September 9, 2020

MEMORANDUM

TO: **Council Members**

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

SUBJECT: **2021 Power Plan Draft Wholesale Electricity Price and Avoided CO_2 Emissions Rate Forecast Part 2**

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. 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 and interpretation of the avoided market emissions rate data. 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.

851 S.W. Sixth Avenue, Suite 1100
Portland, Oregon 97204-1348
www.nwcouncil.org

Steve Crow
Executive Director

503-222-5161
800-452-5161
Fax: 503-820-2370

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:

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 2021 Power Plan Draft Wholesale Electricity Price Forecast

Power Committee

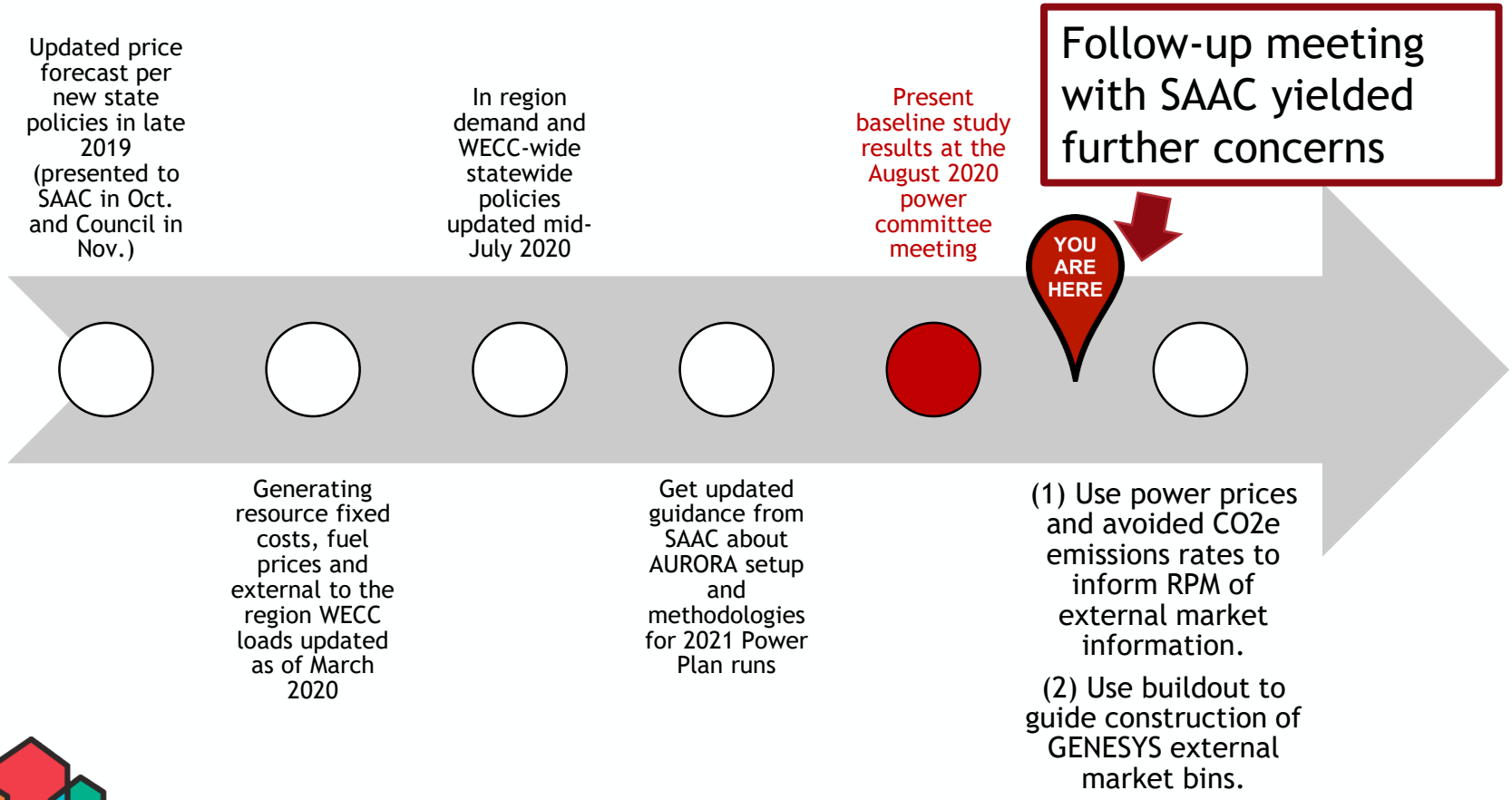
9/15/2020

John Ollis

THE 2021
NORTHWEST
POWER PLAN

FOR A SECURE & AFFORDABLE
ENERGY FUTURE

Timeline – *Wholesale Power Price and Market Emissions Rate Forecast*



WECC-Wide Buildout Update

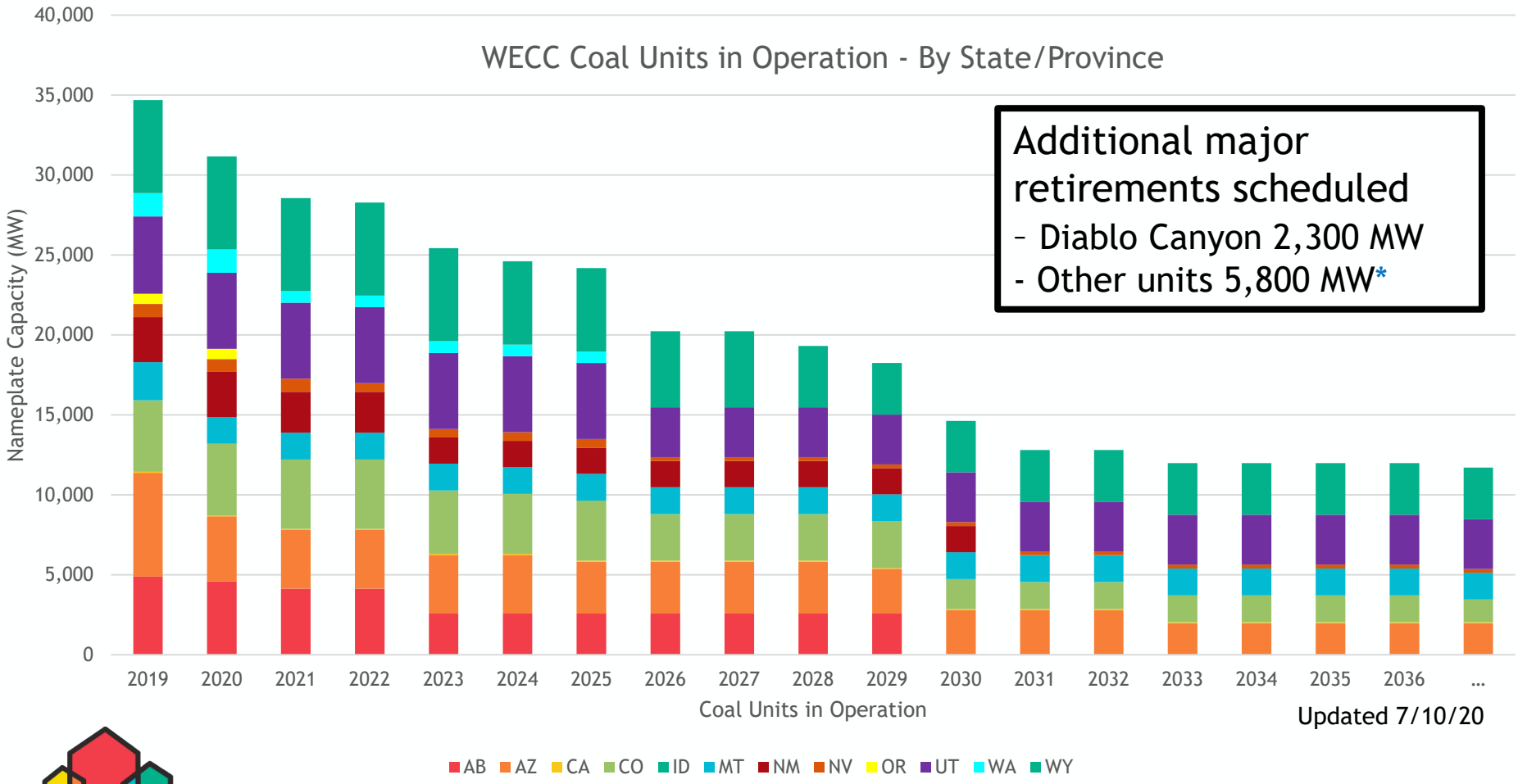
NERC Assessment Areas

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**

Review: WECC coal units in operation, decreasing over time…



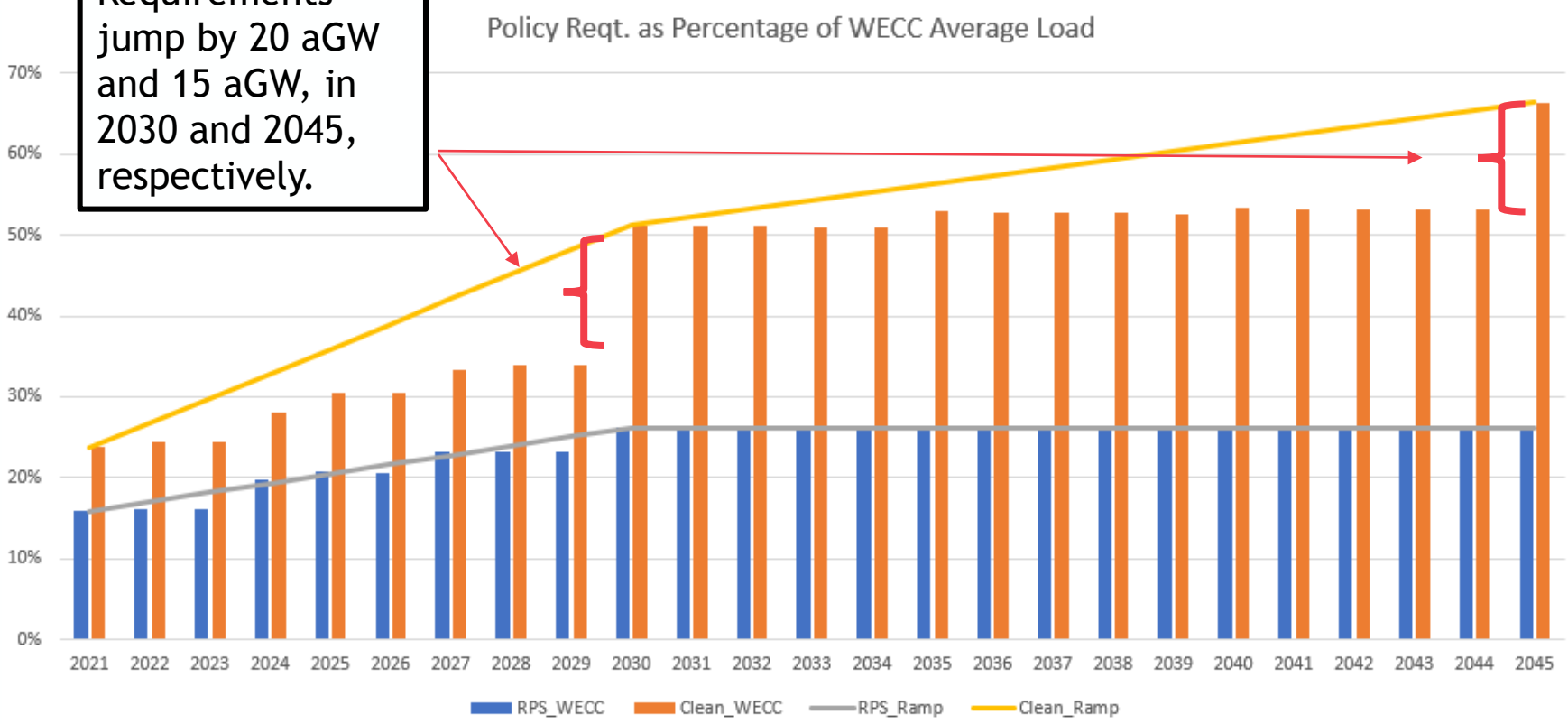
Additional major retirements scheduled
- Diablo Canyon 2,300 MW
- Other units 5,800 MW*

Updated 7/10/20

*Over 1,300 MW of gas units in CA replacing OTC retirements

Review of Clean/RPS Policies: *Direct Interpretation Versus Interpolation for Modeling*

Requirements jump by 20 aGW and 15 aGW, in 2030 and 2045, respectively.



Without some interpolation the model has a hard time solving the problem.

Buildout Comparison Presented at the SAAC/Power Committee

Cumulative Buildout in Nameplate M

This is where we started…

Limited Gas per Regulatory and Policy Clima						
Year	Solar	Natural Gas	4 Hour Battery	Wind	Battery	al
2025	16,050	17,082	6,100	38,600	12,300	0
2030	30,900	19,362	8,100	68,800	18,500	
2035	39,000	20,220	8,100	91,400	22,100	
2040	42,150	20,649	8,100	100,900	22,700	
2045	46,350	20,649	8,100	102,400	22,800	

Too many gas builds for current policy

Limited Gas per Regulatory and Policy Climate (August 2020) DRAFT					
Year	Solar	Natural Gas	4 Hour Battery	Wind	Solar with Battery
2025	25,950	31,423	12,100	22,300	14,100
2030	45,450	39,545	12,100	47,400	25,800
2035	69,300	46,481	12,100	67,200	43,700
2040	77,250	51,514	12,100	109,400	50,300
2045	78,450	54,517	12,100	131,600	51,200

Review: Primary Methodology Changes After First SAAC

1. Incorporated Dynamic Peak Credit to top 8 hours
2. Further limited gas everywhere but primarily in Desert SW where builds were limited to 1 per period and maxed out around 7000 MW

		Report	ID	Name	Nameplate Capacity	Fuel	Area	Variable O&M	Fixed O&M	Var Cost Mod1	Var Cost Mod2	Fix Cost Mod1	Fix Cost Mod2	Annual Max	Overall Max
					MW			$/MWh	$/MW-Week	$/MWh	$/MWh	$/MW-Week	$/MW-Week		
