Phase II – Market Design Proposals

Load-Side Reliability Mechanism. The Commission has agreed to develop a load-side reliability mechanism that will serve the purpose of ensuring the supply of dispatchable generation is sufficient to meet system demand in ERCOT. The Commission will develop a load-side reliability mechanism that will adhere to the principles listed below. The Commission's development of a load-side reliability mechanism will take into consideration the following proposals and how they can be implemented adhering to the stated principles.

Load-Serving Entity (LSE) Obligation

- E3's load-serving entity (LSE) Obligation Proposal
- As proposed in Chairman Lake's 10/20/21 Memorandum
- Proof of Purchase with required showing, as described by Lubbock Power and Light excluding the transmission studies

Dispatchable Energy Credits (DECs)

- DEC as proposed in Commissioner McAdams's 11/17/21 Memorandum
- Eolian's Proposal

- **Principles:** A load-based reliability mechanism should:
  - Offer economic rewards and provide robust penalties or alternative compliance payments based on a resource's ability to meet established standards (including penalty at cost of new entry for both non-compliance of load and non-performance of generation).
  - Build on ERCOT's existing Renewable Energy Credit (REC) trading program framework or other existing framework to the extent practicable.
  - Be self-correcting (in a properly functioning market, higher energy prices will incentivize new supply and over time that additional supply will drive energy prices back down to market equilibrium).
  - Have clear performance standards (incentivize higher performance).
  - Sizing of the program must be dynamic (e.g., peak net load).
  - Provide a forward price signal to encourage investment in dispatchable generation resources.
  - Value or qualify resources based on capability.
  - Establish standards that can be regularly tested or certified upon the start of commercial operation.
  - Be proportional to the system need, with dynamic pricing and sizing to ensure reliability needs are met without over-purchasing reserves.
  - Be compatible with ERCOT's robust competitive retail electricity market that provides choice for consumers.
  - Ensure market power concerns are mitigated, especially regarding electric generation companies that also serve retail customers, so that competition and innovation will continue to thrive in the ERCOT market.

Backstop Reliability Service. The Commission has agreed to develop a backstop reliability service that will serve as a new dynamic and flexible reliability tool to prospectively target and

meet specific reliability needs that will not be met by ERCOT's real-time and ancillary services market. The backstop reliability service will be used to procure accredited new and existing dispatchable resources to serve as an insurance policy to help prevent emergency conditions in ERCOT.

- **Principles:** The backstop reliability service should:
  - Be sized on a dynamic, flexible basis to meet a specific reliability need (i.e., seasonal net load variability, low-probability/high-impact scenarios).
  - Include new and existing accredited dispatchable generation resources that are seasonally tested and able to meet specific minimum and maximum start-time and duration requirements.
  - Include robust non-performance penalties and clawback of payment for non-compliance.
  - Deploy generation resources in a manner that does not negatively impact real-time energy prices (i.e., the deployed generation resources will truly serve as a backstop).
  - Provide a forward price signal through an annual procurement on a seasonal basis to encourage investment in dispatchable generation resources.
  - Include cost allocation to load based on a load ratio share basis that is measured on a coincident net-peak interval basis.
  - Be developed through a framework that would allow maximum expedited implementation by ERCOT.
  - Be analyzed in conjunction with other long-term market design enhancements.

Hybrid Models

The Commission may also evaluate various combinations of the above models—the Backstop Reliability Service, the DEC proposals, and the LSE Obligation proposals—to determine whether the models' features can complement each other to provide long-term enhanced grid reliability.

Preliminary Methodology to Determine 2023 ECRS Requirements

ERCOT Staff

August 18, 2022 | PDCWG
August 19, 2022 | WMWG

Introduction

- ERCOT is in the process of implementing ERCOT Contingency Reserve Service (ECRS).
  - ERCOT is targeting to implement ECRS prior to the "EMS freeze" period (around May 2023 – Jan 2024)
- This presentation will discuss a proposed* methodology to determine the minimum quantities for ECRS in 2023. A spreadsheet that contains ECRS quantities from August 2022 through July 2023 that have been computed using this proposed methodology have been posted to today's meeting page.
  - ERCOT is seeking stakeholder feedback on the proposed ECRS methodology.

Note on Non-Spinning Reserve Service (Non-Spin) quantities post ECRS implementation

- ECRS and Non-Spin differ in the reliability risks these services address, qualification criteria, response time and duration. As a result, upon ECRS' implementation, Non-Spin requirement cannot entirely be substituted by the amount of ECRS procured as was originally proposed during NPRR863 discussions.
- That said, ERCOT expects the risks that Non-Spin is used to cover will evolve upon ECRS' implementation. Hence the methodology to determine Non-Spin quantities in a world where ECRS exists may need revisions.
  - ERCOT plans to discuss the Non-Spin methodology that will apply with ECRS' implementation as a part of the annual AS Methodology review process.

* Note, ERCOT may refine the ECRS methodology further as a part of the annual effort to review the methodology for determining Ancillary Service (AS) quantities (AS Methodology).

ECRS Requirements Methodology

- ECRS is a service that is provided using capacity that can be sustained at a specified level for two consecutive hours and is used to restore or maintain the frequency of the ERCOT System:
  a) In response to significant depletion of RRS;
  b) As backup Regulation Service;
  c) By providing energy to avoid getting into or during an Energy Emergency Alert (EEA); and
  d) Upon detection of insufficient capacity for net load ramps.

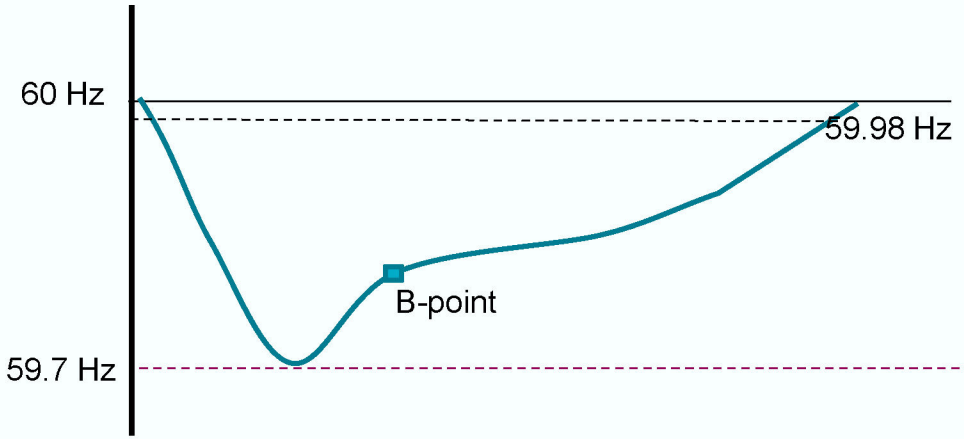
- ERCOT is proposing to compute ECRS requirements as the sum of,
  1. capacity needed to recover frequency following a large unit trip and
  2. capacity needed to support sustained net load ramps.

- The next few slides will discuss the detail about each of these components that establish the ECRS requirements.

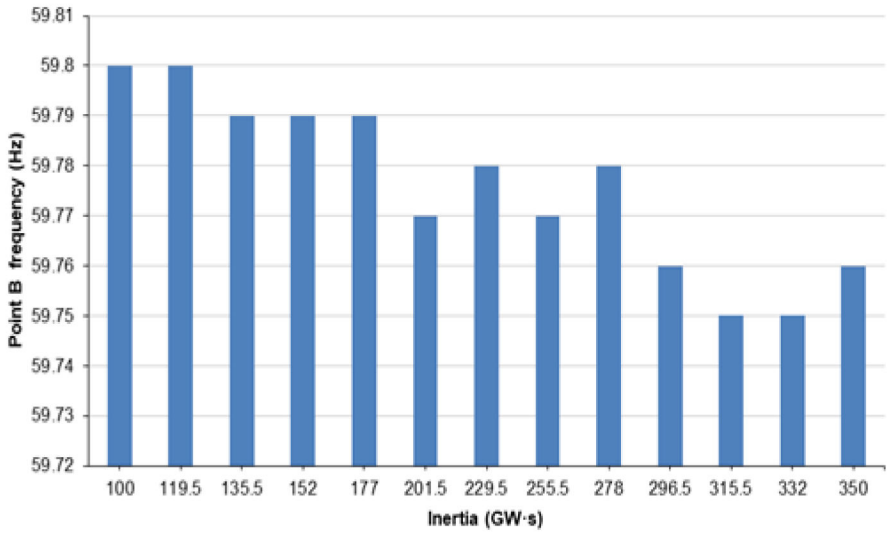
Method for Determining MWs needed for Frequency Recovery

- Capacity needed to recover frequency from B-point (i.e., settling frequency) to 59.98 Hz is determined by using dynamic simulations/studies that are run at varying inertia levels.
- In every simulation, a single medium-size unit is tripped offline such that the C-point (frequency nadir) is stays just above 59.7 Hz*.
- Capacity needed to recover frequency using this approach is determined for each hour of each month using two years historical data.

*59.7Hz is the trigger frequency for Load Resources that are providing RRS using an under-frequency relay.

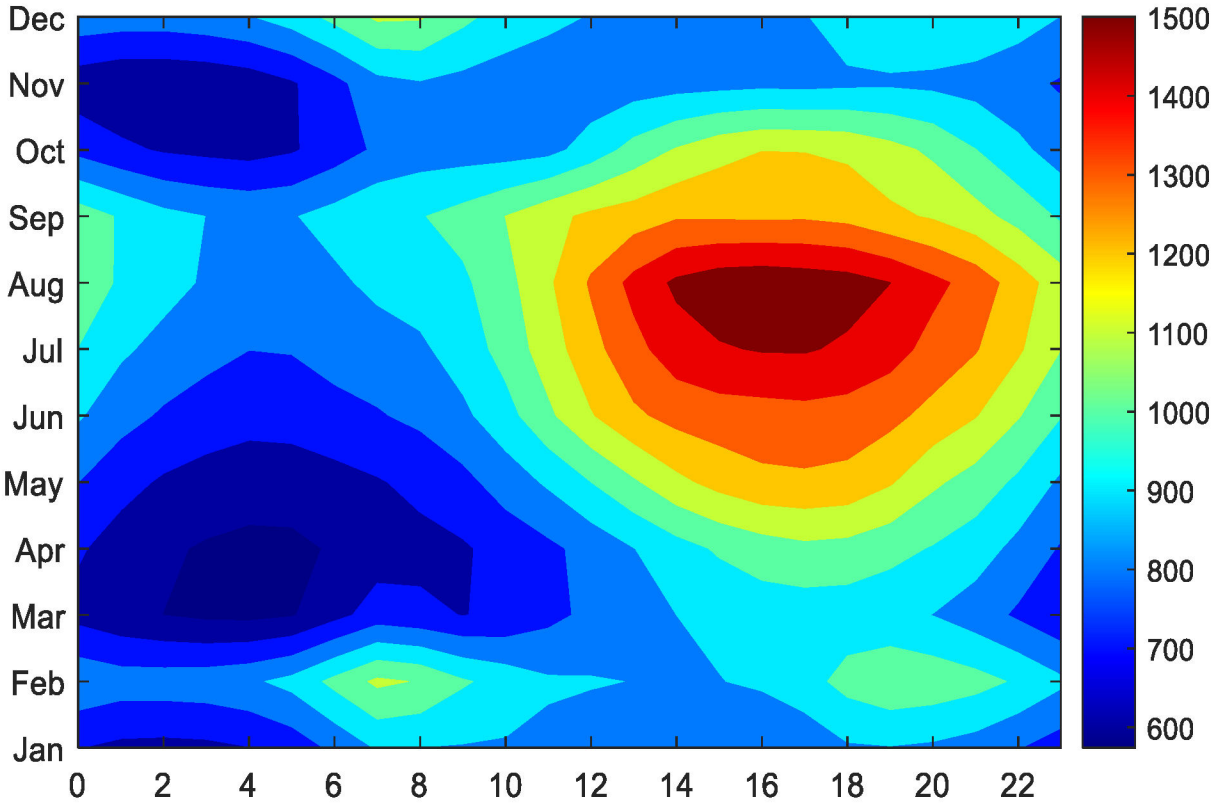


B-point (settling frequency) is determined using dynamic simulations/studies that are run at varying inertia levels. In every simulation, a single medium-size unit is tripped offline such that the C-point (frequency nadir) is stays just above 59.7 Hz.*



$MW_{need} = (59.98\ Hz - Freq_{B\text{-}point}) * (1\%\ load\ in\ MW/0.1\ Hz)$

MWs needed for Frequency Recovery



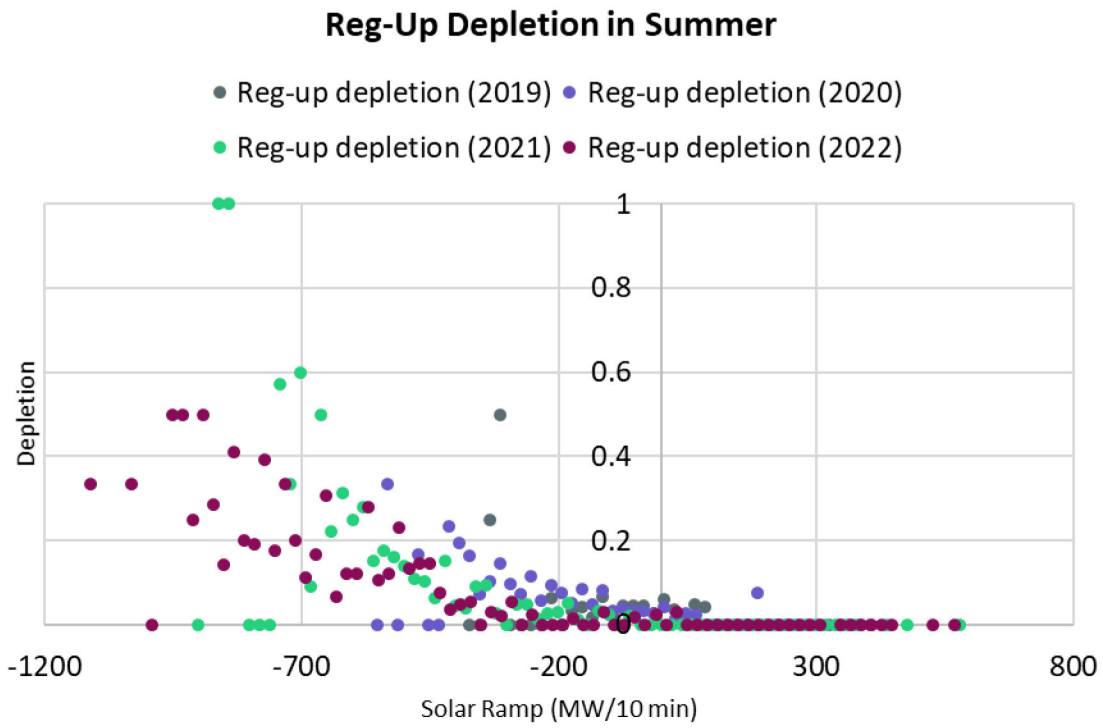
	Min	Mean	Max
MW_{need}	574 MW	951 MW	1,572 MW

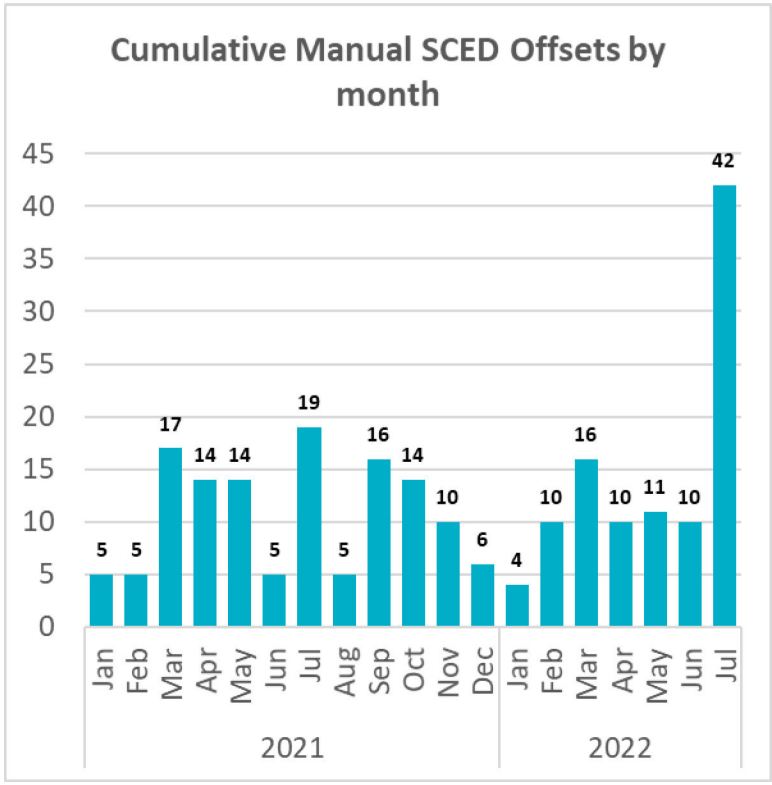
Method for Determining Additional MWs needed for sustained Net Load Ramps

- Capacity needed to support sustained net load ramps will be computed using
  - 85th to 95th percentile of 30-minute ahead intra-hour net load forecast errors for same hour same month of previous two years
    - The percentile associated with every hour will be determined based on the risk of net load up ramp. Periods where the risk of net load ramp is highest will use 95th percentile and 85th percentile for periods with lowest risks.
  - An additional adjustment will be included to account for the impact of increase in over-forecast error from expected growth in solar generation installed capacity.

Regulation usage and SCED offset Trends

- As the solar installed capacity has increased, during the evening hours, the magnitude of 10-min solar ramps have increased and there has been more reliance on regulation up deployments and SCED offsets.





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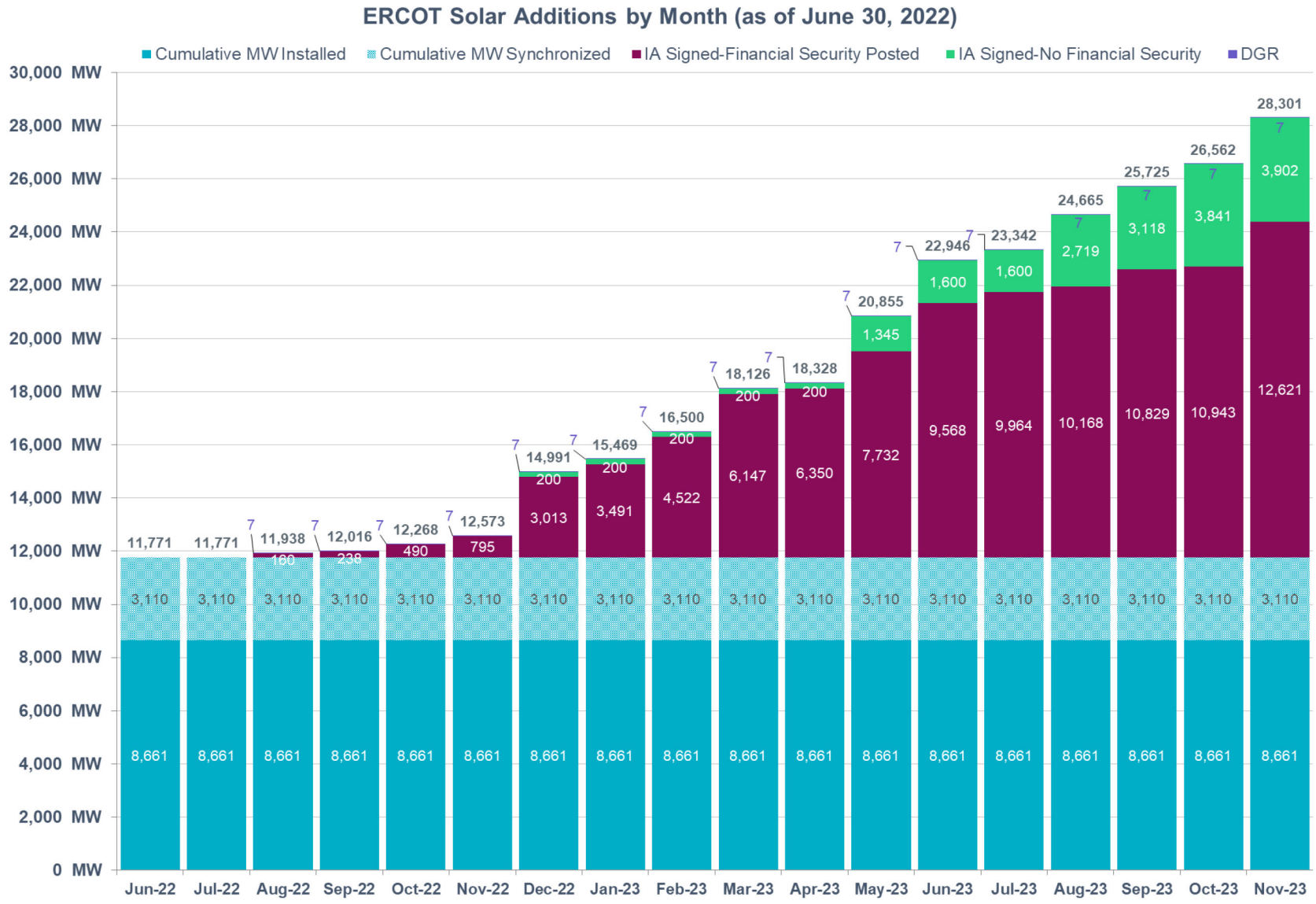
Projected Solar Generation Installed Capacity



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Adjustment for Increase in Solar Installed Capacity

- Intra-hour Solar Over-Forecast Error Adjustment Table tracks estimated increase in 30-min ahead solar over forecast error per 1000 MW increase in installed solar capacity.

ADDITIONAL ECRS PER 1,000 MW INCREASE IN SOLAR INSTALLED CAPACITY

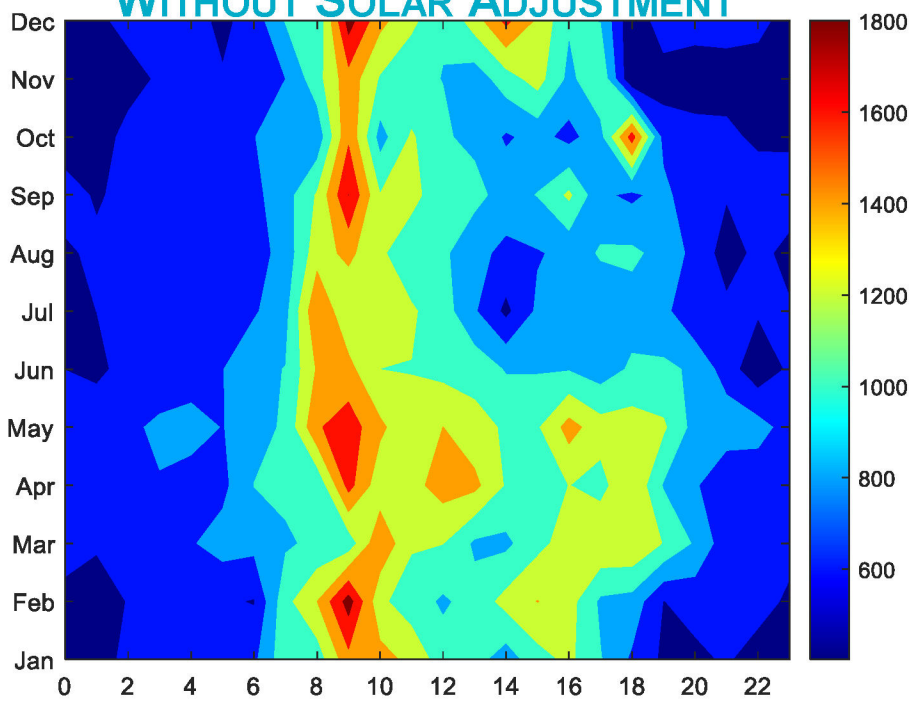
	HE 1-2, 23	HE 3-6	HE 7-10	HE 11-14	HE 15-18	HE 19-22
Jan	0	0	0	25	19	0
Feb	0	0	23	16	39	3
Mar	0	0	0	32	37	10
Apr	0	0	0	18	42	13
May	0	0	0	20	48	15
Jun	0	0	0	32	30	36
Jul	0	0	17	25	21	16
Aug	0	0	3	24	38	17
Sep	0	0	0	17	27	7
Oct	0	0	0	7	19	0
Nov	0	0	0	22	25	0
Dec	0	0	0	39	42	0

ADJUSTMENT FOR 2023 (MIN: 0 MW | MEAN: 68 MW | MAX 283 MW)

	H01	H02	H03	H04	H05	H06	H07	H08	H09	H10	H11	H12	H13	H14	H15	H16	H17	H18	H19	H20	H21	H22	H23	H24
Jan	0	0	0	0	0	0	0	0	0	0	150	150	150	150	113	113	113	113	0	0	0	0	0	0
Feb	0	0	0	0	0	0	138	138	138	138	93	93	93	93	232	232	232	232	16	16	16	16	0	0
Mar	0	0	0	0	0	0	0	0	0	0	192	192	192	192	221	221	221	221	62	62	62	62	0	0
Apr	0	0	0	0	0	0	0	0	0	0	106	106	106	106	248	248	248	248	78	78	78	78	0	0
May	0	0	0	0	0	0	0	0	0	0	121	121	121	121	283	283	283	283	90	90	90	90	0	0
Jun	0	0	0	0	0	0	0	0	0	0	191	191	191	191	178	178	178	178	211	211	211	211	0	0
Jul	0	0	0	0	0	0	103	103	103	103	150	150	150	150	124	124	124	124	96	96	96	96	0	0
Aug	0	0	0	0	0	0	20	20	20	20	141	141	141	141	223	223	223	223	99	99	99	99	0	0
Sep	0	0	0	0	0	0	0	0	0	0	103	103	103	103	161	161	161	161	42	42	42	42	0	0
Oct	0	0	0	0	0	0	0	0	0	0	40	40	40	40	110	110	110	110	0	0	0	0	0	0
Nov	0	0	0	0	0	0	0	0	0	0	131	131	131	131	146	146	146	146	0	0	0	0	0	0
Dec	0	0	0	0	0	0	0	0	0	0	233	233	233	233	248	248	248	248	0	0	0	0	0	0

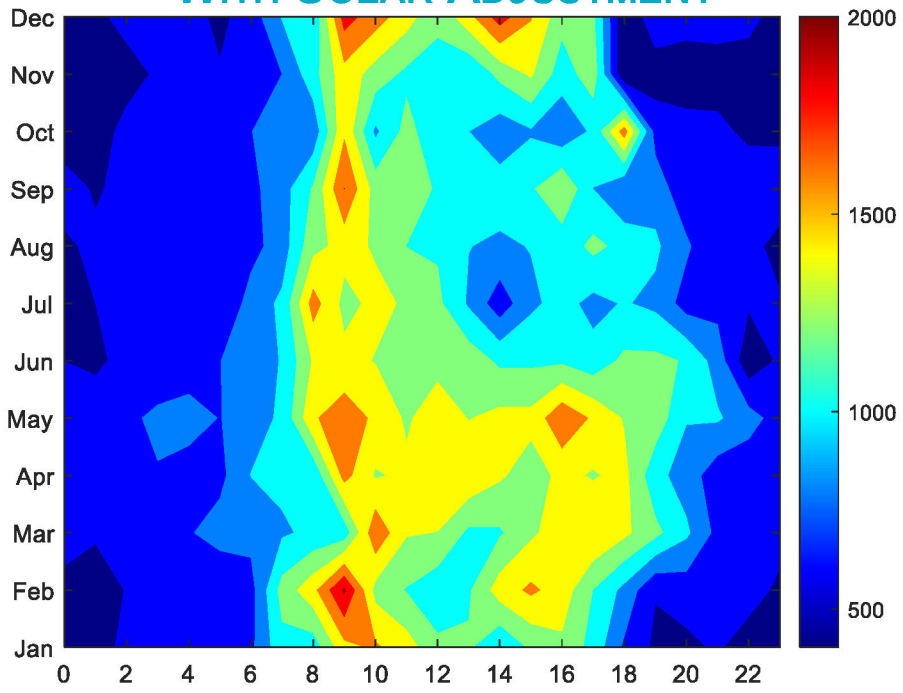
MWs needed for Intra-hour Net Load Forecast Errors

Without Solar Adjustment



	Min	Mean	Max
MW_{need}	403 MW	913 MW	1,889 MW

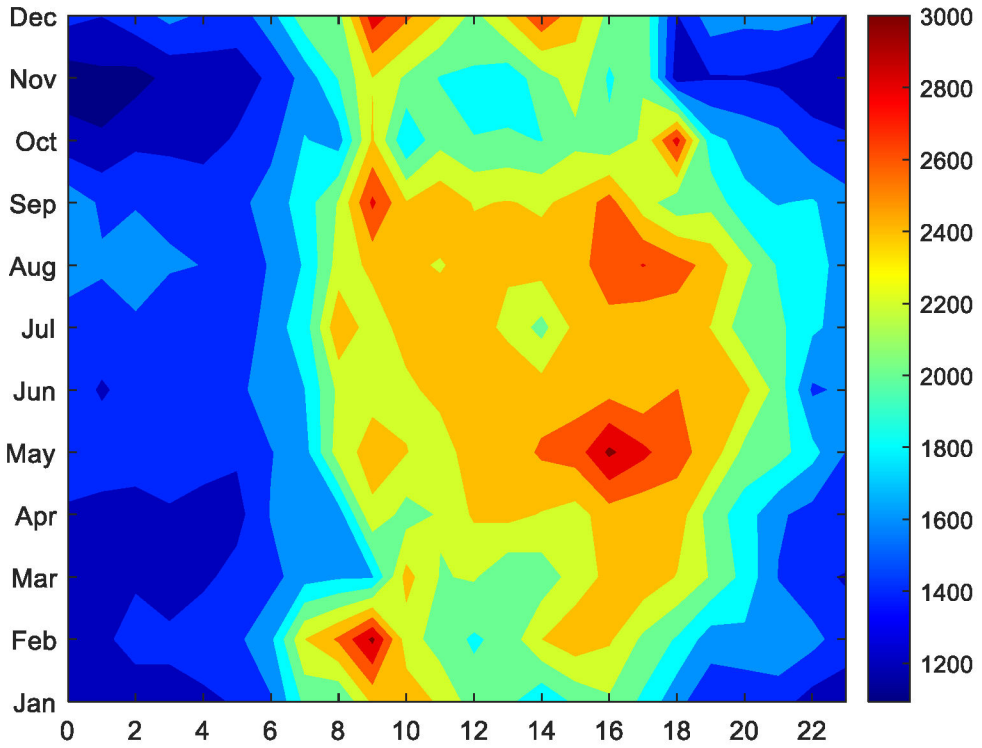
With Solar Adjustment



	Min	Mean	Max
MW_{need}	403 MW	981 MW	2,027 MW

ECRS Requirement for 2023

- Total ECRS requirement for every hour is computed as the sum of
  1. capacity needed to recover frequency following a large unit trip and
  2. capacity needed to support sustained net load ramps (with solar adjustment)



	Min	Mean	Max
ECRS	1,093 MW	1,933 MW	3,039 MW

Summary and Next Steps

- Using the preliminary* methodology to determine the minimum quantities for ECRS, hourly ECRS requirements in 2023 may vary between 1,093 and 3,039 MW.
  - A spreadsheet that contains the associated ECRS quantities for January through July of 2023 have been posted to today's meeting page.

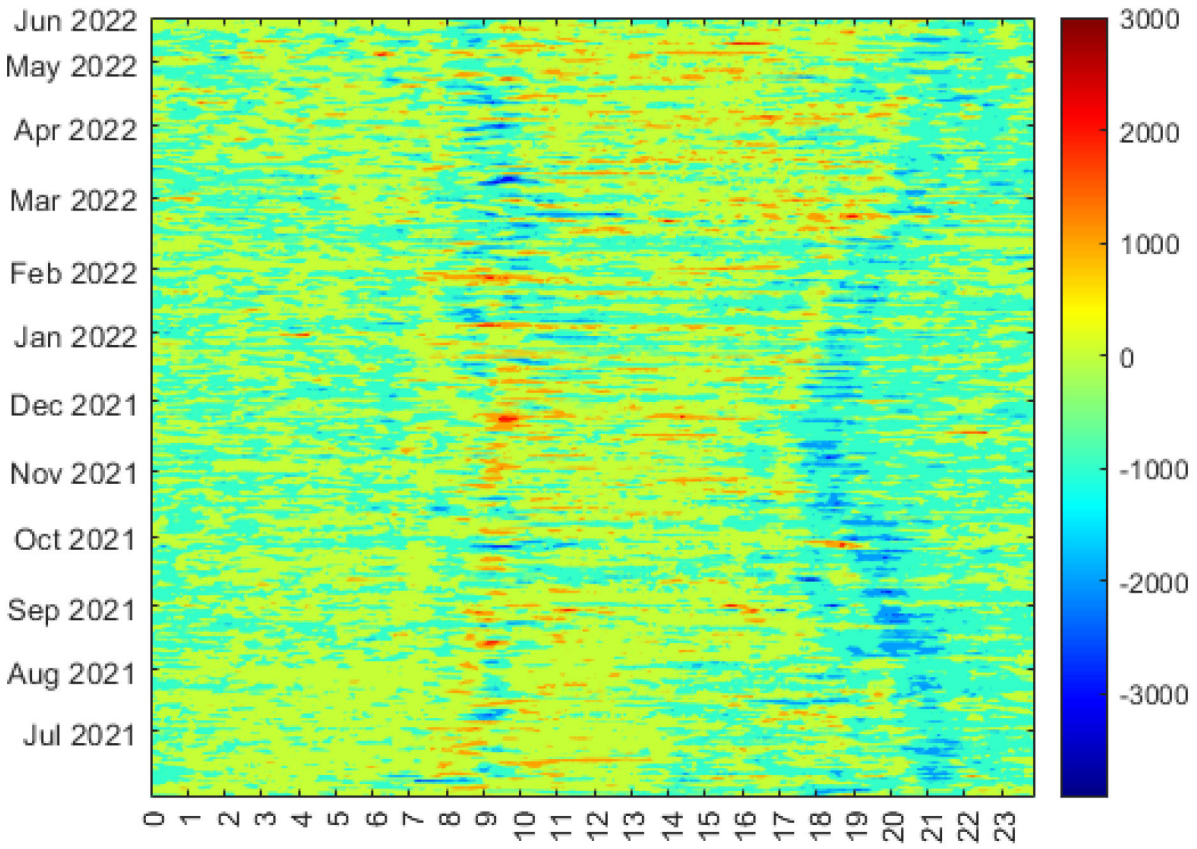
- ERCOT is seeking stakeholder feedback on the proposed ECRS methodology.

