Industrial electrification and the PNW electric system

WA EITE Joint Advisory Group

June 26, 2025

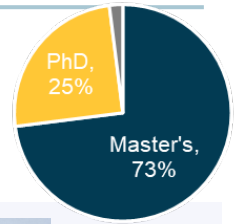
Energy+Environmental Economics

Dan Aas, Partner

Who is E3?

Thought Leadership, Fact Based, Trusted.

100+ full-time consultants | 30 years of deep expertise | Engineering, Economics, Mathematics, Public Policy…




San Francisco

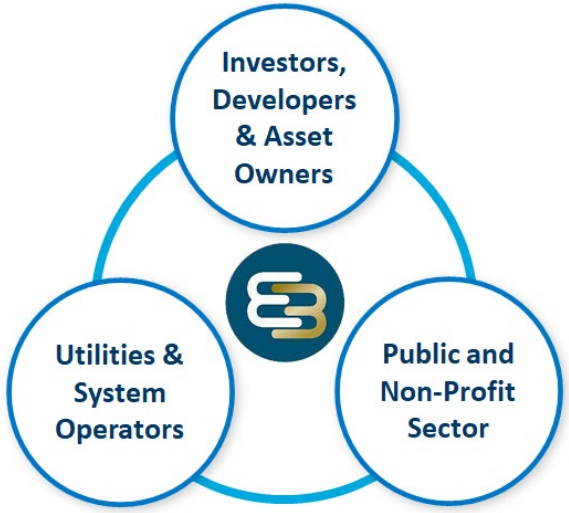

New York


Boston


Calgary

E3 Clients

300+ projects per year across our diverse client base



Recent Examples of E3 Projects

Buy-side diligence support on several successful investments in electric utilities (~$10B in total)

Acquisition support for investment in a residential demand response company (~$100M)

Supporting investment in several stand-alone storage platforms and individual assets across North America (10+ GW | ~$1B)

Acquisition support for several portfolios and individual gas-fired and renewable generation assets (20+ GW | ~$2B)

United Nations Deep Decarbonization Pathways Project

California: 100% clean energy planning and carbon market design for California agencies

Net Zero New England study with Energy Futures Initiative

New York: NYSERDA 100% clean energy planning

Pacific Northwest: 100% renewables and resource adequacy studies for multiple utilities

Outline

- Intro and key takeaways
- Industrial Electrification: policy mechanisms and cost effectiveness
- Can the NW electricity system both decarbonize and reliably meet growing loads?
- Conclusions

Key Takeaways

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Key Takeaways

+ **WA is relatively well positioned to with respect to industrial electrification**
  - Low electricity prices, high prevalence of low-temp heat needs, and large potential emissions savings from heat pumps.
+ **The PNW electricity system must simultaneously decarbonize and grow to meet new loads.**
  - Without investment in renewables, storage, firm capacity, transmission and other supportive infrastructure, the Northwest grid cannot reliably meet rising demand from industry, data centers, buildings, transportation and other sources.
+ **Electrification of industrial heating and EITE competitiveness will only be possible with well considered policy and planning.**
  - Polices that improve the economics industrial electrification (e.g., clean heat PTC) AND planning that allows for sufficient clean energy and firm capacity infrastructure to be developed to manage electric rate impacts.

Industrial Electrification: policy mechanisms and cost effectiveness

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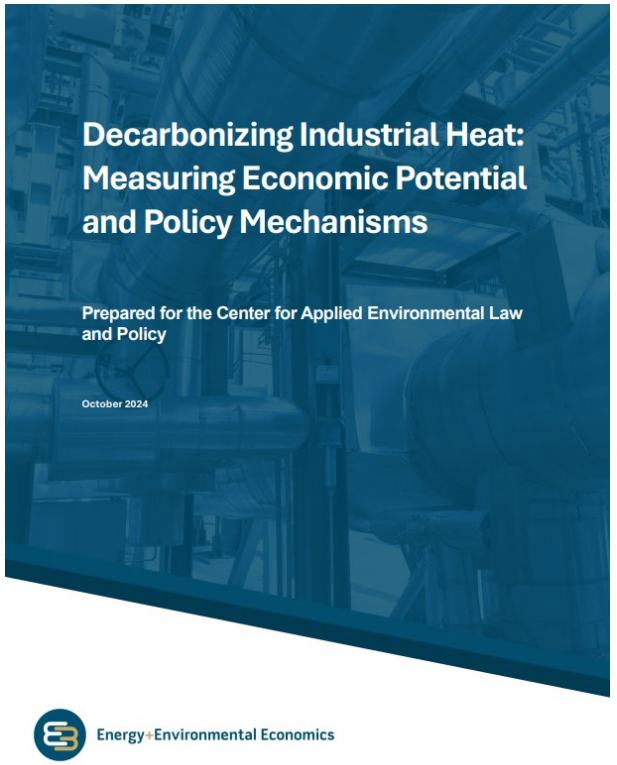
About the E3-CAELP Study

+ **Commissioned by CAELP and conducted by E3, the study evaluates the cost-effectiveness, emissions reduction potential, and policy options for decarbonizing industrial indirect heat, with a focus on electrification pathways.**
  - The *Center for Applied Environmental Law & Policy (CAELP)* is a nonprofit that provides legal and policy expertise to support ambitious, science-based climate action in the U.S.
+ **Key research questions**
  - Where is heat electrification already cost-effective?
  - What factors drive or limit adoption (e.g., temperature, capacity factor, energy prices)?
  - How much GHG and NOx can be reduced?
  - Which policies (e.g., carbon pricing, tax credits, low-cost capital) are most effective in enabling deployment?

