

Council Power Plan Work Sessions

April 14 & 16, 2026



Northwest **Power** and
Conservation Council

Agenda

Day 1: April 14th

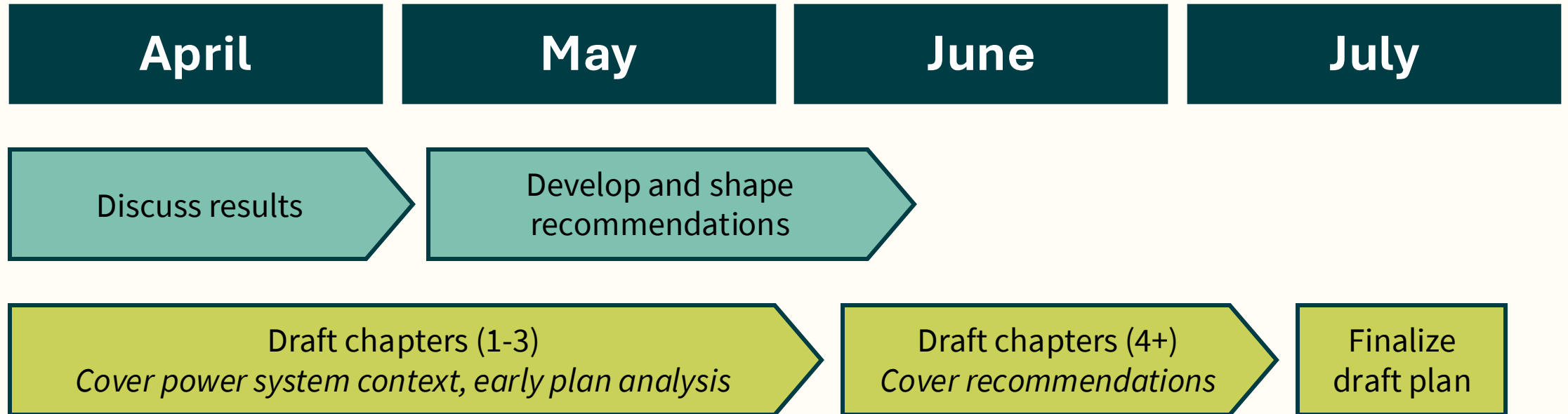
- Reminder of work to date
- Discussion of results

Day 2: April 16th

- Wrap-up of items from day 1, if needed
- Discussion of Chapters 1-3

What's Coming Up

The Road Ahead



Lots of Opportunity to Work Together



Reminder of Work to Date

We've Come A Long Way!



It's Been a Real Group Effort!

Climate and Weather (5)	Generating Resources (10)
Conservation (14)	Fuels (5)
Demand Forecast (3)	Resource Adequacy (5)
Demand Response (8)	System Analysis (9)

Advisory Committee Members:

AEG
 Alliance of Western Energy Consumers
 Amazon Web Services
 Avista
 Benton County PUD
 Better Climate Research and Policy Analysis
 Bonneville Power Administration
 Brightline Group
 Cadmus Group
 California Energy Commission
 Cascade Natural Gas
 Central Lincoln PUD
 Chelan PUD
 Clark County PUD
 CLEAResult
 CRITFC
 Columbia Riverkeeper
 Cowlitz PUD
 Energy Northwest
 Energy Trust of Oregon

+ 46 additional interested parties

Energy Exemplar
 EPRI
 Eugene Water & Electric Board
 Flathead Electric Coop
 Fortis BC
 Grant County PUD
 Gray's Harbor PUD
 Idaho Falls Power
 ID Office of Energy and Mineral Resources
 Idaho Power
 ID Public Utilities Commission
 Inland Power & Light
 Jim Lazar Consulting
 Kootenai Electric Cooperative
 Lighthouse Energy Consulting
 Mitsubishi Power
 MT Consumer Counsel
 MT Department of Commerce
 MT Department of Environmental Quality
 MT Electric Cooperatives Association

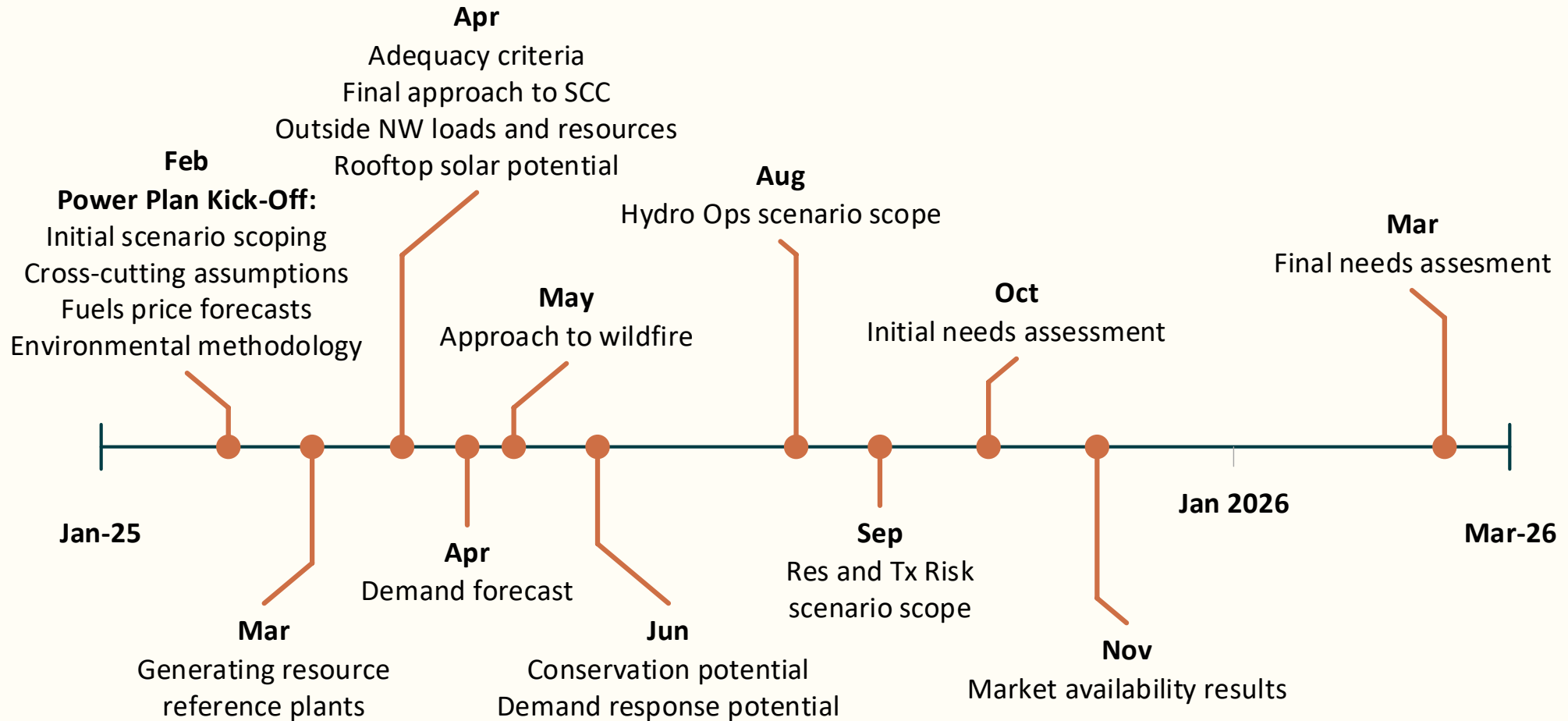
Natural Resources Defense Council
 Northwest Energy Coalition
 Northwest Energy Efficiency Alliance
 Northwest Energy Efficiency Council
 Northwest Gas Association
 Northwest Hydroelectric Association
 Northwest Requirements Utilities
 NorthWestern Energy
 NIPPC
 NW Innovation Works
 NW Natural
 Obsidian Renewables
 OR Department of Energy
 OR Public Utilities Commission
 OR Solar Energy Industries Association
 Pacific Northwest National Laboratory
 PNUCC
 PacifiCorp
 PNGC Power
 Portland General Electric

Portland State University
 PSR
 Public Generating Pool
 Public Power Council
 Puget Sound Energy
 Renewable Hydrogen Alliance
 Renewable Northwest
 Seattle City Light
 Snohomish PUD
 Tacoma Power
 TC Energy
 The Energy Authority
 Umatilla Electric
 University of Washington
 US Army Corps of Engineers
 WA Department of Commerce
 WA Energy Office
 WA Public Utility Districts Association
 WA Utilities and Transportation Commission
 Western Power Pool

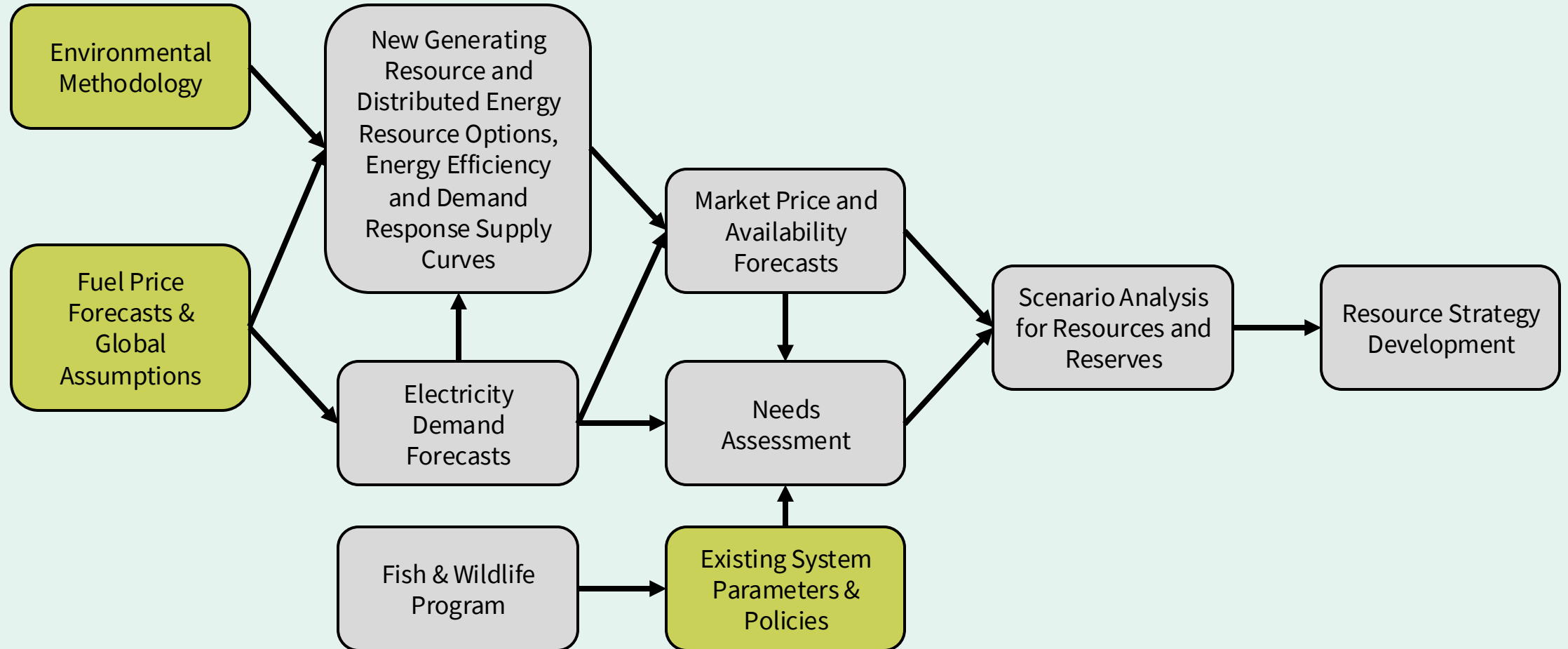
Before We Get Into the Results

- Council kicked off the Ninth Plan development in February 2025
- Since then, the Council has worked on several elements of the plan
 - Developed the scope and cross cutting assumptions
 - Created forecasts of future load
 - Developed estimates of new resource potential and cost
 - Conducted initial studies around market availability and regional resource needs
- Given the amount covered to date, we want to take a few minutes to remind everyone of these key decision points along the way

Timeline of Progress Since Kick-Off



Power Plan Development Process



Representation of the Existing System

- Existing system is defined to reflect the known realities of what is in the ground today serving the region's needs as of the start of modeling (summer 2025)
- Includes:
 - Existing resources and transmission
 - Planned resources and transmission that are under construction
 - Owner announced retirements or conversions of existing resources
- Similar approach is used for the WECC-wide resource and transmission assumptions
- A couple key updates were made in the process
 - With the TransAlta announcement for the Centralia 2 coal-to-gas conversion, staff updated the approach from assuming the plant would be retired to it being available as a gas unit starting 2029
 - Hydro operations were updated to reflect the Draft 2026 Fish and Wildlife Program, in addition to testing different sensitivities on other possible operations

Global Assumptions

Forecast Period

(2027-2046)

Financial Parameters

(Base year, inflation data source, discount rate, etc.)

Climate Model Weather Stations

(Consistent set to inform loads and resources)

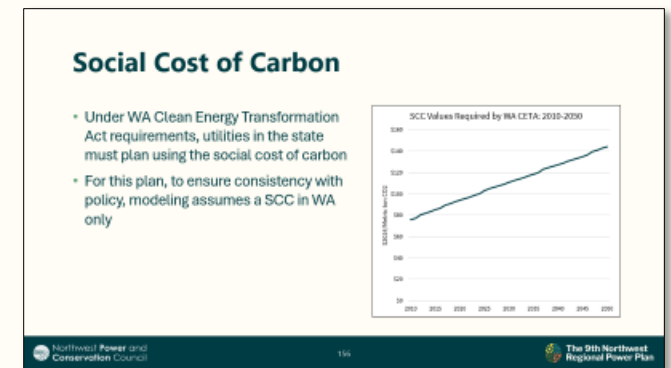
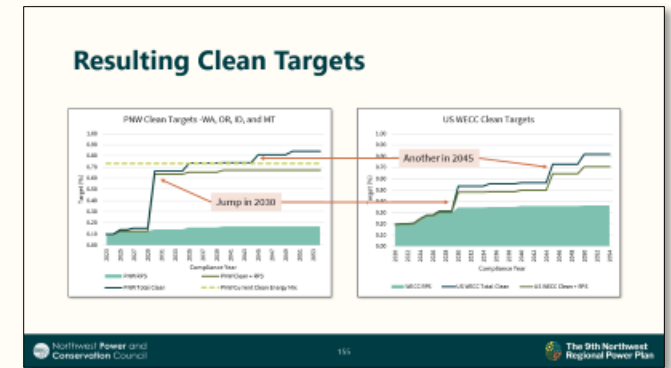
Peak Factors

(Accounting for line losses, within zone T&D deferral)

Policy Framework

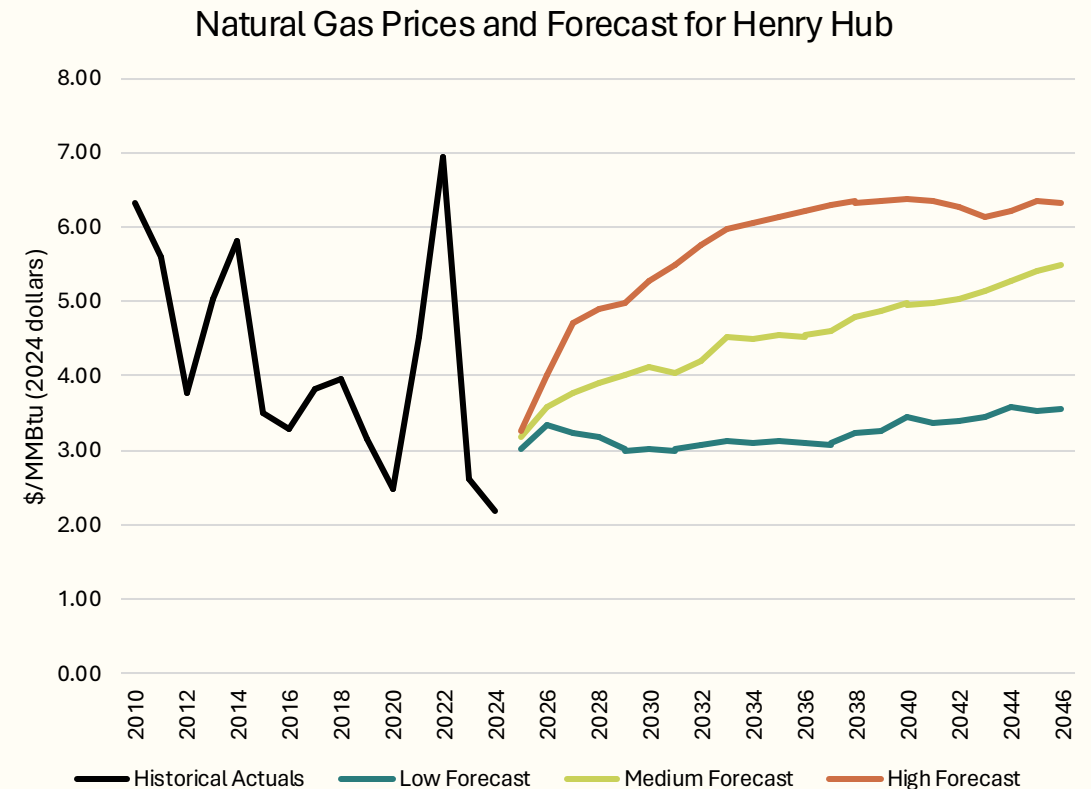
- Modeling assumes all existing policies and goals are met
 - Includes federal, state, city/jurisdiction, and utility
 - Analysis includes policies across the WECC, but with particular focus on those in the region
- Because policies impact resource options, resource costs, and load forecasts, the policy framework must be set at the start of plan development
- For the Ninth Plan, this was policies and goals in place as of January 2025
 - Federal policies changed after this date, and these were accounted for in the scenario modeling (more later)

Resource Option	Resource Cost	Load
<ul style="list-style-type: none"> • Oregon: <ul style="list-style-type: none"> • HB2021 • SB2547 Community Solar • Renewable Portfolio Standard • Washington: <ul style="list-style-type: none"> • Clean Energy Transition Act • Renewable Portfolio Standard • Montana: <ul style="list-style-type: none"> • Missoula/Helena/Boulevard City-Wide Clean Goals • NorthWestern Energy "NetZero Vision" • Idaho: <ul style="list-style-type: none"> • Baker's Energy Future • Idaho Power Clean Goal • Avista Clean Goal 	<ul style="list-style-type: none"> • Washington: <ul style="list-style-type: none"> • CETA—Social Cost of Carbon to be incorporated into utility planning <p>Notably, most policies that impact resource costs are set at the federal level</p>	<ul style="list-style-type: none"> • Oregon: <ul style="list-style-type: none"> • Climate Protection Program 2024 • Advanced Clean Cars • Energy Performance Standard for Commercial Buildings • State Codes & Standards • Washington: <ul style="list-style-type: none"> • Climate Commitment Act • Advanced Clean Cars • Clean Fuel Standard • Clean Building Performance Standard • State Codes & Standards

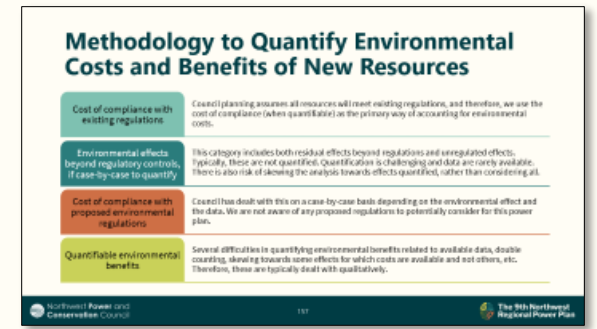


Forecasts of Fuel Costs

- Another early input is a set of forecasts for fuel costs
- This is done for all relevant fuels in the model, but with the most granularity around natural gas prices
- For natural gas, Council developed:
 - 3 trajectories for prices (see graph)
 - 10 volatility pathways to capture potential for random one-off event in a future year



Environmental Methodology



- Power Act requires that the Council develop a methodology to quantify directly attributable environmental costs and benefits of new resources
- Since this informs the cost assumptions for new resources, it is developed early in the power plan process
- Approach for the Ninth Plan is consistent with the methodology used in previous power plans
 - Key component is the cost of compliance with existing regulations
 - Water reduction benefit from relevant demand-side resources is also accounted for
 - All other factors are hard to quantify in a symmetric fashion without risk of skewing or double-counting potential effects, and therefore are mostly dealt with qualitatively

Scope – Sensitivities

See cheat sheet!

New Resources and Transmission Risk

Constrained Resources and Transmission

Changing Transmission Availability

Changing Emerging Technology Costs

Limited Short-Duration Storage Availability

Slower Demand Side Resource Availability

Evolving Federal Policy Landscape

Changing Hydro Operations

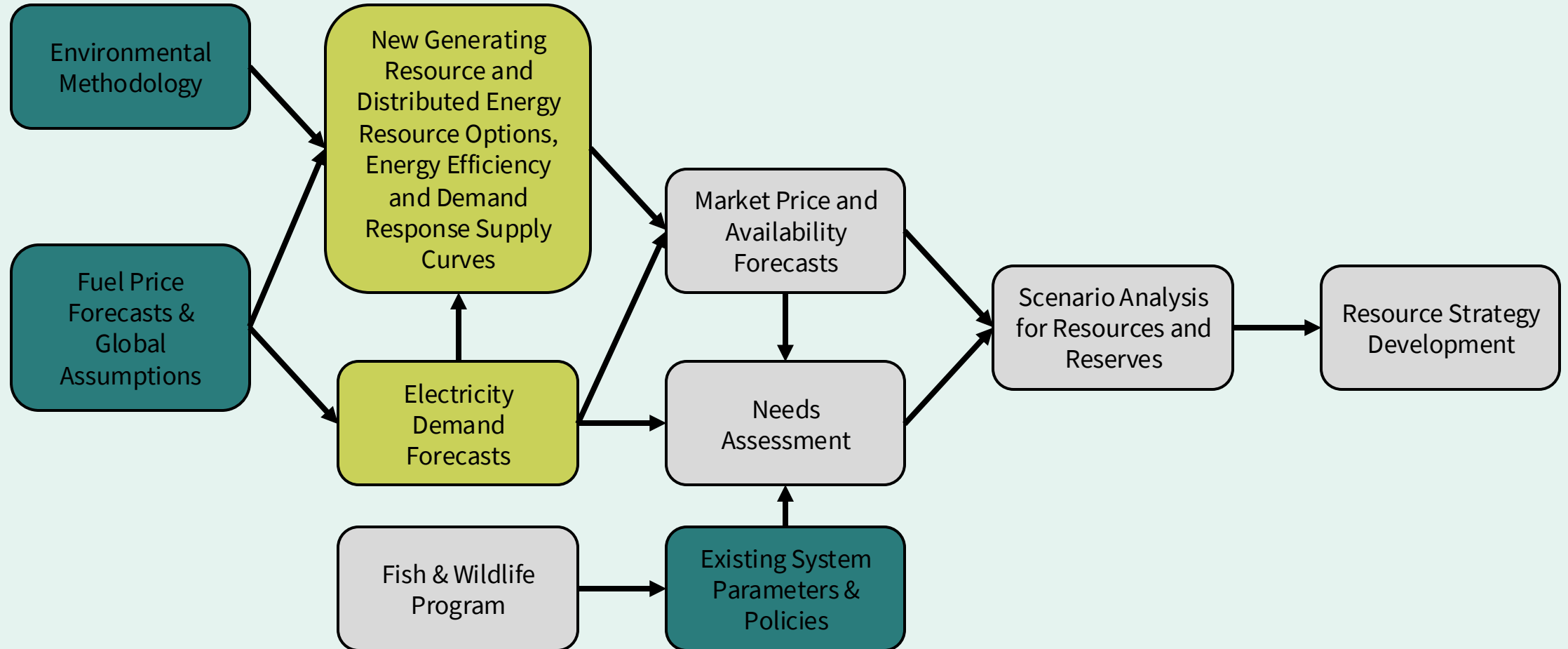
2020 BiOp Flex Spill Operation

2023 RCBA Operation

Recommended Spill and MOP Targets

Limited Flex Operation

Power Plan Development Process



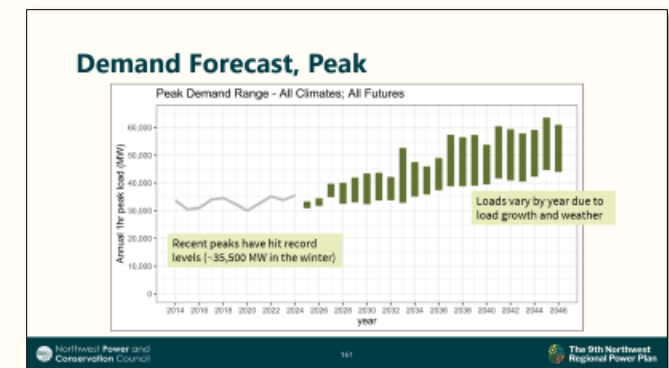
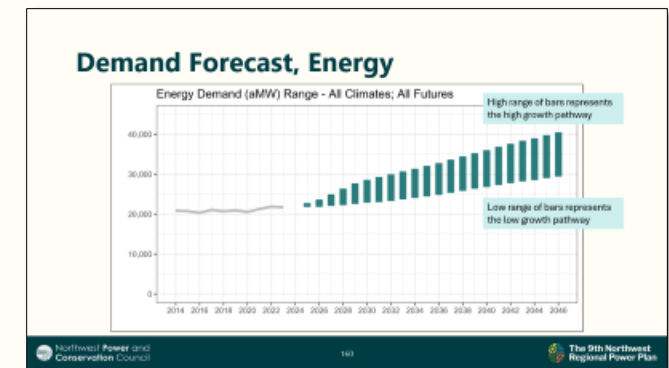
Demand Forecast

- Developed five pathways of load growth reflecting a range of assumptions across different sectors to account for uncertainty in timing, size, and shape
 - Economics
 - Transportation
 - Data centers and high-tech
 - Building electrification
 - Hydrogen (or industrial electrification)
- Future energy demand increases between 50 and 100% over the next 20 years
- Peaks also grow significantly, doubling in some of the pathways by the end of the study

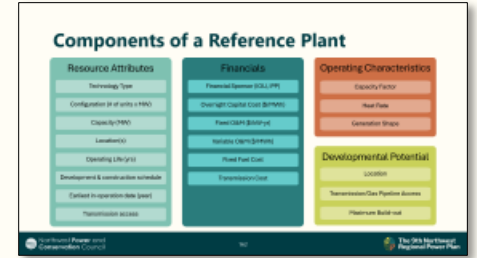
Demand Forecast Pathways

Pathways	Economics	Transportation	Data Centers	Building Electrification	Hydrogen
Persistent high growth	Medium	Higher	Higher	Higher	Higher
Persistent low growth	Lower	Lower	Lower	Lower	Lower
Early growth	Medium	Lower	Higher	Lower	Lower
Late growth	Medium	Higher	Medium	Higher	Higher
Mixed bag	Medium	Higher	Medium	Lower	Lower

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New Generating Resource Potential



Primary

- ⚙️ Utility Scale Solar PV
- ⚙️ Onshore Wind
- ⚙️ Small Scale Renewables
- ⚙️ Gas Combined Cycle
- ⚙️ Gas Simple Cycle
- ⚙️ Battery Storage (Li-Ion)
- ⚙️ Renewables + Storage

Limited Availability

- ⚙️ Conventional Geothermal
- ⚙️ Offshore Wind
- ⚙️ Pumped Storage
 - Biomass
 - Hydro Upgrades
 - Biogas
 - Small Hydro
 - Combined Heat and Power

Emerging Technology

- ⚙️ Clean Baseload
- ⚙️ Clean Long Duration Storage
- ⚙️ Clean Peaker/Medium Duration Storage

⚙️ Generating resources explicitly modeled

See cheat sheet!

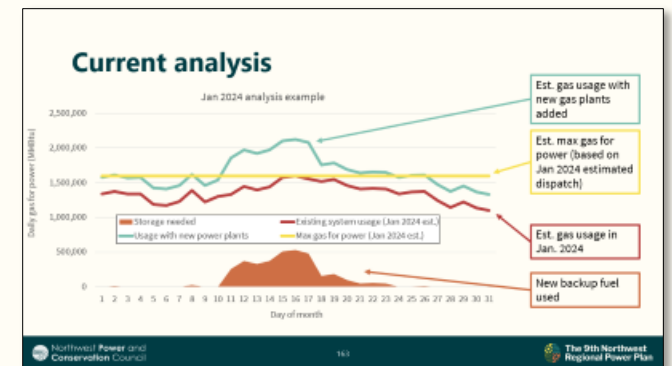
Accounting for Gas System Constraints

- Existing gas system is running at high utilization rates, especially in winter, and is essentially fully subscribed
- Because gas plants need firm fuel supply for adequacy, the modeling assumes two things:
 - Cost adder for back up fuel oil (simple cycles) or liquified natural gas/pipeline expansion (combined cycles)
- New!** – Cap of 3,000 MW nameplate for new gas builds through 2032, increasing to 10,000 MW for the rest of the study
- Goal is to represent the physical capabilities of the system
- Both assumptions were reviewed by the Fuels Advisory Committee

Analysis overview

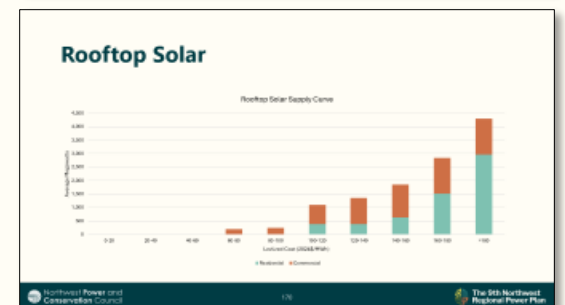
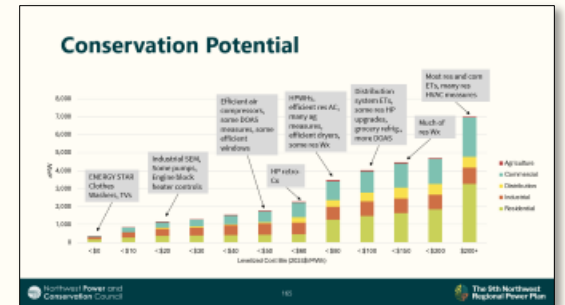
1. We estimate the highest 1-day gas usage from the power system in January 2024, and assume that could be available any day of the month
 - a) ~1.6 million MMBtu/day, this level of supply for a month could require pipeline expansions
2. We assume new gas power plants are built with back-up fuel storage (9 days for CCCT via LNG, 6 days for SCCT/ recip with a refillable fuel tank)
3. The question is: how many new gas plants can we add, assuming a 1.6 million/day MMBtu supply is consistently available for power, before the new storage is insufficient to provide firm fuel?

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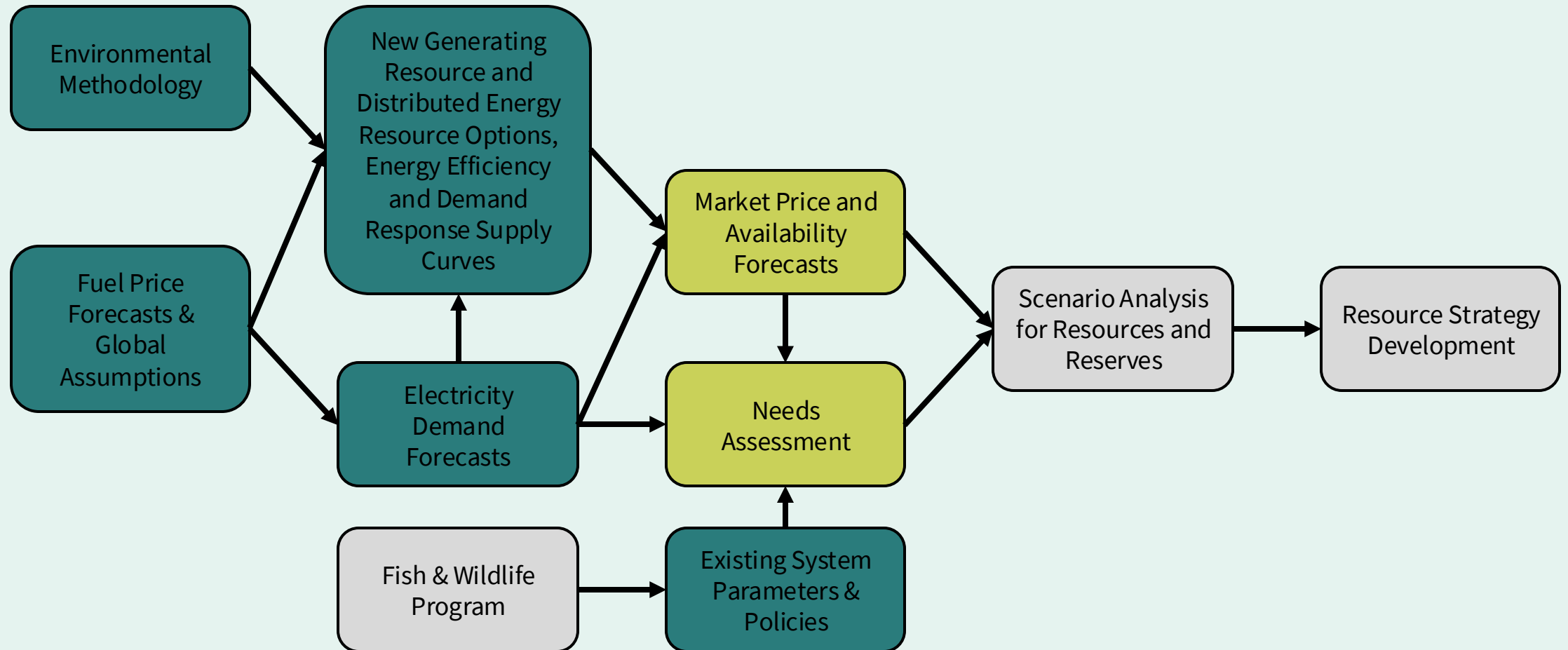


New Demand Side Resource Potential

- Ninth Plan includes potential for conservation, demand response, and rooftop solar
 - This is the first plan to assess rooftop solar in this way
- Because of the number of individual measures and products that make up this potential, the Council developed supply curves, which capture information on
 - Savings, including shape of savings
 - Costs, using a consistent approach as with generating resources
 - Overall availability, including pace of acquiring the resource
 - Timing of resource availability

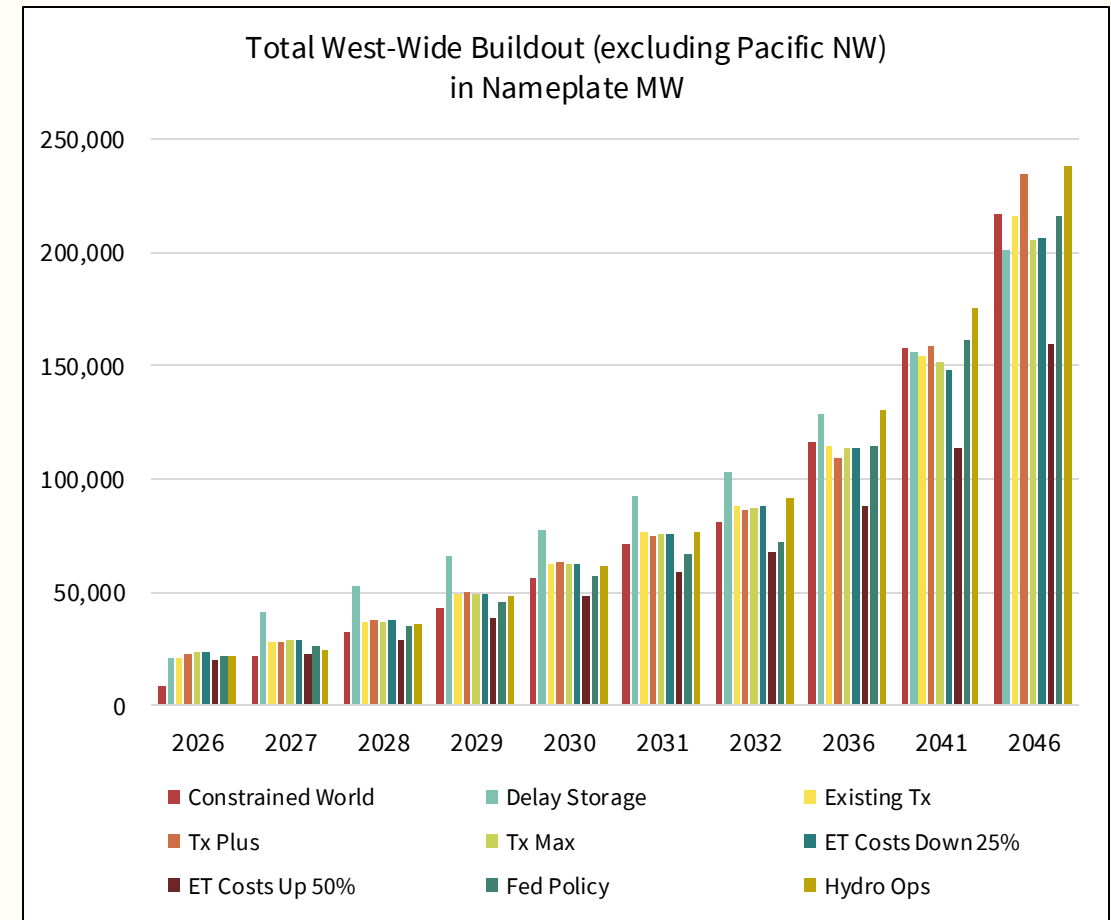


Power Plan Development Process



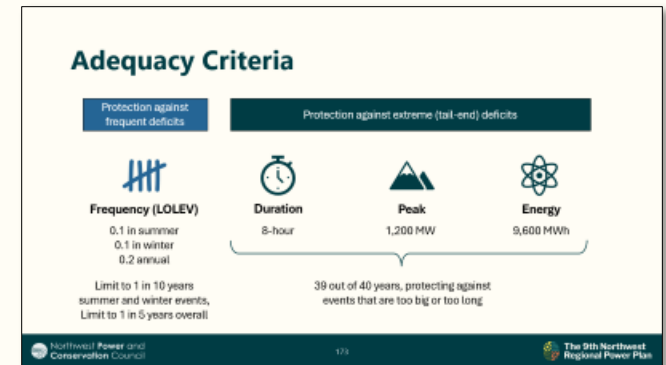
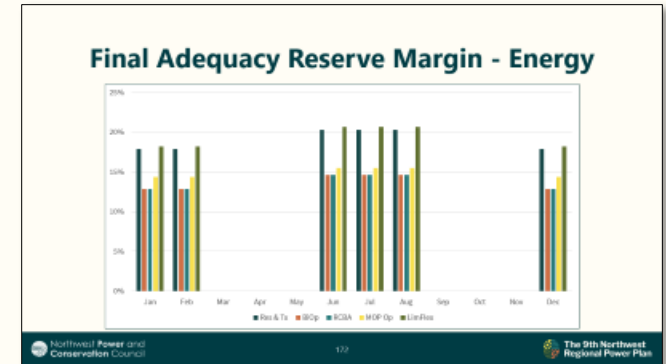
Market Availability Study

- Market availability study provides information on the resources developed across the WECC, which informs market depth and economics
- Results were not significantly different across the various studies
 - Mix of resources across all sensitivities
 - Key drivers of builds are demand growth and state policies, specifically carbon pricing in CA, WA, and Canada
- There are some differences that do play into regional buildouts, and we will talk about those as we get to the results discussion

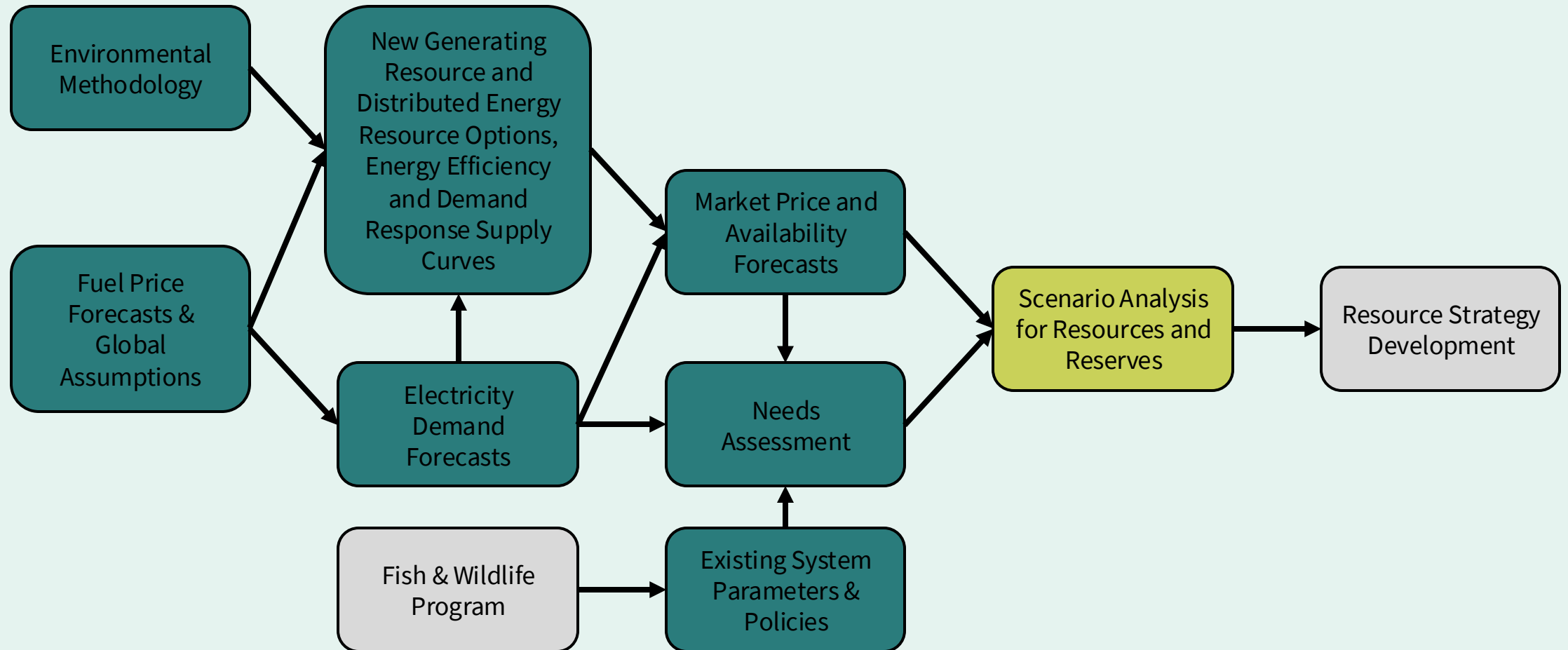


Needs Assessment Study

- Last piece before the in-region optimization is the needs assessment, looking at the gap between where the existing system is today and the future load forecasted
- Results show significant needs
 - Peak needs in all seasons, particularly the winter and summer
 - Energy signal for summer and winter
 - Longest and largest events to solve for are in the winter
- These studies send a signal to OptGen to ensure the regional buildouts meet the Council's adequacy criteria



Power Plan Elements and Analytical Flow



Reminder about OptGen/SDDP

- OptGen/SDDP tool combines a capital expansion module with product cost software that together solve for an investment strategy that meets demand and minimizes costs, over a range of futures, while also meeting constraints for adequacy, reserves, policy, hydro system requirements, etc.
- This analysis focuses on one year at a time, so the Council developed “snapshot years” to gather information to inform the 20-year look
 - This results in 7 years studied for each of the 13 sensitivities
 - When stepping through the years, some resources are locked in from early years to guide decisions in later years, ensuring both adequacy while allowing the model some foresight
- Each study is run with a set of 10 futures that are sampled from the 13,500 combinations representing a range of load, hydro and variable energy resource generation scenarios, climate data, gas prices, and gas price volatility
- The strategy from each of 13 sensitivities is then checked in GENESYS for adequacy, all of which have meet the Council’s adequacy criteria

Regional Optimization Model: OptGen/SDDP

- SDDP is a production cost software from PSR
 - SDDP minimizes WECC-wide power supply costs while meeting demand within system operating constraints including reserves, emissions pricing, and hydro system operation requirements
 - The reserve module within SDDP can address specified reserves by percentage of demand and by forecasted availability of variable energy resources
- OptGen is a capital expansion module from PSR that uses a simplified version of SDDP to provide production costs of existing and new resources
 - OptGen co-optimizes the investment and operation decision making simultaneously, one year at a time, seeking to minimize costs
 - Additionally, OptGen can address other constraints, including policy or adequacy needs
 - OptGen can solve for an investment strategy that minimizes costs over a range of futures

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Capturing Resource Decision Across the Years

- Resource decisions in certain years will be “locked in” to guide decisions in later years
 - This helps ensure adequacy in the buildout
 - For example, resource acquired in 2032 will still be available in 2046, so we want to provide that information to the model
- We are not locking in every year to allow the model some foresight

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Developing Clusters

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	2028	2030	2032	2034	2038	2042	2046
T _x +	✓	✓	✓	✓	✓	✓	✓
T _x -	✓	✓	✓	✓	✓	✓	✓
T _x MAX	✓	✓	✓	✓	✓	✓	✓
Battery ↓	✓	✓	✓	✓	✓	✓	✓
Constrained All	✓	✓	✓	✓	✓	✓	✓
ET \$↑	✓	✓	✓	✓	✓	✓	✓
ET \$↓	✓	✓	✓	✓	✓	✓	✓
EE/DR ↓	✓	✓	✓	✓	✓	✓	✓
Fed Policy	✓	✓	✓	✓	✓	✓	✓
BiOP	✓	✓	✓	✓	✓	✓	✓
MOP OP	✓	✓	✓	✓	✓	✓	✓
RCBA	✓	✓	✓	✓	✓	✓	✓
Lim Flex	✓	✓	✓	✓	✓	✓	✓

Before Getting Into Results

- These modeling results are **not** the power plan
- There will be different buildouts for each sensitivity tested (all of which are adequate)
- The results from a single sensitivity are also not the power plan
- We will have more than one chance to understand results
 - We will get as far as we can today, bring back more on Thursday if it makes sense
 - We will use the late April webinar to go deeper and answer questions that we couldn't get to today
 - Multiple advisory committee meetings are scheduled between now and then, which will provide more insight
 - Staff is also available to meet with members to discuss further
- Ultimately, Council will use the information from these studies, in addition to other analysis, to develop a resource strategy and supporting recommendations → **This is the power plan**
- For today, the goal is to get an understanding of what the model is showing and to ask questions where more information is needed

Last Couple Notes (I Promise!)