- Lastly, ERCOT expects the risks that Non-Spin is used to cover will evolve upon ECRS' implementation. Hence the methodology to determine Non-Spin quantities in a world where ECRS exists may need revisions.
  - ERCOT plans to discuss the Non-Spin methodology that will apply with ECRS' implementation as a part of the annual AS Methodology review process.

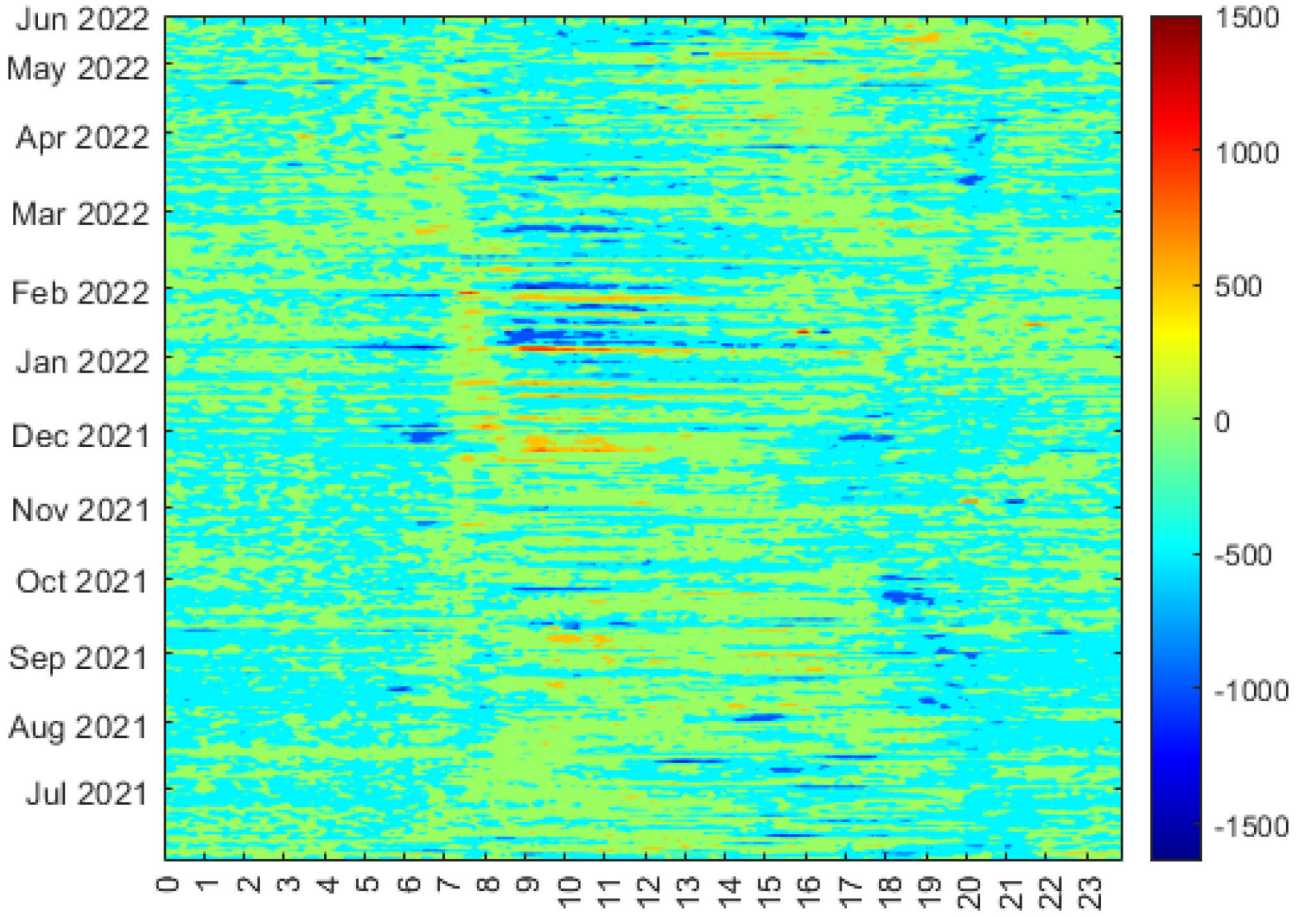
* Note, ERCOT may refine the ECRS methodology further as a part of the annual effort to review the AS Methodology).

Appendix

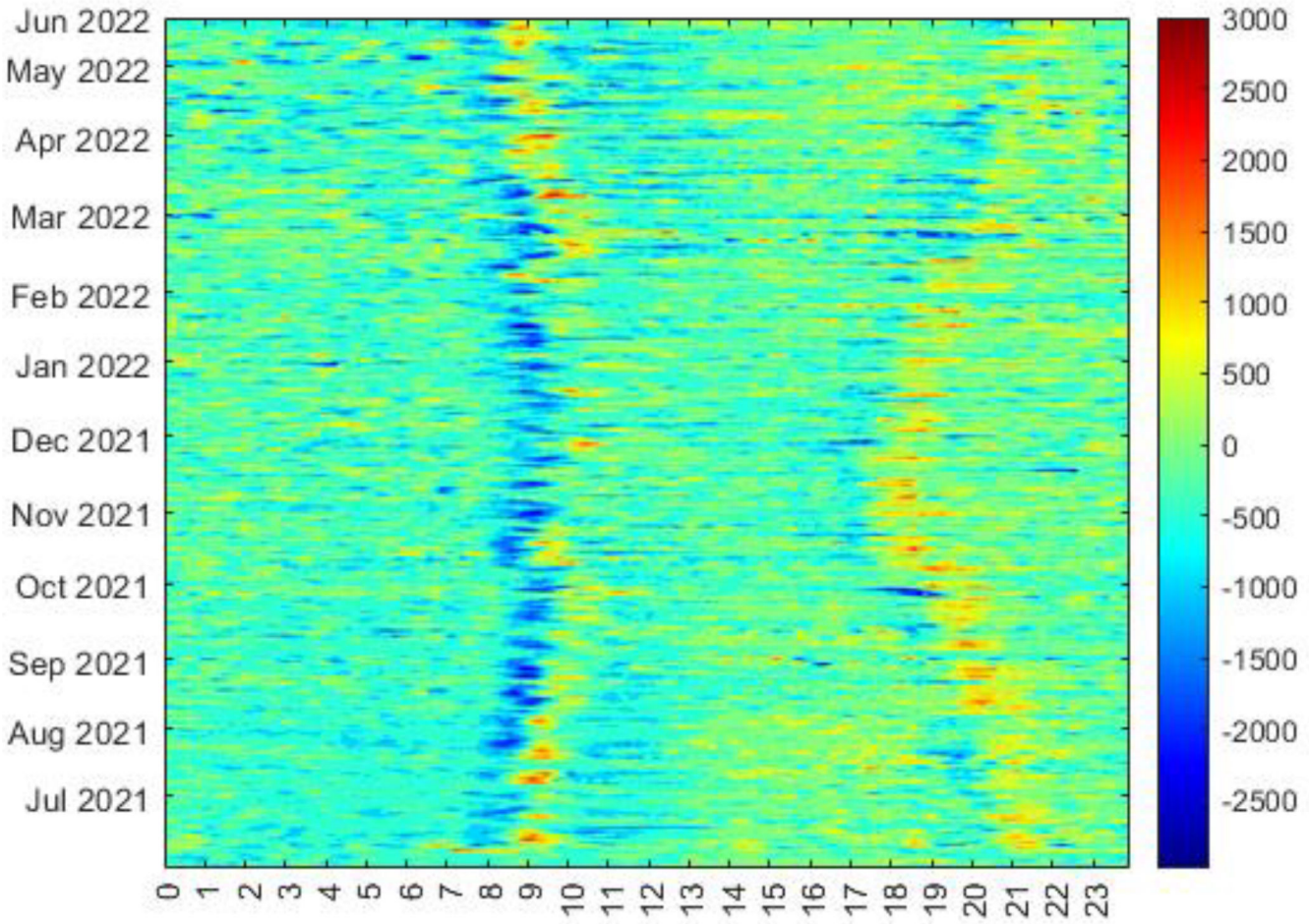
30-min-ahead Intra-hour Netload Forecast Error



30-min-ahead Intra-hour Load Forecast Error



30-min-ahead Intra-hour Wind Forecast Error



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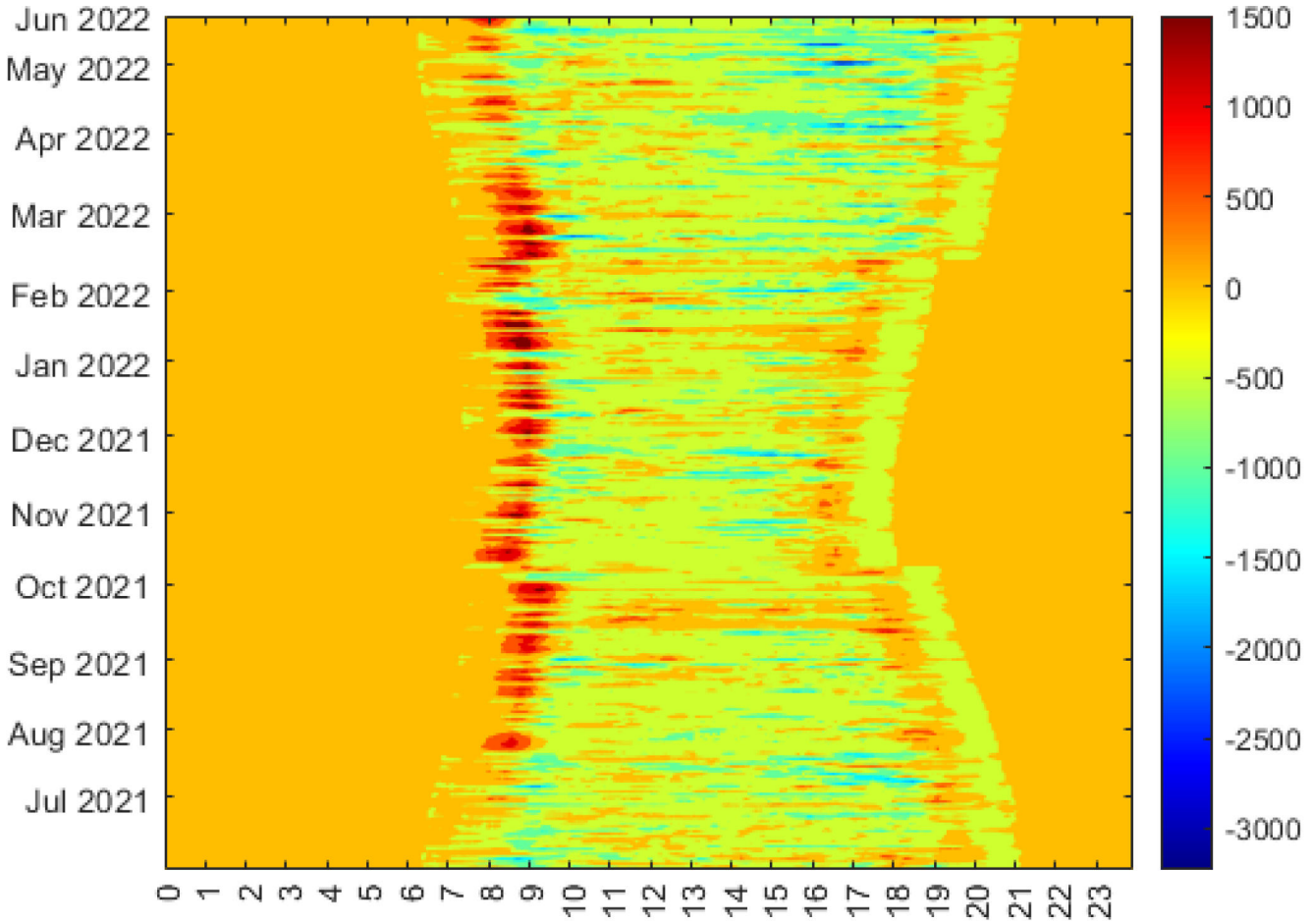
30-min-ahead Intra-hour Solar Forecast Error



Comparison between ECRS and Non-Spin

	ECRS	Non-Spin
Reliability Objective	ECRS may be deployed to a) Help restore the frequency to 60 Hz within ten minutes of a significant frequency deviation b) Provide energy upon detection of insufficient capacity for net load ramps c) Provide energy to avoid or during the implementation of an EEA d) Provide backup to Reg-Up	Non-Spin may be deployed to provide additional capacity, a) During situations when there isn't sufficient capacity for energy dispatch b) For intra-day forced outage of units and during sustained frequency decay or sustained low frequency operations. c) When SCED does not have enough energy available to execute successfully
Primary Forecast Risk	Errors in 5-minute load/wind/solar forecast that is used in SCED dispatch (via GTBD)	Errors in hourly load/wind/solar forecast that is used in RUC
Qualification Criteria	Provided using capacity that can be sustained at a specified level for two consecutive hours	Provided using capacity that can be sustained at a specified level for four consecutive hours
Response	Deployed within 10 minutes upon the receipt of deployment instruction	Deployed within 30 minutes upon the receipt of deployment instruction

ECRS and Non-Spin differ in the reliability risks to be addressed, the response time and the duration requirement. It is not recommended to substitute Non-Spin requirement either entirely or partially by the amount of ECRS procured.

Discussion On 2023 Ancillary Service Methodology

ERCOT Staff

Sep 14, 2022 | PDCWG
Sep 23, 2022 | WMWG

Stakeholder Discussion Timeline

- September 14, 2022 – PDCWG (Methodology Discussion)
- September 23, 2022 – WMWG (Methodology Discussion)

- October 20, 2022 – PDCWG (Proposed Methodology)
- October 21, 2022 – WMWG (Proposed Methodology)
- October 27, 2022 – OWG (Proposed Methodology)

- November 02, 2022 - WMS
- November 07, 2022 - ROS

- December 5, 2022 - TAC
- December 20, 2022 - BoD

Discussion Scope for Today

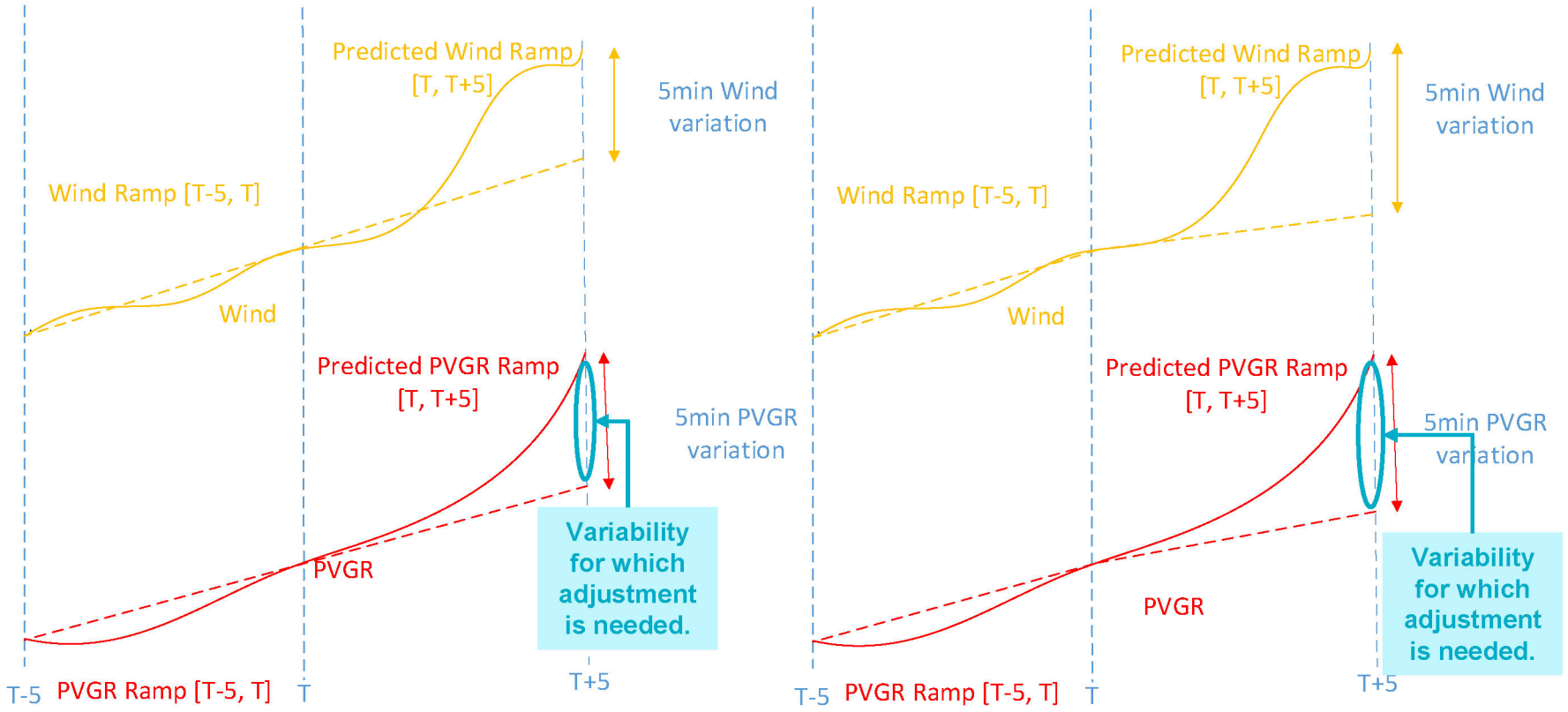
- This presentation will discuss the various approaches ERCOT is considering to determine Ancillary Service (A/S) quantities for 2023.
  - ERCOT is not considering any changes in the methodologies used to compute Regulation Service and Responsive Reserve Service requirements for 2023.
  - NERC's preliminary BAL-003 Interconnection Frequency Response Obligation (IFRO) for Operating Year (OY) 2023 assessment for ERCOT shows an increase in ERCOT's IFRO. In order to align with ERCOT's new IFRO, the minimum RRS-PFR limit for 2023 will change to 1,390 MW.
  - ERCOT is considering some changes in the methodology used to compute minimum Non-Spin requirements in 2023 both prior to and after ECRS is implemented.
- The Ancillary Service (A/S) quantities for 2023 contained in this presentation are based on the methodology that was approved in December 2021. The quantities for 2023 reflect moving forward the historic data on which these are based, unless otherwise noted.

Regulation Service Methodology

- ERCOT is not considering any change to the methodology used to compute the minimum Regulation Service requirements in 2023.
  - ERCOT is considering an update to the methodology used to compute the Solar Adjustment tables for 2023 to better align it with how 5-minute wind and solar forecasted ramps are currently used in operations.

- The preliminary Regulation quantities for January 2023 through August 2023 in subsequent slides have been computed using current methodology (2021 and 2022 five-minute net load variability), updated Wind Adjustment tables and the updated Solar Adjustment tables.

Solar Adjustment Table Changes

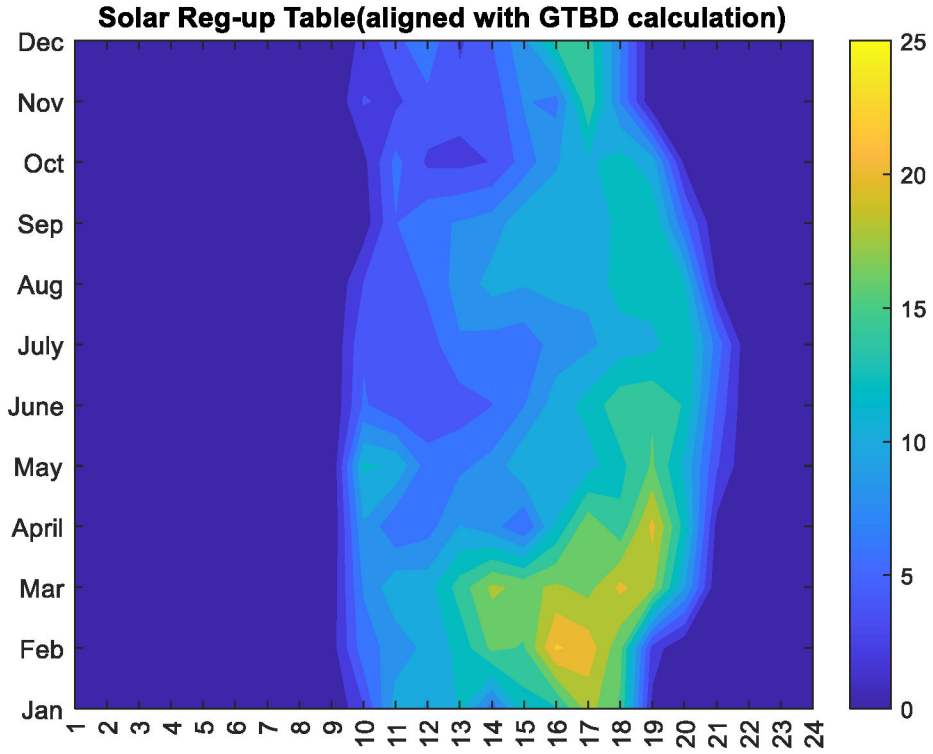


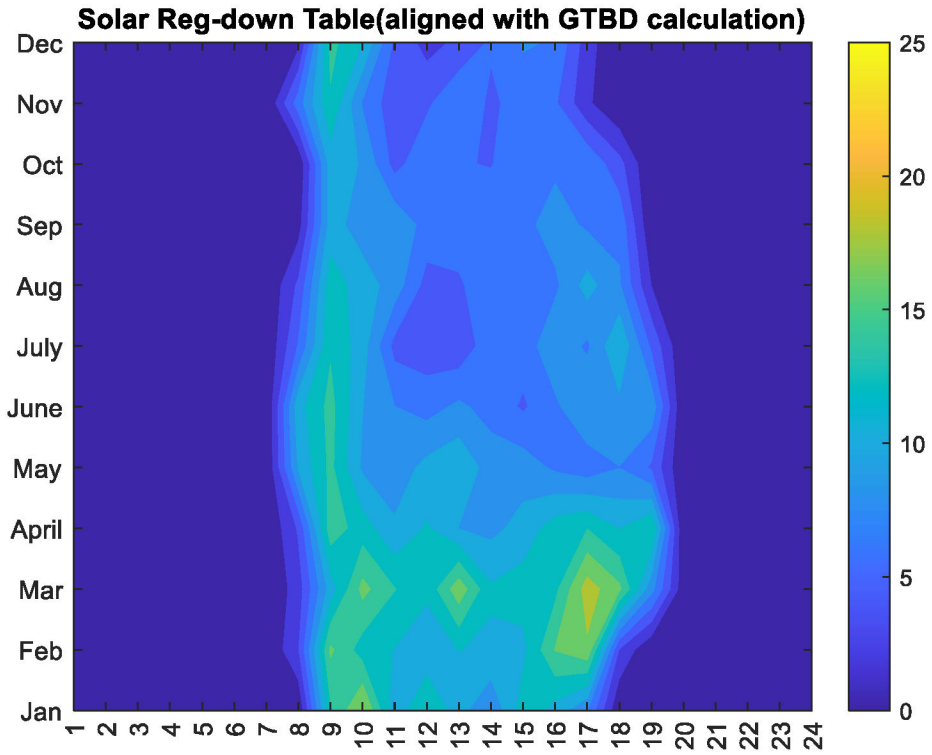
2022 Methodology: When computing the additional variability for which an adjustment is needed, in 2022, the predicted PVGR and wind ramp calculation fully discounts the actual ramp from the previous 5-minutes.

2023 Methodology: There exists an upper bound on the amount of PVGR and wind ramp that are used in establishing GTBD. In 2023, in order to account for this upper bound, when computing the additional variability for which an adjustment is needed, the predicted PVGR and wind ramp calculation will partially discount the actual ramp from the previous 5-minutes.

2023 Solar Adjustment Tables

Solar Adjustment Tables track incremental MWs of Regulation needed to account for additional variability per 1000 MW increase in installed solar capacity.

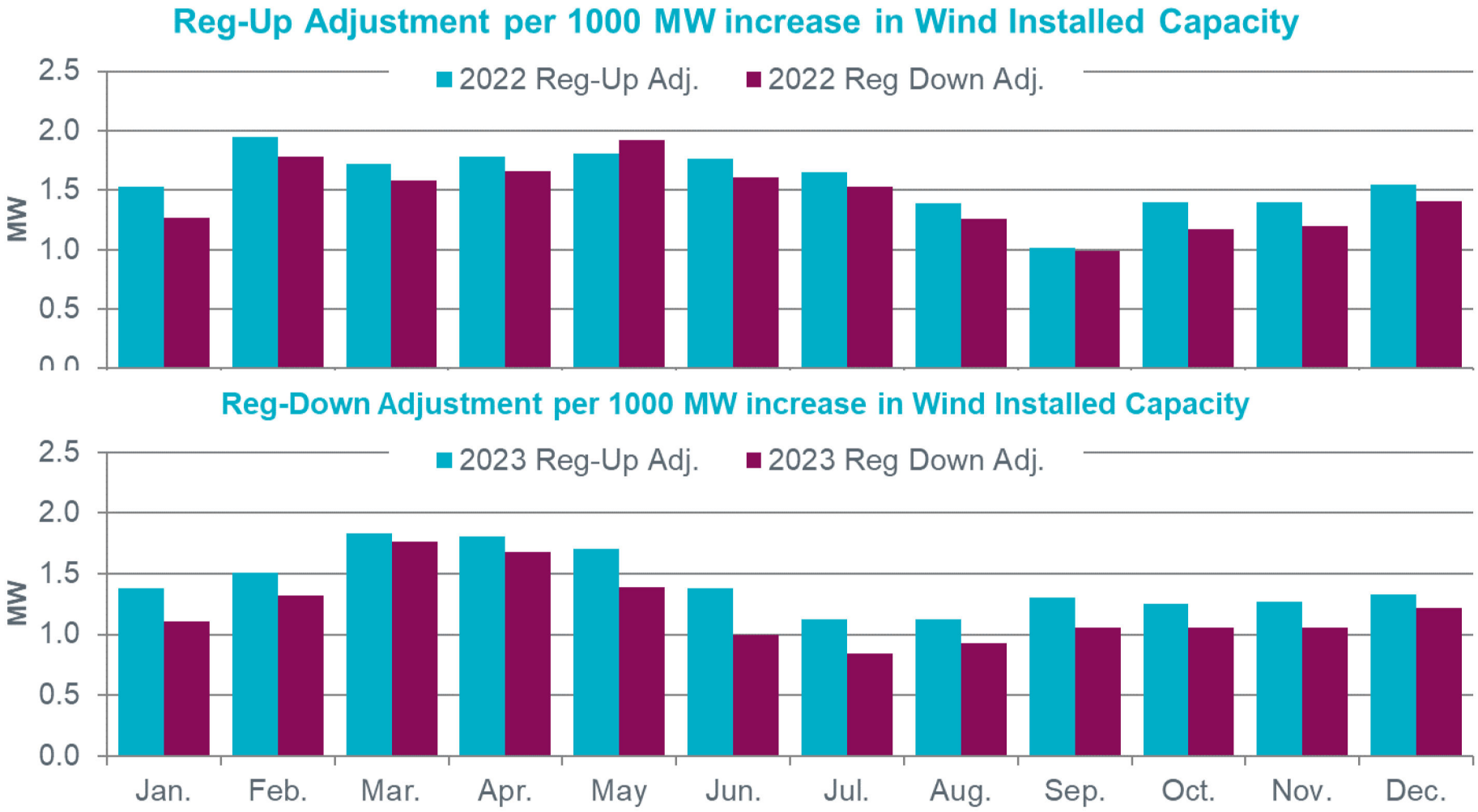




	Min (MW)	Max (MW)	Average (MW)
Reg Up	0	25.4	9.9
Reg Down	0	22.4	8.2

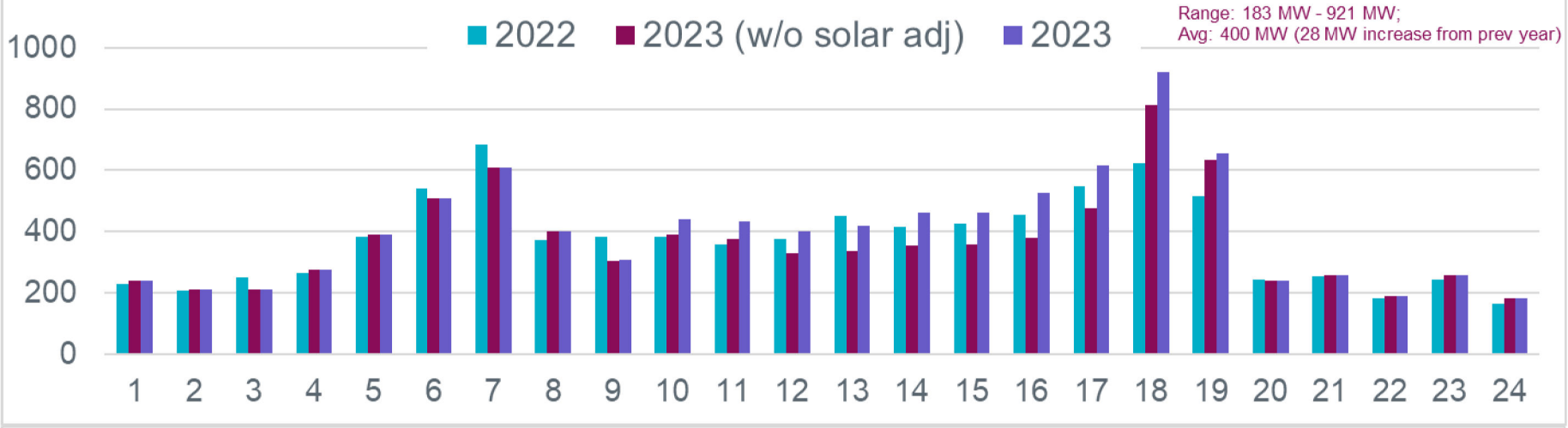
2023 Wind Adjustment Tables

Wind Adjustment Tables track incremental MWs of Regulation needed to account for additional variability per 1000 MW increase in installed wind capacity.