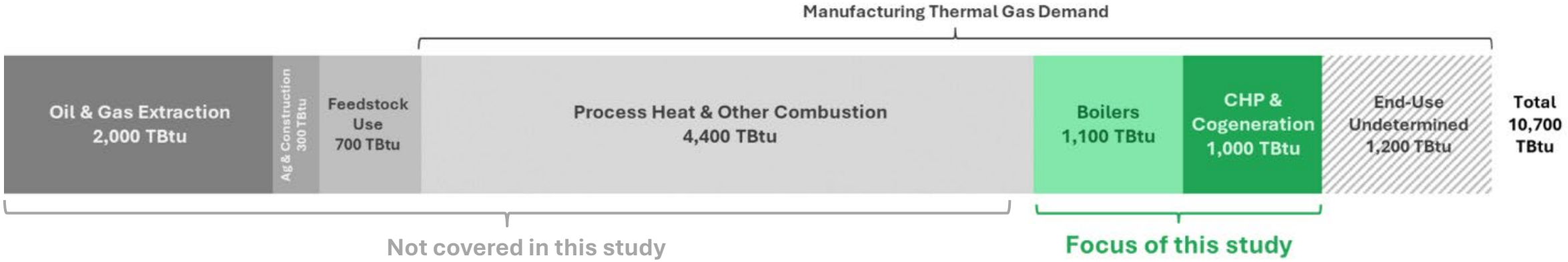
Center for Applied Environmental Law and Policy



E3, Decarbonizing Industrial Heat: Measuring Economic Potential and Policy Mechanisms

Industrial emissions are hard to tackle, but indirect heat is a large and actionable wedge within the industrial sector

- Indirect heat—produced by boilers and CHP systems and delivered via steam or water—is a significant (20% of national industrial gas demand) and actionable source of emissions in the industrial sector.
- Unlike direct process heat, it can often be electrified with commercially available technologies like heat pumps.



PROCESS/DIRECT HEAT – heat is directly applied to material (e.g. concrete, steel, glass)

INDIRECT HEAT – heating air, water, or steam, which is then used for manufacturing process

Sources:
Oil & Gas Extraction – EIA Natural Gas by End Use 2022
Ag & Construction – EIA Annual Energy Outlook 2023
Feedstock Use – EPA National GHG Inventory 2022
Process Heat & Other Combustion, Boilers, CHP & Cogeneration – E3/CAELP Database
End-Use Undetermined – Remainder from EIA SEDS 2022 industrial total after accounting for quantified end-uses

The study examined several different technologies to decarbonize indirect heat. Industrial heat pumps were most promising.

Technology	Temp Range	Maturity (TRL)	Key Attributes
Industrial Heat Pumps	**Up to ~200°C**	**High (TRL 8–9)**	**High efficiency (COP 2–6); Best at low temps**
Electric Resistance Boilers	Up to ~1800°C	High	Simple and mature; high operating cost
Electric Resistance + Thermal Energy Storage	Up to ~1800°C	Moderate	Load shifting via storage; requires low-cost renewables
Renewable Natural Gas (RNG)	All temps	Medium	Drop-in fuel; limited availability; price tied to credits
Green Hydrogen	All temps	Emerging	High-temp capable; storage and infra challenges

We evaluated 2 types of policies that would increase the cost effectiveness of low-carbon options relative to natural gas

