cycle.

Background: Sonia Aggarwal is Chief Executive Officer of Energy Innovation, a non-partisan energy and climate policy think tank providing research and policy analysis to decision-makers. Energy Innovation develops technology-neutral policy recommendations based on empirical analysis using their open-source and peer-reviewed Energy Policy Simulator model. In efforts to enhance the Council's transportation load forecast for the upcoming adequacy assessment and considerations for the next power plan, Council staff are utilizing the Energy Policy Simulator model as part of their forecasting tools. Ms. Aggarwal had key roles in developing the Inflation Reduction Act and the Bipartisan Infrastructure law as Special Assistant to the President for Climate Policy, Innovation, and Deployment. She spearheaded creation of America's Power Plan, a platform to identify innovative thinking on decarbonization policy solutions for affordable, reliable electric power. Before Energy Innovation, Sonia managed global research at ClimateWorks Foundation, worked on the McKinsey carbon abatement cost curves, advised the International Energy Agency's "Accelerating Technology Transitions" project, advised clean energy companies on technology and financial communications, and worked in accident prevention design engineering at a nuclear power plant.

Angela Becker-Dippmann will speak to regional opportunities for innovation with specific reference to some of the key challenges facing the region, including transmission development, new resources, demand response capability, and unlocking the potential for cooperation among utilities, states, and federal energy players. In her current position as Director of the Energy & Environment Directorate's Program Development Office at Pacific Northwest National Laboratory, Ms. Becker-Dippmann plays a key role with respect to federal innovation investments and deployment in the region. Before her current role at Pacific Northwest National Laboratory, Ms. Becker-Dippmann was the Staff Director at the

US Senate Committee on Energy and Natural Resources under Ranking Member Maria Cantwell. She has held positions in public affairs and consulting, as staff for the Senate Energy and Natural Resources Committee under Jeff Bingaman, and as staff to Senator Cantwell

Josh Jacobs will add a local utility perspective to the panel, discussing the strategies and programs that will enable rapid, economy-wide decarbonization while maintaining reliability for customers. He leads Puget Sound Energy's implementation of Washington's Clean Energy Transformation Act and decarbonization of the utility's natural gas service, alongside several other key planning functions, as well as PSE's "Beyond Net Zero Carbon" goal. Mr. Jacobs has been with PSE since 1998, serving in a variety of positions across many departments, including energy supply, grid operations, transmission asset management and optimization of transmission capacity, and led PSE's entry into the CAISO Energy Imbalance Market.



Innovation for **least-cost resource adequacy**

Sonia Aggarwal

ENERGY INNOVATION
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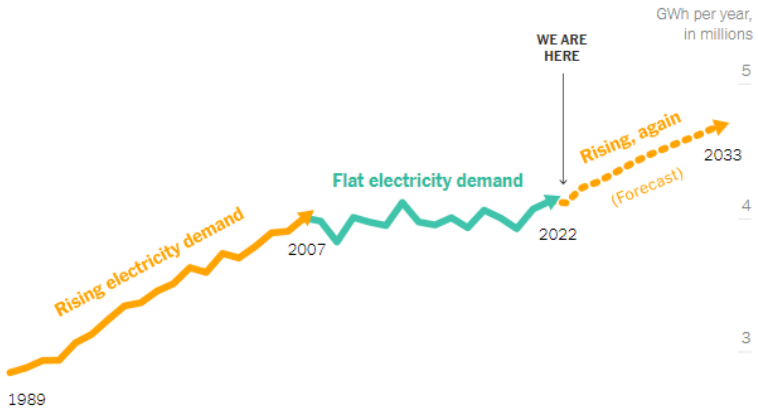
Breathless Headlines: Is it time for emergency measures?

The New York Times



A New Surge in Power Use Is Threatening U.S. Climate Goals

A boom in data centers and factories is straining electric grids and propping up fossil fuels.

By Brad Plumer and Nadja Popovich March 14, 2024

The Washington Post

Democracy Dies in Darkness

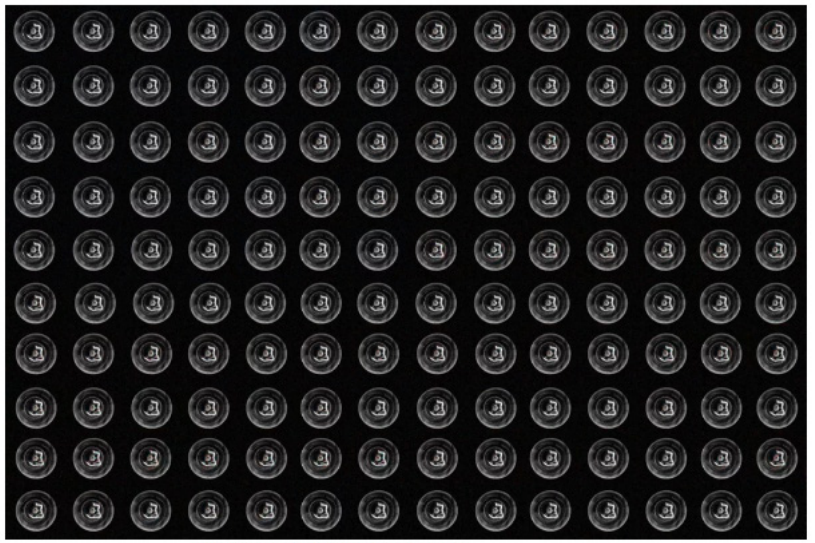
BUSINESS

Amid explosive demand, America is running out of power

AI and the boom in clean-tech manufacturing are pushing America's power grid to the brink. Utilities can't keep up.