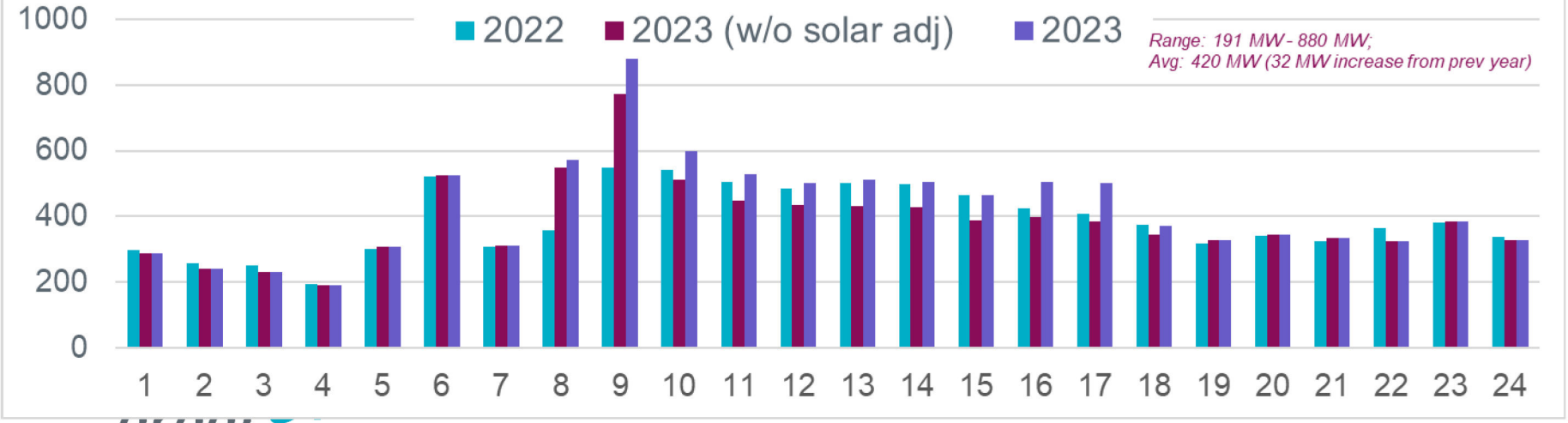


Regulation Comparison February

Regulation Up Requirement Comparison for February

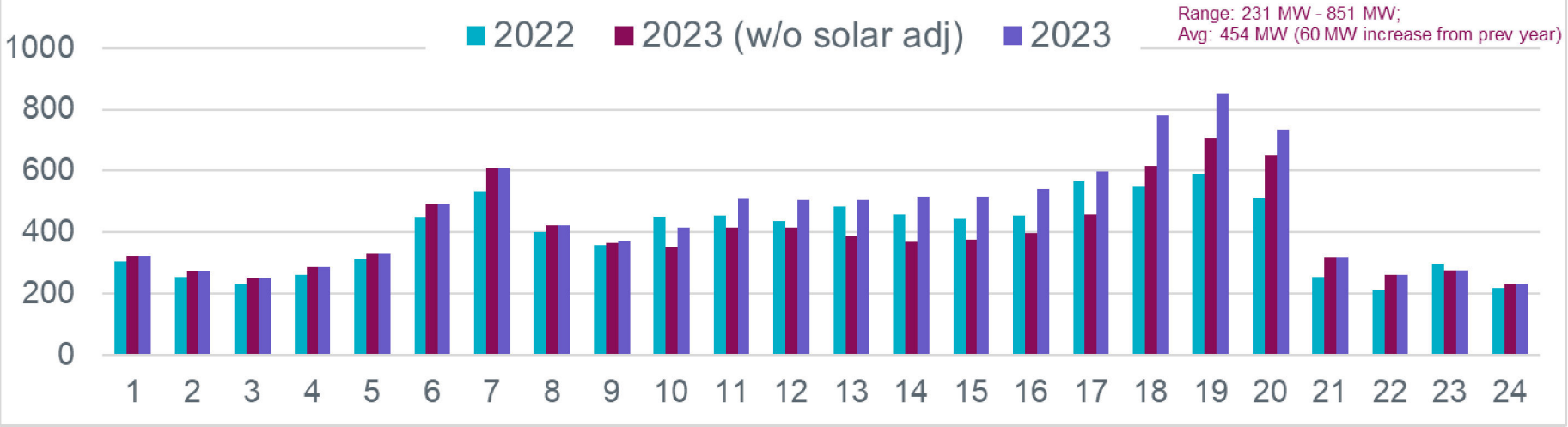


Regulation Down Requirement Comparison for February

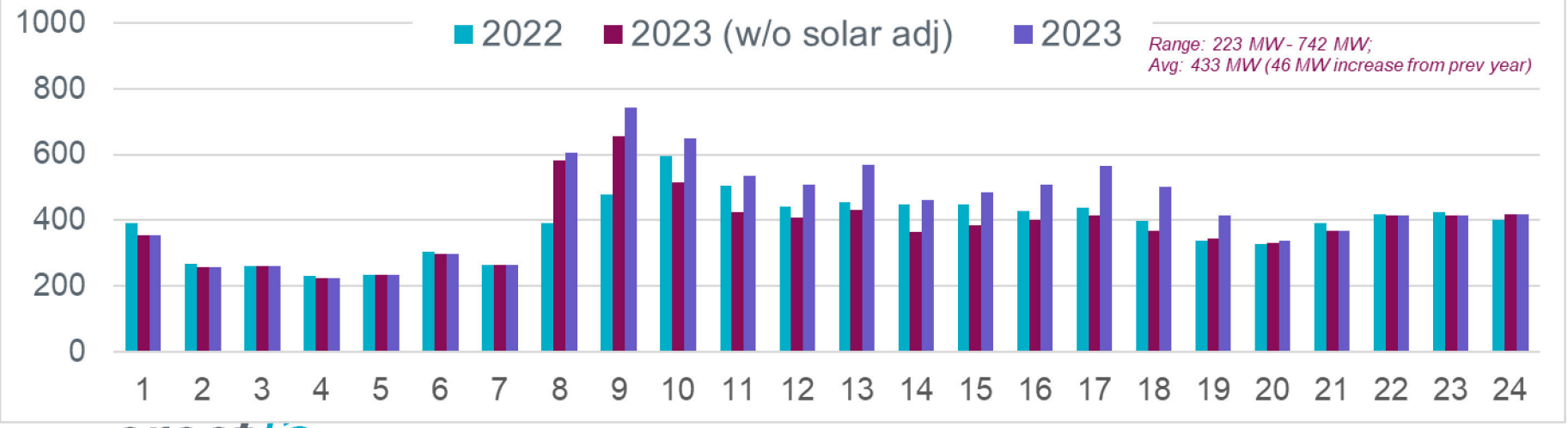


Regulation Comparison March

Regulation Up Requirement Comparison for March

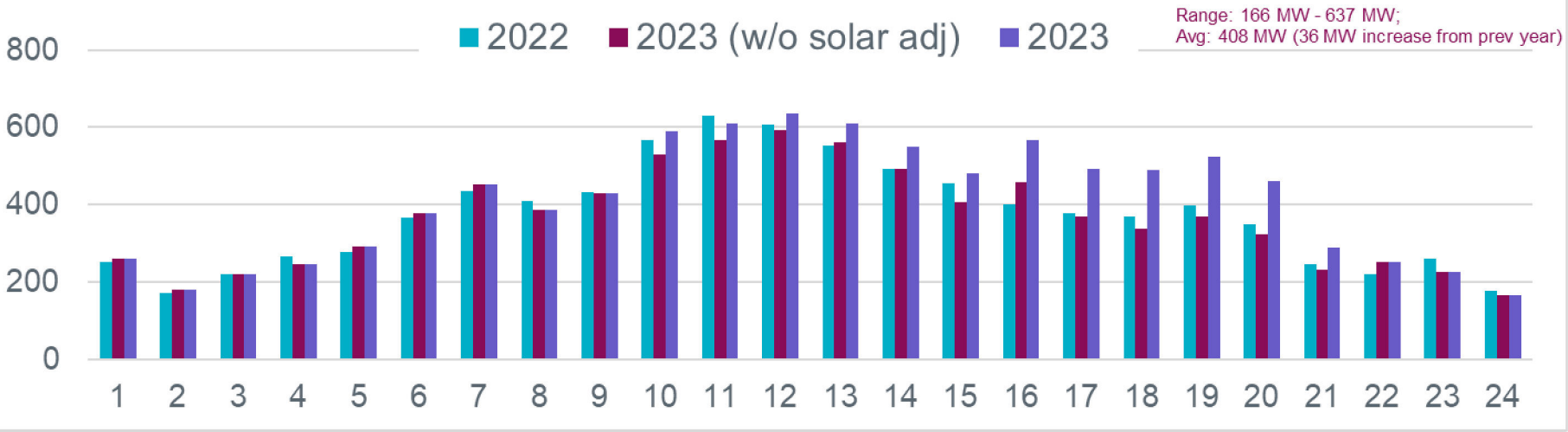


Regulation Down Requirement Comparison for March

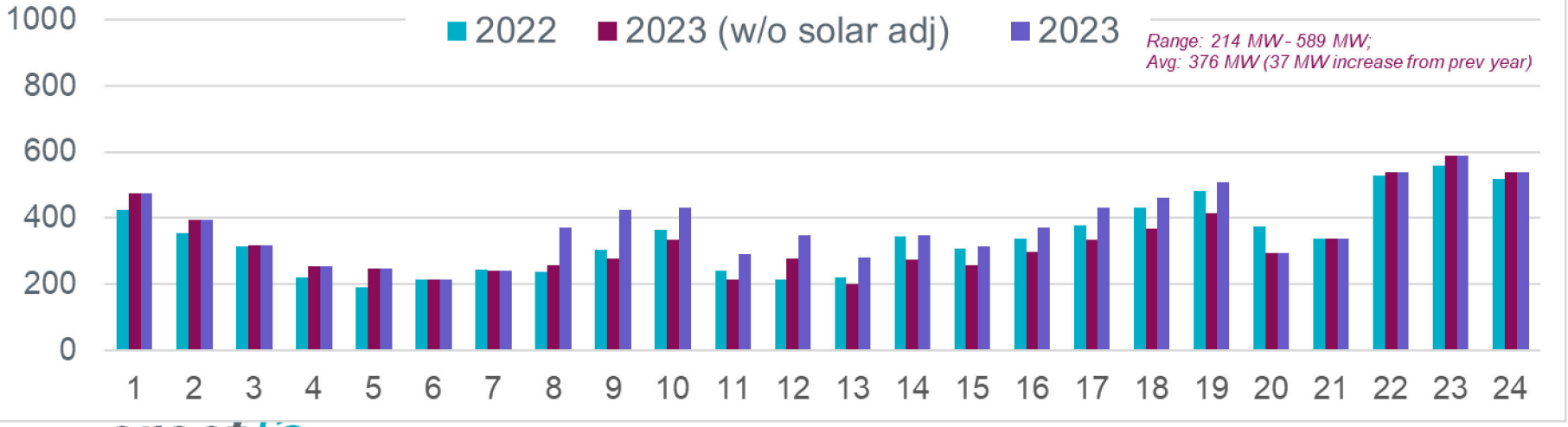


Regulation Comparison June

Regulation Up Requirement Comparison for June

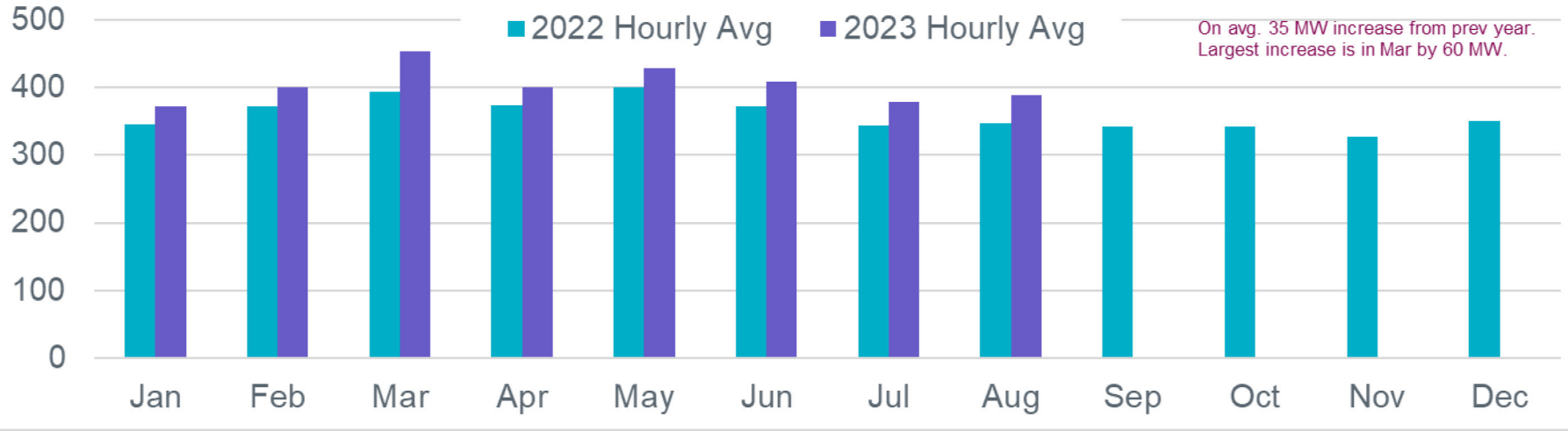


Regulation Down Requirement Comparison for June

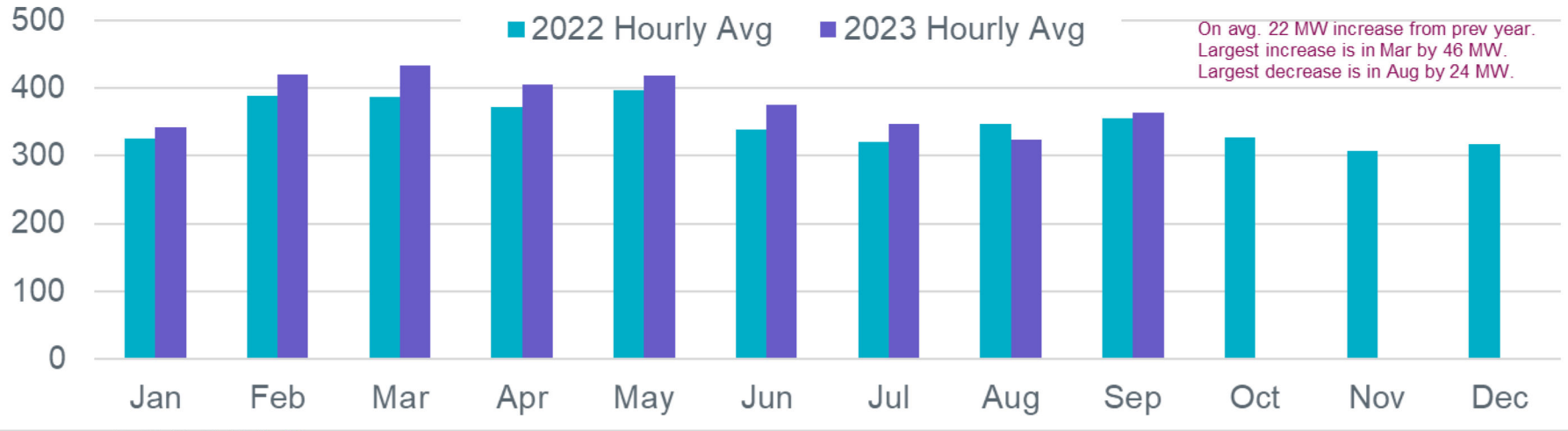


Hourly Average Regulation Comparison (Revised)

Average Regulation Up Requirement Comparison

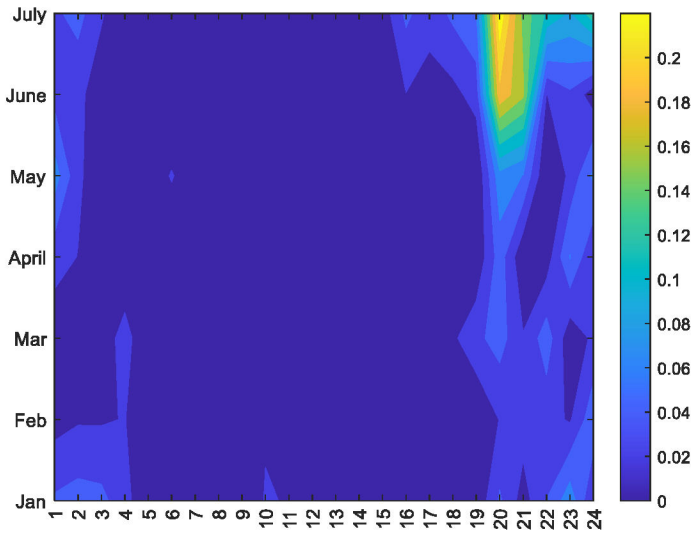


Average Regulation Down Requirement Comparison

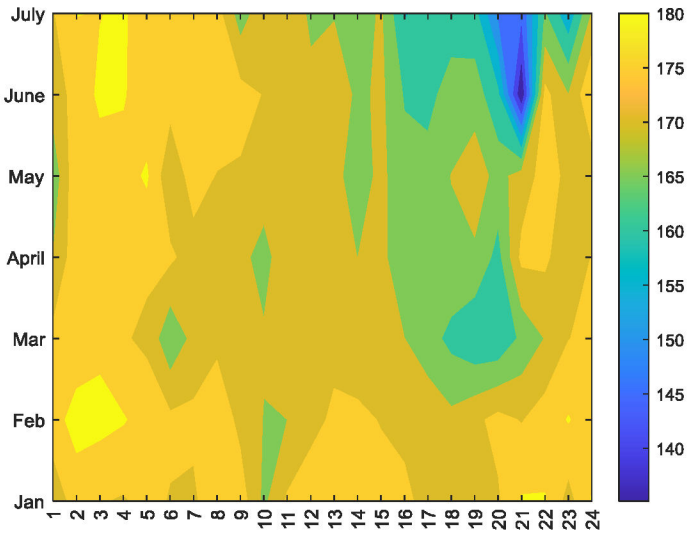


2022 Reg Up Exhaustion Rate and 2023 Quantities

In the first half of 2022, most Regulation Up exhaustion is in the evening hours around sunset.



Reg-Up



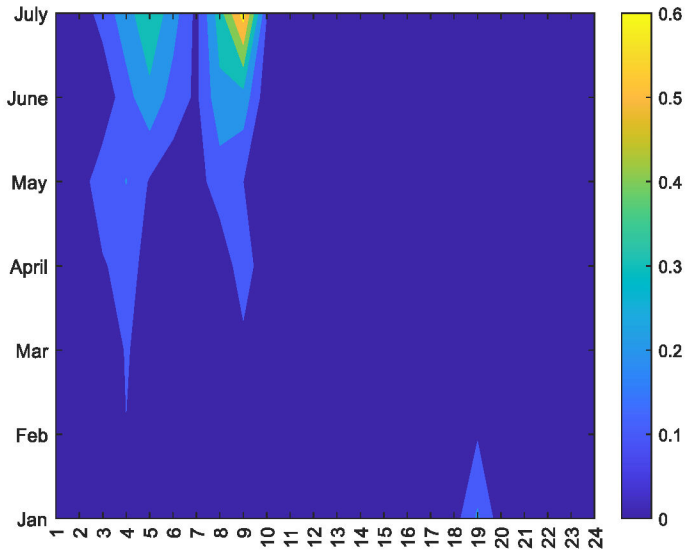
Hourly Average CPS1

2023 – 2022 Reg Up (%)

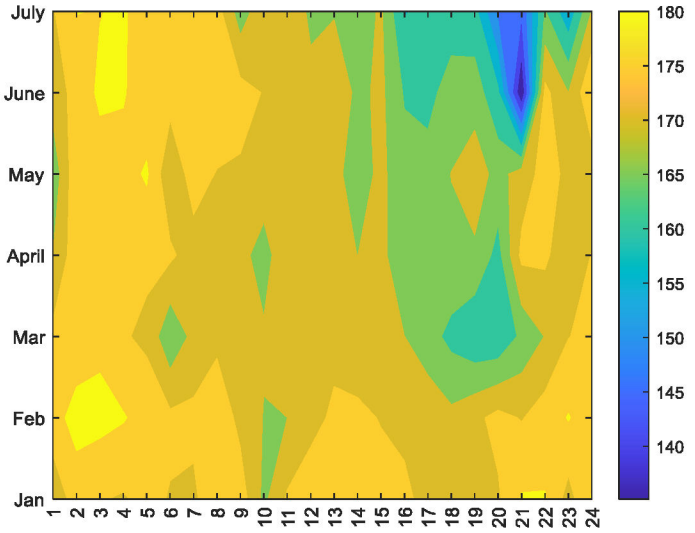
% Change in Reg Up Quantities In 2023																							
	HE																						
Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Jul	3%	-9%	-8%	3%	-11%	-1%	-6%	-8%	-12%	8%	11%	9%	20%	18%	15%	20%	23%	23%	41%	40%	21%	-8%	2%	-24%
Jun	3%	6%	0%	-8%	5%	4%	4%	-5%	-1%	4%	-3%	5%	11%	12%	6%	41%	30%	32%	32%	32%	18%	15%	-13%	-7%
May	10%	-12%	4%	5%	5%	16%	4%	-7%	-1%	11%	7%	11%	8%	13%	14%	8%	6%	37%	13%	20%	32%	-40%	-10%	11%
Apr	7%	3%	8%	4%	5%	3%	4%	5%	-14%	9%	-5%	-4%	4%	11%	-1%	7%	12%	5%	33%	35%	9%	5%	7%	-4%
Mar	6%	6%	7%	9%	7%	10%	14%	5%	4%	-8%	11%	16%	4%	13%	17%	19%	6%	42%	44%	43%	26%	24%	-7%	6%
Feb	4%	0%	-15%	3%	1%	-6%	-11%	8%	-19%	15%	22%	7%	-7%	11%	9%	16%	12%	48%	27%	-1%	1%	3%	5%	12%
Jan	3%	2%	15%	-1%	-6%	0%	-2%	0%	0%	12%	21%	-7%	13%	3%	7%	3%	29%	26%	6%	27%	1%	4%	15%	4%

2023 Reg Down Exhaustion Rate and 2023 Quantities

In the first half of 2022, most Regulation Down exhaustion is in the morning hours around sunrise .



Reg-Down



Hourly Average CPS1

2023 – 2022 Reg Down (%)

% Change in Reg Down Quantities In 2023																								
	HE																							
Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Jul	-3%	1%	12%	-4%	15%	-11%	0%	87%	39%	44%	16%	7%	8%	17%	27%	17%	8%	10%	-5%	-22%	-3%	7%	3%	3%
Jun	12%	12%	1%	15%	31%	0%	-1%	57%	39%	19%	21%	63%	27%	1%	2%	10%	14%	7%	6%	-21%	0%	2%	6%	4%
May	14%	11%	12%	9%	-6%	-7%	-8%	28%	20%	8%	-27%	16%	28%	11%	12%	2%	6%	5%	0%	2%	-7%	0%	0%	18%
Apr	7%	3%	5%	4%	-1%	0%	1%	16%	40%	15%	5%	7%	10%	5%	11%	13%	12%	16%	15%	-2%	1%	6%	4%	6%
Mar	-9%	-4%	0%	-3%	0%	-1%	0%	55%	56%	9%	6%	15%	25%	3%	9%	19%	29%	25%	22%	2%	-5%	-1%	-3%	4%
Feb	-3%	-7%	-9%	-2%	2%	1%	1%	60%	60%	11%	5%	3%	2%	1%	-1%	19%	23%	-1%	3%	2%	4%	-12%	1%	-3%
Jan	2%	1%	2%	20%	2%	9%	2%	-19%	49%	8%	2%	9%	4%	3%	10%	13%	10%	-9%	7%	-4%	-13%	-18%	2%	3%

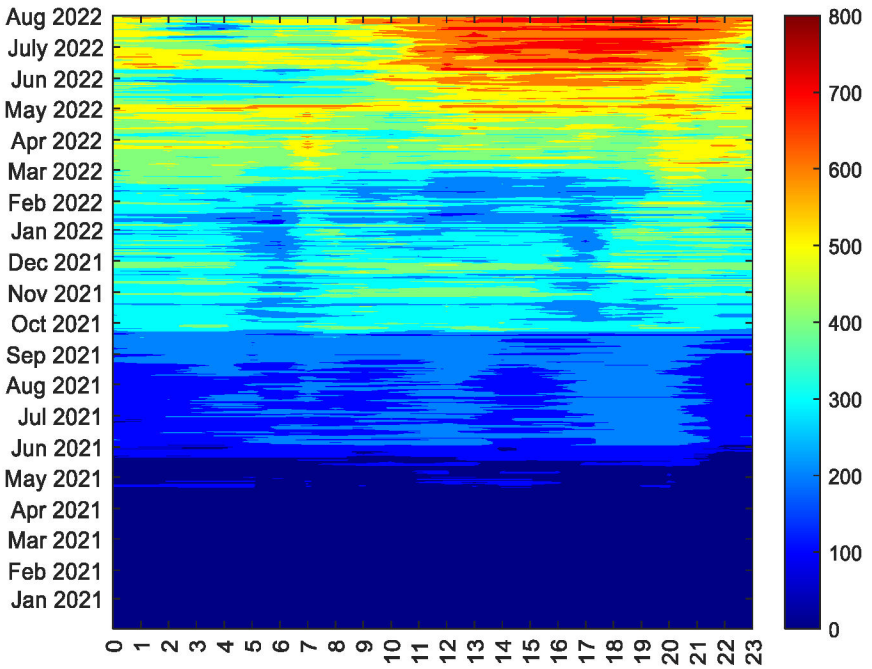
Responsive Reserve Service (RRS) Methodology

- ERCOT is not considering any changes to methodology used to compute the minimum RRS requirements for 2023.
  - NERC's preliminary BAL-003 Interconnection Frequency Response Obligation (IFRO) for Operating Year (OY) 2023 assessment for ERCOT shows an increase in ERCOT's IFRO. In order to align with ERCOT's new IFRO, minimum RRS-PFR limit for 2023 will change to 1,390 MW.

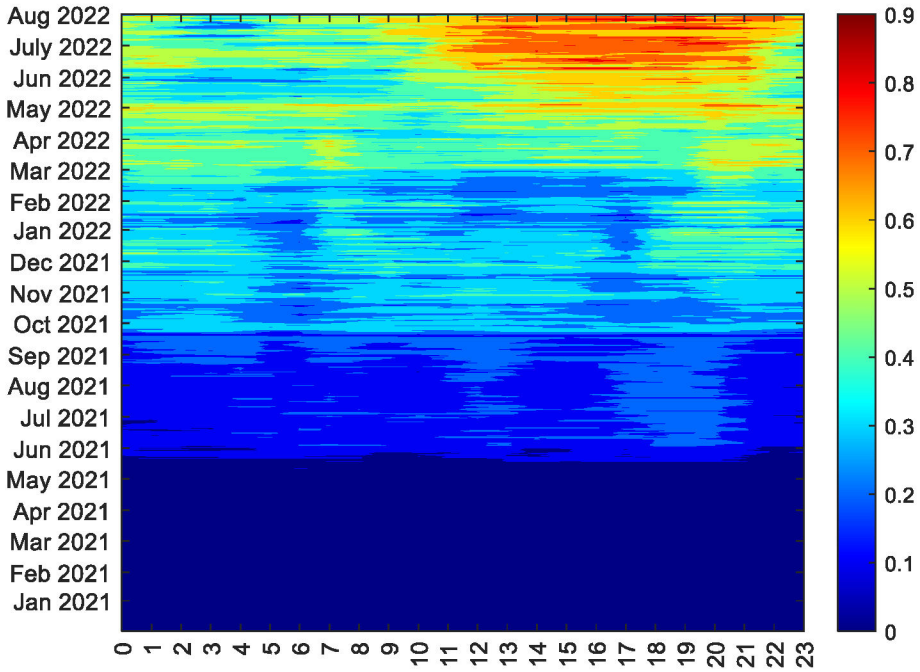
- The preliminary RRS quantities for January 2023 through August 2023 in subsequent slides have been computed using 2021 and 2022 system inertia conditions and updated RRS table.
  - The RRS table tracks RRS requirements for different inertia conditions. This table was updated in 2023 to use a minimum RRS-PFR limit of 1,390 MW.

RRS-PFR from Energy Storage Resources (ESRs) in 2022

- ESRs are providing larger volumes of RRS-PFR in 2022.
  - ERCOT has modified its tools that measure performance of ESRs during Frequency Measurable Events (FMEs) beginning April 2022. Since then, ERCOT has been closely working with Resources that have not met the performance criteria.



MW
Max: 878 MW
Avg: 269 MW



Percentage*
Max: 92%
Avg: 26%

*RRS-PFR from ESRs as a percentage of total RRS-PFR from CLRs, Gas, Coal and ESRs.

2023 RRS Table

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7	Scenario 8	Scenario 9	Scenario 10	Scenario 11	Scenario 12
LR/PFR	2.35:1	2.2:1	2.06:1	1.94:1	1.83:1	1.74:1	1.65:1	1.58:1	1.51:1	1.44:1	1.39:1	1.33:1
Inertia (GW·s)	130	140	150	160	170	180	190	200	210	220	230	240
PFR Req. (no LR) (MW)	5960	5563	5200	4892	4622	4329	4114	3920	3744	3522	3314	3139
*RRS Curr IFRO (MW)	*3293*	*3234*	*3178*	*3128*	*3088*	*3015*	*2982*	*2936*	*2898*	*2825*	*2732*	*2668*
**RRS Upd IFRO (MW)	3335	3287	3239	3195	3156	3079	3041	2991	2949	2871	2774	2705

	Scenario 13	Scenario 14	Scenario 15	Scenario 16	Scenario 17	Scenario 18	Scenario 19	Scenario 20	Scenario 21	Scenario 22	Scenario 23	Scenario 24	Scenario 25
LR/PFR	1.28:1	1.24:1	1.19:1	1.15:1	1.12:1	1.08:1	1.04:1	1.01:1	1:1	1:1	1:1	1:1	1:1
Inertia (GW·s)	250	260	270	280	290	300	310	320	330	340	350	360	370
PFR Req. (no LR) (MW)	3004	2890	2784	2686	2595	2510	2421	2353	2290	2230	2173	2119	2068
*RRS Curr IFRO (MW)	*2618*	*2571*	*2538*	*2498*	*2450*	*2416*	*2375*	*2342*	*2290*	*2230*	*2173*	*2119*	*2068*
**RRS Upd IFRO (MW)	2651	2600	2562	2517	2466	2427	2381	2344	2290	2230	2173	2119	2068

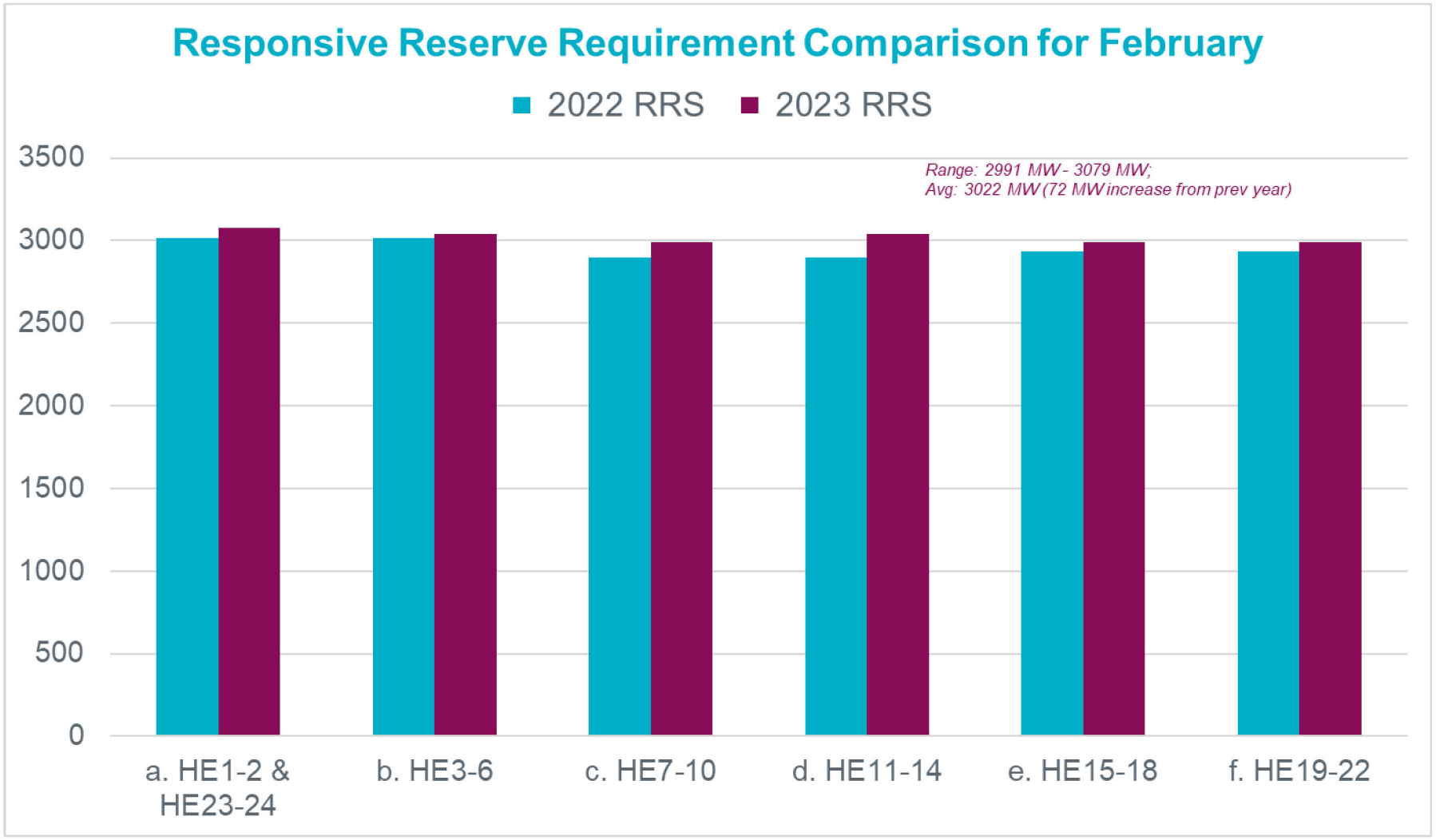
*RRS quantity is calculated for RCC of 2805 with limit of 60% limit on LRs and min RRS-PFR limit of 1,240 MW.

**RRS quantity is calculated for RCC of 2805 with limit of 60% limit on LRs and min RRS-PFR limit of 1,390 MW.

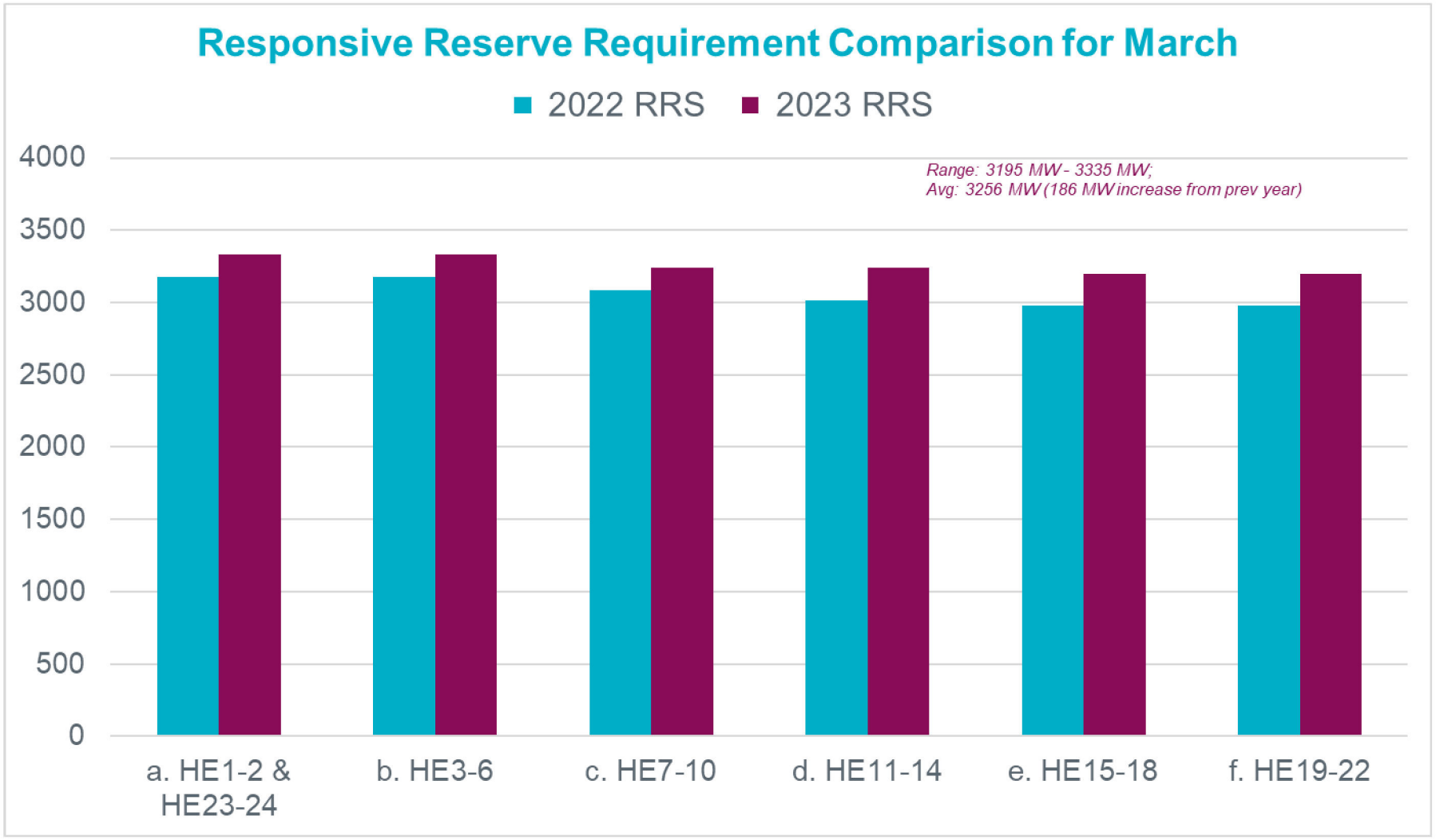
***Red font in table above identifies study scenario where RRS needed < 2300 MW. RRS requirement during these is based on the applicable floor.