1. Policies that reduce upfront capital costs

Investment Tax Credit

- Tax credit available in year 1 relative to % of heat pump capital cost

Low Cost Financing

- Capital costs can be financed at lower rate than investment discount rate

2. Policies that reduce operating costs

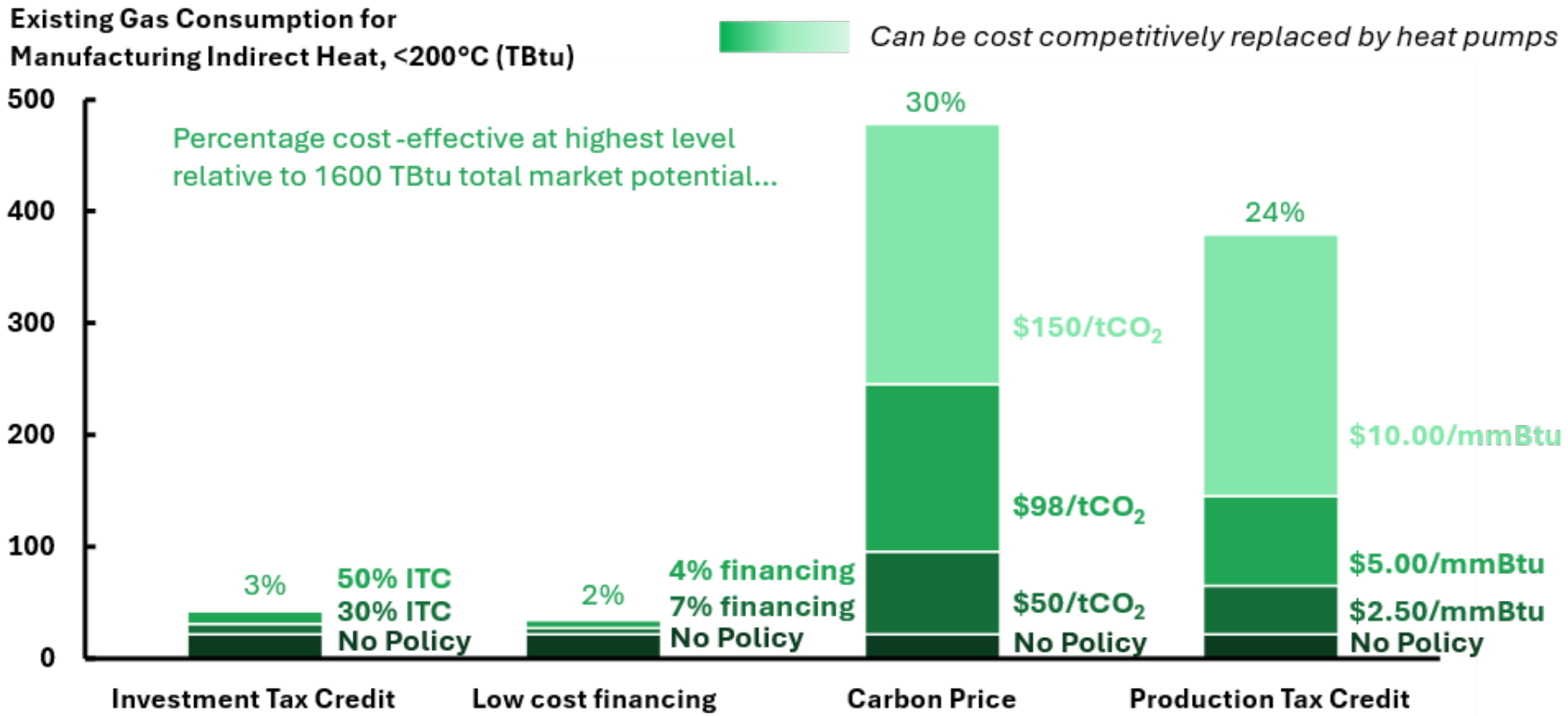
Carbon Price

- Improves relative economics of low carbon alternative by pricing emissions, including on upstream electric system

Production Tax Credit

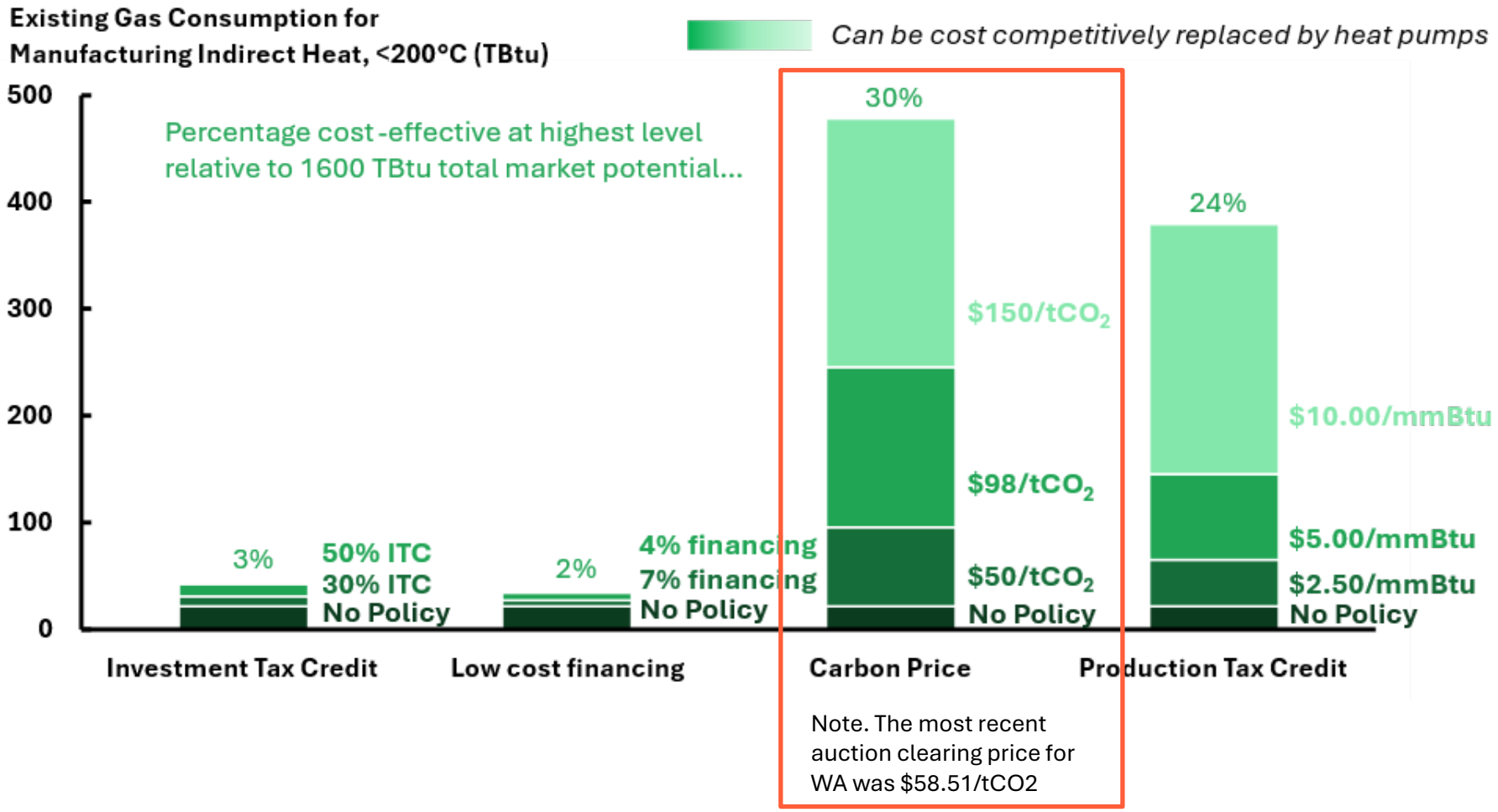
- Annual tax credit for 10 years for each unit of heat produced, scaled down from nominal value by % reduction in heating emissions