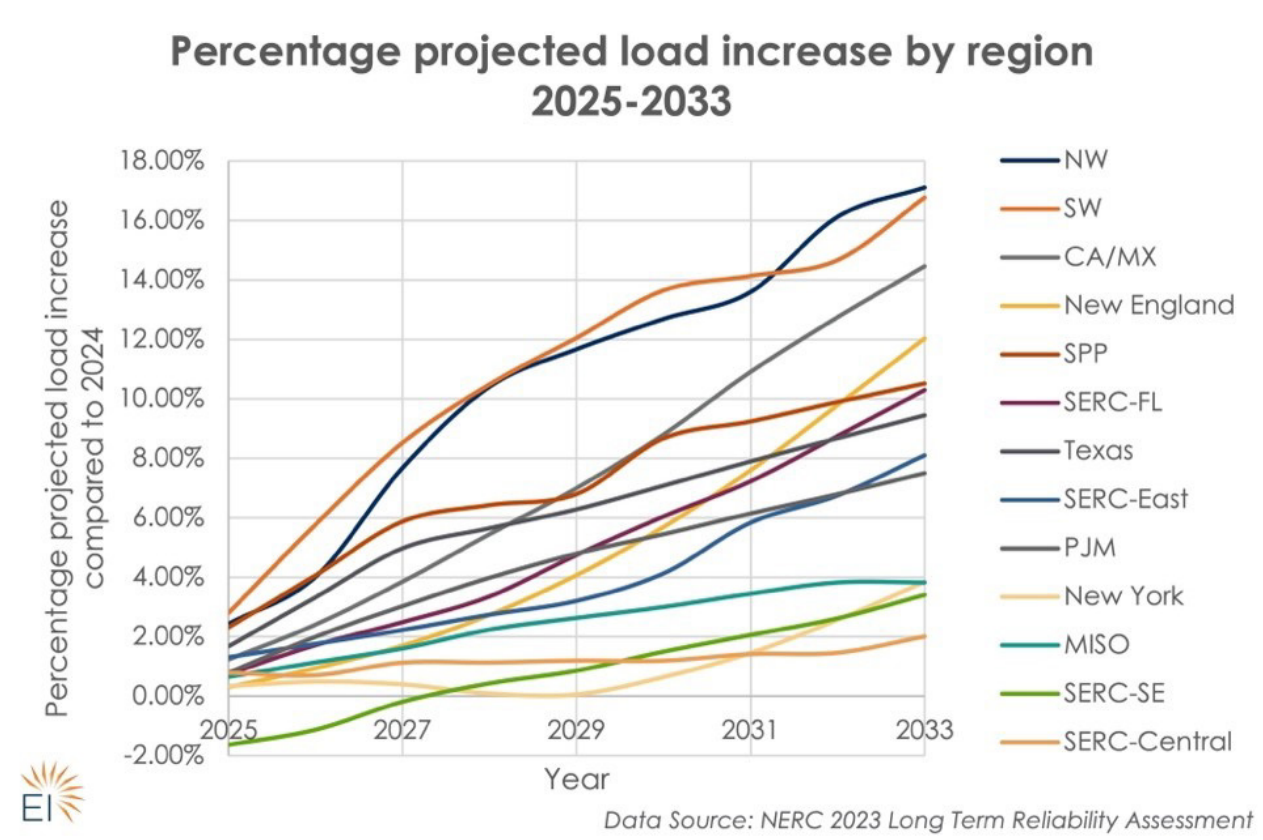
By Evan Halper

March 7, 2024 at 6:05 a.m. EST

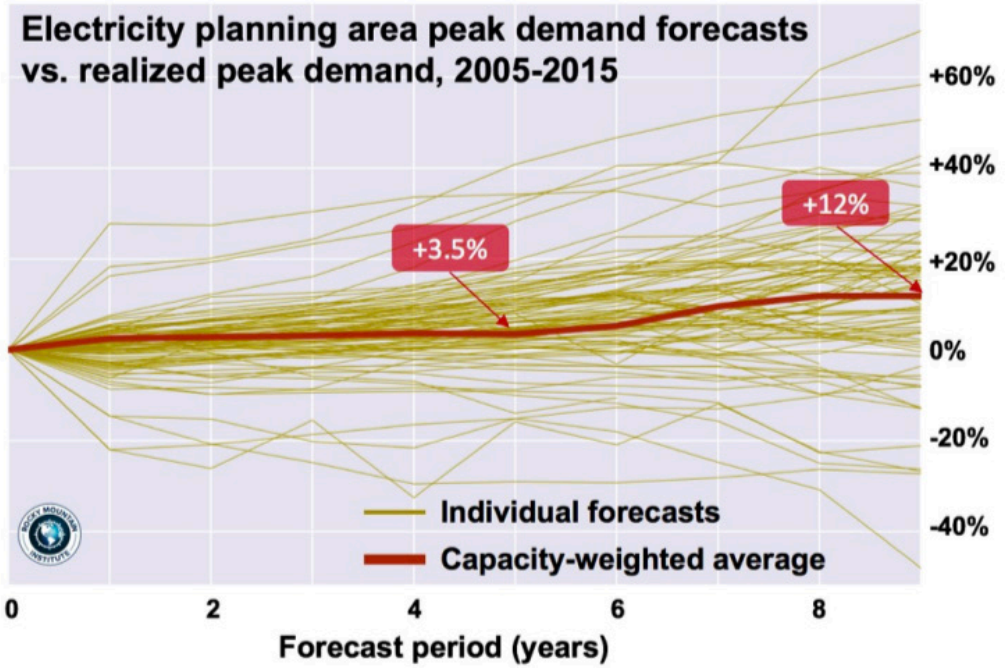


(Video: Illustration by Laura Padilla Castellanos/The Washington Post)

True: Load Growth Anticipated Across the US



Also True: Load growth is consistently overestimated



Every year, the Federal Energy Regulatory Commission (FERC) requires utilities and other grid planning areas to project their peak demand 10 years into the future. This figure summarizes forecasts submitted to FERC from 2005 to 2015. Each line indicates by what percentage, on average, a utility's forecasted peak varied from actual realized peak (forecasts for 2009 and 2010 were removed to reduce the impact of recession-affected data).

Source: Rocky Mountain Institute https://rmi.org/billion-dollar-costs-forecasting-electricity-demand/

Let's Take a Breath: What works? **Efficiency** and **Innovation**

The resulting electricity demand, shown in Figure ES-1, indicates that more than 600 additional billion kWh would have been required across the decade.

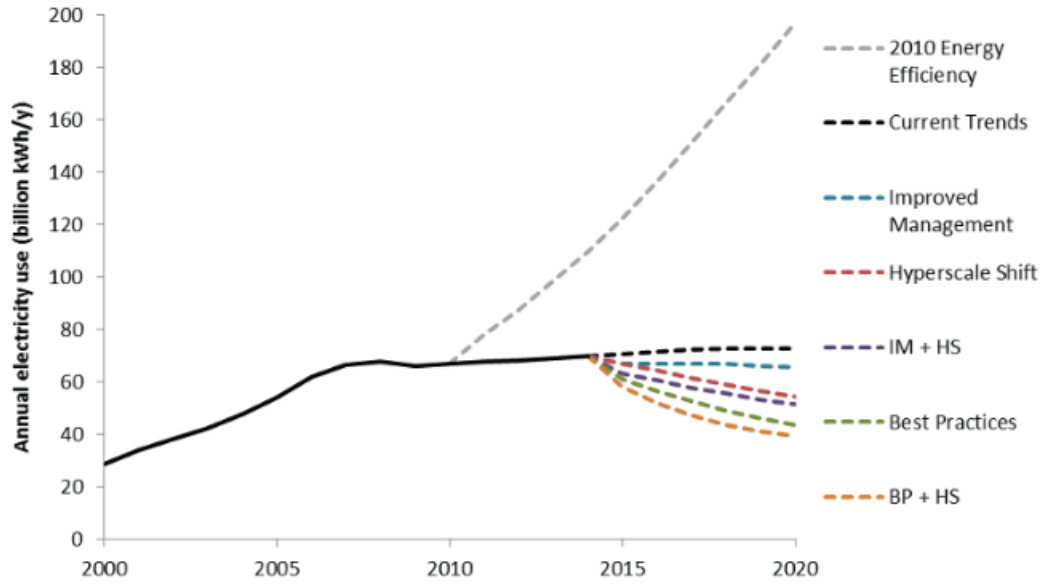


Figure ES-1 Projected Data Center Total Electricity Use

← Efficiency works wonders.

Demand response is an efficiency innovation that can boost impact.

- **EXAMPLE: Google has piloted a new way to reduce data centers' electricity consumption when there is stress on the local power grid, by shifting some non-urgent compute tasks to other times and locations without impacting Google services.**

Innovation can get more from existing infrastructure.

- **EXAMPLE: Grid-enhancing technologies like dynamic line rating, power flow controllers, and storage can be installed in months, as opposed to the 5-15 years needed for new transmission.**
- **EXAMPLE: Reconductoring existing lines can nearly double transmission capacity in 1-3 years.**
- **EXAMPLE: PGE and Pacificorp are joining the Enhanced Day Ahead Market.**

Innovation can get more generation capacity online faster.

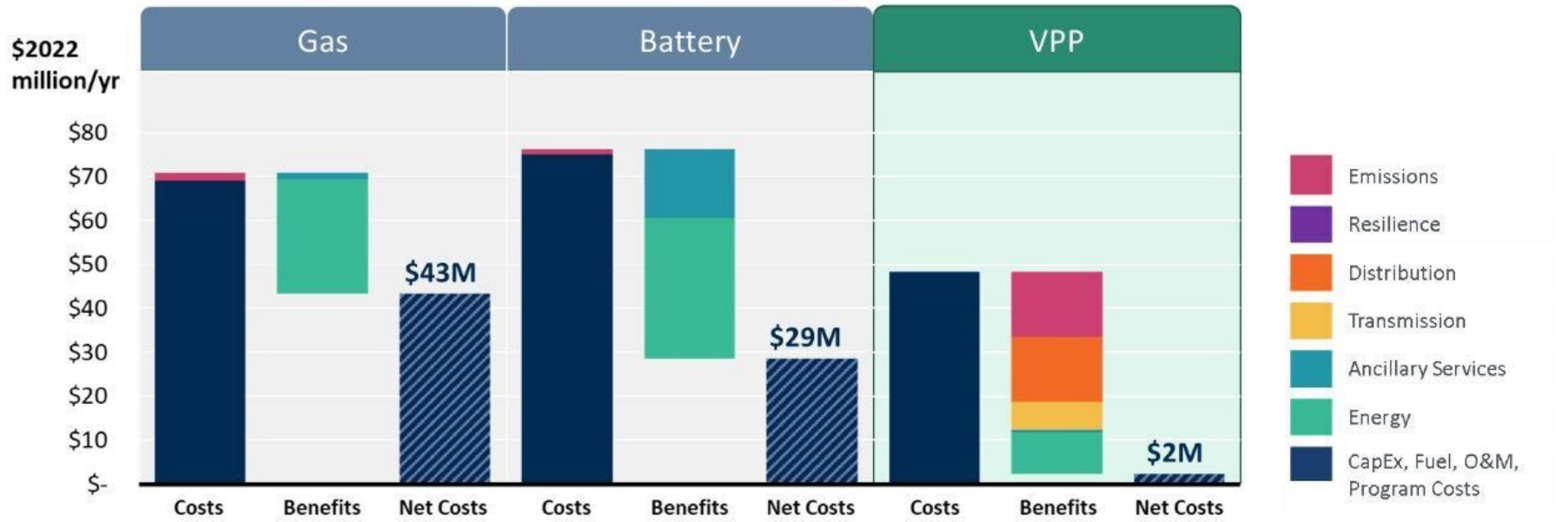
- **EXAMPLE: Building generation closer to demand can avoid grid bottlenecks – a steel mill in Pueblo, Colorado structured a deal for 300 MW of solar right near their facility.**
- **EXAMPLE: Renewables plus storage can be built at retiring coal sites or at gas plant interconnections where the gas is not running 24/7.**

Another Innovation:
Virtual Power Plants Could Save US Utilities $15-$35 Billion over 10 Years

Resource Adequacy… For Cheap

The VPP could provide the same resource adequacy at a significant cost discount relative to the alternatives.

