April 27, 2021

MEMORANDUM

TO: **Council Members**

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

SUBJECT: **Markets Related Scenario Findings**

BACKGROUND:

Presenter: John Ollis and Ben Kujala

Summary: This scenario explores some of the changing structural and fundamental drivers of the market and its interactions with resources available to the region. Some of the explorations look at implications of a WECC-wide organized market, a market reflecting current policies but not built to reserve margins, and markets where resource build is limited by regulation or current contract structures. We have been assessing the implied changes in regional needs and analyzing resource strategies to highlight potential risks and benefits or different markets.

Relevance: External market supply changes associated with projected extremely high renewable resource builds have surfaced as a key area of stakeholder concern in this plan per the advent of significant statewide/ municipal policies and utility goals. In the process of developing the WECC buildout for the baseline, the council and its advisory committees have discussed the effects of limited resources available for builds, insufficient reserve margins, and opportunities to increase regional coordination. This scenario is to help understand the impact of some of these uncertainties and frame the regional discussion.

Workplan: A.6.1 Complete scenario analysis for the plan

More Info: Simulation results related to this scenario were discussed at the following recent meetings:

March 31st System Analysis Advisory Committee (SAAC)

April 7th Power Committee

April 14th SAAC

April 21st Power Committee Webinar

Organized and Limited Market Scenario

Council Meeting

May 5, 2021

John Ollis, Ben Kujala

THE 2021
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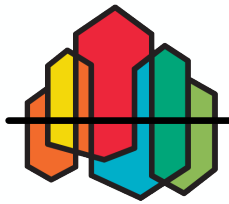
POWER PLAN
FOR A SECURE & AFFORDABLE
ENERGY FUTURE

Summary

- Discuss methodological approaches and setup for markets for energy and capacity scenario
- Review high-level takeaways from buildouts from AURORA for the following sensitivities:
  1. *Organized Market*
  2. *Limited Market (ignore reserve margins)*
  3. *No Gas Build Limitations*
- Discuss needs assessment and resource strategy results from the *Organized Markets* and *Limited Markets* sensitivities



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.

Organized markets

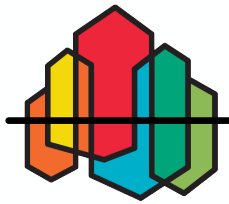
One planning reserve margin AND zero wheeling costs (or a single wheeling cost)

Limited markets

Examine effects of limits on gas builds

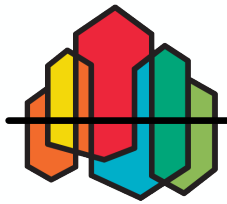
Examine a market built outside the region without considering planning reserve margins

Examine effects of removing regional renewable builds



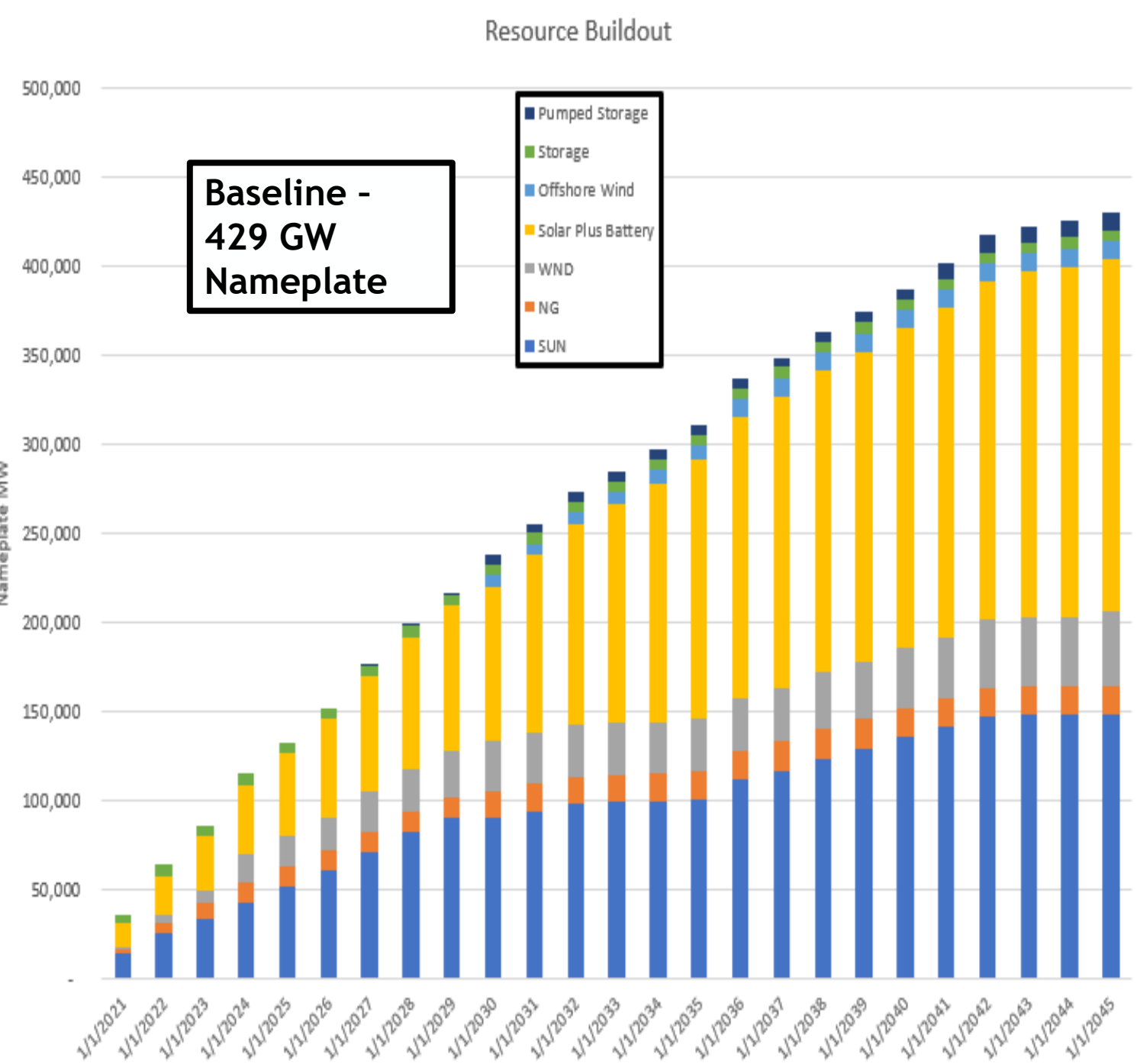
Buildout Summary: Review

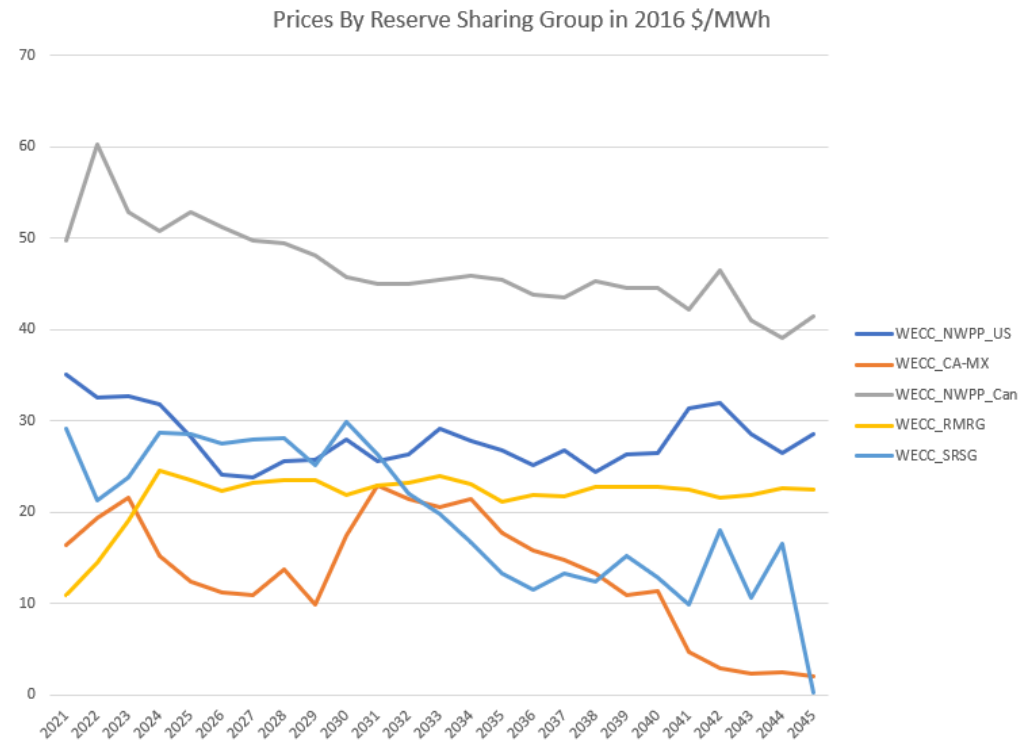
- Almost half of the builds seem to be for economics and state policies when disregarding regional load resource balance concerns
- Removing limitations on building natural gas plants significantly reduces overall build.
- Removing planning reserve margin requirements in WECC cuts build in half, but while WECC is less adequate in general, PNW primarily just has higher prices.
- Organized markets allow for significantly less builds (15% less), less renewable curtailment and changes economics for stand-alone short duration energy limited resources
- More builds in the PNW region occur in the organized market simulation (51 GW more) and the limited markets or no gas build limits (36 GW more) runs than in the baseline.
  - This usually translates into more needs



Baseline

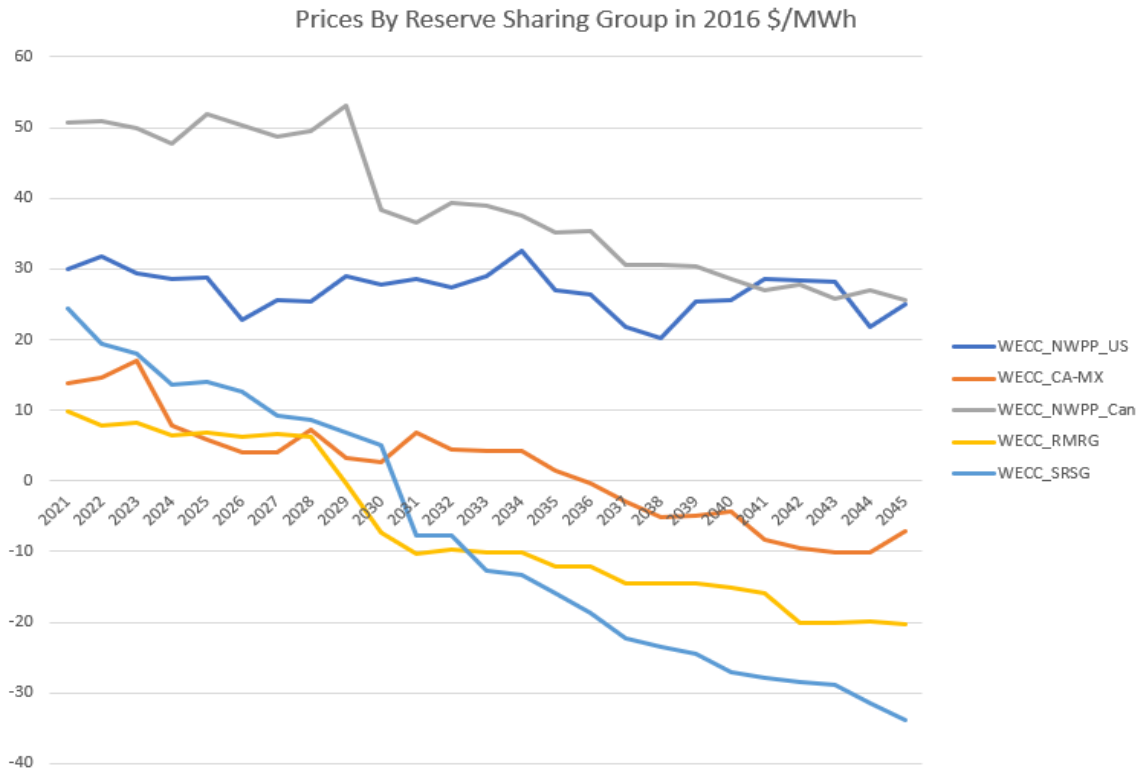
1. Planning reserve margins are mostly met
2. Clean/RPS Policies met until 2037

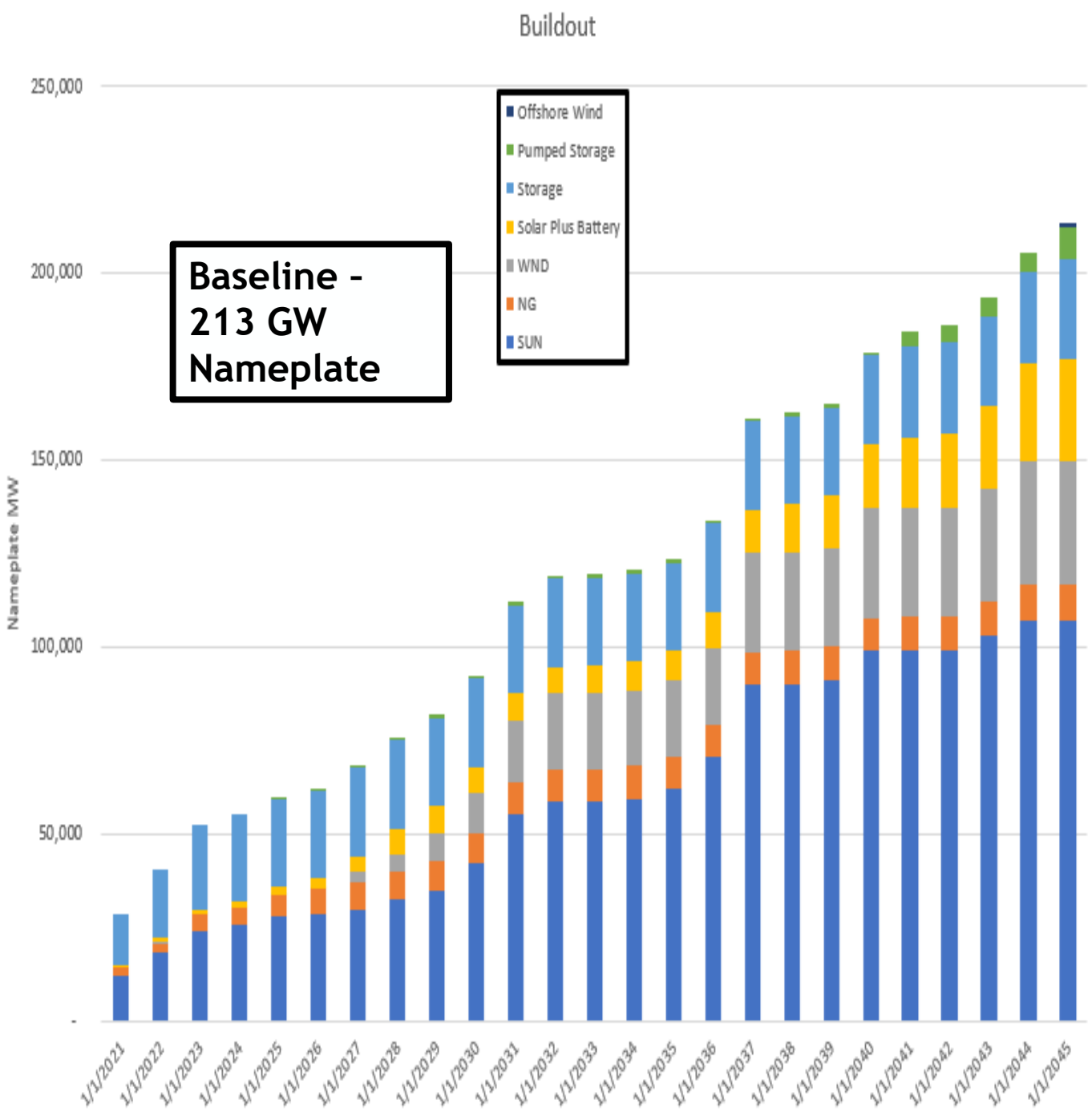




Limited Market (No reserve margins outside region)

