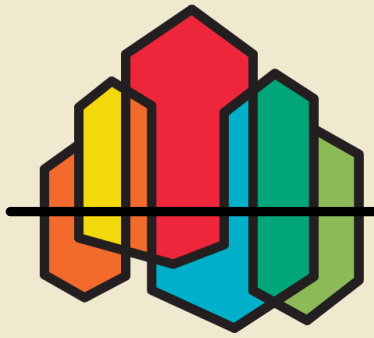
Power Plan Update



THE 2021
NORTHWEST
POWER PLAN

FOR A SECURE & AFFORDABLE
ENERGY FUTURE

Full fathom five thy father lies;
Of his bones are coral made;
Those are pearls that were his eyes:
Nothing of him that doth fade,
But doth suffer a sea-change
Into something rich and strange.
Sea-nymphs hourly ring his knell:
Ding-dong.
Hark! now I hear them,—ding-dong, bell.

William Shakespeare – The Tempest

sea change

/ˈsē ˌCHānj/

noun

a profound or notable transformation.
"recent years have witnessed a sea change in the fortunes of car safety as a marketable quantity"

Similar: transformation | change | alteration | modification | variation | conversion

Definitions from Oxford Languages *Feedback*

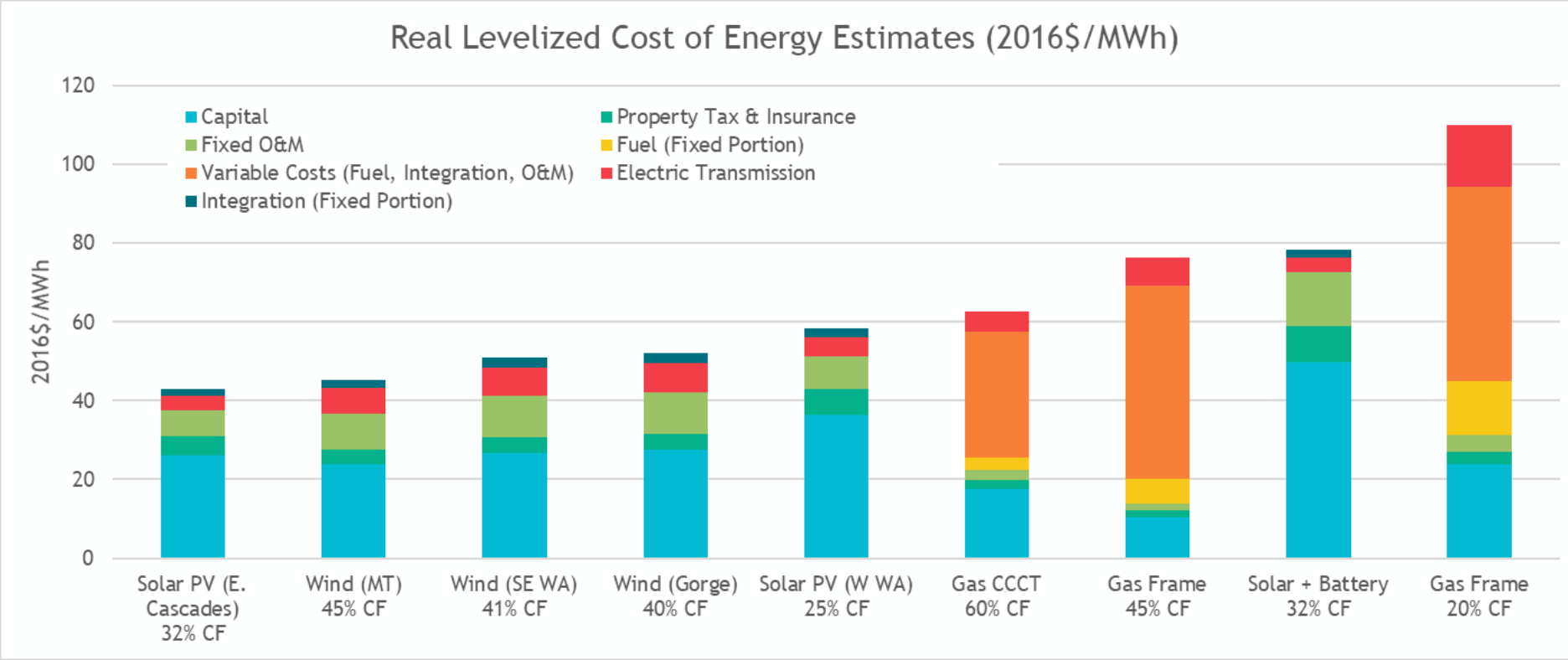
Baseline Conditions

What it takes to meet policy objectives

What are baseline conditions?

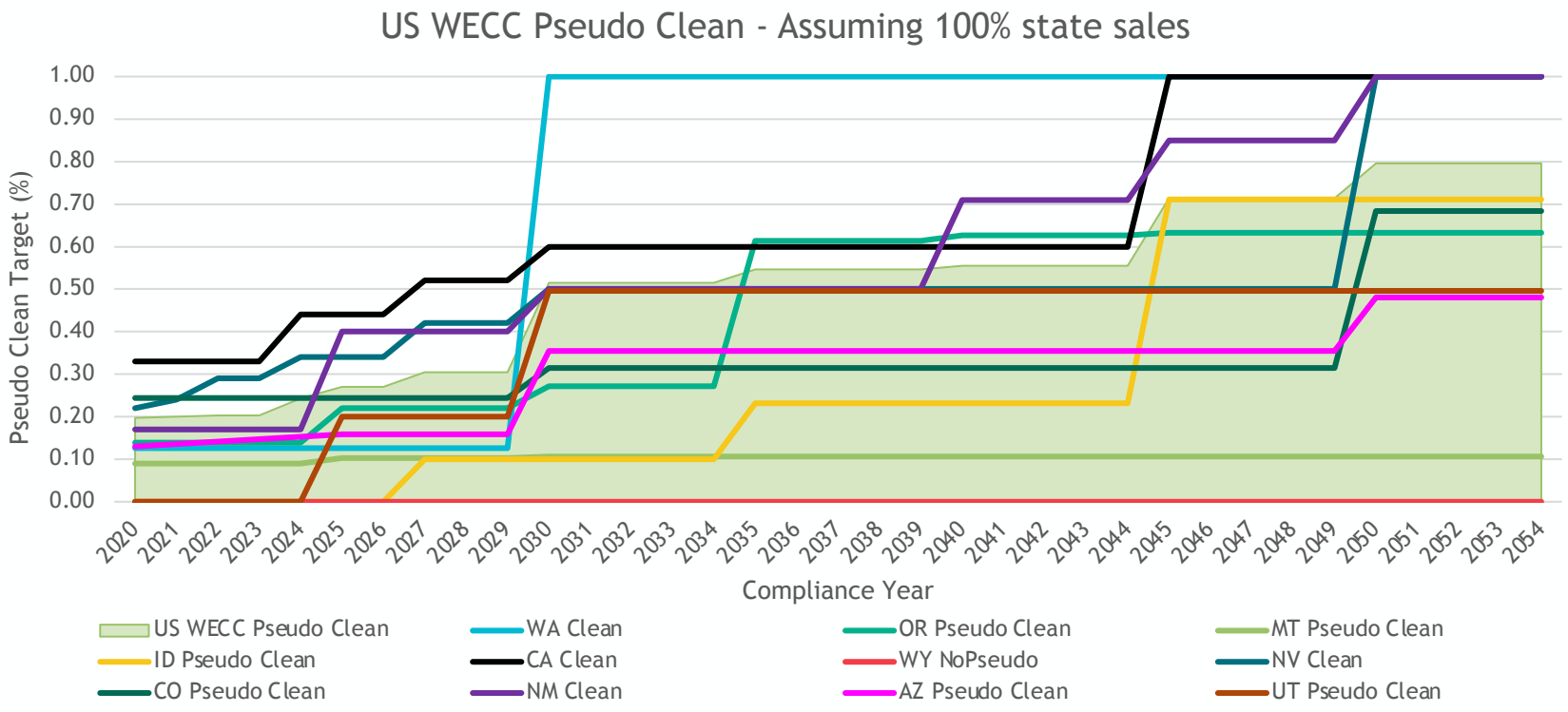
- Baseline conditions are a basis for comparison when developing scenarios
- Baseline conditions are assumptions that are common between 2 or more scenarios
- Baseline conditions are **not**:
  - Business as usual
  - A forecast of what is likely to occur
  - Recommended regional resource strategy

Draft 2021 Plan – LCOE Estimates of Select New Generating Resources*



*Based on draft 2021 plan generating resource reference plants (size, configuration, technology, location, etc.) and financial assumptions in MicroFin

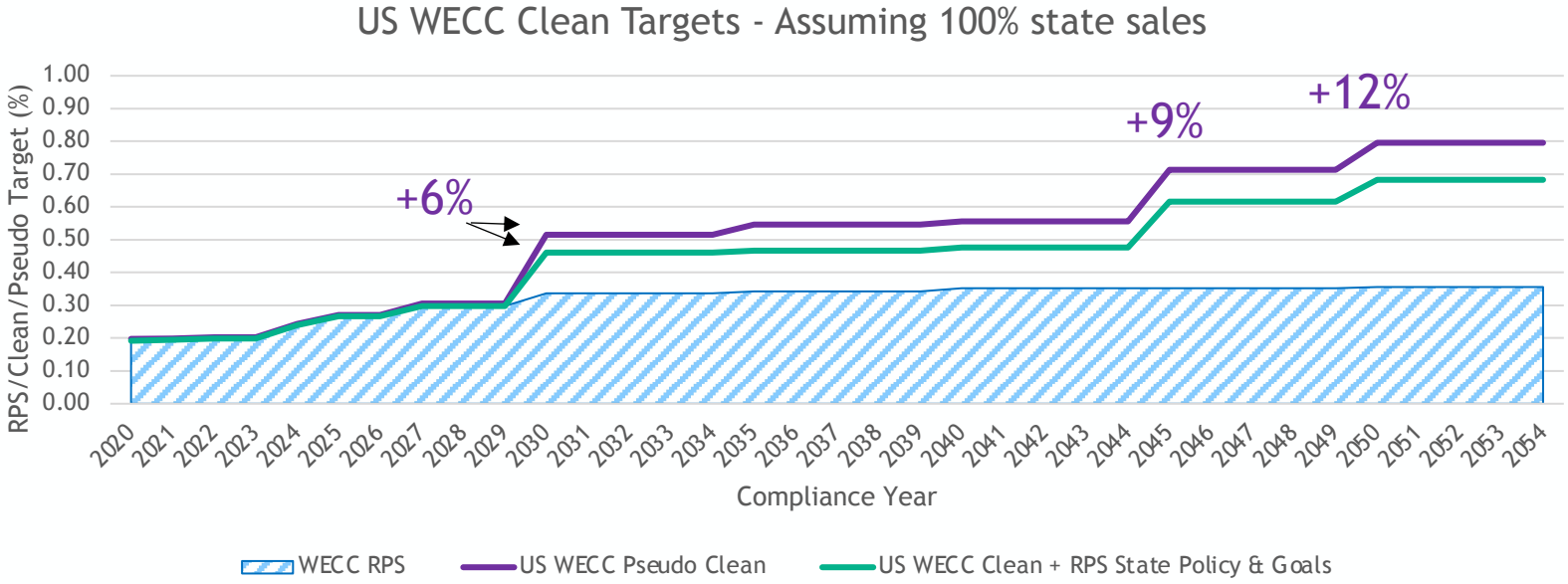
Clean Policy + RPS + Utility/Community Goals:
US WECC* Aggregate Pseudo Clean Target



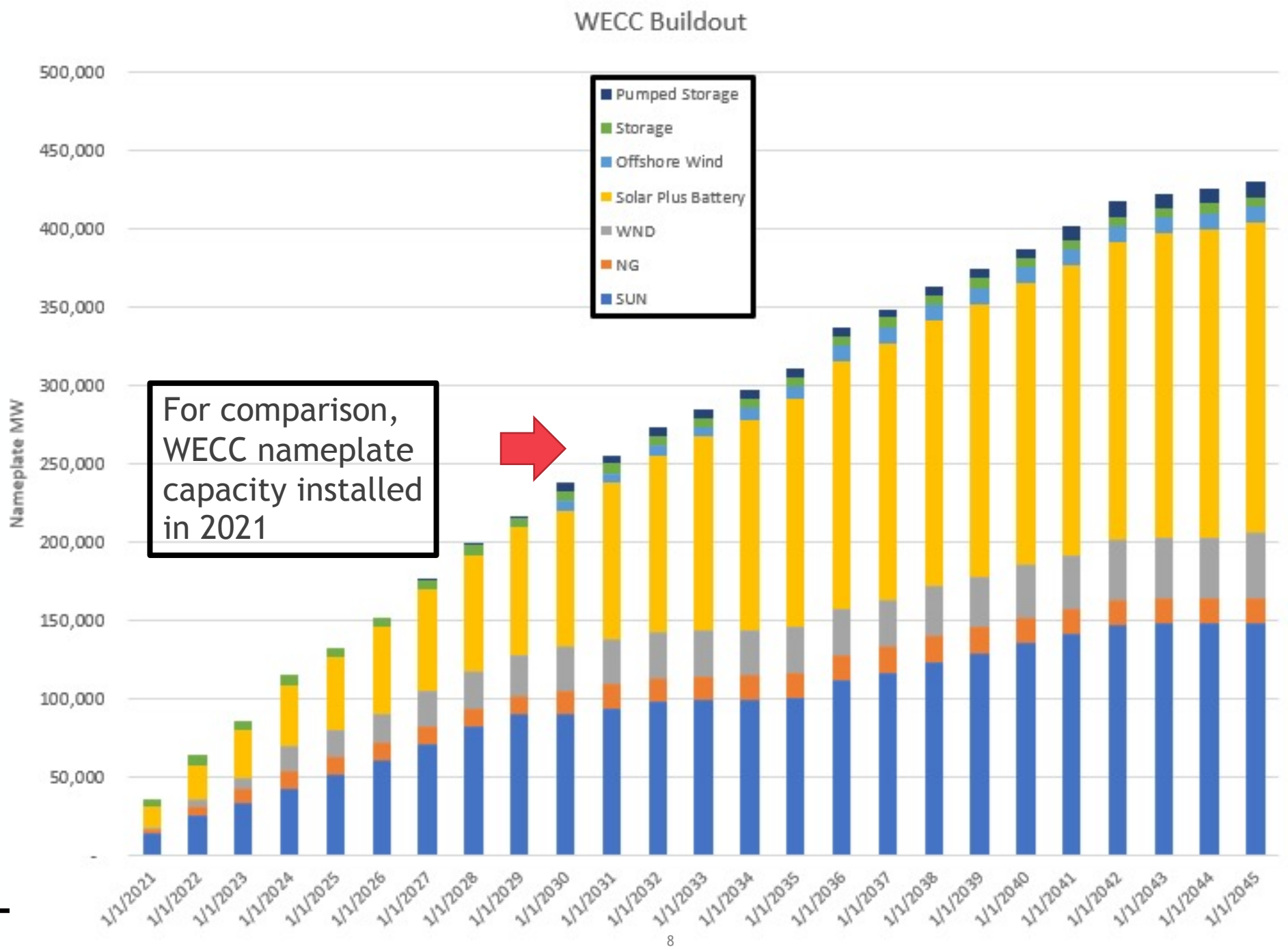
WECC Pseudo Clean Agg Target	
2020	20%
2025	27%
2030	52%
2040	55%
2045	71%
2050	80%

* For presentation purposes, assuming 100% of the state of Montana; includes state RPS policy and goal (UT), state clean policy, and pseudo clean policy
* Based on 2018 utility bundled retail sales, EIA-861

Magnitude between aggregate clean and pseudo clean targets in the US WECC



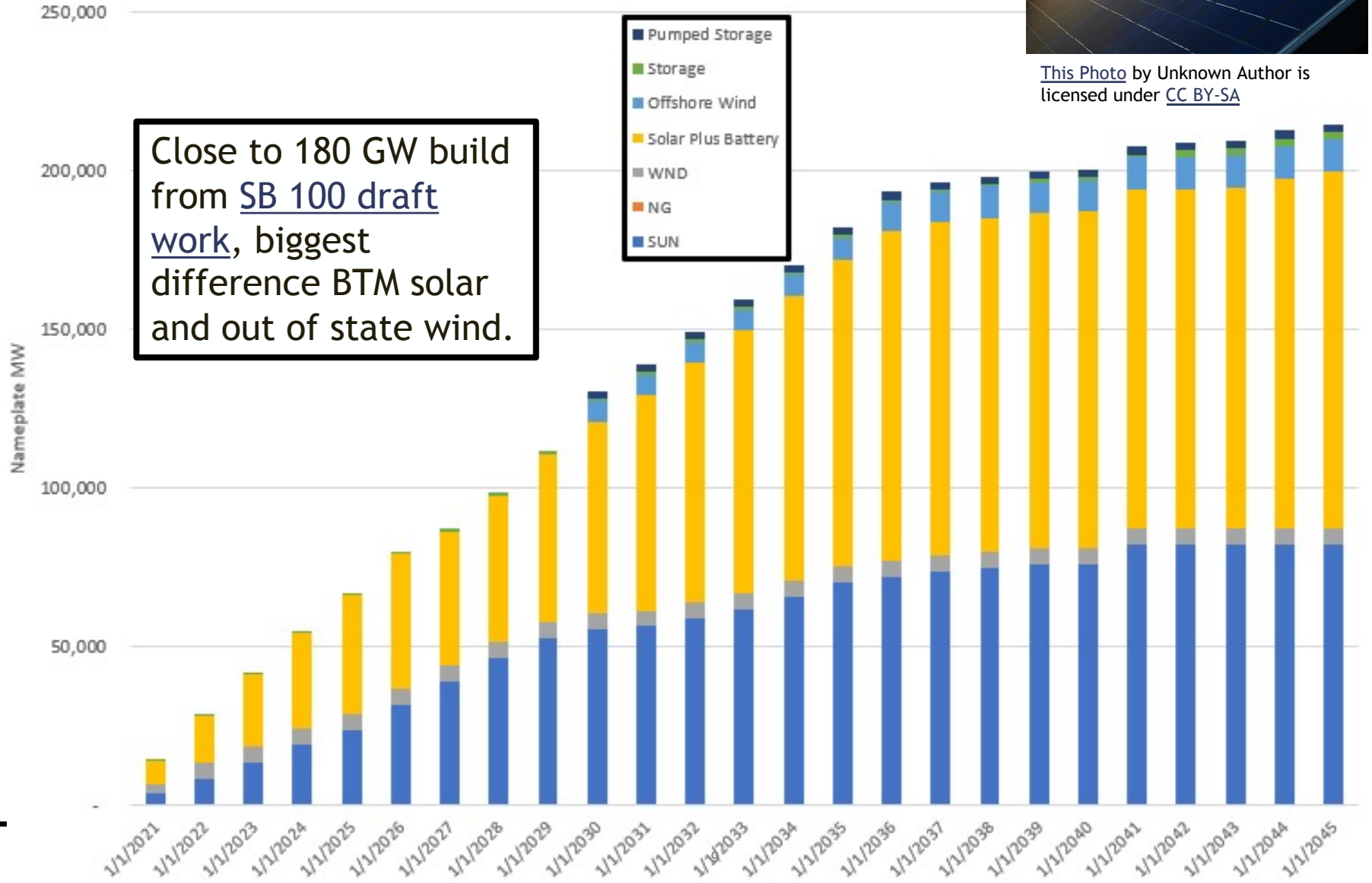
- Largest gap between the pseudo clean forecast and strictly clean is 12%, starting in 2050
- Compliance years 2030 to 2044 are fairly stable, before the 2045 target increase
- Of the pseudo clean forecast, eligible renewable resources must account for about half of the clean resources by 2045 (WECC RPS is 34-36% of total sales between 2030-2054)



