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

November 10, 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 5**

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 November 4th System Analysis Advisory Committee. Per previous discussions with the Power Committee, Staff has attempted 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.

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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: Some of the slides for this presentation are pending on ongoing studies and recommendations from the November 4th, 2020 System Analysis Advisory Committee meeting.

Supporting presentation

Previous presentations on this forecast:

Update on Long Term Buildout in November 4 SAAC

Update on Long Term Buildout in October 22 SAAC

Update on Long Term Buildout in October 13 Power Committee

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 Wholesale Power Price Forecast and Avoided Emissions Rate Study

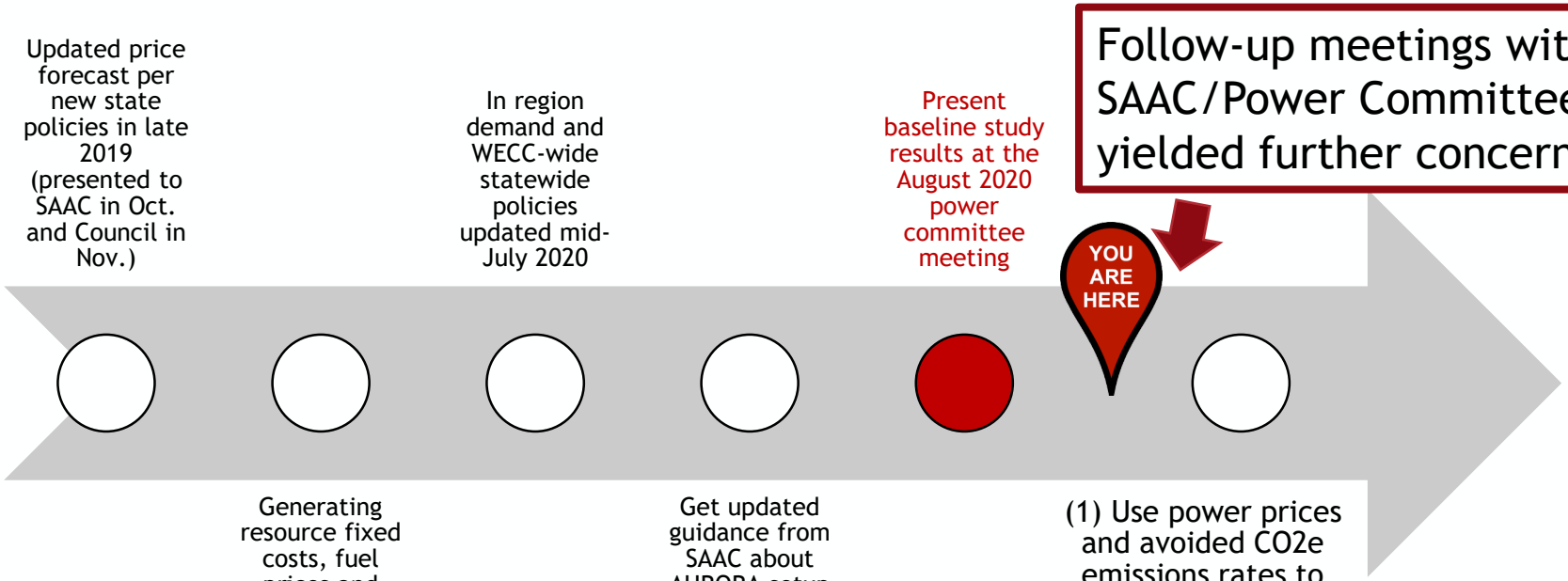
Power Committee

11/17/2020

John Ollis

THE 2021
NORTHWEST
POWER PLAN
FOR A SECURE & AFFORDABLE
ENERGY FUTURE

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



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

AURORA Buildout

YOU ARE HERE

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

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***

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

AURORA Buildout

YOU ARE HERE

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

AURORA Check

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.

RPM

GENESYS Check

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

Revising our Instinct for a “Reasonable” Amount of Builds

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/Reserves Capability/Need Timing**

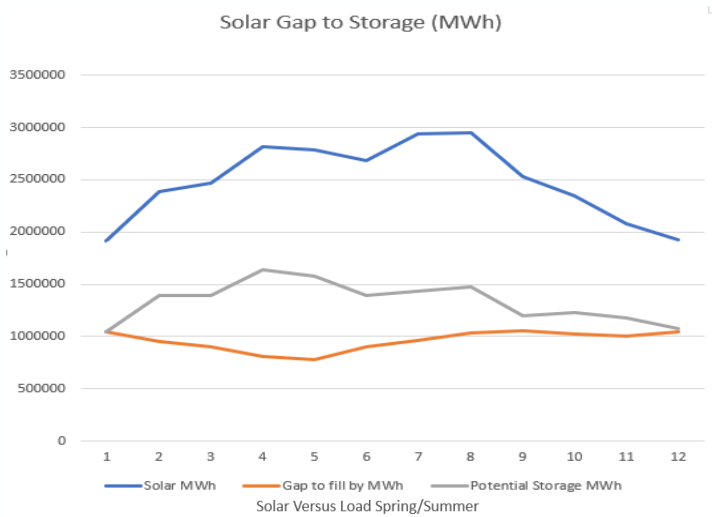
Recent Planning Shows More Builds

- 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)

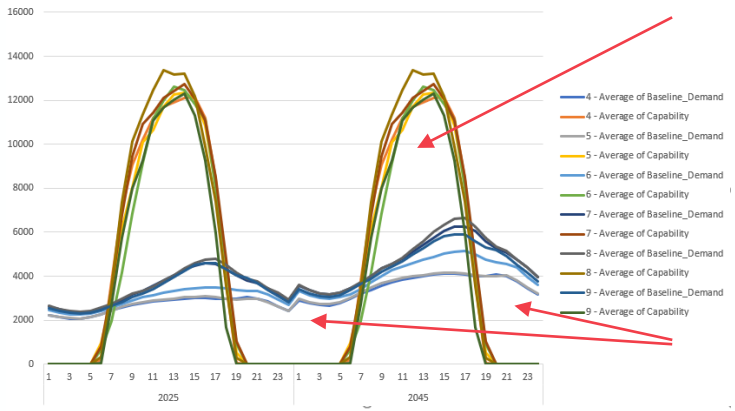
Review Case Study: LADWP

How much can we really trust our ‘back of the envelope’ calculations or gut?

Why Hoping for a Build Less Than 300 MW is Probably Optimistic.

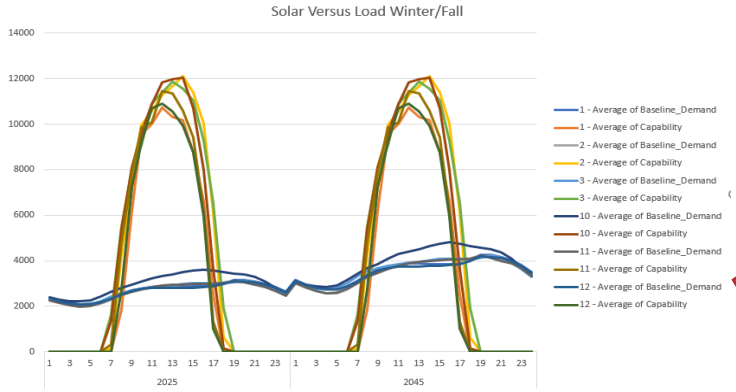


Seasonal/ Daily Needs Versus Capability Creates Solar Oversupply



Charge storage with excess solar

Discharge storage where storage does not cover load



24 to 26 GW nameplate to cover a peak of 6641 MW

Example:

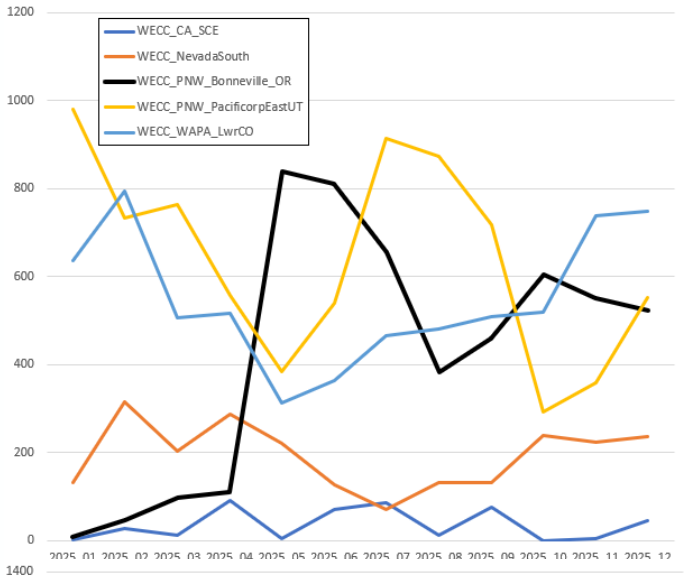
Using LADWP load and solar without other resources or market help

	Storage Volume Driven	Capacity Driven	No Storage Needed
	4 Hour Battery	8 hour Pumped Storage	CCCT
Other			6641
Storage	8801	5433	
Nameplate Solar	17428	18489	
Cost per year	$ 2.1 billion	$2 billion	$0.5 billion
Ratio of Solar to Storage	1.98	3.4	
Solar Curtailed	53%	51%	
Gas Price $/MMBtu			$4

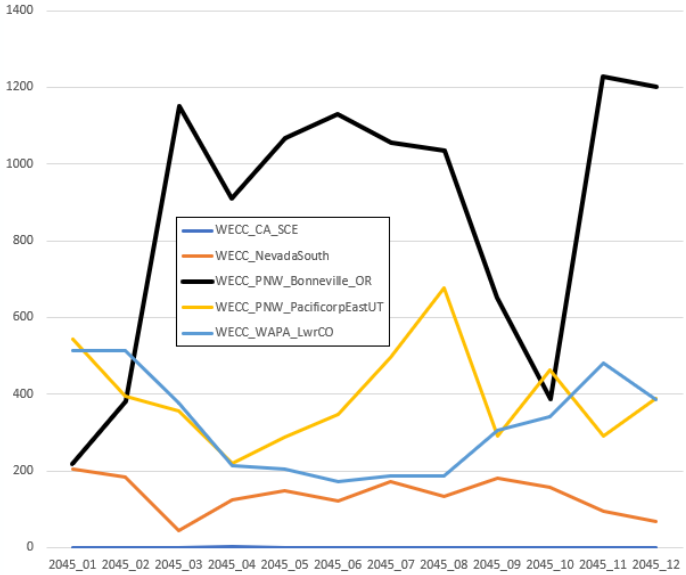
So Diversity Helps, Is It Available?

Here market reliance saves money, but where is it coming from? Does another region build?

	Storage Volume Driven	Capacity Driven	No Storage Needed	Market Help
	4 Hour Battery	8 hour Pumped Storage	CCCT	1135 aMW Market
Other			6641	6641
Storage	8801	5433		5554
Nameplate Solar	17428	18489		11063
Cost per year	$ 2.1 billion	$2 billion	$0.5 billion	$1.4 billion
Ratio of Solar to Storage	2.0	3.4		2.0
Solar Curtailed	53%	51%		46%
Gas Price $/MMBtu			$4	



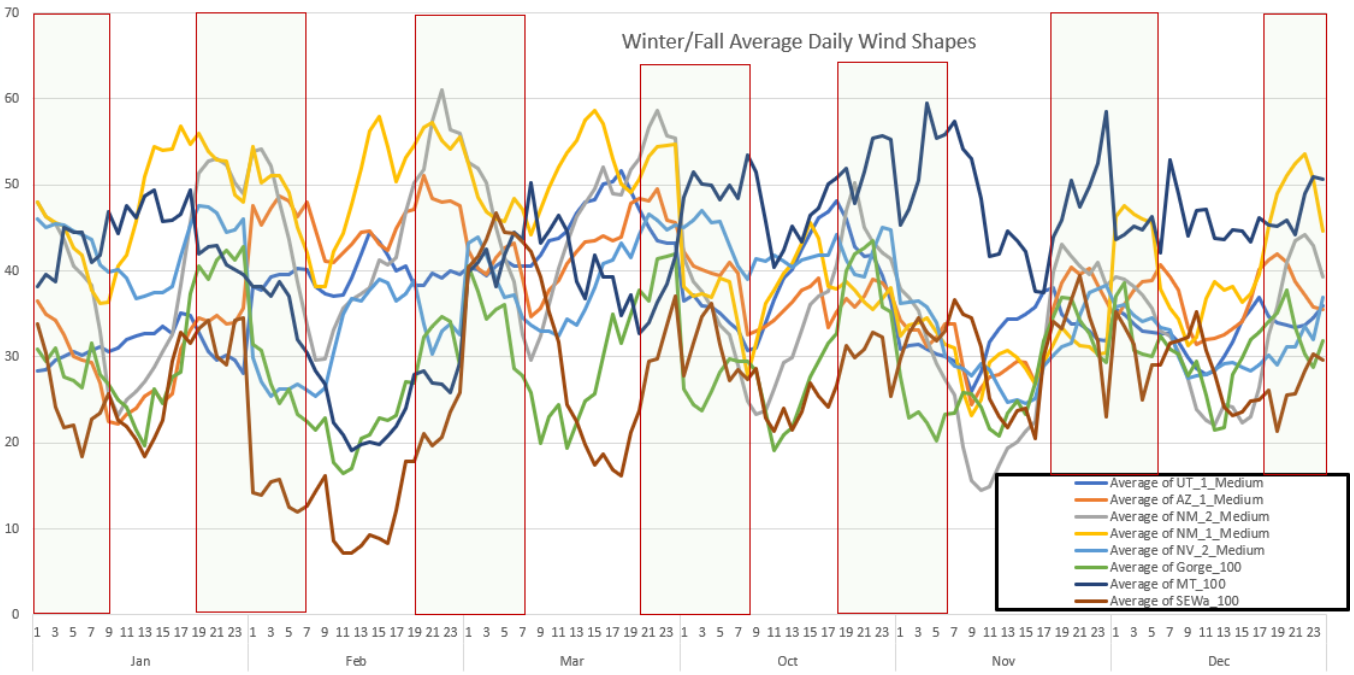
In 2025, diverse market sources NW, Mountain West, SW…

