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October 6, 2020

MEMORANDUM

TO: Council Members

FROM: John Ollis, Manager of Planning and Analysis

SUBJECT: 2021 Power Plan Draft Wholesale Electricity Price and Avoided CO₂ Emissions Rate Forecast Part 4

BACKGROUND:

Presenter: John Ollis

Summary: This presentation will continue to update the Council on the status of the 2020 wholesale electricity price forecast and avoided emissions rate study updates for the 2021 Power Plan, and the most recent response from the System Analysis Advisory Committee. Per previous discussions with the Power Committee, Staff continues to attempt to improve the forecast and incorporate the significant stakeholder feedback. Several additional methodological changes have been implemented relating to the modeling in AURORA. Staff will report on the current status of these studies per these changes.

Relevance: The Council periodically updates a 20-year forecast of electric power prices and avoided emissions rate studies using the AURORA model. The AURORA model dispatches all resources in the WECC generating a fundamentals-based wholesale electricity price forecast.

The study of avoided carbon dioxide production rates of the northwest power system will evaluate what the implied avoided carbon emissions rate is in the WECC and the implications for regional conservation replacing the need for that production.

Since the development of the midterm and previous avoided emissions rate study, more baseload plant retirements have been announced and further clean policies and goals have been announced. These municipal, utility and state policies/goals along with the retirements and pressures on conventional fossil fuel resources continue to fundamentally change the wholesale market dynamics in the WECC, and this updated price forecast helps Staff incorporate the effects of these changes on Mid-C market prices and the implied avoided market emission rate.

For the 2021 Power Plan, the Regional Portfolio Model will use the power prices from this study to develop electricity price futures which are used as a starting point for resource valuation in the resource strategy analysis. Additionally, the avoided market emissions rate is used in the resource strategy analysis to determine the emissions associated with reliance on the market.

Workplan: Forecast Wholesale Electricity Prices (A.6.3)

Background: The Council's wholesale electricity price forecast is a fundamentals-based, forecast that reflects actual power system operation, relationships of supply and demand for, and transmission of electricity. In addition, underlying a wholesale electricity price forecast in this region would be an understanding of the operating characteristics of future and existing supply and demand-side resources, as well as unit commitment, ancillary services, fuel prices, hydro, wind and solar conditions. The AURORA software captures many of these characteristics of the power system well and has a periodically updated WECC database, and thus, AURORA has been the Council's wholesale market electricity price forecasting model.

Additionally, the cost of future carbon dioxide regulation has been a significant factor in resource planning in the Pacific Northwest. To avoid making higher cost resource choices, a direct evaluation of this risk requires an estimate of the carbon dioxide emissions avoided by purchasing conservation or another resource. The Council has periodically updated this study using the AURORA model to help inform Council staff and regional stakeholder analysis.

More Info: Slides for this presentation are pending on ongoing studies and recommendations from the September 2nd, 2020 System Analysis Advisory Committee meeting and since the previous power committee presentation.

Previous presentations on this forecast:

[Update on Long Term Buildout in October 1 Power Committee](#)

[Update on Long Term Buildout in September 29 SAAC](#)

[Update on Proposed Price Forecast in September 15 Power Committee](#)

[Updated Proposed Price Forecast Discussion in September 2 SAAC](#)

[Discussion of Price Forecast in August 2020 Power Committee](#)

[Discussion of Price Forecast in August 2020 SAAC](#)

Previous studies:

[2019 Wholesale Price Forecast Update](#)

[Wholesale Price Forecast in 7th Plan Midterm](#) (see 3-10 through 3-17)

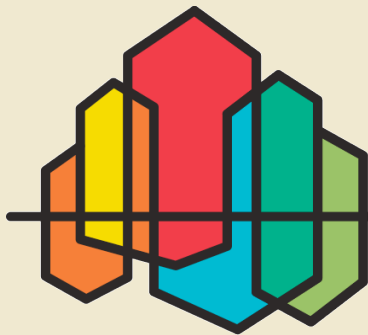
[Avoided Carbon Dioxide Production Rates in the Northwest Power System](#)

Update on Long Term Capacity Expansion for Wholesale Price Forecast

Power Committee

10/13/2020

John Ollis

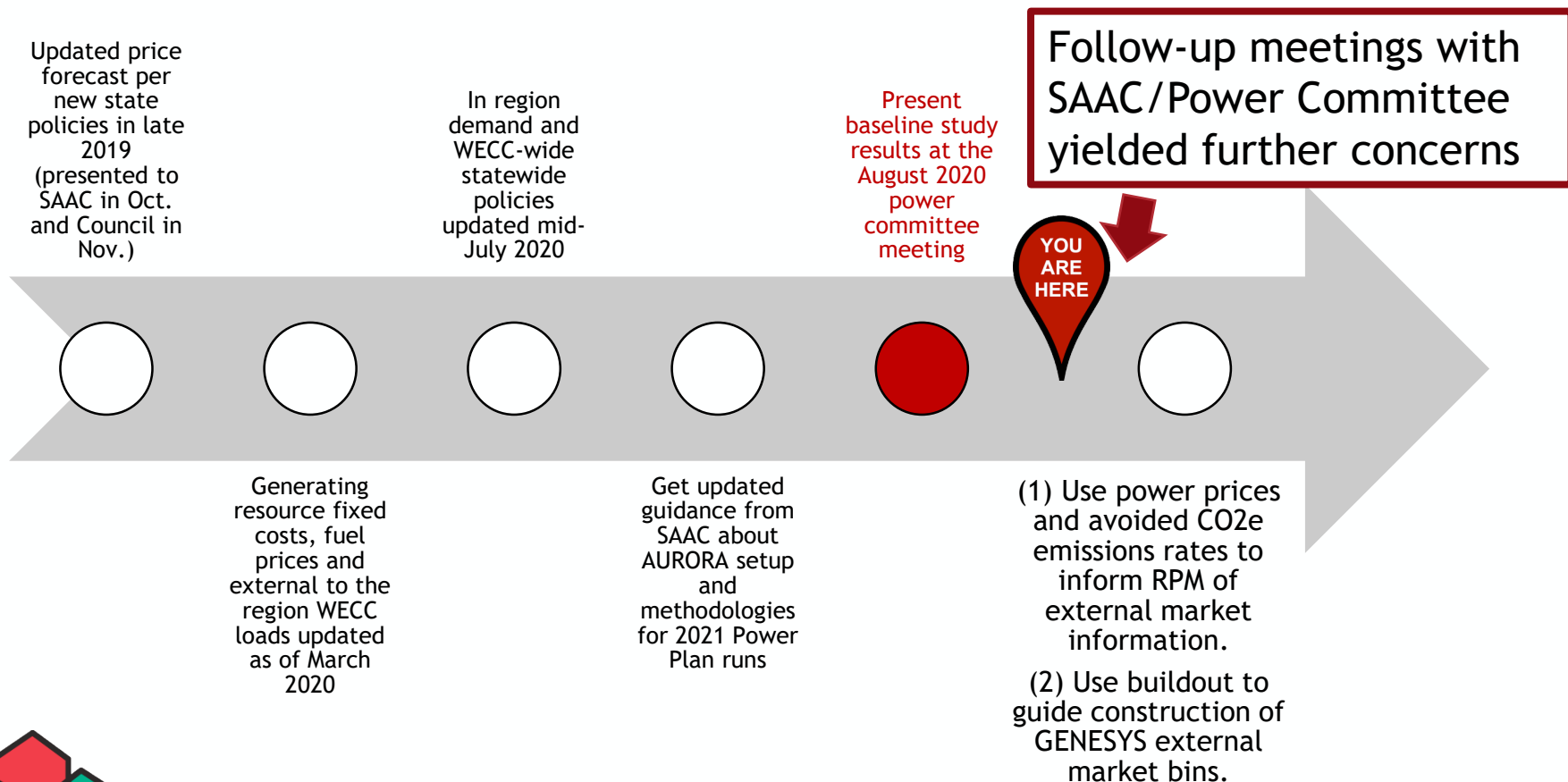


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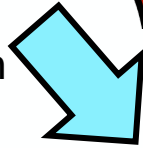
Timeline –

Wholesale Power Price and Market Emissions Rate Forecast



AURORA Buildout

Long term capital expansion for the WECC ensures that price simulations in AURORA are informed by an *adequate system* that *meets policies*



AURORA Price Runs

Hourly market capability is needed for GENESYS to provide *a good adequacy signal for the NW* informed by changing market fundamentals



Get A Strategy: Why a *Reasonable* WECC-Wide Build Out Matters

Hourly WECC-wide price simulations inform *market prices* and *associated emissions* in the RPM, both can significantly impact *regional resource strategy economics*



GENESYS



RPM

Hourly analysis in GENESYS creates quarterly ARMs and ASCCs, which the RPM uses *to select an adequate resource strategy*



AURORA Buildout

Long term capital expansion for the WECC ensures that a check in AURORA is informed by an *adequate system* that *meets policies*

YOU ARE HERE

AURORA Check

Check A Strategy: Reminder why a *Reasonable* WECC-Wide Build Out Matters

Candidate *regional resource strategy* may be checked within the context of the WECC to ensure we are *consistent with policies* and *operational feasibility* within a WECC-wide context.

GENESYS Check

RPM

Candidate *regional resource strategy* is checked in GENESYS to ensure the *system is adequate* and *operationally feasible*.





Review: Getting an Instinct for a “Reasonable” Amount of Builds

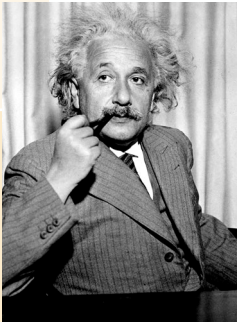


Review: Building out the WECC to Regional Reserve Margins



- Before we can run prices, we need to simulate likely plant buildout in all of the WECC.
- Key reasons to build.
 - 1. Planning Reserve Margins for each reserve sharing group.**
 - Southwest Reserve Sharing Group
 - Rocky Mountain Reserve Sharing Group
 - California ISO (includes part of Baja California)
 - Northwest Power Pool US
 - Northwest Power Pool Canada
 - 2. WECC clean and RPS policy levels.**
 - 3. Peaking capability/need timing**

Calculating Nameplate* Need	Solar	Solar Plus Battery	Wind	4-hour Battery
Peak Contribution*	25%	33%	10%	.25%
Energy	20%	25%	33%	88% efficient
Peak Load + PRM + Retirements MW	$67 / .25 = 268 \text{ GW}$	$67 / .33 = 203 \text{ GW}$	$67 / .1 = 670 \text{ GW}$	$67 / .25 = 268 \text{ GW}$
Load + Retirements aMW	$47 / .2 = 235 \text{ GW}$	$47 / .25 = 188 \text{ GW}$	$67 / .33 = 142 \text{ GW}$	$(268 / .88) * 4 * 365 / 8760 = -18 \text{ aGW}$ (how much energy required to provide daily capacity for 4 hours)
Clean/RPS requirements	$36 / .2 = 180 \text{ GW}$	$36 / .25 = 144 \text{ GW}$	$36 / .33 = 109 \text{ GW}$	



Or, alternatively somewhere between 200 and 270 GW buildout should not be too surprising...



Doing this by hand requires a lot of calculations...

- (1) **Solar** is the least expensive resource has a mediocre capacity and energy contribution **. (*no nighttime energy*)
- (2) **Wind** is also cheap and gets a lot of clean/RPS energy, but does not help as much with summer peak needs **. (*mostly nighttime energy*)
- (3) **Solar plus storage** seems to be a happy medium but is more expensive (*no nighttime energy*)
- (4) **Batteries** are fairly inexpensive but cost energy.
- (5) **Gas** is inexpensive has high energy and capacity contributions but is now only allowed on a limited basis in certain places



The Reason We Have a Model Even if Sometimes it is a Pain



***Note: Some of these resources start out with a decent capacity contribution but over time it decreases significantly.*

How Does all this Guide an Instinct for Overall Build Size?

- My gut says to get an adequate system (day and night) that meets the requirements for peak and energy with the resources we have listed, and that meet policy mandates, we need at least *270 GW to 300 GW*
- Knowing that high renewable builds have curtailments of probably 10% or more, I would be happy with any adequate build under *300 GW* total nameplate (not counting battery).
- I have not seen a build under **300 GW** without significant curtailments somewhere in the WECC.



Recent Planning Strategy Changes

- Way more discussion of role of EE and DR as important in deferring builds throughout WECC planning.
- Resource plans released before current round of policies (<20 GW)
 - PNM and El Paso Electric plan for 2.2 GW nameplate/delivered of renewables by 2035
 - Xcel planning for 2.5 GW nameplate by 2035
(1.8 GW of renewables and .3 GW of storage and .4 GW of gas)
 - BC Hydro building Site C (1.1 GW) and AESO contracted 1.5 GW of wind and has planned conversions of at least 2 GW of coal to gas
(13 GW of new or converted gas planned before 2039)
 - Tri-State has a very dated plan but has many impending retirements
- Resource plans finalized after current round of policies (~180 GW)
 - ❑ CEC plans for 144 GW nameplate by 2045 reference case
(90 GW Renewables, 50 GW Batteries, 4 GW Pumped Storage)
 - ❑ PacifiCorp and NV Energy plan for 17 GW nameplate by 2045
(13.6 GW Renewables, 3.4 GW Storage)
 - ❑ APS, Tucson Energy and SRP plan for 18.5 GW nameplate/delivered by 2035
(11.9 GW of renewables, 6.6 GW of storage)

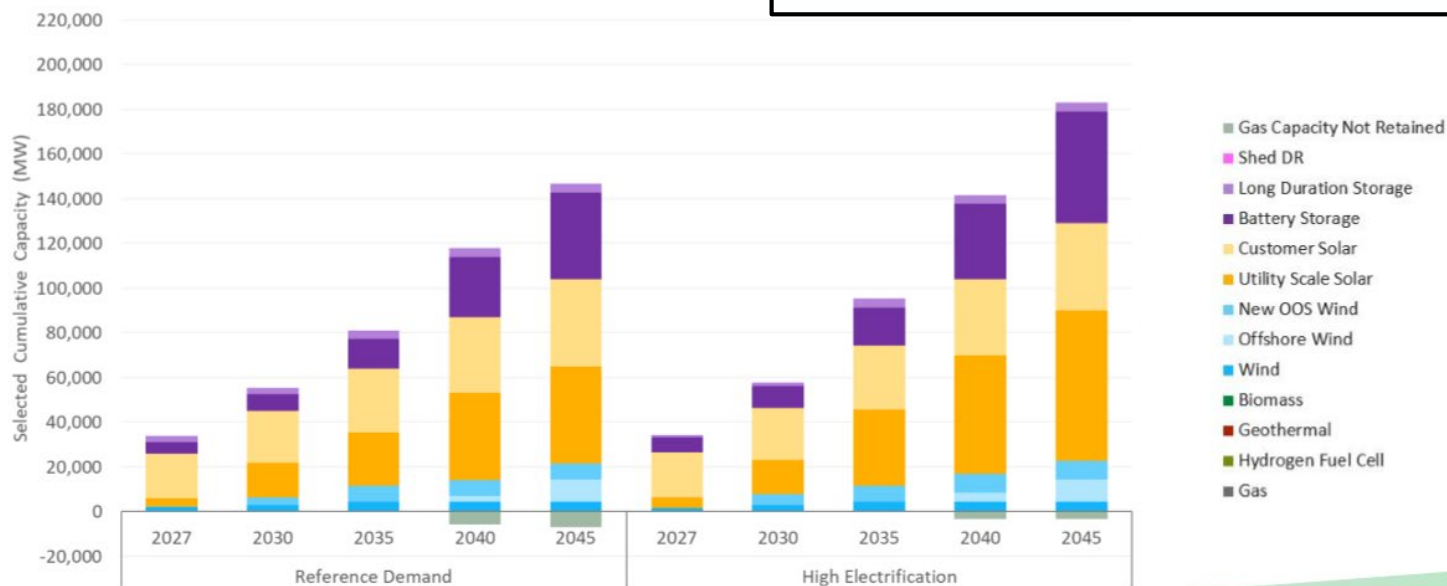


CA SB100 Modeling Uses More Diverse Resource Set, Over 140 GW Nameplate by 2045



Demand Sensitivities

<https://www.energy.ca.gov/event/workshop/2020-09/senate-bill-100-draft-results-workshop>



Load Coverage: Core; Resource Options: All

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Recent Findings

Updated buildouts, SAAC thoughts, future improvements

A Recent WECC Buildout (10/7 SAAC)

Cumulative Buildout in Nameplate MWs by Year

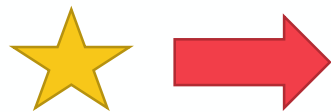
DRAFT

Limited Gas per Regulatory and Policy Climate (October 7, 2020)

Year	Solar	Natural Gas	4 Hour Battery	Wind	Solar with Battery	PNW EE (aMW)	Pumped Storage
2025	11,584	9,276	21,108	5,757	24,853	211	
2030	11,855	13,227	21,108	16,268	57,936	587	500
2035	34,855	13,227	22,853	20,566	85,103	932	2,450
2040	66,157	13,227	25,164	37,242	113,269	1,229	3,900
2045	71,907	13,227	27,203	50,796	128,035	1,229	6,100