For comparison, WECC nameplate capacity installed in 2021

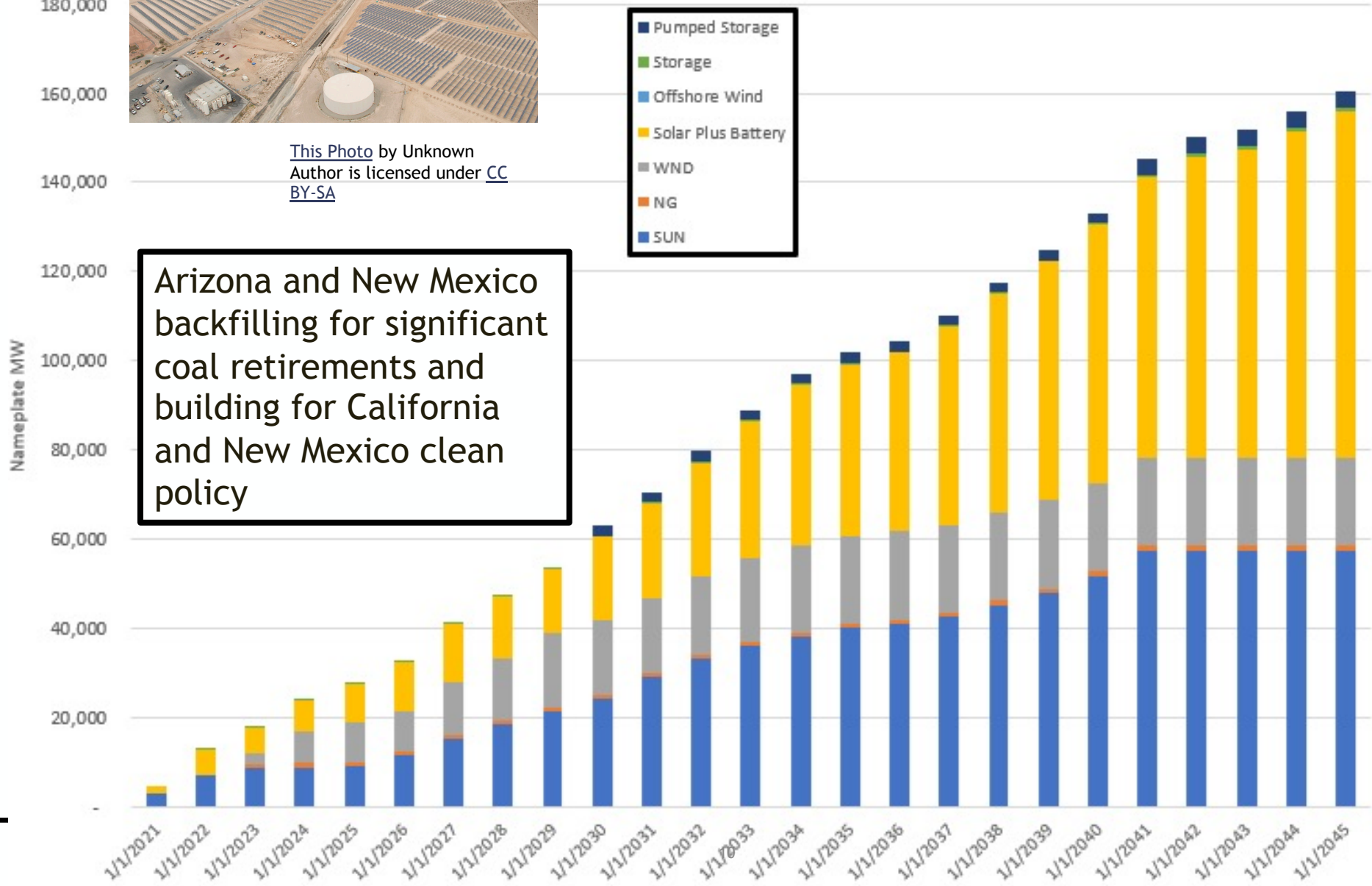
CA Buildout

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

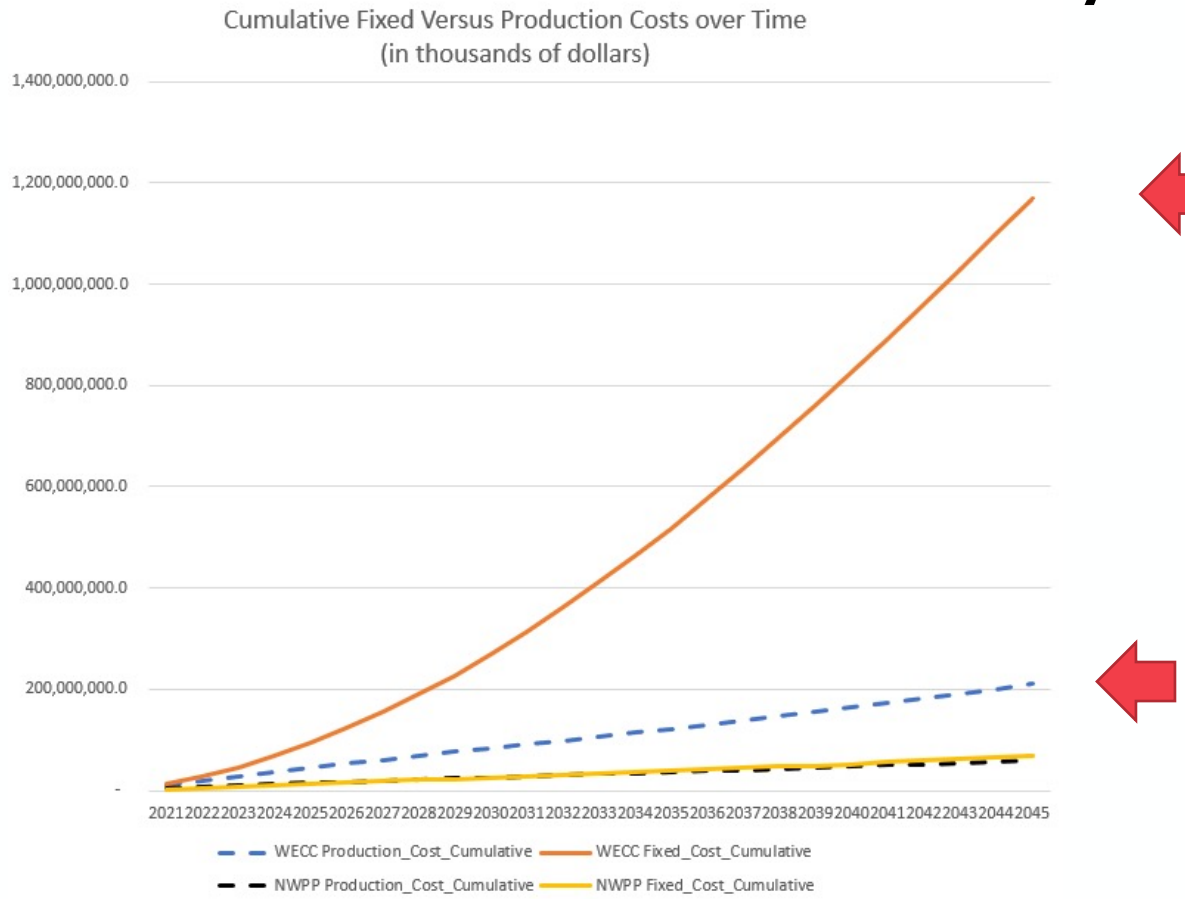


Desert SW Buildout

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



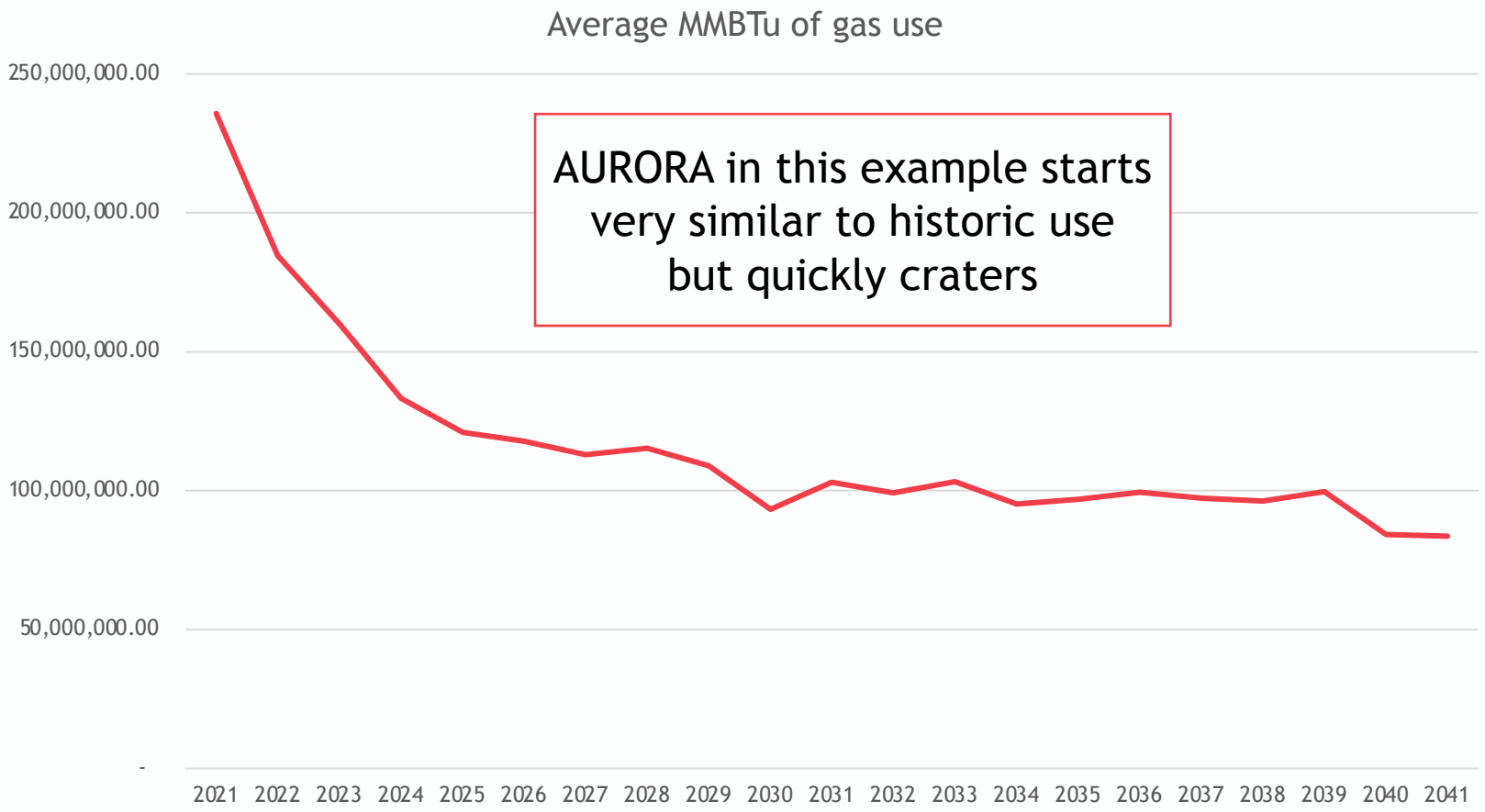
Fixed costs more than **6 times** production costs for WECC, NWPP fixed and production costs stay similar.



Historic Natural Gas Used for Power Generation

Year	ID	MT	OR	WA	Total
2017	21,698,065	4,860,949	77,493,291	75,529,382	**179,581,686**
2018	24,558,956	5,318,808	89,762,440	72,881,400	**192,521,604**
2019	32,570,753	5,698,068	103,475,154	95,668,078	**237,412,053**
2020	32,168,577	4,576,444	97,222,903	97,624,569	**231,592,492**

AURORA Example Natural Gas Fuel Use



Analysis of Decarbonization

Introduction

To combat climate change - the states of Oregon and Washington have set goals and limits on future greenhouse gas emissions from their respective states

Oregon

45 % below 1990 levels by 2035
80 % below 1990 levels by 2050

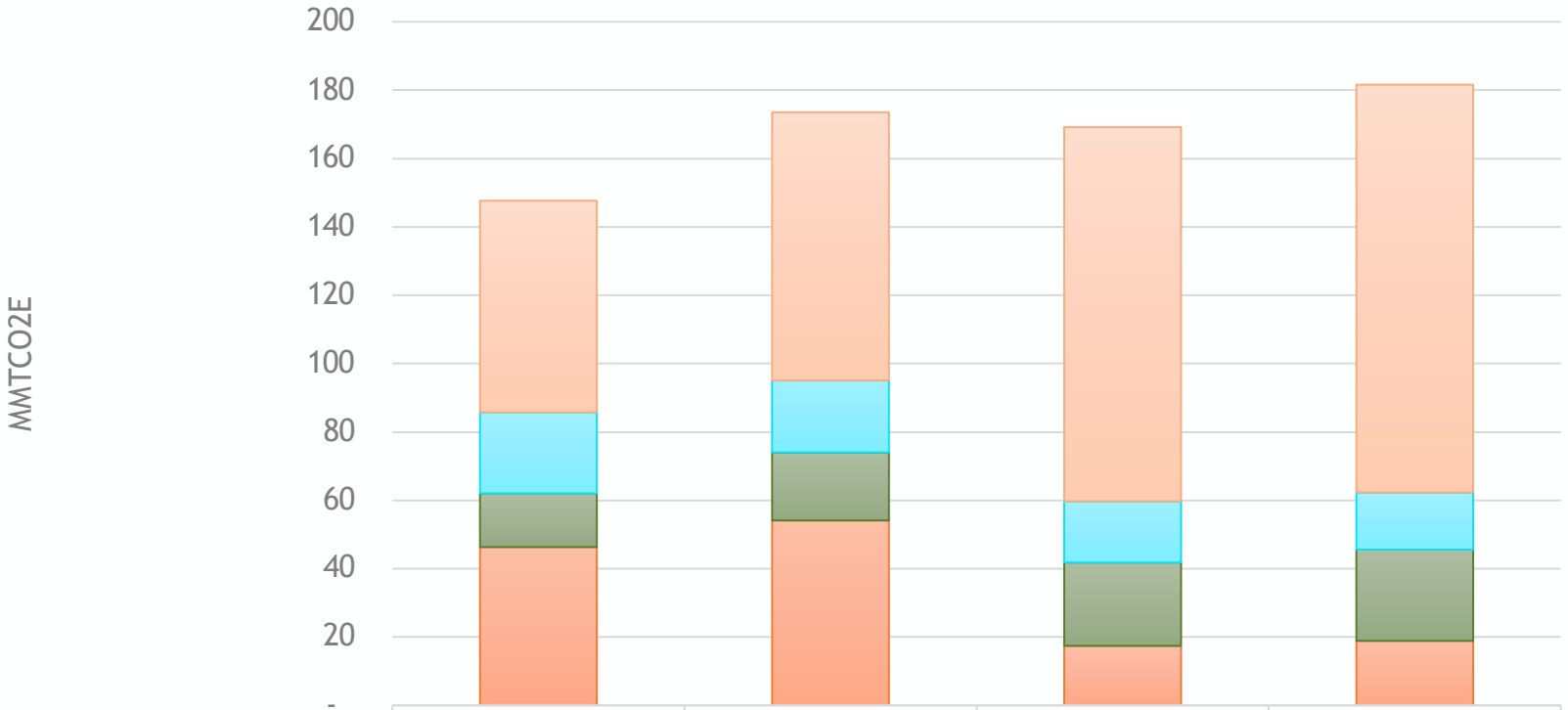
Washington

45 % below 1990 levels by 2030
70 % below 1990 levels by 2040
95 % below 1990 levels by 2050
and net zero emissions

For the 2021 Power Plan – in order to form a more comprehensive understanding of expected regional emissions - we expanded our forecasting out past the power sector to include the use of fuels for transportation, the home, the business and industry

The Paths to Decarbonization Scenario is an investigation into methods that can reduce greenhouse gas emissions from the **entire economy** – both energy related & non-energy related

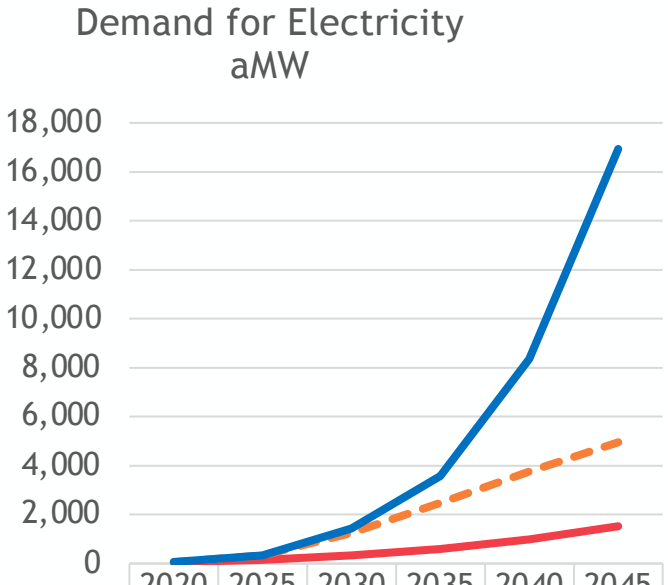
Baseline Conditions Emissions



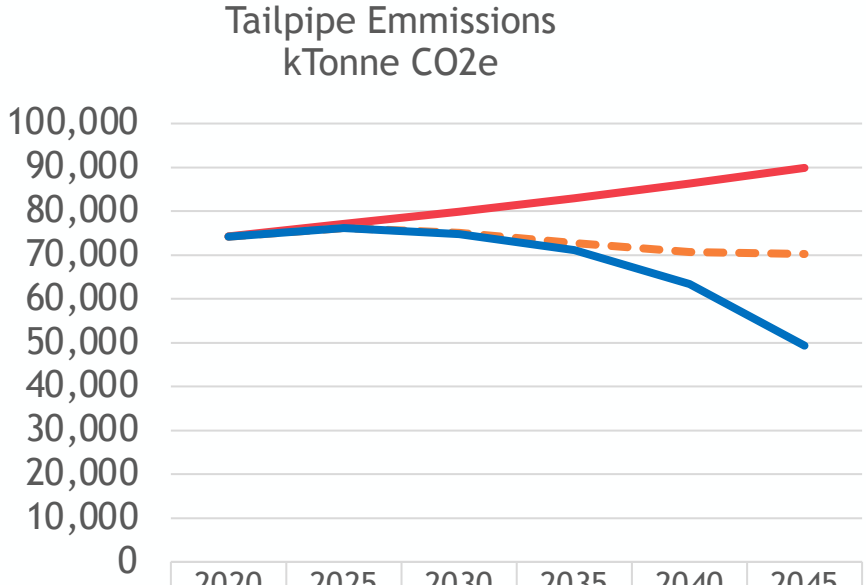
	1990	2005	2041	2050
Transportation	62	78	109	119
Industrial, w/o Agric	24	21	18	17
Residential/Commercial	16	20	24	27
Electric Sector	46	54	17	19

Results

ELEC Only – electrification changes only – no H_2

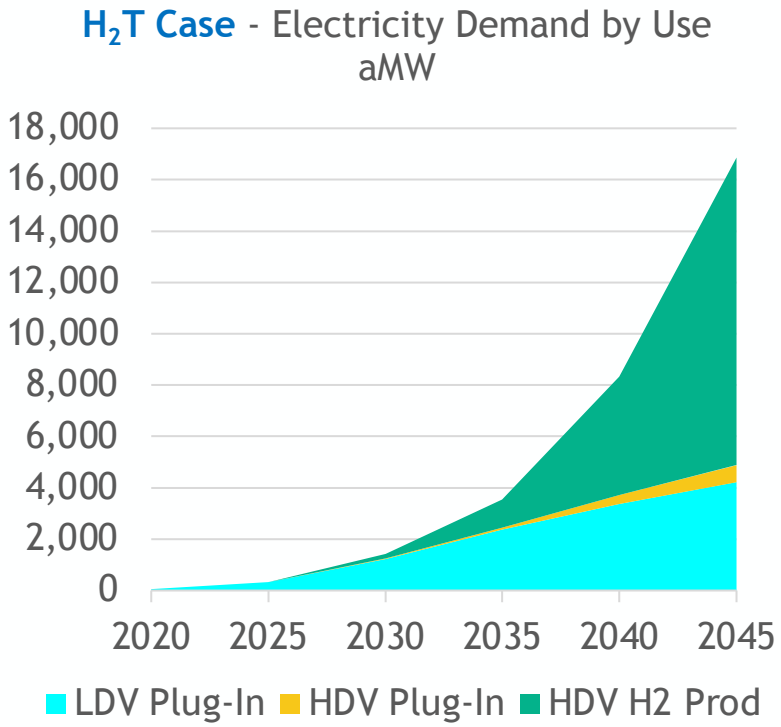


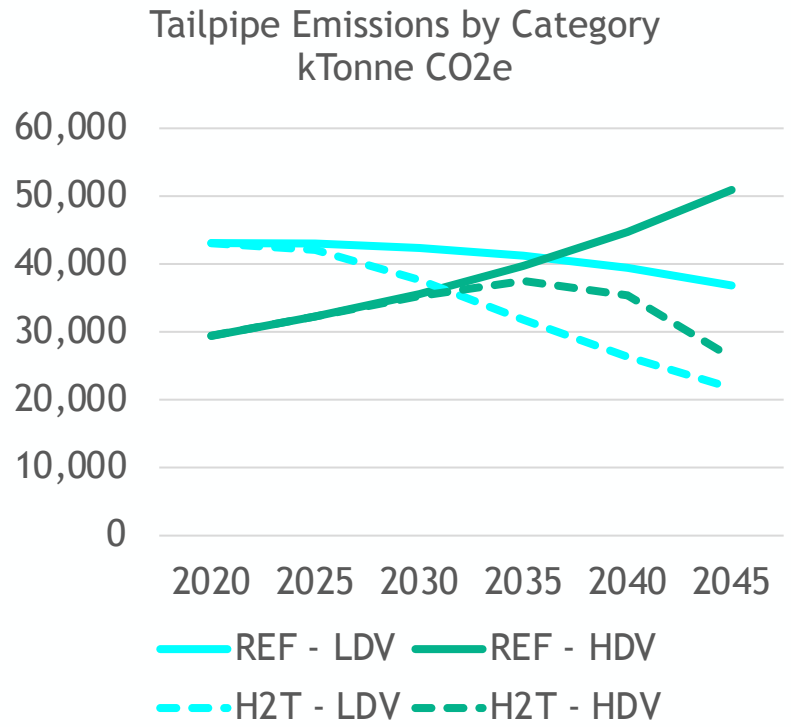
	2020	2025	2030	2035	2040	2045
REF	60	161	336	603	993	1,524
ELEC Only	63	332	1,246	2,475	3,771	4,954
H2T	63	332	1,436	3,570	8,367	16,934



