RPAG meeting

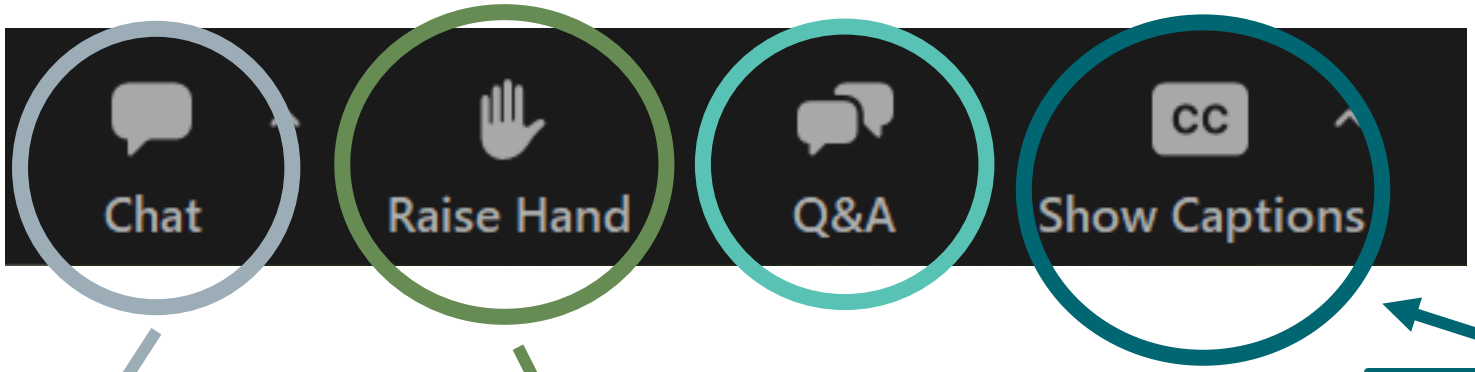
2025 IRP

January 12, 2024

PUGET SOUND ENERGY

Welcome to the webinar!

The Q&A tool will be turned off during the meeting



RPAG members and PSE staff are welcome to use the chat feature

During the public comment period, raise your hand if you would like to make a verbal comment

Click to see real-time closed captioning

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Safety moment

Extension cord safety

- Never plug an extension cord into another extension cord
- Make sure your extension cord is properly rated for their intended indoor or outdoor use
- Always plug an outdoor extension cord into a GFCI outlet
- Discard frayed or cracked cords

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Facilitator requests

- Engage constructively and courteously towards all participants
- Respect the role of the facilitator to guide the group process
- Avoid use of acronyms and explain technical questions
- Use the Feedback Form for additional input to PSE
- Aim to focus on the webinar topic
- Public comments will occur after PSE's presentations

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Agenda

Time	Agenda Item	Presenter / Facilitator
12:00 p.m. – 12:05 p.m.	Introduction and agenda review	Sophie Glass, Triangle Associates
12:05 p.m. - 12:10 p.m.	Timeline update and public feedback summary	Phillip Popoff, PSE
12:10 p.m. - 1:05 p.m.	Demand forecast	Lorin Molander, PSE Allison Jacobs, PSE Stephanie Price, PSE
1:05 p.m. - 1:50 p.m.	Emerging resource assessment overview	Elizabeth Hossner, PSE
1:50 p.m. - 2:00 p.m.	Next steps and public comment opportunity	Sophie Glass, Triangle Associates
2:00 p.m.	Adjourn	All

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Today's speakers

Sophie Glass

Facilitator, Triangle Associates

Phillip Popoff

Director, Resource Planning Analytics

Lorin Molander

Manager, Load Forecasting and Analysis, PSE

Allison Jacobs

Consulting Load Forecast Analyst (gas)

Stephanie Price

Consulting Load Forecast Analyst (electric)

Elizabeth Hossner

Manager, Resource Planning and Analysis

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2025 IRP timeline update

- Washington Utilities and Transportation Commission approved PSE's petition to extend the 2025 gas and electric IRP filing date to March 31, 2025
- PSE's updated work plan reflects this approved timeline
- Please reach out if you have concerns about any specific meeting dates

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December 7 Emerging resources: hydrogen public webinar feedback summary

- Meeting summary and feedback report available on the PSE IRP website
- PSE received 16 questions or comments during the meeting and 2 comments via feedback form
- 45 people participated via Zoom, 101 views on YouTube
- Feedback themes included:
  - Support for leveraging hydrogen for high value uses (peaking capacity, industrial)
  - Concerns with blending hydrogen in the gas system
  - Questions about the cost effectiveness of hydrogen

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Demand forecast

Base Case Results

Lorin Molander, Manager Load Forecasting & Analysis
Allison Jacobs, Consulting Load Forecast Analyst (Gas)
Stephanie Price, Consulting Load Forecast Analyst (Electric)

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Updated demand forecast

- Overview
- Natural gas results
- Electric results
- Next steps
- Appendix

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Overview

- The forecast period is 2026 – 2050
- The forecasts presented herein are for PSE's entire service area
- The base/reference forecast is "business as usual"
- IRP analytics will determine the amount of future demand-side resources (DSR)

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Base/reference case assumptions

- Impacts of numerous **natural gas decarbonization policies in effect that impact new customer growth** are included, driving residential natural gas growth down to zero starting in 2024
- Impacts of potential future policies or **programs incentivizing *existing* gas customers to switch to electric are not assumed** in this reference case forecast (but will be addressed in scenarios)
- Recent federal and state **transportation electrification** policies significantly increase the electric load forecast
- An **economic slow down** in 2024 is expected
- The 2025 IRP reflects post-pandemic **usage trends**, so the forecast assumes patterns similar to 2022 usage behaviors

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Major drivers of the forecast

	Update	Impact
Electric Vehicles	Includes impact of recent legislation and forecast of medium and heavy duty EVs	Increases electric energy and peak forecasts
Economy	Near term slowdown expected	Lower customer growth before IRP forecast period
Climate Change	As with the 2023 IRP, forecast assumes normal temperatures that reflect continued warming over time	Decreases energy and peaks for heating and increases energy and peaks for cooling
Other	Incorporates recent actual customer counts and billed sales data, new major block loads	Mixed impacts
Scenario **Policy**	Impacts of building electrification policies beyond policies currently in effect	TBD, not included in the base case

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Natural gas results

- Customer growth
- Energy
- Peak

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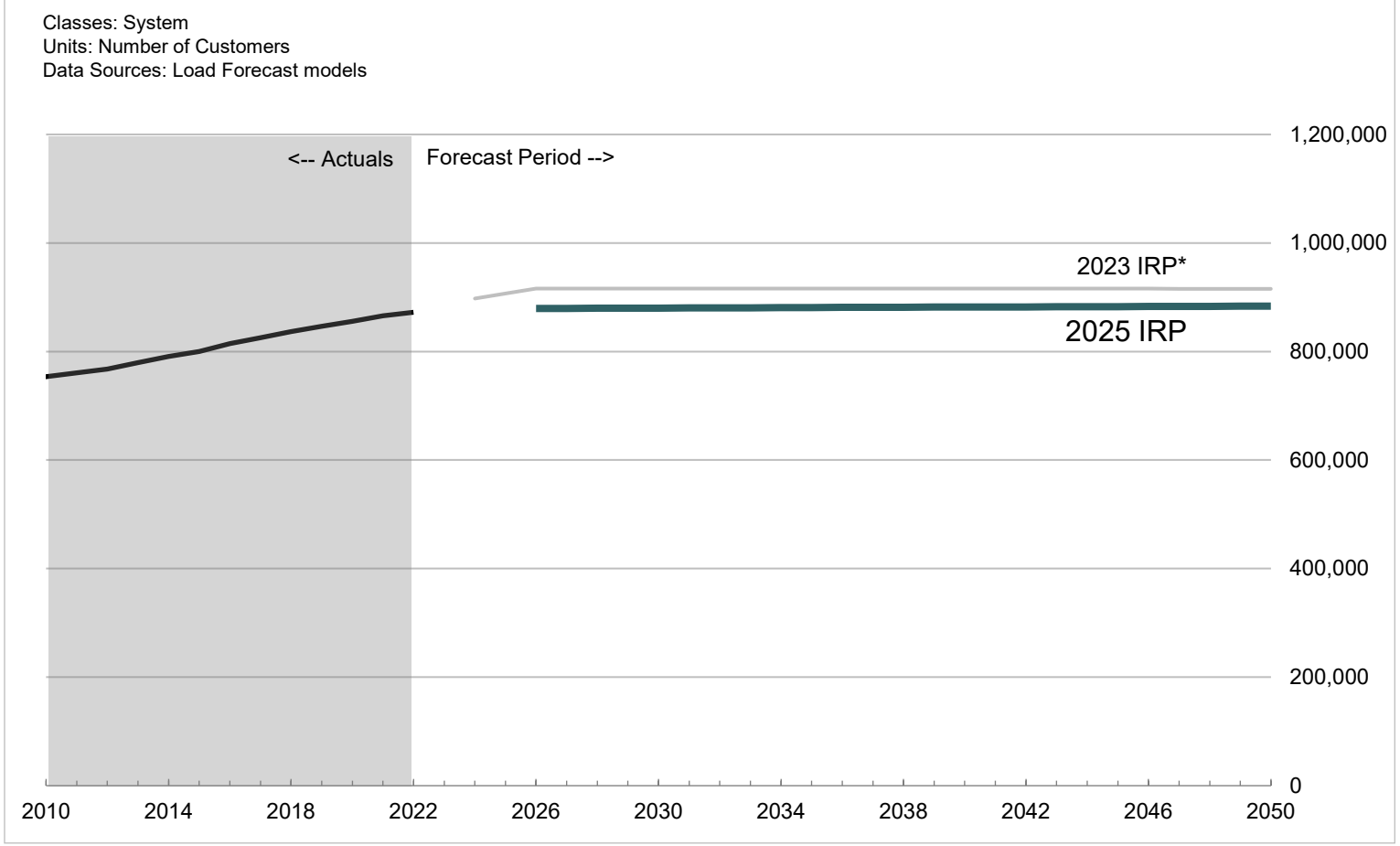
Natural gas: customer growth forecast vs. 2023 IRP

- No new residential customers
- Commercial class grows modestly
- Industrial class declines