- These results are our first look through the data, trying to tease out the big themes, but there are some areas we know we need to go deeper:
 - Costs, particularly production costs at the regional level
 - Resource utilization
 - Emissions
- As with all studies of this nature, digging into the results may identify issues that may need to be addressed
 - As we identify these, we will flag for members, particularly if there is an impact on the results
- We have identified one such issue around the hydrogen loads
 - Remember, Council developed two load forecasts for hydrogen
 - In reviewing data, we found that the high hydrogen future was not being pulled into the model appropriately
 - This was a software issue that has been resolved by PSR
 - Because hydrogen is modeled as an elastic load (meaning it will be curtailed if needed for adequacy), this should not affect the buildout, and therefore staff is not recommending any re-running of the model to account for this change

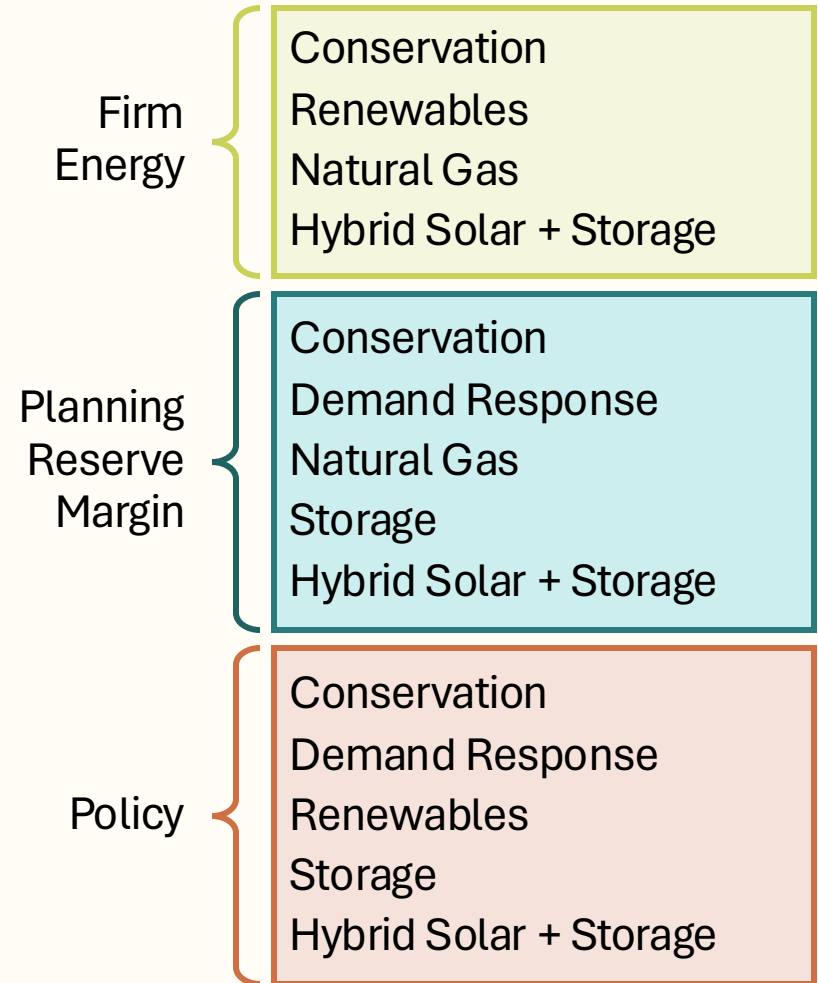
Time for Results!!

Key Theme: Portfolio of Resources

- A portfolio of resources will be needed to meet needs
- In the Action Plan period (2027-2032)
 - Conservation, demand response, wind, solar, battery storage and natural gas show up in every sensitivity in all years available
 - Long duration energy storage also shows up in all but two, one when it is not allowed in the study and one when the costs are 50% higher
- Over the 20-year period
 - Conservation, demand response, wind, solar, storage, and natural gas continue to play a role
 - Conventional geothermal and clean medium duration storage also show up in every sensitivity
 - Clean baseload shows up in 2046 in about half the studies
 - The remaining three resources (rooftop solar, pumped storage, and offshore wind) only show up in one sensitivity each, meaning there is not a strong signal for these resources

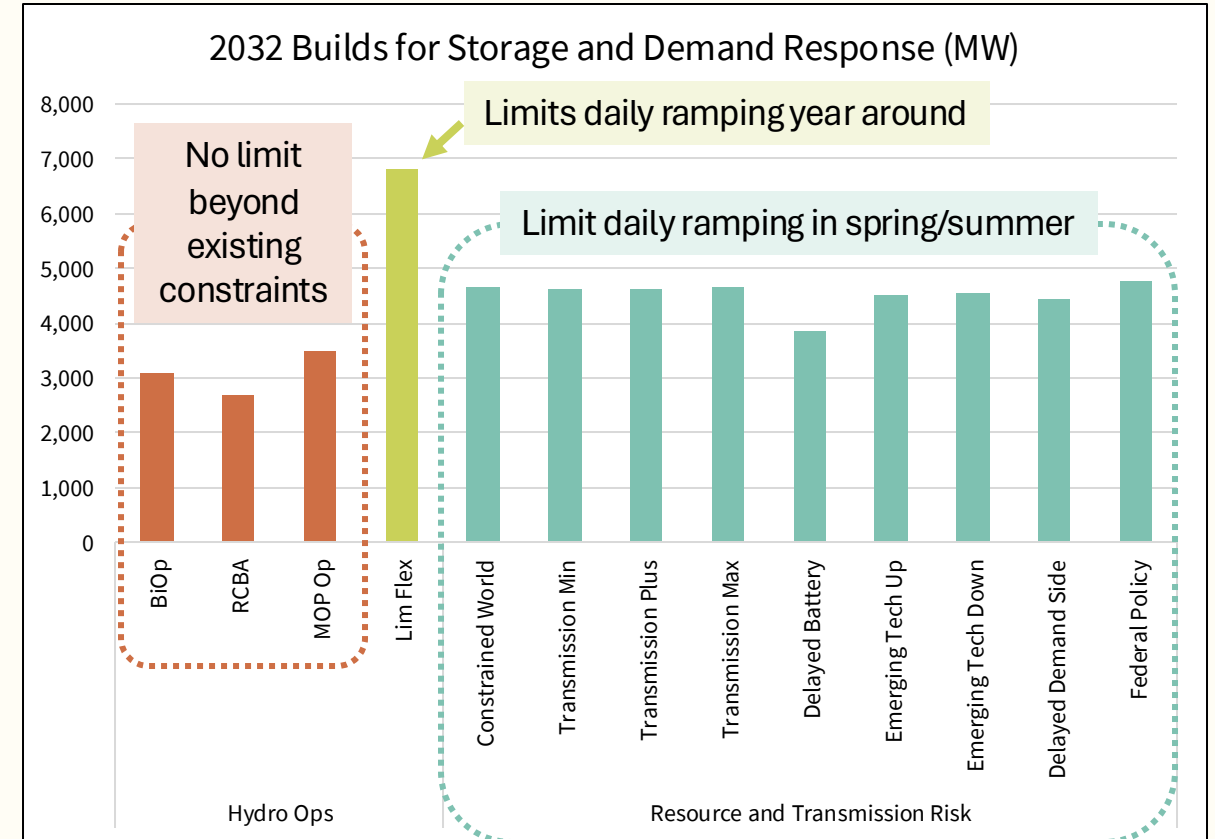
Key Theme: Resource Mix Needed to Meet Diverse Set of Needs

- Model is building to meet adequacy, economics, and policy
- Firm energy requirement for adequacy is one of the most binding constraints
- Model is also trying to meet the planning reserve margin (% above load)
- Policy is also binding in some cases, particularly CETA in WA in 2030 and 2038
- A mix of resources are required to meet all of these needs



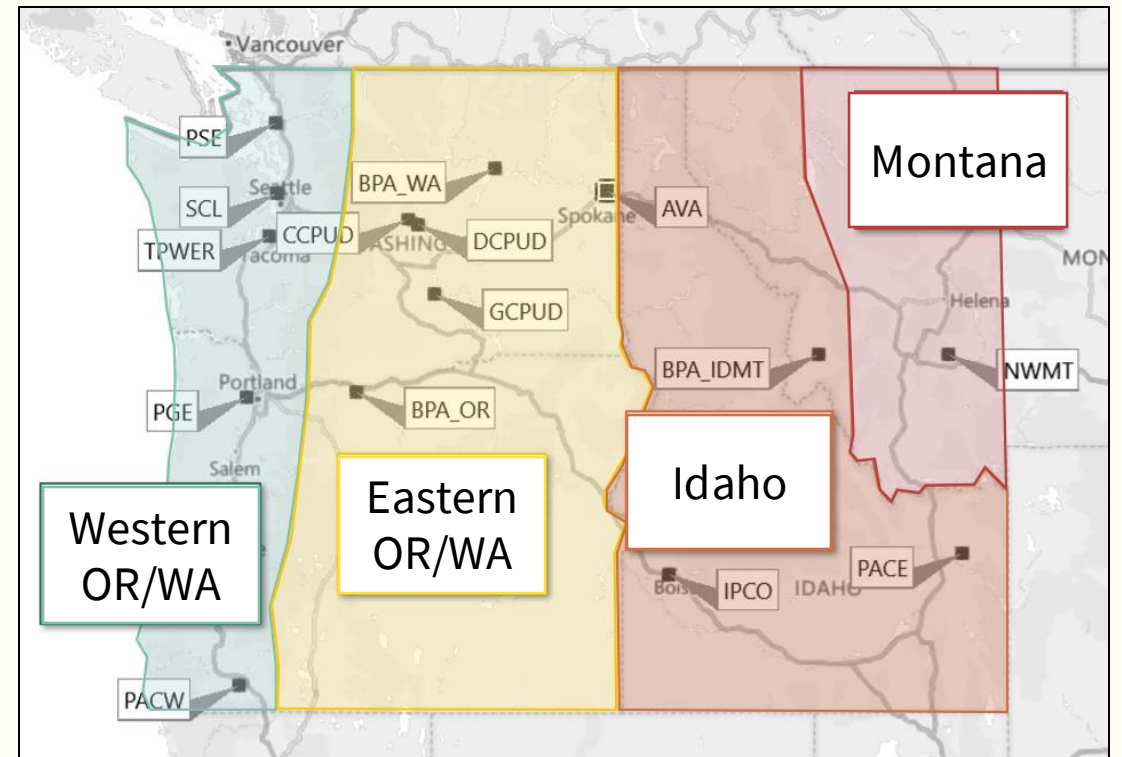
Key Theme: Hydro Flexibility


- Model is picking up differences in hydro operations, particularly those seeking to minimize daily ramping of the system
- This shows:
 - Hydro system can play an important role in overall power system flexibility
 - When needed to limit that flexibility for the benefit of fish, other resources can be developed that provide those same attributes
 - The investment cost differences for those new resources is relatively minimal (more on costs later)



Key Theme: Locational Value of Resources

- This is the first plan to model the region with more than one zone
- Approach allowed better reflection of differences in:
 - Load growth
 - Policy requirements
 - Transmission access and connections
 - Resource availability and profiles
- Results show strong signals for the locational value of some resources



 Generating resources developed in a specific zone does not mean that utility must develop those resources.

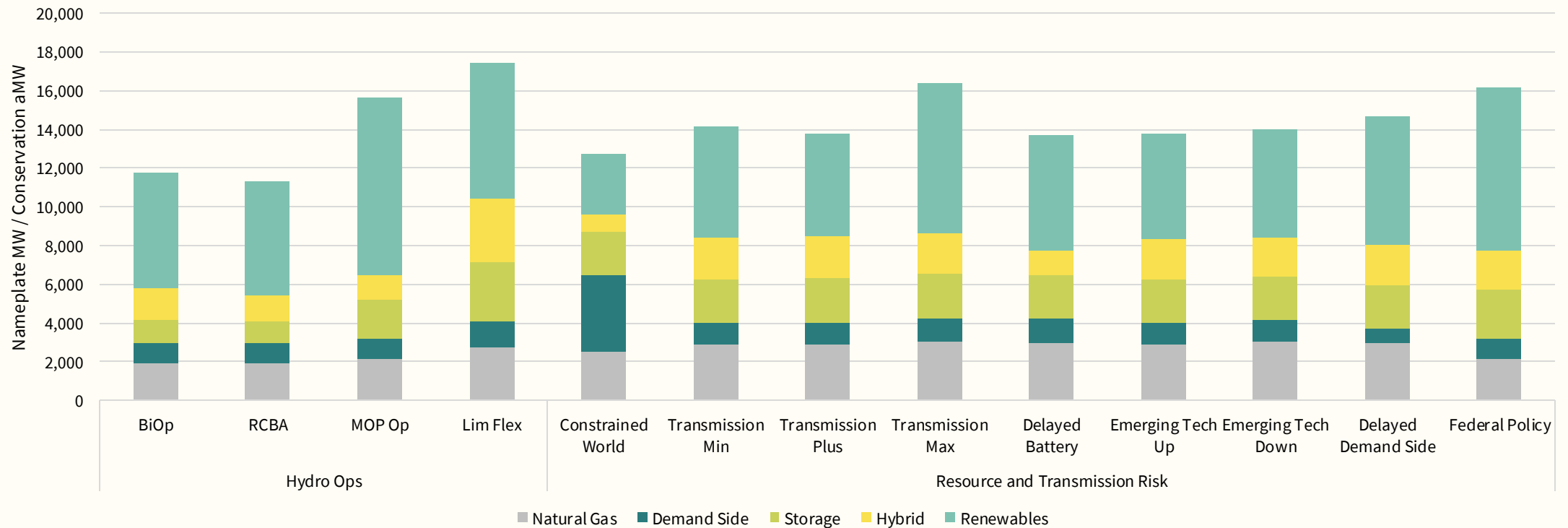
Total Buildout in 2032



Conservation is in energy (aMW), while the rest are in terms of nameplate capacity (MW)



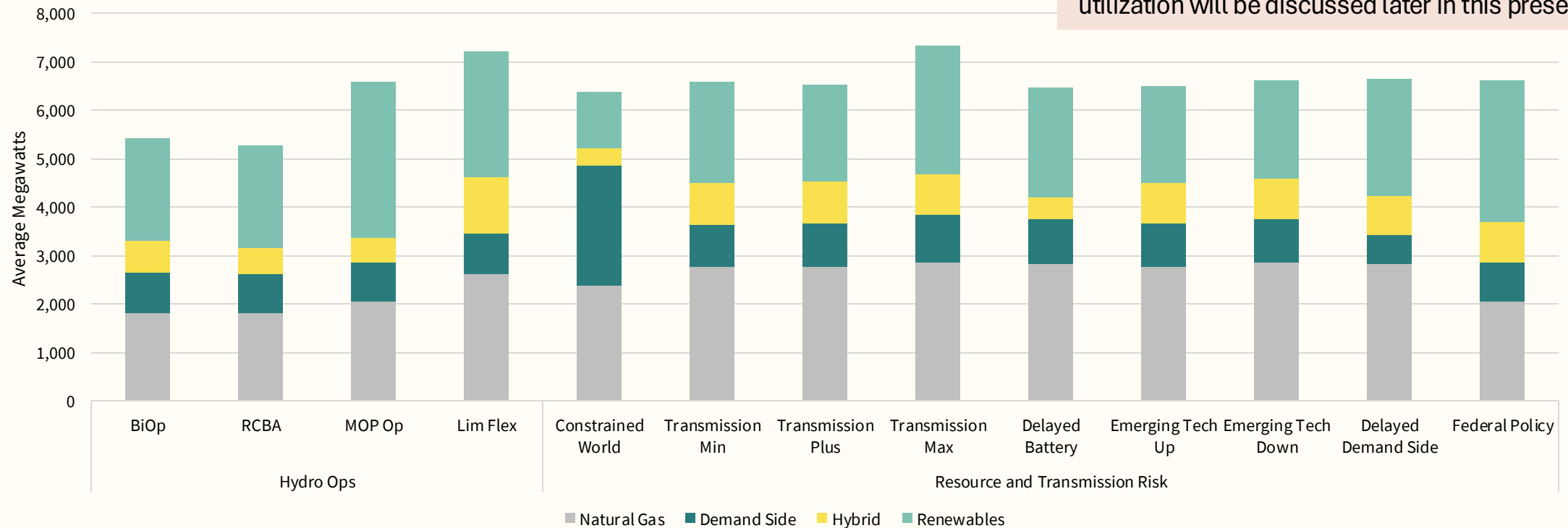
2032 Buildout Across Sensitivities



Buildout Contribution to Firm Energy Credit in 2032

This represents the maximum energy produced by each resource per the fuel available. This is not the same as annual generation in 2032. More on resource utilization will be discussed later in this presentation.

Firm Energy Credit of Buildout in 2032



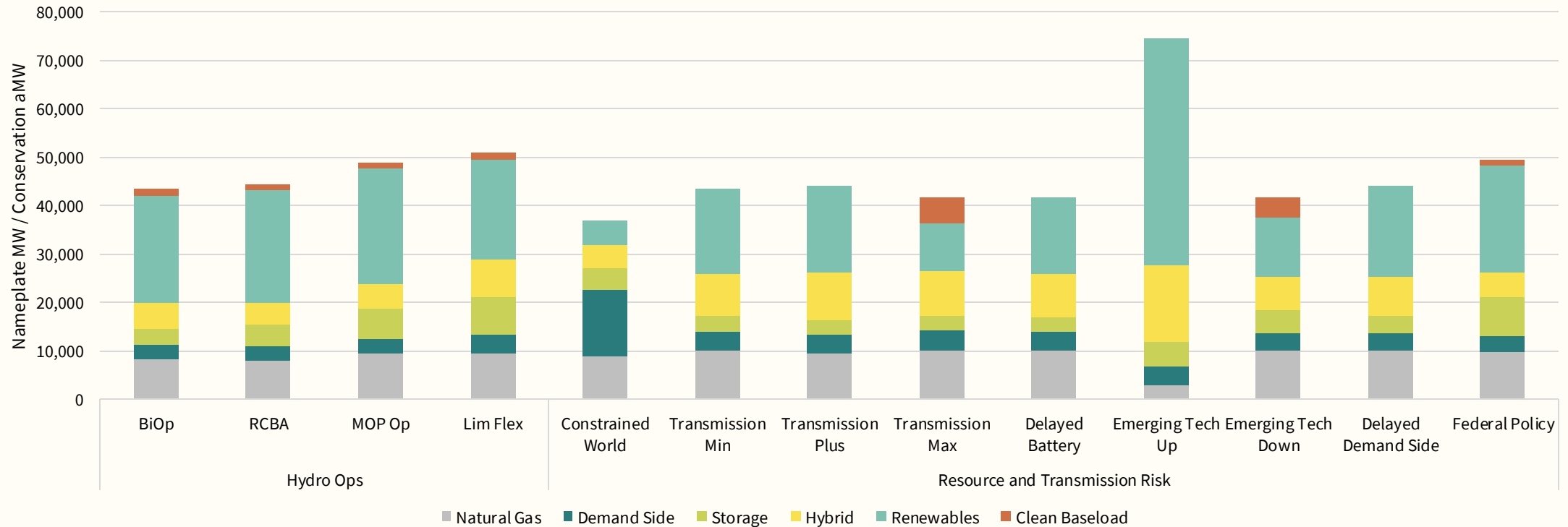
Total Buildout in 2046



Conservation is in energy (aMW), while the rest are in terms of nameplate capacity (MW)

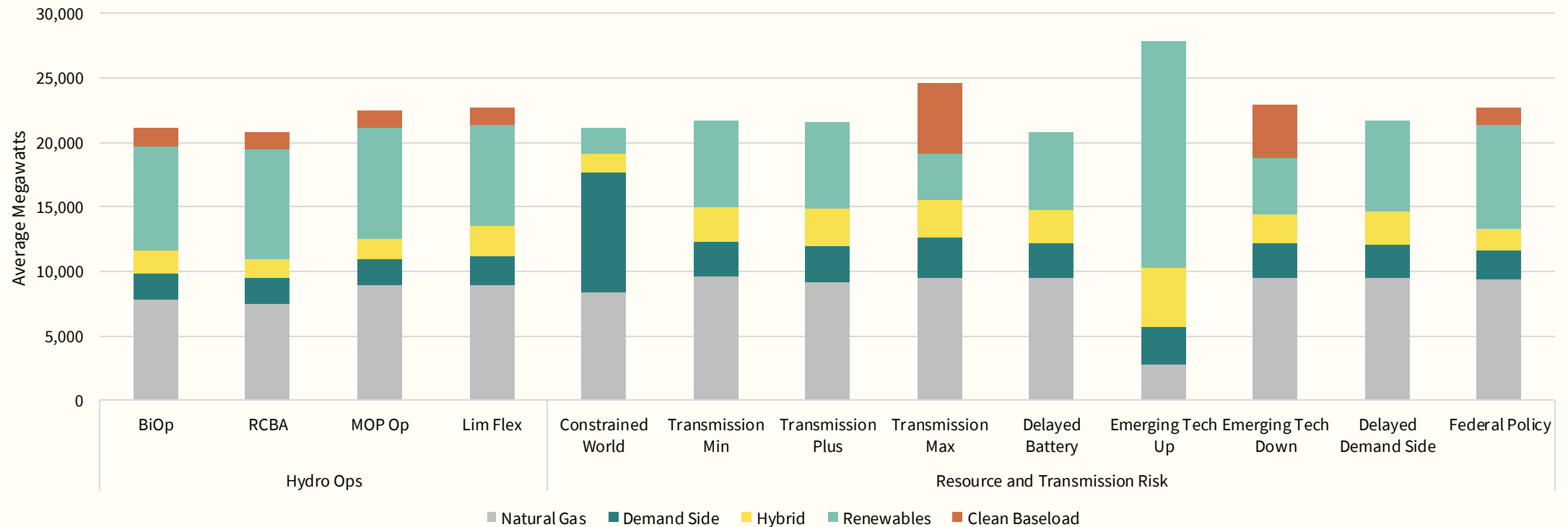


2046 Buildout Across Sensitivities



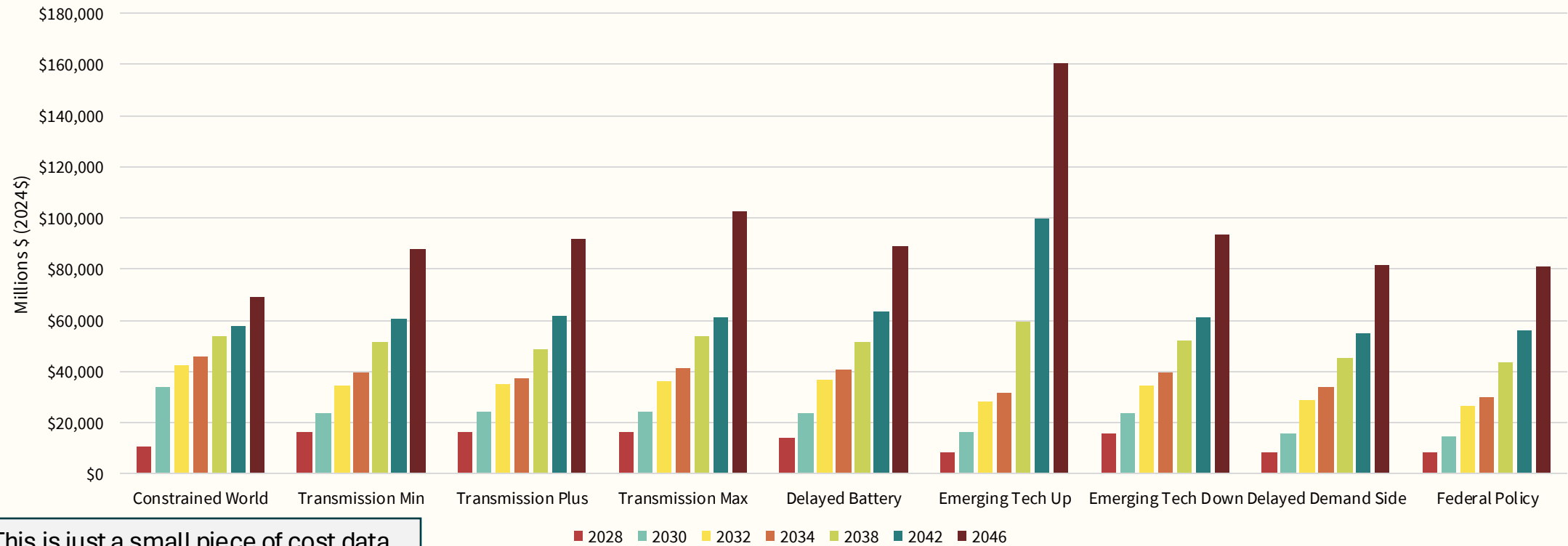
Buildout Contribution to Firm Energy Credit in 2046


Firm Energy Credit of Buildout in 2046



Investment Costs: New Resource and Transmission Risk Sensitivities

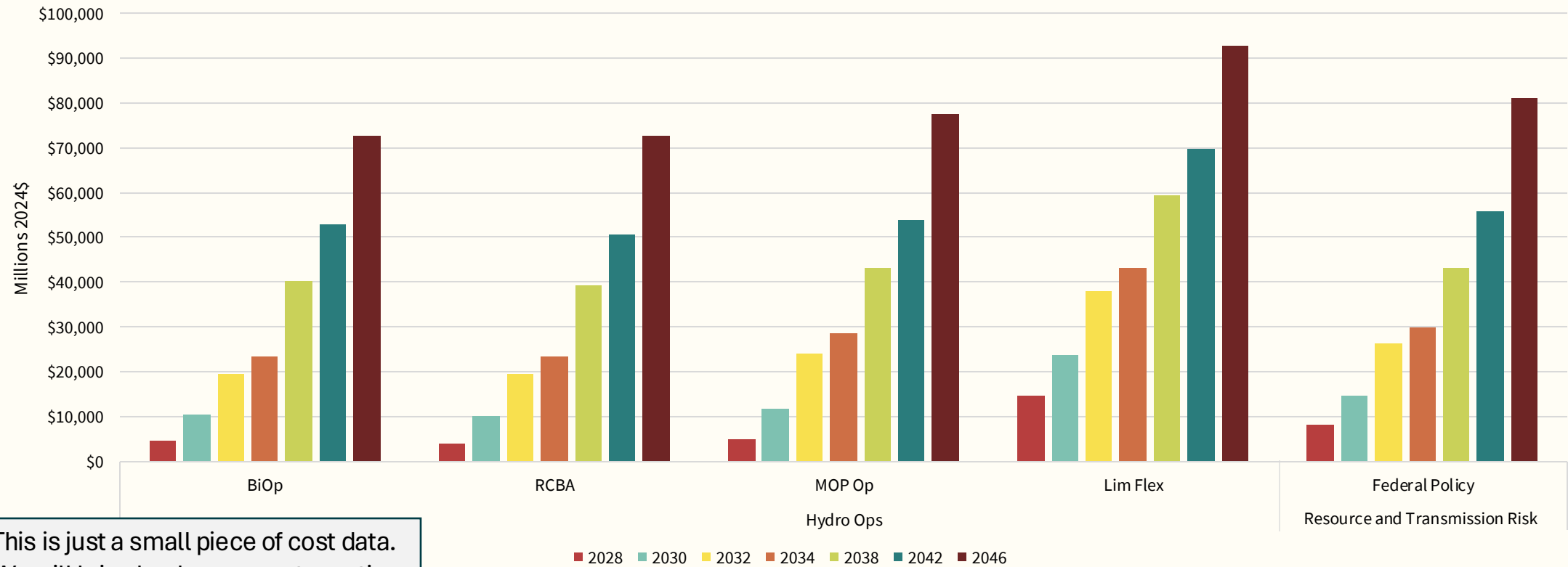
Portfolio Investment Costs (Draft)




 This is just a small piece of cost data. We will bring back more next meeting.

Investment Costs: Hydro Operations Sensitivities

Portfolio Investment Costs (Draft)



 This is just a small piece of cost data. We will bring back more next meeting.

Conservation

Conservation Results

- Conservation is acquired in all sensitivities
- Can be limited by economics
 - Does not do well when market prices are low, as it can't be “turned off” like other resources
 - In worlds with renewable tax credits, those resources become more cost competitive and less conservation is acquired
- Other important factors
 - If the supply side is constrained, more conservation (and other demand side resources) are selected to ensure adequacy
 - Model generally wants to buy more expensive conservation over time, which suggests more investment today
 - See different signals for the value of conservation across the region

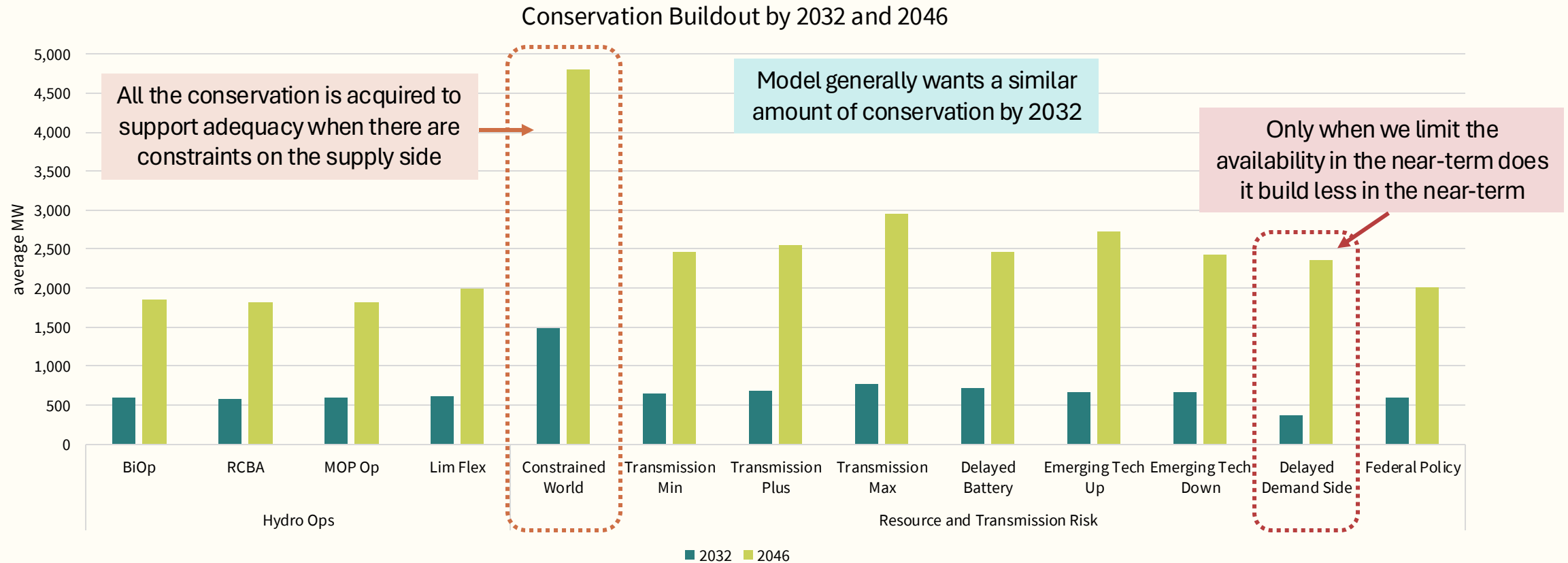
Reminder

Firm energy

Planning reserve margin

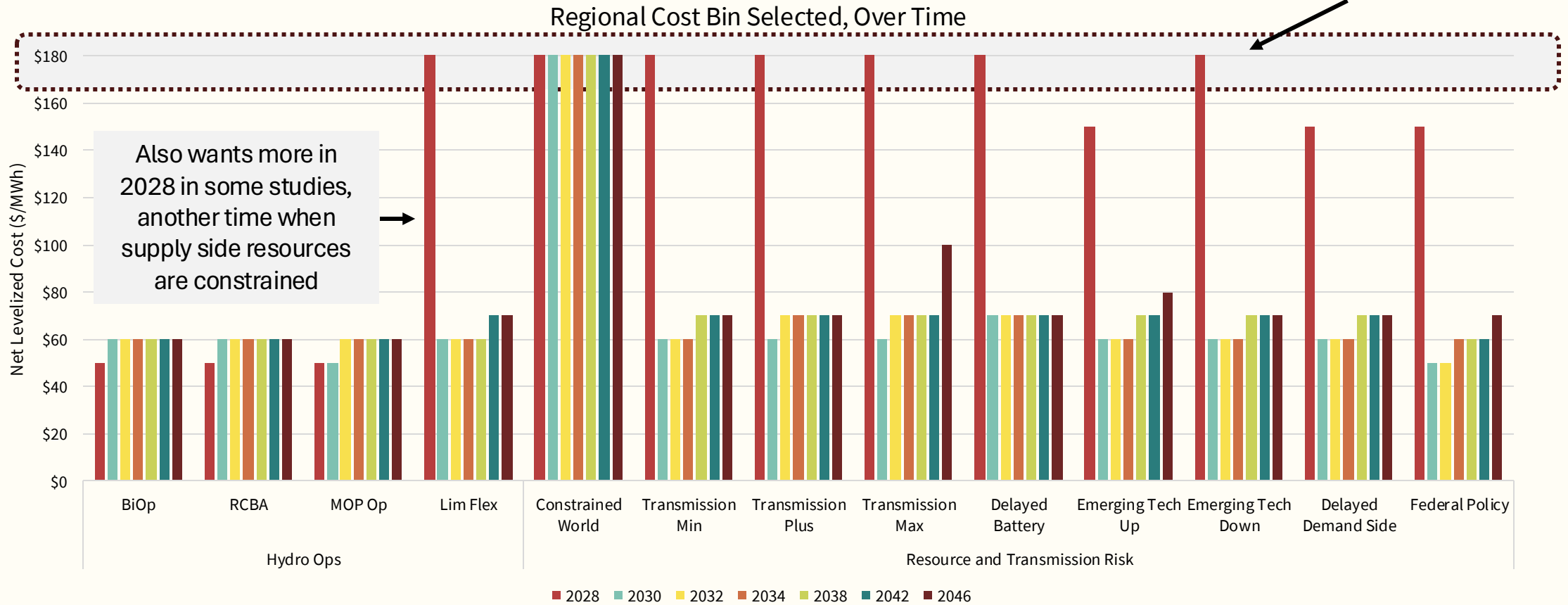
Policy

Conservation Buildout

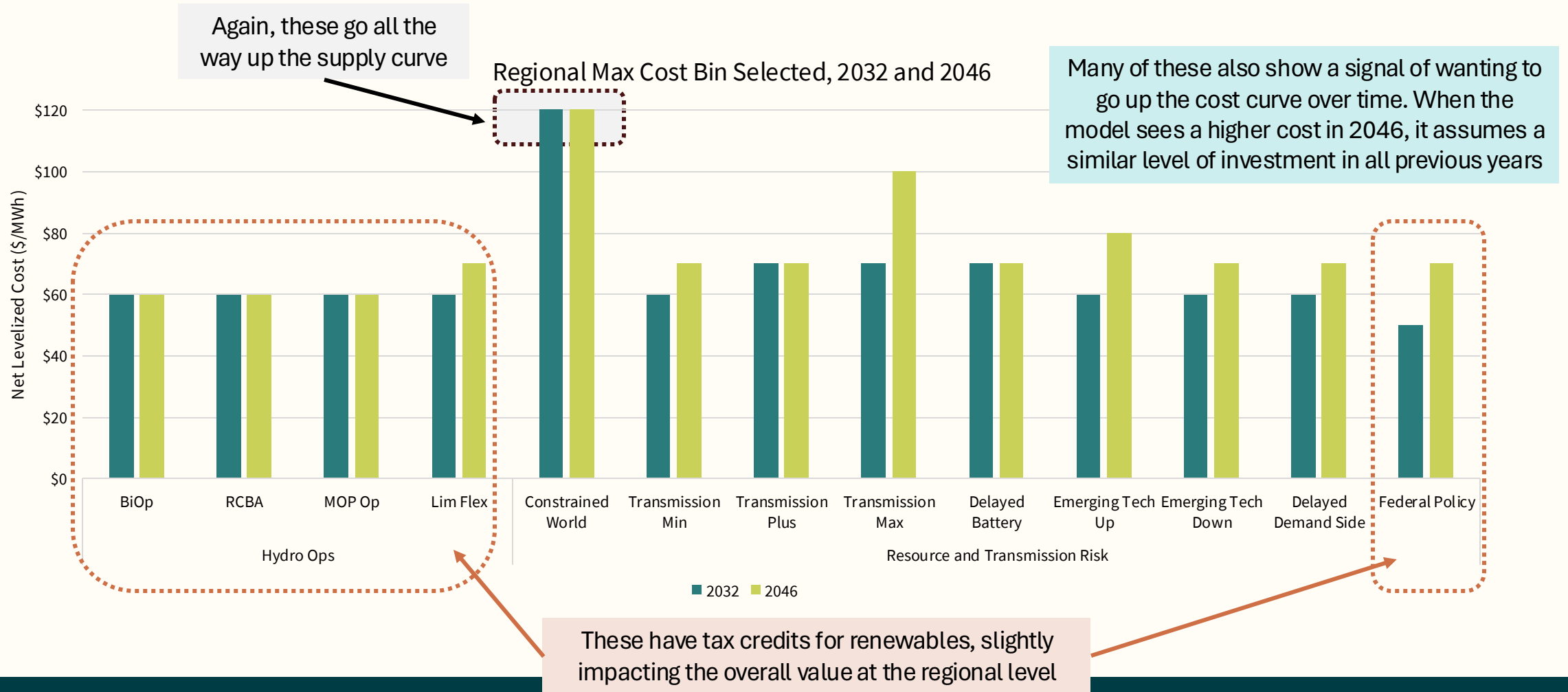


Cost of Conservation Acquired: Regional Max Cost

These ones are buying all the way up the cost bins, including \$200+ conservation, to maintain adequacy



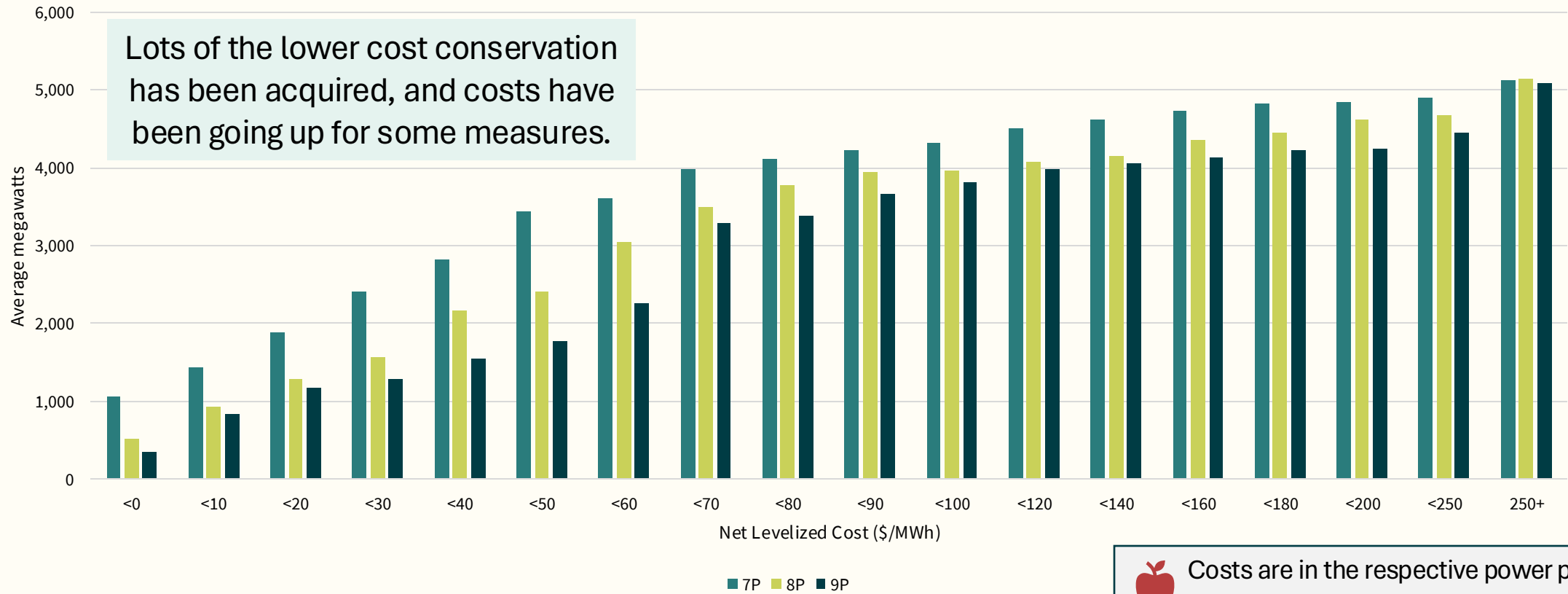
Closer Look at Costs



Comparison to Past Plans

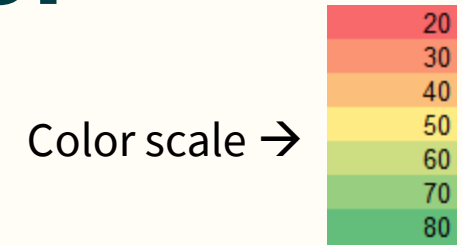
Cost-Effectiveness Limit:
 Seventh Plan: ~\$100/MWh
 2021 Plan: ~\$40-50/MWh

Comparison of Seventh Plan, 2021 Plan, and Ninth Plan Conservation Supply Curves



Costs are in the respective power plan dollar year (2012, 2016, and 2024)

Understanding Difference in Value of Conservation Across the Region



- Previous slides show the max cost bin across the region, but the model shows differences across the region
 - Each zone has its own maximum cost bin
 - This varies by sensitivity
 - The sensitivities show a similar trend
- Next slide shows the max cost bin by zone over time for all sensitivities

Study years →
(Note: 2028 is excluded because it skews the scale)

Model Zones
Roughly organized west to east →

	2030	2032	2034	2038	2042	2046
NWMT						
BPAIDMT						
IPCO						
PACE						
AVA						
BPAOR						
BPAWA						
CCPUD						
DCPUD						
GCPUD						
PACW						
PGE						
PSEC						
PSEN						
PSEO						
SCL						
TPWR						

Max Cost Bin, By Zone

Changing Transmission

Less → More

Constraining Resources

All supply side → Batteries → EE

Changing Costs

ET ↑ → ET ↓ → Tax credits for all clean

Changing Hydro

Transmission Min						
	2030	2032	2034	2038	2042	2046
NWMT	20	40	40	40	40.0	40.0
BPAIDM	40	50	50	50	50.0	50.0
IPCO	40	50	50	50	50.0	50.0
PACE	40	50	50	50	50.0	50.0
AVA	60	60	60	60	60.0	60.0
BPAOR	40	50	50	60	60.0	60.0
BPAWA	50	50	50	60	60.0	60.0
CCPUD	60	60	60	60	60.0	70.0
DCPUD	60	60	60	60	60.0	70.0
GCPUD	60	60	60	60	60.0	70.0
PACW	50	60	60	60	70.0	70.0
PGE	50	60	60	60	60.0	70.0
PSEC	60	60	60	60	70.0	70.0
PSEN	60	60	60	60	70.0	70.0
PSEO	60	60	60	60	70.0	70.0
SCL	60	60	60	70	70.0	70.0
TPWR	60	60	60	70	70.0	70.0

Constrained World						
	2030	2032	2034	2038	2042	2046
NWMT	333	333	333	333	333	333
BPAIDM	333	333	333	333	333	333
IPCO	333	333	333	333	333	333
PACE	333	333	333	333	333	333
AVA	333	333	333	333	333	333
BPAOR	333	333	333	333	333	333
BPAWA	333	333	333	333	333	333
CCPUD	333	333	333	333	333	333
DCPUD	333	333	333	333	333	333
GCPUD	333	333	333	333	333	333
PACW	333	333	333	333	333	333
PGE	333	333	333	333	333	333
PSEC	333	333	333	333	333	333
PSEN	333	333	333	333	333	333
PSEO	333	333	333	333	333	333
SCL	333	333	333	333	333	333
TPWR	333	333	333	333	333	333

Emerging Tech Up						
	2030	2032	2034	2038	2042	2046
NWMT	20	40	40	40	40	40
BPAIDM	20	50	50	50	50	50
IPCO	40	50	50	60	60	60
PACE	40	50	50	50	60	60
AVA	50	60	60	60	60	70
BPAOR	40	60	60	60	60	70
BPAWA	50	60	60	60	60	70
CCPUD	60	60	60	60	60	70
DCPUD	50	50	50	60	60	60
GCPUD	60	60	60	60	60	70
PACW	40	60	60	60	70	70
PGE	40	60	60	60	70	70
PSEC	60	60	60	60	70	70
PSEN	60	60	60	60	70	70
PSEO	60	60	60	60	70	70
SCL	60	60	60	70	70	70
TPWR	60	60	60	70	70	70

BiOp						
	2030	2032	2034	2038	2042	2046
NWMT	40	40	40	40	40	40
BPAIDM	40	40	40	40	40	40
IPCO	40	50	50	50	50	50
PACE	50	50	50	50	50	50
AVA	50	50	50	50	50	60
BPAOR	50	50	50	50	50	60
BPAWA	50	50	50	50	50	60
CCPUD	50	50	50	50	50	60
DCPUD	50	50	50	50	50	60
GCPUD	50	50	50	50	60	60
PACW	50	50	50	60	60	60
PGE	50	50	50	50	60	60
PSEC	50	50	50	50	60	60
PSEN	50	50	50	50	60	60
PSEO	50	50	50	50	60	60
SCL	50	50	50	60	60	60
TPWR	60	60	60	60	60	60

Transmission Plus						
	2030	2032	2034	2038	2042	2046
NWMT	20	40	40	40	40	40
BPAIDM	20	50	50	50	50	50
IPCO	40	50	50	50	50	50
PACE	40	50	50	50	50	50
AVA	60	60	60	60	60	60
BPAOR	40	60	60	60	60	70
BPAWA	50	60	60	60	60	60
CCPUD	60	60	60	60	60	70
DCPUD	60	60	60	60	60	60
GCPUD	60	60	60	60	60	70
PACW	40	60	60	60	70	70
PGE	40	60	60	60	60	70
PSEC	60	60	60	60	70	70
PSEN	60	60	60	60	70	70
PSEO	60	60	60	60	70	70
SCL	60	60	60	70	70	70
TPWR	60	70	70	70	70	70

Delayed Battery						
	2030	2032	2034	2038	2042	2046
NWMT	20	40	40	40	40	40
BPAIDM	40	50	50	50	50	50
IPCO	40	50	50	50	50	50
PACE	40	50	50	50	50	50
AVA	60	60	60	60	60	60
BPAOR	40	60	60	60	60	60
BPAWA	60	60	60	60	60	60
CCPUD	60	60	60	60	60	70
DCPUD	60	60	60	60	60	60
GCPUD	60	60	60	60	60	70
PACW	40	60	60	60	70	70
PGE	40	60	60	60	70	70
PSEC	70	70	70	70	70	70
PSEN	70	70	70	70	70	70
PSEO	70	70	70	70	70	70
SCL	70	70	70	70	70	70
TPWR	70	70	70	70	70	70

Emerging Tech Down						
	2030	2032	2034	2038	2042	2046
NWMT	20	40	40	40	40	40
BPAIDM	20	50	50	50	50	50
IPCO	40	50	50	50	50	50
PACE	40	50	50	50	50	50
AVA	50	60	60	60	60	60
BPAOR	40	60	60	60	60	60
BPAWA	50	60	60	60	60	60
CCPUD	60	60	60	60	60	60
DCPUD	50	60	60	60	60	60
GCPUD	60	60	60	60	60	60
PACW	40	60	60	60	70	70
PGE	40	60	60	60	60	60
PSEC	60	60	60	60	70	60
PSEN	60	60	60	60	70	60
PSEO	60	60	60	60	60	60
SCL	60	60	60	70	70	70
TPWR	60	60	60	70	70	70