Policies that impact operational costs move the needle more than policies that reduce investment cost



*This graphic compared HPs to existing gas equipment

Carbon pricing raises the cost of natural gas relative to electricity, but could result in carbon leakage for EITEs



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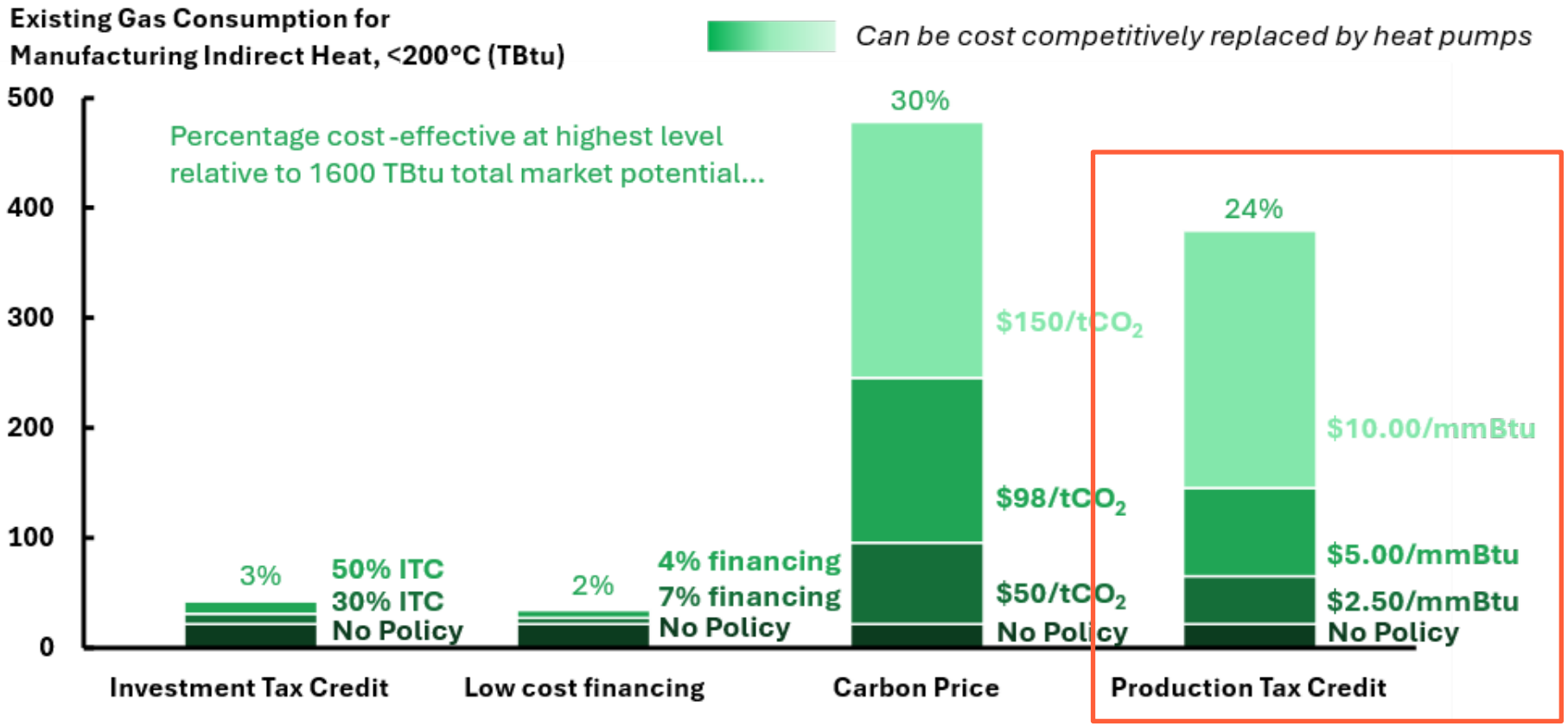
A clean heat production tax credit could be similarly effective, but carries implementation challenges and requires a funding source



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Washington's industrial sector is relatively well situated with respect to industrial electrification.