Annualized Net Cost of Providing 400 MW of Resource Adequacy



From "Real Reliability: The Value of Virtual Power" – Brattle Group - May 2023

Take Advantage of Efficiency and Innovation: **All-Source Procurement**

1. **Determine the need. Define in terms of load forecast, not in terms of specific technologies.**
2. **Conduct an all-source procurement. Be open to all technologies and approaches, let a least-cost approach select the mix of capacity and energy to meet the need.**
3. **Do an advance review *before* the RFP is complete. To ensure fair treatment of innovative solutions, review assumptions, the bid evaluation process, contract terms and conditions.**
4. **Ensure utility ownership is not at odds with competitive bidding – seeking instead the least-cost solution to provide resource adequacy considering innovative approaches.**

Thank you

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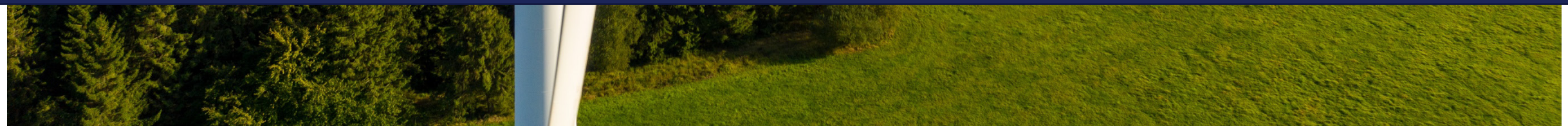

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Innovations to Achieve Energy Transition Goals

April 10, 2024

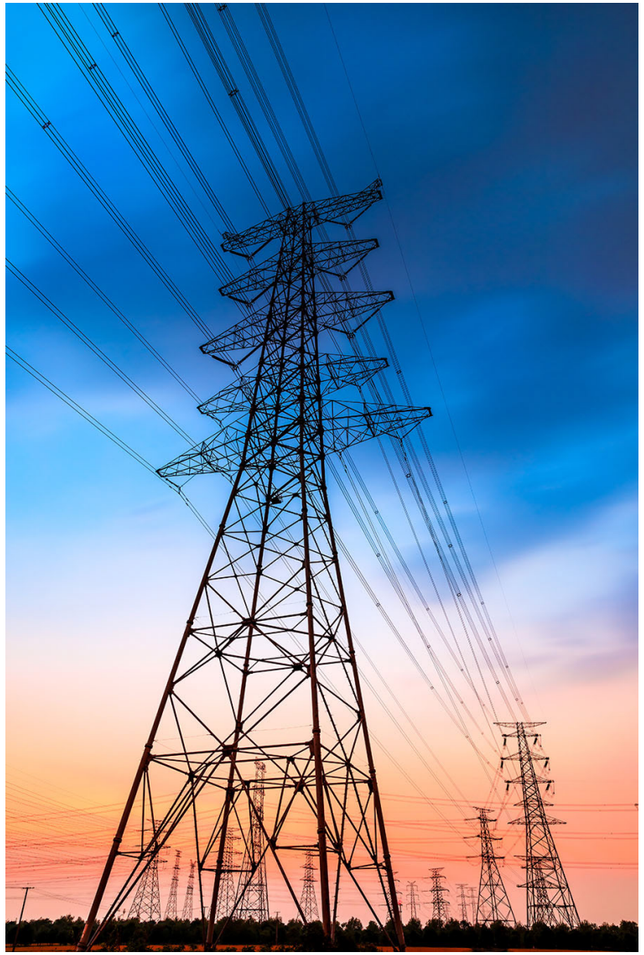
Angela Becker-Dippmann
Director, Program Development
Energy and Environment Directorate

U.S. DEPARTMENT OF ENERGY BATTELLE

PNNL is operated by Battelle for the U.S. Department of Energy

Presentation overview

- PNNL overview and the role of the national labs
  - Key collaborations with Idaho National Laboratory
- Highlights of relevant research and development
  - Advancing performance of key technologies
  - Accelerating energy storage
  - Enabling distribution-level flexibility
  - Integrating earth and energy models to inform planning
  - Preventing, recovering and responding to wildfires
  - Providing technical assistance to communities
- DOE and Washington State investment
- Discussion and questions



About the national laboratories and PNNL

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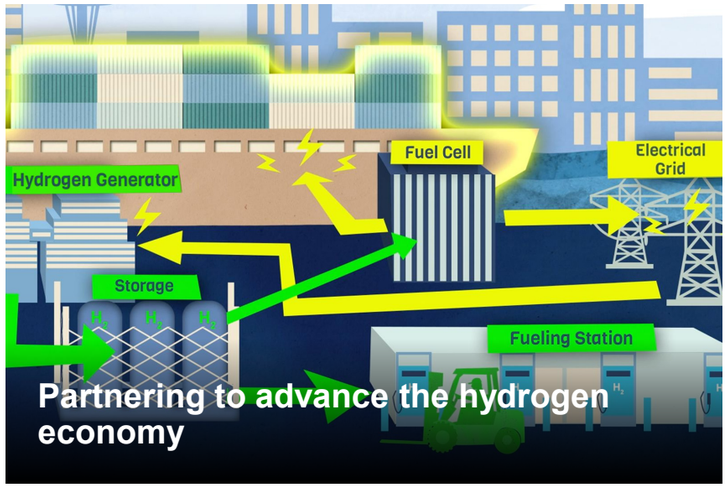
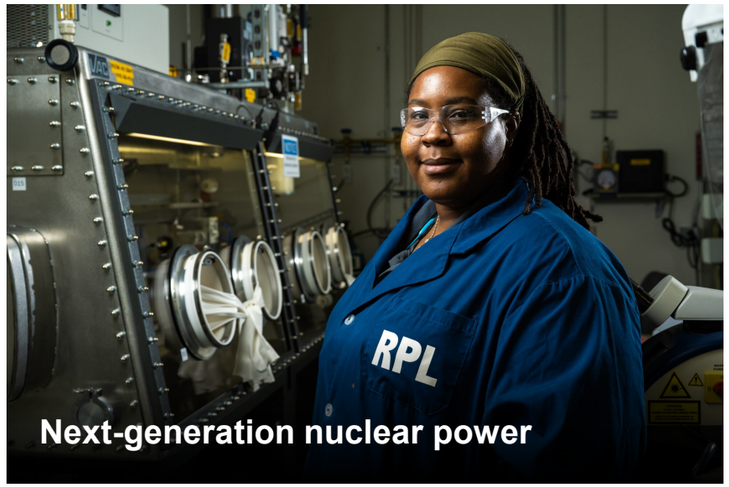
DOE's 17 **national laboratories** tackle critical scientific challenges

Areas of collaboration with Idaho National Laboratory



Partnering to advance the hydrogen economy


Vehicle electrification and infrastructure security



Next-generation nuclear power


Advanced hydropower and irrigation modernization


Biomass and advanced fuels

Grid cyber security

Highlights of Relevant Research & Development

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Advancing performance of key technologies

