NW Natural
2025 IRP- Technical Working Group

TWG #3
Scenarios and Climate
November 21, 2024

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Forward Looking Statement

This and other presentations made by NW Natural from time to time, may contain forward-looking statements within the meaning of the U.S. Private Securities Litigation Reform Act of 1995. Forward-looking statements can be identified by words such as “anticipates,” “intends,” “plans,” “seeks,” “believes,” “estimates,” “expects” and similar references to future periods. Examples of forward-looking statements include, but are not limited to, statements regarding the following: including regional third-party projects, storage, pipeline and other infrastructure investments, commodity costs, competitive advantage, customer service, customer and business growth, conversion potential, multifamily development, business risk, efficiency of business operations, regulatory recovery, business development and new business initiatives, environmental remediation recoveries, gas storage markets and business opportunities, gas storage development, costs, timing or returns related thereto, financial positions and performance, economic and housing market trends and performance shareholder return and value, capital expenditures, liquidity, strategic goals, greenhouse gas emissions, carbon savings, renewable natural gas, hydrogen, gas reserves and investments and regulatory recoveries related thereto, hedge efficacy, cash flows and adequacy thereof, return on equity, capital structure, return on invested capital, revenues and earnings and timing thereof, margins, operations and maintenance expense, dividends, credit ratings and profile, the regulatory environment, effects of regulatory disallowance, timing or effects of future regulatory proceedings or future regulatory approvals, regulatory prudence reviews, effects of regulatory mechanisms, including, but not limited to, SRRM and the Company’s infrastructure investments, effects of legislation, including but not limited to bonus depreciation and PHMSA regulations, and other statements that are other than statements of historical facts.

Forward-looking statements are based on our current expectations and assumptions regarding our business, the economy and other future conditions. Because forward-looking statements relate to the future, they are subject to inherent uncertainties, risks and changes in circumstances that are difficult to predict. Our actual results may differ materially from those contemplated by the forward-looking statements, so we caution you against relying on any of these forward-looking statements. They are neither statements of historical fact nor guarantees or assurances of future performance. Important factors that could cause actual results to differ materially from those in the forward-looking statements are discussed by reference to the factors described in Part I, Item 1A “Risk Factors,” and Part II, Item 7 and Item 7A “Management’s Discussion and Analysis of Financial Condition and Results of Operations,” and “Quantitative and Qualitative Disclosure about Market Risk” in the Company’s most recent Annual Report on Form 10-K, and in Part I, Items 2 and 3 “Management’s Discussion and Analysis of Financial Condition and Results of Operations” and “Quantitative and Qualitative Disclosures About Market Risk”, and Part II, Item 1A, “Risk Factors”, in the Company’s quarterly reports filed thereafter.

All forward-looking statements made in this presentation and all subsequent forward-looking statements, whether written or oral and whether made by or on behalf of the Company, are expressly qualified by these cautionary statements. Any forward-looking statement speaks only as of the date on which such statement is made, and we undertake no obligation to publicly update any forward-looking statement, whether as a result of new information, future developments or otherwise, except as may be required by law.

Today's Agenda

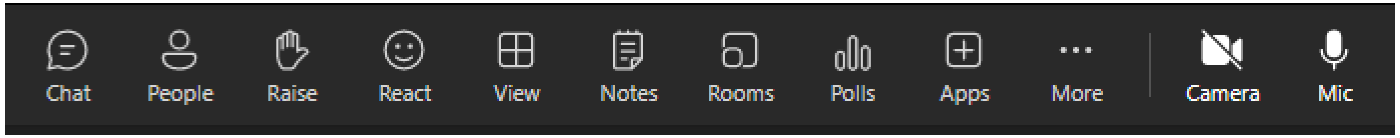
- Logistics
- Recap of Previous Technical Working Group (TWG)
- Scenario Discussion Continued
- ICF Power Sector Modeling
- Scenario Discussion
- Break
- ICF Climate Science Support
- Daily Temperature Modeling

Facilitator Requests

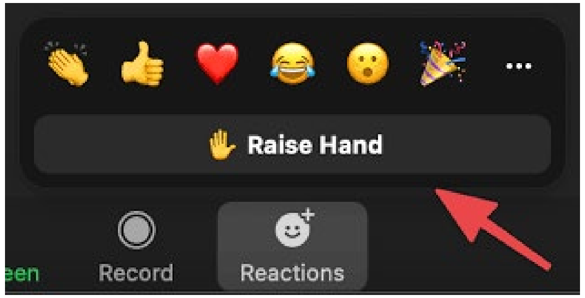
- Engage constructively and courteously towards all participants
- Take space and make space
- Respect the role of the facilitator to guide the group process
- Avoid use of acronyms and help each other understand
- Aim to focus on the meeting topic

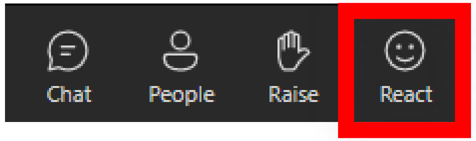
How to Interact in a Teams Meeting

- Participant Controls are at the top or bottom of your screen



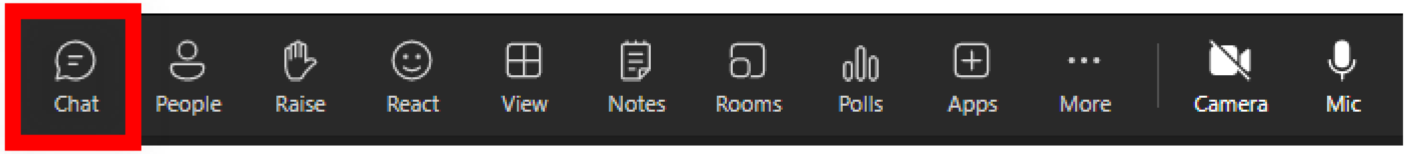
- Ask a question or comment at any time using the “raised hand”





A member of the IRP team will monitor the chat, and participant list for raised hands during the meeting.

- You may also use the chat box



Meeting Best Practices – virtual spaces

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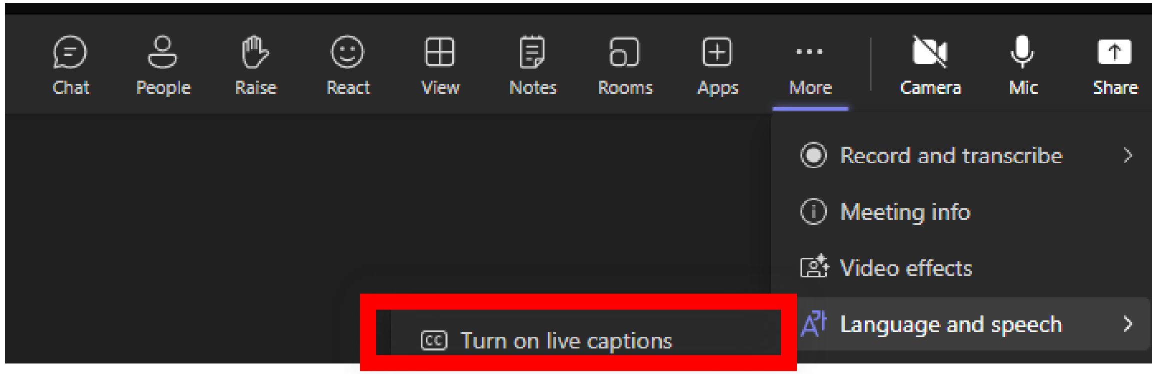
To maintain an engaged and productive space, please:

- Mute your mic unless asking a question and/or providing comment
- Turn your camera on when speaking (if you are comfortable and your bandwidth allows)
- Limit side conversations in the chat
- Make efforts to adhere to the meeting schedule

Teams Meeting – Accessibility Functions

- Live Captions - real-time auto-generated text of what is said in a meeting. They appear a few lines at a time for a user who has turned them on, and aren't saved



- Reducing Distractions and Customizing Views:
  - Microsoft Teams has a variety of features to support different learning styles, please find reference material for:
    - Turn on live captions during meetings
    - Customize your meeting view
    - Change background effects in Teams meetings
    - Reduce background noise in Teams meetings
    - 5 tips for using Teams when you're deaf or hard of hearing
- Meeting Recordings:
  - NW Natural will record IRP virtual meetings and will post them to the NW Natural website on the resource planning webpage

Two Minutes for Safety:

Prepare yourself and your vehicle for Fall & Winter

- Check tires for damage, pressure and tread depth
- Working with a buddy, check all vehicle lights
- Make sure you have traction devices for your feet in your vehicle(s)
- Clean out unnecessary items
- Add extra clothes, batteries, food and water
- Ensure you have tires chains and/or auto socks — Check for the correct size; Make sure you know how to put them on

Recap Nov. 1 TWG

- Understand the role of scenarios in the IRP process and the constraints of scenario analysis
- Introduced scenarios for the modeling process,
- Addressed clarifying questions about:
  - Range of scenarios considered
  - Assumptions and constraints of scenario modeling
  - Potential effects of local ballot measures
  - Electrification modeling

Today's objectives

- Answer clarifying questions about the scenarios
- Collect feedback on the range of scenarios
- Gain a shared understanding of climate science used in scenario modeling

Current Technical Working Group Schedule

TWG No.	Date	Type & Purpose of Engagement
TWG#1	Oct 22, 2024	Planning Environment
TWG#2	Nov 1, 2024	Scenarios
--	Nov 13, 2024	Cancelled
TWG#3	Nov 21, 2024	Scenarios Cont. and Climate
TWG#4	Dec 12, 2024	Load Forecast
TWG#5	Dec 17, 2024	Avoided Costs & Demand- Side Resource
TWG#6	Jan 21, 2025	Energy Trust Energy Efficiency Forecast and Supply-Side & Compliance Resources
TWG#7	Jan 28, 2025	Supply-Side & Compliance Resources
TWG#8	Apr 1, 2025	Distribution System Planning
TWG#9	April 8, 2025	Distribution System Planning
TWG#10	Apr 29, 2025	Resource Optimization Planning Model
TWG#11	May 6, 2025	Portfolio Results and Action Plan
File Draft	Jun 13, 2025	Comments due by July 7th
File 2025 IRP	**Aug 2, 2025**	**Beginning of formal process**

- All TWGs will be facilitated and virtual
- Dates and topics are tentative and subject to change
- Please refer to website for most up to date information: IRP Website
- Feedback form direct link: Feedback Form
- Email us at IRP@nwnatural.com

Other Public Engagement Opportunities

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Public Engagement Opportunity & Topic	Date	Type & Purpose of Engagement
Energy Resource (IRP) Fair #1:	November 16, 2024	**In-Person Only. Opportunity to learn and engage on IRPs and Energy Services & Programs. Event to be held in collaboration with community partners.** ***Parkrose High School from 11:00am to 2:00pm***
Public Engagement Webinar #1:	February 4, 2025	**Opportunity to learn and engage on an IRP and key topics previously presented and related to resource planning and utility energy services.**
Energy Resource (IRP) Fair #2:	May 10, 2025	**In-Person Only. Opportunity to learn about IRPs and Energy Services & Programs & Proposed Action Plan and engage. Event to be held in collaboration with community partners.**
Public Engagement Webinar #2:	May 12, 2025	**Opportunity to learn and engage on an IRP and key topics previously presented and related to resource planning and utility energy services.**

- Please check our dedicated IRP website for the most current information:

  IRP Website

Scenario Discussion Continued

Goal of these Scenarios

- Be able to represent a set of realistic outcomes and how NW Natural would plan its resources accordingly under each scenario
- The IRP does not advocate for one scenario over another, but may have discussions about how likely or unlikely certain scenarios are to occur
- Scenarios can help establish bookend results, knowing that what future ultimately unfolds will likely be somewhere in-between
- Every scenario plans resources to reliably serve our customers and meet our compliance requirements

