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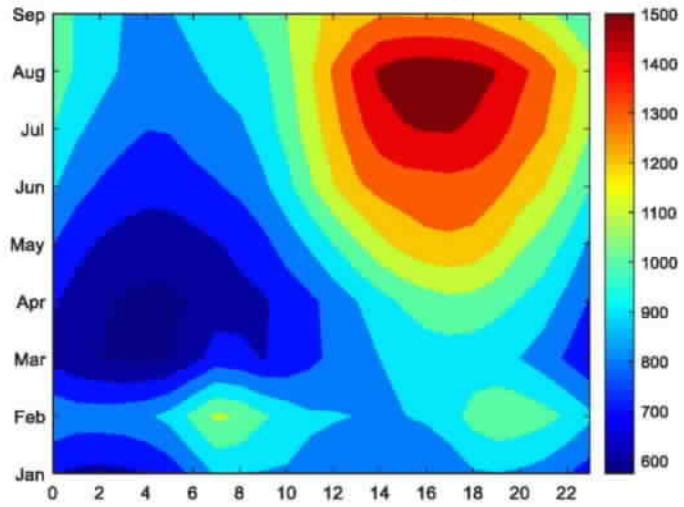
ECRS Requirement for 2023

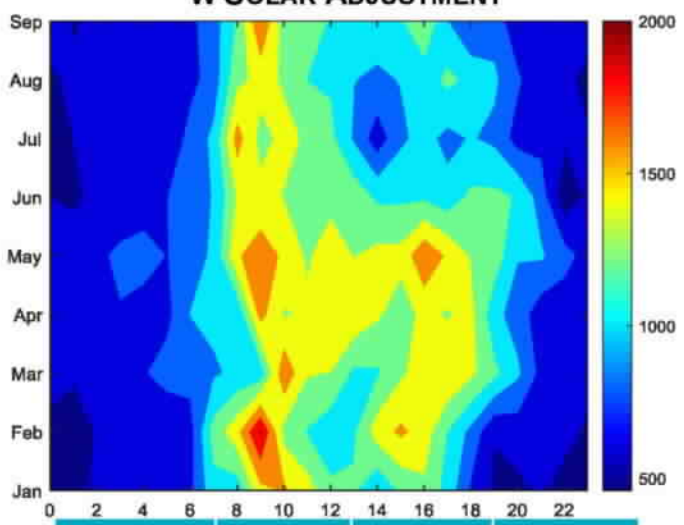
Frequency Recovery (F.R.)



	Min	Mean	Max
F.R.	574 MW	974 MW	1,572 MW

+

Intra-Hour NLFE w Solar Adjustment



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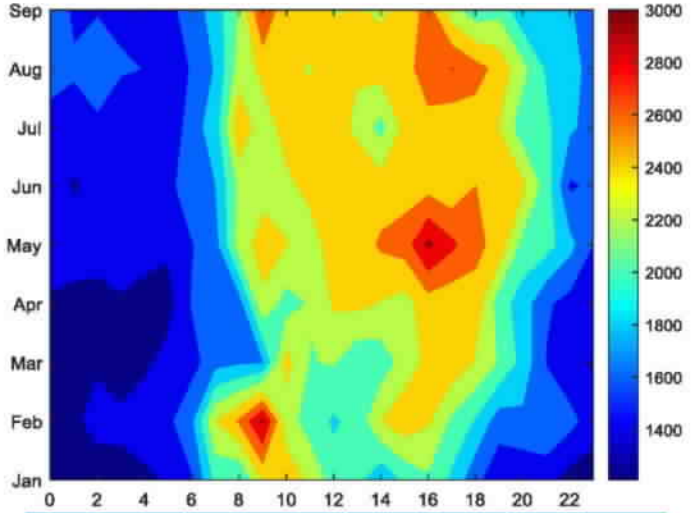

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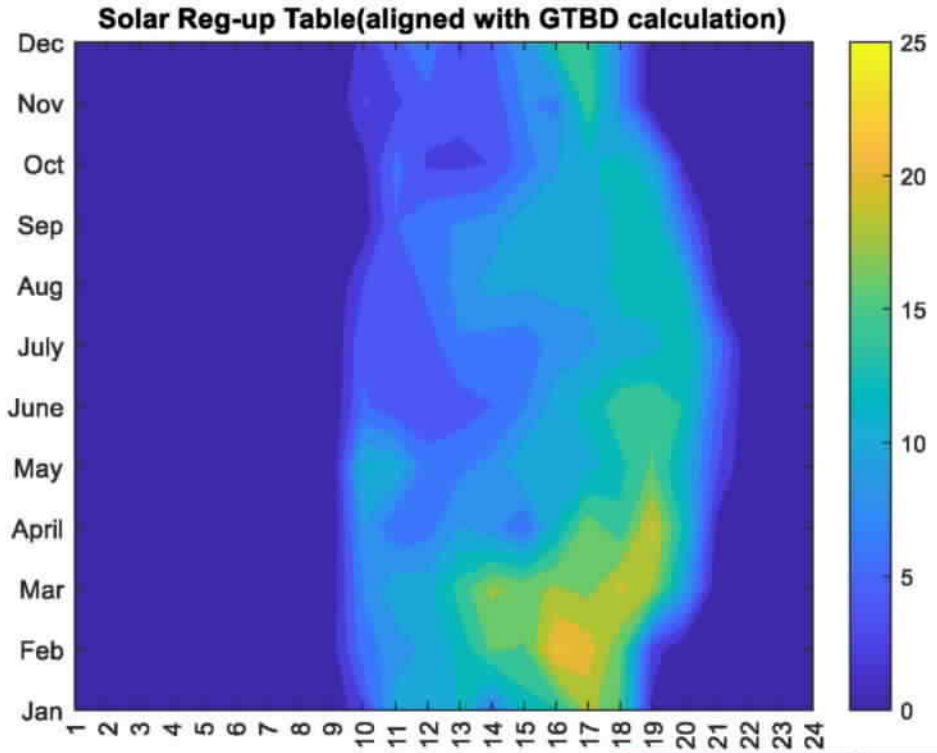