49	Mod	FALSE	2518	CCCT gas/oil Adv		NG1AZ	620	1.80	543			yr_FOM_Adv_Gas_Oi		yr_MaxPerYear01	1
50	Mod	FALSE	2519	SCCT Adv		NG1AZ	620	9.63	348			yr_FOM_Adv_CT_EM		yr_MaxPerYear01	2
51	Mod	FALSE	2535	CCCT gas/oil Adv		NG1AZ	625	1.80	543			yr_FOM_Adv_Gas_Oi		yr_MaxPerYear01	1
52	Mod	FALSE	2536	SCCT Adv		NG1AZ	625	9.63	348			yr_FOM_Adv_CT_EM		yr_MaxPerYear01	2
53	Mod	FALSE	2541	CCCT gas/oil Adv		NG1AZ	626	1.80	543			yr_FOM_Adv_Gas_Oi		yr_MaxPerYear01	1
54	Mod	FALSE	2542	SCCT Adv		NG1AZ	626	9.63	348			yr_FOM_Adv_CT_EM		yr_MaxPerYear01	2
55	Mod	False	2608	CCCT gas/oil Adv		NG1AZ	624	1.80	543			yr_FOM_Adv_Gas_Oi		yr_MaxPerYear01	1
56	Mod	False	2609	SCCT Adv		NG1AZ	624	9.63	348			yr_FOM_Adv_CT_EM		yr_MaxPerYear01	2
57	Mod	False	459	CCCT gas/oil Adv		NG1BajaN	59	1.80	586			yr_FOM_Adv_Gas_Oi		yr_MaxPerYear02	0
58	Mod	False	659	SCCT Adv		NG1BajaN	59	9.63	353			yr_FOM_Adv_CT_EM		yr_Zero	0
59	Mod	FALSE	2434	CCCT gas/oil Adv 1x1		NG1BajaN	59	1.80	742			yr_FOM_Adv_Gas_Oi		yr_MaxPerYear02	10

3. Let batteries meet reserve needs in Mountain West and Desert SW where there are reserve shortages.

mparison per Most Recent Buildout

Buildout in Nameplate MWs by Year

Last month this is where we were…

gulatory and Policy Climate (October 201					
Year	Solar	Natural Gas	4 Hour Battery	Wind	Solar with Battery
2025	16,050	17,082	6,100	38,600	12,300
2030	30,900	19,362	8,100	68,800	18,500
2035	39,000	20,220	8,100	91,400	22,100
2040	42,150	20,649	8,100	100,900	22,700
2045	46,350	20,649	8,100	102,400	22,800

Still too many gas builds for current policy but better, wind builds way higher and battery way lower than expected

Limited Gas per Regulatory and Policy Climate (September 2, 2020) DRAFT					
Year	Solar	Natural Gas	4 Hour Battery	Wind	Solar with Battery
2025	32,850	29,279	9,300	77,000	20,900
2030	54,450	34,970	9,300	150,300	25,600
2035	56,250	35,870	9,600	199,000	45,500
2040	56,250	35,970	10,200	235,100	50,000
2045	56,400	35,970	10,600	237,900	50,500

Since September 2nd SAAC, More Methodology Changes and Corrections

- With further help and collaboration with the stakeholder community and some closer validation of results…

1. **California demand forecast correction**
   A. Previous forecast did not include EE (lowered forecast 1 aGW)
   B. Some PG&E load was counted twice during zonal breakout (lowered forecast 5 aGW)
   C. Lowered clean requirements in the WECC by around 6 aGW by 2045
2. **Clean/RPS constraints correction**
   A. Inputs were offset by a year
3. **Methodology change on carbon content on imports to California**
   A. Default treatment static and likely overestimating emissions associated with imports
4. **Started using partial build logic for renewables and batteries.**
   A. Renewable and battery installations vary considerably in size and can be more easily right sized to meet needs. This also reduces overbuilds and speeds up the modeling.