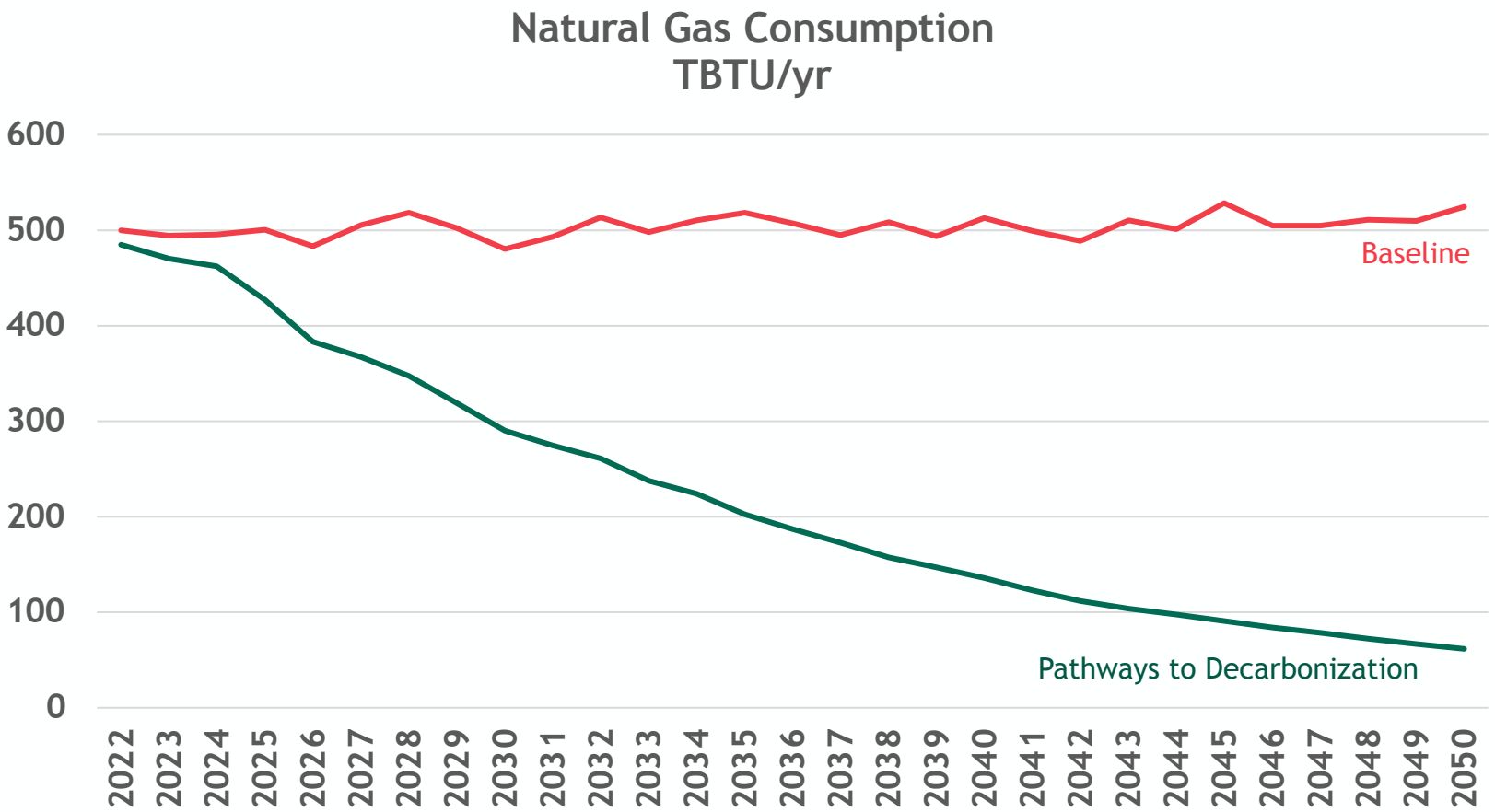
	2020	2025	2030	2035	2040	2045
REF	74,257	77,084	79,874	82,964	86,256	89,879
ELEC Only	74,232	76,156	75,034	72,803	70,756	70,240
H2T	74,232	76,156	74,750	71,112	63,325	49,332

More Results

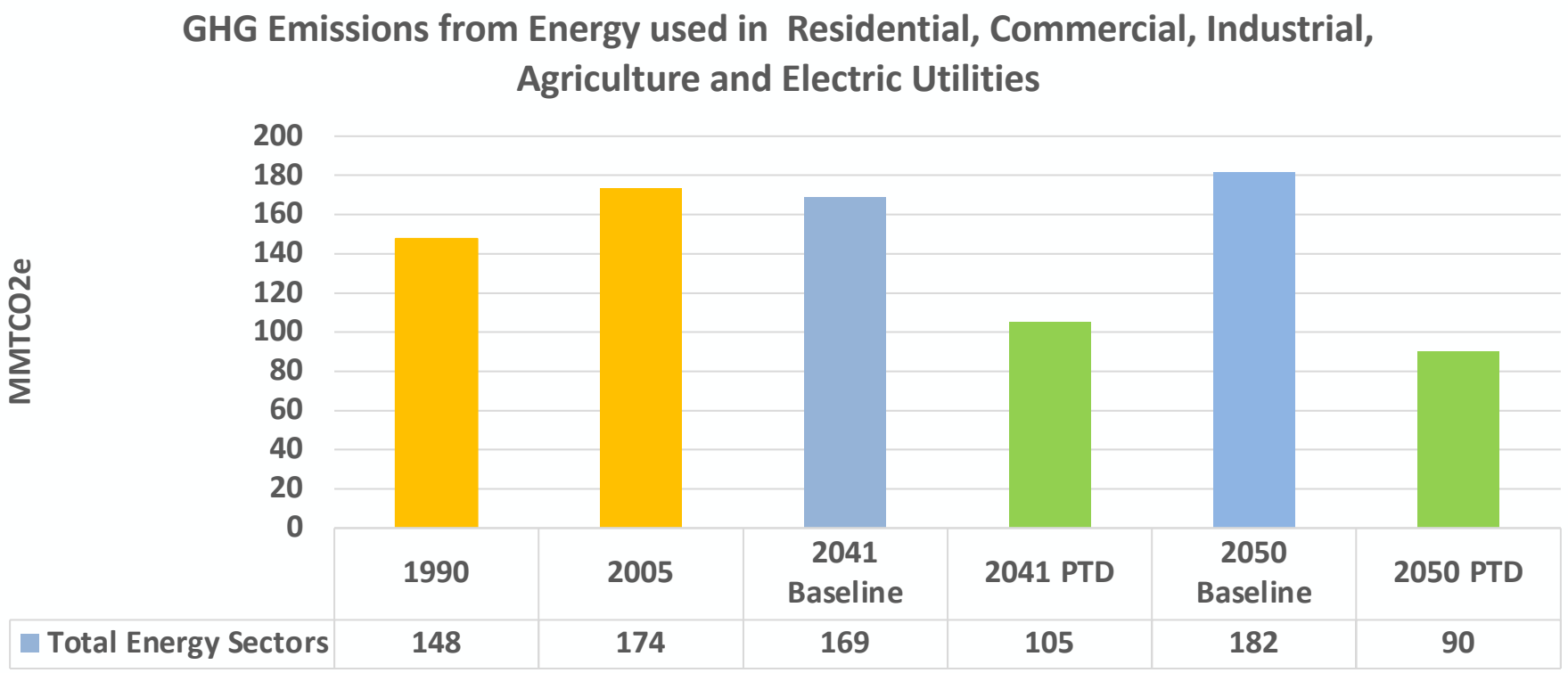




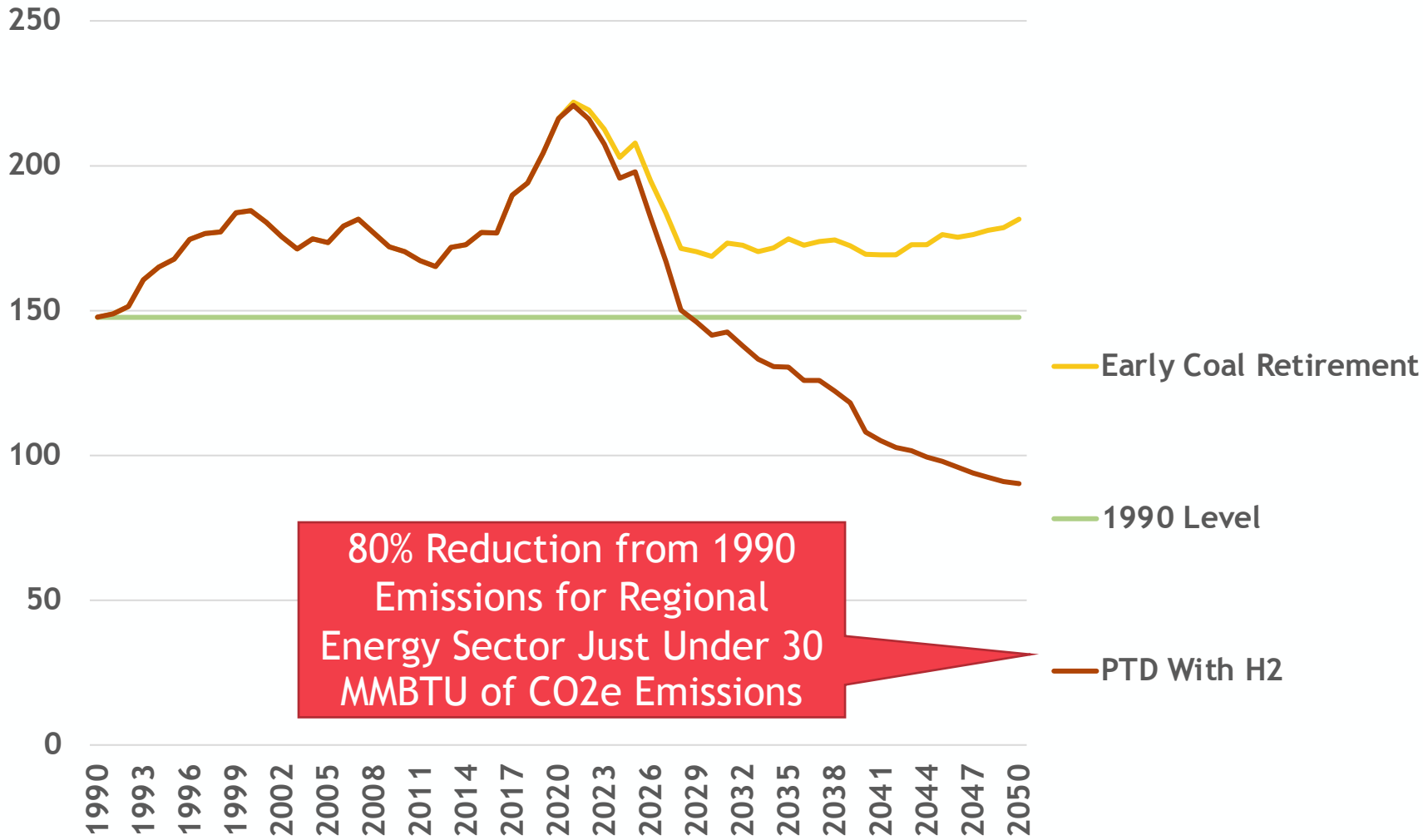
Natural Gas Consumption (Excludes Electric Utility Demand)



Where Does This Leave Us for Emissions from Energy Use in the Northwest?



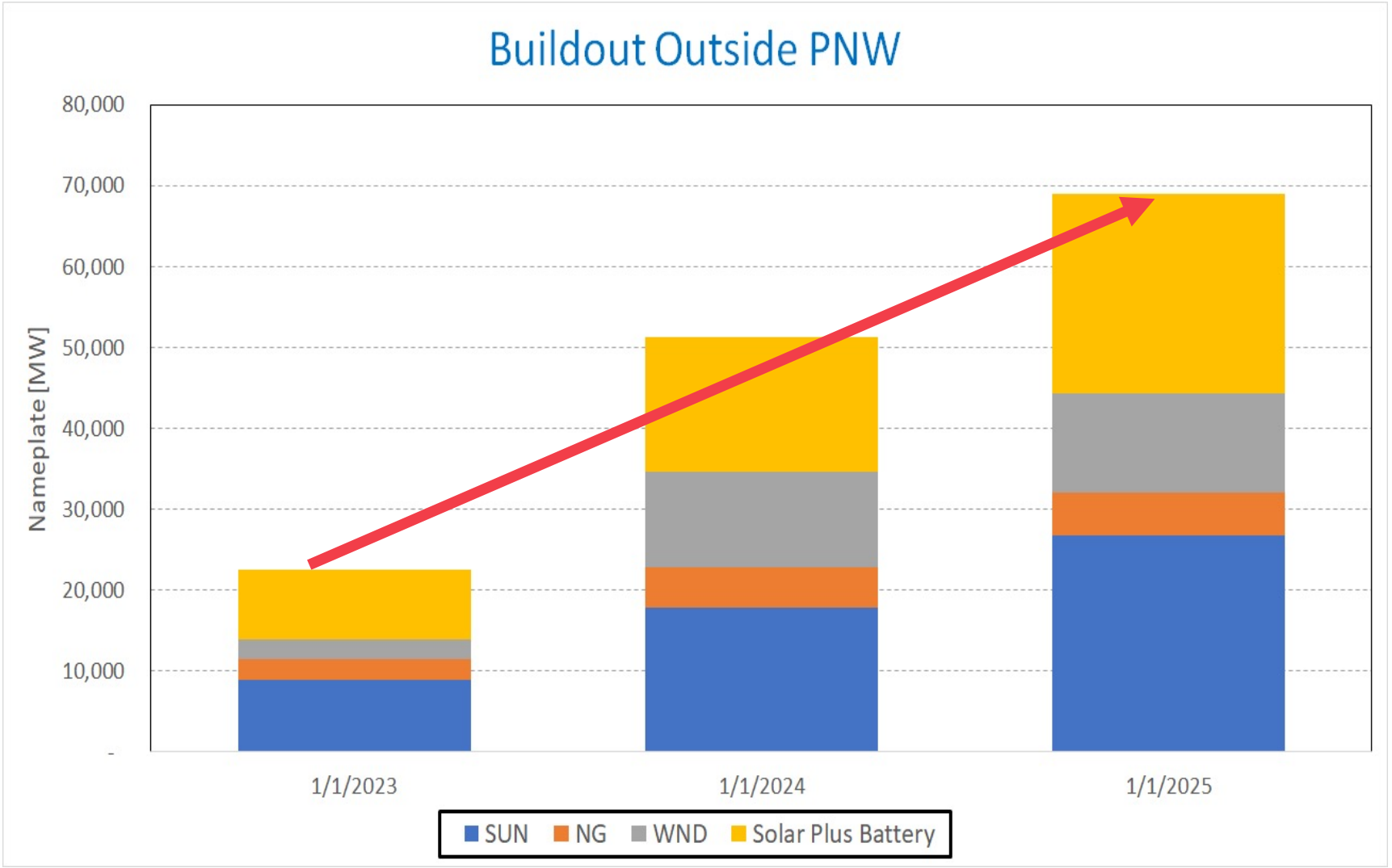
Decarbonization Looking at Energy Sector Falls Short of Targets