- Energy efficiency
- Hydrogen
- Vehicle batteries
- Carbon management


Validating technology performance and aiding market transformation


Generating hydrogen by using electricity to split water


Preparing, fabricating and validating pouch cell batteries


Safely storing carbon dioxide in basalts

Leveraging the Grid Storage Launchpad to advance energy storage solutions

ACCELERATE

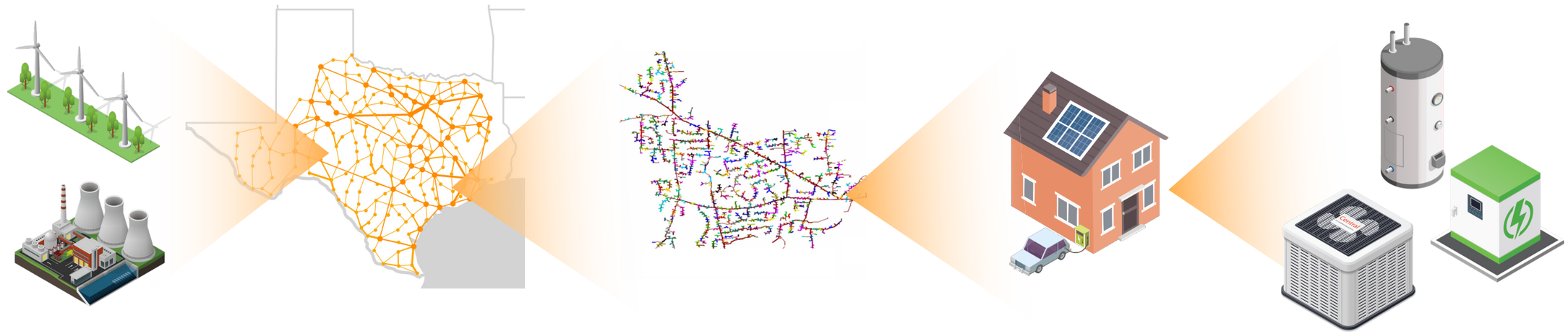
VALIDATE

COLLABORATE

EDUCATE

Enhancing system flexibility through grid edge control

Generation | Transmission | Distribution | Customers | DERS



Physical System Behavior

Control and Market Coordination

Valuation and Economic Performance

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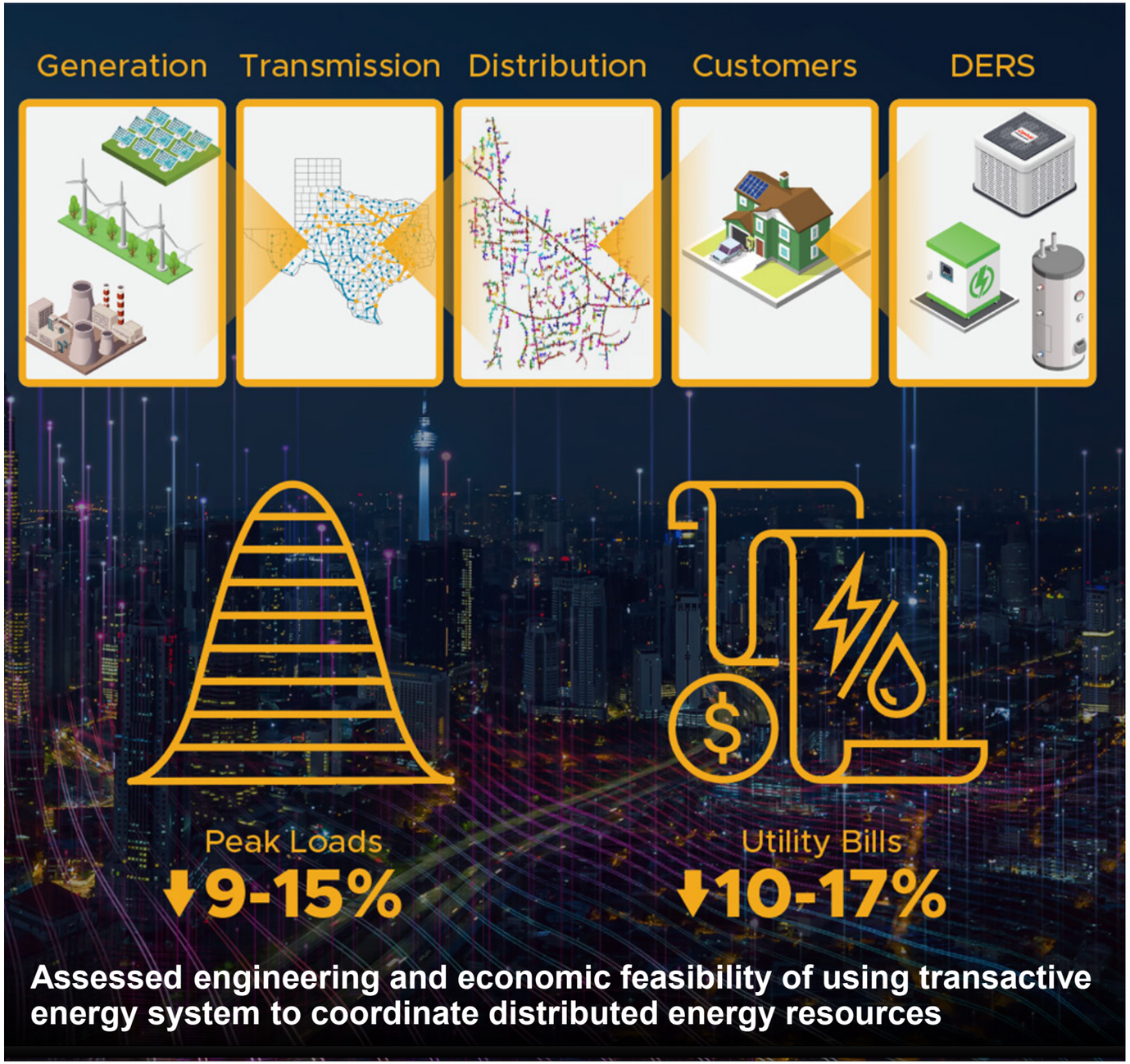
Demonstrating load flexibility at regional scale

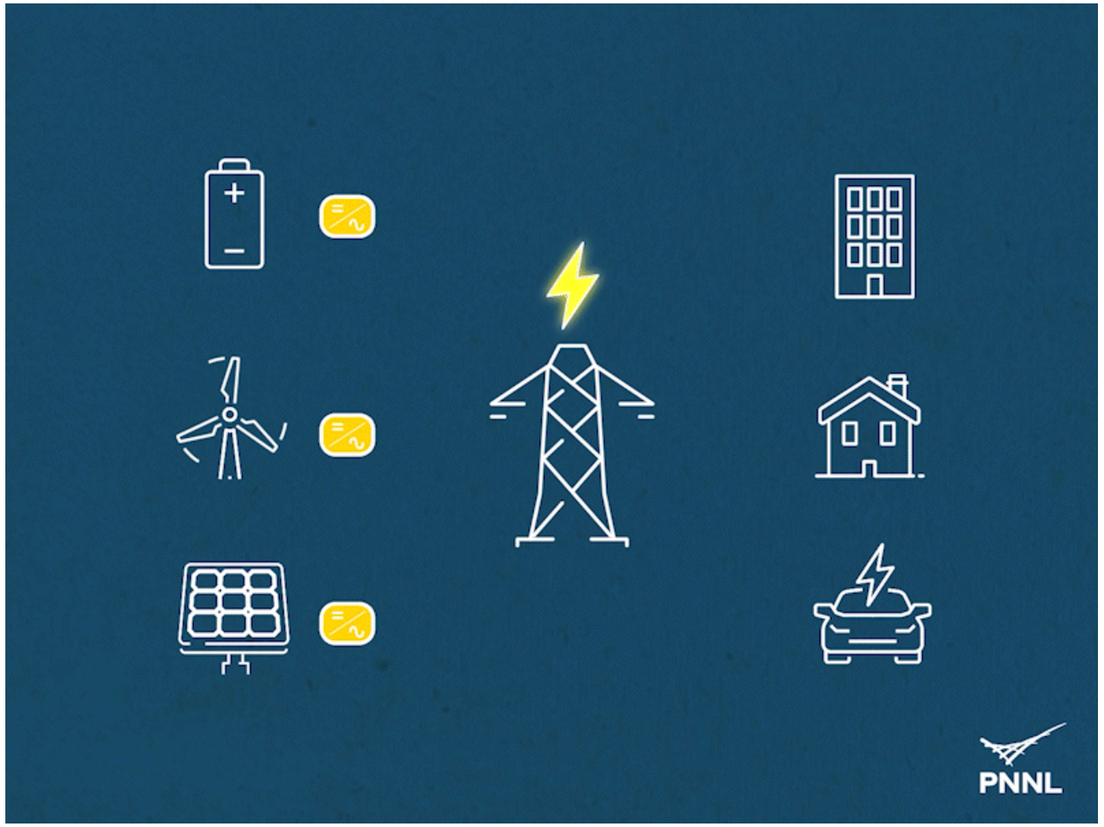
- Modeled entire grid from generation to transmission systems to distribution system operators all the way to end customers and individual DERs
- Analyzed region-wide impacts on the Texas Grid



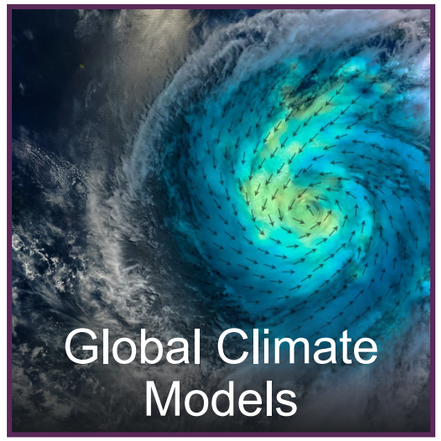
Understanding ubiquitous power electronics at all levels: Fundamentally changing grid control and protection

PNNL is framing an analytic testbed and national strategy for systems-level power electronics utilization and integrity

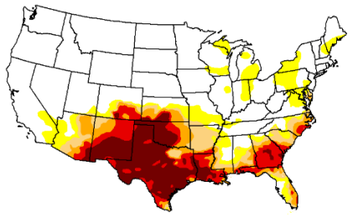
- How to control system with 80%+ inverter-based systems?
- How does low inertial physics affect resilience?
- How is system protection designed?
- What are the risks and benefits of portfolios of “grid forming” and “grid following” inverters?
- How do we secure the PE supply chain?