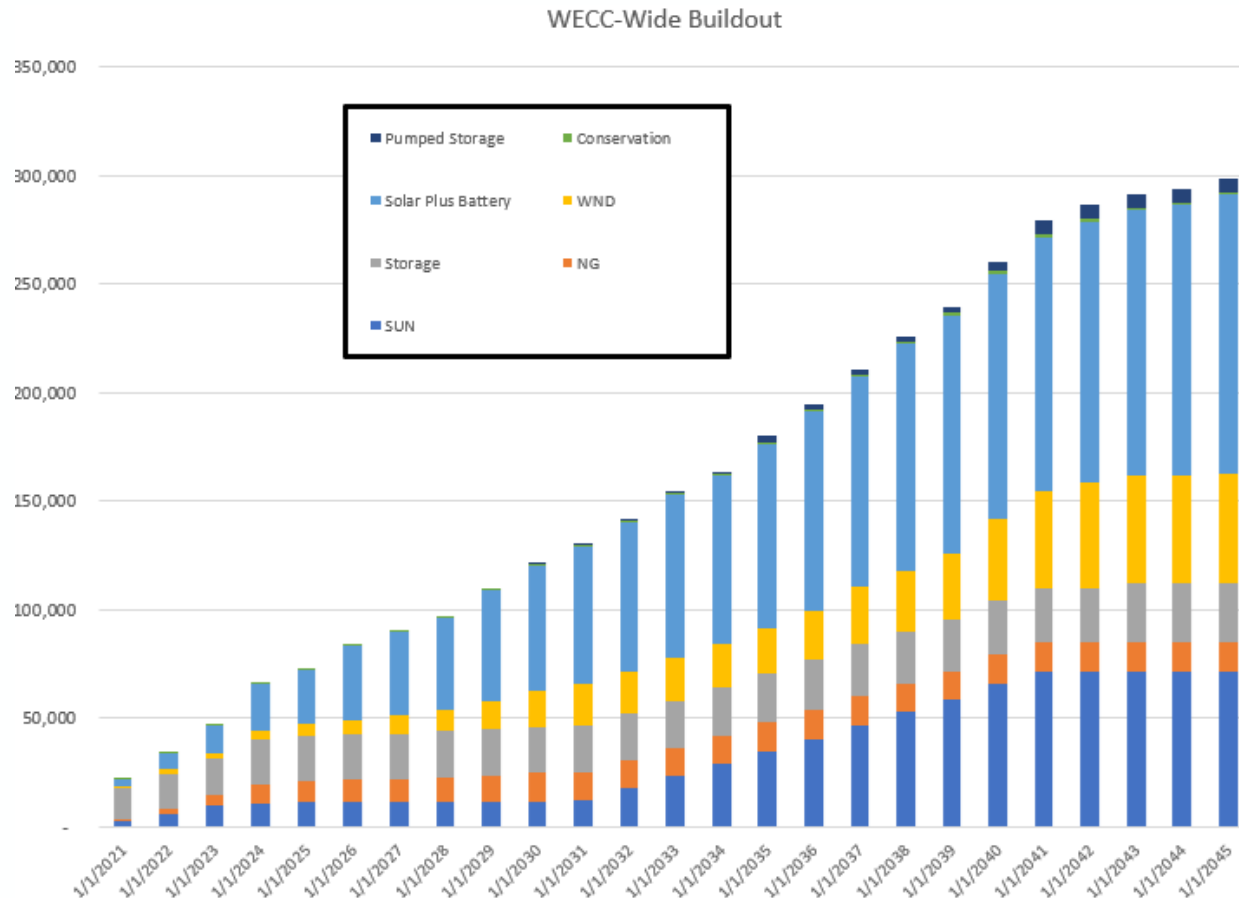


Early Results of Adding Pumped Storage as an Option

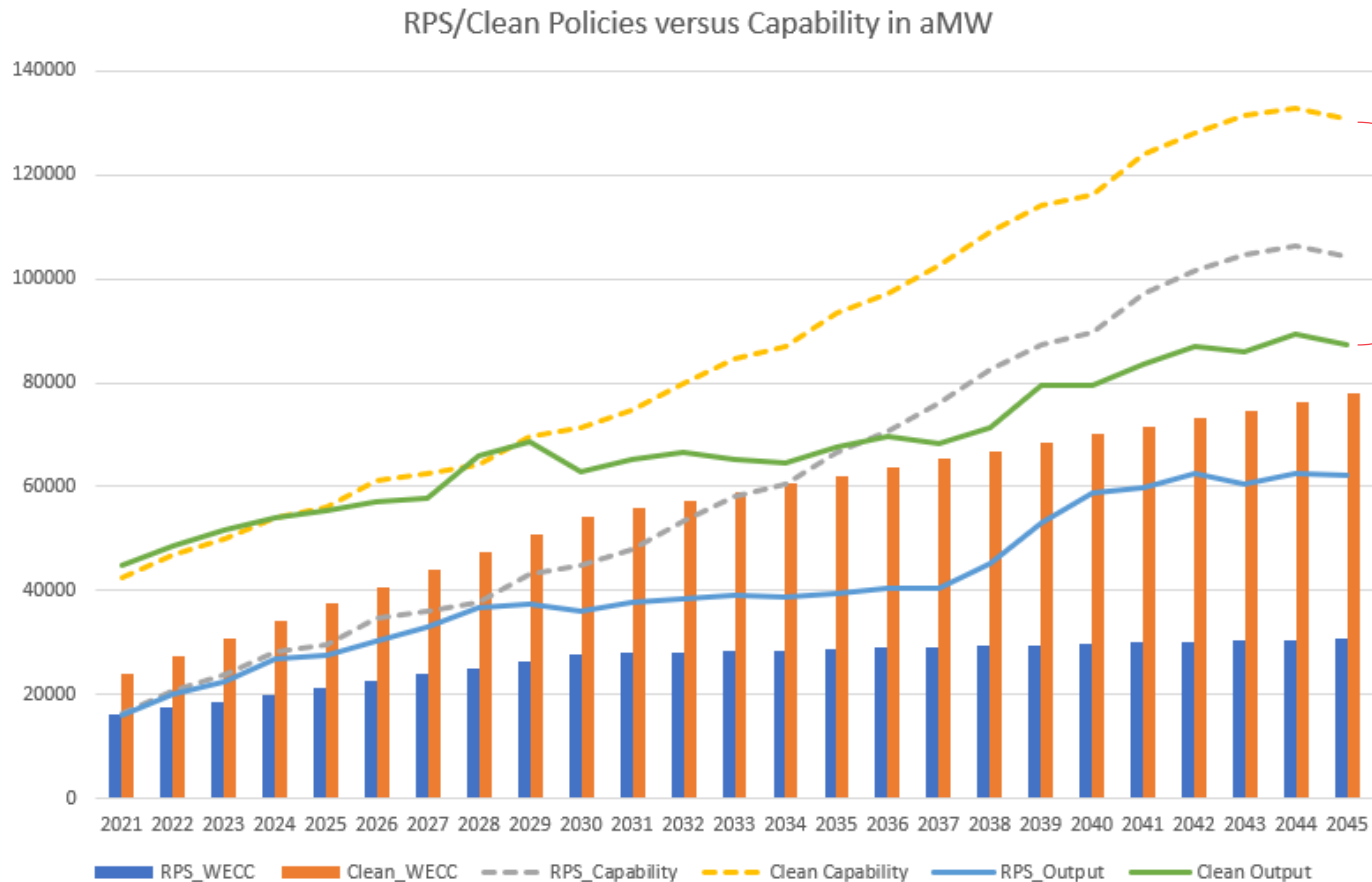


Meets clean
and RPS
policies and
goals!

Looks close
to
adequate...



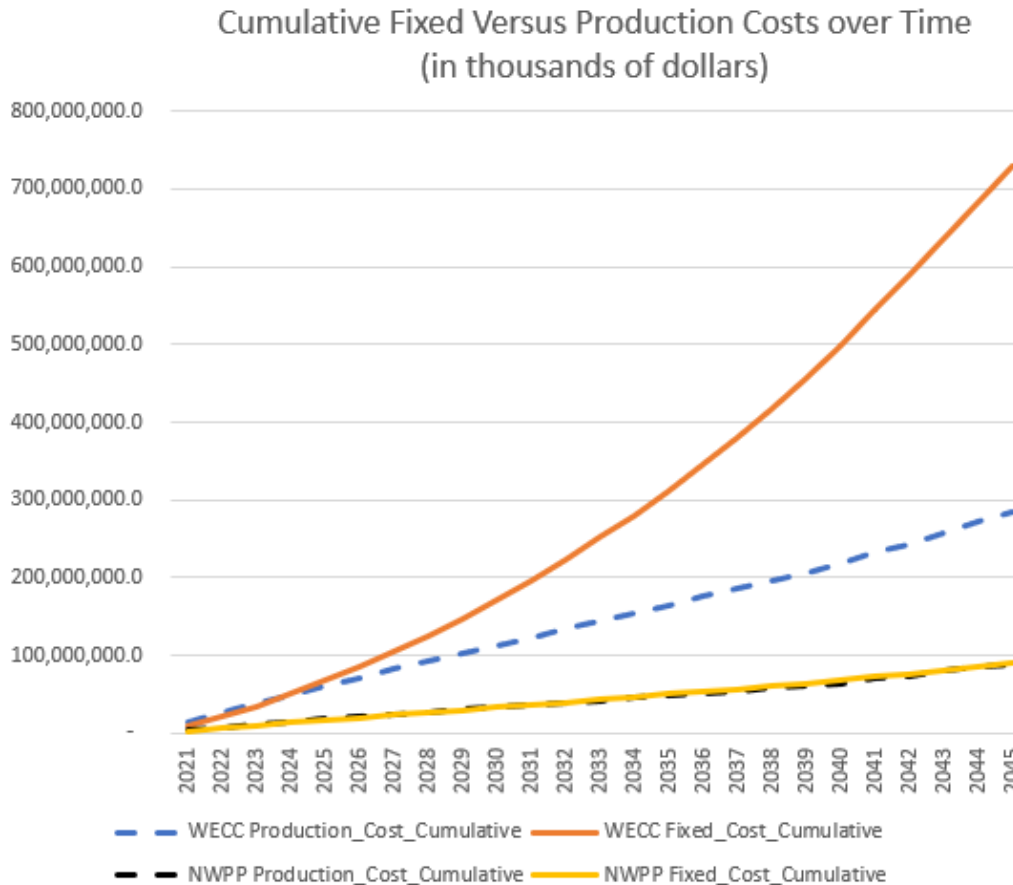
Meeting Clean Policy Requirements With Less Overbuilds



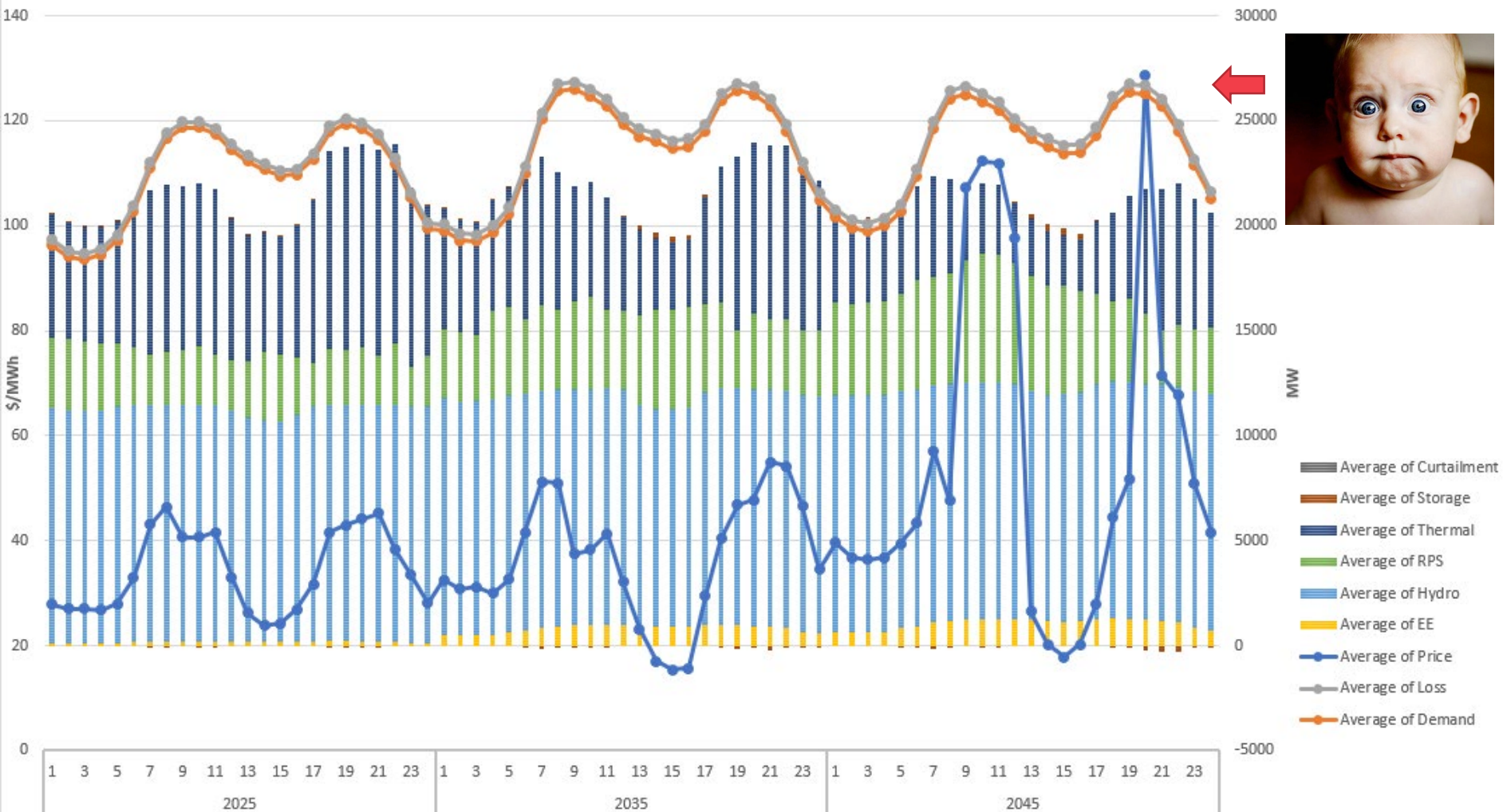
This is smaller than in a less diverse portfolio



Fixed costs more than double production costs for WECC, **NWPP** fixed and production costs stay similar.



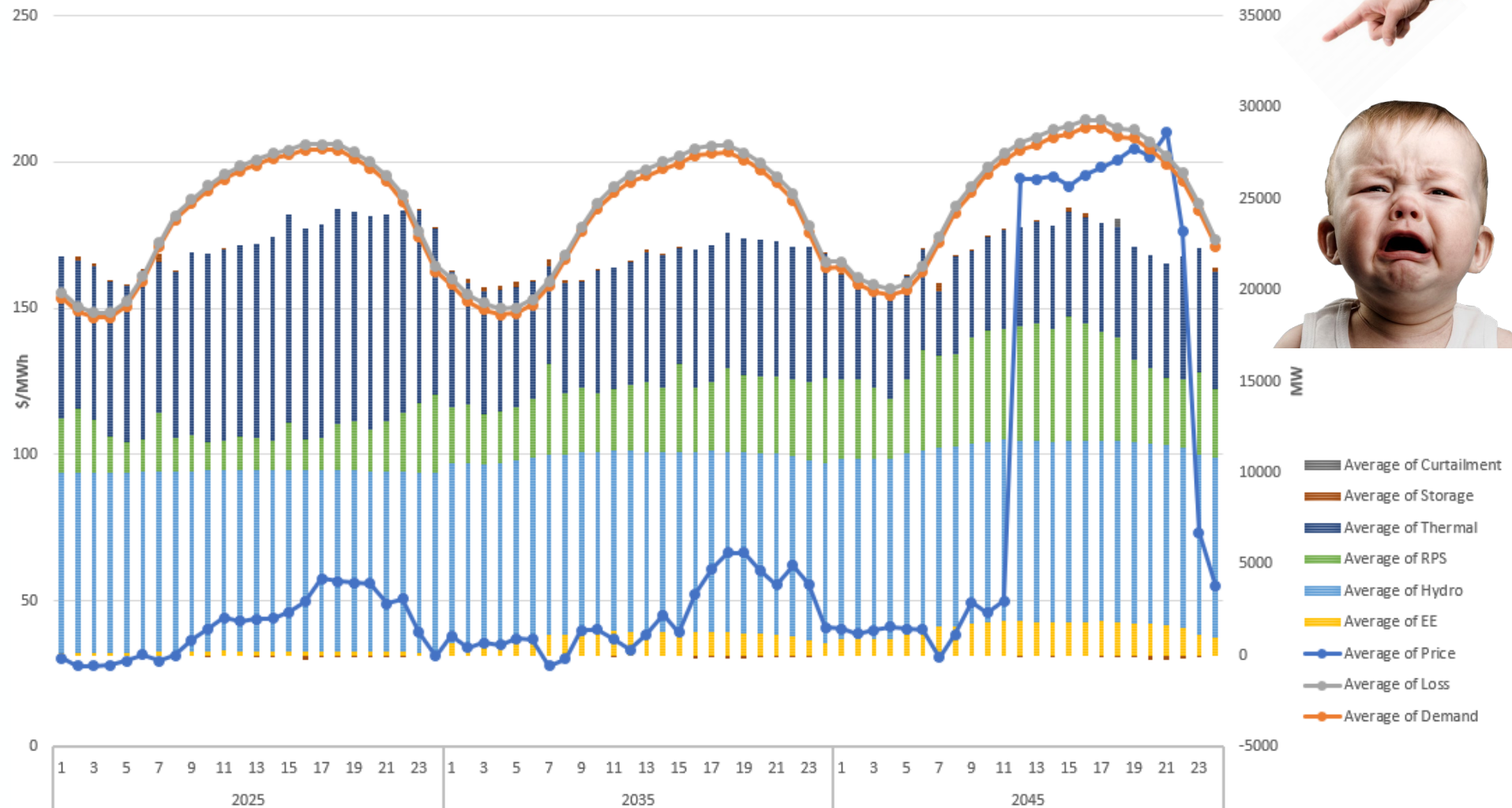
AVERAGE WINTER DAY IN 2025, 2035 AND 2045