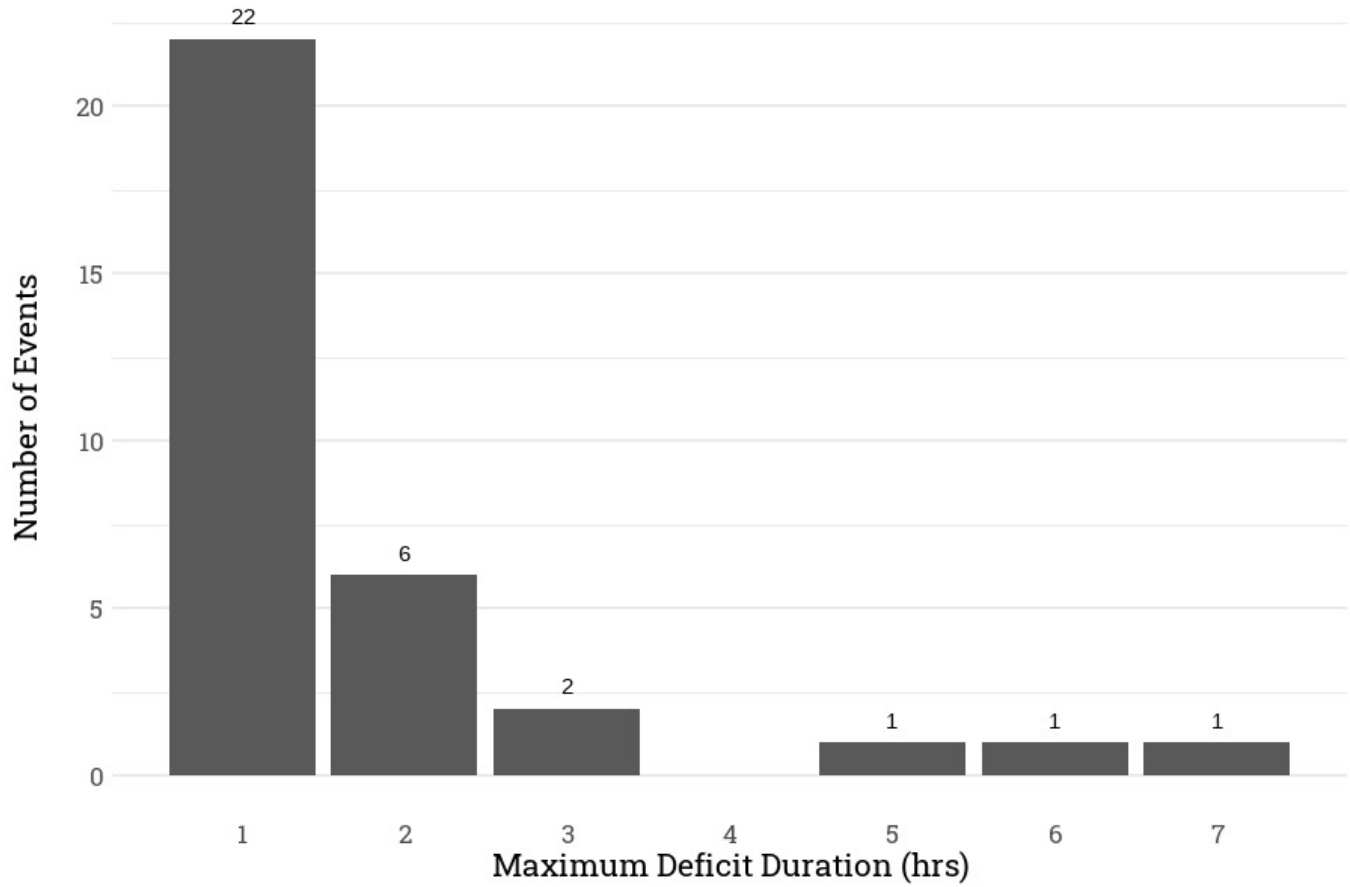
Adequacy Assessment

Large WECC Buildout Implied by Policy Goals

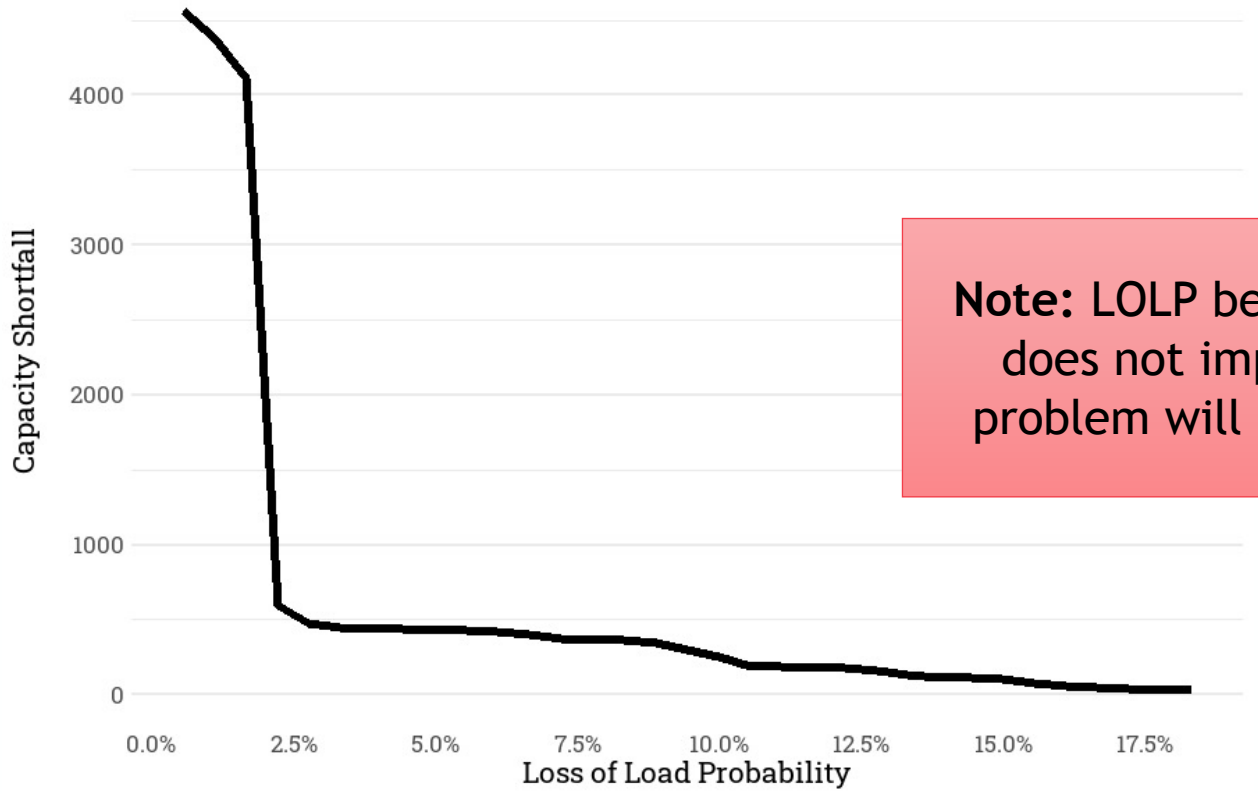
- Baseline has 70 GW of non-PNW buildout by 2025
- Buildouts were extensively reviewed by the SAAC
- Even with lower buildout, midday cheap market supply should increase
- GENESYS substantially limits market import
- With no WECC buildout the 2025 LOLP only increases to 2.2%



Deficits are Short Duration Events (2023)

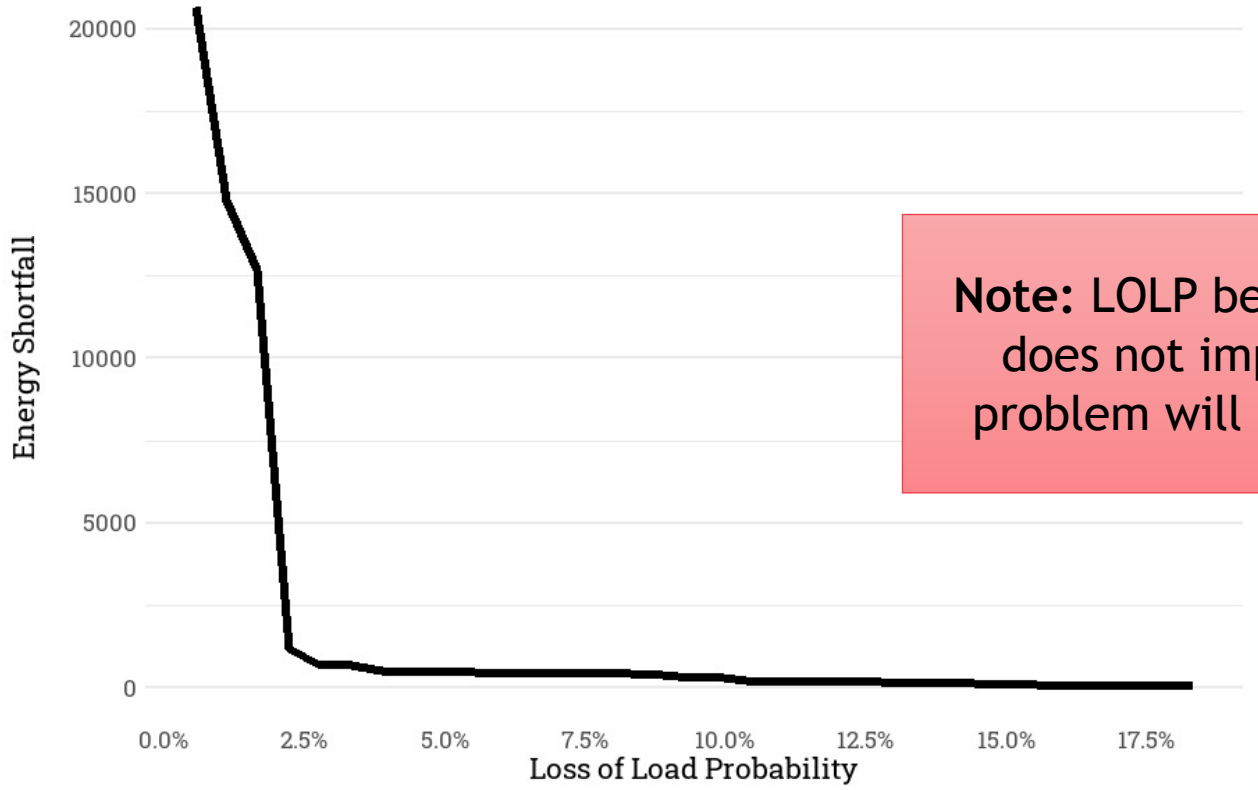


Capacity Shortfalls Tend to be Small (2023)



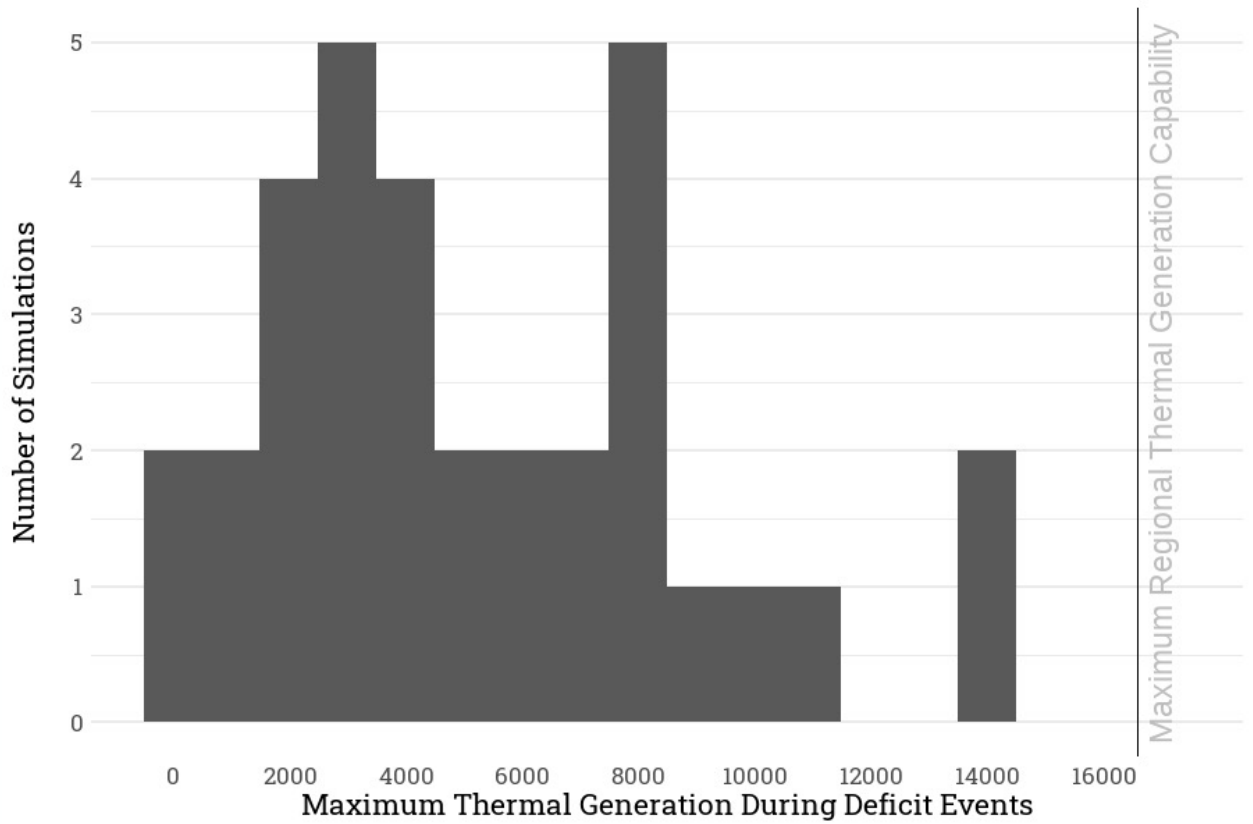
Note: LOLP being large does not imply the problem will be large

Energy Shortfalls Also Tend to be Small (2023)



Note: LOLP being large does not imply the problem will be large

Thermal Generation is Under-utilized During Deficit Events (2023)

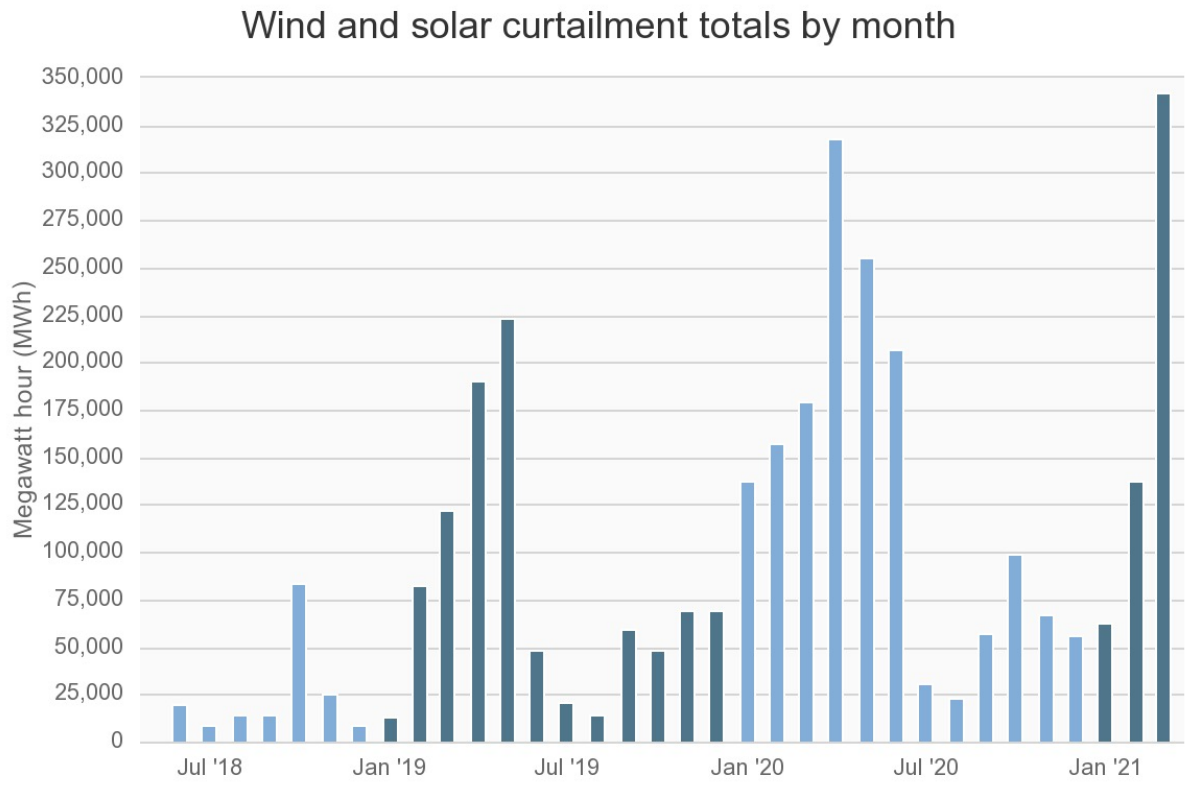


Load/Resource Balance

	2023	2025	1999 Analysis
LOLP[1]	12.8%	2.8%	≈ 24%
Energy L/R Balance[1]	2,409 aMW	1,983 aMW	≈ (4,000) aMW
Implied Reserve	11%	9%	
Winter Peak L/R Bal	6,192 MW	5,571 MW	
Implied Reserve	19%	17%	
Summer Peak L/R Bal	2,748 MW	2,421 MW	
Implied Reserve	9%	8%	

[1]Because the new GENESYS explicitly models unit commitment and market prices, the relationship between L/R balance and LOLP is not as intuitive as it was for the classic GENESYS model.

California Already Experiencing Ramping Issues Related to Renewables



Data Source:
http://www.caiso.com/informed/Pages/ManagingOversupply.aspx

Flexible Ramping Product:
https://www.oasis.oati.com/PPW/PPWdocs/2016-06-24_FlexibleRampingProduct_ER16-2023.pdf

https://www.caiso.com/Documents/DraftFinalTechnicalAppendix-FlexibleRampingProduct.pdf


Questions?

Additional Slides for Reference

Baseline Conditions

Fuel Burn Comparisons (Bcf – Million MMBTU)

	2019	2020	2022 Average	2022 Max
Natural Gas	237	231	122	331
Montana Coal	162	101	58	121
Wyoming Coal*	348	361	137	279
Idaho, Oregon, Washington	100	78	N/A	N/A

Note: All figures are for state-wide use to generate electricity, not all electricity generation would be represented in RPM because it is not used to serve regional load

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

Mountain West Buildout

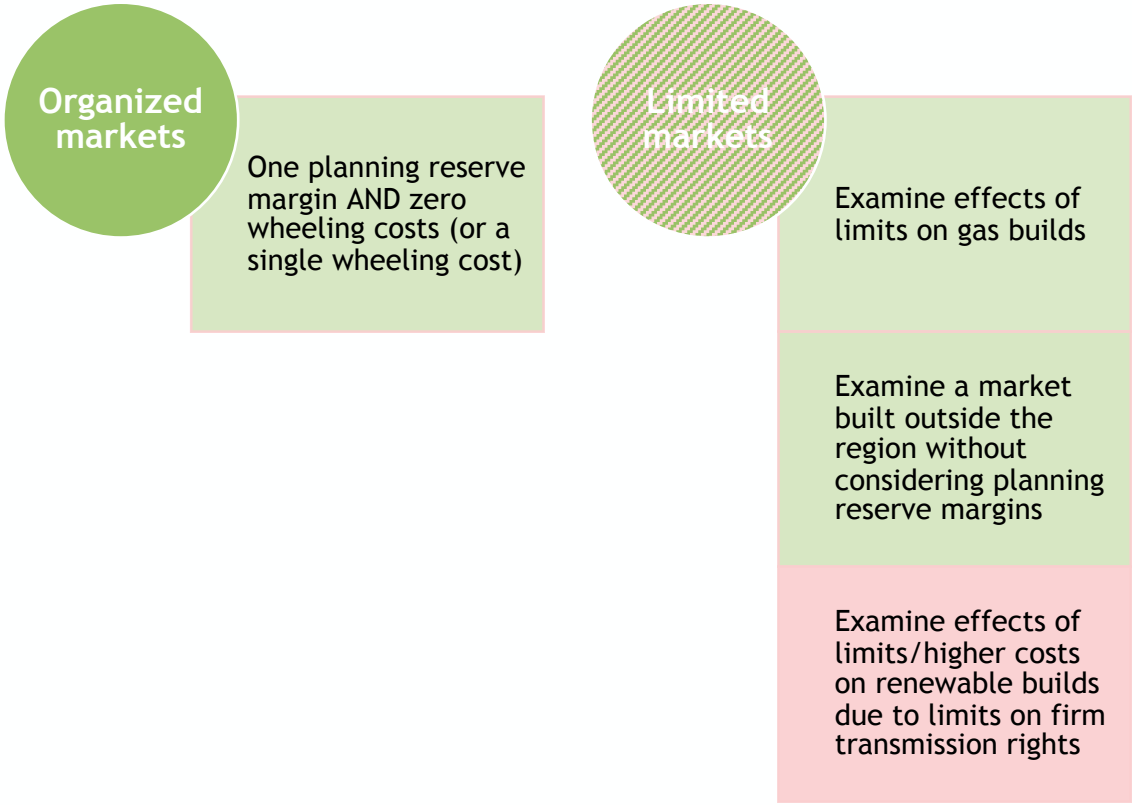
EE in 2021P World

- Renewables are competing directly with EE
  - No carbon emissions
  - Low cost with additional benefits (ITC and RECs)
  - Interruptible
- Low market prices that are *decreasing* over time reduce value of EE as a hedge
  - Only first couple bins of EE show negative long-term energy value (when CO2 prices are included)
- EE as an incremental build resource is less desirable than a immediate build generation resource

External Markets

Scenario Description

- Examine the impact on the resource strategy of organized or limited markets under different fundamental, structural and regulatory assumptions.
- We will also estimate changes to adequacy, market and reserve requirements where appropriate.



