Northwest **Power** and **Conservation** Council

September 7, 2022

MEMORANDUM

TO: **Council Members**

FROM: **John Ollis, Manager of Planning and Analysis**

SUBJECT: **WECC Buildouts for Adequacy Assessment**

BACKGROUND:

Presenter: John Ollis

Summary: Staff are in the process of developing the Council's annual resource adequacy assessment. Resource adequacy is a critical component of the Council's mandate to develop a regional power plan that "ensures an adequate, efficient, economic and reliable power supply" and this year's assessment is an important check on implementation of the Council's 2021 Power Plan. Some of the potential resource adequacy assessment scenario work relies on the buildout information from the wholesale power market study. The focus of this presentation is to update the Power Committee on the scenario results from the market study that will likely be used to inform scenarios in the adequacy assessment analysis, and recent advisory committee feedback associated with this work.

Relevance: Wholesale power markets outside the region were highlighted as a key data point to monitor coming out of the 2021 Power Plan in which policy changes throughout the western states impacted not just wholesale power markets in the long term, but also in the short term. This update will revisit some of the plan market study findings and discuss the major drivers of changes in the updated study.

Background: The Council has periodically updated its wholesale electricity price study using the AURORA model to help inform Council staff and regional stakeholder analysis. The Council relies on the System Analysis Advisory Committee to help provide expert feedback on market fundamentals and power system modeling assumptions related to the market price study.

The Council's 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.

Due to significant clean and RPS policies and less dependence on new baseload generation to meet growing loads, the market price forecast studies from the 2021 Power Plan scenarios consistently showed extremely large buildouts of new resources, especially solar generation outside the region. These buildouts implied a persistence of market fundamentals that seemed to be just emerging at the time of the plan's development, like significant renewable generation curtailment and negative pricing mid-day. This market update is an early look at how the plan work compares to current market behavior and highlights some of the data sources the staff uses to monitor this behavior for reference.

The Council's adequacy model, GENESYS now relies on understanding the capabilities of resources external to the region to incorporate the WECC-wide supply and demand fundamentals. Different assumptions on these fundamentals of market supply may affect system adequacy and are under consideration by the Resource Adequacy Advisory Committee.

More Info: Presentation of draft results relating to buildouts to inform the adequacy assessment work

August 31st SAAC Meeting

August 10th SAAC Meeting

July 27th SAAC/RAAC Meeting

Wholesale Power Price Forecast from the 2021 Plan

John Ollis

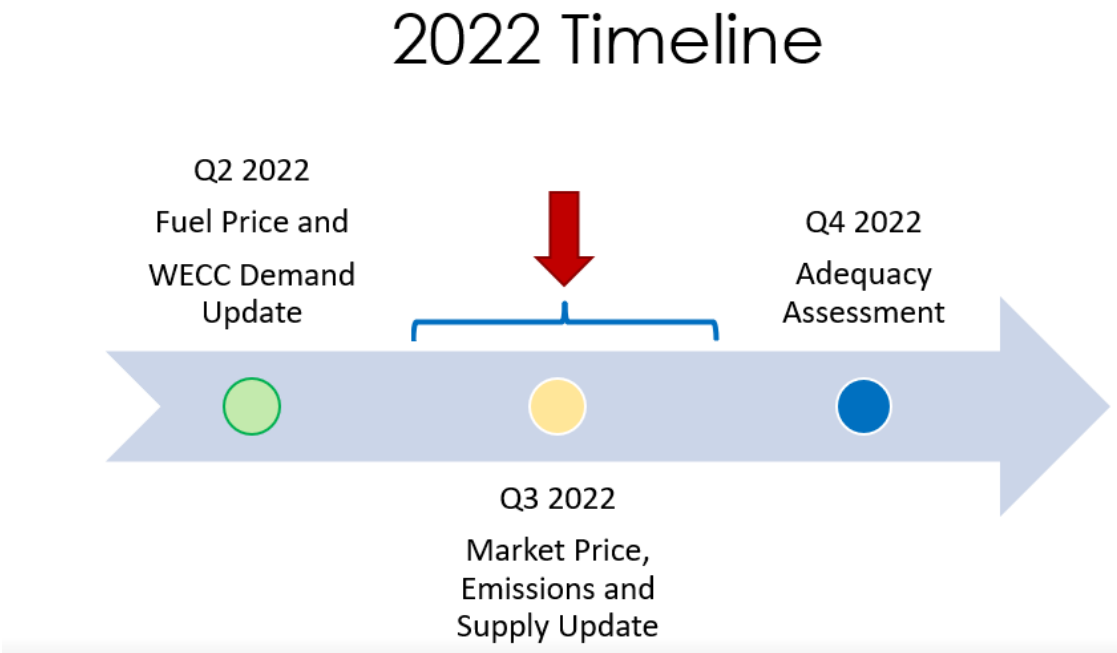
September 13, 2022

Power Committee

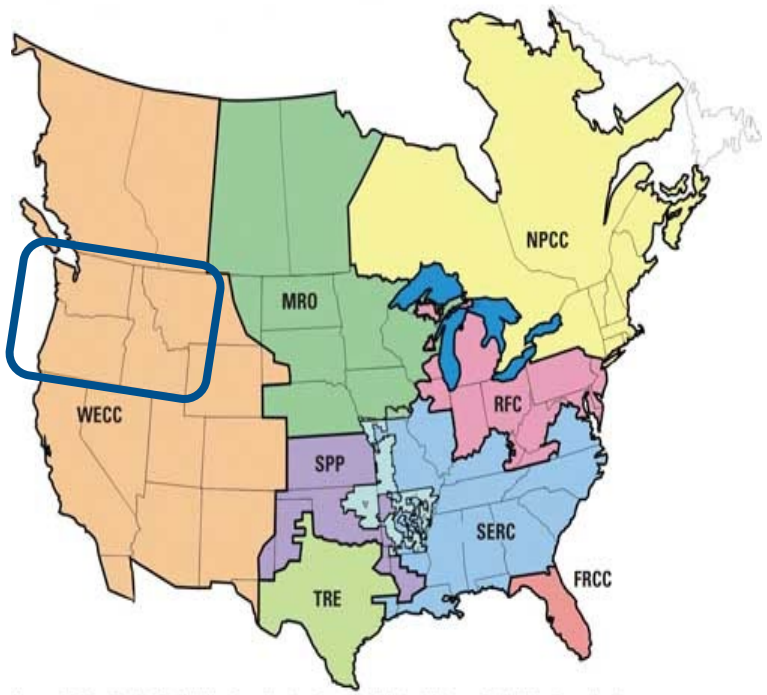
WECC BUILDOUTS TO SUPPORT ADEQUACY ASSESSMENT

Discussion Today

- Methodological changes and review
- Scenario description review, results and analysis
- Using buildout information in the adequacy assessment

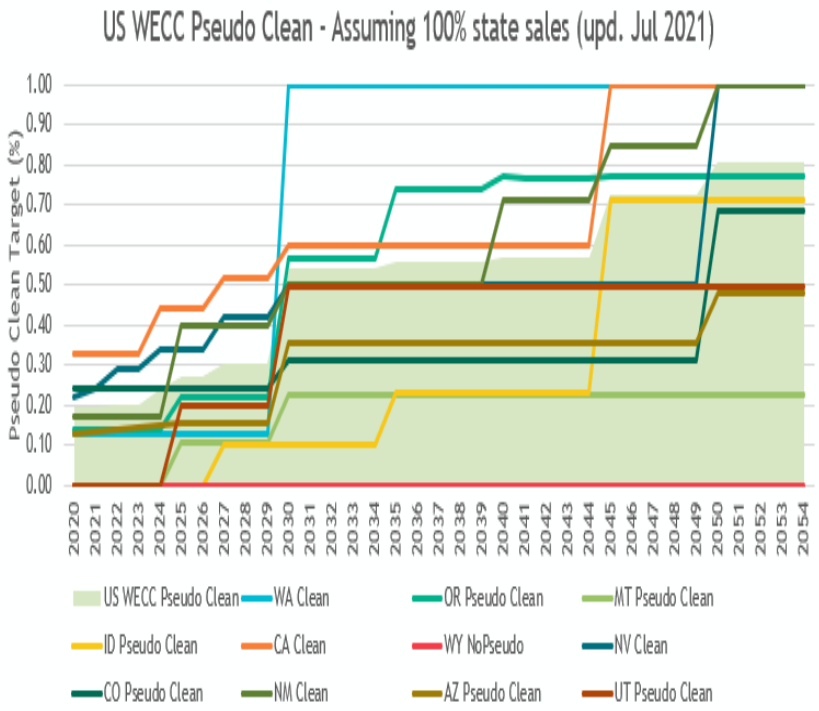


Major Drivers that Change Market Fundamentals Forecasts



Notes: FRCC = Florida Reliability Coordinating Council, MRO = Midwest Reliability Organization, NPCC = Northeast Power Coordinating Council, RFC = Reliability First Corp., SERC = SERC Reliability Corp., SPP = Southwest Power Pool, TRE = Texas Regional Entity, WECC = Western Electric Coordinating Council.

1. Changes in existing system resources or transmission
2. Changes in timing or magnitude of net peak
3. Changes in reserve margins
4. Changes in policies
5. Changes in new resource availability or costs



Major Drivers that Change Market Fundamentals Forecasts and Corresponding Updates

1. Changes in existing system resources or transmission
   - *Existing WECC resources, gas prices and loads updated as of May 2022*
2. Changes in timing or magnitude of net peak
   - *Updated hourly demand shape for California utilities*
3. Changes in reserve margins
   - *Operating pool updates (revised reserve margins, RMRSG joins NWPP)*
4. Changes in policies
   - *RPS and zero emissions resources have negative bid adder to reflect foregone cost of lost generation in case of curtailment*
   - *Clean and RPS policies requirements are updated for a new sales forecast and interpolated using a three year rolling average rather than a linear interpolation.*
5. Changes in new resource availability or costs
   - One emerging tech resource available in all scenarios.

Scenarios to Inform Adequacy Assessment

Scenarios in black require a buildout, those in red do not

Proposed Scenarios

Set up scenarios that will help evaluate RAAC frame market risk in 2027 time period

- Buildout Scenarios:
  - Baseline
  - Limited Markets (no PRMs)
  - High WECC Demand (Increased electrification)
  - Persistent Global Instability (Build limitations and high gas prices)
- Fixed Buildout Stress Scenarios:
  - *CA/Desert SW Drought (no or low hydro)*
  - *Gas Pipeline Issues Desert SW (gas plants not available)*
  - *No buildout in WECC by 2027?*
  - *Transmission stress?*

Scenario Description Review: Limited Markets

- Removed planning reserve margins
  - Implemented by setting operating pool planning reserve margins to -99 in AURORA
  - All other inputs the same as the baseline

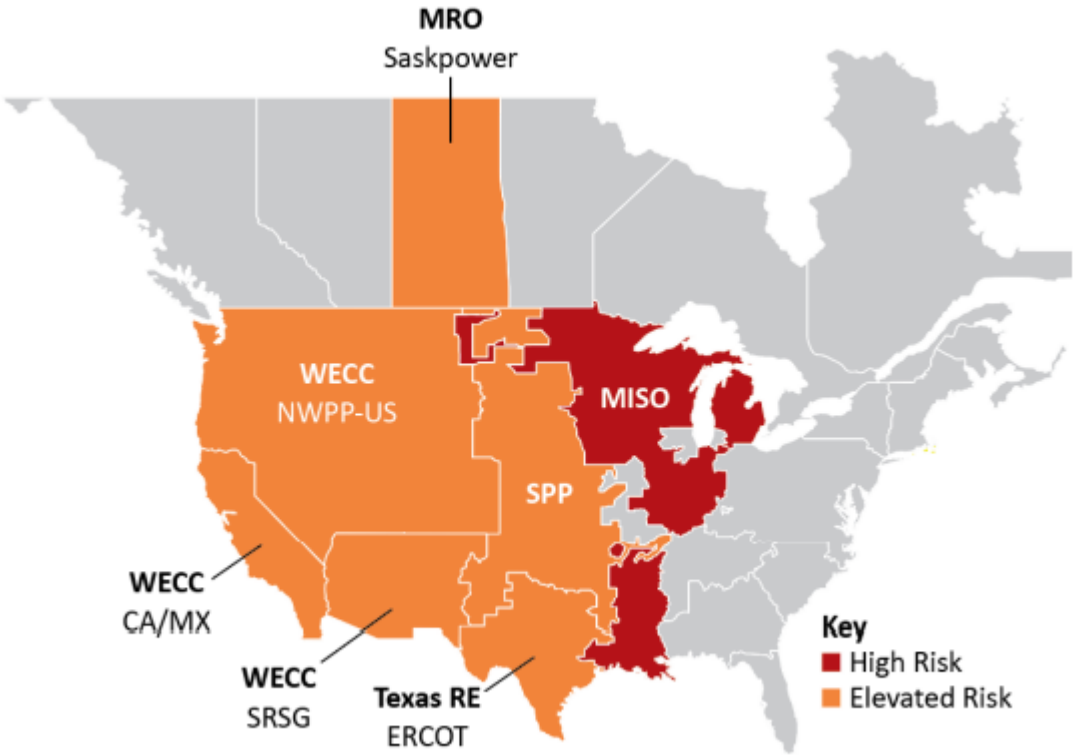


Figure 1: Summer Reliability Risk Area Summary

Scenario Description Review: High WECC Demand

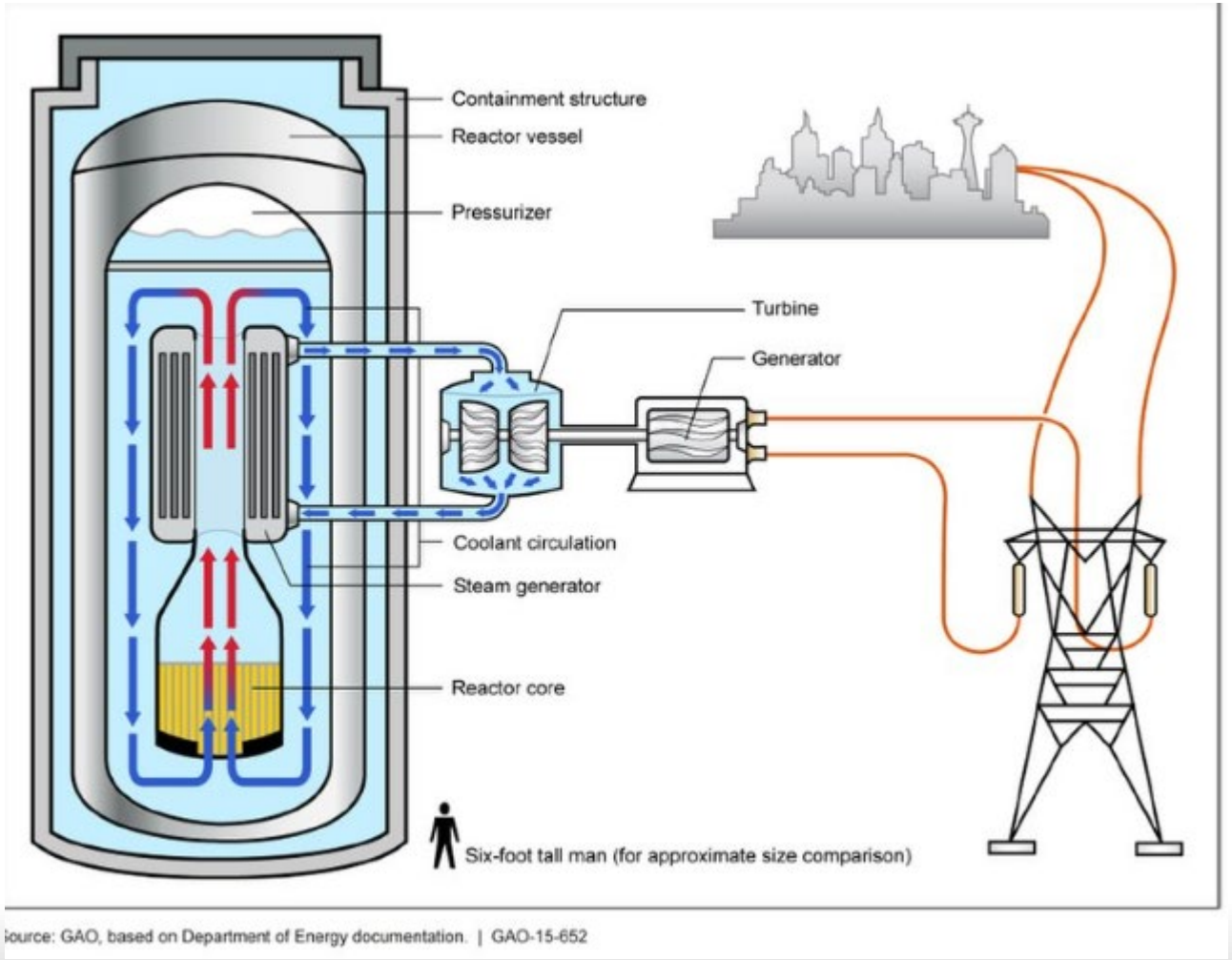
- Multiple sensitivities
  - High electrification Pacific NW, California, BC and Alberta
    - High demand only in those areas, baseline forecast elsewhere
  - High electrification throughout WECC
  - All other inputs the same as the baseline, except updating policy targets (in MWhs)

Scenario Description Review: Persistent Global Instability

- Implemented by limiting maximum new additions of resources on short duration storage, solar and wind generation until 2030.
- Other resource ramps unchanged due to online date or previous restrictions
- All other inputs the same as the baseline

Scenario Description Review: Clean Baseline Review

- Significant uncertainty about possible online dates of hydrogen peakers or small modular reactors
  - Delayed online date from 2030 to 2040.
  - All other settings the same as the Baseline