RCBA						
Row La	2030	2032	2034	2038	2042	2046
NWMT	20	20	20	40	40	40.0
BPAIDM	20	40	40	40	40	40.0
IPCO	40	40	40	40	40	40.0
PACE	40	40	40	40	40	40.0
AVA	50	50	50	50	50	60.0
BPAOR	40	50	50	50	50	60.0
BPAWA	50	50	50	50	50	60.0
CCPUD	50	50	50	50	50	50.0
DCPUD	50	50	50	50	50	50.0
GCPUD	50	50	50	50	60	60.0
PACW	40	50	50	60	60	60.0
PGE	40	50	50	50	60	60.0
PSEC	50	50	50	50	60	60.0
PSEN	50	50	50	50	60	60.0
PSEO	50	50	50	50	60	60.0
SCL	50	50	50	60	60	60.0
TPWR	60	60	60	60	60	60.0

Transmission Max						
	2030	2032	2034	2038	2042	2046
NWMT	20	40	40	40	40	50
BPAIDM	20	50	50	50	50	60
IPCO	40	60	60	60	60	70
PACE	40	60	60	60	60	70
AVA	50	60	60	60	60	70
BPAOR	40	60	60	60	60	80
BPAWA	50	60	60	60	60	70
CCPUD	60	60	60	60	60	70
DCPUD	60	60	60	60	60	70
GCPUD	60	60	60	60	60	70
PACW	40	70	70	70	70	100
PGE	40	70	70	70	70	80
PSEC	60	70	70	70	70	70
PSEN	60	70	70	70	70	70
PSEO	60	70	70	70	70	70
SCL	60	70	70	70	70	80
TPWR	60	70	70	70	70	70

Delayed Demand Side						
	2030	2032	2034	2038	2042	2046
NWMT	20	40	40	40	40	40
BPAIDM	20	50	50	50	50	50
IPCO	40	50	50	50	50	50
PACE	40	50	50	50	50	50
AVA	50	60	60	60	60	60
BPAOR	40	60	60	60	60	60
BPAWA	50	60	60	60	60	60
CCPUD	60	60	60	60	60	70
DCPUD	60	60	60	60	60	60
GCPUD	60	60	60	60	60	70
PACW	40	60	60	60	70	70
PGE	40	60	60	60	60	70
PSEC	60	60	60	60	60	70
PSEN	60	60	60	60	60	70
PSEO	60	60	60	60	60	70
SCL	60	60	60	60	70	70
TPWR	60	60	60	60	70	70

Fed Policy						
	2030	2032	2034	2038	2042	2046
NWMT	20	20	20	40	40	40
BPAIDM	20	40	40	40	40	40
IPCO	40	50	50	50	50	50
PACE	40	40	40	40	40	40
AVA	40	50	50	50	50	60
BPAOR	40	50	50	50	50	60
BPAWA	50	50	50	50	50	60
CCPUD	40	50	50	50	60	60
DCPUD	40	50	50	50	60	60
GCPUD	40	50	50	50	60	60
PACW	40	50	60	60	60	70
PGE	40	50	50	50	60	60
PSEC	50	50	50	60	60	60
PSEN	50	50	50	60	60	60
PSEO	50	50	50	50	60	60
SCL	50	50	50	60	60	60
TPWR	50	50	60	60	60	60

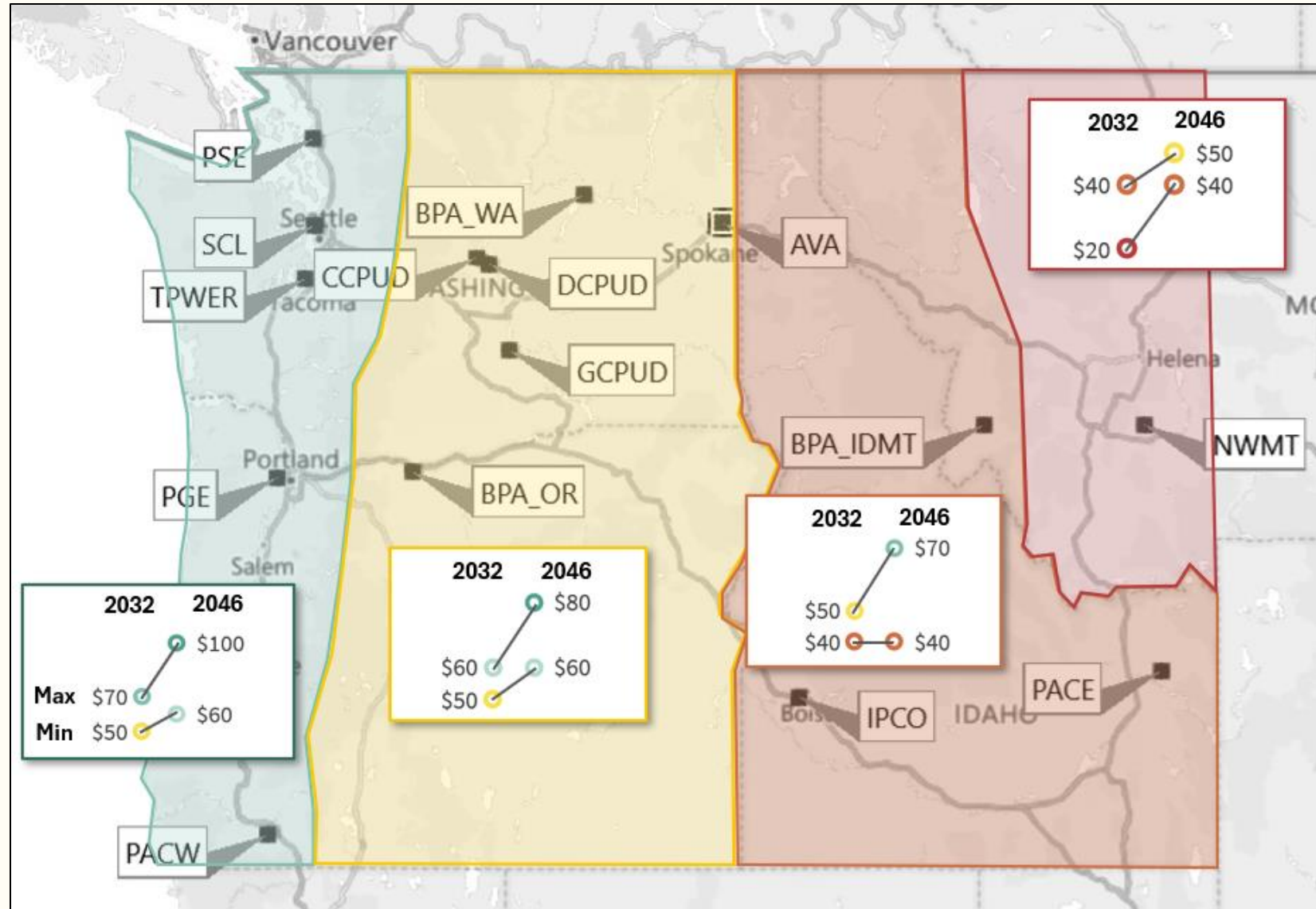
MOP OP						
	2030	2032	2034	2038	2042	2046
NWMT	20	40	40	40	40	

Costs Across the Region

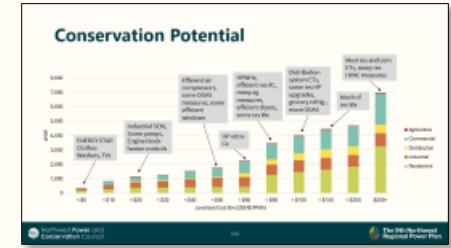
- Shaded areas show generally consistent costs in the zones
- Min and Max are for those zones in the shaded area based on variance across sensitivities
- Time period shows the trend in cost increases across all zones



Does not include costs of constrained world sensitivity



Additional Notes on Conservation



- Conservation measures vary widely in terms of costs
 - Table on the right shows some of the main measures available in different cost bin ranges
- Cost is not the only reason utilities are acquiring efficiency
 - Other benefits considered by some include health, comfort, productivity, etc.

Cost Bin	Measures
<\$40	Electronics, some commercial HVAC, commercial whole building, commercial water heating, motors and drives, pumps, commercial and industrial lighting, industrial processing, compressed air, industrial energy management, irrigation
\$40-\$60	More of the commercial HVAC and lighting, refrigeration, industrial HVAC, residential heat pump retro-commissioning
\$60-\$80	Residential water heating, clothes dryers, industrial compressed air, a little more commercial HVAC and residential heat pump retro-commissioning
\$80-100	Some residential heat pump upgrades
>\$100	Residential HVAC (generally >\$200), residential weatherization, more advanced commercial HVAC, commercial lighting, most emerging tech

Demand Response

Demand Response Results

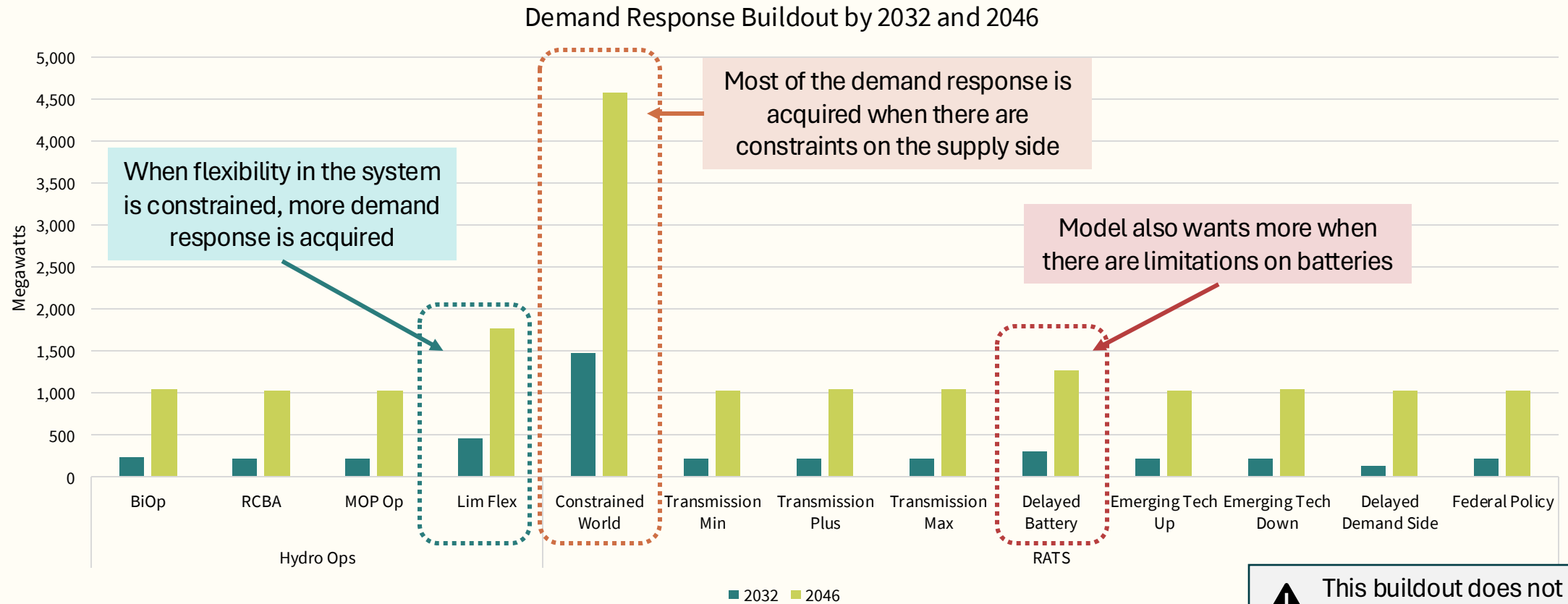
Reminder

Planning reserve margin*

Policy

- Demand response is acquired in all sensitivities
- Model selects more demand response when:
 - Supply side resources are constrained
 - Limitations are placed on batteries
 - More flexibility is needed in the system
- In other cases, the amount of demand response is limited to the lowest cost bin of the time of use rates for EV charging
- Some of this limitation is likely driven by:
 - Firm energy requirements are driving much of the build, and demand response does not fill this need
 - Limitations in the modeling approach may mask the value of this resource, particularly for some utilities
 - Results for demand response do not include demand voltage regulation

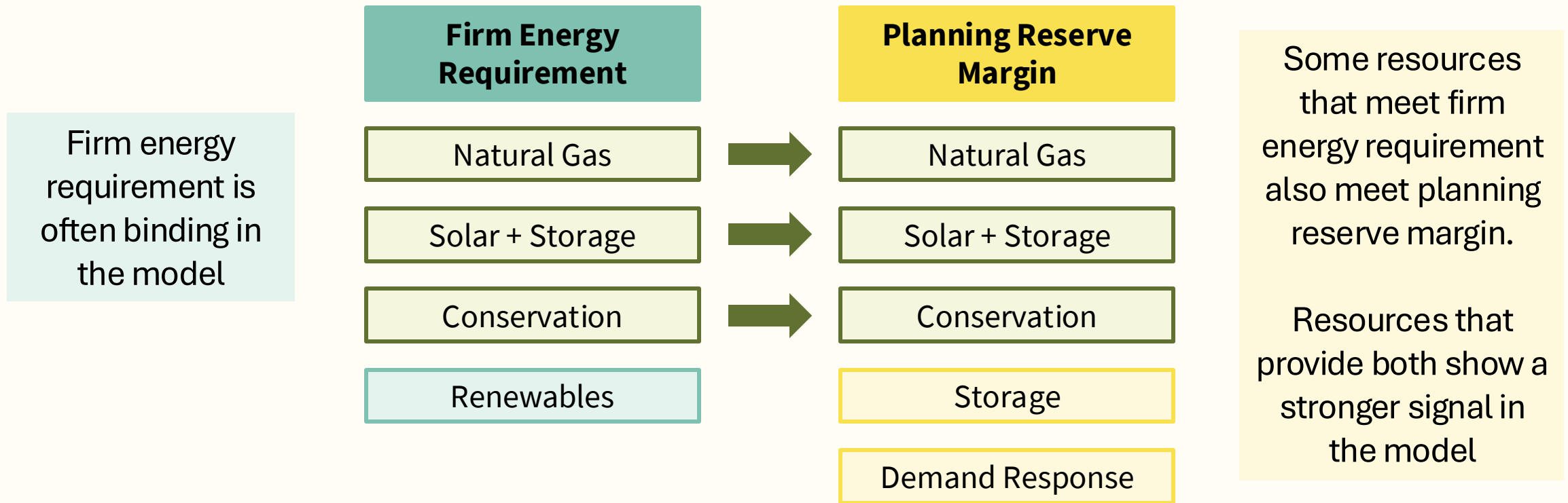
Demand Response Buildout



! This buildout does not include demand voltage reduction.

Building for Both Firm Energy and Peak

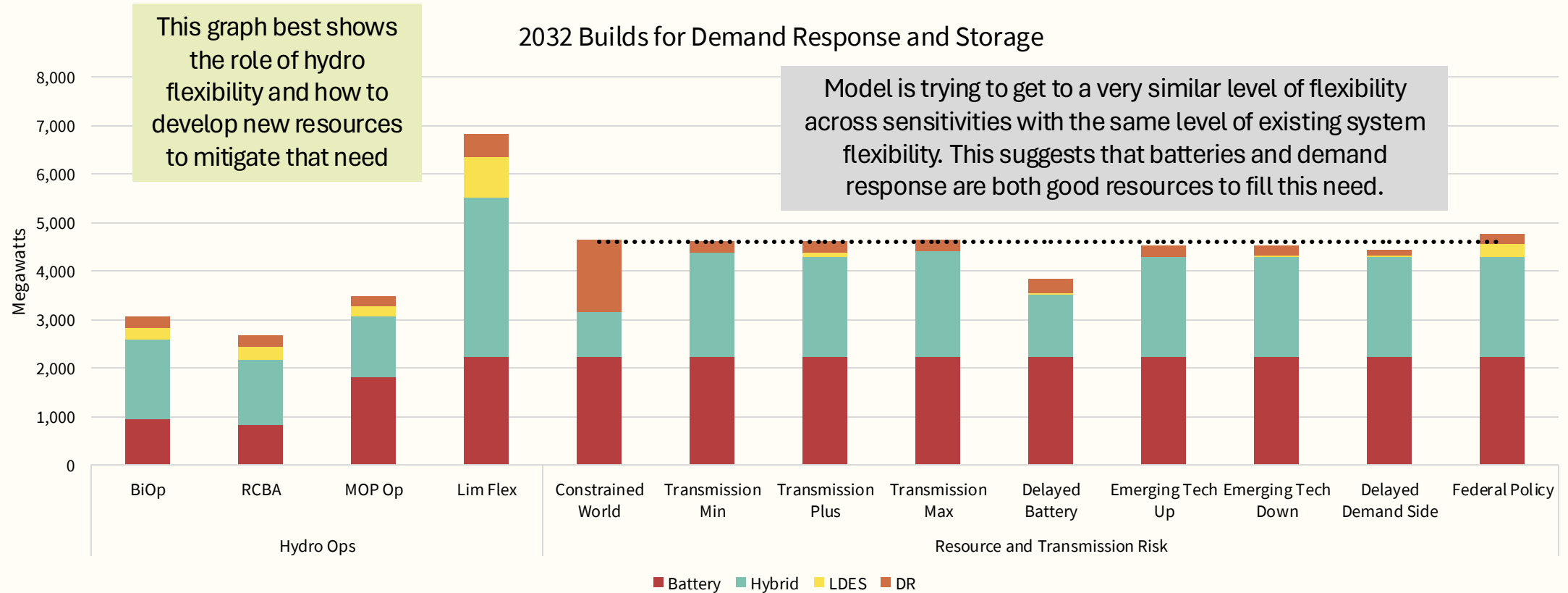
Model is building for both firm energy requirement and planning reserve margin



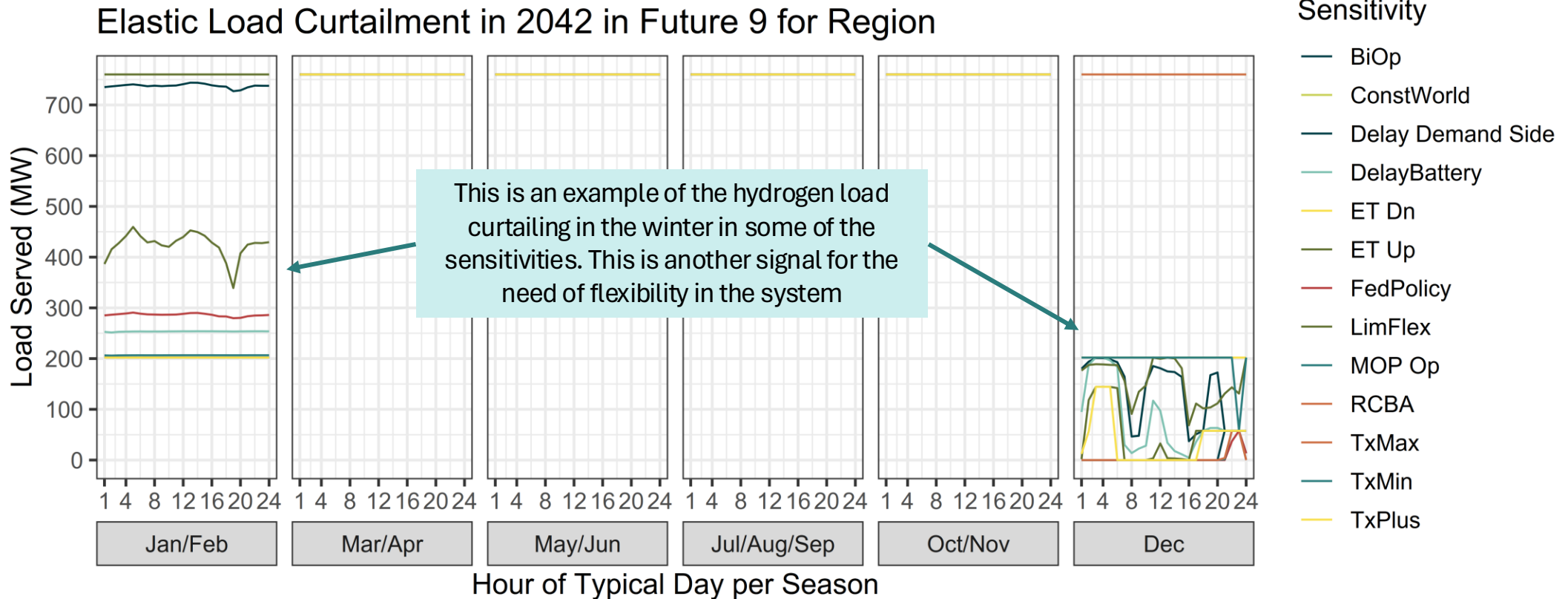
Other Modeling Considerations

- Modeling approach likely mutes the economic value of demand response
 - Demand response is modeled in a way that once the model selects the resource, it must use that resource regardless of the economic signal
 - This means that demand response must run in futures with low market prices, the same as it would run in futures with periods of high market prices, which is not the reality of this resource
 - Additionally, the model uses a “typical day” structure, which may not capture as much price volatility as utilities see locally
- Model does see a need for flexibility, and it uses other tools that meet that need, which may mask the signal for demand response
 - Storage resources provide flexibility and can provide reserves
 - Hydrogen load is modeled as an elastic load, which curtails in some futures if needed to support adequacy

Signal for Flexibility Value



Another Signal for Flexibility Value

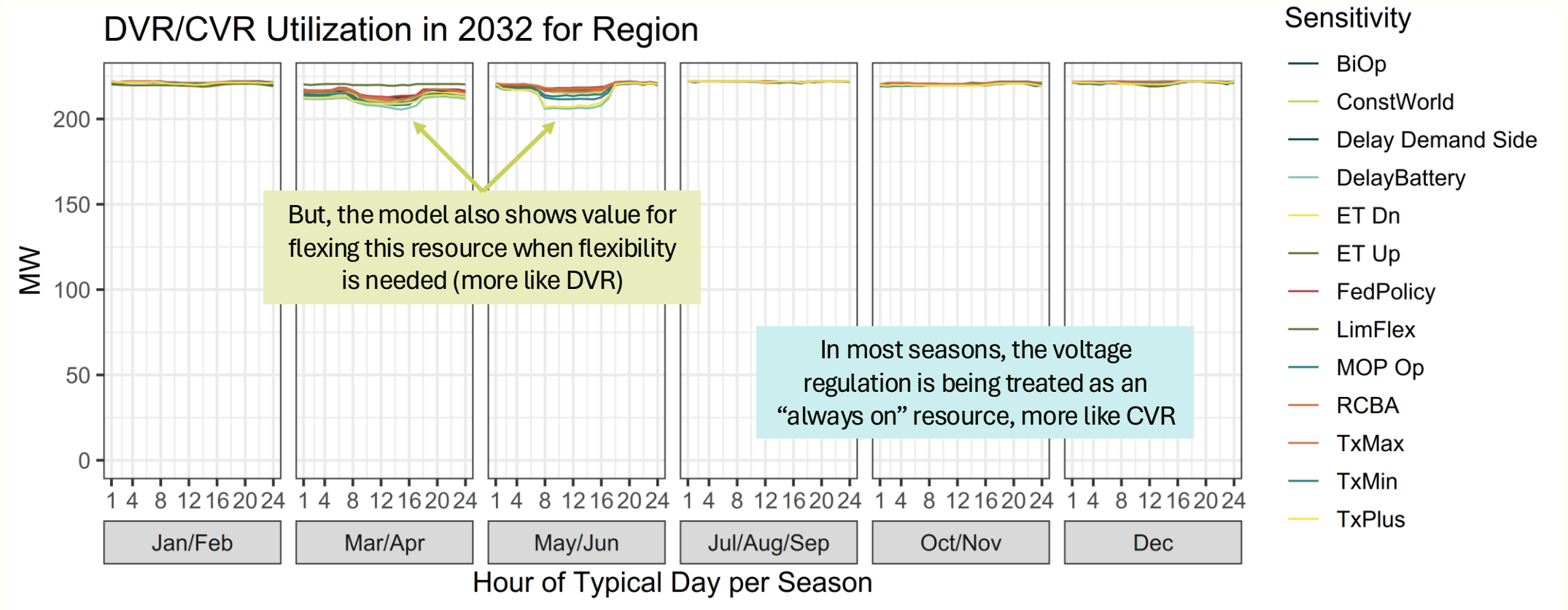


Voltage Regulation

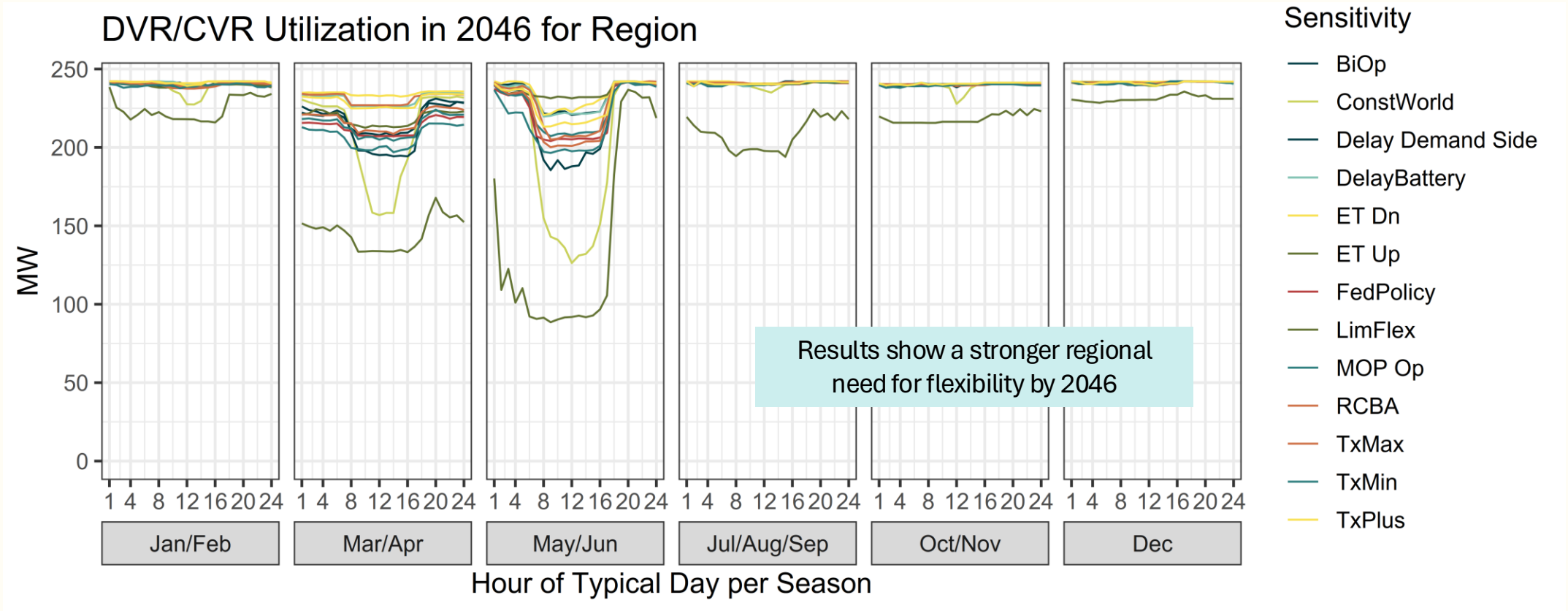
- This is a demand side resources that regulates the voltage on the distribution system to provide energy savings
- It can be operated in two different ways:
 - **Conservation Voltage Reduction (CVR):** lowering the voltage once and keeping it there
 - **Demand Voltage Regulation (DVR):** lowering the voltage at times where it provides value to the system
- For the Ninth Power Plan, this resource was modeled separately from both conservation and demand response to understand what approach might be most valuable for the region

2021 Power Plan recommended DVR as one of two cost-effective demand response products

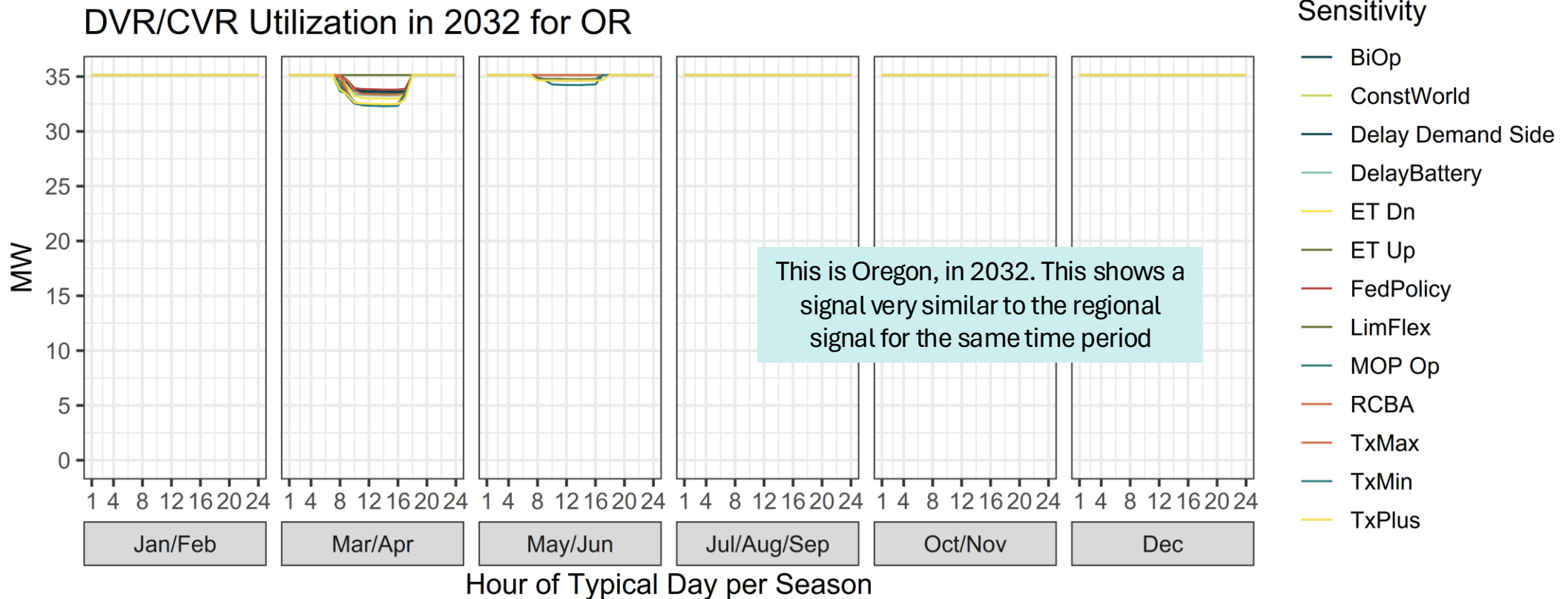
Voltage Regulation Utilization in 2032



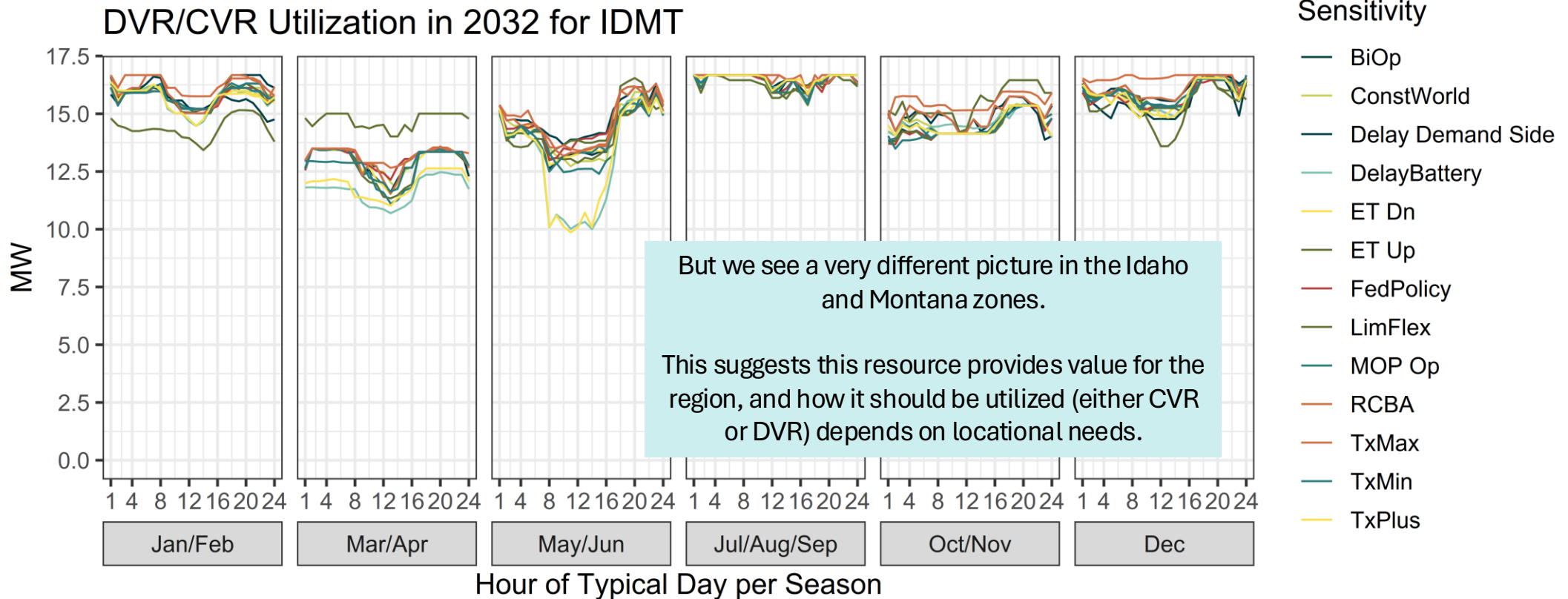
Voltage Regulation Utilization in 2046



Voltage Regulation by Location - Oregon



Voltage Regulation by Location – ID & MT



Other Thoughts on Demand Response

- Some utilities in the region see high value in demand response to meet their needs, including:

- Supporting frequency regulation
- Local transmission and distribution deferral
- Market price volatility
- Avoiding BPA peak power demand charge

These things are not fully captured in our modeling

- Some utilities have also expressed concerns over the ability to quickly build out resources to meet needs, and demand response is a good tool to fill that gap

This we do see in our modeling via the constrained world sensitivity

Storage

Storage Results

- Storage is acquired in all sensitivities
- This is the first power plan to show a strong signal for storage
- Model likes almost all the storage resources available to it
 - Model acquires battery storage and solar + storage in all sensitivities
 - Long-duration energy storage is picked up in all sensitivities by the end of the plan
 - Medium-duration energy storage is picked up in all sensitivities for which it was an eligible resource
 - Pumped storage is the exception, only showing up in one of sensitivities
- Storage resources are playing an important part of meeting reserve requirements
- Hybrid systems are also supporting the firm energy requirements

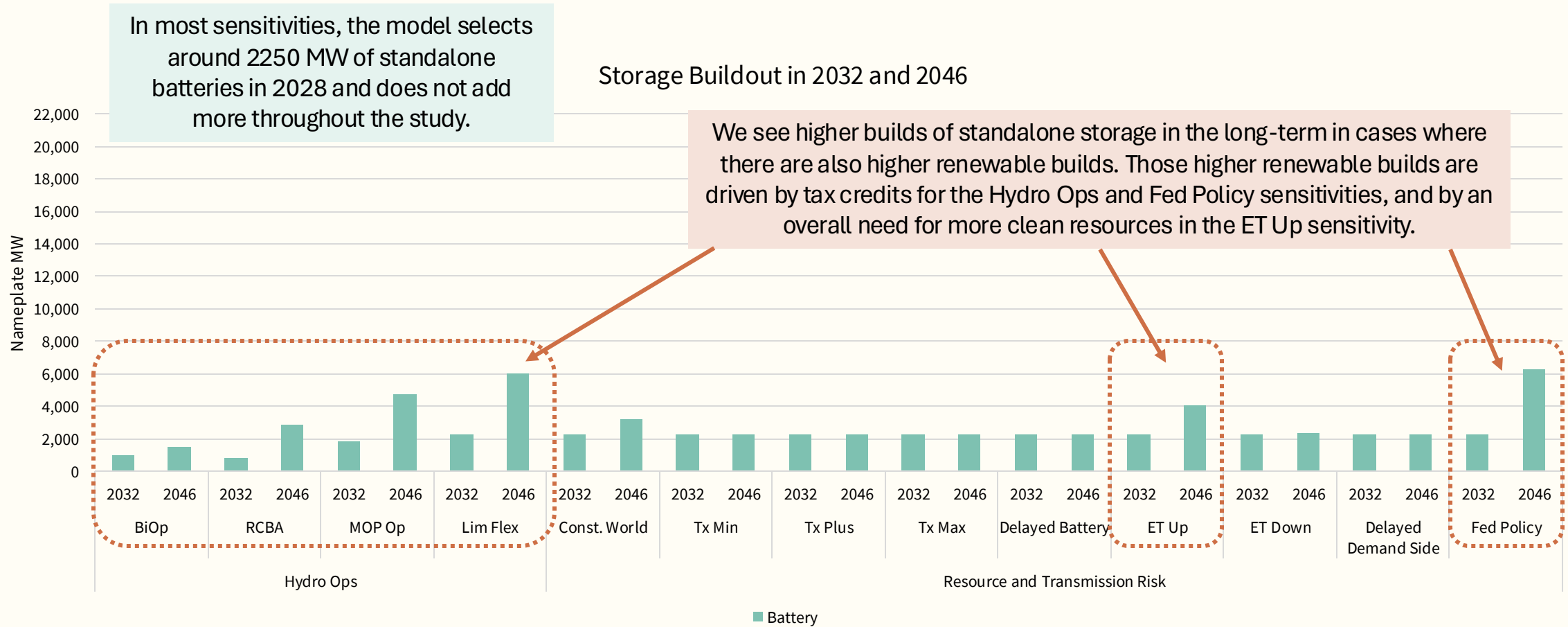
Reminder

Firm energy (*hybrid only*)

Planning reserve margin

Policy

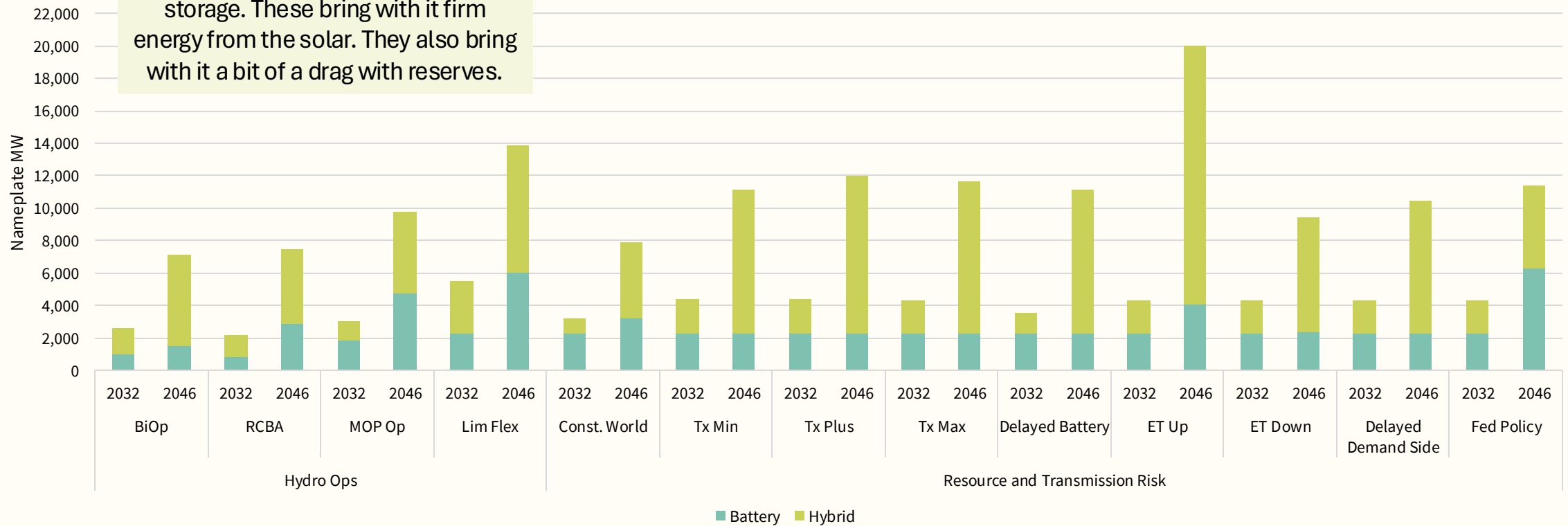
Storage Buildout – Standalone Battery



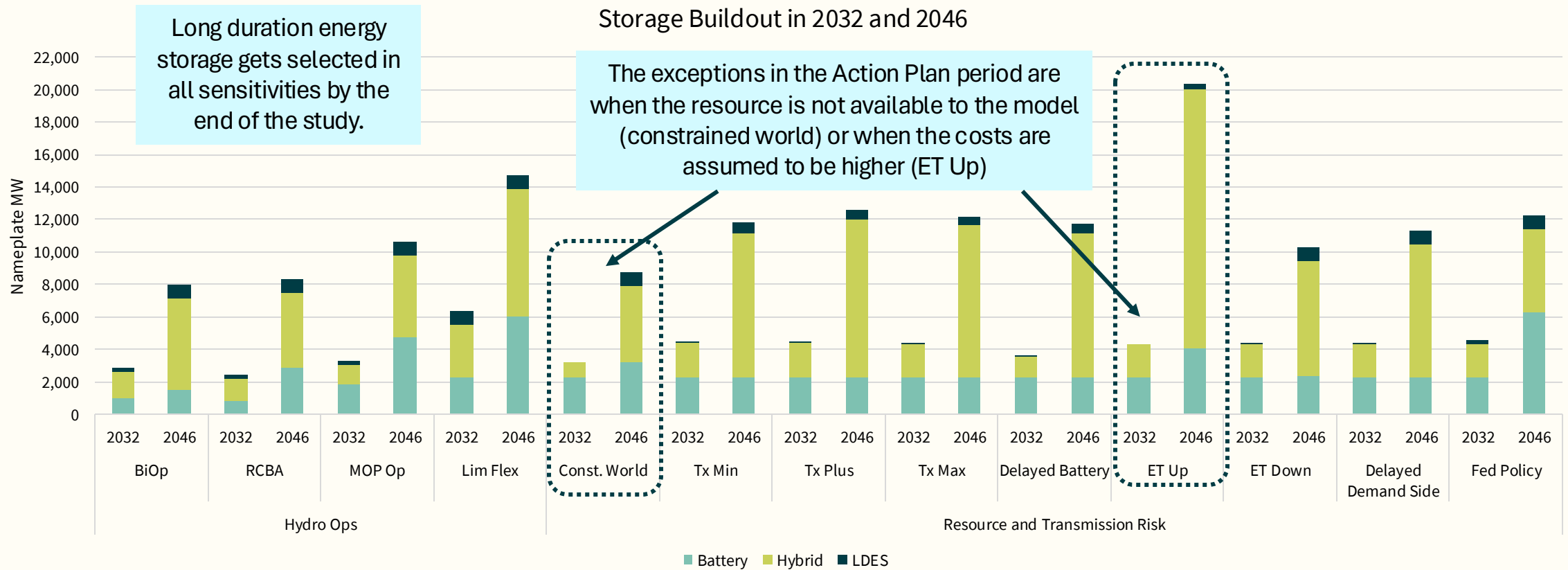
Storage Buildout – Hybrid

Hybrid (solar + storage) resources get added as the model needs more storage. These bring with it firm energy from the solar. They also bring with it a bit of a drag with reserves.