Solar and Solar Plus Storage Build Comparisons

Year	Baseline	Organized	Limited	No Gas Limit
2025	51,538	17,878	27,742	27,183
2030	89,838	26,374	42,077	47,270
2035	100,357	34,003	61,830	68,357
2040	135,054	38,629	98,642	109,221
2045	147,554	38,631	107,032	128,886

Year	Baseline	Organized	Limited	No Gas Limit
2025	46,600	48	1,907	1,041
2030	86,600	3,018	7,098	2,445
2035	145,500	9,140	7,860	2,954
2040	179,800	32,512	17,041	6,008
2045	198,000	46,488	27,598	7,167

Battery and Pumped Storage Build Comparisons

Year	Baseline	Organized	Limited	No Gas Limit
2025	6,004	70,984	23,491	22,846
2030	6,004	70,984	23,558	22,846
2035	6,004	70,984	23,690	22,846
2040	6,004	101,951	23,974	22,846
2045	6,055	154,270	26,622	24,773

Year	Baseline	Organized	Limited	No Gas Limit
2025	0	0	400	0
2030	4,900	0	800	0
2035	5,650	1,500	800	2,700
2040	6,050	3,400	800	2,700
2045	9,690	11,940	8,440	2,700

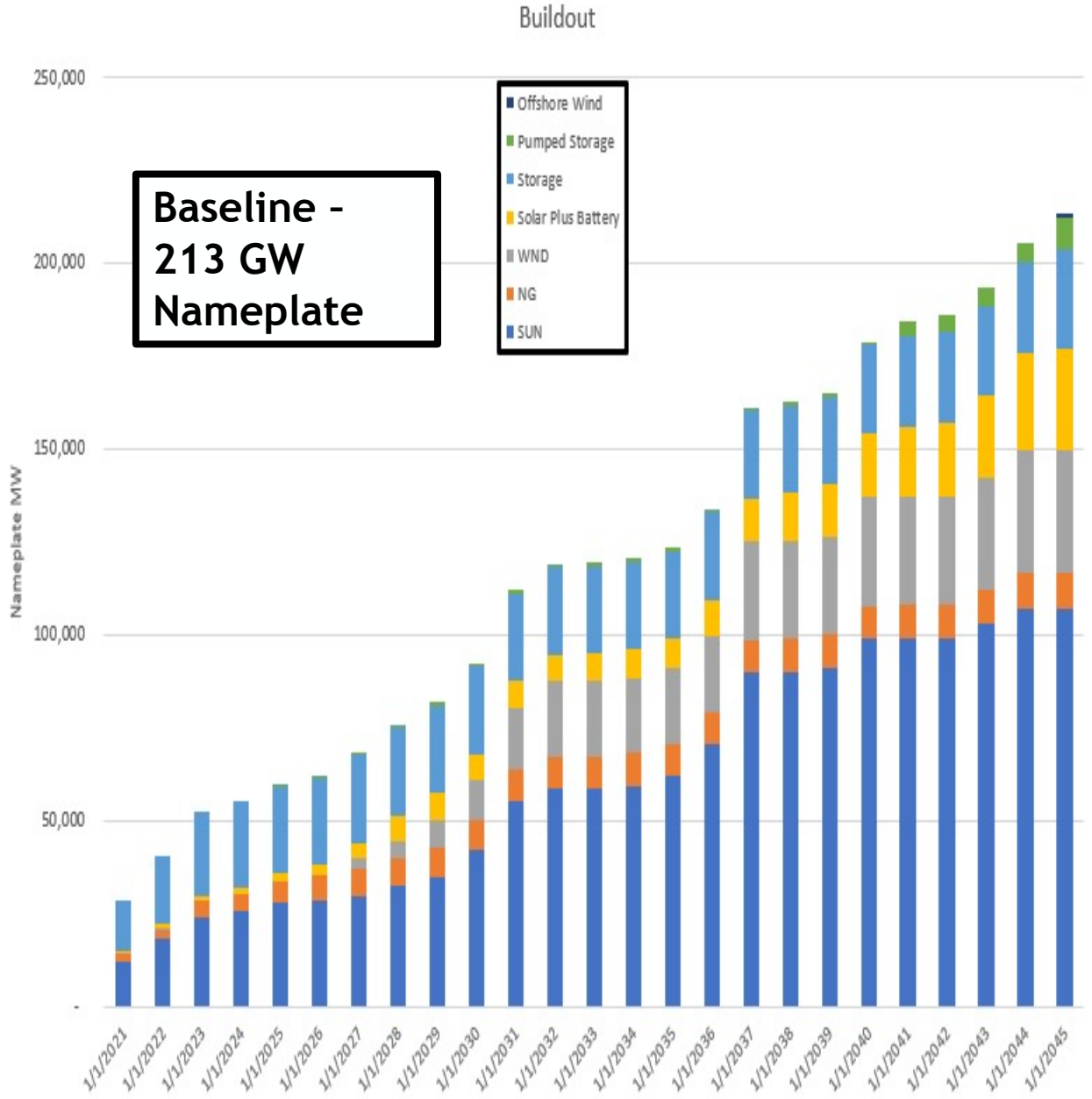
Wind and Gas Build Comparisons

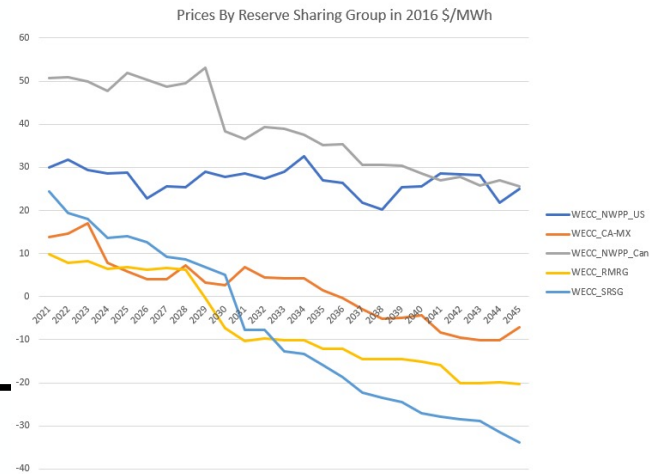
Year	Baseline	Organized	Limited	No Gas Limit
2025	16,775	9,172	110	1,600
2030	35,175	27,526	10,425	7,069
2035	37,063	44,611	20,247	18,354
2040	43,657	74,737	29,255	31,481
2045	51,481	95,394	33,937	32,959

Year	Baseline	Organized	Limited	No Gas Limit
2025	11,351	13,716	5,904	21,003
2030	14,873	17,814	8,192	31,154
2035	16,058	19,824	8,666	38,118
2040	16,532	20,641	8,956	49,407
2045	16,532	20,641	9,536	67,605

Limited Market (No PRM)

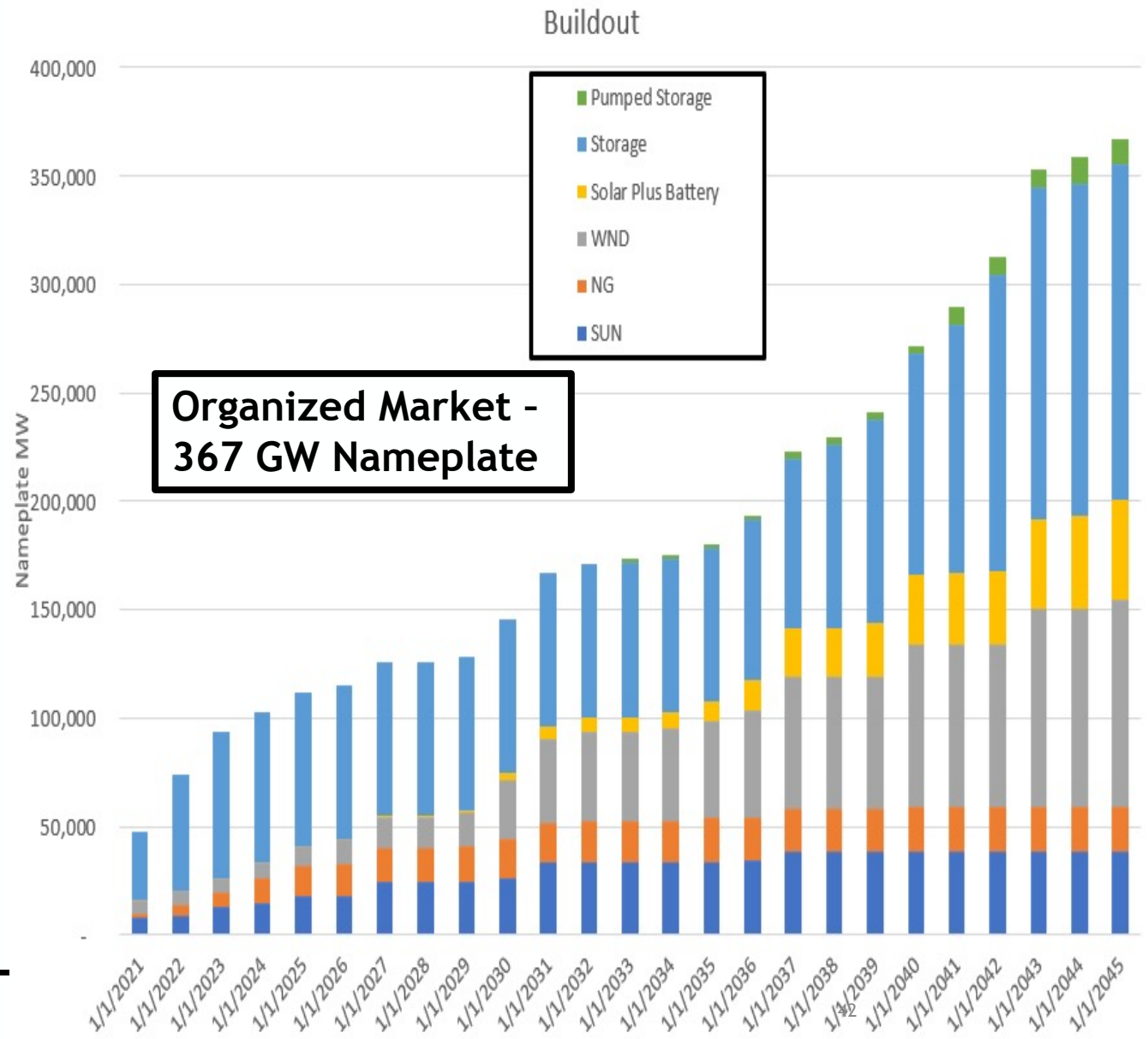
1. Planning reserve margins are missed nearly immediately primarily in California.
2. Clean/RPS Policies met until 2030
3. Prices are low in non-NWPP regions, but volatile





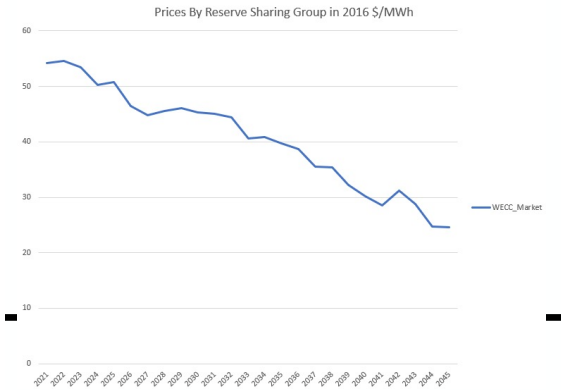
THE 2021 NORTHWEST POWER PLAN

Organized Market (preliminary results)



Simulated market starts in 2021

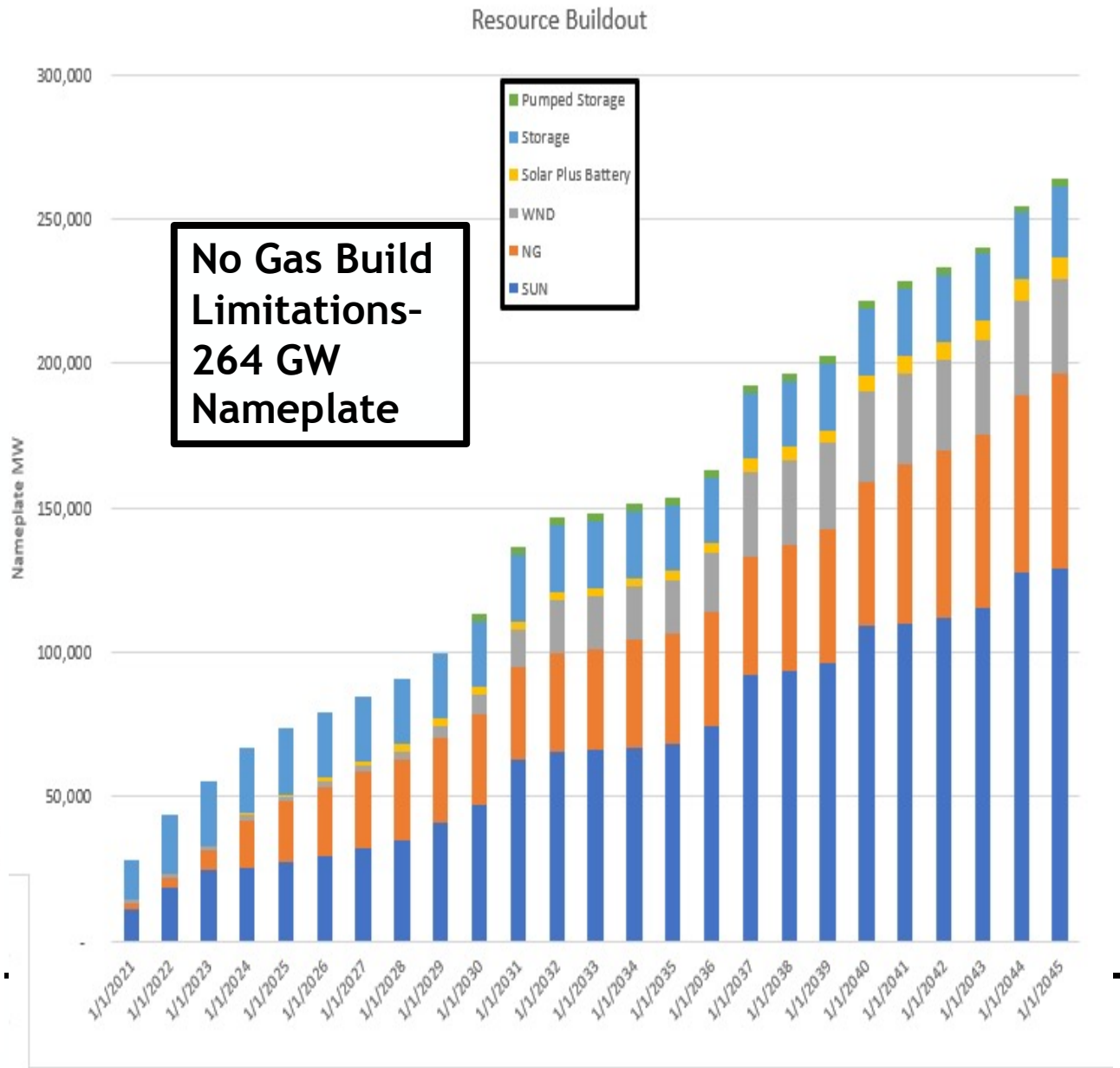
1. Planning reserve margins are met consistently, but system not adequate
2. Clean/RPS Policies met until late 2020s
3. WECC Prices drop

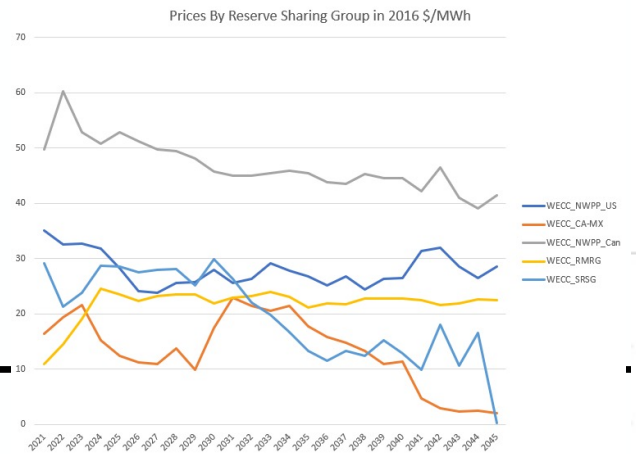


THE 2021 NORTHWEST POWER PLAN

No Gas Build Limitations

1. Planning reserve margins are met consistently
2. Clean/RPS Policies met until 2030
3. Gas stays on the margin more often.

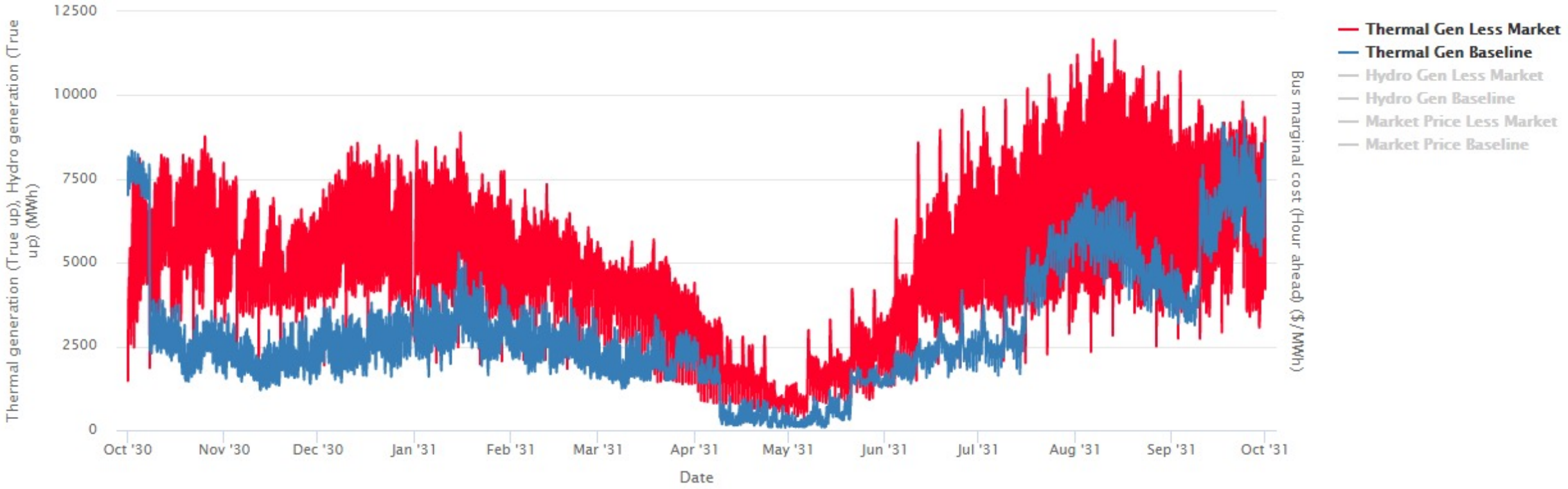




THE 2021 NORTHWEST POWER PLAN

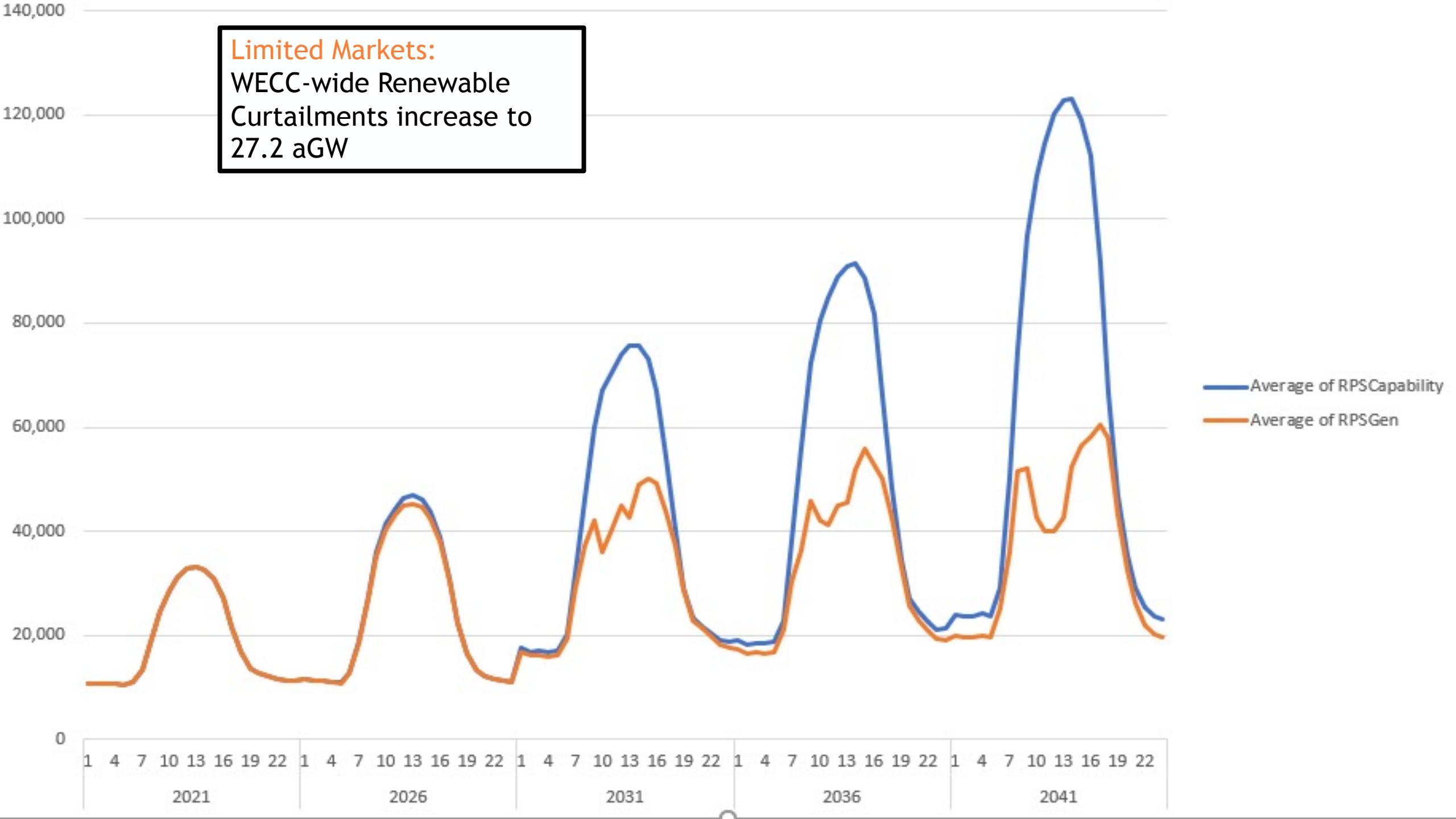
Why Did the Limited Market Not Have More Needs?