Source: GAO, based on Department of Energy documentation. | GAO-15-652

Summary of Buildouts

- **Baseline** (110 GW by 2027, 252 GW by 2045)
  - Adequate and meets policies
  - 50 billion investment in 2045 (83% Fixed costs, 17% production costs)
- **Limited Markets** (73 GW by 2027, 112 GW by 2045)
  - Consistently not adequate, does not meet clean policies in 2030s
  - 40 billion investment in 2045 (46% Fixed costs, 54% production costs)
- **Persistent Global Instability** (98 GW by 2027, 257 GW by 2045)
  - Adequate and meets policies
  - 53 billion investment in 2045 (75% Fixed costs, 25% production costs)
- **High WECC Demand West Coast** (100 GW by 2027, 324 GW by 2045)
  - Adequate and meets policies
  - 71 billion investment in 2045 (80% Fixed costs, 20% production costs)
- **Clean Baseline Delay** (137 GW by 2027, 332 GW by 2045)
  - Mostly adequate and meets policies
  - Early build required to met
  - 51 billion investment in 2045 (84% Fixed costs, 16% production costs)

High-Level Observations

- Generally, less build than in the plan due to decrease in forecasted coincident peaking load in summer evenings in California
  - Mostly impacted solar and solar plus storage build
- Clean resources with high coincident peak capacity contributions can defer larger builds of renewables, but there are uncertainties around availability and price.
  - Timing and price of SMRs, hydrogen peakers, offshore wind
  - Availability and specs of additional storage technologies

Solar and Solar Plus Storage Build Comparisons

Year	Baseline	Global Instability	Limited	High Demand West*	Clean Baseload Delay	2021 Plan Baseline
2025	21,528	10,702	7,608	6,977	28,731	51,538
2030	42,206	53,011	19,739	15,277	80,626	89,838
2035	45,141	73,260	24,164	17,277	108,716	100,357
2040	56,494	94,010	36,089	17,277	135,212	135,054
2045	75,890	106,744	43,761	26,077	157,962	147,554

Year	Baseline	Global Instability	Limited	High Demand West*	Clean Baseload Delay	2021 Plan Baseline
2025	23,386	8,000	0	29,550	24,000	46,600
2030	60,503	12,000	0	57,748	65,118	86,600
2035	60,503	36,000	0	73,900	68,399	145,500
2040	63,429	36,830	0	107,241	76,383	179,800
2045	63,429	53,033	0	136,968	91,122	198,0[illegible]

Battery and Pumped Storage Build Comparisons

Year	Baseline	Global Instability	Limited	High Demand West*	Clean Baseload Delay	2021 Plan Baseline
2025	13,634	15,926	26,522	17,242	16,153	6,004
2030	13,940	22,473	32,433	18,052	17,108	6,004
2035	13,965	22,895	35,047	22,119	18,427	6,004
2040	14,861	23,391	36,918	28,635	19,955	6,004
2045	18,390	32,163	41,372	31,123	19,994	6,055

Year	Baseline	Global Instability	Limited	High Demand West*	Clean Baseload Delay	2021 Plan Baseline
2025	0	0	0	0	0	0
2030	0	3,100	0	1,300	0	4,900
2035	2,200	5,300	0	3,500	0	5,650
2040	2,200	5,300	0	3,500	2,200	6,050
2045	2,200	11,940	0	3,500	2,200	9,690

Wind and Gas Build Comparisons

Year	Baseline	Global Instability	Limited	High Demand West*	Clean Baseload Delay	2021 Plan Baseline
2025	12,155	7,200	12,800	13,294	19,553	16,775
2030	18,634	24,335	16,566	22,294	26,007	35,175
2035	27,906	26,483	16,566	28,973	30,289	37,063
2040	38,221	28,987	16,566	58,682	31,402	43,657
2045	69,769	30,808	16,566	87,188	39,063	51,481

Year	Baseline	Global Instability	Limited	High Demand West*	Clean Baseload Delay	2021 Plan Baseline
2025	7,305	3,575	3,702	5,319	5,307	11,351
2030	14,332	13,803	6,930	13,621	12,808	14,873
2035	14,806	14,514	7,359	14,806	13,519	16,058
2040	15,235	14,514	8,646	15,901	13,519	16,532
2045	15,235	15,372	8,646	15,901	13,519	16,532

WECC

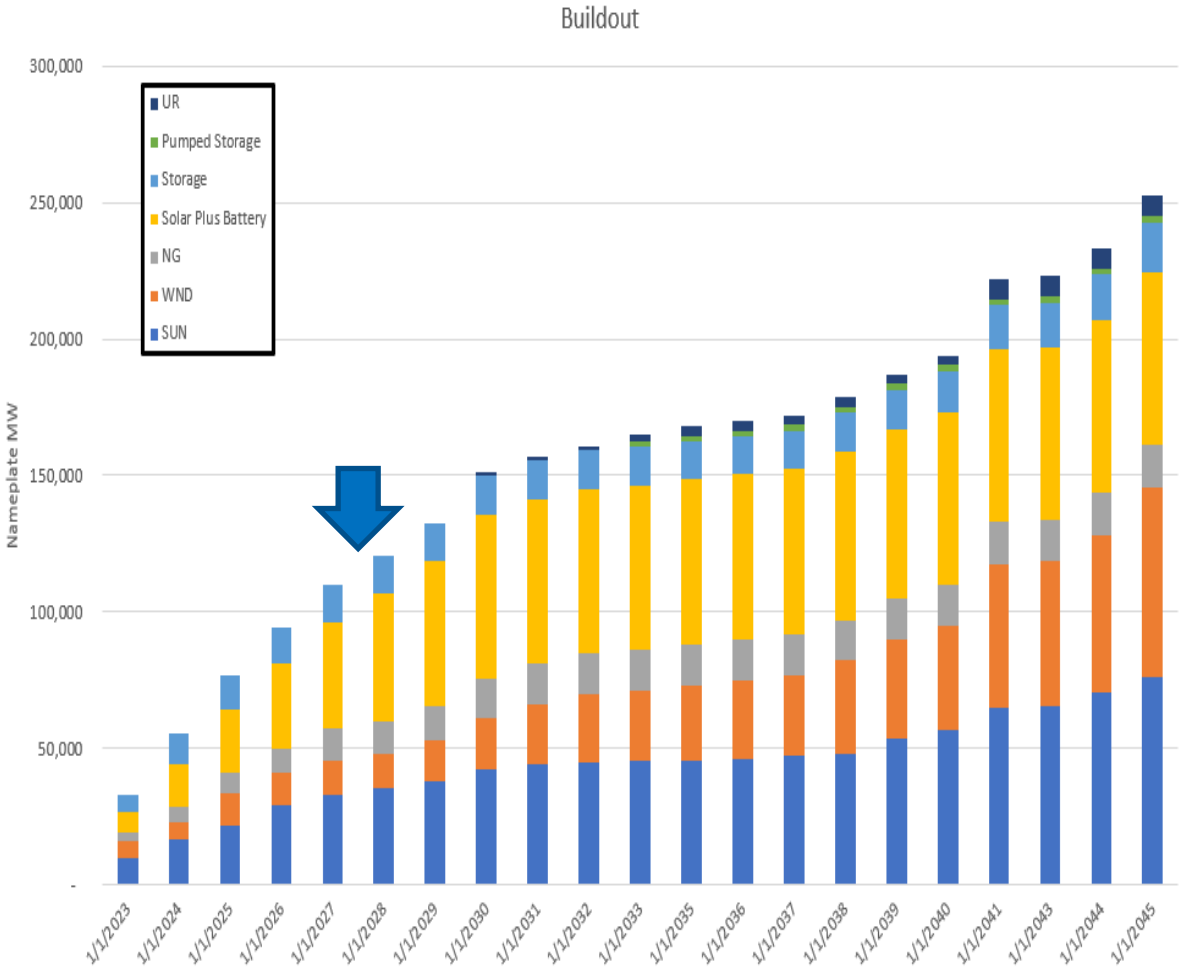
Offshore Wind and Proxy Clean Build Comparisons

Year	Baseline	Global Instability	Limited	High Demand West*	Clean Baseload Delay	2021 Plan Baseline
2025	0	0	0	0	0	0
2030	0	0	0	0	0	6,463
2035	0	0	0	0	157	7,663
2040	0	595	0	339	586	10,000
2045	0	5,356	0	12,600	4,000	10,000

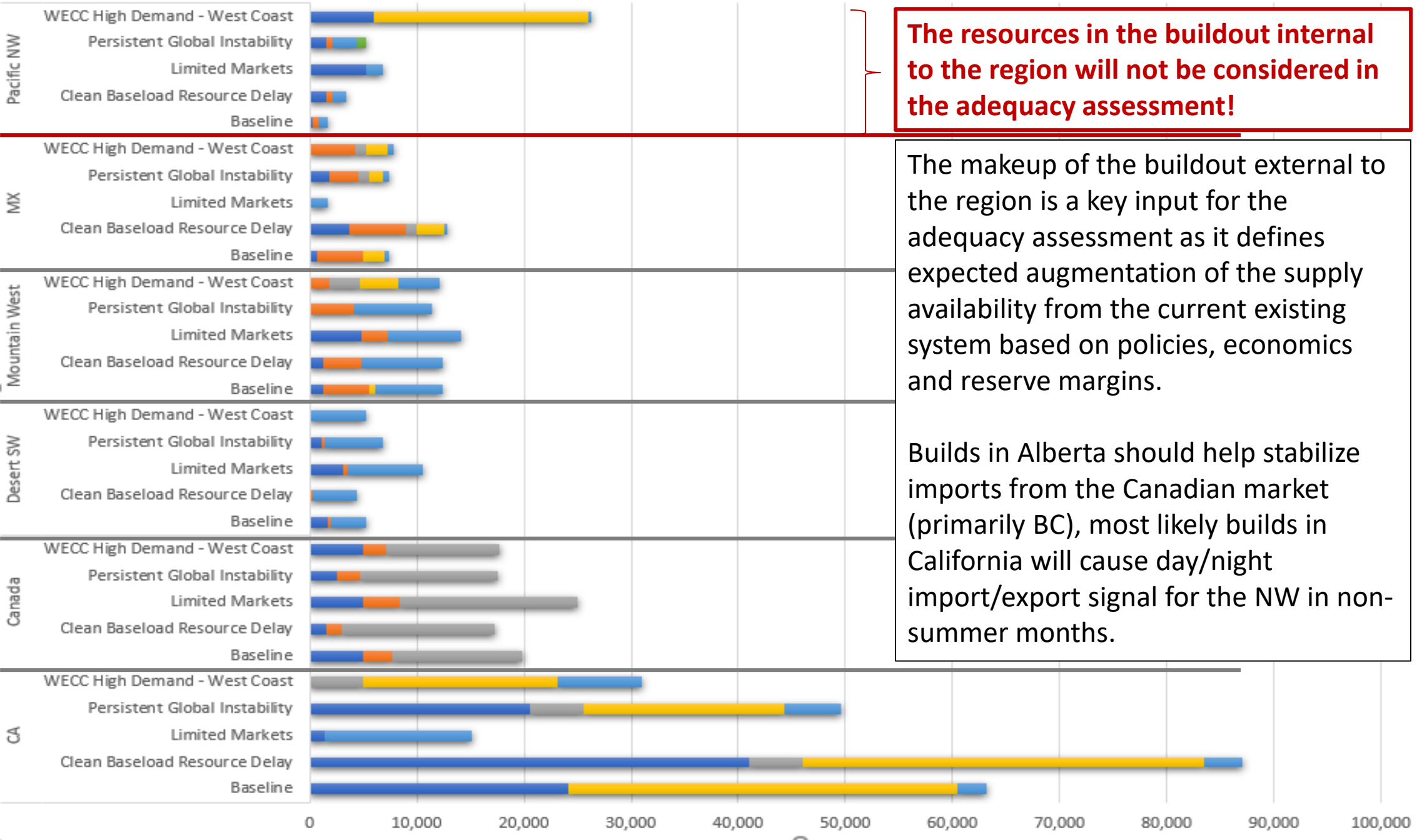
Year	Baseline	Global Instability	Limited	High Demand West*	Clean Baseload Delay	2021 Plan Baseline
2025	0	0	0	0	0	0
2030	1,368	0	684	0	0	0
2035	3,420	684	684	0	0	0
2040	3,420	684	684	9,576	1,368	0
2045	7,524	2,052	1,368	10,944	2,052	0

What Matters in the Adequacy Assessment

- Only new resource builds and existing resources outside the region get used to inform the market in the adequacy assessment.
- More specifically, new resource builds by 2027 and 2028.
  - However, to understand the pace of early builds the entire build can be good context.



2027 Buildout by Region and Fuel Type

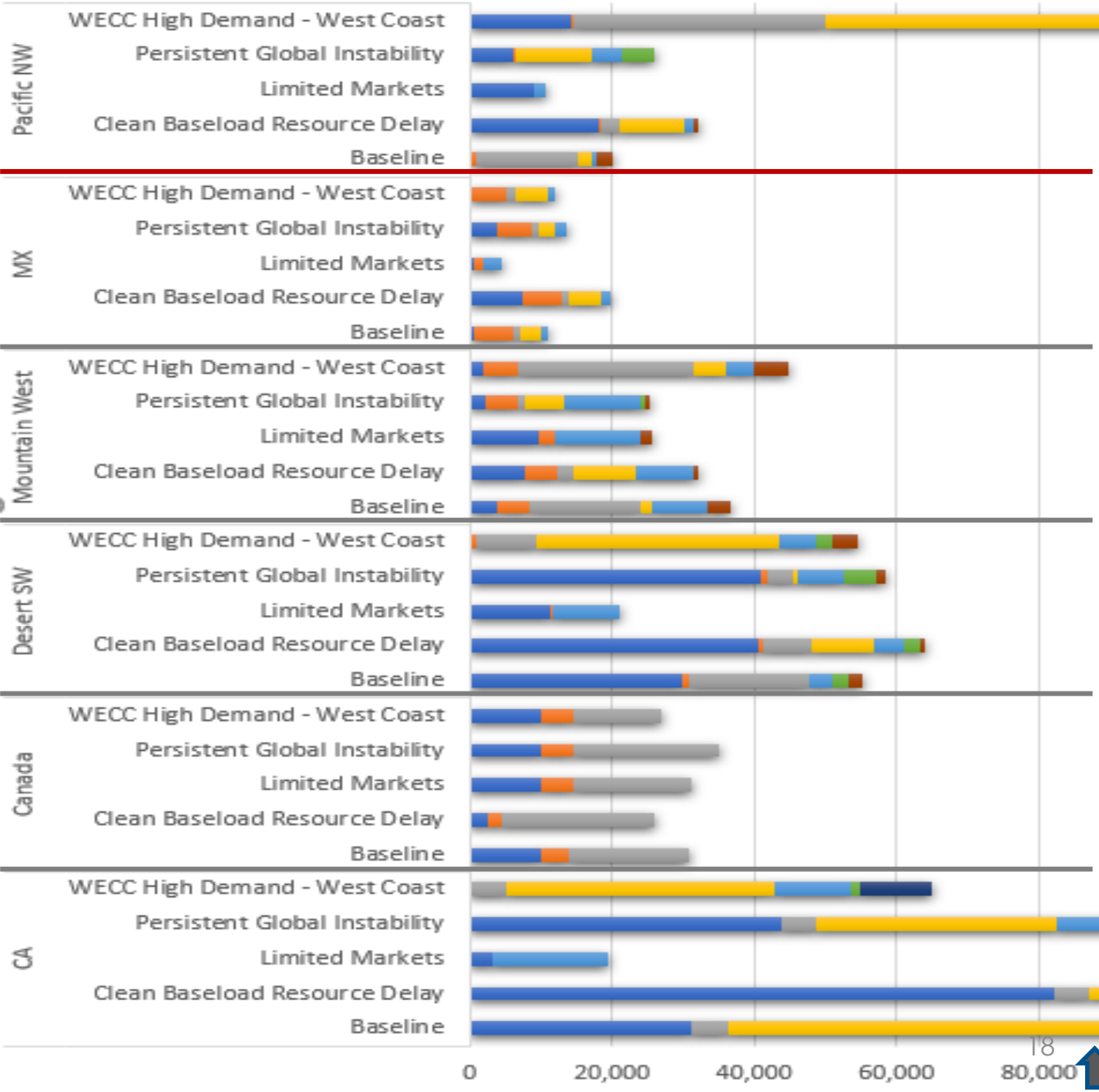


The resources in the buildout internal to the region will not be considered in the adequacy assessment!

The makeup of the buildout external to the region is a key input for the adequacy assessment as it defines expected augmentation of the supply availability from the current existing system based on policies, economics and reserve margins.

Builds in Alberta should help stabilize imports from the Canadian market (primarily BC), most likely builds in California will cause day/night import/export signal for the NW in non-summer months.

2045 Buildout by Region and Fuel Type



Note that for the areas in the WECC with more early adequacy pressure like Alberta, Baja CA and California, a higher proportion of the build is early.

In the Pacific NW, Mountain West and Desert SW, plant retirements and increased load defer need until later in the study.

Many of the later builds unlikely to significantly affect NW market reliance by 2027 but the early builds in Alberta and California likely will.

Length of the lines separating the areas represents largest buildout in any area by 2027 for context

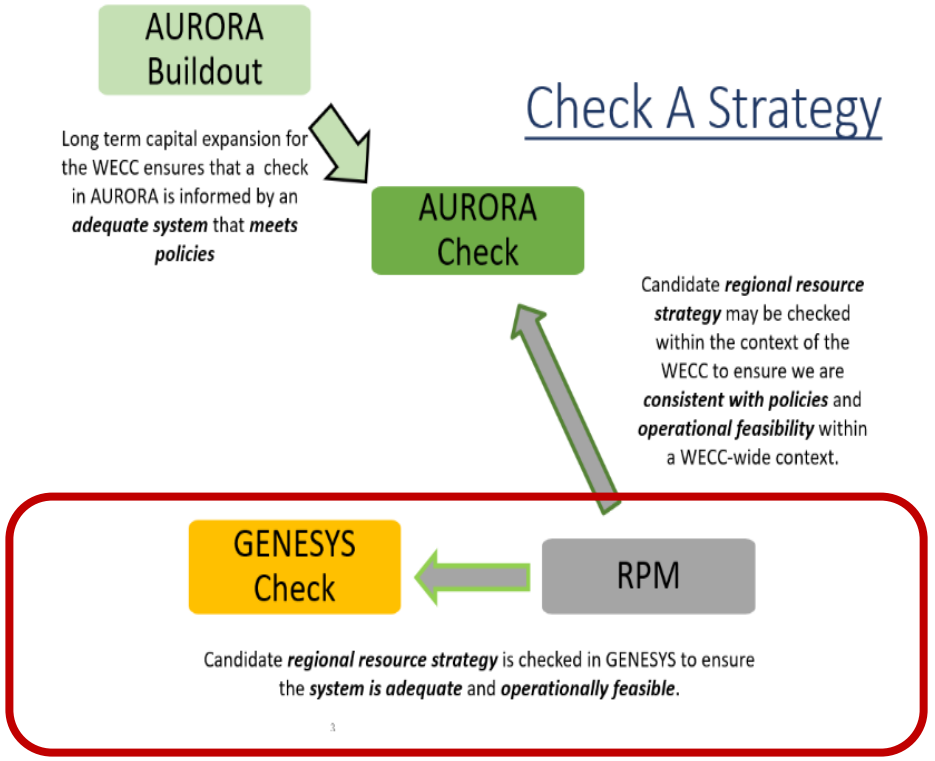
SUN
NG
WND
Solar Plus Battery
Storage
Pumped Storage
Offshore Wind
UR

Other Observations

- Most scenarios have around 30% curtailment of renewables or hydro by the end of the study except WECC High Demand West Coast (23%) and Limited Markets (15%)
- Most scenarios have decreasing thermal plant capacity factors from around 40% at beginning of the study to 25% to 33%, but the Limited Markets scenario thermal plant capacity factors go up to over 50%.