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

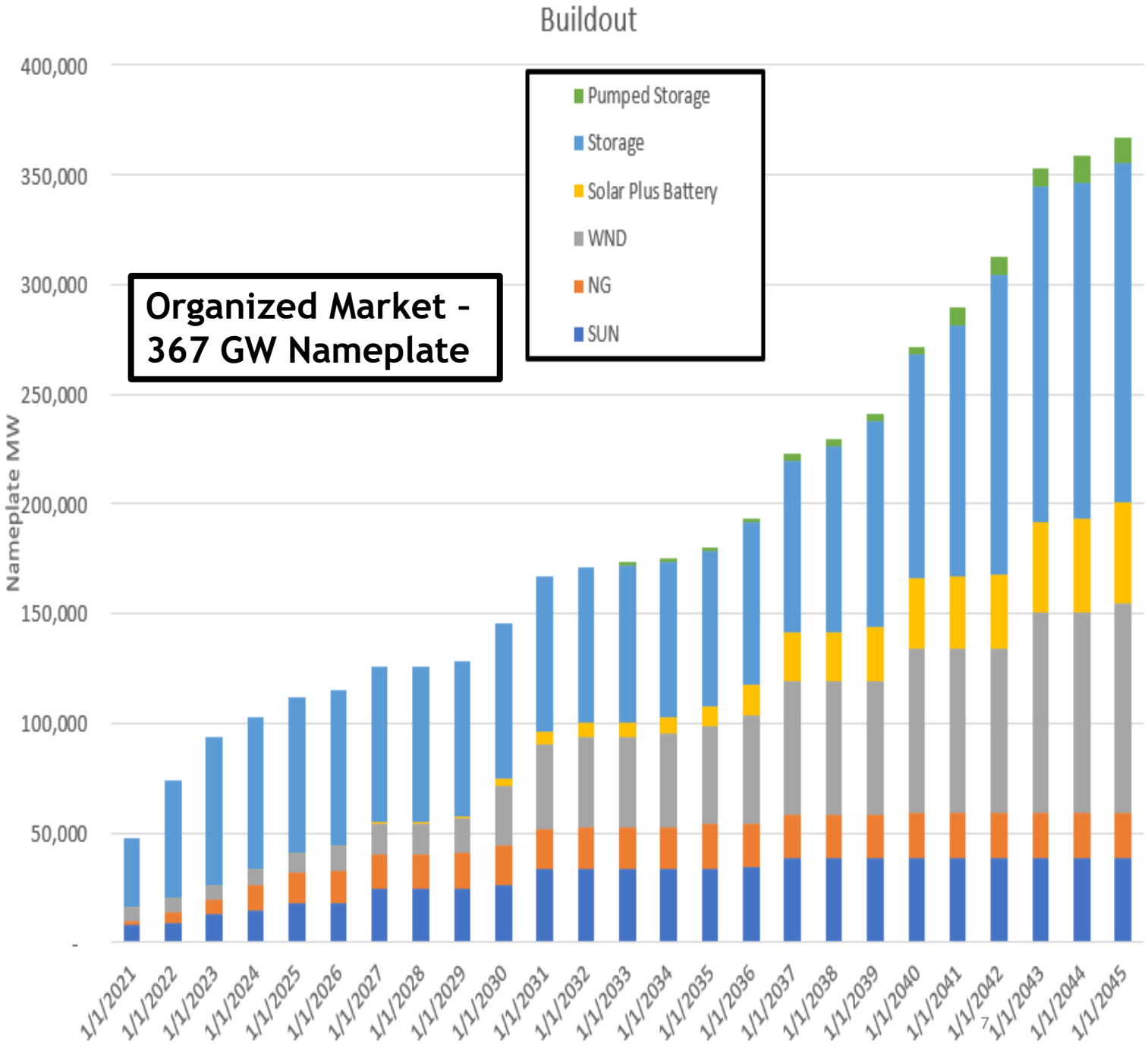


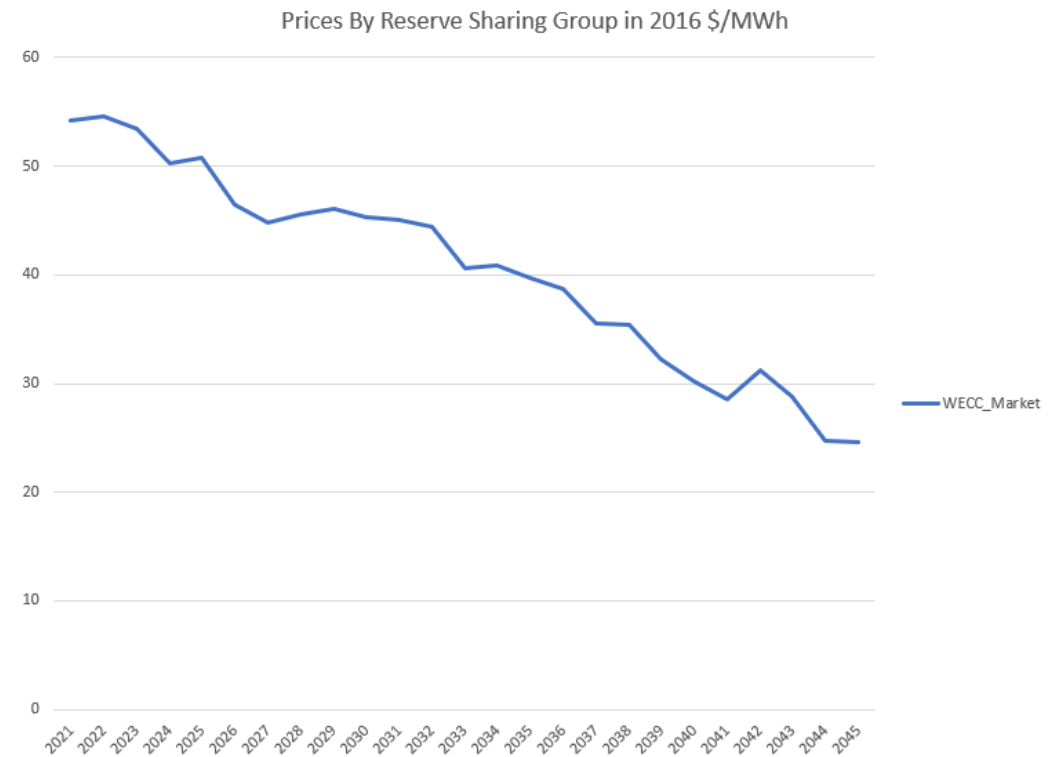


Organized Market

Simulated market starts in 2021

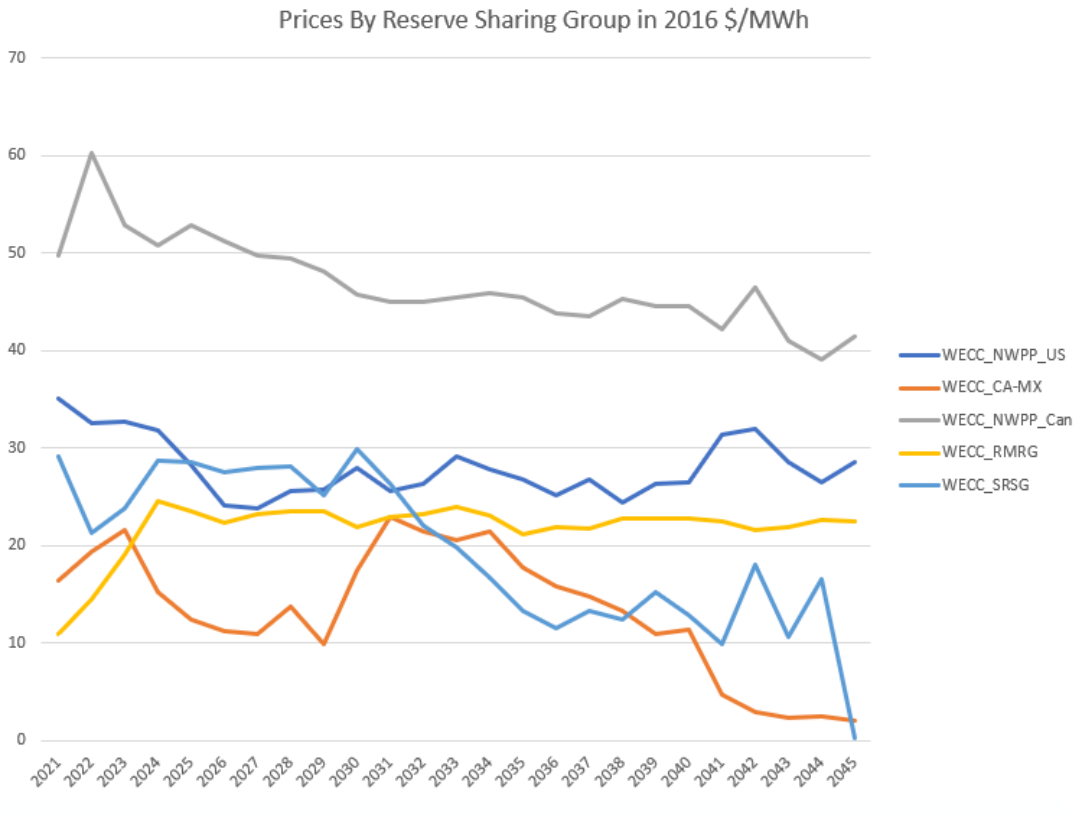
1. Planning reserve margins are met consistently, but system not adequate
2. Clean/RPS Policies met until late 2020s
3. WECC Prices drop

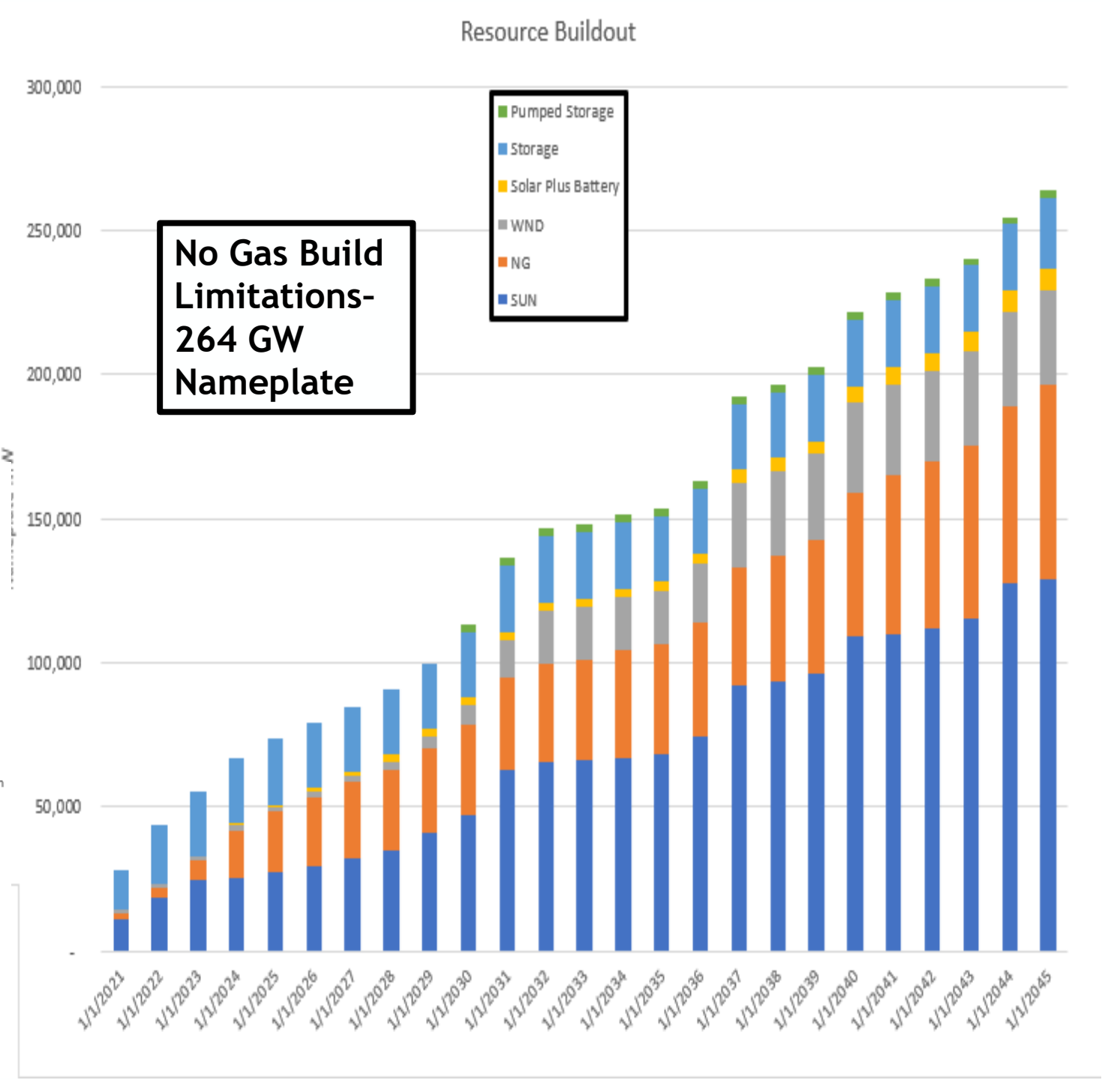




No Gas Build Limitations

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





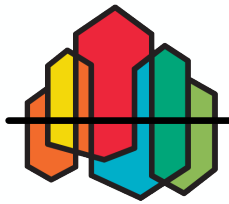
No Gas Build Limit

Prices, Avoided Emissions Rates, Needs Assessment and Resource Strategy Analysis

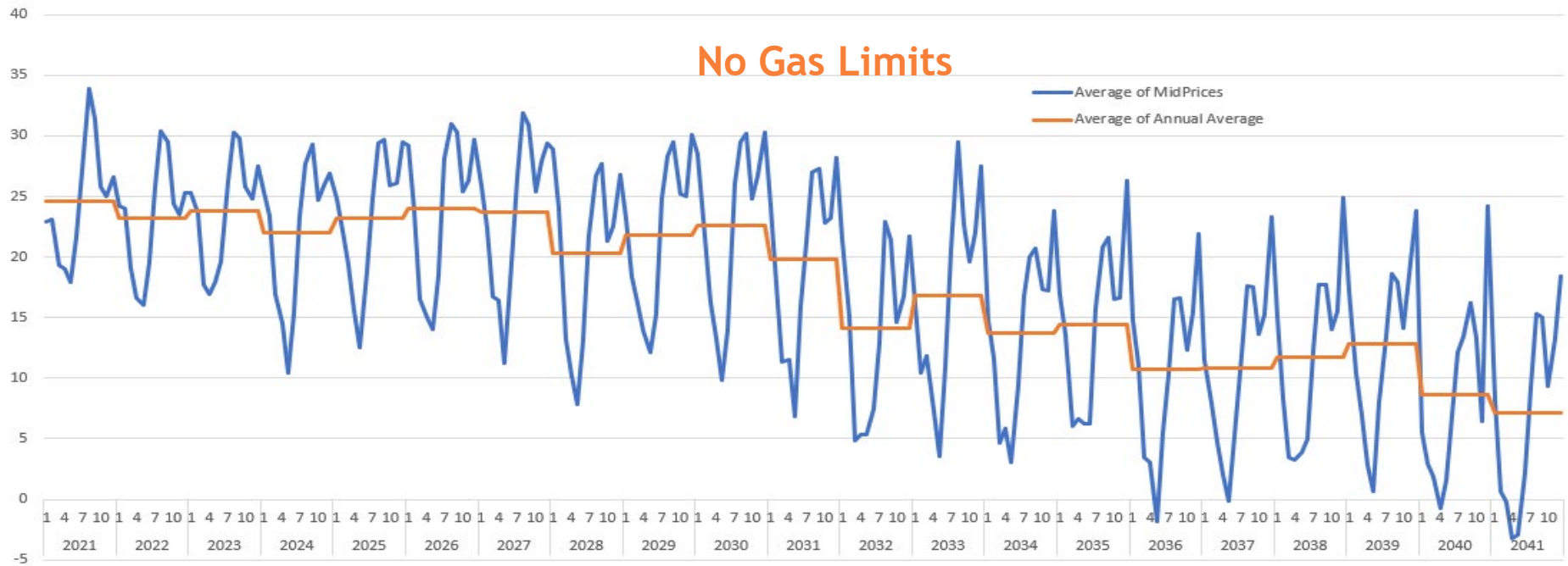
Detailed Comparison of No Gas Build Limit Sensitivity to Baseline

What are some of the effects of not reflecting perceived regulatory limitations on building gas plants?

- Annual average Mid-C Prices start out higher but end lower and show less seasonal variation than the baseline.
- Avoided CO2e Emissions Rates start out higher especially on-peak, but end up lower than in the baseline, especially in the summer.
- Needs go up in the region later in the study due to less builds outside the region.