****Generation mix (CCs, Gas, SC, Coal, Steam) providing 1150 MW of PFR has been aligned with actual historic system operations.
Inertia < 250 GW·s: 30% Coal + 70% Rest. Inertia ≥ 250 GW·s: 15% Coal + 85% Rest

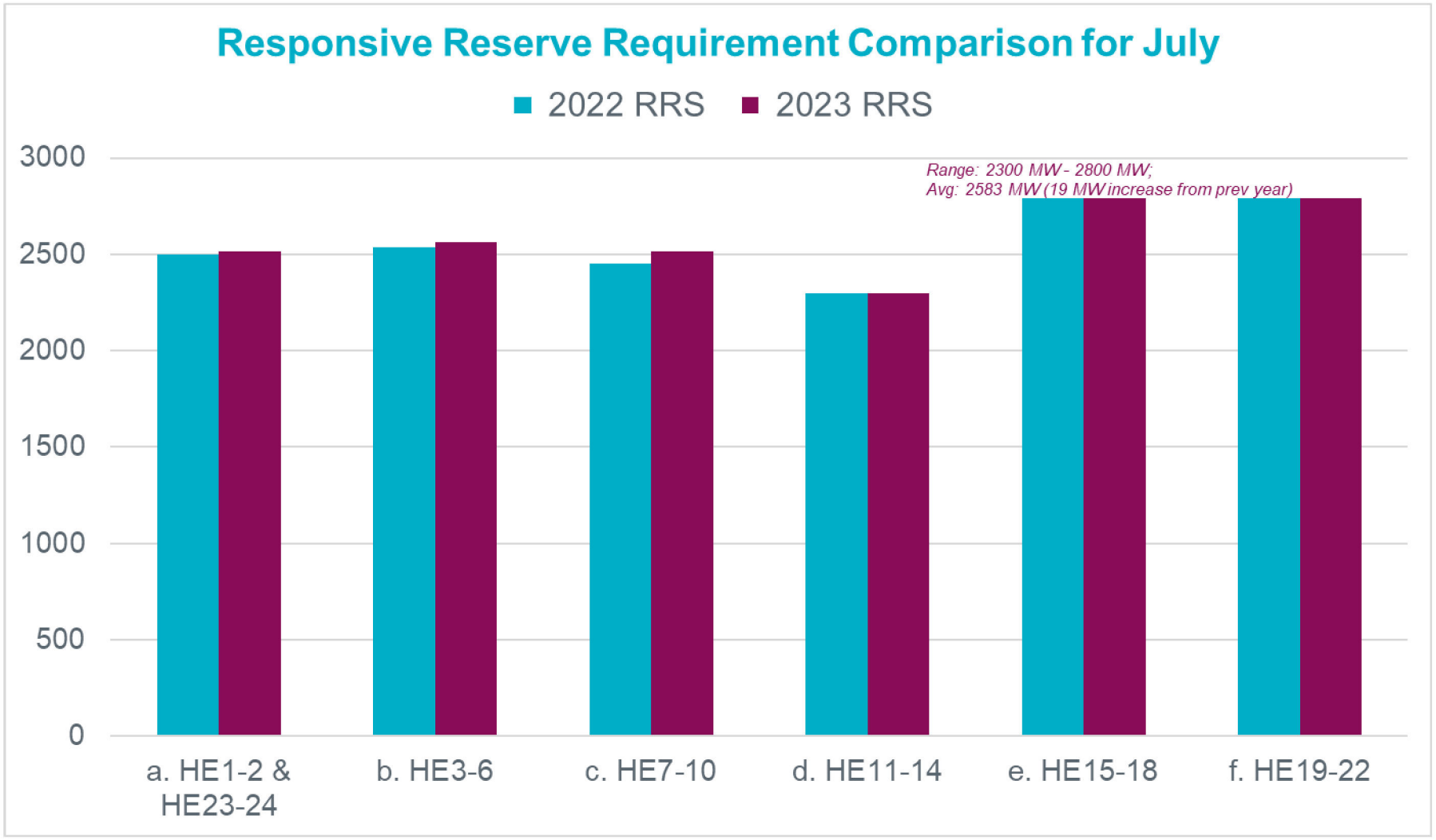
RRS Comparison February (Revised)



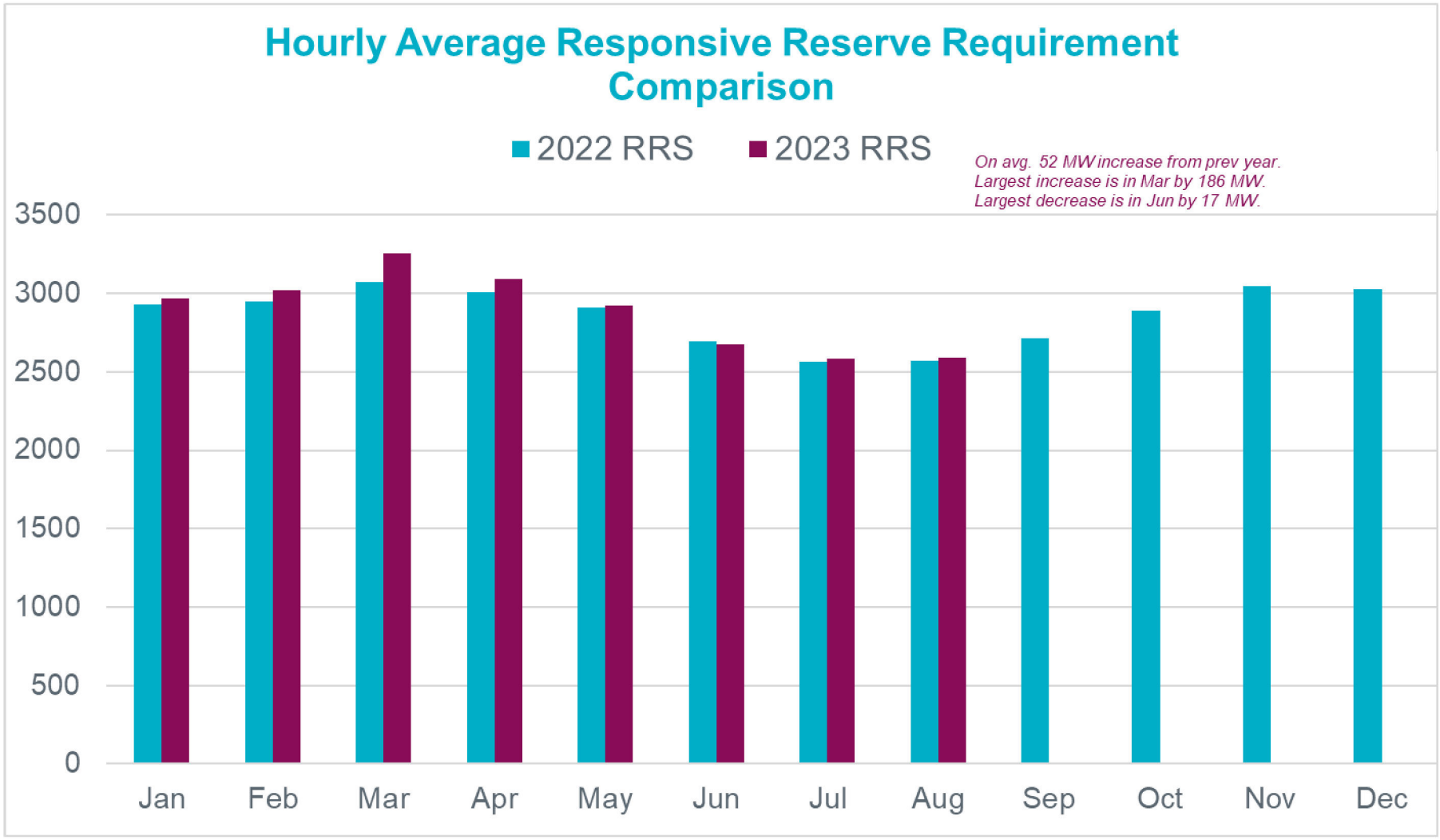
RRS Comparison March (Revised)



RRS Comparison July



Hourly Average RRS Comparison (Revised)



Low Inertia Hours for FFR Prioritization NPRR 1128

- If ERCOT comments dated July 15, 2022 on NPRR 1128 are approved,
  - For certain selected hours FFR procurement up to FFR limit will be prioritized
  - ERCOT is considering a methodology that selects hours in the last 1 year wherein 75% of the time the system inertia is less than 200 GW·s for FFR prioritization.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	191447	153751	123329	146782	181343	228511	266828	266213	208377	169327	139939	147162
2	192319	160482	123871	136257	176361	222575	261209	259337	206197	163086	139772	147225
3	193841	160638	121747	135851	176517	221009	259953	259030	206026	160730	139850	145393
4	194249	162327	122019	134495	176407	221400	259951	259593	206778	160472	140179	146878
5	200137	169370	124764	138357	182259	223829	260076	261497	208785	163750	147168	153954
6	212952	180827	132840	141485	192778	230421	260289	265434	217090	171226	160411	166545
7	215781	185071	134641	149691	198653	234066	263177	265691	221097	179713	167643	170376
8	216399	187142	138862	159873	200581	235571	269075	267163	231432	185226	172662	179142
9	217516	191115	142257	162341	203674	245101	278056	274281	242654	190473	175242	182466
10	217171	189003	145698	163758	212067	258358	289242	284922	255503	200589	173879	183033
11	211934	188904	146155	170097	220028	274380	306938	304818	268850	205439	176657	184530
12	206704	189266	145980	173646	221373	285780	318746	325190	285081	210195	180010	186292
13	201767	186205	148048	182469	226379	297458	326074	331409	293163	215369	183831	193068
14	199925	180837	151003	193658	228755	305096	329477	335955	294512	218018	186315	197838
15	199087	186040	158373	201290	230273	307160	331425	339504	298133	220137	190029	200171
16	203144	186032	166785	204291	231731	310026	332377	339966	300123	225608	191574	202073
17	205613	187140	170980	206904	232347	311578	332514	344176	300120	228363	194125	205999
18	209291	188847	172466	207965	234905	311175	331028	344048	303426	228625	195015	207709
19	212399	190201	173633	208558	234709	308536	330030	342479	303671	229279	194102	206057
20	207573	182556	173665	205560	231952	305441	326343	336864	305851	228829	190401	201345
21	204235	174206	169588	203798	228262	296881	323577	331912	302799	227875	183453	197237
22	200672	168043	164137	193362	225916	281125	316723	319457	280550	220630	167986	185524
23	198944	163085	146924	179302	207034	259262	294462	301899	252783	203972	149513	168988
24	193301	157412	130146	159200	193707	239055	273366	284829	225264	185321	141346	156521

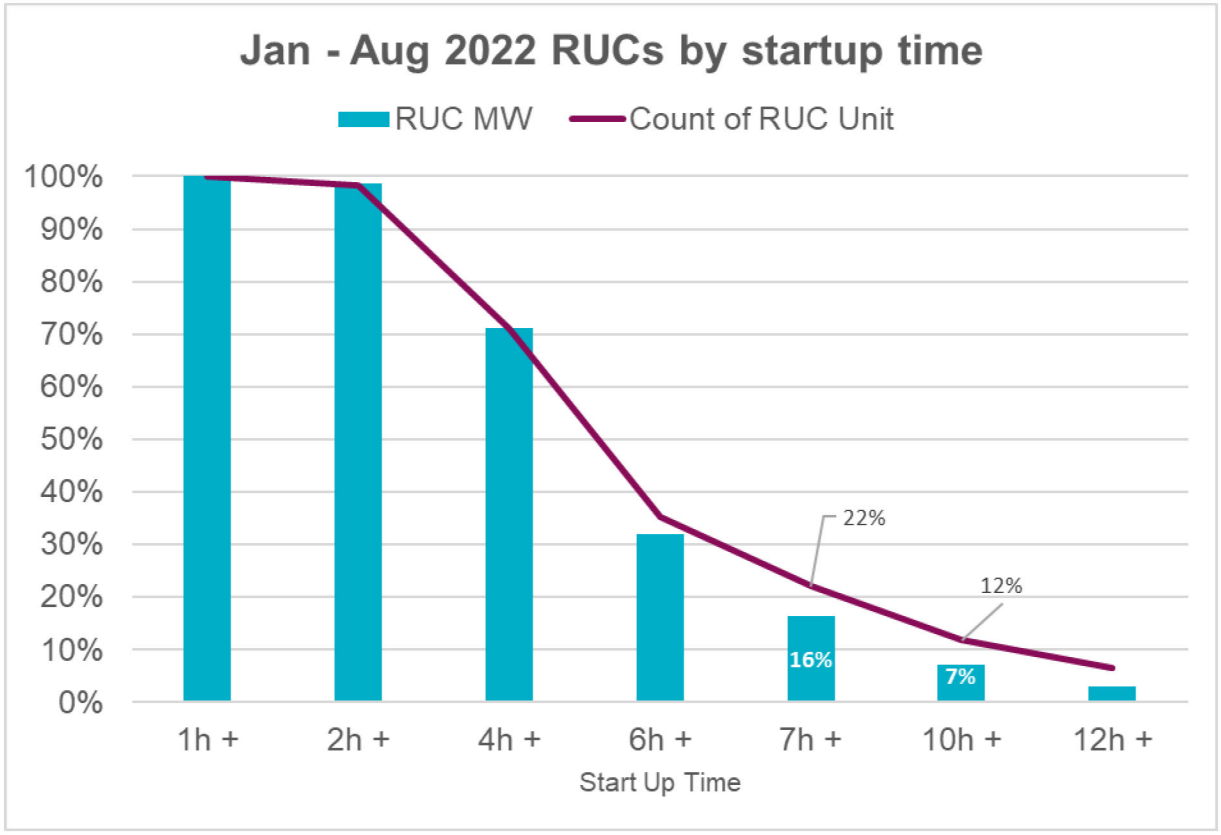
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1	1	1	1	1	0	0	0	0	1	1	1
2	1	1	1	1	1	0	0	0	0	1	1	1
3	1	1	1	1	1	0	0	0	0	1	1	1
4	1	1	1	1	1	0	0	0	0	1	1	1
5	0	1	1	1	1	0	0	0	0	1	1	1
6	0	1	1	1	1	0	0	0	0	1	1	1
7	0	1	1	1	0	0	0	0	0	1	1	1
8	0	1	1	1	0	0	0	0	0	1	1	1
9	0	1	1	1	0	0	0	0	0	1	1	1
10	0	1	1	1	0	0	0	0	0	0	1	1
11	0	1	1	1	0	0	0	0	0	0	1	1
12	0	1	1	1	0	0	0	0	0	0	1	1
13	0	1	1	1	0	0	0	0	0	0	1	1
14	0	1	1	1	0	0	0	0	0	0	1	0
15	0	1	1	0	0	0	0	0	0	0	1	0
16	0	1	1	0	0	0	0	0	0	0	1	0
17	0	1	1	0	0	0	0	0	0	0	1	0
18	0	1	1	0	0	0	0	0	0	0	0	0
19	0	1	1	0	0	0	0	0	0	0	1	0
20	0	1	1	0	0	0	0	0	0	0	1	0
21	0	1	1	0	0	0	0	0	0	0	1	0
22	0	1	1	1	0	0	0	0	0	0	1	1
23	0	1	1	1	0	0	0	0	0	0	1	1
24	1	1	1	1	1	0	0	0	0	1	1	1

Non-Spinning Reserve Methodology - 2023

- ERCOT is considering the following changes in the methodology used to compute minimum Non-Spin requirements in 2023
  - Before ECRS is implemented, use 85th to 95th percentile of 10 Hours Ahead (HA) maximum net load forecast error to compute Non-Spin quantities
  - After ECRS is implemented, use 75th to 95th percentile of 6 Hours Ahead (HA) hourly average net load forecast error to compute Non-Spin quantities.

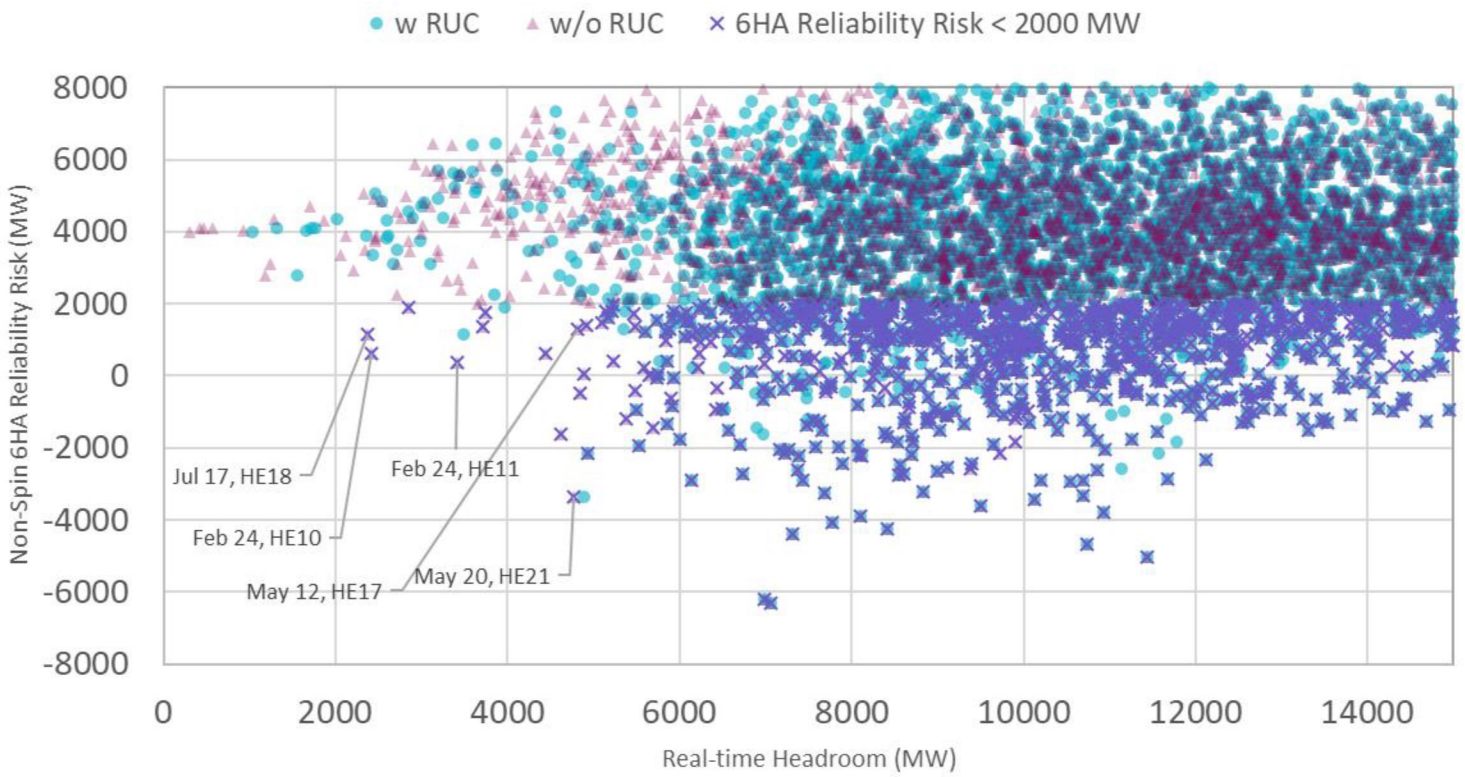
- The preliminary Non-Spin quantities for January 2023 through August 2023 in subsequent slides have been computed using current methodology (2020, 2021 and 2022 Net load and Net load Forecast), updated Wind Over-Forecast Error Adjustment table and the updated Solar Over-Forecast Error Adjustment table.
  - Wind and Solar Over-Forecast Error Adjustment Table track estimated increase in wind over forecast error per 1000 MW increase in installed wind and solar capacity, respectively.

2022 RUCs by Startup Time



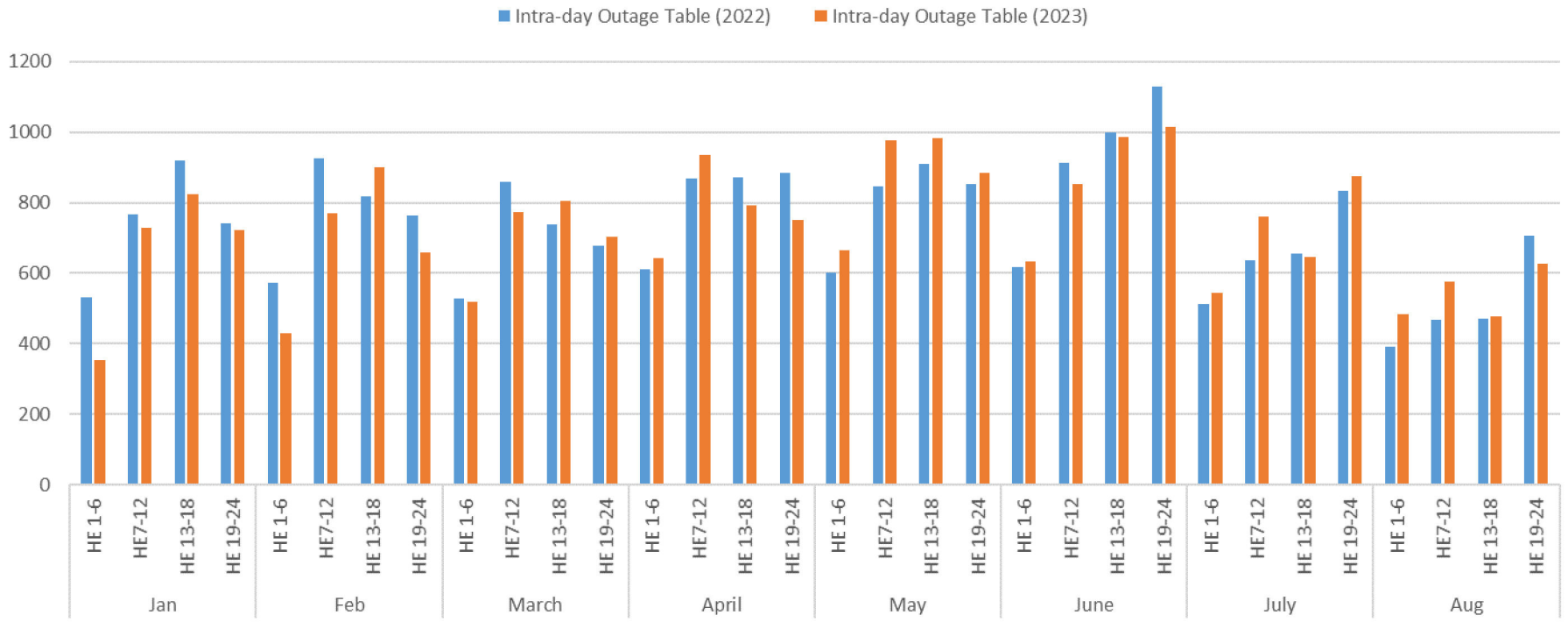
Adequacy of Non-Spin quantities in 2023

- Between Jan 1, 2022 and Jul 31, 2022,
  - ~5% of the time the available Non-Spin was not sufficient to cover the 6HA risk.
    - Lowest Real Time headroom without RUC action was 2,366 MW on July 17@HE18. With RUC the Real Time headroom was around 3,488 MW.
  - ~13% of the time the margin in the available Non-Spin to cover the 6HA risk was less than 1,430 MW.

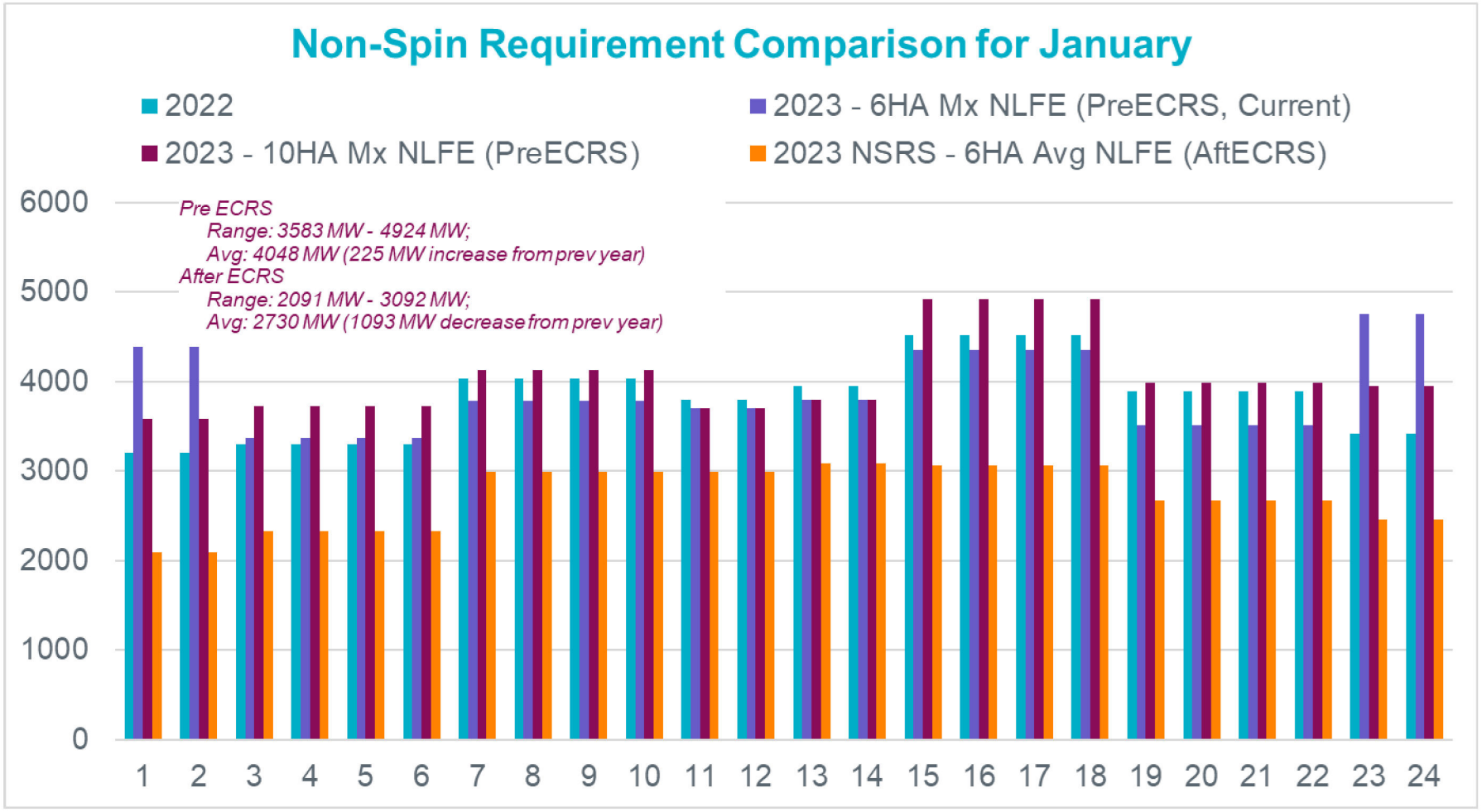


2023 Intra-day Outage Table

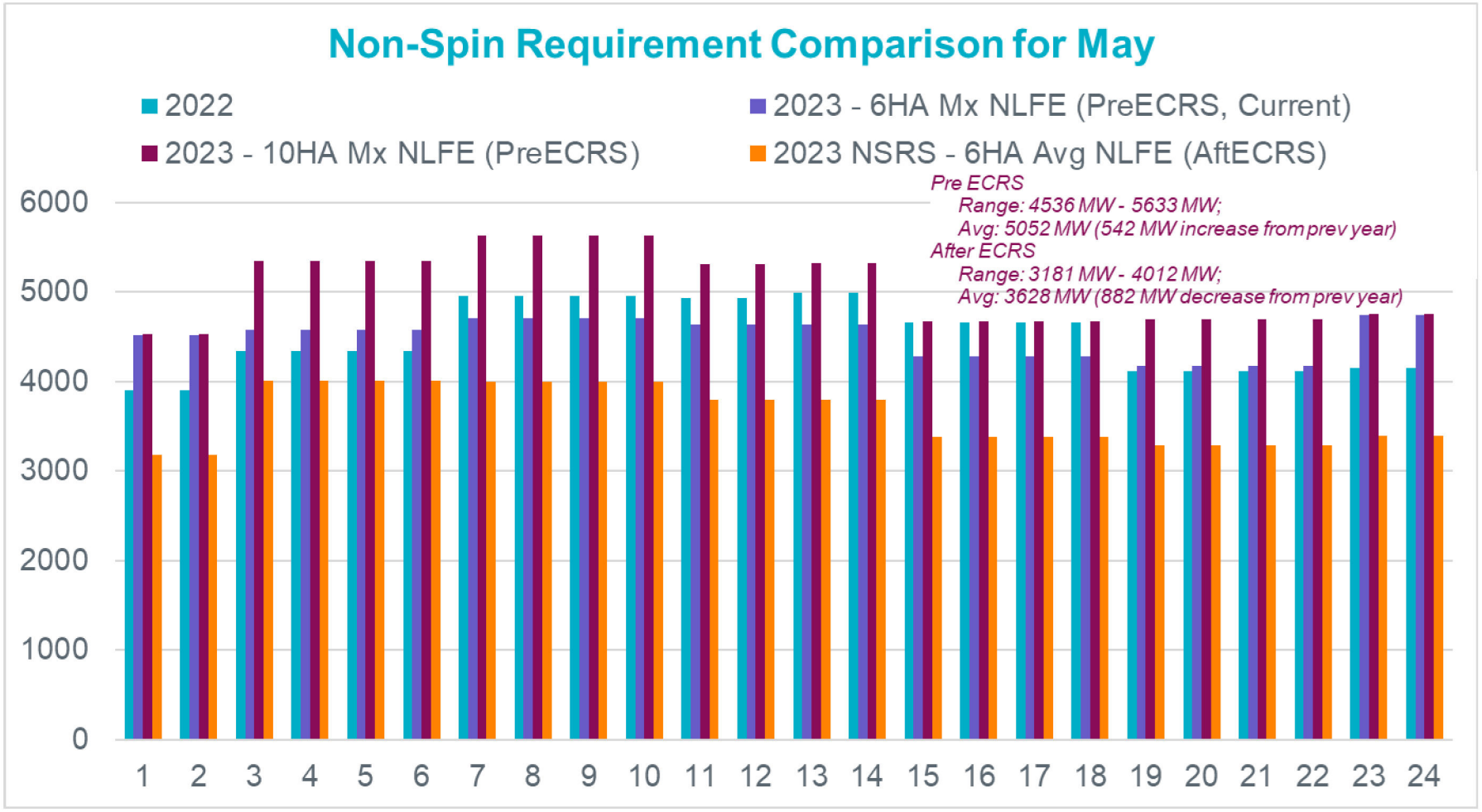
The Intra-day Outage table helps account for increased capacity needs following forced outages of thermal resources within an operating day.