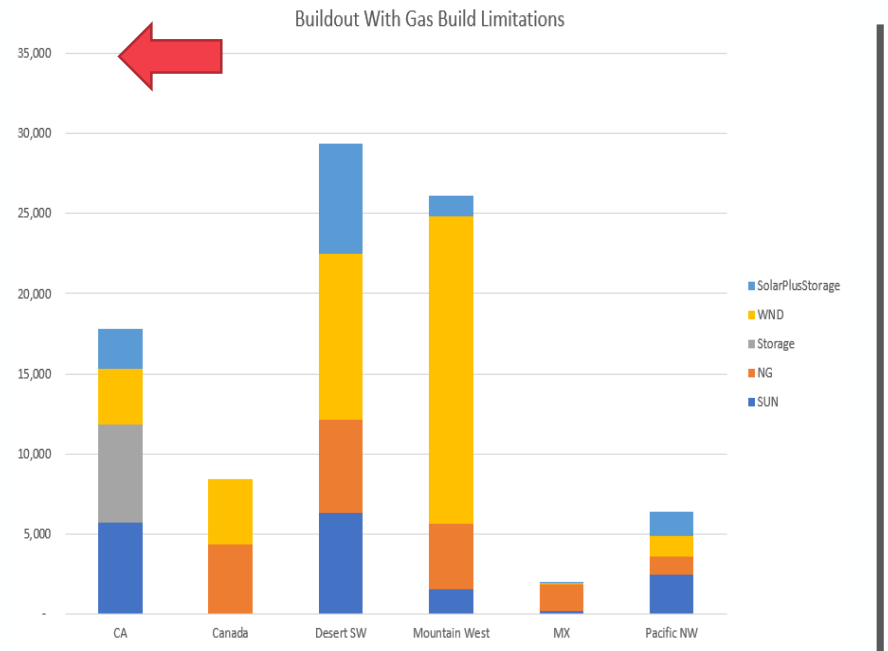
Buildout Comparison Presented at the SAAC

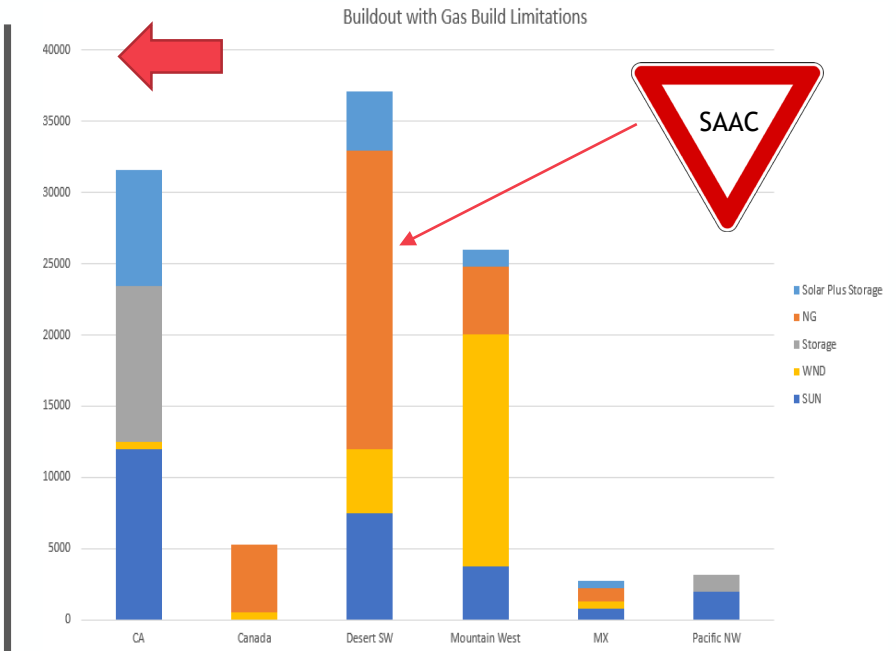
Cumulative Buildout in Nameplate MWs by Year

Limited Gas per Regulatory and Policy Climate (October 2019)						
Year	Solar	Natural Gas	4 Hour Battery	Wind	Solar with Battery	Geothermal
2025	16,050	17,082	6,100	38,600	12,300	0
2030	30,900	19,362	8,100	68,800	18,500	0
2035	39,000	20,220	8,100	91,400	22,100	546
2040	42,150	20,649	8,100	100,900	22,700	858
2045	46,350	20,649	8,100	102,400	22,800	1,170

Limited Gas per Regulatory and Policy Climate (September2020) DRAFT					
Year	Solar	Natural Gas	4 Hour Battery	Wind	Solar with Battery
2025	2,302	26,052	23,561	8,000	27,097
2030	5,176	33,534	23,925	20,335	41,200
2035	5,392	34,956	24,930	20,922	42,217
2040	19,641	34,956	25,951	86,831	56,000
2045	19,641	34,956	27,849	112,431	56,000

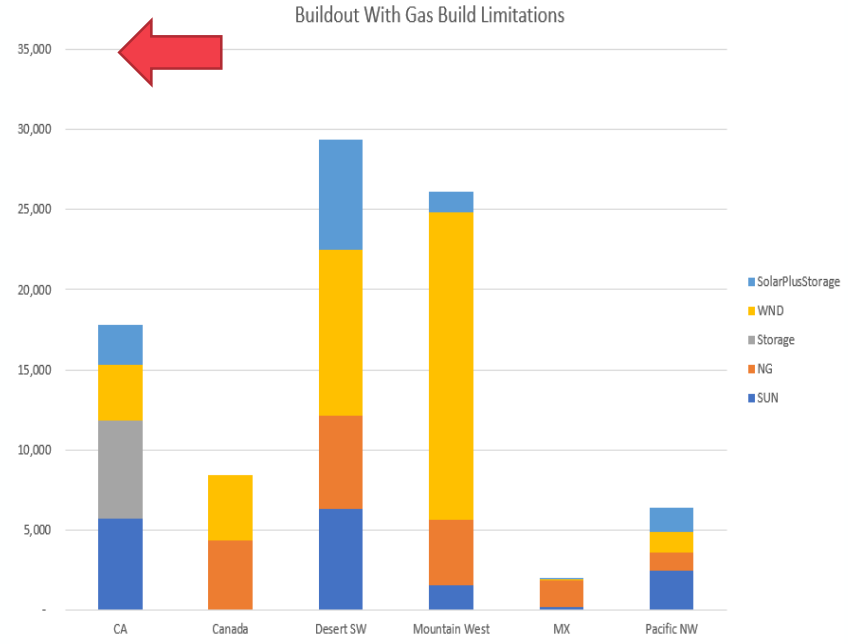
Where and what new resources are built by 2025?

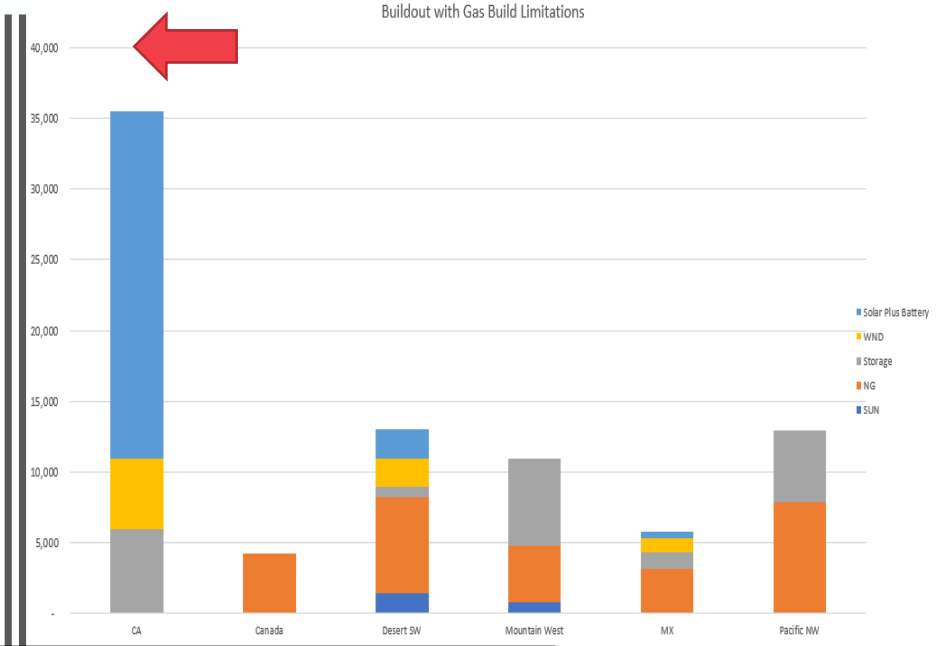




During Action Plan time period buildout is of similar magnitude with more new gas resources filling in for thermal retirements and load increases.