PNW Load Resource Balance

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AVERAGE SUMMER DAY IN 2025, 2035 AND 2045



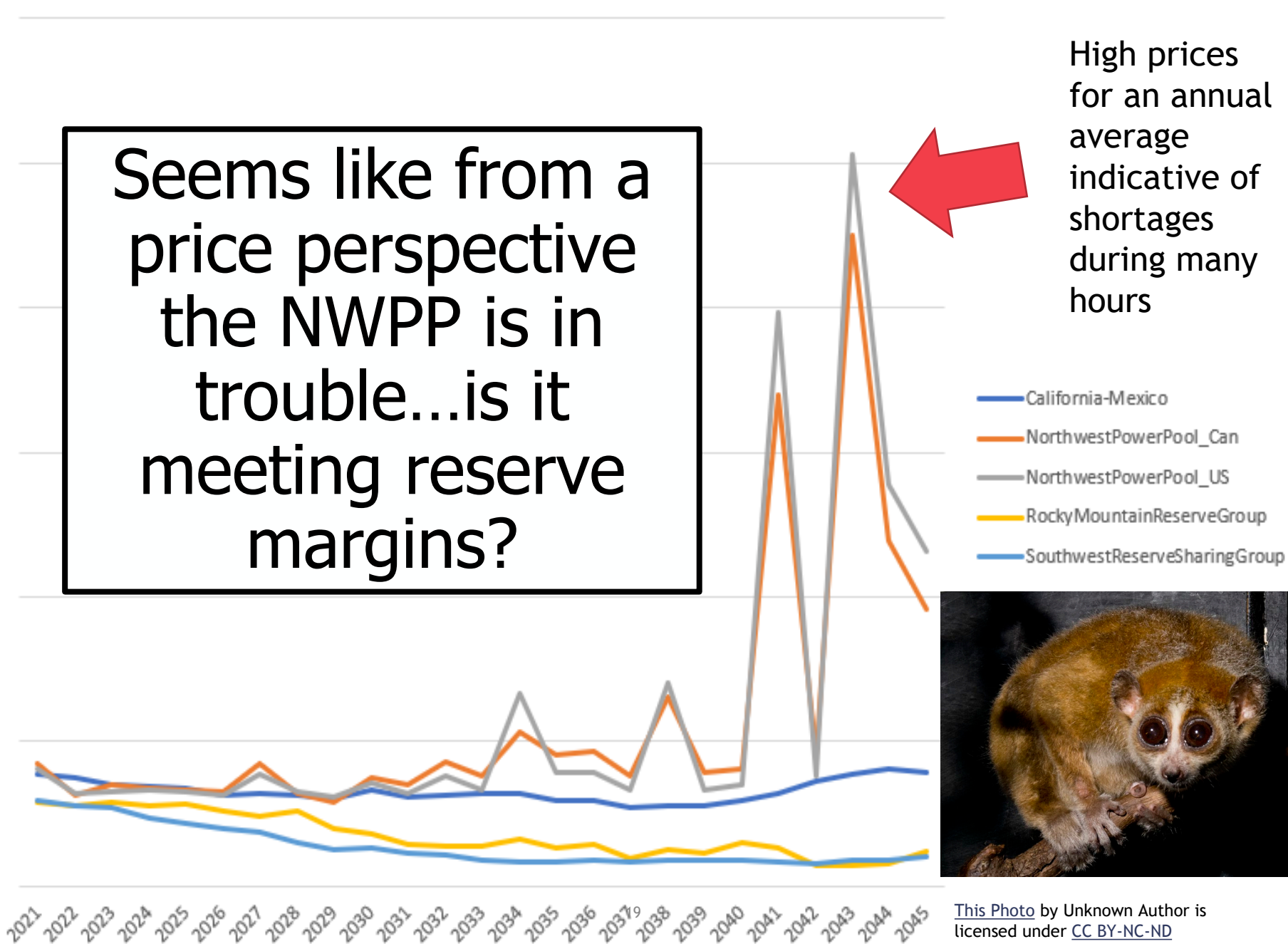
PNW Load Resource Balance

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Prices by Reserve Sharing Group in 2016 \$/MWh

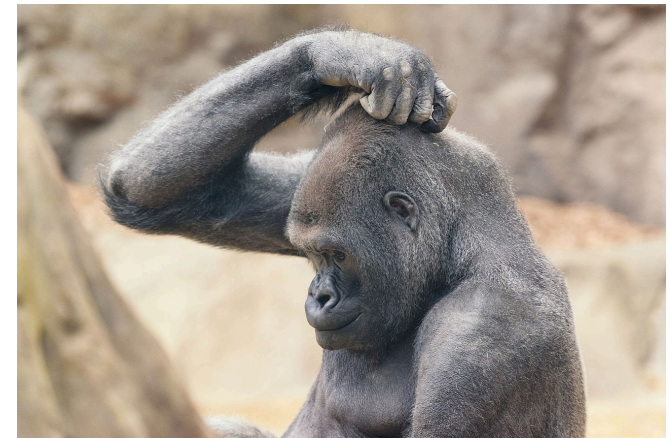
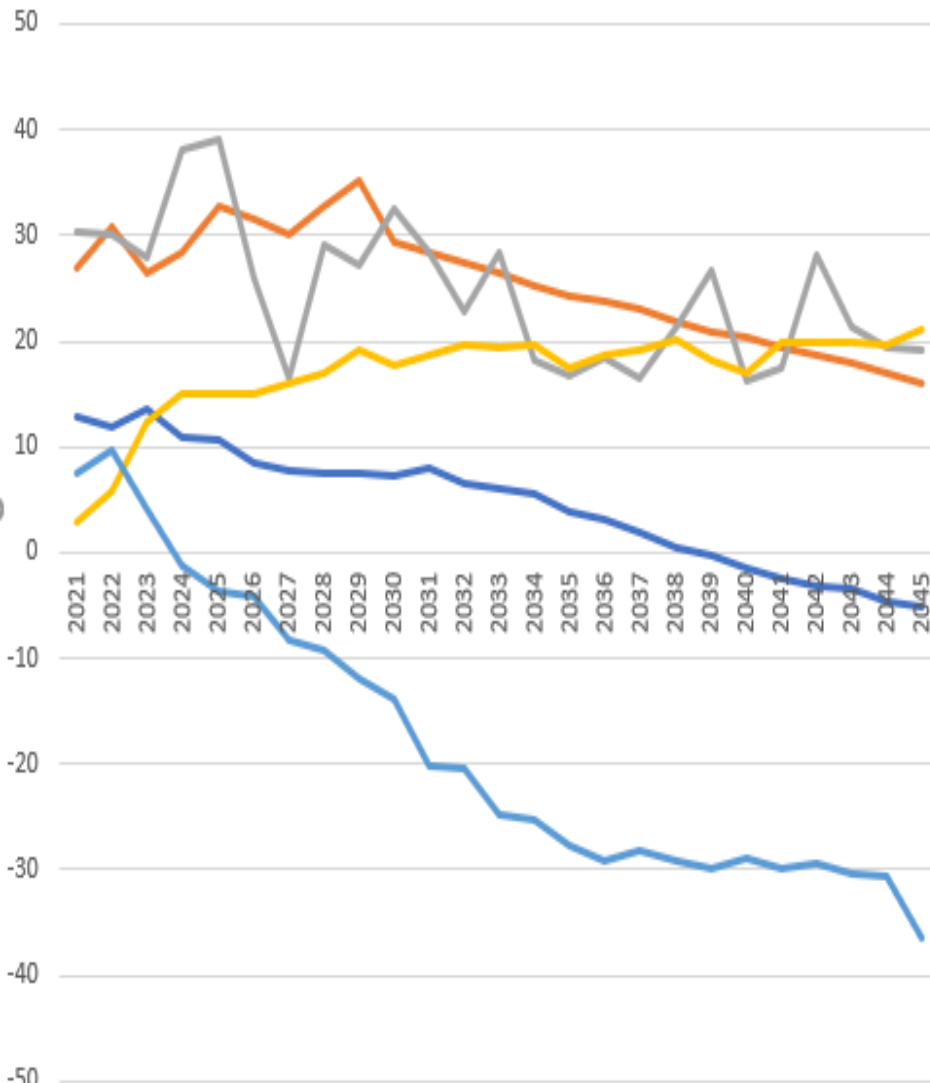
Seems like from a price perspective the NWPP is in trouble...is it meeting reserve margins?

High prices for an annual average indicative of shortages during many hours



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Reserve Margins Over Time (in %)



- California-Mexico
- NorthwestPowerPool_Can
- NorthwestPowerPool_US
- RockyMountainReserveGroup
- SouthwestReserveSharingGroup

From a reserve margin perspective CA/Desert SW seems in trouble...not the NW

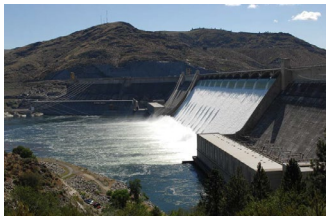


10/7 SAAC

Comments/Observations

- Continue explorations other resource types like offshore wind and pumped storage.
- Buildout with pumped storage seemed more reasonable by 2025.
- Concerned about adequacy signals of buildout in different regions (prices versus reserve margins).
- Be more clear about the role of EE and DR in deferring generating resource builds.



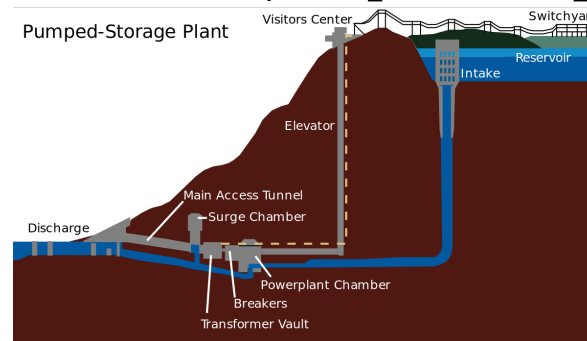
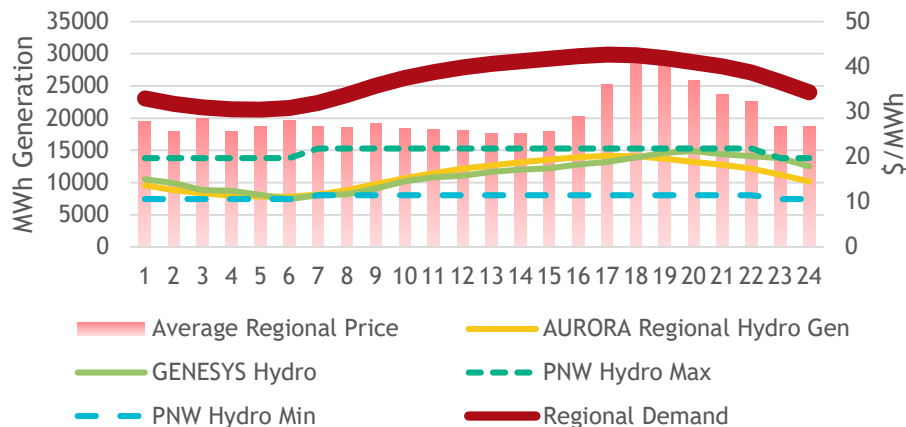


Data Updates and Methodology Tweaks



1. Staff is currently running tests with **offshore wind plants** (10 GW available from 4 sites in CA) and **pumped storage** (11.6 GW available from 15 sites throughout WECC – 8 in the region).
2. **CA demand forecast from 2030 to 2045 will increase significantly** per discussions with the CEC about projected effect of electrification. **AZ demand forecast will decrease** (EE and BTM increases in recent IRPs).
3. **NW hydro modeling methodology adjustments** (refill versus continuous studies in the classic GENESYS, on/off peak shaping)

Hydro “Training Wheels” Within Day Example Summer



Observations About Energy Limited Resources in AURORA Buildout

- **4 Hour Battery** – used for hour to hour flexibility, ancillary services (spin and non-spin), lower adequacy contribution because of energy limits
- **Pumped Storage** – used for ancillary services and adequacy contribution because of lower efficiency (requires bigger price differential for arbitrage)
- Unfortunately value streams are limited because of no forecast error
- May see more in ASCC studies for the region because of inherent forecast error in redeveloped GENESYS



Observations about Offshore Wind

Offshore Wind – used for resource diversity in CA, but has not substantially decreased build on solar.

Limitations

- Only used four sites in CA per the SB 100 guidance on available sites.
- Used onshore wind hourly shape but offshore wind annual capacity factors.
 - In other words, it might look better with better hourly shapes



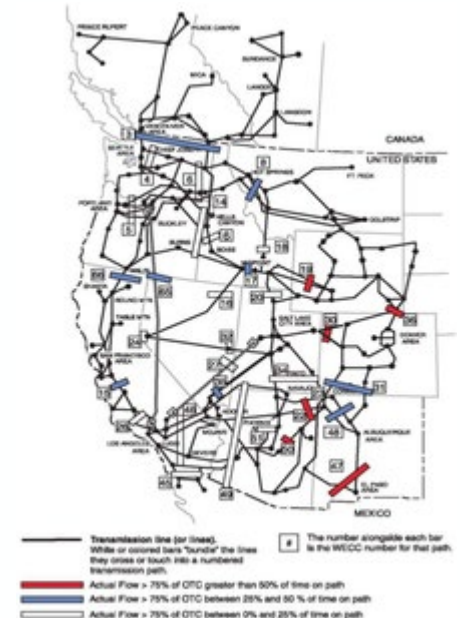
Quick Glance at Load Resource Balance Around the WECC

- Key Regions:
 - Many Retirements, High Requirements
 1. California
 2. Arizona and New Mexico (Desert Southwest)
 3. Pacific NW

Many Retirements, Lower Requirements

1. Nevada, Utah, Western Wyoming (Mountain West)
2. Canada
3. Colorado, Eastern Wyoming (Basin)

Note that for planning we have used an extremely bad hydro year for the NW.