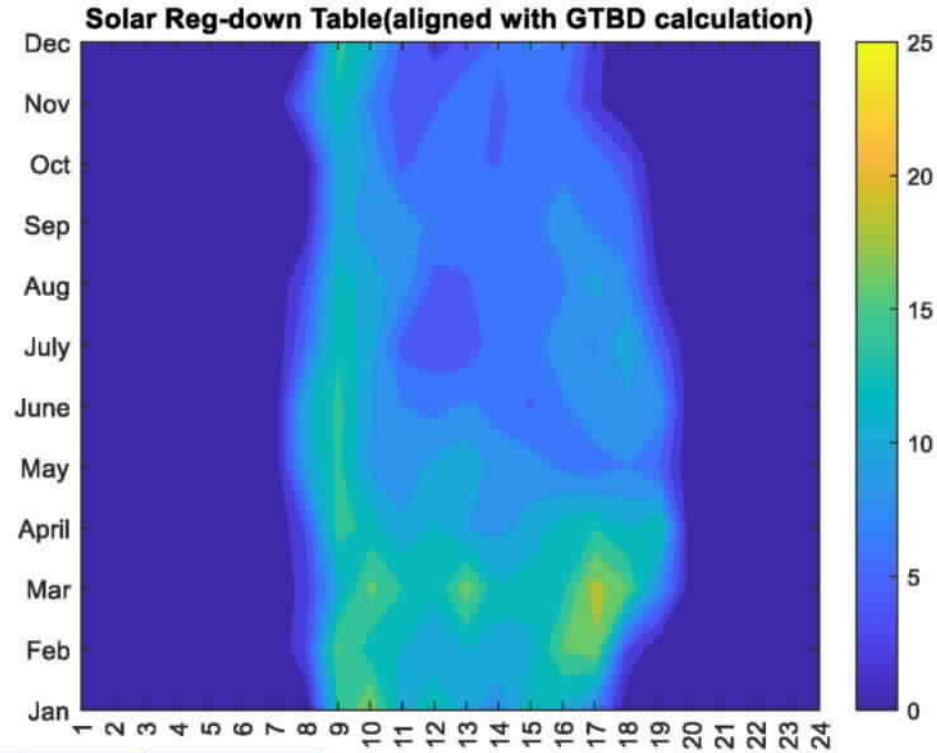

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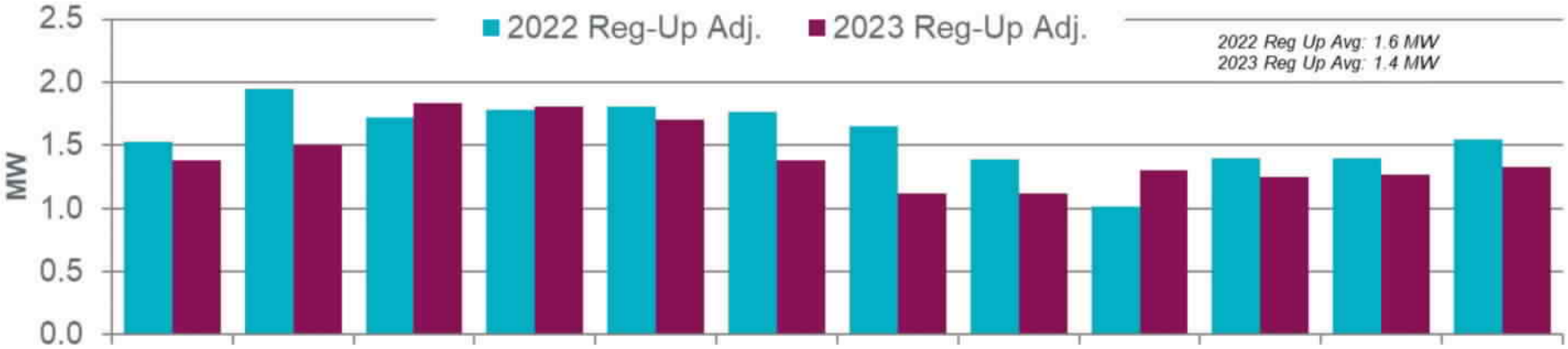
Reg-Up Adjustment per 1000 MW increase in Wind Installed Capacity



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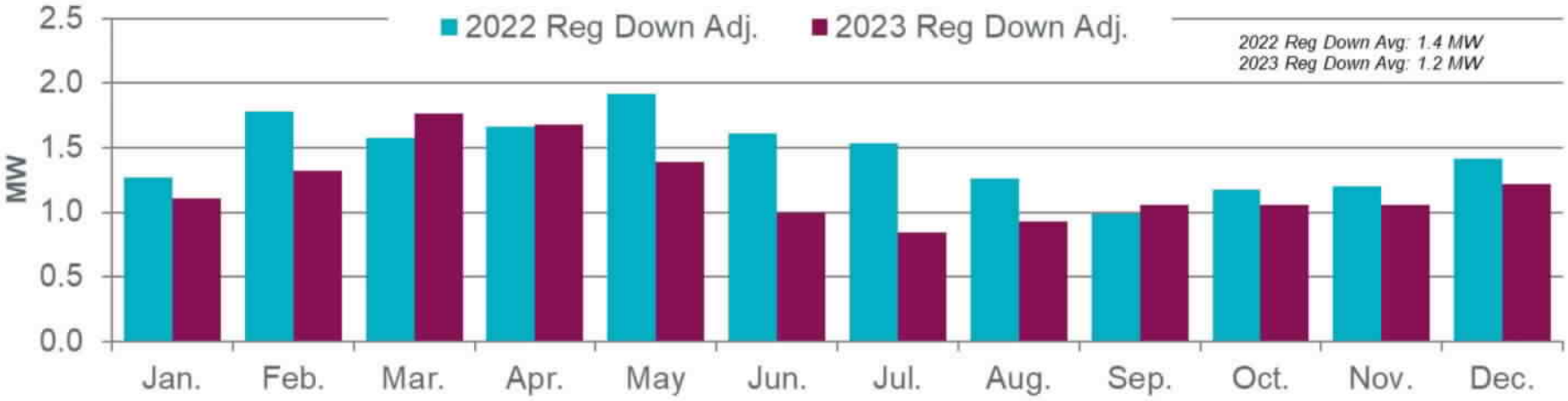

2023 RRS Table

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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.

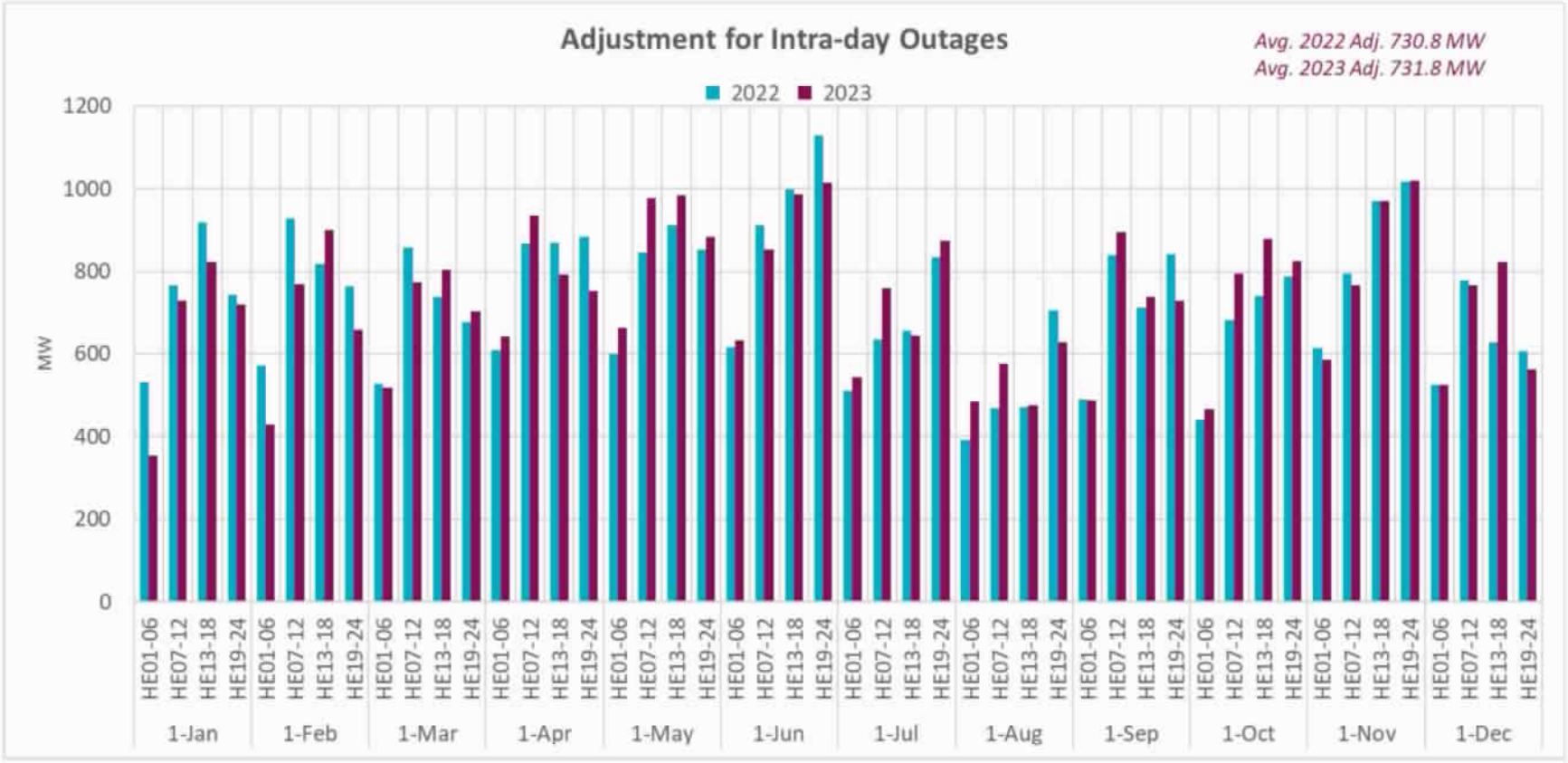
**RRS quantity is calculated for RCC of 2805 with limit of 60% limit on LRs and min RRS-PFR limit of 1,390 MW.

***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

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.



ECRS Adjustment for Increase in Solar Installed Capacity

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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

ADJUSTMENT FOR 2023 (MIN: 0 MW | MEAN: 74 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

ECRS Deployment/Release Conditions

- ERCOT will deploy ECRS-Gen i.e. ECRS from SCED Dispatchable Resources when frequency drops below 59.91 Hz and available Reg-Up is not sufficient to restore frequency.
- ERCOT may deploy ECRS-Gen under the following conditions,
  - Trigger 1 : (PRC – 3200 MW) – (projected 10min Net Load ramp) + Remaining QSGR capacity < X MW
  - Trigger 2: (10min ramp capacity) – (projected 10min Net Load ramp) < 0 MW
    - ECRS will be deployed when there is lack of 10min ramping capacity.
- Non-Controllable Load Resources that are providing ECRS will be separated into deployment groups as defined in Nodal Protocol Section 6.5.9.4.2 EEA Levels paragraph (2).
  - Non-Controllable Load Resources that are providing ECRS can be deployed during an Emergency Condition either individually, in groups, or as an entire block providing Non-Spin. Deployments that do not encompass an entire block may be done to manage inertia, congestion, or for other local needs.
- If a condition other than those listed above indicates that additional capacity may be needed to manage reliability, operators will evaluate the system condition and deploy ECRS as needed if no other better options are available to resolve the system condition. Under emergency, the emergency process will govern the deployment of ECRS.