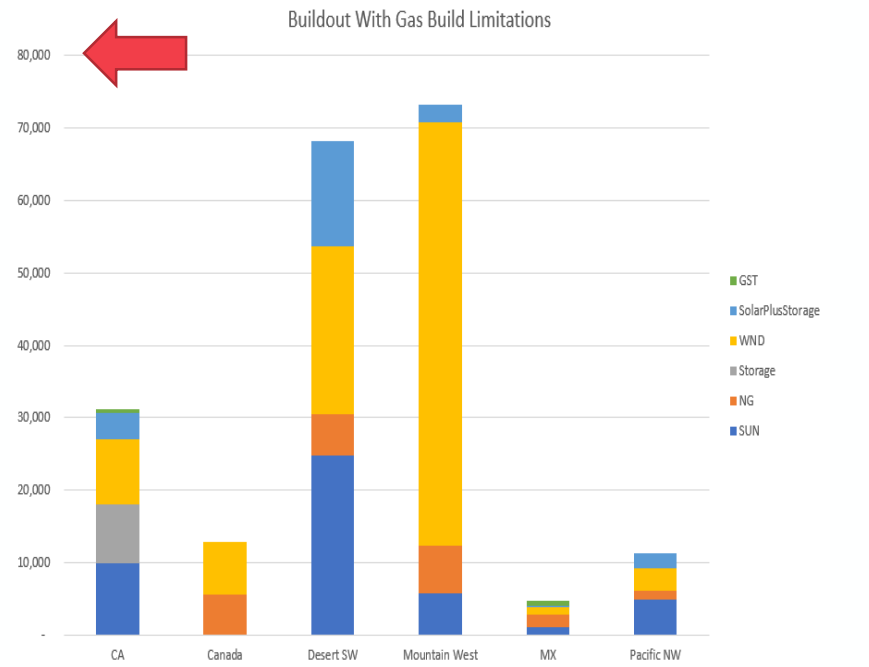
Where and what new resources are built by 2025?

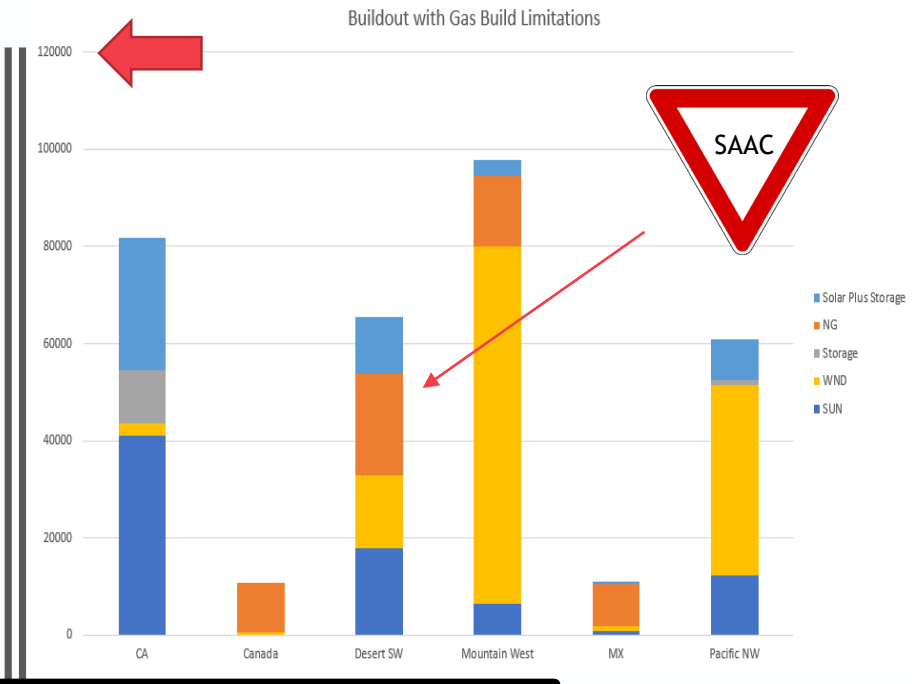




During Action Plan time period buildout is of similar magnitude with more new gas resources filling in for thermal retirements and load increases. New gas mostly displaces existing gas.

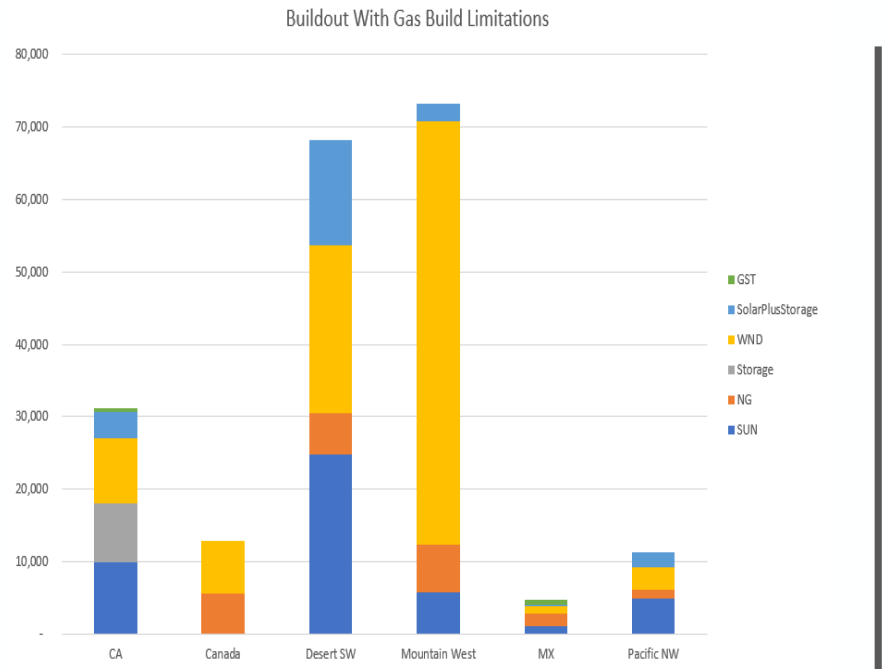
Where and what new resources are built by 2045?

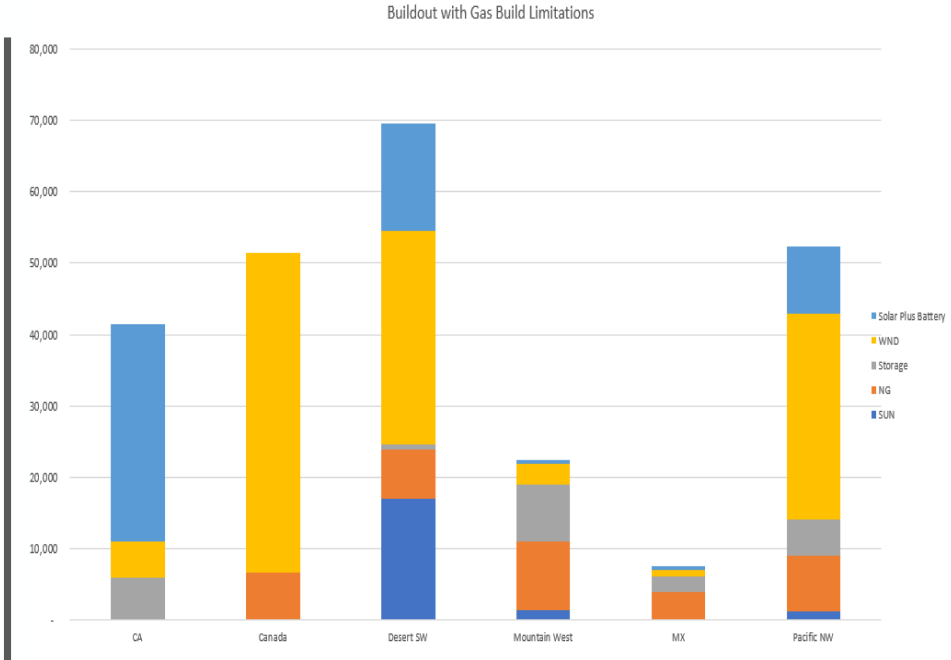




NW hydro contributes less and the NW demand is higher during times when the rest of the WECC is peaking leading to more builds in the NW.

Where and what new resources are built by 2045?