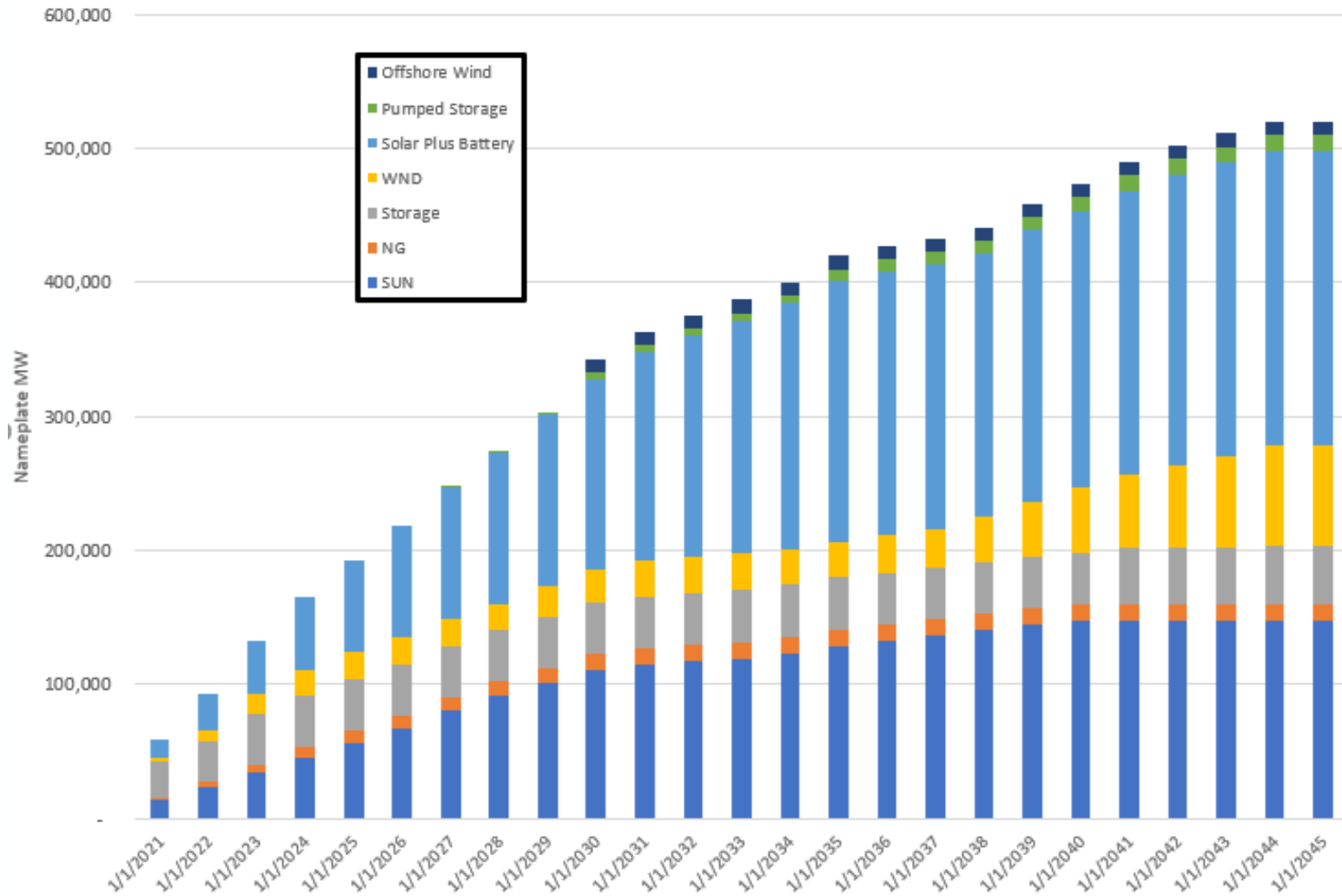


Reserve Margin Issues: A Different Intermediate Run

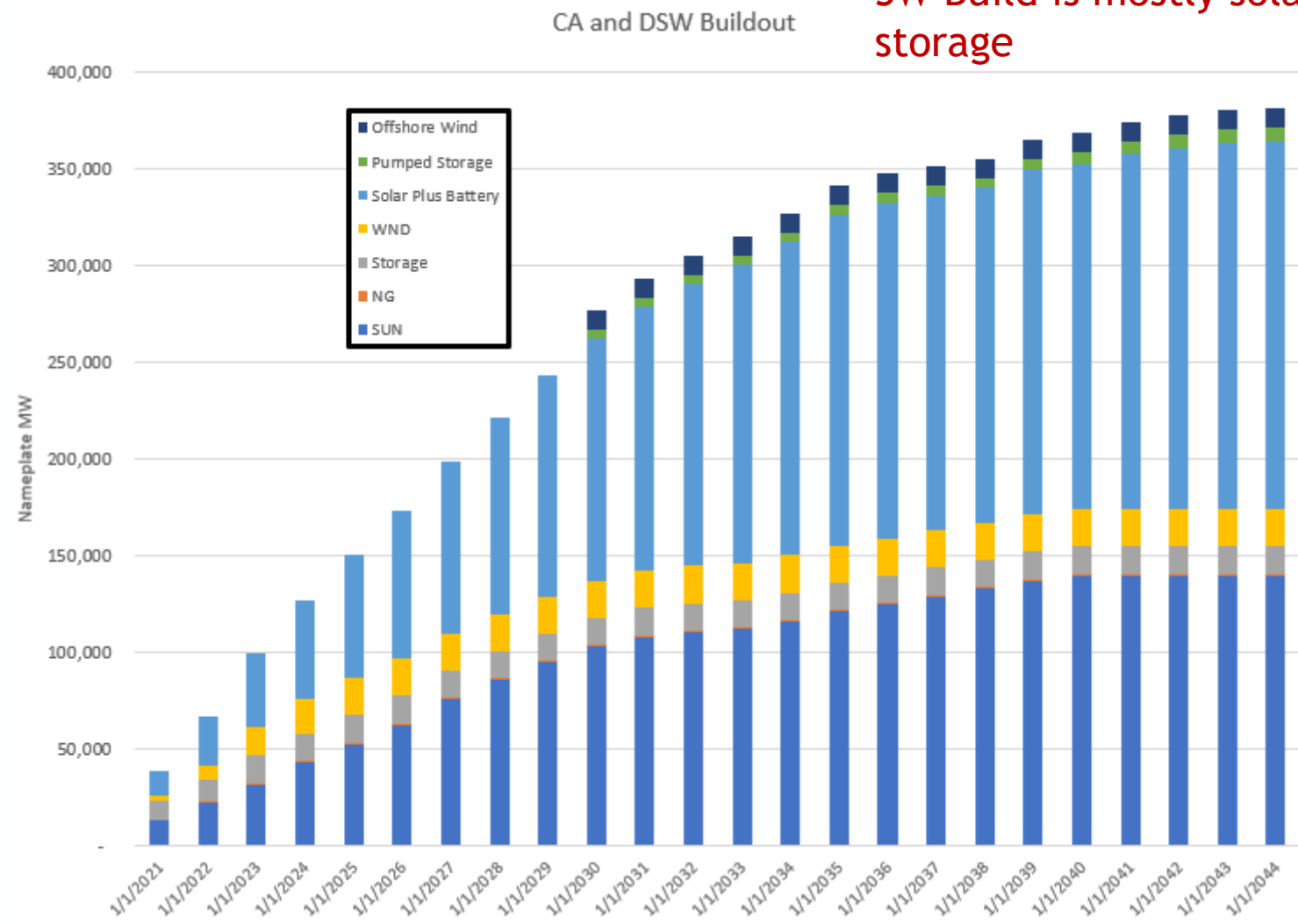
- This is an example of some of the issues we are working through...
- 1. Massive solar and solar plus battery build in CA and Desert SW
 - Massive renewable curtailment in many hours
- 2. Not enough resource in NW and Canada during certain times of day
 - Sometimes in same hours of renewable curtailment



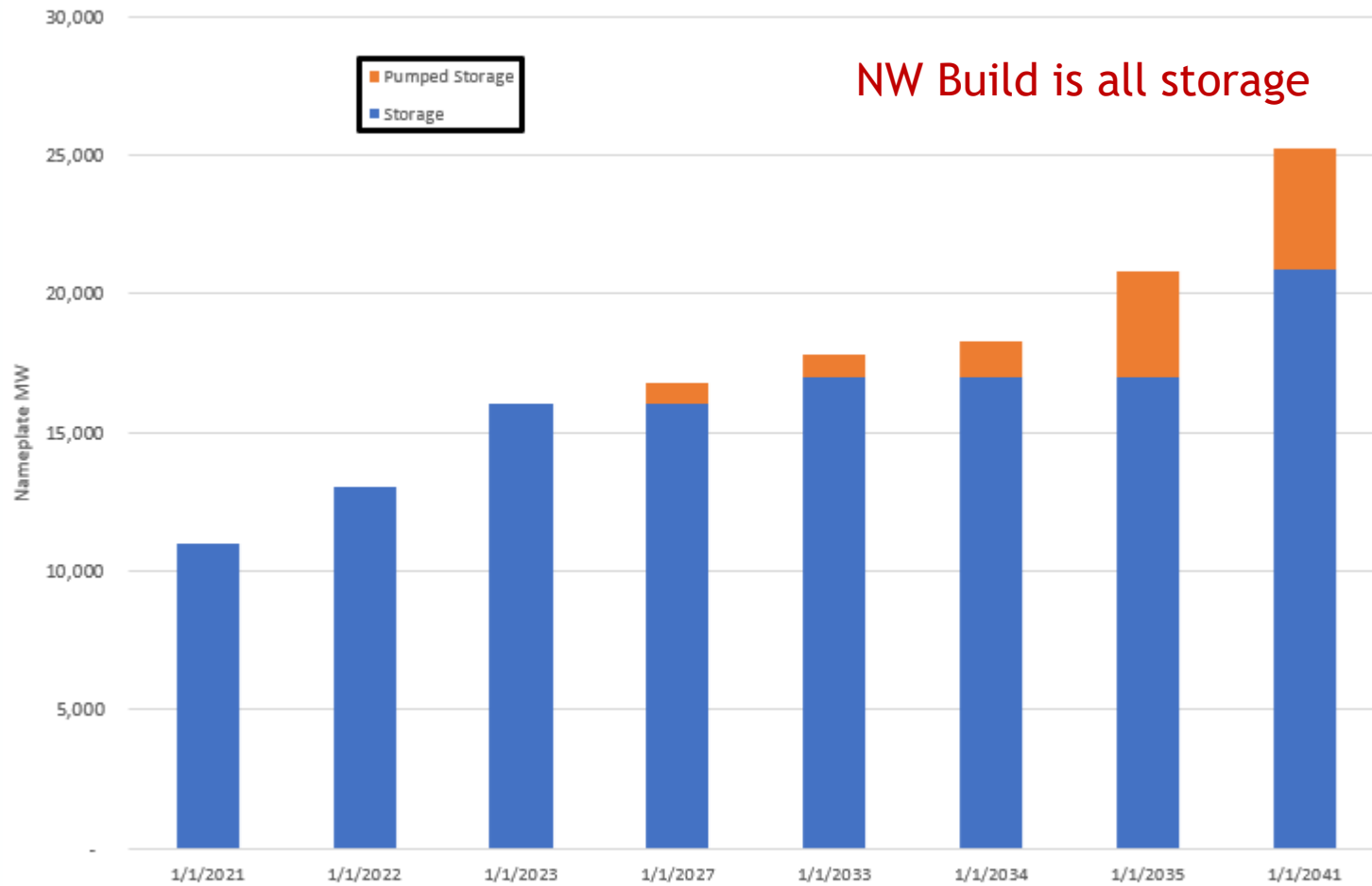
WECC-Wide Buildout

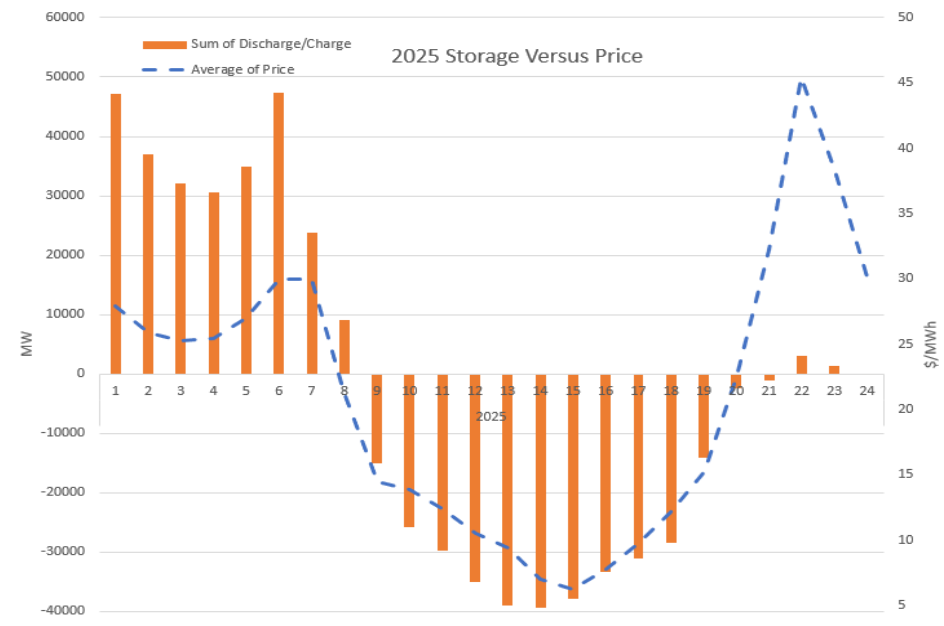
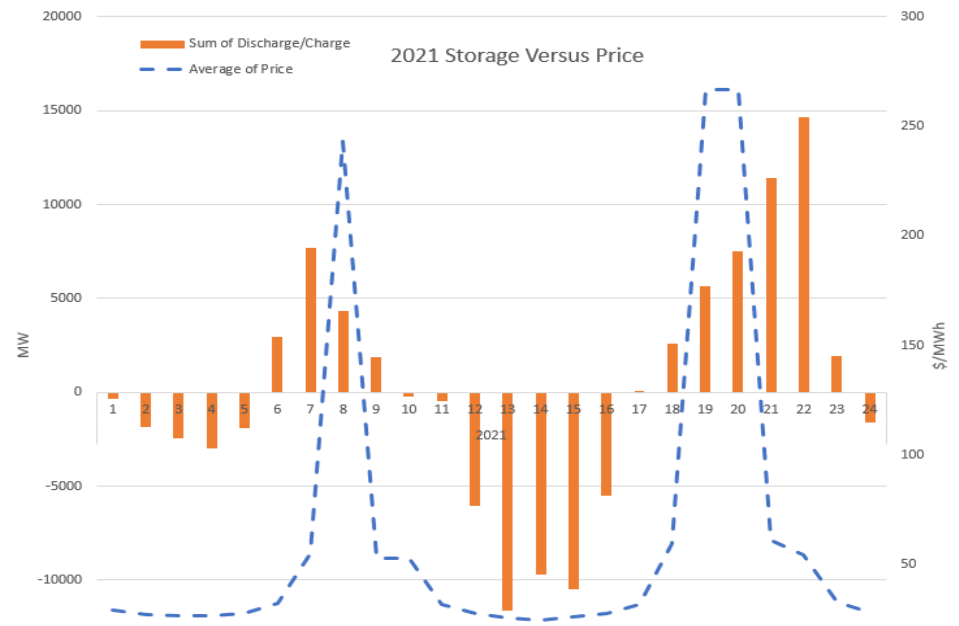


SW Build is mostly solar and storage

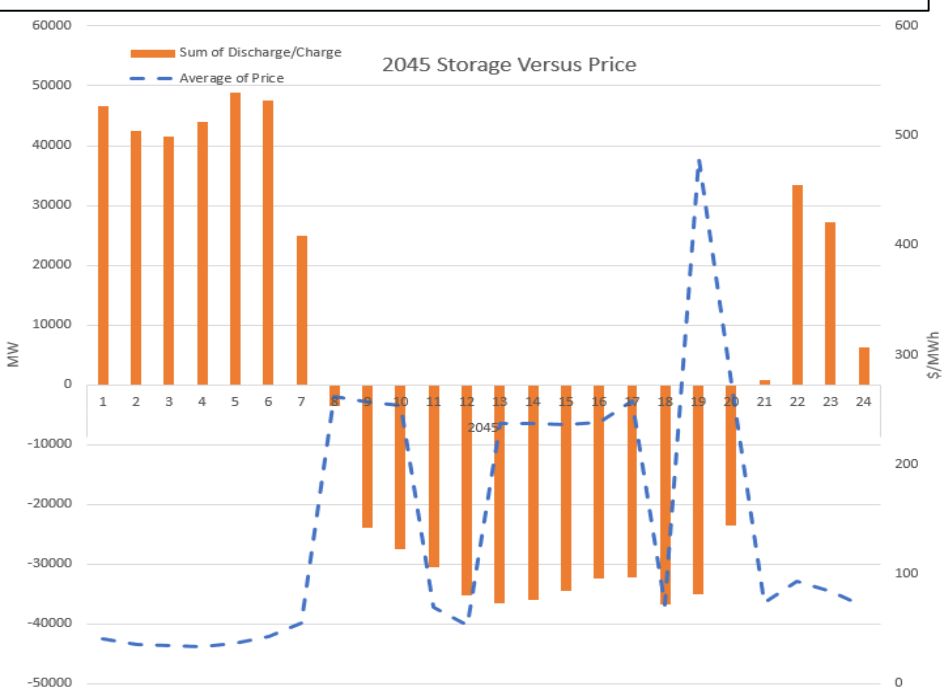
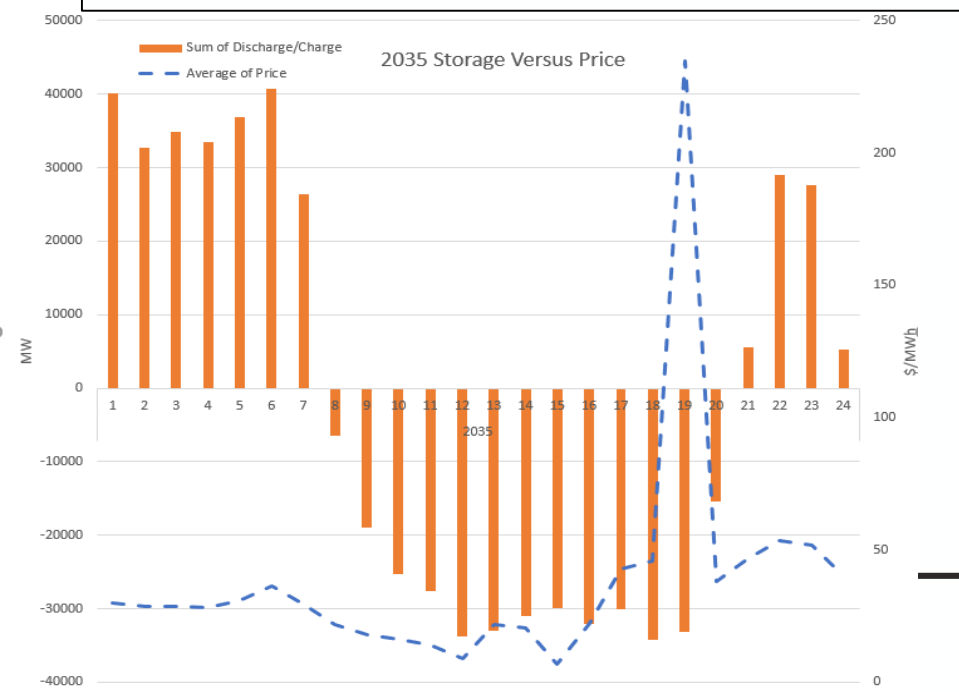