+ Washington ranks among the top states where heat pumps are most cost-competitive, due to:

- Low electricity prices (from hydro and renewables).
- Strong industrial presence in pulp & paper and food & beverage—sectors with high shares of low-temperature heat needs.

+ In Washington:

- ~6 to 13 Tbtu of industrial gas demand is potentially cost-effectively addressable by heat pumps if replacing aging equipment on burnout.
  - Industrial gas demand in WA was ~87 Tbtu in 2022
- Equivalent to CO_2 emissions savings of ~5 to 12 MMT over 20 years
- Additional emissions savings may be possible via strategies such as low-carbon fuels, or other forms of electric heating.

Can the NW electricity system both decarbonize and reliably meet growing loads?

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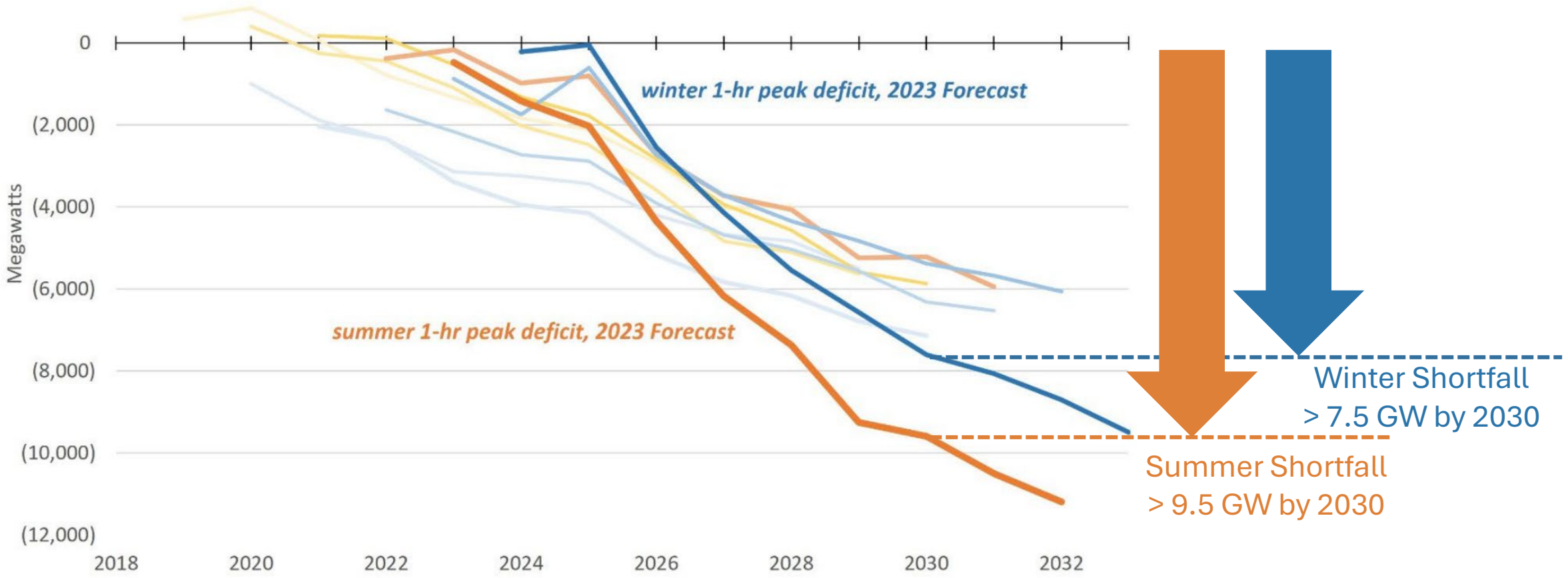
The Northwest electric system already has a significant capacity deficit – PNUCC projects 10 GW by 2030