The Commitment of Thermals



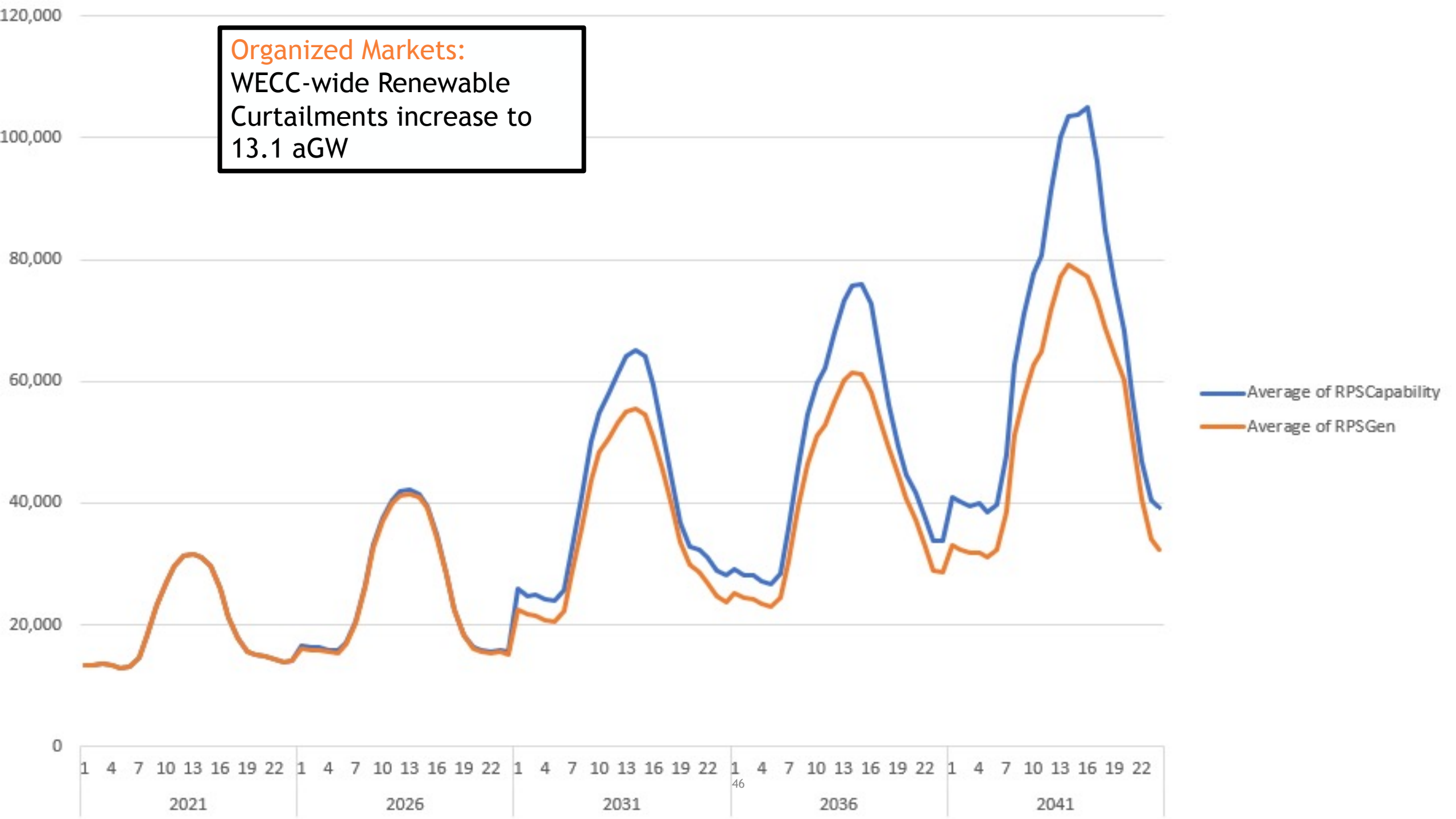
Higher prices means more thermal units are committed, which positions the regional fleet better for adequacy issues.

Limited Markets:
WECC-wide Renewable Curtailments increase to 27.2 aGW



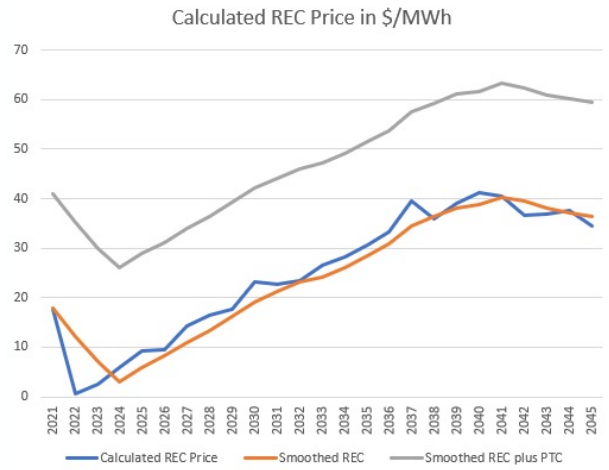
Organized Markets:

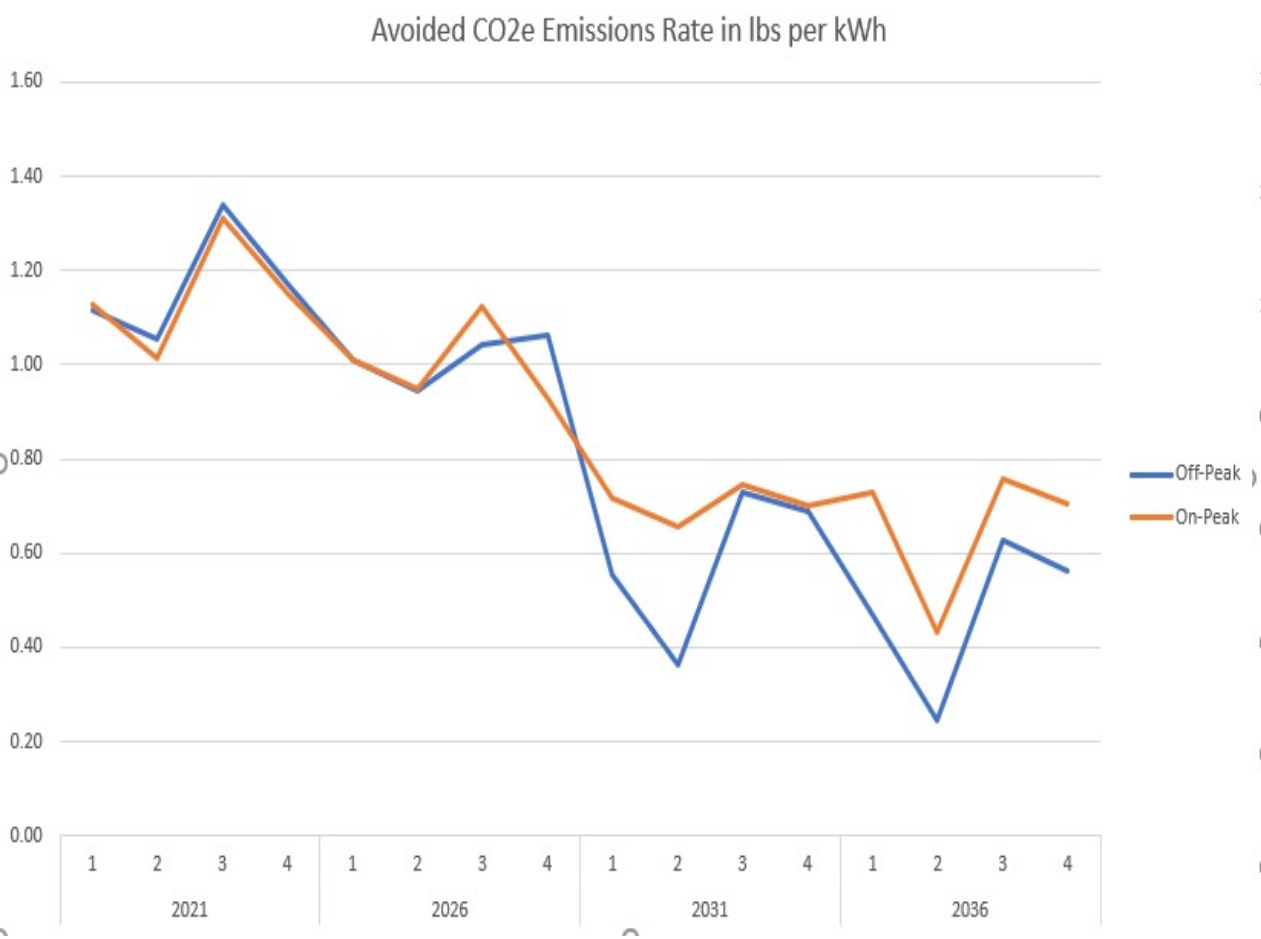
WECC-wide Renewable Curtailments increase to 13.1 aGW

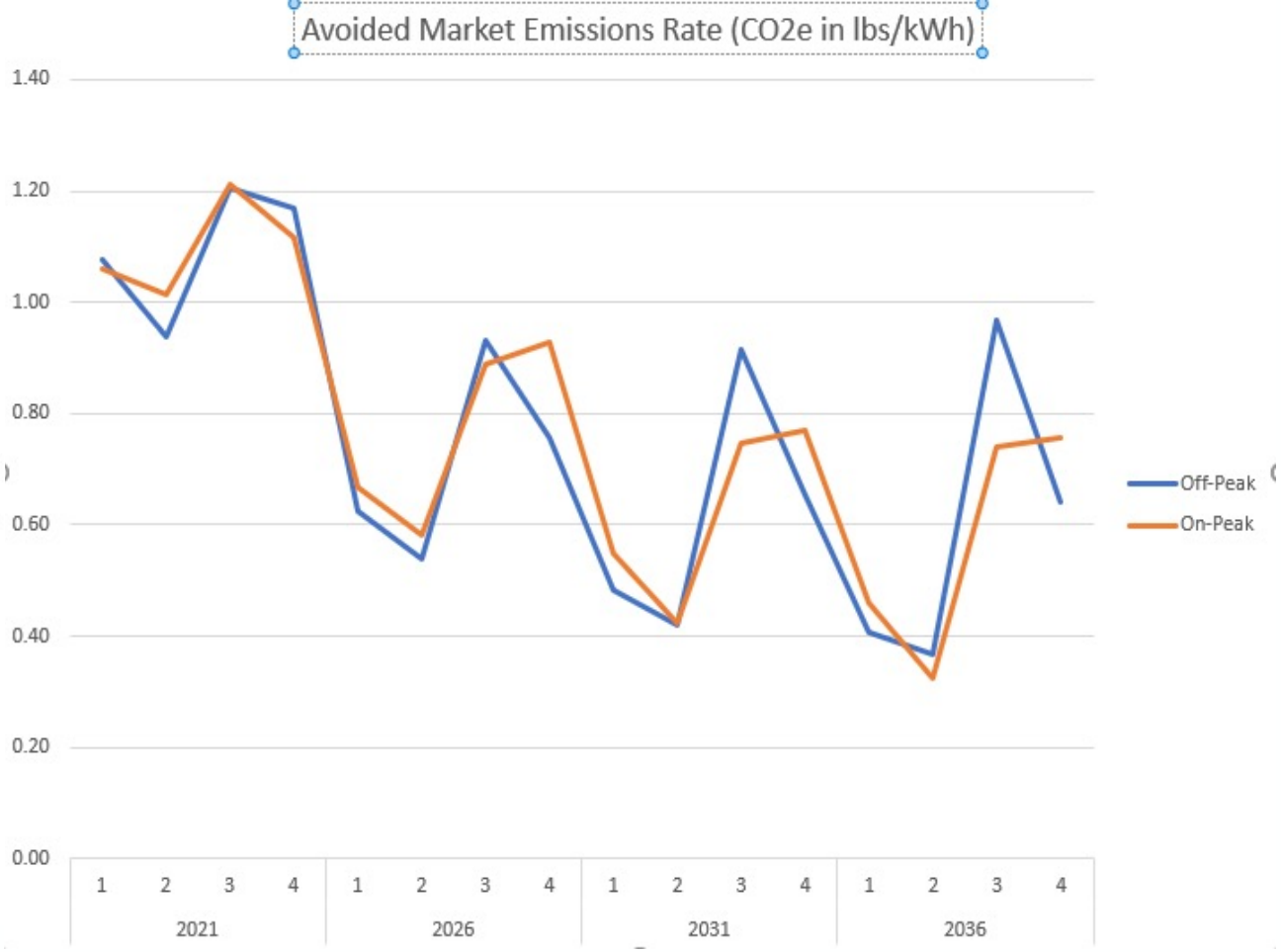


Caveats About Market Studies

- Baseline build is adequate throughout study, all the rest of the builds are less adequate.
  - Adequate in the context of AURORA means minimal or zero load control events.
- Baseline build meets RPS and Clean constraints until late 2030's with current REC price forecast, the rest of the builds have significant risk of missing clean targets persistently.
  - Higher prices enforcing clean credit than RECs
  - Load shifting to time of clean energy use







Organized Markets

Baseline

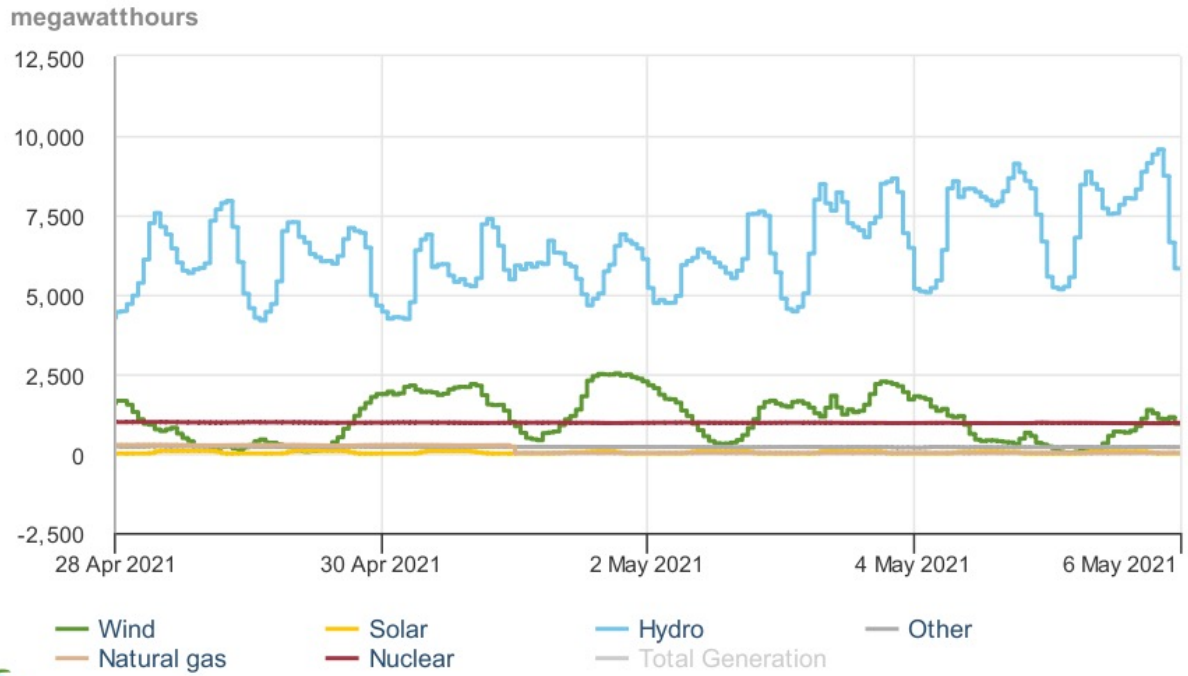
1) Emissions rate starts a little higher in summer, but goes lower than baseline
2) On-peak avoided emissions rate stays around emissions rate of combined cycle gas units.
3) Off-peak avoided emissions rate goes lower than the baseline late in the study. (Less thermal units providing flexibility due to large battery build)

Adequacy Assessment

Current Hourly Operations Show Discretionary Hydro and Thermal Generation Pushed to Ramps and Overnight Periods

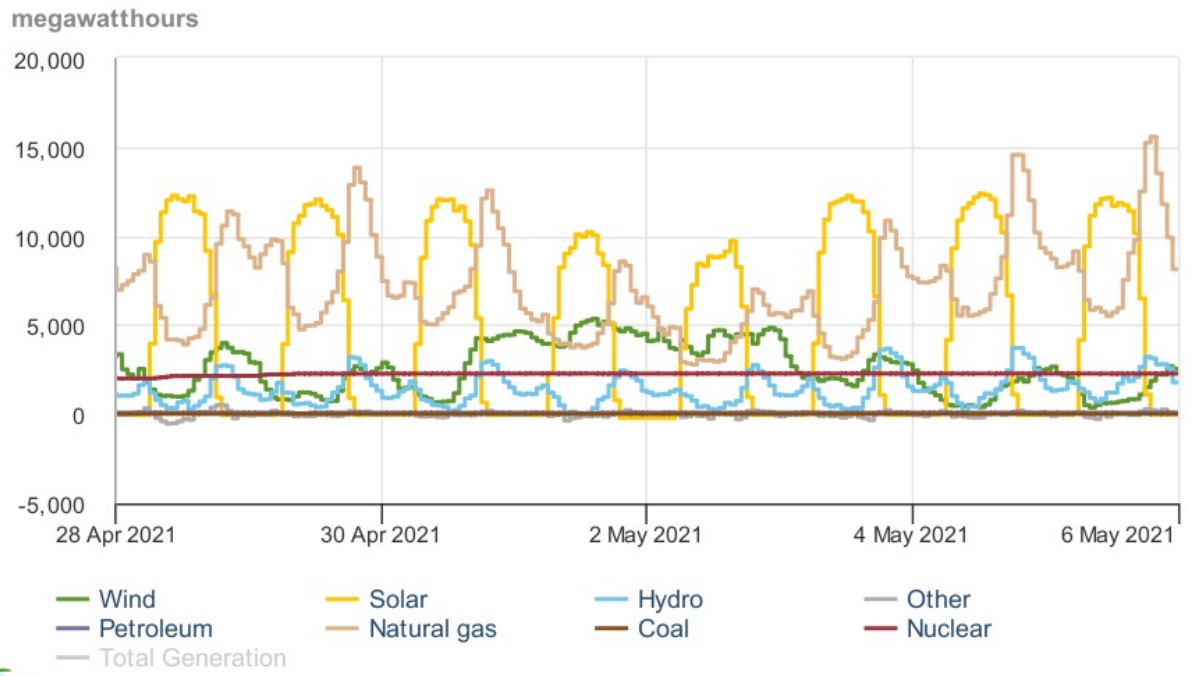
https://www.eia.gov/electricity/gridmonitor/dashboard/

Bonneville Power Administration (BPAT) electricity generation by energy source 4/28/2021 – 5/5/2021, Pacific Time



eia Source: U.S. Energy Information Administration

California Independent System Operator (CISO) electricity generation by energy source 4/28/2021 – 5/5/2021, Pacific Time