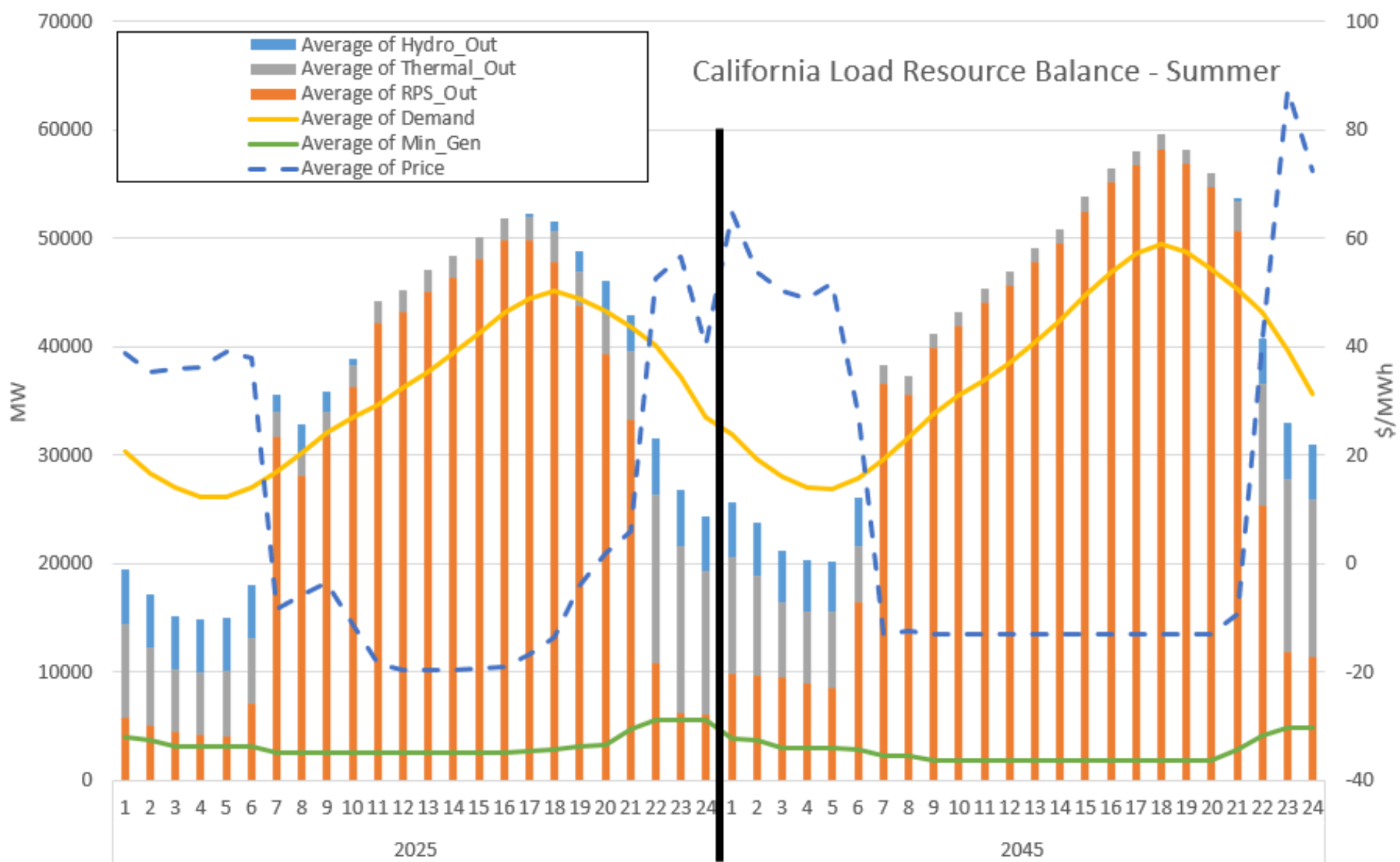
PNW Buildout

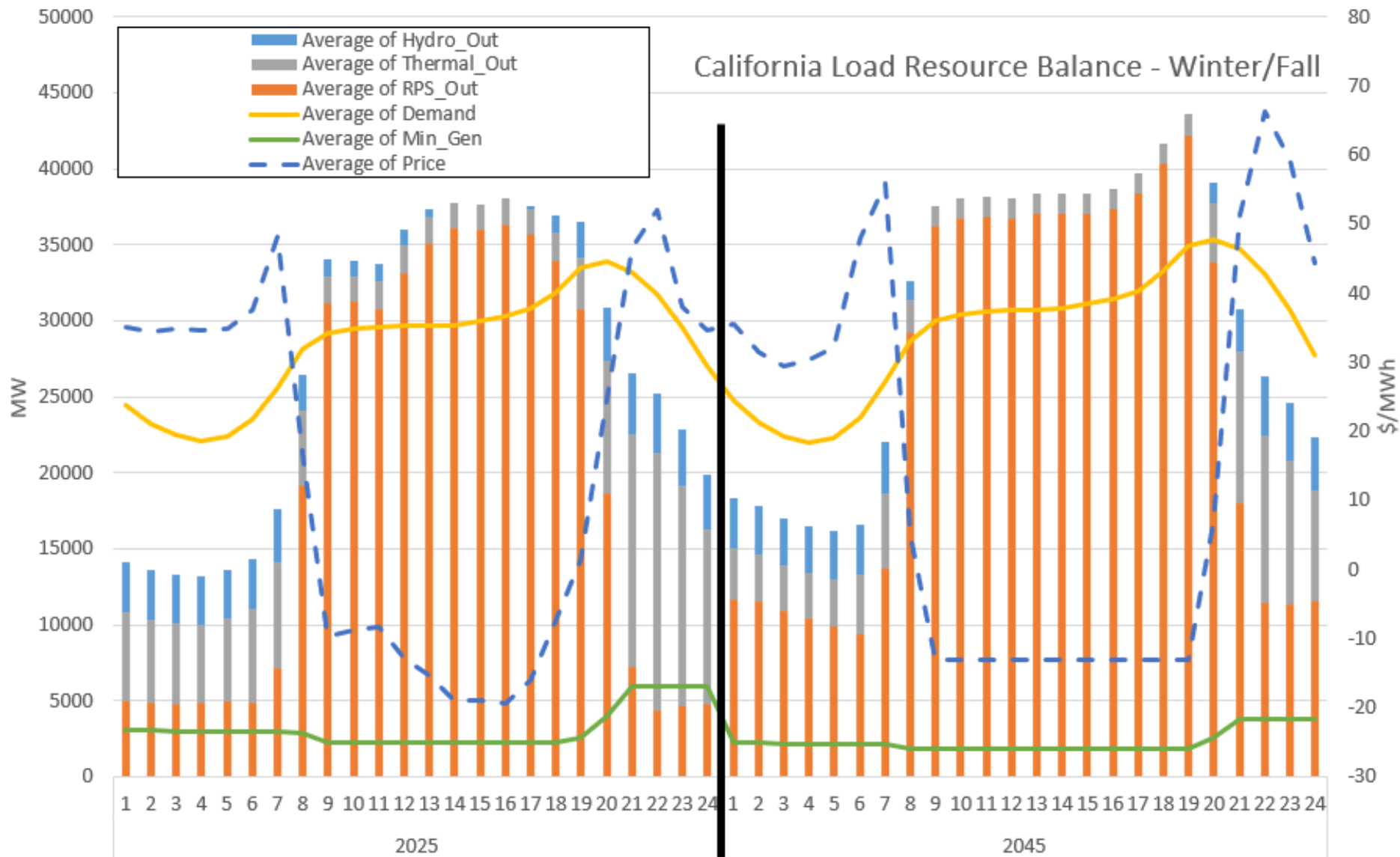


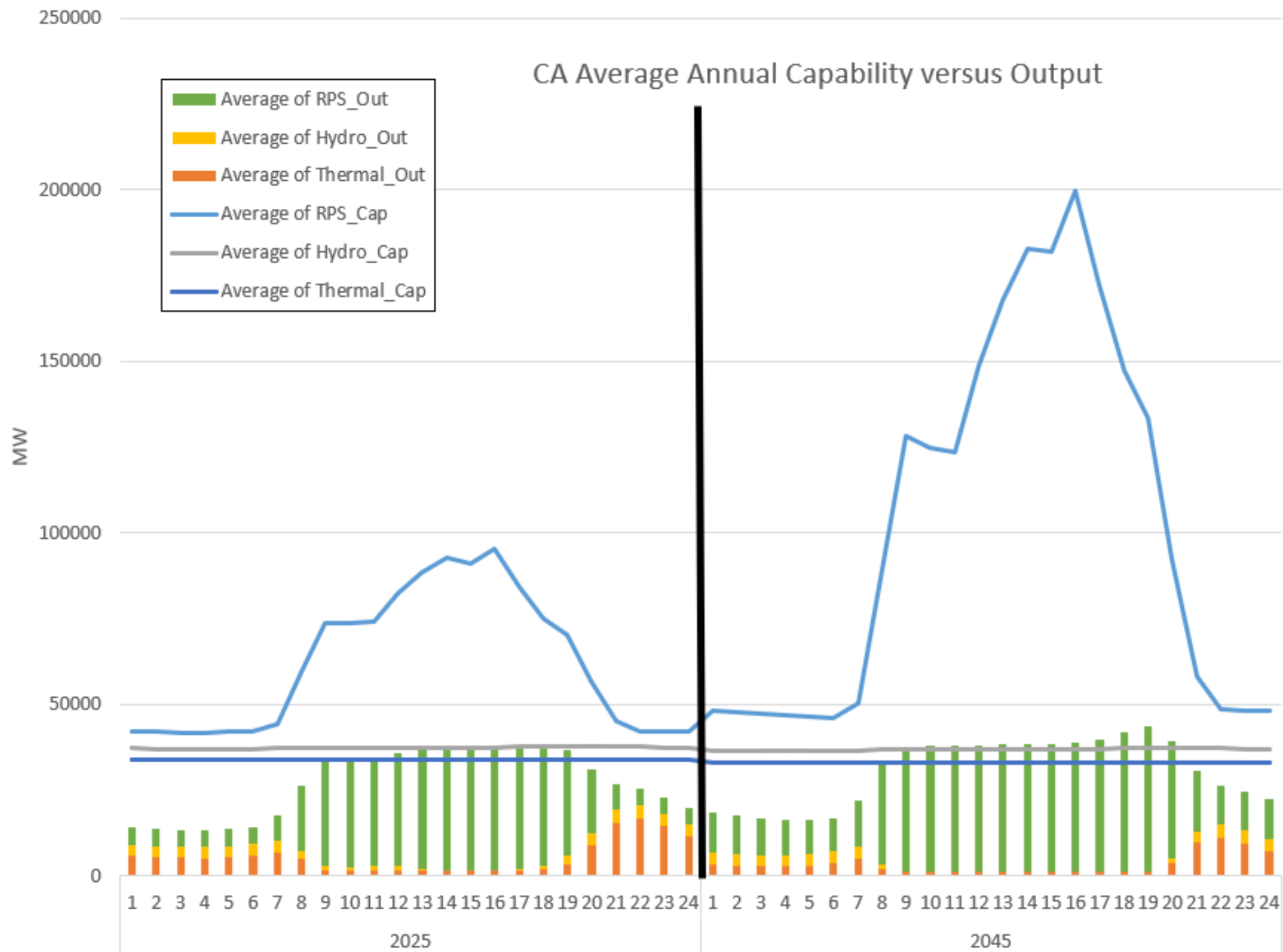


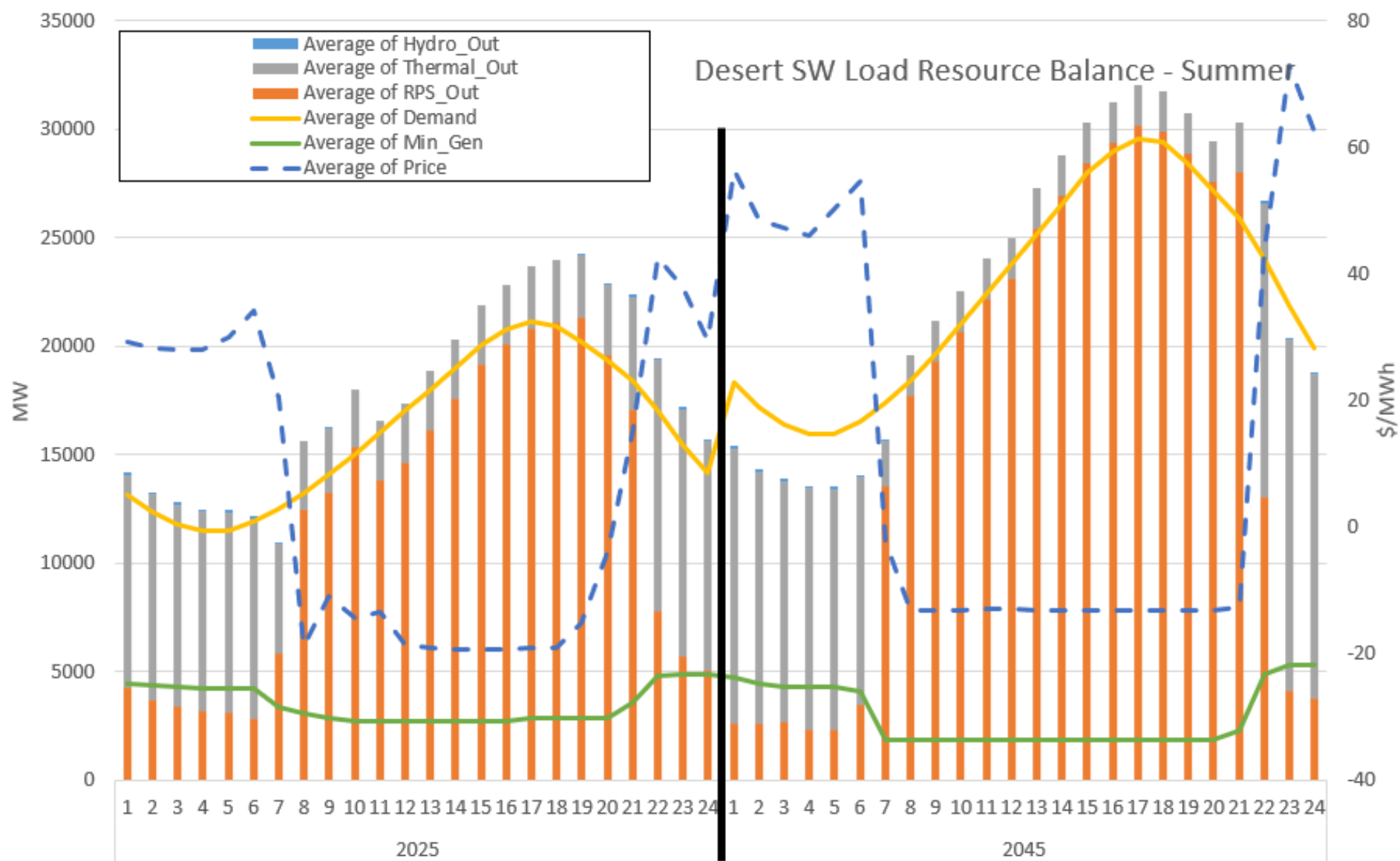
WECC storage usage evolves as more is added and as more renewables are added.