System Level Natural Gas: Forecast of customers from the 2025 IRP and 2023 IRP



*2023 IRP = 2023 IRP Zero-customer growth scenario

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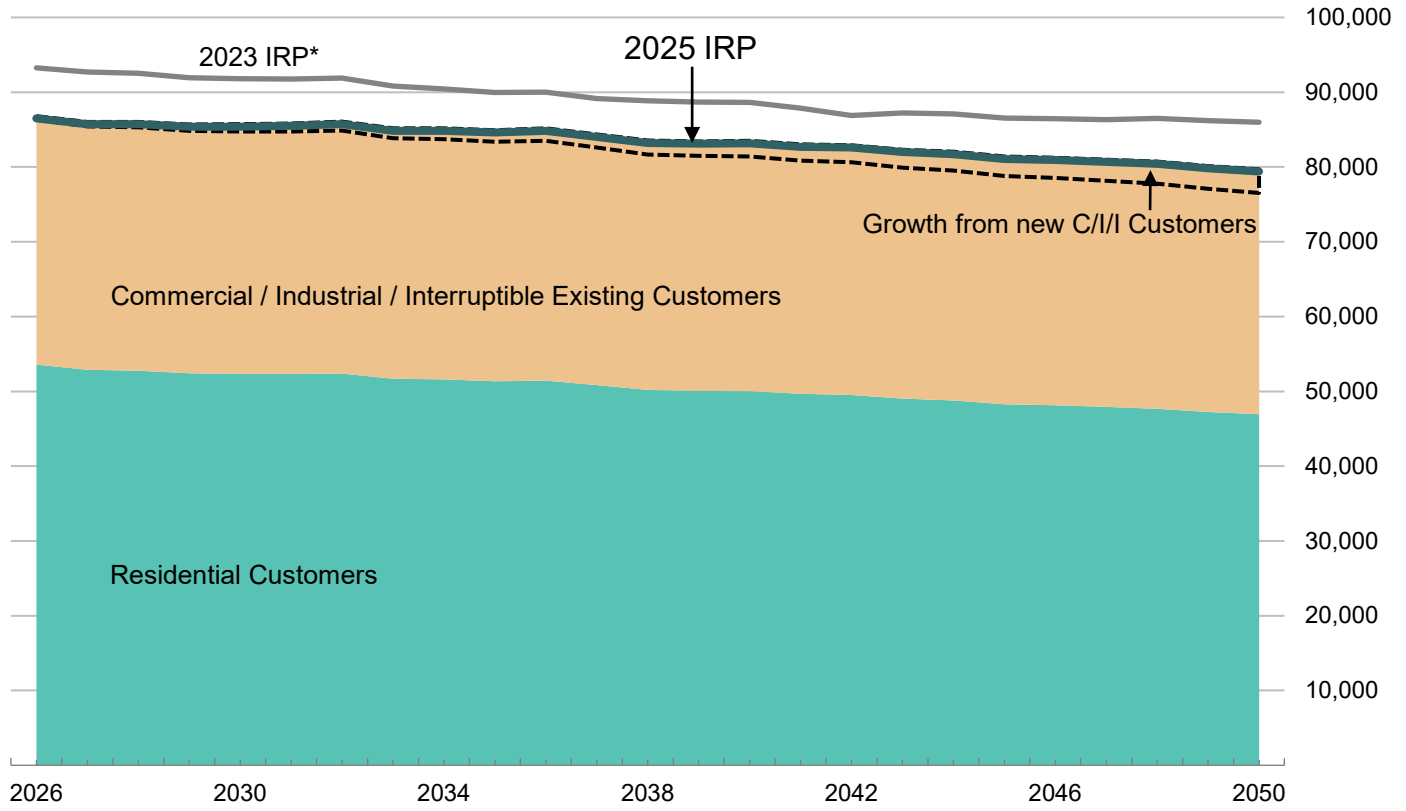
Natural gas: energy forecast composition

System Level Natural Gas: Components of the 2025 IRP demand forecast before DSR

Units: Therms x10,000 (MDth)
Data Sources: Load Forecast models
Notes: Firm and Interruptible customers; No new DSR after committed 2 year targets



*2023 IRP = 2023 IRP Zero-customer growth scenario

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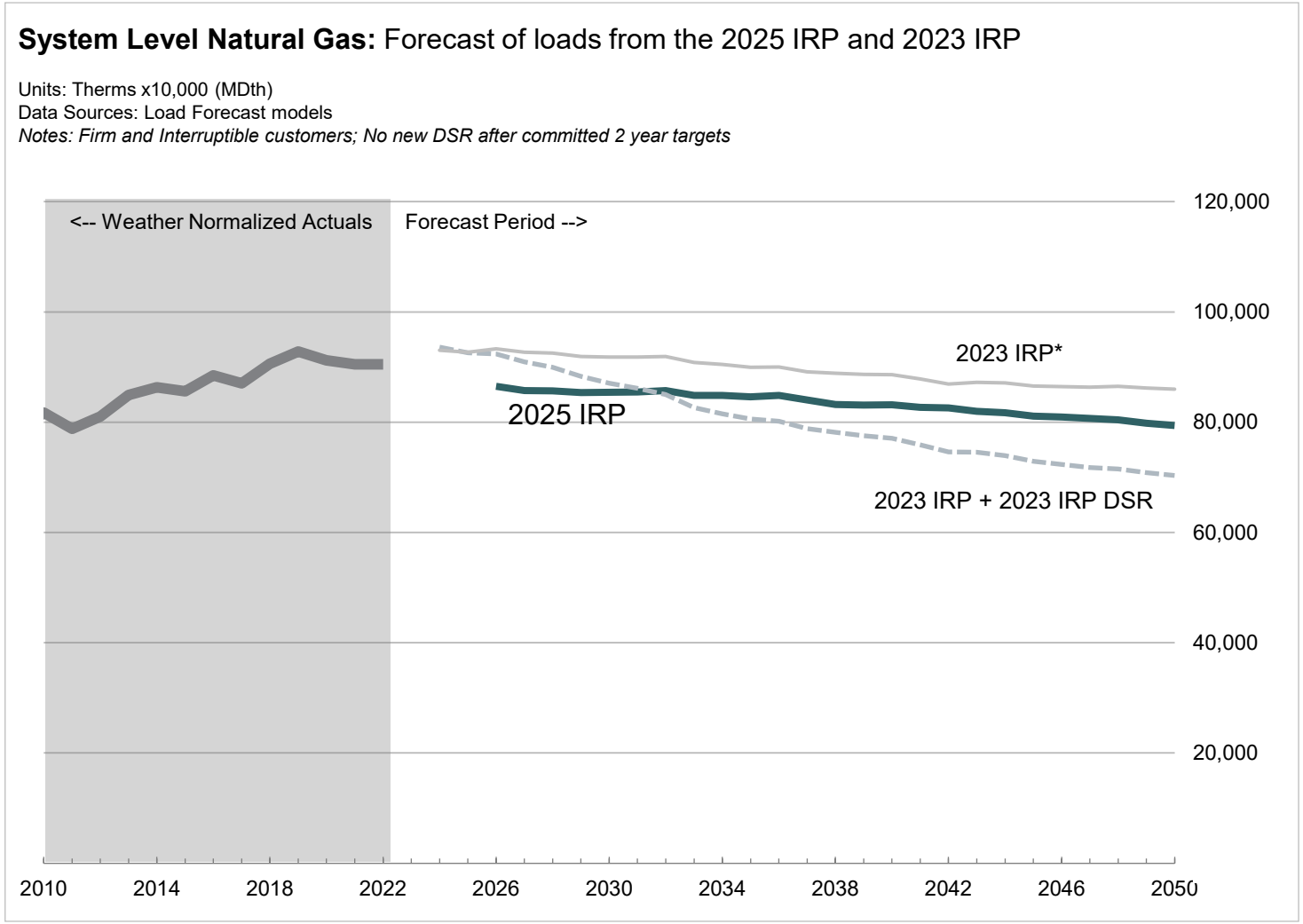
Natural gas: energy forecast vs. 2023 IRP

- Energy is down 8% in 2050 vs. 2023 IRP
- Forecast decreases over time due to
  - Climate change effects
  - Industrial customer decline
- The 2025 IRP demand forecast after DSR will be available once final DSR is determined



*2023 IRP = 2023 IRP Zero-customer growth scenario

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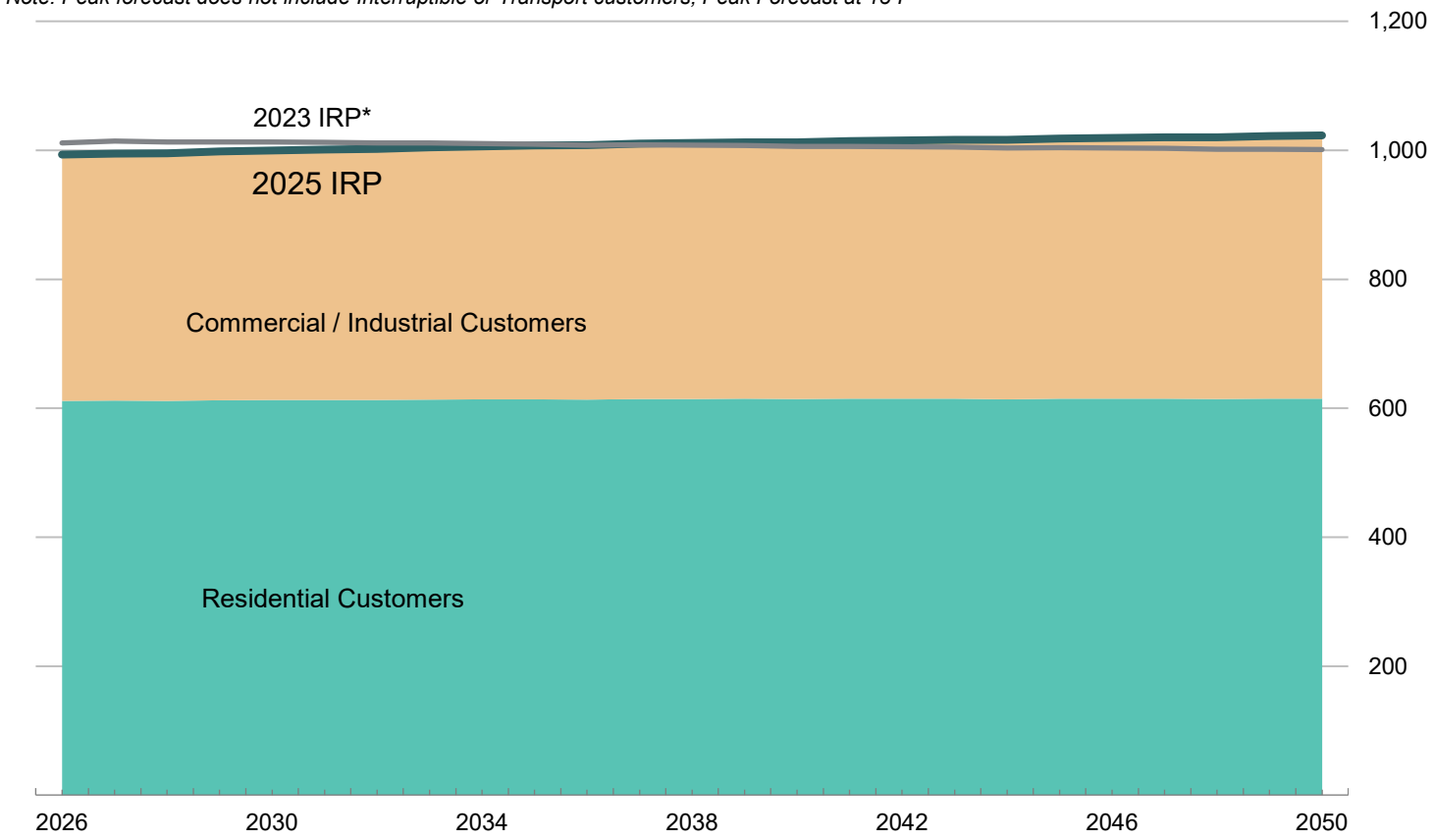
Natural gas: peak forecast composition

System Level Natural Gas: Components of the 2025 IRP peak demand forecast before DSR

Units: Therms x10,000 (MDth)
Data Sources: Load Forecast models
Note: Peak forecast does not include Interruptible or Transport customers; Peak Forecast at 13ºF