Scenarios for this IRP

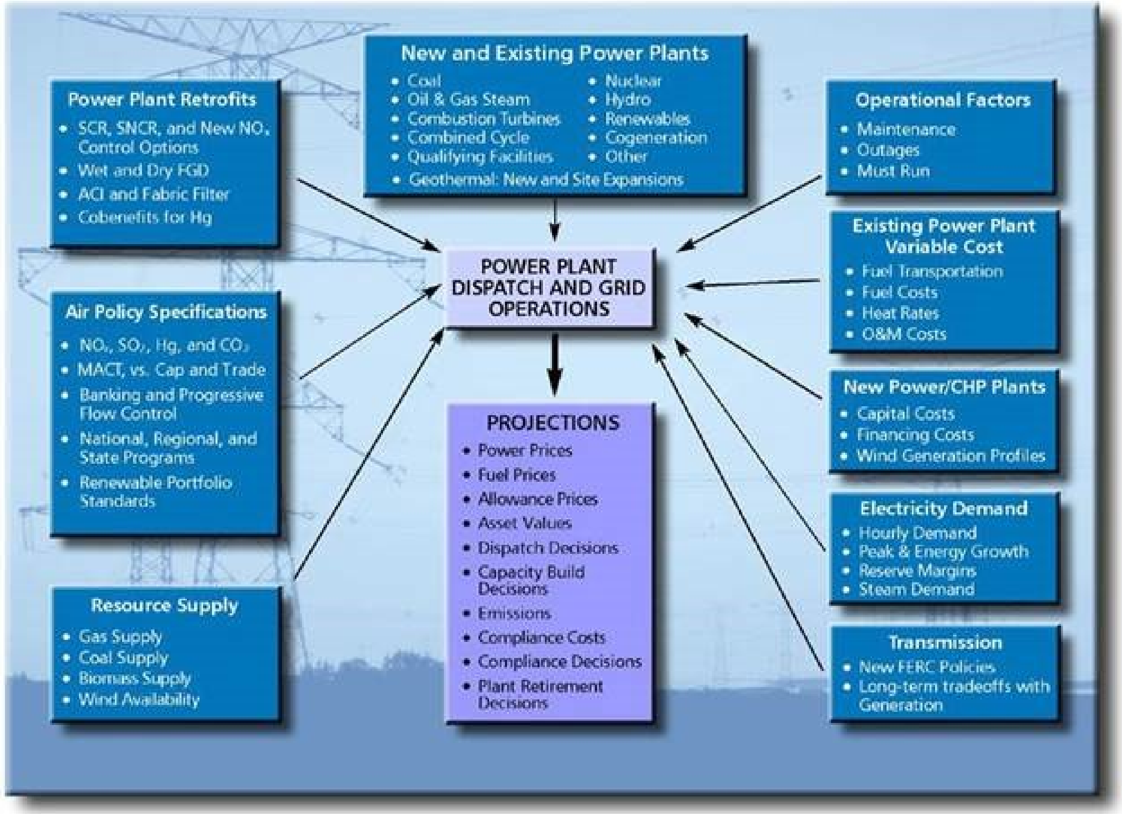
		Scenario	
		Reference Case	Includes all known codes, policies and energy efficiency expectations.
Policy Variations	1	CPP/CCA Compliance	Eligible resources are acquired to meet CPP and CCA compliance.
Policy Variations	2	SB 98 Targets	SB 98 eligible resources are acquired to meet voluntary SB 98 targets. Required by Oregon Administrative Rule 860-150-0100 to be studied in an IRP; Applies to WA for voluntary RNG under HB 1257.
Policy Variations	3	No GHG Compliance Policies	Scenario considers current building codes but is absent CPP/CCA or RNG procurement policies; customers are served with the lowest cost resources.
Demand Variations	4	Growth Recovery	Population and housing trends experience higher growth patterns than the reference case.
Demand Variations	5	Modest Customer Electrification	Aims to aligns with trends from NEEA-RBSA, projections from electric utilities of existing buildings electrifying, and limitations on natural gas in new construction buildings.
Demand Variations	6	Hybrid System Electrification	Hybrid systems [electric heat pump with gas furnace as back up] are installed in existing buildings and new construction based on stock turn-over.
Demand Variations	7	All-Electric Buildings	Significant levels of building electrification of existing buildings and new construction based on stock turn-over.

ICF Power Sector Modeling

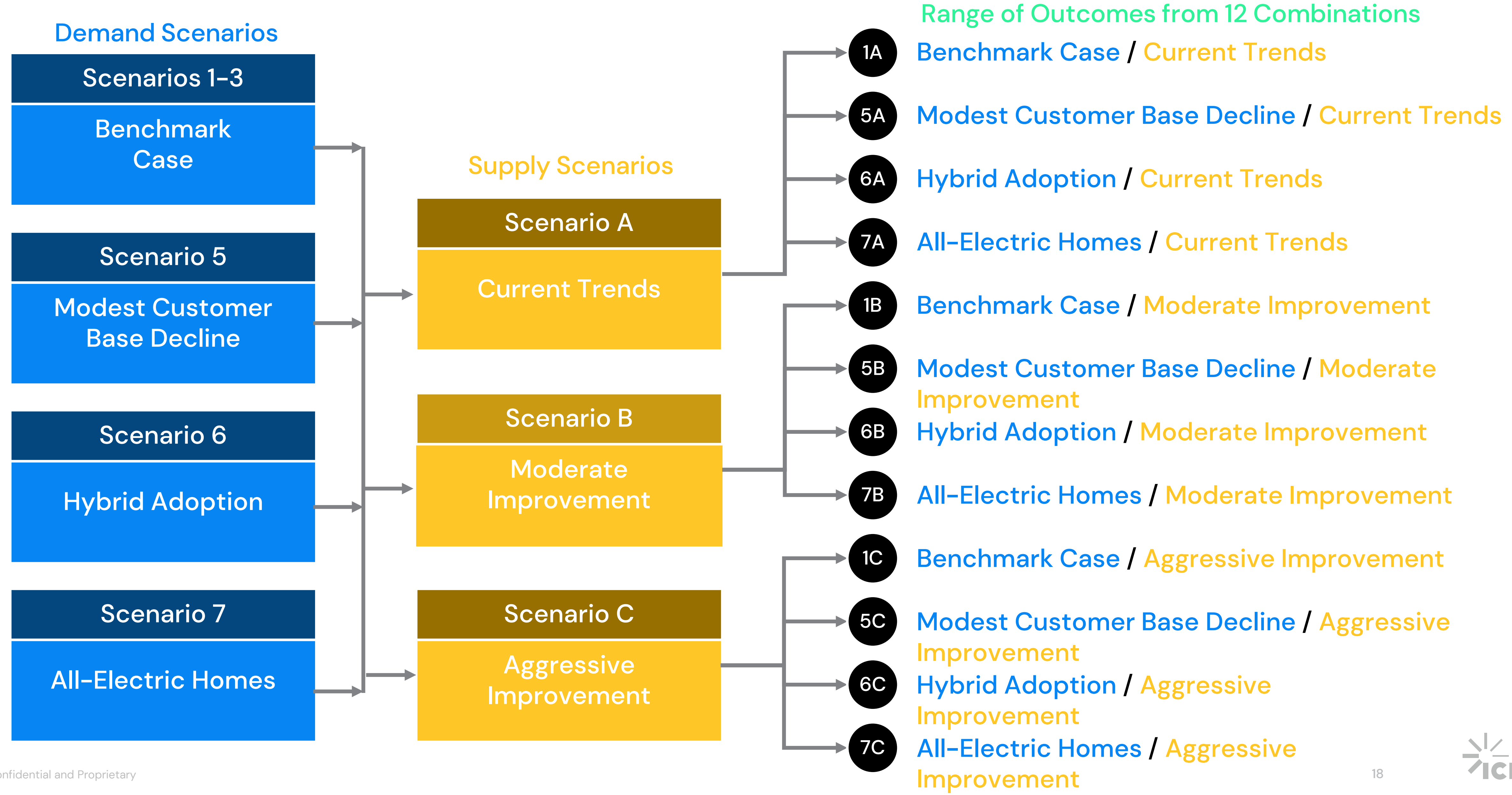
Electric Supply Scenarios

Power Sector Modeling

- **About IPM®**, ICF's capacity expansion and production-costing model of the power sector.
  - Multi-Region, dynamic linear programming model of North America, of which we will model the western-interconnection, with specific attention paid to the electric utilities overlapping Northwest Natural's natural gas service territories in Washington and Oregon.
  - **Provides:**
    - Generation and transmission capacity expansion plans,
    - Unit dispatch and compliance decisions, and
    - Power price forecasts.
  - **Considers:**
    - Resource potential and operational availability,
    - Environmental requirements and policy targets,
    - Demand requirements,
    - Transmission flows, and
    - Investment, fuel, and operational costs.



Demand Scenarios & Supply Scenario Combine for Distinct Sets of Capacity Expansion Modelling Results



Overview of the Electric Supply Scenarios

Scenario A	Scenario B	Scenario C
Current Trends	Moderate Improvement	Aggressive Improvement
Examines impacts of electrification on electric system that evolves consistent with current trends, increasing technology cost and lengthy transmission expansion timelines. Utilities rely on supply resources that continue to increase in cost while transmission development is limited by current permitting and planning timelines.	Examines impacts of electrification on an electric system with moderate improvements that reverse recent technology cost increases and advances transmission permitting and planning. Moderate improvement enables faster transmission expansion and expands role of demand-side resources such as energy efficiency and demand response.	Examines impacts of an electrification on electric system aggressively develops through technology cost declines and accelerated development timelines Cost reductions of technologies, accelerated transmission development timelines and expanded demand-side resources lead to a diverse and lower-cost resource mix.

Summary of Electric Supply Options

- Select generation supply option that differ across scenarios are listed below.
- Technology resources such as solar, onshore wind and battery are offered as options across all scenarios.

Supply Option	Assumption	Current Trends	Moderate Improvement	Aggressive Improvement
Offshore Wind	Cost	↑	→	↓
	Availability	Current Procurements/TX Limitation – 2035+	Beyond current procurements – 2035+	Beyond current procurements – 2032+
Known and Planned Transmission Projects in Advanced Stages		As published	As published	As published/ODOE, whichever is earlier
Unplanned/Early-Stage Projects	Timeline of Deployment	Current timelines	Shortened Timelines	Short Timelines
Alternative Fuels (RNG, H_2, SNG)	Cost	↑	→	↓
	Availability	↓	→	↑
Natural Gas with or without CCS/Nuclear		Not permitted in Oregon. Permitted only as option to build outside of Oregon, including Washington		
Demand Response/EE	Assumed Deployment	Low	Medium Low	High Medium Low

ICF

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Unplanned/Early-Stage Projects	Timeline of Deployment	Current timelines	Shortened Timelines	Short Timelines
Alternative Fuels (RNG, H_2, SNG)	Cost	↑	→	↓
	Availability	↓	→	↑
Technology Costs (Wind, Solar, Battery Storage, Offshore Wind)		↗	→	↓
Demand Response/EE	Assumed Deployment	Low	Medium Low	High Medium Low

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Electric Supply Scenarios – Current Trends Scenario Assumptions

Category	Assumption	Rationale
Offshore Wind Availability	• Limited to 1 GW available, available no earlier than 2035	• Limit based on current lease sale areas identified by BOEM and transmission constraints identified by BPA • Postponed lease sale limits early development opportunities
Known/Planned Transmission in Advanced Stages	• Late-stage projects proceed as planned (B2H) • Projects not yet under construction are delayed	• Transmission projects have faced permitting and process delays. • Oregon permitting process and local opposition creates hurdles for project advancements and completion • Current transmission planning timeline can exceed 20 years, few proposed projects reach commercial operation
Unplanned/Early-Stage Transmission Projects	• No new economic transmission beyond planned projects until 2050	
Alternative Fuels	• Availability based on Alternative Fuels Study	• Costs fall on the high end of the estimated range
Technology Costs (Wind, Solar, Battery Storage, Offshore Wind)	• Costs for established technologies (wind, solar, battery storage) follow high-cost scenario • Emerging technology costs decline in line with high-cost NREL scenario	• Recent technology costs increases for established technologies maintained through 2030 and transition to long-term fundamentals after 2035 • Emerging technology costs decline in line with high-cost NREL scenario
EE/DR	• EE and DR follow projected utility IRP levels of deployments	• EE/DR programs stay in line with IRP projections and grow beyond IRP timeline at projected pace in IRP

Overview of Electric Supply Scenarios

Scenario A	Framework B	Framework C
Current Trends	Moderate Improvement	Aggressive Improvement
Examines impacts of electrification on electric system that evolves consistent with current trends, increasing technology cost and lengthy transmission expansion timelines. Utilities rely on supply resources that continue to increase in cost while transmission development is limited by current permitting and planning timelines.	Examines impacts of electrification on an electric system with moderate improvements that reverse recent technology cost increases and advances transmission permitting and planning. Moderate improvement enables faster transmission expansion and expands the role of demand-side resources such as energy efficiency and demand response.	Examines impacts of an electrification on electric system aggressively develops through technology cost declines and accelerated development timelines Cost reductions of technologies, accelerated transmission development timelines and expanded demand-side resources lead to a diverse and lower-cost resource mix.