Proposed 2023 Ancillary Service Methodology And Preliminary Quantities

ERCOT Staff

Nov 7, 2022
ROS

Stakeholder Discussion Timeline

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

- ✓ October 21, 2022 – WMWG (Proposed Methodology)
- ✓ October 27, 2022 – OWG (Proposed Methodology)
- ✓ October 28, 2022 – PDCWG (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 proposed methodology for computing Ancillary Service (A/S) quantities in 2023.
  - ERCOT is not proposing any changes in the methodologies used to compute Regulation Service and Responsive Reserve Service (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. To align with ERCOT's 2023 IFRO, minimum RRS-PFR limit for 2023 will change to 1,390 MW.
  - ERCOT is proposing some changes in the methodology used to compute minimum Non-Spinning Reserve Service (Non-Spin) requirements in 2023. Specifically,
    - Prior to ECRS: Use 85th to 95th percentile of 10 Hours Ahead (HA) max. net load forecast error
    - After ECRS: Use 75th to 95th percentile of 6 HA hourly avg. net load forecast error
  - Upon its implementation, ERCOT is proposing to compute ECRS requirements as the sum of capacity needed to recover frequency following a large unit trip and capacity needed to support sustained net load ramps.
- 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.
  - Spreadsheets that contain the associated quantities and a redline version of the A/S Methodology document have been posted on today's meeting page.

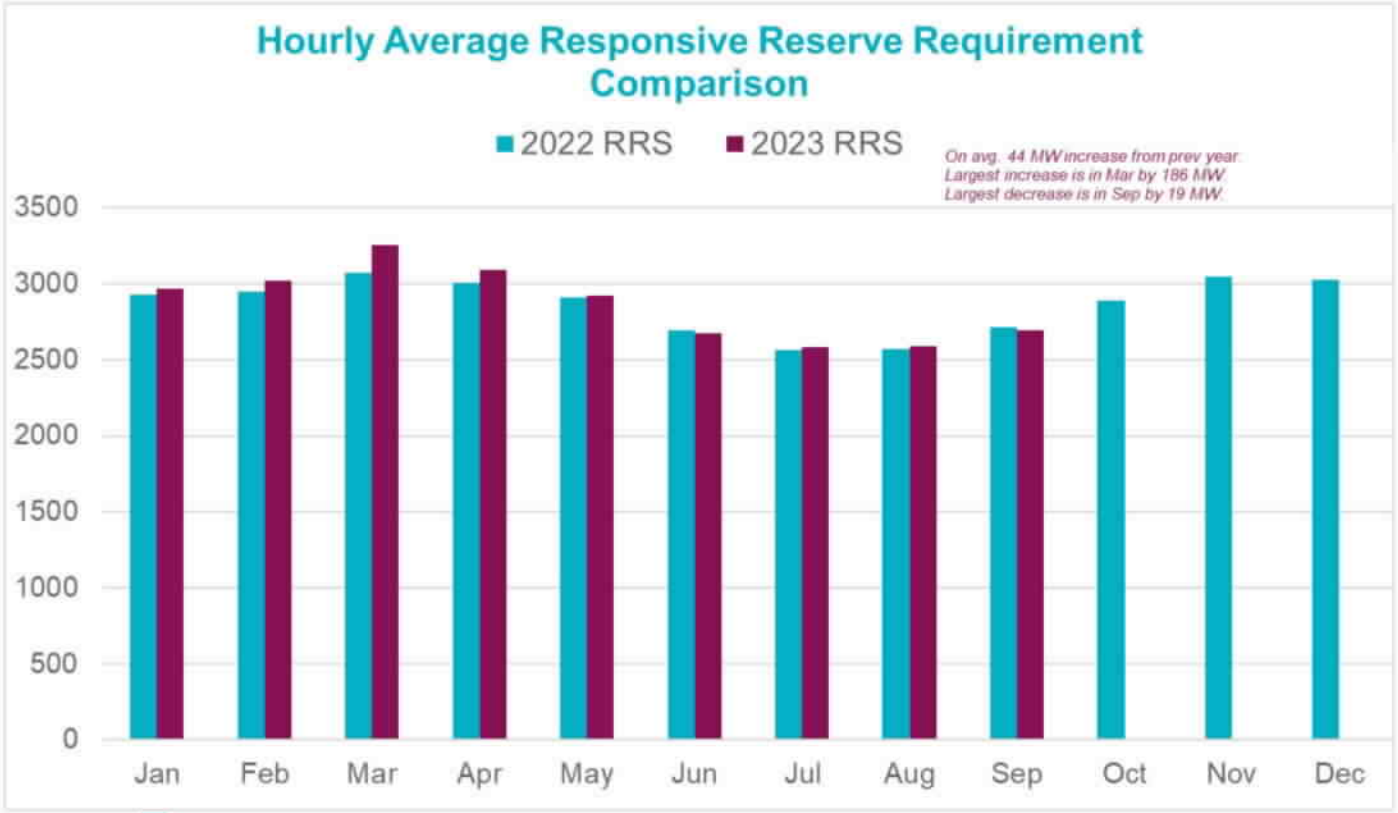
Regulation Service Methodology

- ERCOT is not proposing any change to the methodology used to compute the minimum Regulation Service requirements in 2023.
  - The preliminary Regulation quantities for January 2023 through September 2023 have been computed using 2021 and 2022 five-minute net load variability, updated Wind Adjustment and Solar Adjustment tables*.

*Wind and Solar Adjustment tables track incremental MWs of Regulation needed to account for additional variability per 1000 MW increase in installed wind and solar capacity, respectively.

Responsive Reserve Service (RRS) Methodology

- ERCOT is not proposing any changes to methodology used to compute the minimum RRS requirements for 2023.
  - The preliminary RRS quantities for January 2023 through September 2023 have been computed using 2021 and 2022 system inertia conditions and updated RRS table*.
  - 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. To align with ERCOT's 2023 IFRO, minimum RRS-PFR limit for 2023 will change to 1,390 MW.



*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.

Comparison between ECRS and Non-Spin

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.

	ECRS	Non-Spin
RELIABILITY OBJECTIVE	ECRS may be deployed to a) Help restore the frequency to 60 Hz following 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 intra-hour load/wind/solar forecast that is used in SCED	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

Non-Spinning Reserve Methodology - 2023

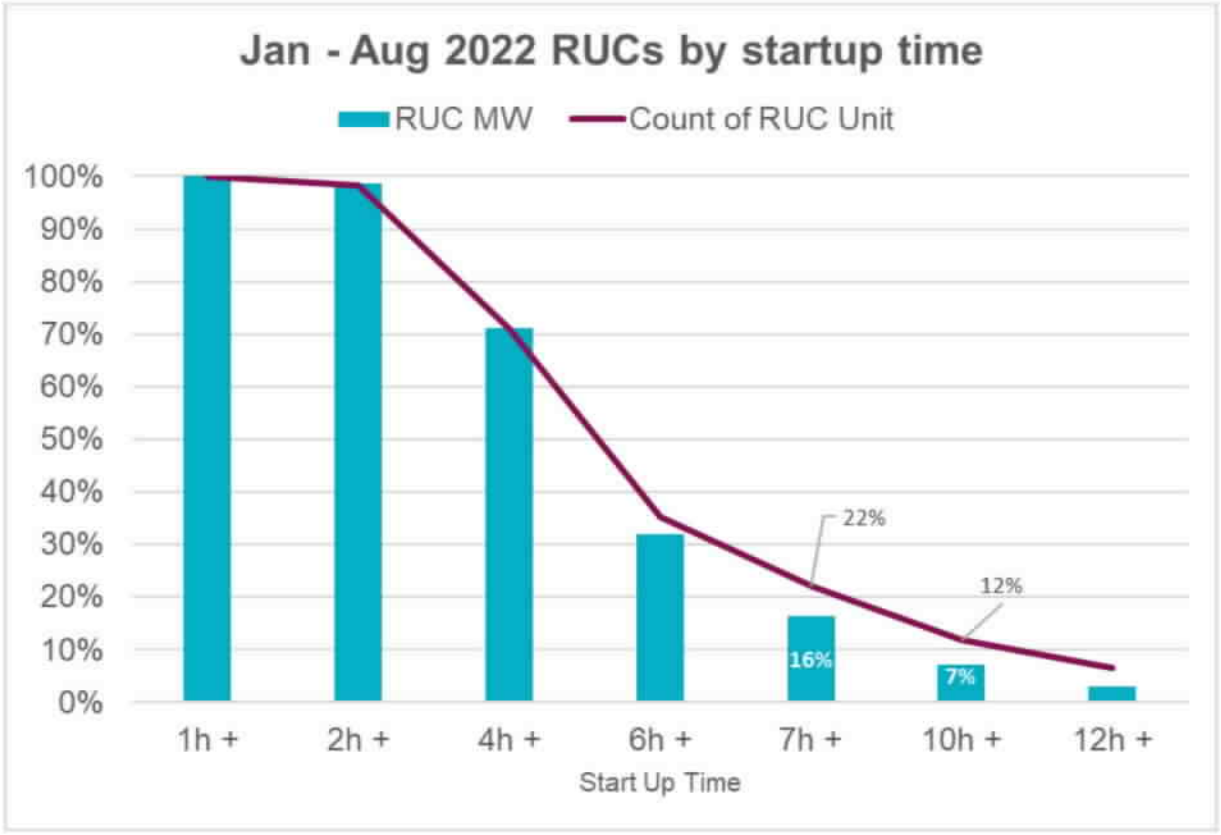
- ERCOT is proposing the following changes in the methodology used to compute minimum Non-Spin requirements in 2023,
  - ***Before ECRS is implemented:*** Use 85th to 95th percentile of 10 HA max. net load forecast error
  - ***After ECRS is implemented:*** Use 75th to 95th percentile of 6 HA hourly avg. net load forecast error