Storage Buildout in 2032 and 2046

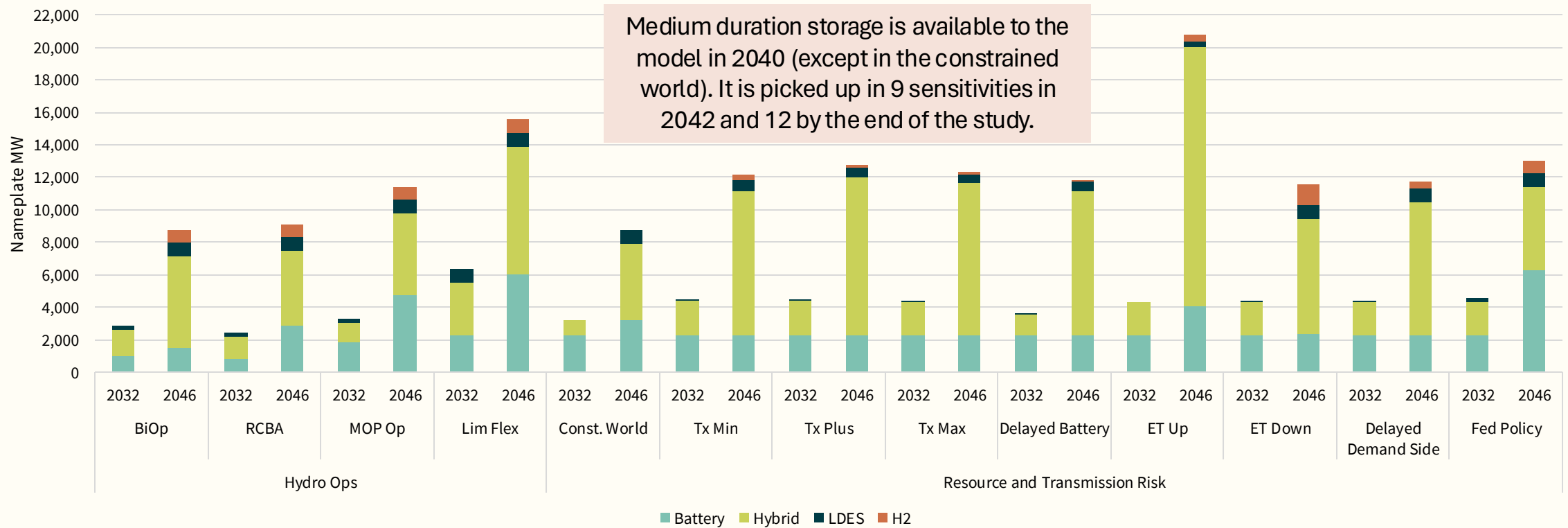


Storage Buildout – Long Duration Energy Storage



Storage Buildout – Medium Duration Storage

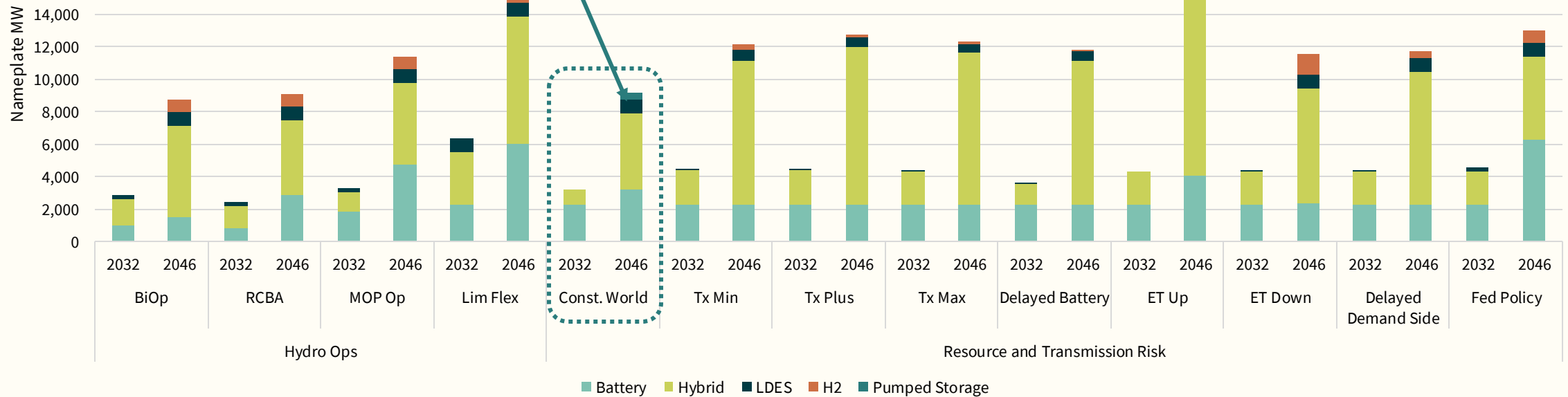
Storage Buildout in 2032 and 2046



Storage Buildout – Pumped Storage

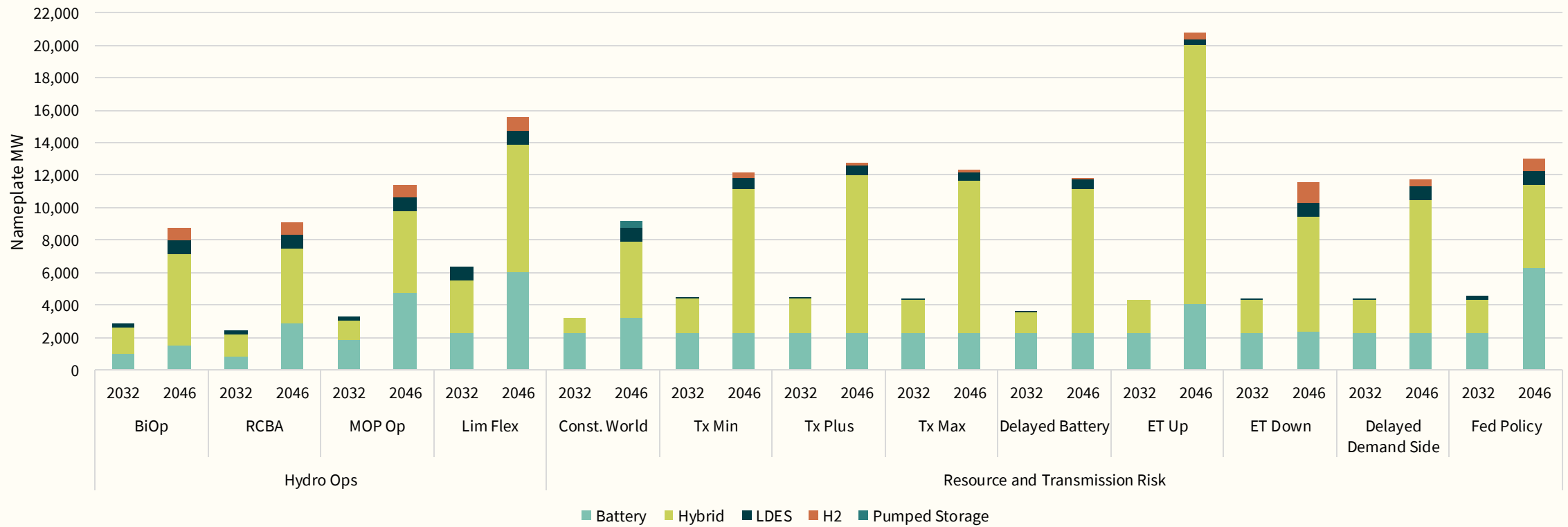
Pumped storage is only picked up in one sensitivity, the constrained world, in 2034. In this sensitivity, long-duration storage is not available until 2042, and medium duration storage is not available at all. This signals that storage beyond batteries and hybrids will be needed, but the attributes of pumped storage are less attractive than those of the other longer duration storage resources.

Storage Buildout in 2032 and 2046



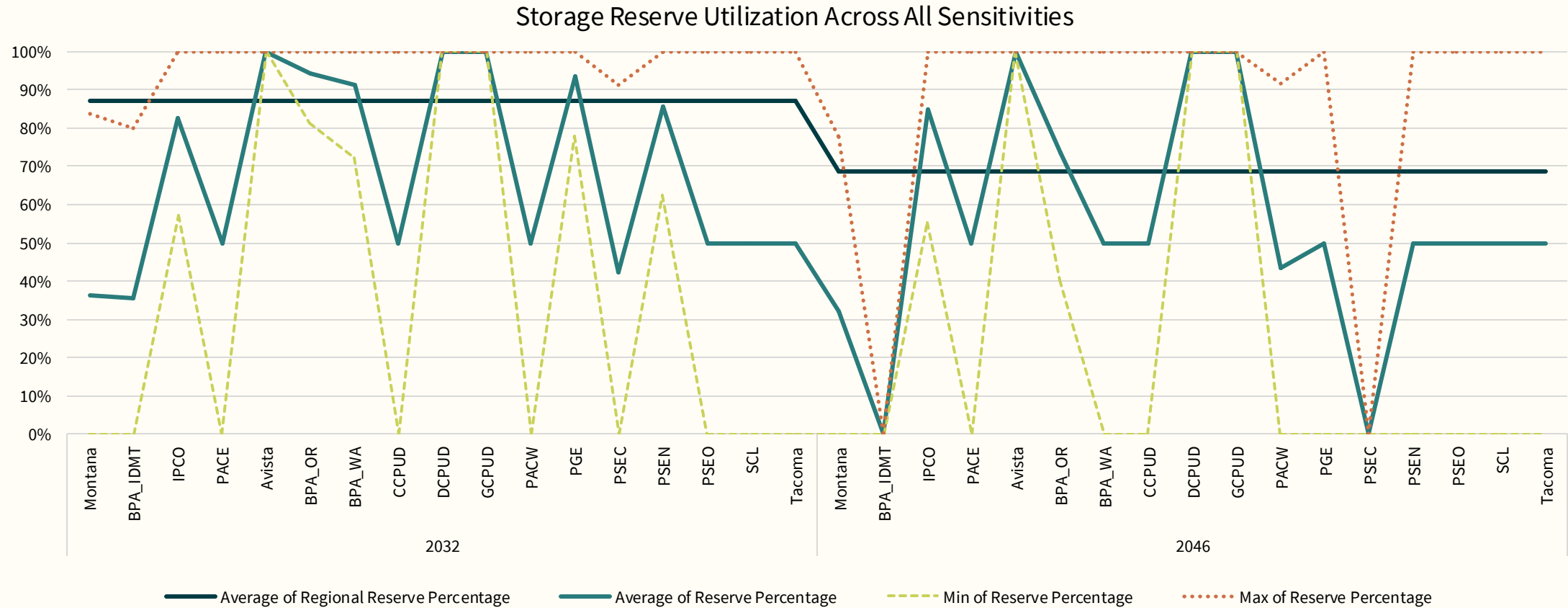
Storage Buildout

Storage Buildout in 2032 and 2046



Storage for Reserves

Storage is being used primarily to support reserves. The amount varies over time, across zones, and by future tested.



Renewables

Renewables Results

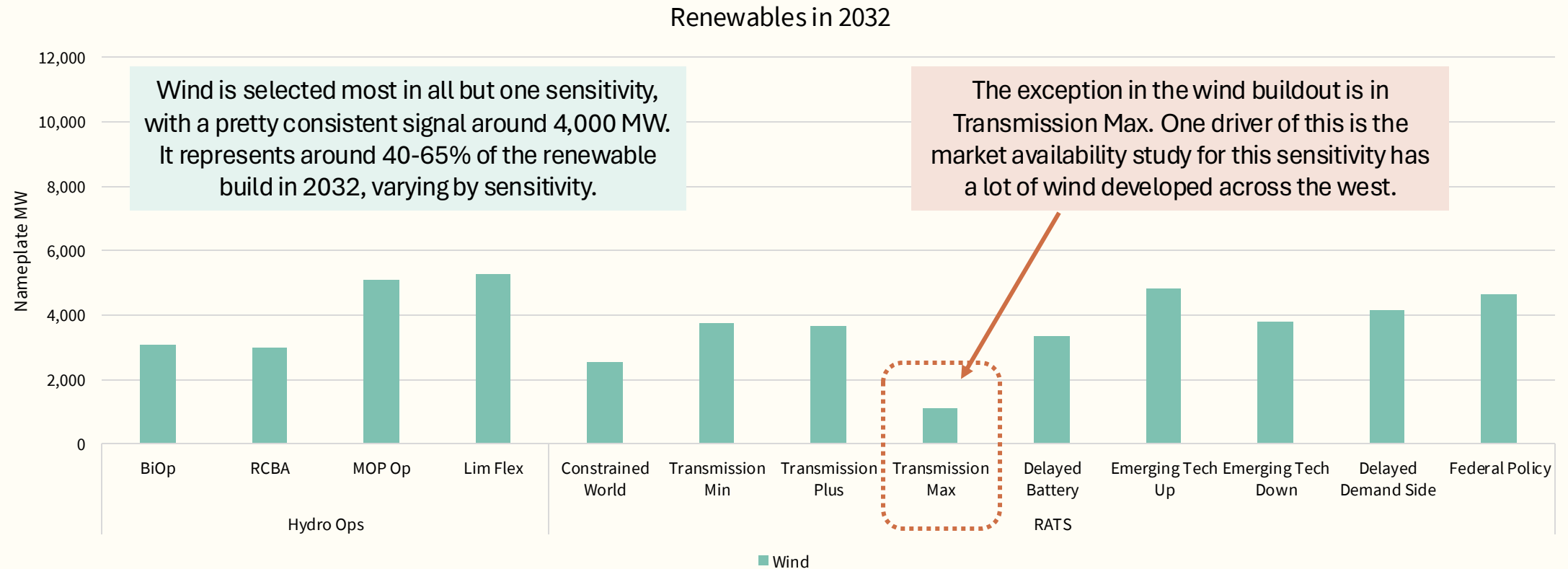
Reminder

Firm energy

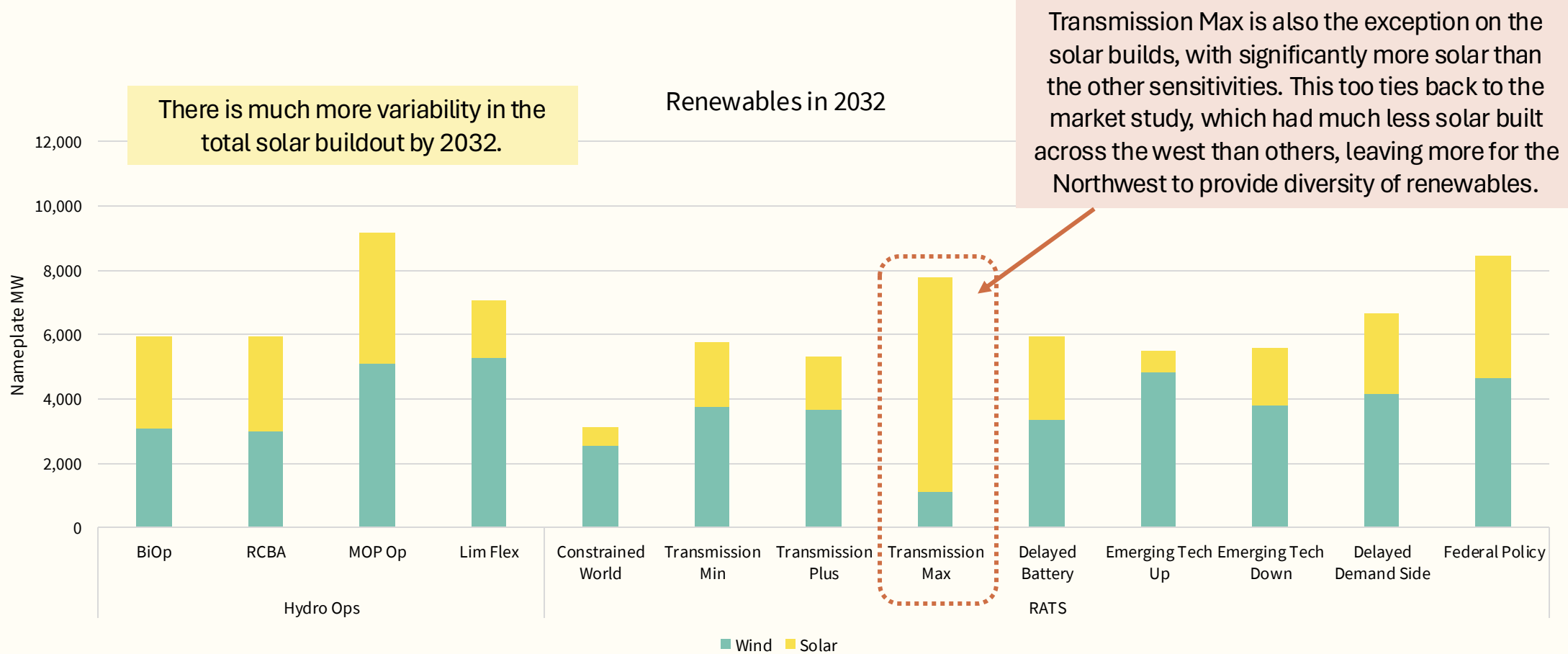
Policy

- Renewables are selected in all sensitivities
 - Wind, solar, and hybrids are available in all sensitivities in the Action Plan period
 - Geothermal is selected in all sensitivities as soon as it is available in the model (2034)
- These resources provide firm energy and support policy
- Model does account for additional reserve requirements through the dynamic probabilistic reserve requirement feature
- Results show a strong signal for the locational value of the different renewable resource types

Renewable Results – Wind in 2032



Renewable Results – Solar in 2032

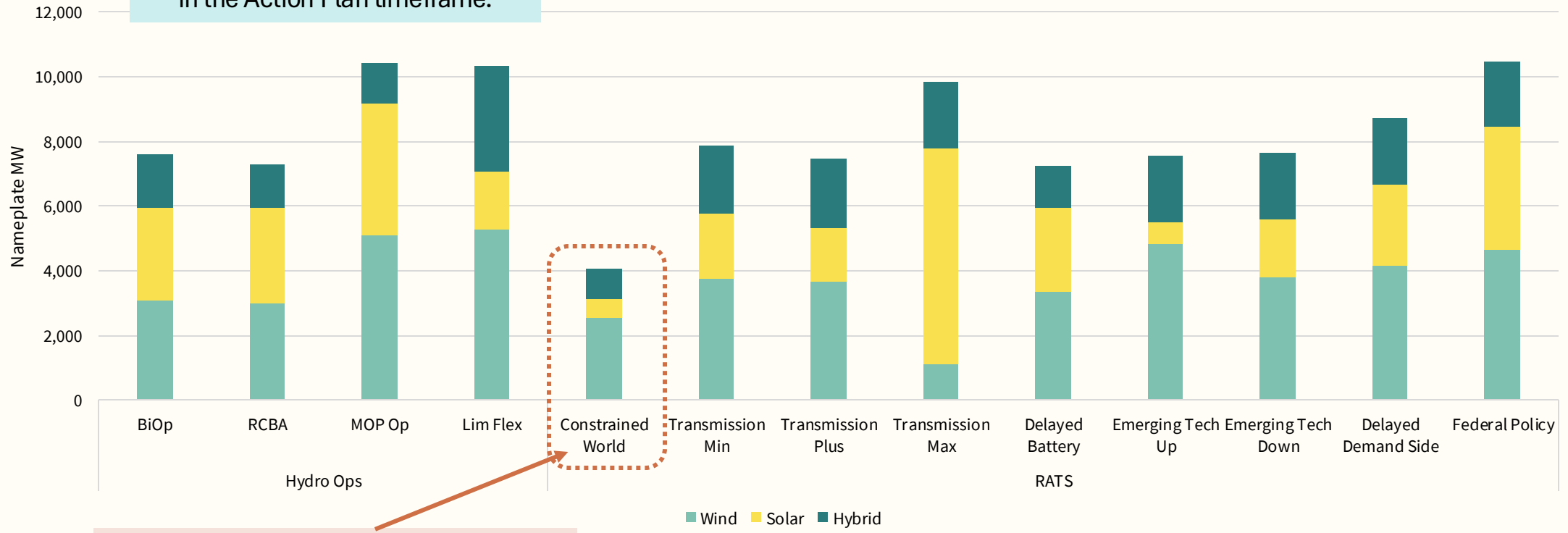


Renewable Results in 2032

The total renewable builds across all these sensitivities are less than what is seen collectively across the regional IRPs

Hybrids (solar + storage) represent the remainder of renewable builds in the Action Plan timeframe.

Renewables in 2032

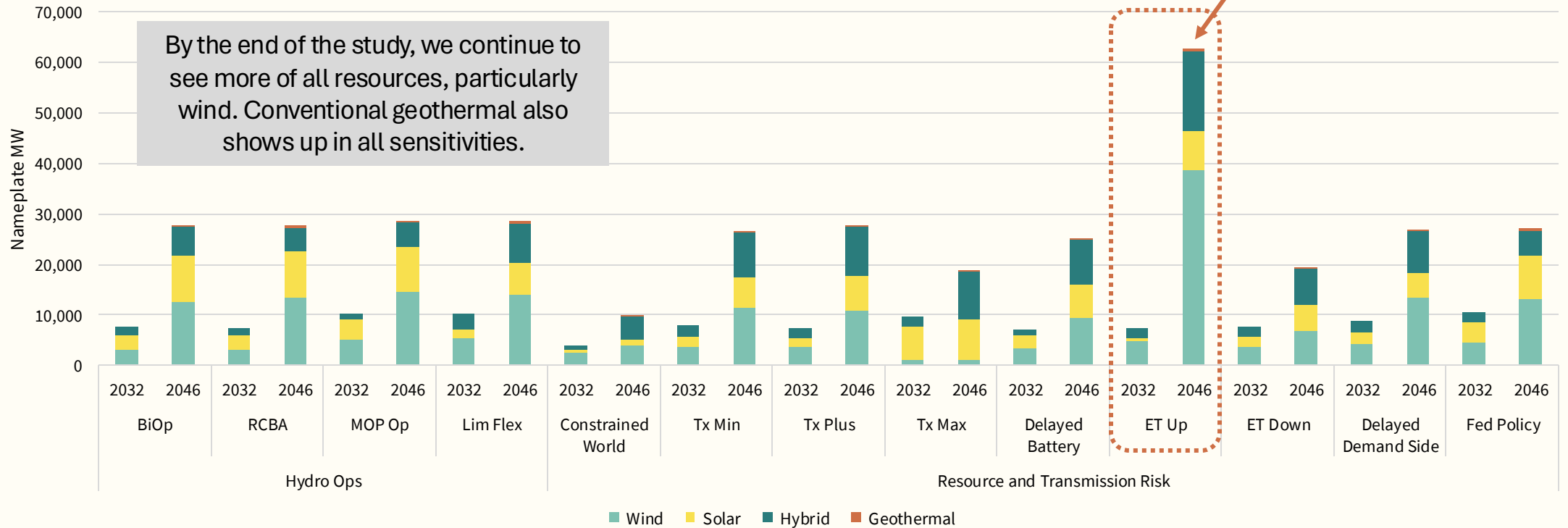


This sensitivity limits the availability of supply side resources, so not surprisingly this is the smallest build by 2032

Renewable Results

The ET Up market buildout is bigger in the NW and smaller in the rest of the WECC. This results in a bigger hole to fill in the region, driving the large renewable buildout.

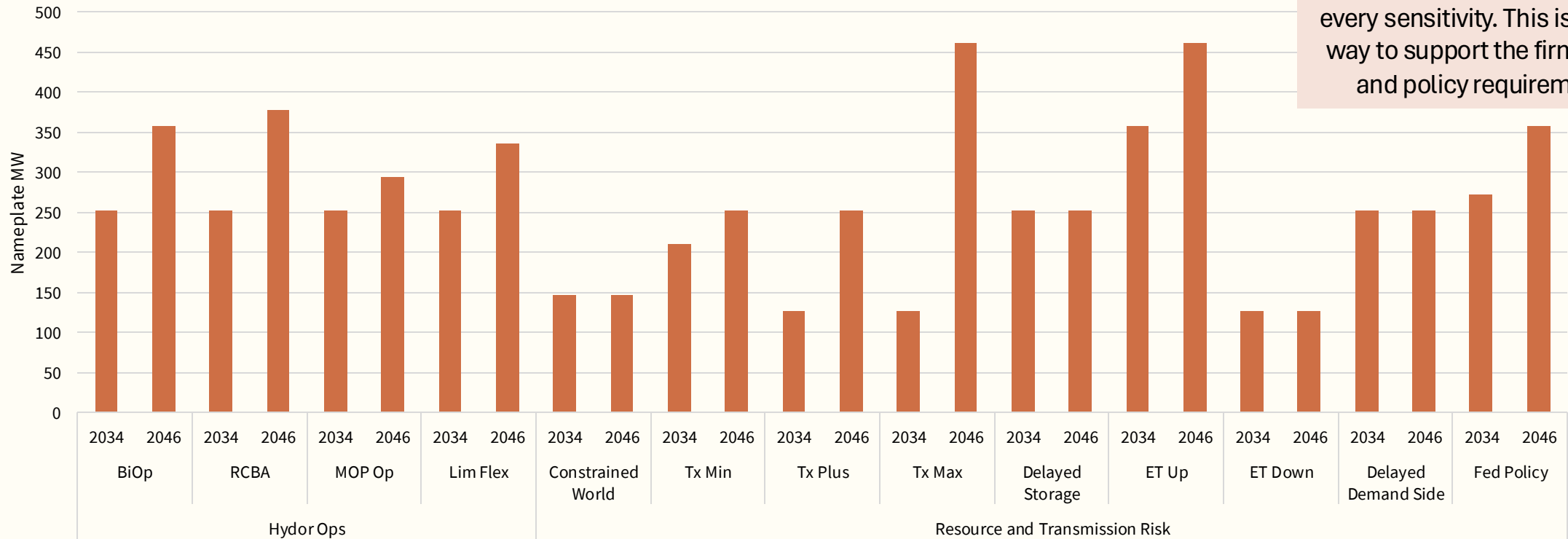
Renewable Buildout in 2032 and 2046



Conventional Geothermal Buildout

Due to the long development time, conventional geothermal is not available until 2034. When it is available, it is picked up in every sensitivity. This is another way to support the firm energy and policy requirements.

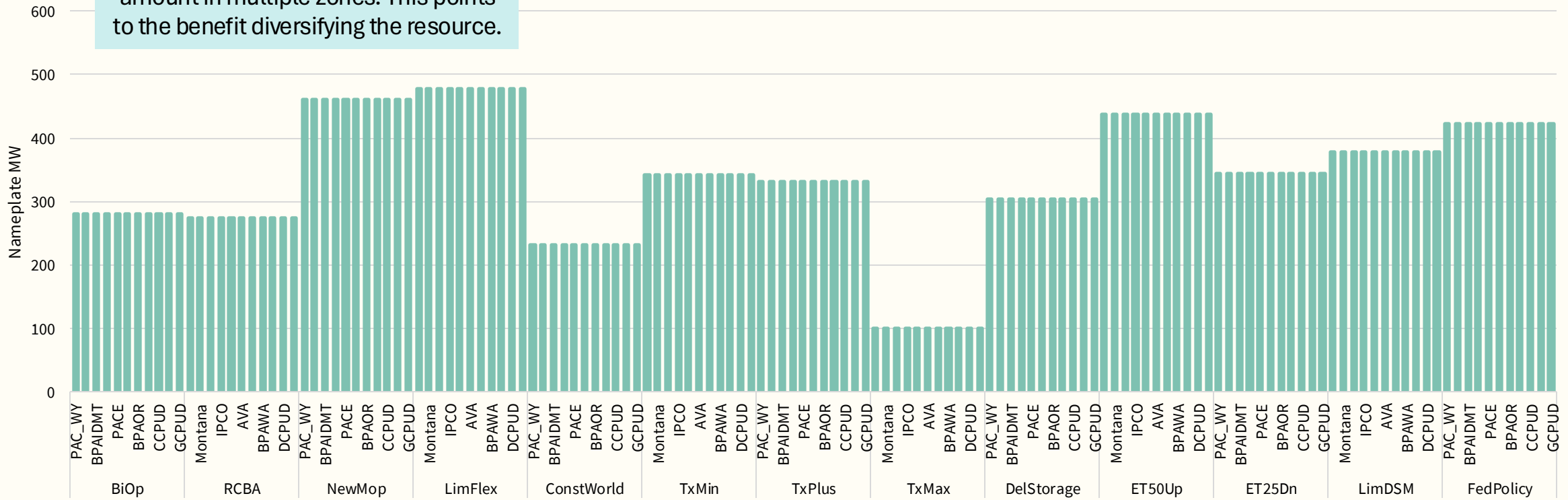
Geothermal Buildout in 2034 and 2046



Wind Buildout by Location in 2032

For each sensitivity, as wind is selected, the model selects a similar amount in multiple zones. This points to the benefit diversifying the resource.

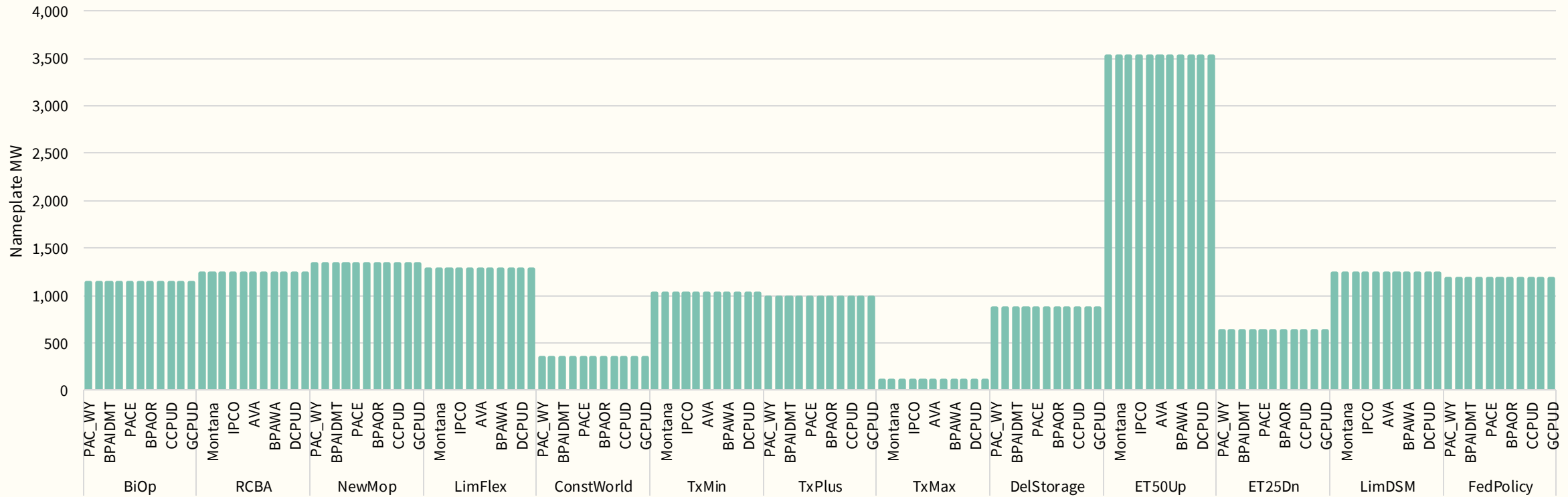
Buildout by 2032



Zones are roughly east to west, reflecting mostly WY, MT, ID/MT, and easter side of WA and OR

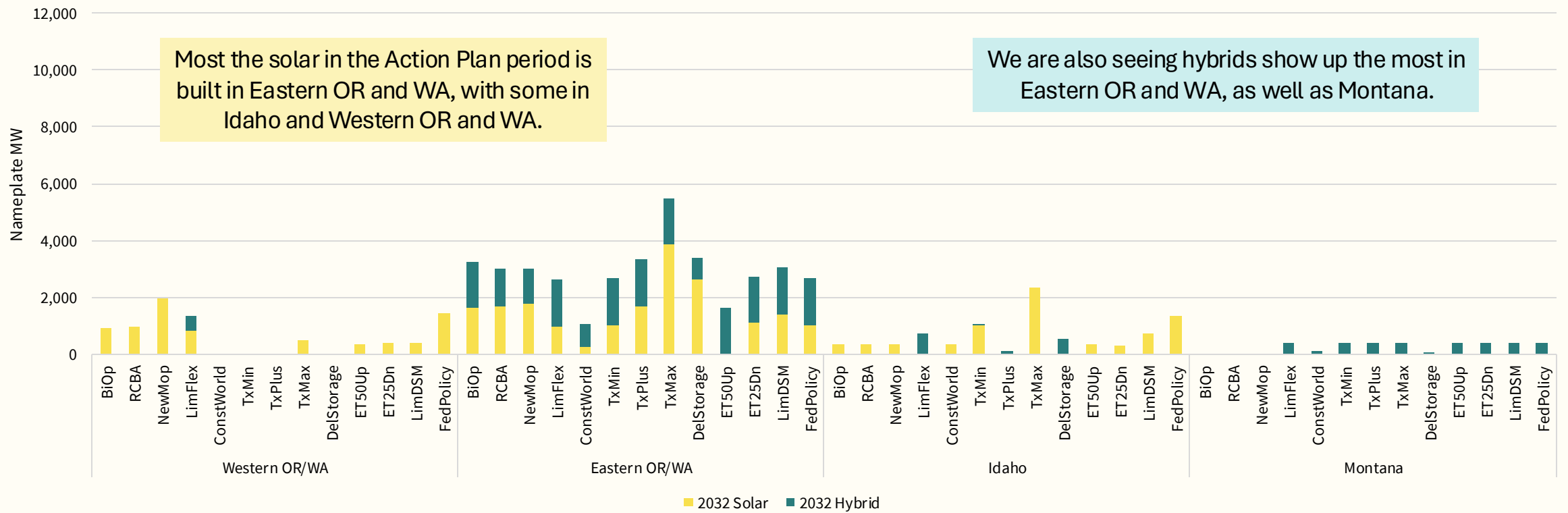
This Trend Continues Throughout the Plan

Wind Buildout in 2046

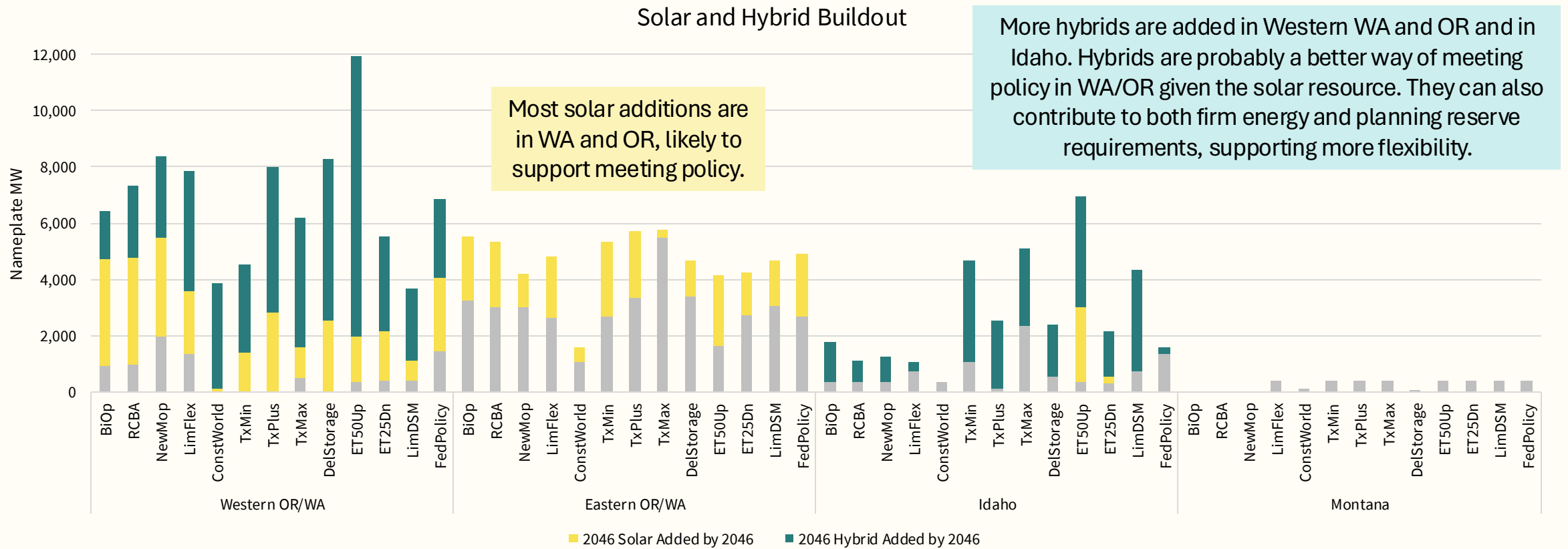


Solar and Hybrid Buildout, by Location (2032)

Solar and Hybrid Buildout



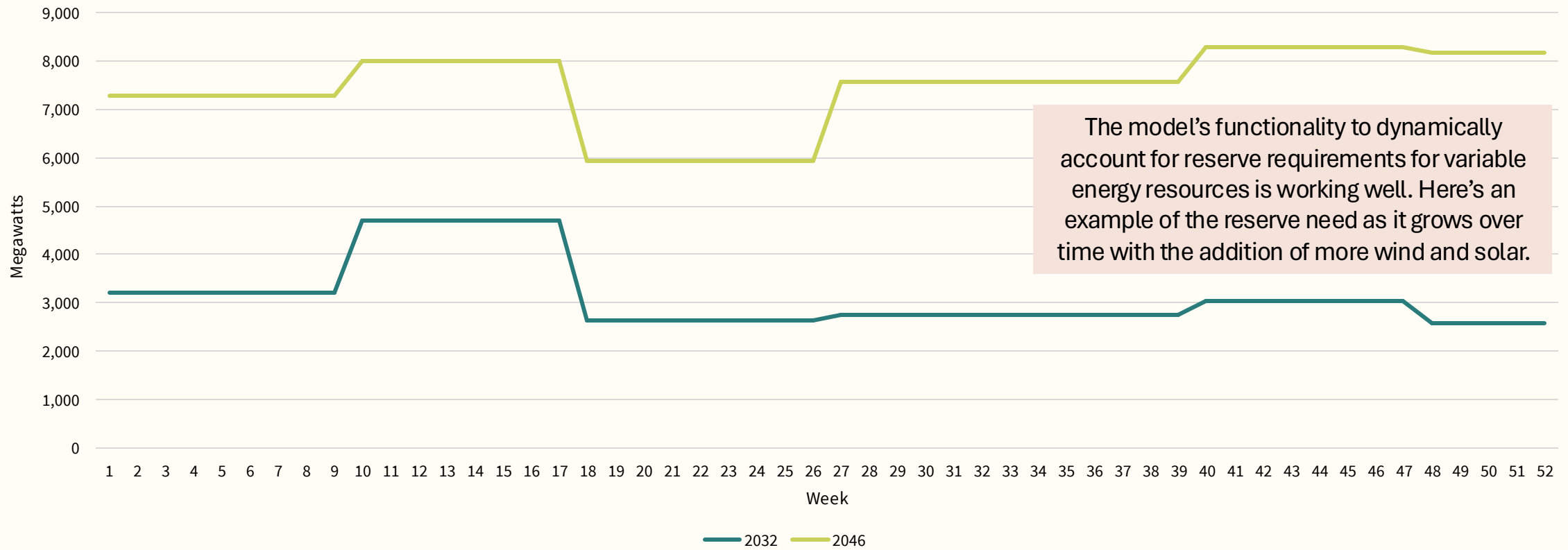
Solar and Hybrid Buildout, by Location (2046)



Renewables and Reserves

Year	VER Buildout
2032	7,472 MW
2046	27,453 MW

Reserve Requirement for Renewables in Transmission Plus Sensitivity



The model's functionality to dynamically account for reserve requirements for variable energy resources is working well. Here's an example of the reserve need as it grows over time with the addition of more wind and solar.

Natural Gas

Natural Gas Results

Reminder

Firm energy

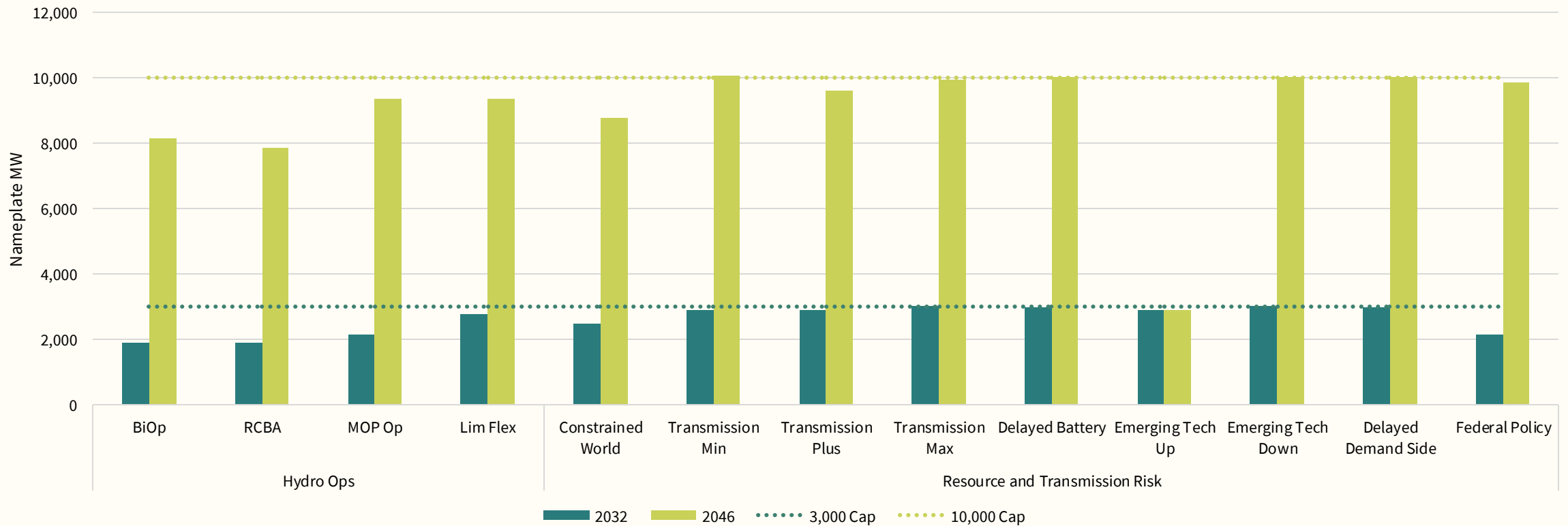
Planning reserve margin

- Natural gas is acquired in all sensitivities
 - In many of the sensitivities, it hits the gas limits in the model
- Most of the new gas getting selected is simple cycle combustion turbines
 - Lower cost, less efficient, and more flexible than other options
 - This flexibility can provide economic value by dispatching down when market prices are low
- Strategies with the lowest natural gas builds in the near-term are those with renewable energy credits
- Gas plants get utilized more heavily in futures with larger data center loads
- All strategies meet policy for the Action Plan, as well as by the end of the study
 - Note, the Constrained World sensitivity does not have enough clean resources available in 2030 to both meet the adequacy requirements and CETA requirements within build limitations

Natural Gas Buildout

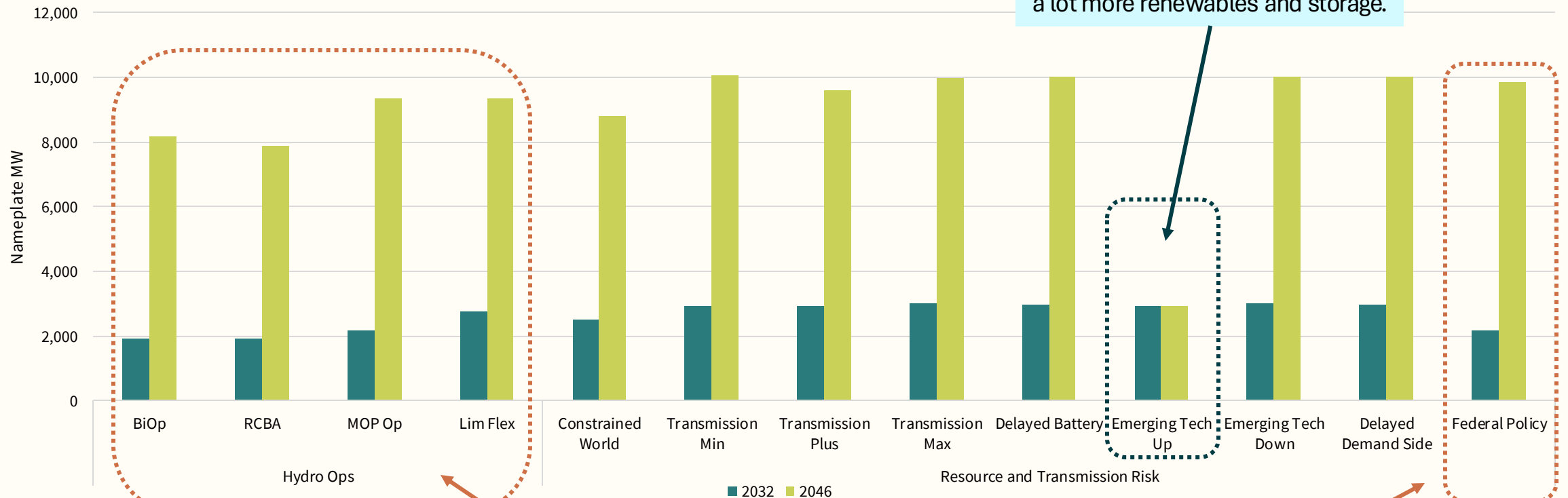
These are hitting, or getting near, the caps in most sensitivities

Natural Gas Builds by 2032 and 2046



Natural Gas Buildout

Natural Gas Builds by 2032 and 2046

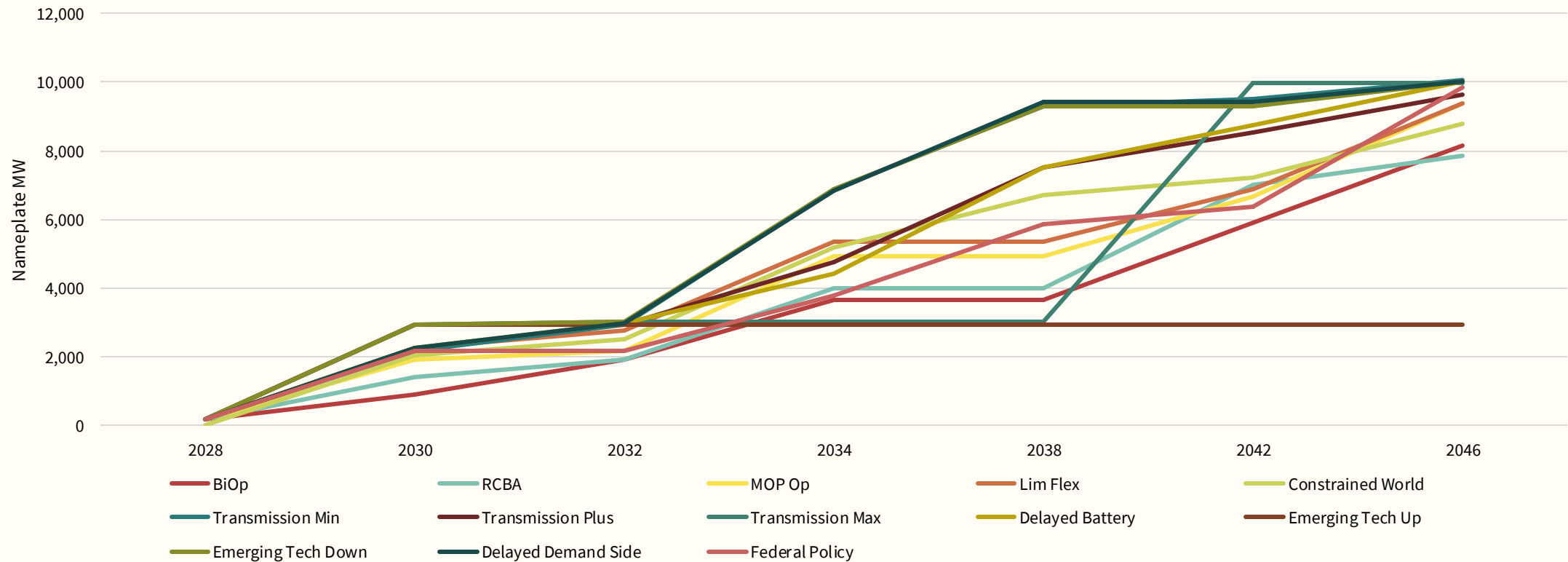


The clean requirements are binding in this sensitivity in 2038 and beyond. To meet those policies, and to provide the firm energy and planning reserve margin requirements, the model is building a lot more renewables and storage.

These have tax credits for renewables, generally reducing the build, at least in the near-term. The amount of flexibility in the hydro operations is also noticeable here too.