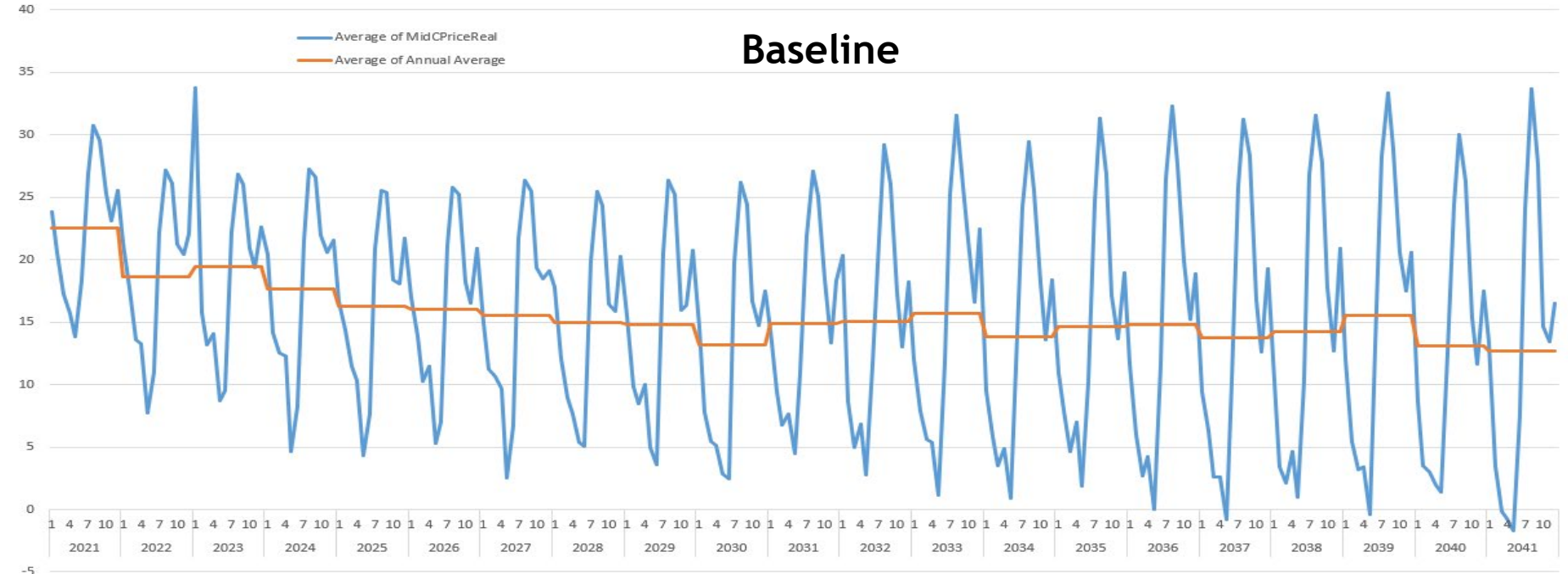


No Gas Limits

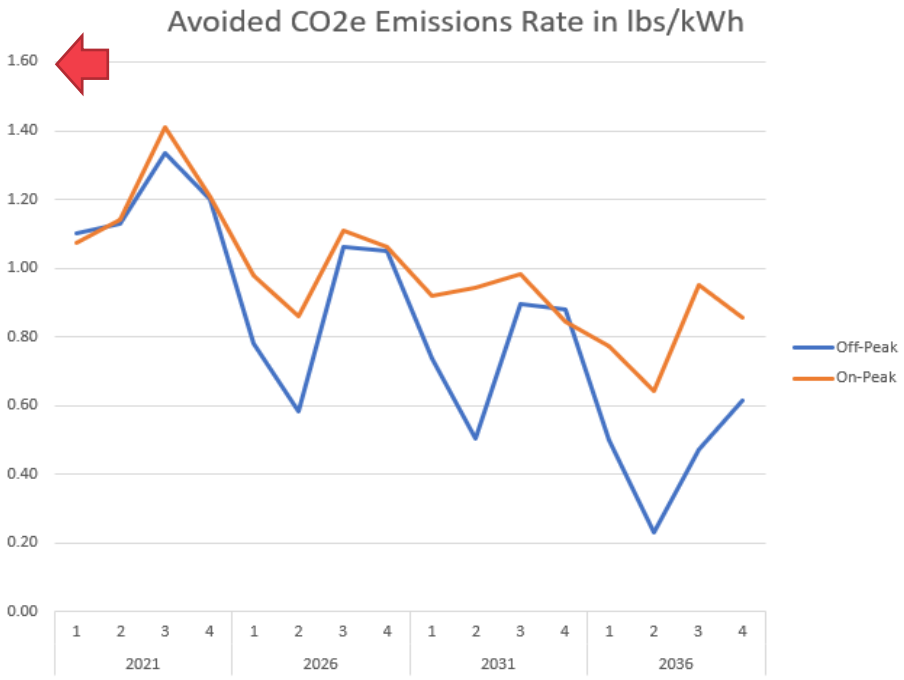


MidC Prices 2016 $ per MWh Monthly

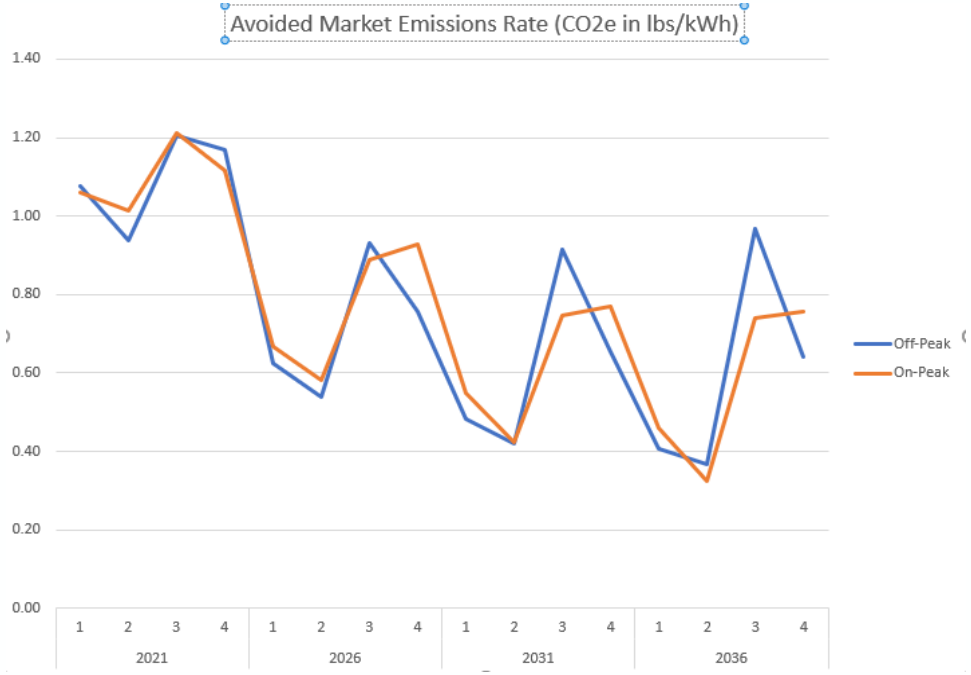
Baseline



1) Emissions rate starts higher, 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 as new gas displaces coal.



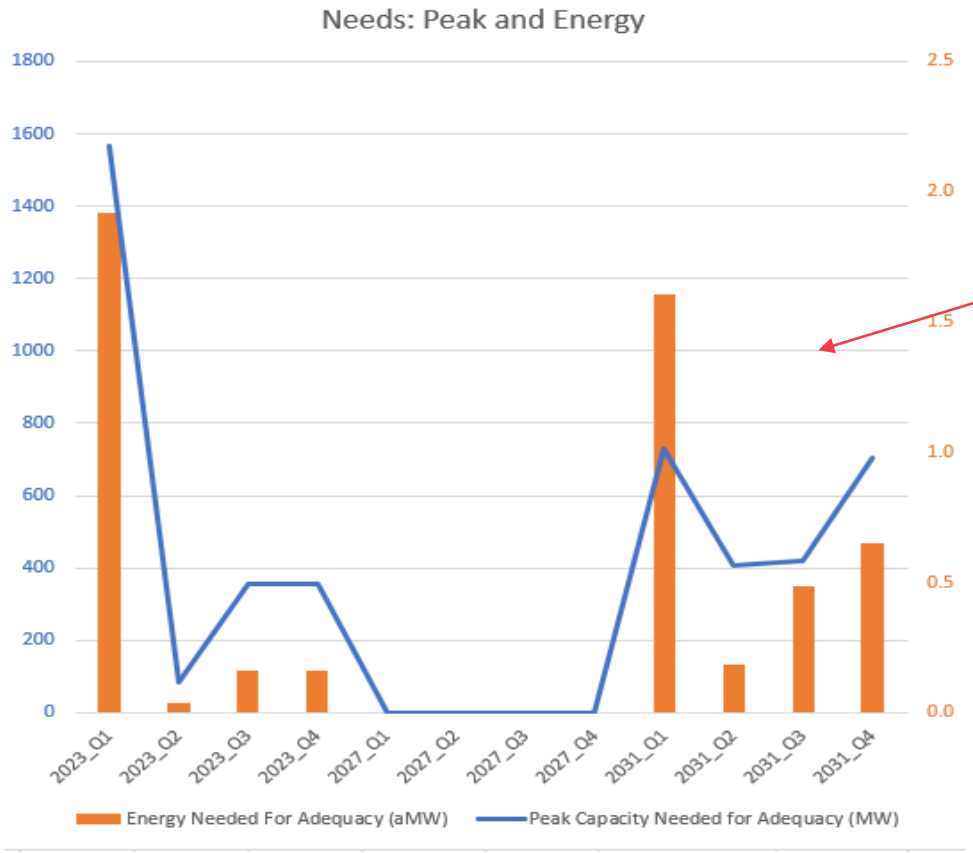
No Gas Limits



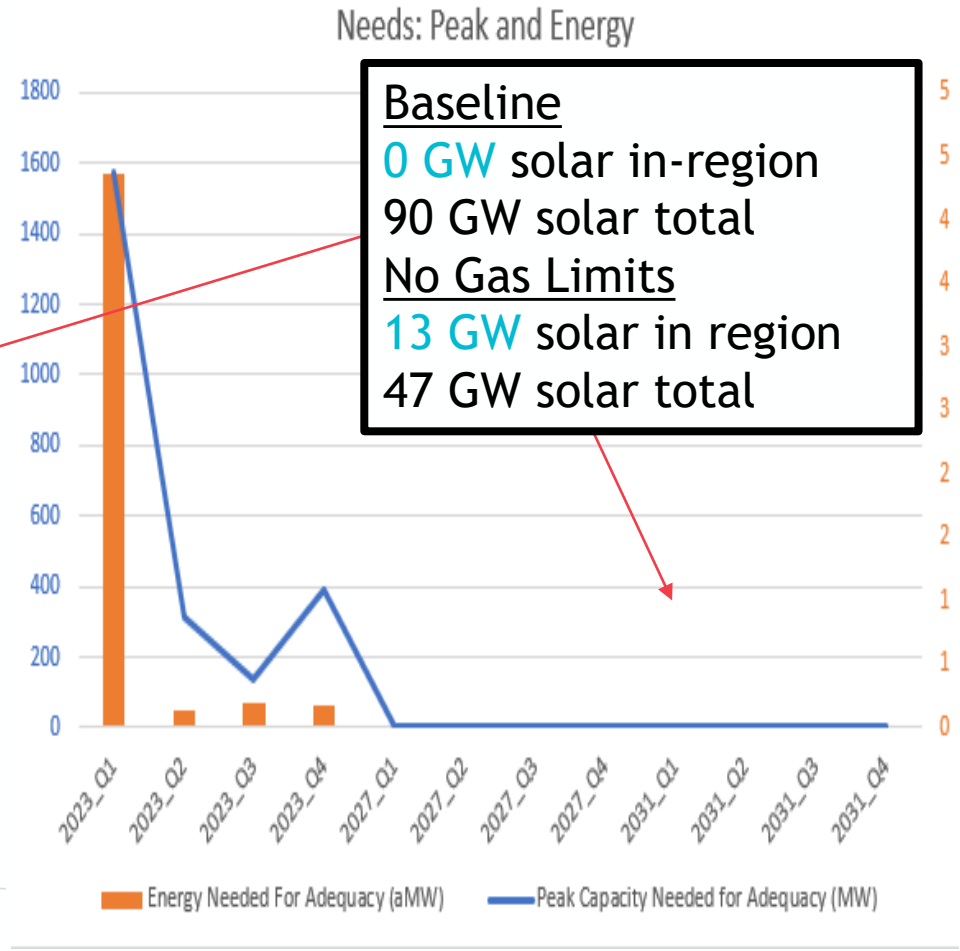
Baseline

Peak needs are similar in the early years, but are higher in the later years in the *No Gas Build Limits* sensitivity.

Significant regional builds identified by AURORA are removed for regional needs assessment, which has the effect of increasing regional needs.



No Gas Limits



Baseline

0 GW solar in-region
90 GW solar total

No Gas Limits

13 GW solar in region
47 GW solar total

Baseline

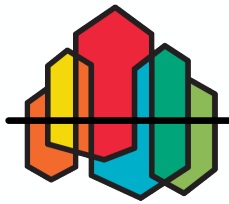
Limited Markets

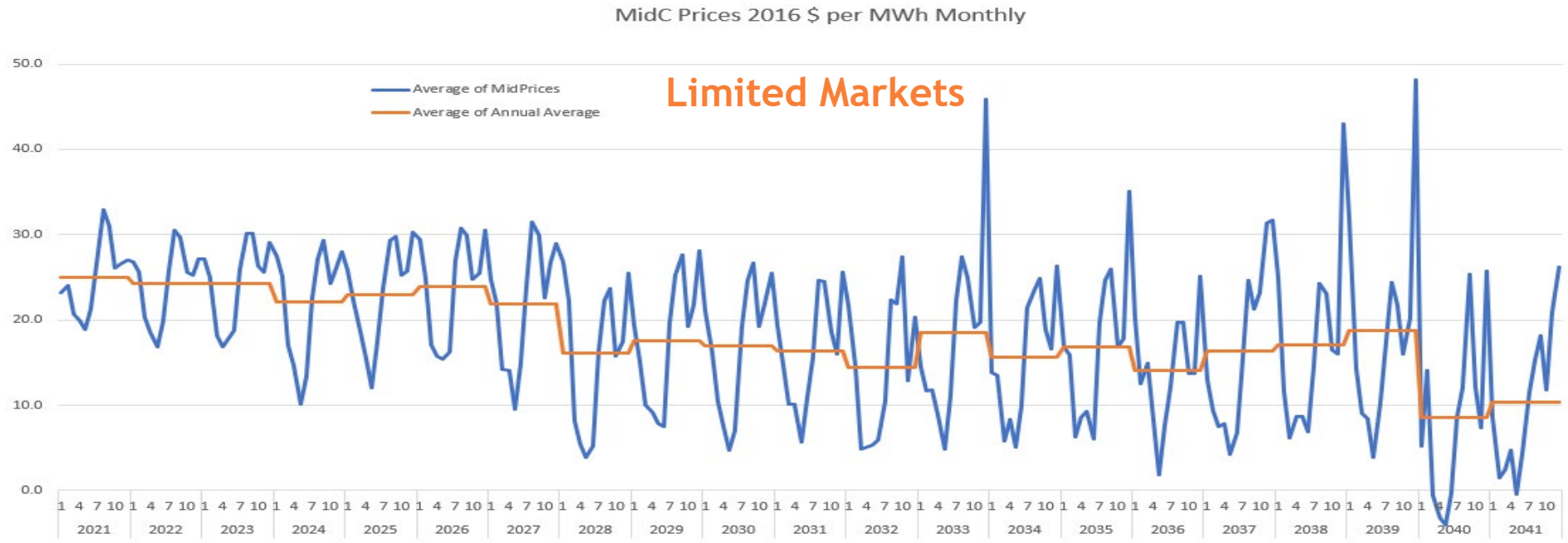
Prices, Avoided Emissions Rates, Needs Assessment and Resource Strategy Analysis

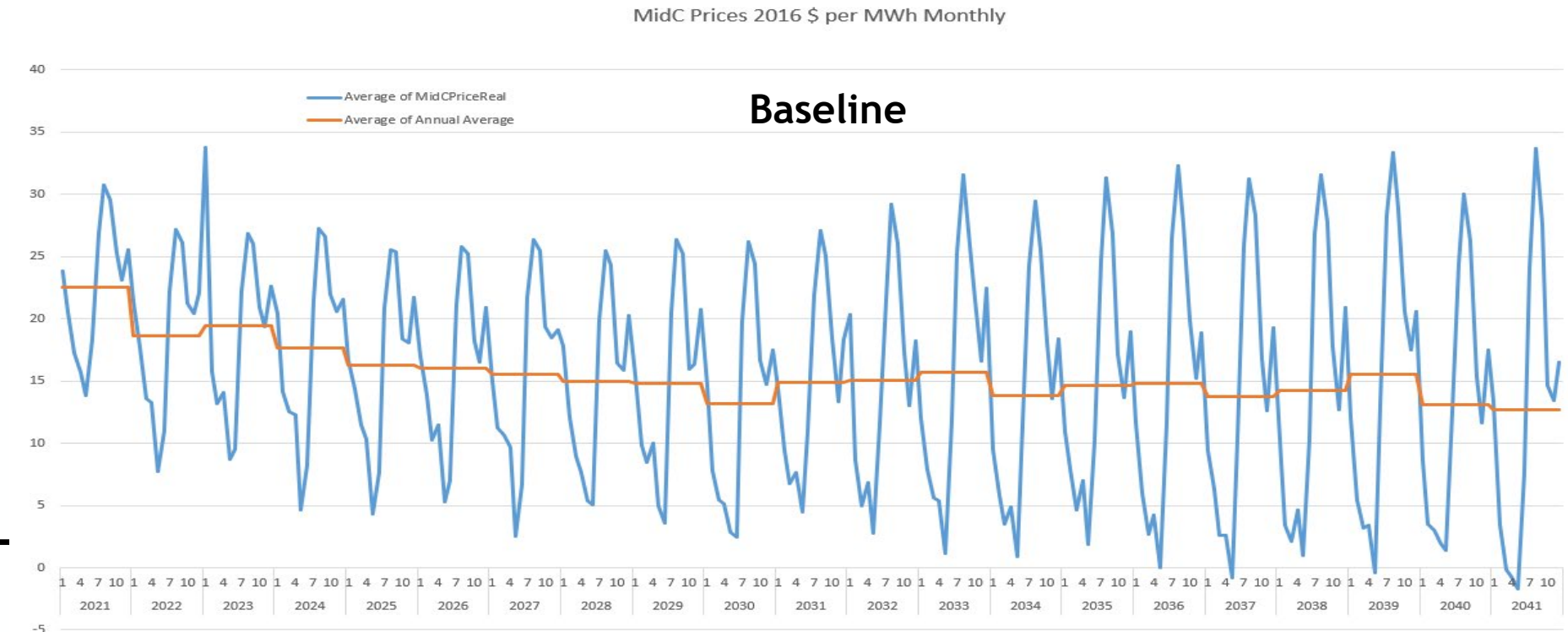
Detailed Comparison of Limited Markets Sensitivity to Baseline

What are some of the effects of not assuming other regions will build to planning reserve margins?

- Mid-C Prices are a little higher on average and show higher prices in late fall and early winter than in the baseline.
- Avoided CO2e Emissions Rates start out higher especially on-peak, but end up lower than in the baseline, especially in the summer.
- Needs go up in the region later in the study due to less builds outside the region.