Electric Supply Scenarios– Aggressive Improvement Scenario Assumptions

<table>
<tr><th>Category</th><th>Assumption</th><th>Rationale</th></tr>
<tr><td>Offshore Wind Availability</td><td>• Limited to EPA offshore wind build bounds Available no earlier than 2032
• Expansion beyond 1 GW available with incremental TX cost starting in 2032</td><td>• Limit beyond currently announced lease sites
• Deployments could support energy needs based on accelerated development timelines, assuming swift lease awards</td></tr>
<tr><td>Known/Planned Transmission in Advanced Stages</td><td>• All projects proceed as planned and in line with ODOE assumption on project completion dates</td><td rowspan="2">• Proposed transmission project advance on currently known and planned trajectories, to allow for transmission to serve as a resource in policy attainment.
• Economic transmission additions can support in time for full policy attainment by 2035, assuming significant improvements in permitting and planning processes</td></tr>
<tr><td>Unplanned/Early-Stage Transmission Projects</td><td>• Economic transmission additions available as early as 2035</td></tr>
<tr><td>Alternative Fuels</td><td>• Availability based on Alternative Fuels Study</td><td>• Supply curve falls into the high end of the distribution range of Alternative Fuels scenarios</td></tr>
<tr><td>Technology Costs (Wind, Solar, Battery Storage, Offshore Wind)</td><td>• Costs for established technologies (wind, solar, battery storage) follow a low-cost scenarios
• Emerging technology costs decline in line with low-cost NREL scenario</td><td>• Recent technology costs increases for established technologies reverse and costs decline imminently.
• Emerging technologies continue significant cost declines due to continued learning</td></tr>
<tr><td>EE/DR</td><td>• EE and DR go beyond levels identified in IRPs</td><td>• EE/DR programs assumed drive load lower and approach achievable potential/high deployment forecasts</td></tr>
</table>

Overview of Electric Supply Scenarios

Scenario A	Scenario B	Scenario C
Current Trends	Moderate Improvement	Aggressive Improvement
Examines impacts of electrification on electric system that evolves consistent with current trends, increasing technology cost and lengthy transmission expansion timelines. Utilities rely on supply resources that continue to increase in cost while transmission development is limited by current permitting and planning timelines.	Examines impacts of electrification on an electric system with moderate improvements that reverse recent technology cost increases and advances transmission permitting and planning. Moderate improvement enables faster transmission expansion and expands the role of demand-side resources such as energy efficiency and demand response.	Examines impacts of an electrification on electric system aggressively develops through technology cost declines and accelerated development timelines Cost reductions of technologies, accelerated transmission development timelines and expanded demand-side resources lead to a diverse and lower-cost resource mix.

Electric Supply Scenarios – Moderate Improvement Scenario Assumptions

Category	Assumption	Rationale
Offshore Wind Availability	• Limited to EPA offshore wind build bounds • Expansion beyond 1 GW available with incremental TX upgrade cost starting in 2035	• Limit beyond currently announced lease sites • Deployments could support energy needs consistent with current development timelines, assuming swift lease awards in coming years
Known/Planned Transmission in Advanced Stages	• Late-stage projects proceed as planned Projects in early planning stages are expected to complete in time for policy attainment in 2040	• Key transmission projects advance but face limited delays. • Oregon permitting process and local opposition creates hurdles for project advancements and completion • Current transmission planning timeline is assumed to shorten to 15 years to reflect alternative technologies and improvements in permitting and financing processes.
Unplanned/Early-Stage Transmission Projects	• 15-year development timelines for economic transmission development, may provide limited incremental capacity starting in 2040	
Alternative Fuels	• Availability based on Alternative Fuels Study	• Supply curve falls into the middle of the distribution range of Alternative Fuels scenarios
Technology Costs (Wind, Solar, Battery Storage, Offshore Wind)	• Costs for established technologies (wind, solar, battery storage) fall between high and low-cost scenarios • Emerging technology costs decline in line with mid-cost NREL scenario	• Cost scenario between high and low-cost option, largely flat trend over time • Emerging technologies continue cost declines due to continued learning
EE/DR	• EE and DR follow projected utility IRP levels of deployments from low load cases	• EE/DR programs stay in line with low load IRP projections and grow beyond IRP timeline at projected pace in IRP

State and Regional Policies

- All scenarios will be modeled to comply with existing regulations, which will require significant additions of capacity in a short period of time while facing load growth on the system.

Regulation	Oregon	Washington
Clean Energy Standard (CES)	HB 2021 - Large electric utilities serving more than 25k customers (i.e., PGE & PacifiCorp) required to reduce GHG emissions by 80% by 2030, 90% by 2035, and 100% by 2040 from 2010-2012 levels.	Reduce emissions 45% below 1990 levels by 2030, 70% by 2040, and 95% by 2050.
Renewable Portfolio Standard (RPS)	Utilities serving at least 3% of state load • 25% by 2025 • 35% by 2030, • 45% by 2035, • 50% by 2040 Utilities serving 1.5-3% of state load: 10% by 2025 Smaller Utilities: 5% by 2025	15% by 2030 and 100% by 2045
Coal	No Coal supplying state electricity by 2030, inclusive of imports	No Coal supplying state electricity by 2025
Natural Gas	Prohibition on new or expanded natural gas-fired power plants	
Nuclear	In-state moratorium for new Nuclear plants	Nuclear construction permitted

Energy Import Availability

- All scenarios are constrained to existing transmission capacity until certain planned lines go into service, adding capacity to deliver energy into Oregon
- Additional economic builds can be added starting between 2035 and 2050, depending on the scenario

New Line	Path	Current Trends	Moderate Improvement	Aggressive Improvement
Gateway West (Seg. E)	Wyoming to Oregon	2037	2037	2030*
Boardman to Hemingway	Idaho to Oregon	By 2030	By 2030	By 2030*
Big Eddy to Chemawa	Oregon East-West of Cascades	2050	2040	2035*
Round Butte to Bethel	Oregon East-West of Cascades	2050	2040	2035*
Unplanned Economic Transmission Expansion	Any to allow new resource development for import	No new, unplanned transmission before 2050	Allowed, beginning in 2040, limited to historical benchmarks (MW/year)	Allowed, beginning in 2035*, uncapped, as assumed costs.

*The aggressive improvement scenario assumes the latest utility information or ODOE assumption, whichever is earlier

Technology Cost and Performance

- Technology cost and performance for technology types are assumed based on industry sources such as:
  - National Renewable Energy Laboratory (NREL) Annual Technology Baseline (ATB)
  - EPA Documentation for power sector modeling using IPM
  - Energy Information Administration (EIA) Annual Energy Outlook (AEO)
  - DOE Solar and Wind Energy Industry Reports

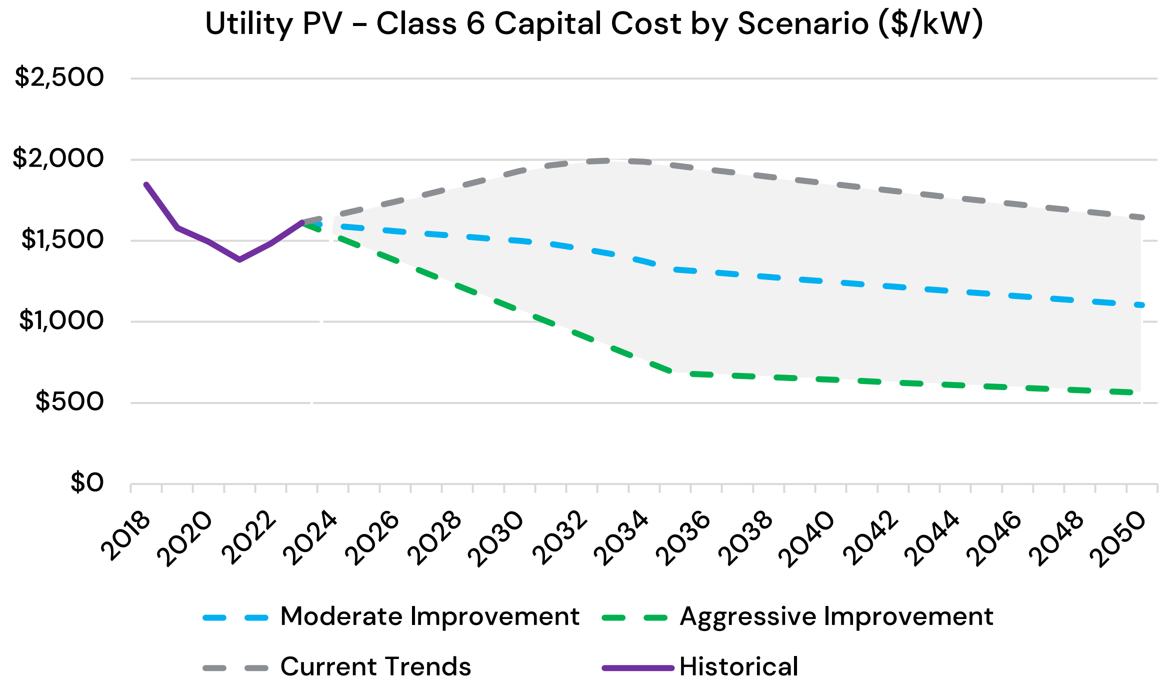
- Cost and performance of technologies (wind, solar, storage, offshore) are regionalized to the Northwest.