*2023 IRP = 2023 IRP Zero-customer growth scenario

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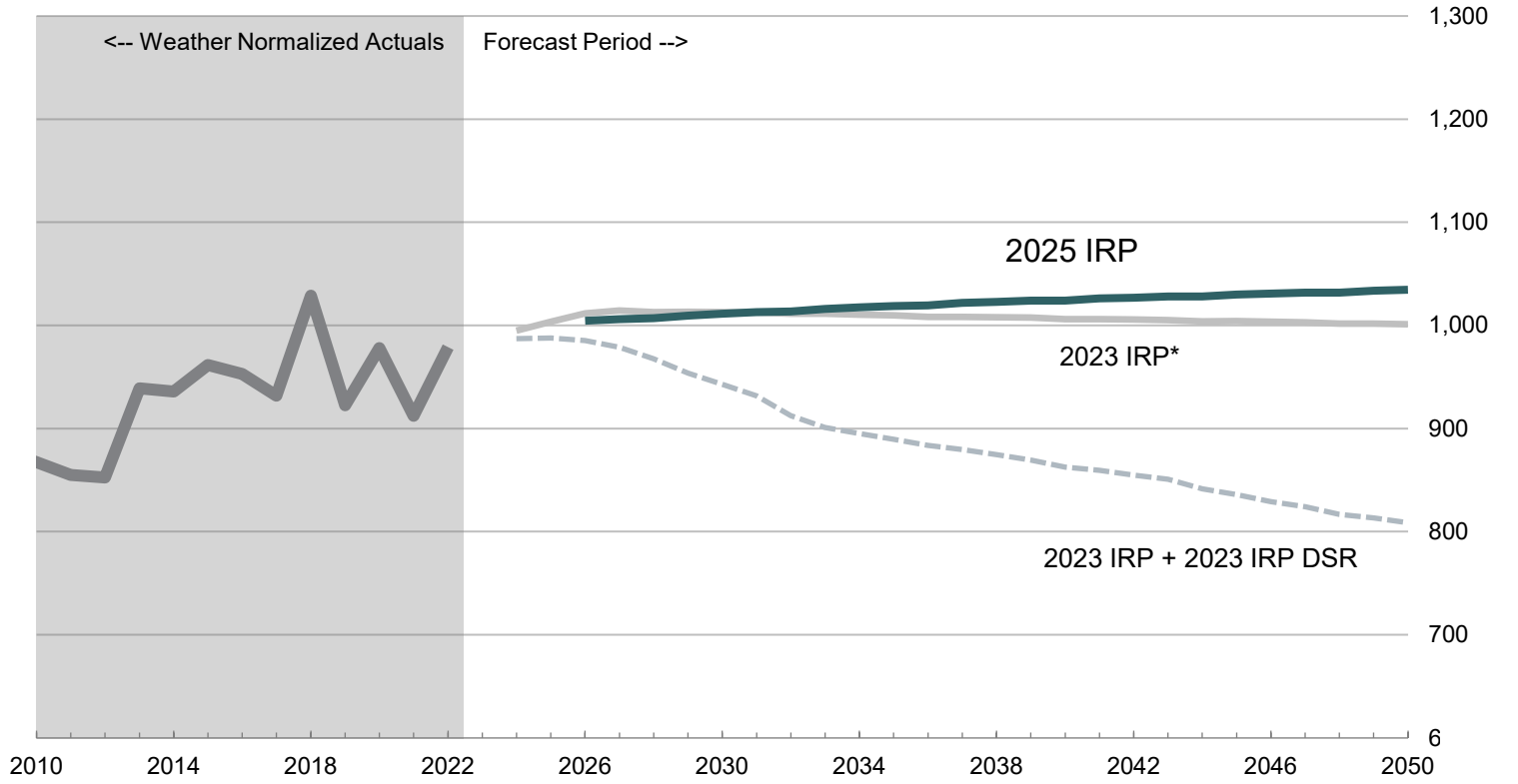
Natural gas: peak forecast vs. 2023 IRP

- Peak is up 3% in 2050 vs. 2023 IRP
- Commercial customers increase over time
- The 2025 IRP peak forecast after DSR will be available once final DSR is determined

System Level Natural Gas: Forecast of design peaks from the 2025 IRP and 2023 IRP

Units: Dekatherms x1000 (MDth)
Data Sources: Load Forecast models



*2023 IRP = 2023 IRP Zero-customer growth scenario

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Electric results

- Customer growth
- Energy
- Peak – winter and summer

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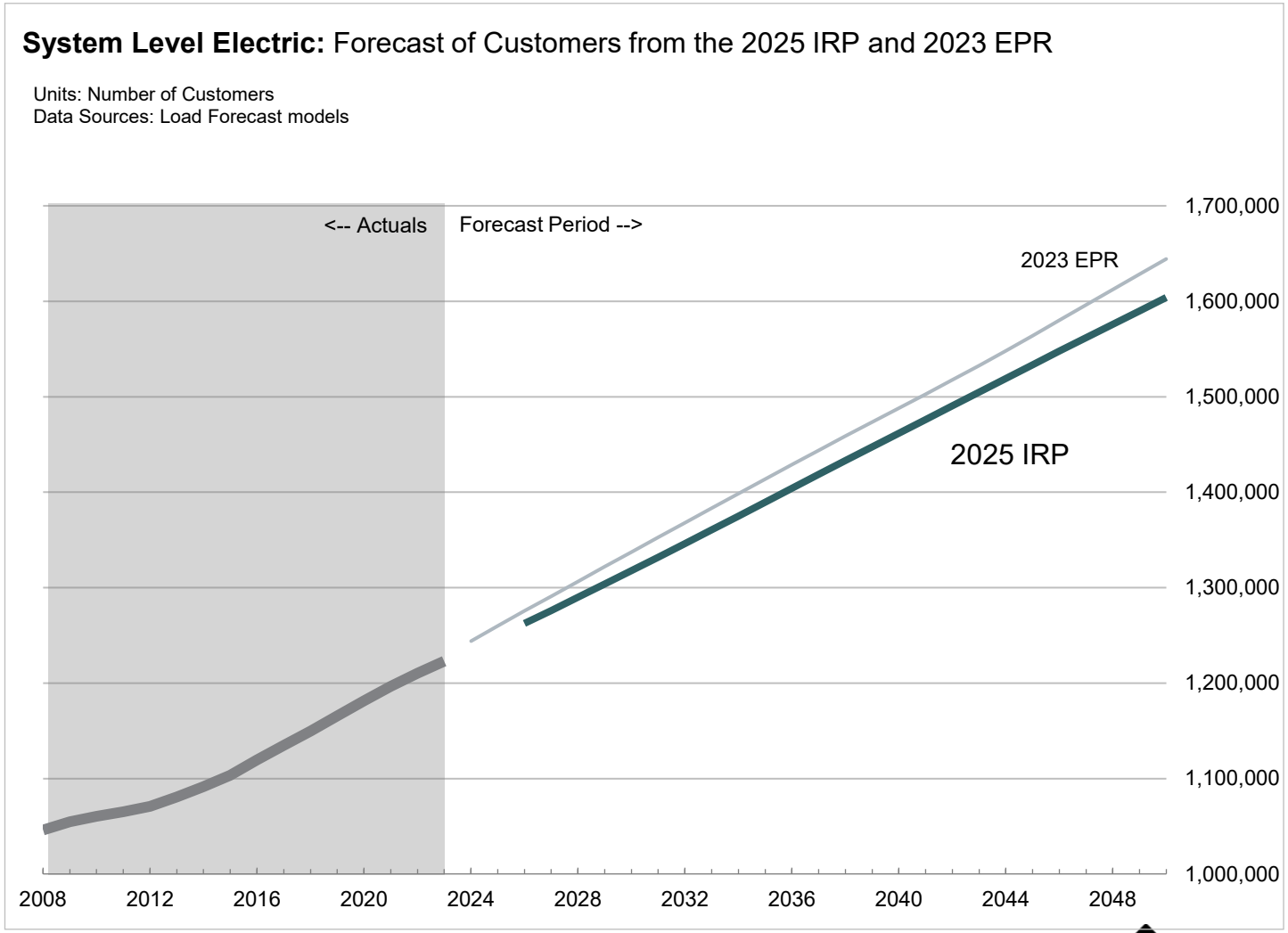
Electric: customer growth forecast vs. 2023 Electric Progress Report (EPR)

- Less customer growth than 2023 Electric Progress Report
- Updates: post-pandemic trends and softer near-term economic outlook



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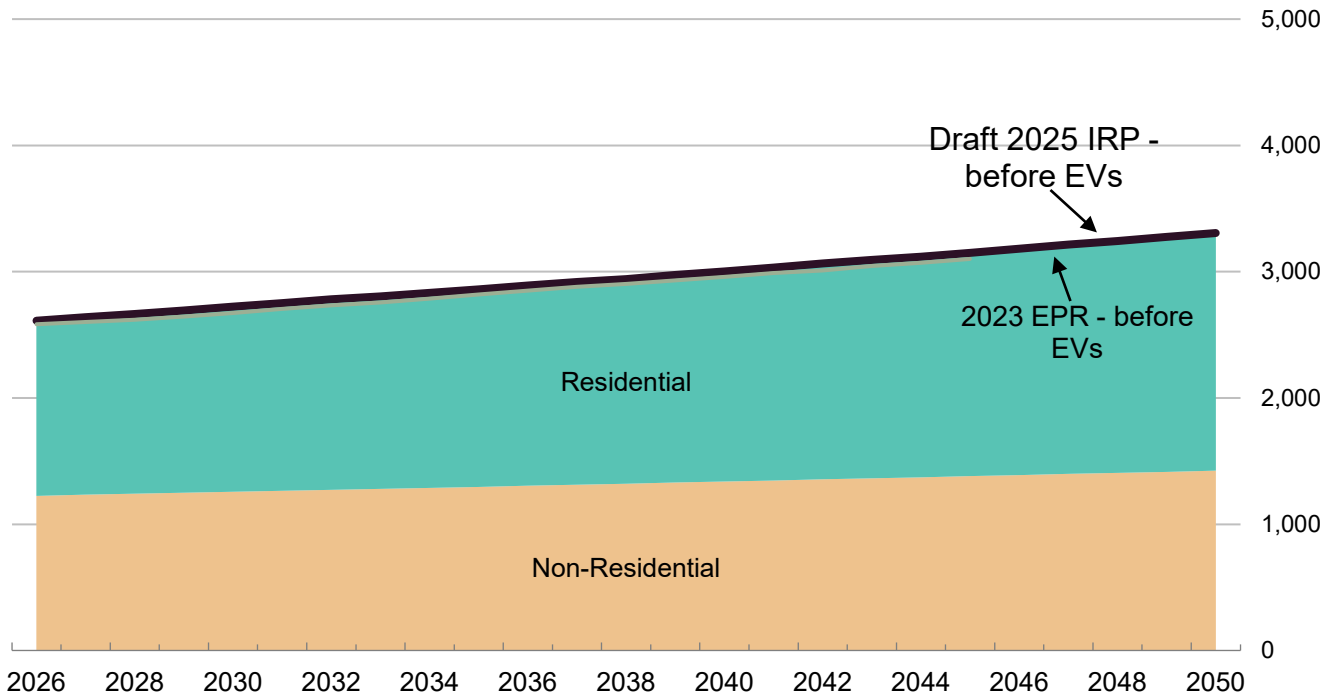
Electric: energy forecast composition – not including electric vehicles (EVs) or new demand side resources (DSR)

System Level Electric: Forecast of demand before Electric Vehicles and DSR

Units: aMW
Data Sources: Load Forecast models
Notes: No new DSR after committed 2 year targets, excludes electric vehicle growth



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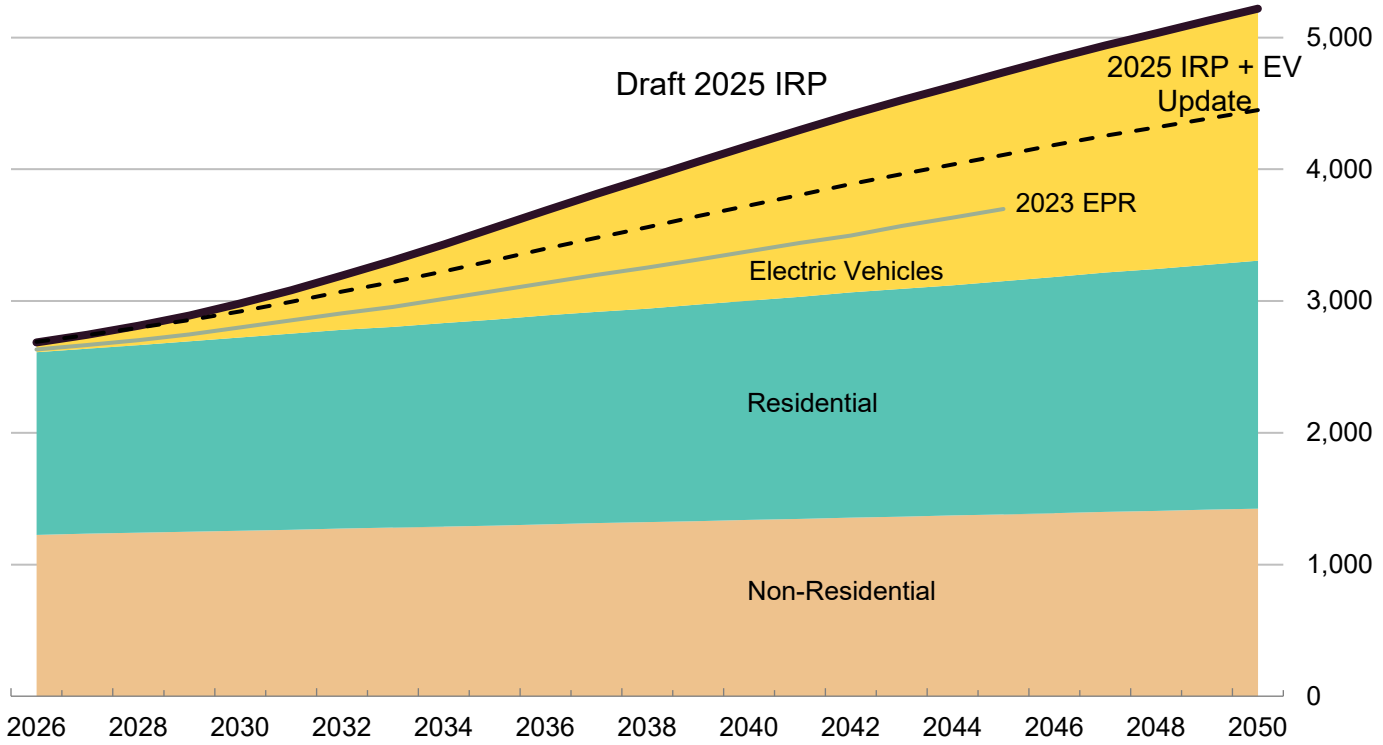
Electric: energy forecast composition – with EVs