Pace of Build Varies by Sensitivity, Particularly in the Out Years

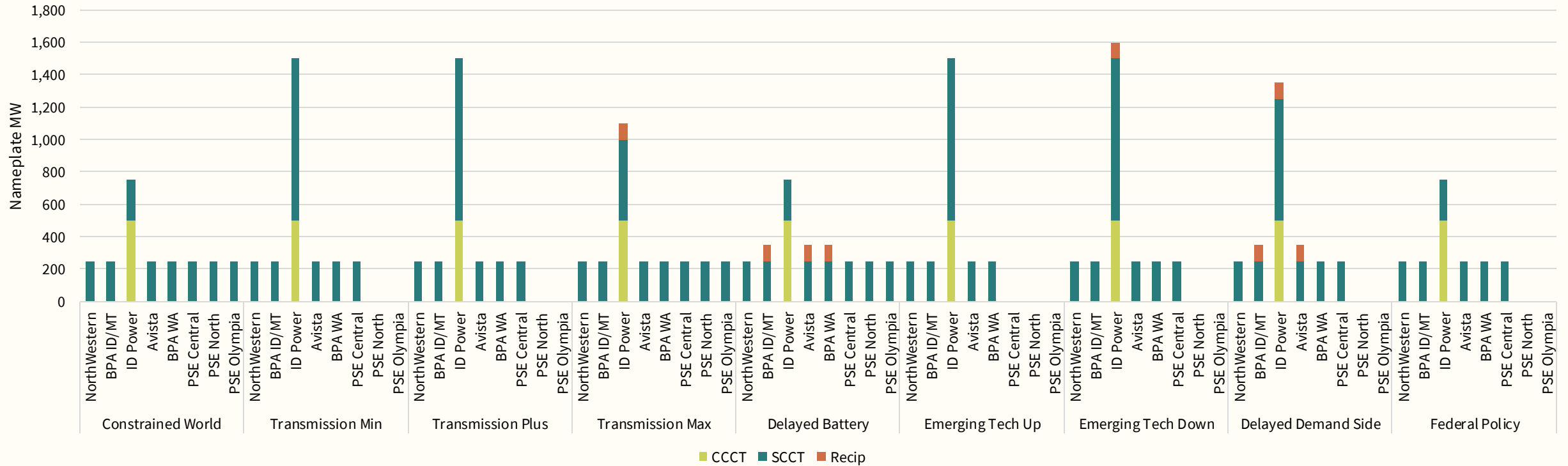
Natural Gas Build Over Time



New Natural Gas Builds by 2032

Resource and Transmission Risk Sensitivities

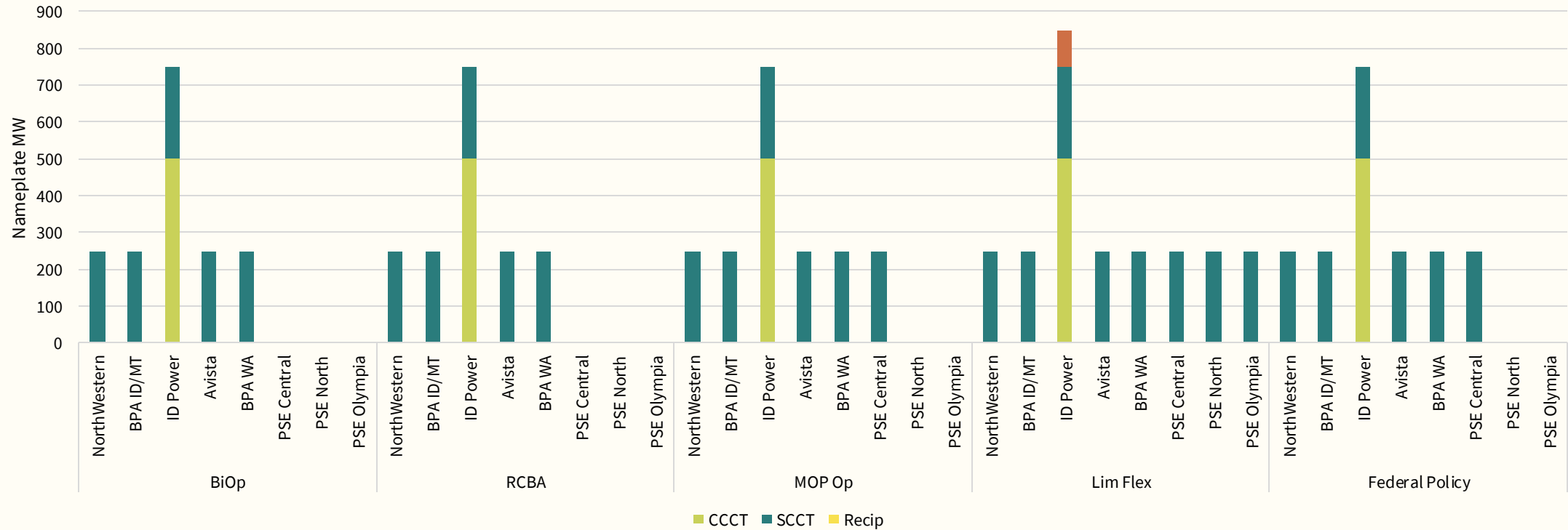
Natural Gas Build by 2032



New Natural Gas Builds by 2032

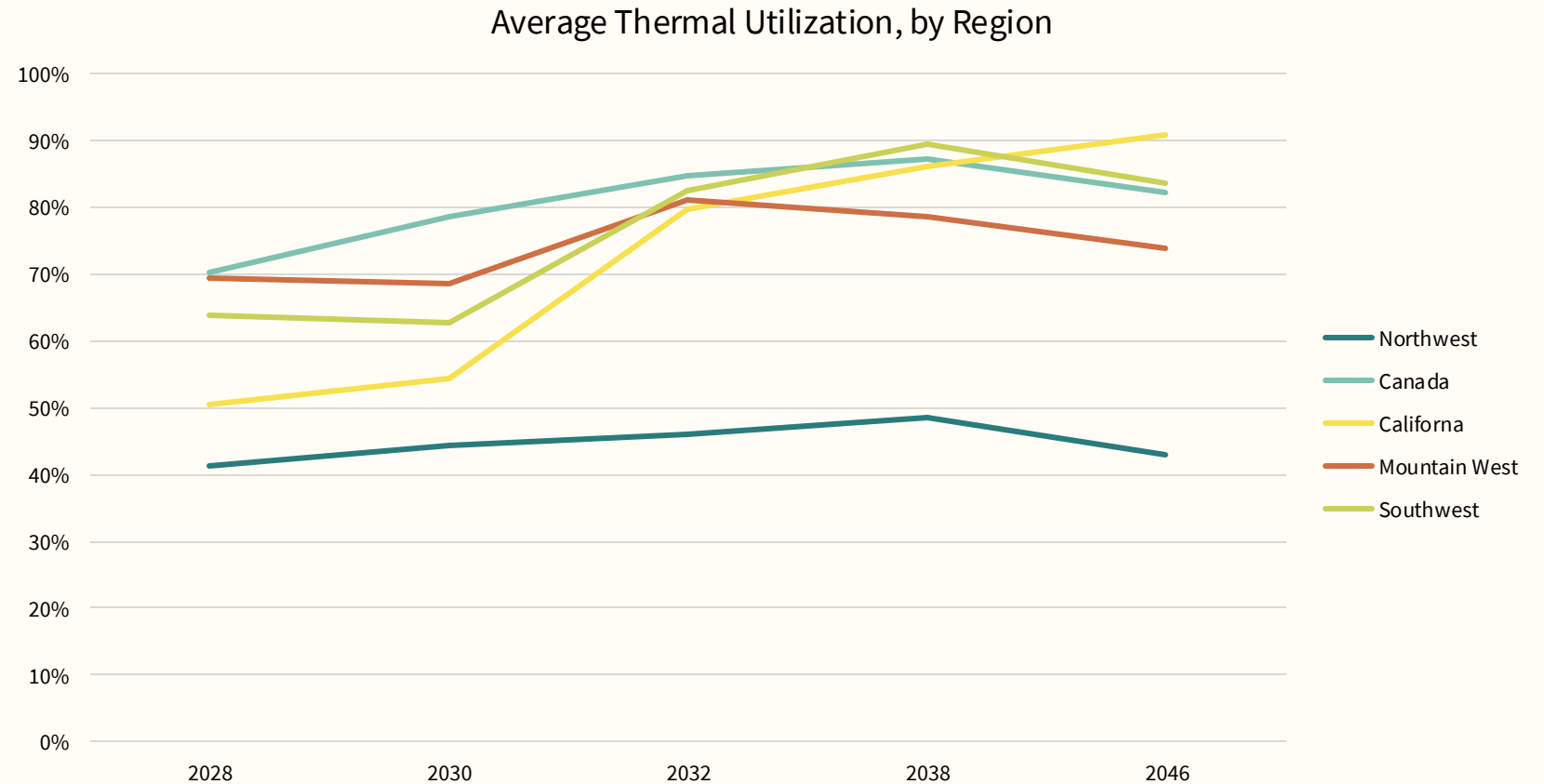
Hydro Operations Sensitivities and Fed Policy

Natural Gas Built by 2032



Thermal Utilization Across the West

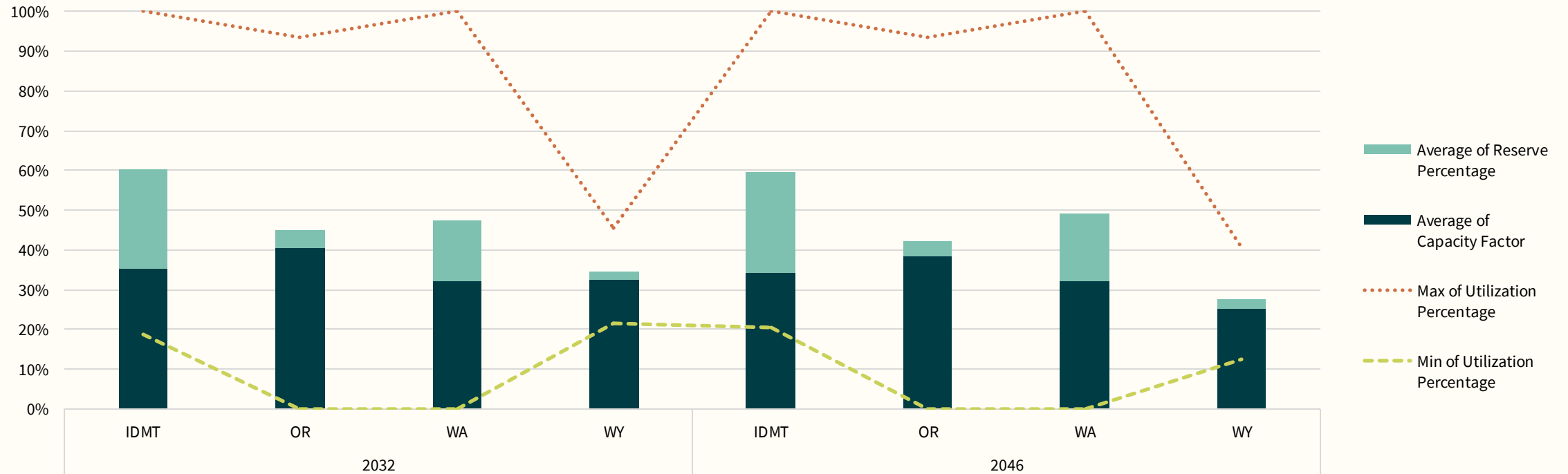
- Model provides information on the utilization of thermals across the west
- Northwest has the lowest thermal utilization, on average, for the WECC



Thermal Utilization Varies Across the Region

In some futures they are used **a lot**, in others **not at all**. This ability to dispatch based on the future is part of the economic benefit for these units.

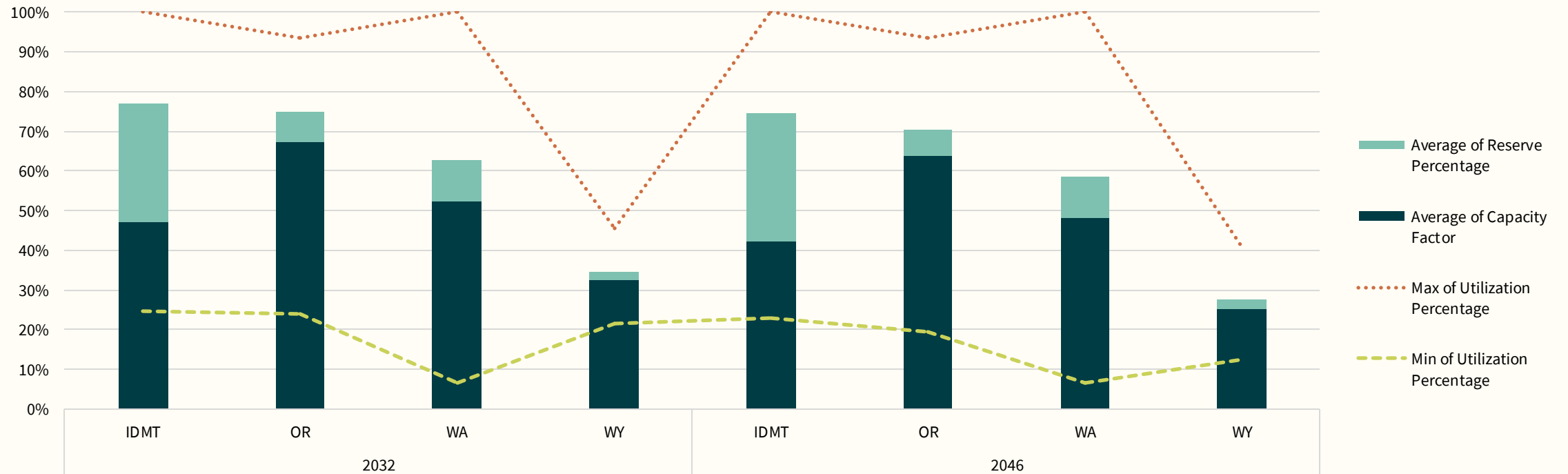
Average Thermal Utilization, Across All Sensitivities, New and Existing



Thermal Utilization of Existing Plants

On average, the existing system is being used more for generation, and less for reserves. There are more combined cycles in the existing system.

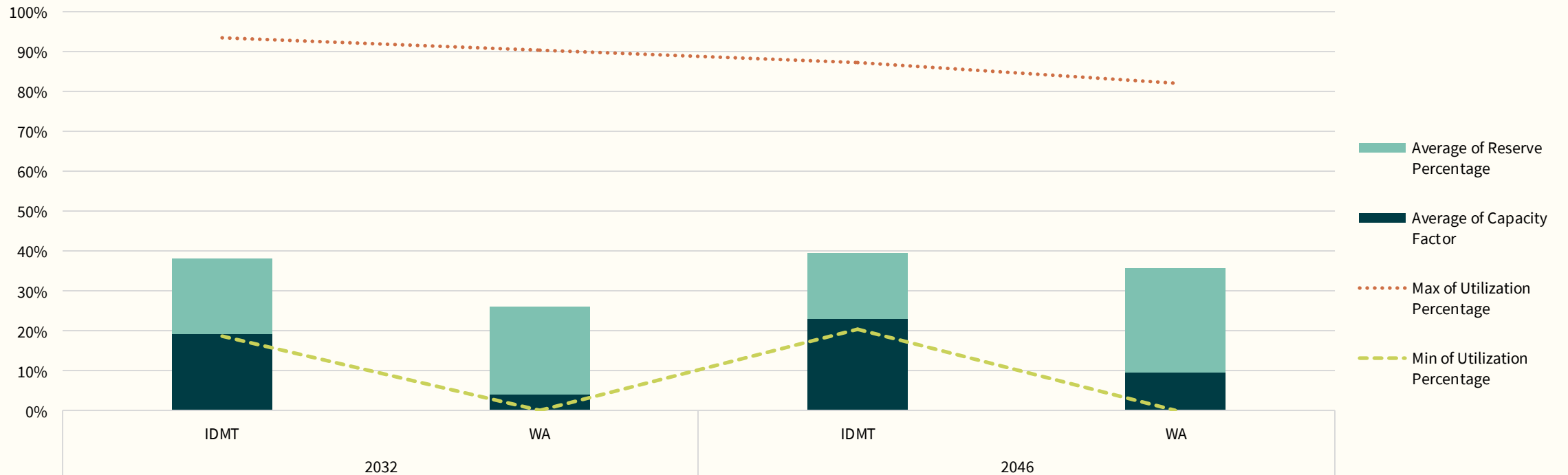
Average Thermal Utilization of Existing Plants



Thermal Utilization of New Plants

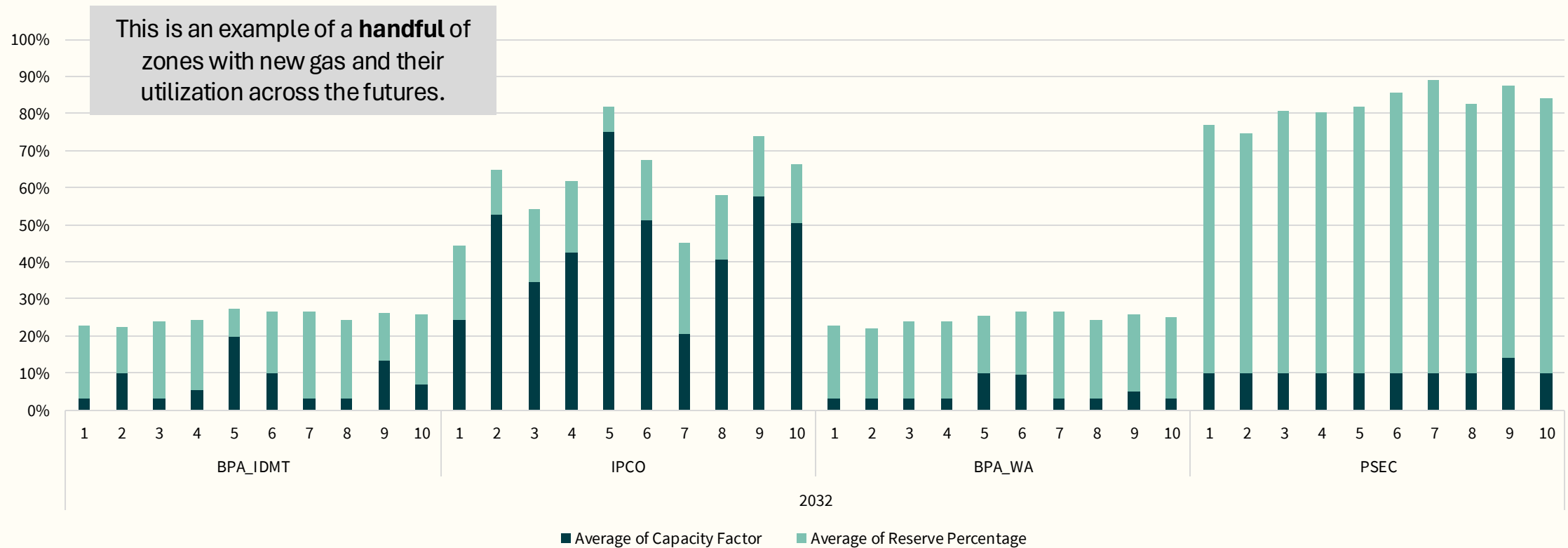
New plants are mostly being used for reserves.
Remember, these are mostly simple cycle plants, with the one combined cycle in Idaho.

Average Thermal Utilization of New Plants



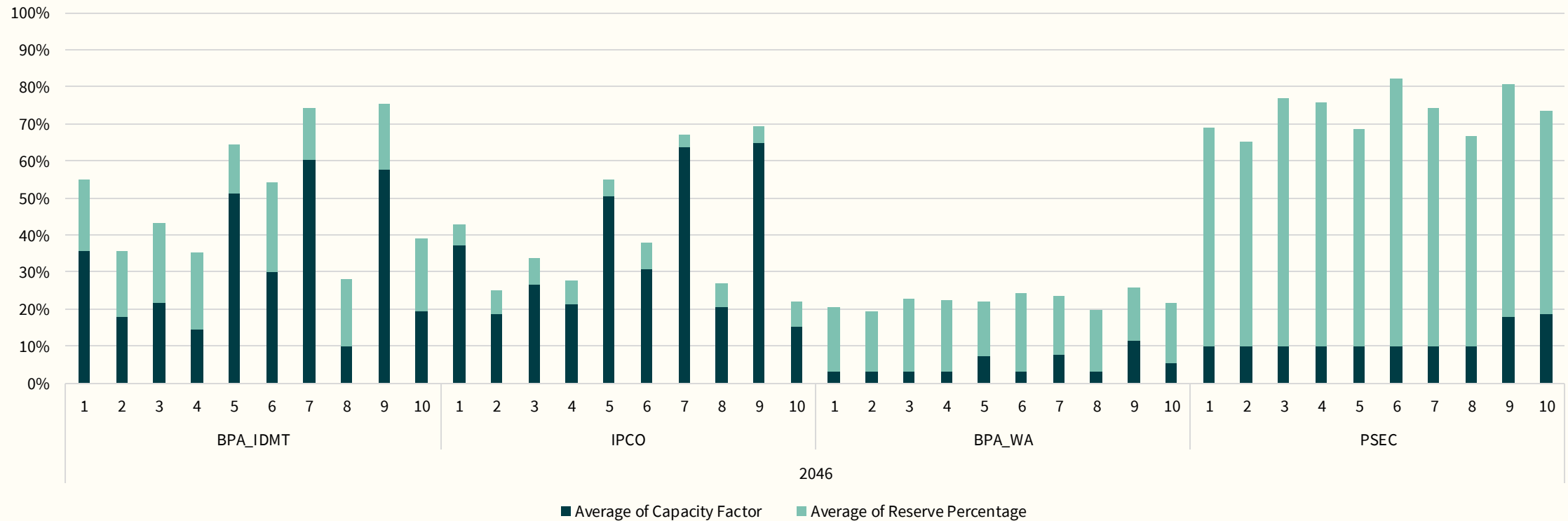
Thermal Utilization of *Some* New Plants, by Future, in 2032

New Natural Gas Thermal Utilization by Future, in Transmission Plus in 2032



Thermal Utilization of *Some* New Plants, by Future in 2046

New Natural Gas Thermal Utilization by Future, in Transmission Plus in 2046



Emerging Tech

Emerging Technology Results

- Modeling suggests value in the clean emerging technologies
- Storage proxies were both selected in all sensitivities
 - Provide flexibility to the system
- Clean baseload proxy was selected in about half the sensitivities in the last year of the study
 - All of these show up in Washington
 - Many show up in the PSE Olympia zone, which is where Centralia 2 is retired from in 2045
- If costs come down, the emerging technologies are more attractive to the model

Reminder

Firm energy (*baseload only*)

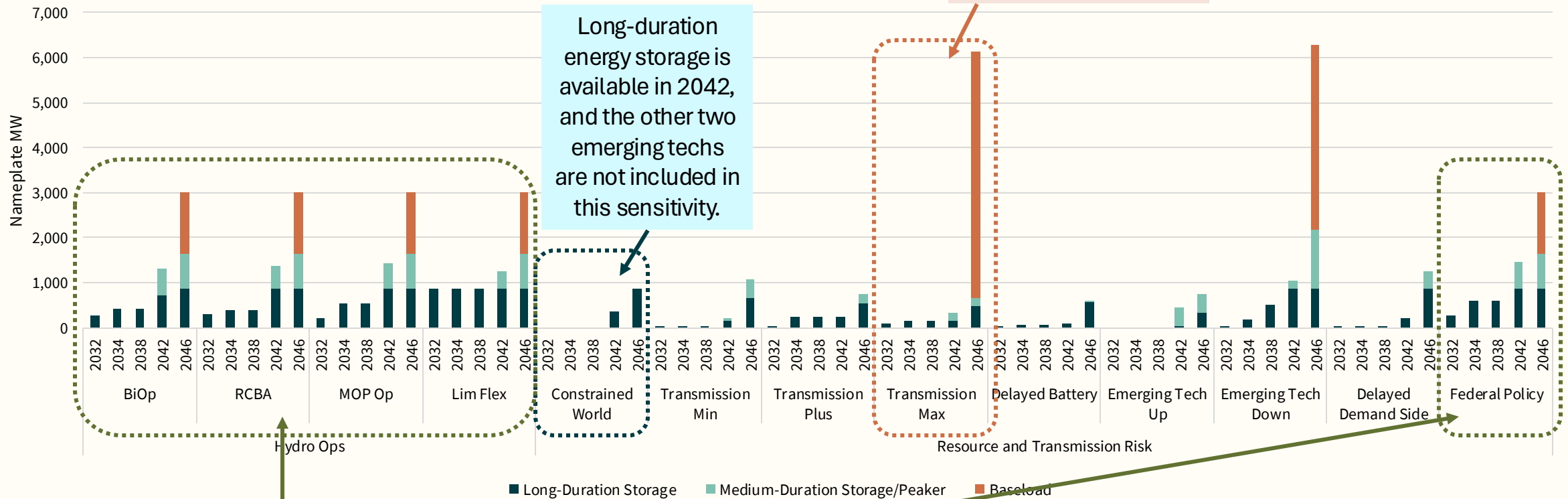
Planning reserve margin

Policy

Emerging Tech Buildout

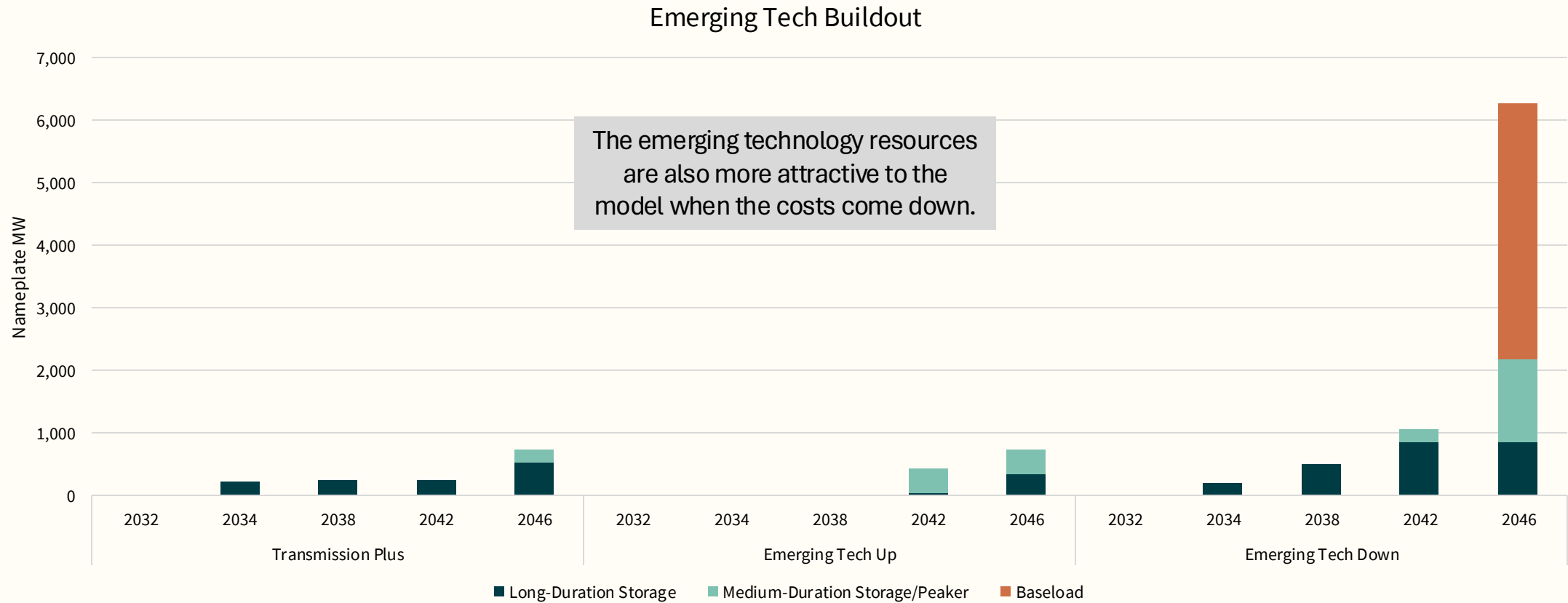
This study has some interesting market dynamics. The market has a lot more wind and a lot less solar. CA is importing more. In this study, the NW is also exporting more.

Emerging Tech Buildout

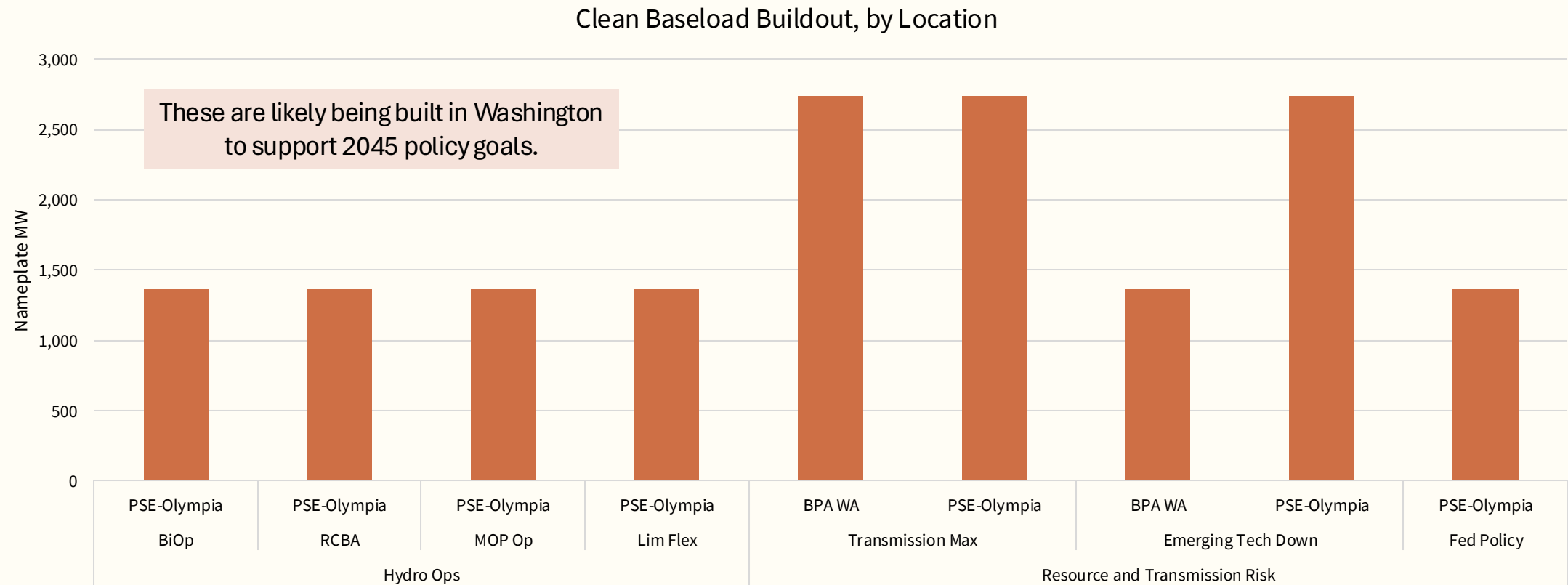


These studies build more renewables, with the tax credits, and (like batteries) the emerging tech is helping to balance the system

Emerging Technology Cost Comparisons



Clean Baseload Buildout by Zone



Emissions

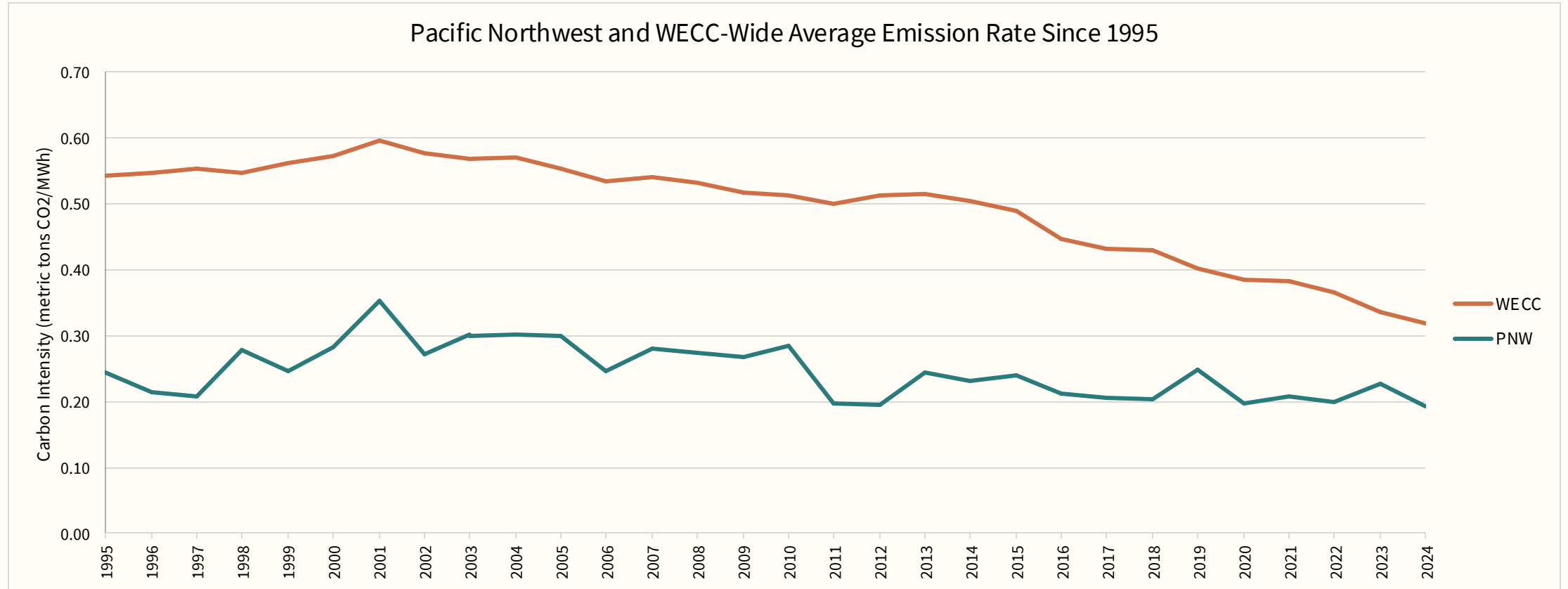
Emissions Results



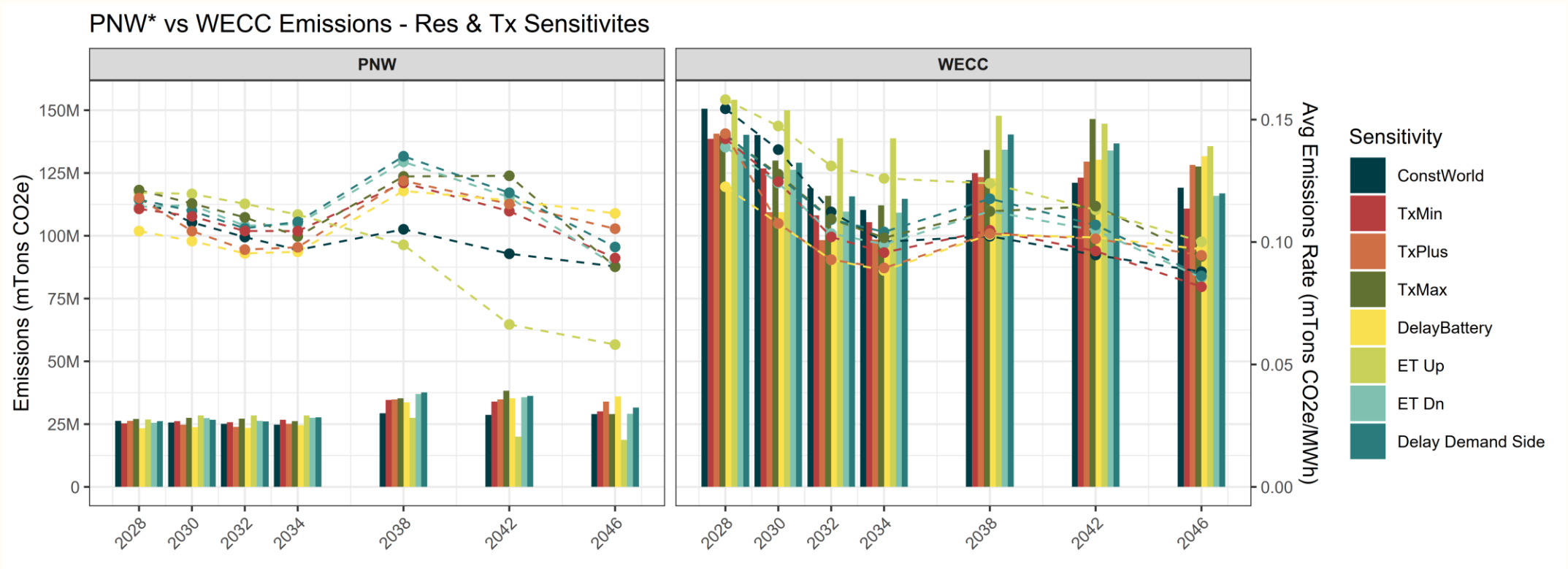
This is just an initial look. More analysis is needed on the emissions picture.

- Emissions decline in the near-term, with some declines in the long-term
- Factoring in the load growth shows a decline in the average emissions rate
- Emissions in the broader west decline more so than in the region
 - Thermal in the Northwest has primarily been a hedge for bad hydro conditions
 - The broader West relies more on thermal generation
- Not seeing significant differences in WECC-wide emissions from the different sensitivities
 - This suggests that the clean policies are driving the change in emissions more than any single strategy that is being developed by OptGen

Regional vs West-Wide Avg. Emissions Rate



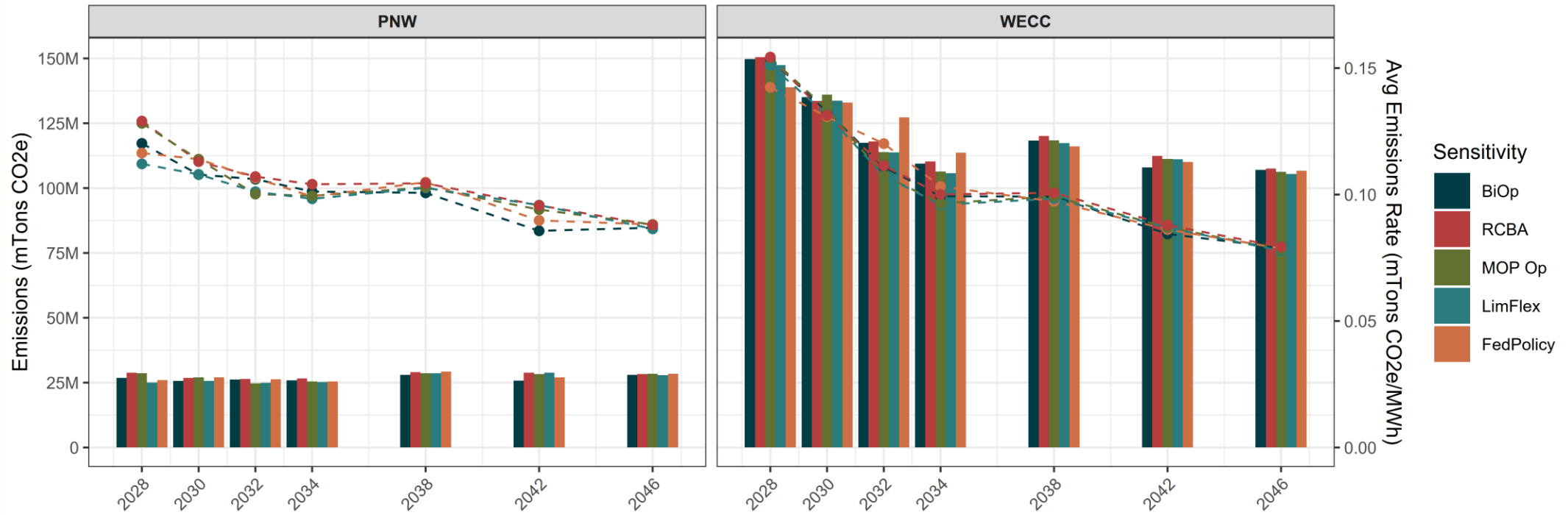
Emissions for Resource and Transmission Risk Sensitivities



! Northwest values represent in region generation and do not account for market transactions.

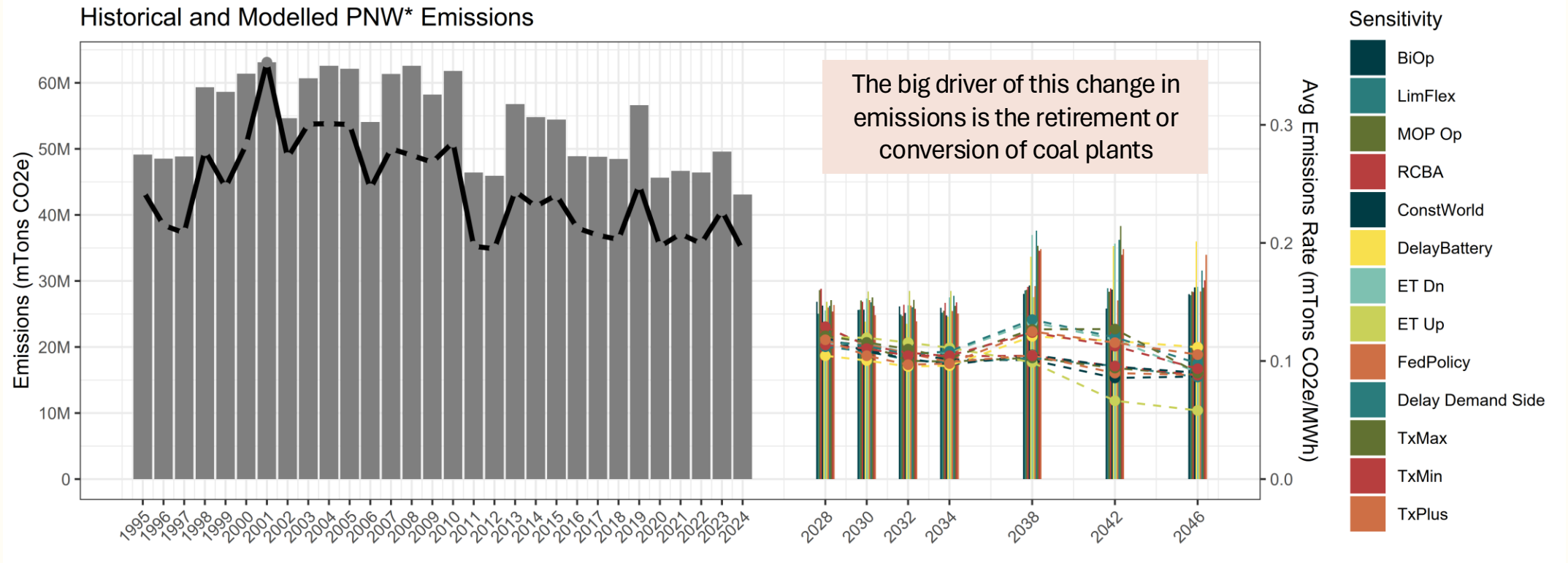
Emissions for Hydro Ops Sensitivities and Fed Policy Sensitivity

PNW* vs WECC Emissions - Hydro Op Comparison



! Northwest values represent in region generation and do not account for market transactions.

Historical Emissions vs Modeled Emissions



! Northwest values represent in region generation and do not account for market transactions.

Questions?

- Are there any remaining questions around the material we presented so far?
- Are there other questions you were hoping we would provide information on that we haven't yet answered?

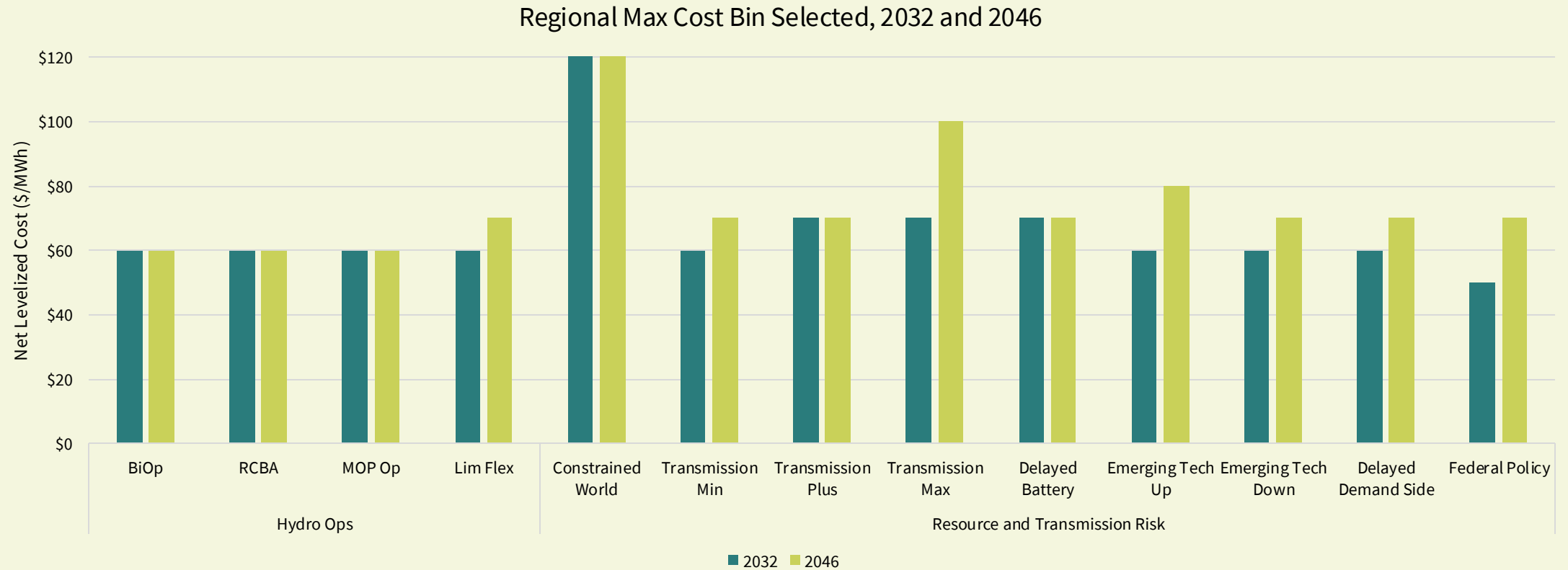
Follow-Up from Tuesday

- Topics for deeper analysis
 - Costs, particularly incorporating the variable costs and discussion of risk
 - Resource utilization, more on variance across the futures and discussion of risk
 - Emissions, more comprehensive evaluation
- A couple quick pieces for today
 - Levelized cost of selected resources
 - Voltage regulation in WA
 - Thermal utilization in 2046 and link to combined cycles
 - Near-term emissions differences across sensitivities
 - Role of reserves and market

Levelized Cost of Selected Resources

After seeing the maximum cost bins for conservation costs, there was a question around how these compare to other resources the model is selecting.

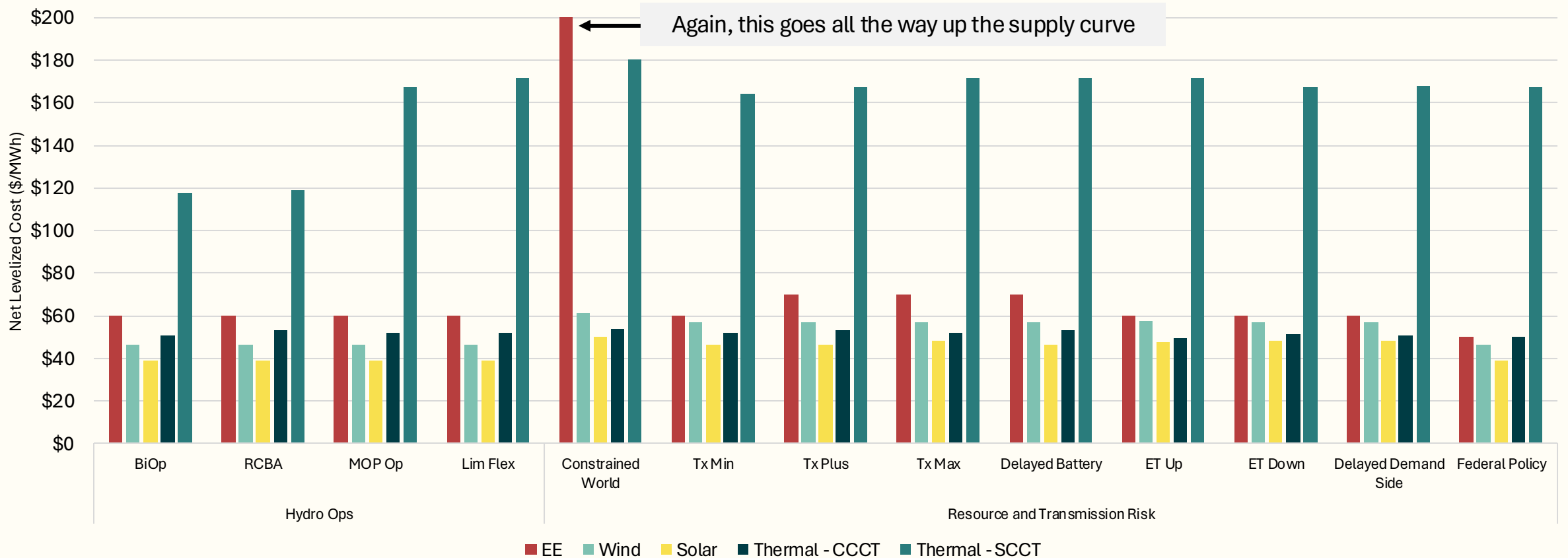
Closer Look at Costs



Comparison of Max Levelized Cost of Selected Resources

Note: These are the **MAX** levelized cost of resources acquired. The weighed average for resources is lower. For example, the weighed average of the SCCT is less than \$100/MWh.