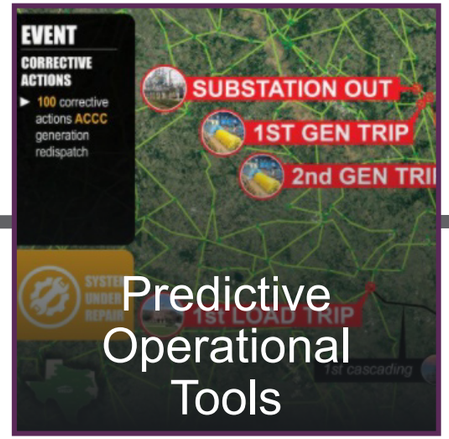


Integrating models from global to local scales to inform planning and operations



Regional Resource Availability





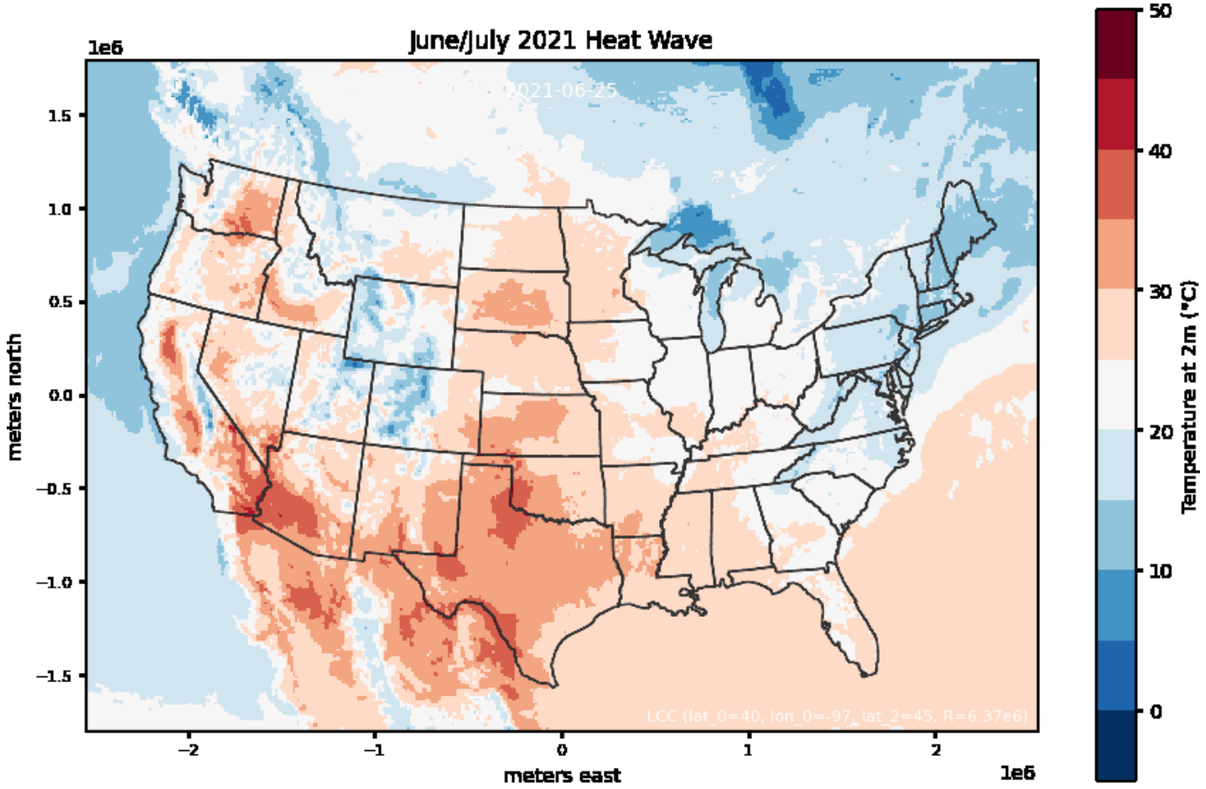
Resilient Grid Operations

Integrated Modeling for Planning

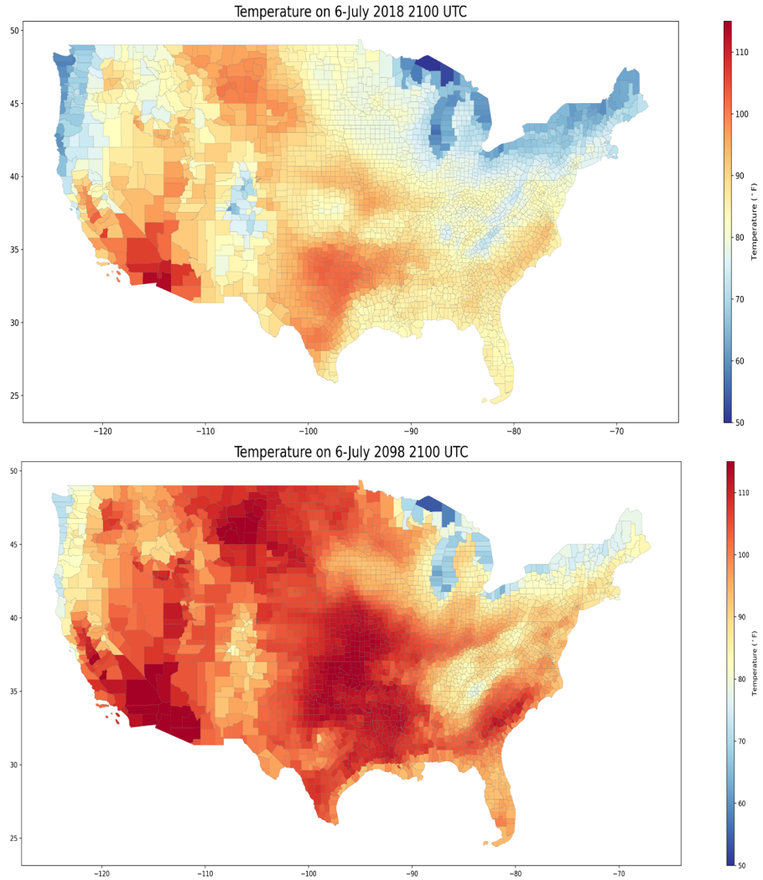
Grid and Environment for Operations

Grid Systems

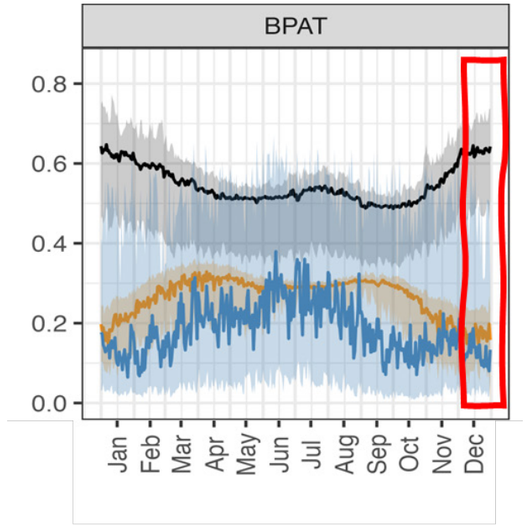
Applying climate data to underpin systems scenarios and future reliability studies