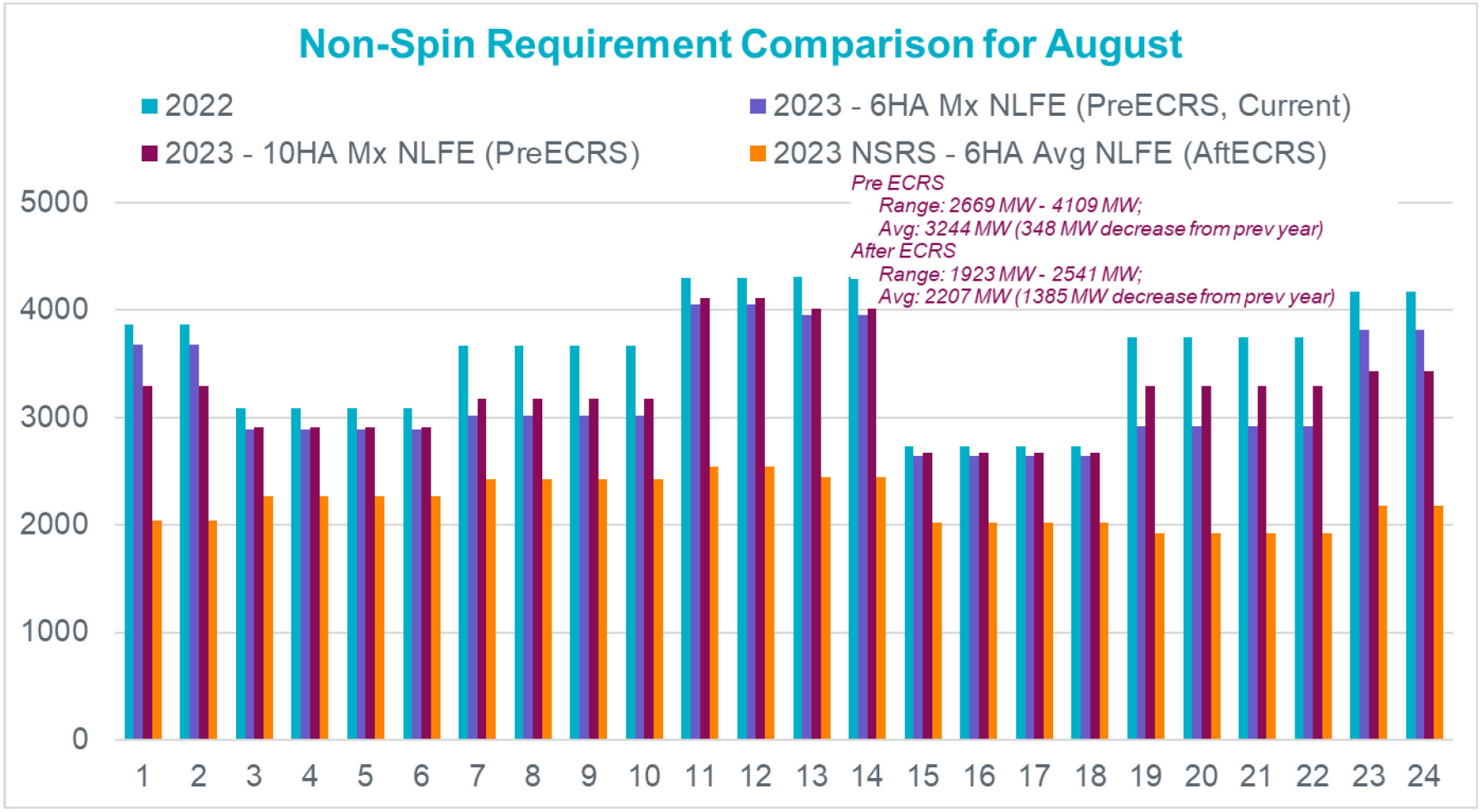
Non-Spin Comparison January



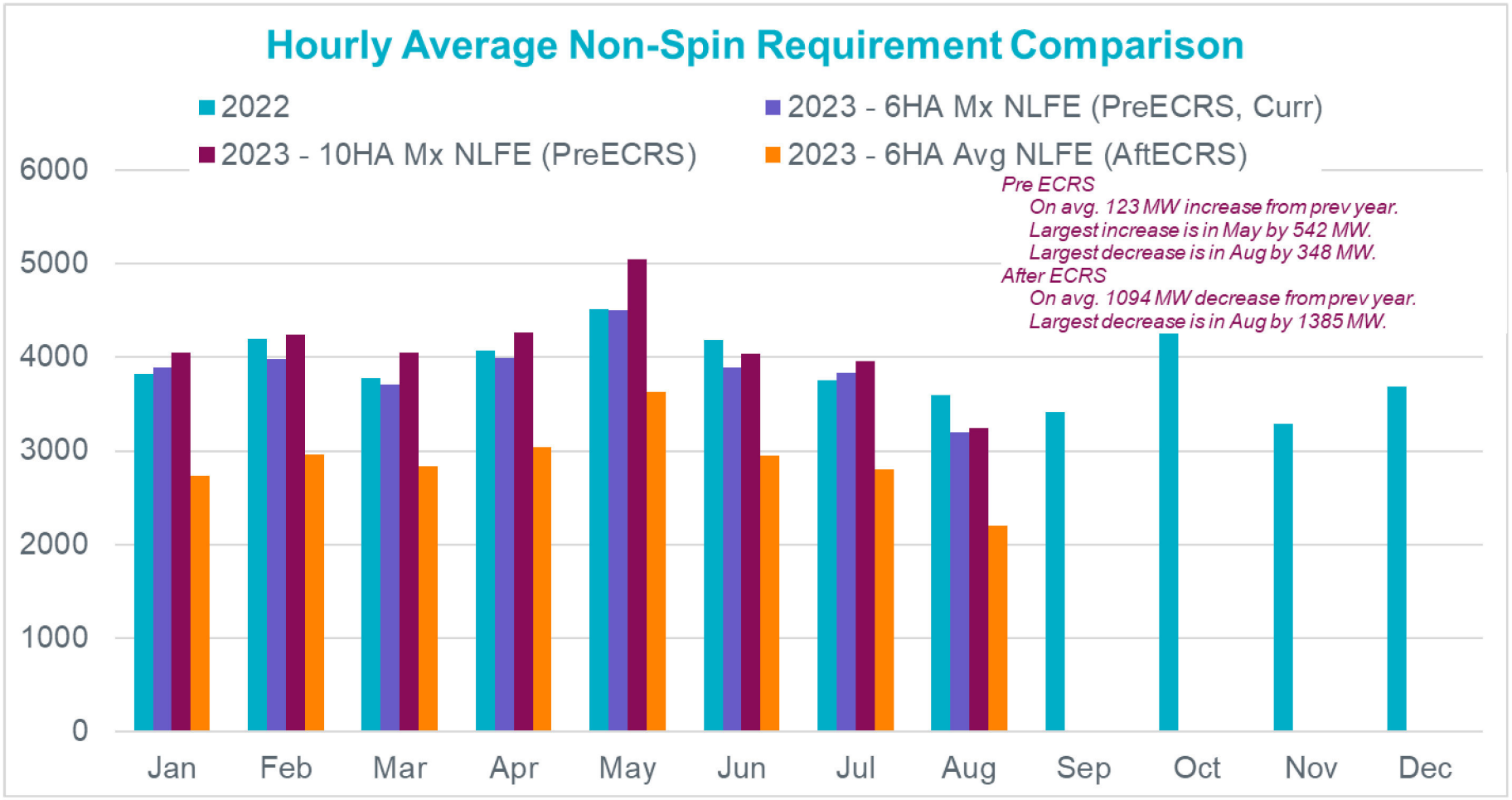
Non-Spin Comparison May



Non-Spin Comparison August

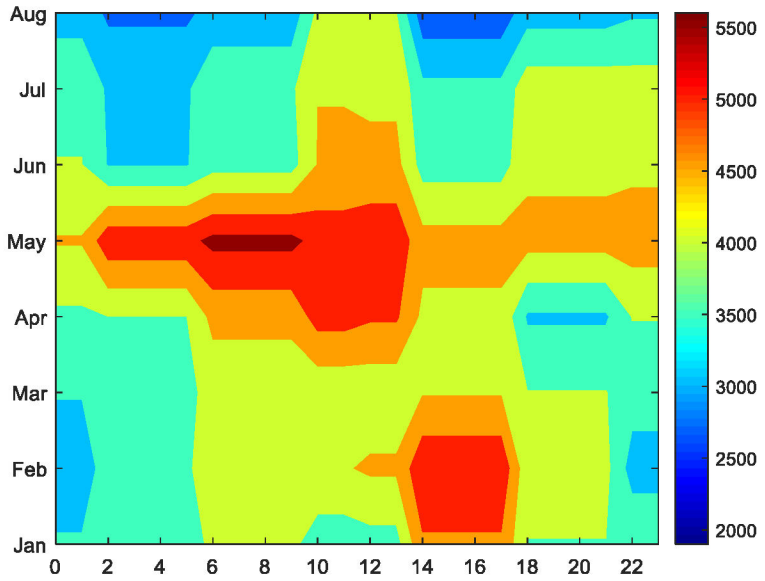


Hourly Average Non-Spin Comparison

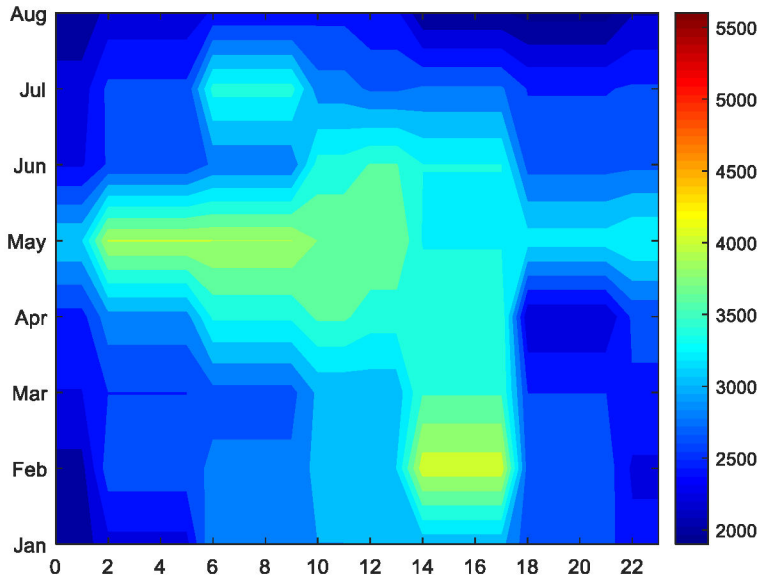


Post ECRS Non-Spin Quantities

- With the proposed "after ECRS approach" for Non-Spin, overall, the Non-Spin quantities are expected to decrease.



Pre-ECRS Non-Spin
Min: 2,669 MW
Max: 5,633 MW



After ECRS Non-Spin
Min: 1,923 MW
Max: 4,112 MW

Net Load Variability Evaluation

- Since July 12, 2021, ERCOT has been monitoring the weather forecast near Real Time and in during the following days has procured up to an additional 1,000 MW of Non-Spin during periods that were identified as having an increased potential of high forecast variability that may cause a higher net load during these hours.
  - 2021: Jul 29, Aug 1, Aug 2, Aug 14, Aug 27, Aug 29, Aug 30, Sep 3, Sep 4
  - 2022: Jan. 2, Jan. 3, Jan. 20, Feb. 3, Feb. 4, May 22, May 23, May 24, Jun 1

- Additional Non-Spin may be procured for Operating Hours that are
  a) identified as having an increased potential of high forecast variability,
  b) there is a risk that the actual net load during these Operating Hours could be higher than forecast (after making appropriate forecast model selection) AND
  c) the expected available capacity and expected reserves including the posted minimum Non-Spin requirements during these Operating Hours is not sufficient to cover the projected net load forecast uncertainty risk.

- In 2023, ERCOT is proposing to continue the practice of monitoring the weather near Real Time and may procure up to an additional 1,000 MW of Non-Spin for specific Operating Hours.

SUGGESTIONS?

Preliminary Methodology to Determine 2023 ECRS Requirements

ERCOT Staff

August 18, 2022 | PDCWG
August 19, 2022 | WMWG

Introduction

- ERCOT is in the process of implementing ERCOT Contingency Reserve Service (ECRS).
  - ERCOT is targeting to implement ECRS prior to the "EMS freeze" period (around May 2023 – Jan 2024)
- This presentation will discuss a proposed* methodology to determine the minimum quantities for ECRS in 2023. A spreadsheet that contains ECRS quantities from August 2022 through July 2023 that have been computed using this proposed methodology have been posted to today's meeting page.
  - ERCOT is seeking stakeholder feedback on the proposed ECRS methodology.

Note on Non-Spinning Reserve Service (Non-Spin) quantities post ECRS implementation

- ECRS and Non-Spin differ in the reliability risks these services address, qualification criteria, response time and duration. As a result, upon ECRS' implementation, Non-Spin requirement cannot entirely be substituted by the amount of ECRS procured as was originally proposed during NPRR863 discussions.
- That said, ERCOT expects the risks that Non-Spin is used to cover will evolve upon ECRS' implementation. Hence the methodology to determine Non-Spin quantities in a world where ECRS exists may need revisions.
  - ERCOT plans to discuss the Non-Spin methodology that will apply with ECRS' implementation as a part of the annual AS Methodology review process.

* Note, ERCOT may refine the ECRS methodology further as a part of the annual effort to review the methodology for determining Ancillary Service (AS) quantities (AS Methodology).

ECRS Requirements Methodology

- ECRS is a service that is provided using capacity that can be sustained at a specified level for two consecutive hours and is used to restore or maintain the frequency of the ERCOT System:
  a) In response to significant depletion of RRS;
  b) As backup Regulation Service;
  c) By providing energy to avoid getting into or during an Energy Emergency Alert (EEA); and
  d) Upon detection of insufficient capacity for net load ramps.

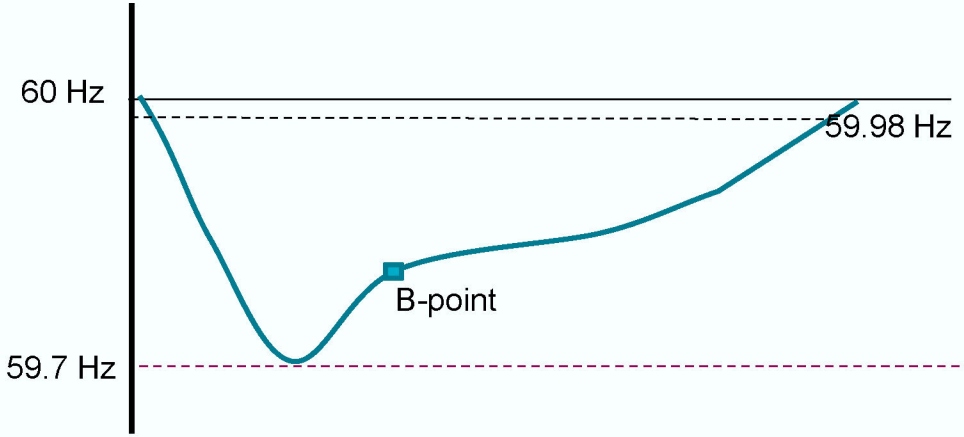
- ERCOT is proposing to compute ECRS requirements as the sum of,
  1. capacity needed to recover frequency following a large unit trip and
  2. capacity needed to support sustained net load ramps.

- The next few slides will discuss the detail about each of these components that establish the ECRS requirements.

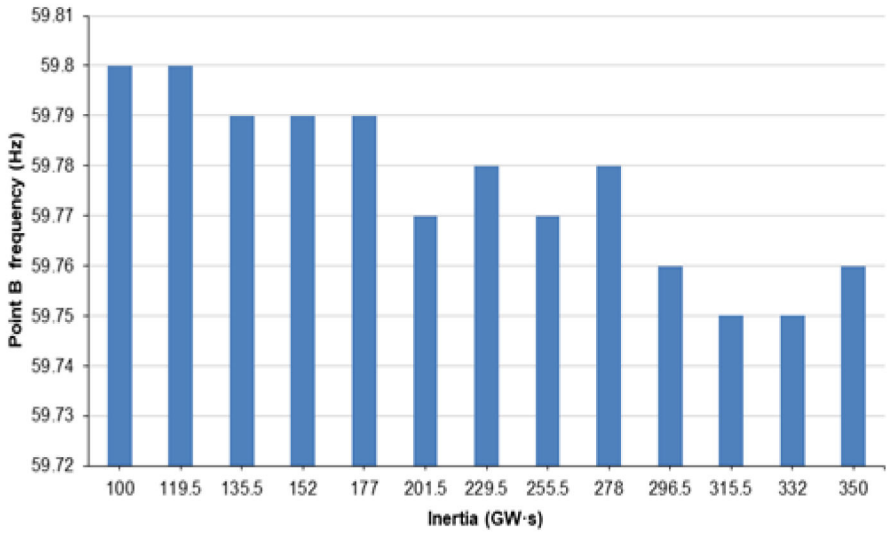
Method for Determining MWs needed for Frequency Recovery

- Capacity needed to recover frequency from B-point (i.e., settling frequency) to 59.98 Hz is determined by using dynamic simulations/studies that are run at varying inertia levels.
- In every simulation, a single medium-size unit is tripped offline such that the C-point (frequency nadir) is stays just above 59.7 Hz*.
- Capacity needed to recover frequency using this approach is determined for each hour of each month using two years historical data.

*59.7Hz is the trigger frequency for Load Resources that are providing RRS using an under-frequency relay.

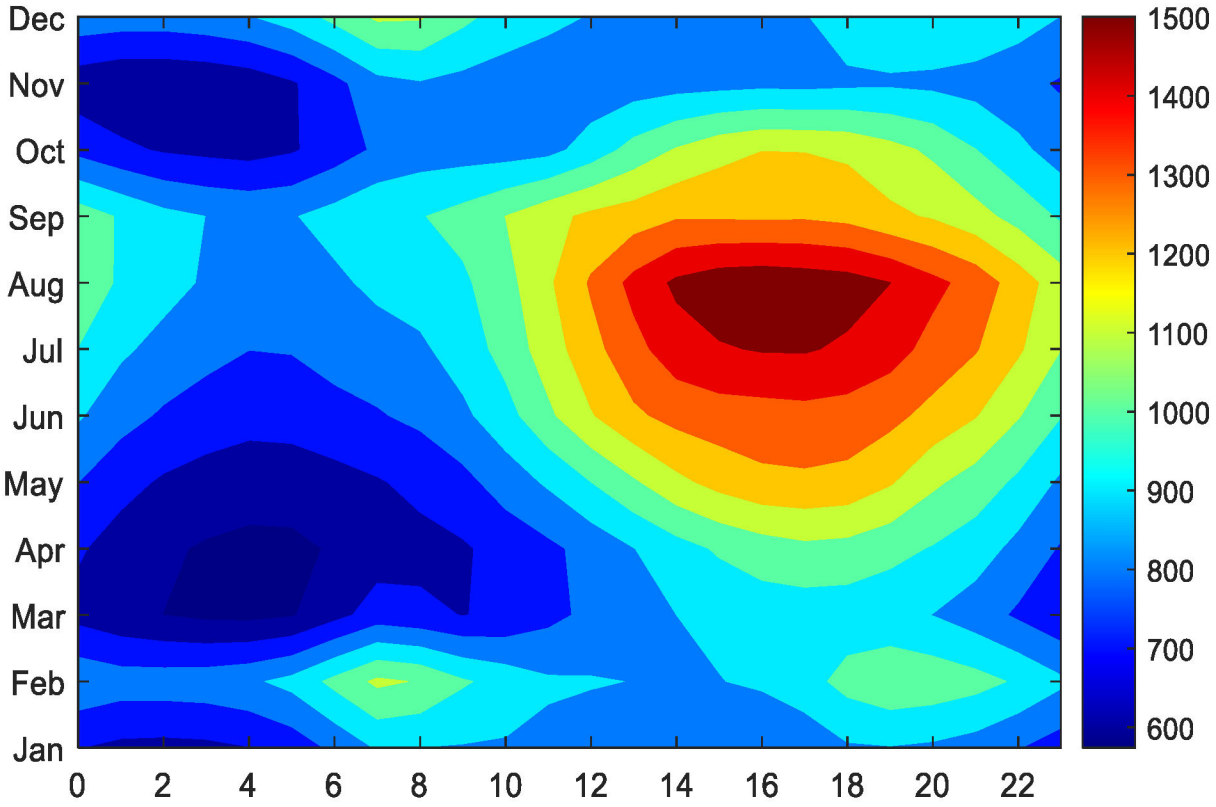


B-point (settling frequency) is determined using dynamic simulations/studies that are run at varying inertia levels. In every simulation, a single medium-size unit is tripped offline such that the C-point (frequency nadir) is stays just above 59.7 Hz.*



MW_{need} = (59.98 Hz – $Freq_{B\text{-}point}$) * (1% load in MW/0.1 Hz)

MWs needed for Frequency Recovery



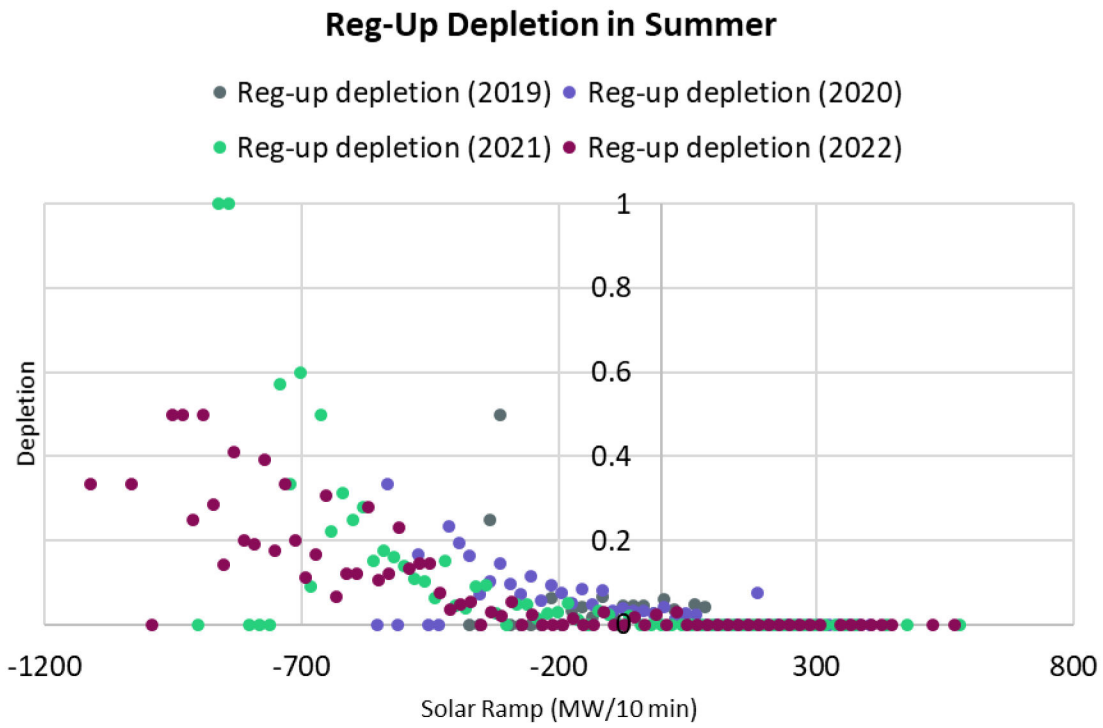
	Min	Mean	Max
MW_{need}	574 MW	951 MW	1,572 MW

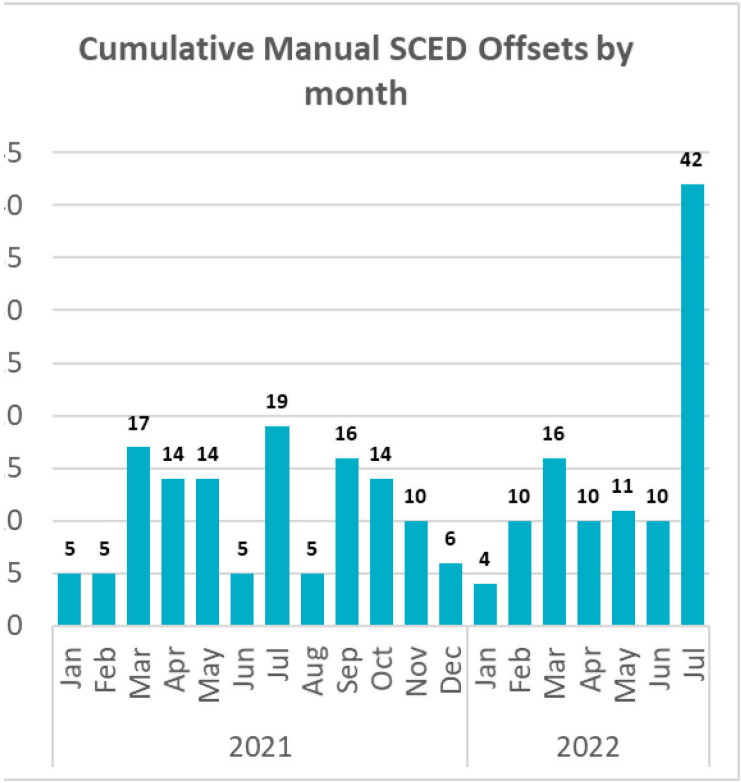
Method for Determining Additional MWs needed for sustained Net Load Ramps

- Capacity needed to support sustained net load ramps will be computed using
  - 85th to 95th percentile of 30-minute ahead intra-hour net load forecast errors for same hour same month of previous two years
    - The percentile associated with every hour will be determined based on the risk of net load up ramp. Periods where the risk of net load ramp is highest will use 95th percentile and 85th percentile for periods with lowest risks.
  - An additional adjustment will be included to account for the impact of increase in over-forecast error from expected growth in solar generation installed capacity.

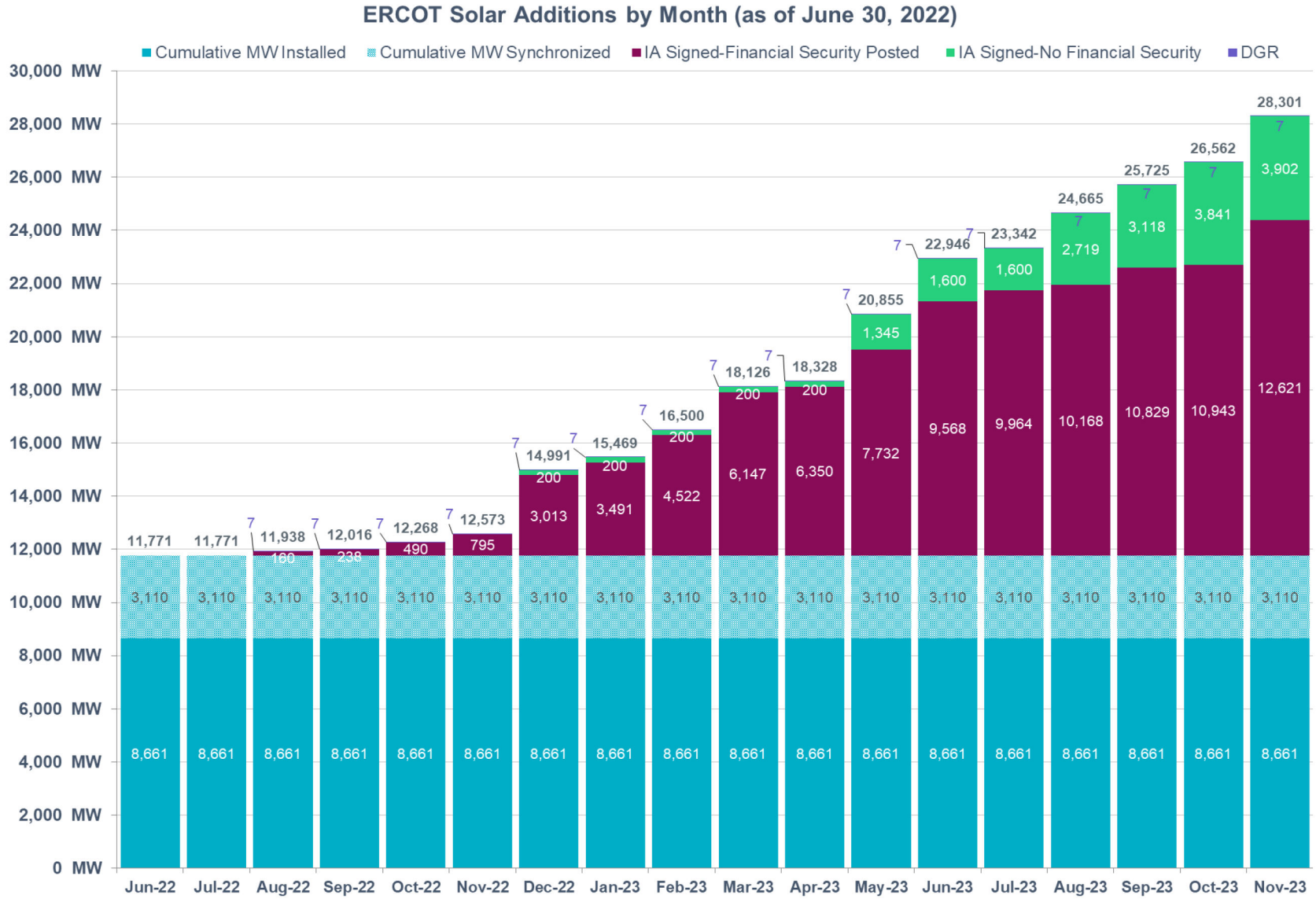
Regulation usage and SCED offset Trends

- As the solar installed capacity has increased, during the evening hours, the magnitude of 10-min solar ramps have increased and there has been more reliance on regulation up deployments and SCED offsets.





Projected Solar Generation Installed Capacity



Adjustment for Increase in Solar Installed Capacity

- Intra-hour Solar Over-Forecast Error Adjustment Table tracks estimated increase in 30-min ahead solar over forecast error per 1000 MW increase in installed solar capacity.

ADDITIONAL ECRS PER 1,000 MW INCREASE IN SOLAR INSTALLED CAPACITY

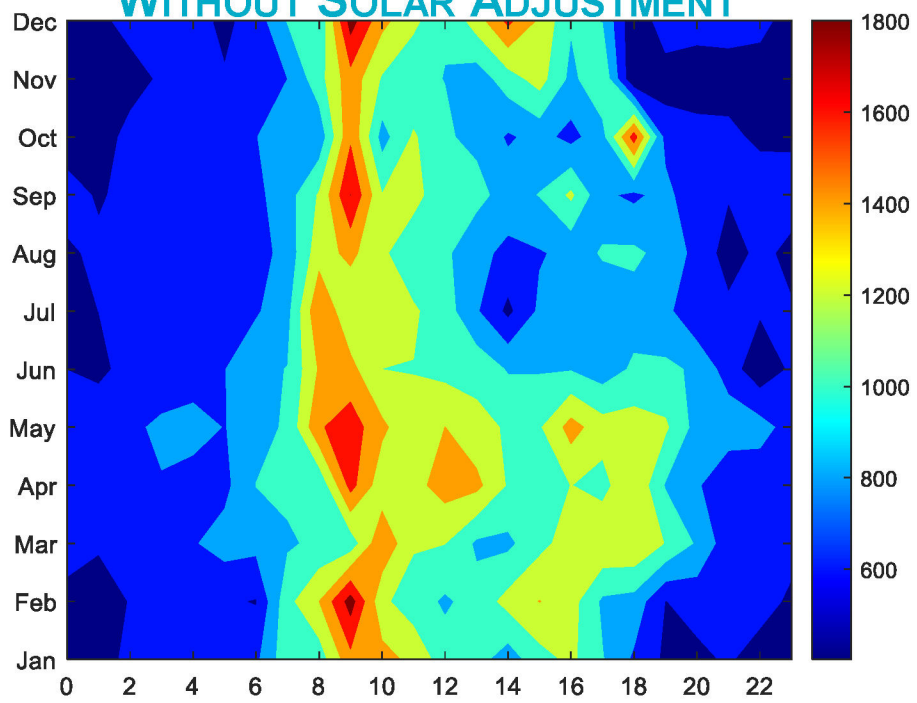
	HE 1-2, 23	HE 3-6	HE 7-10	HE 11-14	HE 15-18	HE 19-22
Jan	0	0	0	25	19	0
Feb	0	0	23	16	39	3
Mar	0	0	0	32	37	10
Apr	0	0	0	18	42	13
May	0	0	0	20	48	15
Jun	0	0	0	32	30	36
Jul	0	0	17	25	21	16
Aug	0	0	3	24	38	17
Sep	0	0	0	17	27	7
Oct	0	0	0	7	19	0
Nov	0	0	0	22	25	0
Dec	0	0	0	39	42	0

ADJUSTMENT FOR 2023 (MIN: 0 MW | MEAN: 68 MW | MAX 283 MW)

	H01	H02	H03	H04	H05	H06	H07	H08	H09	H10	H11	H12	H13	H14	H15	H16	H17	H18	H19	H20	H21	H22	H23	H24
Jan	0	0	0	0	0	0	0	0	0	0	150	150	150	150	113	113	113	113	0	0	0	0	0	0
Feb	0	0	0	0	0	0	138	138	138	138	93	93	93	93	232	232	232	232	16	16	16	16	0	0
Mar	0	0	0	0	0	0	0	0	0	0	192	192	192	192	221	221	221	221	62	62	62	62	0	0
Apr	0	0	0	0	0	0	0	0	0	0	106	106	106	106	248	248	248	248	78	78	78	78	0	0
May	0	0	0	0	0	0	0	0	0	0	121	121	121	121	283	283	283	283	90	90	90	90	0	0
Jun	0	0	0	0	0	0	0	0	0	0	191	191	191	191	178	178	178	178	211	211	211	211	0	0
Jul	0	0	0	0	0	0	103	103	103	103	150	150	150	150	124	124	124	124	96	96	96	96	0	0
Aug	0	0	0	0	0	0	20	20	20	20	141	141	141	141	223	223	223	223	99	99	99	99	0	0
Sep	0	0	0	0	0	0	0	0	0	0	103	103	103	103	161	161	161	161	42	42	42	42	0	0
Oct	0	0	0	0	0	0	0	0	0	0	40	40	40	40	110	110	110	110	0	0	0	0	0	0
Nov	0	0	0	0	0	0	0	0	0	0	131	131	131	131	146	146	146	146	0	0	0	0	0	0
Dec	0	0	0	0	0	0	0	0	0	0	233	233	233	233	248	248	248	248	0	0	0	0	0	0

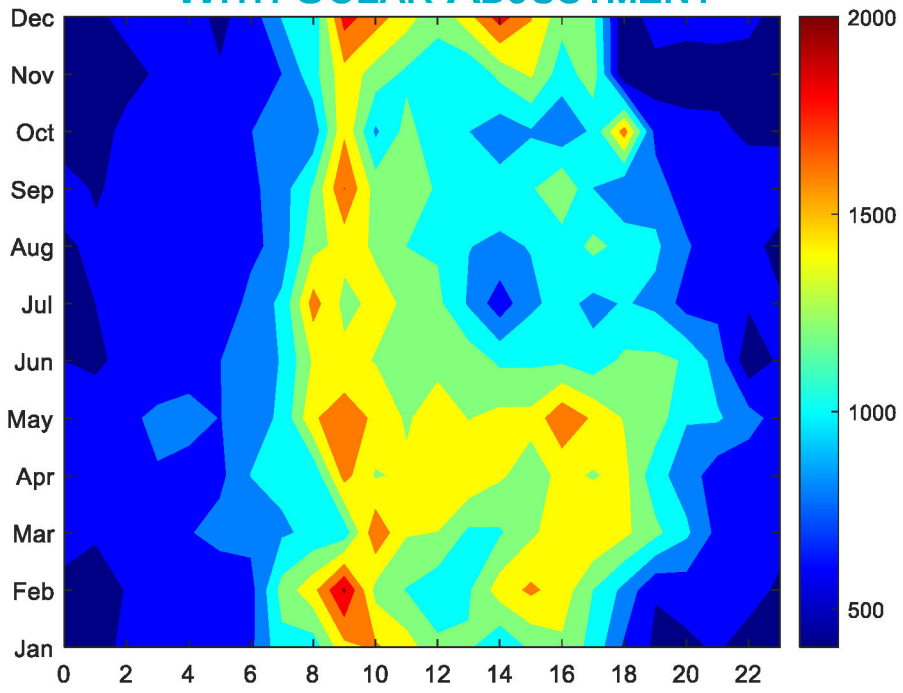
MWs needed for Intra-hour Net Load Forecast Errors

Without Solar Adjustment



	Min	Mean	Max
MW_{need}	403 MW	913 MW	1,889 MW

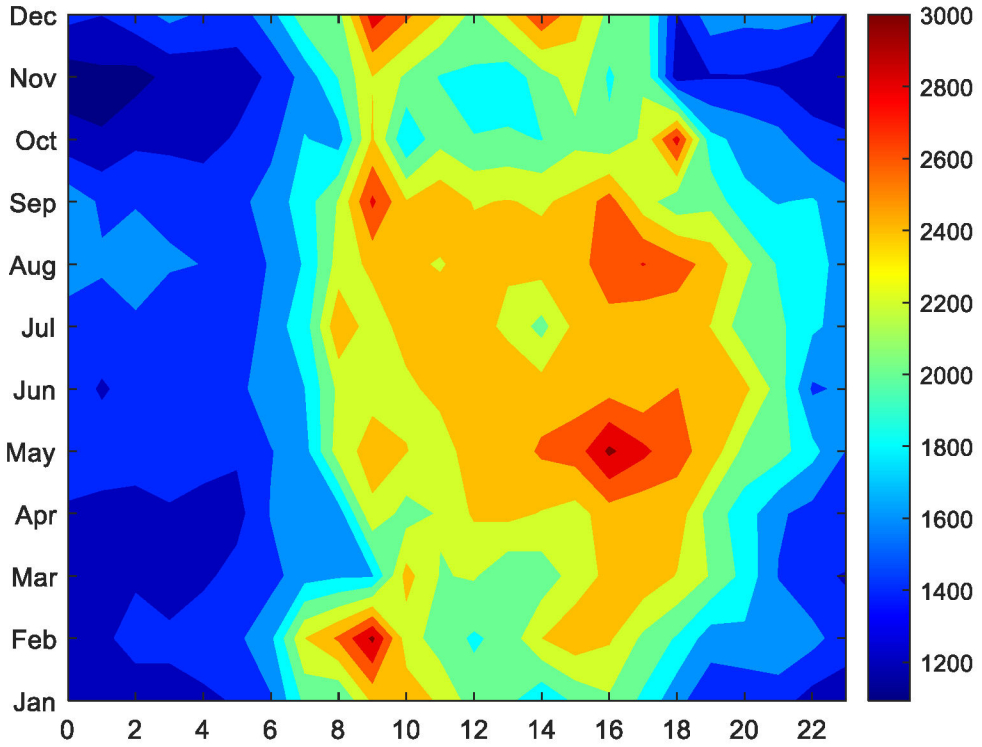
With Solar Adjustment



	Min	Mean	Max
MW_{need}	403 MW	981 MW	2,027 MW

ECRS Requirement for 2023

- Total ECRS requirement for every hour is computed as the sum of
  1. capacity needed to recover frequency following a large unit trip and
  2. capacity needed to support sustained net load ramps (with solar adjustment)



	Min	Mean	Max
ECRS	1,093 MW	1,933 MW	3,039 MW

Summary and Next Steps

- Using the preliminary* methodology to determine the minimum quantities for ECRS, hourly ECRS requirements in 2023 may vary between 1,093 and 3,039 MW.
  - A spreadsheet that contains the associated ECRS quantities for January through July of 2023 have been posted to today's meeting page.