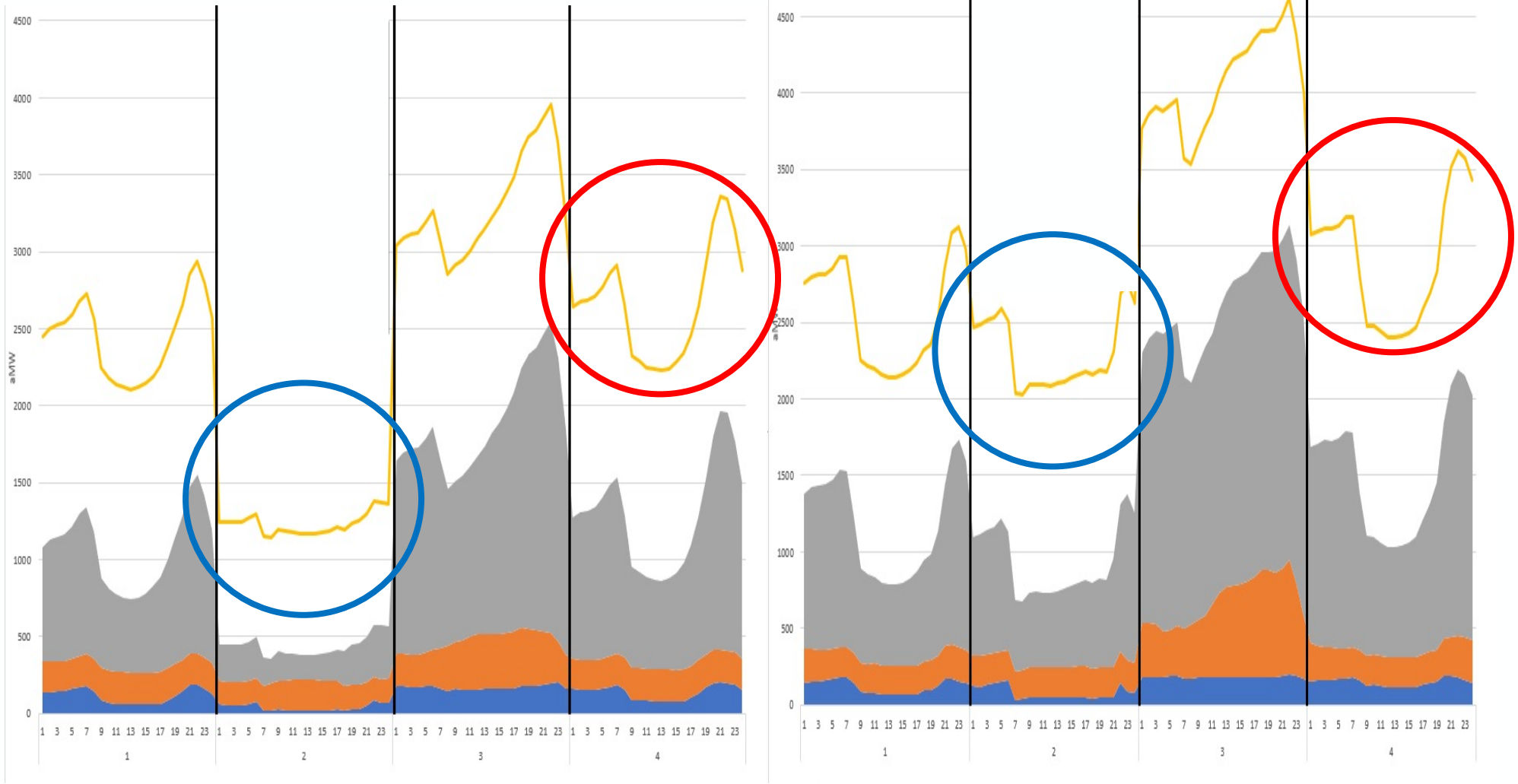
eia Source: U.S. Energy Information Administration

Illustration of Unit Commitment Effects on Thermal Generation

2023

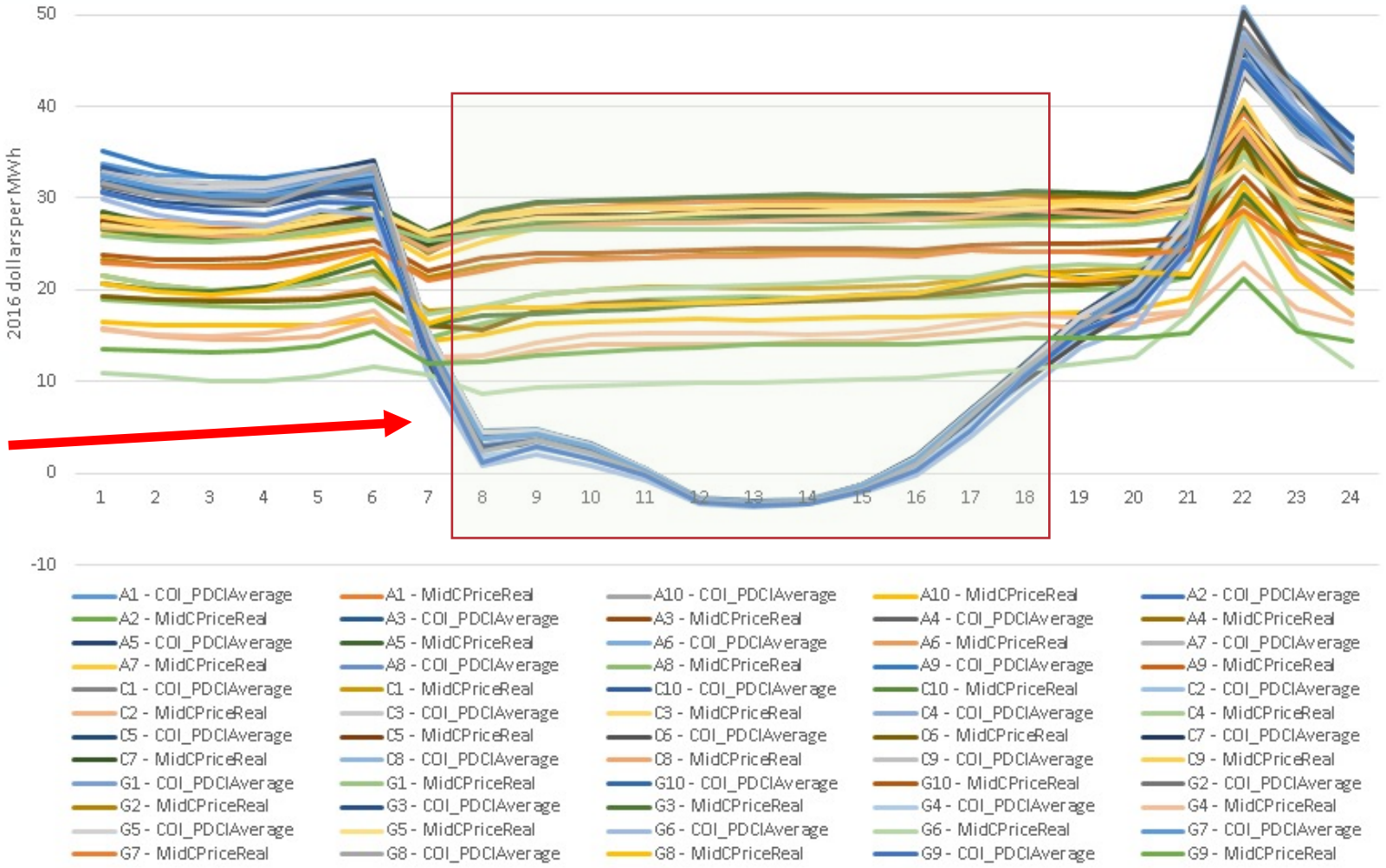
2027 (Bridger2, N Valmy2, Centralia 2 retire)

All
CCCT
SCCT
Coal



Expected Summer Market Prices

Daily period when the market supply from California is cheaper than mid-C prices



Summer Market Expected Daily Shape for 30 CC Hydro Conditions

Market Assumptions

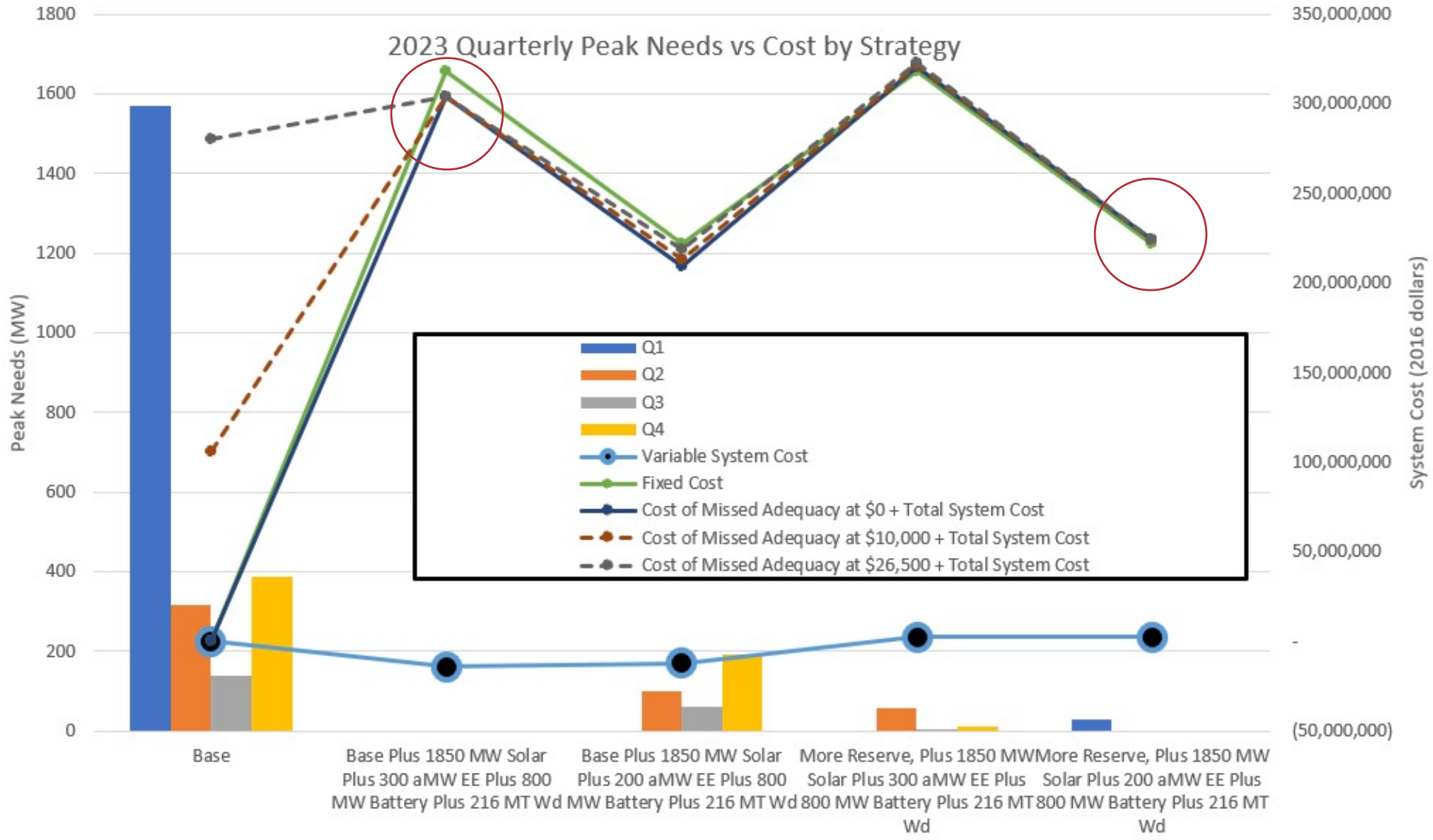
Resource	Classic GENESYS	Redeveloped GENESYS
Winter SW spot market	2,500 MW any hour	2,500 MW net, any hour
Winter SW purchase ahead	3,000 MW 8 hours (10pm to 6am)	2,500 MW net, any hour
Winter IPP availability	2,400 MW	2,400 MW
Total winter hourly max import	3,400 MW	2,500 MW
Summer SW spot market	1,250 MW 5 hours (9am to 2pm)	1,250 MW net, any hour
Summer SW purchase ahead	None	1,250 MW net, any hour
Total summer hourly max import	1,250 MW	1,250 MW
Summer IPP availability	2,400 MW 10 hours (8am to 6pm)	2,400 MW

Effect of added reserves and WECC buildout

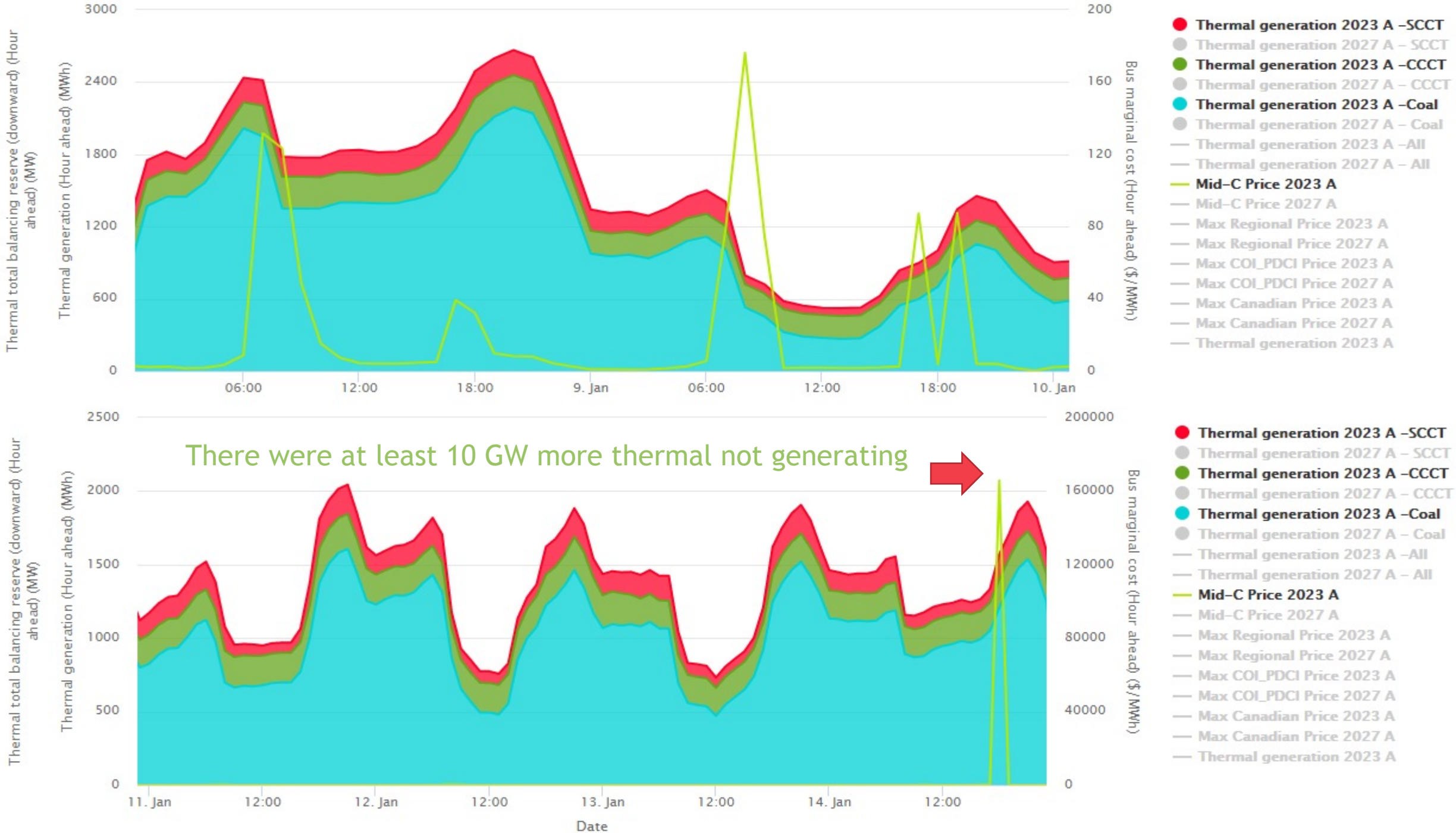
LOLP	2023	2025
Classic GENESYS	15.7%	22.6%
New GENESYS	32.0%	1.7%
Classic with 10 hours market availability		21.5%
Classic with 15 hours market		15.2%
Classic with 18 hours market		7.6%
Classic with 15 hours market + additional 1K borrowed hydro		6.0%
Classic with 15 hours market + additional 2K borrowed hydro		1.2%
New model with no WECC buildout		2.2%
New model with higher reserves	9%	

Load/Resource Balance	ELCC	Average Energy 2023	Average Energy 2025	Capacity 2023	Capacity 2025
Avg Load		21972	21947		
Winter Peak Load				32498	32589
Summer Peak Load				32140	31937
Avg Contract		445	445		
Winter Peak Contract				1039	1039
Summer Peak Contract				1586	1586
Reserves		0	0	0	0
Wind	0.25	1824	1824		
Wind Winter	0.13			948	948
Wind Summer	0.30			2189	2189
Solar	0.46	505	505		
Solar Winter	0.37			406	406
Solar Summer	0.50			549	549
Thermal (NP * .85)		10479	10029		
Thermal Winter				12838	12308
Thermal Summer				11819	11289
Hydro		12018	12018		
2-hr Sus Hydro Winter				25537	25537
2-hr Sus Hydro Summer				21918	21918
L/R Balance		**2409**	**1983**		
L/R Winter				**6192**	**5571**
L/R Summer				**2748**	**2421**
Implied Reserve		**11%**	**9%**	**19%**	**17%**
Implied Reserve				**9%**	**8%**

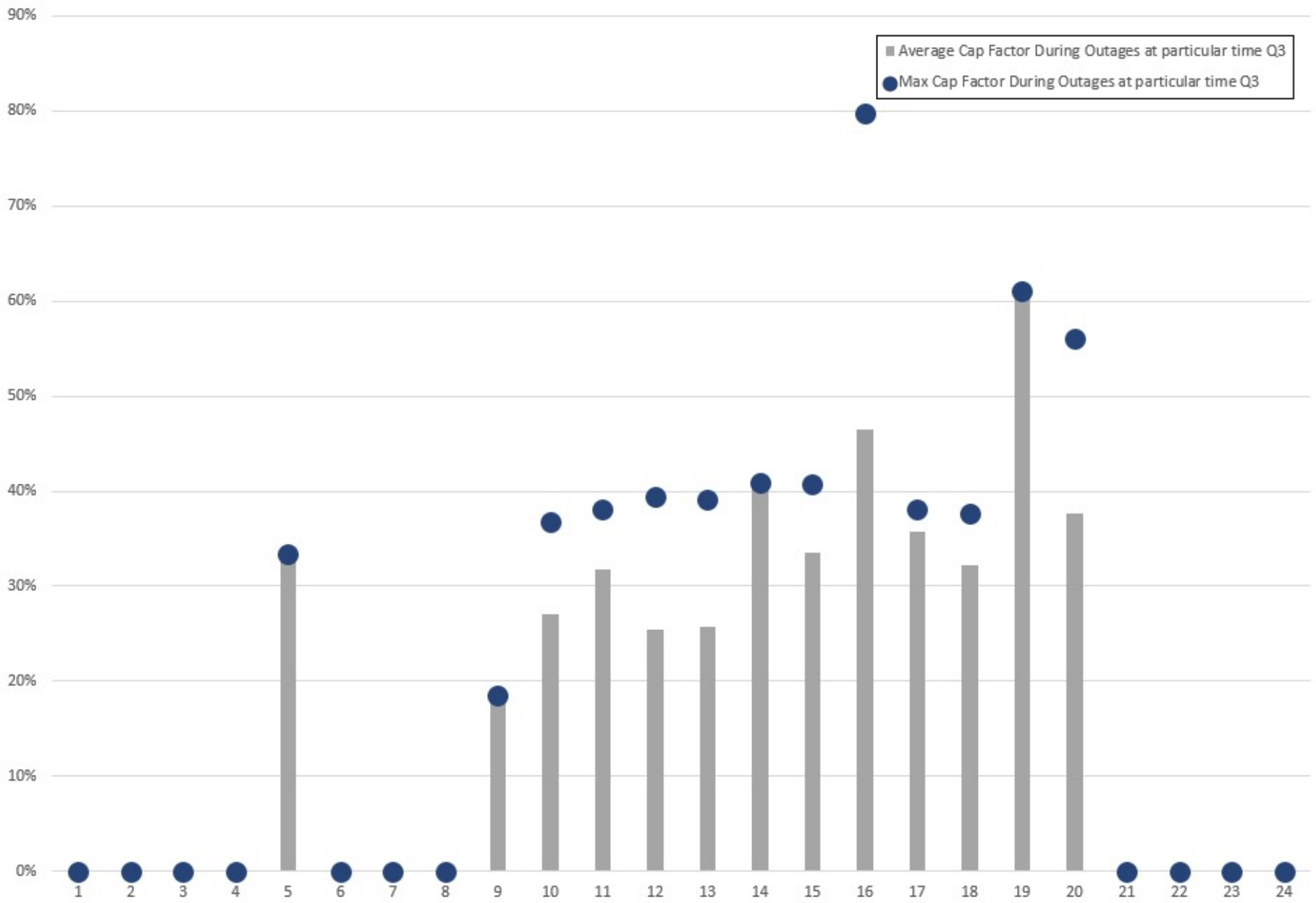
Solar Nameplate	1097	1097
Wind Nameplate	10859	10859
NW Wind NP	7295	7295



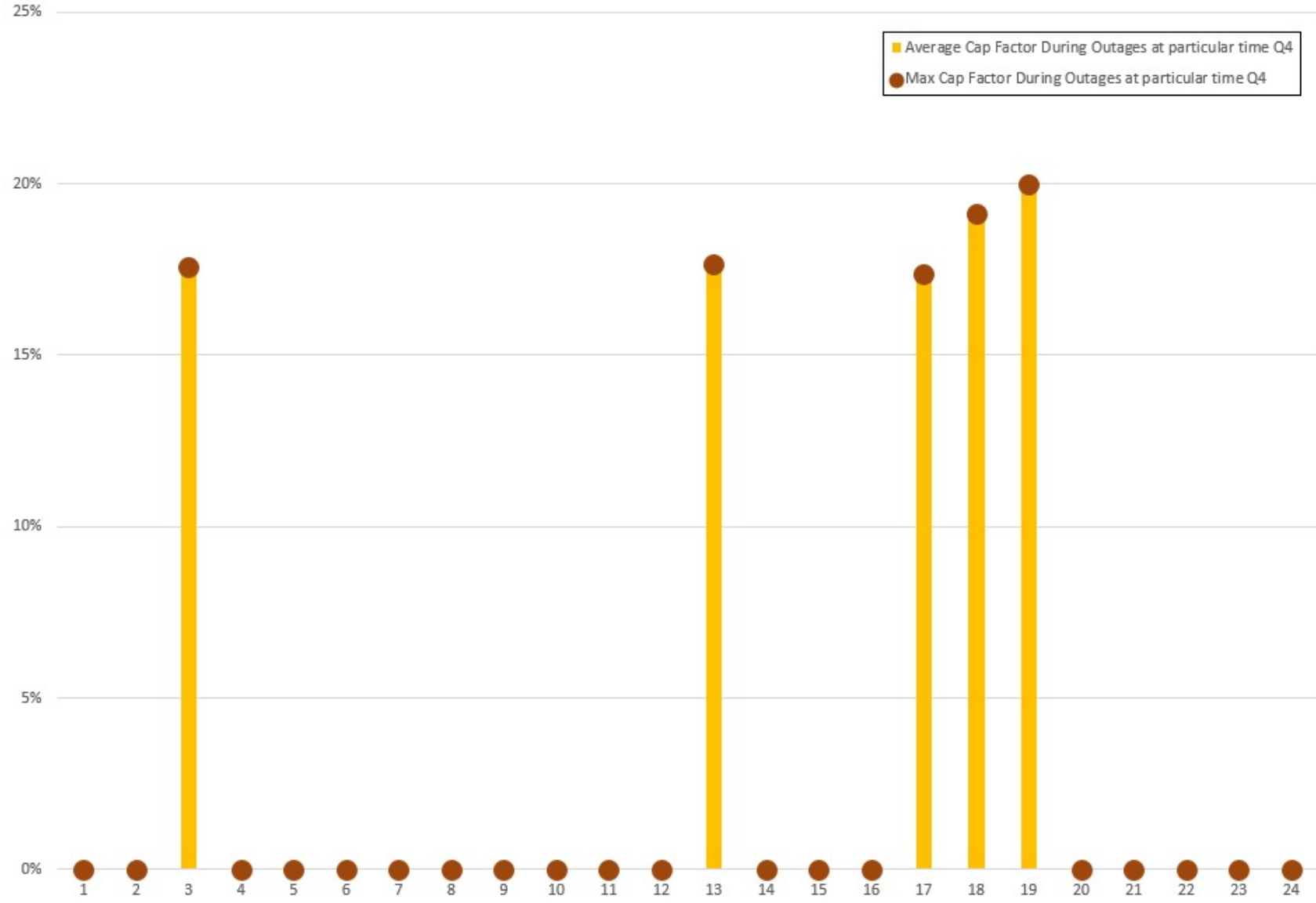
More EE or More Conservative Utilization of Existing System?