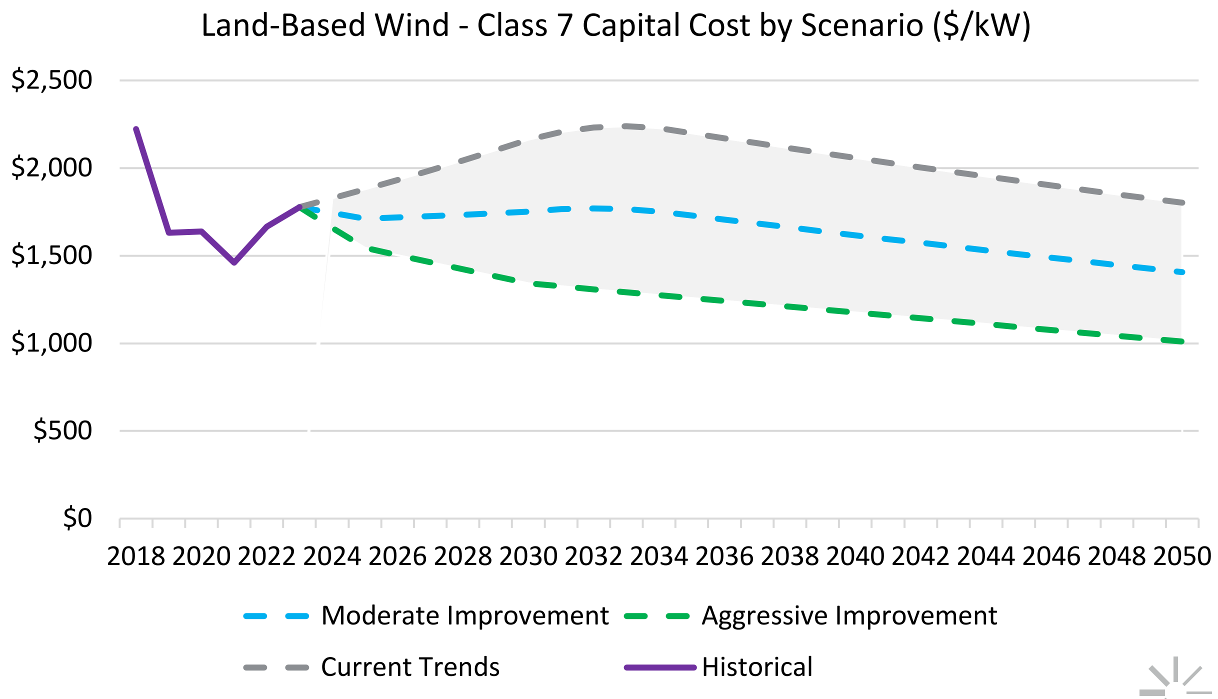
- All costs shown in upcoming slides are inclusive of NREL assumed grid interconnection costs, reflect unsubsidized costs prior to PTC/ITC application and are reflective of resources assumed to be available in Oregon.

- Technology cost and performance varies by scenario and technology types. For emerging technologies (offshore wind, 8hr battery storage), trends are based on NREL's 2024 ATB scenarios. For established technologies (solar, wind, 4hr battery), the cost trends are based on the following:
  - Current Trends: Near-term technology cost based on 2020 – 2023 cost trends, long-term reverts to NREL trends
  - Aggressive Improvement: Based on NREL's Advanced Improvement Scenario
  - Moderate Improvement: Average between Current Trends and Aggressive Improvement

Technology Cost – Wind and Solar

- Wind and solar represent established technologies. Cost trends for wind and solar vary by scenario.
  - <u>Current Trends</u>:
    - Between 2023 and 2030, capital costs increase consistent with the average NREL capital cost increases between 2020 and 2023.
    - After 2035, costs decline consistent with NREL's Advanced Scenario technology cost declines
    - Between 2030 and 2035, growth rates are interpolated from pre-2030 increase to post-2035 decline
  - <u>Aggressive Improvement:</u> Costs based on NREL's Advanced Scenarios
  - <u>Moderate Improvement:</u> Costs average between Current Trends and Aggressive Improvement Scenario

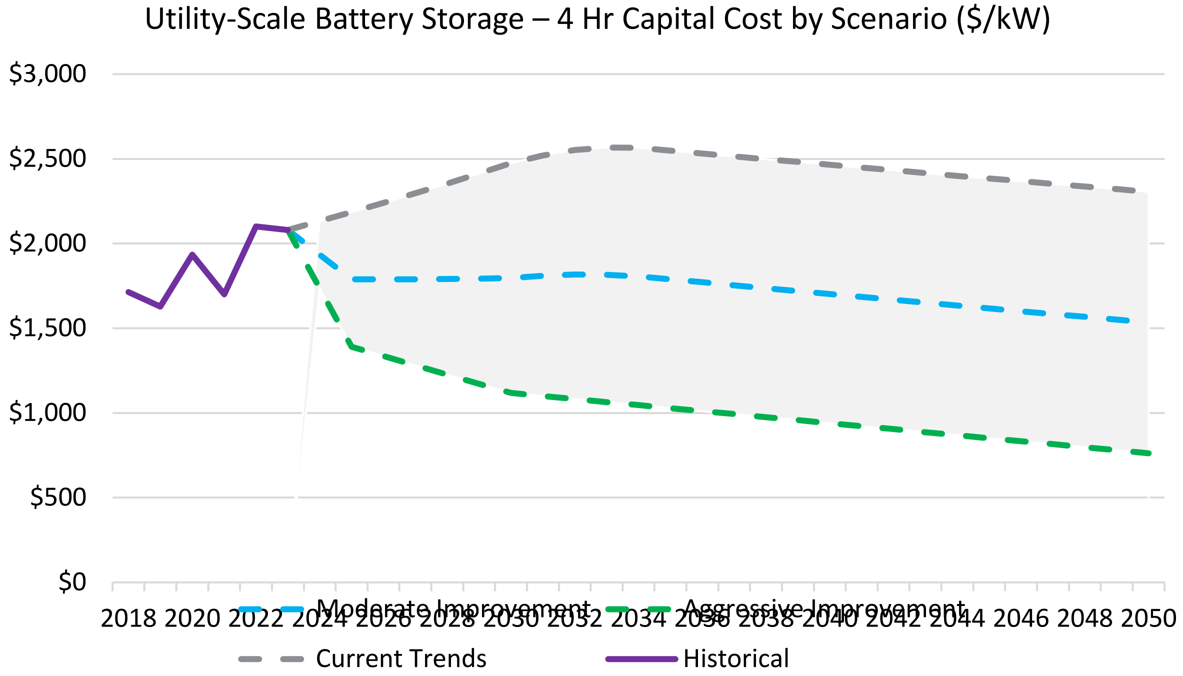


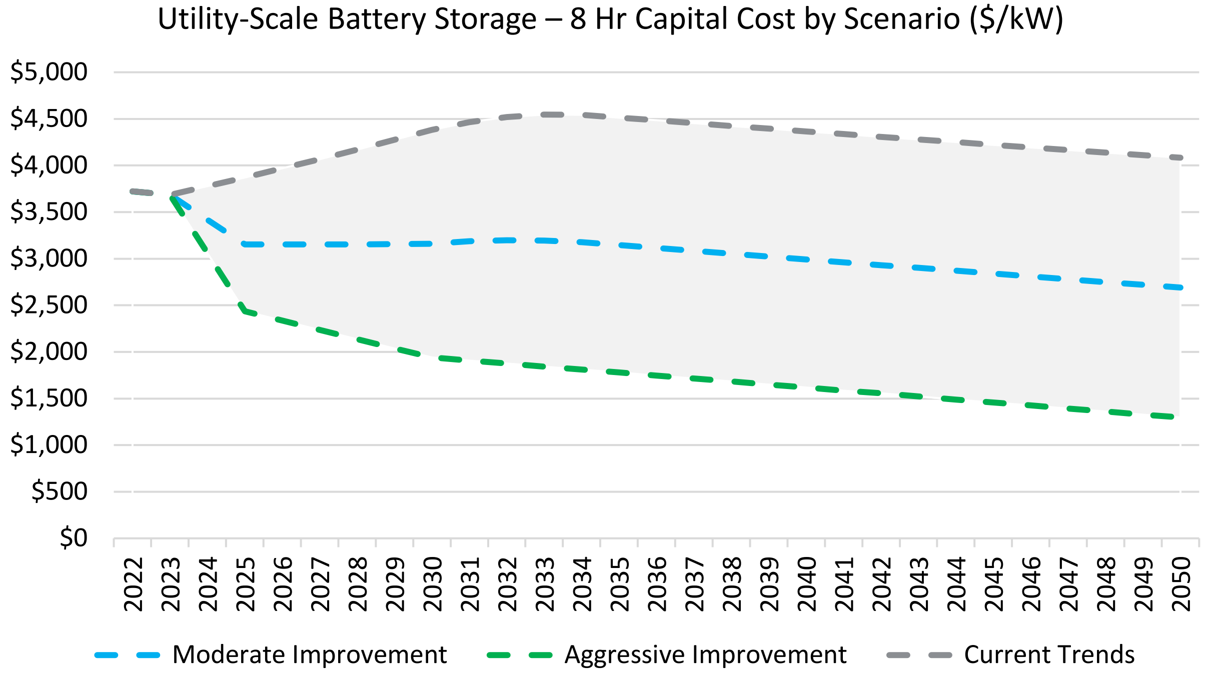


All costs shown in real $2022

Storage Costs

- Cost trajectories for storage follow the same methodology as wind and solar
  - Current Trends:
    - Between 2023 and 2030, capital costs increase consistent with the average NREL capital cost increases between 2020 and 2023.
    - After 2035, costs decline consistent with NREL's Advanced Scenario technology cost declines
    - Between 2030 and 2035, growth rates are interpolated from pre-2030 increase to post-2035 decline
  - Aggressive Improvement: Costs based on NREL's Advanced Scenarios
  - Moderate Improvement: Costs average between Current Trends and Aggressive Improvement Scenario

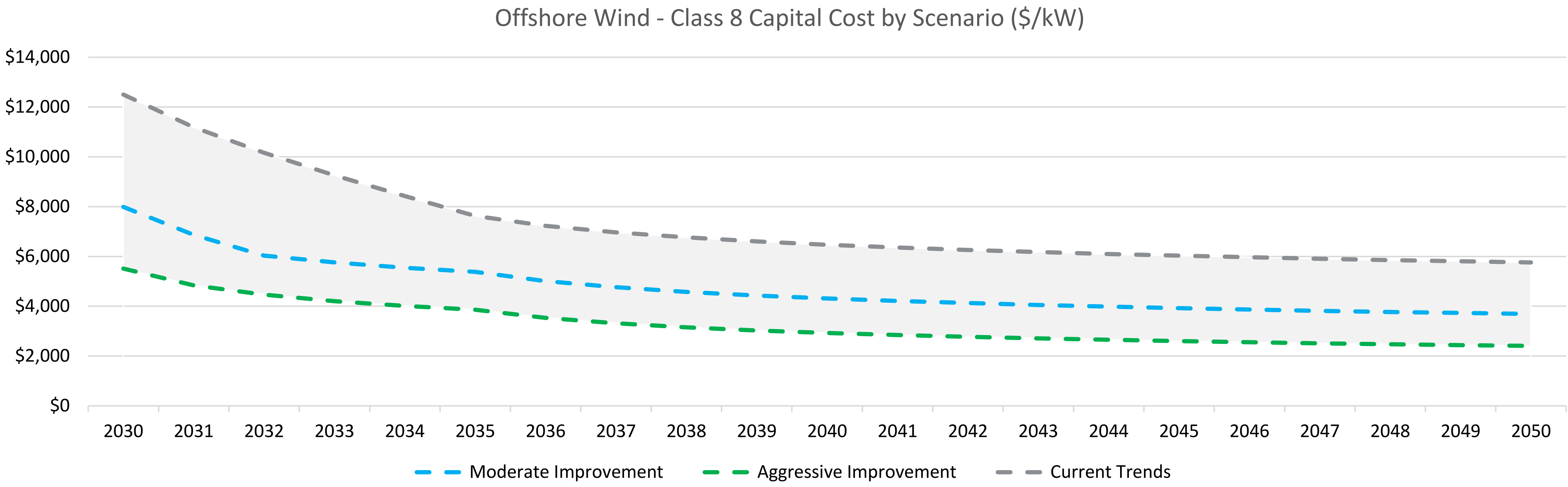




Note: All costs are shown as unsubsidized costs prior to PTC/ITC Application.