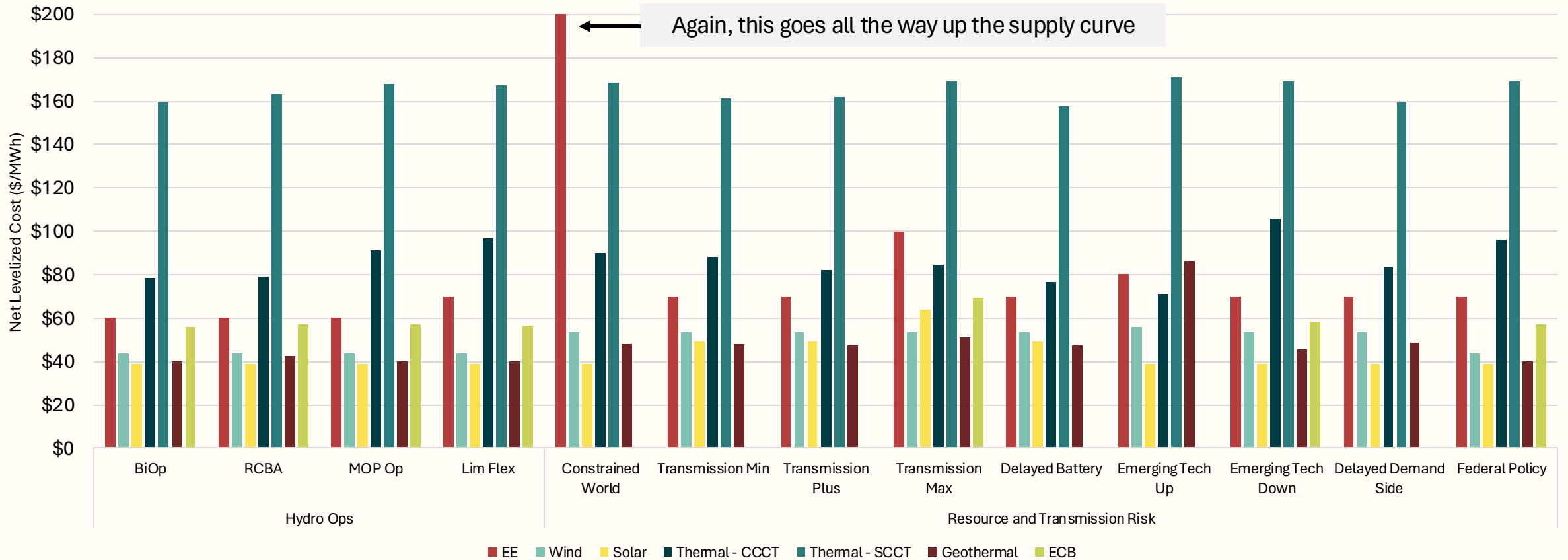
Levelized Cost of Resources Selected in 2032 (excluding storage and DR)



Comparison of Max Levelized Cost of Selected Resources

Note: These are the **MAX** levelized cost of resources acquired. The weighed average for resources is lower. For example, the weighed average of the SCCT is less than \$100/MWh.

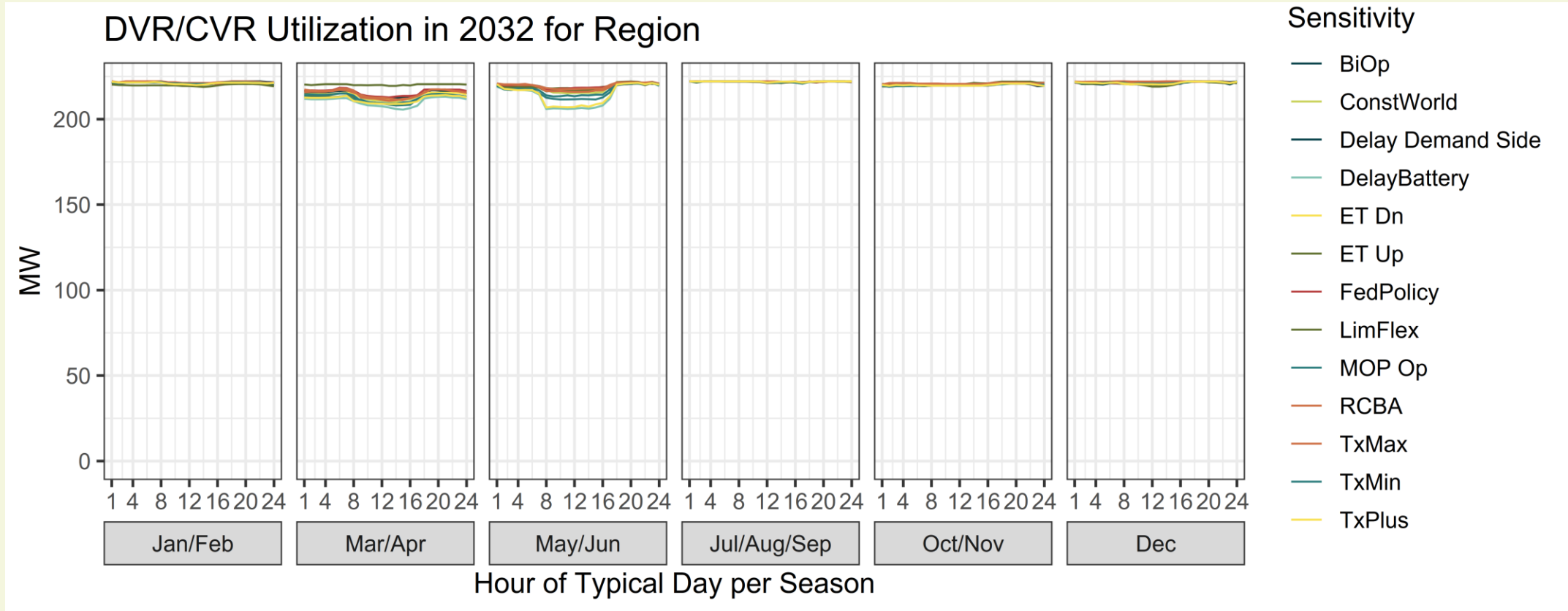
Levelized Cost of Resources Selected in 2046 (except storage and DR)



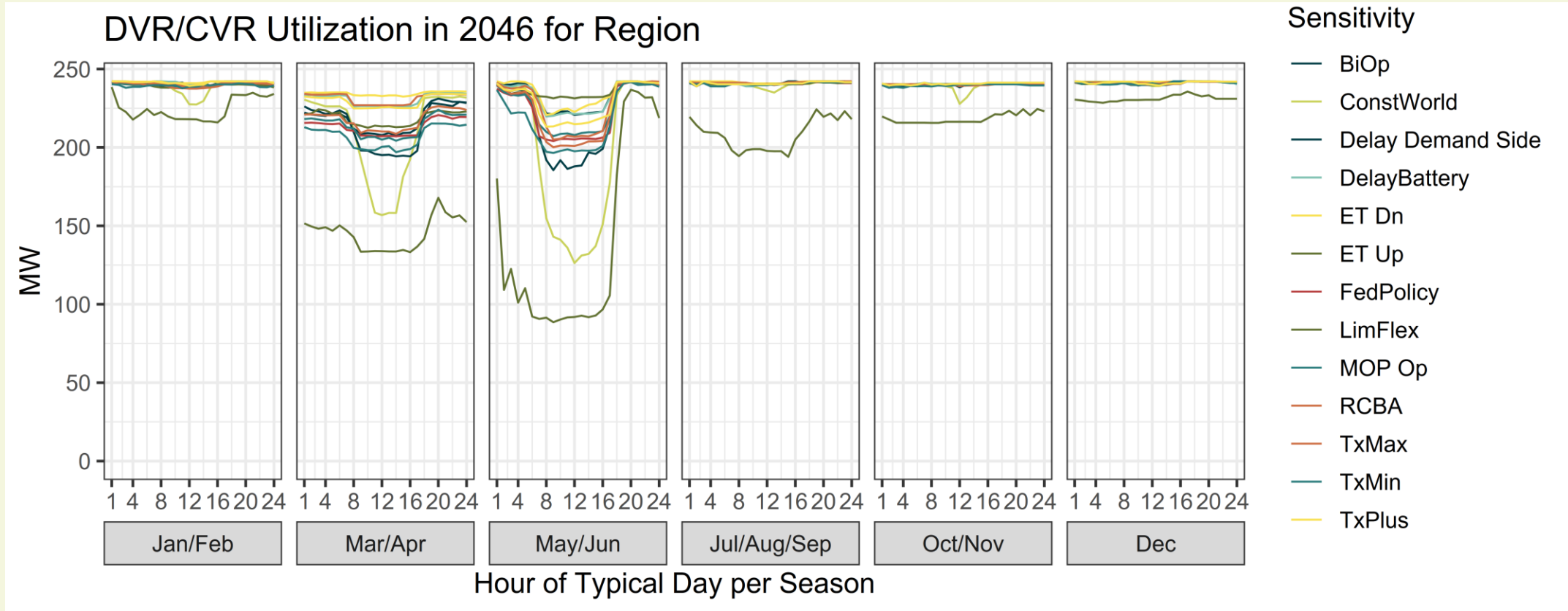
Voltage Regulation Utilization

Staff shared information on voltage regulation for the region, Oregon, and Idaho/Montana. There was a question on the utilization in Washington.

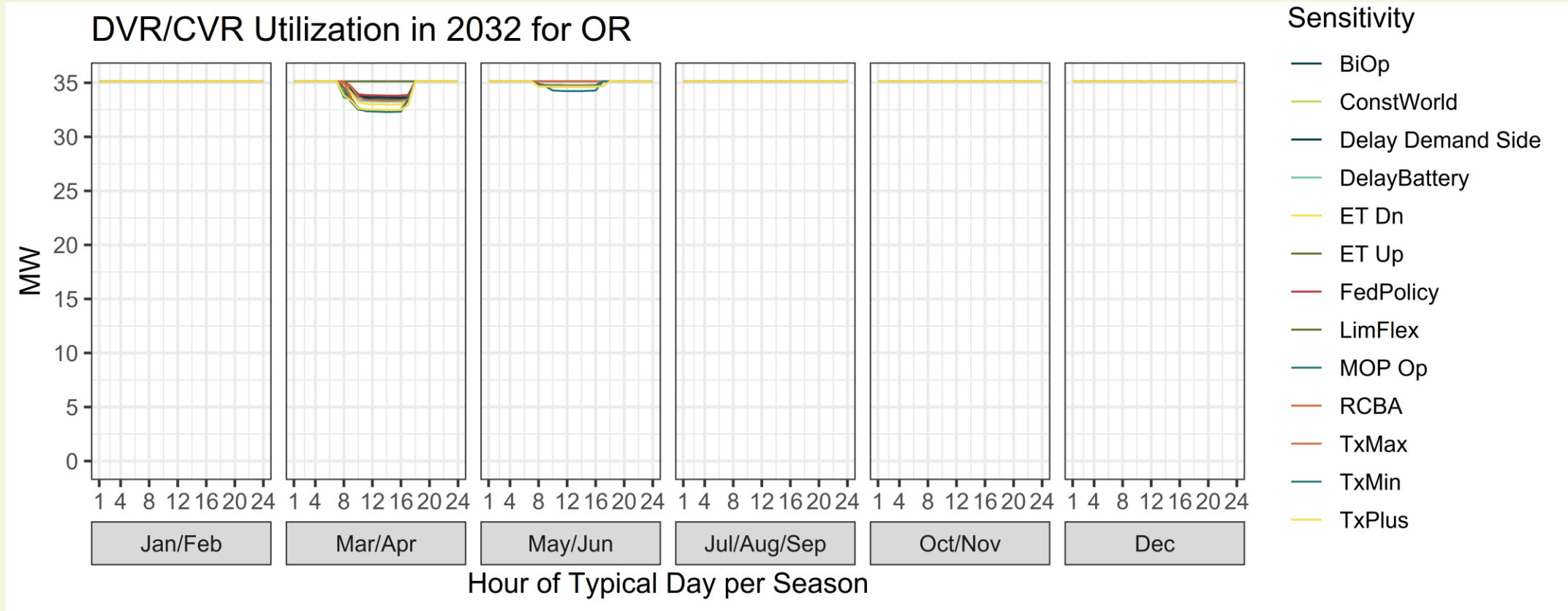
Voltage Regulation Utilization Region in 2032



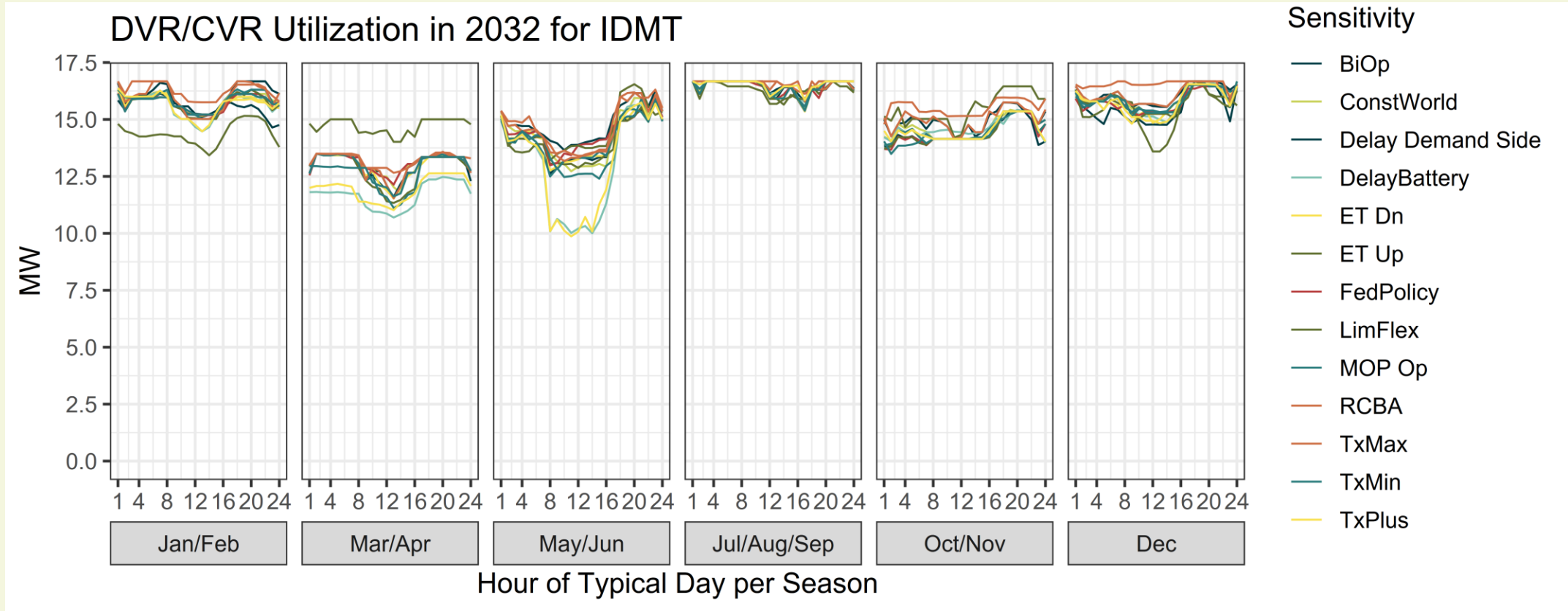
Voltage Regulation Utilization Region in 2046



Voltage Regulation by Location Oregon in 2032

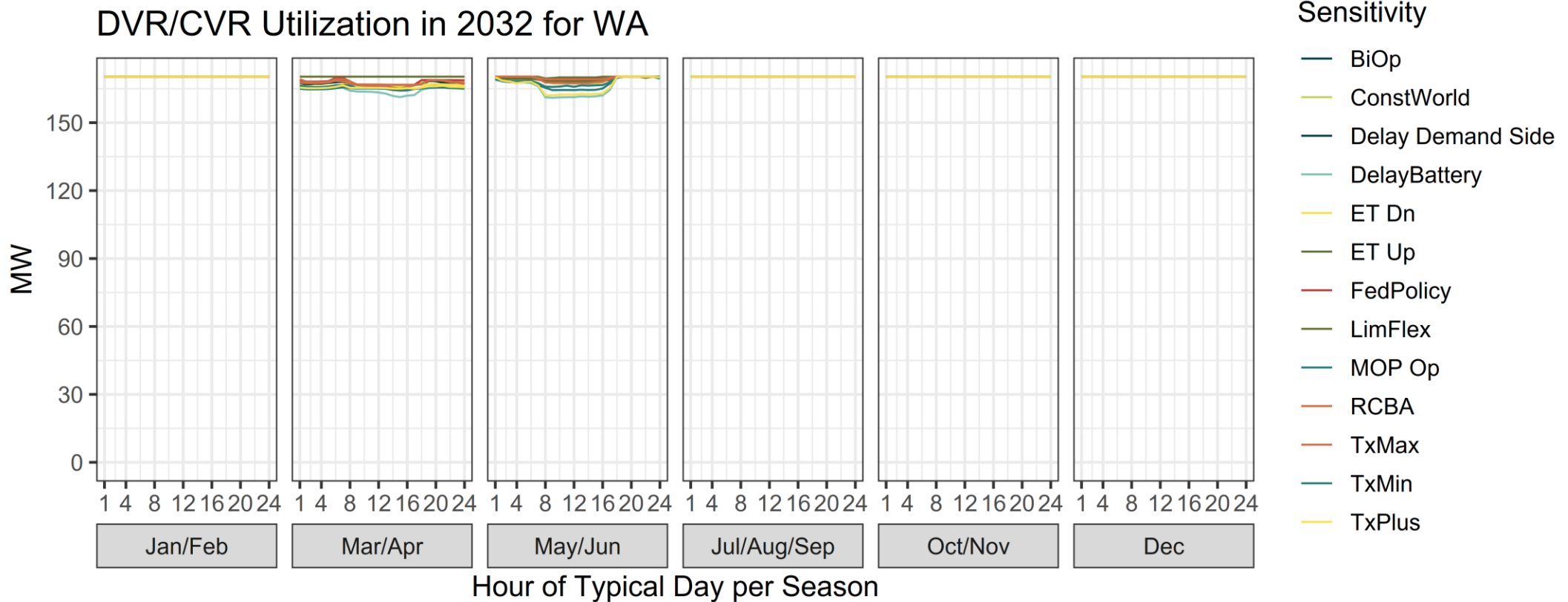


Voltage Regulation by Location Idaho/Montana in 2032

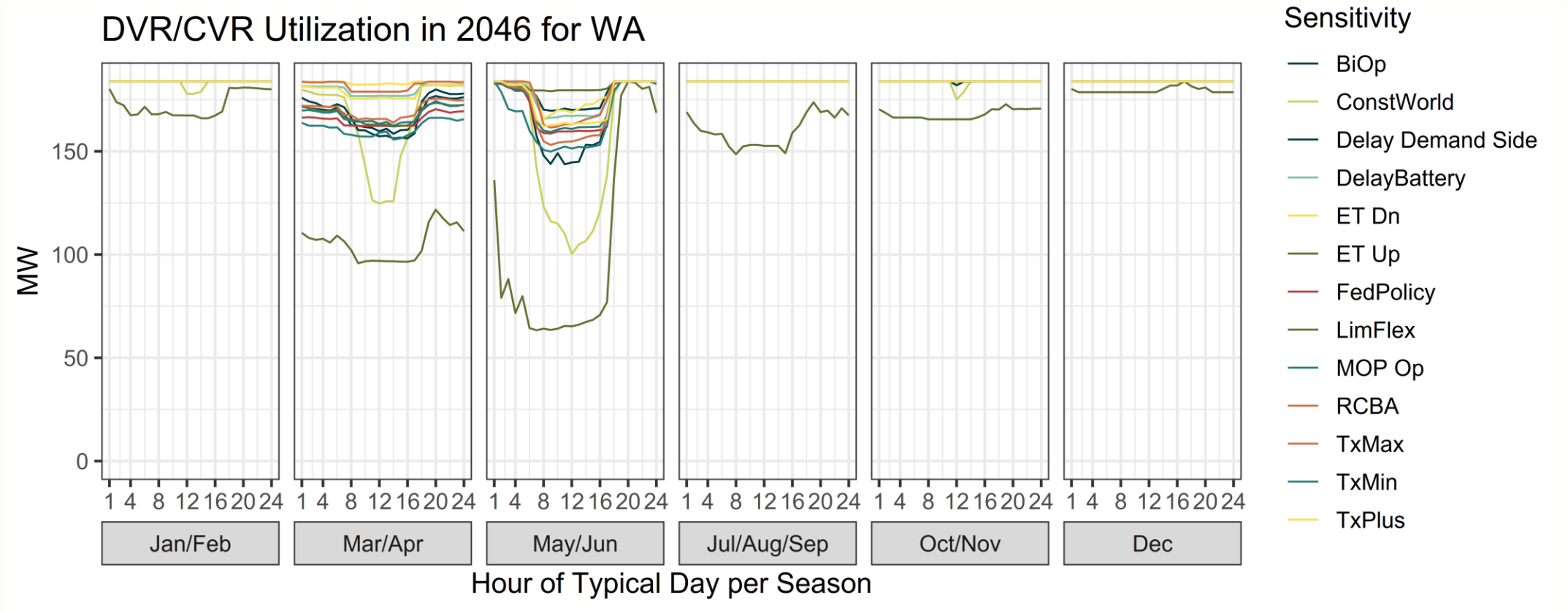


Voltage Regulation by Location

Washington in 2032

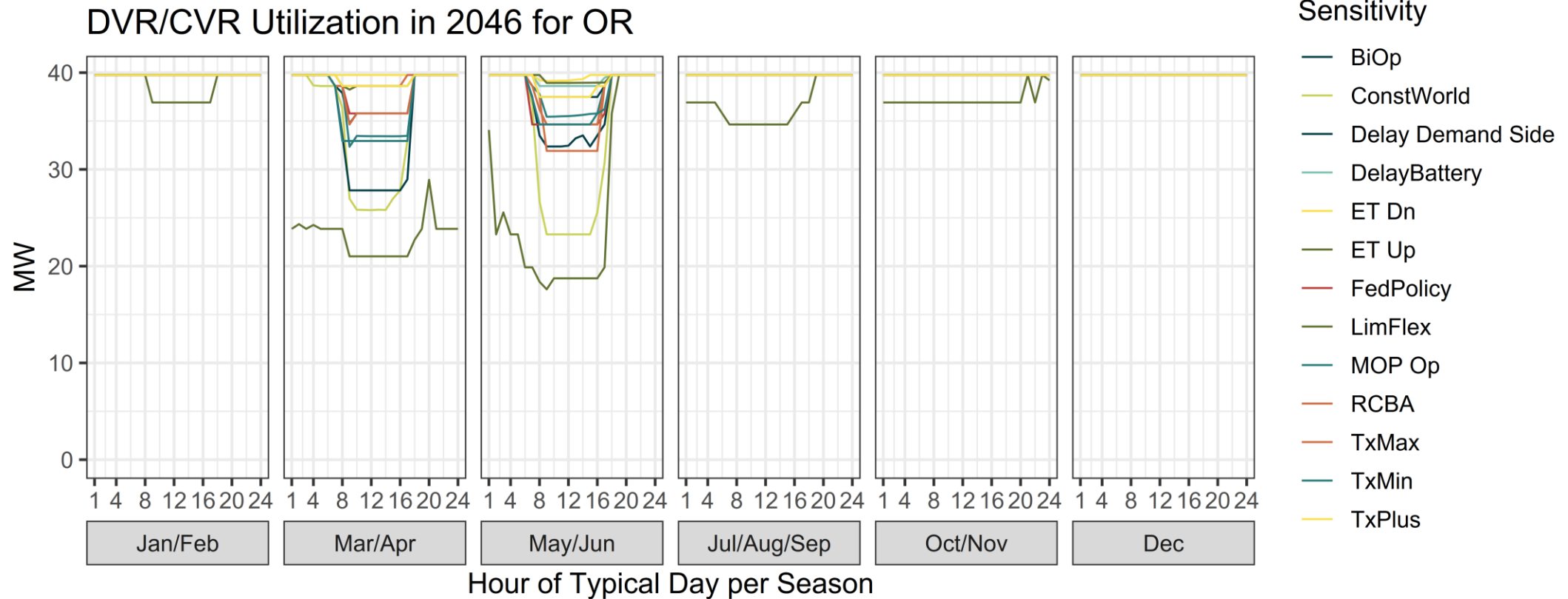


Voltage Regulation by Location Washington in 2046



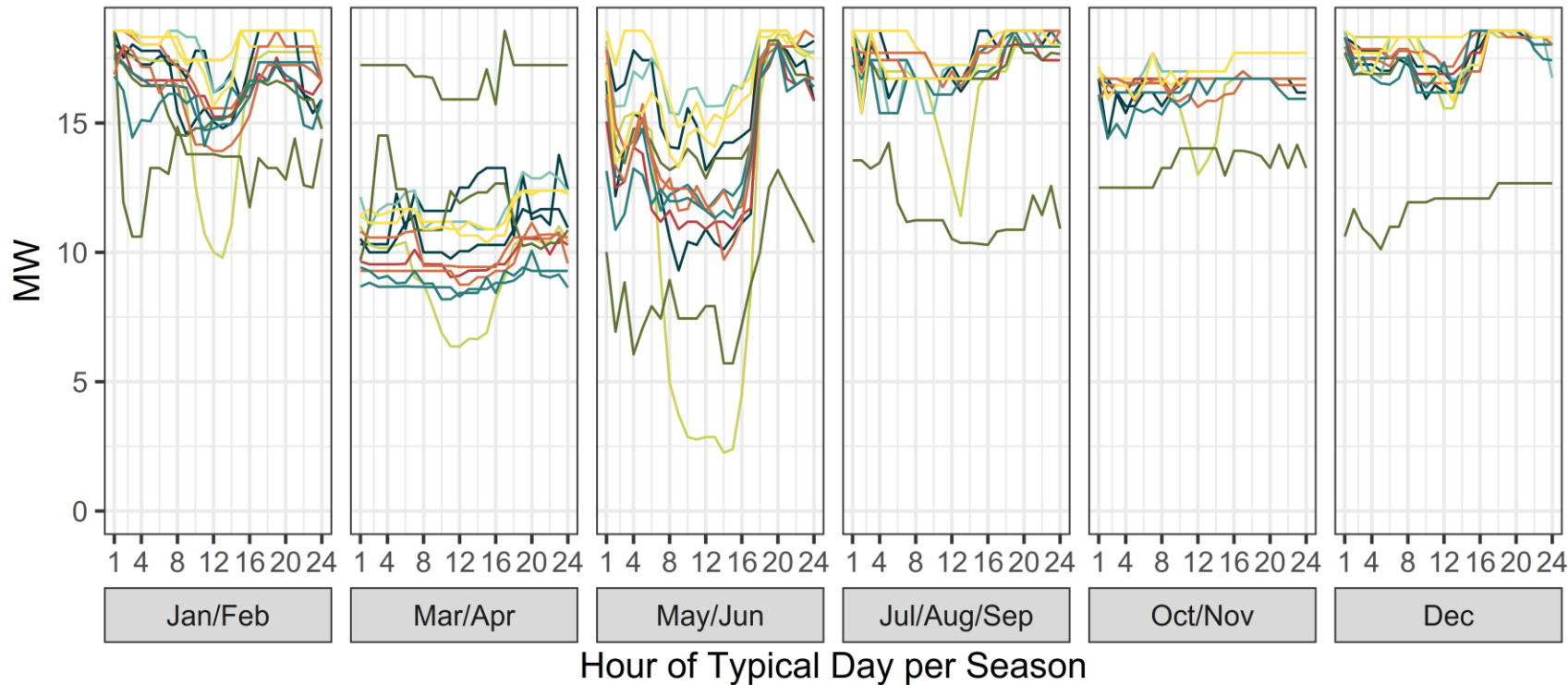
Voltage Regulation by Location

Oregon in 2046



Voltage Regulation Idaho/Montana in 2046

DVR/CVR Utilization in 2046 for IDMT



Sensitivity

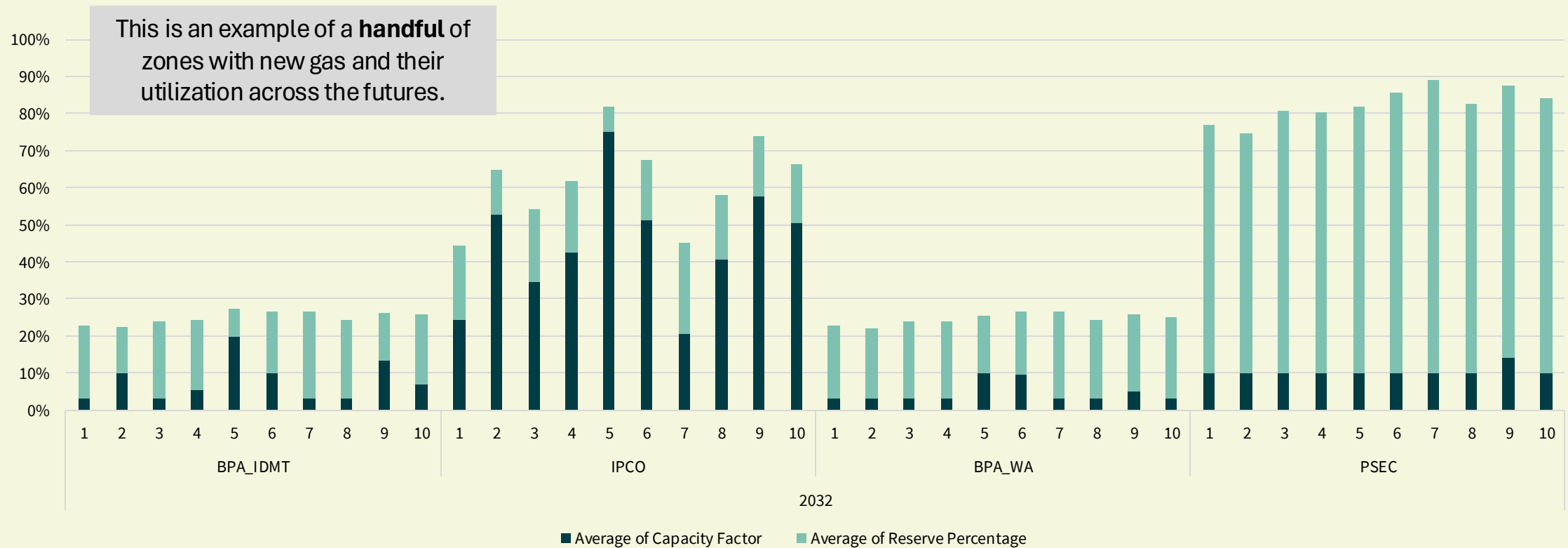
- BiOp
- ConstWorld
- Delay Demand Side
- DelayBattery
- ET Dn
- ET Up
- FedPolicy
- LimFlex
- MOP Op
- RCBA
- TxMax
- TxMin
- TxPlus

Natural Gas Buildout in 2046

Question arose around natural gas utilization in 2046, and if some of the increased generation vs reserves was connected to additional combined cycles.

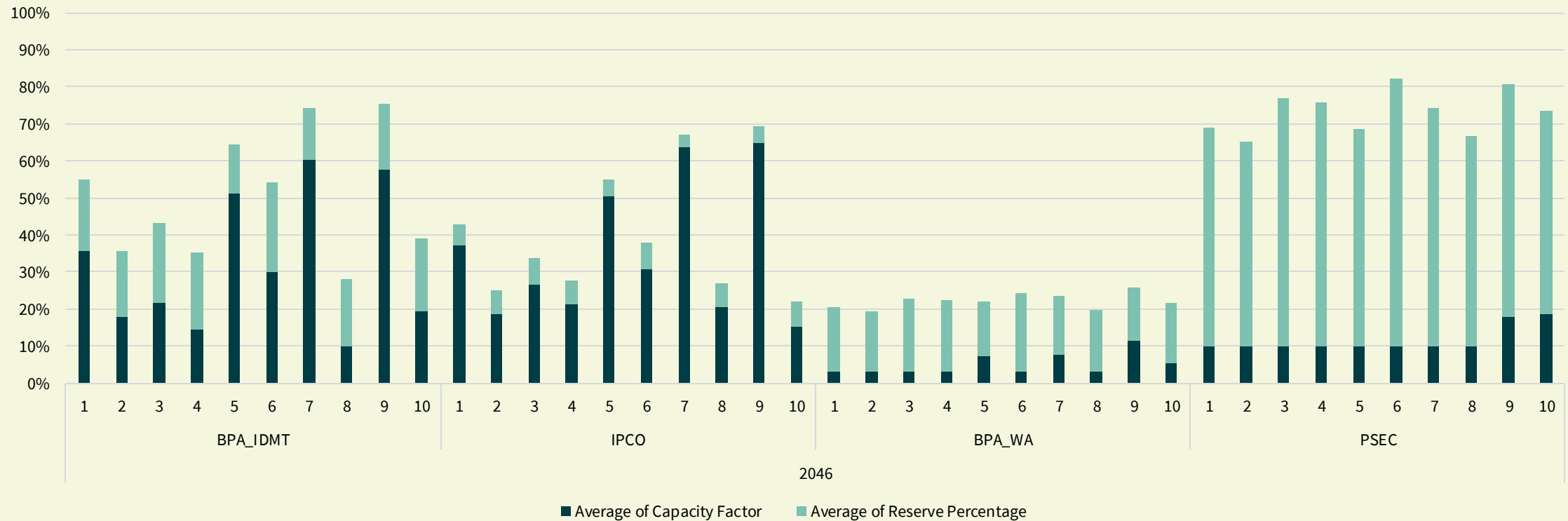
Thermal Utilization of *Some* New Plants, by Future, in 2032

New Natural Gas Thermal Utilization by Future, in Transmission Plus in 2032



Thermal Utilization of *Some* New Plants, by Future in 2046

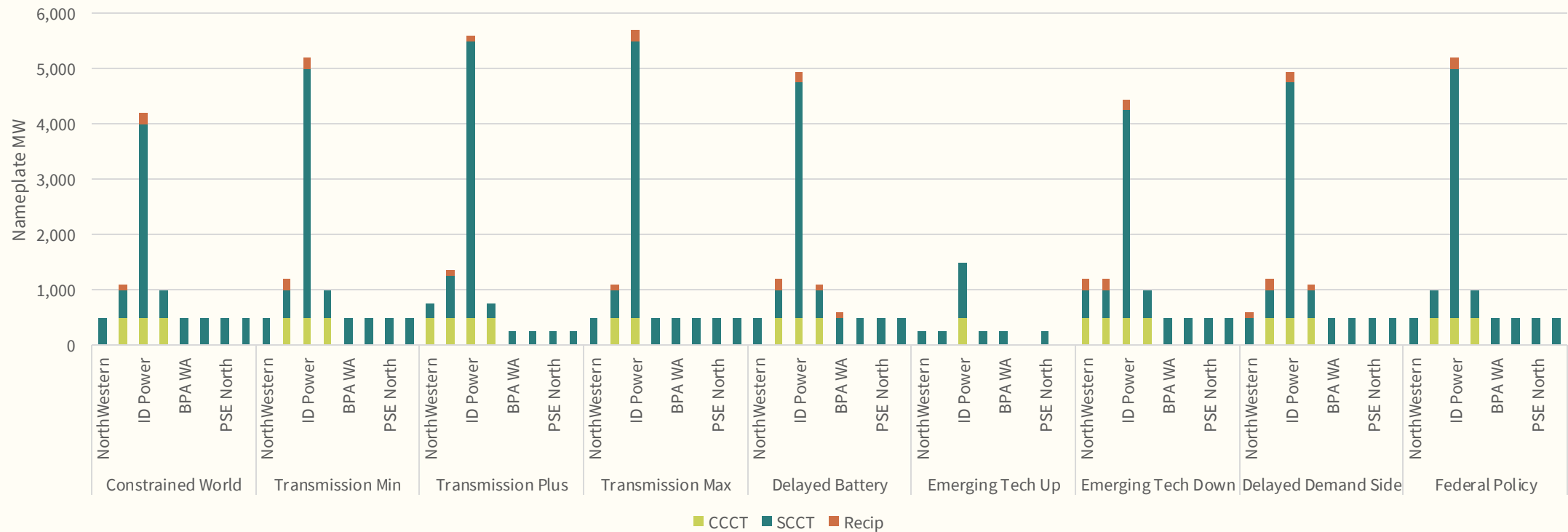
New Natural Gas Thermal Utilization by Future, in Transmission Plus in 2046



New Natural Gas Builds by 2046

Resource and Transmission Risk Sensitivities

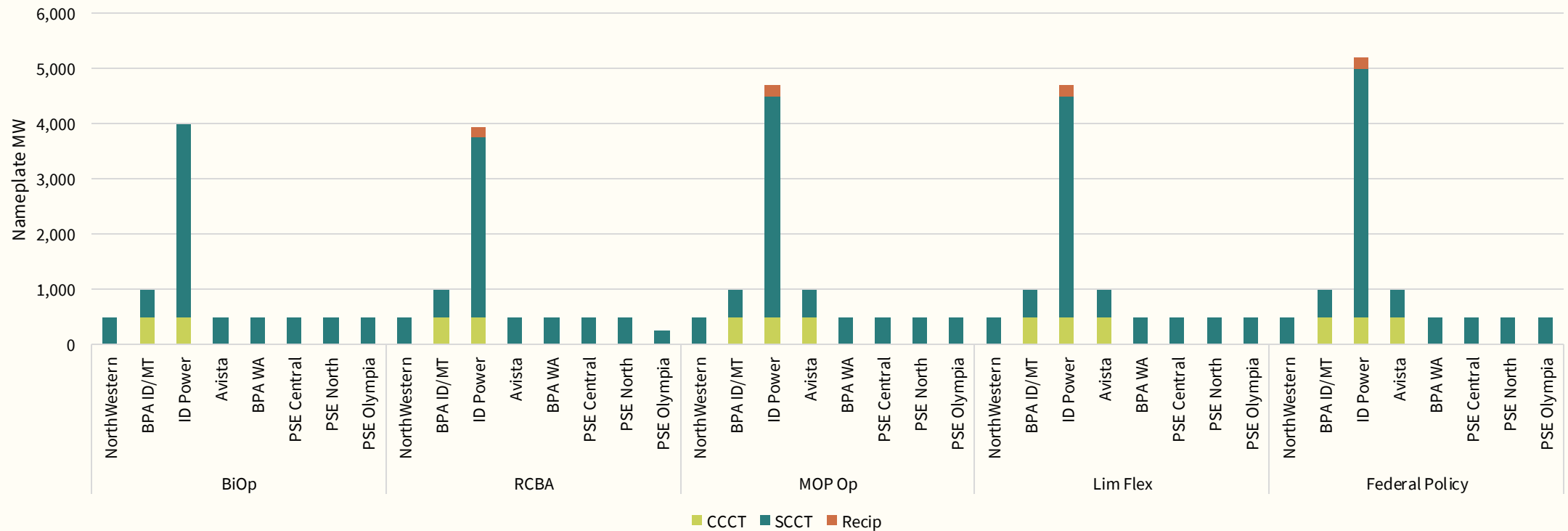
Natural Gas Build by 2046



New Natural Gas Builds by 2046

Hydro Operations Sensitivities and Fed Policy

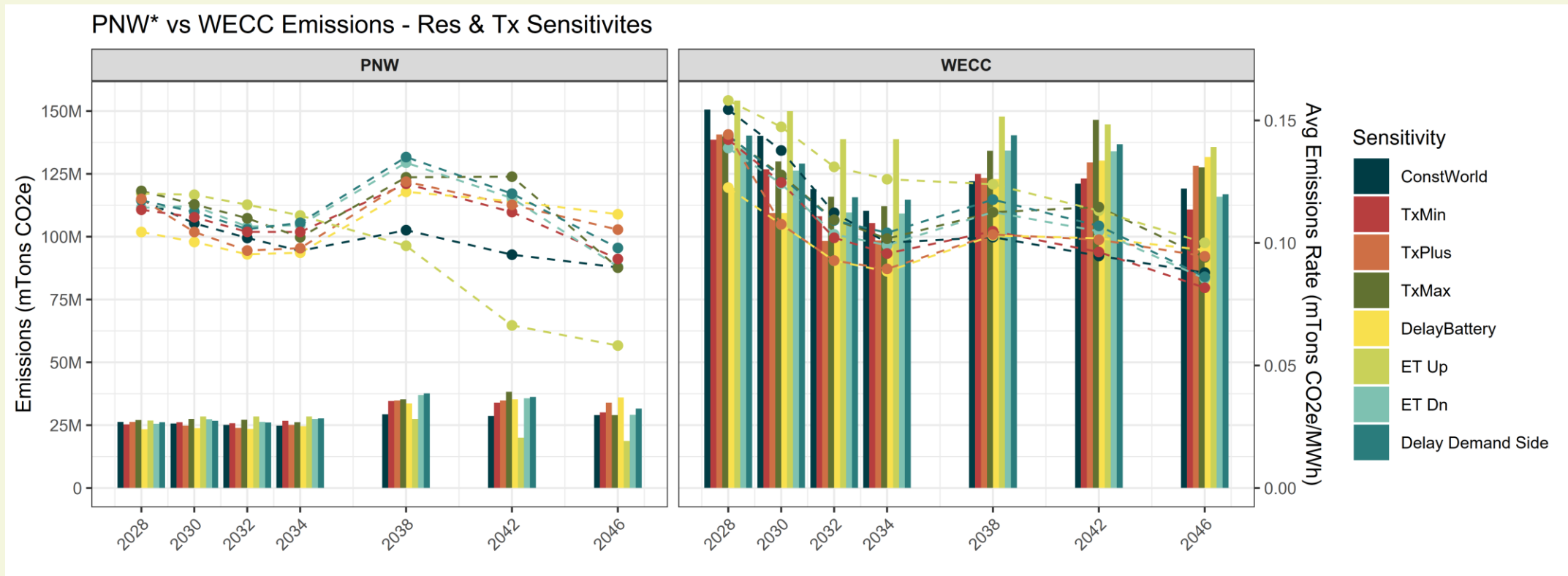
Natural Gas Build by 2046



Near-Term Emissions

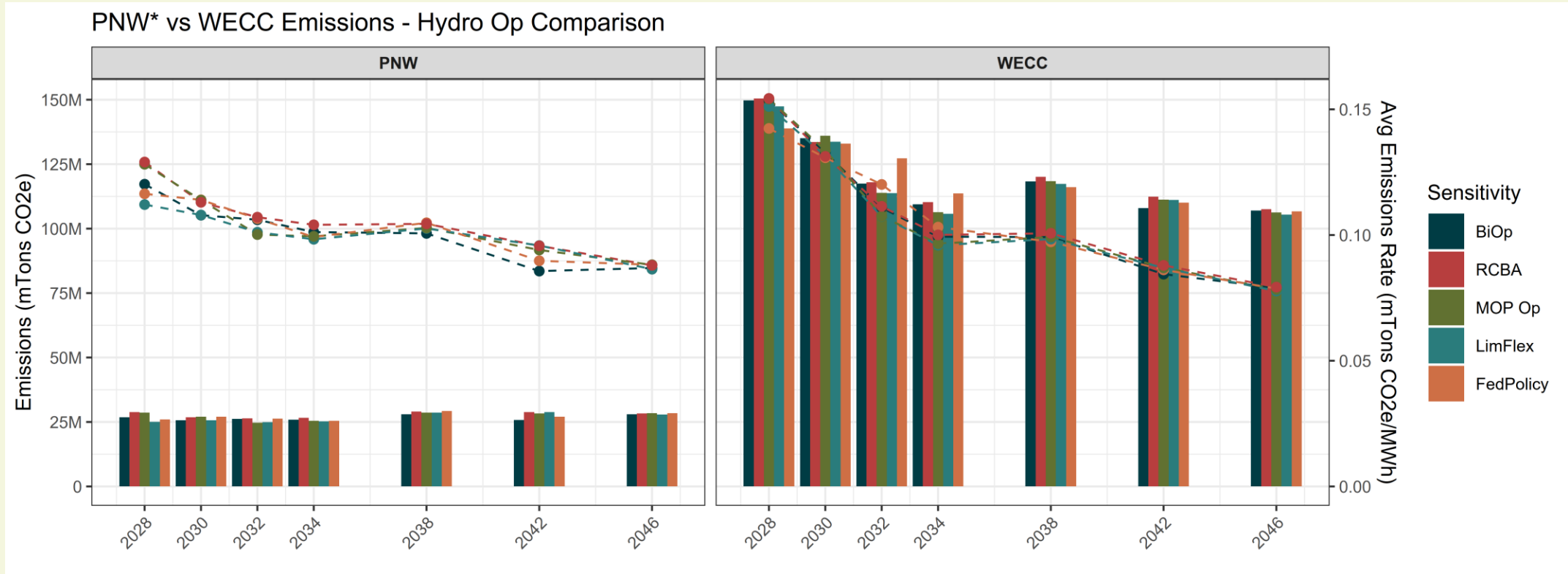
Question around near-term emissions differences between some of the sensitivities.


Emissions for Resource and Transmission Risk Sensitivities




! Northwest values represent in region generation and do not account for market transactions.