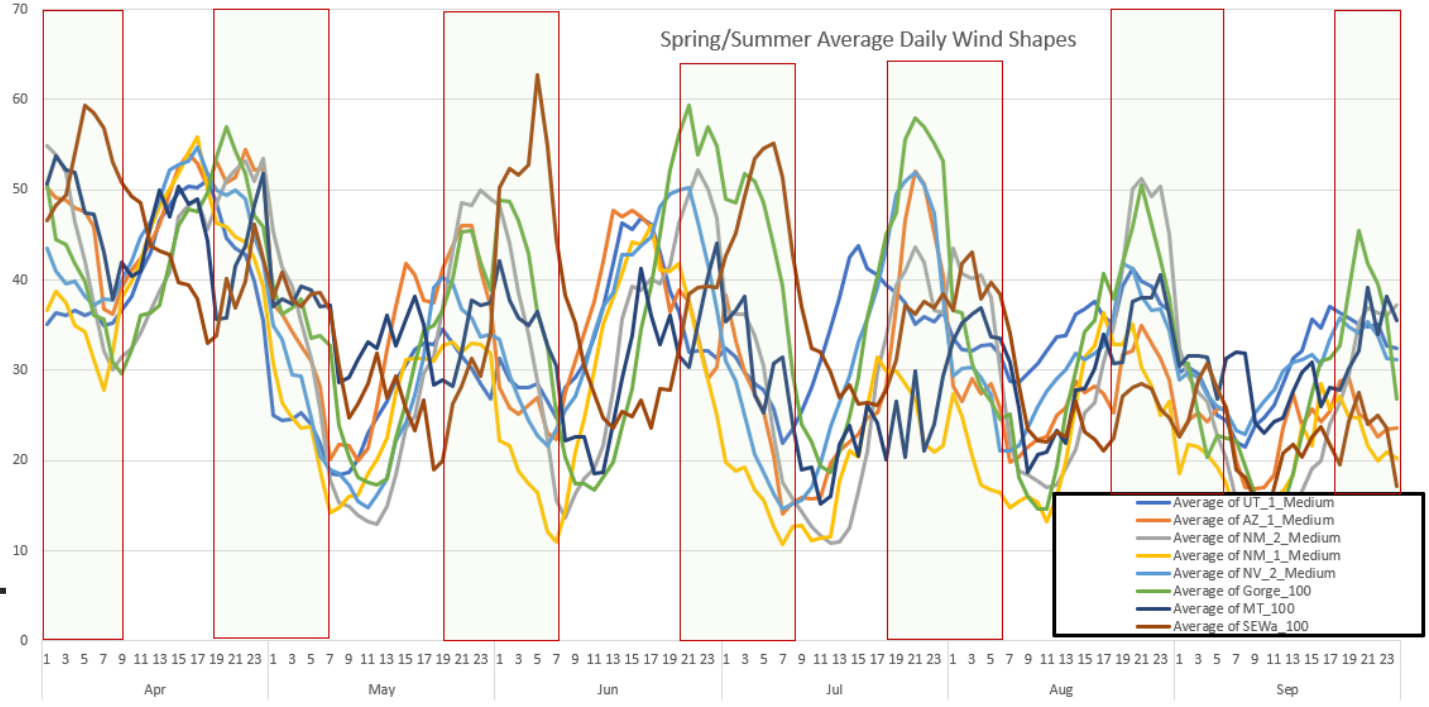


In 2045, more reliance on NW…

Wind into LA in AURORA

- Seems like not all the transmission import capability is utilized.
- Why not reduce solar/storage strategy more by accessing nearby wind resources?
  - CA and SW maxed out on wind per current transmission
  - NW wind would have to displace NW hydro, especially in spring
  - Wyoming and New Mexico wind needs transmission expansion





LA Review: Sun, More Sun, Storage and Curtailment midday

- Unless there is more transmission in the rest of the WECC,
- And wind resources are sufficiently high enough in capacity factor to the storage and more solar,
- We should likely not be surprised by the following:

1. Upwards of **50% curtailment of solar** at the end of the study in places with a large solar and solar/battery buildout
2. The battery build will be at least **twice** the need and the solar will be **four** times the need.
3. Fixed cost investment will probably be order of magnitude 6 times more than just building baseload gas.

- Effects of demand response, BTM solar/storage and effects on transmission and distribution.

Note that LADWP has done some comprehensive work on this topic at the following link: LA 100

New “Back of Envelope” look

Data Updates, Load Diversity and Renewable Curtailments

Resource Planning 201:

How Much Do We Need to Build? The fancier version…

- After the CA and AZ demand forecast adjustments…

1. Since there is uncertainty around demand and supply, we add a reserve margin.
   - Reserve Margins in the WECC are between 11% and 17% (*15.5%* weighted average by peak load)
2. Coincident load and peak load has traditionally increased over time to some extent, but not as much as non-coincident load.
   - Coincident peak load in the WECC forecasted to go from 143 GW in 2021 to 177 GW in 2045 (approximately *34 GW* of peak load growth)
   - Non-coincident peak load in the WECC forecasted to go from 177 GW in 2021 to 229 GW in 2045 (approximately *52 GW* of peak load growth)
3. Assuming everyone has planned to reserve margins, we need at least *34 GW * (1+.155) = 39 GW of peak load*

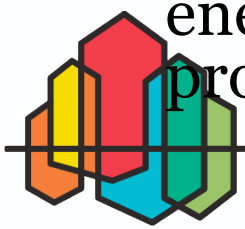
Resource Planning 201:
What to Expect from a Buildout?

- How do we balance demand with supply?
- Average demand increases from 100 aGW to 127 aGW

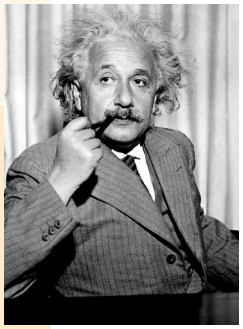
1. Existing resources are periodically retired and need to be replaced
   - Approximately *31 GW (after approx. 10% scheduled and unscheduled outages 28 aGW)* of retirements between 2021 and 2045, and 9 GW from 2018 to 2020)
2. New resource options do not replace resource peak MW (*39+31 = 70 GW need*) and average MW (*27+28 = 53 aGW need*) on a 1-1 basis.

Power Planning 201:
The Planner's Nightmare

- Mandates change what can be built and where
  - Between 2021 and 2045, an additional *15 aGW* qualifying resources to meet RPS policies, respectively.
  - In 2021, the WECC starts out with *42-ish aGW* of qualifying clean resources and is trying to meet *105 aGW* by the end of the study to meet clean policies. (So *63 aGW* more for those who are still counting..)
  - More issues from losses, forced renewable curtailments and other transmission constraints depending on siting
  - More diversity in resource pools helps, even with the transmission considerations, so smaller reserve pools may increase overall need.
- Since the clean requirement need is higher than the energy need (*63 aGW > 53 aGW*), let's just use *63 aGW* as a proxy for our energy need calculations



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	70 /.25=280 GW	70 /.33=210 GW	70 /.1=700 GW	70 /.25=280 GW
Clean/RPS requirements	63/.2=315 GW	63/.25=252 GW	63/.33=189 GW	



Higher CA load forecast and decrease in AZ forecast changes the calculations…

Seems like between 252 and 315 GW buildout should not be too surprising…

Adding Some Nuance Our Back of the Envelope Considerations

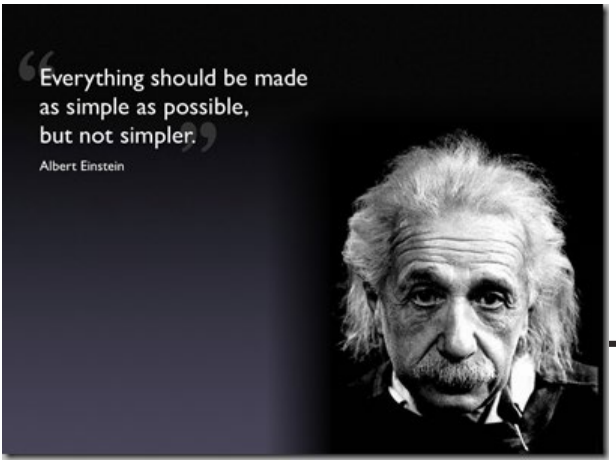
WECC is adequate to a 15% PRM under *average hydro* conditions, but we try to plan to considering difficult hydro conditions.

- Assumption that WECC was adequate to a 15% PRM is short by approximately 10 GW (based on capability per low hydro conditions and transmission losses)
- Peak +PRM need before was 70 GW, now goes up by 10 GW for current capability shortage gets us to approximately 80 GW by the end of the study

Solar buildouts at the sizes we are talking about usually result in at least 50% curtailment by the end of the study

- With solar and solar plus battery strategy heavy builds we have been seeing significant curtailment even when more storage is associated.

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	80 /.25=320 GW	80 /.33=240 GW	80 /.1=800 GW	80 /.25=320 GW
Clean/RPS requirements	63/.2/.5=630 GW	63/.25/.5= 504 GW	63/.33=189 GW	

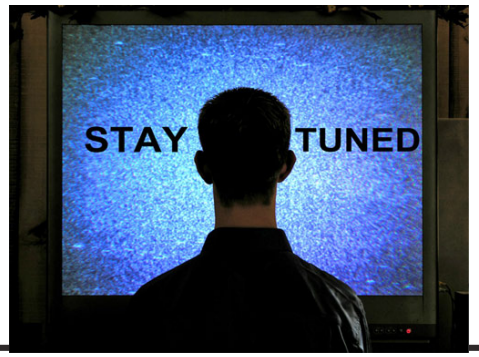


If only it could be simpler, now we are between 504 GW and 630 GW nameplate buildout …

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

- Knowing that there are transmission limitations but also resource diversity, per the LADWP example, AURORA should still be able to reduce the renewable curtailment by at least 5 to 10%.
- If renewable curtailment can be reduced by 10% our range would then be *420 GW to 525 GW* .

Good news! We have multiple options from 429 GW to 437 GW.



Review Recent Findings and Methodology Changes

Updated buildouts, methodology improvements

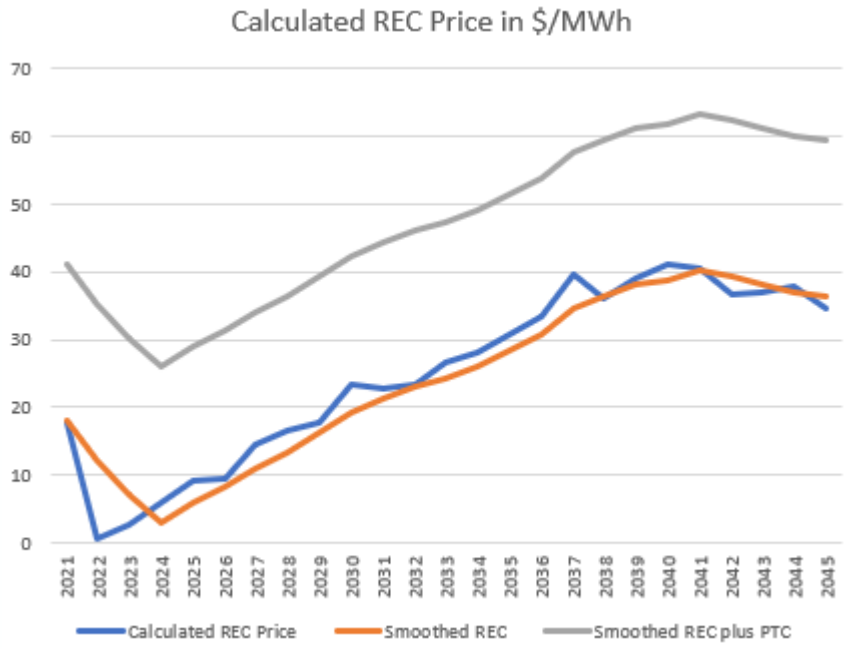
Tried 3 Changes since 10/22: 2 out of 3 Methods Improved Result

- Knowing the SAAC was tentatively OK with the build from last time as a backstop. Staff attempted three improvements of which two were fairly successful.

1. Calculated the REC cost using shadow prices and an adequate system in AURORA.
   - REC cost at 8 $/MWh was still producing many curtailments.
2. Assigned CA the firm imports ramping up per draft SB100 analysis.
   - Solved the PRM and price disconnect.
3. Attempted a simulation with increased transmission.
   - This did not reduce overall buildout as much as hypothesized.

Calculation of REC Price from AURORA

1. Ensure an adequate system.
   - Setup AURORA with unlimited simple cycle plants with no fixed costs.
2. Do a long-term buildout with no REC pricing.
3. See shadow price (in $/MWh) of meeting the RPS constraint in the model.
4. This should be better tuned to ensure enough energy is produced to meet long-term RPS/Clean constraints.



This may be useful/necessary for RPM work as well!

WECC Buildout from Last Meeting (10/21/2020)

Cumulative Buildout in Nameplate MWs by Year

DRAFT

Limited Gas per Regulatory and Policy Climate (October 21,2020)							
Year	Solar	Natural Gas	Wind	Solar with Battery	Offshore Wind	4 Hour Battery	Pumped Storage
2025	54,409	11,521	11,460	64,000	-	5,952	-
2030	112,727	16,971	16,927	130,201	10,000	5,952	2,600
2035	132,107	19,443	20,200	189,735	10,000	5,952	4,900
2040	152,482	21,012	20,200	195,634	10,000	5,952	7,050
2045	158,855	21,012	23,935	201,550	10,000	10,701	11,140

This is our buildout shown in the 10/22/2020 SAAC.