- ERCOT is seeking stakeholder feedback on the proposed ECRS methodology.

- Lastly, ERCOT expects the risks that Non-Spin is used to cover will evolve upon ECRS' implementation. Hence the methodology to determine Non-Spin quantities in a world where ECRS exists may need revisions.
  - ERCOT plans to discuss the Non-Spin methodology that will apply with ECRS' implementation as a part of the annual AS Methodology review process.

* Note, ERCOT may refine the ECRS methodology further as a part of the annual effort to review the AS Methodology).

Discussion On 2023 Ancillary Service Methodology

ERCOT Staff

Sep 14, 2022 | PDCWG
Sep 23, 2022 | WMWG

Stakeholder Discussion Timeline

- September 14, 2022 – PDCWG (Methodology Discussion)
- September 23, 2022 – WMWG (Methodology Discussion)

- October 20, 2022 – PDCWG (Proposed Methodology)
- October 21, 2022 – WMWG (Proposed Methodology)
- October 27, 2022 – OWG (Proposed Methodology)

- November 02, 2022 - WMS
- November 07, 2022 - ROS

- December 5, 2022 - TAC
- December 20, 2022 - BoD

Discussion Scope for Today

- This presentation will discuss the various approaches ERCOT is considering to determine Ancillary Service (A/S) quantities for 2023.
  - ERCOT is not considering any changes in the methodologies used to compute Regulation Service and Responsive Reserve Service requirements for 2023.
  - NERC's preliminary BAL-003 Interconnection Frequency Response Obligation (IFRO) for Operating Year (OY) 2023 assessment for ERCOT shows an increase in ERCOT's IFRO. In order to align with ERCOT's new IFRO, the minimum RRS-PFR limit for 2023 will change to 1,390 MW.
  - ERCOT is considering some changes in the methodology used to compute minimum Non-Spin requirements in 2023 both prior to and after ECRS is implemented.
- The Ancillary Service (A/S) quantities for 2023 contained in this presentation are based on the methodology that was approved in December 2021. The quantities for 2023 reflect moving forward the historic data on which these are based, unless otherwise noted.

Regulation Service Methodology

- ERCOT is not considering any change to the methodology used to compute the minimum Regulation Service requirements in 2023.
  - ERCOT is considering an update to the methodology used to compute the Solar Adjustment tables for 2023 to better align it with how 5-minute wind and solar forecasted ramps are currently used in operations.

- The preliminary Regulation quantities for January 2023 through August 2023 in subsequent slides have been computed using current methodology (2021 and 2022 five-minute net load variability), updated Wind Adjustment tables and the updated Solar Adjustment tables.

Solar Adjustment Table Changes

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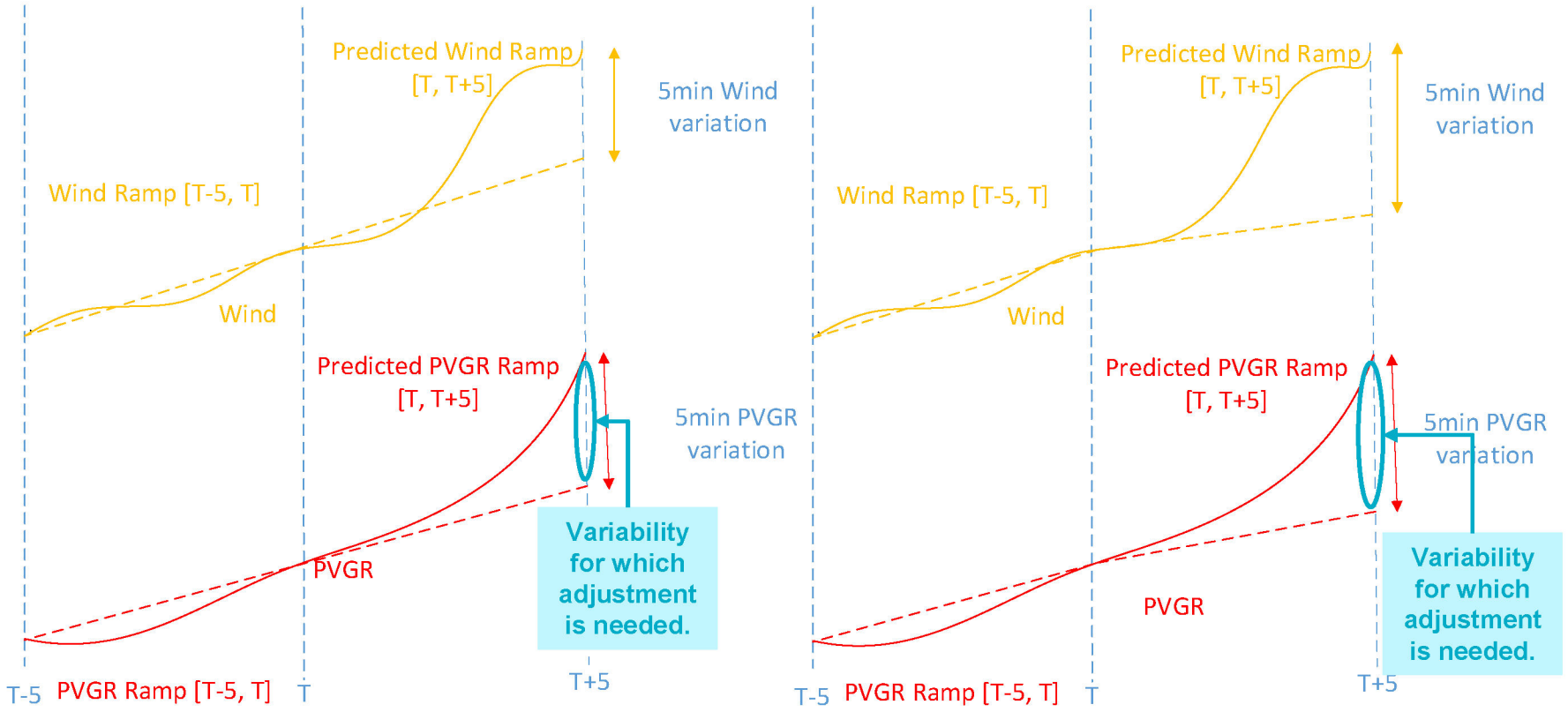

2022 Methodology: When computing the additional variability for which an adjustment is needed, in 2022, the predicted PVGR and wind ramp calculation fully discounts the actual ramp from the previous 5-minutes.

2023 Methodology: There exists an upper bound on the amount of PVGR and wind ramp that are used in establishing GTBD. In 2023, in order to account for this upper bound, when computing the additional variability for which an adjustment is needed, the predicted PVGR and wind ramp calculation will partially discount the actual ramp from the previous 5-minutes.

2023 Solar Adjustment Tables

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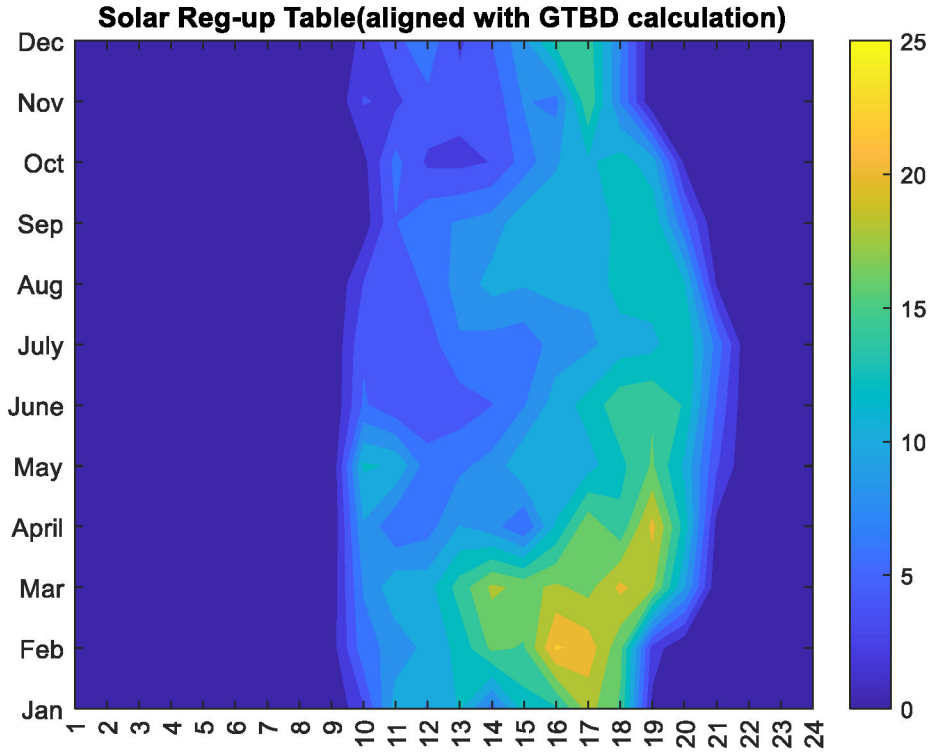
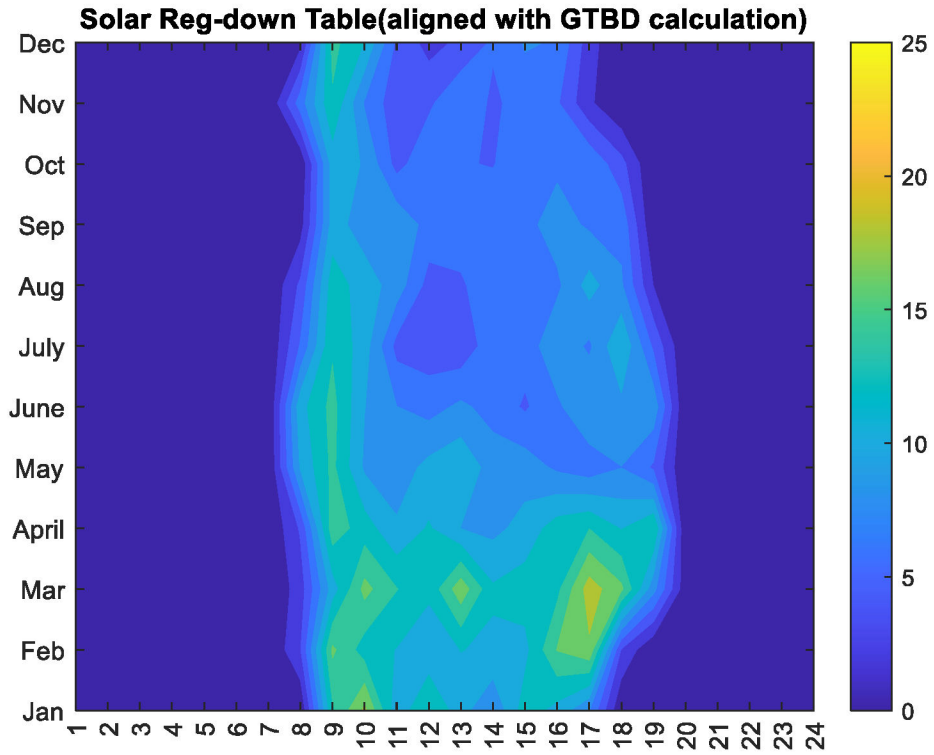
Solar Adjustment Tables track incremental MWs of Regulation needed to account for additional variability per 1000 MW increase in installed solar capacity.





	Min (MW)	Max (MW)	Average (MW)
Reg Up	0	25.4	9.9
Reg Down	0	22.4	8.2

2023 Wind Adjustment Tables

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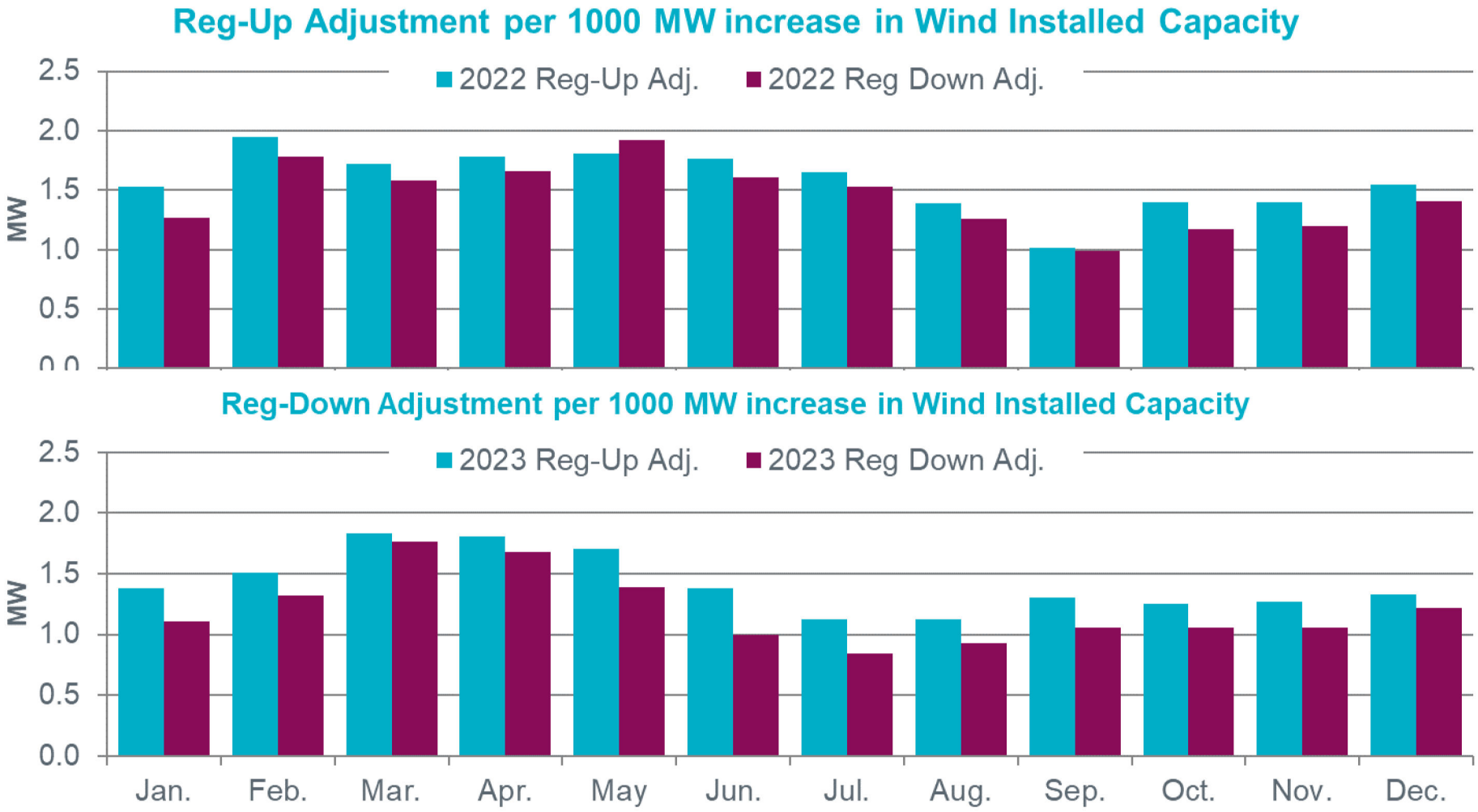
Wind Adjustment Tables track incremental MWs of Regulation needed to account for additional variability per 1000 MW increase in installed wind capacity.



Regulation Comparison February

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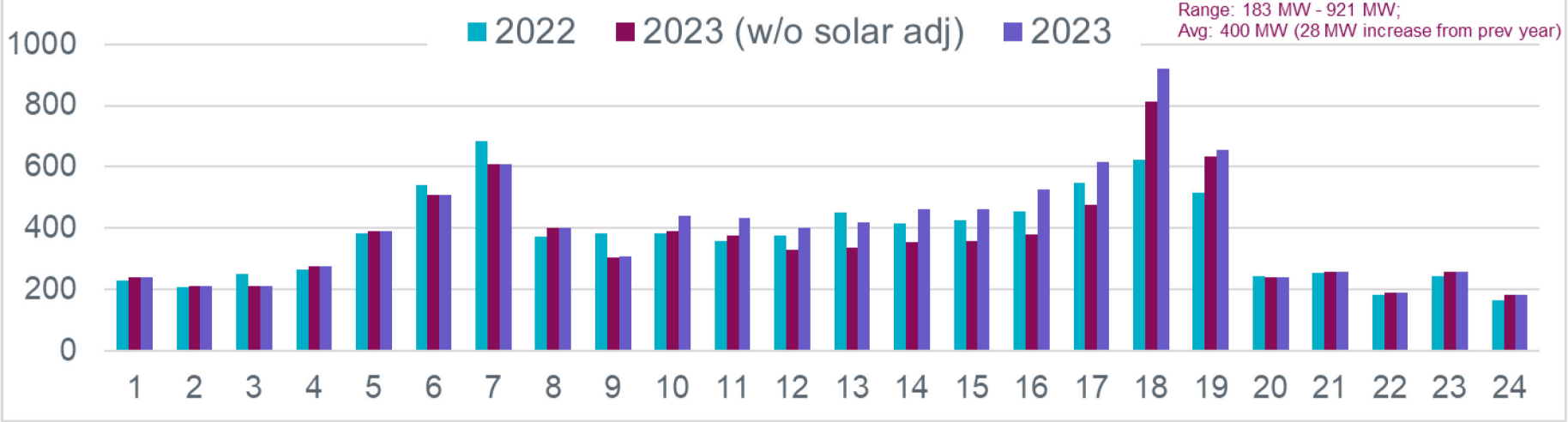
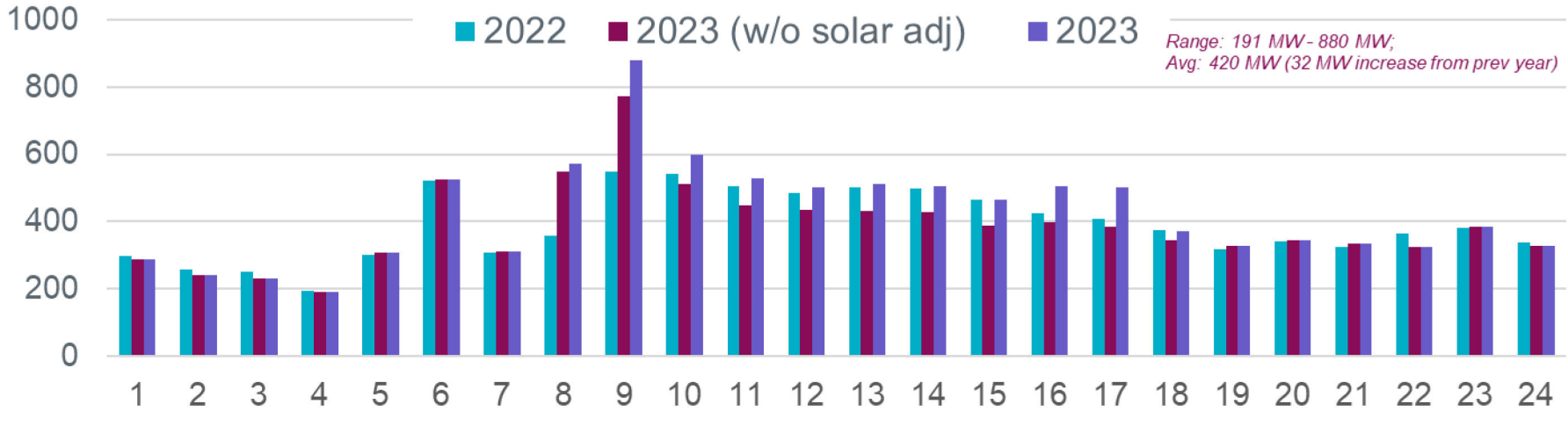
Regulation Up Requirement Comparison for February



Regulation Down Requirement Comparison for February



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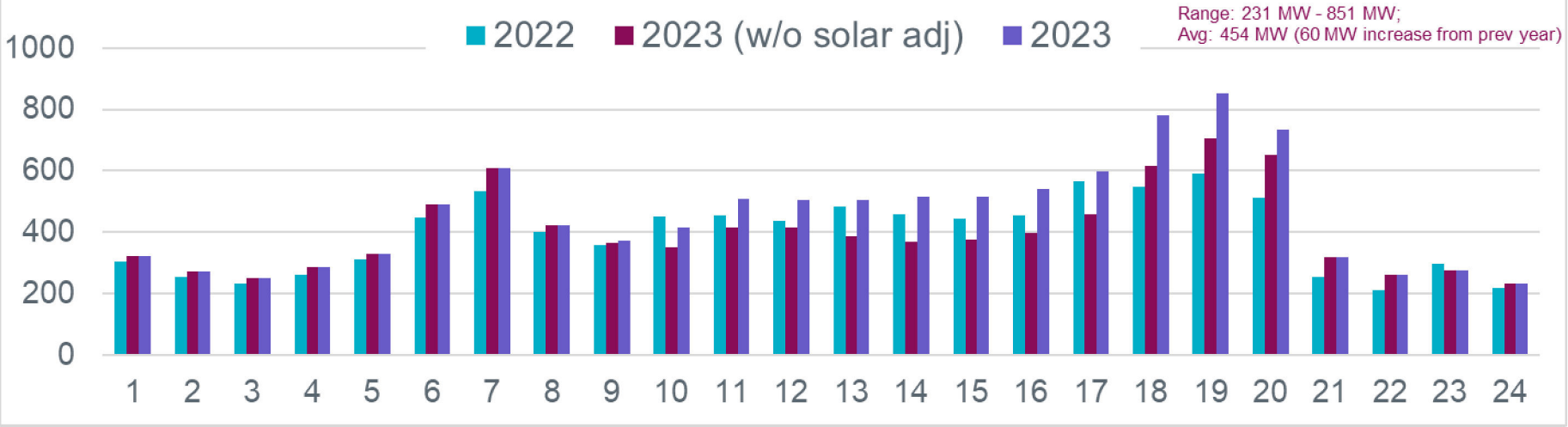
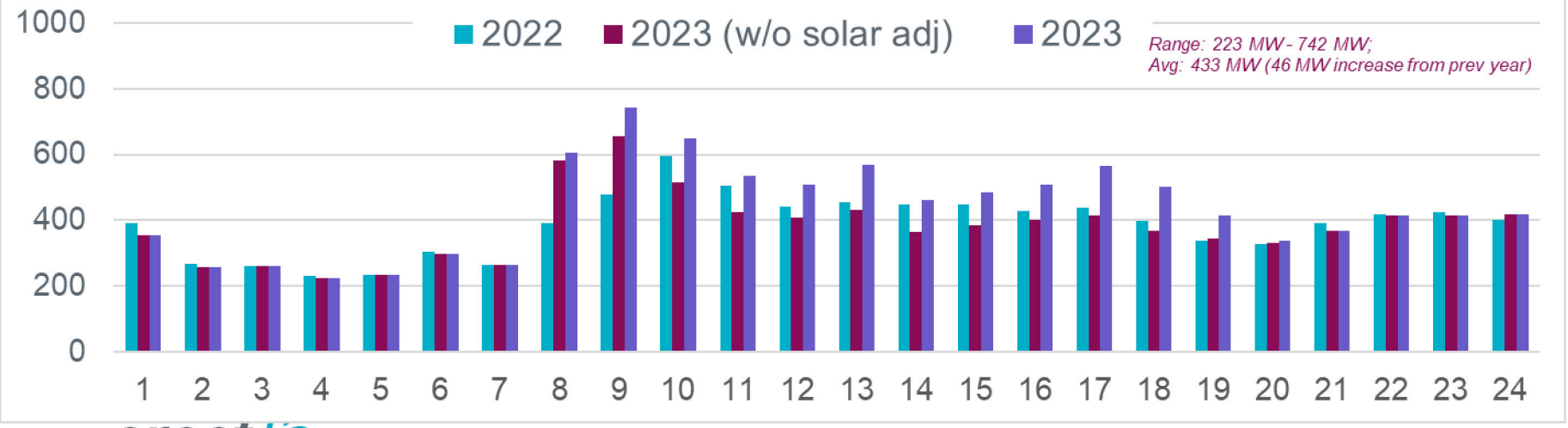
Regulation Comparison March

Regulation Up Requirement Comparison for March



Regulation Down Requirement Comparison for March



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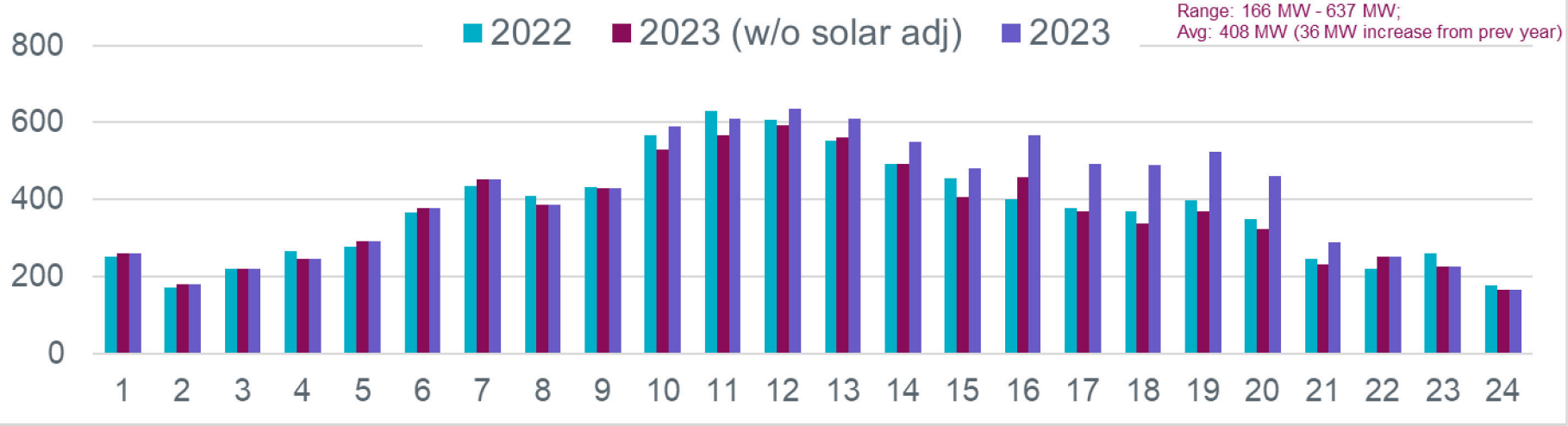
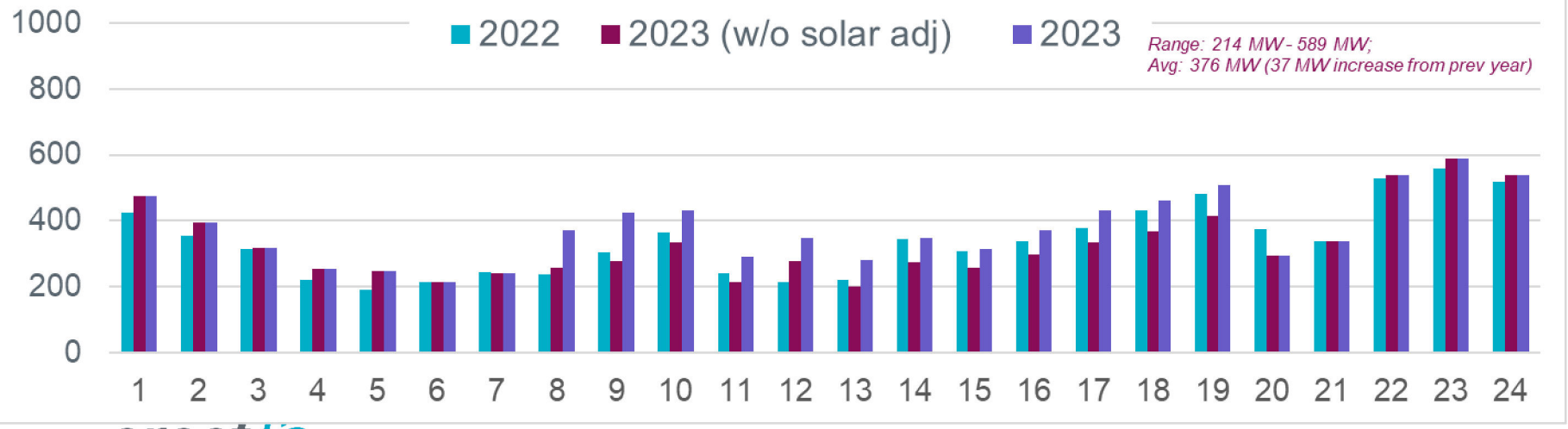
Regulation Comparison June

Regulation Up Requirement Comparison for June



Regulation Down Requirement Comparison for June



Hourly Average Regulation Comparison (Revised)

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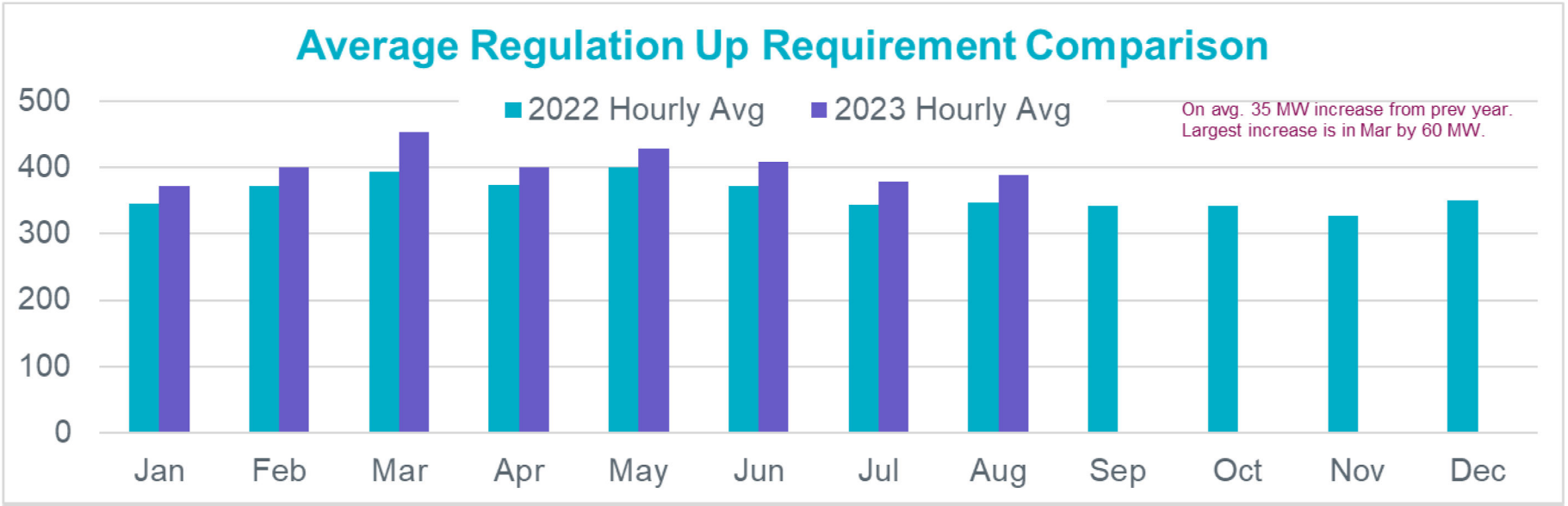

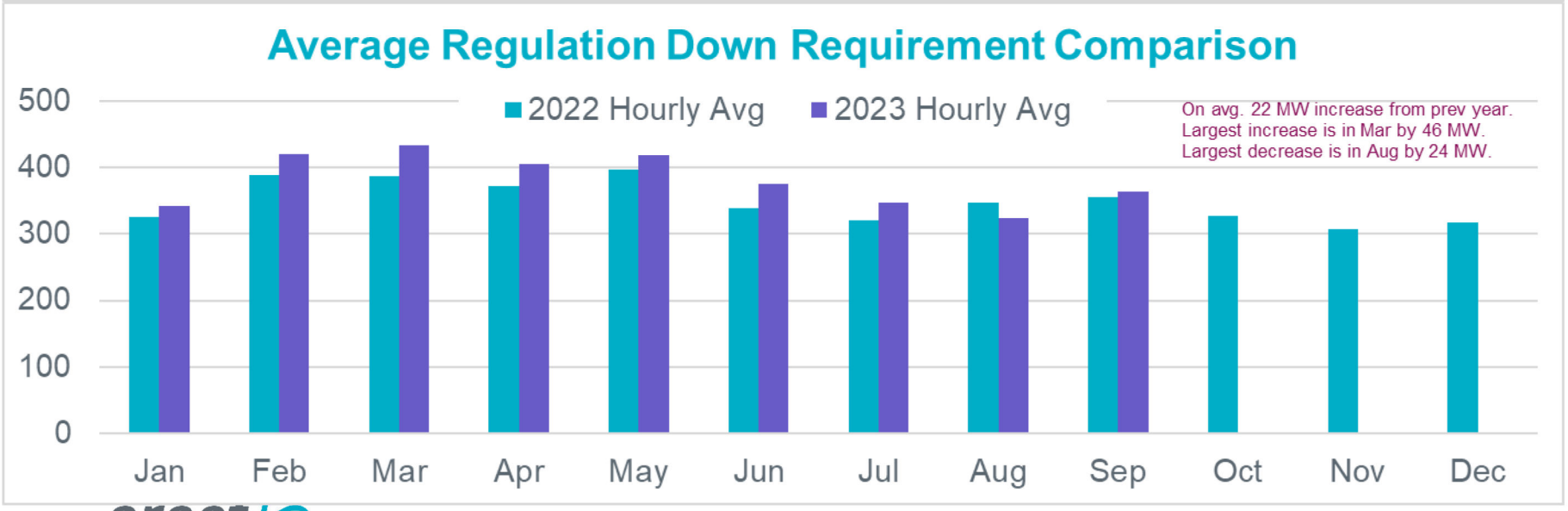

2022 Reg Up Exhaustion Rate and 2023 Quantities

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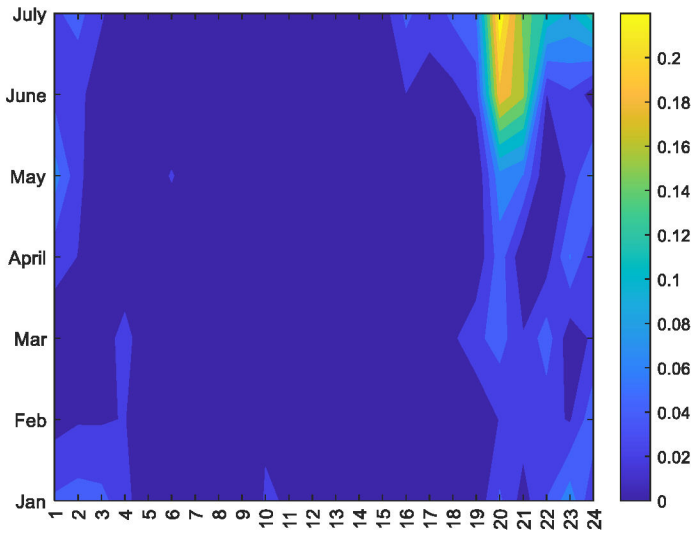
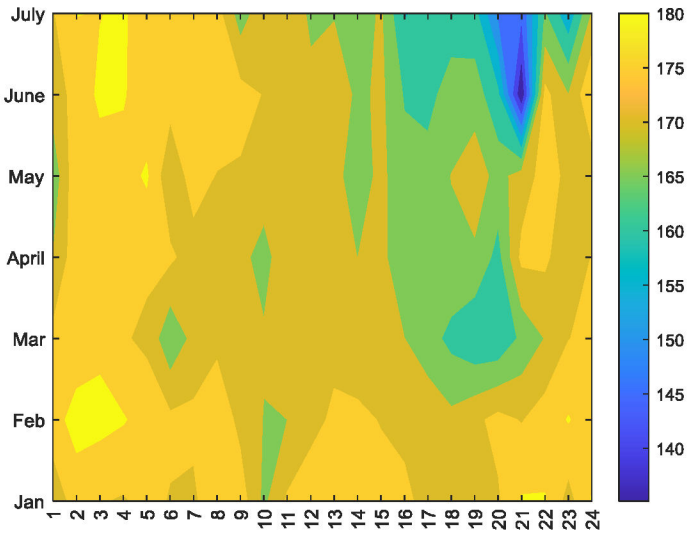
In the first half of 2022, most Regulation Up exhaustion is in the evening hours around sunset.