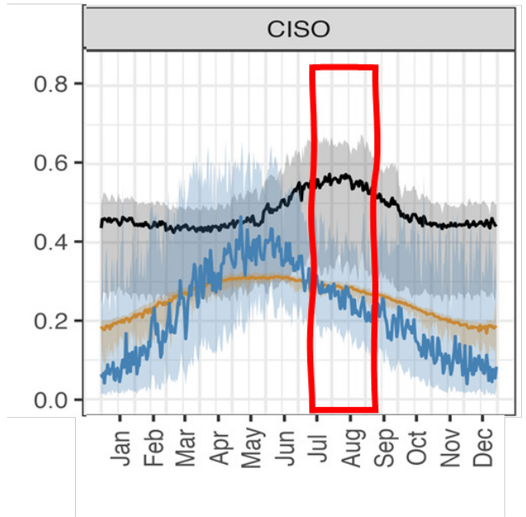


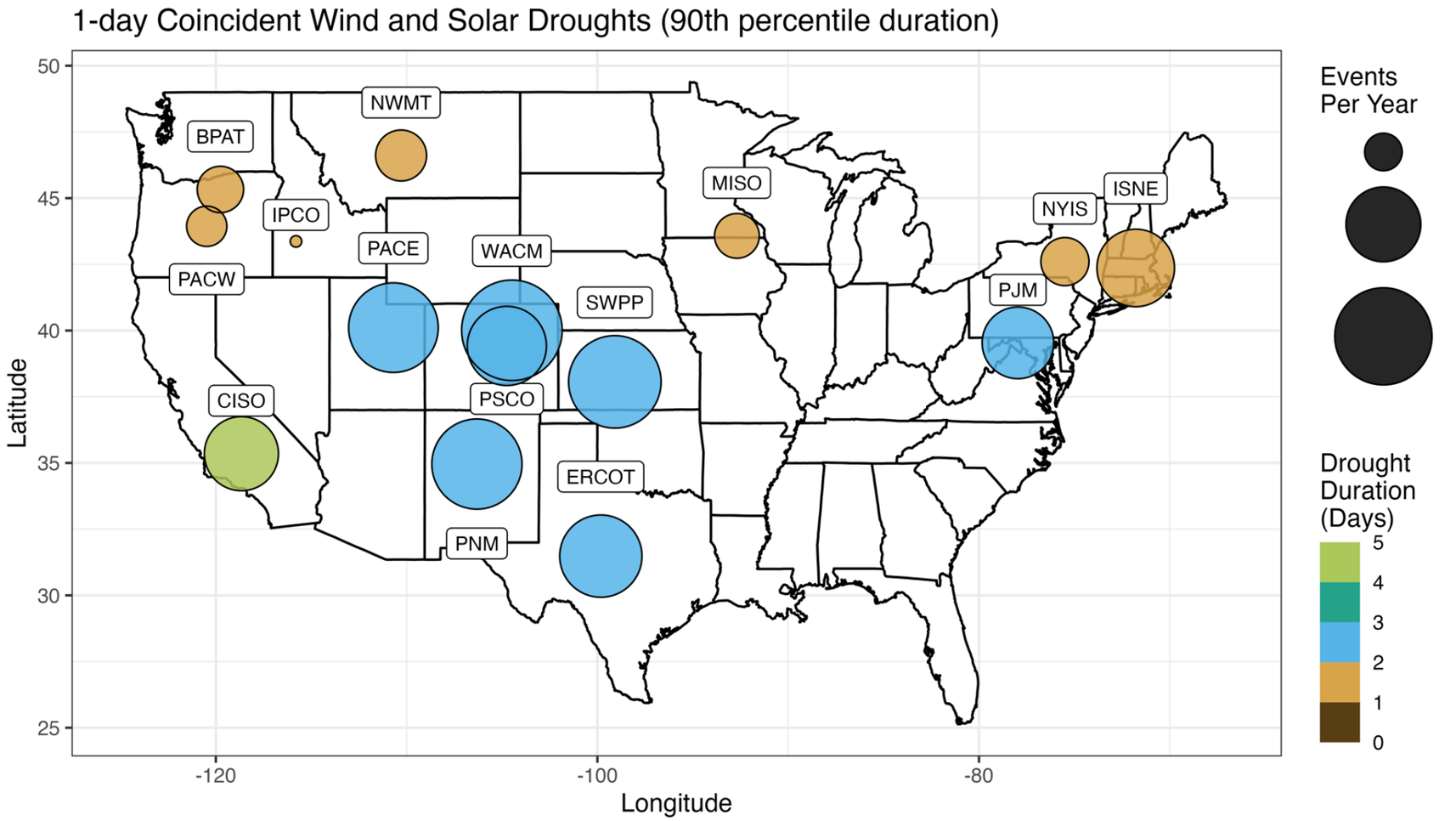
Extreme Events Used in the
National Transmission Planning Study
Heat waves worsened under climate change conditions



Combining future grid scenarios and extreme events to understand impacts to operations







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Aiding wildfire prevention, response & recovery through AI-powered tools

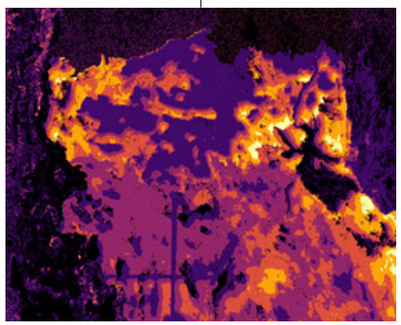
RADR FIRE

Prevention & Mitigation

Pre-Season Wildfire Risk

-Evaluate the past 10-30 years of met & fire regimes
-Update fuelscape
-Probabilistic risk modeling

-Vegetation management
-Priority asset replacement
-Priority asset hardening
-Annual PSPS planning
-Consequence analysis
-Asset ignition vs. landscape ignition

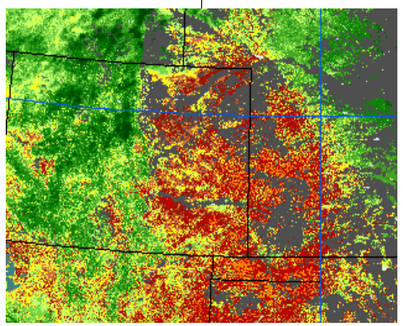


Response

Weekly Wildfire Risk

-Observed meteorology
-Current fuelscape
-Observed veg condition
-Wildfire risk + simulation

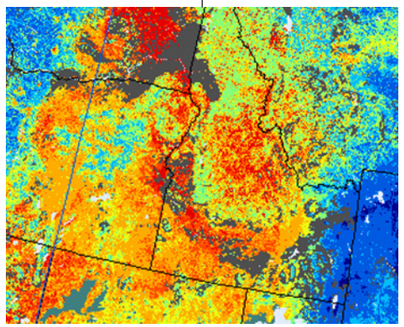
-PSPS tuning/activation
-Consequence analysis
-Ongoing mitigation
-Protection strategies



Forecasted Monthly Wildfire Risk

-Forecasted meteorology
-Last observed veg state
-Wildfire risk + simulation

-PSPS tuning/activation
-Consequence analysis
-Ongoing mitigation
-Protection strategies

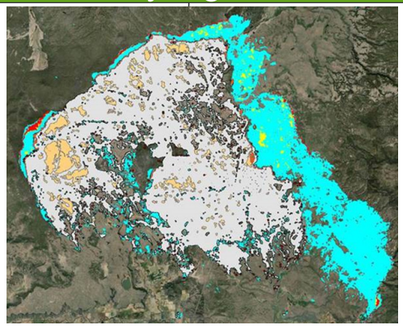


Recovery & Preparedness

Active Event Monitoring

-Automated high-res satellite monitoring
-High frequency
-Burn area and intensity
-Post-fire risks

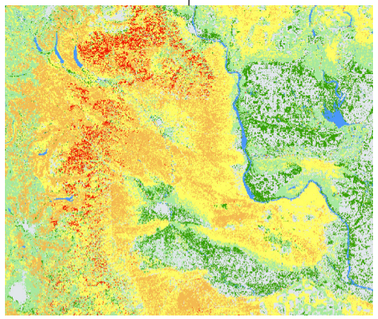
-Asset exposure analysis
-Situational awareness
-Operational response
-Damage assessment
-Post-fire risks
-Recovery logistics



Future Wildfire Risk

-Climate projections
-Vegetation dynamics
-Fire regimes
-Wildfire risk modeling

-Infrastructure strategy
-Long-term resiliency
-Energy contingency
-Microgrid planning



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Driving community engagement, technical support and deployment

- Evaluating electric heat pumps in different regions
- Supporting community goals for energy resilience
- Energy storage technical assistance and demonstration projects

DOE & Washington State Investment

Data analytics can help accelerate regional planning | Center for Reliable Electricity Decarbonization

- Establish the first-of-its-kind regional energy analytics capability
- Develop a user interface and data governance to enable use by diverse entities
- Offer a competitive advantage and a trusted resource for the Pacific NW


Thank you!