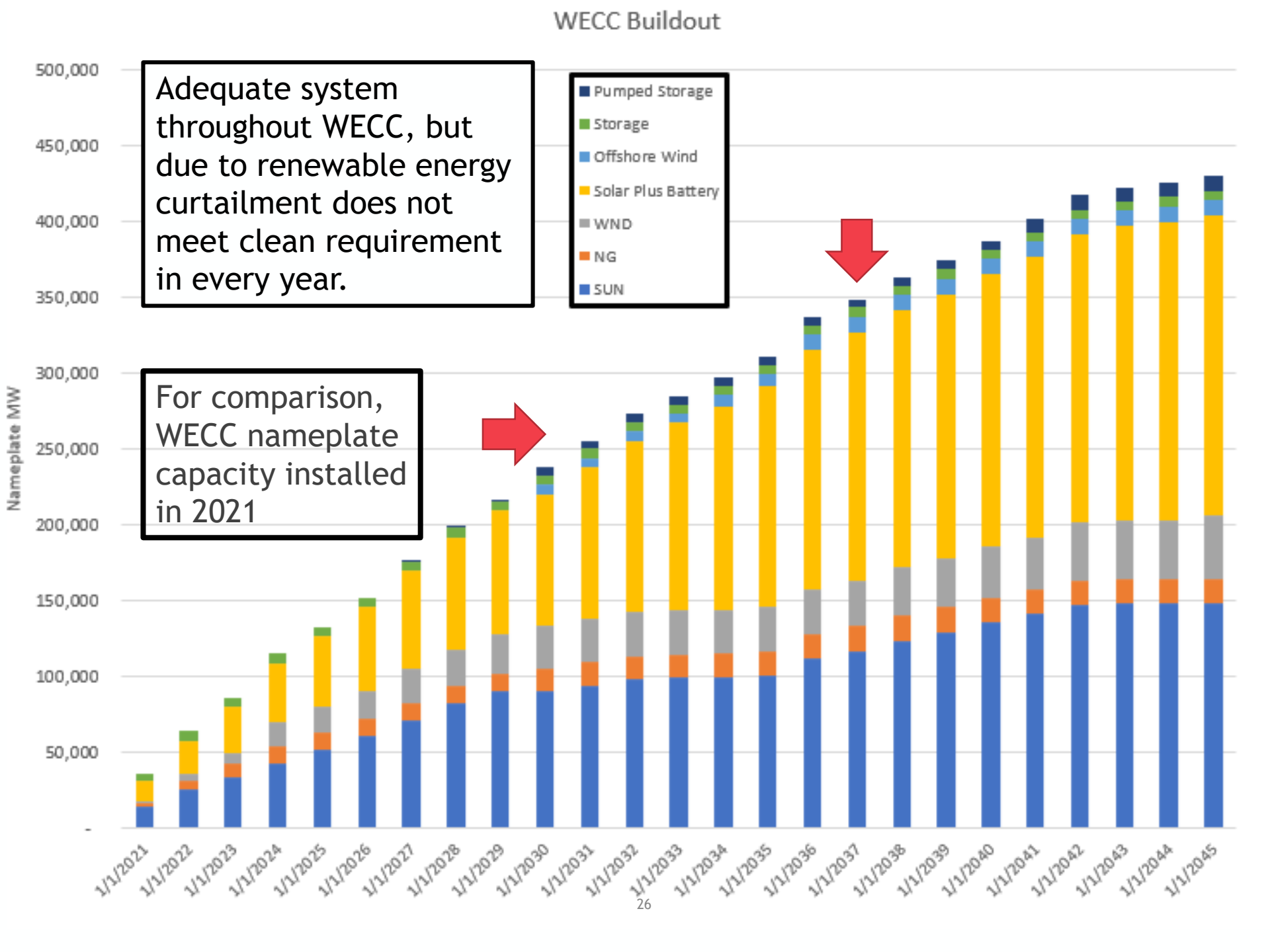
Most Recent WECC Buildout (10/28/2020)

Cumulative Buildout in Nameplate MWs by Year

DRAFT

Limited Gas per Regulatory and Policy Climate (October 28,2020)							
Year	Solar	Natural Gas	Wind	Solar with Battery	Offshore Wind	4 Hour Battery	Pumped Storage
2025	51,538	11,351	16,775	46,600	-	6,004	-
2030	89,838	14,873	28,712	86,600	6,463	6,004	4,900
2035	100,357	16,058	29,401	145,500	7,663	6,004	5,650
2040	135,054	16,532	33,657	179,800	10,000	6,004	6,050
2045	147,554	16,532	41,481	198,000	10,000	6,055	9,690

Solar and gas builds go down and wind builds go up. Overall build size is 8 GW less. Build is deferred to later in study.


WECC Buildout
Adequate system throughout WECC, but due to renewable energy curtailment does not meet clean requirement in every year.
For comparison, WECC nameplate capacity installed in 2021
Pumped Storage
Storage
Offshore Wind
Solar Plus Battery
WND
NG
SUN
Nameplate MW
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
-
1/1/2021
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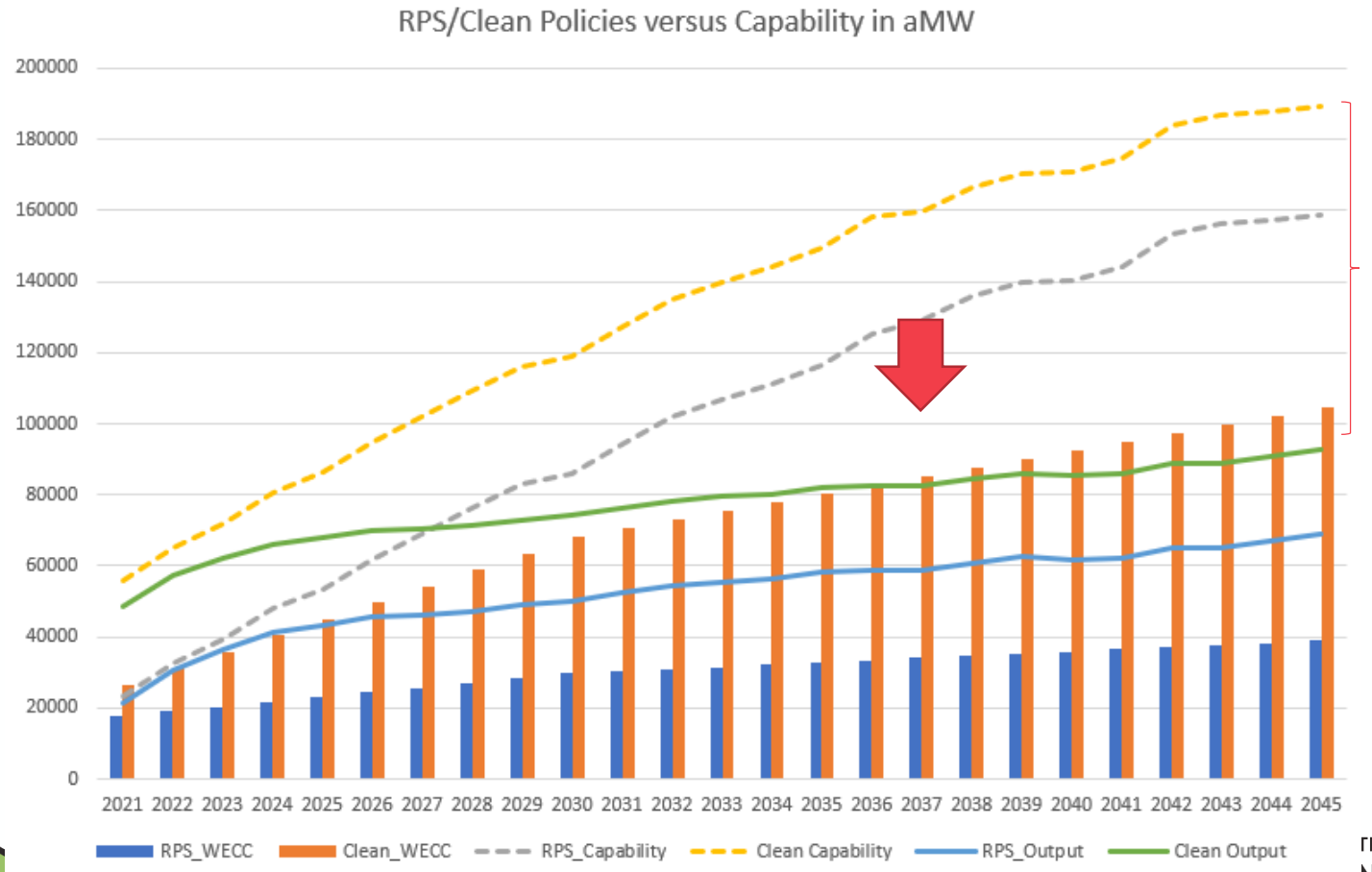
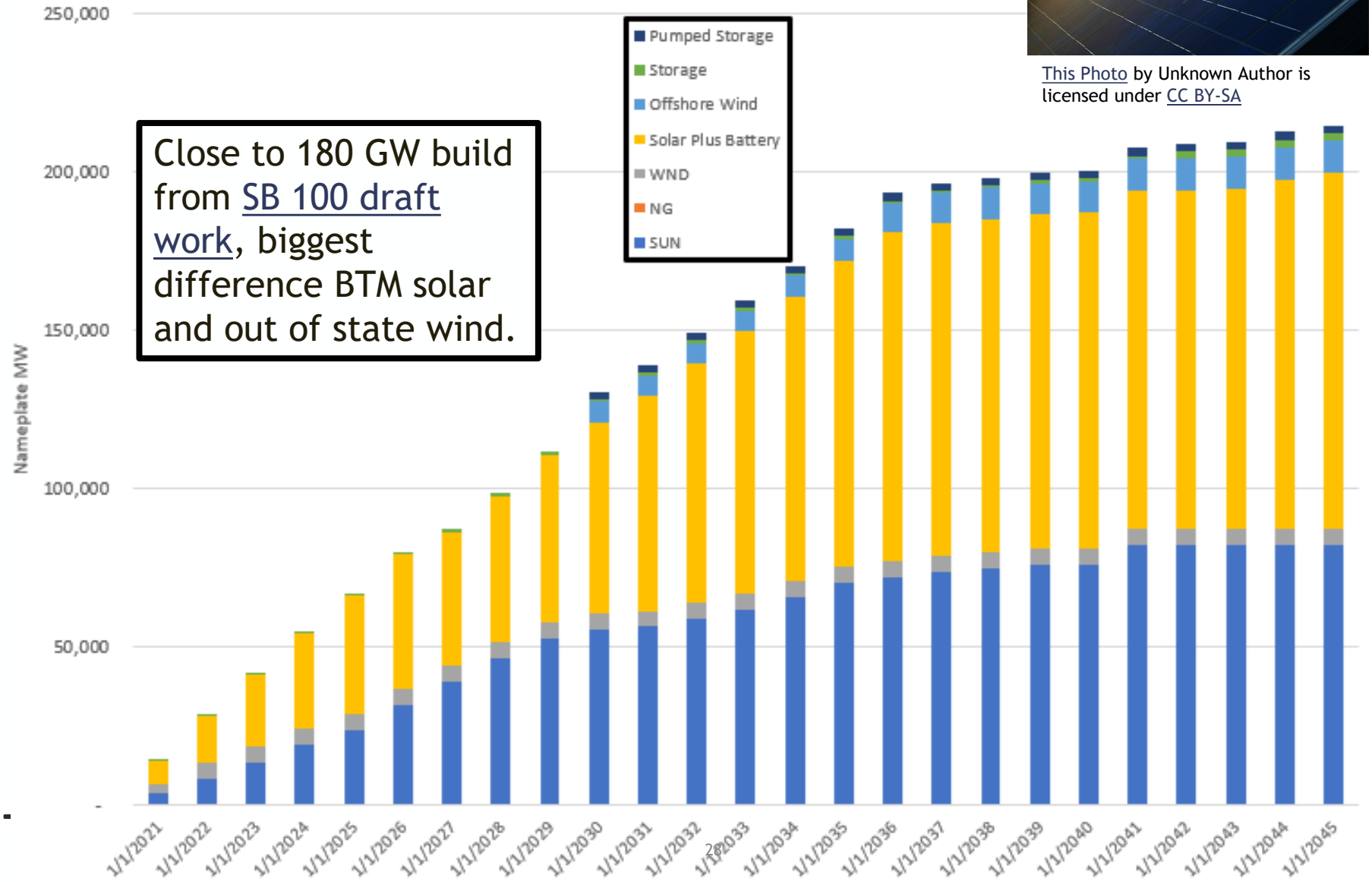
Meeting Clean Policy Requirements Until Late 2030's With Less Overbuilds



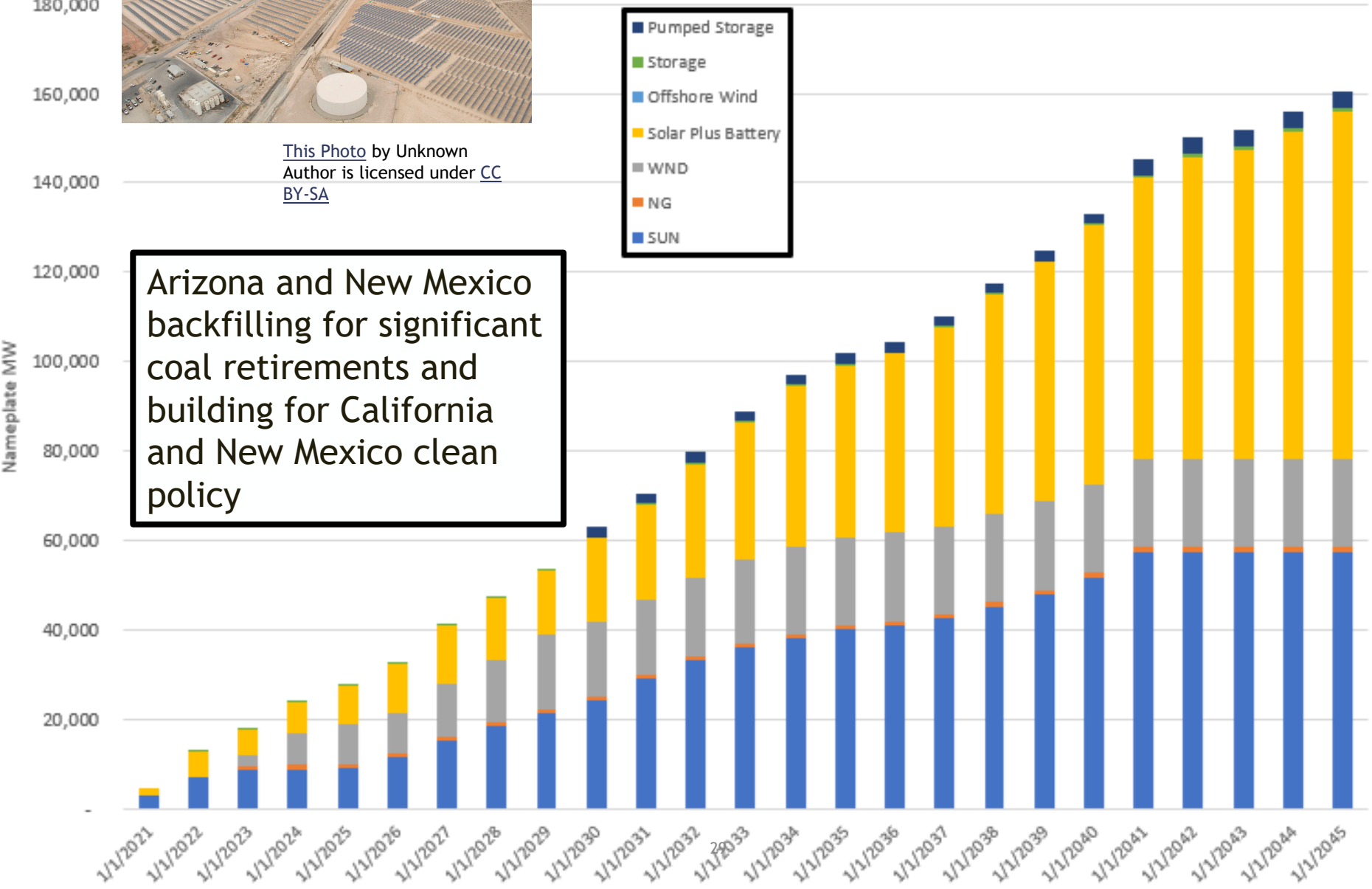
This is smaller than in a less diverse portfolio

CA Buildout



Close to 180 GW build from SB 100 draft work, biggest difference BTM solar and out of state wind.