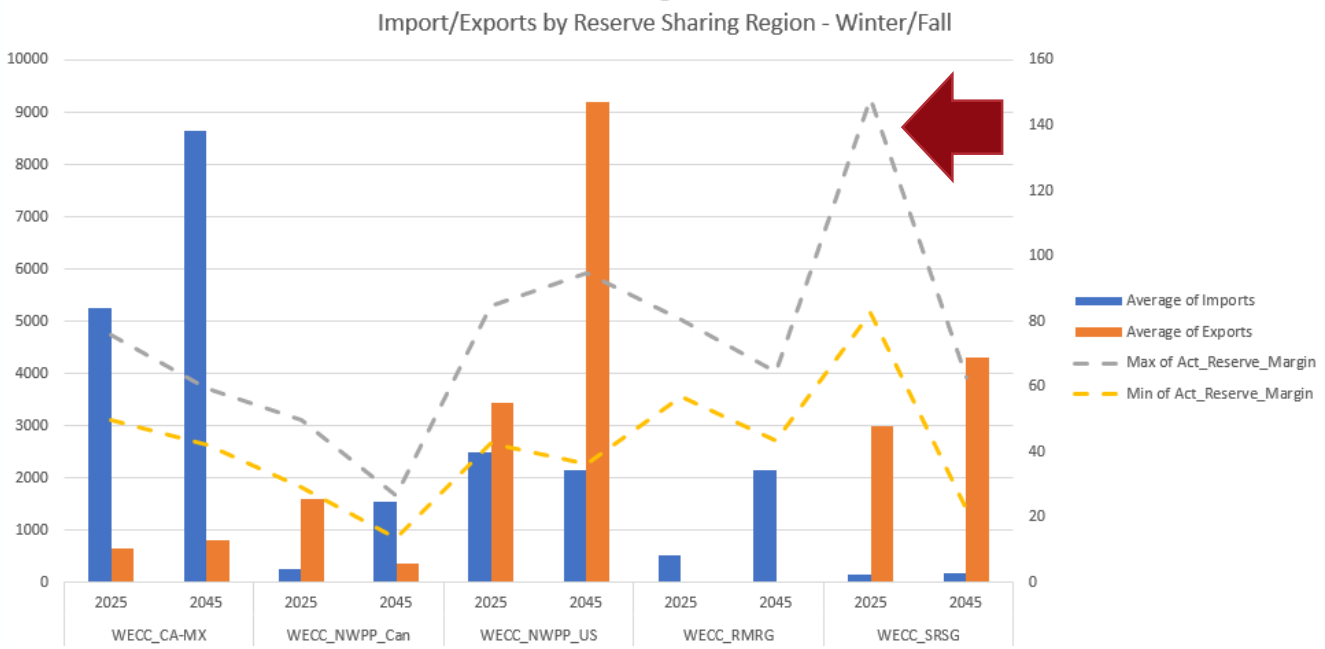




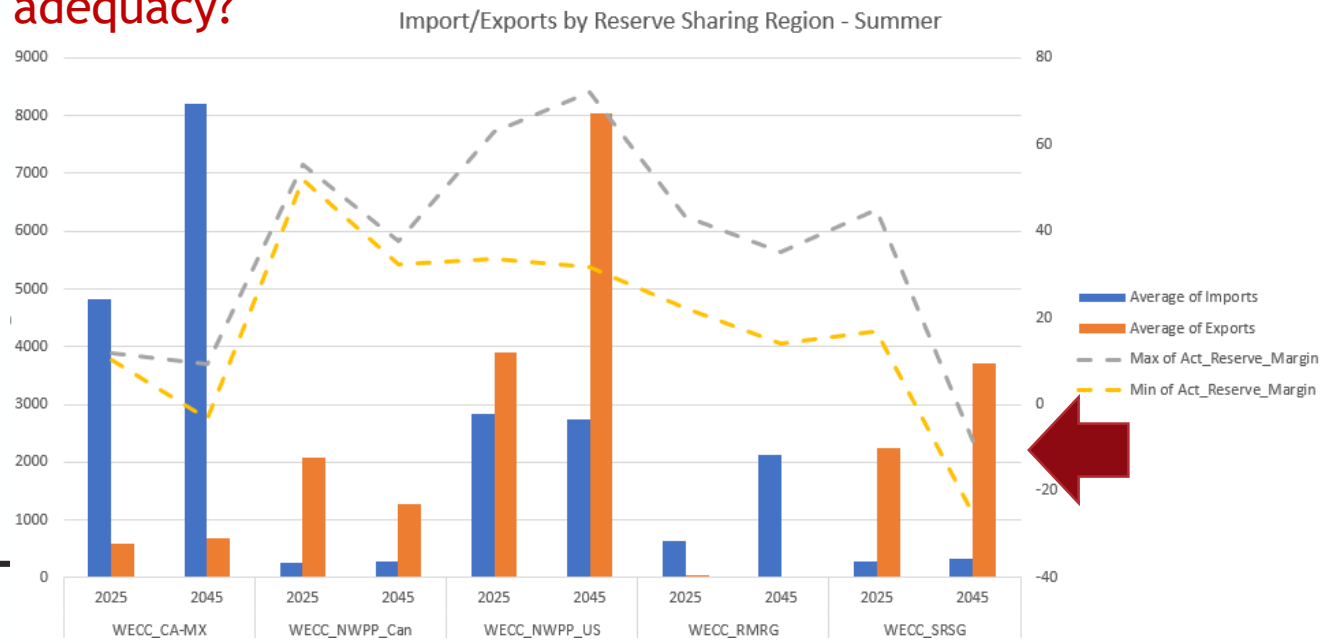
NW hydro contributes less and the NW demand is higher during times when the rest of the WECC is peaking leading to more builds in the NW.

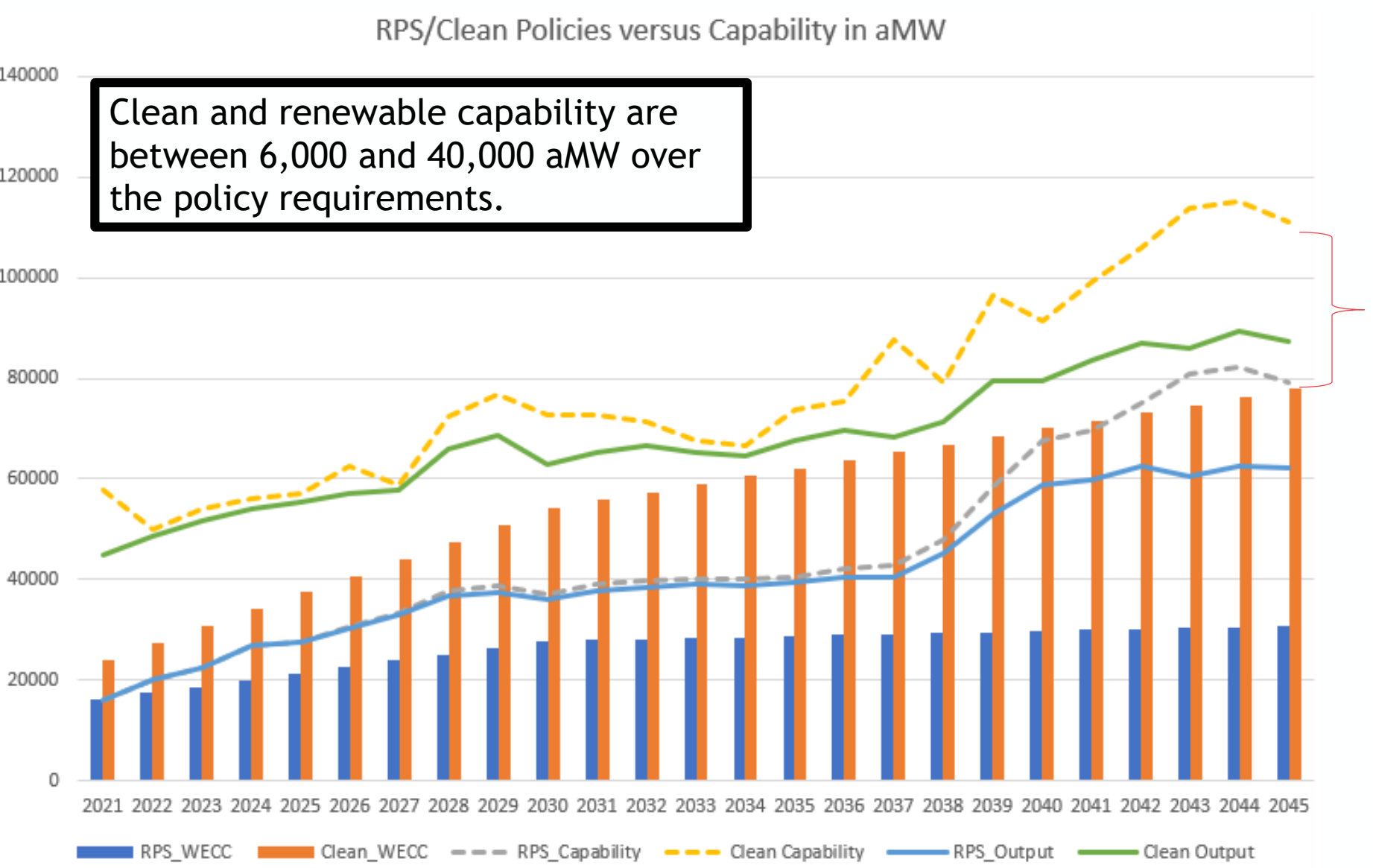
Imports and Exports

- California increases its reliance on other regions.
- NWPP (Pacific NW, Utah and Nevada) send a lot of power to CA.
- Southwest Reserve Sharing Group sends the rest.
- Seasonal reserve margins in all pools degrade over time.
- Summer reserve margins go negative in California and Desert SW.