System Level Electric: Components of the 2025 IRP demand forecast before DSR

Units: aMW
Data Sources: Load Forecast models
Notes: No new DSR after committed 2 year targets



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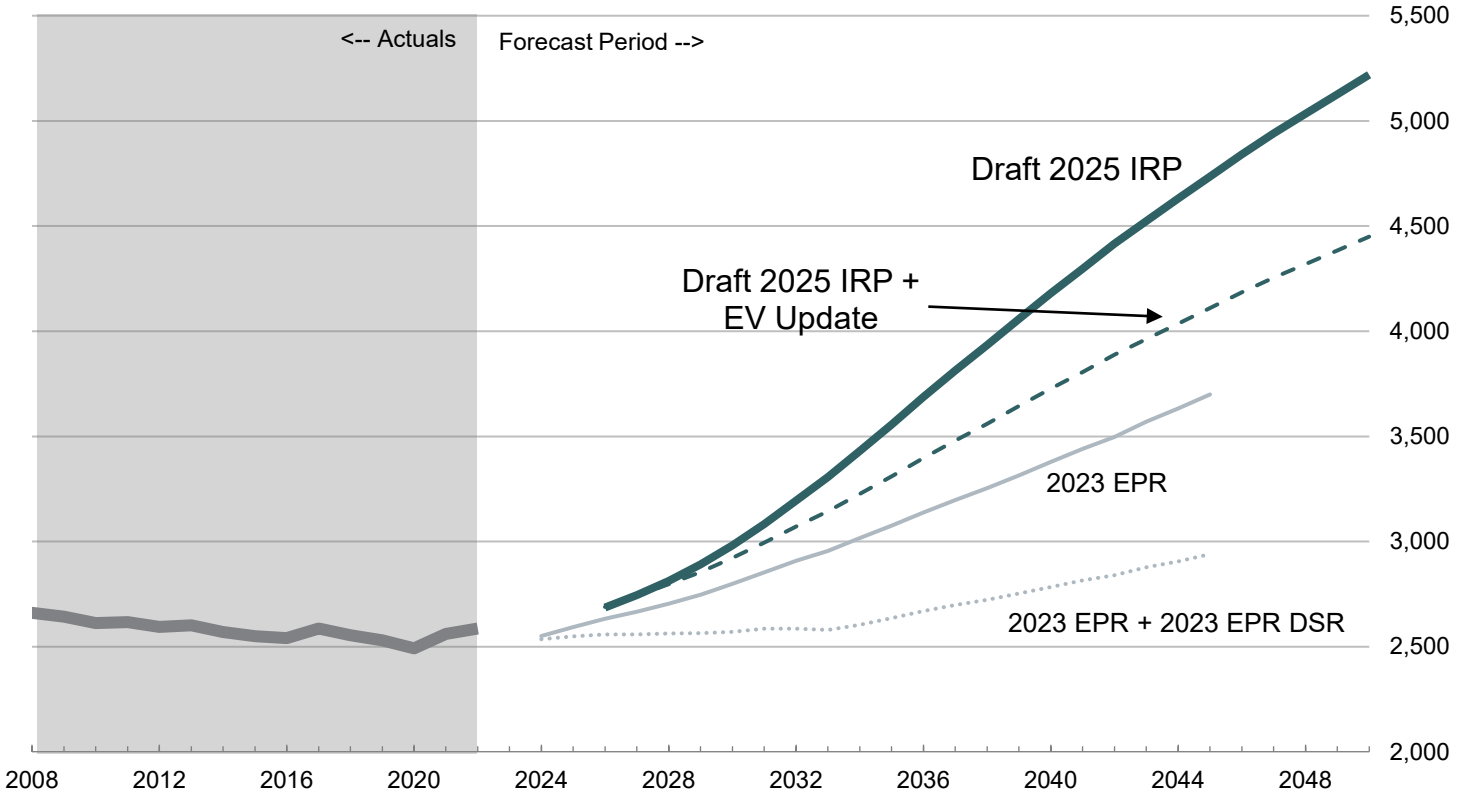
Electric: energy forecast vs. 2023 Electric Progress Report

- Demand higher by 1-2% before EV growth
- Including EV growth, demand higher by 24% in 2040
- Positive customer growth, steady use per customer (UPC), and new EVs yield demand growth, before DSR
- Updates: all new customers assume electric HVAC usage and post-pandemic usage increase average usage, 2023 Guidehouse EV Forecast
- The 2025 IRP demand forecast after DSR will be available once final DSR is determined

System Level Electric: Forecast of demand from the 2025 IRP and 2023 EPR

Units: aMW
Data Sources: Load Forecast models
Notes: No new DSR after committed 2 year targets



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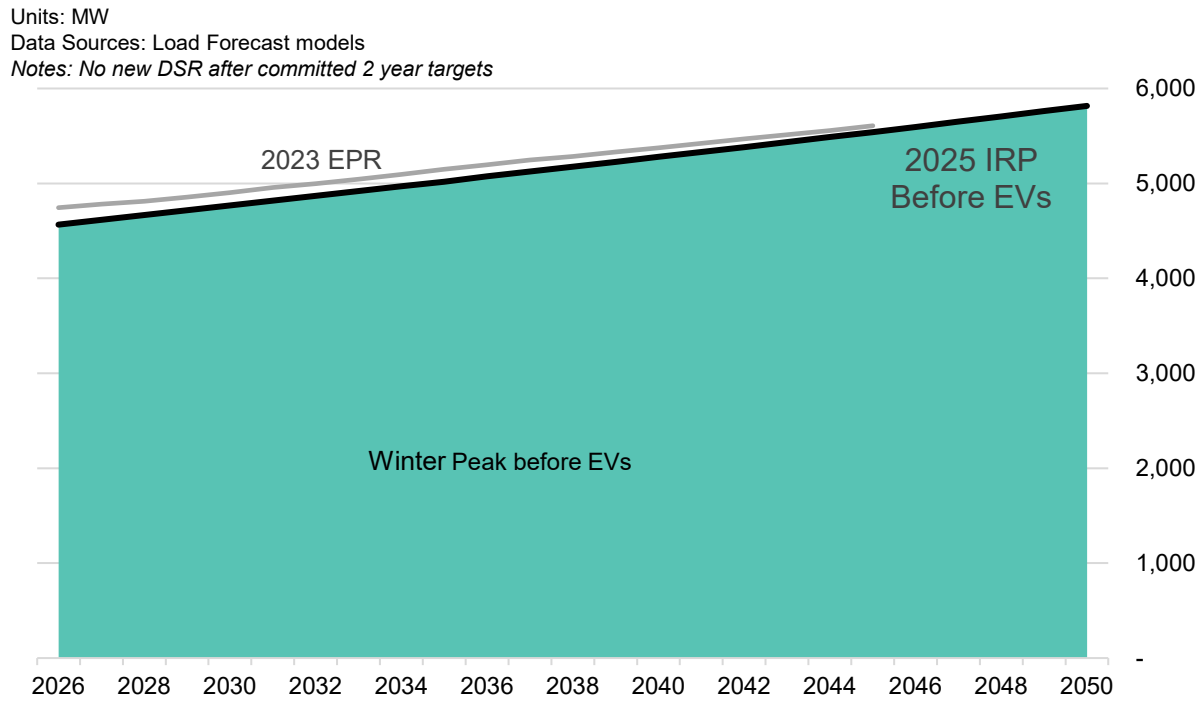
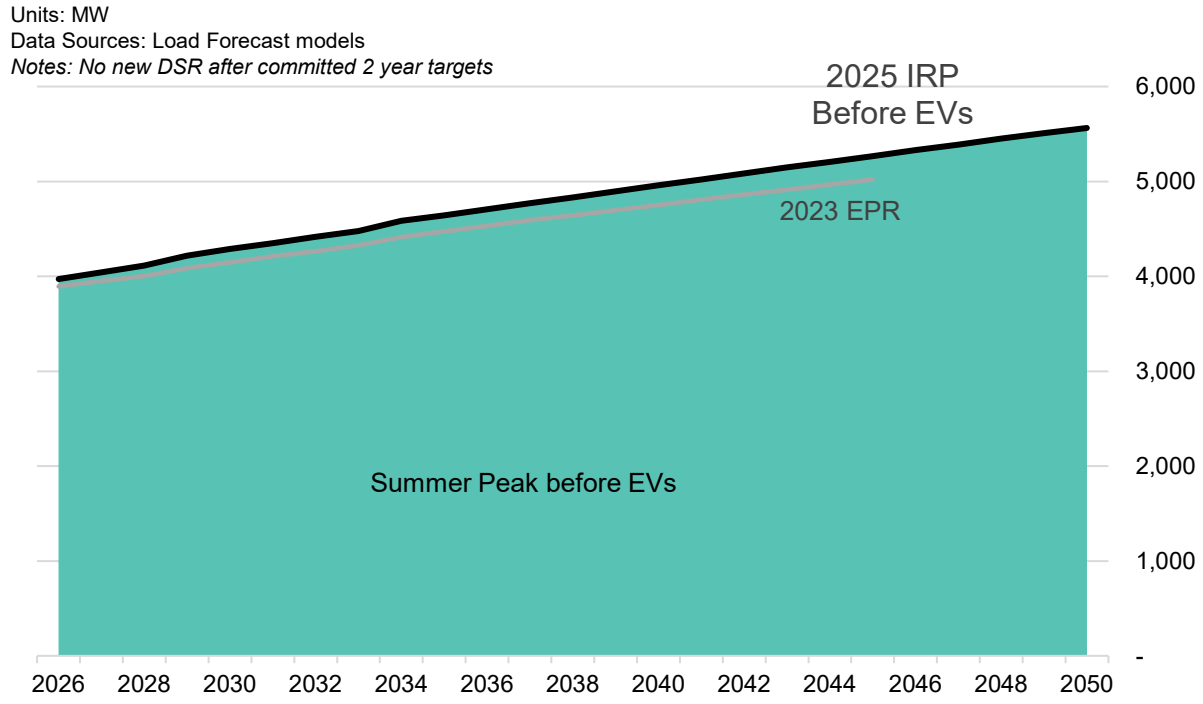
Electric: Winter and summer peak forecast composition – not including EVs (or additional DSR)

System Level Electric: Forecast of Winter Peak before Electric Vehicles and DSR from the 2025 IRP



System Level Electric: Forecast of Summer Peak before Electric Vehicles and DSR from the 2025 IRP