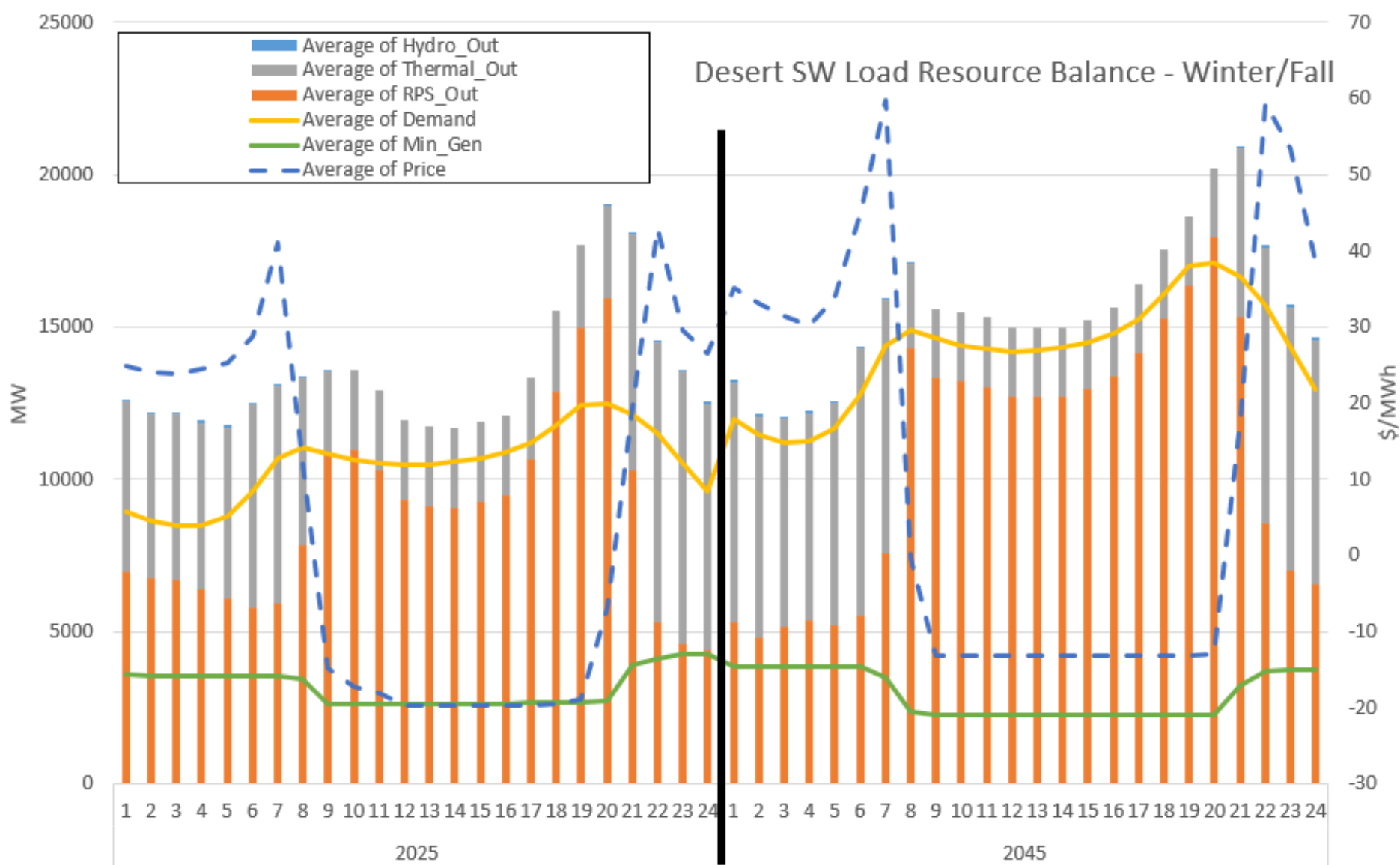




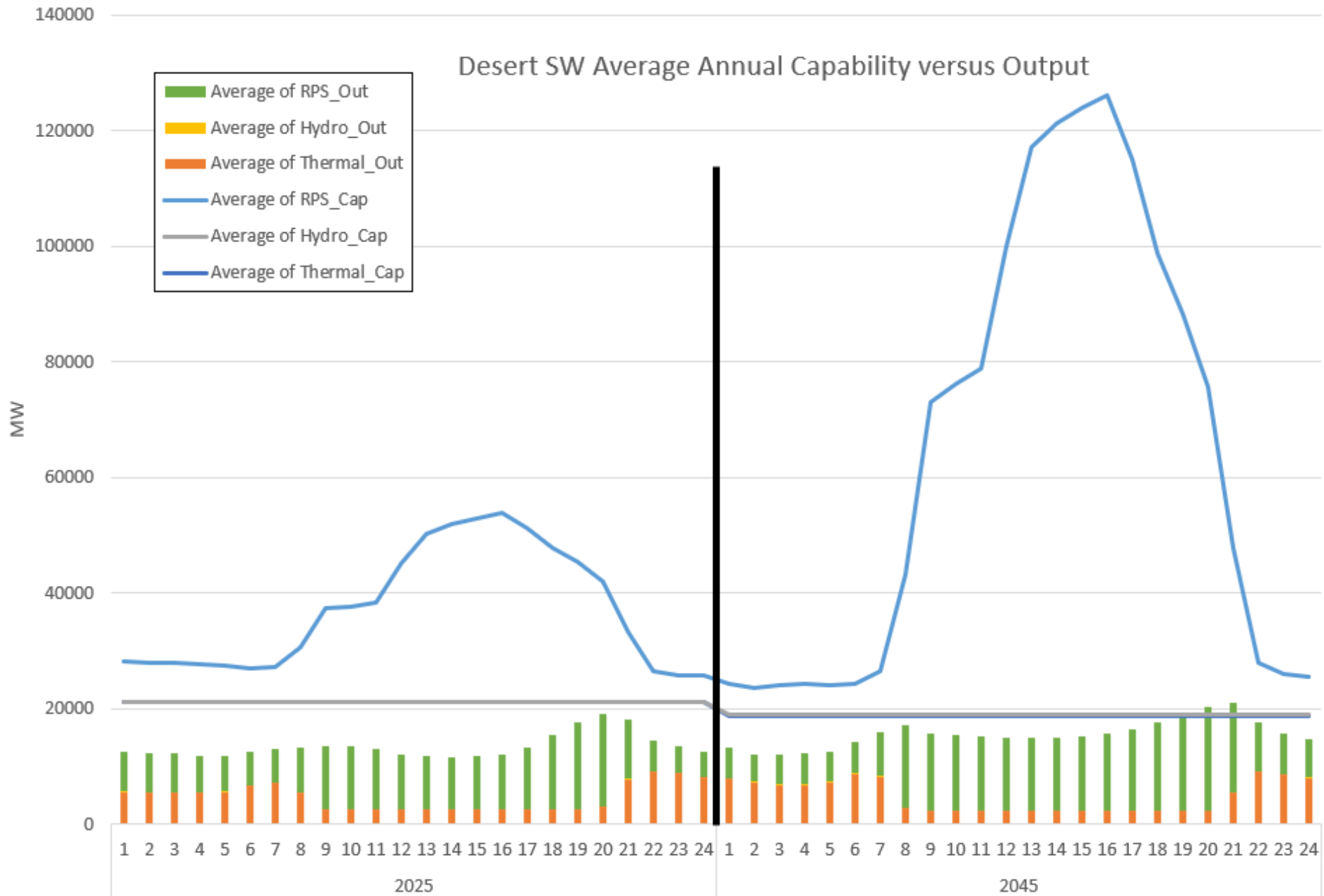




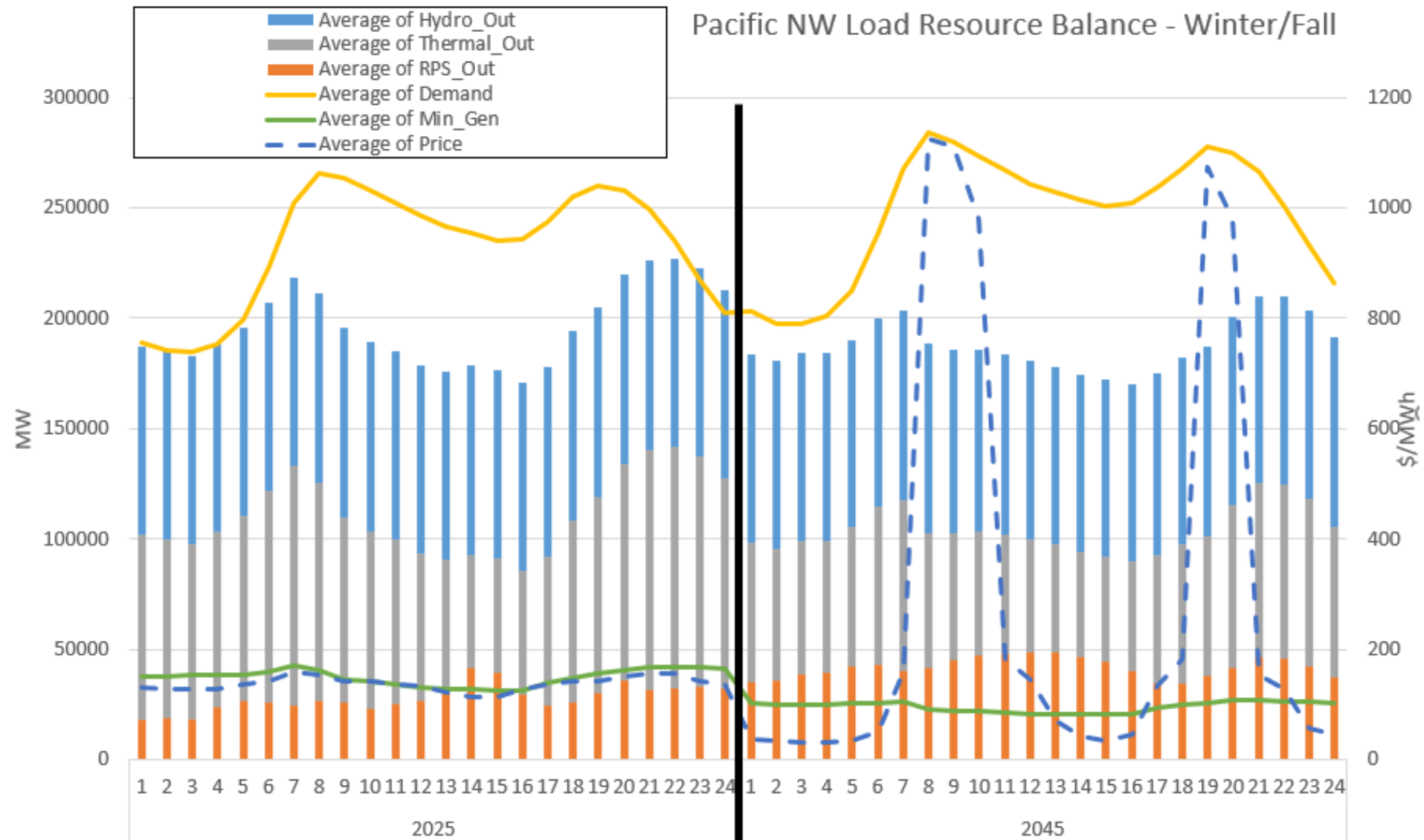




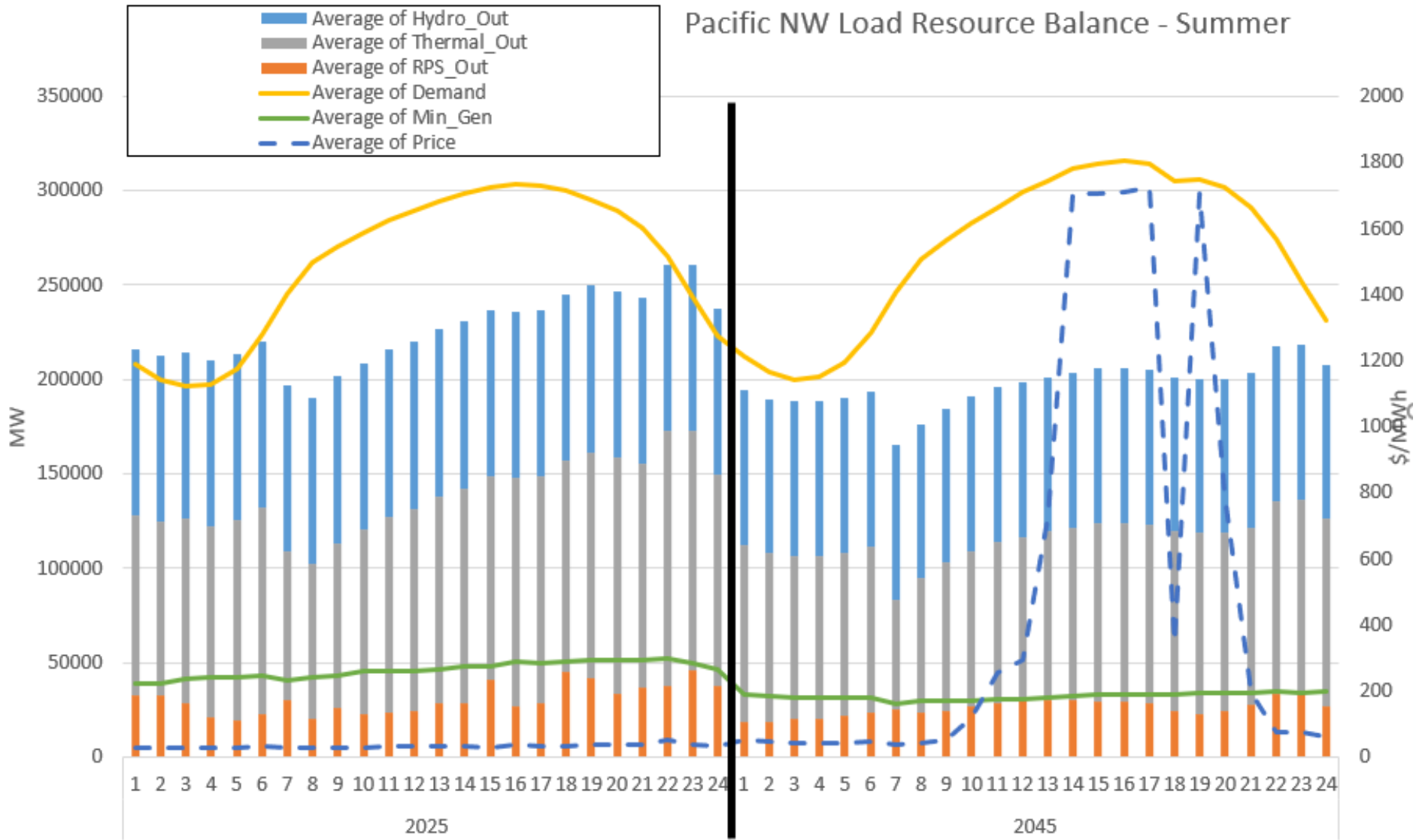
Desert SW Average Annual Capability versus Output



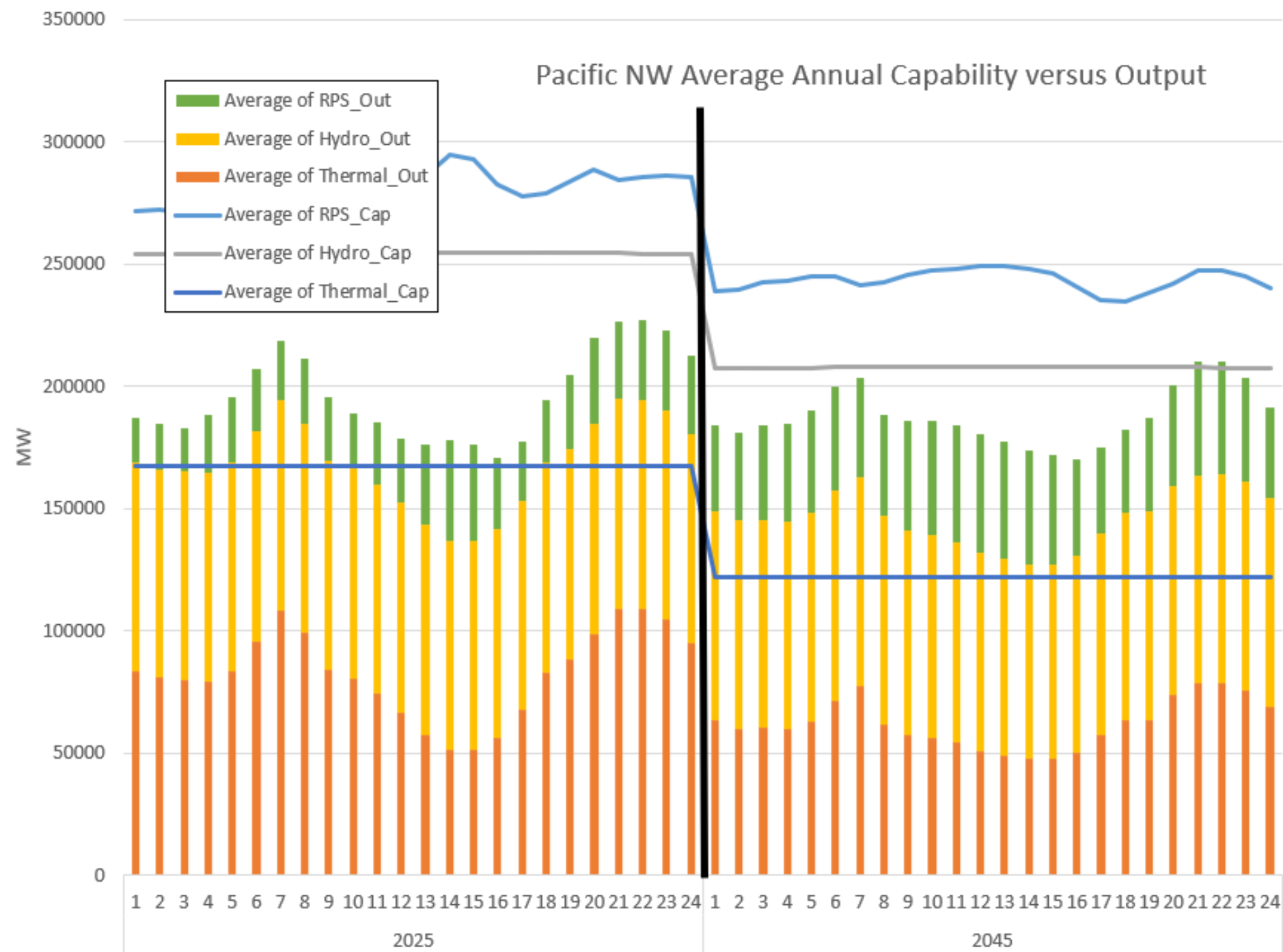
Pacific NW Load Resource Balance - Winter/Fall



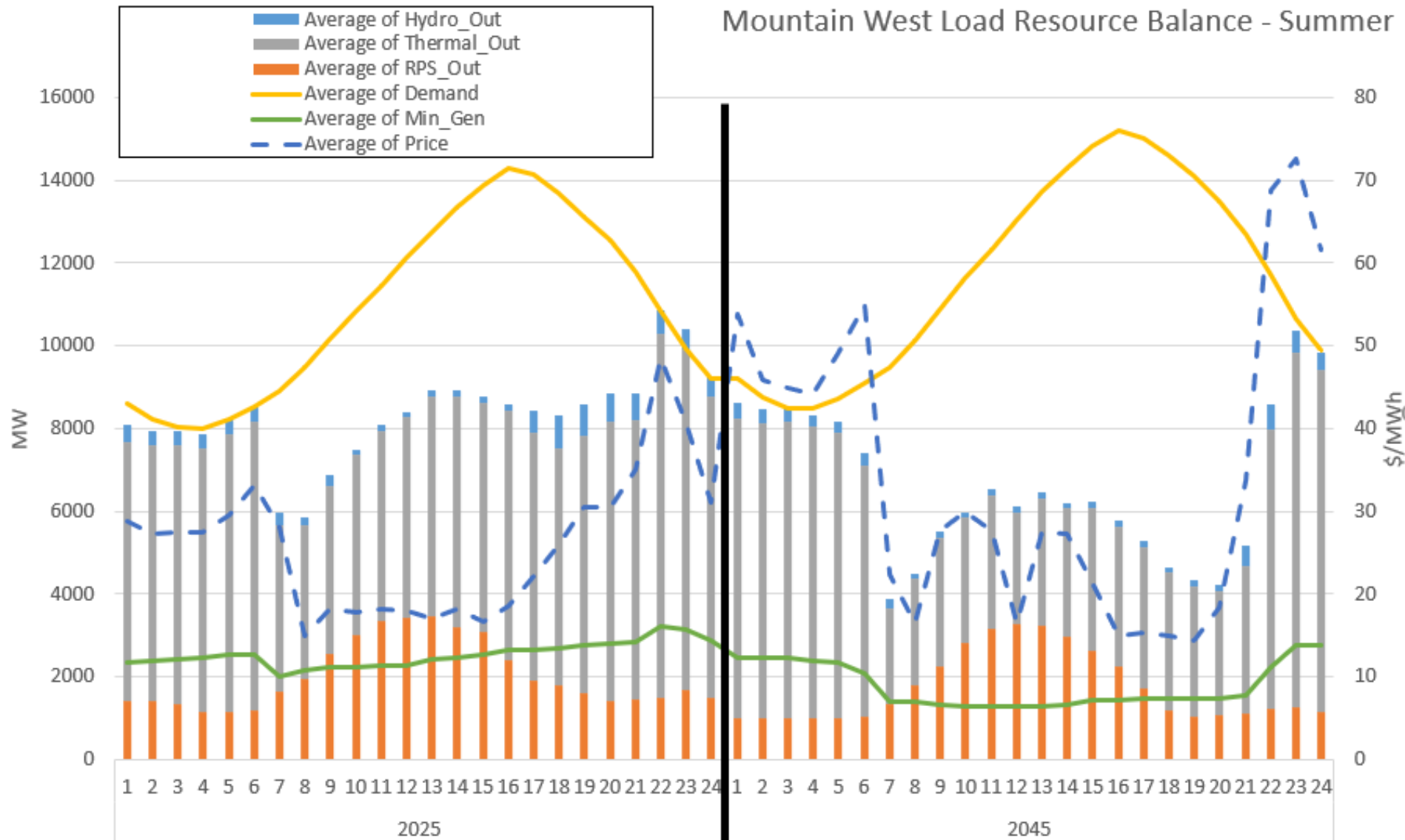
Pacific NW Load Resource Balance - Summer