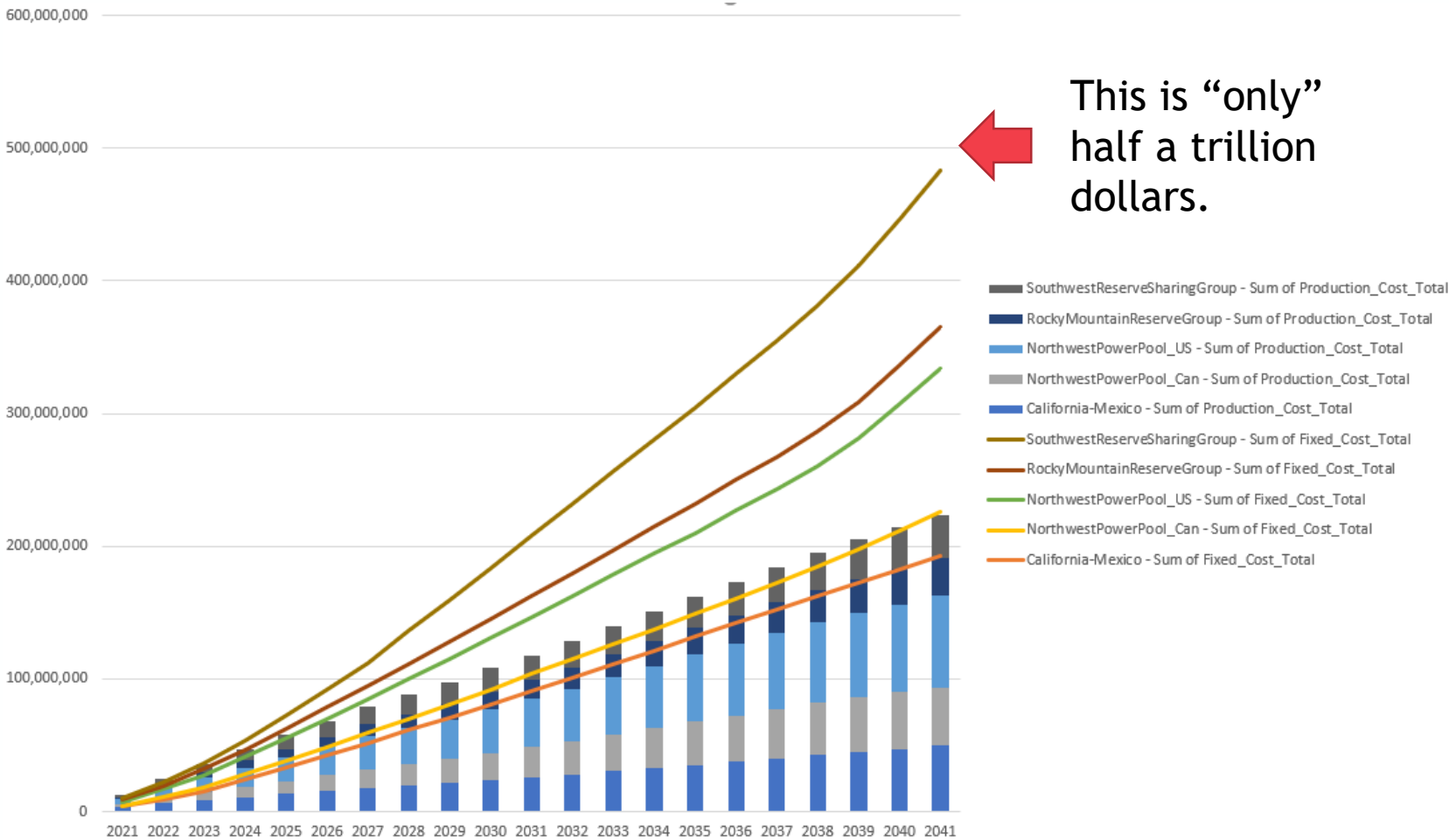


When striving for annual clean/RPS targets, what drives adequacy?




RPS/Clean Policies versus Capability in aMW
Clean and renewable capability are between 6,000 and 40,000 aMW over the policy requirements.
140000
120000
100000
80000
60000
40000
20000
0
2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045
RPS_WECC
Clean_WECC
RPS_Capability
Clean Capability
RPS_Output
Clean Output

Fixed Costs Over Two Times Production Costs for this Buildout



This is “only” half a trillion dollars.

Attempting to Itemize Build Reasons

- ***Economics* (energy only) –**
  - 6,600 MW of gas plants (mostly plants in Alberta replacing coal retirements) and 1,600 MW of solar (mostly backfilling for retirements)
- ***Economics* (energy, capacity) –**
  - 1,300 MW of solar, 1,200 MW of solar plus storage and 22,400 MW of gas (mostly in NWPP and Baja CA).
- **Clean/RPS Policies**
  - 19,600 MW of solar, 56,000 MW of solar plus storage and 112,400 of wind (~90 to 100 aGW of renewable energy) qualify.
  - Using just accounting over 12 aGW too much, but due to timing some of the output must be curtailed.
- **Planning Reserve Margin, Load Growth and Ancillary Services**
  - Approximately 6 GW of Battery, almost 180 GW of renewables(mostly wind and solar with storage) and 5.6 GW of gas built to maintain peak reserve margins
  - Additional 16 GW of Battery built for flexibility capacity

Buildout Summary

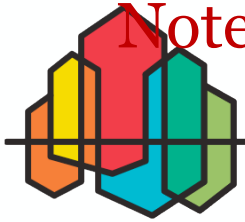
- Buildout seems about as reasonable as we will get it without slowing the Plan down considerably.
- Major takeaways:
  1. Gas builds are backfilling for thermal retirements AND displacing less efficient gas plants.
     - But is this much build possible?
  2. Renewables are keeping up with load growth, reserve margins and policies.
  3. California choices in how they meet policy will really effect WECC adequacy and prices in the future.
  4. Much higher fixed cost than variable costs.
  5. Enough builds to send a reasonable price signal to the RPM.

Wholesale Power Price Forecast – Sample Daily Shapes

Preliminary Price Discussion

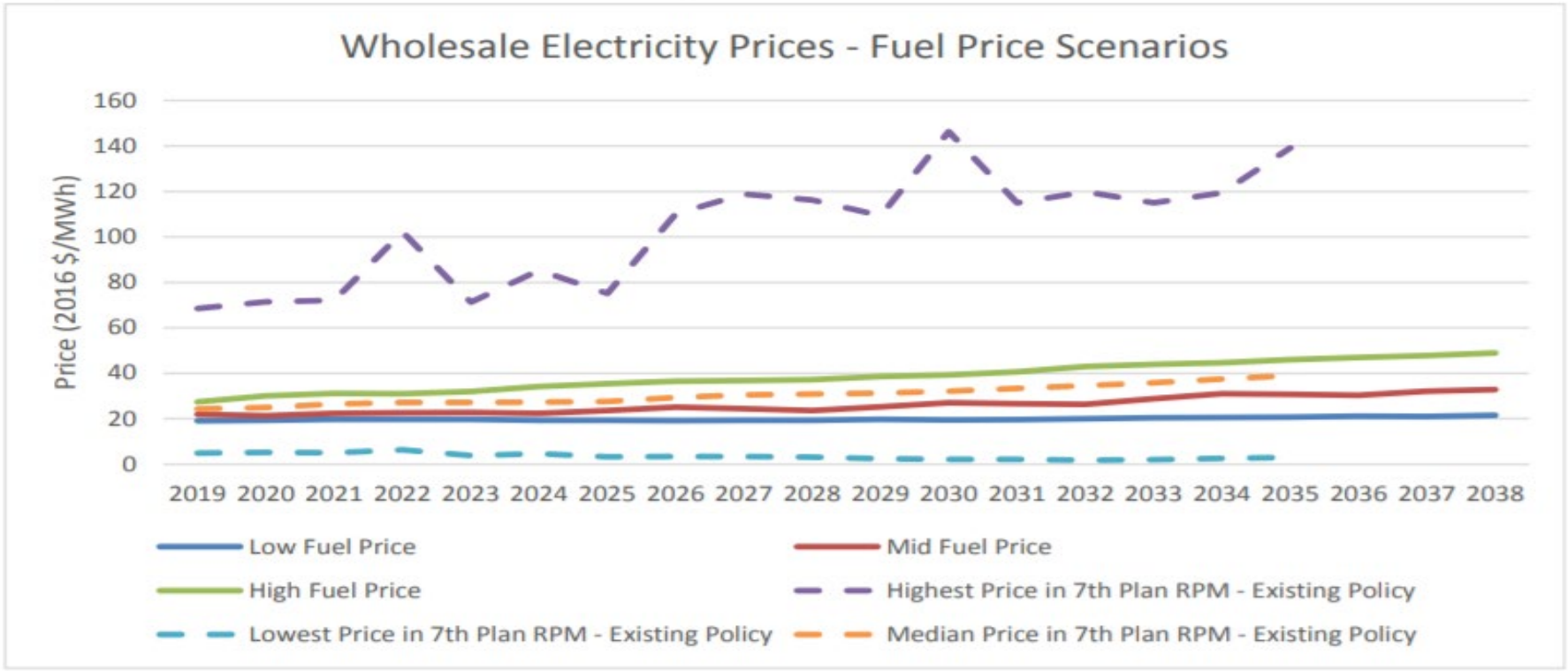
- Previous study pricing for context
- Price forecast is a starting point for developing RPM price futures
- Do not have to be perfect, but need a buildout in AURORA that is resource sufficient and complies with policies to get realistic pricing.