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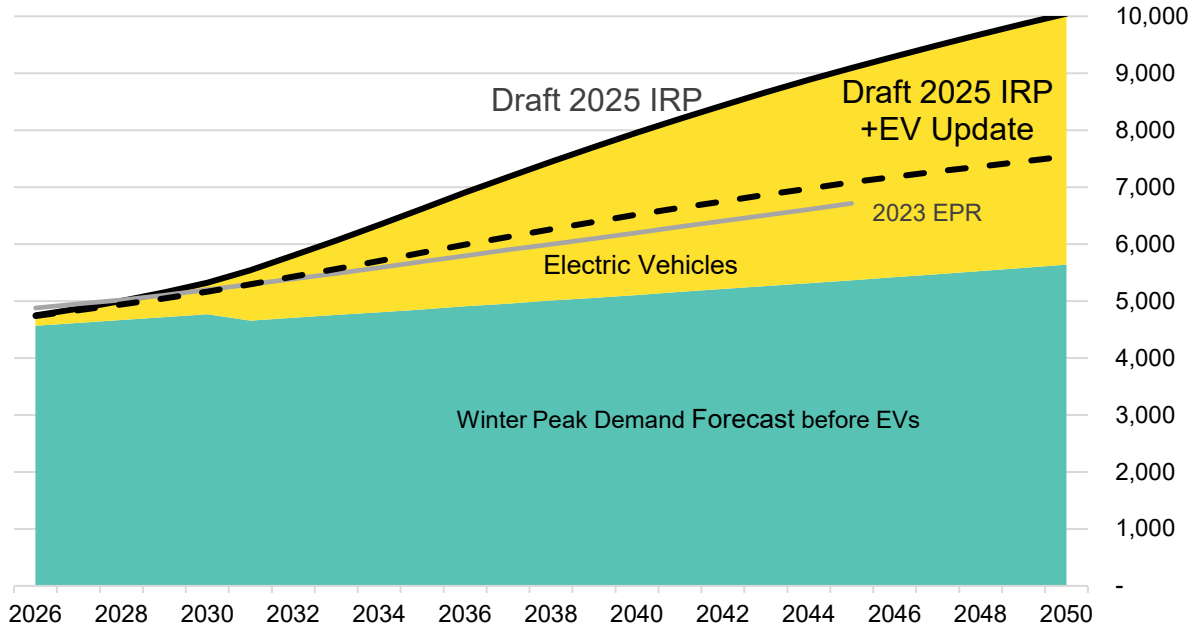
Electric: winter and summer peak forecast composition – with EVs

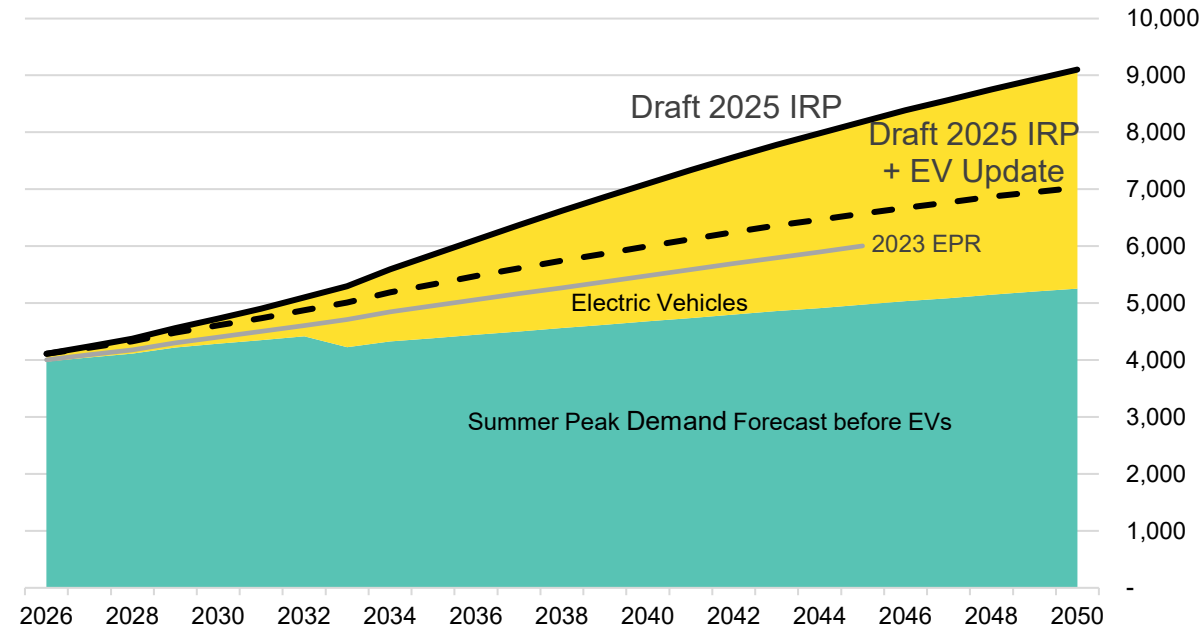
System Level Electric: Forecast of Winter Peak before DSR from the 2025 IRP

Units: MW
Data Sources: Load Forecast models
Notes: No new DSR after committed 2 year targets



System Level Electric: Forecast of Summer Peak before DSR from the 2025 IRP

Units: MW
Data Sources: Load Forecast models
Notes: No new DSR after committed 2 year targets



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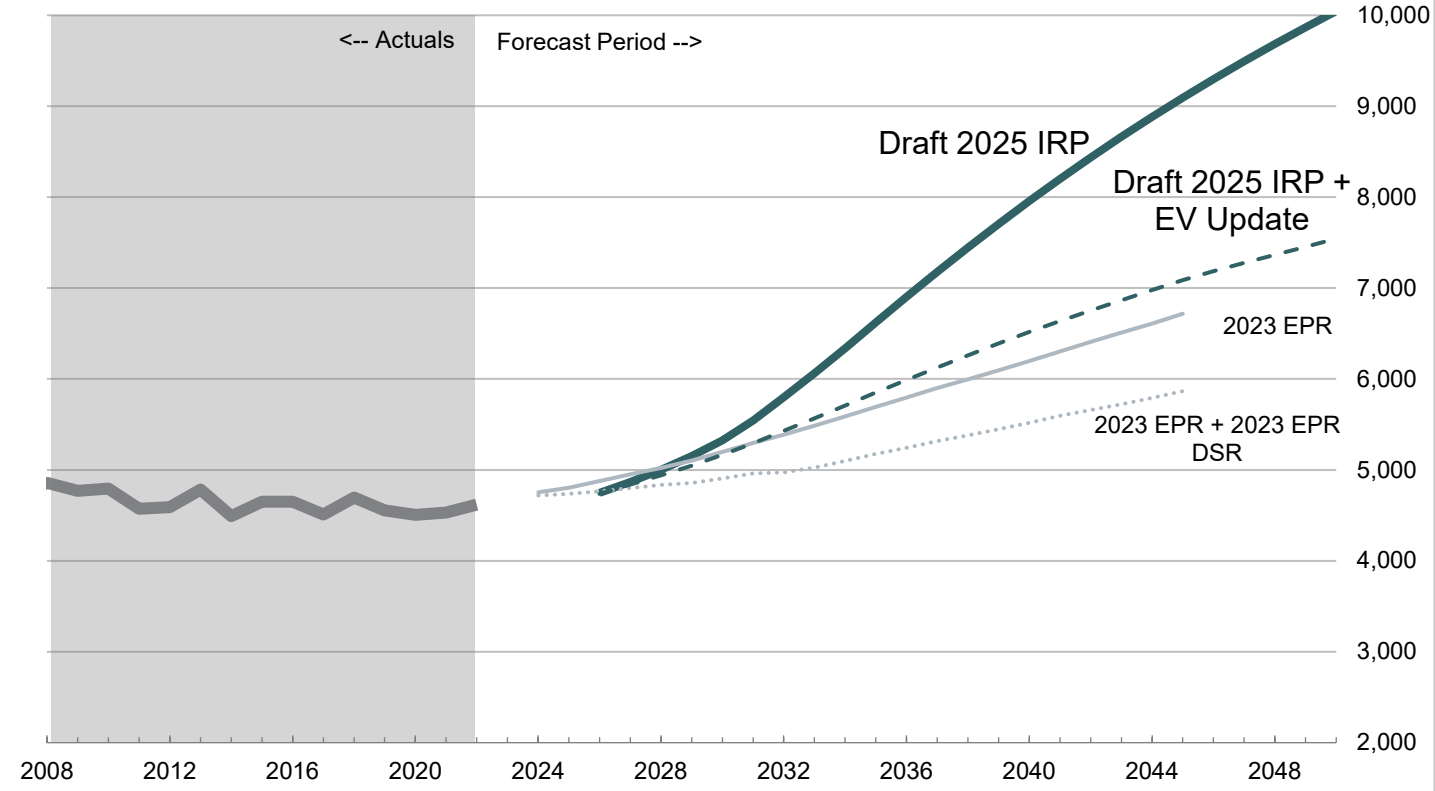
Electric: winter peak forecast vs. 2023 Electric Progress Report

- Winter peak lower by 1-3% before EV growth
- Including EV growth, winter peak higher by 28% in 2040
- Long-term growth drivers:
  - New customer growth
  - Electric vehicles
  - 2021 WA Code update
- The 2025 IRP peak forecast after DSR will be available once final DSR is determined

System Level Electric: Forecast of Winter Peak from the 2025 IRP and 2023 EPR

Units: MW
Data Sources: Load Forecast models
Notes: No new DSR after committed 2 year targets



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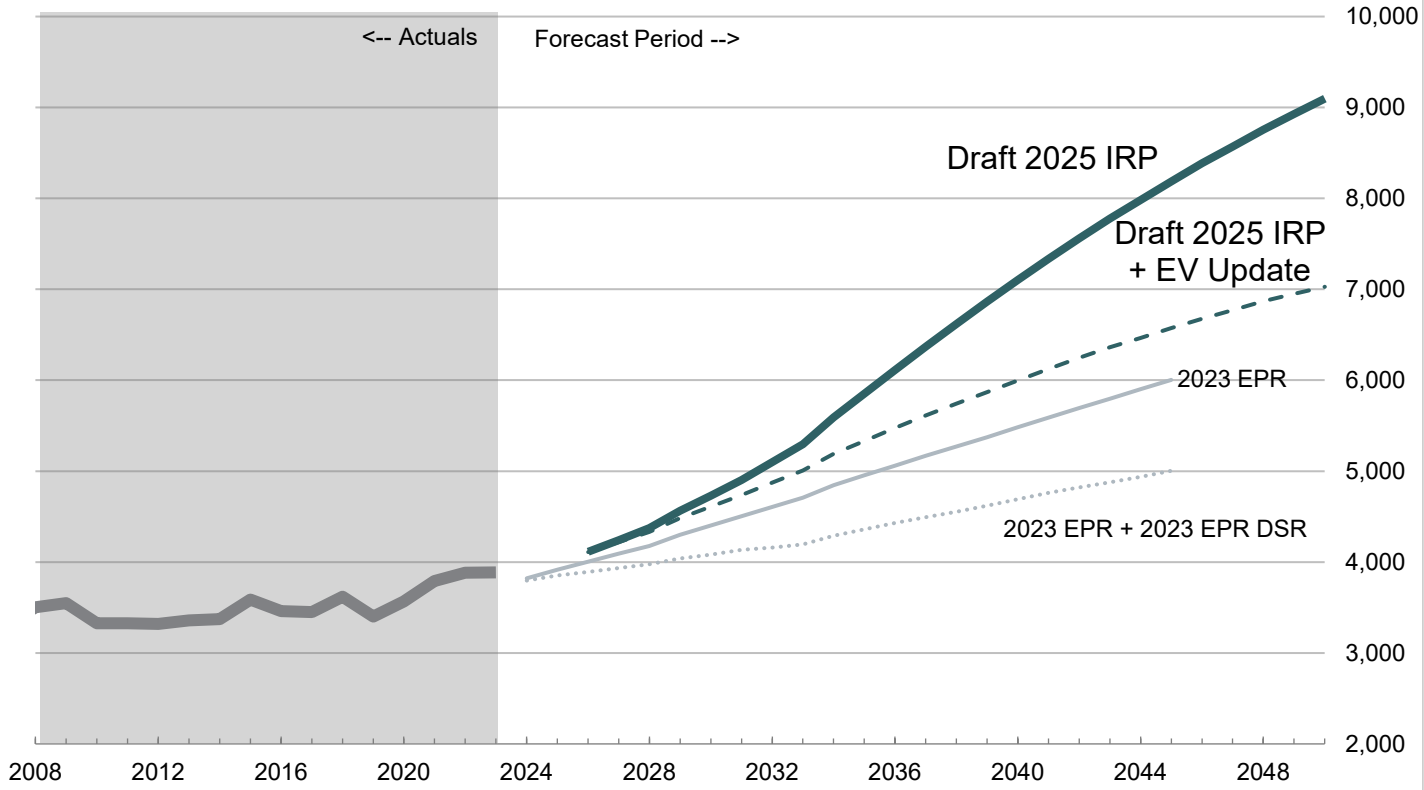
Electric: summer peak forecast vs. 2023 Electric Progress Report