Thermal total balancing reserve (downward) (Hour ahead) (MW)
Thermal generation (Hour ahead) (MWh)
Bus marginal cost (Hour ahead) ($/MWh)
3000
2400
1800
1200
600
0
200
160
120
80
40
0
06:00
12:00
18:00
9. Jan
06:00
12:00
18:00
10. Jan
Thermal generation 2023 A –SCCT
Thermal generation 2027 A – SCCT
Thermal generation 2023 A –CCCT
Thermal generation 2027 A – CCCT
Thermal generation 2023 A –Coal
Thermal generation 2027 A – Coal
Thermal generation 2023 A –All
Thermal generation 2027 A – All
Mid–C Price 2023 A
Mid–C Price 2027 A
Max Regional Price 2023 A
Max Regional Price 2027 A
Max COI_PDCI Price 2023 A
Max COI_PDCI Price 2027 A
Max Canadian Price 2023 A
Max Canadian Price 2027 A
Thermal generation 2023 A
There were at least 10 GW more thermal not generating
Thermal total balancing reserve (downward) (Hour ahead) (MW)
Thermal generation (Hour ahead) (MWh)
Bus marginal cost (Hour ahead) ($/MWh)
2500
2000
1500
1000
500
0
200000
160000
120000
80000
40000
0
11. Jan
12:00
12. Jan
12:00
13. Jan
12:00
14. Jan
12:00
Date
Thermal generation 2023 A –SCCT
Thermal generation 2027 A – SCCT
Thermal generation 2023 A –CCCT
Thermal generation 2027 A – CCCT
Thermal generation 2023 A –Coal
Thermal generation 2027 A – Coal
Thermal generation 2023 A –All
Thermal generation 2027 A – All
Mid–C Price 2023 A
Mid–C Price 2027 A
Max Regional Price 2023 A
Max Regional Price 2027 A
Max COI_PDCI Price 2023 A
Max COI_PDCI Price 2027 A
Max Canadian Price 2023 A
Max Canadian Price 2027 A
Thermal generation 2023 A

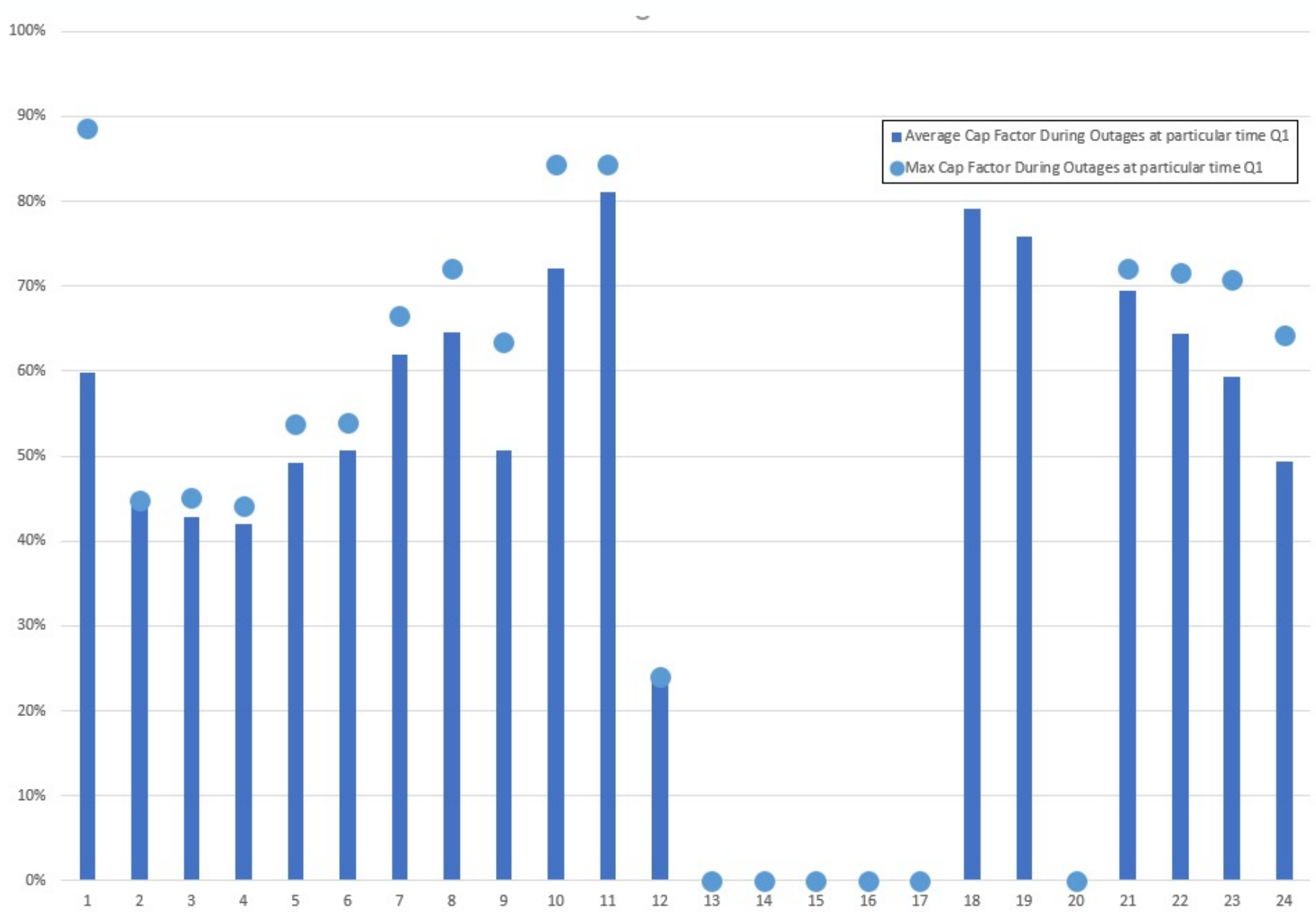
2023 Summer Thermal Generation Capacity Factors During Outages Always Lower Than 80%



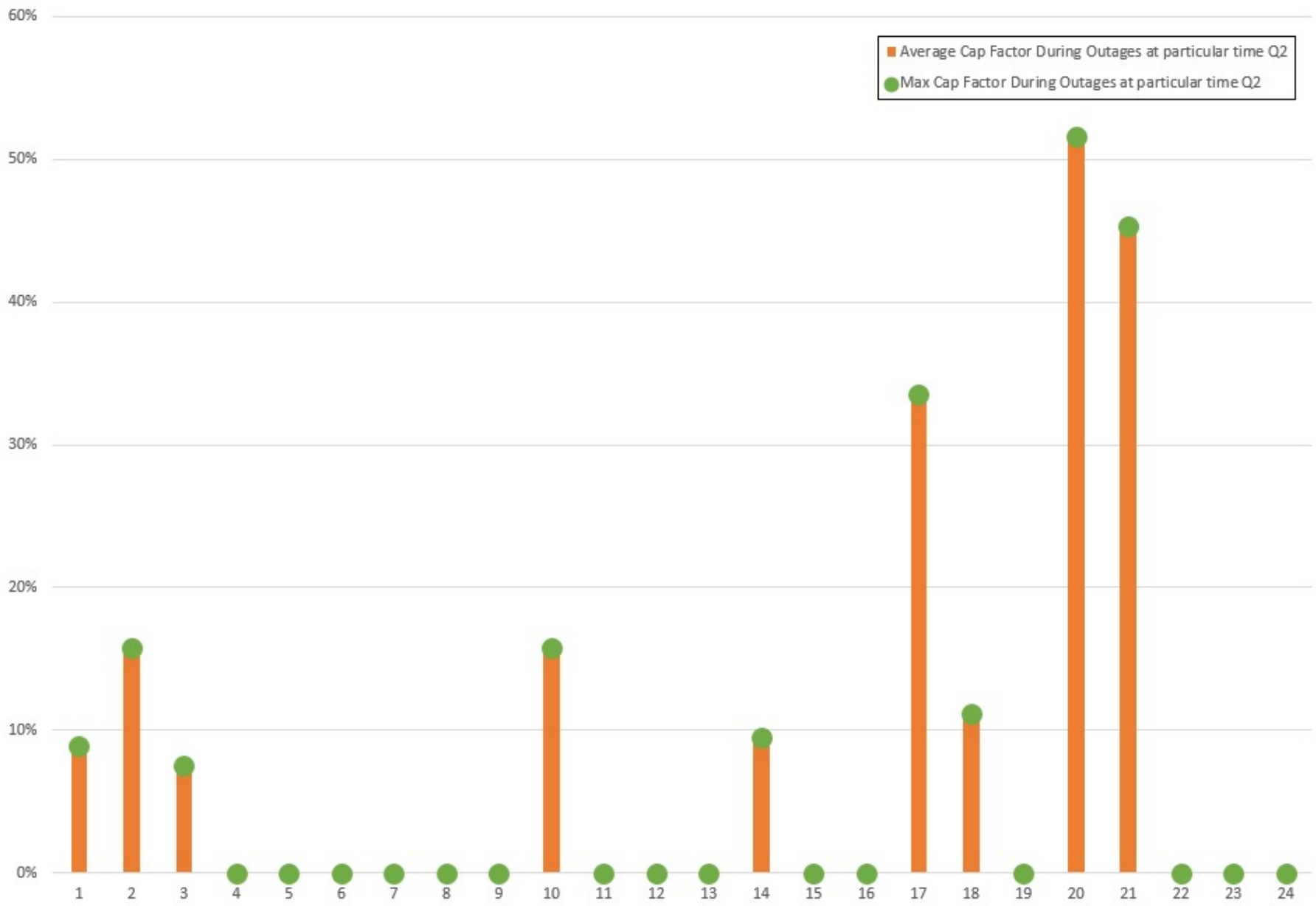
2023 Fall Thermal Generation Capacity Factors During Outages Always Lower Than 20%



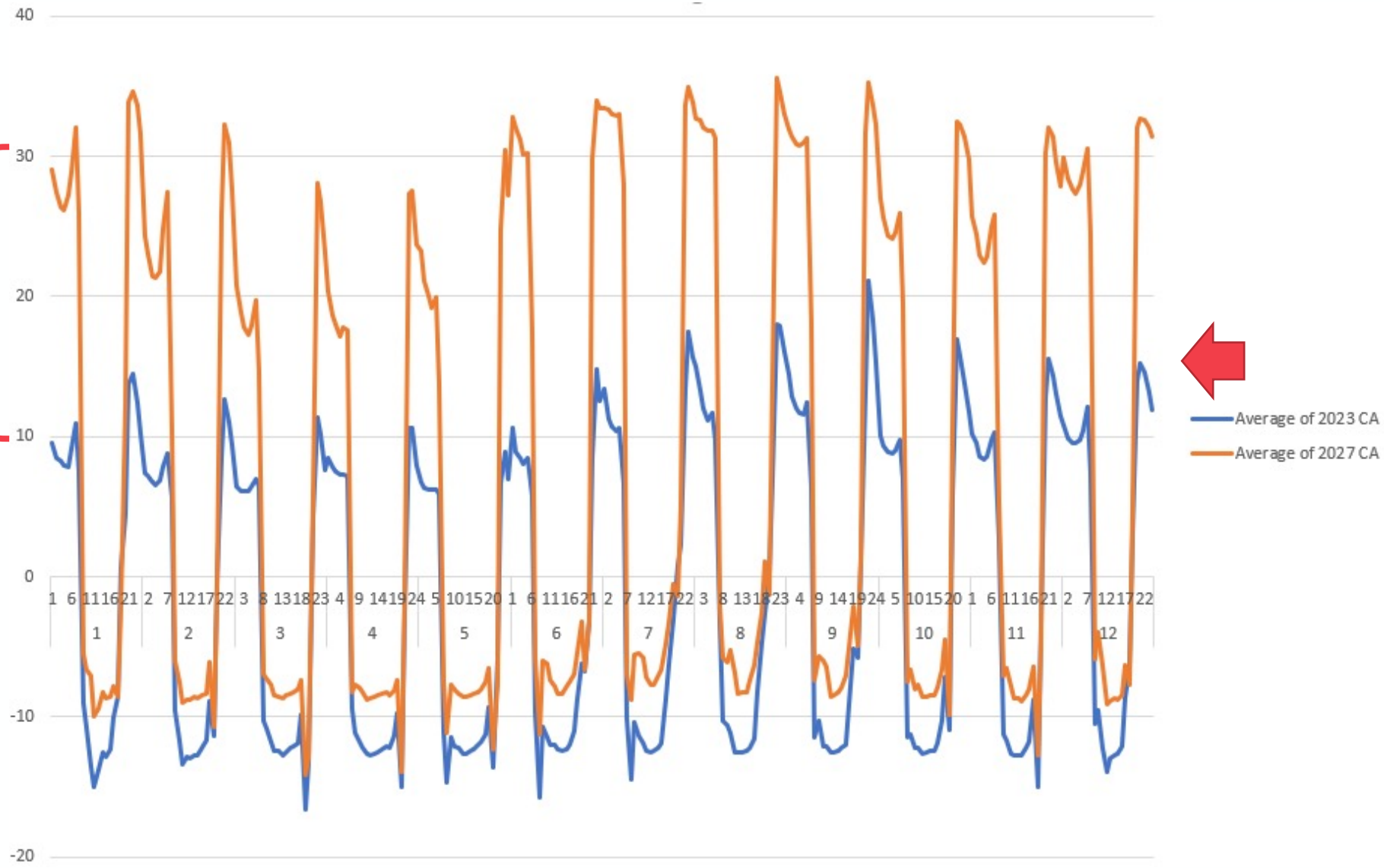
2023 Winter Thermal Generation Capacity Factors During Outages Always Lower Than 90%



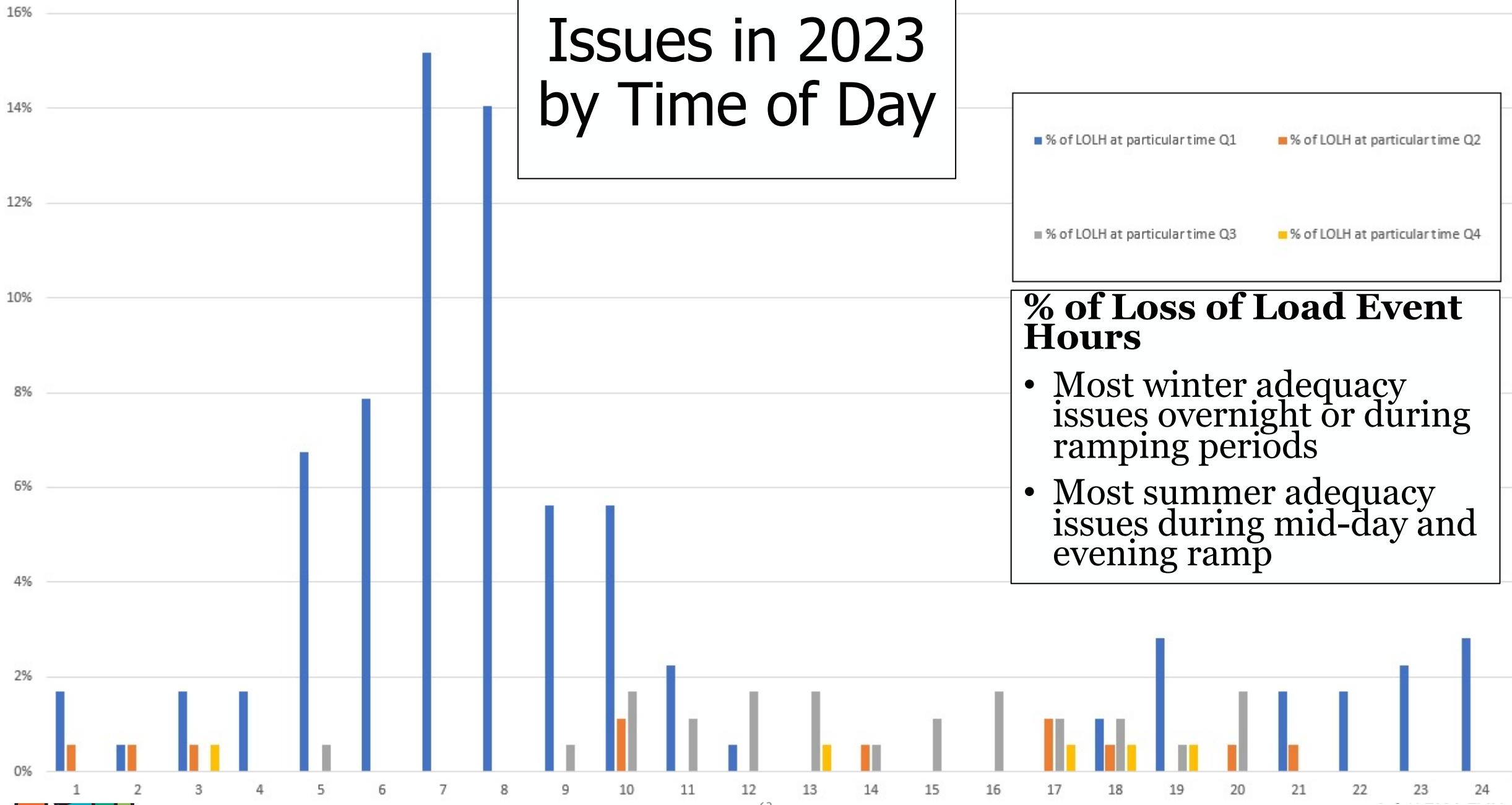
2023 Spring Thermal Generation Capacity Factors During Outages Always Lower Than 55%



Loads are Higher in 2027 which Leads to Higher Prices Overnight Supporting More Thermal Commitment



Issues in 2023 by Time of Day



% of Loss of Load Event Hours

- Most winter adequacy issues overnight or during ramping periods
- Most summer adequacy issues during mid-day and evening ramp