Desert SW Buildout

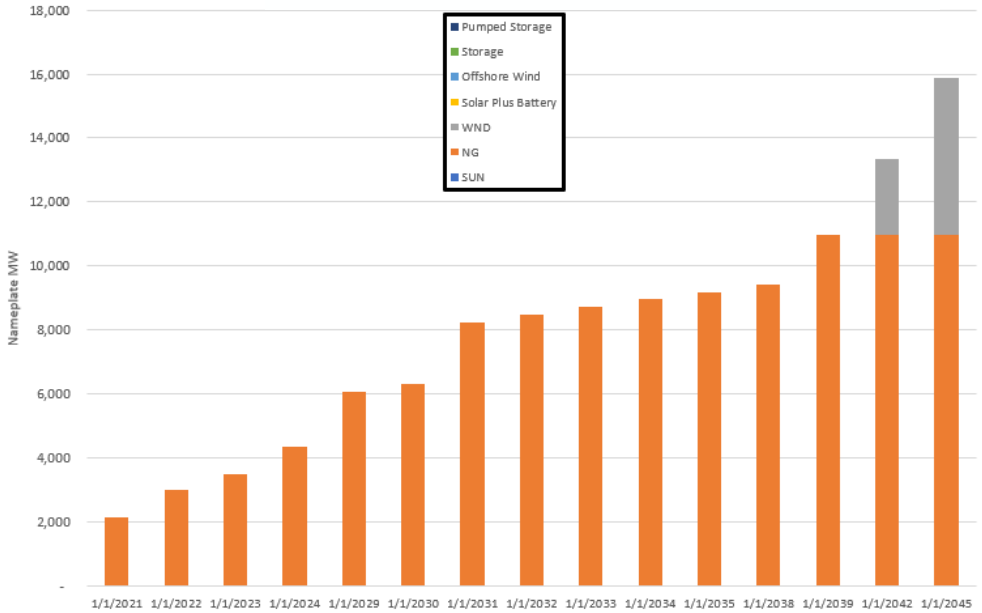


Arizona and New Mexico backfilling for significant coal retirements and building for California and New Mexico clean policy

Nevada, Wyoming, Colorado, and Utah backfilling for significant coal retirements provide some diversity to the CA and Desert SW builds

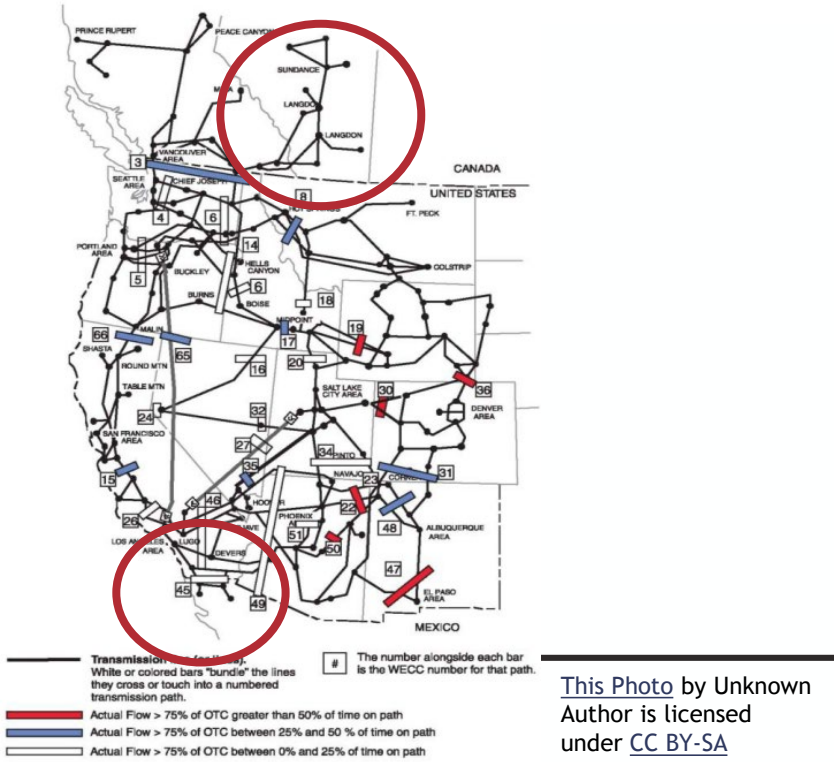
Mountain West Buildout

Alberta Buildout

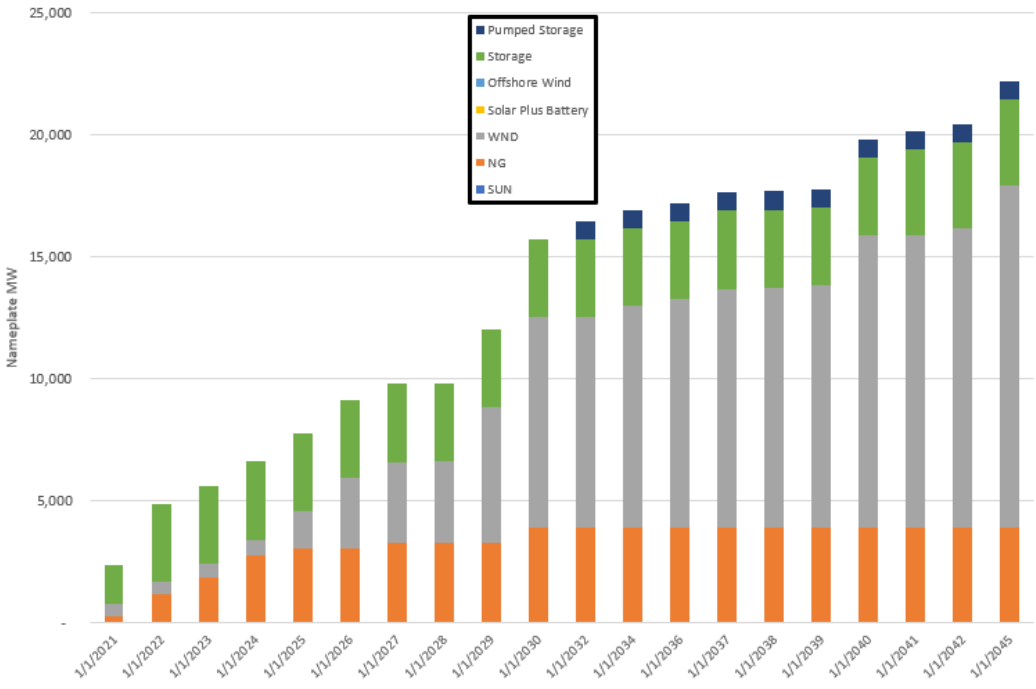


All but 4 GW of natural gas builds in Alberta or Baja CA.

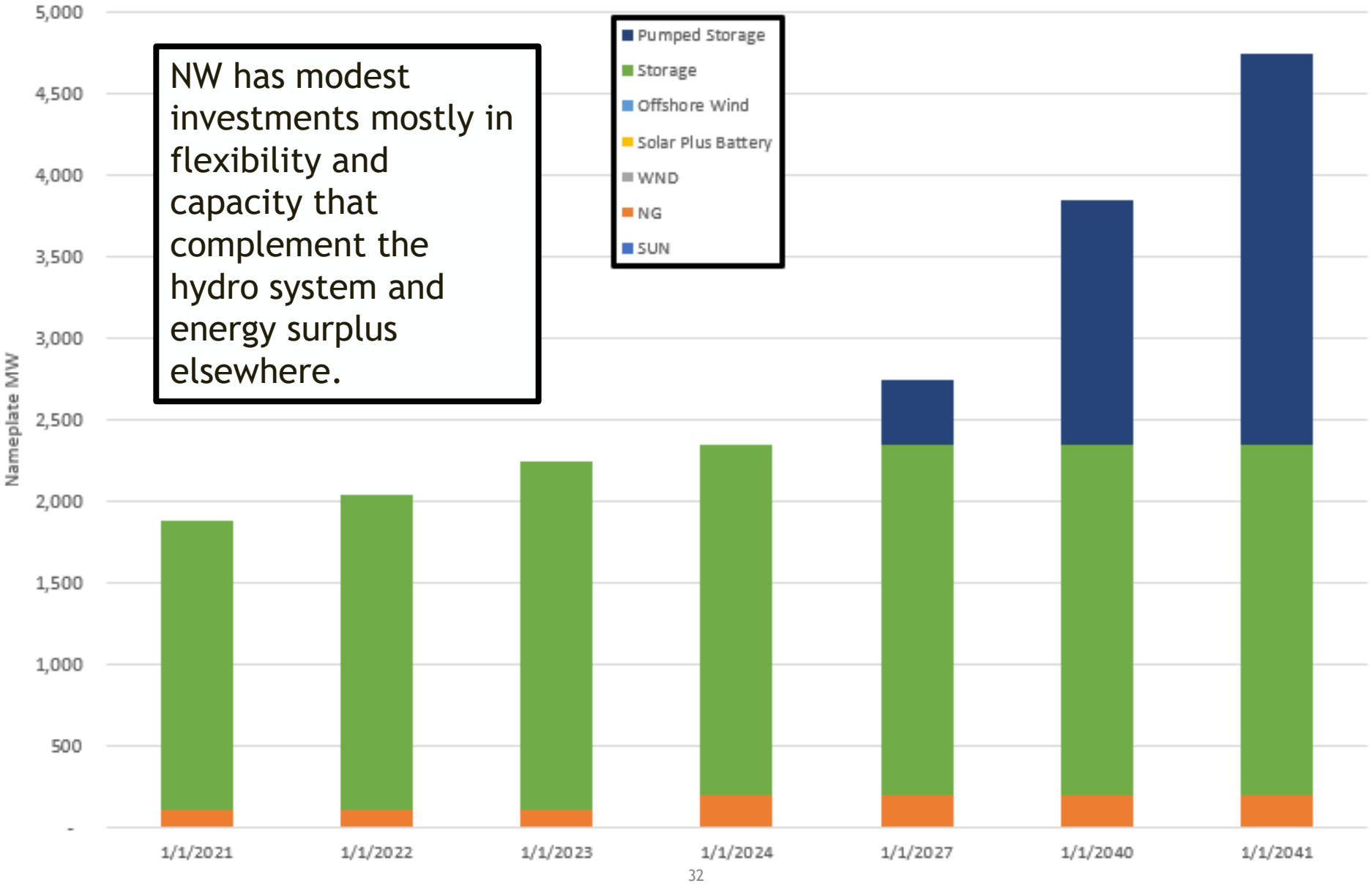
Both have fairly immediate needs and limited resource and transmission options.