- Summer peak higher by 2-4% before EV growth
- Including EV growth, summer peak higher by 30% in 2040
- Long-term growth drivers:
  - New customers/growth
  - Electric vehicles
  - Air conditioning saturation growth
- The 2025 IRP peak forecast after DSR will be available once final DSR is determined

System Level Electric: Forecast of Summer Peak from the 2025 IRP and 2023 EPR

Units: MW
Data Sources: Load Forecast models
Notes: No new DSR after committed 2 year targets



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Conclusion & next steps

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Next steps

2025 IRP

EV forecast

- PSE load forecast team to work with Guidehouse to validate updated EV forecast results
- Determine if 2025 IRP Draft electric forecast needs to be updated

Other adjustments to forecasts still to be made

- Adjustments related to PSE electrification efforts
- Update for final 2024-2025 energy efficiency targets

Ongoing

Gas to electric fuel switching analysis

- First cut at billing data analysis estimates *about 15 to 20% of customers who needed to replace their gas furnace replaced it with some type of electric heat*
- Expansion/refinement of billing data analysis
- Exploration of other sources of information

No. of residential gas customers	~820,000
Estimated number of residential gas furnaces that turnover annually	~37,000
Estimated number of customers that replaced their gas heat with electric heat in 2022	~5,700 - 8,400
Percentage of customers who needed a new heating system switched from gas to electric	~15-23%

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Emerging technology assessment overview

Elizabeth Hossner, Manager, Resource Planning and Analysis, PSE

January 12, 2024

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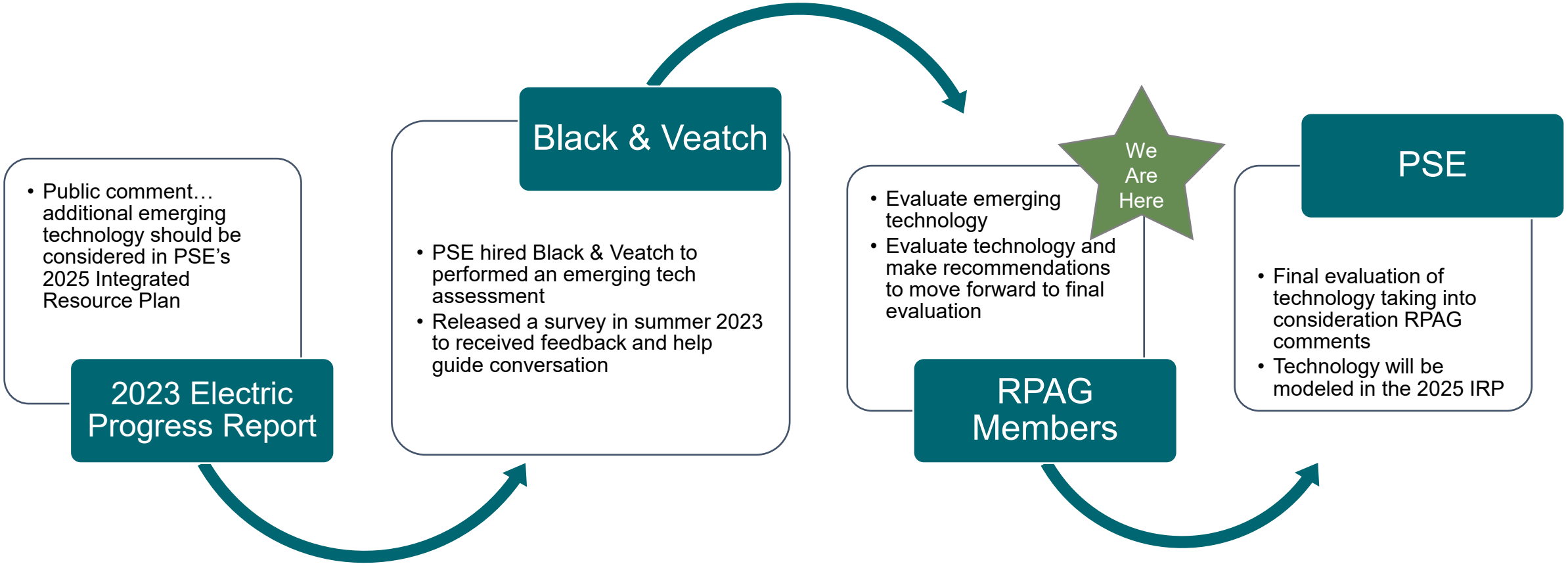
Emerging technology overview



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Black and Veatch – Technology Assessment Scope

Work in Progress

Offshore Wind
- Modeled in 2023 Progress Report
- Plan to model in 2025 IRP
- B&V assessment not completed yet

Advanced Nuclear SMR
- Modeled in 2023 Progress Report
- Plan to model in 2025 IRP
- B&V assessment not completed yet

Geothermal
- Not modeled in 2023 Progress Report
- B&V assessment not completed yet

Combustion Turbine with Carbon Capture and Sequestration
- Not modeled in 2023 Progress Report
- B&V assessment not completed yet

Ready for Review

Storage
- Modeled in 2023 Progress Report
- Plan to model additional technologies and duration ranges 2025 IRP

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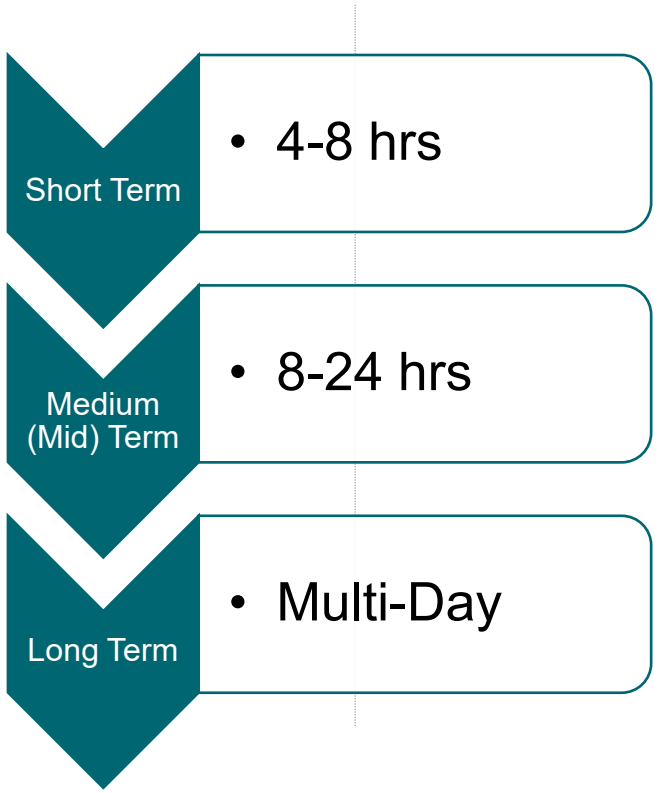
Storage

Previously, PSE modeled short duration storage options. Today, PSE see's the growing need to model multiple configurations that are short, medium, and long duration as renewables join the grid. PSE aims to match each duration range with an appropriate storage technology.

2023 Electric Progress Report

- Modeled short and medium duration storage
  - Lithium-ion (2,4,6 hrs)
  - Pumped Hydro (8 hrs)



2025 IRP

- Model additional short-medium duration storage as well as long duration storage
  - Metal Air Batteries
  - Sodium-ion Batteries
  - Compressed Air Energy Storage (CAES)
  - Flow Batteries
  - Pumped Hydro
  - Lithium-ion Batteries

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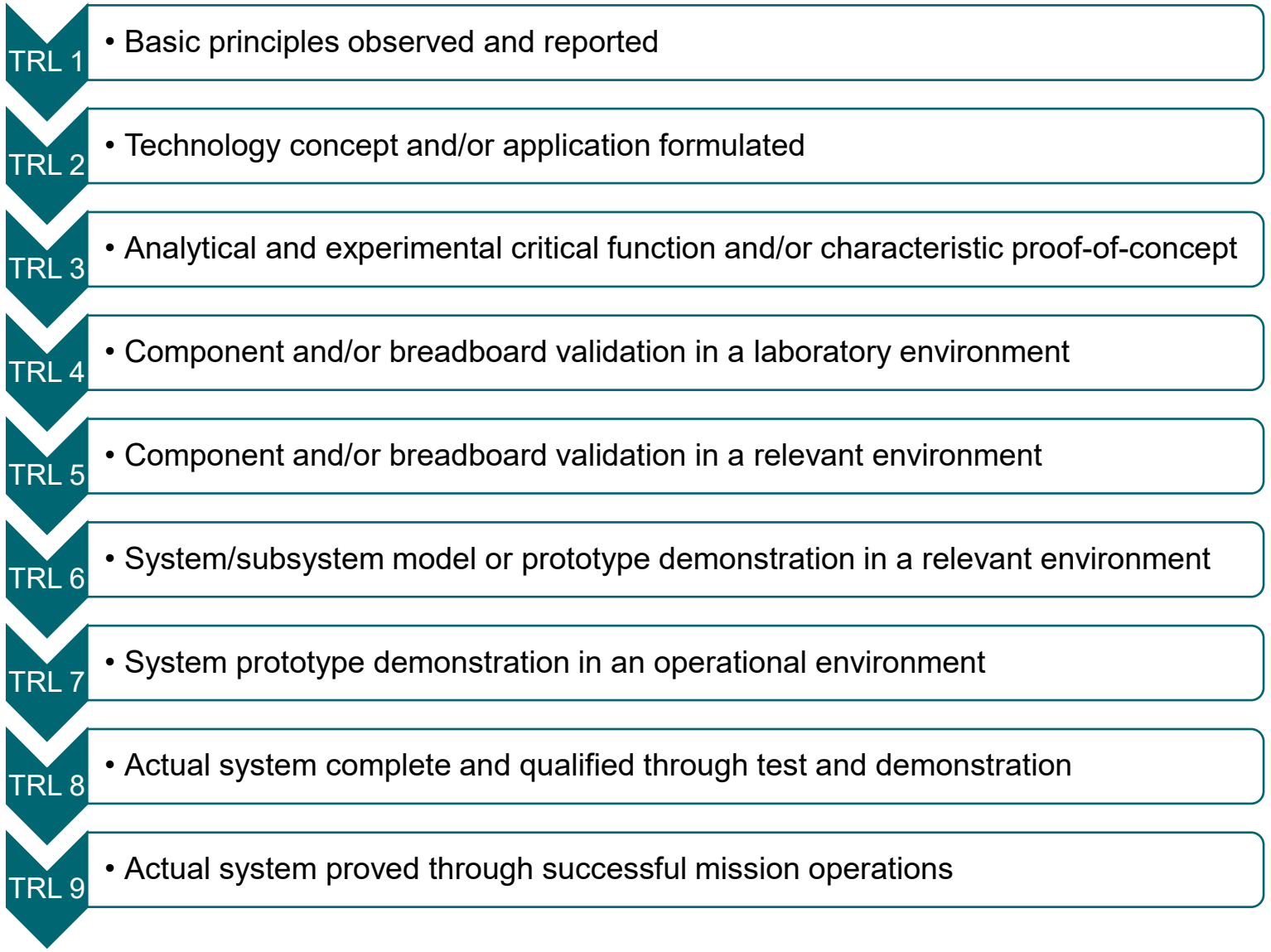
Technological Feasibility

Technology Readiness Levels (TRLs)

- Storage options have been broken down by Black & Veatch
- Estimates the maturity of technology through their conceptualization, development, and application stages
- On a scale of one (lowest level of maturity) to nine (highest level of maturity)



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Storage technology comparisons