Reminder of Next Steps

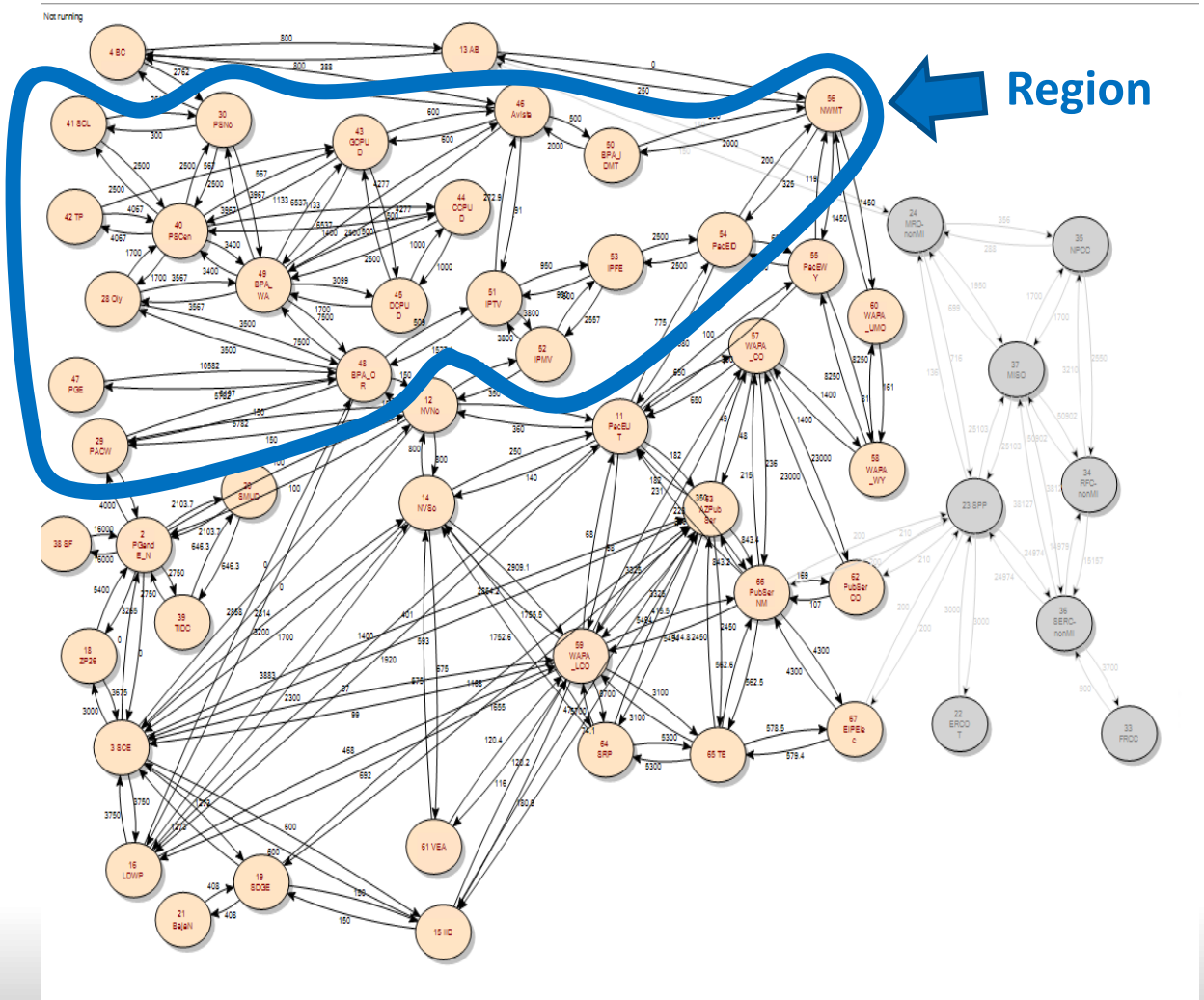
- Create market supply curves for GENESYS for adequacy assessment work
- Finish production cost model runs over many hydro conditions to get price distribution.



Establish Market Supply Curves for GENESYS

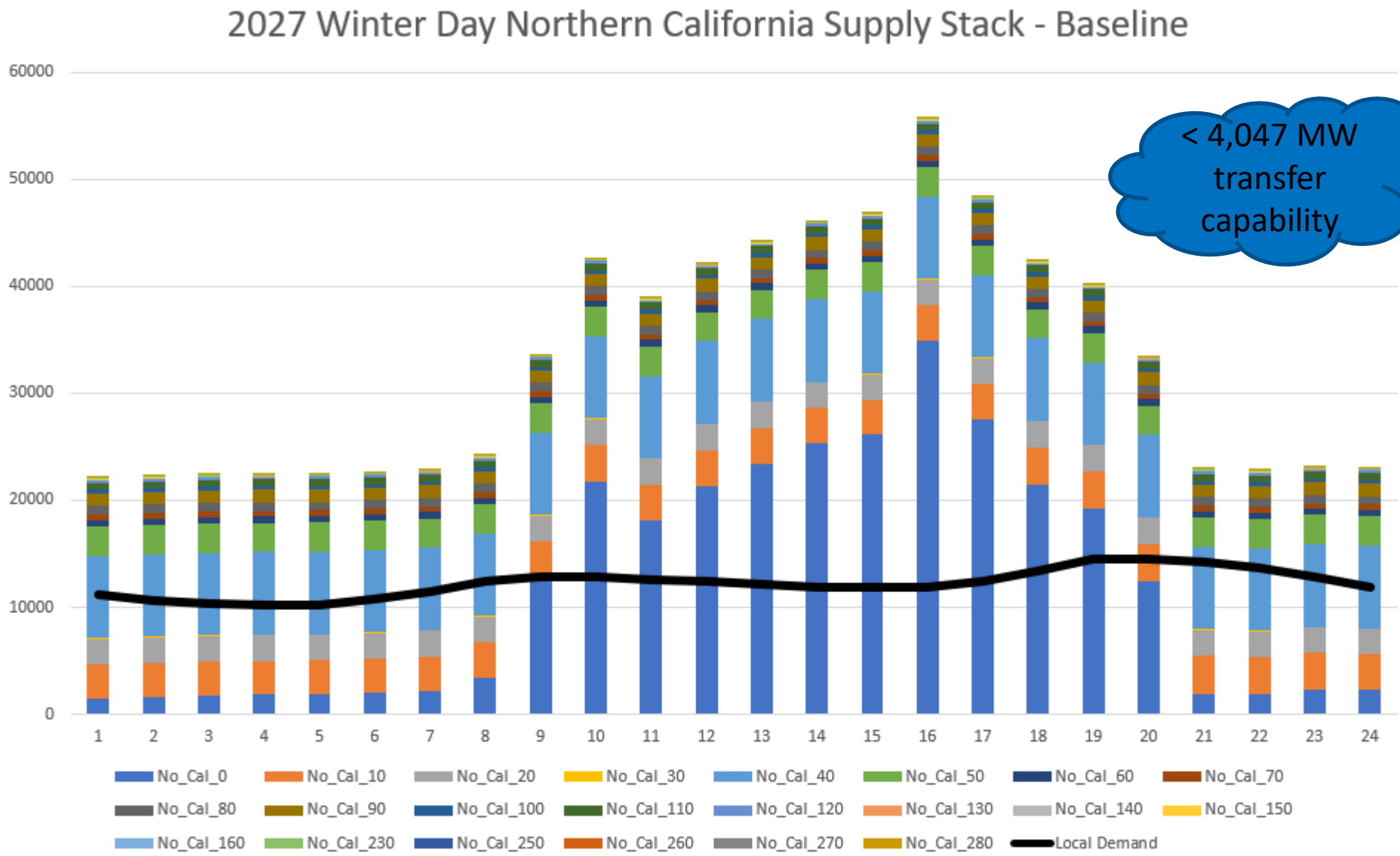
What do we do?

- Convert long-term buildouts (reflecting existing policies) in AURORA to a reasonable hourly market capability curves for GENESYS.
- Speeds up adequacy runs by simplifying external to the region economic calculations to supply blocks.
  - Still considers flexibility and operations external to the region via seasonal shape of electricity price blocks



Two Scenarios Two Regional Markets

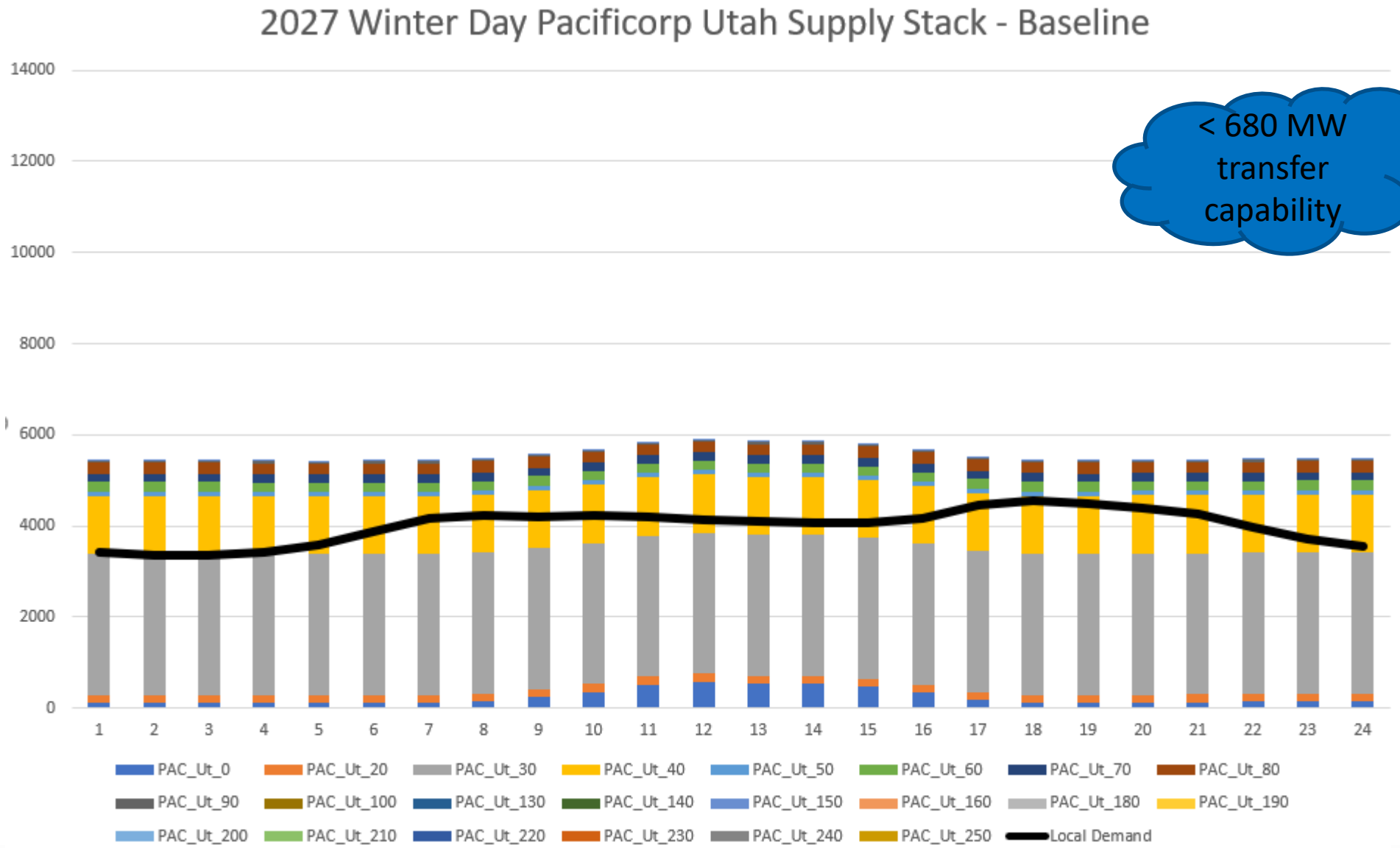
How GENESYS interacts with buildout information from AURORA



< 4,047 MW transfer capability

Example

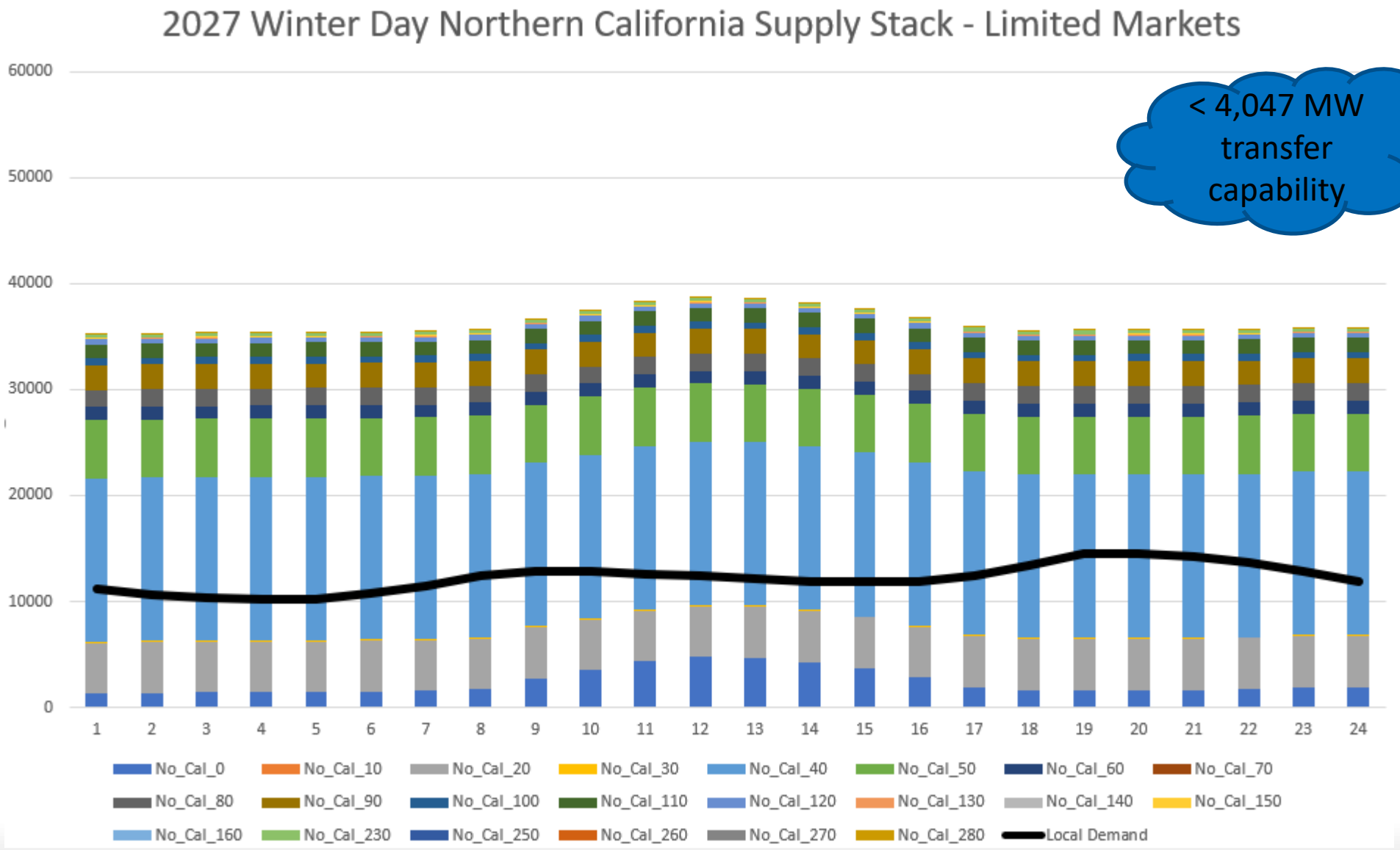
All capability above local demand candidate to be economic for export within market reliance limits