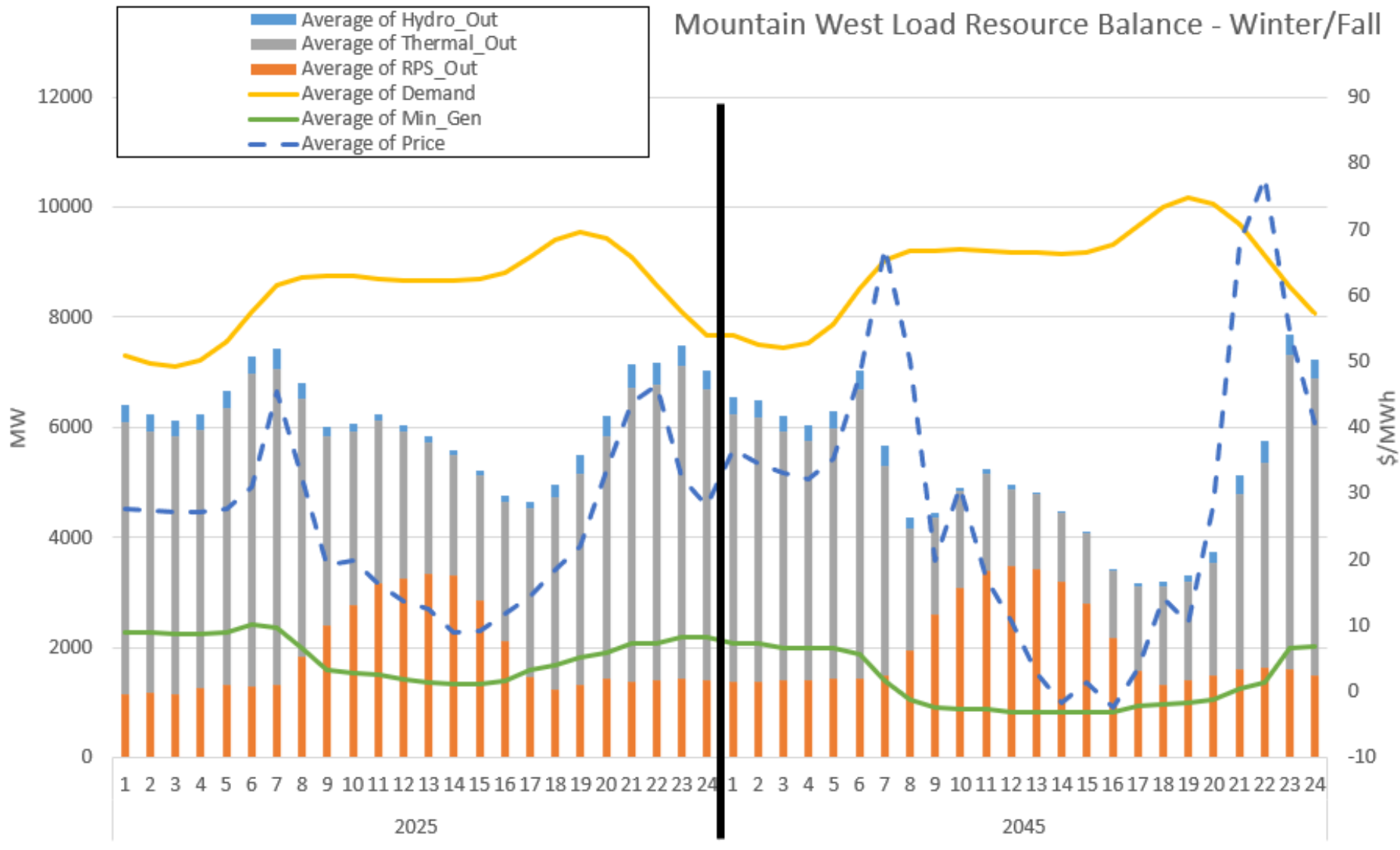
Pacific NW Average Annual Capability versus Output



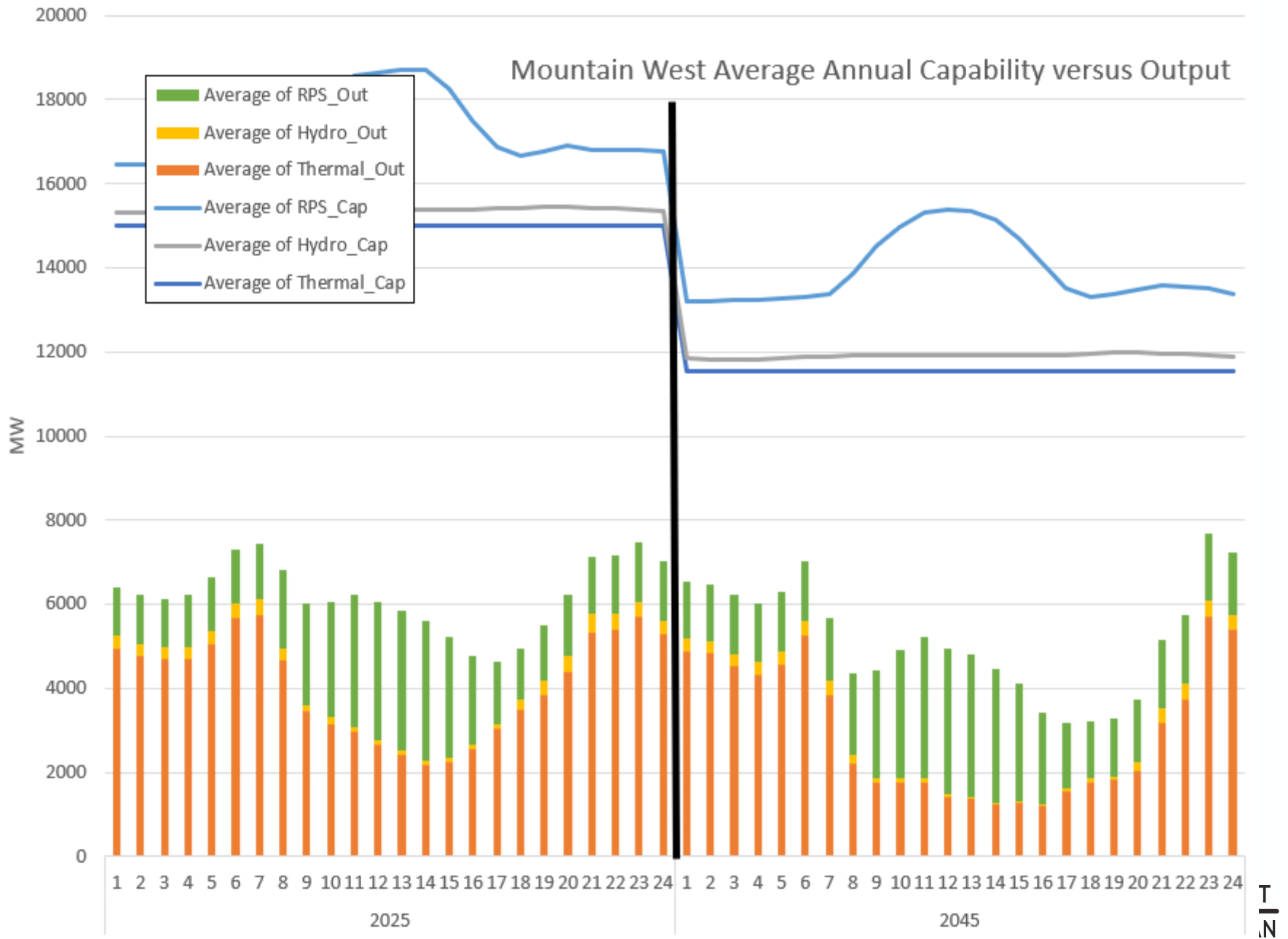
Mountain West Load Resource Balance - Summer



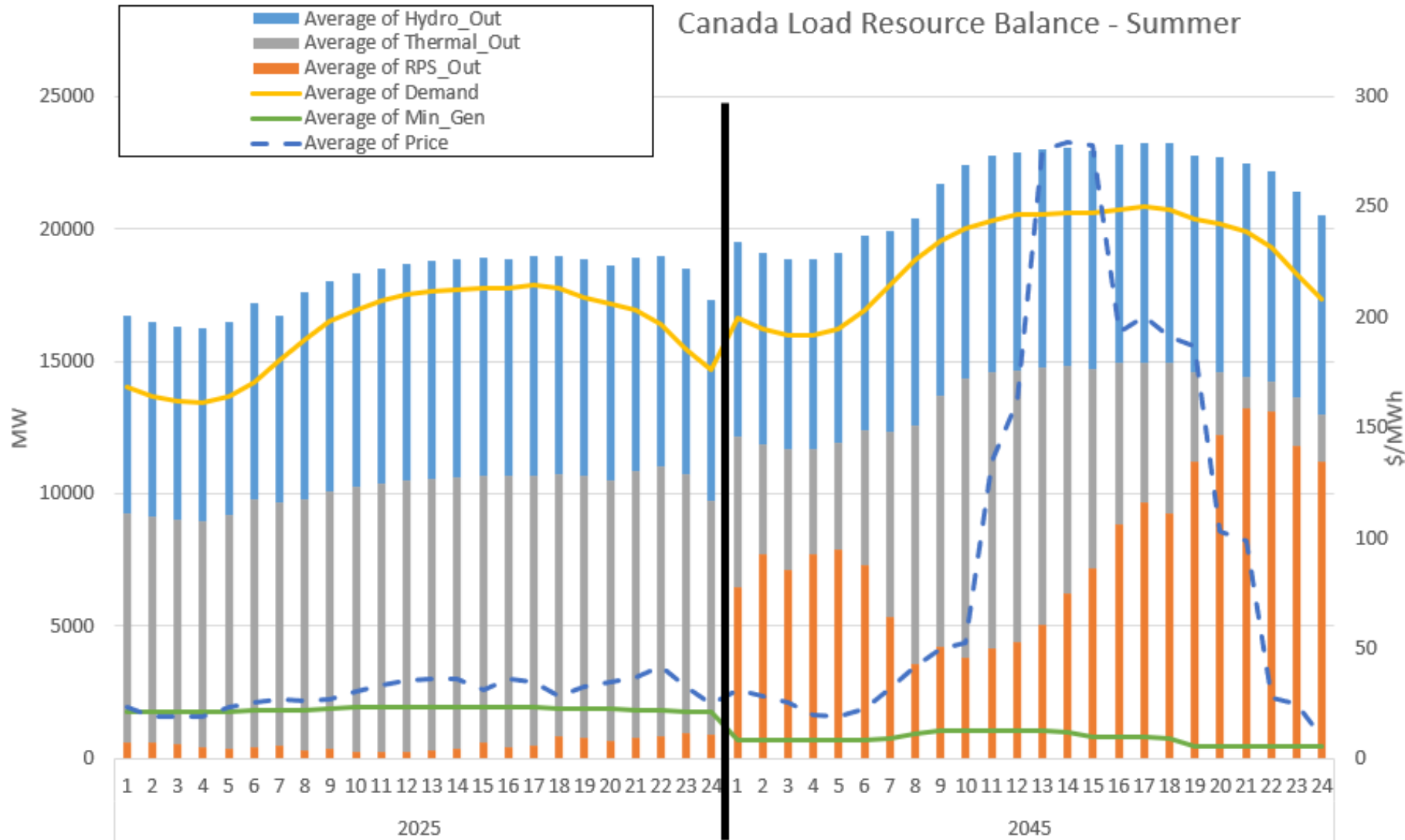
Mountain West Load Resource Balance - Winter/Fall



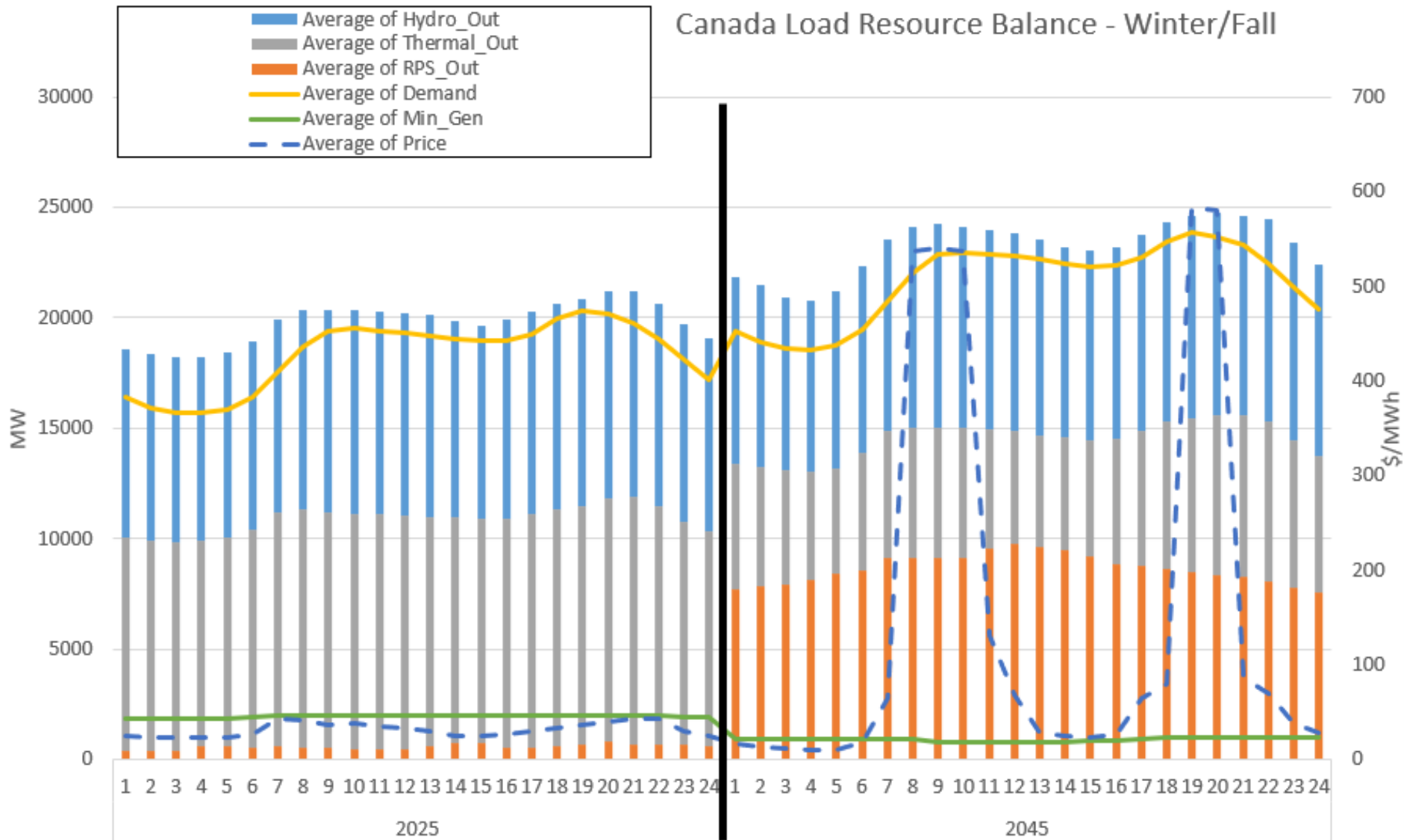
Mountain West Average Annual Capability versus Output