Offshore Wind Costs

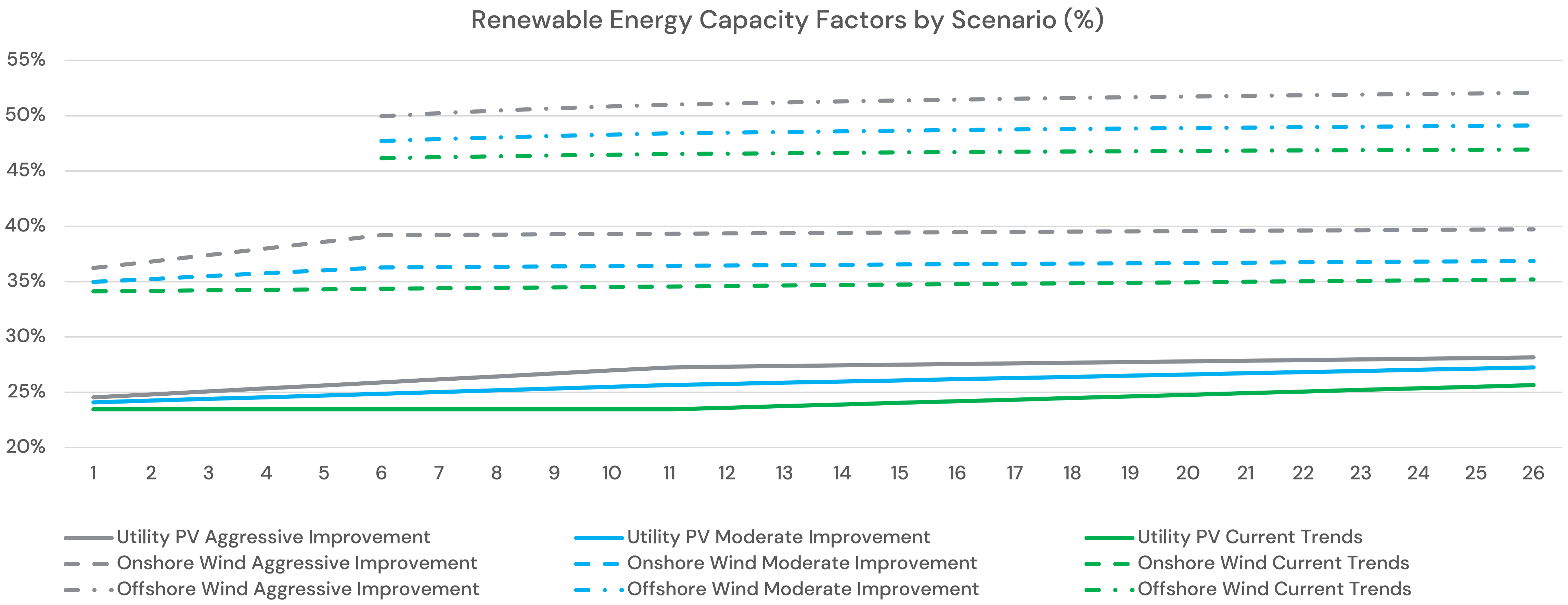
- Offshore wind costs have seen the sharpest upward revision of any technology type in NREL's latest ATB release and shows the most variation across cost scenarios. Costs are shown starting in 2030, and availability for Offshore wind in Oregon varies by supply side scenario. Only floating offshore wind is assumed available in Oregon
- As an emerging technology, Offshore wind capital cost declines are modeled with declining cost curves consistent with the NREL's three cost and performance scenarios.
- Oregon's offshore wind potential would require more costly floating offshore wind turbines.



Note: All costs are shown as unsubsidized costs prior to PTC/ITC Application. Costs reflect NREL technology class assumed to be available in Oregon

Technology Performance

- In addition to capital costs, the supply side scenarios differ in the performance achieved by the various technology types.
- Capacity factors for onshore and offshore wind vary by an absolute of ~5% between the Current Trends and Aggressive scenario, and by 3% for solar.
- All technology performance levels shown below are specific to the resources assumed available to Oregon



Scenario Discussion

Scenarios for this IRP

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		Scenario
		Reference Case
Policy Variations	1	CPP/CCA Compliance
	2	SB 98 Targets
	3	No GHG Compliance Policies
Demand Variations	4	Growth Recovery
	5	Modest Customer Electrification
	6	Hybrid System Electrification
	7	All-Electric Buildings

TBD

Stochastics
Weather
Gas Prices
Compliance Resource Costs
Compliance Resource Availability

8 Gas Resource Outcomes for Comparison

Additional sensitivities within these scenarios will be considered

X3 Electric Supply Scenarios

12 Outcomes for Building Electrification Comparison

Prepared for IRP TWG - Not to be used for investment purposes.

Break

IRP Climate Science Support

ICF's climate resilience for utilities

We offer unparalleled experience working with utilities across the country on climate risk assessment and resilience planning

Best-in-class climate science: We leverage best-available downscaled climate hazard/science projections that are utilized by both peer utilities and the government for risk assessment and resilience planning

Deep utility experience: We have successfully supported more than 10 major electric and gas utilities in the United States and Canada on complex climate risk and resiliency projects

50+
years of energy work

40+
years of climate science, impacts, and adaptation

2K+
climate, energy, and environment experts

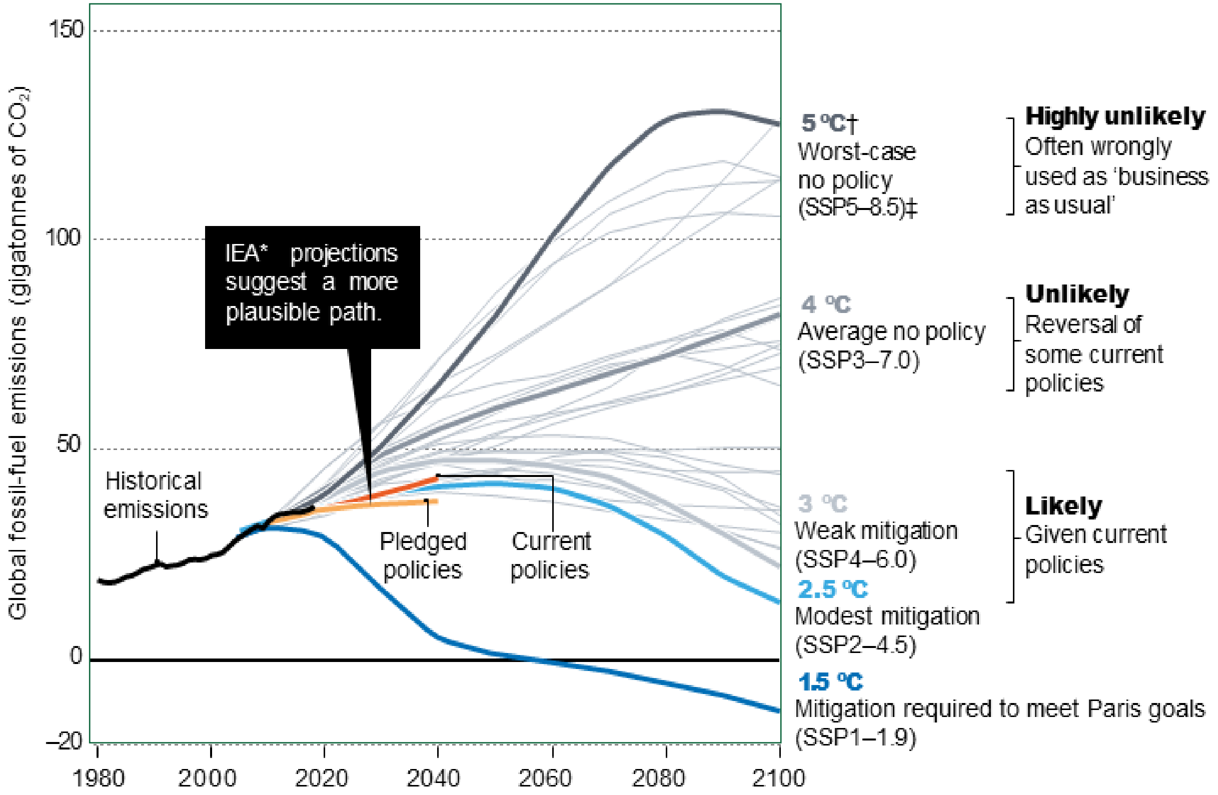
Climate Science Background

- Scientists develop climate change projections using **Global Climate Models (GCMs)**, which simulate Earth's climate and physical processes.
- Using a method called **downscaling,** scientists translate GCM output to a higher spatial resolution to better capture local climate characteristics and support local planning.
- **Probabilistic projections** use an ensemble of GCMs to capture a fuller range of potential future climate conditions and constrain uncertainty.

Global Climate Model schematic

Future Climate Pathways

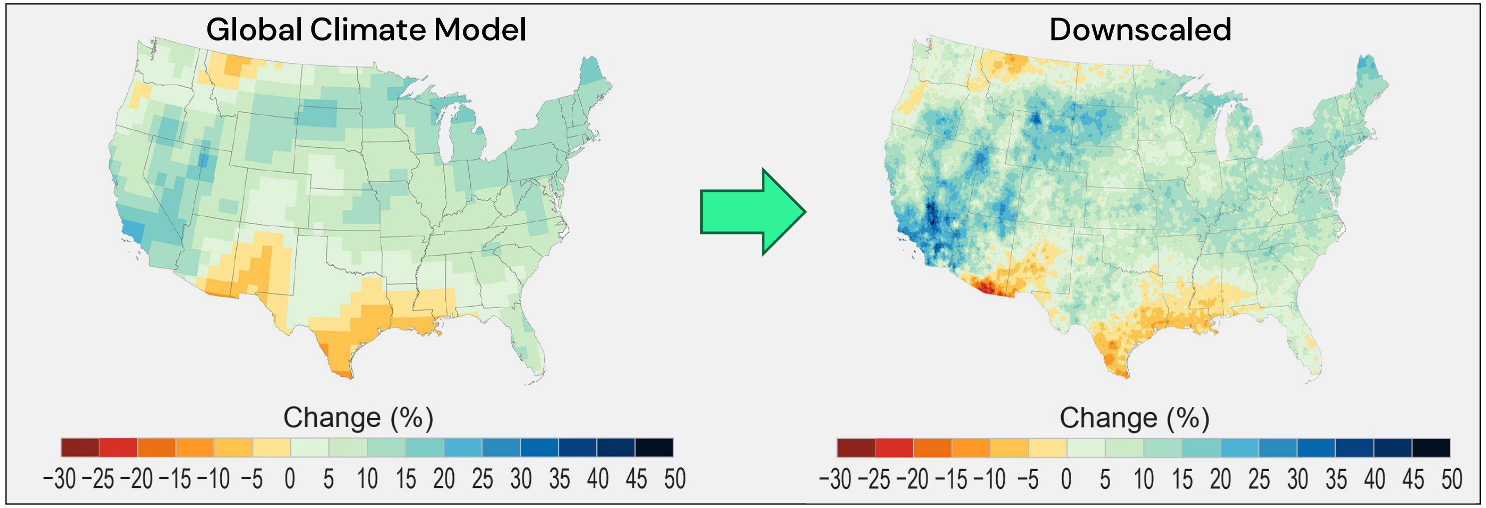
- NW Natural Gas developed climate projections under multiple future greenhouse gas emissions pathways and a large ensemble of GCMs to account for uncertainty in future emissions and climate sensitivity.
- The most recent climate projections developed for the Intergovernmental Panel on Climate Change use Shared Socioeconomic Pathways (SSPs) emission scenarios:
  - SSP2-4.5 represents a more likely pathway assuming meaningful greenhouse gas emissions reductions by mid-century.
  - SSP3-7.0 represents a less likely pathway assuming greenhouse gas emission increase throughout the century.