Note: All prices are in 2016 dollars per MWh.

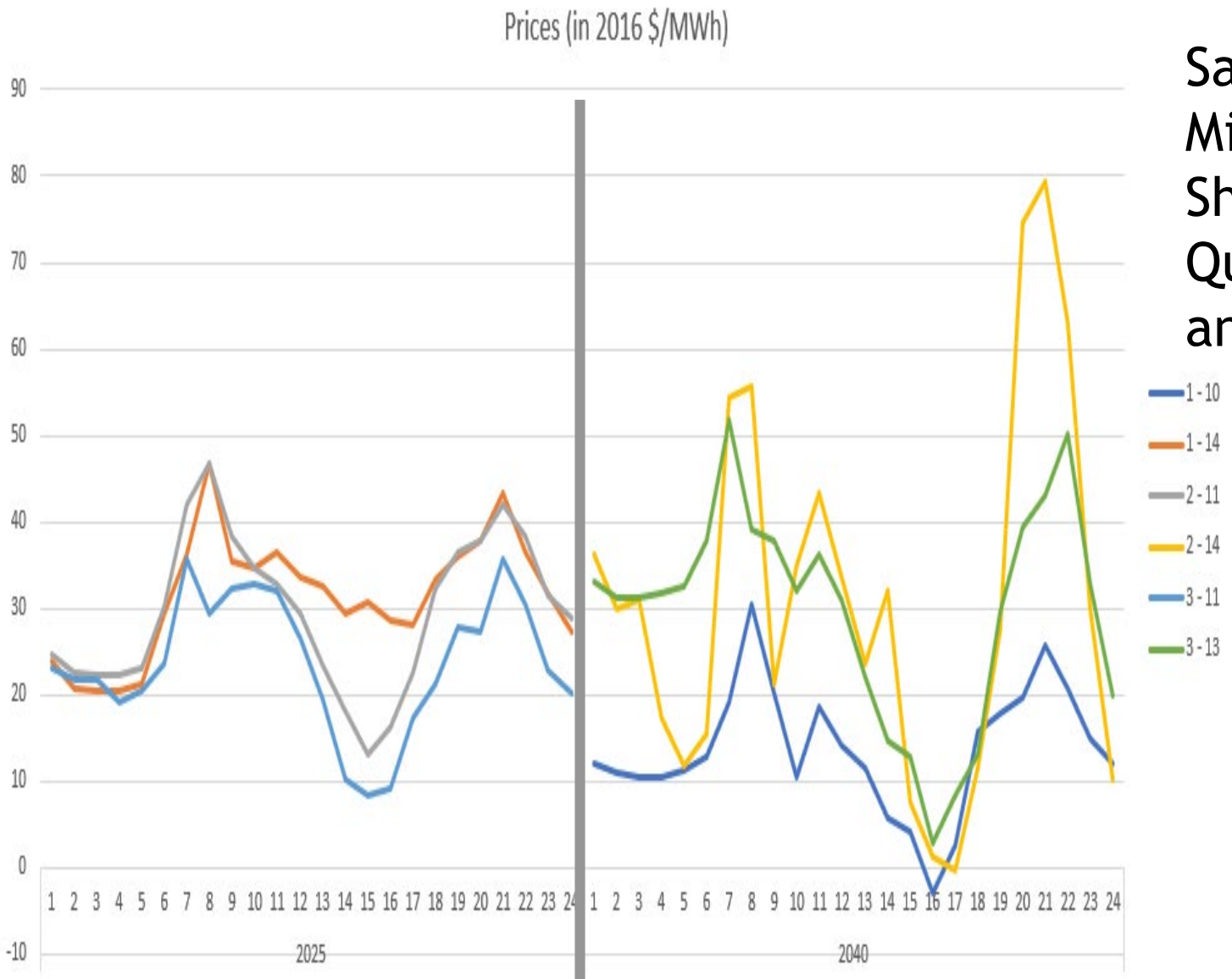


Price Ranges in Midterm and Seventh Power Plan

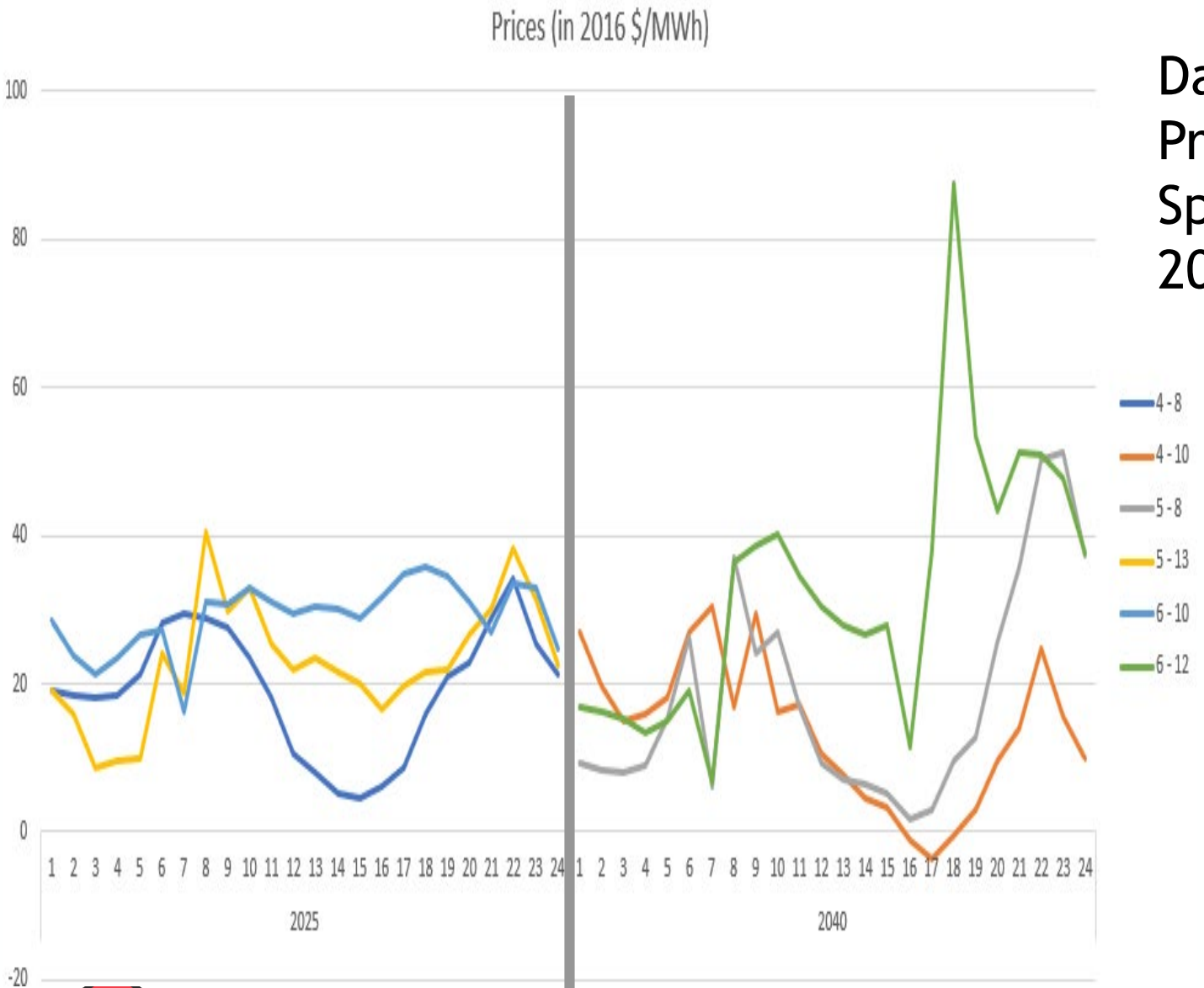
Figure 3 - 7: Annual Wholesale Electricity Prices Under Different Natural Gas Price Forecasts