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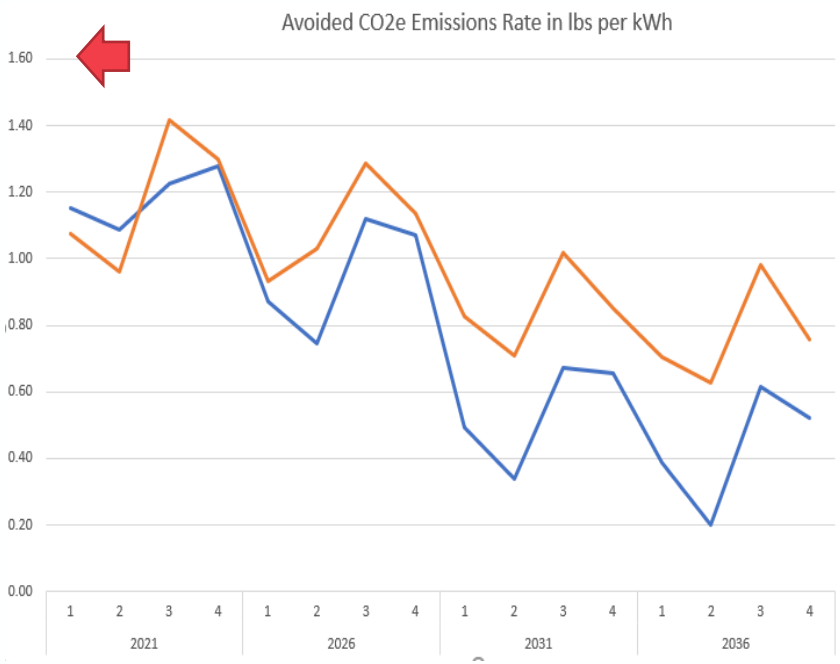
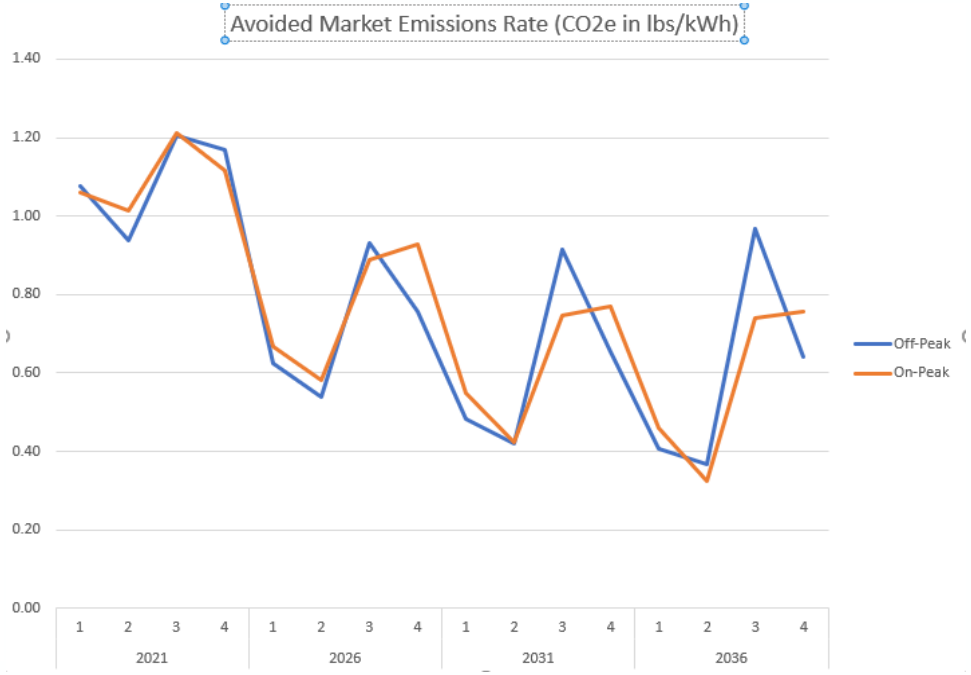
1) Emissions rate starts higher, but goes lower than baseline
2) On-peak avoided emissions rate stays around emissions rate of combined cycle gas units.
3) Off-peak avoided emissions rate goes lower than the baseline late in the study. (less builds, more CCCTs running than SCCTs on the margin)

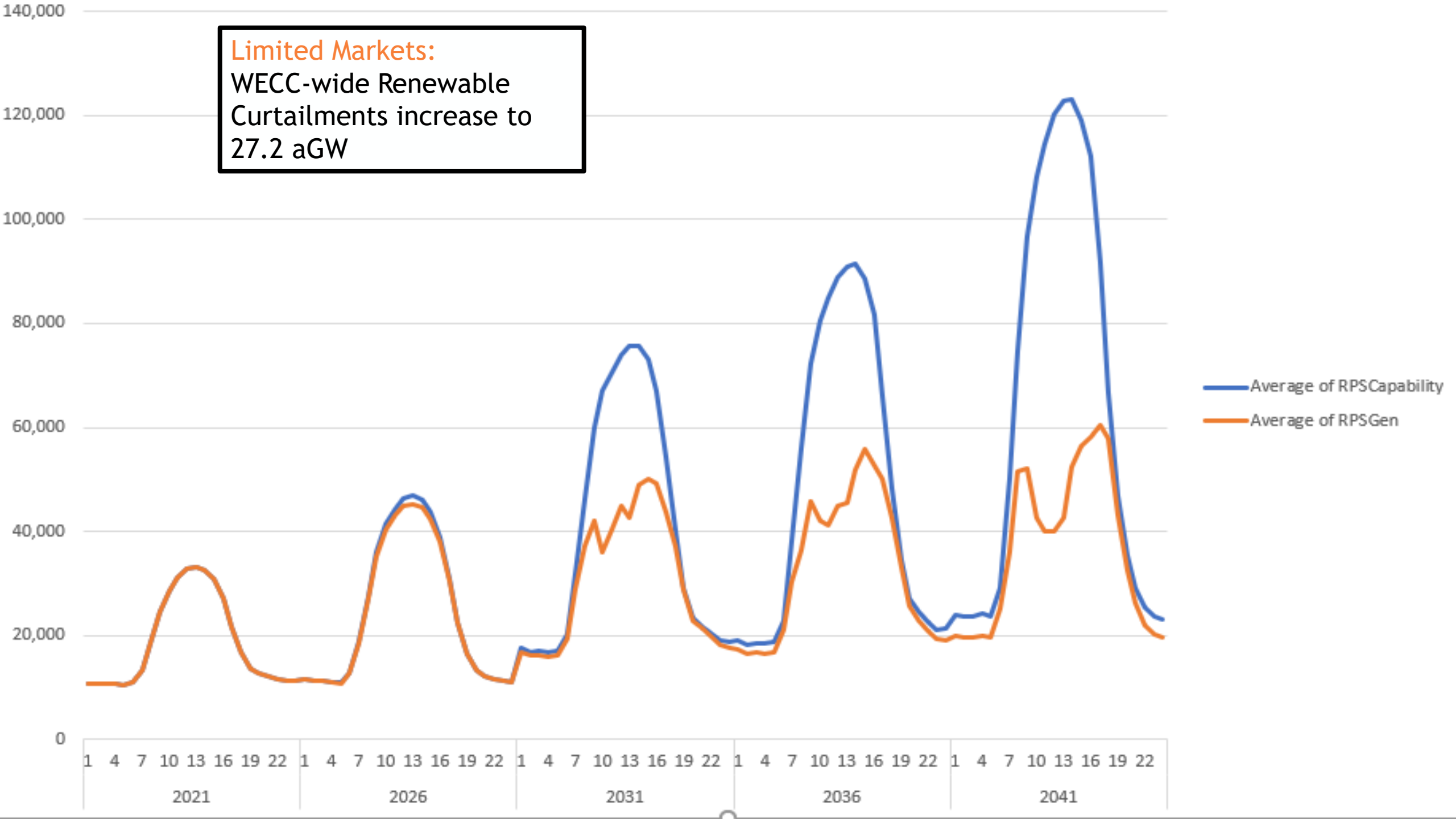


Limited Markets



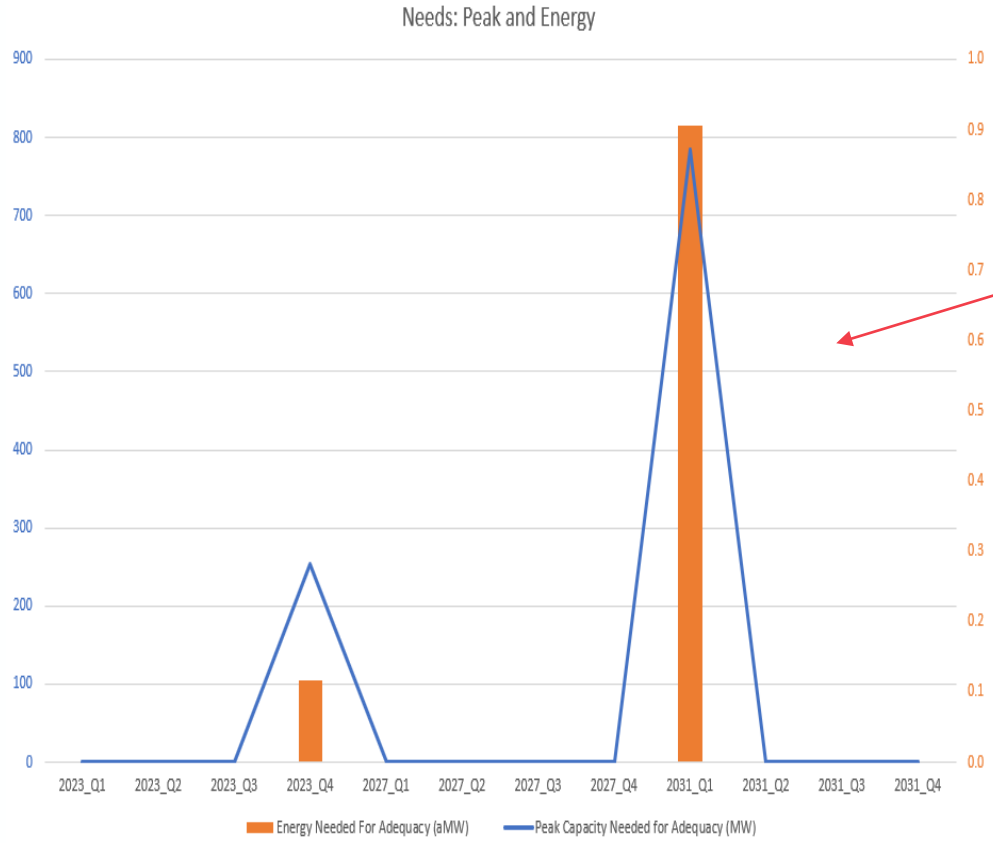
Baseline

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

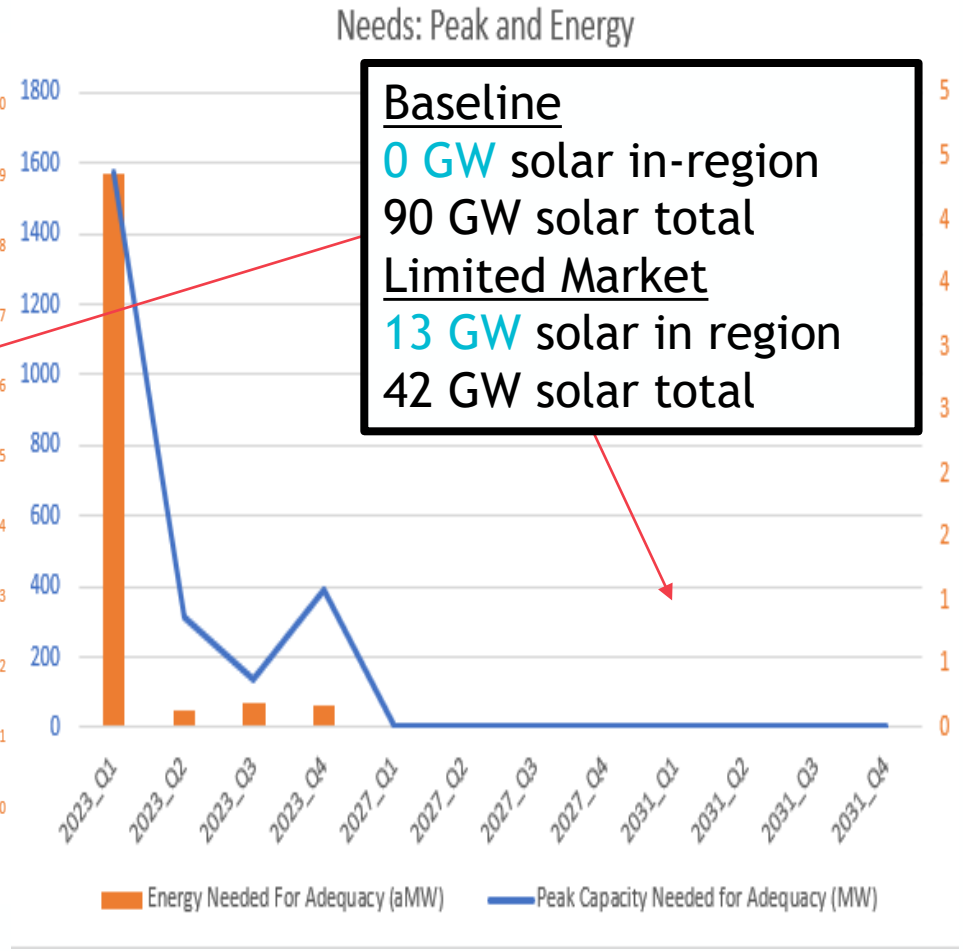


Peak needs are higher in the *Baseline* in the early years, but are higher in the later years in the *Limited Markets* sensitivity.

Significant regional builds identified by AURORA are removed for regional needs assessment, which has the effect of increasing regional needs.



Limited Markets



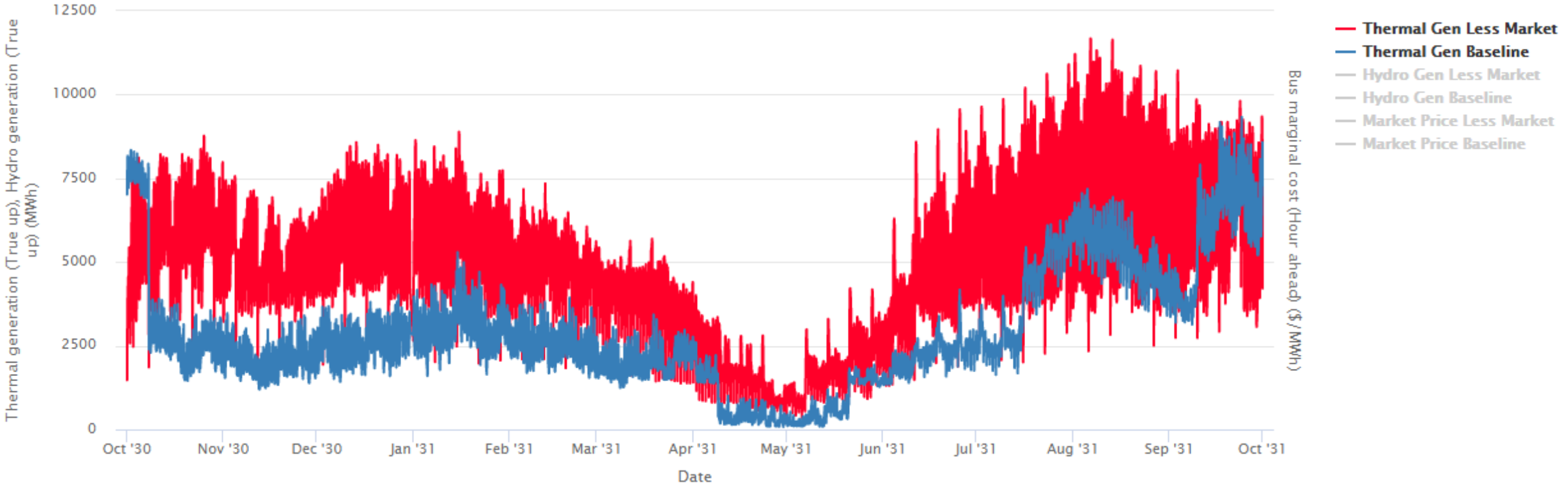
Baseline

Baseline
0 GW solar in-region
90 GW solar total

Limited Market
13 GW solar in region
42 GW solar total

Why Did the Limited Market Not Have More Needs?

The Commitment of Thermals



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

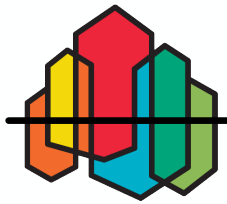
Organized Markets

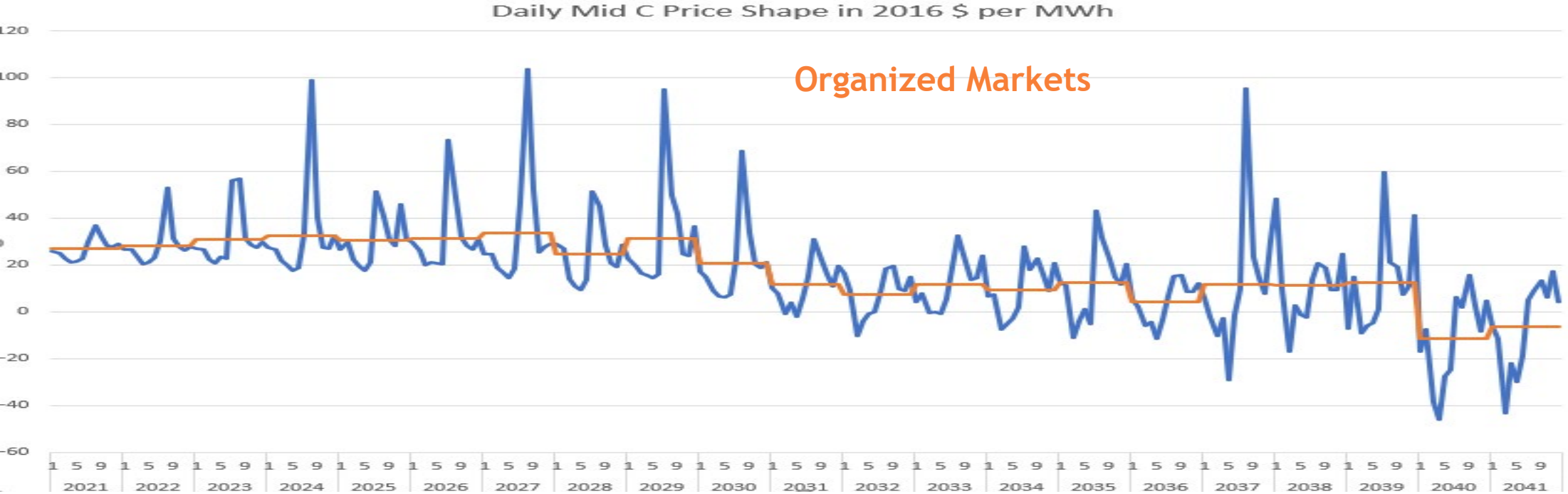
Prices, Avoided Emissions Rates, Needs Assessment and Resource Strategy Analysis

Detailed Comparison of Organized Markets Sensitivity to Baseline

What are some of the effects of assuming the WECC will act more in concert?