Emissions pathways and their likelihoods. Source: Hausfather and Peters, Nature 2020

Methods and Datasets

- NW Natural Gas used Localized Constructed Analogs Version 2 (LOCA2) downscaled climate projections to developed custom heating degree day (HDD) projections for weather stations across the service area.
    - Peer-reviewed and used in landmark climate assessments (e.g., Fifth National Climate Assessment).
    - Supports 22 common models between SSP2-4.5 and SSP3-7.0.
    - Downscales projections to a 6km resolution across the service area to better resolve temperature extremes.
- NW Natural Gas paired LOCA2 projections with observational time series to account for historical biases relative to observations and better resolve local climatology.



LOCA2 example

Illustration of LOCA2 statistical downscaling of percent change in total annual precipitation from 1985-2014 to 2071-2100 under SSP5-8.5 across the Continental United States.
Source: Adapted from 5th National Climate Assessment.

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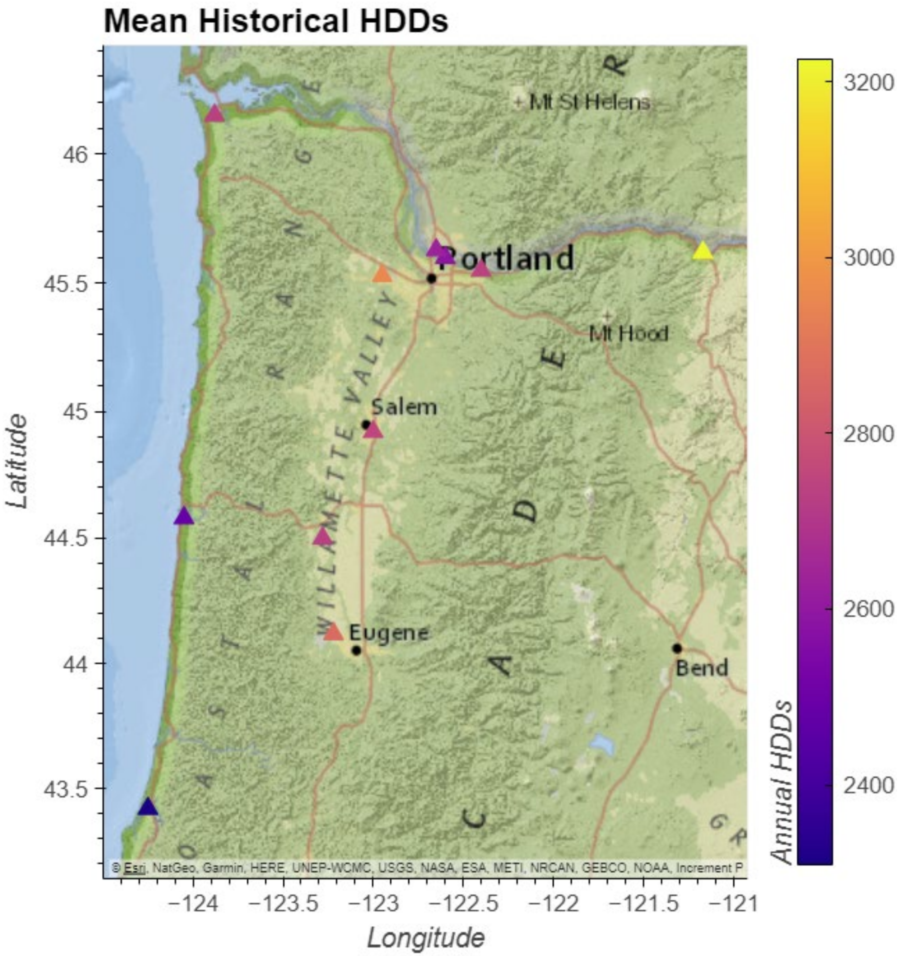
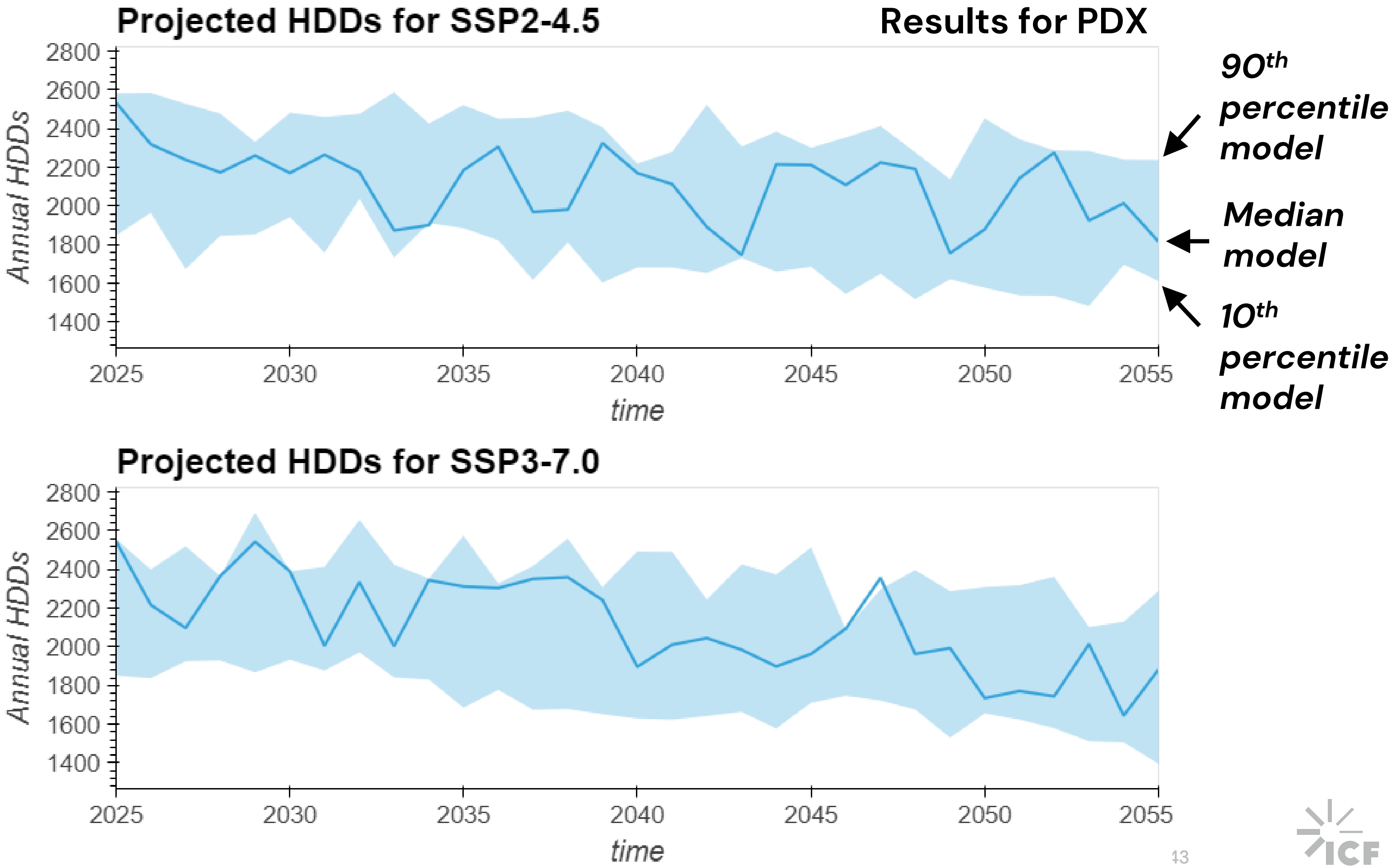
Results: Heating Degree Days

- Projections reveal **decreases in Heating Degree Days across the service area** for both SSP2-4.5 and SSP3-7.0.
- Future projected HDDs show **significant interannual variability**.





Results: Extreme Cold Weather Outbreaks

- NW Natural Gas has historically experienced extreme cold events, though the magnitude of these extremes varies regionally.
- Climate change is projected to drive warmer temperatures in the Pacific Northwest, **reducing the overall frequency of extreme cold events** across the region.
- **This does not preclude cold snaps from occurring**. Some evidence suggests that climate change could worsen cold extremes resulting from polar vortex events or other processes in the near-to medium-term (e.g., through 2050).[1,2]
- Cold-side temperature distributions in the Pacific Northwest are non-Gaussian, which means that the region could experience a slower decrease in the frequency of extreme cold outbreaks relative to other regions in the United States.[3]

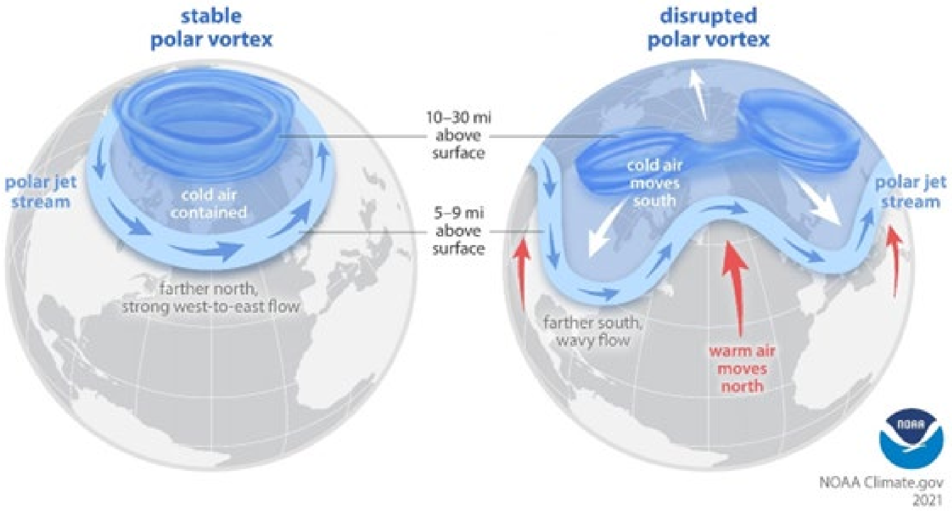


Illustration of a stable and disrupted polar vortex and how each scenario impacts temperature at lower latitudes. Source: NOAA.

Example references

1. Francis, J. A., & Vavrus, S. J. (2012). Evidence linking Arctic amplification to extreme weather in mid-latitudes. *Geophysical Research Letters*, 39(6).
2. Cohen, J., Agel, L., Barlow, M., Garfinkel, C. I., & White, I. (2021). Linking arctic variability and change with extreme winter weather in the United States. *Science*, *373*(6559).
3. Loikith, P.C. and Neelin, J.D. (2019). Non-Gaussian Cold-Side Temperature Distribution Tails and Associated Synoptic Meteorology. *Journal of Climate*.