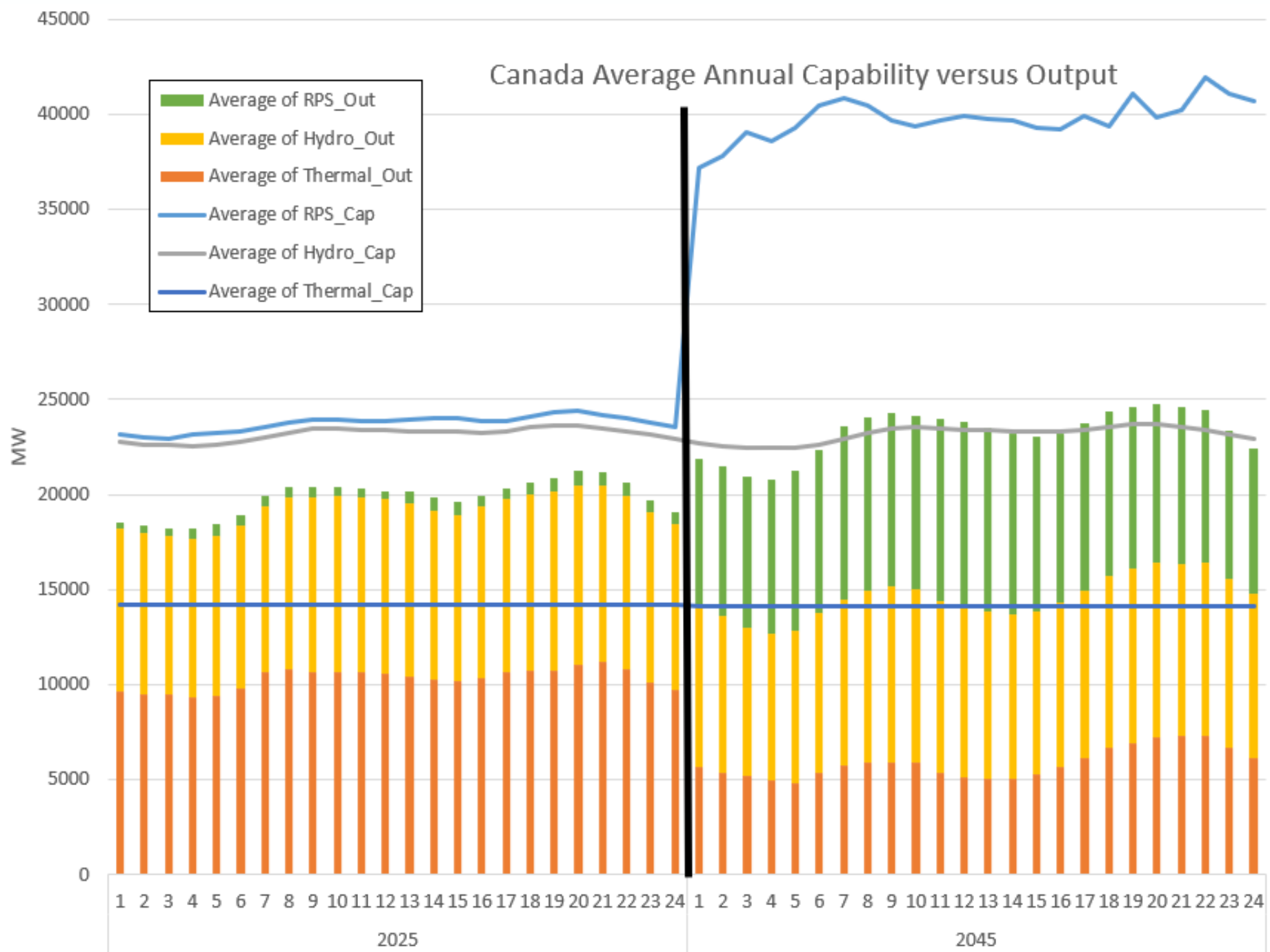


Canada Load Resource Balance - Summer

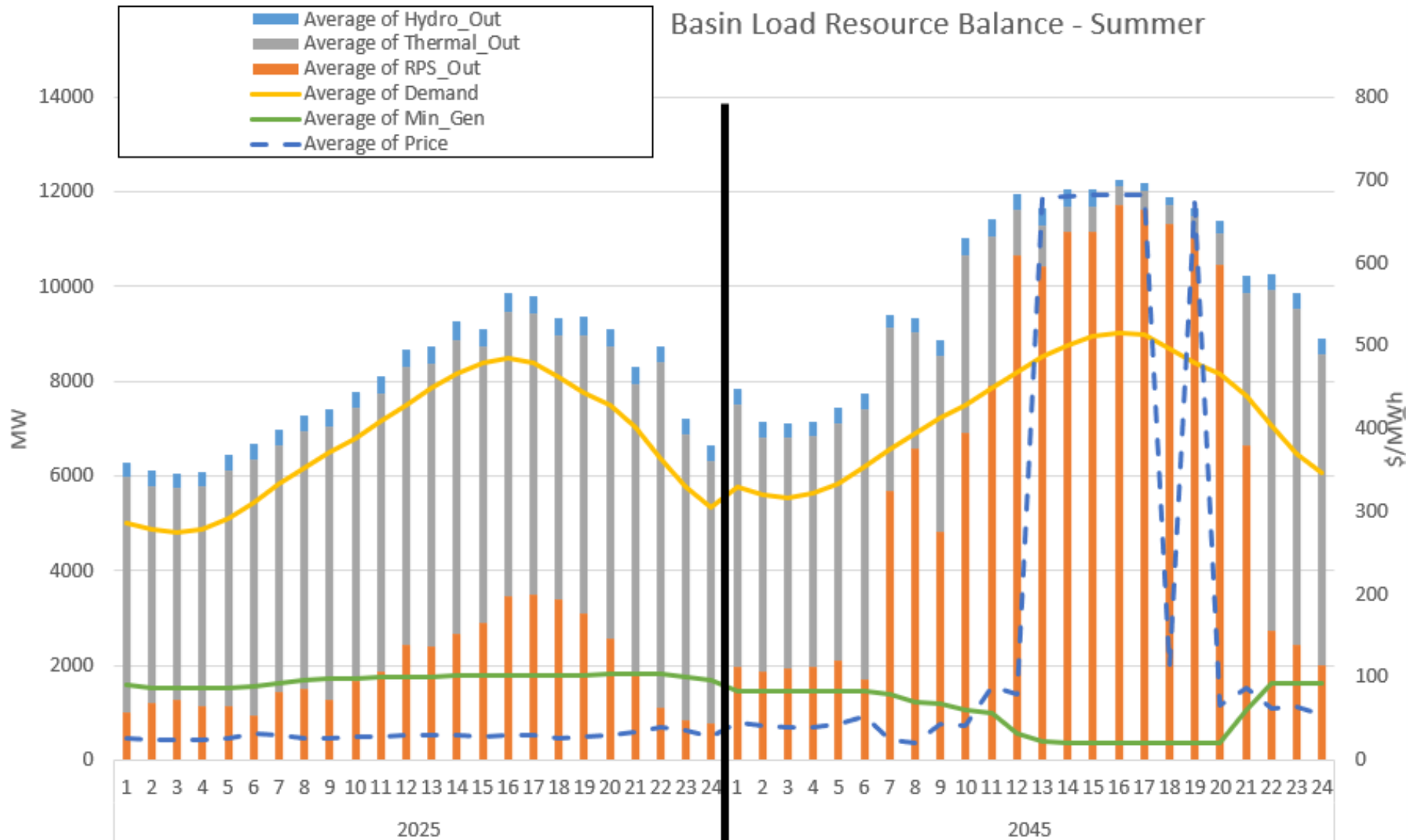


Canada Load Resource Balance - Winter/Fall

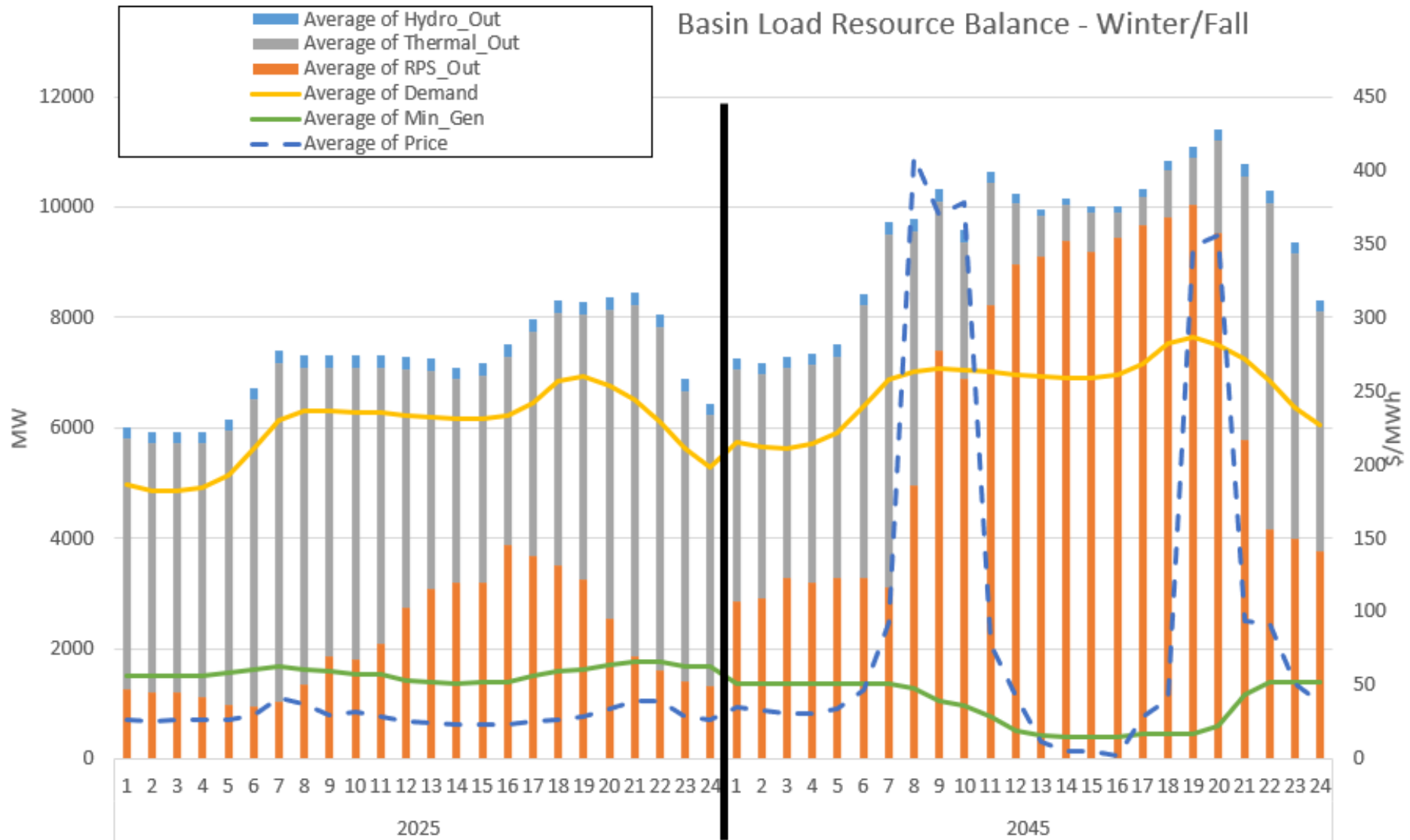


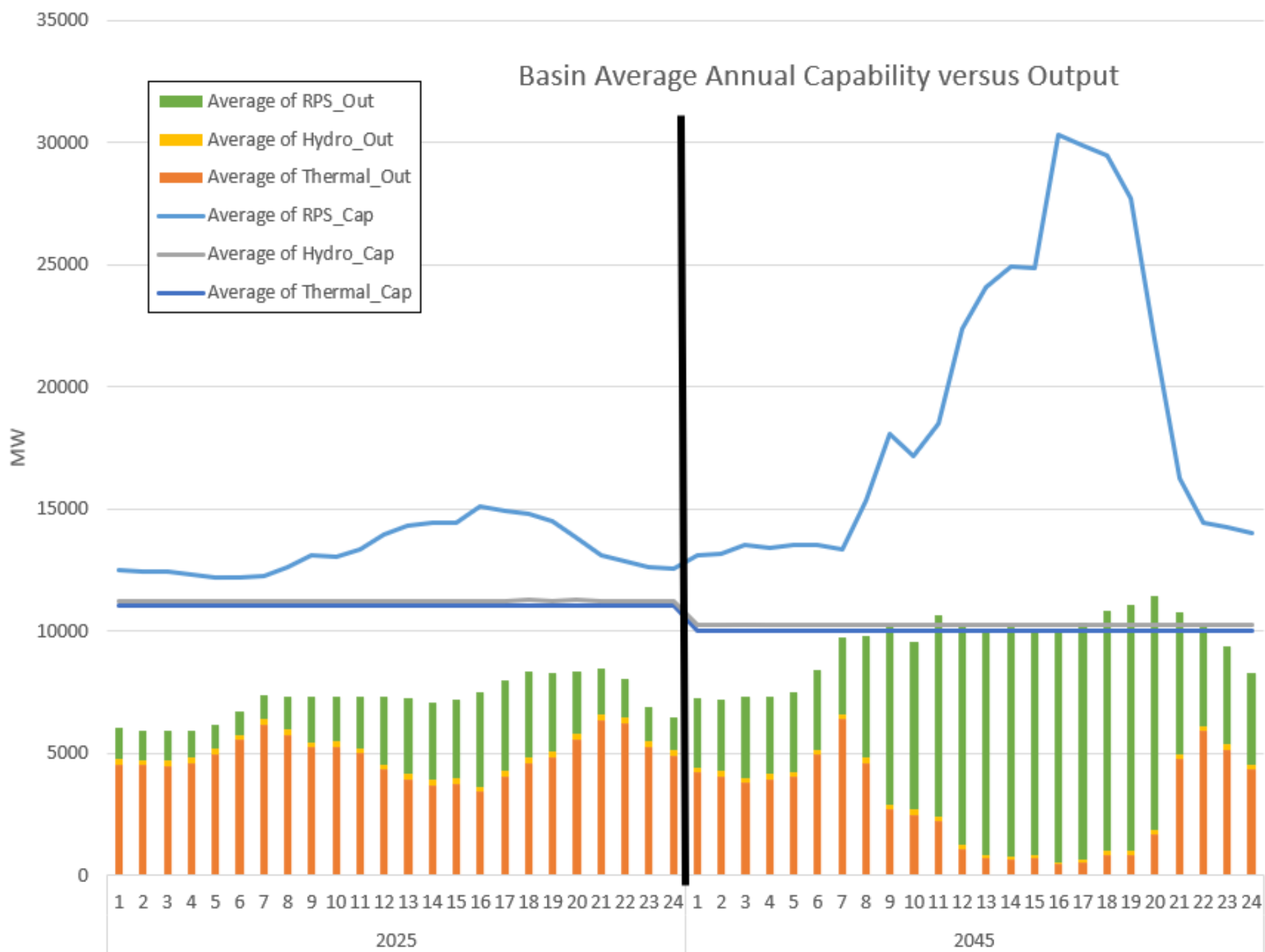


Basin Load Resource Balance - Summer



Basin Load Resource Balance - Winter/Fall



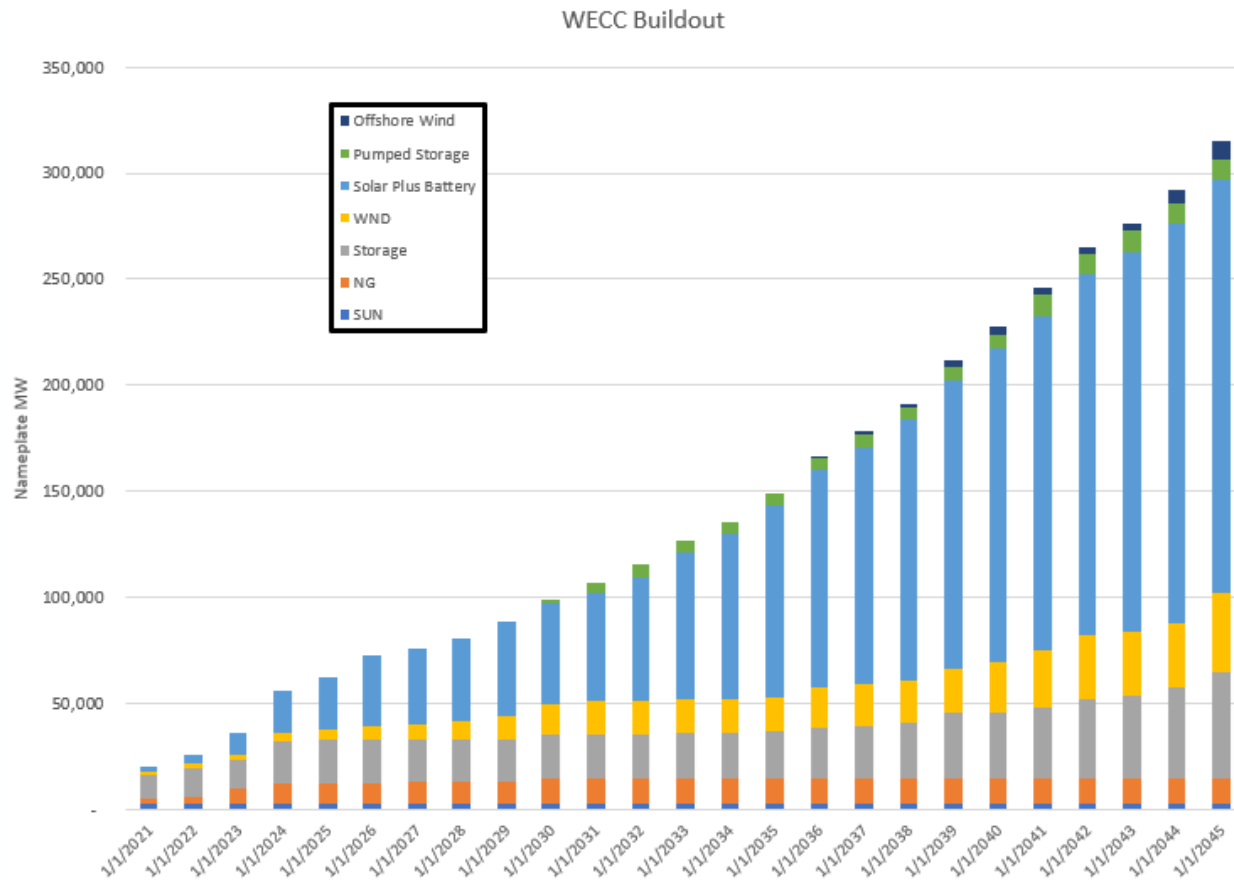


Reserve Margins Versus Needs

- CA and Desert SW solar builds to meet reserve margin needs keep them adequate on an average but struggle on a peak basis (missing reserve margin in summer).
 - However, they curtail a massive amount of the year.
 - Seem like they would be ripe for more storage, flexible/shaped demand, transmission or diversity of load (organized market)
- Pacific NW, Canada and the Basin meet reserve margin based on calculations in model, but still have hours where the margin is missed
 - Possible issues in NW are due to really bad hydro year in climate change record (recall that reserve margin calculations based on adequacy over all hydro)
 - Seems like existing system has excess capability in some places that cannot get to load or is not committed.
 - Seem like they would be ripe for more storage, flexible/shaped demand, transmission or diversity of load (organized market)



This morning's build...



Proposed Next Steps

- Continue to implement the methodology tweaks, small corrections and resource type additions until we get a forecast that meets **pool reserve margins, policy constraints** and **does not have significant curtailment**.
- Follow up with SAAC on methodology changes and proposed buildout on October 22nd and/or November 4th.
- Continue to update Council members on status of the results even if between Council meetings.