Back-up: DOE's Charge for Regional Planning

Overview of the study scope

What the study can do:

- Inform existing planning processes by using industry-grade tools and data
- Test assumptions outside of existing planning frameworks
- Provide a wide range of granular social, economic, reliability, and resilience indicators credible to all parties
- Build a platform for the region to support additional questions in the future

What the study <u>will not</u> do:

- Replace existing regional and utility planning processes
- Provide results that replace utility choices
- Site specific individual transmission lines, generators, DERs, storage, etc.
- Address detailed environmental impact studies
- Explore every scenario

Objective: Identify best ways to meet the region's needs and goals

- **Conduct a regional analysis and stakeholder engagement-based planning process**
  - Design process to advance resource development and infrastructure investment required to meet region's economy-wide decarbonization and resource adequacy requirements and goals
- **Identify medium- and long-term transmission and grid infrastructure needs** and develop a more granular assessment of which resources in which locations, including distributed energy resources, can best meet the region's goals
  - Analyze scenarios for potential combinations of specific resources capable of replacing the energy services of the LSR dams in the event Congress authorizes power replacement and breach of the dams
- **Enable development of long-term regional energy planning by creating a detailed, transparent, interactive power system model of the Pacific Northwest**
  - Enhance informed collaboration among Tribal and other government entities and regulators, energy providers, customers and others

Driving factors (assumptions) for exploring future scenarios

Major drivers may include:

- Climate-informed changes (e.g., demand, extreme events, efficiency)
- Technology adoption rates (e.g., energy efficiency, grid-scale storage)
- Multi-sector energy consumption changes (e.g., transportation electrification)
- Investments by other regions (e.g., interregional transmission, imported power)
- Changes in water usage (e.g., dam breach scenarios, operational changes)

Additional considerations to include:

- Maintaining reliable and affordable electricity, with emphasis on overburdened communities
- Prudent land use (e.g., locating new generation for social equity)

Proposed engagement process principles

- High-quality **independent analysis** is the central objective of this process
- Engagement process will **invite input into key priorities** of the study scope
- Decision-making structure will **represent regional perspectives**
- Analytical options will be **limited by time and budget constraints**
- Process design should include mechanisms to **ensure it supports a high-quality study**

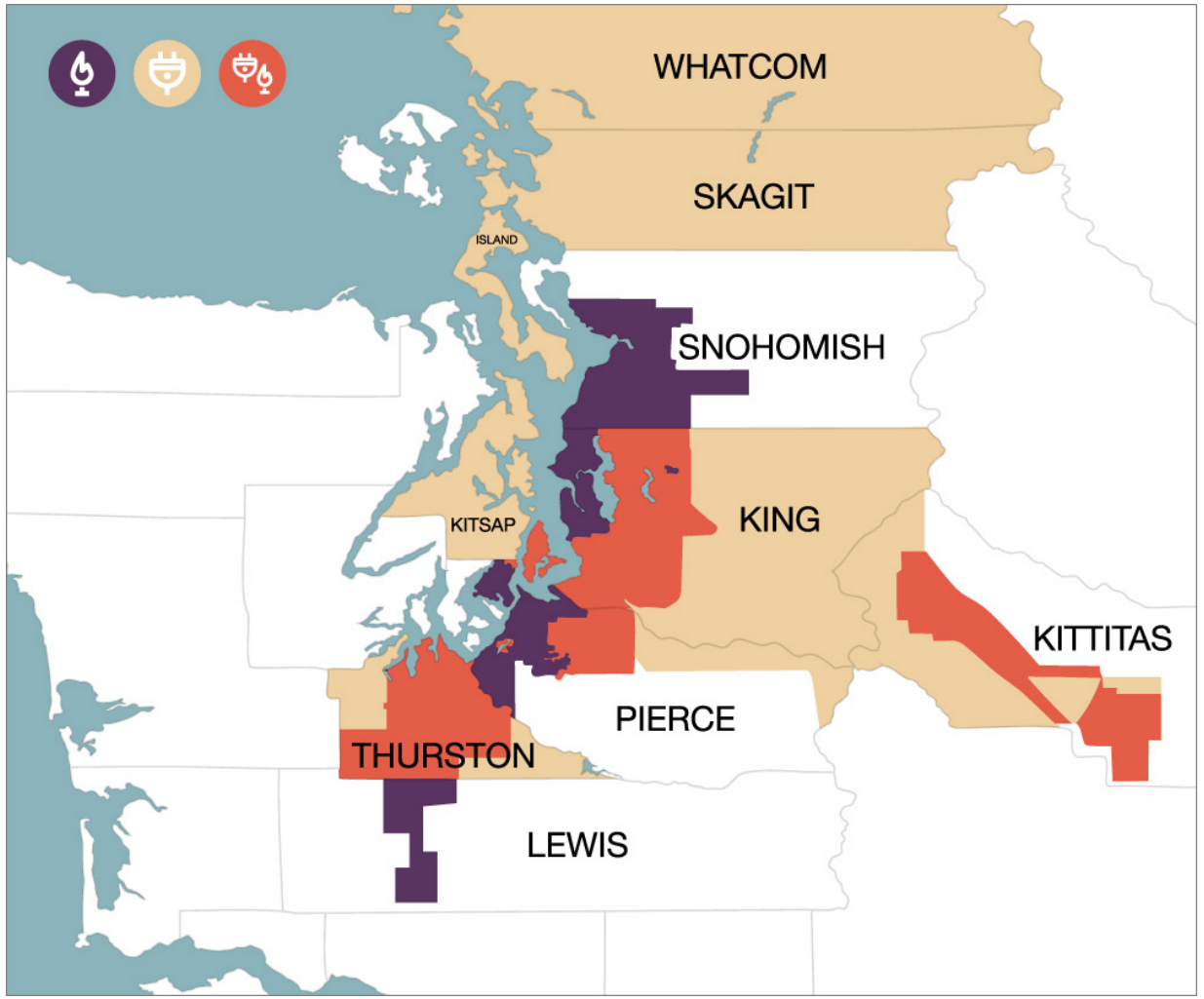
PSE's Clean Energy Transformation

April 10, 2024

PUGET SOUND ENERGY

Puget Sound Energy

- Service area: 6,000 square miles, primarily in Western Washington
- Over 1.2 million electric customers
- Nearly 900,000 natural gas customers
- 3,300 employees
- 6,656 MW of generation capacity (owned, operated, or under long-term contract)[1]
- 23,700 miles electric distribution system; 2,900 miles electric transmission[2] system
- 12,955 miles natural gas pipeline; 13,351 miles natural gas service lines

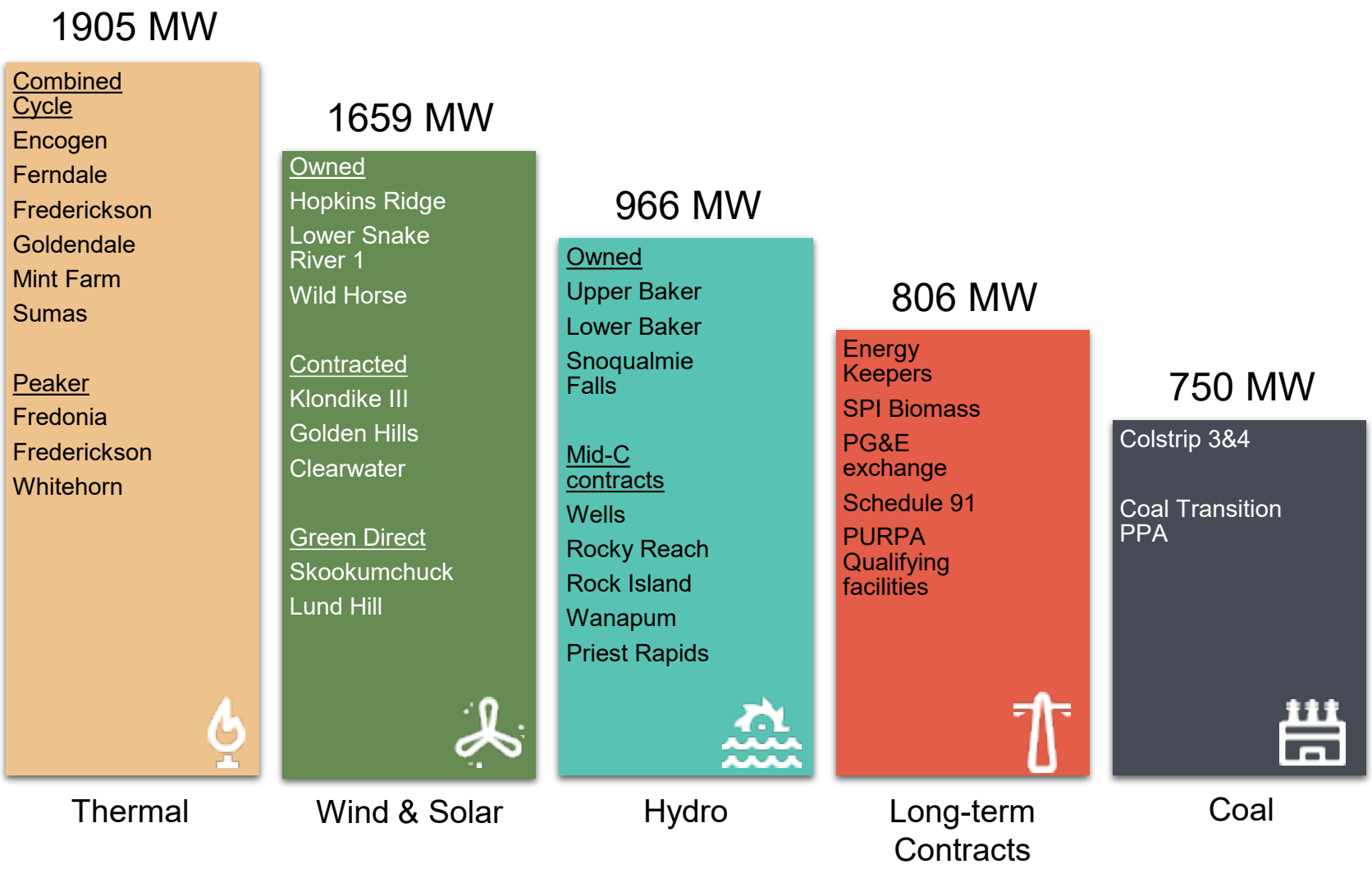


Data as of December 2022

1. Puget Energy Form 10K, Annual Report for the fiscal year ended December 31, 2022, page 15. https://www.pugetenergy.com/pages/filings.html
2. Includes jointly owned transmission