< 680 MW transfer capability

Example

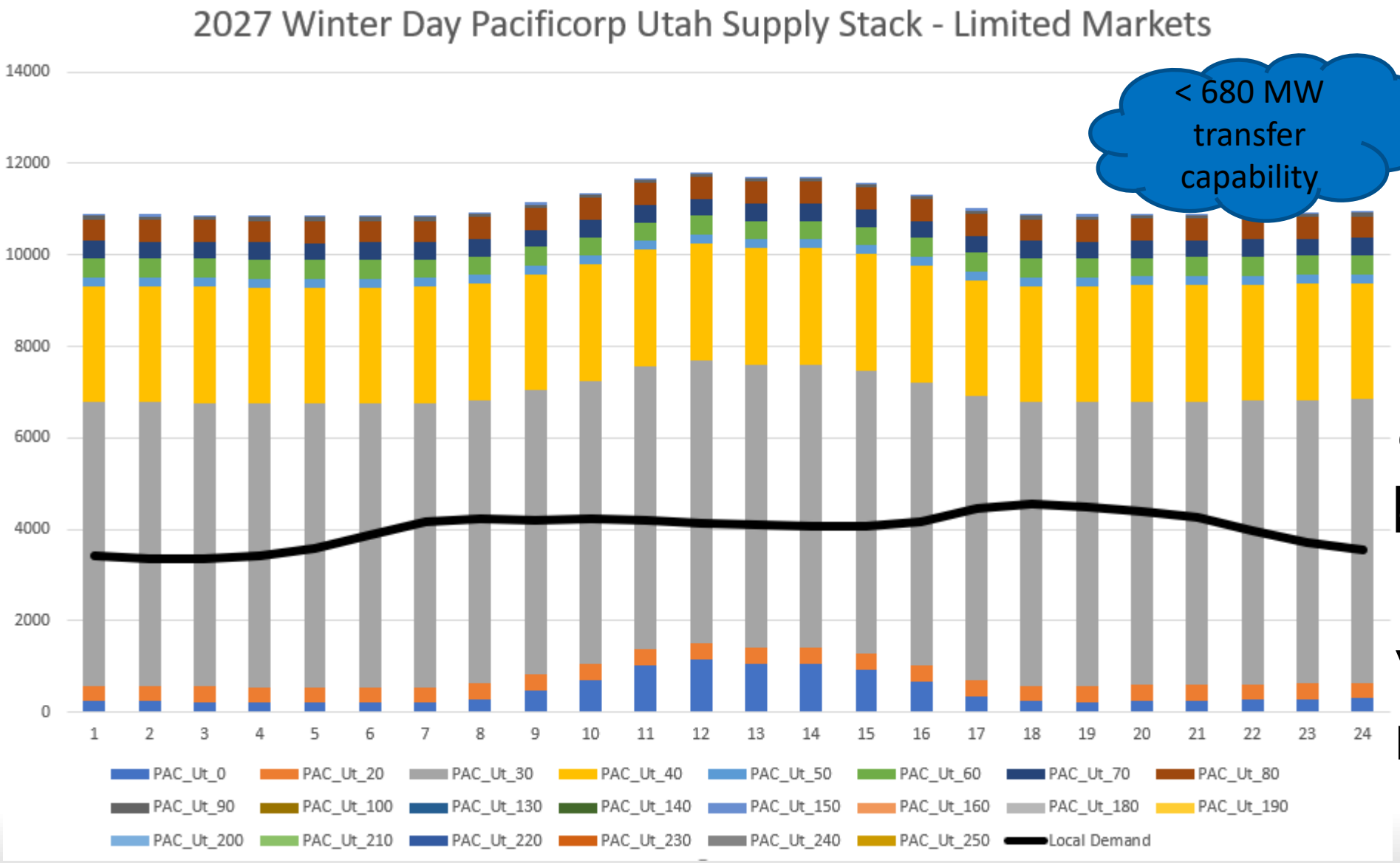
All capability above local demand candidate to be economic for export within market reliance limits



< 4,047 MW transfer capability

Example

All capability above local demand candidate to be economic for export within market reliance limits



Example

All capability above local demand candidate to be economic for export within market reliance limits

Finishing Additional Scenarios to Inform Price Forecast

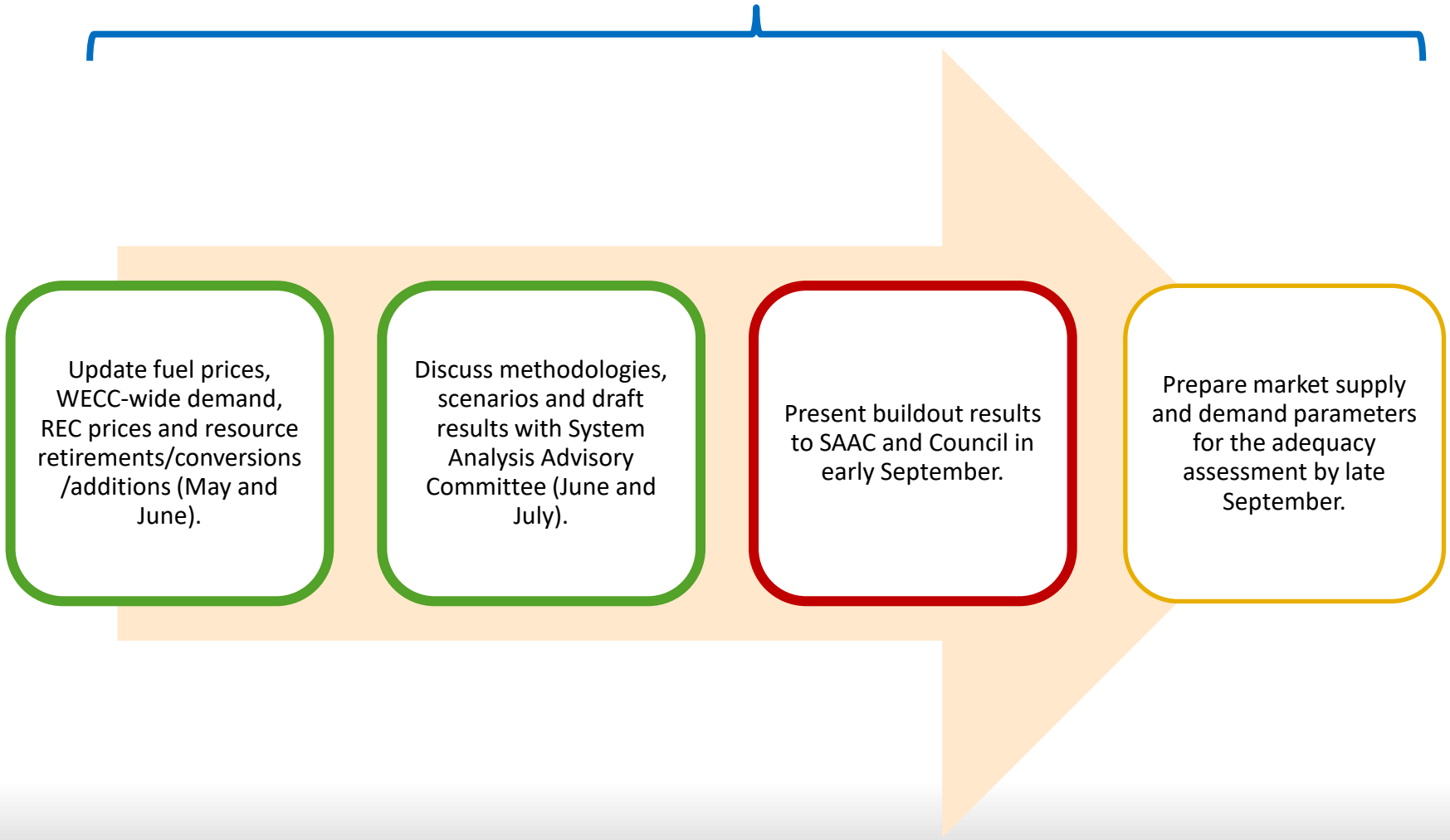
Staff Proposal

Set up scenarios that will help investigate prices and avoided market emissions rates over the 2023 to 2045 time period.

- Buildout Scenarios:
  - Organized Market (One PRM, wheeling rate)
  - Emissions Price (Universal Carbon Price)
  - Alternative Compliance
  - No Gas Build Limits
  - Increased Transmission

- Fixed Buildout Stress Scenarios:
  - *High Gas Price*

High-Level Market Price Forecast Project Plan



Questions

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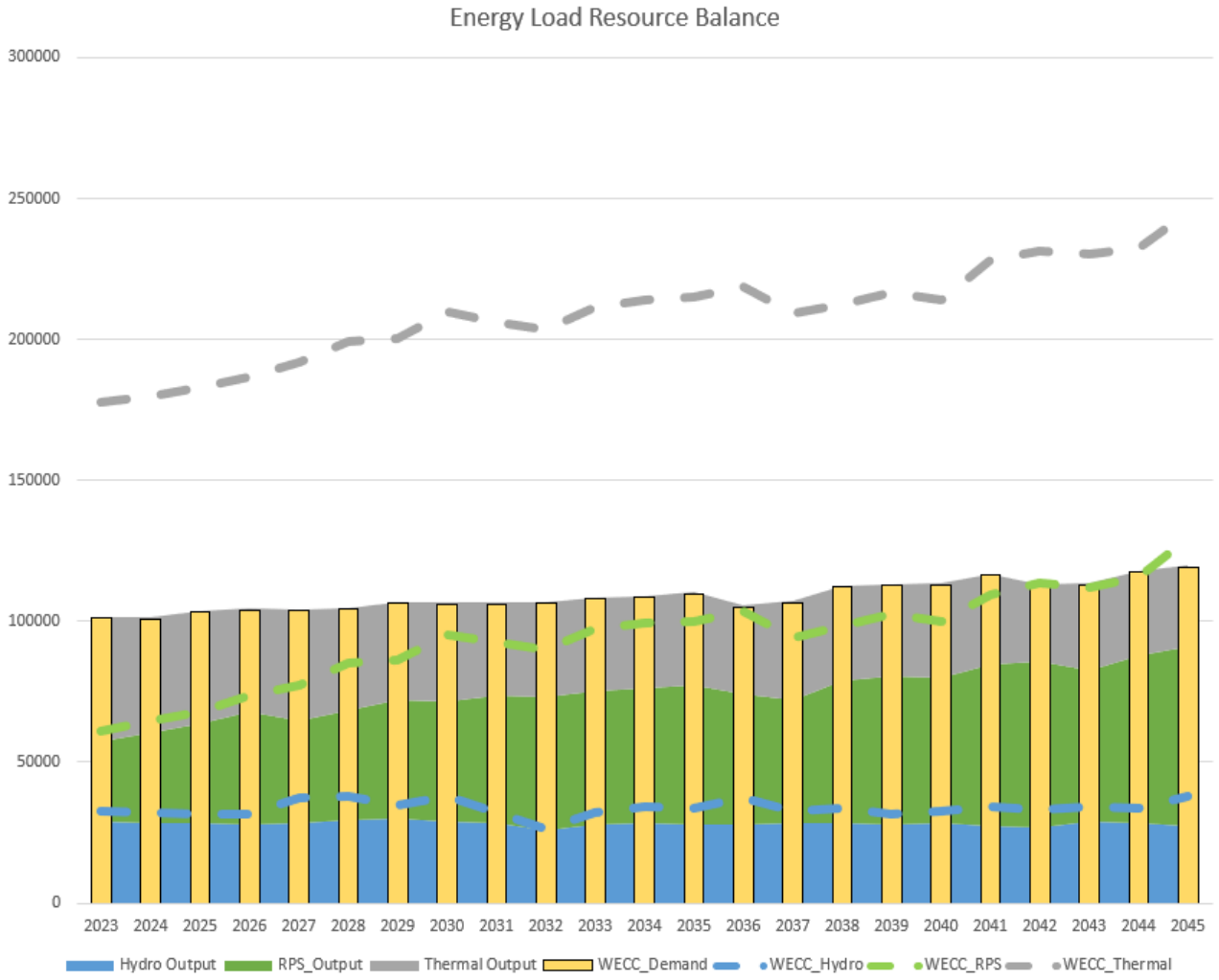
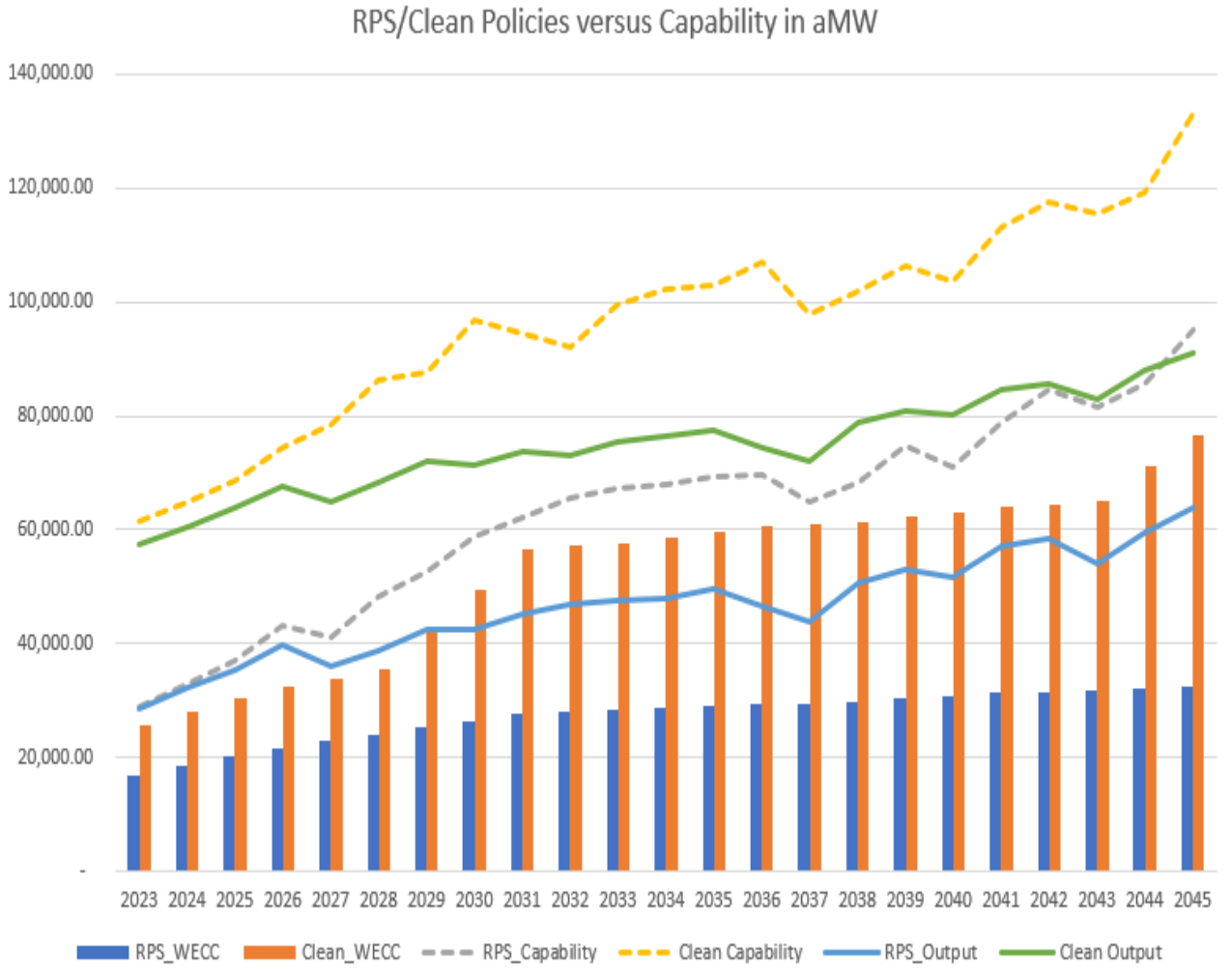
Extra Slides For Reference

Baseline


Energy Load Resource Balance
300000
250000
200000
150000
100000
50000
0
2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045
Hydro Output
RPS_Output
Thermal Output
WECC_Demand
WECC_Hydro
WECC_RPS
WECC_Thermal