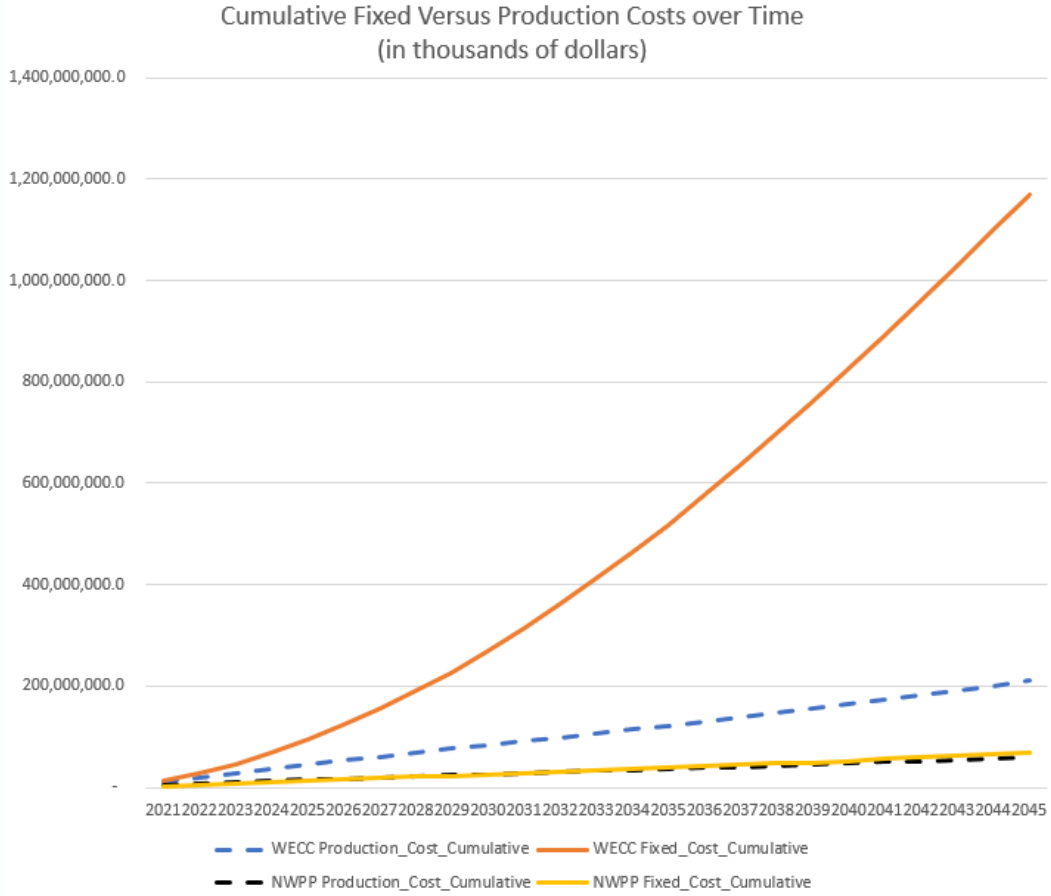
Baja CA Buildout

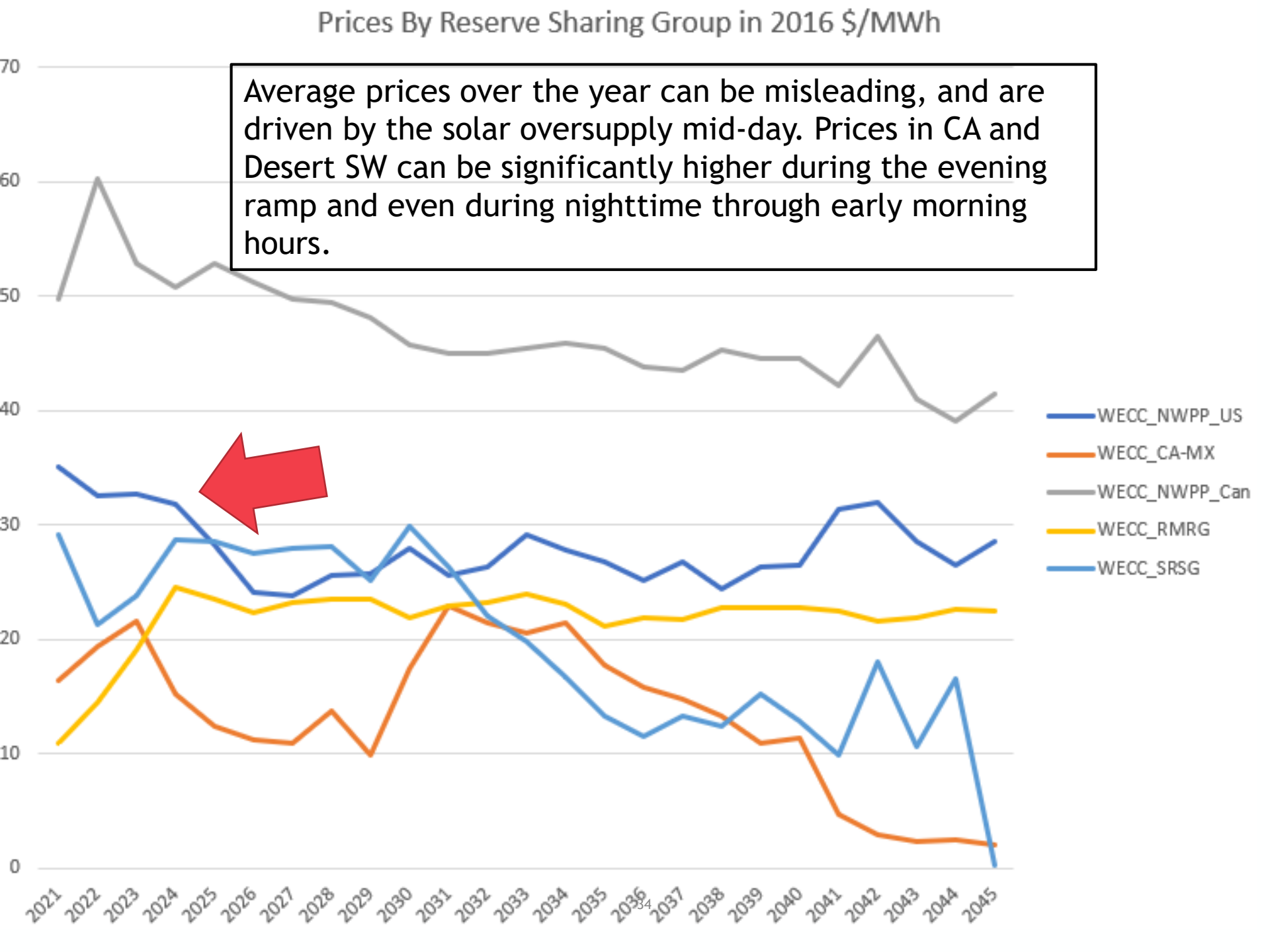


Pacific NW Buildout



Fixed costs more than **6 times** production costs for WECC, NWPP fixed and production costs stay similar.




Prices By Reserve Sharing Group in 2016 $/MWh
Average prices over the year can be misleading, and are driven by the solar oversupply mid-day. Prices in CA and Desert SW can be significantly higher during the evening ramp and even during nighttime through early morning hours.
70
60
50
40
30
20
10
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
WECC_NWPP_US
WECC_CA-MX
WECC_NWPP_Can
WECC_RMRG
WECC_SRSG

System Analysis Advisory Committee Thoughts

1. General support for the buildout as a baseline scenario.
   - Some folks believe that a smaller buildout will be more likely with more gas, alternative resource types and/or alternative compliance with clean policies.
2. Lots of builds in the first 5 years, will they show up?
   - Perhaps do some studies to understand this risk on the adequacy side.
3. Increase coordination with planning processes WECC-wide.
   - Specifically associated with transmission, demand-side and BTM plans for WECC utilities

Mid-C Price and Avoided Emissions Rate Data

Limited results for the Baseline buildout

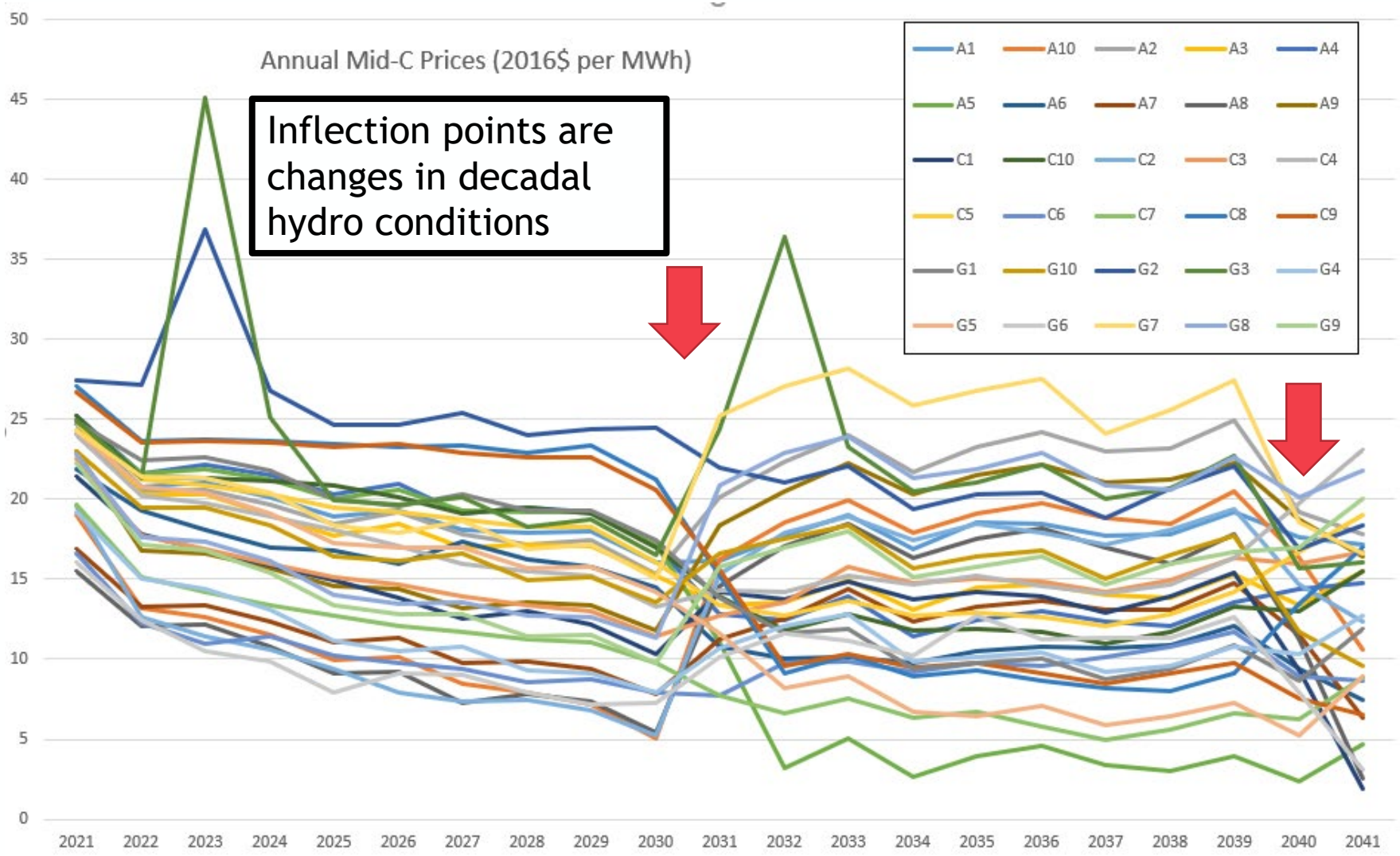
Review:

Three climate change data sets selected to encompass the range of hydro and load variation

	Winter Generation	Summer Generation	Winter HDD	Summer CDD
A	-	*low*	*low*	*high*
C	*high*	*low*	-	-
G	*near low*	*high*	*high*	*near low*

We will be looking at power prices over different climate change sets and weather conditions…

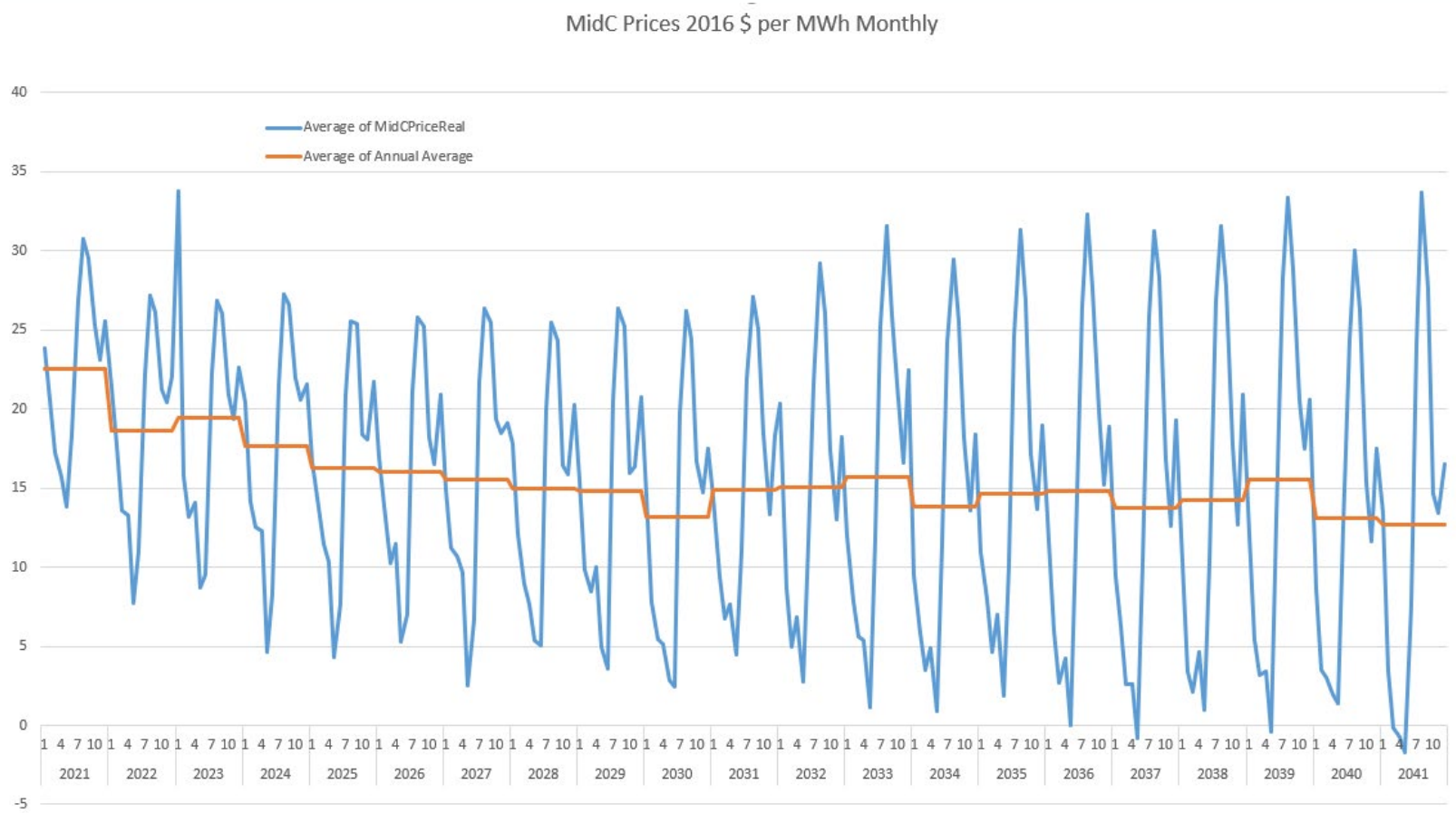
Description	Letter in index	Hydro Year 2020s	Hydro Year 2030s	Hydro Year 2040s
CanESM2_RCP85_BCSD_VIC_P1	A1	2020	2030	2040
CanESM2_RCP85_BCSD_VIC_P1	A2	2021	2031	2041
CanESM2_RCP85_BCSD_VIC_P1	A3	2022	2032	2042
CanESM2_RCP85_BCSD_VIC_P1	A4	2023	2033	2043
CanESM2_RCP85_BCSD_VIC_P1	A5	2024	2034	2044
CanESM2_RCP85_BCSD_VIC_P1	A6	2025	2035	2045
CanESM2_RCP85_BCSD_VIC_P1	A7	2026	2036	2046
CanESM2_RCP85_BCSD_VIC_P1	A8	2027	2037	2047
CanESM2_RCP85_BCSD_VIC_P1	A9	2028	2038	2048
CanESM2_RCP85_BCSD_VIC_P1	A10	2029	2039	2049
CCSM4_RCP85_BCSD_VIC_P1	C1	2020	2030	2040
CCSM4_RCP85_BCSD_VIC_P1	C2	2021	2031	2041
CCSM4_RCP85_BCSD_VIC_P1	C3	2022	2032	2042
CCSM4_RCP85_BCSD_VIC_P1	C4	2023	2033	2043
CCSM4_RCP85_BCSD_VIC_P1	C5	2024	2034	2044
CCSM4_RCP85_BCSD_VIC_P1	C6	2025	2035	2045
CCSM4_RCP85_BCSD_VIC_P1	C7	2026	2036	2046
CCSM4_RCP85_BCSD_VIC_P1	C8	2027	2037	2047
CCSM4_RCP85_BCSD_VIC_P1	C9	2028	2038	2048
CCSM4_RCP85_BCSD_VIC_P1	C10	2029	2039	2049
CNRM-CM5_RCP85_MACA_VIC_P1	G1	2020	2030	2040
CNRM-CM5_RCP85_MACA_VIC_P1	G2	2021	2031	2041
CNRM-CM5_RCP85_MACA_VIC_P1	G3	2022	2032	2042
CNRM-CM5_RCP85_MACA_VIC_P1	G4	2023	2033	2043
CNRM-CM5_RCP85_MACA_VIC_P1	G5	2024	2034	2044
CNRM-CM5_RCP85_MACA_VIC_P1	G6	2025	2035	2045
CNRM-CM5_RCP85_MACA_VIC_P1	G7	2026	2036	2046
CNRM-CM5_RCP85_MACA_VIC_P1	G8	2027	2037	2047
CNRM-CM5_RCP85_MACA_VIC_P1	G9	2028	2038	2048
CNRM-CM5_RCP85_MACA_VIC_P1	G10	2029	2039	2049