PUGET SOUND ENERGY

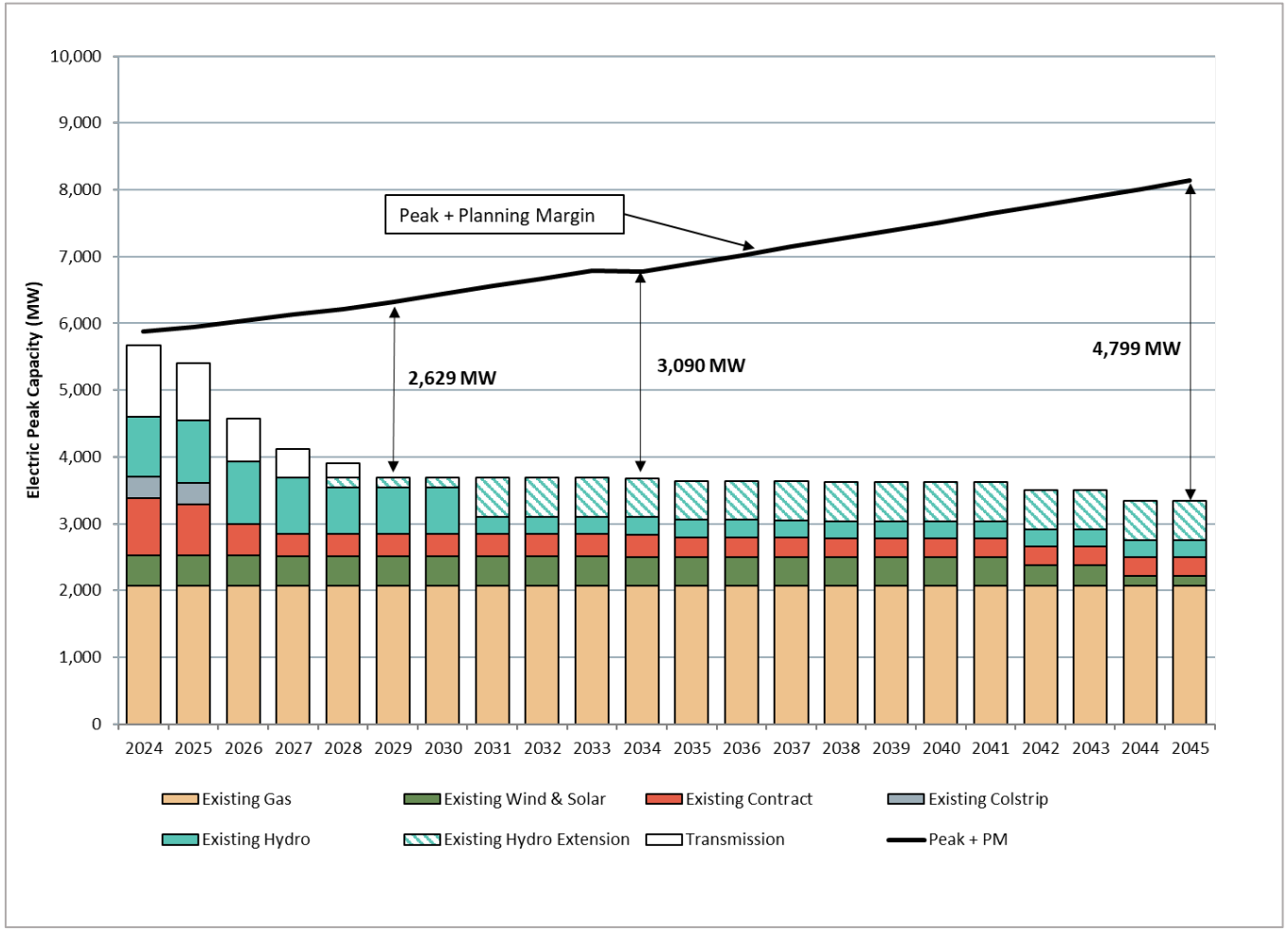
PSE's Current Nameplate Electric Generating Resources



PUGET SOUND ENERGY

Winter Peak Driving Resource Capacity Additions

- Winter peak > summer peak through 2045
- Renewable and energy storage peak capacity contribution is larger in the summer
- New renewable and non-emitting resources will meet summer but not winter peaks
- New peaking capacity resources are needed



PUGET SOUND ENERGY

PSE's 2023 Electric Progress Report

2023 ELECTRIC PREFERRED PORTFOLIO

2025

Eliminate coal-fired resources from its allocation of electricity to Washington retail electric customers, **740 MW total capacity removed**

Consistent with CEIP

Acquire conservation

Pursue demand response

2030

Over **6,700 MW new nameplate** capacity needed to meet CETA and resource adequacy

Reduced market reliance at peak

Add diverse commercially available resources

Expand transmission capacity

2045

Explore new and emerging options to drive diversity in our energy supply and achieve 100 percent renewable and non-emitting resources

Resources Additions (Nameplate MW)	**Total by 2030**	**Total by 2045**
Demand Slide Resources		
Conversation[1]	281	818
Demand Response	337	445
	618	**1,265**
Distributed Energy Resources		
DER Solar	552	2,124
Net metered Solar	284	1,393
CEIP Solar	79	79
New DER Solar	189	652
DER Storage[2]	187	267
	739	**2,392**
Supply Side Resources		
CETA Compliant Peaking Capacity[3]	711	1,588
Wind	1,400	3,650
Solar	700	2,290
Green Direct	100	100
Hybrid (Total Nameplate)	1,450	1,748
Hybrid Wind	600	800
Hybrid Solar	400	398
Hybrid Storage	450	550
Biomass	-	-
Nuclear	-	-
Standalone Storage	1,000	1,800
	5,360	**11,174**
Total	**6,717**	**14,830**

(1) Conservation in winter peak capacity includes energy efficiency, codes and standards, and distribution efficiency; (2) Distributed Energy Resources (DER) storage includes CEIP storage additions, non-wires alternatives, and distributed storage additions; (3) CETA compliant peaking capacity is functionally similar to natural gas peaking capacity, but operates using non-emitting hydrogen or biodiesel fuel.

We’re making progress towards our clean energy goals

- By the end of 2025, our electric supply will be coal free and we’re targeting **63% renewable energy** in our portfolio.
- In 2022, about **43%** of our electricity came from **non-emitting resources**, up from 34% in 2020.
- We’re **aggressively pursuing** renewable energy resources, from large generation projects to energy produced locally in our neighborhoods and communities.

PUGET SOUND ENERGY

PSE's Frederickson generating station is an example of a dispatchable energy resource

PSE's Wild Horse wind facility is an example of an intermittent/variable energy resource

There's a need for on-demand, clean energy resources to replace carbon emitting resources

- After 2025, our resource portfolio will no longer include nearly 750 MW of traditional coal-fired **baseload generation**.
- We need to replace this energy that acts as an **on-demand, easily dispatched** resource, serving customers when the sun isn't shining or the wind isn't blowing.
- **Emerging technologies** that could fill this gap will likely not be **commercially available** for some time.
- In the near term, the large amounts of **variable resources,** including wind and solar**,** being added to the system poses a **reliability risk** and hybrid thermal generation may be needed to **bridge the gap**.

PUGET SOUND ENERGY

We’re pursuing an “all of the above” strategy to address this critical reliability gap

- We’re supporting **early project development** activities for an advanced **small modular nuclear** reactor facility.
- We’re partnering with Form Energy on a 10MW, 100-hour iron-air **long duration battery storage pilot**.
- We’re a part of the **Pacific Northwest Hydrogen Hub** selected last year to receive up to **$ 1 billion** in federal funding.

PSE PUGET SOUND ENERGY

We need to expand and modernize the electric grid to support the transition to clean energy

- The vast majority of **renewable energy resources** in the state are located **east of the Cascade mountains**.
- To bring this energy to PSE's service area, we need to **expand and modernize** the existing **transmission and distribution infrastructure.**
- We **continually invest in our system** to maintain customer and public safety, meet customer growth and service needs, and modernize and automate the grid.

PSE PUGET SOUND ENERGY

PSE PUGET SOUND ENERGY