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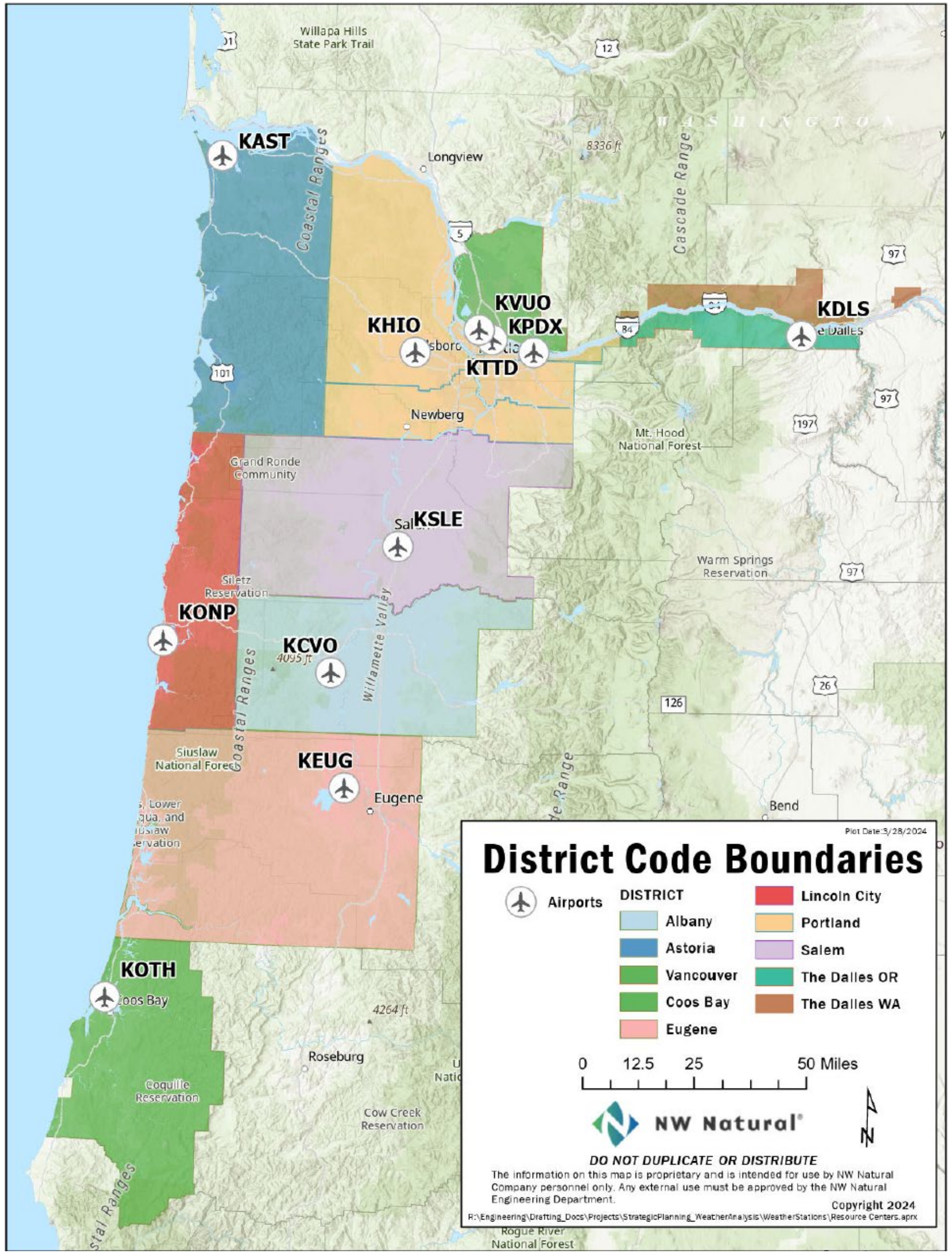
Daily Temperature Modeling

Temperature Modeling

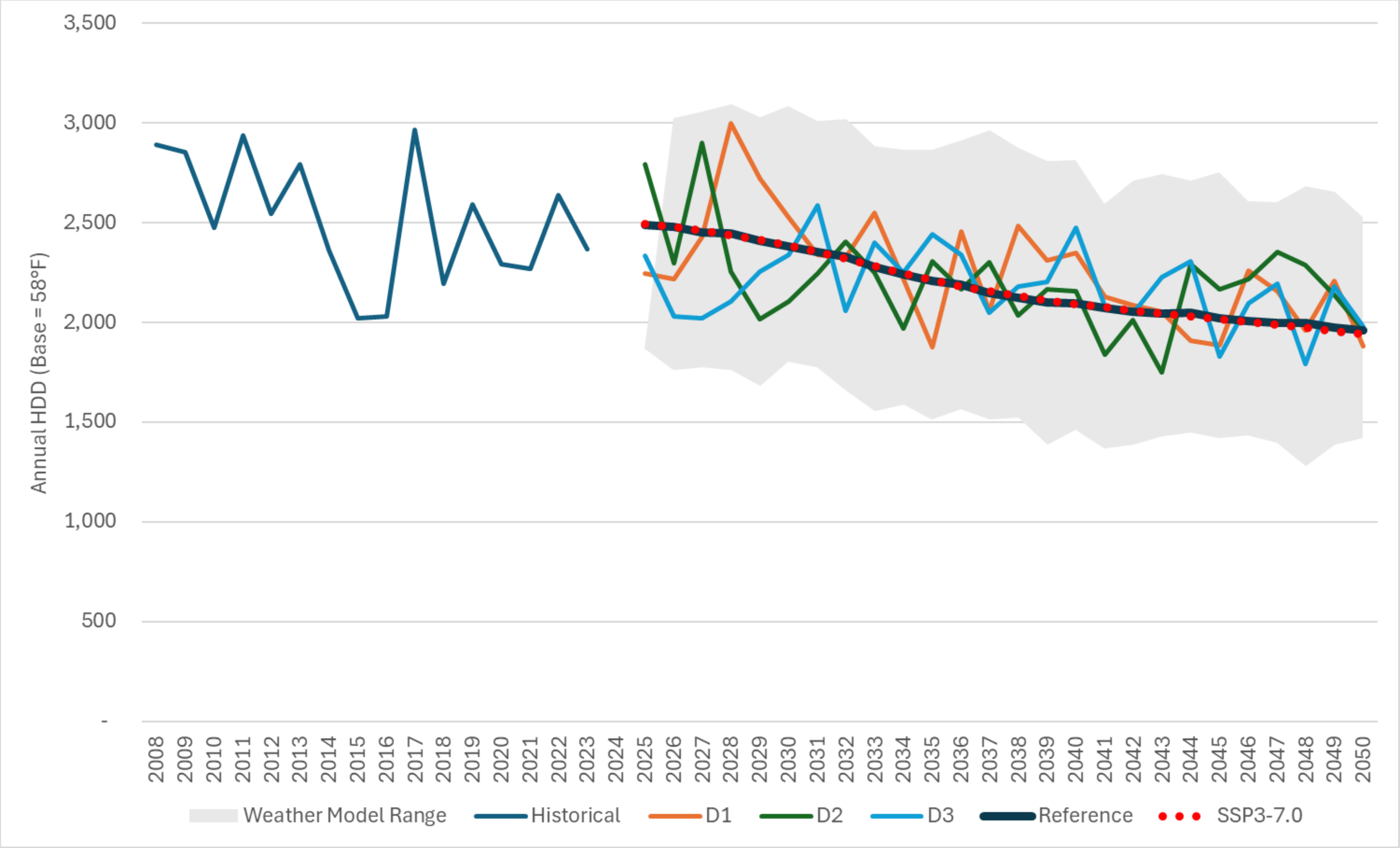
- ICF uses 11 airports throughout our service territory to downscale and calibrate monthly heating degree days (HDDs) forecasts from the IPCC model data

  HDD = maximum(Base Temperature – Daily Temperature; 0)

- Cumulative HDD represents a metric of space heating requirements which are important for energy planning for Natural Gas
- We translate these monthly HDDs into daily temperatures using a corresponding historical representative month
- This creates a forecast of daily temperatures for each of these locations that is used to forecast weather sensitive load for 12 load centers (district codes) around our service territory