- Mid-C Prices have more seasonal variation, and get lower by the end of the study, than in the baseline.
- Renewable curtailments decrease dramatically from all other scenarios
- Avoided CO2e Emissions Rates start out higher especially in the summer, but end up lower than in the baseline, especially off-peak.
- Needs go up in the region later in the study due to less builds outside the region.




Daily Mid C Price Shape in 2016 $ per MWh
Organized Markets
120
100
80
60
40
20
0
-20
-40
-60
2021
2022
2023
2024
2025
2026
2027
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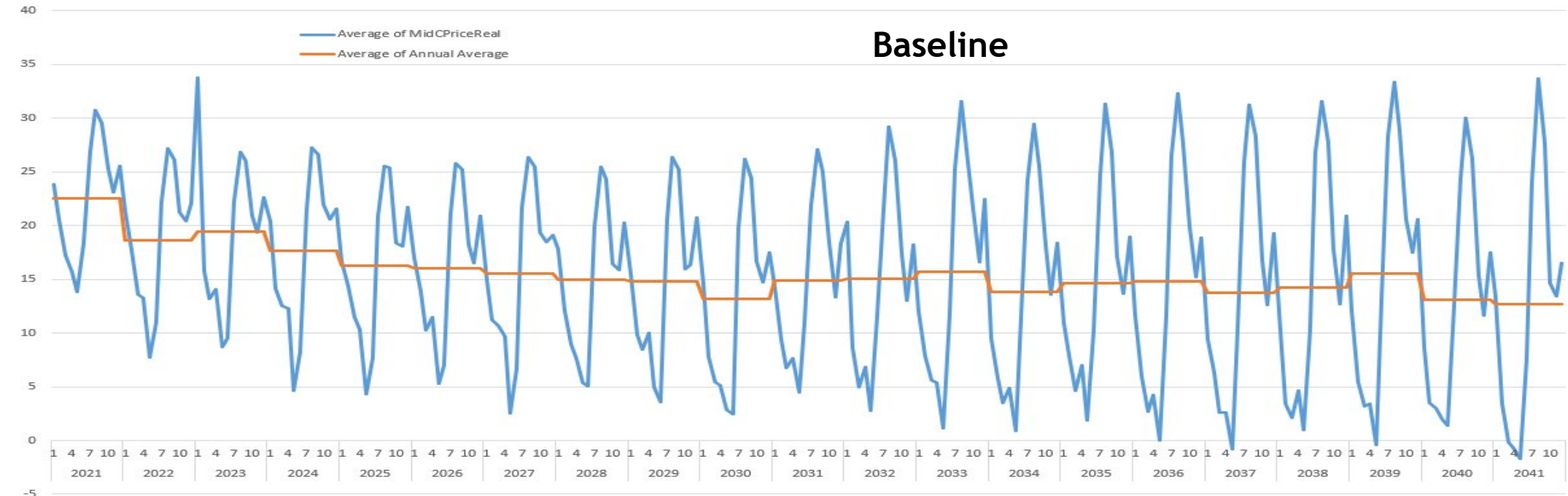
MidC Prices 2016 $ per MWh Monthly
Baseline
Average of MidCPriceReal
Average of Annual Average
40
35
30
25
20
15
10
5
0
-5
2021
2022
2023
2024
2025
2026
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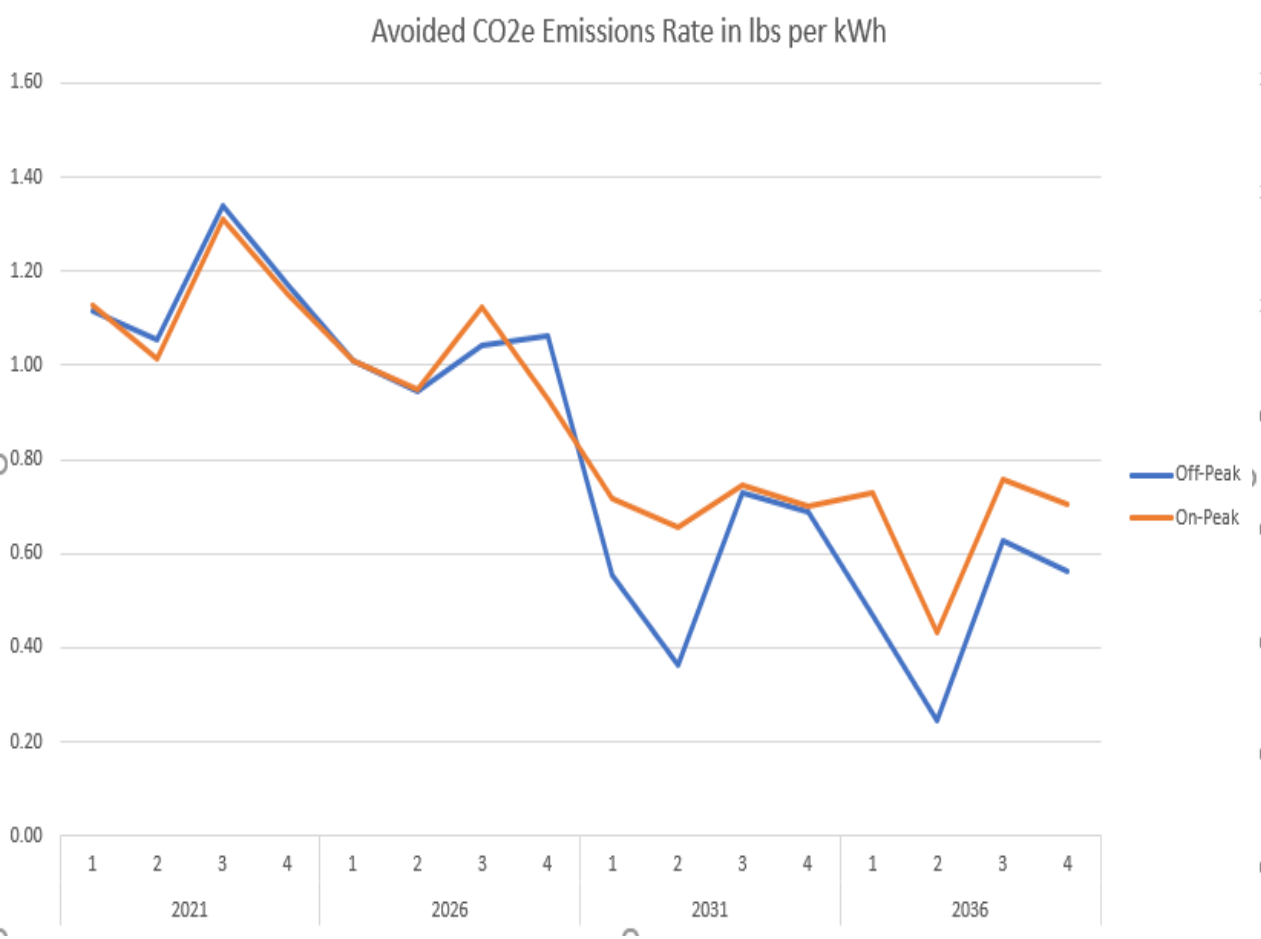
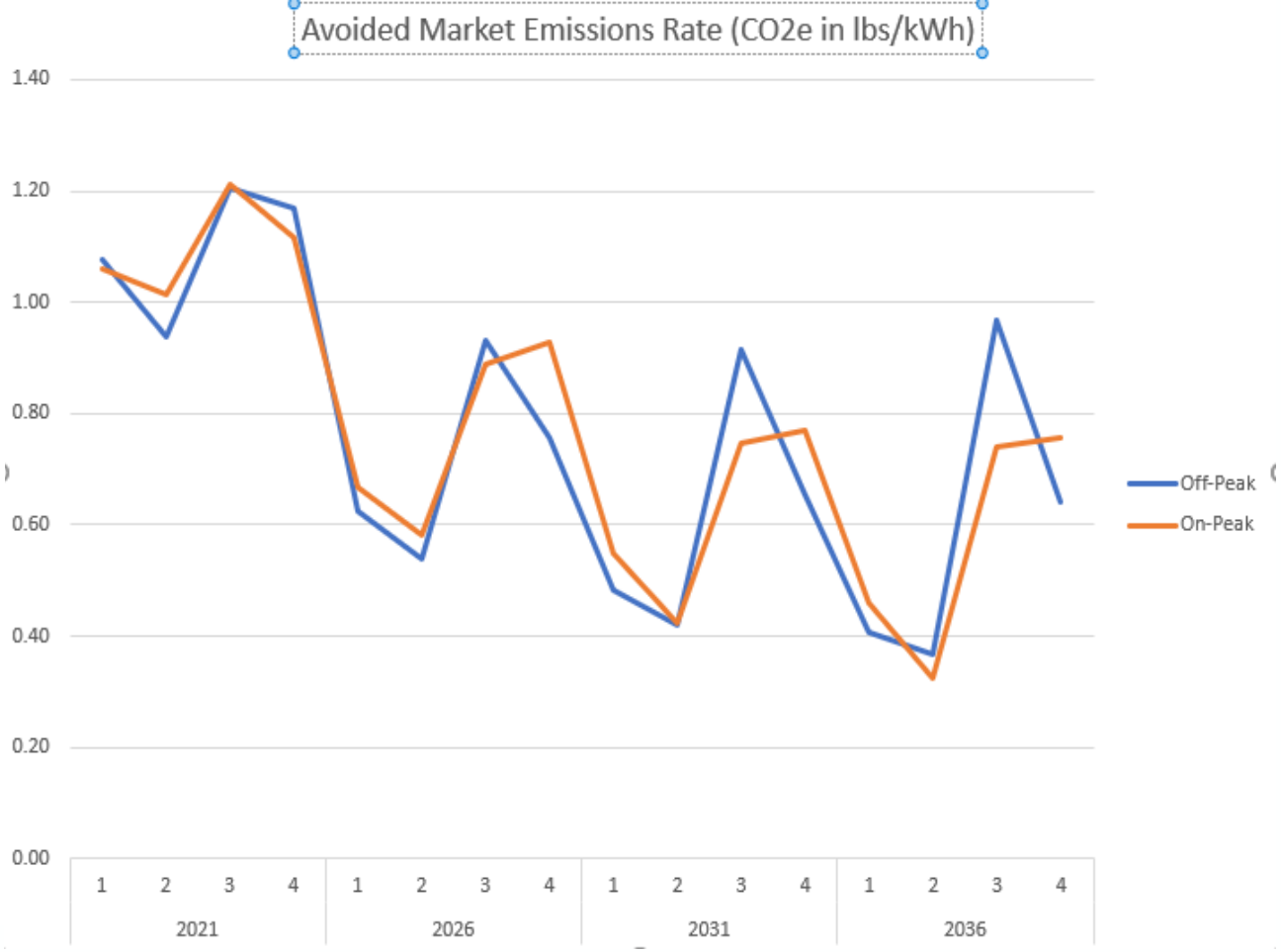
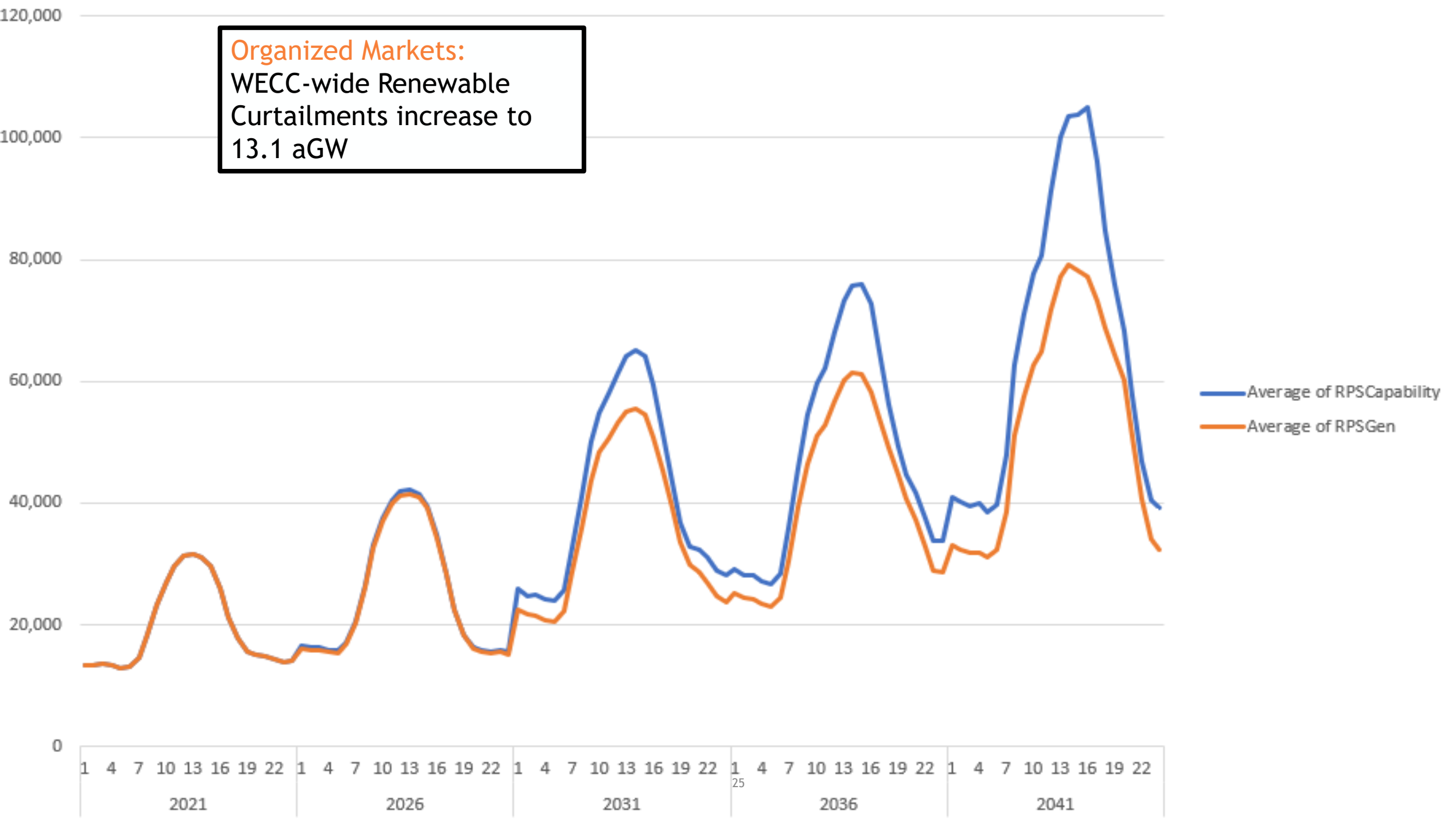




Organized Markets

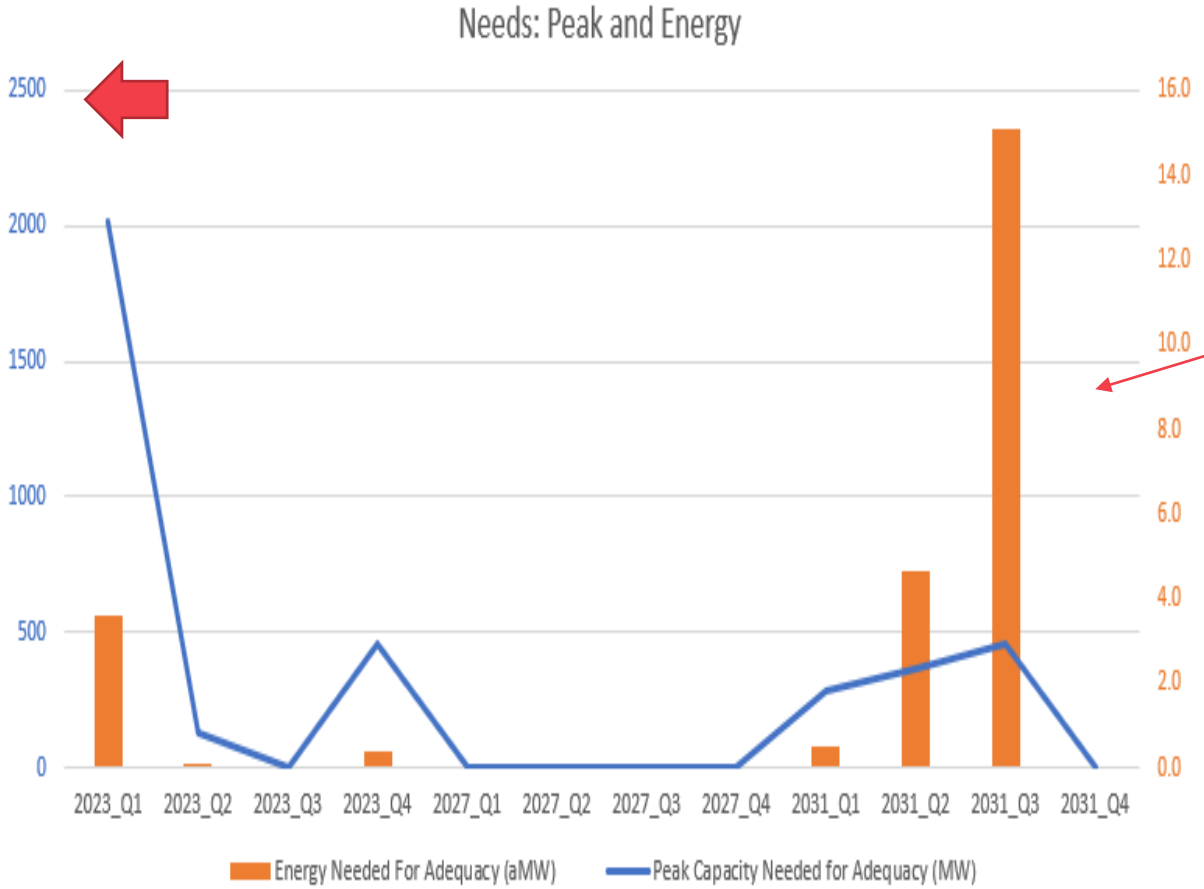
Baseline

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)