Forecasted Peak Capacity Surplus (Deficits) in 2019-2023 Forecasts

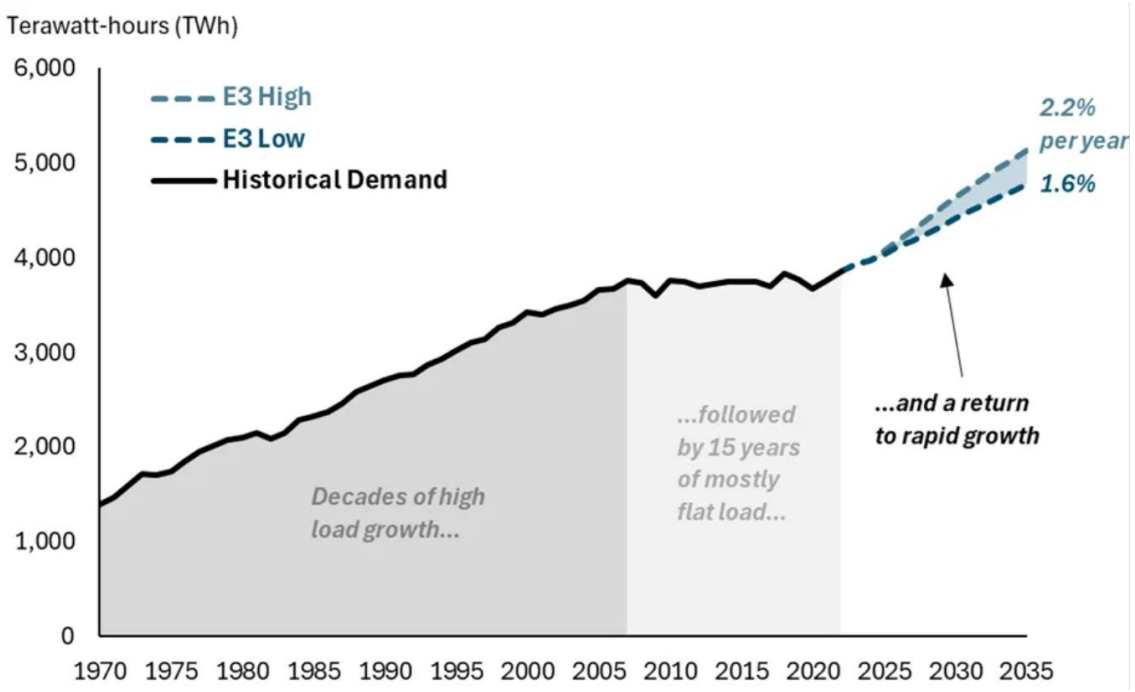


Source: *Northwest Regional Forecast of Power Loads and Resources. PNUCC. May 2023. Page 10.*
https://www.pnucc.org/wp-content/uploads/2023-PNUCC-Northwest-Regional-Forecast-final.pdf

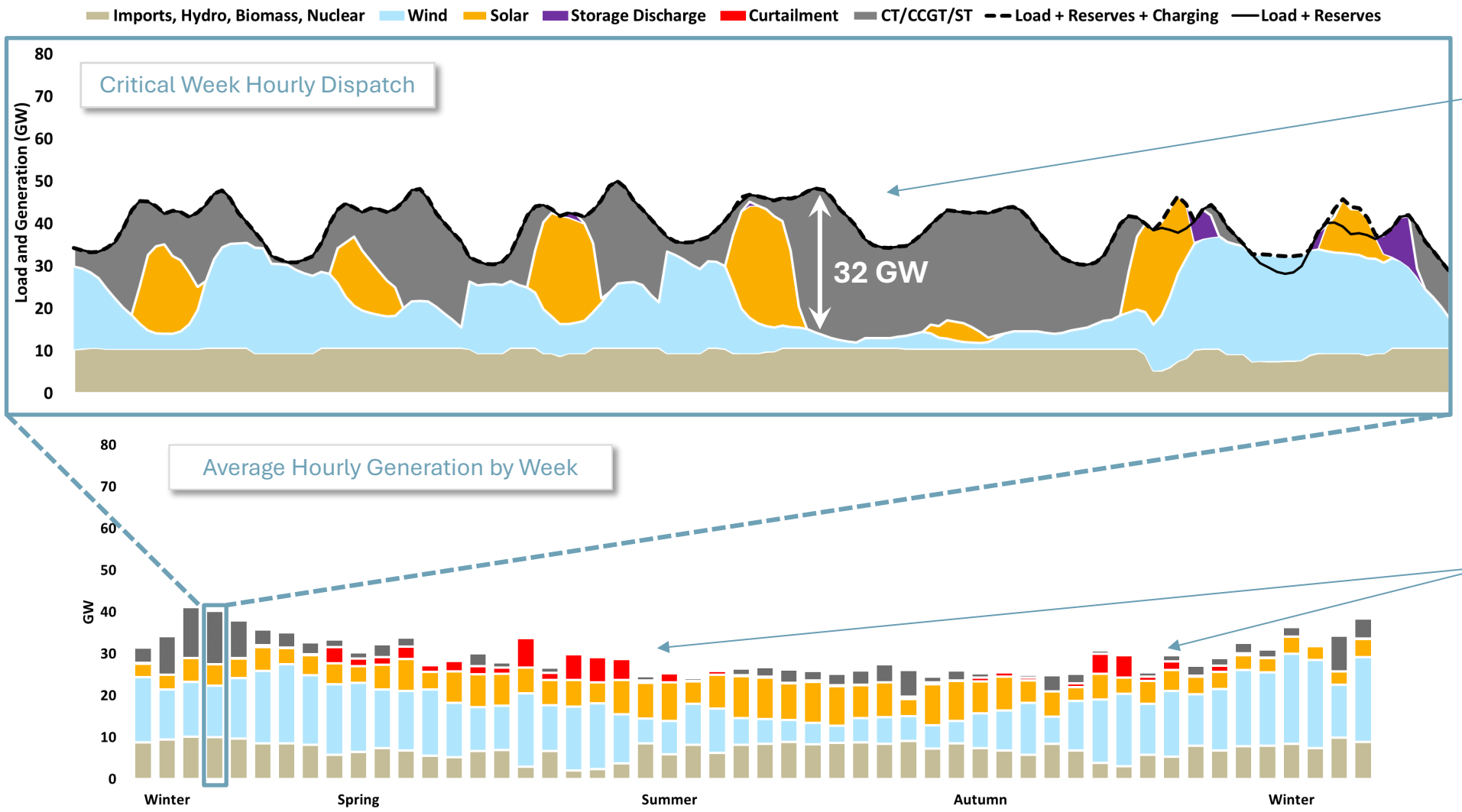
Data centers, AI and electrification are creating significant new demand for electricity