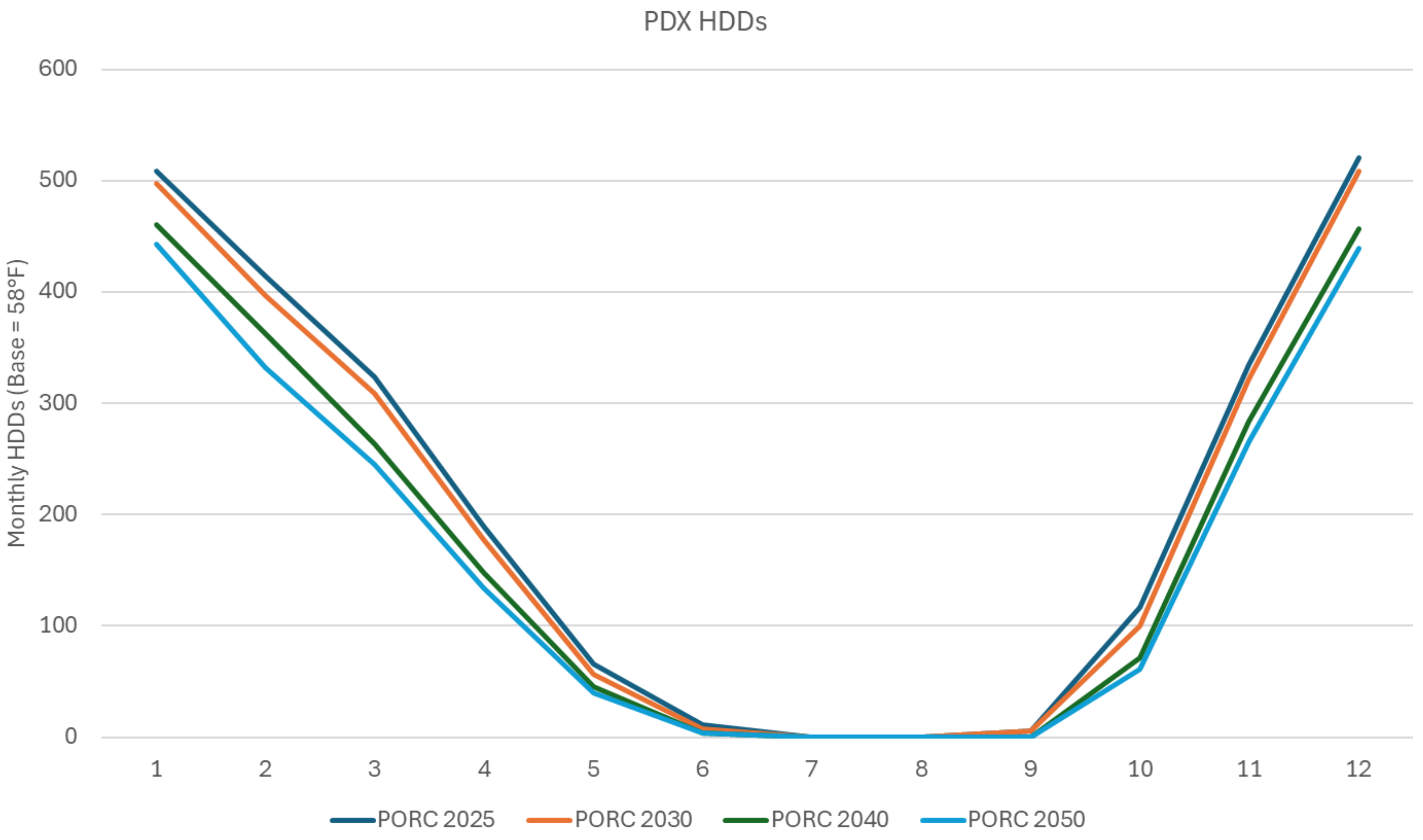


Range of Weather Conditions



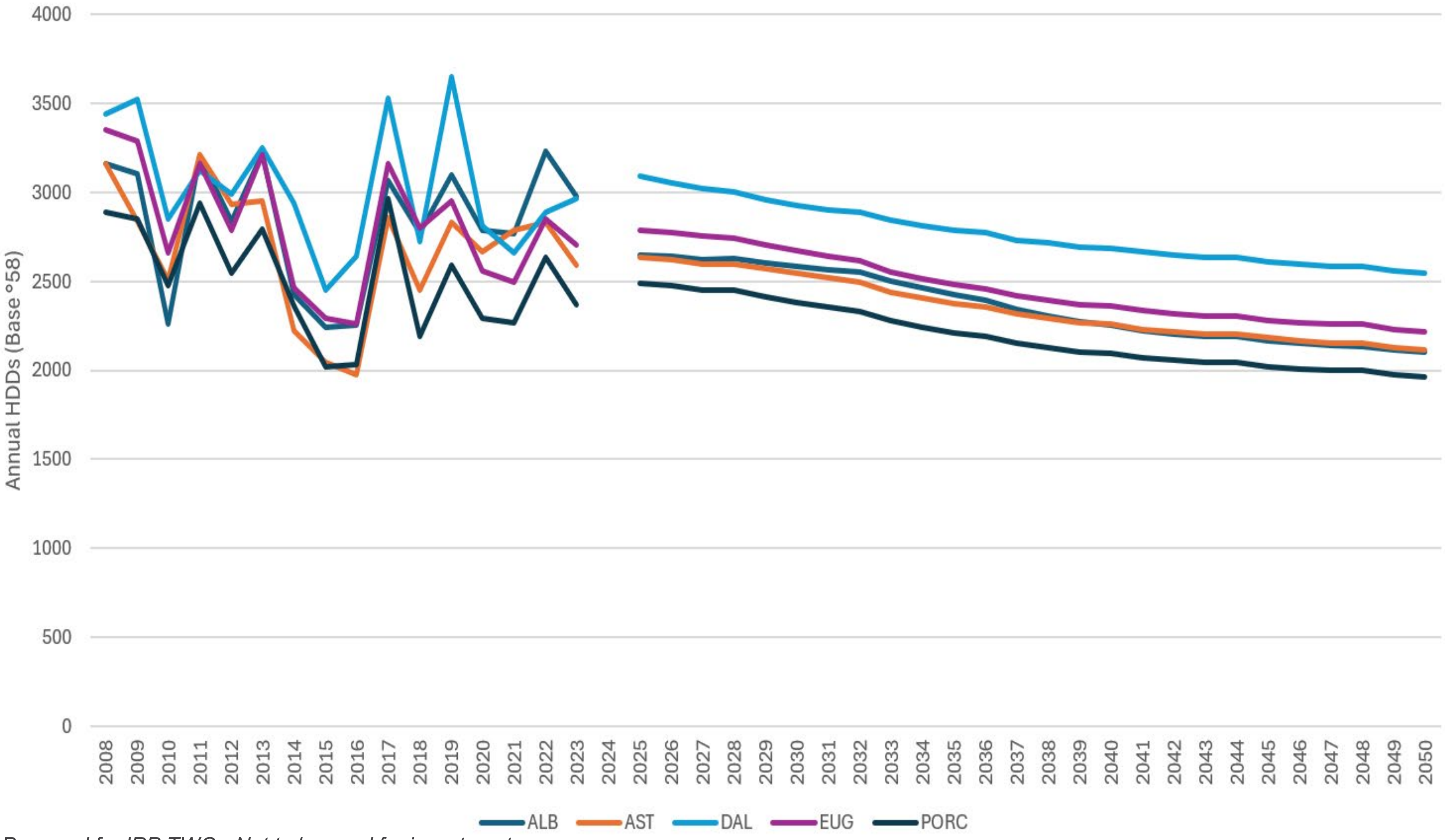
- There are 22 IPCC models that provide monthly HDDs forecast
- All 22 models trend downward and overlap with each other
- The reference case is based on the both SSP2-4.5 IPCC models
- The difference between SSP2-4.5 and SSP3-7.0 for our region before 2050 is not material

HDDs Over Time



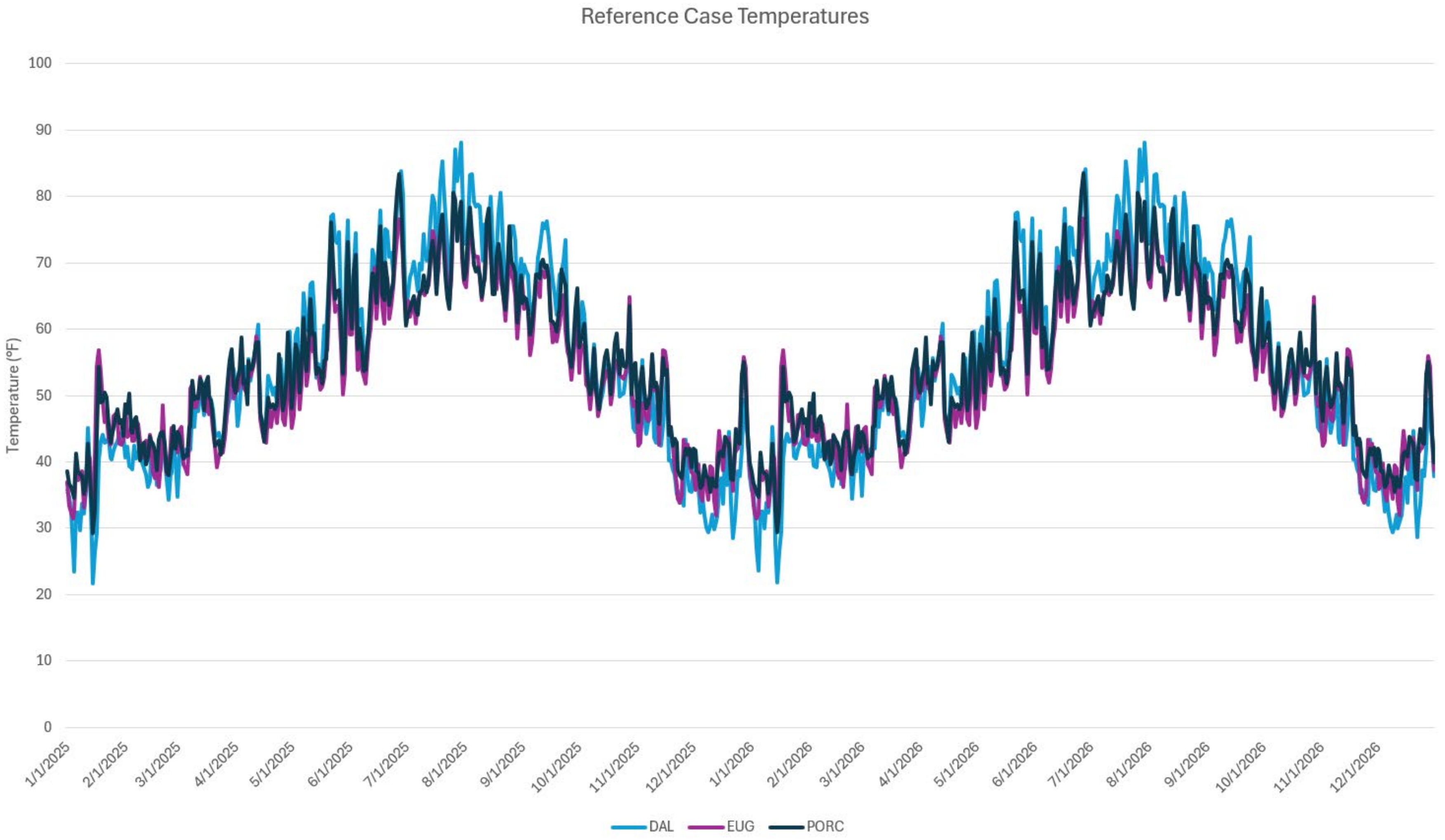
- Downscaled IPCC models show declining HDDs throughout our service territory
- Winters and shoulder months are getting warmer
- On average there will be less energy demand for space heating

Year over Year Weather Volatility



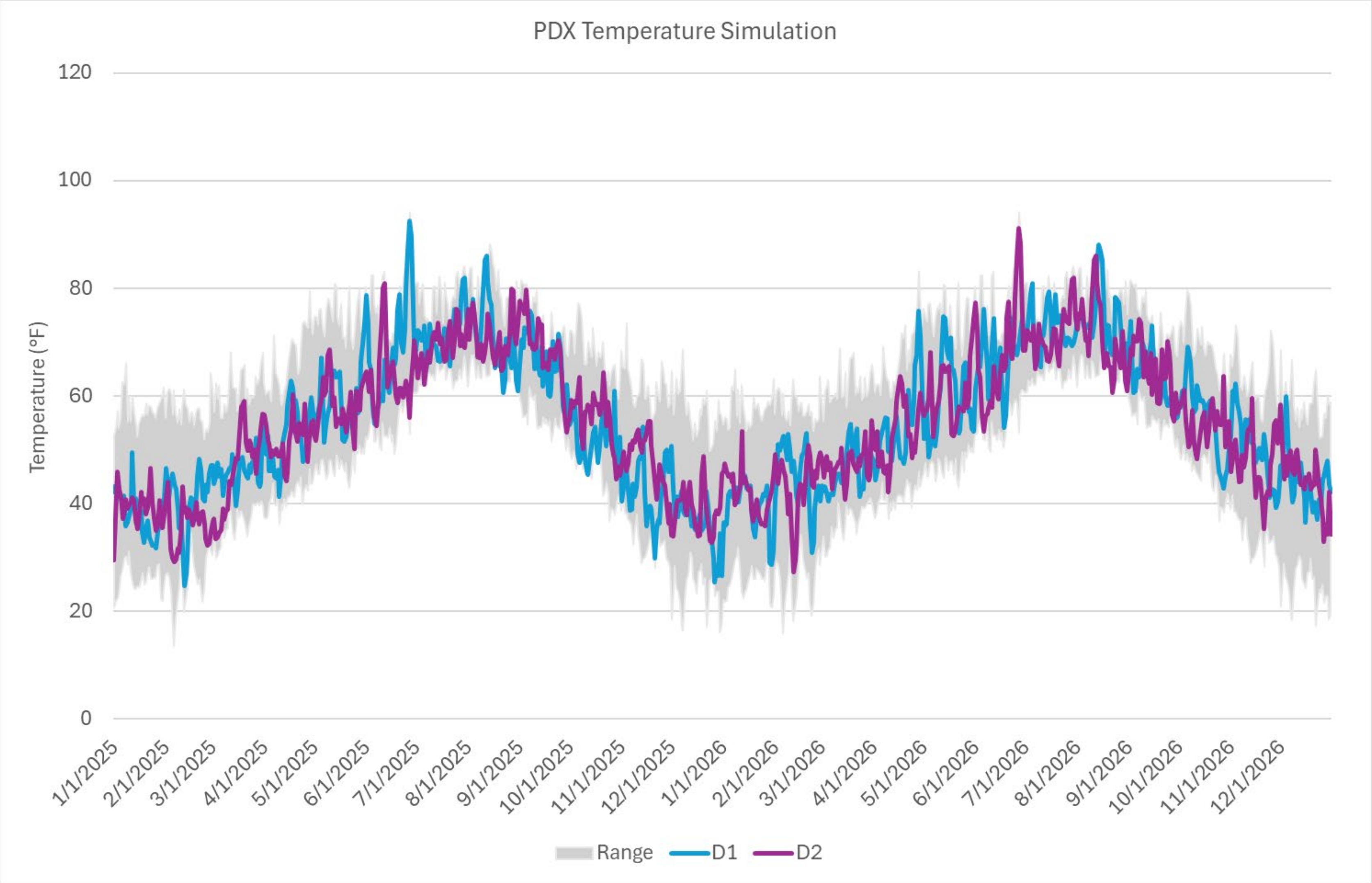
- Weather is volatile year over year and will be volatile in the future
- Weather volatility will be the largest source of uncertainty in the near term
- Annual HDD represents a measure of annual heating requirements
- Peak day capacity requirements are driven by a combination of various demand drivers, which will be discussed at a later technical working group

Daily Volatility



- Our residential and small commercial load forecasting models are a function of daily temperatures
- We use a representative year to shape monthly HDDs into daily temperatures
- Daily volatility is necessary to realistically model resource requirements (i.e., on cold days we need to rely on our storage facilities)

Weather is Random



- Model long term HDD uncertainty from climate change using the IPCC modeling
- Simulate monthly and daily uncertainty using historical shapes
- We use these temperature simulations to define the range

Feedback Form

Feedback preferred by December 5th

https://www.surveymonkey.com/r/NWNaturalIRP

Thank you!

We value your feedback.

IRP@nwnatural.com

IRP Website

IRP Feedback Form