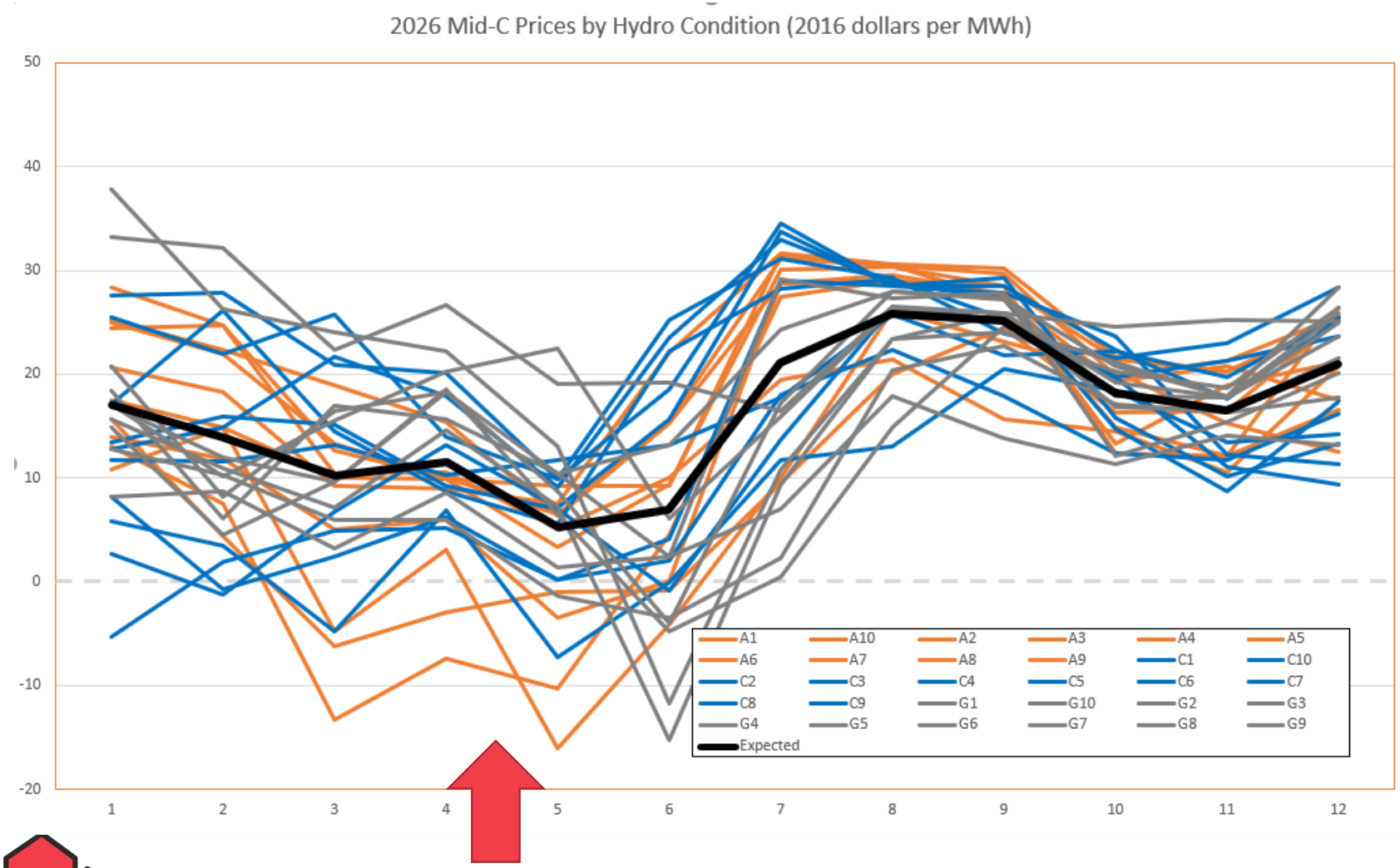
Annual Prices Decrease Over Time

THE 2021 NORTHWEST POWER PLAN

Seasonal Variation Increases Over Time

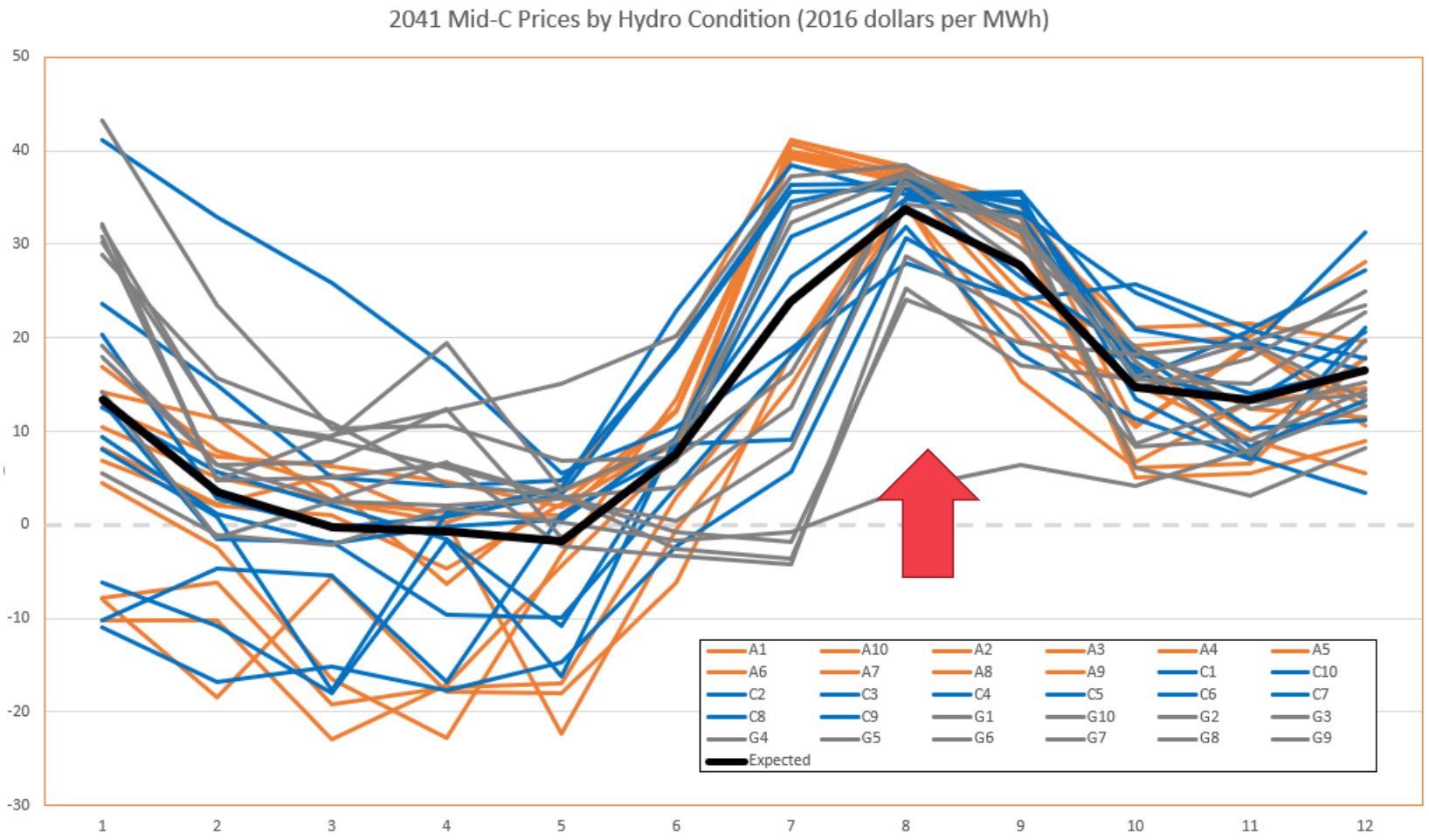


2026 Mid-C Monthly Prices



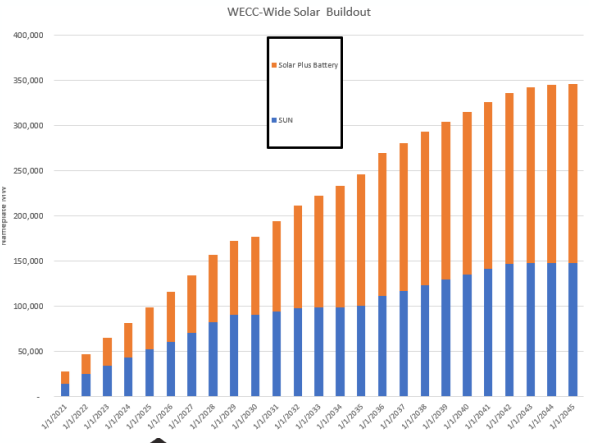
Persistent low pricing in spring and late winter. Throughout climate change record more NW hydro in the winter pushes down prices.