- In 2023, ERCOT will 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.

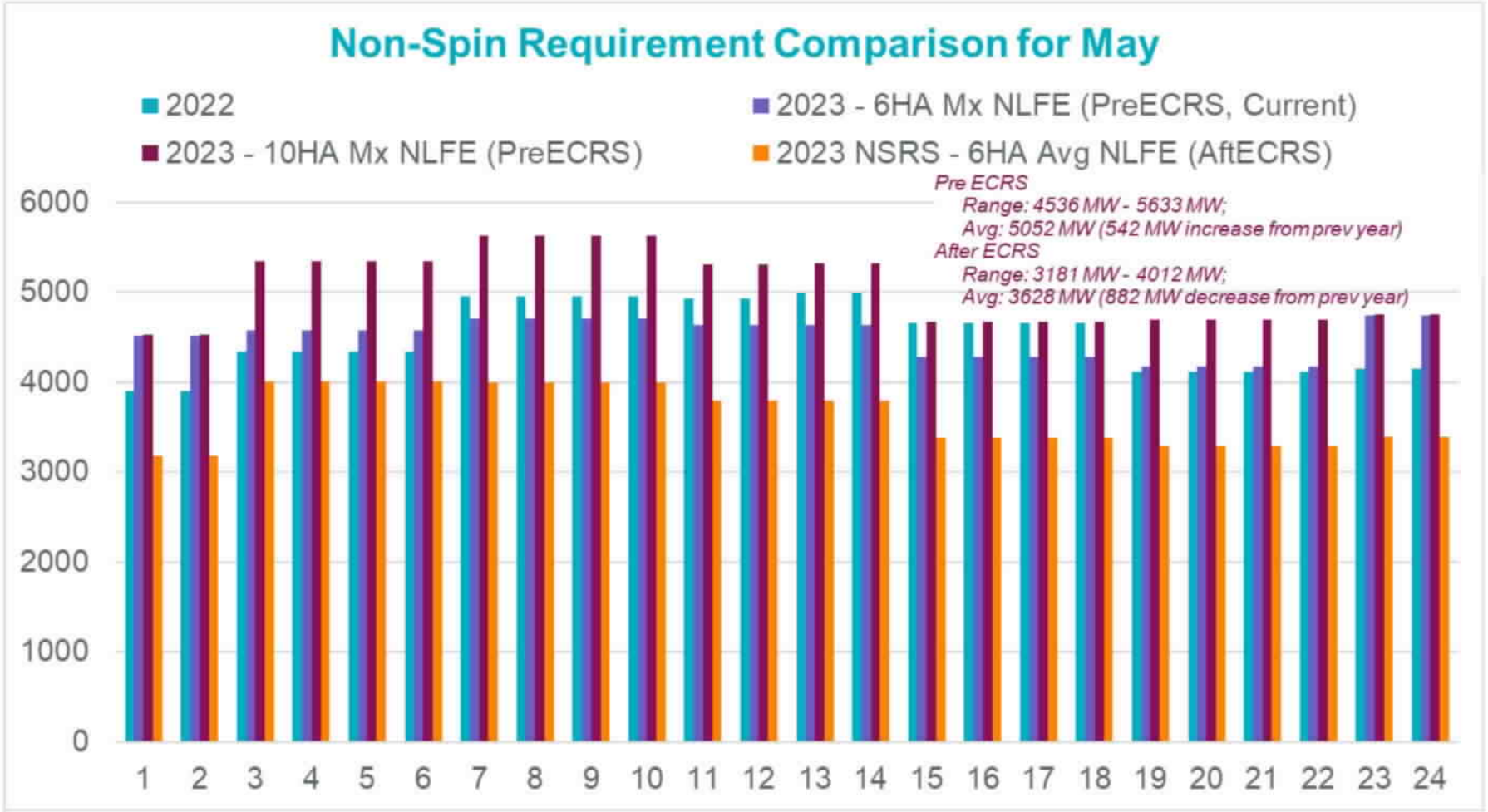
- The preliminary Non-Spin quantities for January 2023 through September 2023 in subsequent slides have been computed using 2020, 2021 and 2022 Net load and Net load Forecast, updated Wind and Solar Over-Forecast Error Adjustment tables and the updated Intra-day Outage table*.