Reg-Up



Hourly Average CPS1

2023 – 2022 Reg Up (%)

% Change in Reg Up Quantities In 2023																								
	HE																							
Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Jul	3%	-9%	-8%	3%	-11%	-1%	-6%	-8%	-12%	8%	11%	9%	20%	18%	15%	20%	23%	23%	41%	40%	21%	-8%	2%	-24%
Jun	3%	6%	0%	-8%	5%	4%	4%	-5%	-1%	4%	-3%	5%	11%	12%	6%	41%	30%	32%	32%	32%	18%	15%	-13%	-7%
May	10%	-12%	4%	5%	5%	16%	4%	-7%	-1%	11%	7%	11%	8%	13%	14%	8%	6%	37%	13%	20%	32%	-40%	-10%	11%
Apr	7%	3%	8%	4%	5%	3%	4%	5%	-14%	9%	-5%	-4%	4%	11%	-1%	7%	12%	5%	33%	35%	9%	5%	7%	-4%
Mar	6%	6%	7%	9%	7%	10%	14%	5%	4%	-8%	11%	16%	4%	13%	17%	19%	6%	42%	44%	43%	26%	24%	-7%	6%
Feb	4%	0%	-15%	3%	1%	-6%	-11%	8%	-19%	15%	22%	7%	-7%	11%	9%	16%	12%	48%	27%	-1%	1%	3%	5%	12%
Jan	3%	2%	15%	-1%	-6%	0%	-2%	0%	0%	12%	21%	-7%	13%	3%	7%	3%	29%	26%	6%	27%	1%	4%	15%	4%

2023 Reg Down Exhaustion Rate and 2023 Quant...

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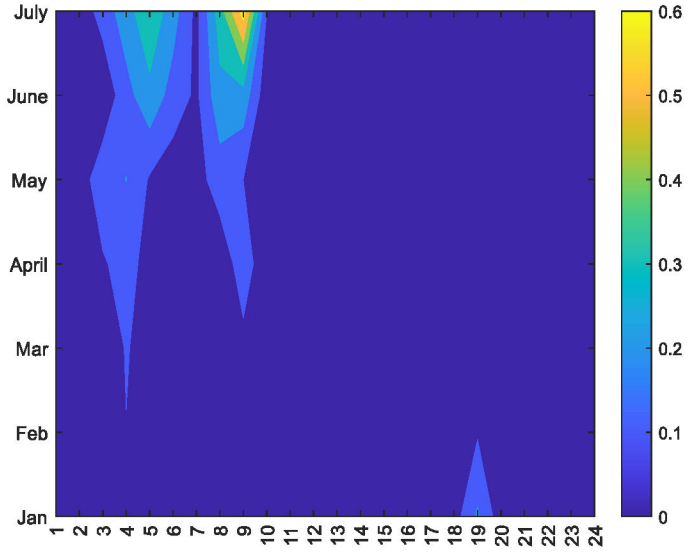
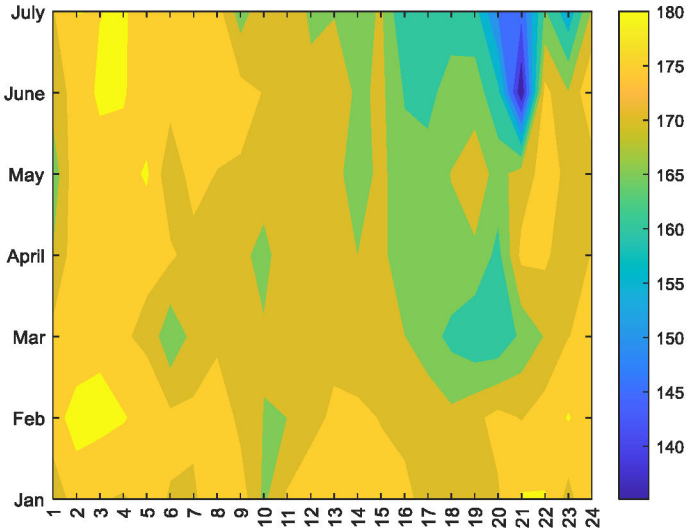
In the first half of 2022, most Regulation Down exhaustion is in the morning hours around sunrise .



Reg-Down



Hourly Average CPS1

2023 – 2022 Reg Down (%)

% Change in Reg Down Quantities In 2023																								
	HE																							
Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Jul	-3%	1%	12%	-4%	15%	-11%	0%	87%	39%	44%	16%	7%	8%	17%	27%	17%	8%	10%	-5%	-22%	-3%	7%	3%	3%
Jun	12%	12%	1%	15%	31%	0%	-1%	57%	39%	19%	21%	63%	27%	1%	2%	10%	14%	7%	6%	-21%	0%	2%	6%	4%
May	14%	11%	12%	9%	-6%	-7%	-8%	28%	20%	8%	-27%	16%	28%	11%	12%	2%	6%	5%	0%	2%	-7%	0%	0%	18%
Apr	7%	3%	5%	4%	-1%	0%	1%	16%	40%	15%	5%	7%	10%	5%	11%	13%	12%	16%	15%	-2%	1%	6%	4%	6%
Mar	-9%	-4%	0%	-3%	0%	-1%	0%	55%	56%	9%	6%	15%	25%	3%	9%	19%	29%	25%	22%	2%	-5%	-1%	-3%	4%
Feb	-3%	-7%	-9%	-2%	2%	1%	1%	60%	60%	11%	5%	3%	2%	1%	-1%	19%	23%	-1%	3%	2%	4%	-12%	1%	-3%
Jan	2%	1%	2%	20%	2%	9%	2%	-19%	49%	8%	2%	9%	4%	3%	10%	13%	10%	-9%	7%	-4%	-13%	-18%	2%	3%

Responsive Reserve Service (RRS) Methodology

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- ERCOT is not considering any changes to methodology used to compute the minimum RRS requirements for 2023.
  - NERC's preliminary BAL-003 Interconnection Frequency Response Obligation (IFRO) for Operating Year (OY) 2023 assessment for ERCOT shows an increase in ERCOT's IFRO. In order to align with ERCOT's new IFRO, minimum RRS-PFR limit for 2023 will change to 1,390 MW.

- The preliminary RRS quantities for January 2023 through August 2023 in subsequent slides have been computed using 2021 and 2022 system inertia conditions and updated RRS table.
  - The RRS table tracks RRS requirements for different inertia conditions. This table was updated in 2023 to use a minimum RRS-PFR limit of 1,390 MW.

RRS-PFR from Energy Storage Resources (ESRs) in 2022

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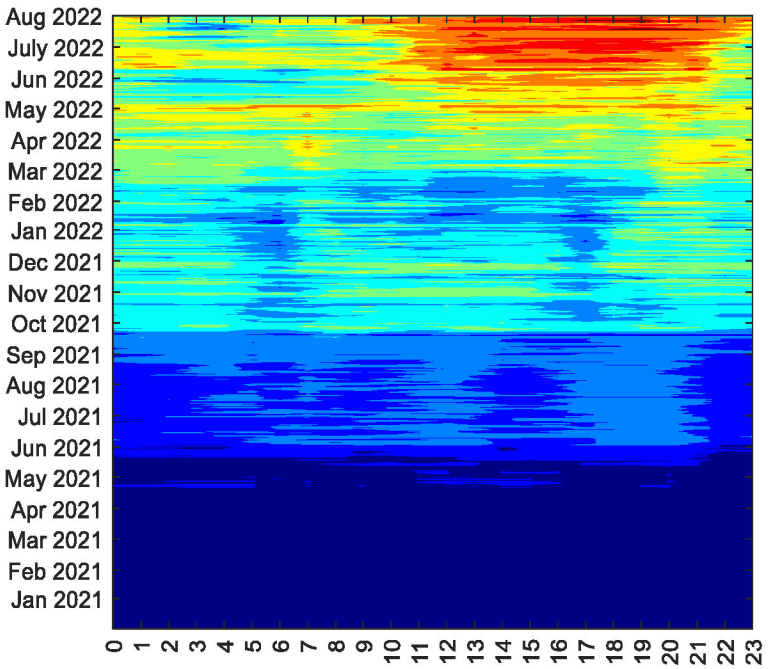
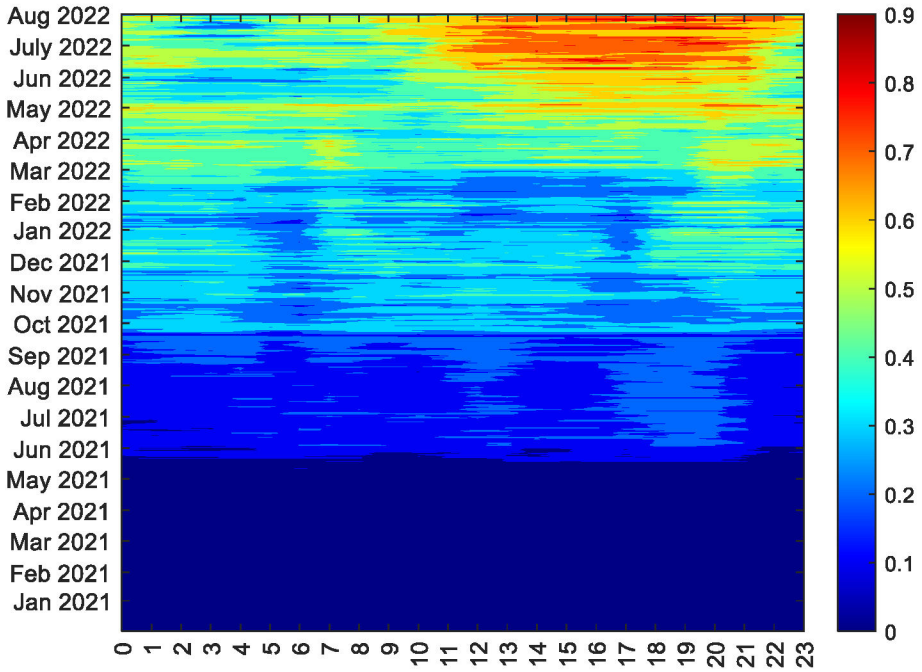
- ESRs are providing larger volumes of RRS-PFR in 2022.
  - ERCOT has modified its tools that measure performance of ESRs during Frequency Measurable Events (FMEs) beginning April 2022. Since then, ERCOT has been closely working with Resources that have not met the performance criteria.



MW
Max: 878 MW
Avg: 269 MW



Percentage*
Max: 92%
Avg: 26%

*RRS-PFR from ESRs as a percentage of total RRS-PFR from CLRs, Gas, Coal and ESRs.

2023 RRS Table

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	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7	Scenario 8	Scenario 9	Scenario 10	Scenario 11	Scenario 12
LR/PFR	2.35:1	2.2:1	2.06:1	1.94:1	1.83:1	1.74:1	1.65:1	1.58:1	1.51:1	1.44:1	1.39:1	1.33:1
Inertia (GW·s)	130	140	150	160	170	180	190	200	210	220	230	240
PFR Req. (no LR) (MW)	5960	5563	5200	4892	4622	4329	4114	3920	3744	3522	3314	3139
*RRS Curr IFRO (MW)	*3293*	*3234*	*3178*	*3128*	*3088*	*3015*	*2982*	*2936*	*2898*	*2825*	*2732*	*2668*
**RRS Upd IFRO (MW)	3335	3287	3239	3195	3156	3079	3041	2991	2949	2871	2774	2705

	Scenario 13	Scenario 14	Scenario 15	Scenario 16	Scenario 17	Scenario 18	Scenario 19	Scenario 20	Scenario 21	Scenario 22	Scenario 23	Scenario 24	Scenario 25
LR/PFR	1.28:1	1.24:1	1.19:1	1.15:1	1.12:1	1.08:1	1.04:1	1.01:1	1:1	1:1	1:1	1:1	1:1
Inertia (GW·s)	250	260	270	280	290	300	310	320	330	340	350	360	370
PFR Req. (no LR) (MW)	3004	2890	2784	2686	2595	2510	2421	2353	2290	2230	2173	2119	2068
*RRS Curr IFRO (MW)	*2618*	*2571*	*2538*	*2498*	*2450*	*2416*	*2375*	*2342*	*2290*	*2230*	*2173*	*2119*	*2068*
**RRS Upd IFRO (MW)	2651	2600	2562	2517	2466	2427	2381	2344	2290	2230	2173	2119	2068

*RRS quantity is calculated for RCC of 2805 with limit of 60% limit on LRs and min RRS-PFR limit of 1,240 MW.

**RRS quantity is calculated for RCC of 2805 with limit of 60% limit on LRs and min RRS-PFR limit of 1,390 MW.

***Red font in table above identifies study scenario where RRS needed < 2300 MW. RRS requirement during these is based on the applicable floor.

****Generation mix (CCs, Gas, SC, Coal, Steam) providing 1150 MW of PFR has been aligned with actual historic system operations.
Inertia < 250 GW·s: 30% Coal + 70% Rest. Inertia ≥ 250 GW·s: 15% Coal + 85% Rest

RRS Comparison February (Revised)

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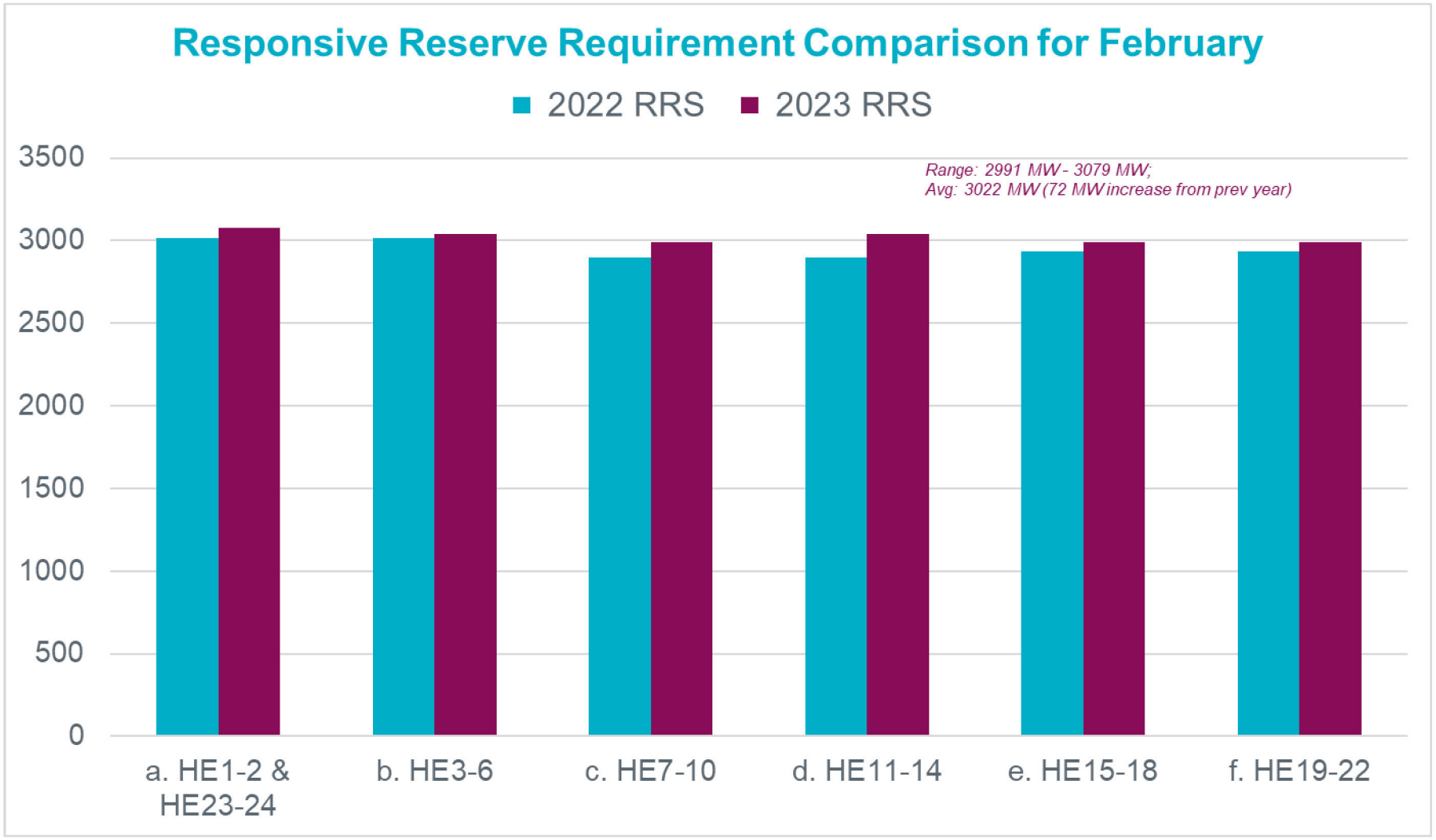

RRS Comparison March (Revised)

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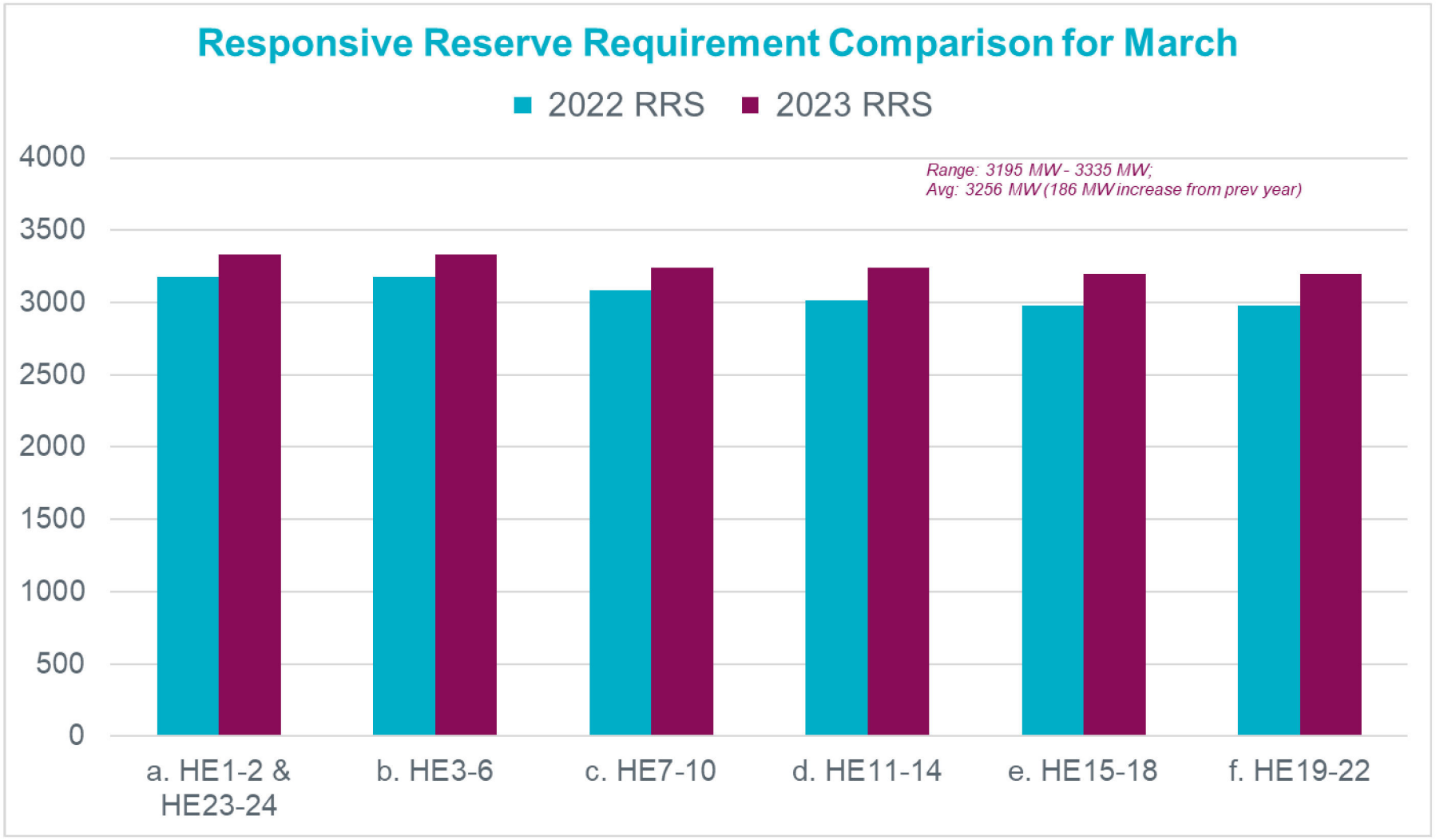

RRS Comparison July

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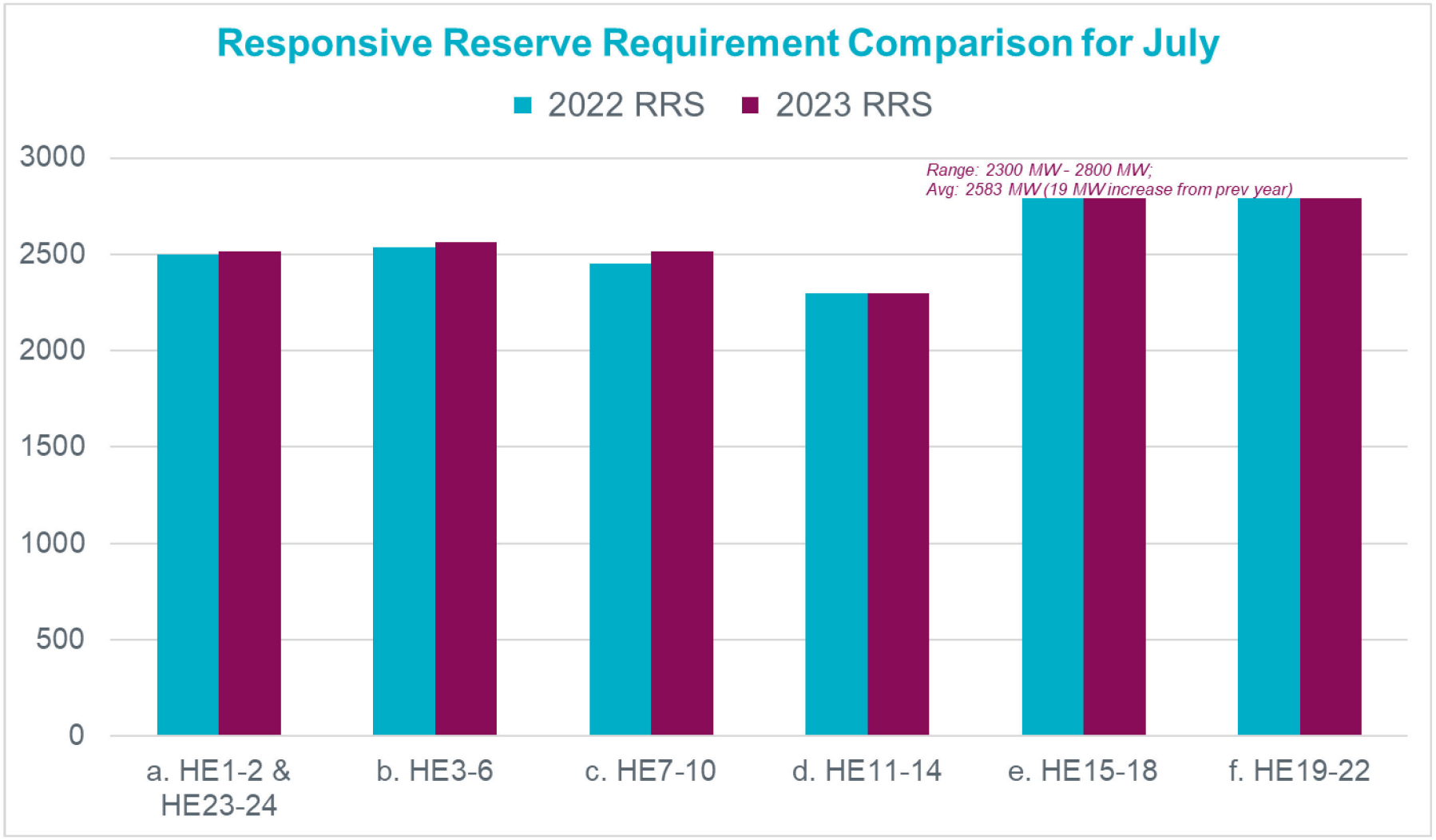

Hourly Average RRS Comparison (Revised)

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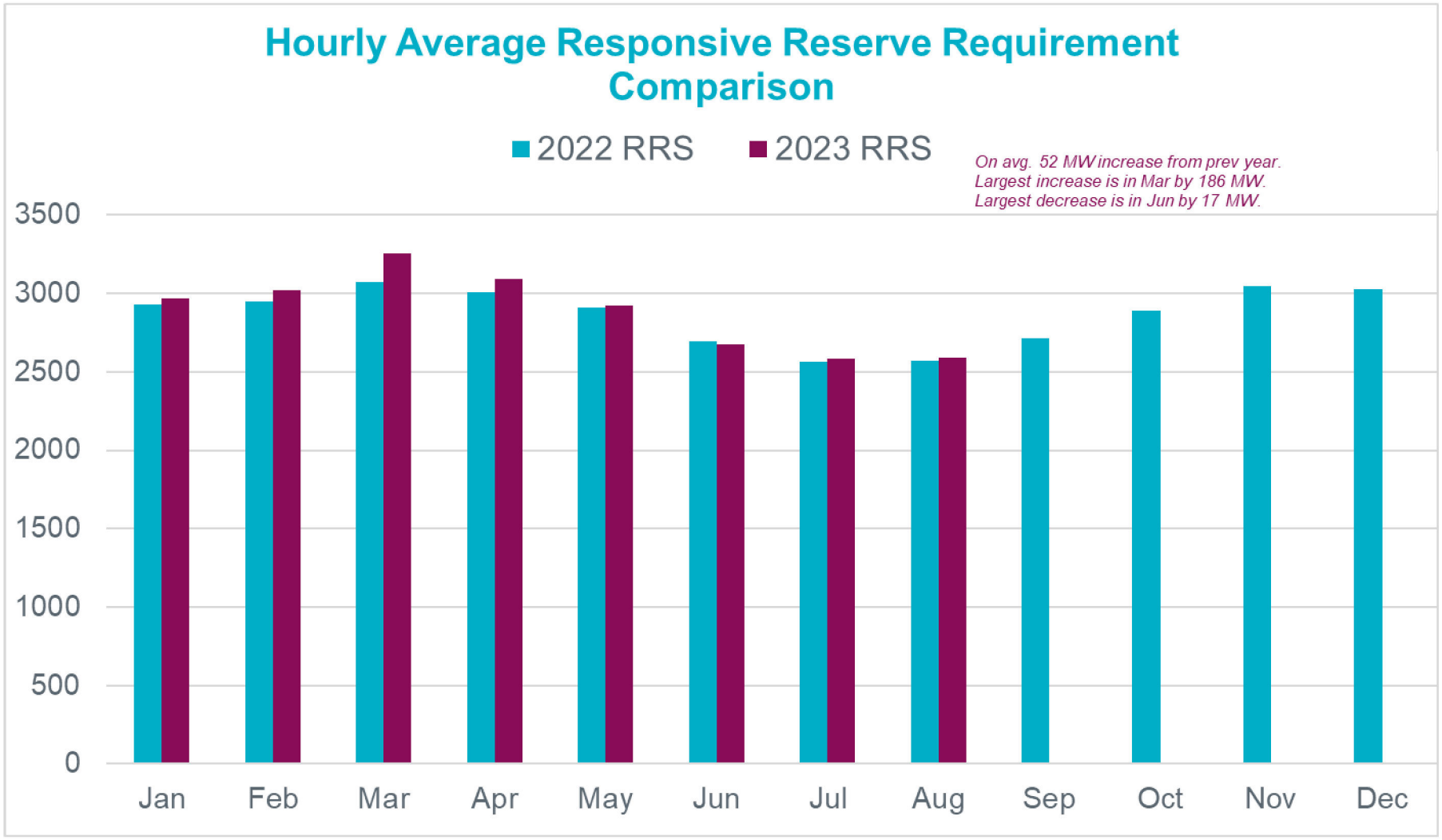

Low Inertia Hours for FFR Prioritization NPRR 112

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- If ERCOT comments dated July 15, 2022 on NPRR 1128 are approved,
  - For certain selected hours FFR procurement up to FFR limit will be prioritized
  - ERCOT is considering a methodology that selects hours in the last 1 year wherein 75% of the time the system inertia is less than 200 GW·s for FFR prioritization.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	191447	153751	123329	146782	181343	228511	266828	266213	208377	169327	139939	147162
2	192319	160482	123871	136257	176361	222575	261209	259337	206197	163086	139772	147225
3	193841	160638	121747	135851	176517	221009	259953	259030	206026	160730	139850	145393
4	194249	162327	122019	134495	176407	221400	259951	259593	206778	160472	140179	146878
5	200137	169370	124764	138357	182259	223829	260076	261497	208785	163750	147168	153954
6	212952	180827	132840	141485	192778	230421	260289	265434	217090	171226	160411	166545
7	215781	185071	134641	149691	198653	234066	263177	265691	221097	179713	167643	170376
8	216399	187142	138862	159873	200581	235571	269075	267163	231432	185226	172662	179142
9	217516	191115	142257	162341	203674	245101	278056	274281	242654	190473	175242	182466
10	217171	189003	145698	163758	212067	258358	289242	284922	255503	200589	173879	183033
11	211934	188904	146155	170097	220028	274380	306938	304818	268850	205439	176657	184530
12	206704	189266	145980	173646	221373	285780	318746	325190	285081	210195	180010	186292
13	201767	186205	148048	182469	226379	297458	326074	331409	293163	215369	183831	193068
14	199925	180837	151003	193658	228755	305096	329477	335955	294512	218018	186315	197838
15	199087	186040	158373	201290	230273	307160	331425	339504	298133	220137	190029	200171
16	203144	186032	166785	204291	231731	310026	332377	339966	300123	225608	191574	202073
17	205613	187140	170980	206904	232347	311578	332514	344176	300120	228363	194125	205999
18	209291	188847	172466	207965	234905	311175	331028	344048	303426	228625	195015	207709
19	212399	190201	173633	208558	234709	308536	330030	342479	303671	229279	194102	206057
20	207573	182556	173665	205560	231952	305441	326343	336864	305851	228829	190401	201345
21	204235	174206	169588	203798	228262	296881	323577	331912	302799	227875	183453	197237
22	200672	168043	164137	193362	225916	281125	316723	319457	280550	220630	167986	185524
23	198944	163085	146924	179302	207034	259262	294462	301899	252783	203972	149513	168988
24	193301	157412	130146	159200	193707	239055	273366	284829	225264	185321	141346	156521

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1	1	1	1	0	0	0	0	1	1	1
1	1	1	1	1	0	0	0	0	1	1	1
1	1	1	1	1	0	0	0	0	1	1	1
1	1	1	1	1	0	0	0	0	1	1	1
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0	1	1	1	0	0	0	0	0	0	1	0
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0	1	1	1	0	0	0	0	0	0	1	1
0	1	1	1	0	0	0	0	0	0	1	1
1	1	1	1	1	0	0	0	0	1	1	1

Non-Spinning Reserve Methodology - 2023

- ERCOT is considering the following changes in the methodology used to compute minimum Non-Spin requirements in 2023
  - Before ECRS is implemented, use 85th to 95th percentile of 10 Hours Ahead (HA) maximum net load forecast error to compute Non-Spin quantities
  - After ECRS is implemented, use 75th to 95th percentile of 6 Hours Ahead (HA) hourly average net load forecast error to compute Non-Spin quantities.

- The preliminary Non-Spin quantities for January 2023 through August 2023 in subsequent slides have been computed using current methodology (2020, 2021 and 2022 Net load and Net load Forecast), updated Wind Over-Forecast Error Adjustment table and the updated Solar Over-Forecast Error Adjustment table.
  - Wind and Solar Over-Forecast Error Adjustment Table track estimated increase in wind over forecast error per 1000 MW increase in installed wind and solar capacity, respectively.