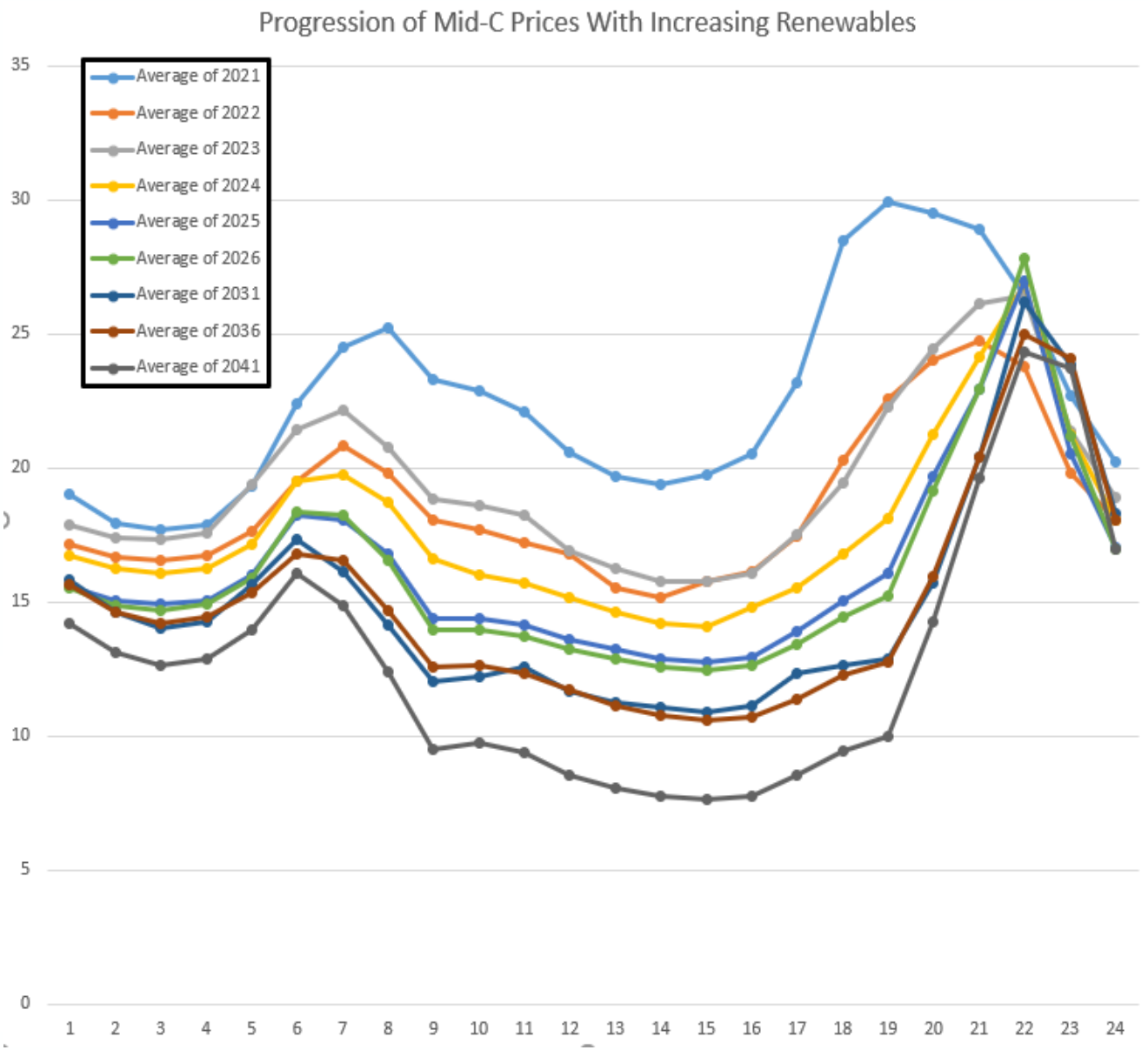
2041 Mid-C Monthly Prices

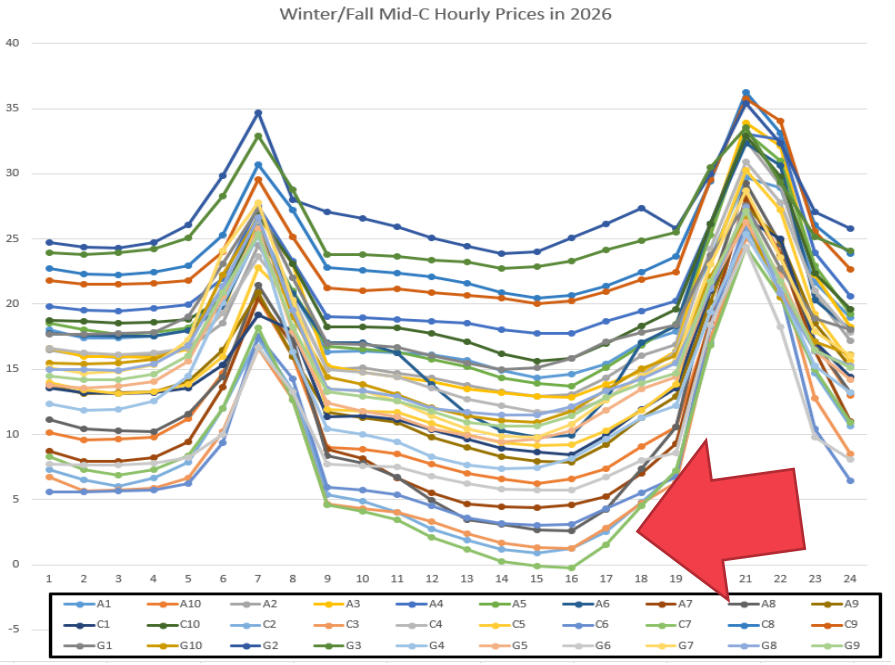


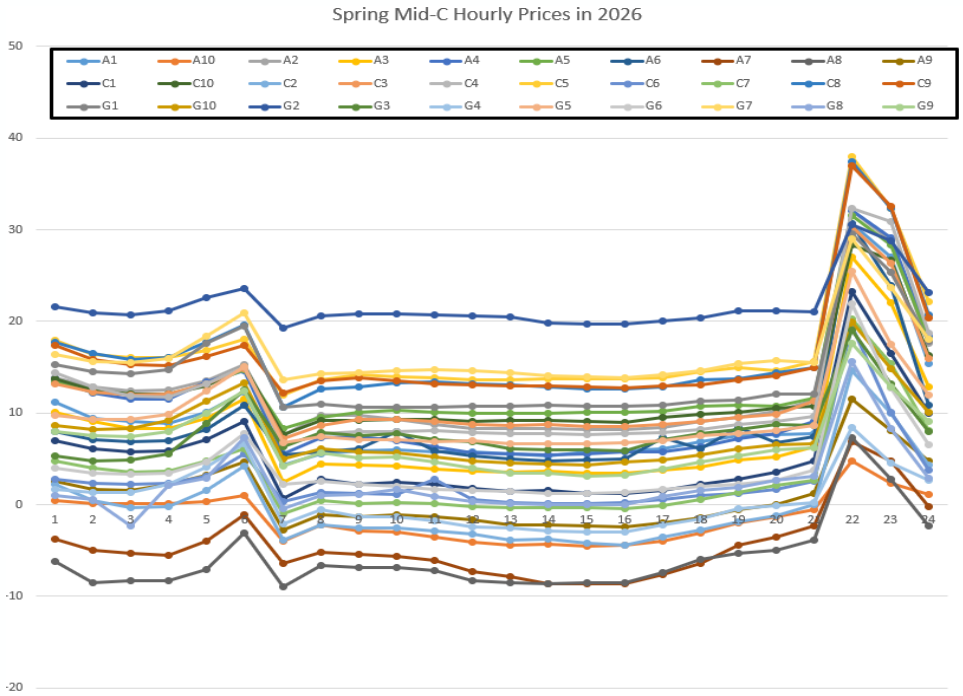
Prices are higher in summer consistently. Throughout climate change record less NW hydro in the summer raises prices.

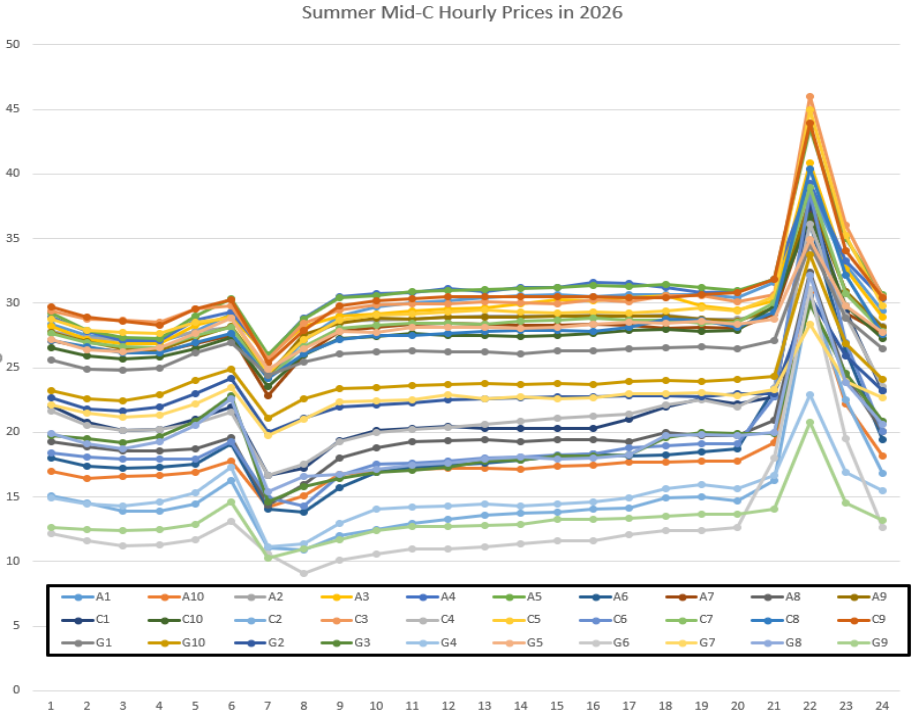
Daily shape changes with more WECC-wide solar



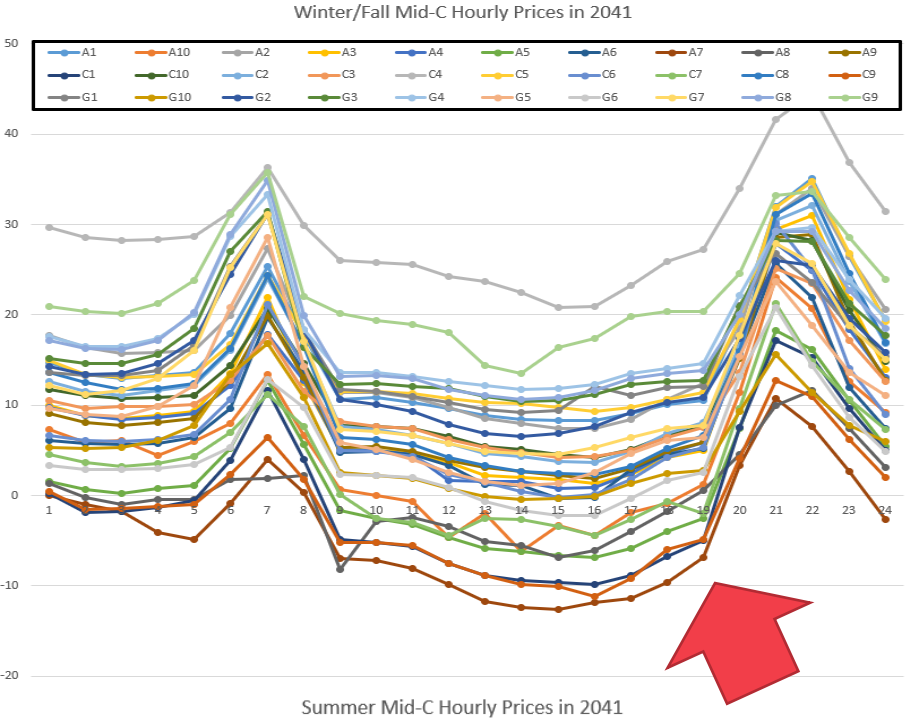


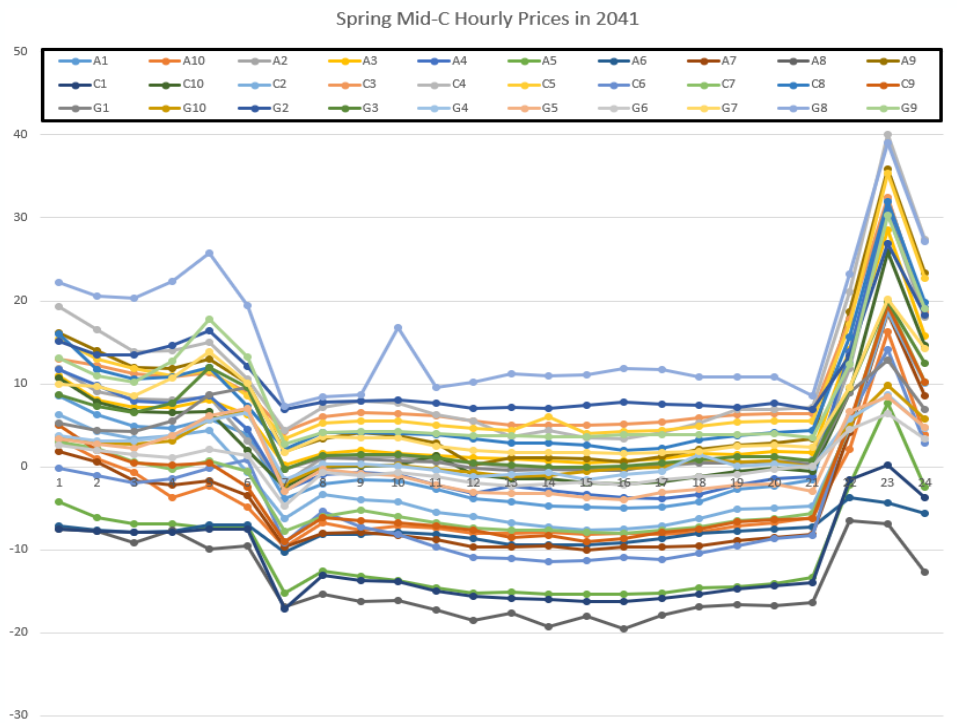


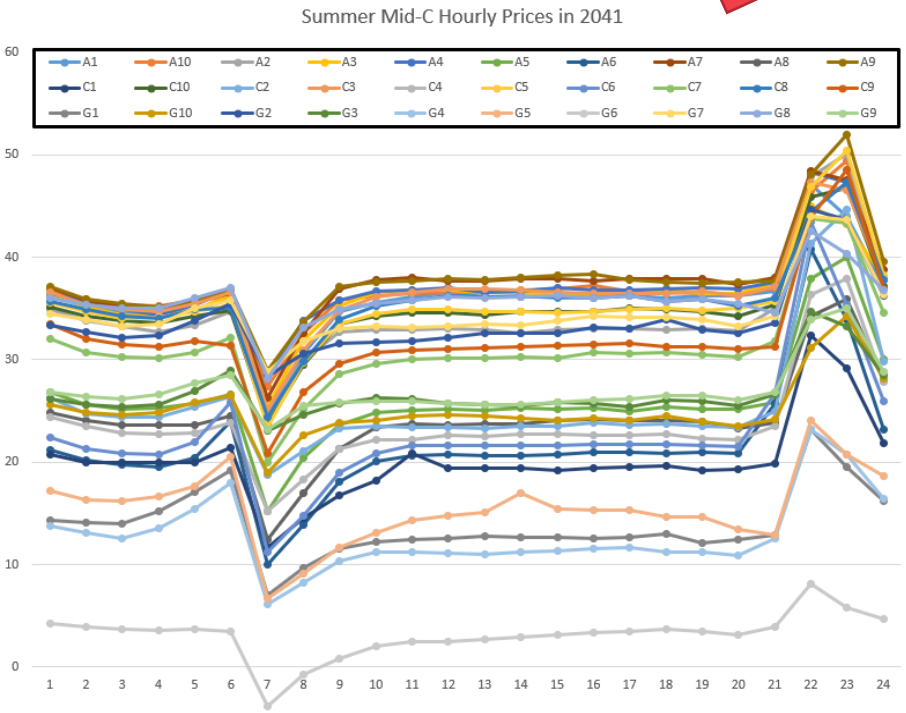




Seasonal daily shapes by 2026 have low mid-day pricing and peaky ramps







Prices by 2041 have persistent negative pricing seasonally for many hours mid-day.