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

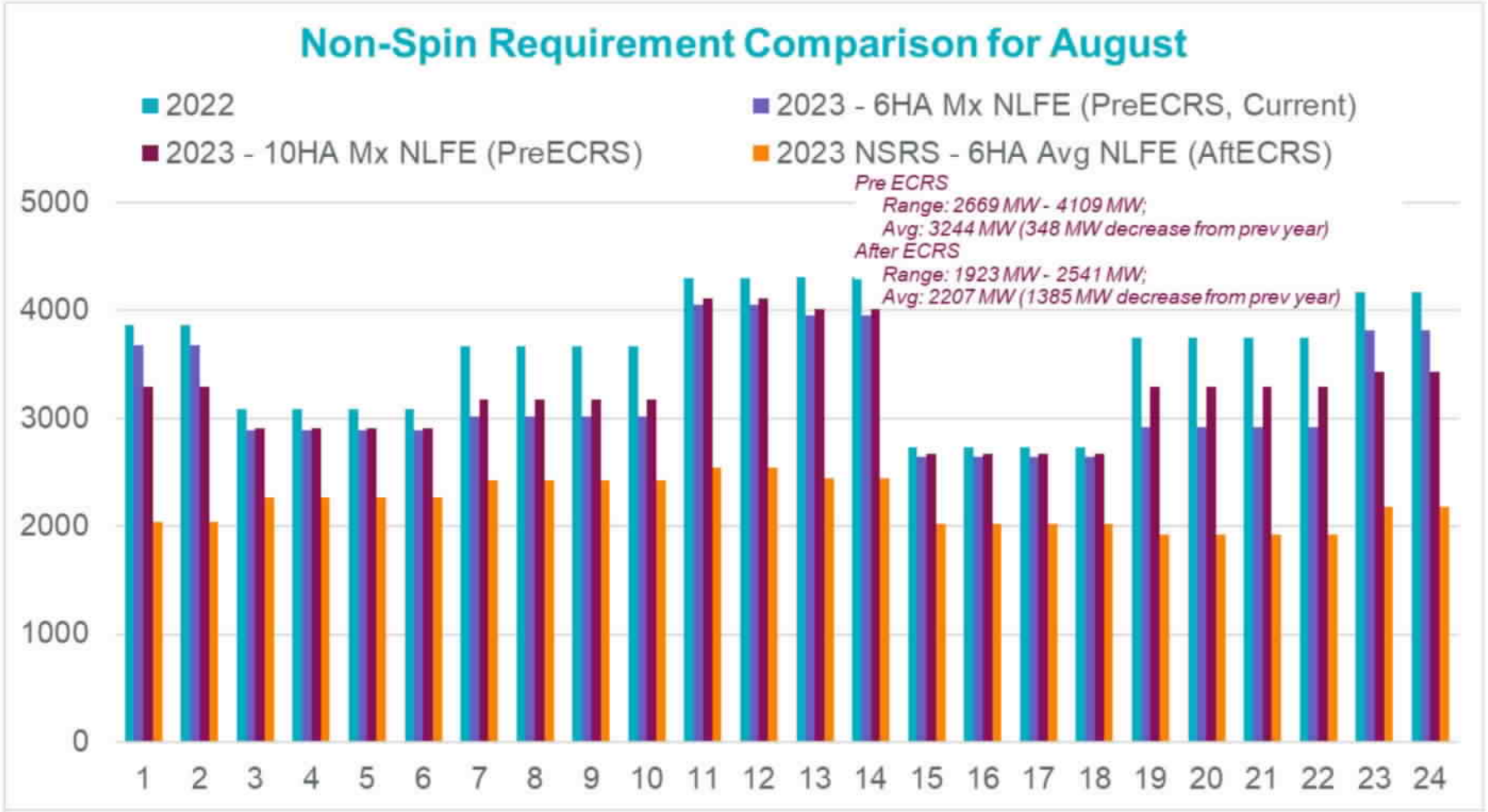
2022 RUCs by Startup Time



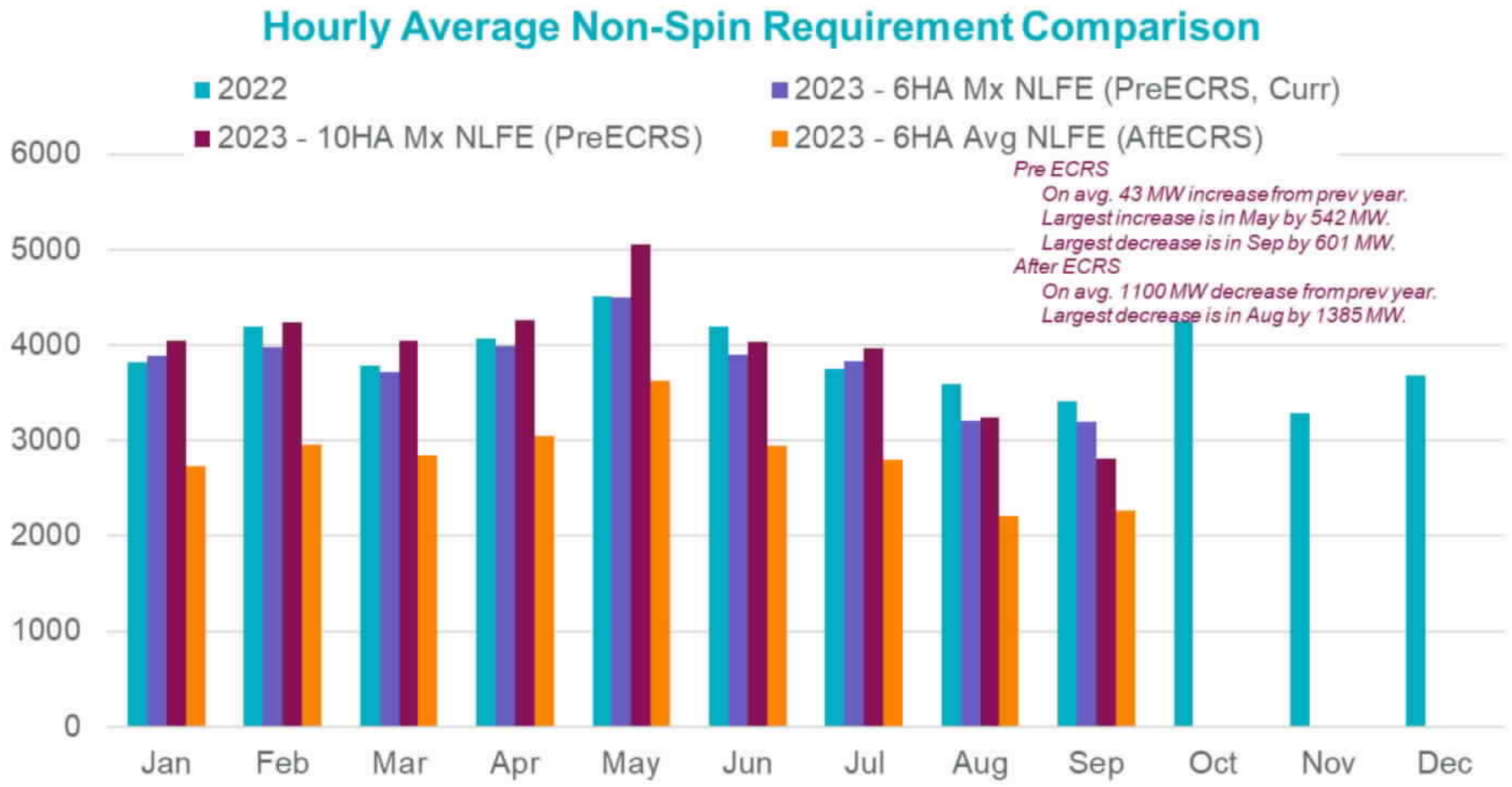
Non-Spin Comparison May



Non-Spin Comparison August



Hourly Average Non-Spin Comparison



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- As work on implementing ECRS in ERCOT systems progresses, ERCOT may further refine the procedure for ECRS deployment.
  - Going forward, ERCOT plans to include a document that summarizes the procedure for ECRS deployment in the A/S Methodology posting.

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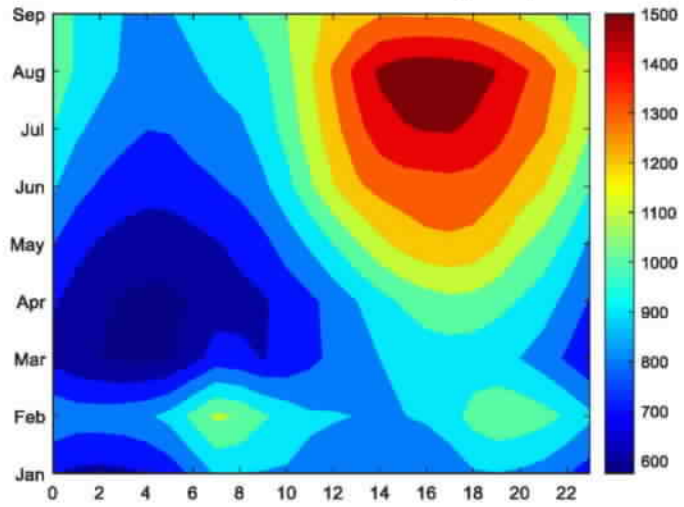

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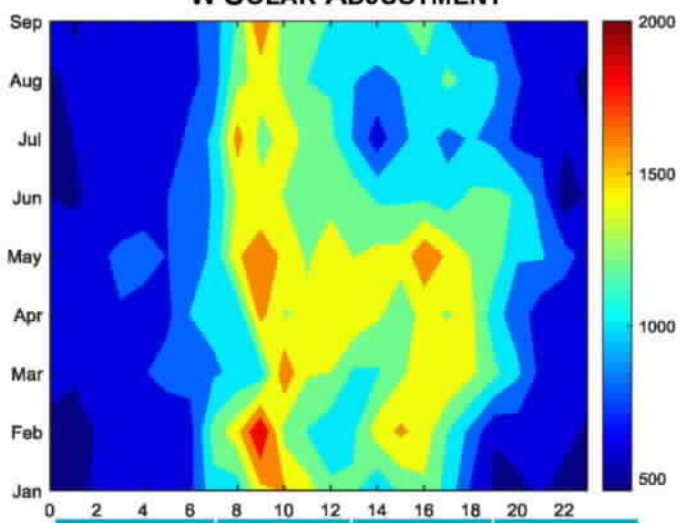

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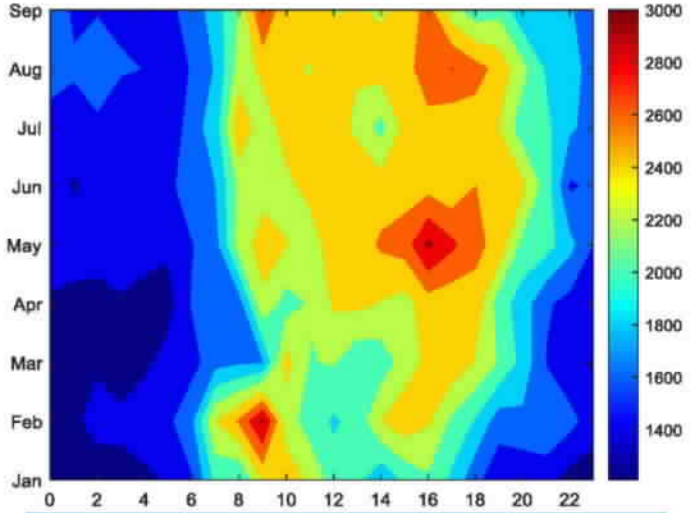