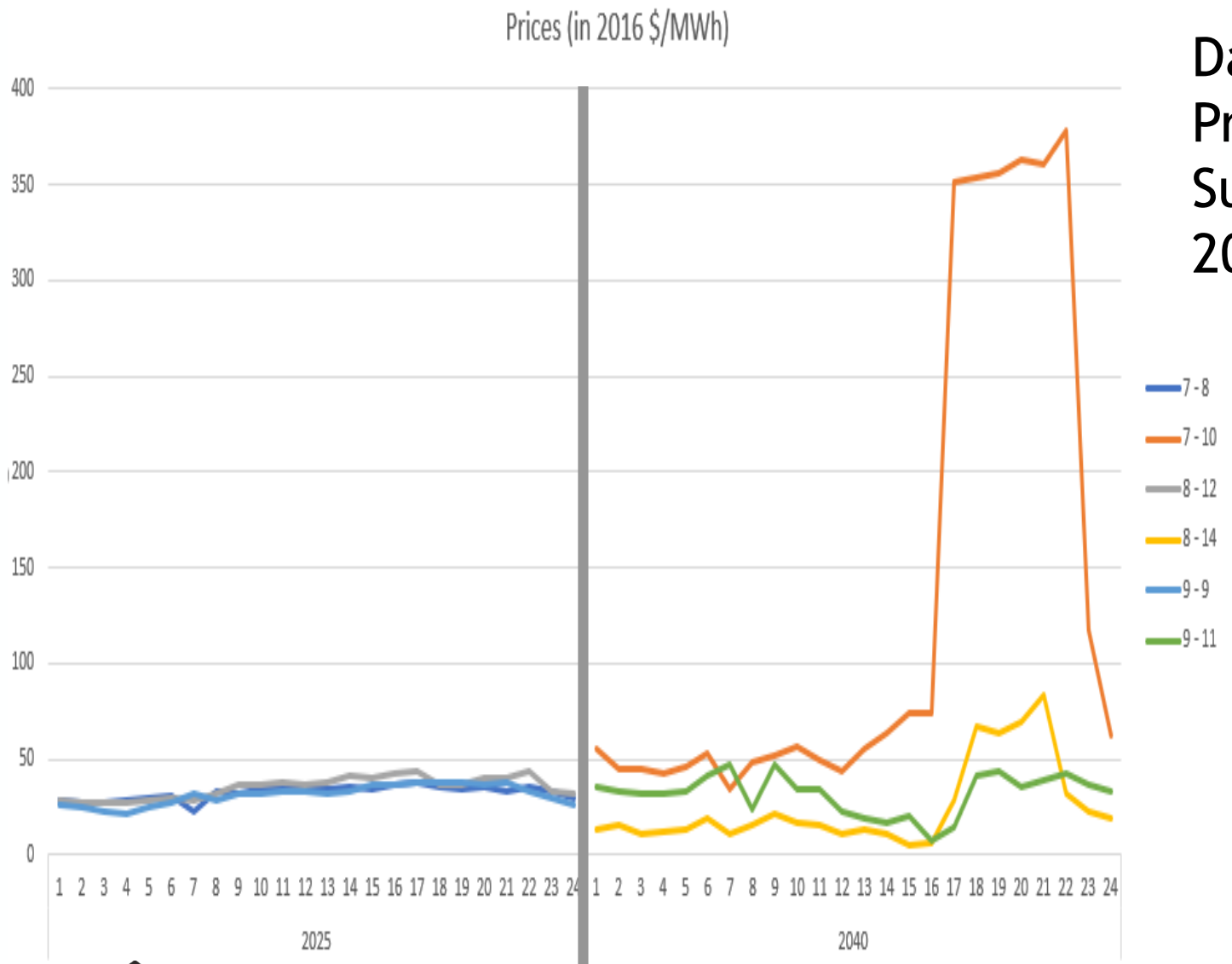
Sample Daily Mid-C Price Shape - Winter Quarter 2025 and 2040



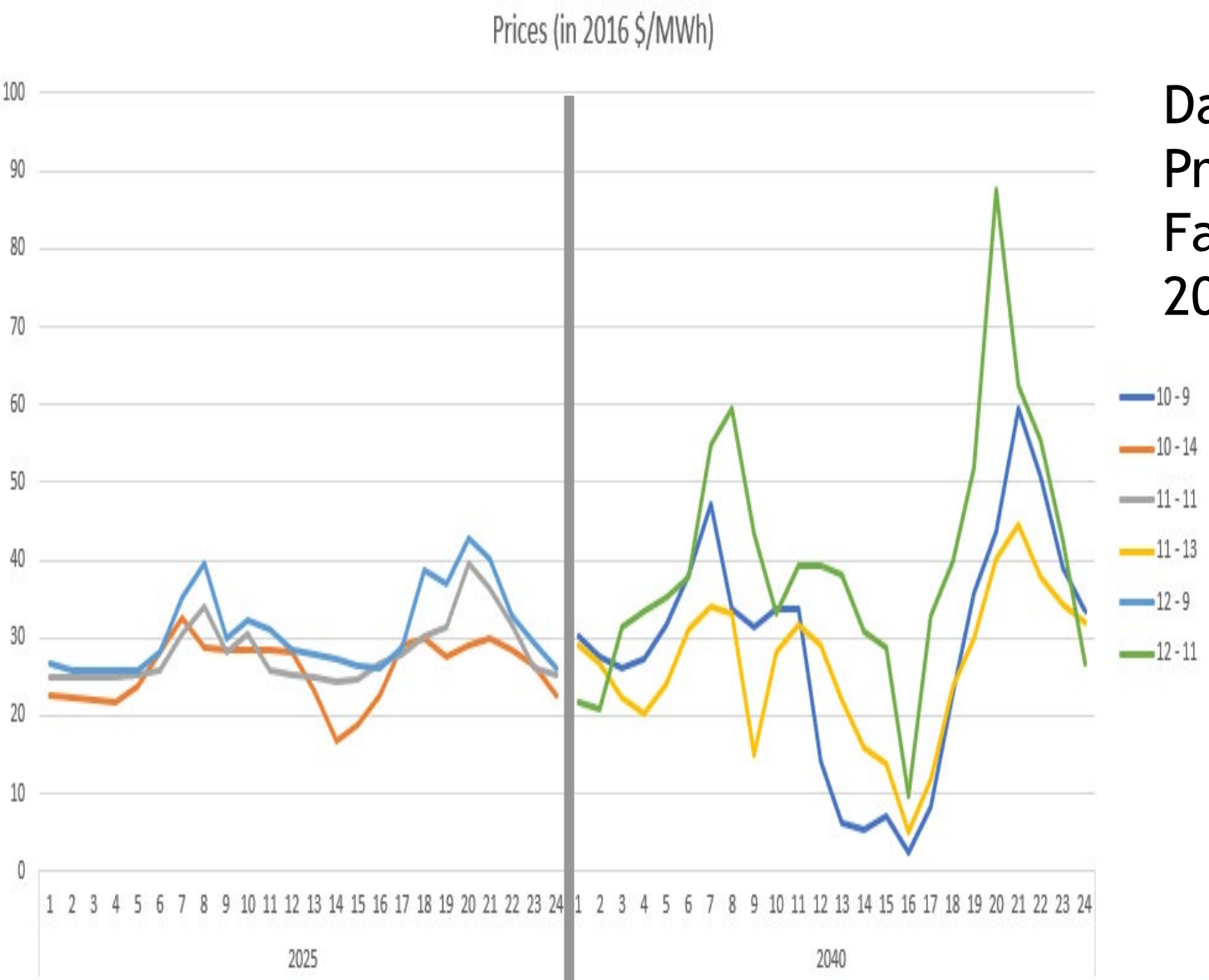
Daily Mid-C Price Shape - Spring Quarter 2025 and 2040



Daily Mid-C Price Shape - Summer Quarter 2025 and 2040



Daily Mid-C Price Shape - Fall Quarter 2025 and 2040



Overall Conclusions

1. Initial stakeholder response to current buildout seems positive.
2. With a vast renewable buildout Mid-C power prices will likely decrease over time, become negative on a seasonal basis by late 2030's and be very volatile intra-day.
3. Emissions rate methodology revision approved by SAAC.

John Ollis

jollis@nwcouncil.org