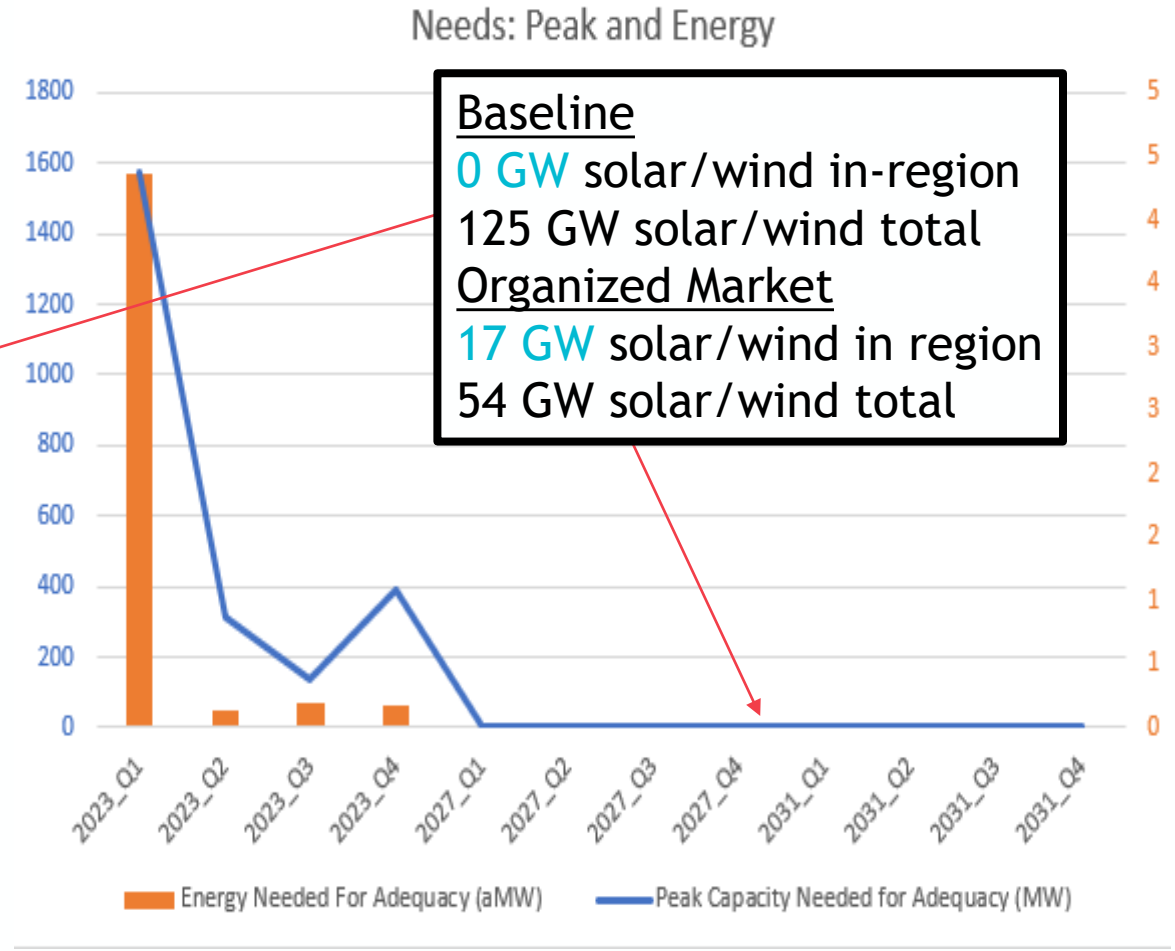

Organized Markets:
WECC-wide Renewable Curtailments increase to 13.1 aGW
120,000
100,000
80,000
60,000
40,000
20,000
0
1 4 7 10 13 16 19 22
2021
2026
2031
2036
2041
Average of RPSCapability
Average of RPSGen

Peak needs are higher in the *Organized Markets* sensitivity than in the *Baseline*.

Significant regional builds identified by AURORA are removed for regional needs assessment, which has the effect of increasing regional needs.



Organized Market



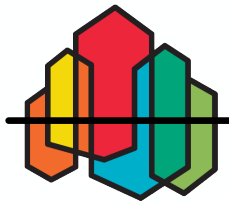
Baseline
0 GW solar/wind in-region
125 GW solar/wind total
Organized Market
17 GW solar/wind in region
54 GW solar/wind total

Baseline

Resource Strategy Results

High-level Take-aways

- Renewable builds are not sensitive to the different external market assumptions
- Energy efficiency acquisition does change based on different external market assumptions
- Electricity prices and residential bills do not substantially diverge based on external market assumptions
- Interactive effects with external markets are better captured by GENESYS - dynamic hydro is a big part of the picture



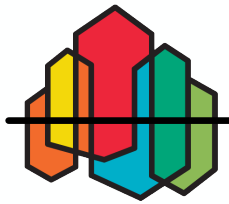
Changes from Baseline

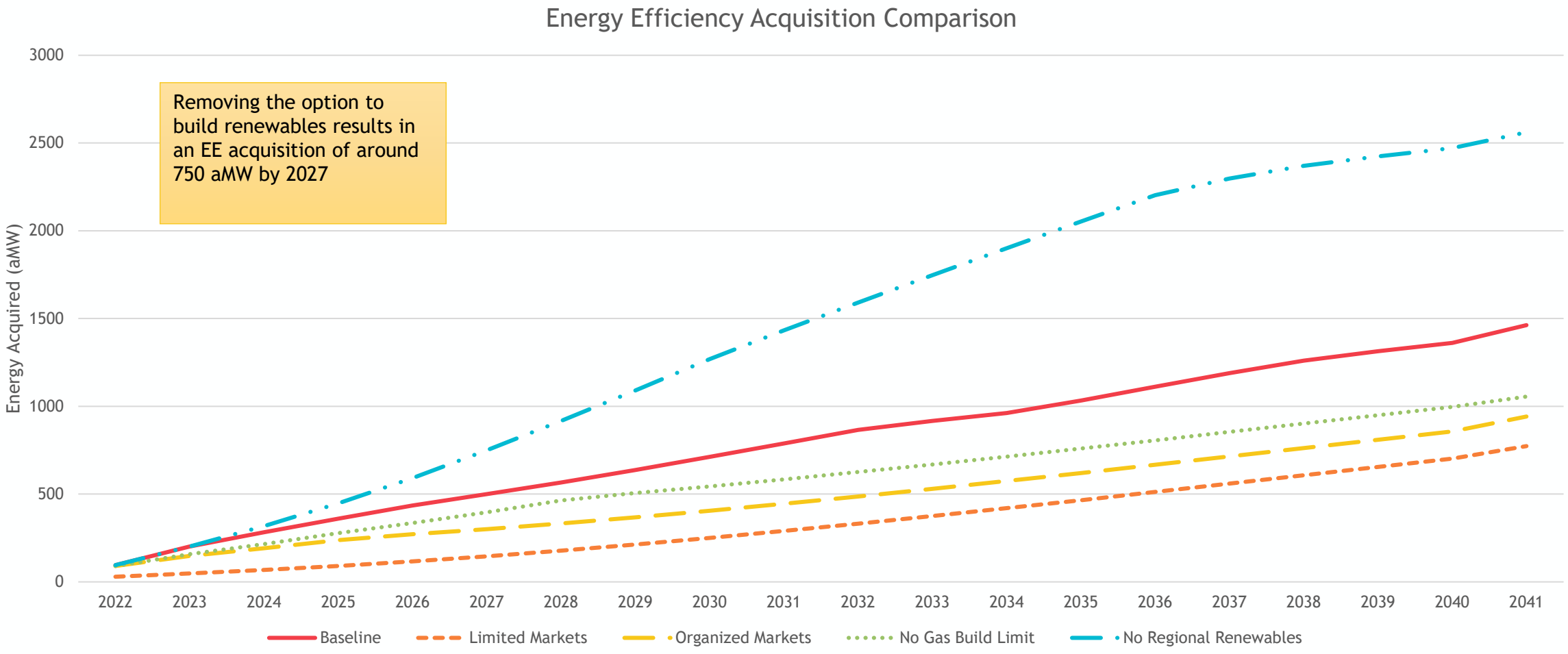
Representing External Market Conditions

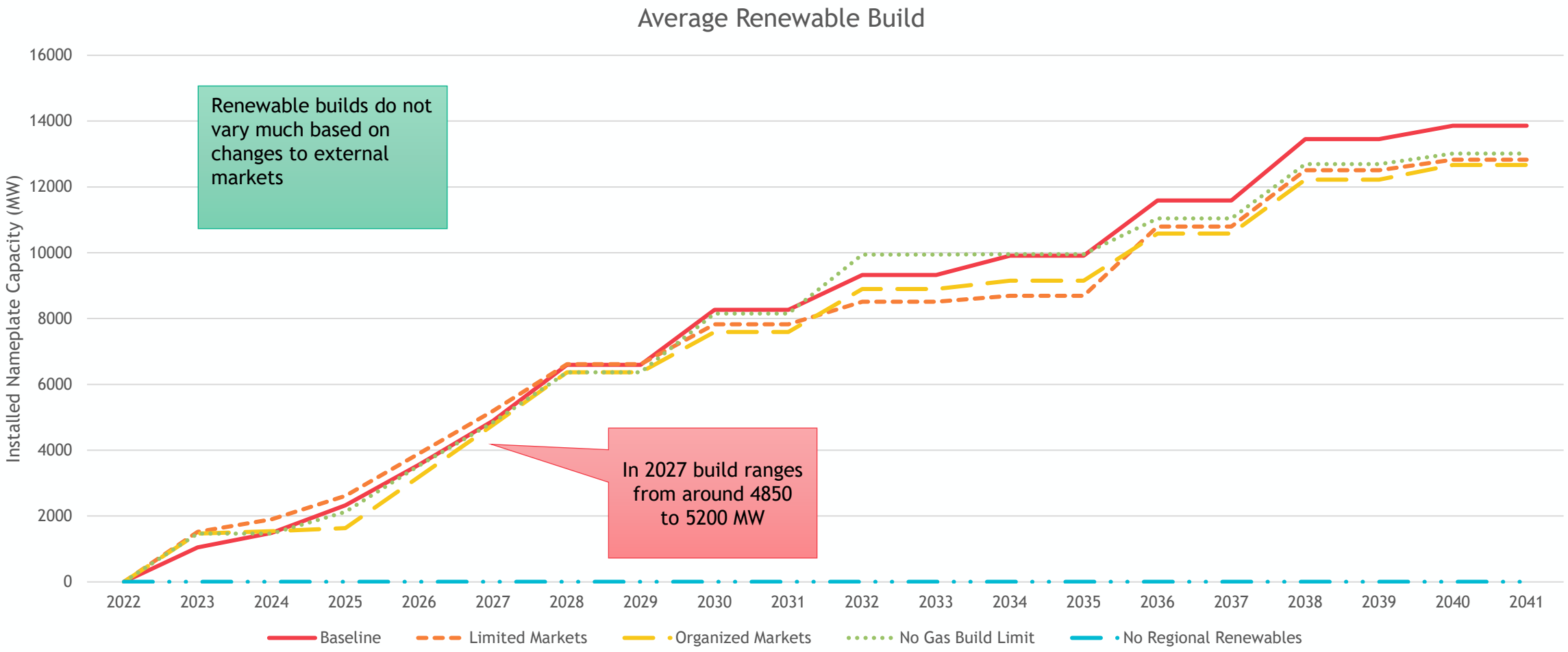
- Adequacy Reserve Margin
- Forecast Hydro Generation
- On & Off-Peak Quarterly Electricity Price Forecast
- Market CO_2 Intensity
- PDF of (Hourly Electricity Price – Mean Electricity Price)

Representing limitations in resources:

- Removed option to build renewable resources to test directional changes

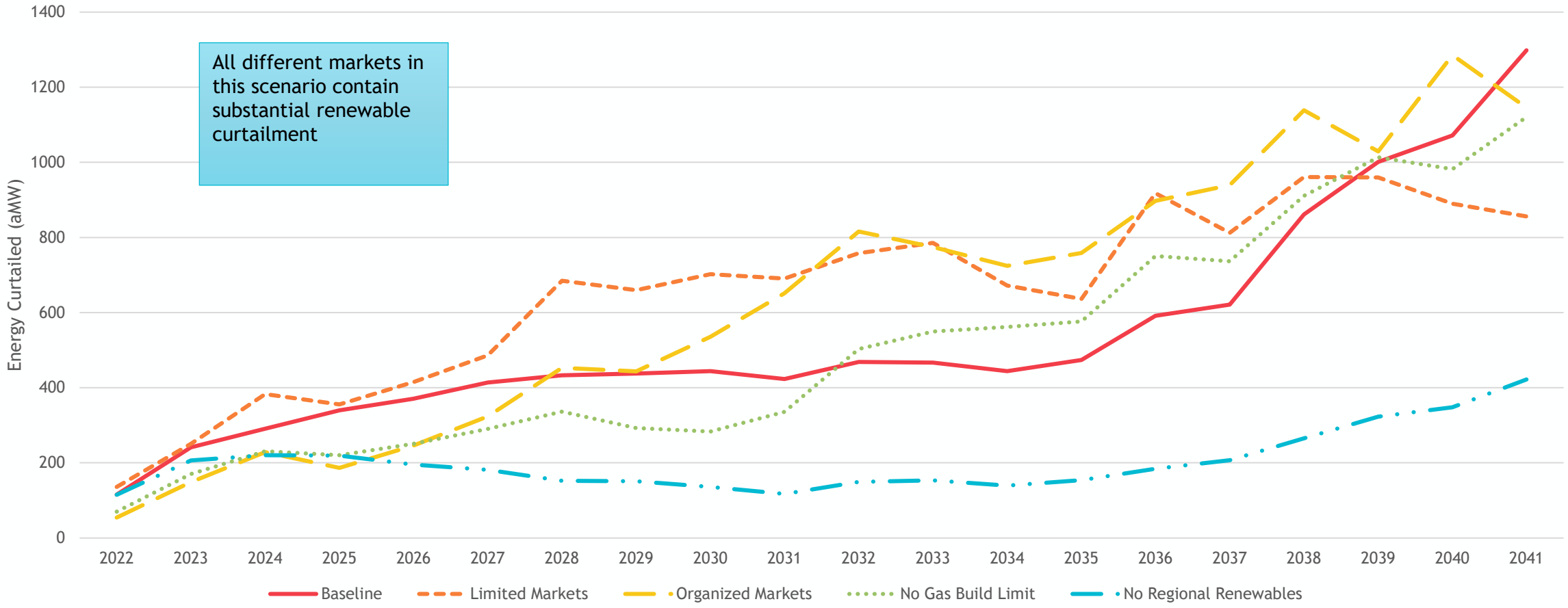


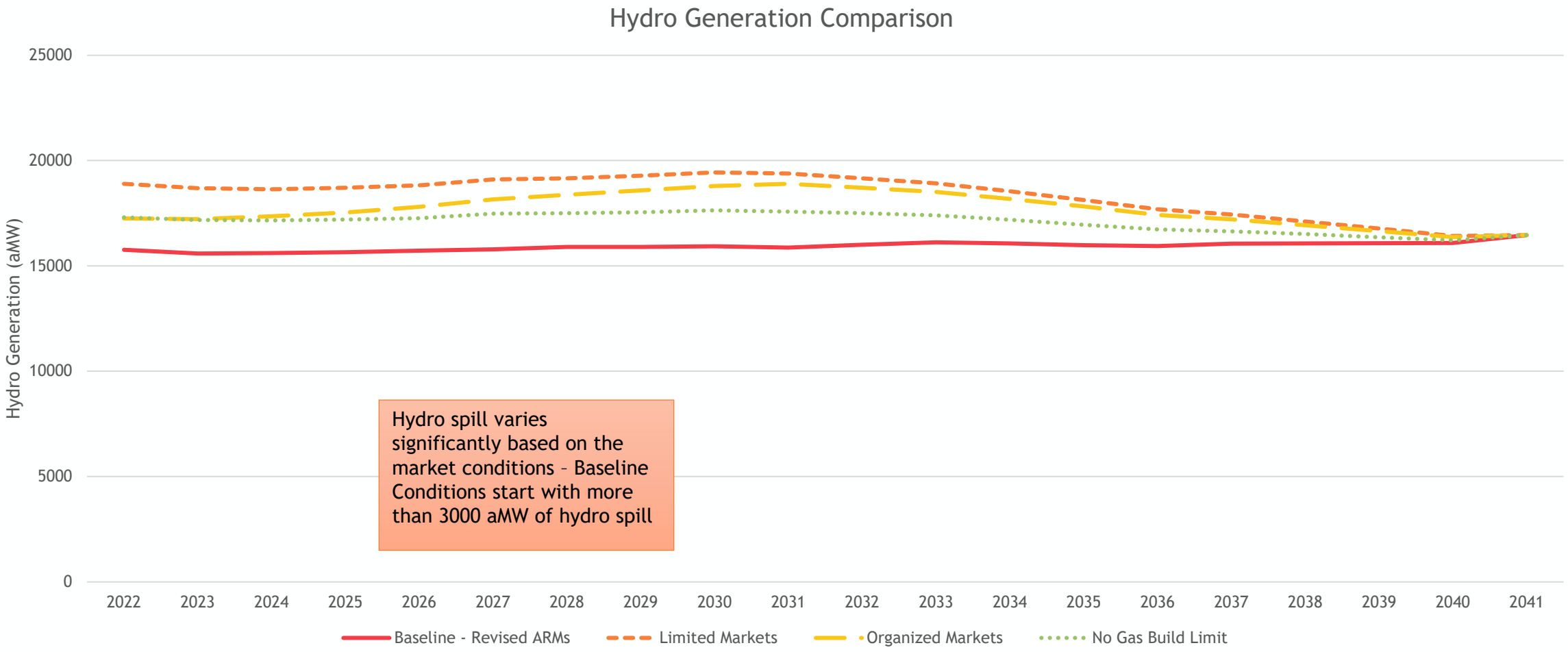

Energy Efficiency Acquisition Comparison
Removing the option to build renewables results in an EE acquisition of around 750 aMW by 2027
Energy Acquired (aMW)
3000
2500
2000
1500
1000
500
0
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
2041
Baseline
Limited Markets
Organized Markets
No Gas Build Limit
No Regional Renewables