Technology		Advantages	Disadvantages	TRL	Previously Modeled
Short Duration	Sodium-ion	• Battery packs have inbuilt heating and insulation systems and can be operated in ambient temp conditions i.e., -4 F to 122 F • Ceramic electrolyte used as a solid state ion conductor – no risk of chemical spill or toxic emitters	• Thermal runaway risk – fire hazard • Require high temps to operate	8-9	No
	Lithium-ion	• Most readably available today • Reliable with long lifespan and little to no maintenance required • Fast charging	• Thermal runaway risk - fire hazard • Low energy density	9	Yes
Medium (Mid) Duration	Compressed Air Energy Storage (CAES)	• No battery pack required • Little to no metals used • Caverns used for CAES systems - less of an eye-sore	• Limited by availability of caverns and/or size requirements for above-ground storage vessels • Diabatic CAES (TRL 9) heats stored air by combusting natural gas, process produces significant emissions	6-9	No
	Pumped Hydro (PHES)	• Low operating costs and long life • Water supply and flood control • Limited CO^2 emissions	• Limited by geography and water supply • High start-up costs	8-9	Yes
Long Duration	Metal Air Battery	• Low materials cost • Likely to gain good market share in next 5-10 yrs • No significant health or safety hazards	• Few technological providers at the moment • Requires multiple metals for use	7	No
	Flow Battery	• Power and energy are stored separately enabling independent scaling of components • Thus, energy storage can be increased simply by expanding the electrolyte capacity • No significant fire hazards	• Vanadium and Bromide based flow batteries are both corrosive and acidic	7-9	No

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Storage technology configurations

B&V Emerging

- **Metal Air Batteries**
  - Iron-air (TRL 7)
  - Zinc-air (TRL 7)
- **Sodium-ion Batteries**
  - Sodium-sulfur (TRL 9)
  - Sodium-metal-halide (TRL 8)
- **CAES**
  - Diabatic (TRL 9)
  - Isothermal (TRL 6)
  - Adiabatic (TRL 8)
- **Flow Batteries**
  - Vanadium redox (TRL 9)
  - Iron (TRL 8)
  - Zinc-bromine (TRL 7)
  - Metal-coordination complex (TRL7)

Previously Modeled

- **Li-ion**
  - Lithium Iron Phosphate (TRL 9)
  - Lithium Nickel Manganese Cobalt Oxide (TRL 9)
- **Pumped Hydro**
  - Open loop (TRL 9)
  - Closed loop (TRL 8)

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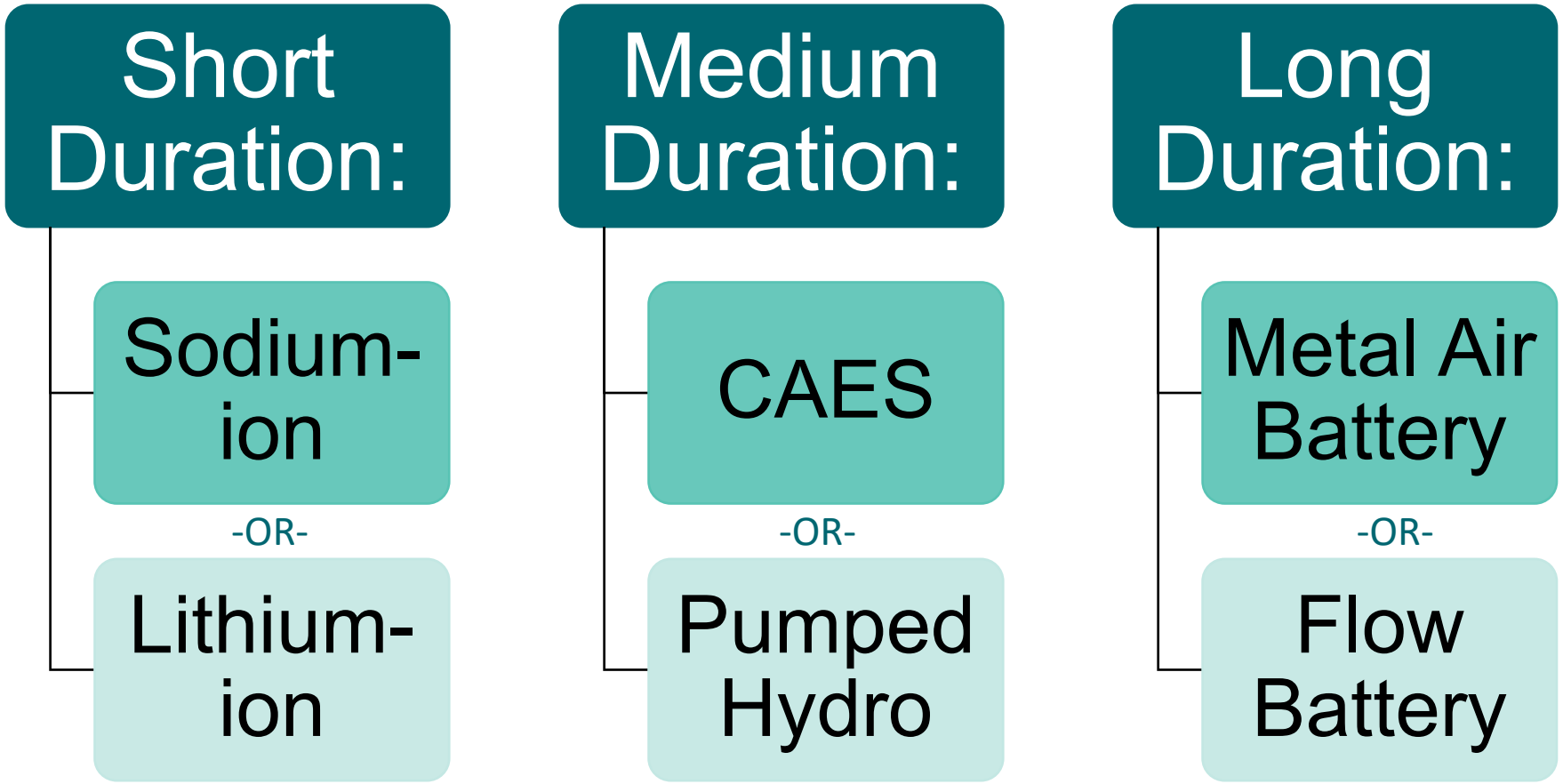
What Energy Storage Technology should we evaluate for each of the three categories? (one from each duration category)



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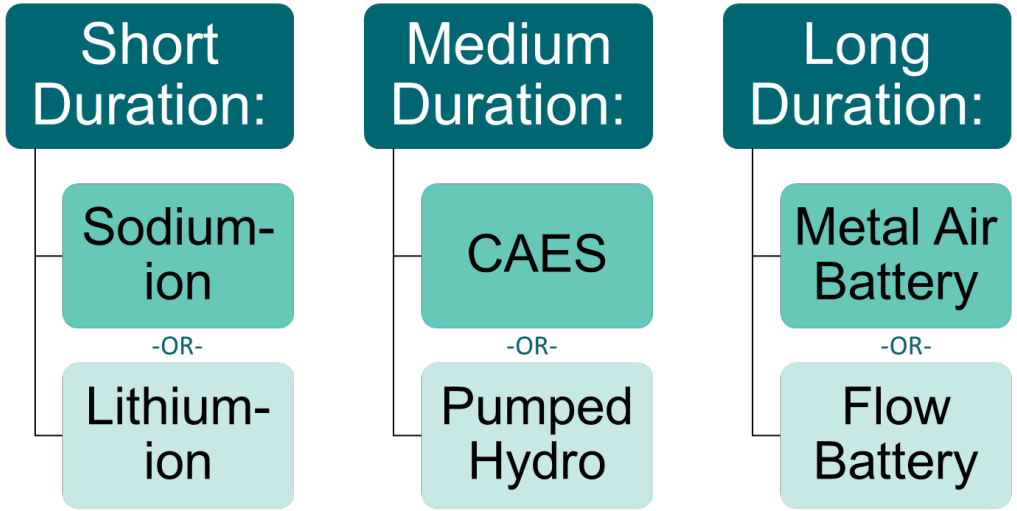
Discussion

- Do you have initial recommendations for the preferred resource in each category?
- Would you replace any?
- If so, with what and why?



Note: Feedback today and/or via the feedback form later is appreciated.

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Next steps

Sophie Glass, Triangle Associates

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Upcoming activities

Date	Activity
January 17, 2024	RPAG meeting
January 19, 2024	Feedback form for 1/12 meeting closes
January 24, 2024	Feedback form for 1/17 meeting closes

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Public comment opportunity

Please raise your “hand” if you would like to provide comment.

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Thanks for joining us!

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Appendix

- Role of demand forecast in IRP
- Normal temperatures
- Economy
- Electric vehicle policies
- References

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Role of demand forecasts in the Integrated Resource Plan

- The 20+ year demand forecasts, before demand-side resources (DSR), are used as an input into the IRP
- DSR is evaluated as a resource in the IRP analysis along with other resources
- The IRP analysis determines resources including:
  - DSR (I.e., utility-sponsored conservation programs, distribution efficiency, and demand response)
  - Changes to codes and standards are developed in the conservation potential assessment and treated as no-cost, must-take conservation in the IRP analysis
  - Distributed generation
  - Potential demand impacts due to policies such as Clean Energy Transformation Act (CETA), Climate Commitment Act (CCA), and Inflation Reduction Act (IRA)
- Therefore, the amount of resources that impact demand will be applied to the demand forecast when IRP analysis is complete

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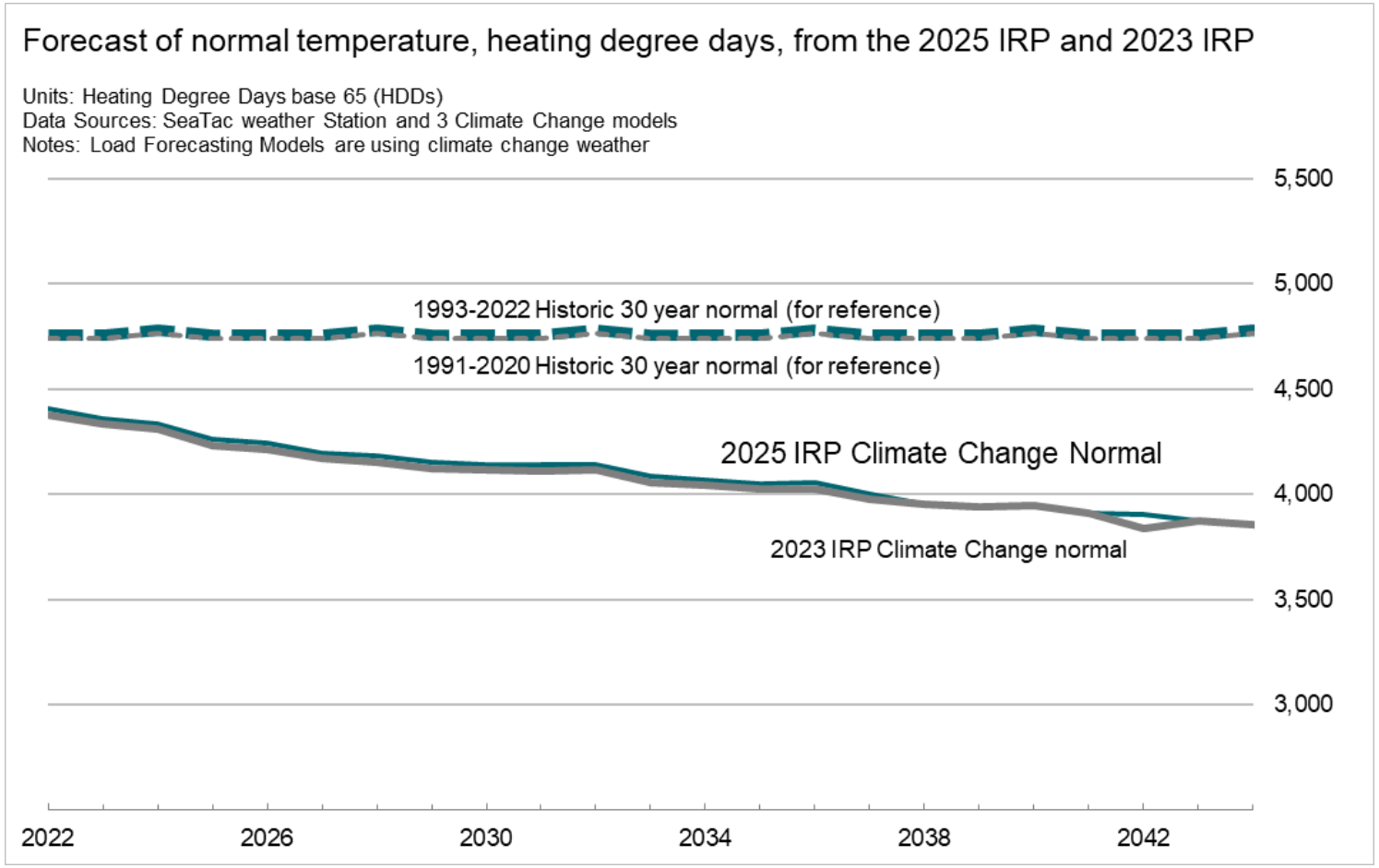
Normal Temperatures: Heating Degree Days (HDD65)