Emissions for Hydro Ops Sensitivities and Fed Policy Sensitivity



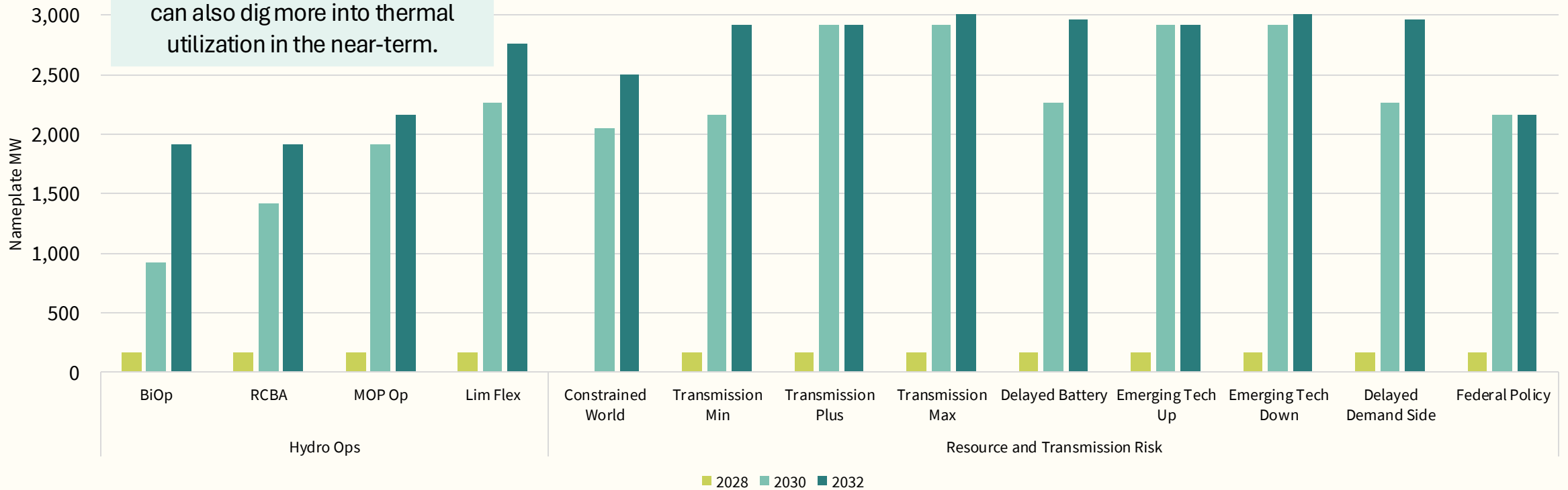
 Northwest values represent in region generation and do not account for market transactions.

Natural Gas Buildout in Action Plan

 More to bring on this topic.

We do see some differences in 2030 builds, which could lead to differences in 2030 emissions. We can also dig more into thermal utilization in the near-term.

Natural Gas Buildout in Action Plan Period



Role of Reserves and Market

Staff discussed that more work was needed to show differences across futures, more on reserves, and more on market. The following slides provide a **brief** preview on how we are digging into some of these insights. We will bring more information at a future meeting.

Regional Load Resource Balance Looks Different By Year, Future and Sensitivity

- The typical day load resource balance reflects the following:
 1. Expected typical day loads and reserves per future
 2. Sample renewable generation
 3. Hydro, thermal and battery generation and reserve provision
 4. Net out-of-region market imports and exports
- The typical day load resource balance will change depending on the following:
 1. **Future** – Load, gas price/volatility, hydro and renewable fuel availability
 2. **Year** – Changing adequacy and policy obligations
 3. **Sensitivity** – Changing buildout of resources per assumptions

Different load resource balance profiles reflect different economics

- Sometimes different resource attributes will be more or less valuable versus a market resource depending on the following:
 1. Fuel availability/price timing
 2. Demand or reserve obligation timing
- Thermal generation/reserve, market, storage reserves and DVR/CVR are readily available
- Hydro, long and mid duration storage generation are often available
- Renewable generation and short duration storage generation are sometimes available

Load Resource Balance Graph 101

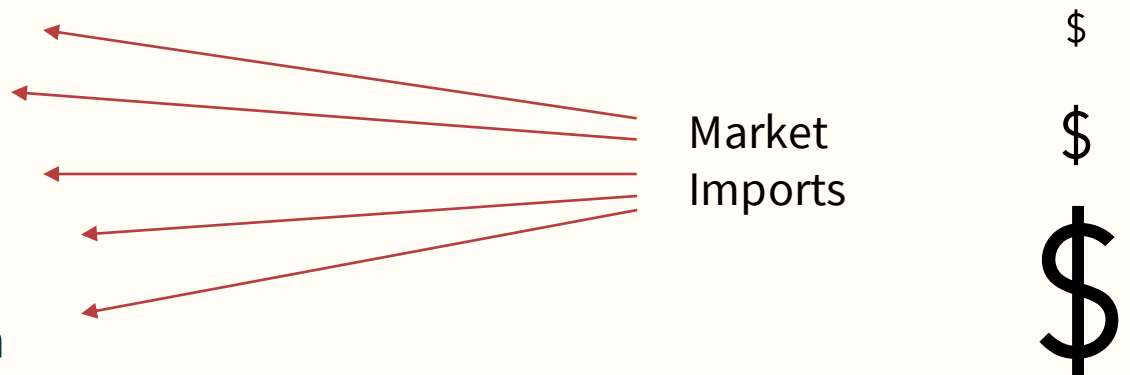
- *Resources* should add up in every hour to meet *Adjusted Demand*.

$$\text{Adjusted Demand} = \text{Demand} + \text{Market Exports}$$

$$\text{Resources} = \text{Generation} + \text{Storage} + \text{DSM} + \text{Market Imports}$$

- *Resources* have differing variable costs listed here in increasing order.

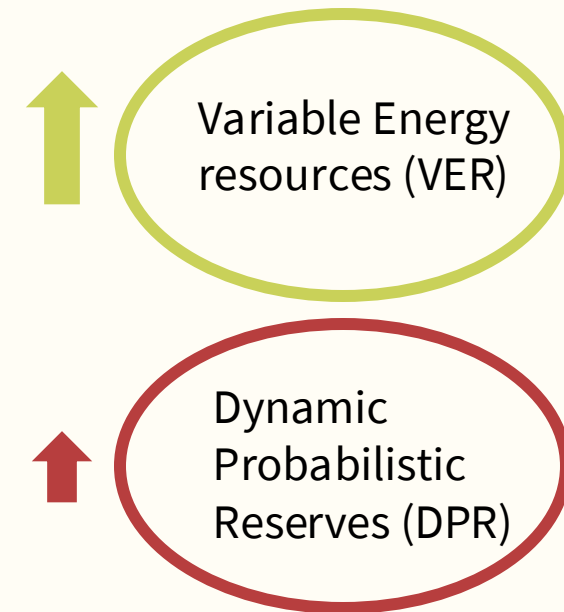
1. Energy efficiency/Demand Response*/CVR/DVR
2. Variable Energy Resources (VER)
3. Hydro Generation
4. Efficient Thermal Generation
5. Storage*
6. Less Efficient Thermal Generation



Load Resource Balance Graph 201

- *Reserves* should add up in every hour to meet *Total Reserves Reqt.*
$$\text{Total Reserves Reqt} = \text{Planning Reserves} + \text{DPR}$$
$$\text{Reserves} = \text{Generation Reserves} + \text{Storage Reserves}$$
- *Reserves* have differing variable costs listed here in increasing order.
 1. DVR
 2. Storage*
 3. Hydro Reserves
 4. Efficient Thermal Reserves
 - High Min Gen, Efficient Heat Rate
 - Low Min Gen, Inefficient Heat Rate
 5. Less Efficient Thermal Generation
 - High Min Gen, Inefficient Heat Rate
- ***Resource + Reserves cannot be more than Capability***

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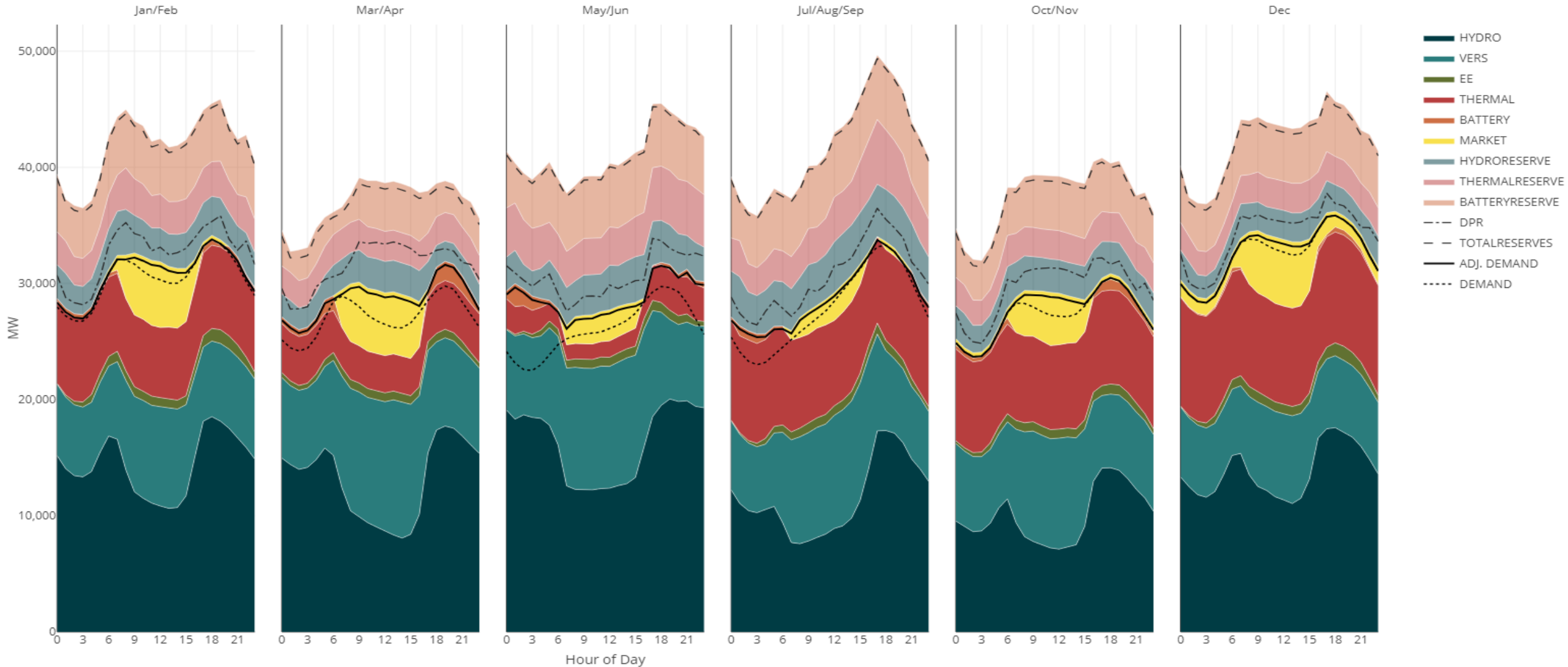


By Future

Different Hydro, Demand, Renewable and Gas Price/Volatility

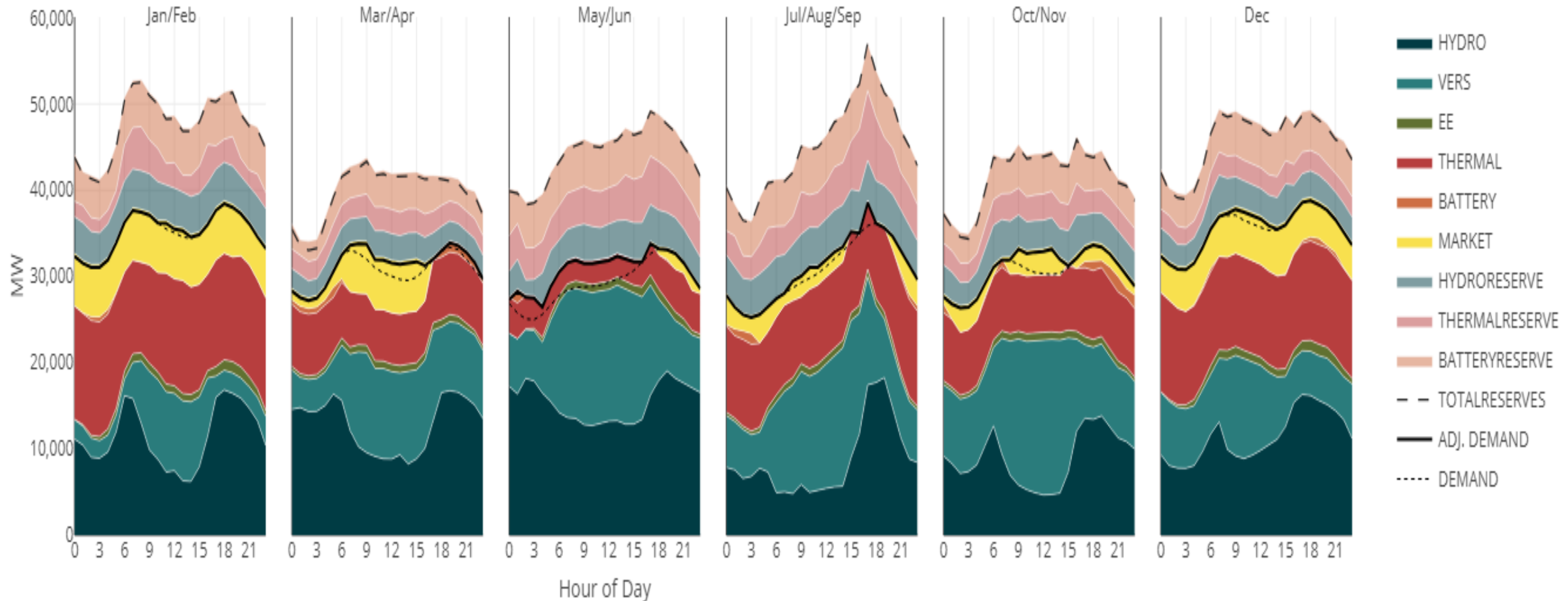
2032 Transmission Plus – Expected Hydro/Load

RATS_TxPlus 2032 Load Resource Balance — Avg. All Futures, Wtd. Avg. Hour



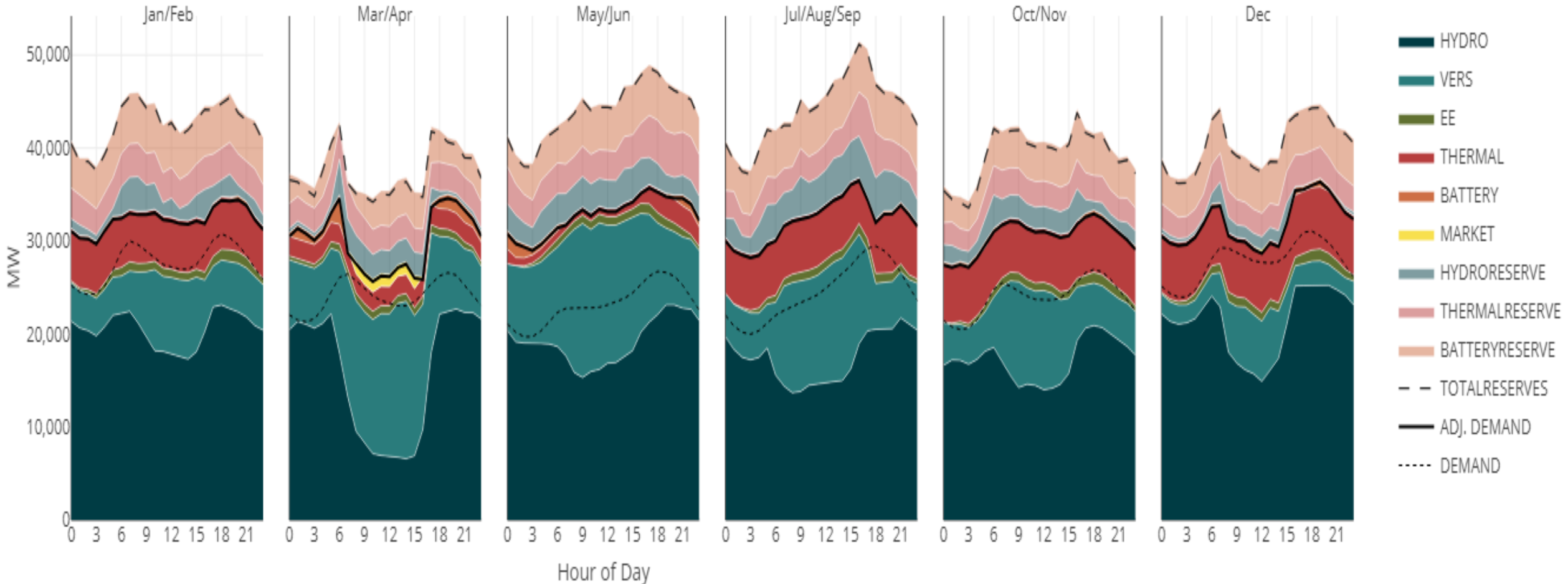
2032 Transmission Plus – High Load, Low Hydro

RATS_TxMax 2032 Load Resource Balance — Future 9 | Weekday



2032 Transmission Plus – High Hydro, Low Load

RATS_TxMax 2032 Load Resource Balance — Future 8 | Weekday

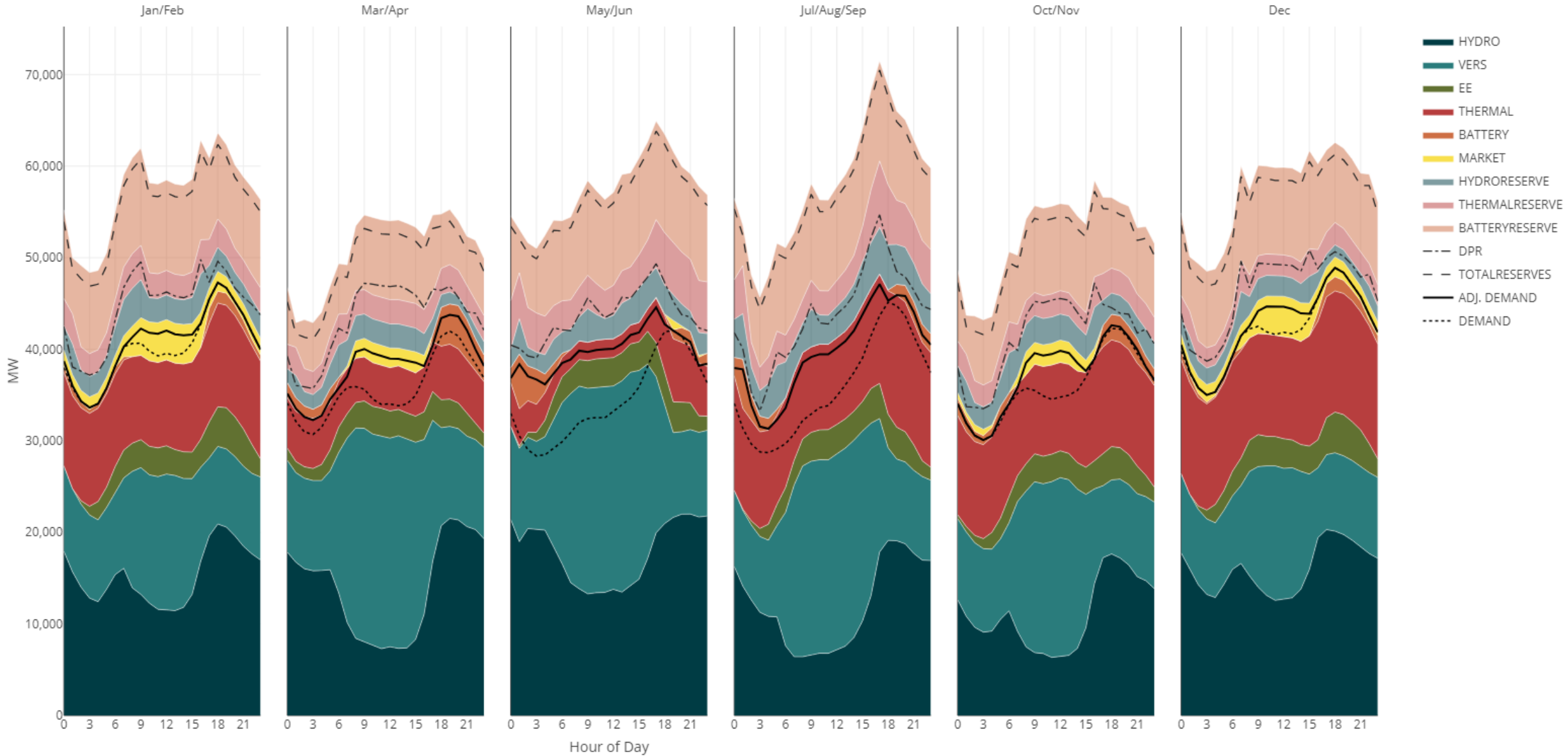


By Sensitivity

Different buildouts will affect regional fundamentals

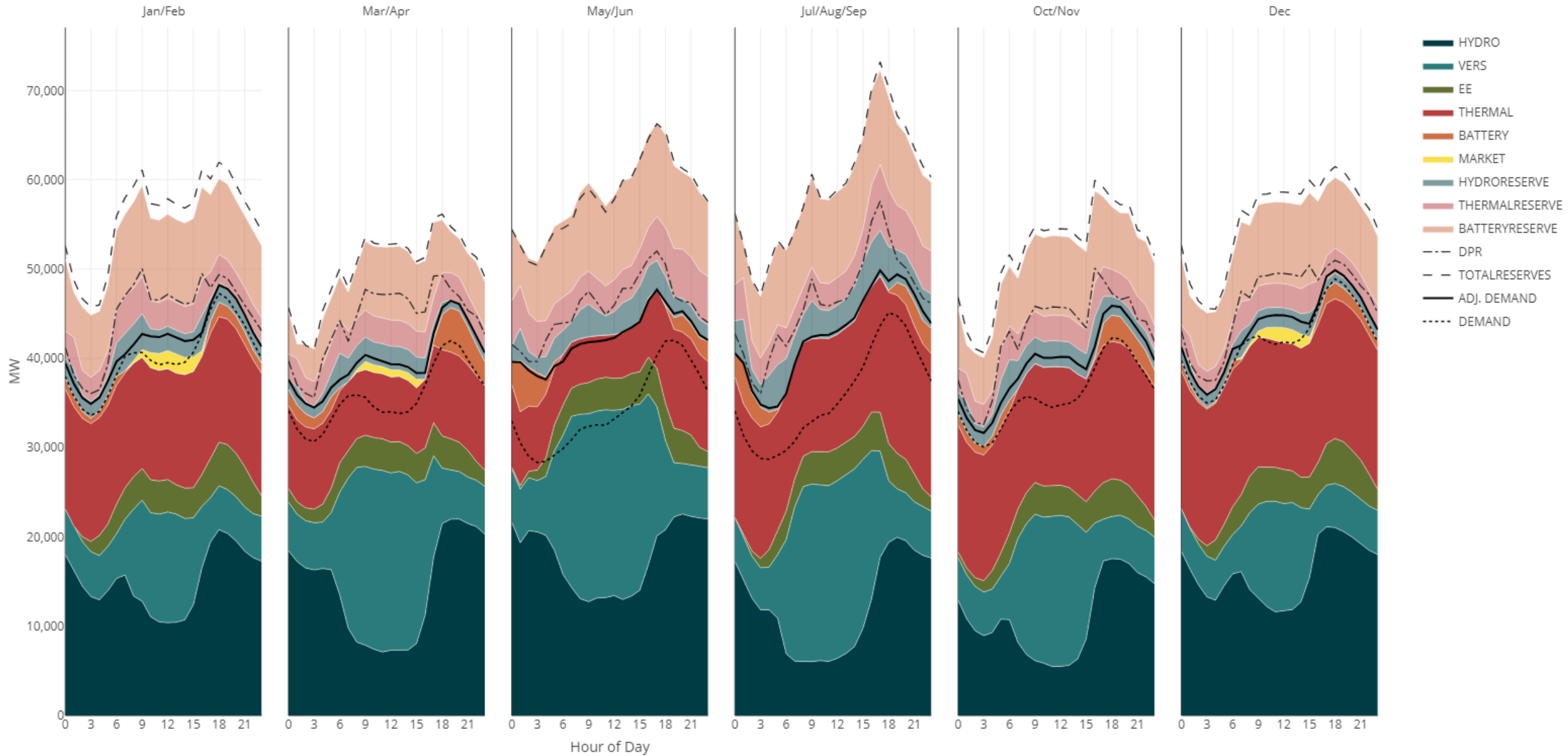
2046 Transmission Plus

RATS_TxPlus 2046 Load Resource Balance — Avg. All Futures, Wtd. Avg. Hour



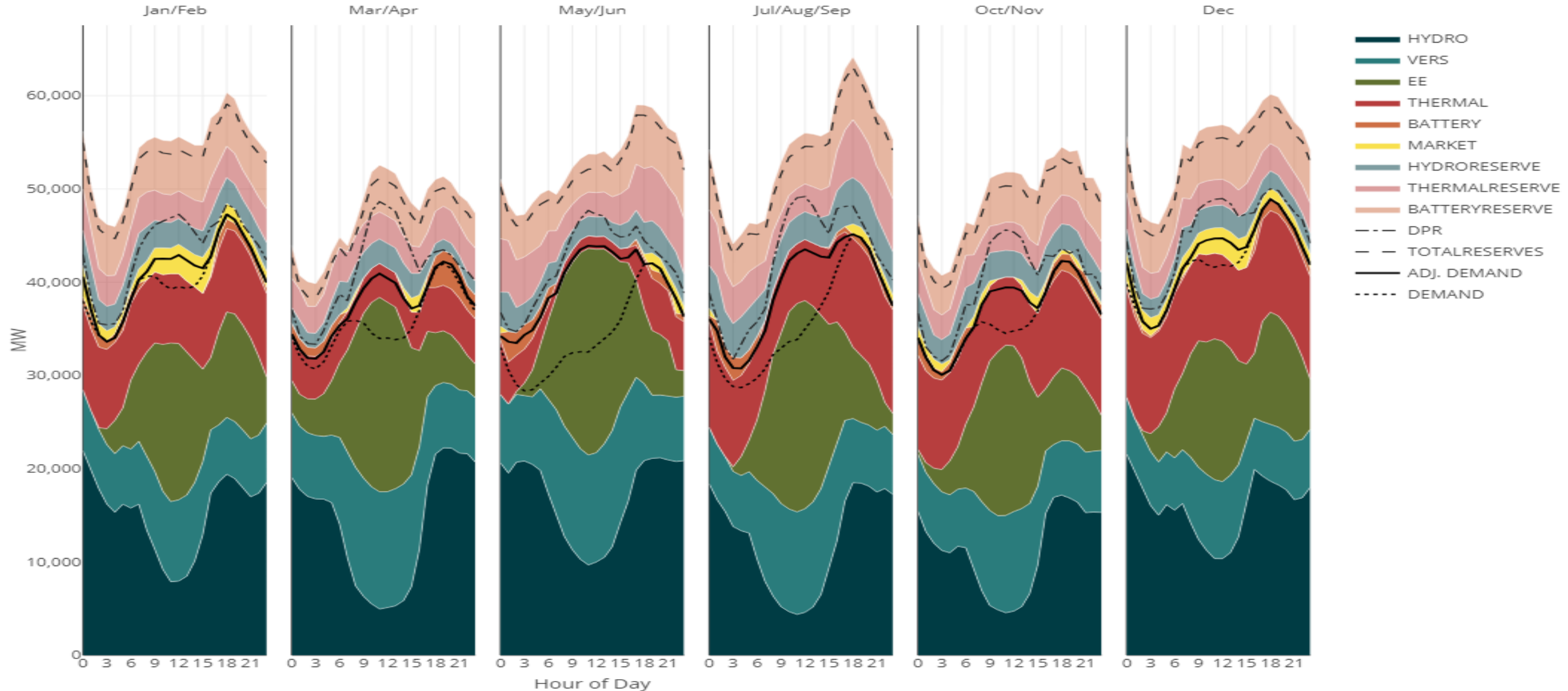
2046 Transmission Max

RATS_TxMax 2046 Load Resource Balance — Avg. All Futures, Wtd. Avg. Hour



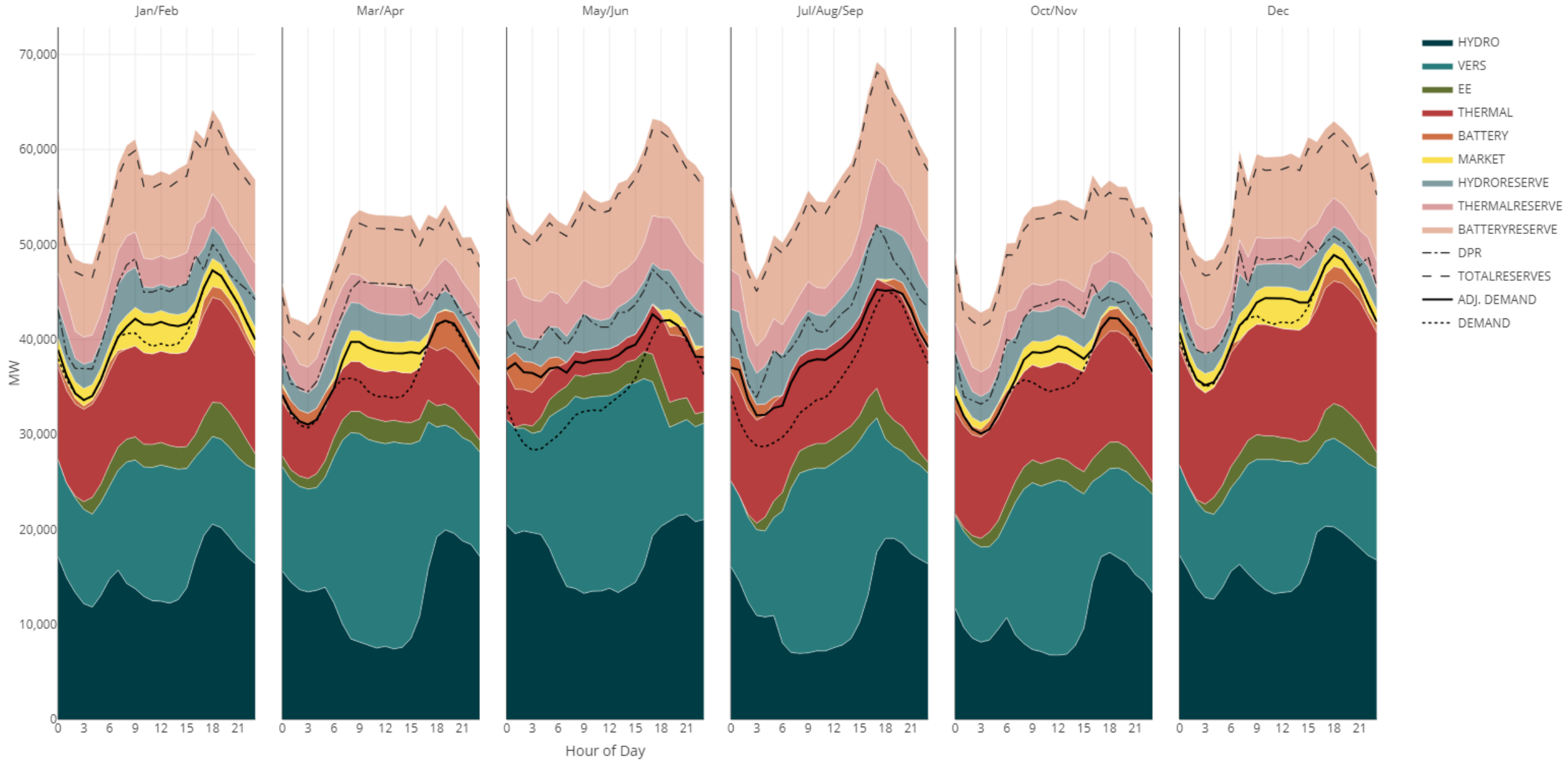
2046 Constrained World

RATS_ConstWorld 2046 Load Resource Balance — Avg. All Futures, Wtd. Avg. Hour



2046 Fed Policy

RATS_FedPolicy 2046 Load Resource Balance — Avg. All Futures, Wtd. Avg. Hour



Questions?

- Are there any remaining questions around the material we presented so far?
- Are there other questions you were hoping we would provide information on that we haven't yet answered?

Draft Chapters 1-3

Reviewing Draft Chapters

- Staff have developed draft chapters for review and discussion
- All material has been drafted to reflect existing Council decisions around the Ninth Power Plan
- Staff are taking notes during the discussion and will develop another draft with redlines for review at the next Council meeting

Table of Contents

- **Executive Summary/Introduction**

- **Ch 1: Power Act Requirements**

- Context for the Act
- Purposes of the Power Act
- Power Plan Provisions in the Power Act
- Public Engagement in the Power Plan Development
- Relationship of the Power Plan to Bonneville and the Region
- Relationship to the Council's Fish and Wildlife Program

- **Ch 2: Existing Northwest Power System**

- Existing Resource Base
- Current Issues Impacting the Northwest Power System
- The Council's Fish and Wildlife Program

- **Ch 3: Future Electricity Needs and New Resource Potential**

- Planning under uncertainty
- Electricity demand forecasts
- New Resource Needs
- New Resource Potential

- **Ch 4: Action Plan: Recommended Resource Strategy for Bonneville and the Region**

- Results discussion
- Action Plan Recommendations

- **Ch. 5: Conservation Program**

**Further Discussion or
Direction?**

Additional Slides

Resource Option

Resource Cost

Load

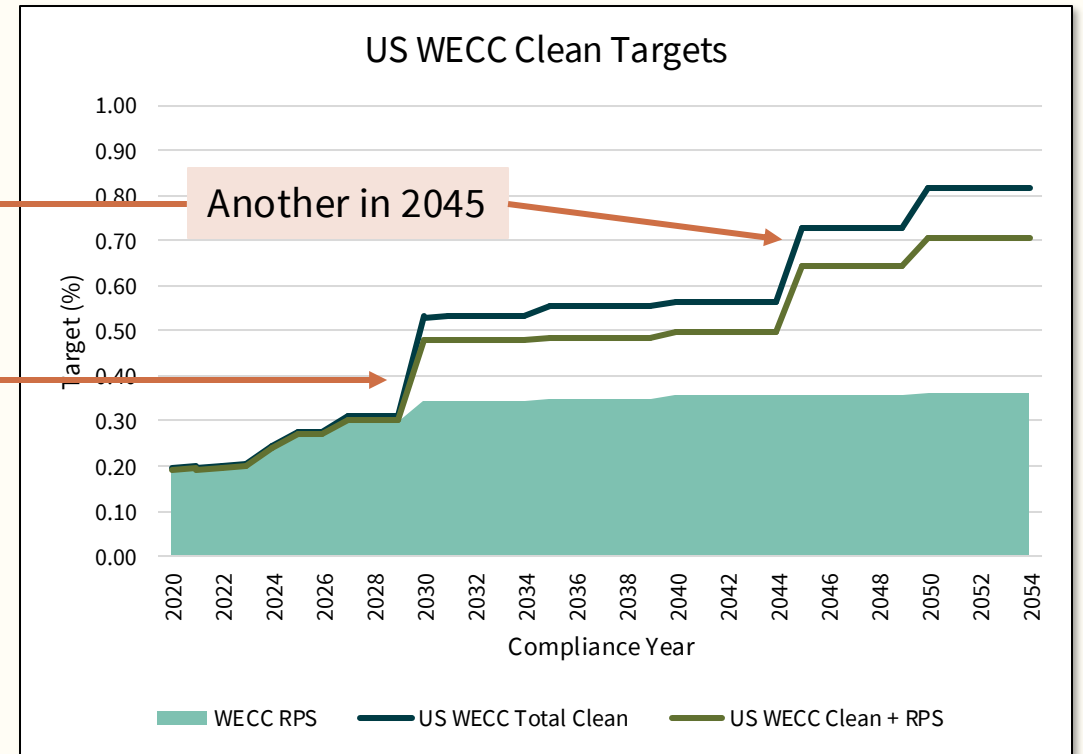
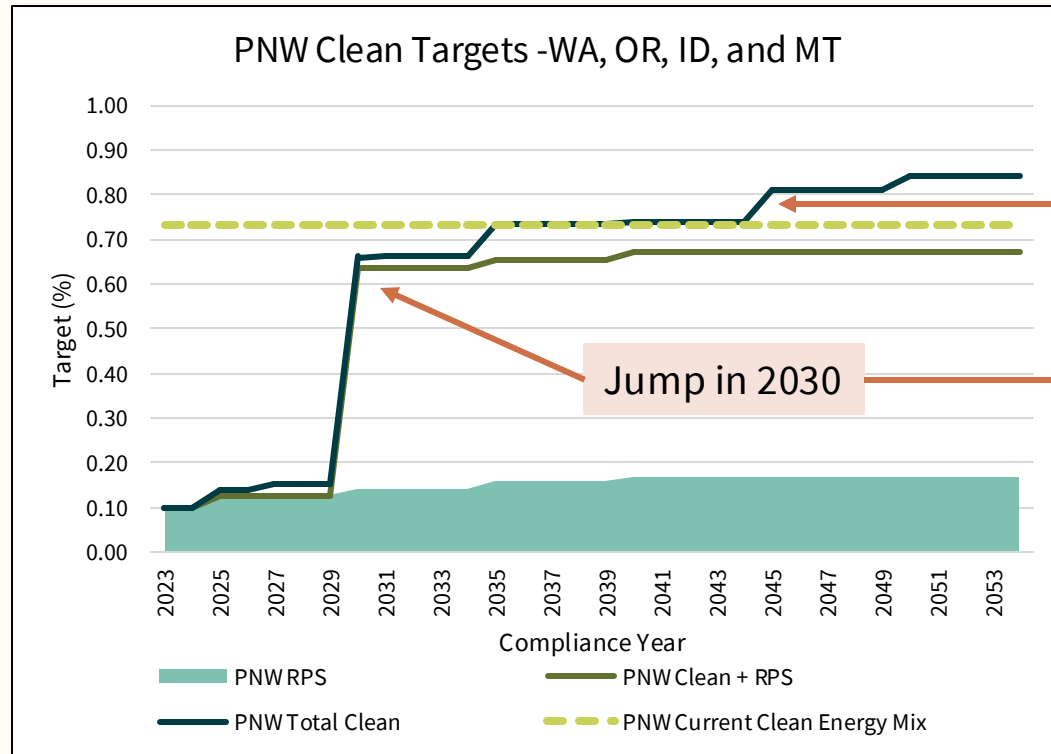
- **Oregon:**
 - HB2021
 - SB1547 Community Solar
 - Renewable Portfolio Standard
- **Washington:**
 - Clean Energy Transition Act
 - Renewable Portfolio Standard
- **Montana:**
 - Missoula/Helena/Bozeman City-Wide Clean Goals
 - NorthWestern Energy “NetZero Vision”
- **Idaho:**
 - Boise’s Energy Future
 - Idaho Power Clean Goal
 - Avista Clean Goal

- **Washington:**
 - CETA—Social Cost of Carbon to be incorporated into utility planning

Notably, most policies that impact resource costs are set at the federal level

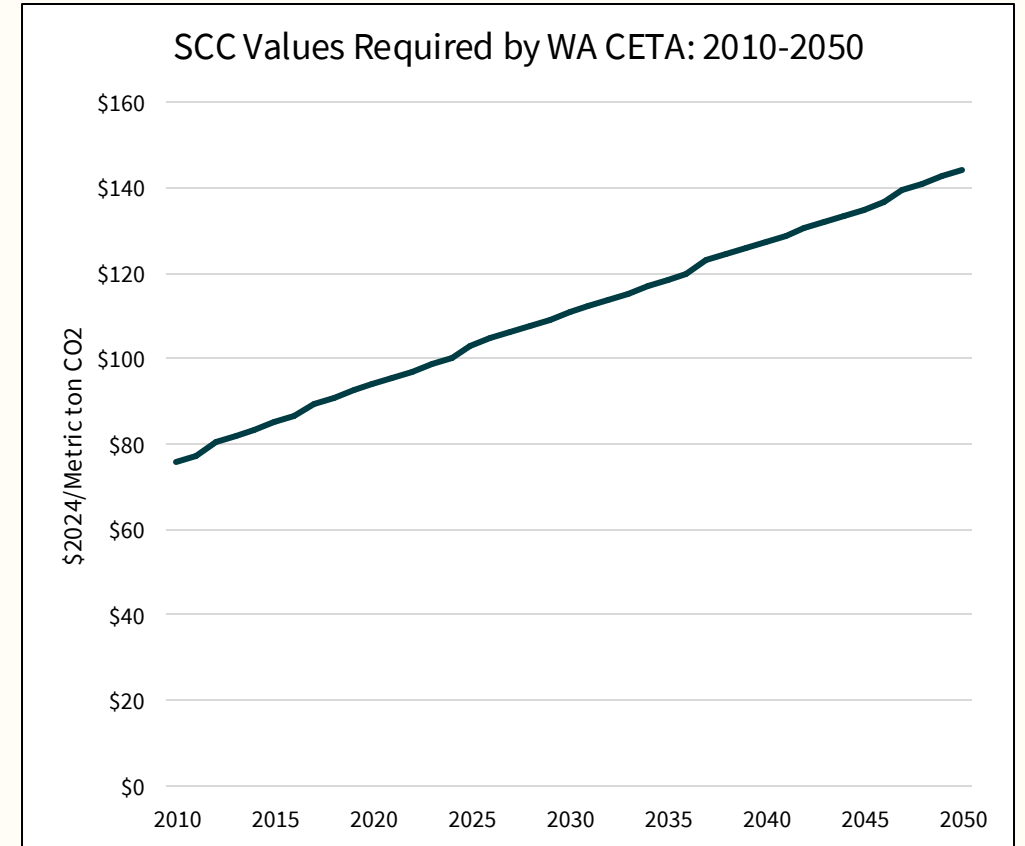
- **Oregon:**
 - Climate Protection Program 2024
 - Advanced Clean Cars
 - Energy Performance Standard for Commercial Buildings
 - State Codes & Standards
- **Washington:**
 - Climate Commitment Act
 - Advanced Clean Cars
 - Clean Fuel Standard
 - Clean Building Performance Standard
 - State Codes & Standards

Resulting Clean Targets



Social Cost of Carbon

- Under WA Clean Energy Transformation Act requirements, utilities in the state must plan using the social cost of carbon
- For this plan, to ensure consistency with policy, modeling assumes a SCC in WA only



Methodology to Quantify Environmental Costs and Benefits of New Resources

Cost of compliance with existing regulations

Council planning assumes all resources will meet existing regulations, and therefore, we use the cost of compliance (when quantifiable) as the primary way of accounting for environmental costs.

Environmental effects beyond regulatory controls, if case-by-case to quantify

This category includes both residual effects beyond regulations and unregulated effects. Typically, these are not quantified. Quantification is challenging and data are rarely available. There is also risk of skewing the analysis towards effects quantified, rather than considering all.

Cost of compliance with proposed environmental regulations

Council has dealt with this on a case-by-case basis depending on the environmental effect and the data. We are not aware of any proposed regulations to potentially consider for this power plan.

Quantifiable environmental benefits

Several difficulties in quantifying environmental benefits related to available data, double counting, skewing towards some effects for which costs are available and not others, etc. Therefore, these are typically dealt with qualitatively.