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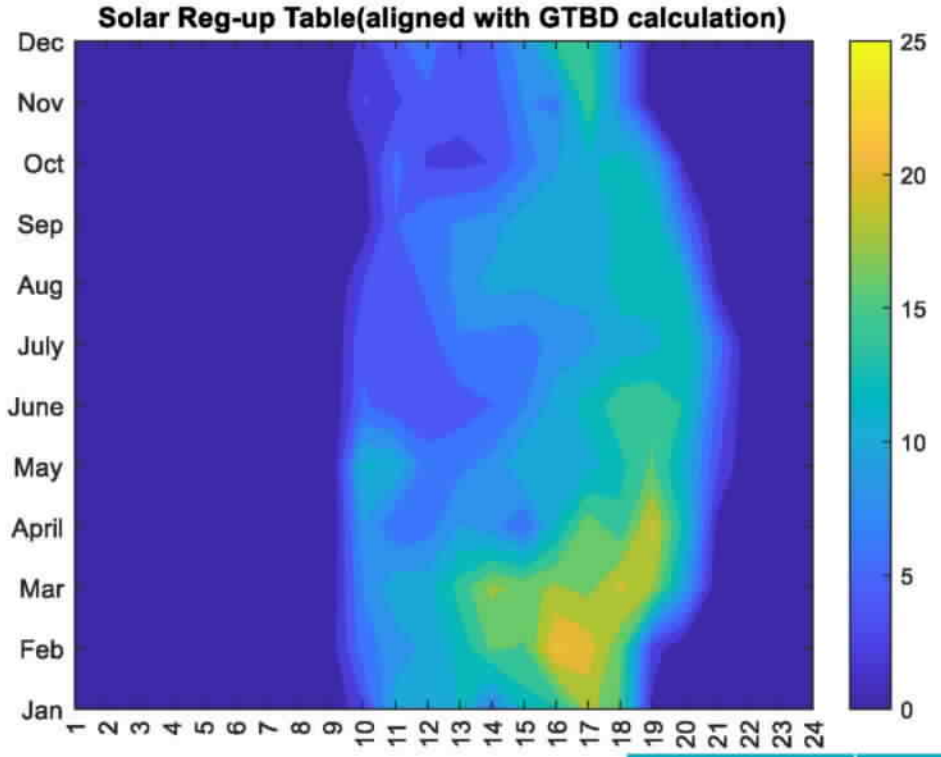

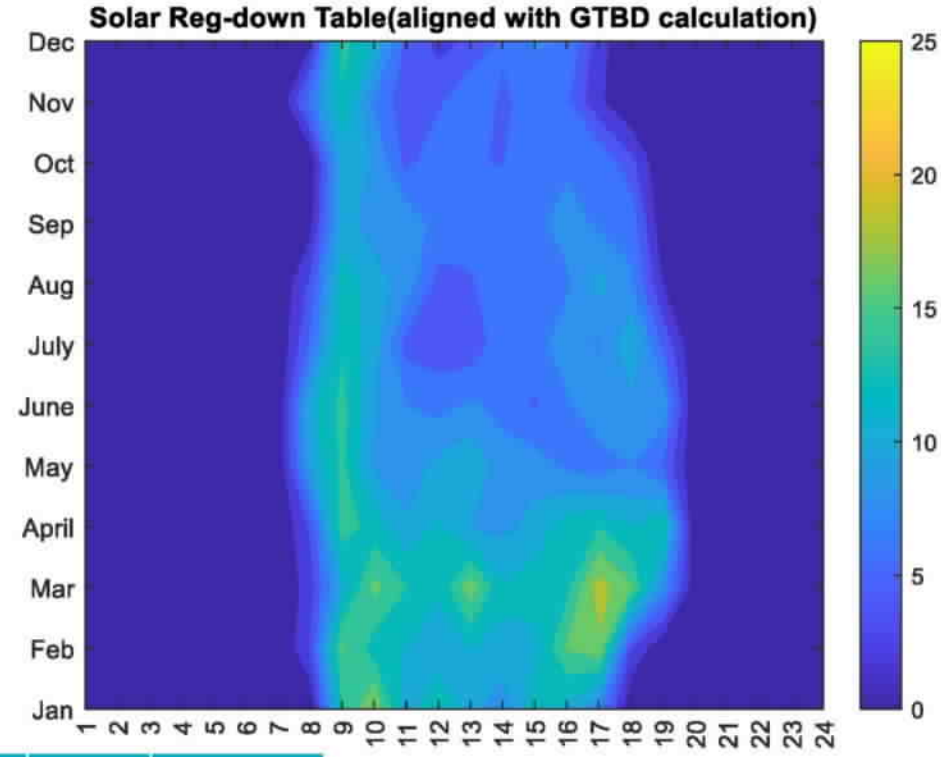

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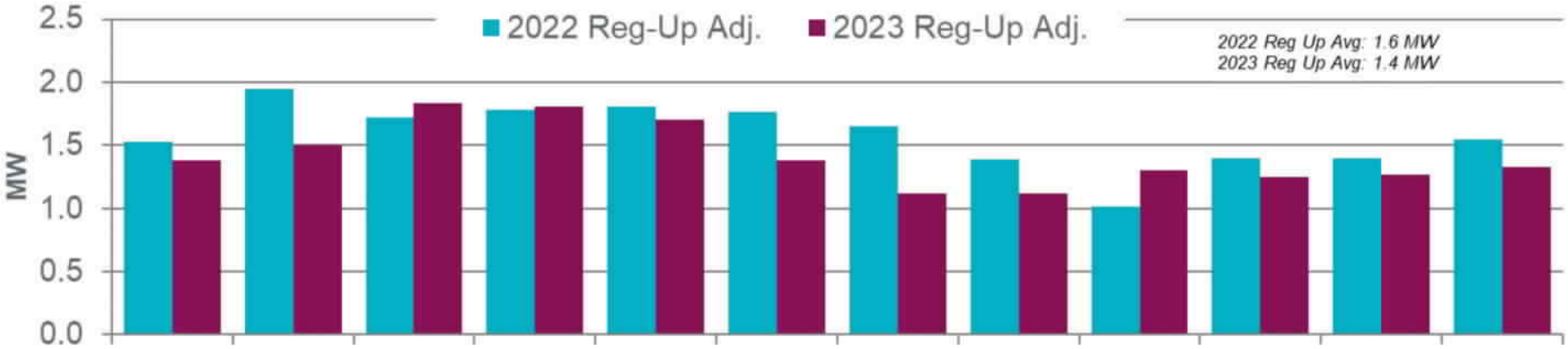
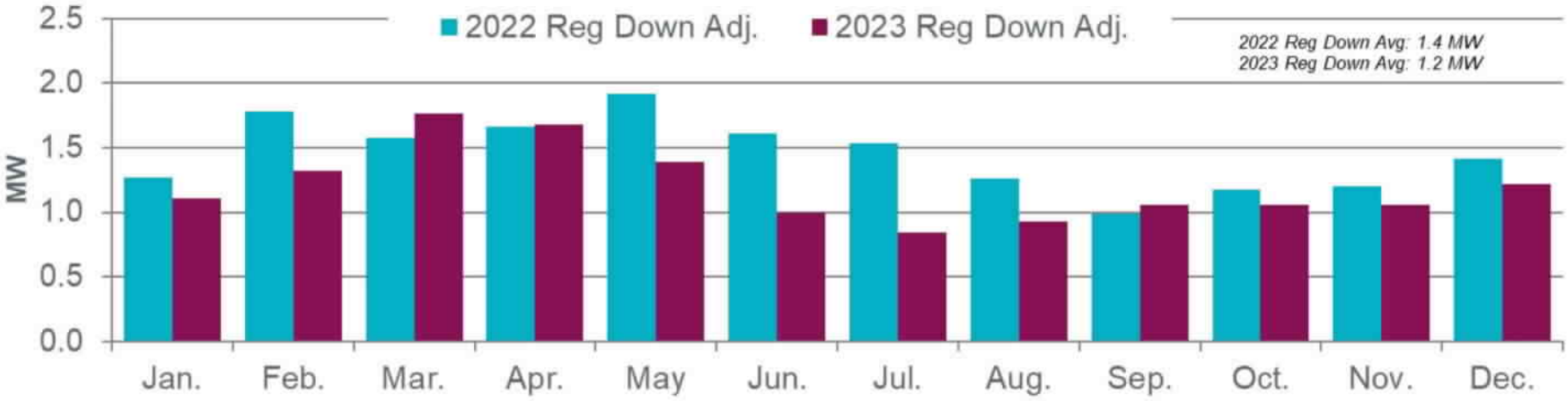