RPS/Clean Policies versus Capability in aMW
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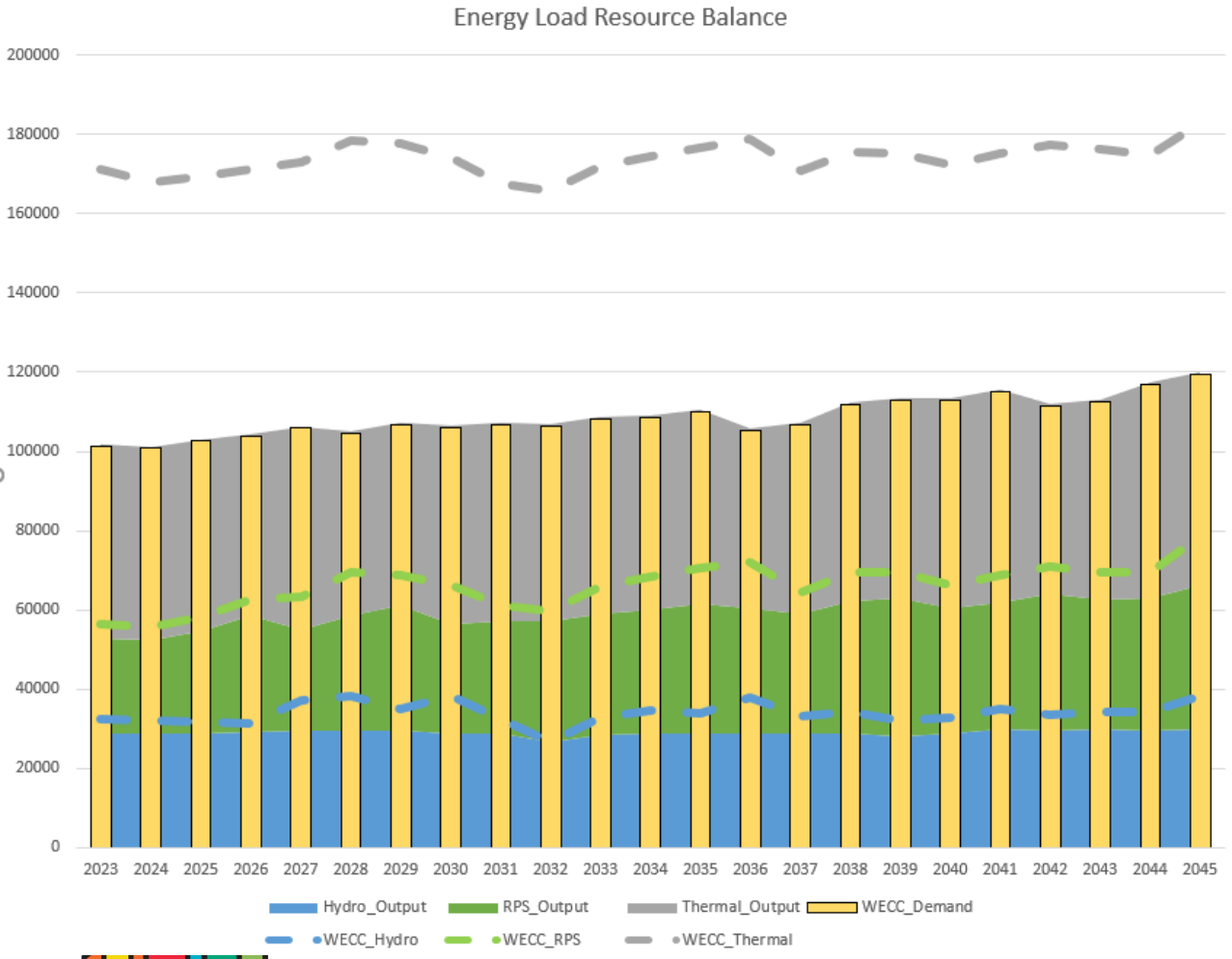
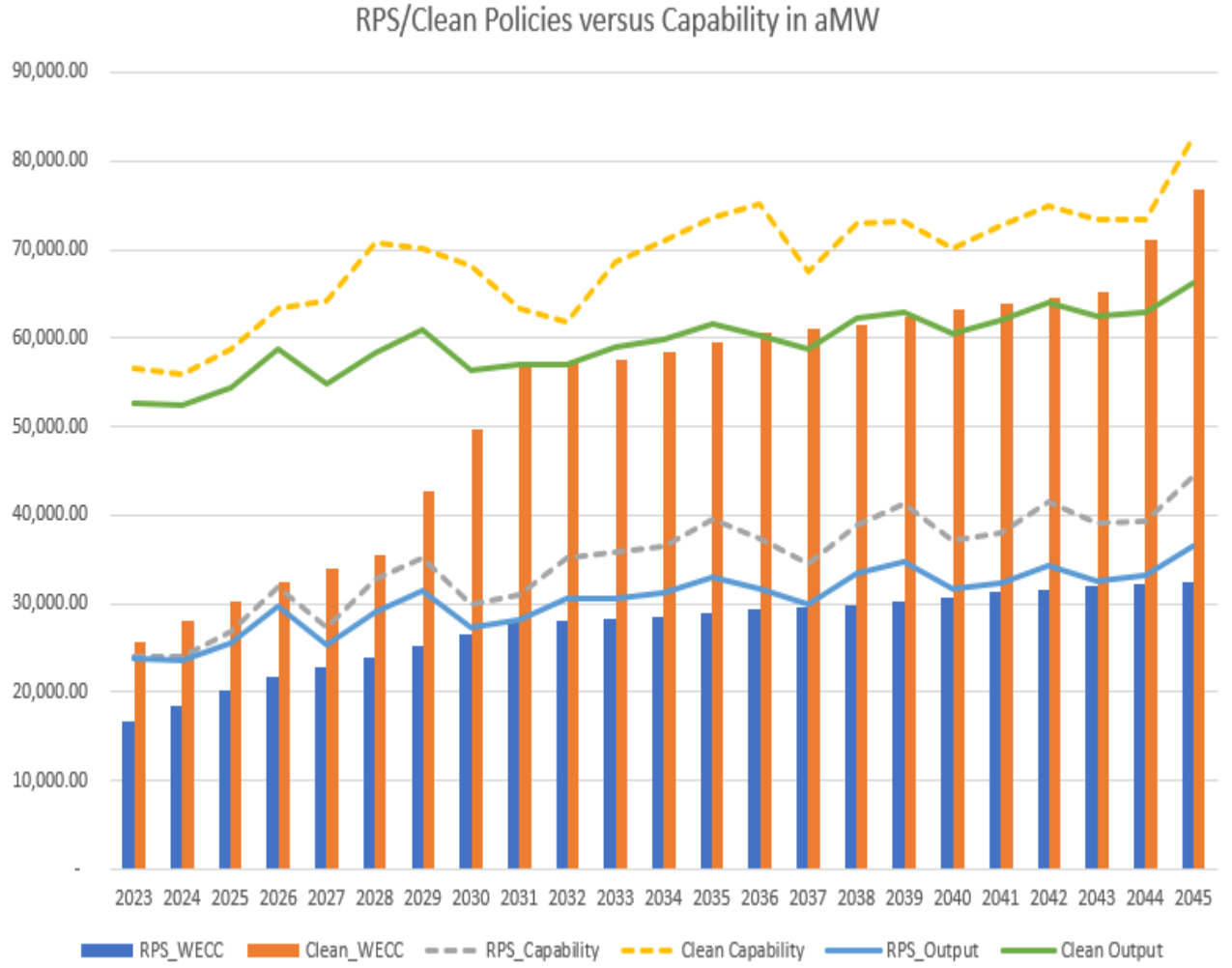
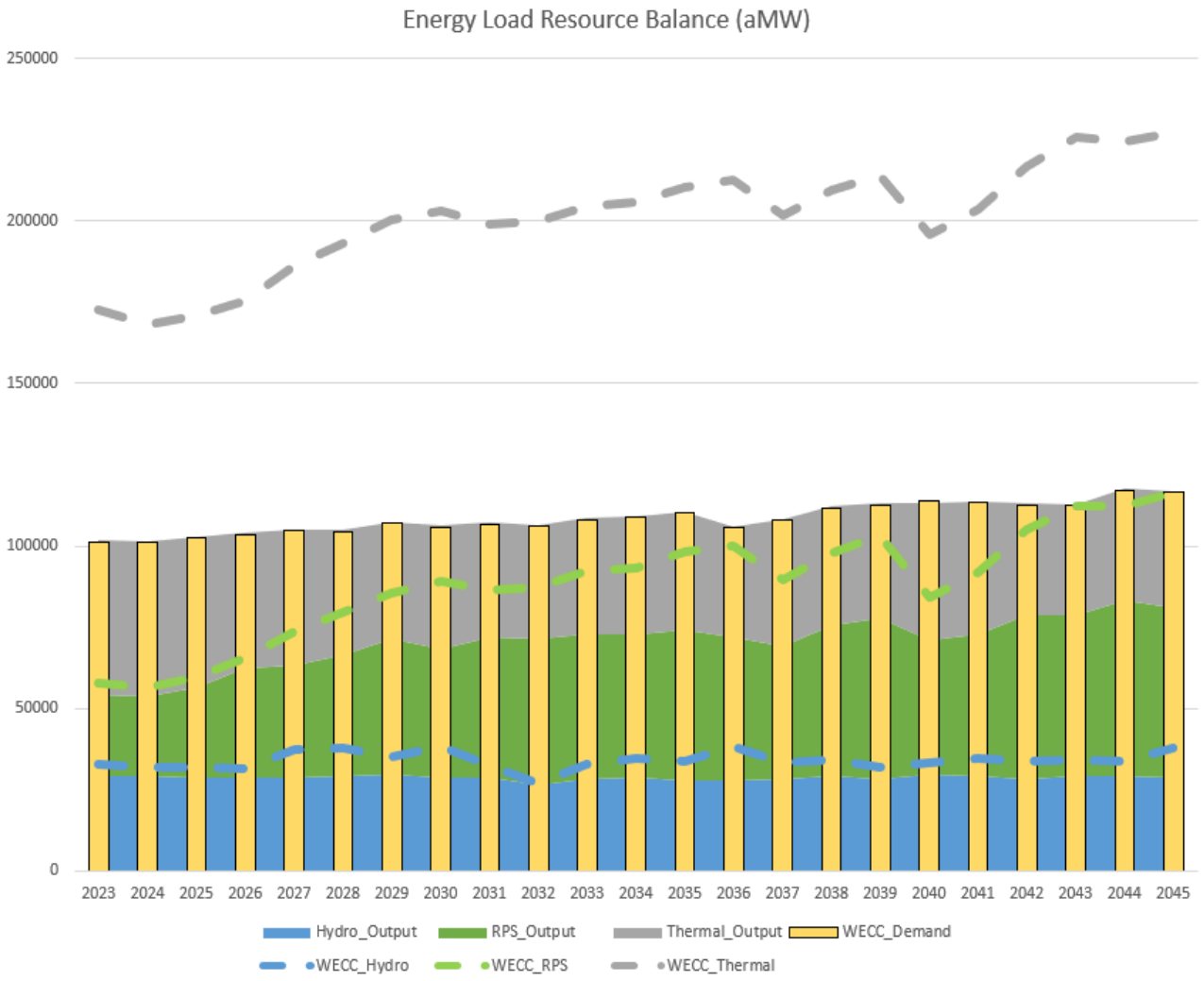
RPS_WECC
Clean_WECC
RPS_Capability
Clean Capability
RPS_Output
Clean Output