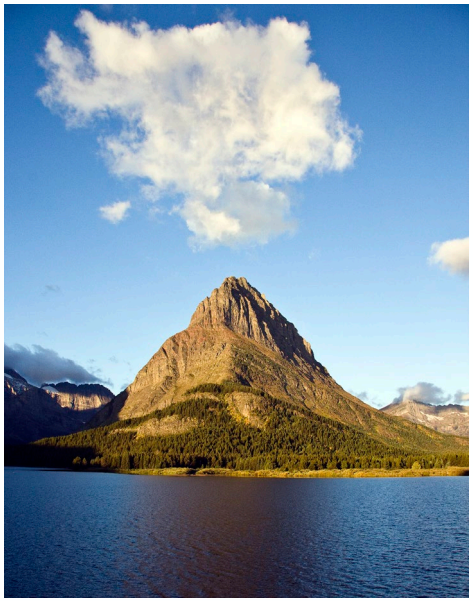
Market Price Conclusions

<u>More Price Spread in RPM</u>

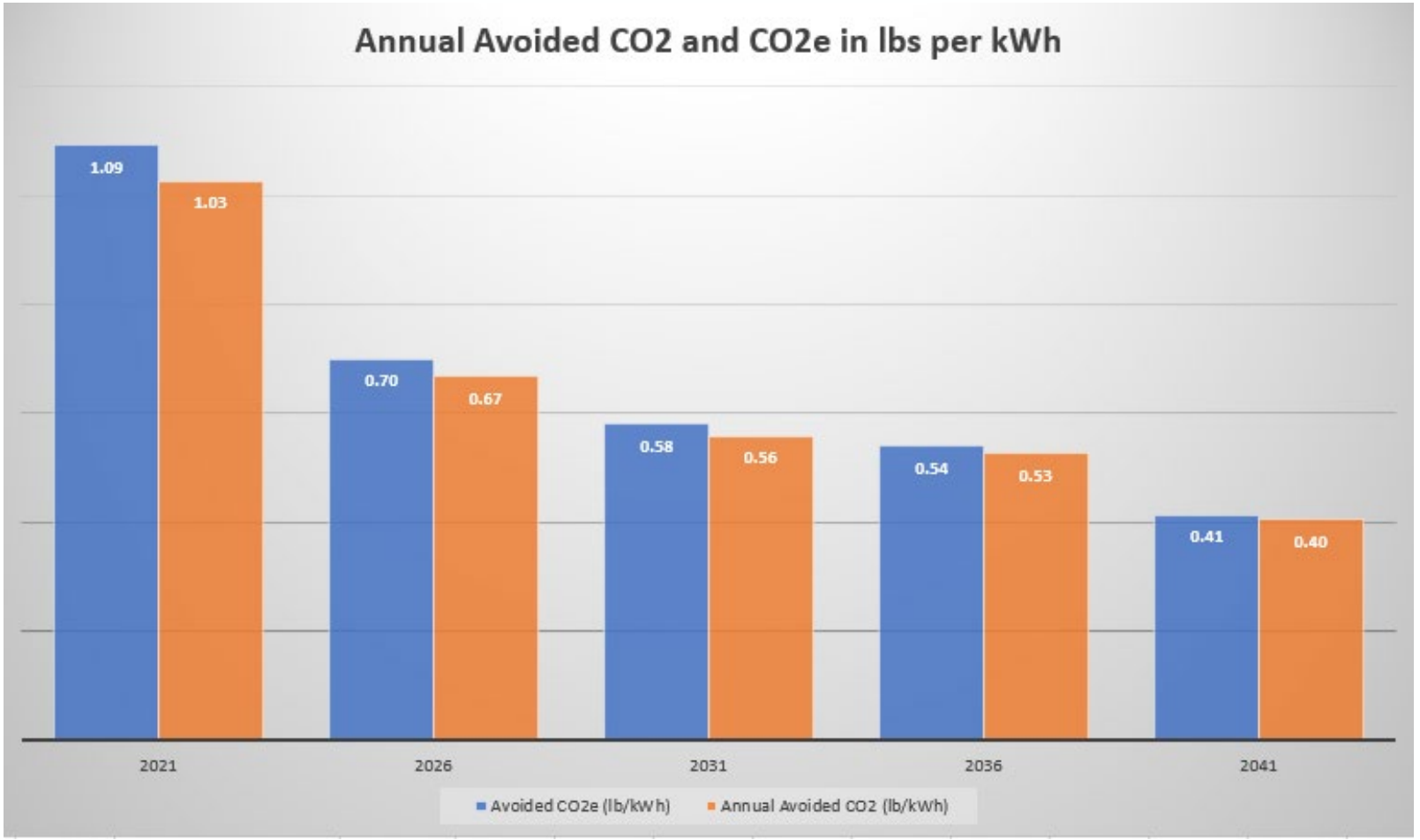
- RPM also looks at different gas price scenarios
- Those simulations are still running…

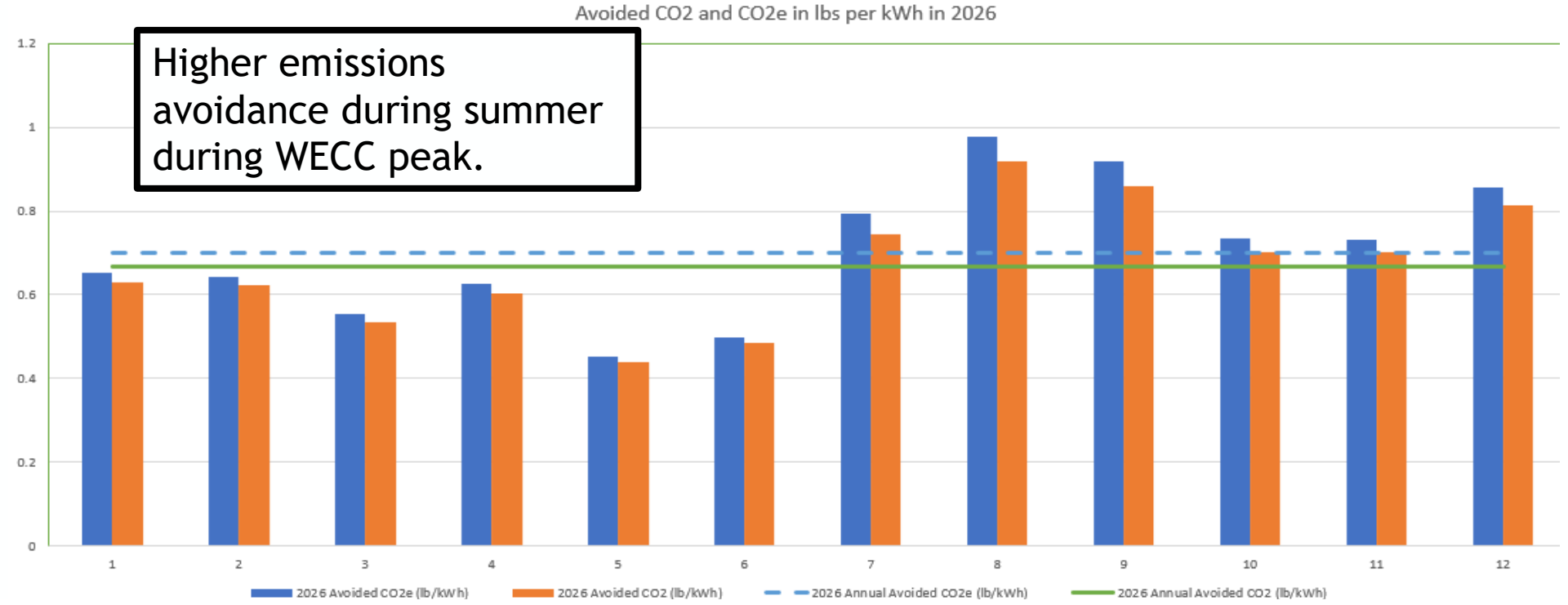
<u>Daily Price Shape is Important</u>

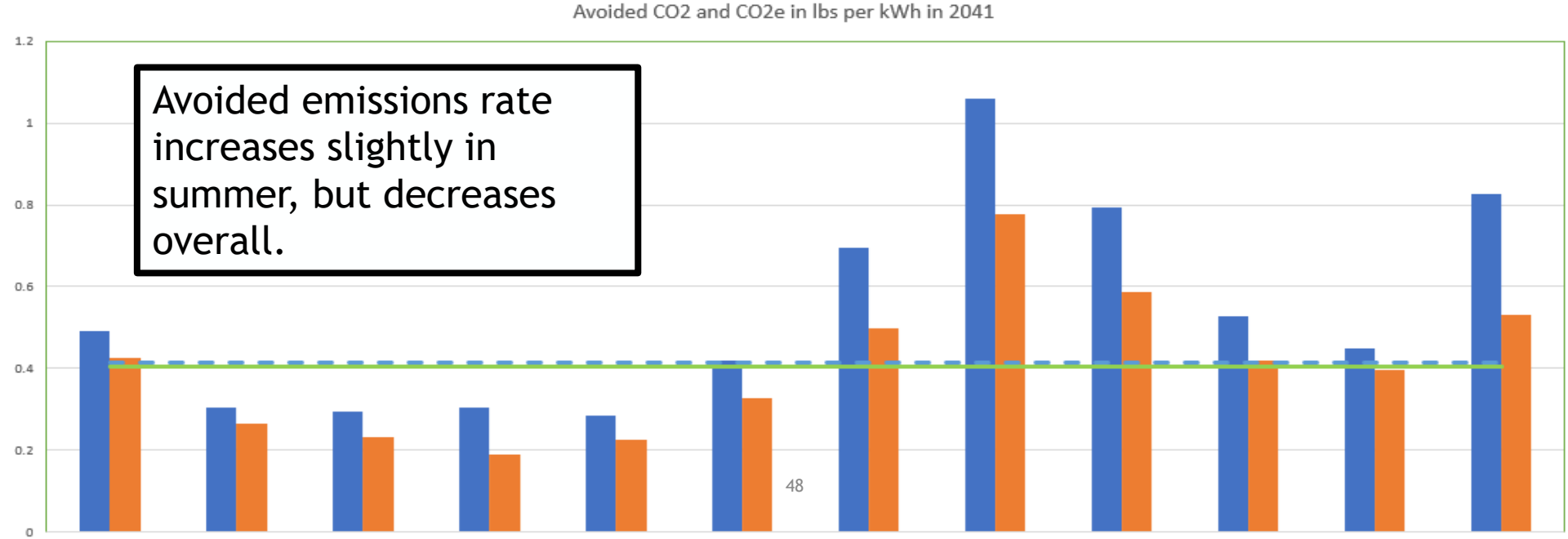
- Net peak driving prices more than peak.
- Resources that must run midday will be competing with extremely low market prices
- Maintaining reserves and ramping capability while undergoing persistent negative price periods could be a challenge for the WECC, and by the end of the study the NW.
- Resources with ramping capability with low must-run requirements will be more and more valuable.
- Hydro conditions still the major driver of price variability at Mid-C.



Avoided Market Emissions Rate Decreases Over Time




Avoided CO2 and CO2e in lbs per kWh in 2026
Higher emissions avoidance during summer during WECC peak.
1.2
1
0.8
0.6
0.4
0.2
0
1
2
3
4
5
6
7
8
9
10
11
12
2026 Avoided CO2e (lb/kWh)
2026 Avoided CO2 (lb/kWh)
2026 Annual Avoided CO2e (lb/kWh)
2026 Annual Avoided CO2 (lb/kWh)


Avoided CO2 and CO2e in lbs per kWh in 2041
Avoided emissions rate increases slightly in summer, but decreases overall.
1.2
1
0.8
0.6
0.4
0.2
0

Lower Market Emissions Rate Implications: **RPM Preview**

- In recent studies, the market emissions rate has been closer to a combined cycle, 0.8 to 0.9 lbs per kWh.
- Recall, we are quantifying emissions damage costs in the RPM
- When market emissions rates drop below emissions rates of existing regional resources, the market will likely start to displace the dispatch of some of the higher emitting existing regional resources to reduce overall costs.

Next Steps

1. Use buildout to guide GENESYS market hourly capability for adequacy work.
2. Develop quarterly and intra-quarterly price information for RPM to use as starting point for the baseline scenario.
3. Develop avoided emissions information for the RPM for the baseline scenario.
4. Begin working on additional AURORA buildouts for other scenarios/sensitivities.
   - Market reliance
   - Organized/limited markets
   - Early retirements
   - ???

Additional Slides

Addition of Transmission

- Explore whether transmission limitations was significantly impacting build size or diversity.

1. Tested 1500 MW additional capability into NW from Wyoming.
2. Tested 1500 MW additional capability into California from Wyoming.
3. Increased possible wind from New Mexico that could sink to Desert SW load, but only make it to California with existing transport between regions

This buildout test is referred to as the "With Transmission Additions"

Most Recent WECC Buildout With Transmission Additions (10/28/2020)

Cumulative Buildout in Nameplate MWs by Year

DRAFT

Limited Gas per Regulatory and Policy Climate (October 28,2020)							
Year	Solar	Natural Gas	Wind	Solar with Battery	Offshore Wind	4 Hour Battery	Pumped Storage
2025	34,669	11,159	16,145	48,600	-	3,891	-
2030	82,595	14,015	31,255	82,400	6,594	6,735	4,900
2035	116,095	16,916	34,756	141,400	6,909	6,735	5,650
2040	134,053	18,677	37,656	170,900	10,000	6,735	6,750
2045	147,003	18,677	44,642	198,000	10,000	9,109	9,190

Build is deferred to later in study. Slightly more wind is built in WY and almost all available in NM, but overall build is closer to 10/21 build. **Overall narrative similar.**

Disclaimer!

- Since the run with transmission additions did not yield significantly different results, the following information will be describing the build **without** additional transmission.
- Staff suggests if exploration of transmission additions is desirable, it could be explored via scenario analysis.

Buildout Notes

- Regional energy efficiency is assumed to continue at 7th Power Plan price levels (using new supply curve ramp and shaping data).
  - Over 900 aMW by 2025 and over 4000 aMW by 2041
- AURORA did not have the capability of building new demand response, and significant demand response is below 4 hour battery investment levels.