2025 IRP forecast uses climate change normals

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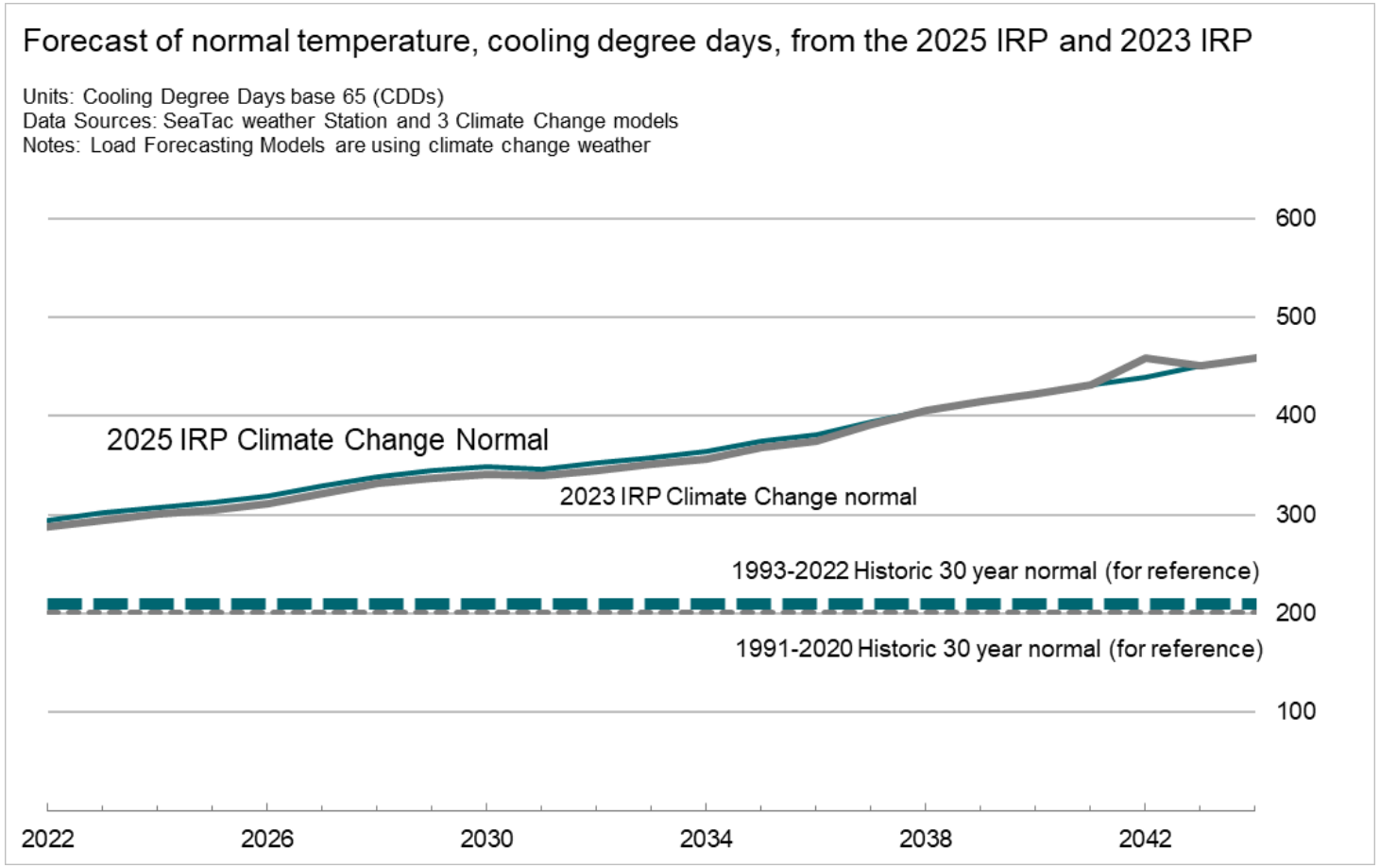
Normal Temperatures: Cooling Degree Days (CDD65)



2025 IRP forecast uses climate change normals

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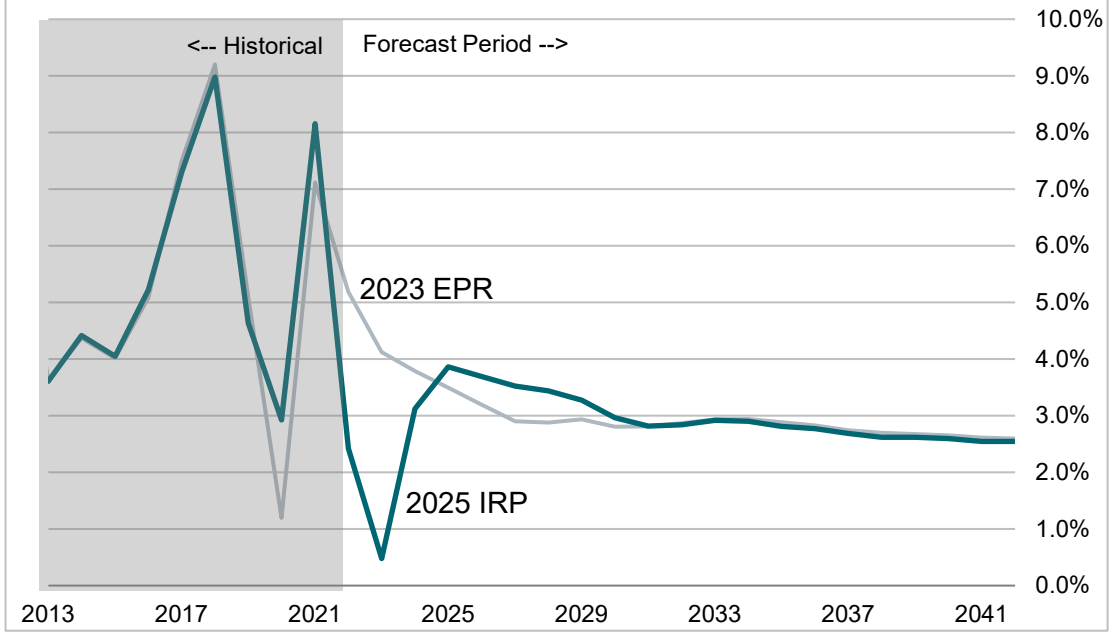
Economy: GDP and unemployment forecast vs. 2023 EPR

In the near term, PSE's service area will likely experience a short economic slowdown, but not a full recession. Gas service area economic forecasts are similar to electric service area economic forecasts (shown below).

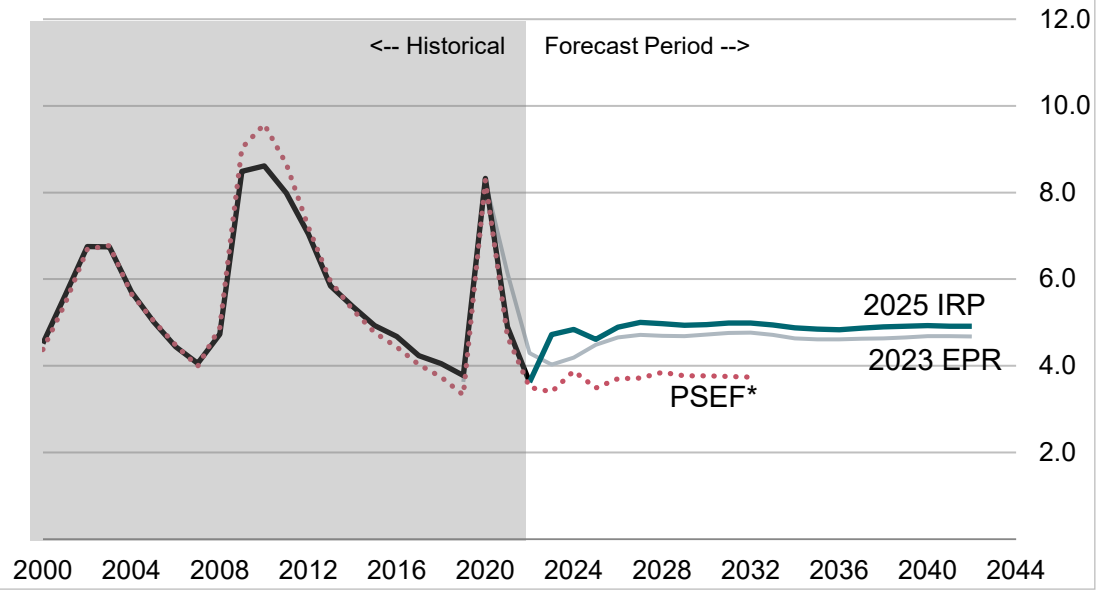
Economy: Forecast of GDP growth (electric service area)

Units: Percent Change
Data Sources: Moody Analytics



Economy: Forecast of unemployment rate (electric service area)

Units: Percentage
Data Sources: Moody's Analytics; Puget Sound Economic Forecaster (PSEF); Load Forecast models



*Puget Sound Economic Forecaster regional forecast used as a benchmark for shape

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Electric Vehicle Forecast: Policies driving adoption

Legislation		Description	Legislature	Effective Date	New as of 2025 IRP?
ZEV	Zero Emission Vehicle Bill	Sets a schedule for increasing the percentage of zero-emission vehicles a vehicle manufacturer delivers for sale	State	2020	Included in 2023 EPR
LCFS	Low Carbon Fuel Standard	Designed to decrease the carbon intensity of transportation fuel pool and provide an increasing range of low-carbon and renewable alternatives	State	2021	Included in 2023 EPR
IIJA/BIL	Infrastructure Investment and Jobs Act/ Bipartisan Infrastructure Law	Makes the largest federal investment in infrastructure	Congress/Federal	2021	✓
IRA	Inflation Reduction Act	Is a significant investment in clean energy and transportation technologies and includes an array of supportive electric vehicle (EV) incentives	Congress/Federal	2022	✓
ACT	Advanced Clean Trucks Rule	Accelerates a large-scale transition of zero-emission medium-and heavy-duty vehicles from Class 2b to Class 8	State	2022	✓
ICE	Internal Combustion Engine Ban	Increases new zero-emission vehicle sales of passenger cars, light-duty trucks, and medium-duty vehicles to 100 percent starting in 2035	State	2022	✓

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Demand forecast references

Description of methodology and climate change normal temperatures are included in Electric Progress Report/Gas IRP chapters, and models are described in detail in the appendices.

Electric - 2023 Electric Progress Report

https://www.pse.com/-/media/PDFs/IRP/2023/electric/chapters/06_EPR23_Ch6_Final.pdf?modified=20230331182920
https://www.pse.com/-/media/PDFs/IRP/2023/electric/appendix/15_EPR23_AppF_Final.pdf?modified=20230331195806

Gas – 2023 Gas Utility IRP

https://www.pse.com/-/media/PDFs/IRP/2023/gas/chapters/05_IRP23_Ch5_Final.pdf?modified=20230331212338
https://www.pse.com/-/media/PDFs/IRP/2023/gas/appendix/10_IRP23_AppD_Final.pdf?modified=20230331213553

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