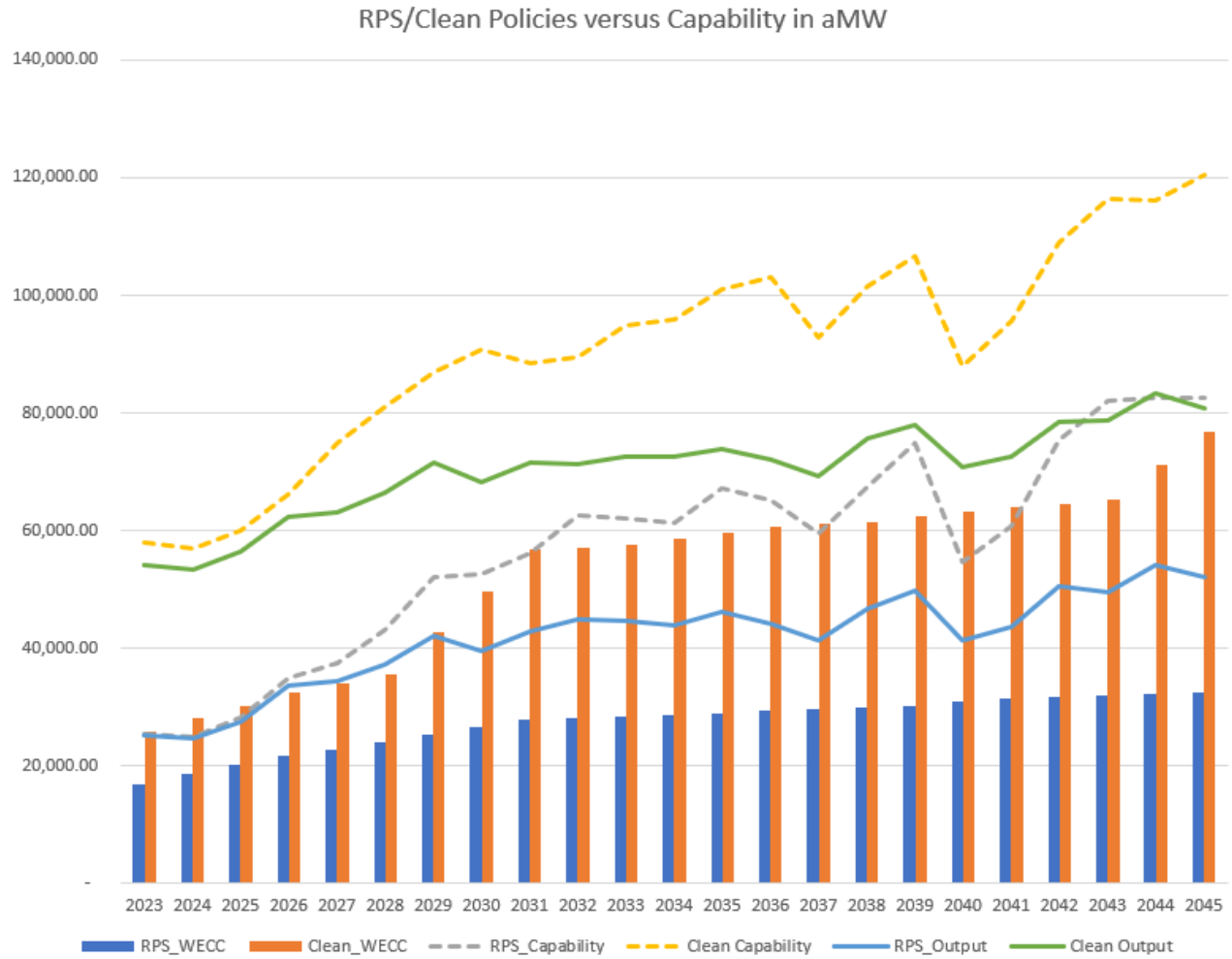
Limited Markets



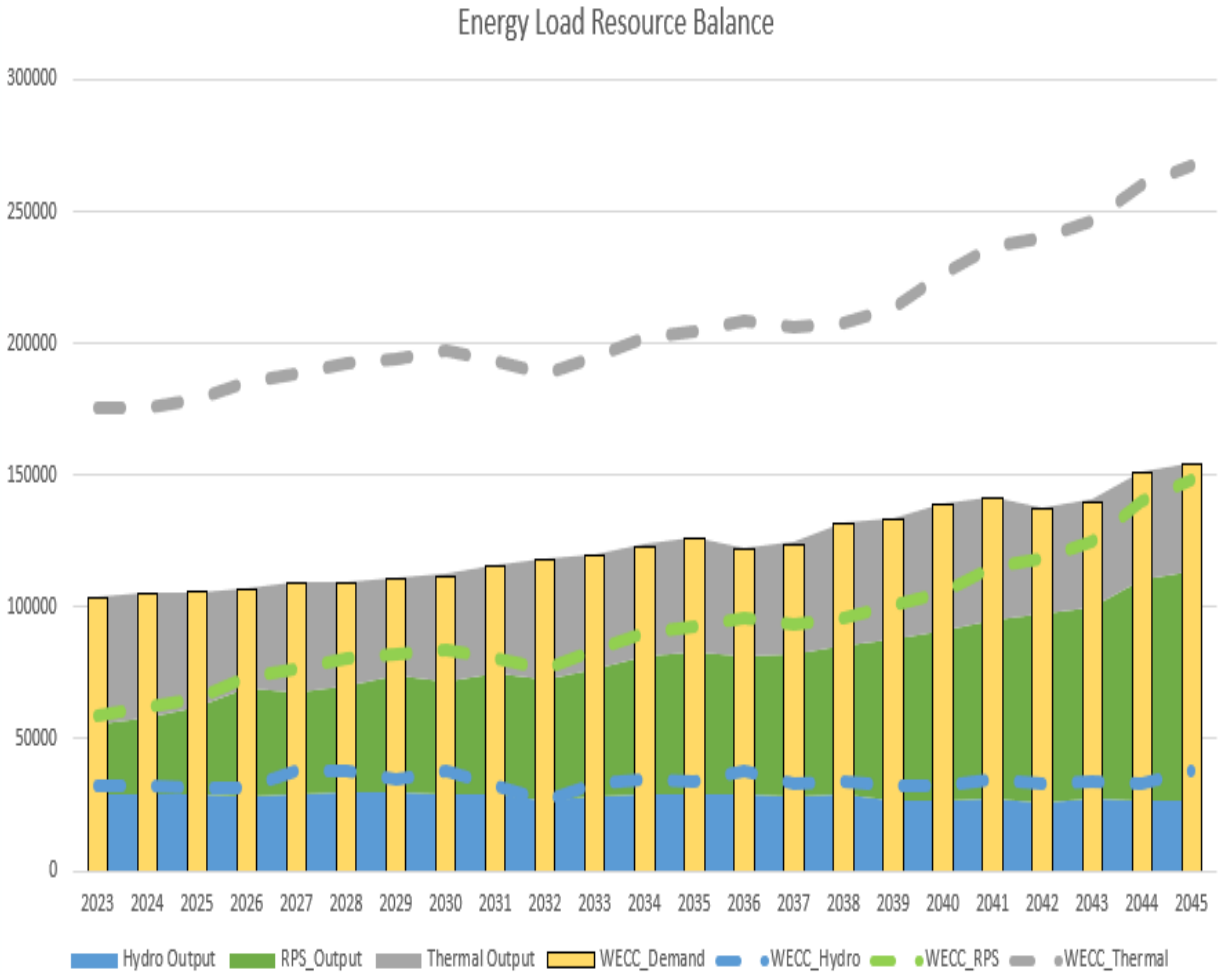


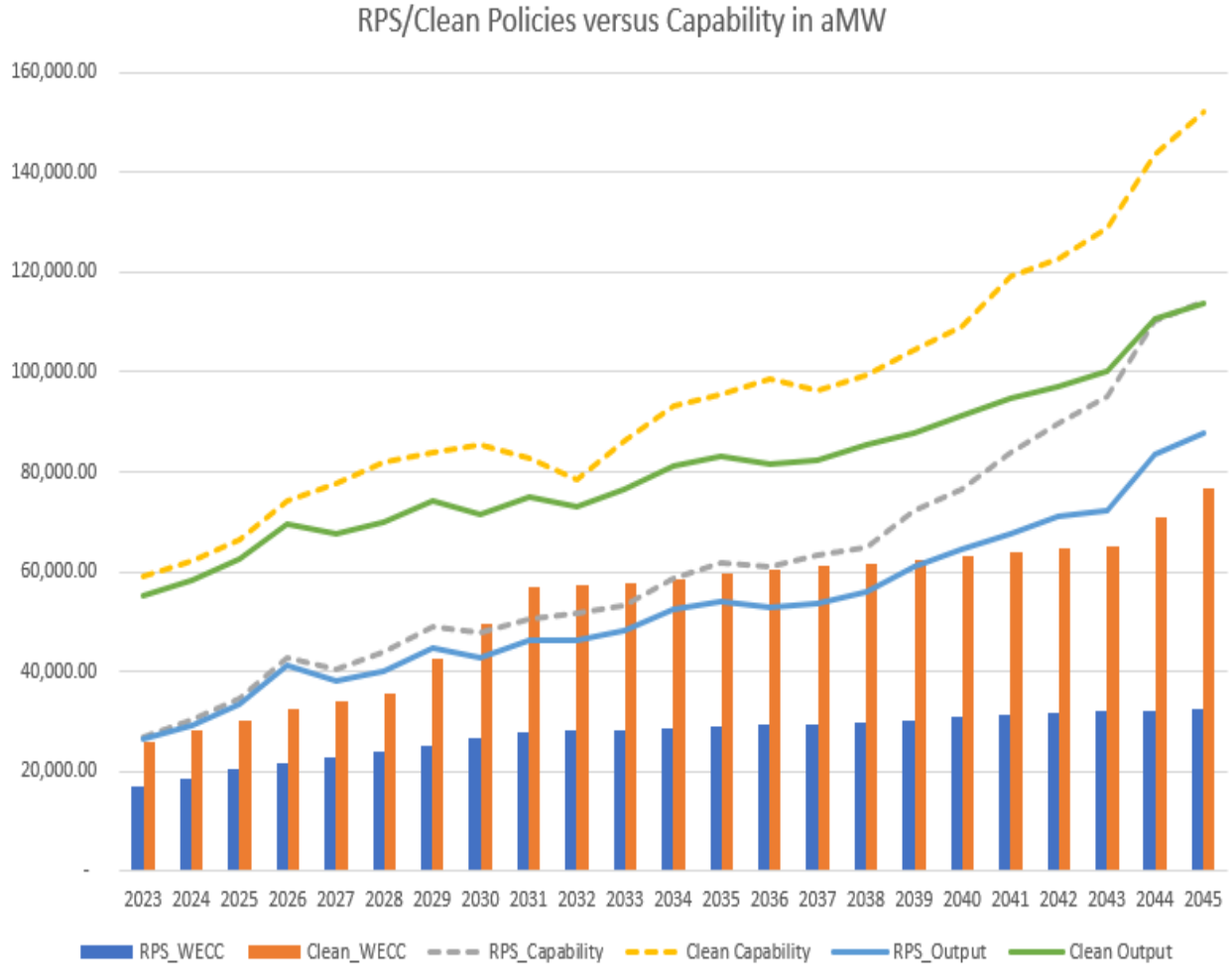
Persistent Global Instability



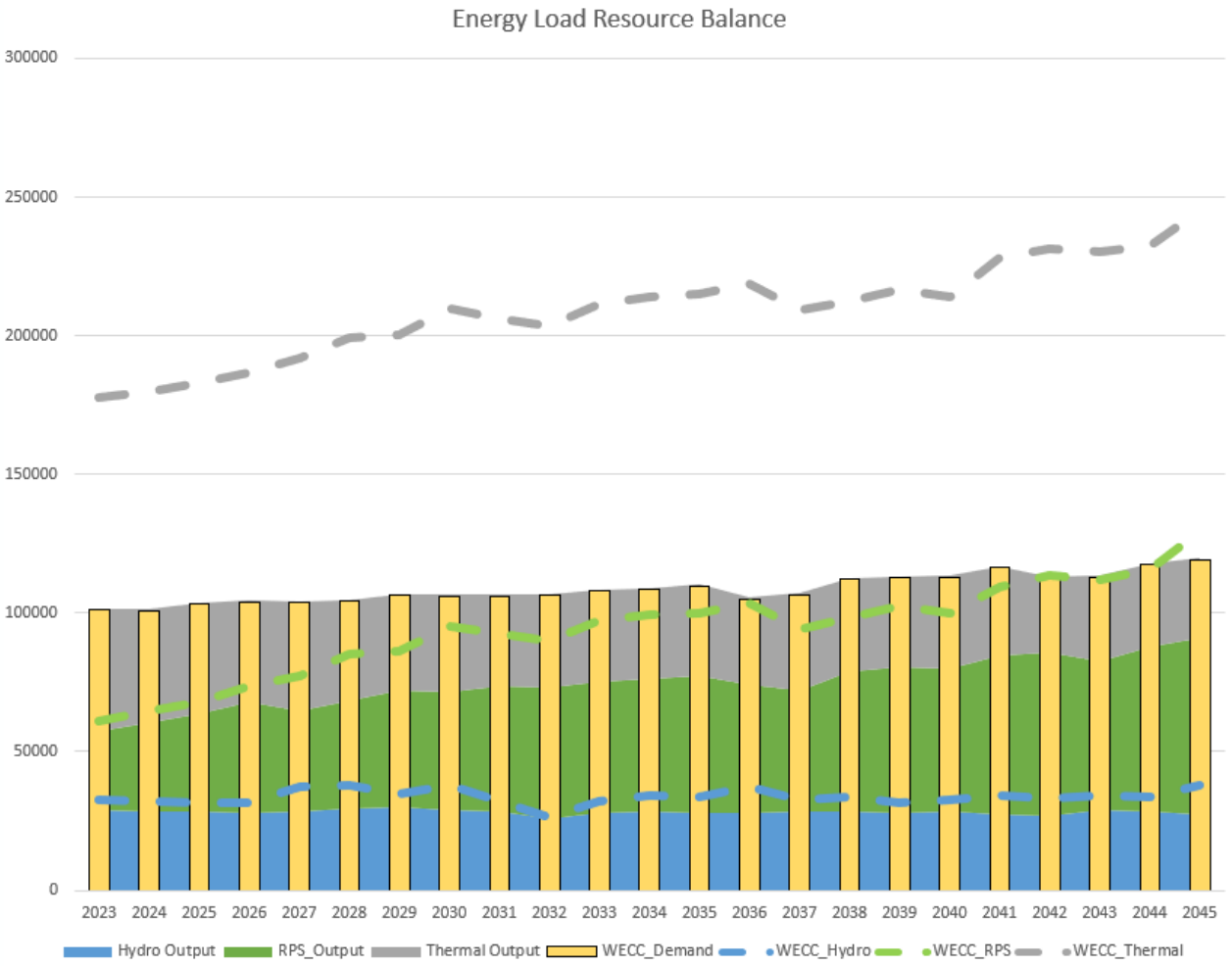


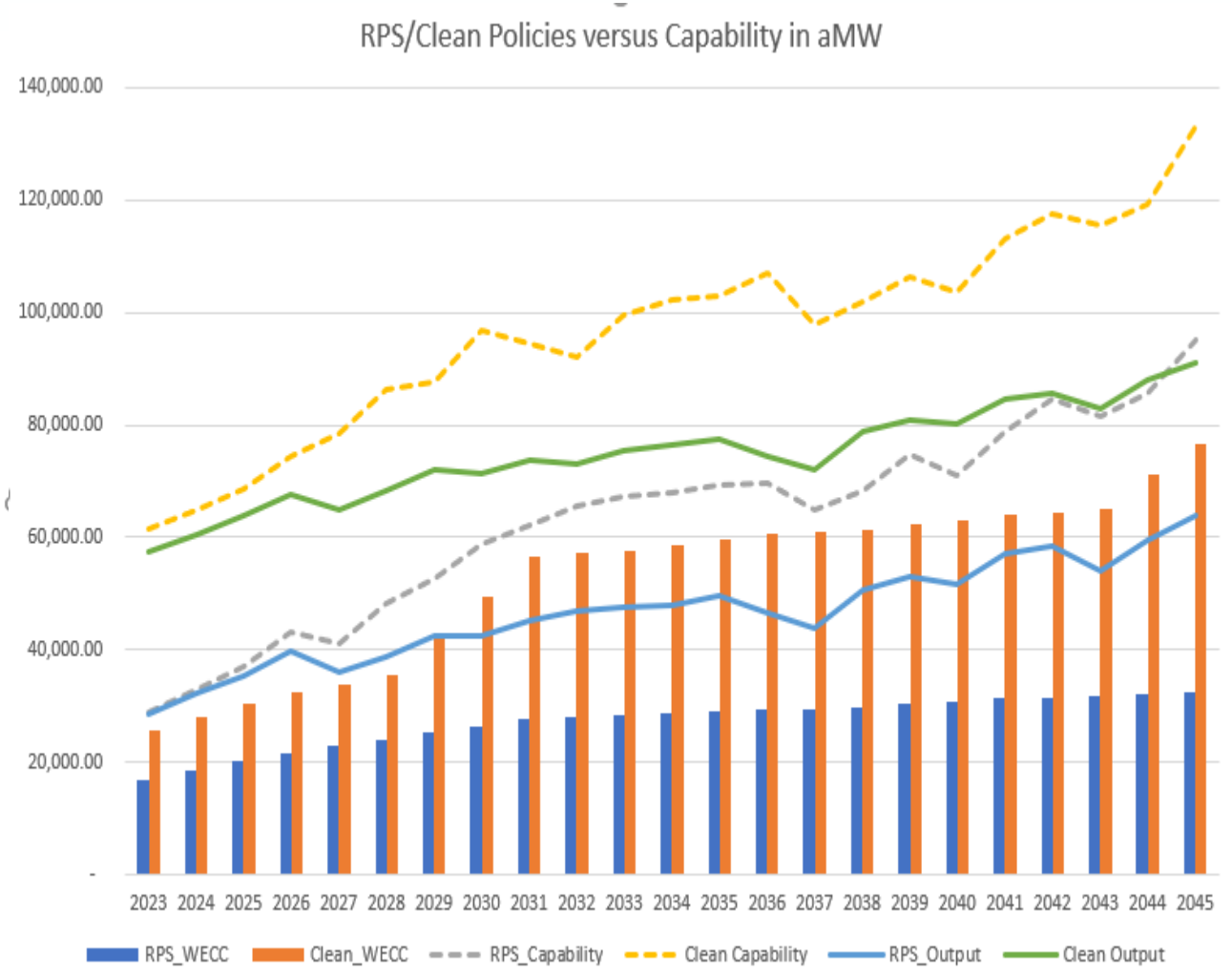
High West Coast Demand





Clean Baseline Resource Delay





Outside the Region Builds

California-Mexico

	Baseline	Limited Markets	Persistent Global Instability	High West Demand
2027	71 GW (Mostly hybrid solar and solar, MX gas)	17 GW (mostly storage in CA)	57 GW (Mostly hybrid solar and solar)	39 GW (Hybrid solar, storage, wind, MX gas)
2045	110 GW (Mostly hybrid solar and solar, wind, storage, MX gas)	23 GW (storage in CA and solar and gas in MX)	113 GW (Mostly hybrid solar, solar, some offshore wind/PS)	77 GW (Hybrid solar, wind, offshore wind/PS)

Desert SW

Baseline	Limited Markets	Persistent Global Instability	High West Demand
5 GW (Mostly storage and solar)	11 GW (mostly storage and some solar)	7 GW (Mostly storage and solar)	5 GW (Storage)
58 GW (Mostly solar, wind, storage, clean res.)	21 GW (more solar and storage)	58 GW (Mostly storage, solar, wind)	54 GW (Mostly hybrid solar,wind storage, clean res.)

Outside the Region Builds

Mountain West

	Baseline	Limited Markets	Persistent Global Instability	High West Demand
2027	12 GW (storage, gas, and solar)	14 GW (solar, storage and gas)	11 GW (mostly storage and gas)	12 GW (hybrid solar, storage,wind and gas)
2045	37 GW (wind, gas solar, storage, hybrid solar, clean res)	25 GW (solar, storage, gas and clean baseload)	25 GW (mostly storage and mix of gas/clean resources)	45 GW (wind, hybrid solar, gas, storage, clean res)

BC and Alberta

Baseline	Limited Markets	Persistent Global Instability	High West Demand
20 GW (mostly wind, plus solar and gas)	25 GW (mostly wind, plus solar and gas)	18 GW (mostly wind, plus solar and gas)	18 GW (mostly wind, plus solar and gas)
31 GW (mostly wind, plus solar and gas)	31 GW (mostly wind, plus solar and gas)	35 GW (mostly wind, plus solar and gas)	27 GW (mostly wind, plus solar and gas)

Regional Builds

Northwest

	Baseline	Limited Markets	Persistent Global Instability	High West Demand
2027	2 GW (storage, gas, solar)	7 GW (mostly solar, plus storage)	5 GW (mostly solar and storage)	26 GW (Mostly hybrid solar, solar)
2045	20 GW (Mostly wind, hybrid solar, storage, clean res.)	11 GW (mostly solar, plus storage)	26 GW (mostly solar and storage)	121 GW (Hybrid solar, wind, solar, offshore wind, clean res.)

Reminder

These are not used in the adequacy assessment!

Coal to gas conversions on existing resources

How do we want to treat coal to gas conversions in general?

Reached out, awaiting further information.

Conservative assumption would be same heat rate.

Sheerness Generating Plant is now converted to a natural gas fired powerplant according to owners Heartland Generation

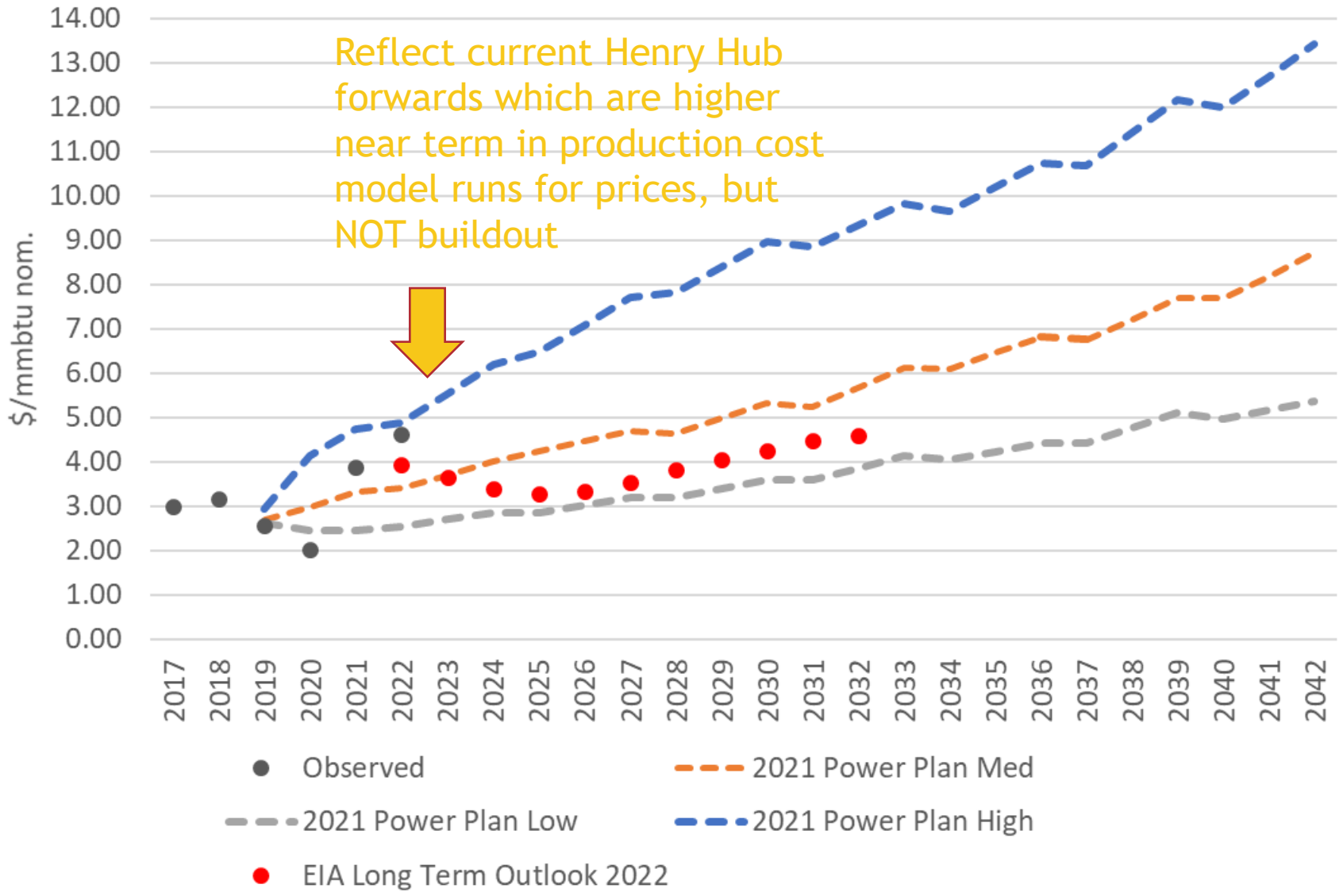
Observed and forecast for Henry Hub – annual prices

*note 2022 for Jan – Mar only

Updated with 2022 financial deflators

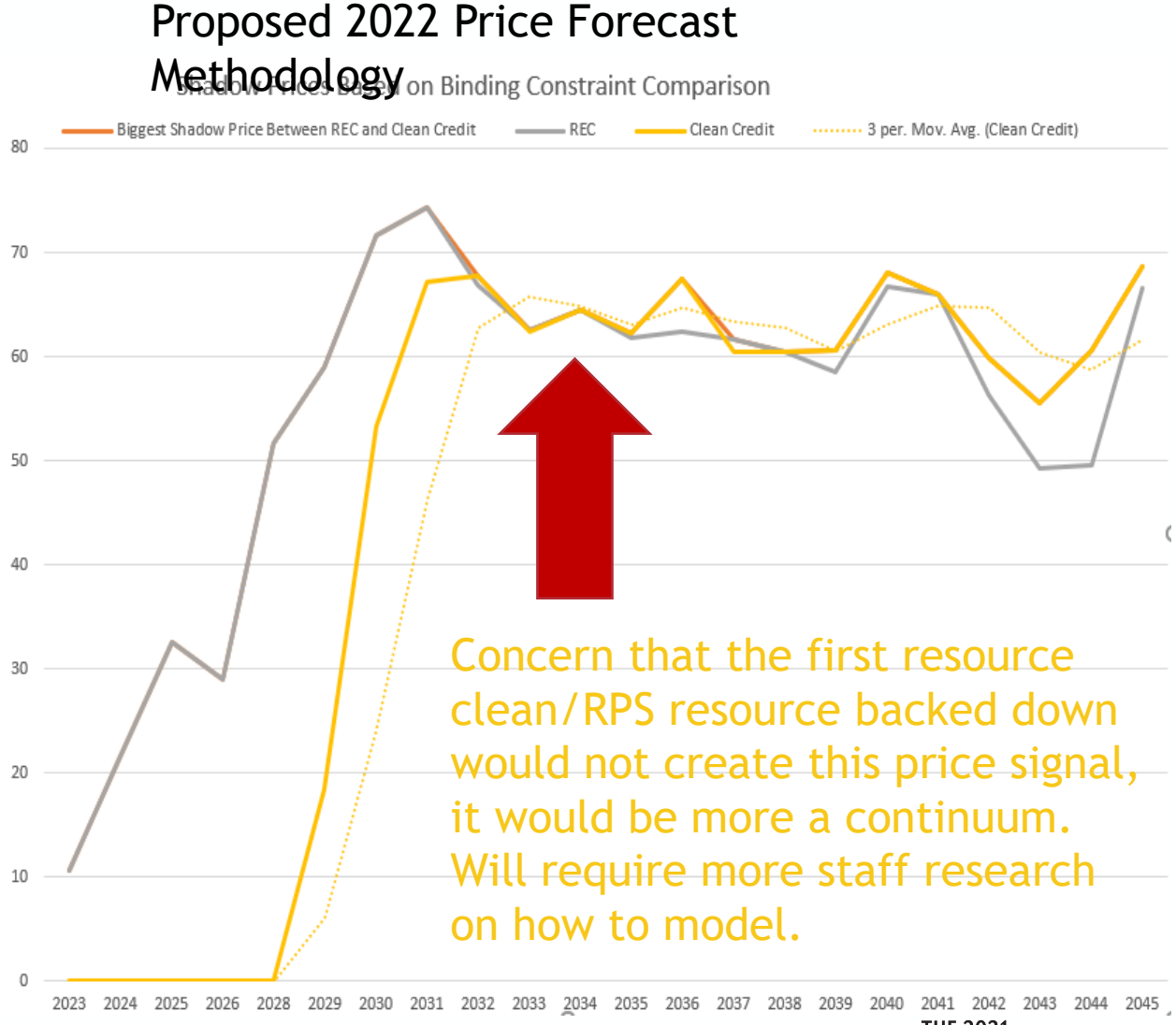
Review:

Near term gas prices higher



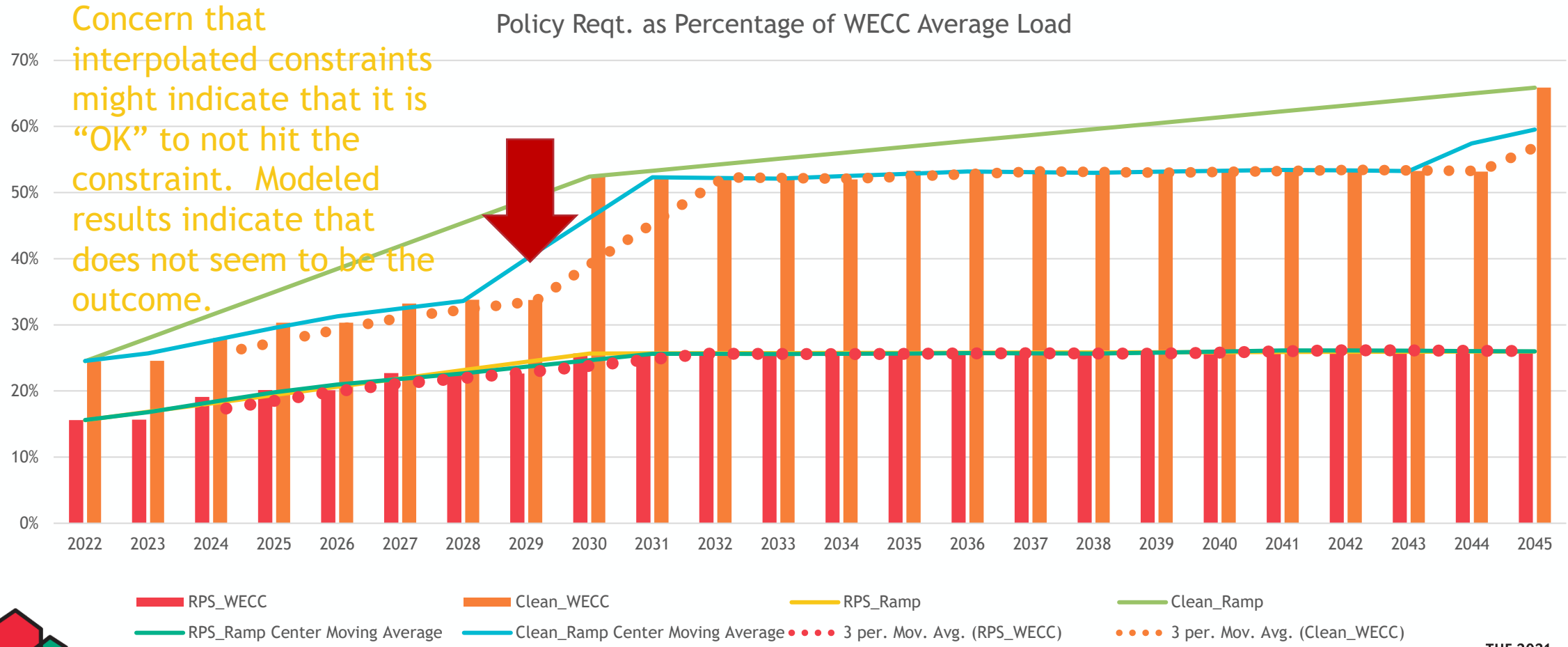
Review: Zero Emissions Bid Adder Methodology

- Per the previous SAAC meeting discussion, the concept is to extend the REC price methodology to clean resources meeting a WECC-wide clean energy target specified on the *Constraint* table.
- The methodology uses a negative bid adder on the *Resources* or *New Resources* table to represent the value of the foregone generation.
- Modeling change to reflect stakeholder concern not possible under current timeframes, will research and try to incorporate next study.



Review: Requirements Modeled with Moving Average Rather than Simple Linear Interpolation

Concern that interpolated constraints might indicate that it is "OK" to not hit the constraint. Modeled results indicate that does not seem to be the outcome.



Review: Emerging Tech/Unknown Online Date Resource Available in Baseline

- Should we have this resource in the baseline?

  Coastal

  - Offshore wind in Oregon (2.6 GW)
    - Similar pricing to California, split between north and south coast
  - Offshore wind in California (10 GW)

  Inland

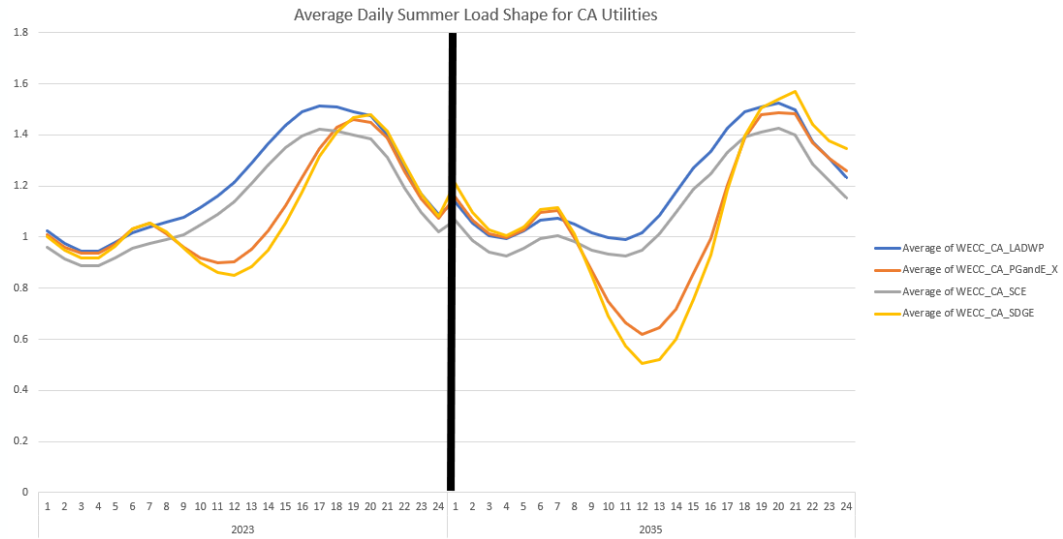
  - SMR (< 11 GW)

Review: Capacity Credit of Short Duration Storage

- Short Duration Storage Capacity Contribution
  - Many folks give these resource full nameplate value as a capacity credit
  - Set capacity contribution to peak be dynamic in current modeling

Review: Updated California Hourly Loads for IOUs

- LADWP, PG&E, SCE and SDGE
- Used time series hourly to specify hourly demand for 2023 through 2045
- Split up PG&E hourly load into three zones per the percent of total PG&E historical hourly load.
  - Enforced the hourly load percentages via demand collection functionality



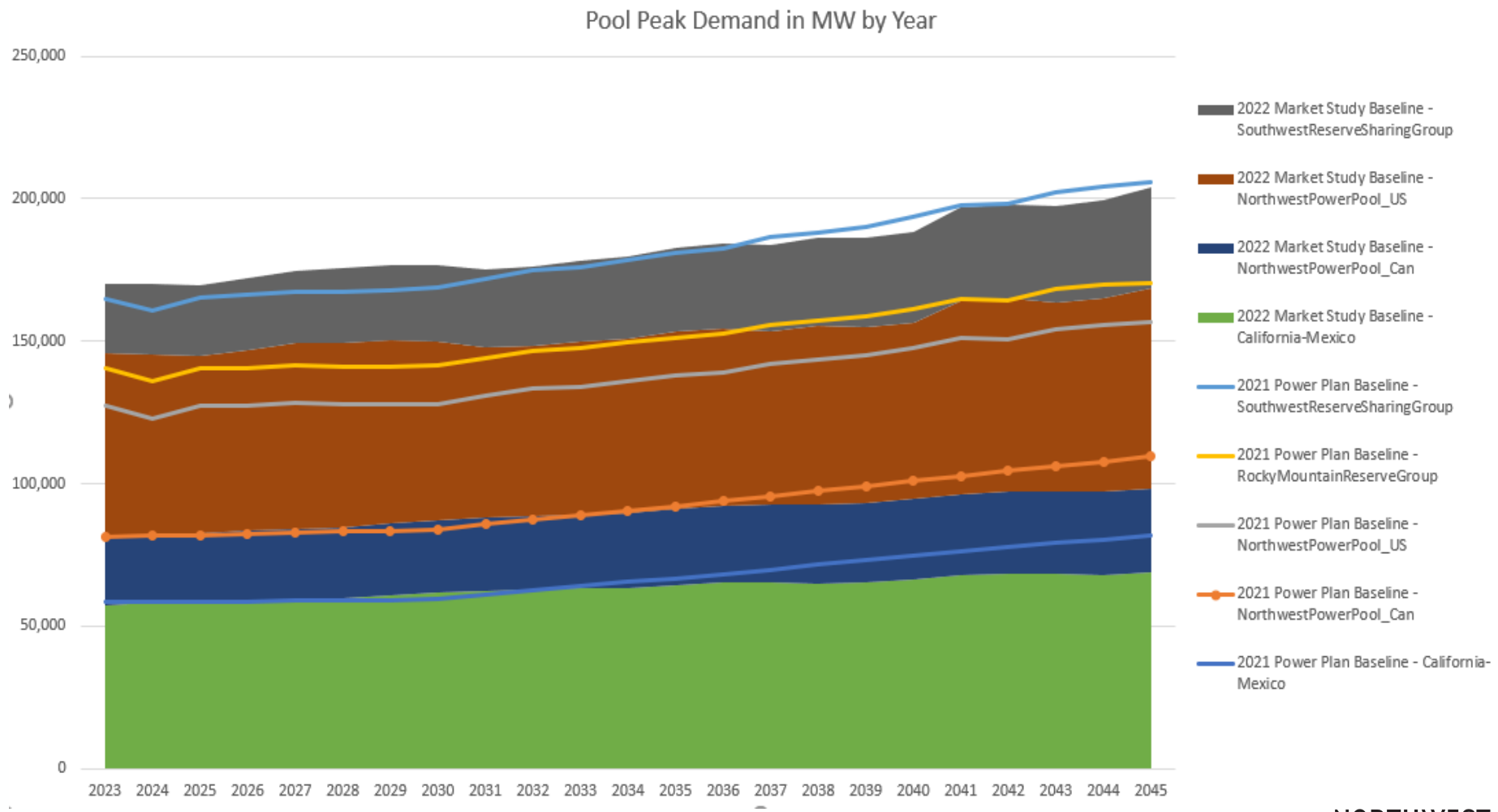
Other Updates from new AURORA DB

- Updated planning reserve margins for all reserve sharing groups to NERC reserve targets
  - Maintained three-year ramp in methodology to prevent early overbuild
- Updated Canadian and California Carbon market information
  - California and Canadian Carbon prices increased
  - Washington and Alberta have carbon prices
- Updated wheeling information and transmission capacity from Baja to SDGE
- Updated WAPA loads

Peak Load Changes by Pool

Overall peak MW reduction throughout WECC from 2021 Plan assumptions to 2022 Study

- California peak MW decreased by ~14 GW
  Hourly shape
- Canada peak MW increased by ~2 GW
- NWPP-US/RMRG peak MW increased by ~10 GW
  Combined RA
- SWRSG peak MW decreased

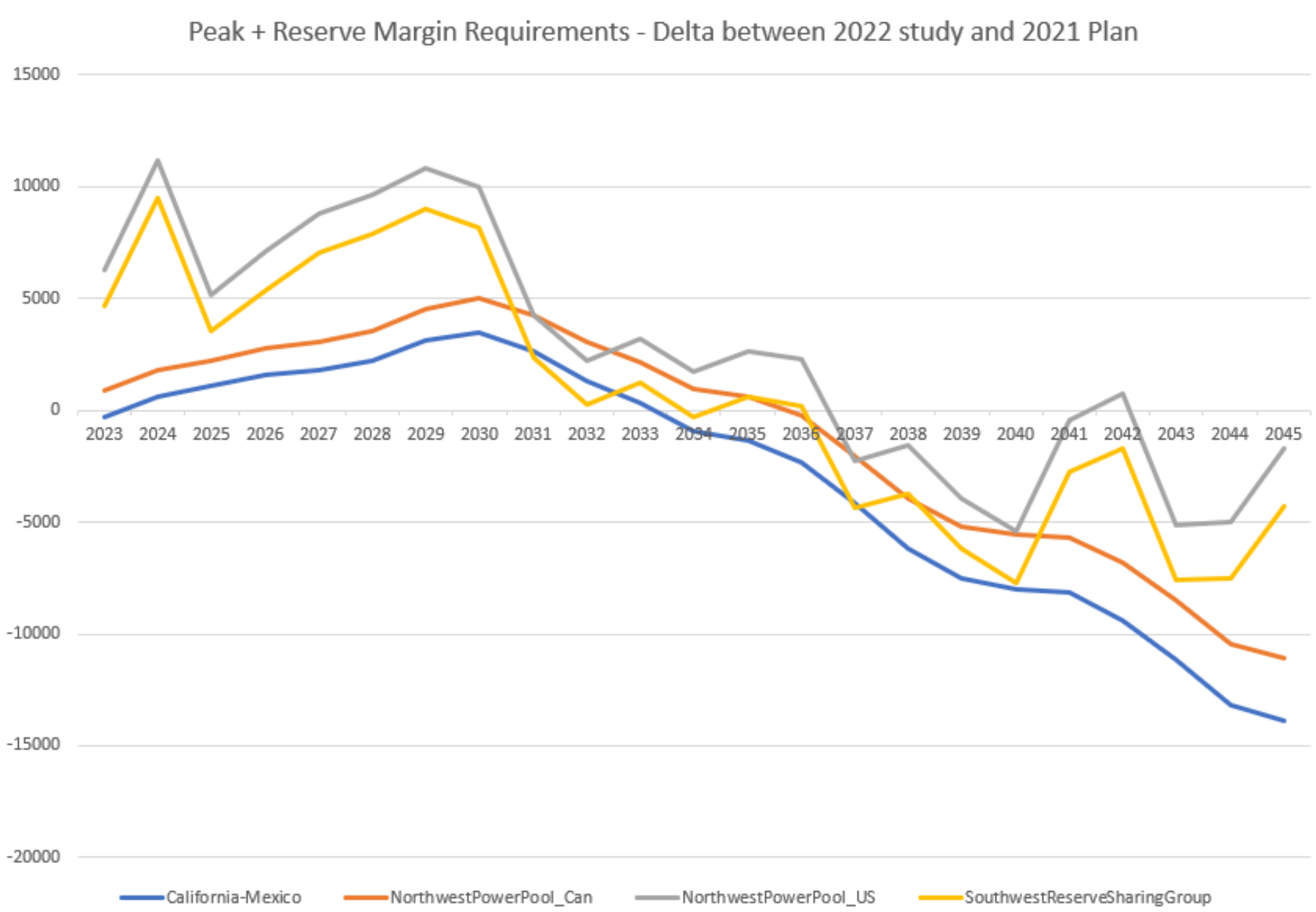


Planning Reserve Margin Change

- Changes in reserve margins are per NERC Long Term Reliability Assessment for 2021
- Energy Exemplar updated to previous LTRA in recent DB update
- Note that NWPP now contains entities from RMRG (circa 2018)

*Average PRMs over study timeframe

Reserve Sharing Group	2021 Plan Assumptions	2022 Market Study Update*
WECC CA/MX	16.16%	18.08%
WECC NWPP-US	16.32%	13.5%
WECC SRSG	15.82%	10.01%
WECC NWPP-Canada	11.03%	12.88%
WECC RMRG	14.14%	Part of NWPP-US



Coincident Peak plus Reserve Margins Requirements in the WECC changed from the 2021 Plan as follows:

<u>2030</u>

- 10 GW more in California, Canada and NWPP
- 2 GW less in Desert SW

<u>2045</u>

- 12 GW more in NWPP and Canada
- 16 GW less in California and Desert SW

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8/9/2022 4:32:13 PM Warning: Zonal transport dispatch infeasible for 5/14/2024 Hr 11
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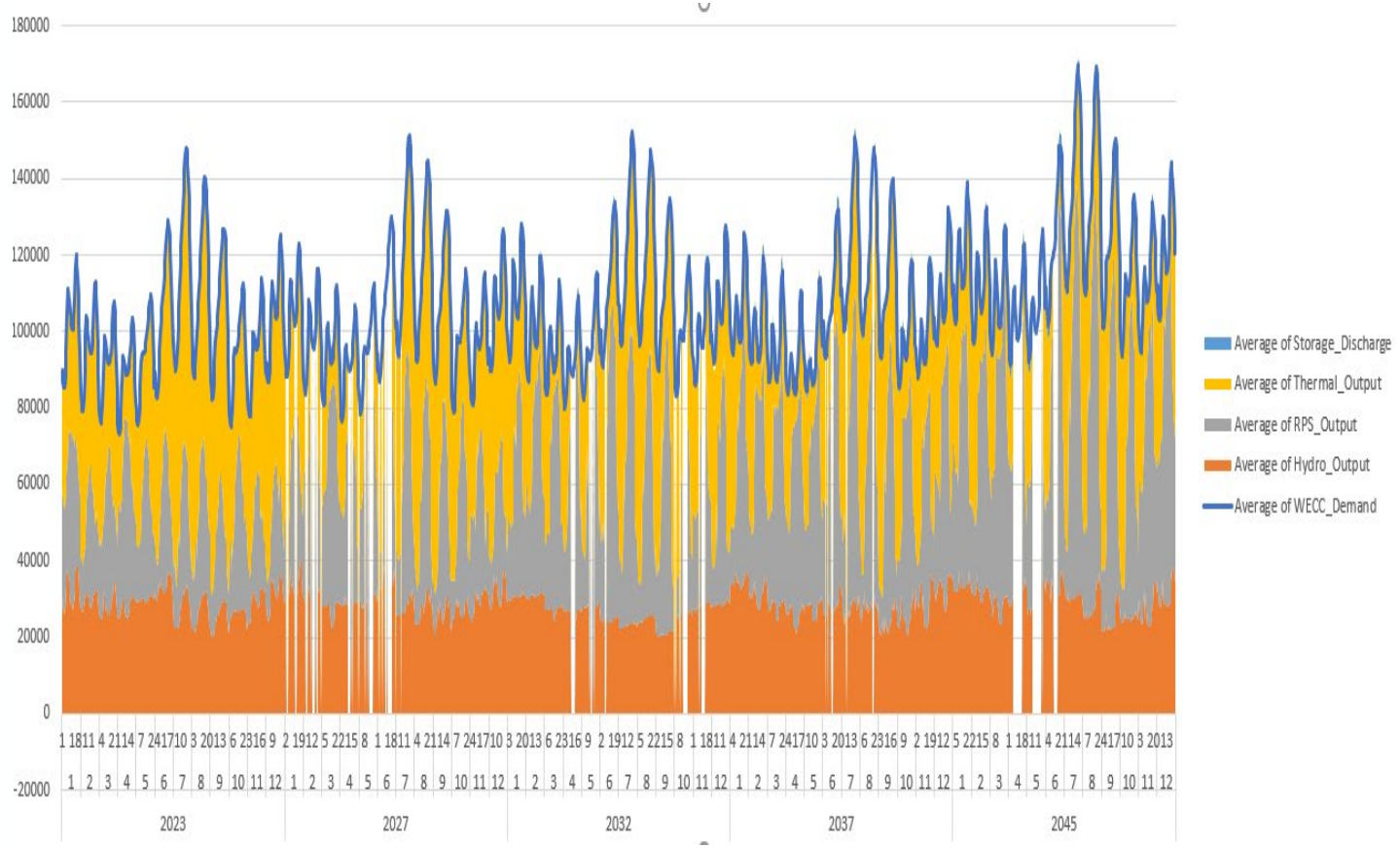


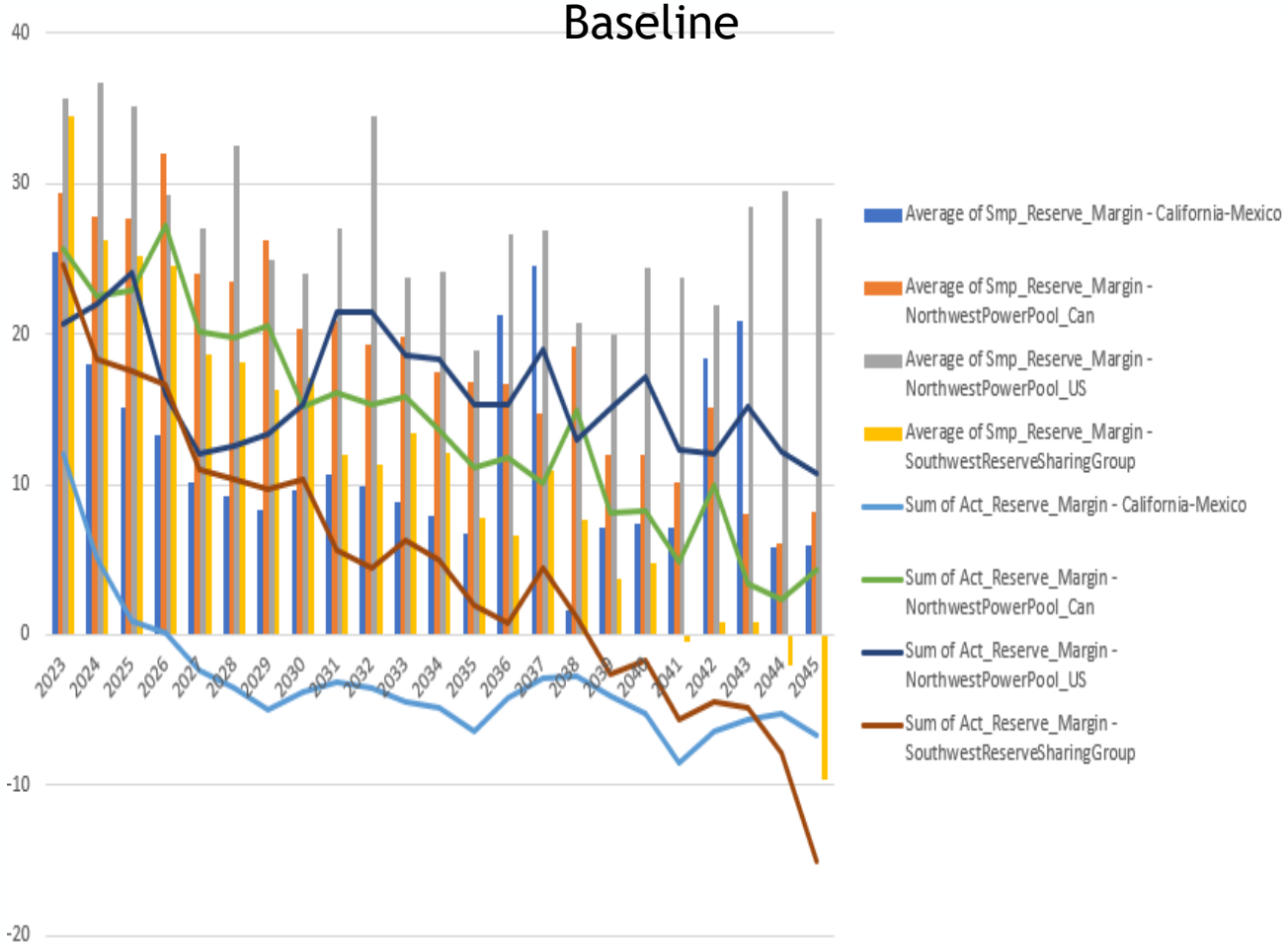
Infeasibilities

May need to Increase MIP time or gap?

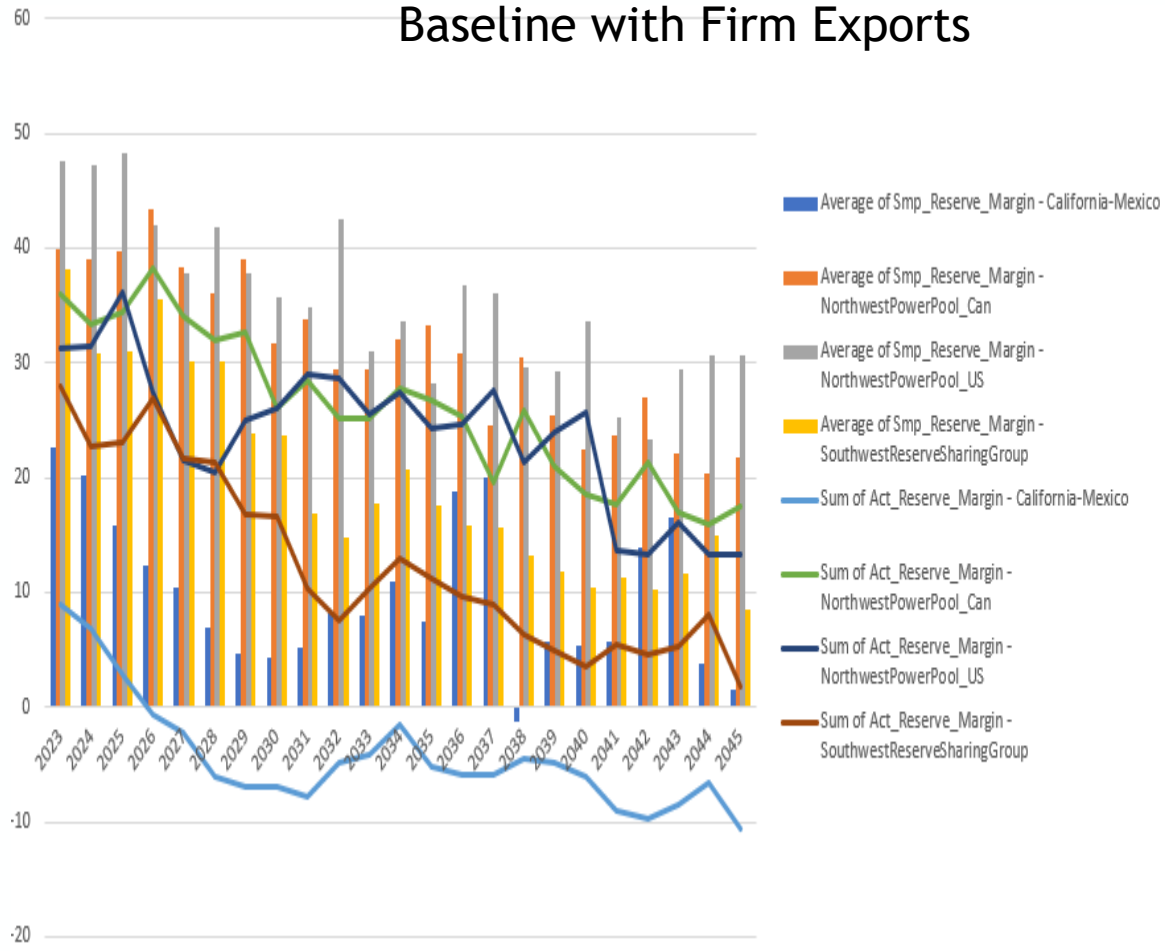
Maybe run more sample days for better unit commitment and storage dispatch?

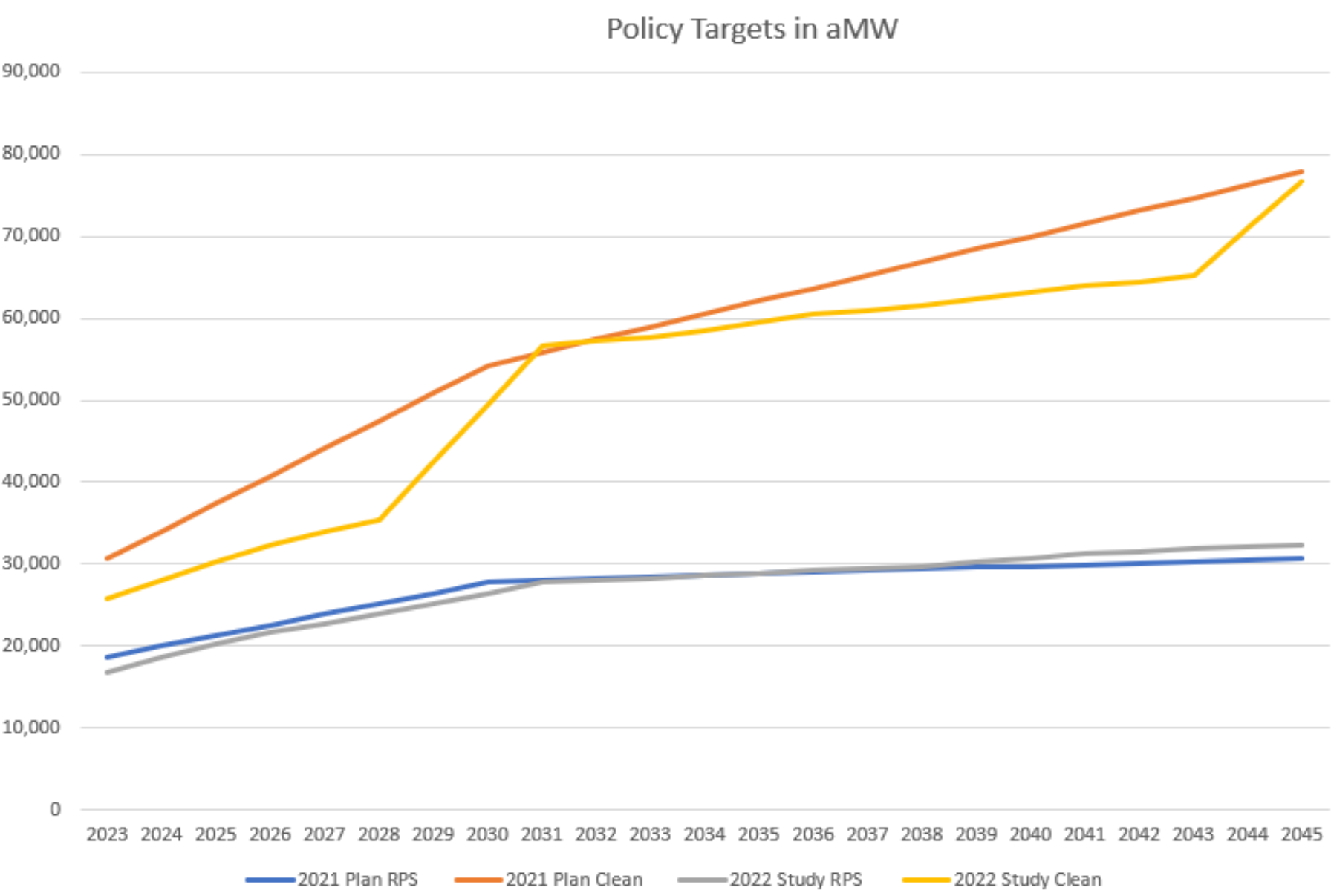
Building to Reserve Margins and Firm Exports Assumptions

Baseline



Baseline with Firm Exports

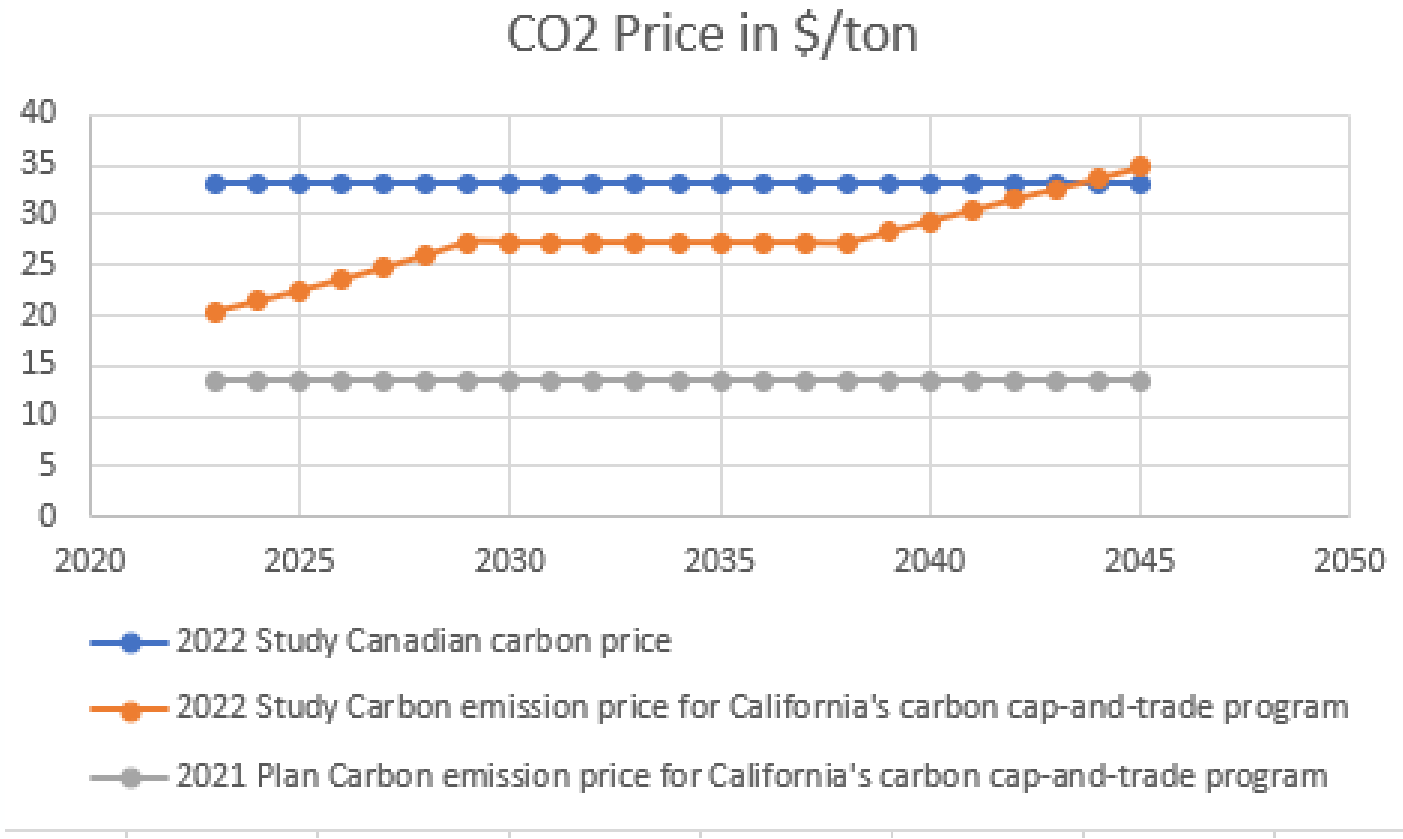




Policy Targets More Front Loaded in Plan studies

Carbon Pricing Increased

- California Carbon pricing increased
- Alberta (same as BC) and Washington(same as CA) carbon pricing added to reflect new policies



Finishing the Price Forecast

- Production Cost Model
  - Simulates thermal unit commitment, dispatch of all resources and zonal transmission operation based on least cost of producing power and providing reserves
  - The power price in each zone set by marginal unit.
- For a buildout scenario run multiple NW hydro conditions to get prices and avoided emissions rates