- US and Washington electricity demand could more than double by 2050
- Data centers are competing with utilities and other load-serving entities for both existing and new resources
- Electrification of buildings, transportation and industry will drive additional resource needs.

E3 National Load Growth Projections



Renewables and storage could reliably meet growing loads most of the time, but firm resources are needed for critical periods (New England example)

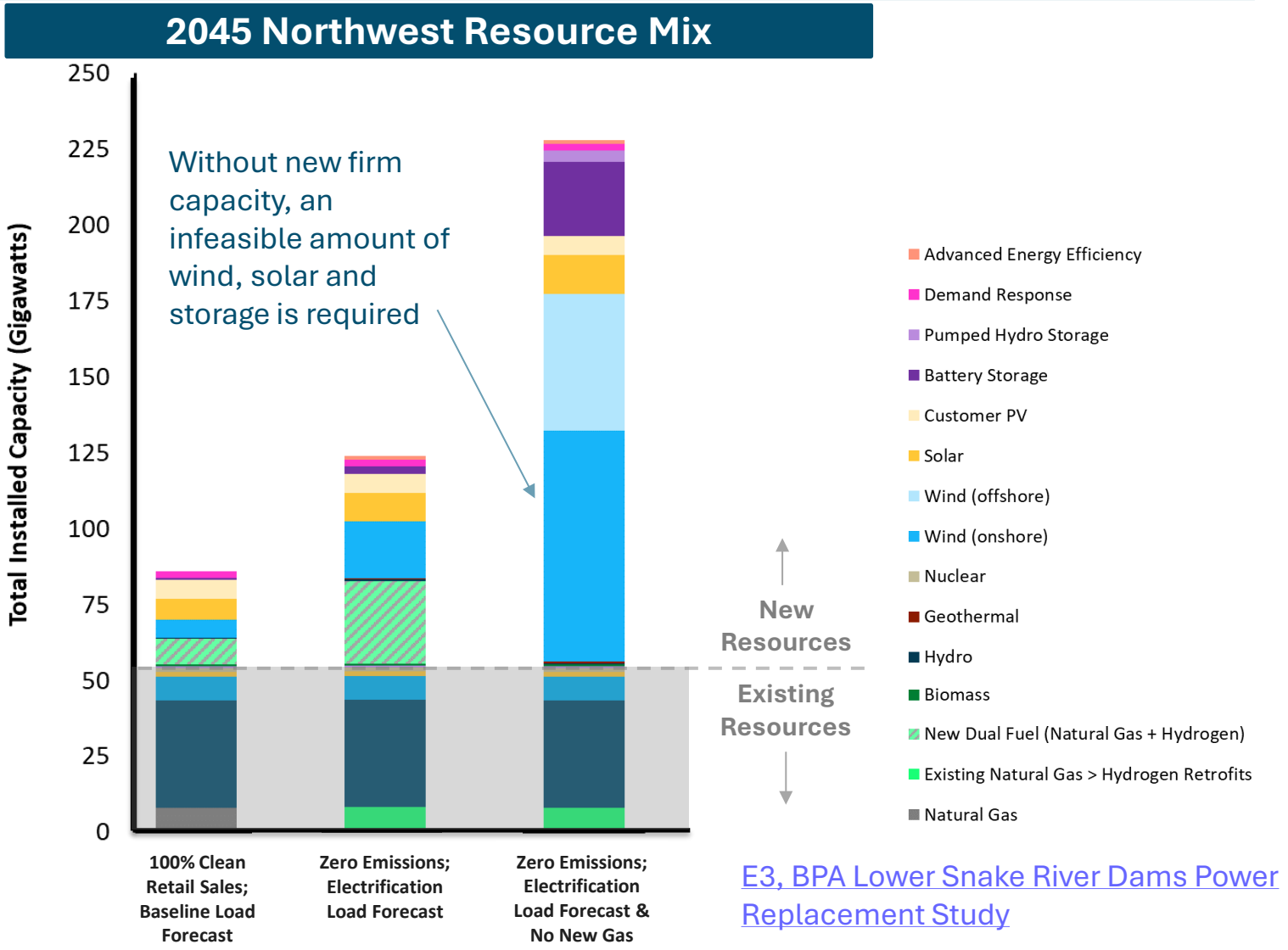


During low renewable conditions, 32 GW of thermal peaking generation is dispatched for reliability

During favorable conditions, clean generation is more than sufficient to meet load

The Northwest electric system will need to expand to meet decarbonization goals

- Under baseline load growth, without electrification and data centers, the installed capacity on the NW energy system would need to increase by ~80% to meet clean energy policies.
- Capacity must more than double to meet electrification loads, provided that firm resources can be built to cover critical periods.
- Absent firm resources, an infeasible amount of renewables and storage would need to be built.