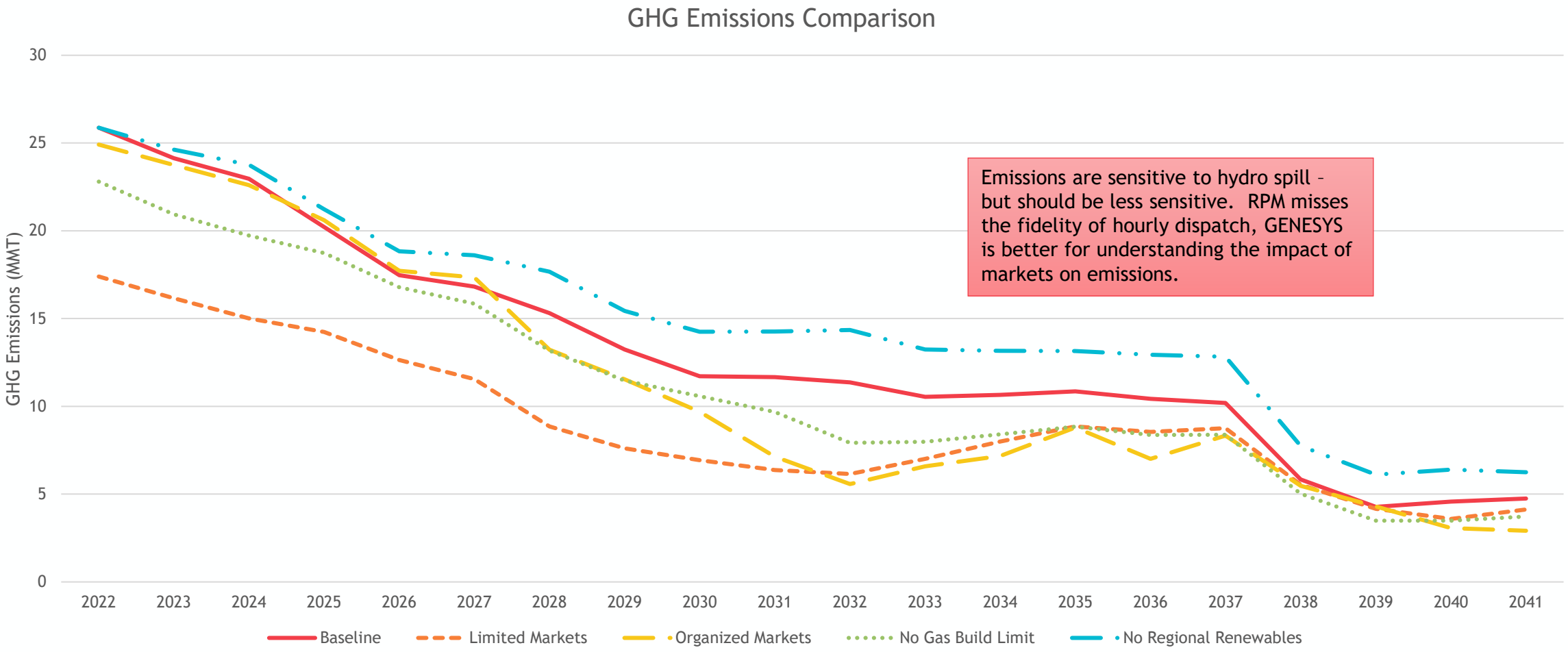

Average Renewable Build
Installed Nameplate Capacity (MW)
16000
14000
12000
10000
8000
6000
4000
2000
0
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
2041
Renewable builds do not vary much based on changes to external markets
In 2027 build ranges from around 4850 to 5200 MW
Baseline
Limited Markets
Organized Markets
No Gas Build Limit
No Regional Renewables

Renewable Curtailment Comparison

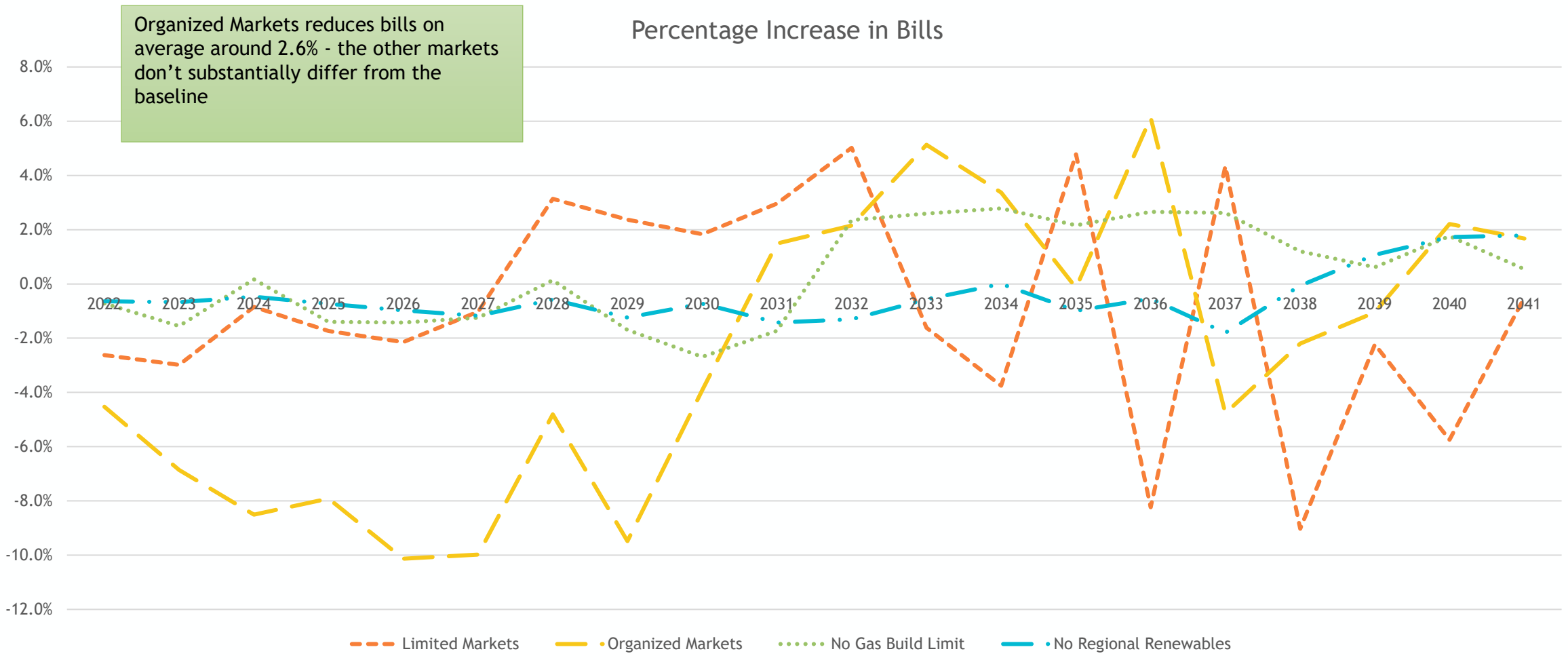
All different markets in this scenario contain substantial renewable curtailment

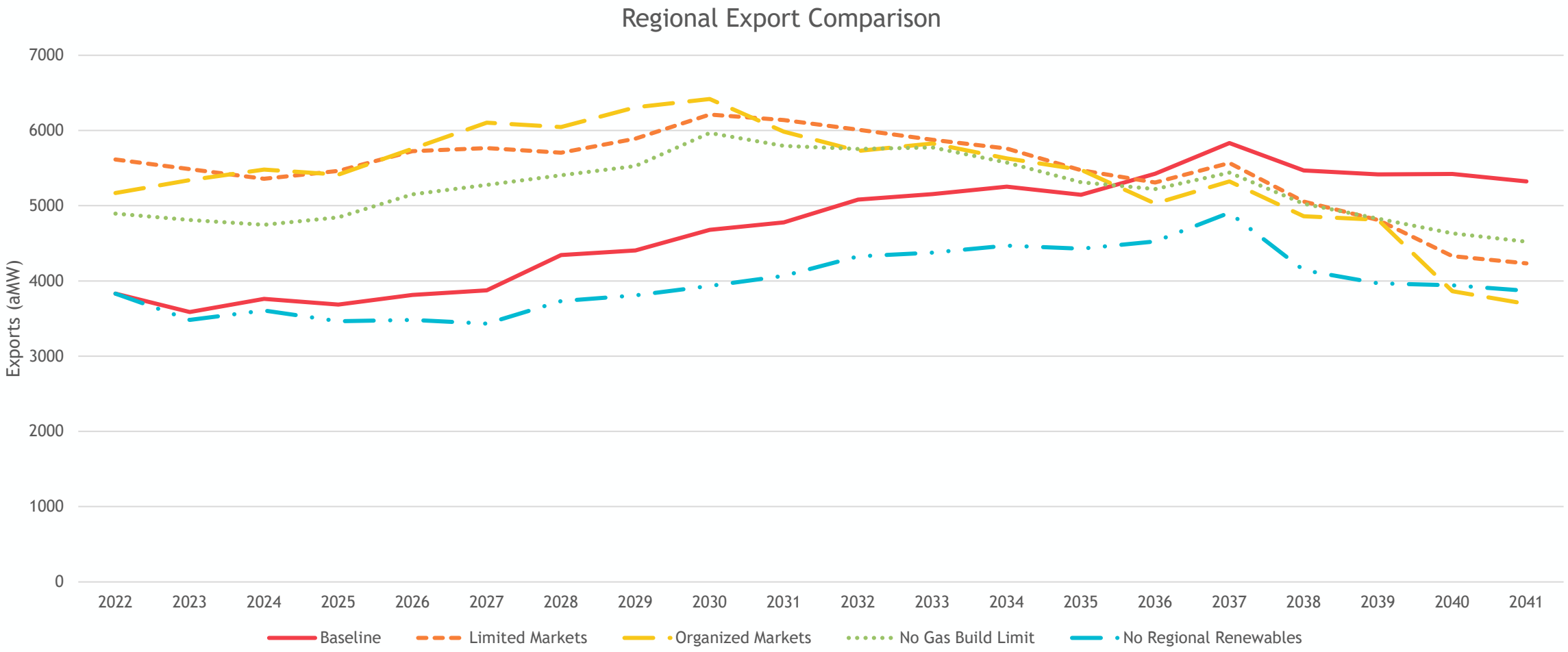



Hydro Generation Comparison
Hydro Generation (aMW)
25000
20000
15000
10000
5000
0
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
2041
Hydro spill varies significantly based on the market conditions – Baseline Conditions start with more than 3000 aMW of hydro spill
Baseline - Revised ARMs
Limited Markets
Organized Markets
No Gas Build Limit

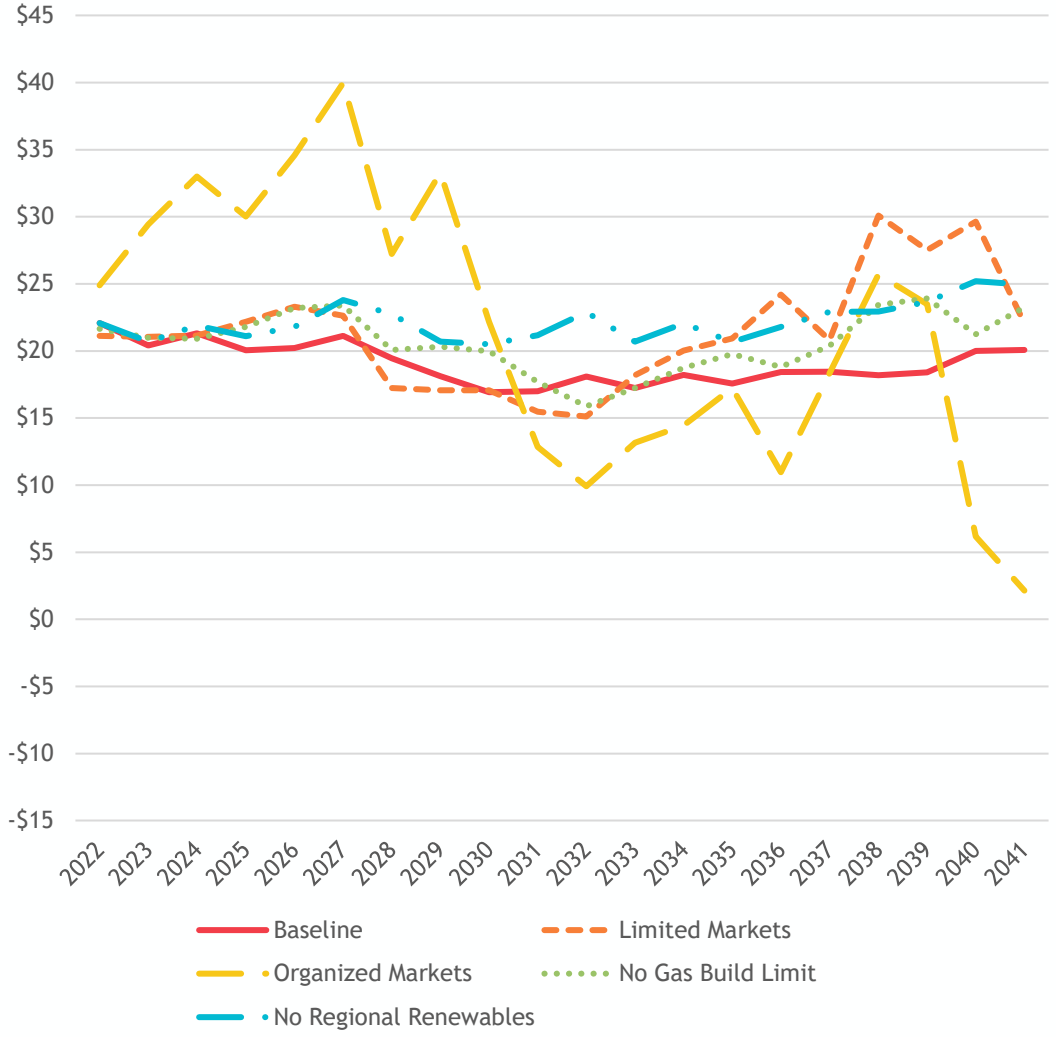

GHG Emissions Comparison
GHG Emissions (MMT)
30
25
20
15
10
5
0
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
2041
Baseline
Limited Markets
Organized Markets
No Gas Build Limit
No Regional Renewables
Emissions are sensitive to hydro spill – but should be less sensitive. RPM misses the fidelity of hourly dispatch, GENESYS is better for understanding the impact of markets on emissions.

Organized Markets reduces bills on average around 2.6% - the other markets don't substantially differ from the baseline

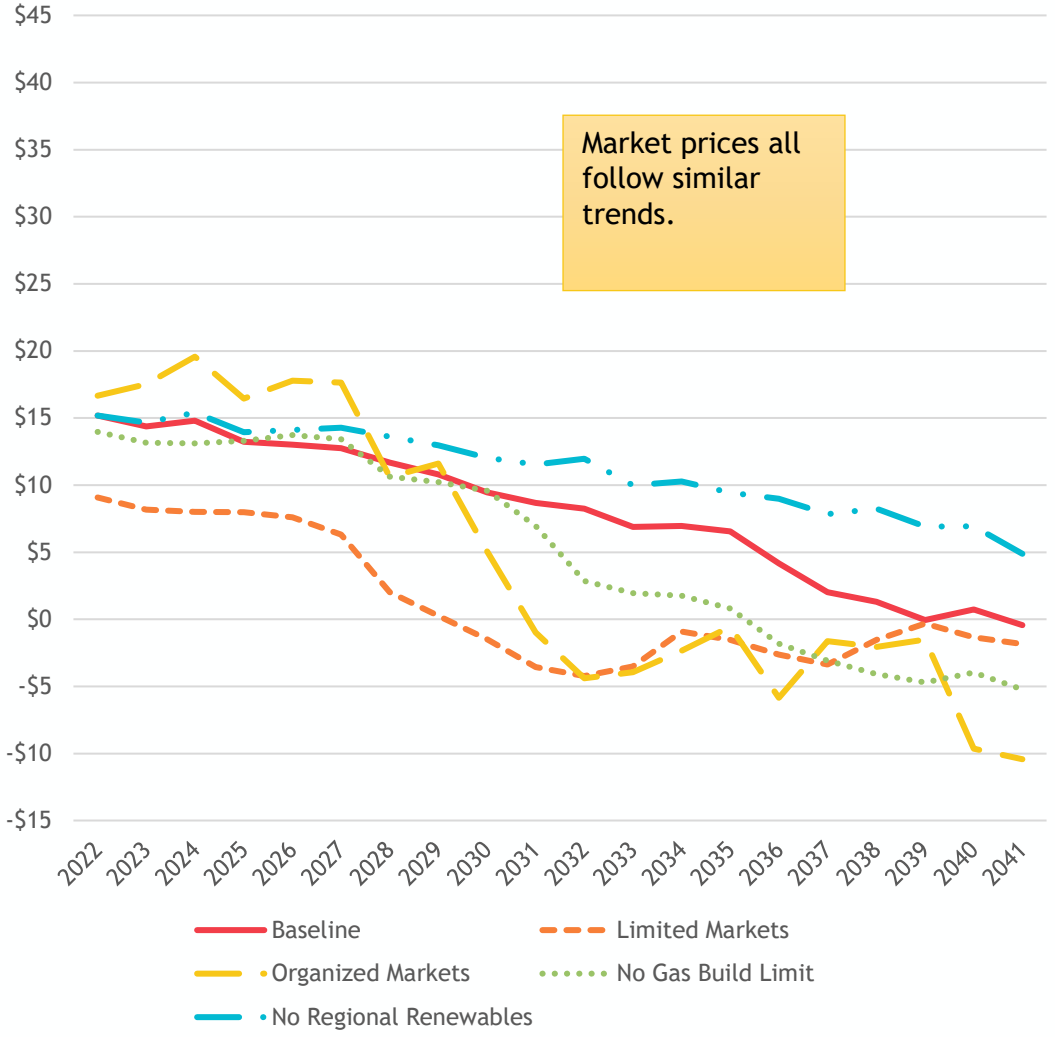



Regional Export Comparison
Exports (aMW)
7000
6000
5000
4000
3000
2000
1000
0
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
2041
Baseline
Limited Markets
Organized Markets
No Gas Build Limit
No Regional Renewables