Reg-Down Adjustment per 1000 MW increase in Wind Installed Capacity



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

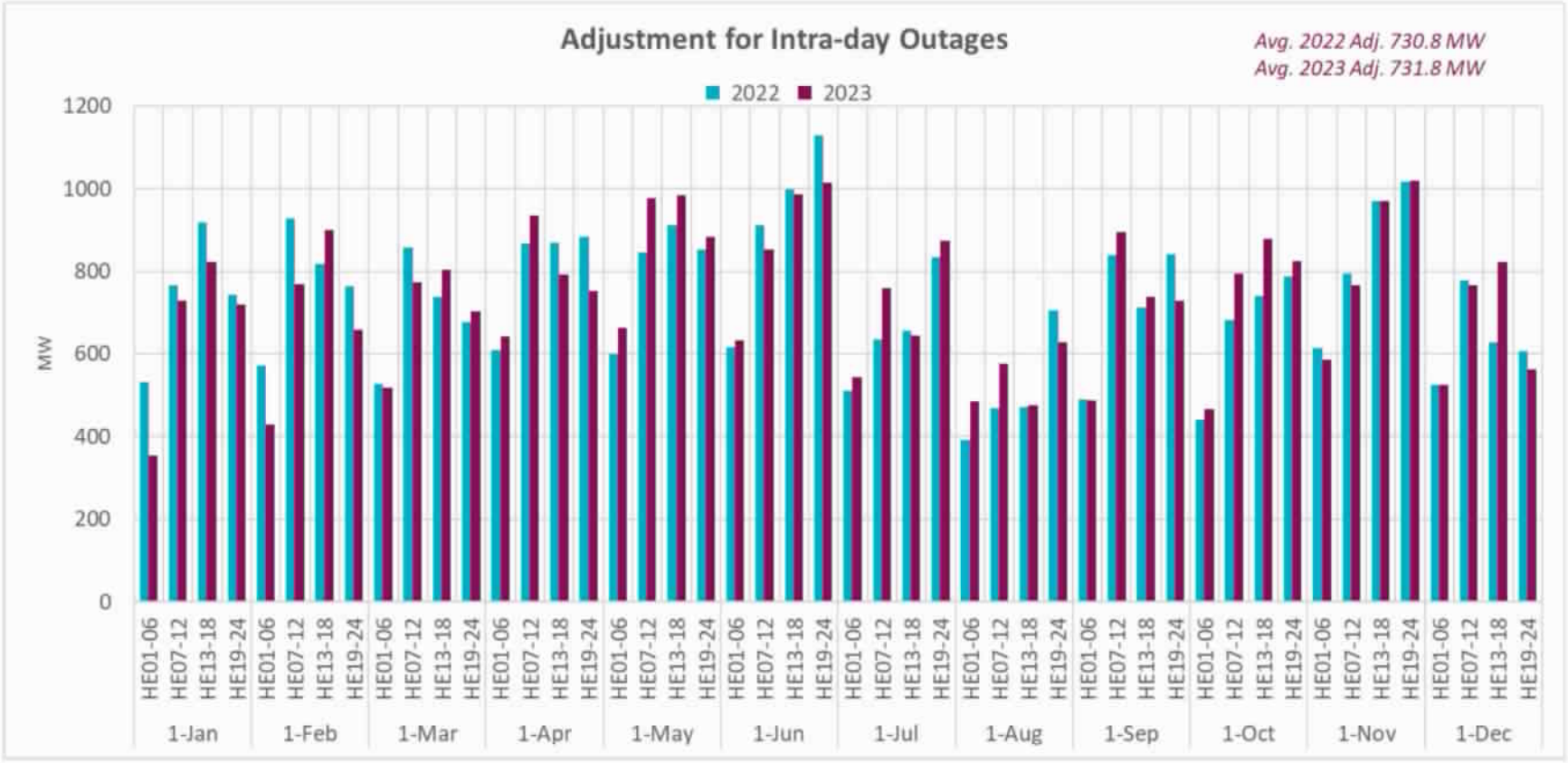
NPRR 1128 | FFR Prioritization during Low Inertia Hours

- If ERCOT comments dated July 15, 2022 on NPRR 1128 are approved and implemented, during certain selected hours when FFR is beneficial in improving reliability, FFR procurement up to FFR limit will be prioritized. In this regard,
  - ERCOT is proposing to use a methodology that selects hours in the last two years wherein 25% of the time the system inertia in a 4-hour block is less than 185 GW·s for FFR prioritization. The hours marked with a "1" in the table below represent hours for FFR prioritization.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1	1	1	1	0	0	0	0	0	1	1	1
2	1	1	1	1	0	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	1	1	1	1	1	0	0	0	0	1	1	1
6	1	1	1	1	1	0	0	0	0	1	1	1
7	0	1	1	1	0	0	0	0	0	0	1	1
8	0	1	1	1	0	0	0	0	0	0	1	1
9	0	1	1	1	0	0	0	0	0	0	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	1
15	0	1	1	1	0	0	0	0	0	0	0	0
16	0	1	1	1	0	0	0	0	0	0	0	0
17	0	1	1	1	0	0	0	0	0	0	0	0
18	0	1	1	1	0	0	0	0	0	0	0	0
19	0	1	1	1	0	0	0	0	0	0	1	1
20	0	1	1	1	0	0	0	0	0	0	1	1
21	0	1	1	1	0	0	0	0	0	0	1	1
22	0	1	1	1	0	0	0	0	0	0	1	1
23	1	1	1	1	0	0	0	0	0	1	1	1
24	1	1	1	1	0	0	0	0	0	1	1	1

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.



ECRS 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	0	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	0	25	21	16
Aug	0	0	0	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: 64 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	0	0	0	0	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	0	0	0	0	150	150	150	150	124	124	124	124	96	96	96	96	0	0
Aug	0	0	0	0	0	0	0	0	0	0	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

ECRS Deployment/Release Conditions

- ERCOT will deploy ECRS-Gen i.e. ECRS from SCED Dispatchable Resources when frequency drops below 59.91 Hz and available Reg-Up is not sufficient to restore frequency.
- ERCOT may deploy ECRS-Gen under the following conditions,
  - Trigger 1 : (PRC – 3200 MW) – (projected 10min Net Load ramp) + Remaining QSGR capacity < X MW
  - Trigger 2: (10min ramp capacity) – (projected 10min Net Load ramp) < 0 MW
    - ECRS will be deployed when there is lack of 10min ramping capacity.
- Non-Controllable Load Resources that are providing ECRS will be separated into deployment groups as defined in Nodal Protocol Section 6.5.9.4.2 EEA Levels paragraph (2).
  - Non-Controllable Load Resources that are providing ECRS can be deployed during an Emergency Condition either individually, in groups, or as an entire block providing Non-Spin. Deployments that do not encompass an entire block may be done to manage inertia, congestion, or for other local needs.
- If a condition other than those listed above indicates that additional capacity may be needed to manage reliability, operators will evaluate the system condition and deploy ECRS as needed if no other better options are available to resolve the system condition. Under emergency, the emergency process will govern the deployment of ECRS.

Proposed 2023 Ancillary Service Methodology And Preliminary Quantities

ERCOT Staff

Dec 5, 2022
TAC

Stakeholder Discussion Timeline

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

- ✓ October 21, 2022 – WMWG (Proposed Methodology)
- ✓ October 27, 2022 – OWG (Proposed Methodology)
- ✓ October 28, 2022 – PDCWG (Proposed Methodology)