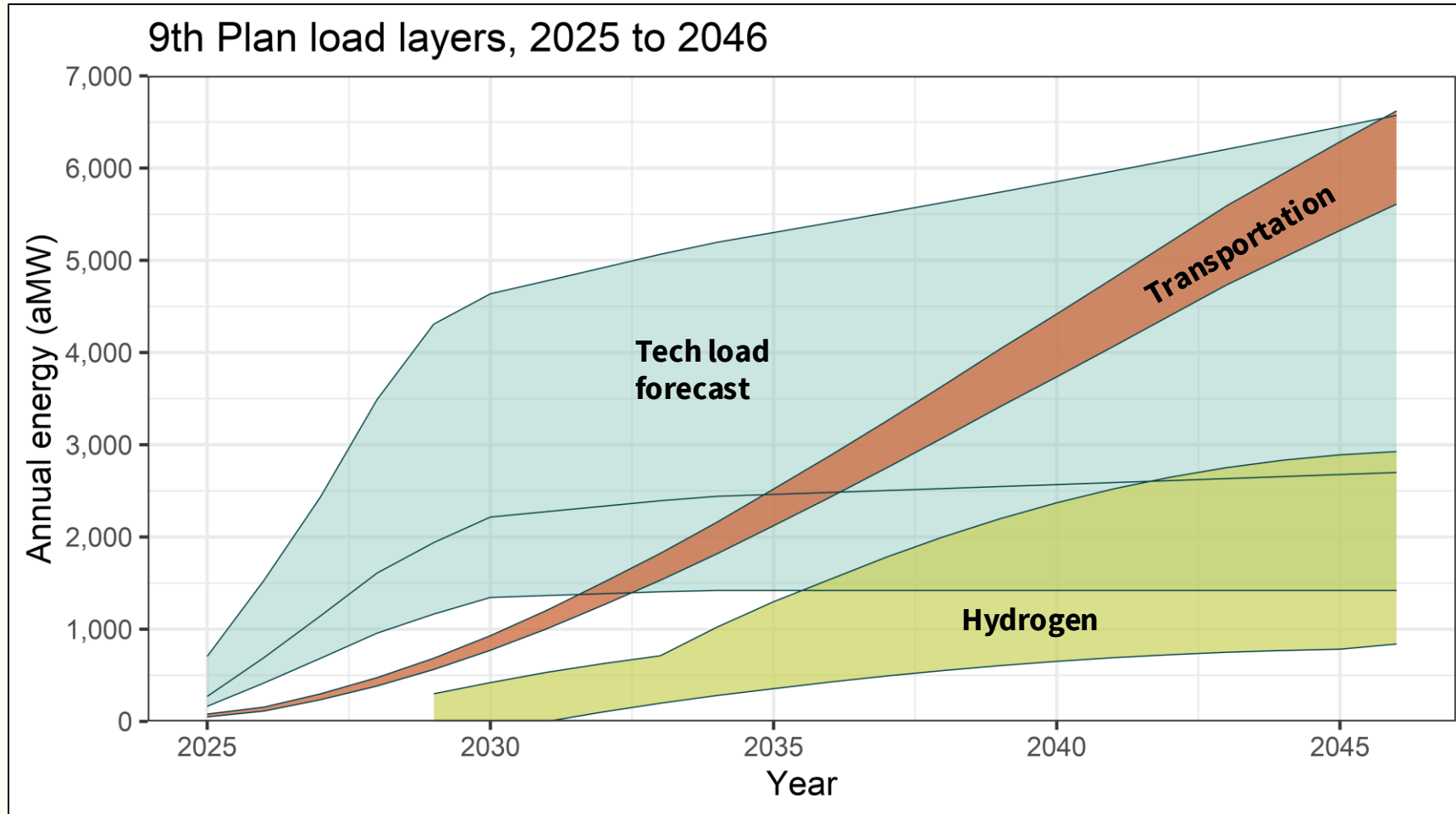
Demand Forecast Pathways

Pathways	Economics	Transportation	Data Centers	Building Electrification	Hydrogen
Persistent high growth	Medium	Higher	Higher	Higher	Higher
Persistent low growth	Lower	Lower	Lower	Lower	Lower
Early growth	Medium	Lower	Higher	Lower	Lower
Late growth	Medium	Higher	Medium	Higher	Higher
Mixed bag	Medium	Higher	Medium	Lower	Lower

Load Forecast, Key Sectors

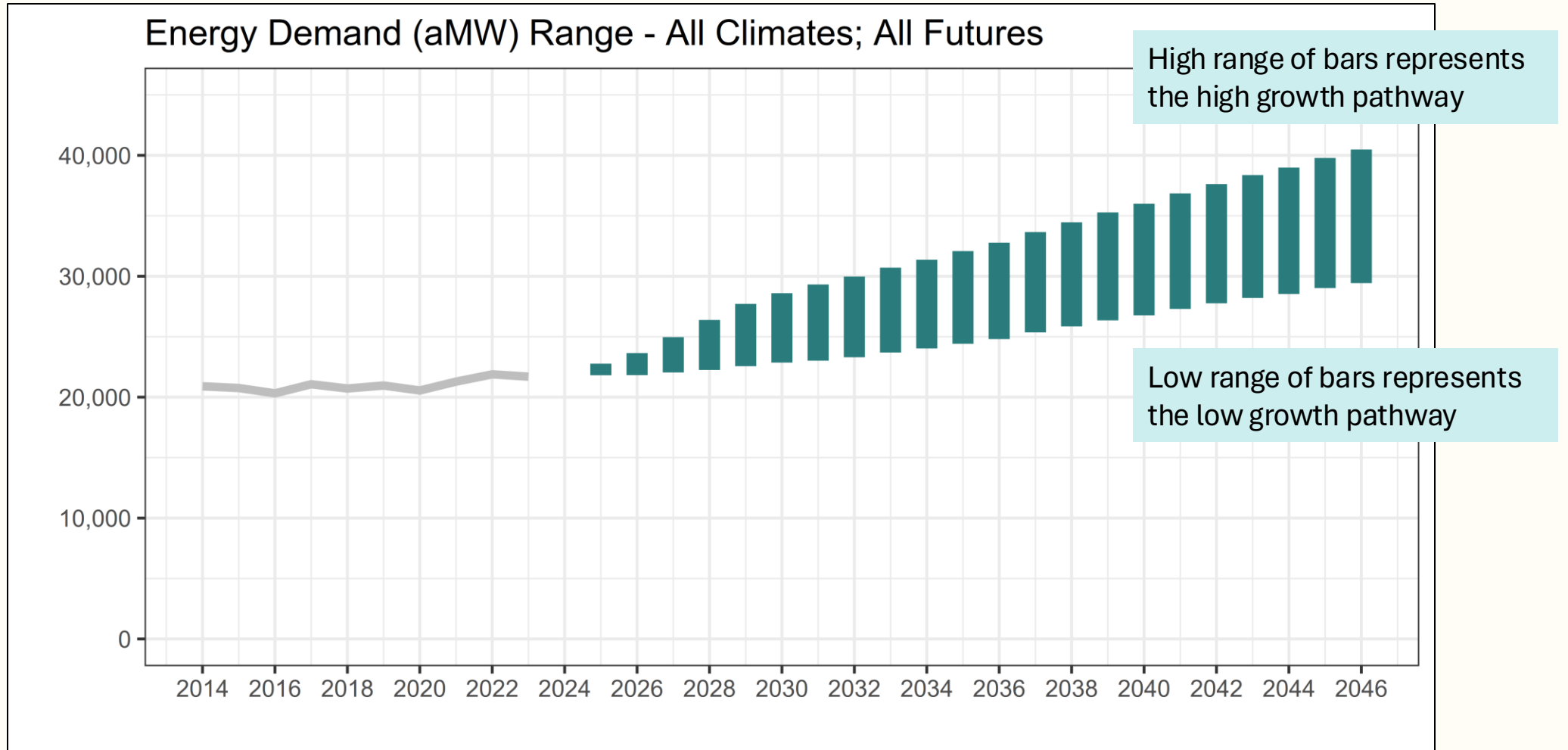
Demand Forecast

- Developed five pathways of load growth reflecting a range of assumptions across different sectors to account for uncertainty in timing, size, and shape
 - Scenarios
 - Transportation
 - Data centers and high-tech
 - Building electrification
 - Hydrogen (or industrial electrification)
- Future energy demand increases between 50 and 100% over the next 20 years
- Peaks also grow significantly, doubling in some of the pathways by the end of the study

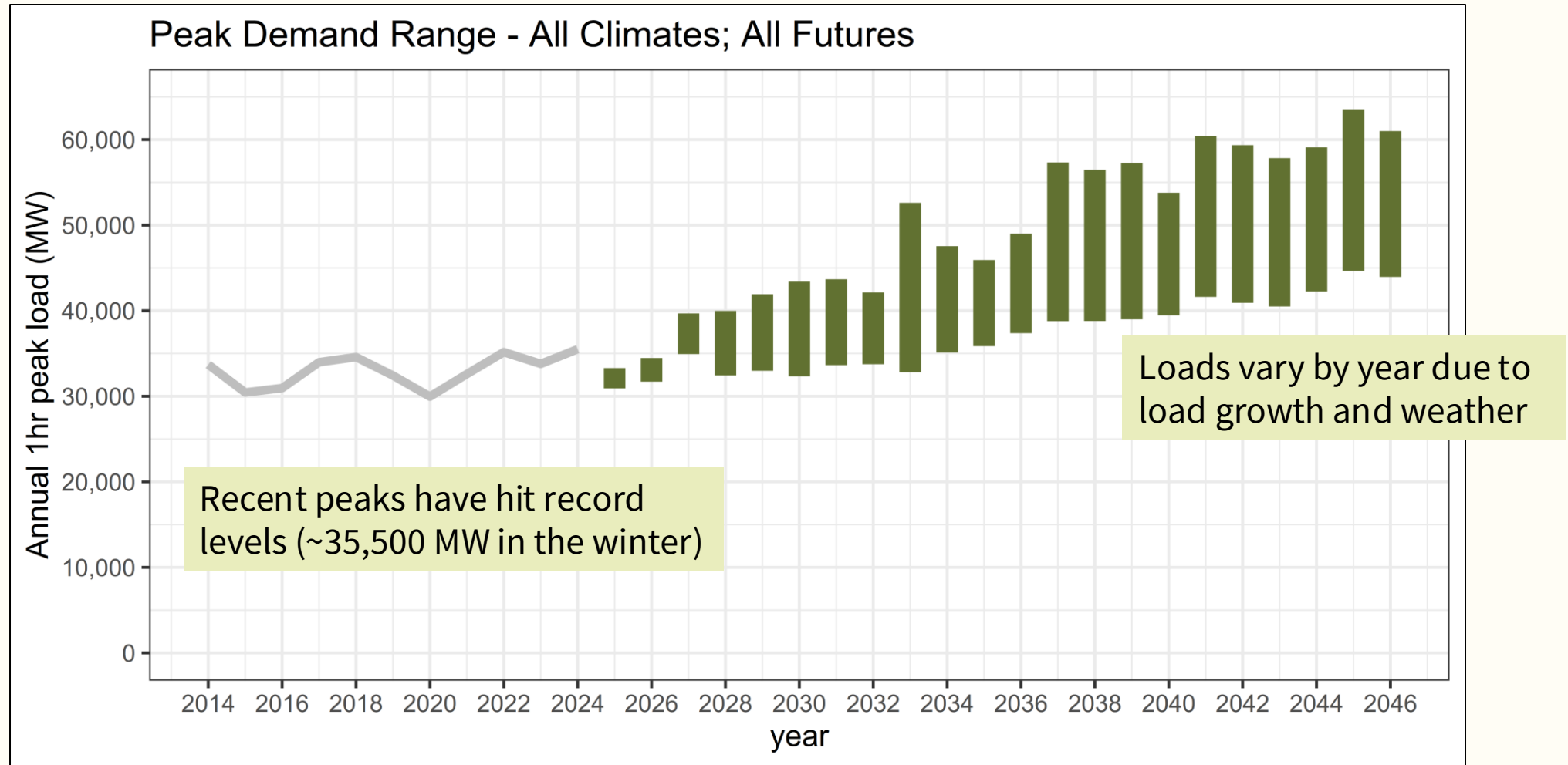



Tech and transportation electrification can reach similar levels by 2046

Demand Forecast, Energy



Demand Forecast, Peak



Components of a Reference Plant

Resource Attributes

Technology Type

Configuration (# of units x MW)

Capacity (MW)

Location(s)

Operating Life (yrs)

Development & construction schedule

Earliest in-operation date (year)

Transmission access

Financials

Financial Sponsor (IOU, IPP)

Overnight Capital Cost (\$/MWh)

Fixed O&M (\$/kW-yr)

Variable O&M (\$/MWh)

Fixed Fuel Cost

Transmission Cost

Operating Characteristics

Capacity Factor

Heat Rate

Generation Shape

Developmental Potential

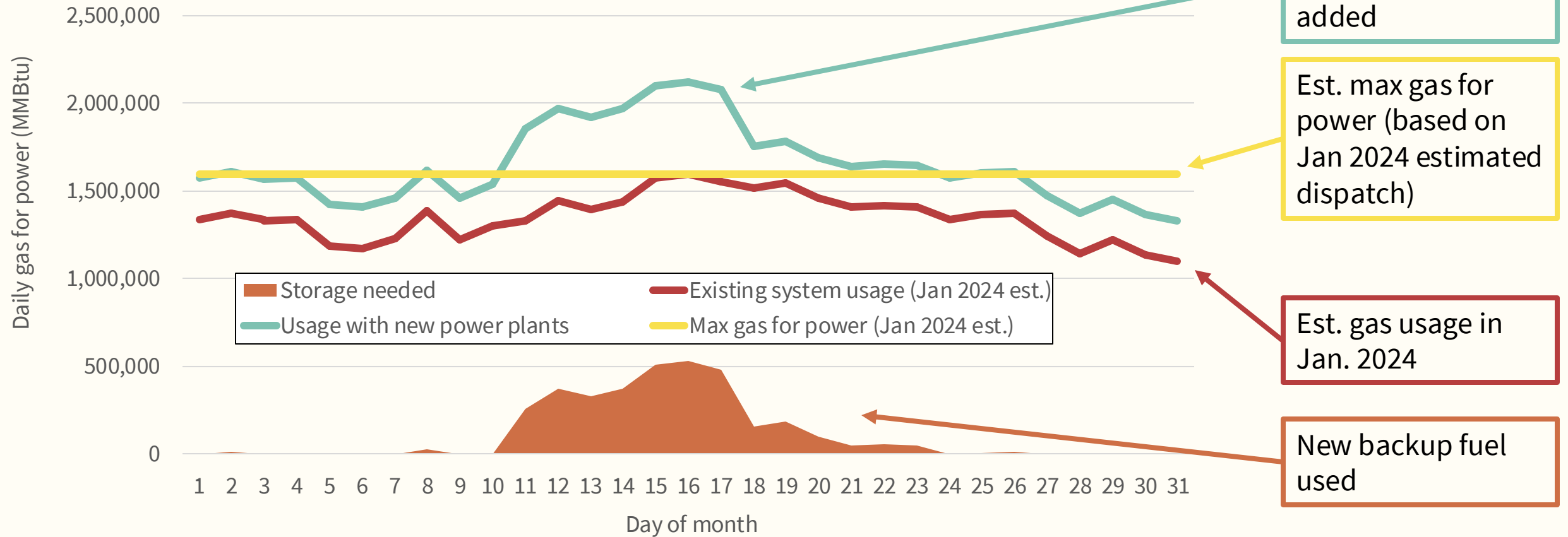
Location

Transmission/Gas Pipeline Access

Maximum Build-out

Current analysis

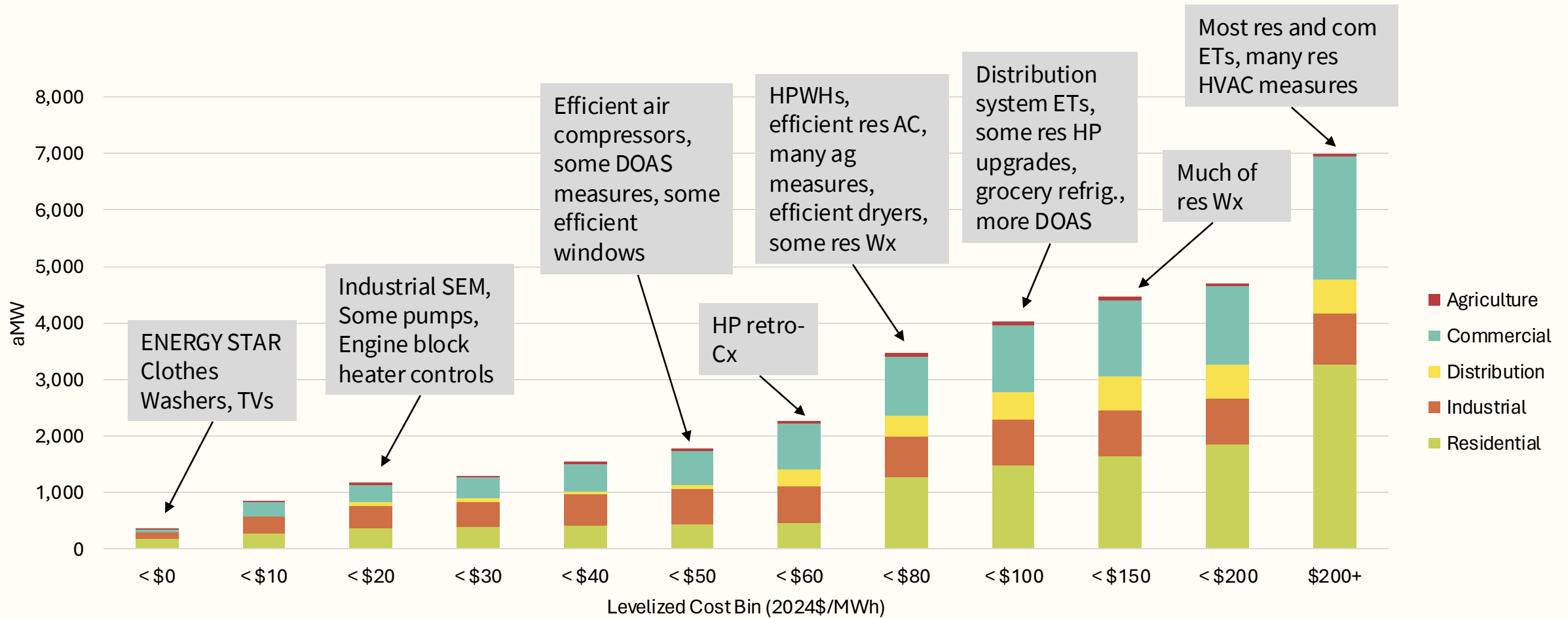
Jan 2024 analysis example



Analysis overview

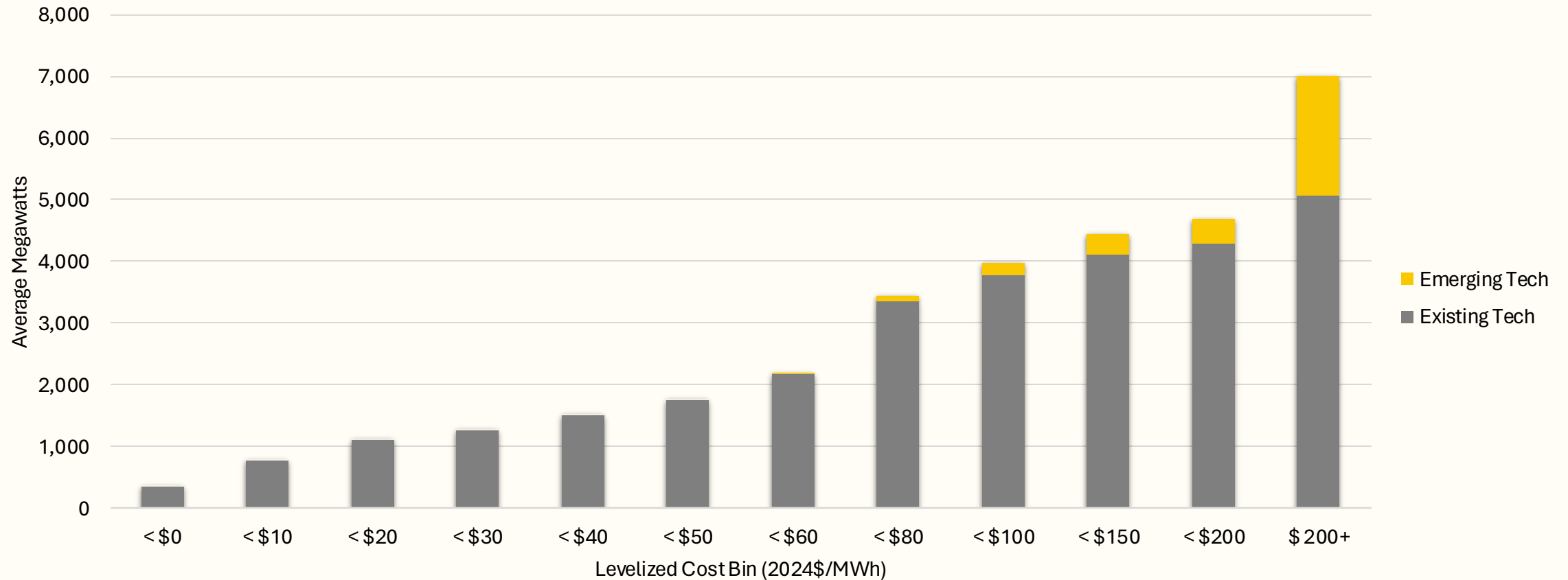
1. We estimate the highest 1-day gas usage from the power system in January 2024, and assume that could be available any day of the month
 - a) ~1.6 million MMBtu/day, this level of supply for a month could require pipeline expansions
2. We assume new gas power plants are built with back-up fuel storage (9 days for CCCT via LNG, 6 days for SCCT/ recip with a refillable fuel tank)
3. The question is: how many new gas plants can we add, assuming a 1.6 million/day MMBtu supply is consistently available for power, before the new storage is insufficient to provide firm fuel?

Conservation Potential



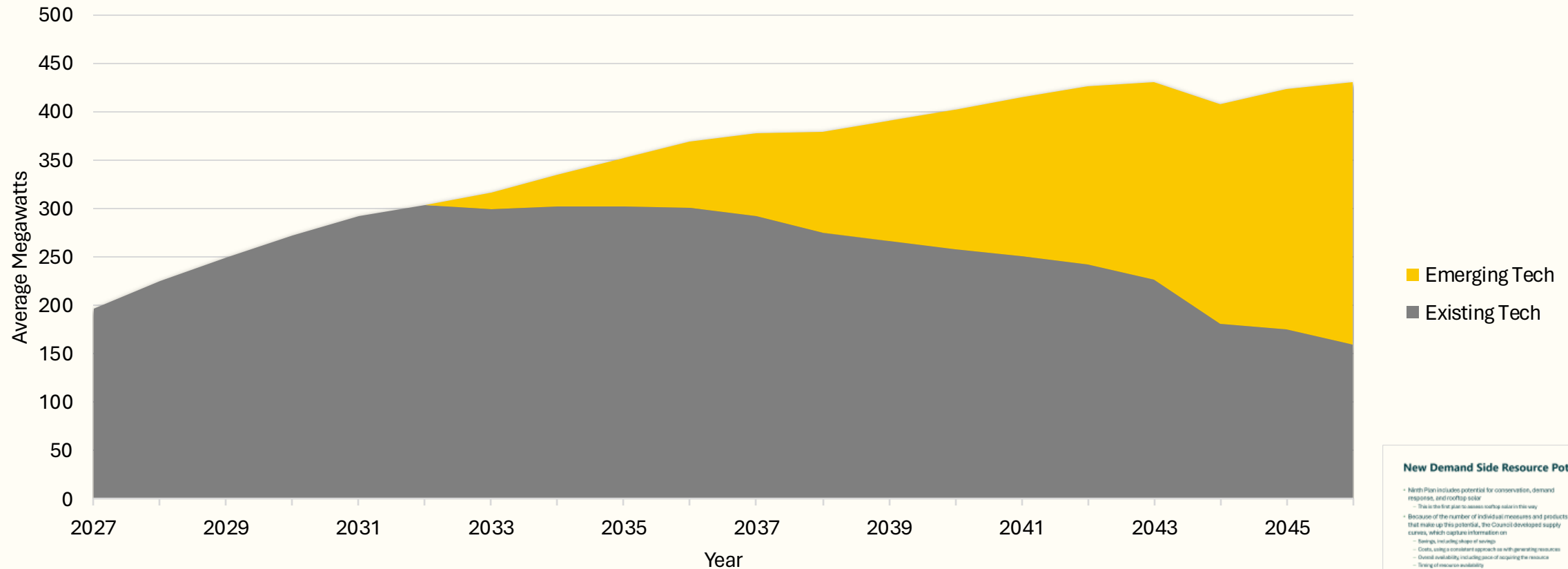
Potential Includes Emerging Technologies for Some of the Sensitivities

Conservation Supply Curve 20-Year Potential



Emerging Technology Potential Provides Options for Consideration in Outer Years

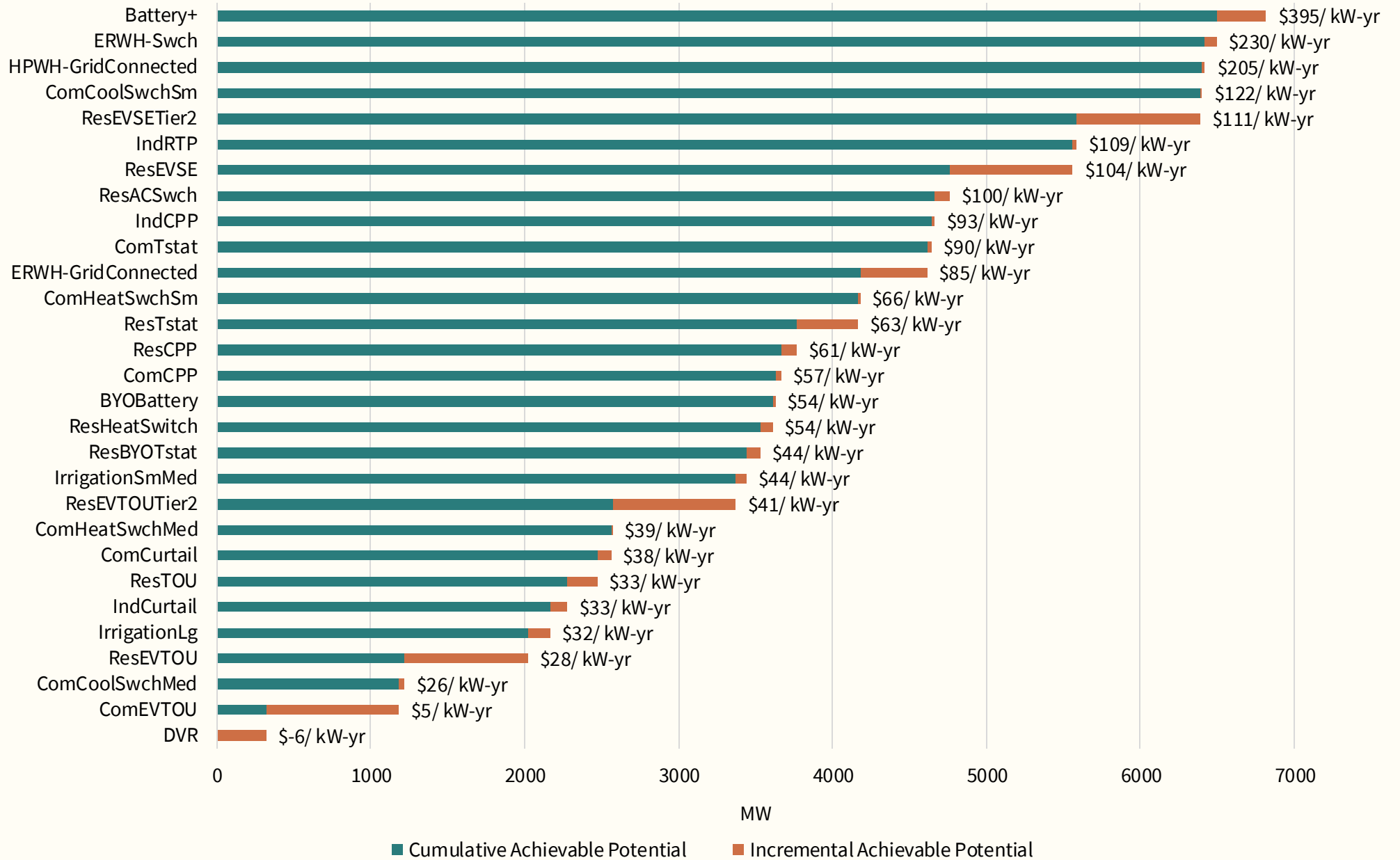
Incremental Conservation Potential Over 20-Year Plan Horizon



New Demand Side Resource Potential

- Ninth Plan includes potential for conservation, demand response, and rooftop solar
 - This is the first plan to assess rooftop solar in this way
- Because of the number of individual measures and products that make up this potential, the Council developed supply curves, which capture information on
 - Savings, including shape of savings
 - Costs, using a consistent approach on with generating resources
 - Overall availability, including pace of acquiring the resource
 - Timing of resource availability


DR Supply Curve



Demand Response Products

New Demand Side Resource Potential

- Ninth Plan includes potential for conservation, demand response, and rooftop solar
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 - Timing of resource availability



Northwest Power and Conservation Council | The 9th Northwest Regional Power Plan

HVAC switches & thermostat controls

Water heating controls

Pricing programs, including time of use programs

Electric vehicle programs

Battery management

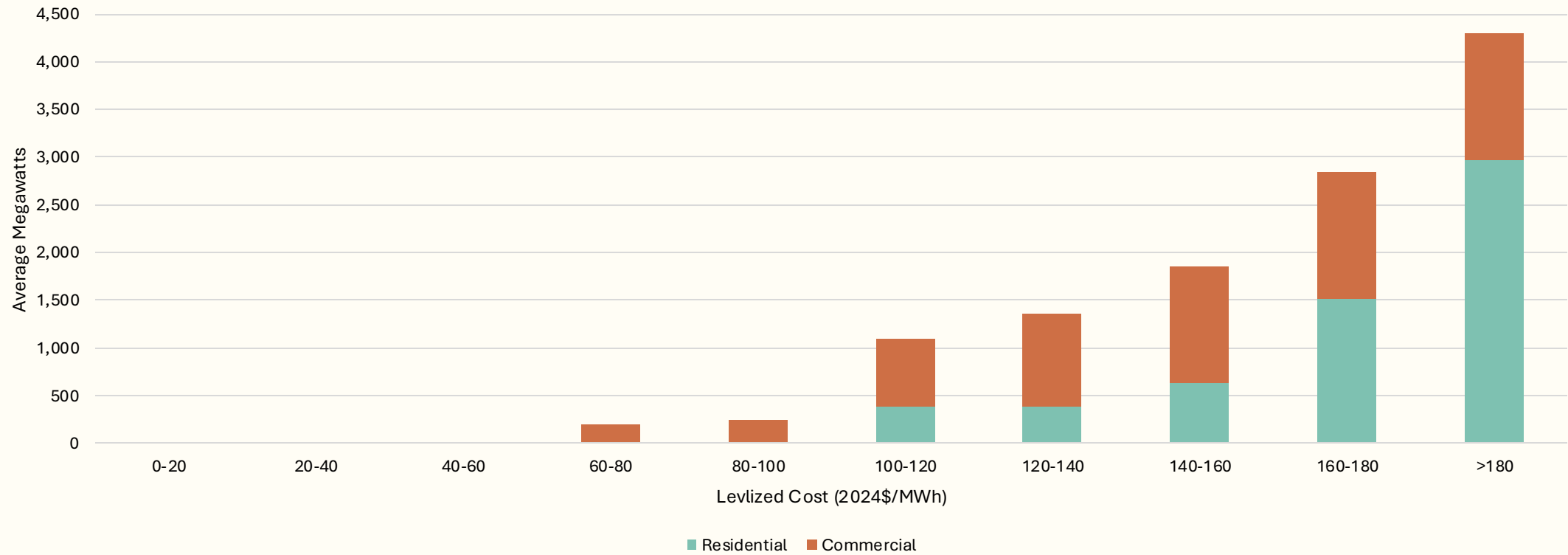
Demand curtailment

Irrigation Control

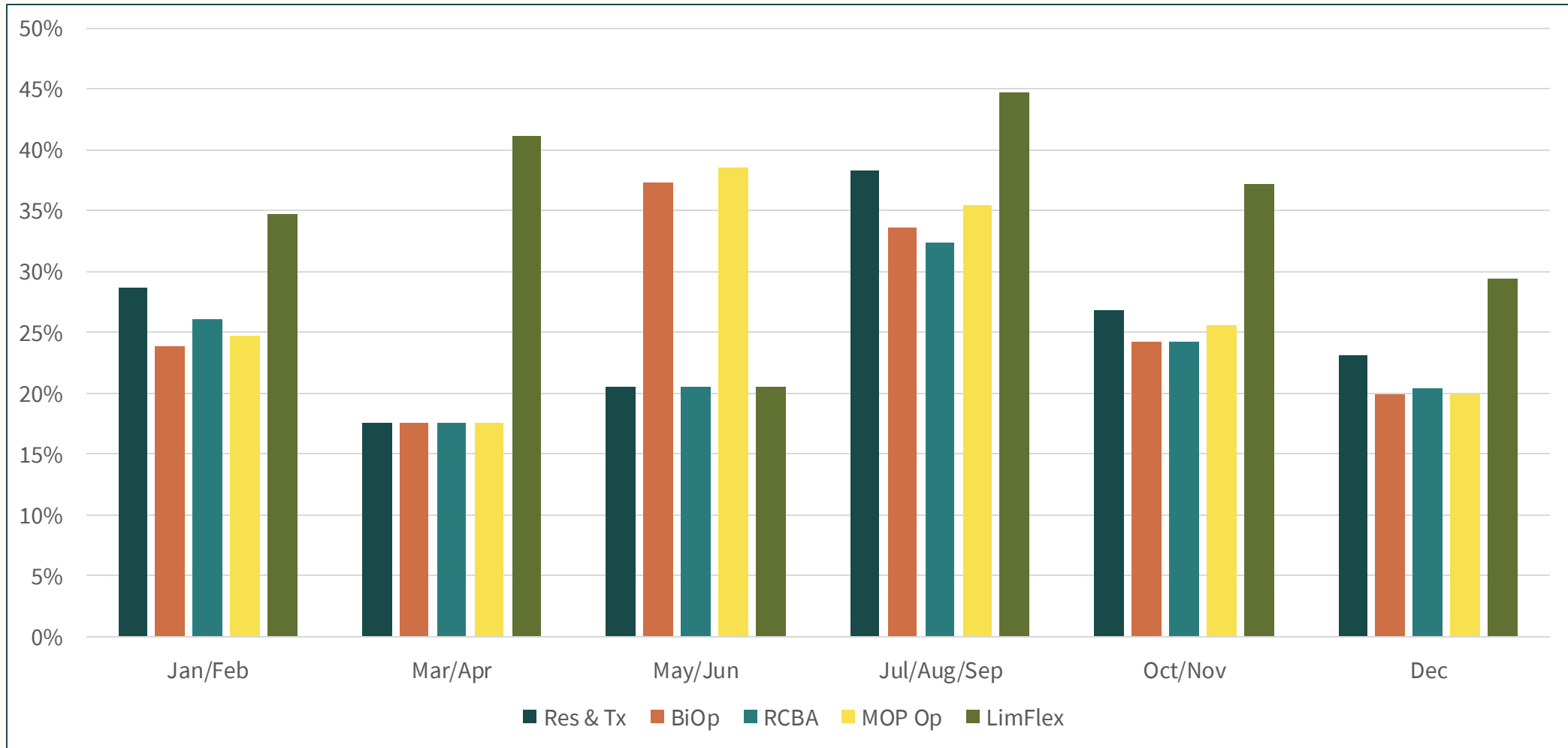
Demand Voltage regulation

Rooftop Solar

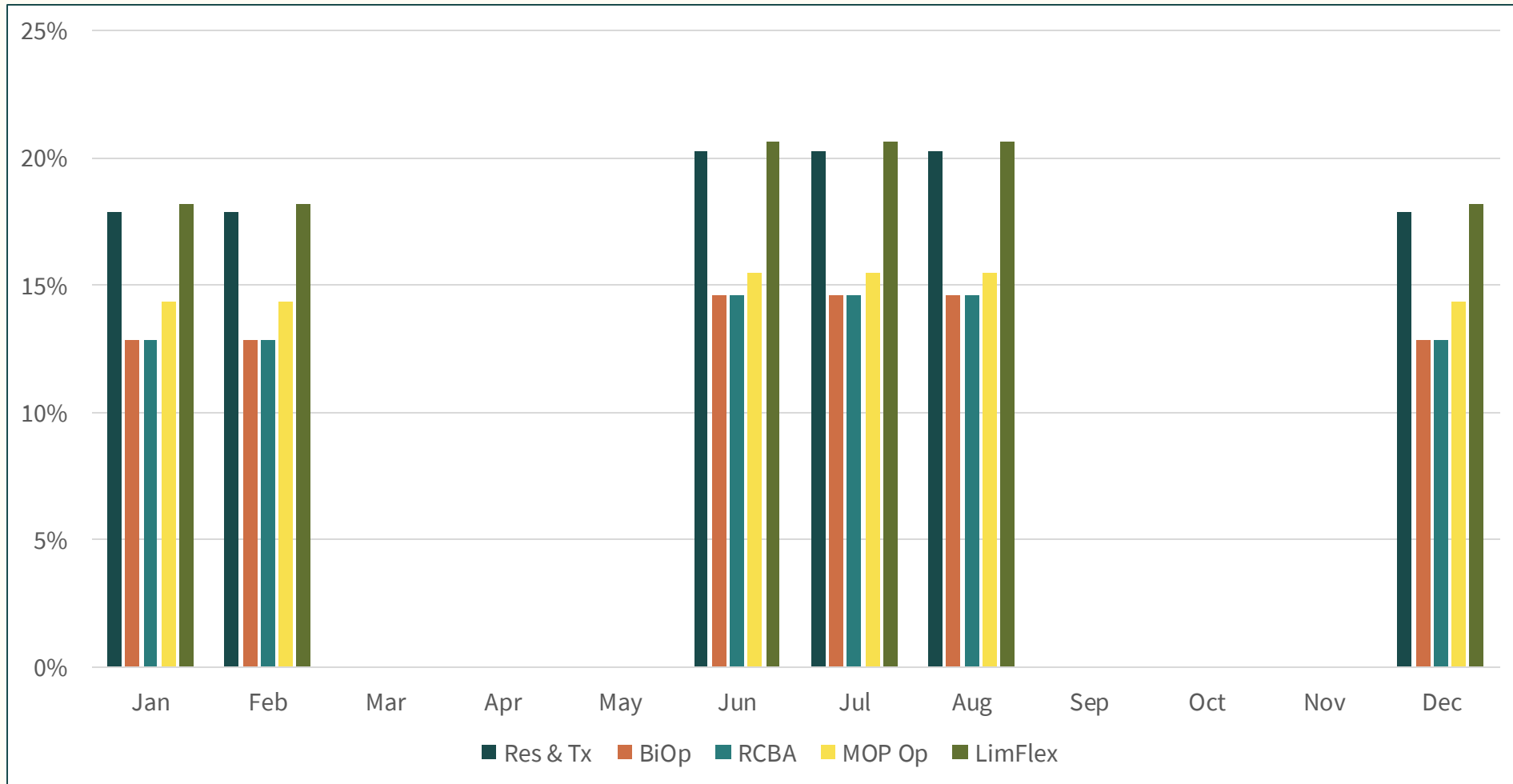
Rooftop Solar Supply Curve



Final Planning Reserve Margin - Peak



Final Adequacy Reserve Margin - Energy



Adequacy Criteria

Protection against frequent deficits



Frequency (LOLEV)

0.1 in summer
0.1 in winter
0.2 annual

Limit to 1 in 10 years
summer and winter events,
Limit to 1 in 5 years overall

Protection against extreme (tail-end) deficits



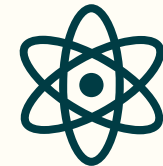
Duration

8-hour



Peak

1,200 MW



Energy

9,600 MWh

39 out of 40 years, protecting against
events that are too big or too long

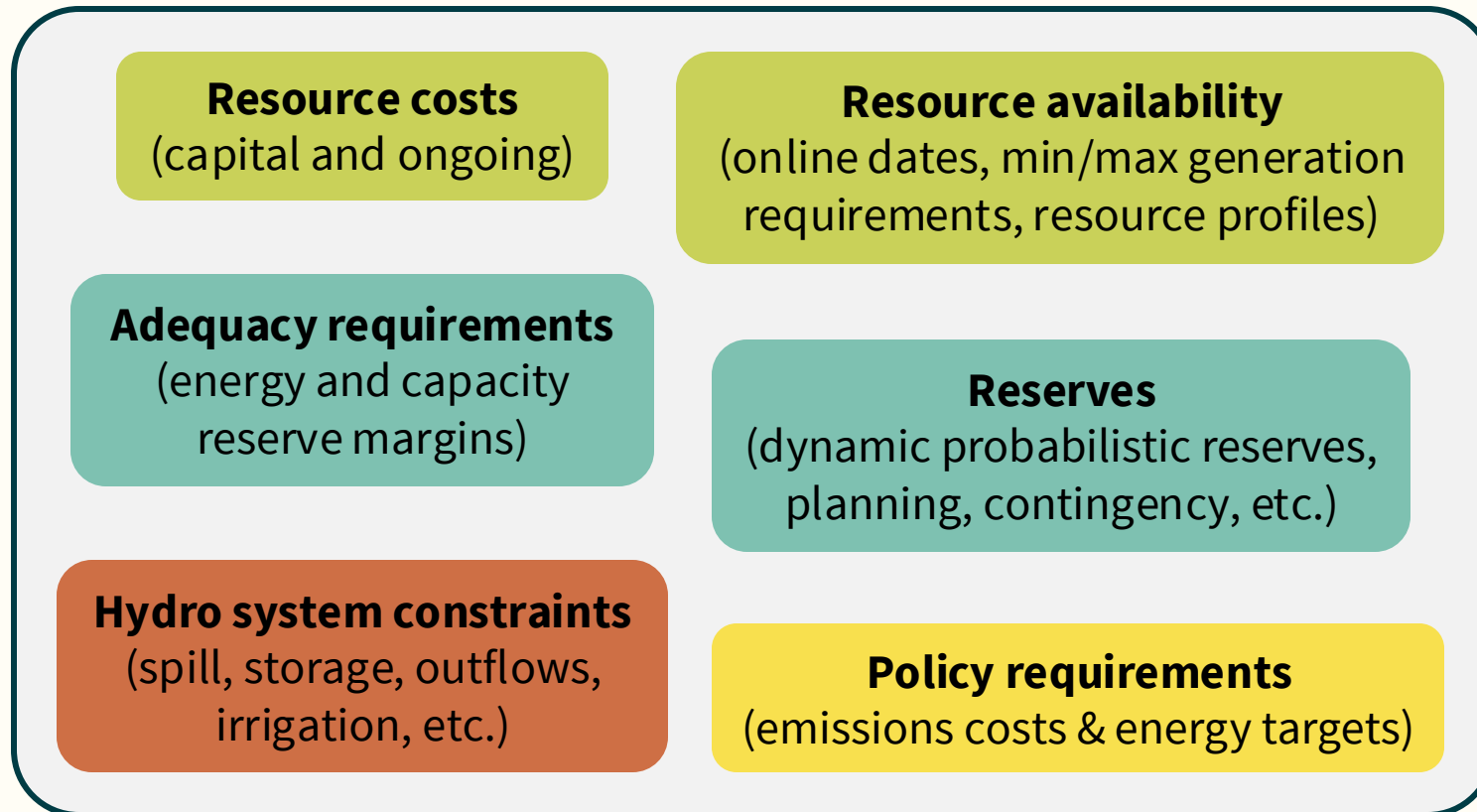
Regional Optimization Model: OptGen/SDDP

- SDDP is a production cost software from PSR
 - SDDP minimizes WECC-wide power supply costs while meeting demand within system operating constraints including reserves, emissions pricing, and hydro system operation requirements
 - The reserve module within SDDP can address specified reserves by percentage of demand and by forecasted availability of variable energy resources
- OptGen is a capital expansion module from PSR that uses a simplified version of SDDP to provide production costs of existing and new resources
 - OptGen co-optimizes the investment and operation decision making simultaneously, one year at a time, seeking to minimize costs
 - Additionally, OptGen can address other constraints, including policy or adequacy needs
 - OptGen can solve for an investment strategy that minimizes costs over a range of futures

Data Considered in Optimization

Data are translated into MW and costs, guiding decision making

As the model steps through years and futures, it is seeking to meet the needs (MWs) at the least cost, across the range of futures tested



Regional Buildout

Big Drivers for Resource Builds



Economics

Model is seeking least cost buildout across the range of uncertainty



Adequacy

Model is ensuring loads are met and sufficient reserves are held

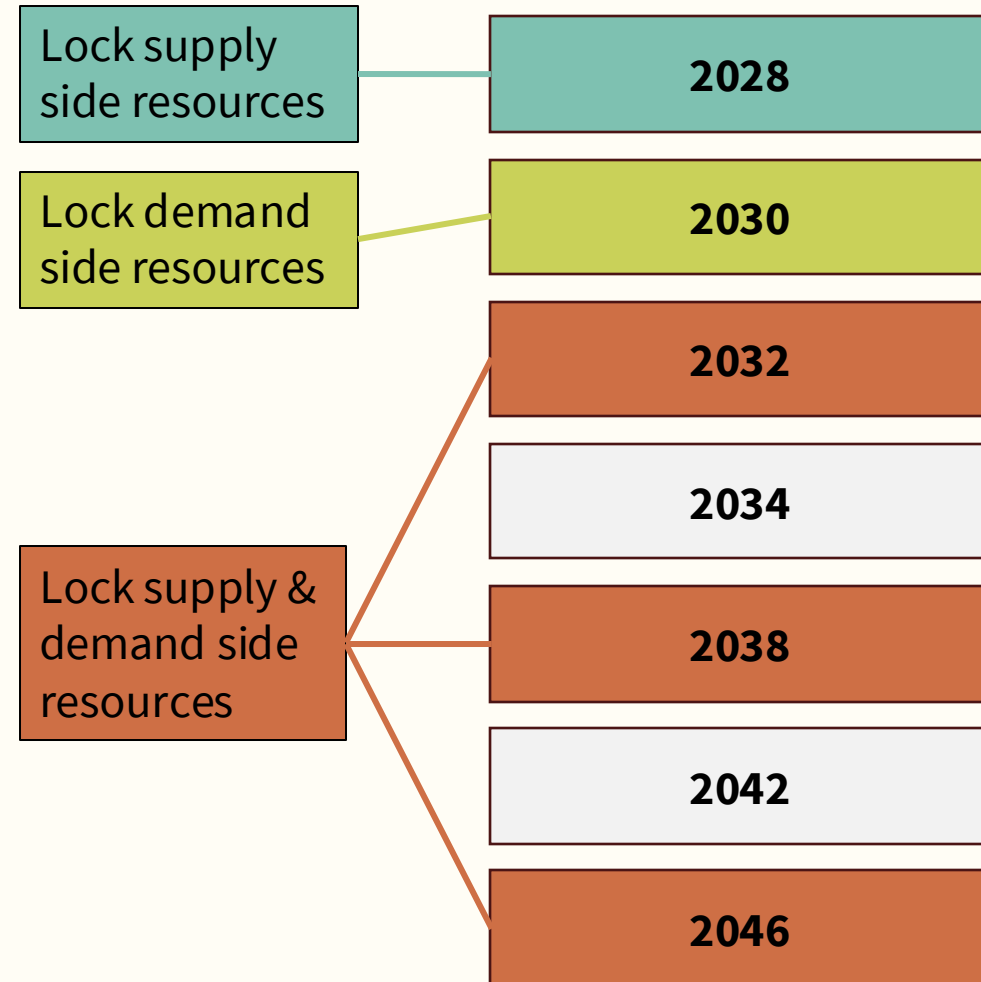


Policy

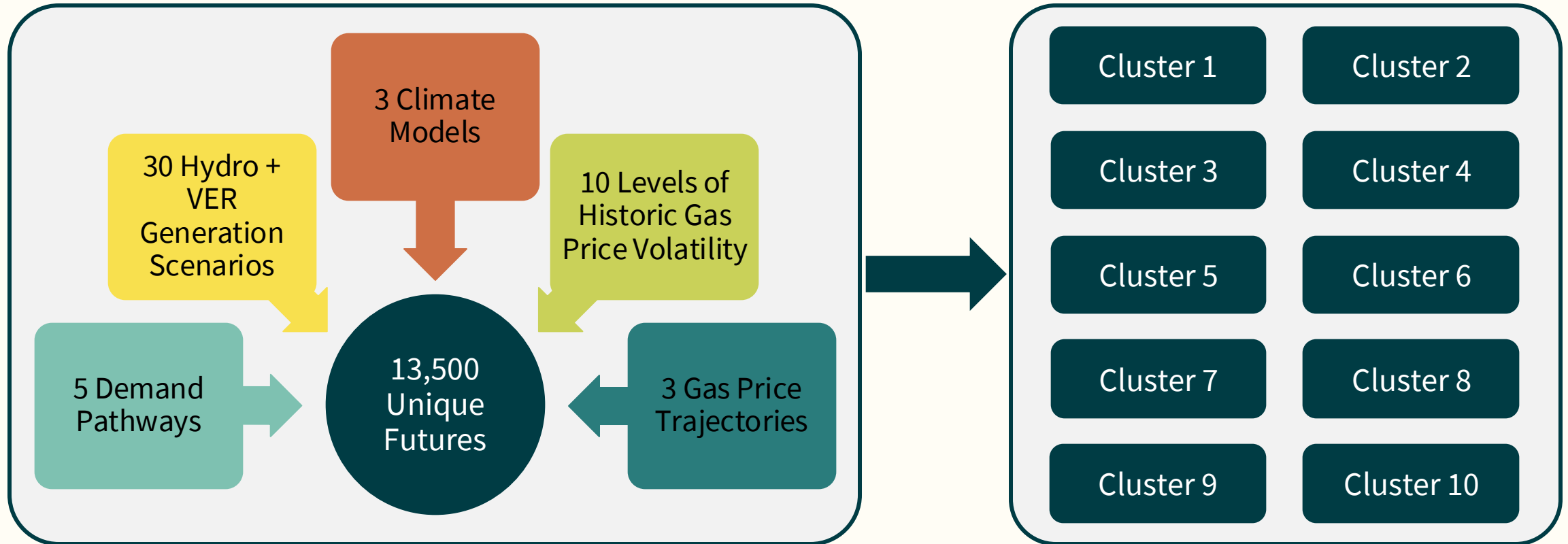
Model is ensuring policies are met, including hydro operations requirements

Capturing Resource Decision Across the Years

- Resource decisions in certain years will be “locked in” to guide decisions in later years
 - This helps ensure adequacy in the buildout
 - For example, resource acquired in 2032 will still be available in 2046, so we want to provide that information to the model
- We are not locking in every year to allow the model some foresight



Developing Clusters



High Level Approach



Use a linear program to pick ten “futures” for the model following a series of rules:

- An even selection of **net-load** variation (1 year from every 10-percentile bin)
- An even selection of **hydro** conditions (1 year from every 10-percentile bin)
- An even selection of **gas prices** (targeting 4 mid, 3 high, and 3 low price futures)
- Balanced **gas price volatility**
- A balance of the **load** pathways (2 high pathways, 2 low, 2 early, etc.)
- Set number of **climate** scenarios (4 model A futures, 3 C, 3 G)