On-Peak Internal Electricity Prices



Off-Peak Internal Electricity Prices



Questions

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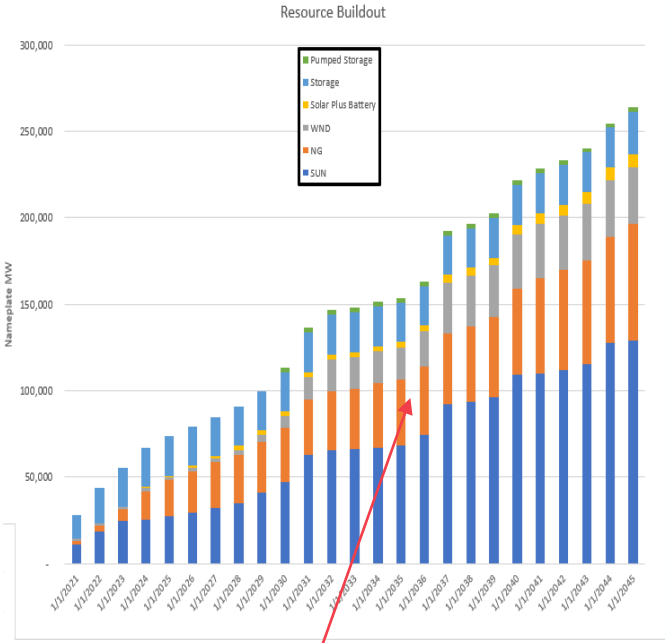
Ben Kujala bkujala@nwcouncil.org

Additional material for reference

Comparisons of Buildout

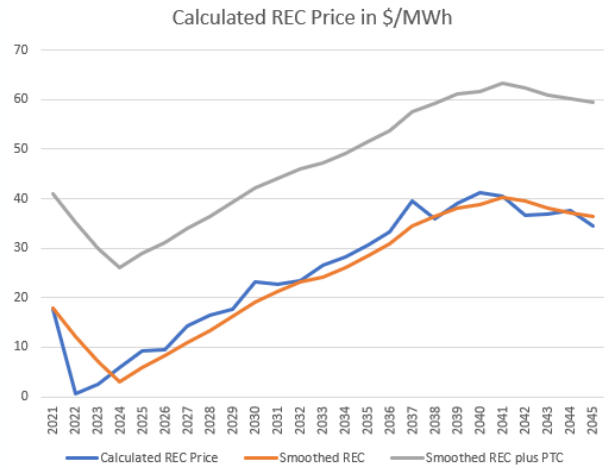
- WECC-wide and PNW builds
- By Nameplate MW's by fuel type
- Color coding of table should align (almost) with previous graphs
- Wind includes onshore and offshore wind *in CA only*



Year	Baseline
2025	
2030	

Caveats About Market Studies

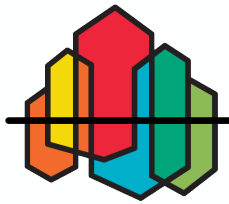
- Baseline build is adequate throughout study, all the rest of the builds are less adequate.
  - Adequate in the context of AURORA means minimal or zero load control events.
- Baseline build meets RPS and Clean constraints until late 2030's with current REC price forecast, the rest of the builds have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



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

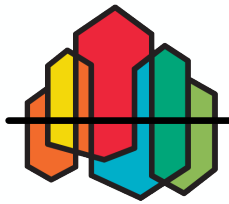
Year	Baseline	Organized	Limited	No Gas Limit
2025	46,600	48	1,907	1,041
2030	86,600	3,018	7,098	2,445
2035	145,500	9,140	7,860	2,954
2040	179,800	32,512	17,041	6,008
2045	198,000	46,488	27,598	7,167



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

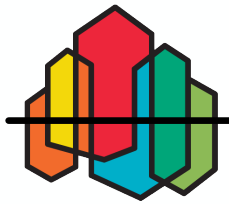
Year	Baseline	Organized	Limited	No Gas Limit
2025	16,775	9,172	110	1,600
2030	35,175	27,526	10,425	7,069
2035	37,063	44,611	20,247	18,354
2040	43,657	74,737	29,255	31,481
2045	51,481	95,394	33,937	32,959

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

Solar and Solar Plus Storage Build Comparisons

Year	Baseline	Organized	Limited	No Gas Limit
2025	0	7,703	11,241	8,090
2030	0	11,556	12,545	12,992
2035	0	13,801	15,701	19,116
2040	459	13,954	21,368	27,366
2045	459	13,954	22,177	28,444

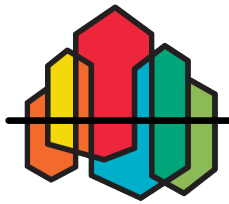
Year	Baseline	Organized	Limited	No Gas Limit
2025	0	0	1,178	0
2030	0	1,841	4,888	0
2035	0	4,246	5,048	0
2040	0	9,472	6,645	690
2045	0	10,850	7,411	690



Battery and Pumped Storage Build Comparisons

Year	Baseline	Organized	Limited	No Gas Limit
2025	2,248	9,000	1,100	2,005
2030	2,248	9,000	1,100	2,005
2035	2,248	9,000	1,100	2,005
2040	2,248	9,000	1,100	2,005
2045	2,248	9,000	1,100	2,005

Year	Baseline	Organized	Limited	No Gas Limit
2025	0	0	400	0
2030	400	0	800	0
2035	400	1,500	800	0
2040	800	3,400	800	0
2045	2,900	4,400	3,600	0



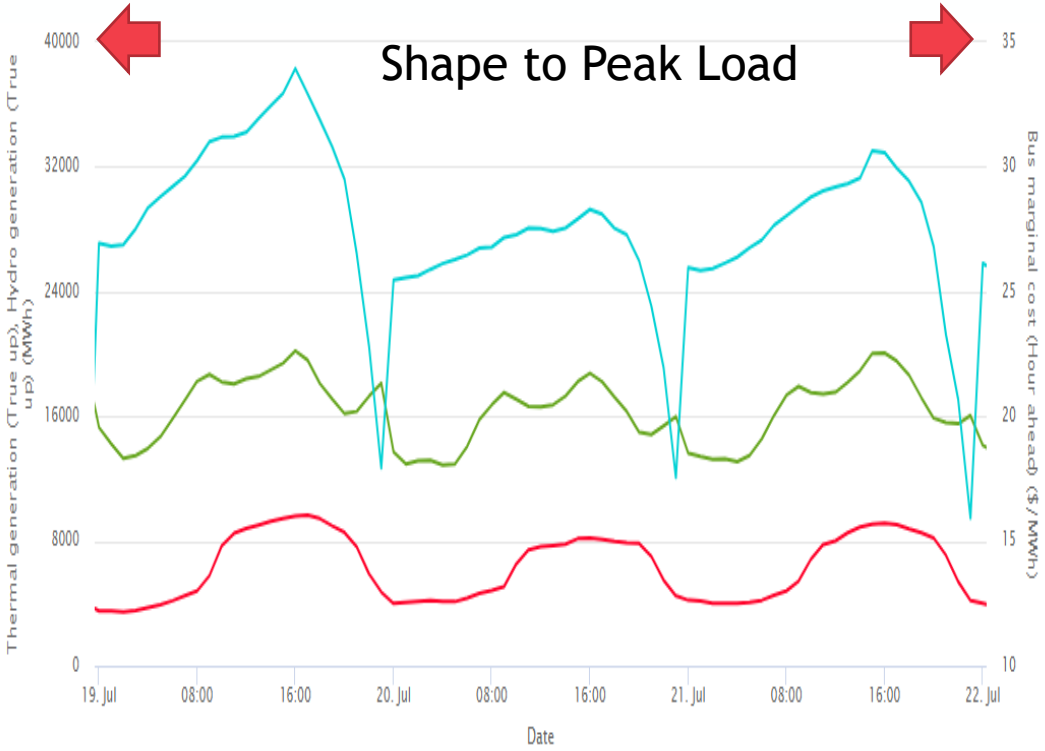
Wind and Gas Build Comparisons

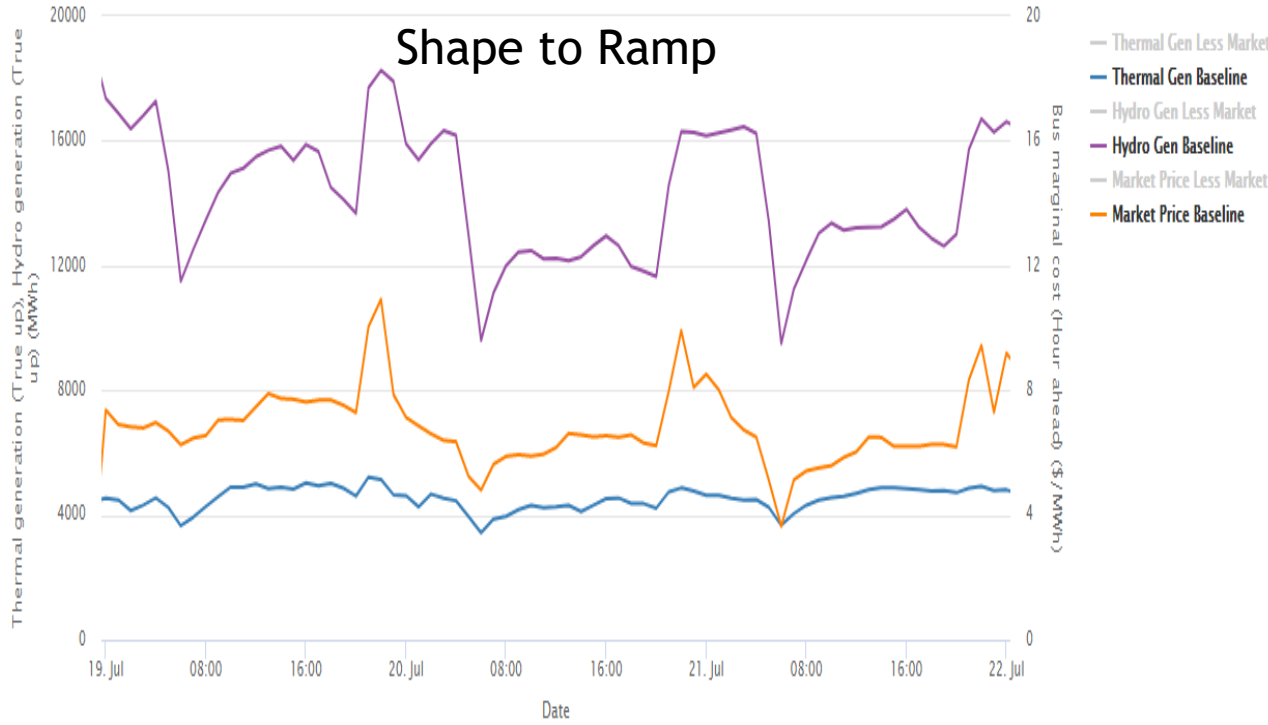
Year	Baseline	Organized	Limited	No Gas Limit
2025	0	0	0	0
2030	0	5,718	2,467	0
2035	0	10,048	2,467	0
2040	0	14,372	2,467	0
2045	0	18,339	2,467	0

Year	Baseline	Organized	Limited	No Gas Limit
2025	100	0	0	1,659
2030	100	0	0	1,949
2035	100	0	0	1,949
2040	100	0	0	1,949
2045	100	0	0	5,381

Why Did the Limited Market Not Have More Needs?

Daily Dispatch Shape Summer

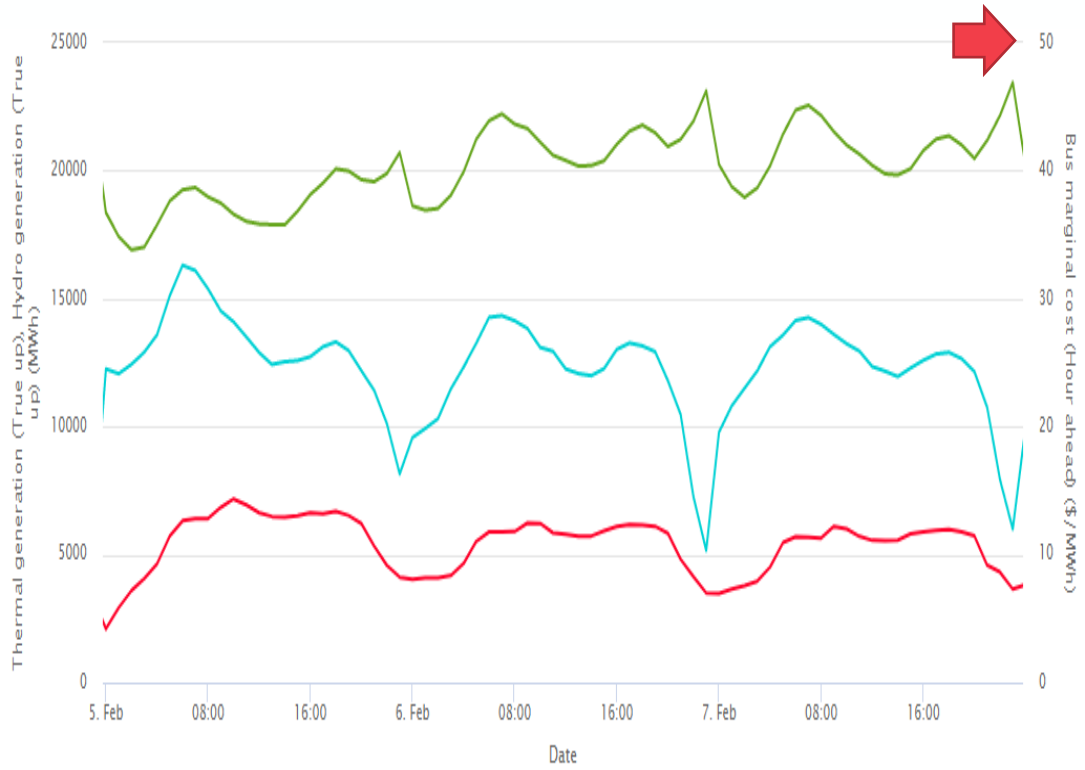


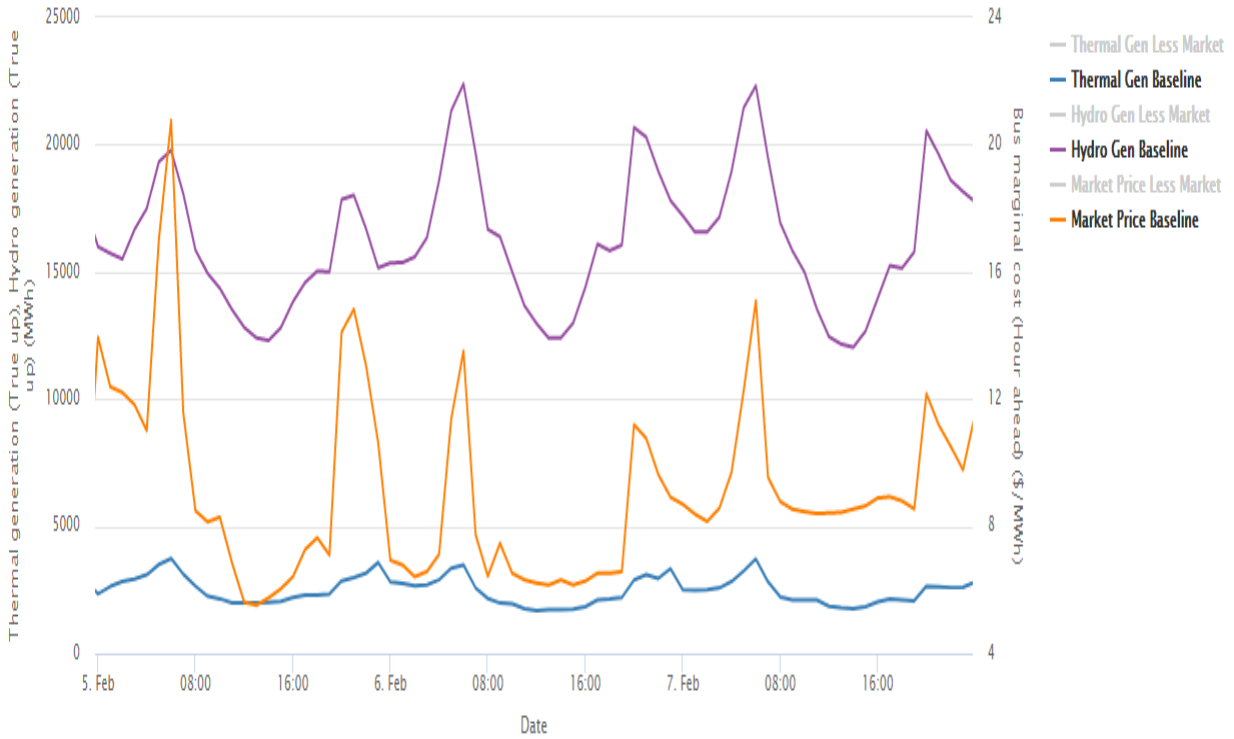


Dispatch shape is totally different in *Limited Markets* versus *Baseline* due to higher price signal in many hours and different daily price shape

Why Did the Limited Market Not Have More Needs?

Daily Dispatch Shape Winter





Dispatch shape is totally different in *Limited Markets* versus *Baseline* due to higher price signal in middle of the day and different daily price shape

Renewable Curtailments in the Baseline increase to 82 aGW