2022 RUCs by Startup Time

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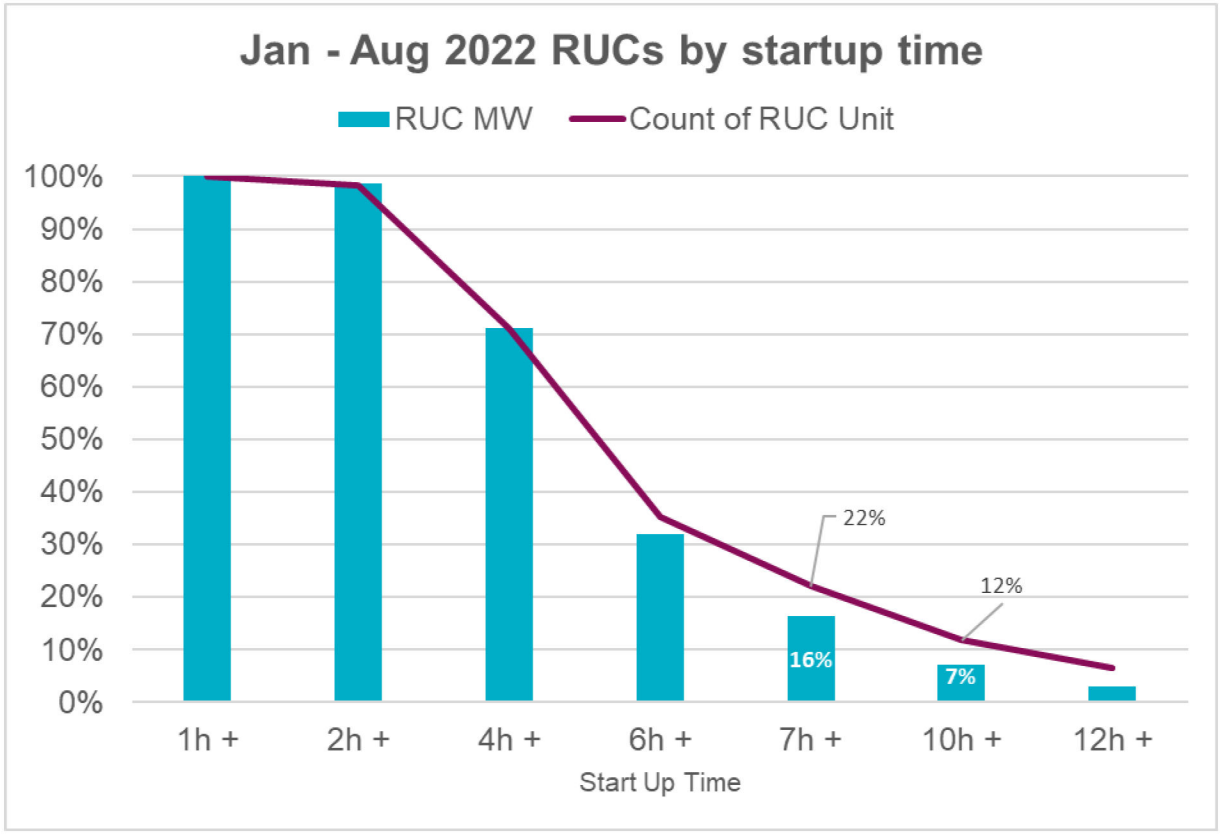
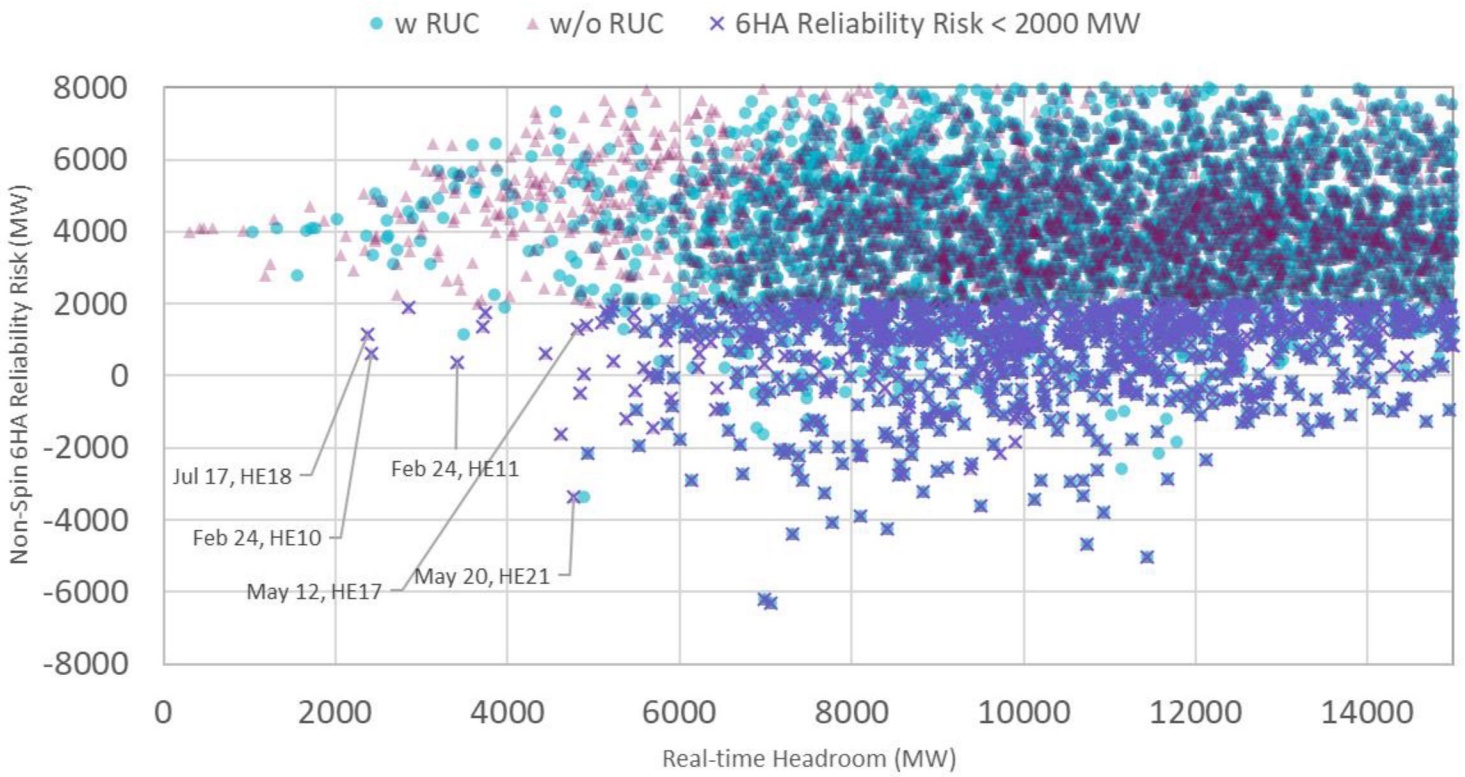


Adequacy of Non-Spin quantities in 2023

- Between Jan 1, 2022 and Jul 31, 2022,
  - ~5% of the time the available Non-Spin was not sufficient to cover the 6HA risk.
    - Lowest Real Time headroom without RUC action was 2,366 MW on July 17@HE18. With RUC the Real Time headroom was around 3,488 MW.
  - ~13% of the time the margin in the available Non-Spin to cover the 6HA risk was less than 1,430 MW.



2023 Intra-day Outage Table

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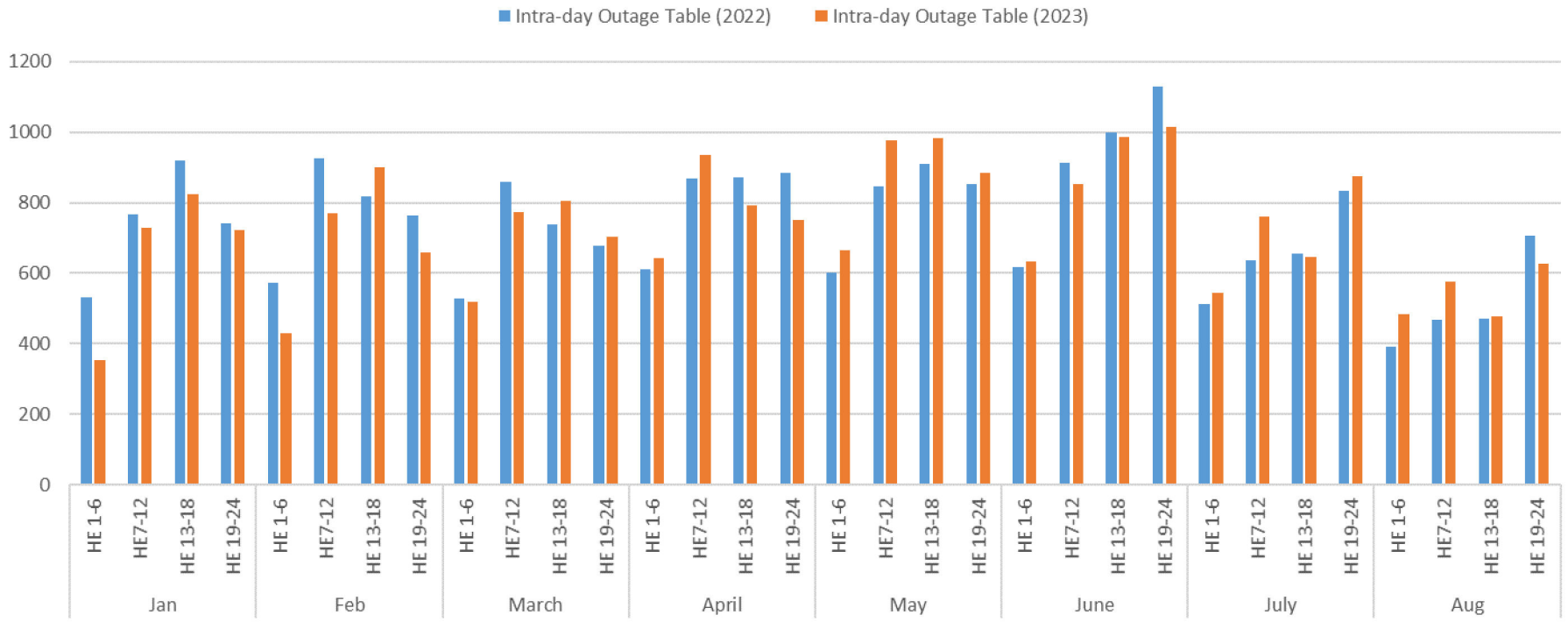
The Intra-day Outage table helps account for increased capacity needs following forced outages of thermal resources within an operating day.



Non-Spin Comparison January

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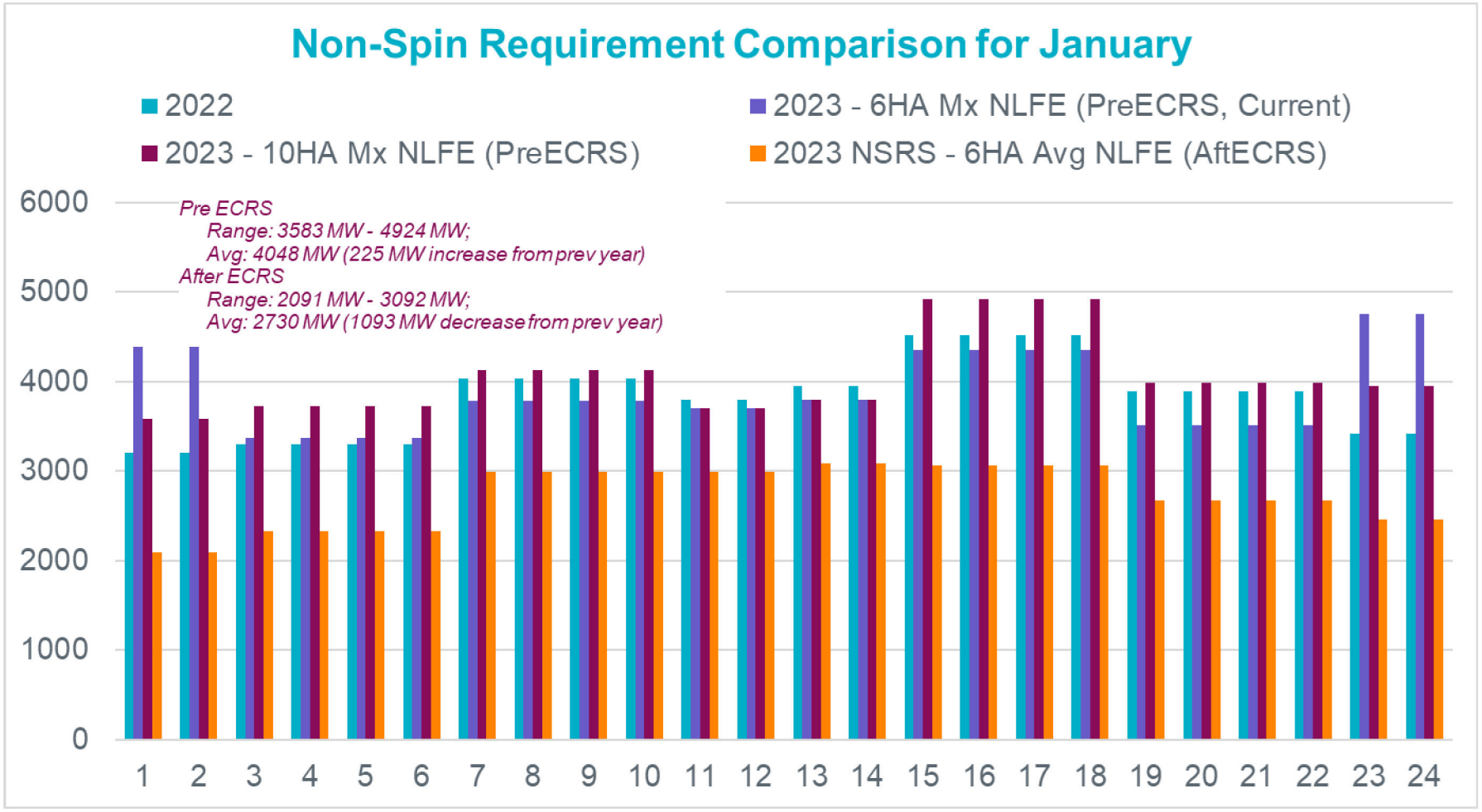

Non-Spin Comparison May

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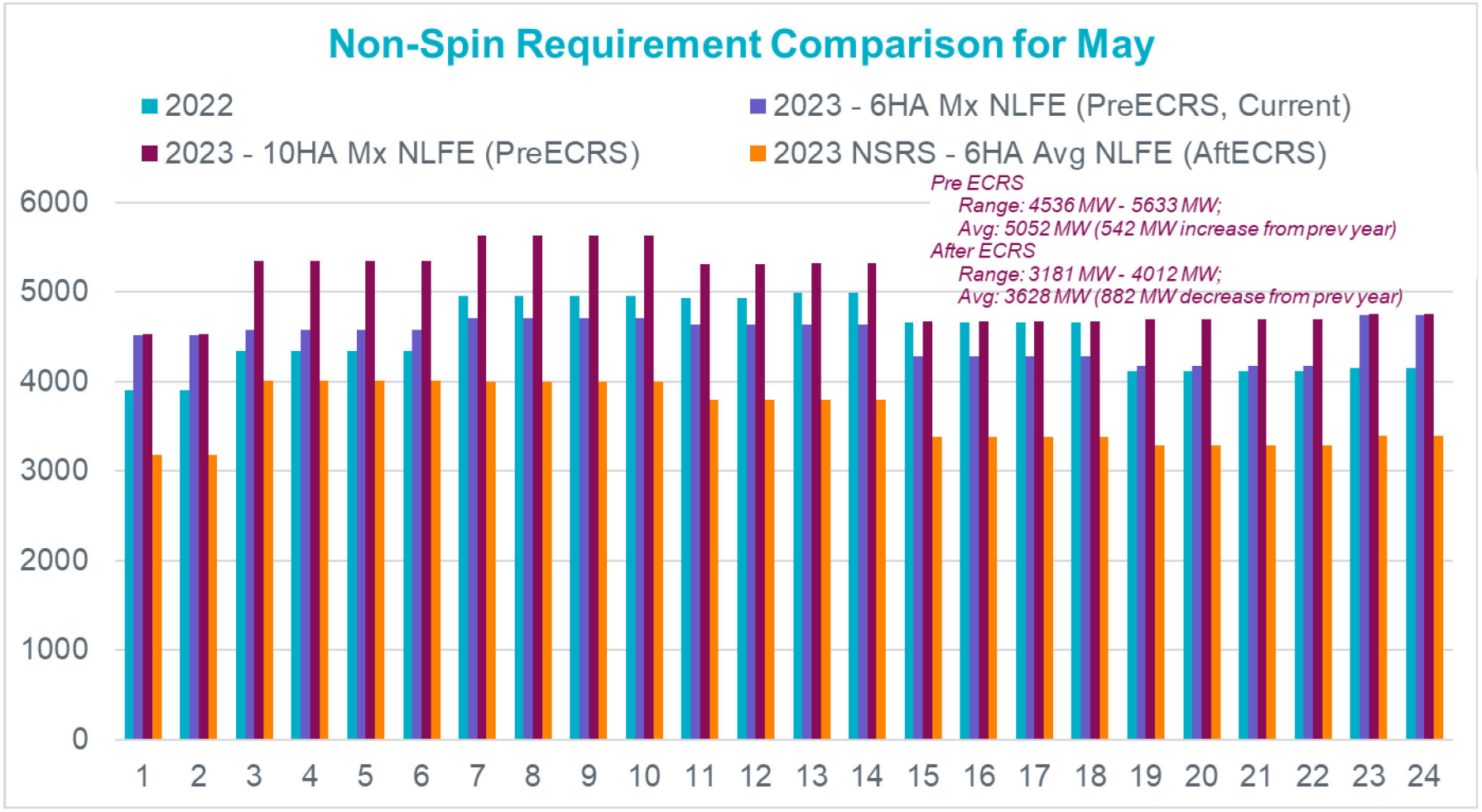

Non-Spin Comparison August

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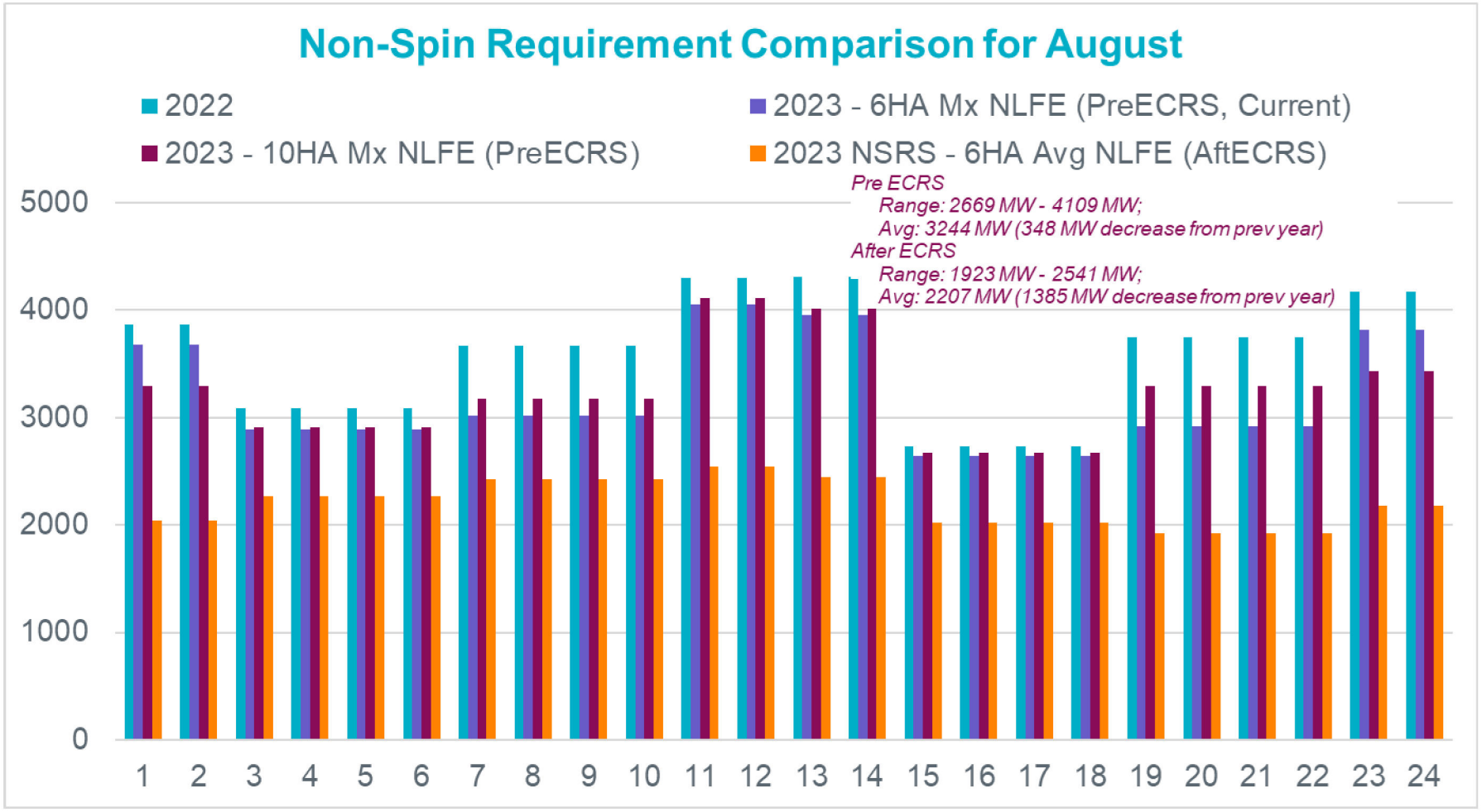

Hourly Average Non-Spin Comparison

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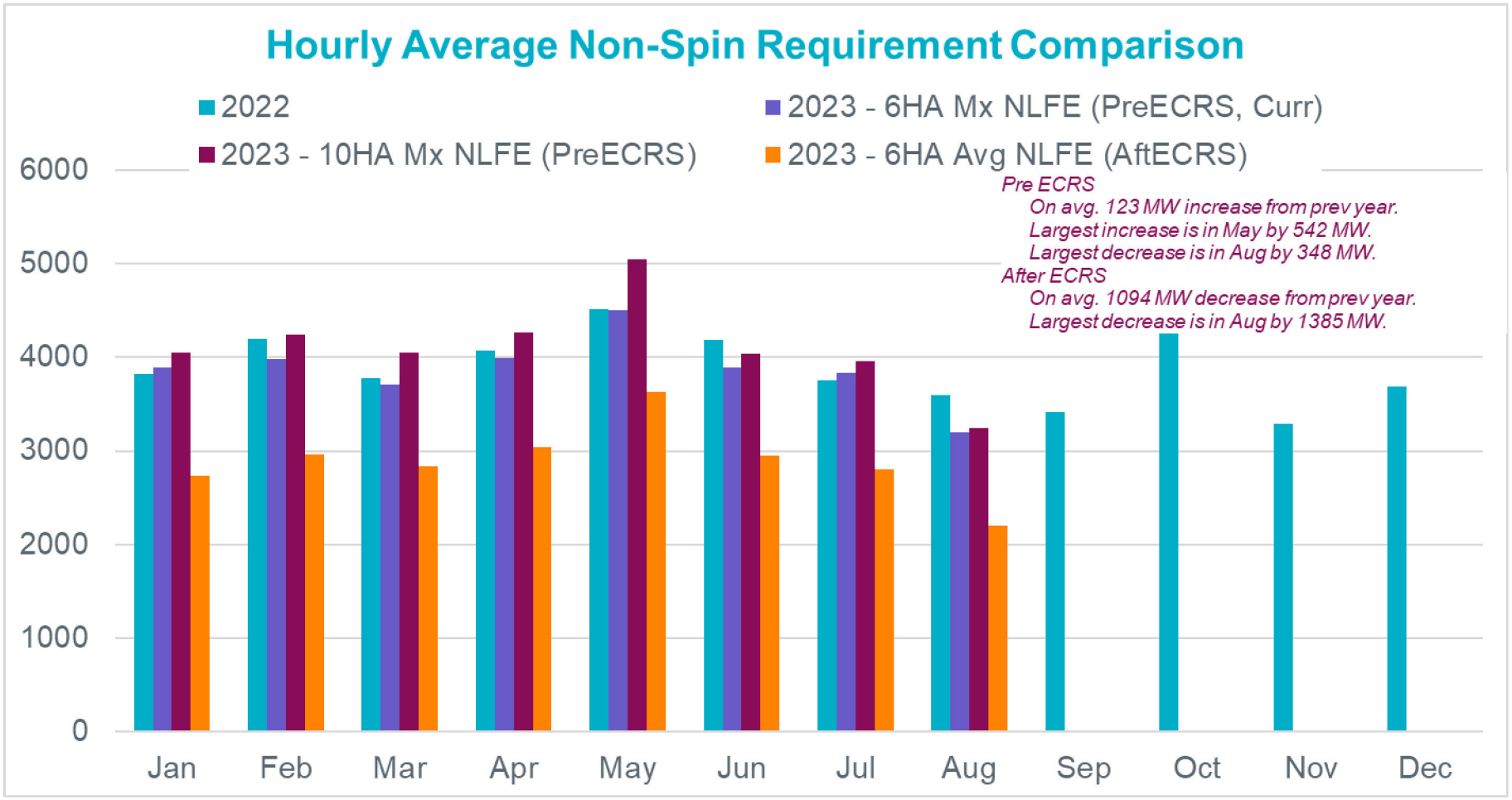

Post ECRS Non-Spin Quantities

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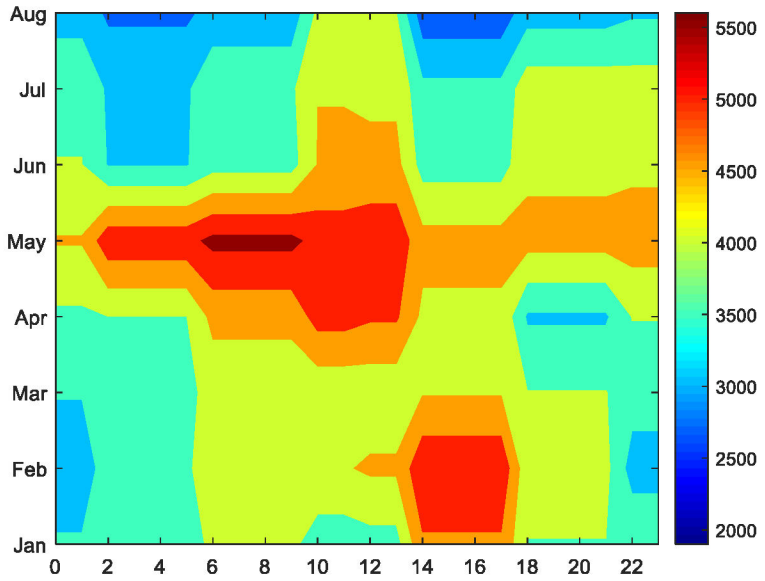
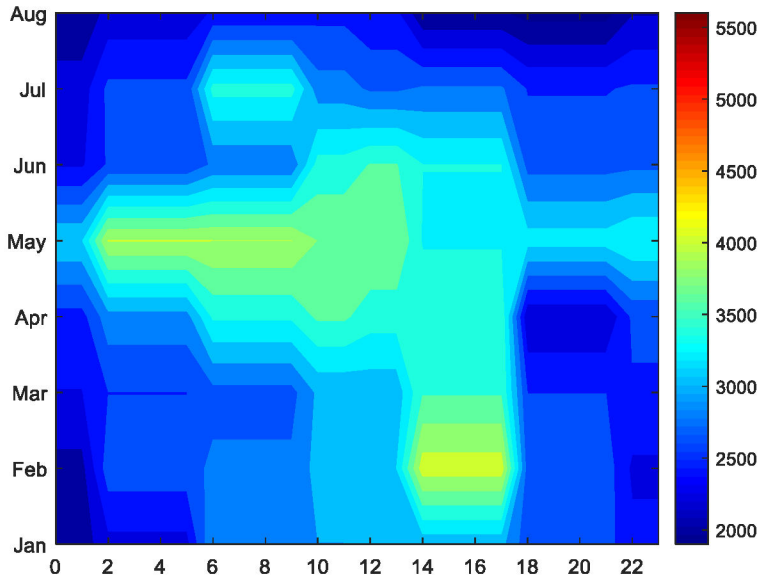
- With the proposed "after ECRS approach" for Non-Spin, overall, the Non-Spin quantities are expected to decrease.



Pre-ECRS Non-Spin
Min: 2,669 MW
Max: 5,633 MW



After ECRS Non-Spin
Min: 1,923 MW
Max: 4,112 MW

Net Load Variability Evaluation

- Since July 12, 2021, ERCOT has been monitoring the weather forecast near Real Time and in during the following days has procured up to an additional 1,000 MW of Non-Spin during periods that were identified as having an increased potential of high forecast variability that may cause a higher net load during these hours.
  - 2021: Jul 29, Aug 1, Aug 2, Aug 14, Aug 27, Aug 29, Aug 30, Sep 3, Sep 4
  - 2022: Jan. 2, Jan. 3, Jan. 20, Feb. 3, Feb. 4, May 22, May 23, May 24, Jun 1

- Additional Non-Spin may be procured for Operating Hours that are
  a) identified as having an increased potential of high forecast variability,
  b) there is a risk that the actual net load during these Operating Hours could be higher than forecast (after making appropriate forecast model selection) AND
  c) the expected available capacity and expected reserves including the posted minimum Non-Spin requirements during these Operating Hours is not sufficient to cover the projected net load forecast uncertainty risk.

- In 2023, ERCOT is proposing to continue the practice of monitoring the weather near Real Time and may procure up to an additional 1,000 MW of Non-Spin for specific Operating Hours.

SUGGESTIONS?

Preliminary Methodology to Determine 2023 ECRS Requirements

ERCOT Staff

August 18, 2022 | PDCWG
August 19, 2022 | WMWG

Introduction

- ERCOT is in the process of implementing ERCOT Contingency Reserve Service (ECRS).
  - ERCOT is targeting to implement ECRS prior to the "EMS freeze" period (around May 2023 – Jan 2024)
- This presentation will discuss a proposed* methodology to determine the minimum quantities for ECRS in 2023. A spreadsheet that contains ECRS quantities from August 2022 through July 2023 that have been computed using this proposed methodology have been posted to today's meeting page.
  - ERCOT is seeking stakeholder feedback on the proposed ECRS methodology.

Note on Non-Spinning Reserve Service (Non-Spin) quantities post ECRS implementation

- ECRS and Non-Spin differ in the reliability risks these services address, qualification criteria, response time and duration. As a result, upon ECRS' implementation, Non-Spin requirement cannot entirely be substituted by the amount of ECRS procured as was originally proposed during NPRR863 discussions.
- That said, ERCOT expects the risks that Non-Spin is used to cover will evolve upon ECRS' implementation. Hence the methodology to determine Non-Spin quantities in a world where ECRS exists may need revisions.
  - ERCOT plans to discuss the Non-Spin methodology that will apply with ECRS' implementation as a part of the annual AS Methodology review process.

* Note, ERCOT may refine the ECRS methodology further as a part of the annual effort to review the methodology for determining Ancillary Service (AS) quantities (AS Methodology).

ECRS Requirements Methodology

- ECRS is a service that is provided using capacity that can be sustained at a specified level for two consecutive hours and is used to restore or maintain the frequency of the ERCOT System:
  a) In response to significant depletion of RRS;
  b) As backup Regulation Service;
  c) By providing energy to avoid getting into or during an Energy Emergency Alert (EEA); and
  d) Upon detection of insufficient capacity for net load ramps.

- ERCOT is proposing to compute ECRS requirements as the sum of,
  1. capacity needed to recover frequency following a large unit trip and
  2. capacity needed to support sustained net load ramps.

- The next few slides will discuss the detail about each of these components that establish the ECRS requirements.

Method for Determining MWs needed for Frequency Recov

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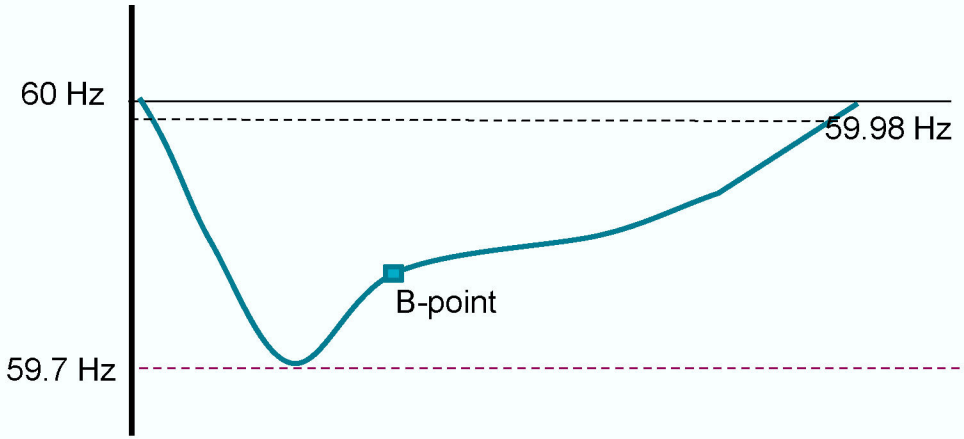
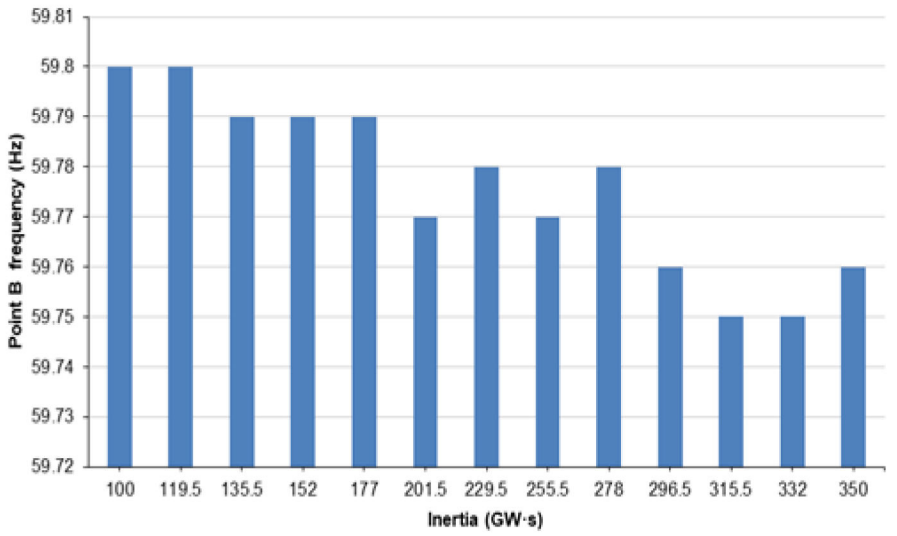
- Capacity needed to recover frequency from B-point (i.e., settling frequency) to 59.98 Hz is determined by using dynamic simulations/studies that are run at varying inertia levels.
- In every simulation, a single medium-size unit is tripped offline such that the C-point (frequency nadir) is stays just above 59.7 Hz*.
- Capacity needed to recover frequency using this approach is determined for each hour of each month using two years historical data.

*59.7Hz is the trigger frequency for Load Resources that are providing RRS using an under-frequency relay.



B-point (settling frequency) is determined using dynamic simulations/studies that are run at varying inertia levels. In every simulation, a single medium-size unit is tripped offline such that the C-point (frequency nadir) is stays just above 59.7 Hz.*



MW_{need} = (59.98 Hz – $Freq_{B\text{-}point}$) * (1% load in MW/0.1 Hz)