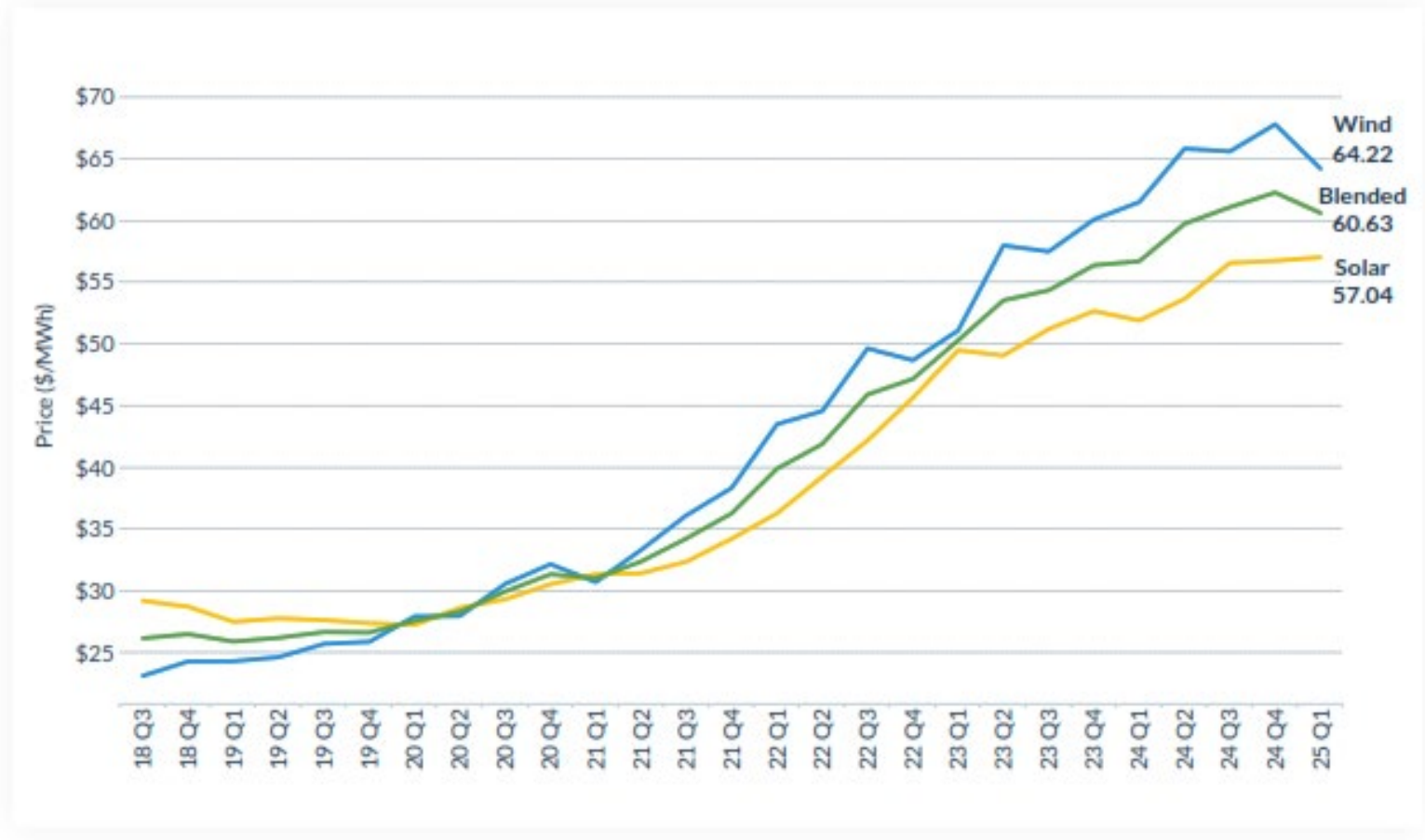


E3, BPA Lower Snake River Dams Power Replacement Study

Costs have risen substantially since the preceding studies were conducted, increasing the challenge of expanding the grid to accommodate electrification.

- **Solar and wind PPAs are now $50-60/MWh**
  - More than double pre-pandemic levels
- **Price pressures will continue due to:**
  - Competition from tech industry
  - Land, labor, equipment, interconnection, tariffs
- **Gas CT costs at or above $2000/kW**
  - Also 2x pre-pandemic levels

Solar and Wind PPA Price Index: North America (LevelTen)



Source: LevelTen Energy (www.leveltenenergy.com/ppa)

Conclusions

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Thank You

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