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

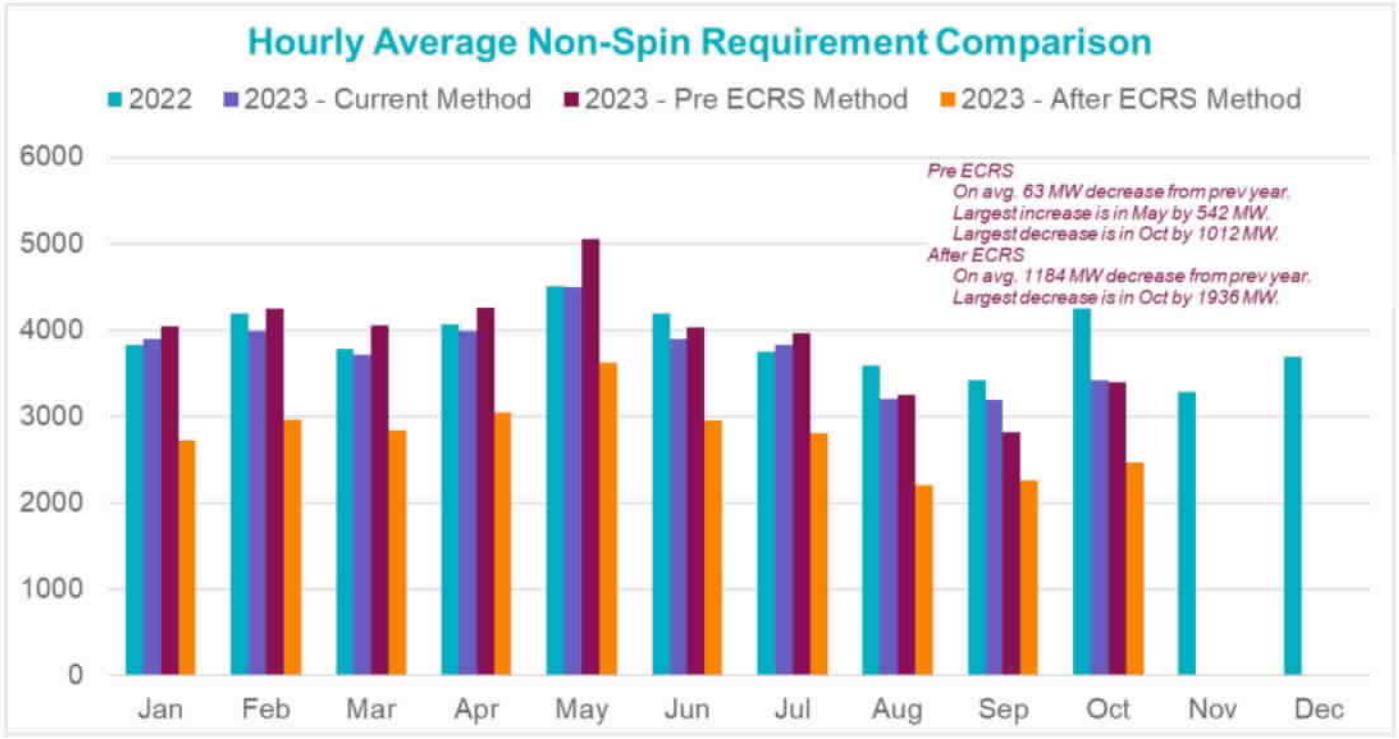
- December 5, 2022 - TAC
- December 20, 2022 – BoD

Introduction

- This presentation will provide a summary of the proposed methodology for computing Ancillary Service (A/S) quantities in 2023.
  - ERCOT is not proposing any changes in the methodologies used to compute Regulation Service and Responsive Reserve Service (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. To align with ERCOT's 2023 IFRO, minimum RRS-PFR limit for 2023 will change to 1,390 MW.
  - ERCOT is proposing some changes in the methodology used to compute minimum Non-Spinning Reserve Service (Non-Spin) requirements in 2023. Specifically,
    - Prior to ECRS: Use 85th to 95th percentile of 10 Hours Ahead (HA) max. net load forecast error
    - After ECRS: Use 75th to 95th percentile of 6 HA hourly avg. net load forecast error
  - Upon its implementation, ERCOT is proposing to compute ECRS requirements as the sum of capacity needed to recover frequency following a large unit trip and capacity needed to support sustained net load ramps.
    - Per the Nov 11 PRS | Project Update, ECRS is currently scheduled for 2023 R3 (5/23 – 5/25) release.
- Spreadsheets that contain the preliminary quantities for 2023 computed using the proposed methodology and a redline version of the A/S Methodology document have been posted on today's meeting page.

Non-Spinning Reserve Methodology - 2023

- ERCOT is proposing changes in the methodology used to compute minimum Non-Spin requirements in 2023,
  - ***Before ECRS is implemented:*** Use 85th to 95th percentile of 10 HA max. net load forecast error
  - ***After ECRS* is implemented:*** Use 75th to 95th percentile of 6 HA hourly avg. net load forecast error
  - The preliminary Non-Spin quantities have been computed using 2020, 2021 and 2022 Net load and Net load Forecast, updated Wind and Solar Over-Forecast Error Adjustment tables and the updated Intra-day Outage table**.

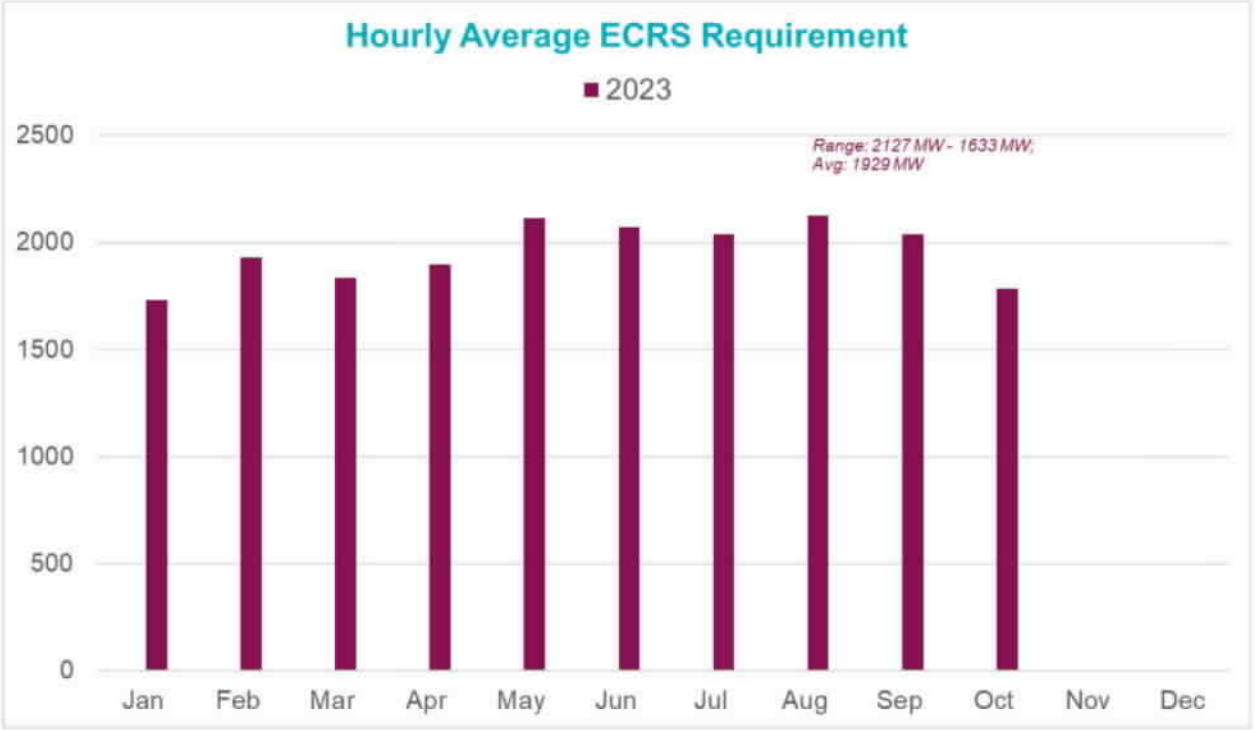


  - Lastly, in 2023, ERCOT will continue the practice of monitoring the weather near Real Time and may procure up to an additional 1,000 MW of Non-Spin for specific Operating Hours.

*Note that per the Nov 11 PRS | Project Update, ECRS is currently scheduled for 2023 R3 (5/23 – 5/25) release.
**Wind and Solar Over-Forecast Error Adjustment Table track estimated increase in wind and solar over forecast error per 1000 MW increase in installed wind and solar capacity, respectively. The Intra-day Outage table accounts for increased capacity needs following forced outages of thermal resources within an operating day.

ECRS Requirements Methodology - 2023

- In 2023, ERCOT is proposing to compute ECRS requirements as the sum of capacity needed to
  - Recover Frequency following a large unit trip:
    - For various inertia levels, a medium-sized supply-side resource is tripped such that frequency nadir is just above 59.7 Hz and amount of response needed to return frequency to 59.98 Hz is determined.
  - Support Intra-Hour Net Load Forecast errors:
    - 85th – 95th percentile of 30-minute ahead intra-hour netload forecast errors for last two years. The percentile is associated with the risk of net load ramp. The larger the netload ramp, the higher the percentile.
    - An additional adjustment will be included to account for the impact of increase in the solar generation installed capacity on the intra hour net load forecast error.



*Note that per the Nov 11 PRS | Project Update, ECRS is currently scheduled for 2023 R3 (5/23 – 5/25) release.
**Solar Intra-Hour Over-Forecast Error Adjustment Table track estimated increase in solar over forecast error per 1000 MW increase in installed solar capacity.

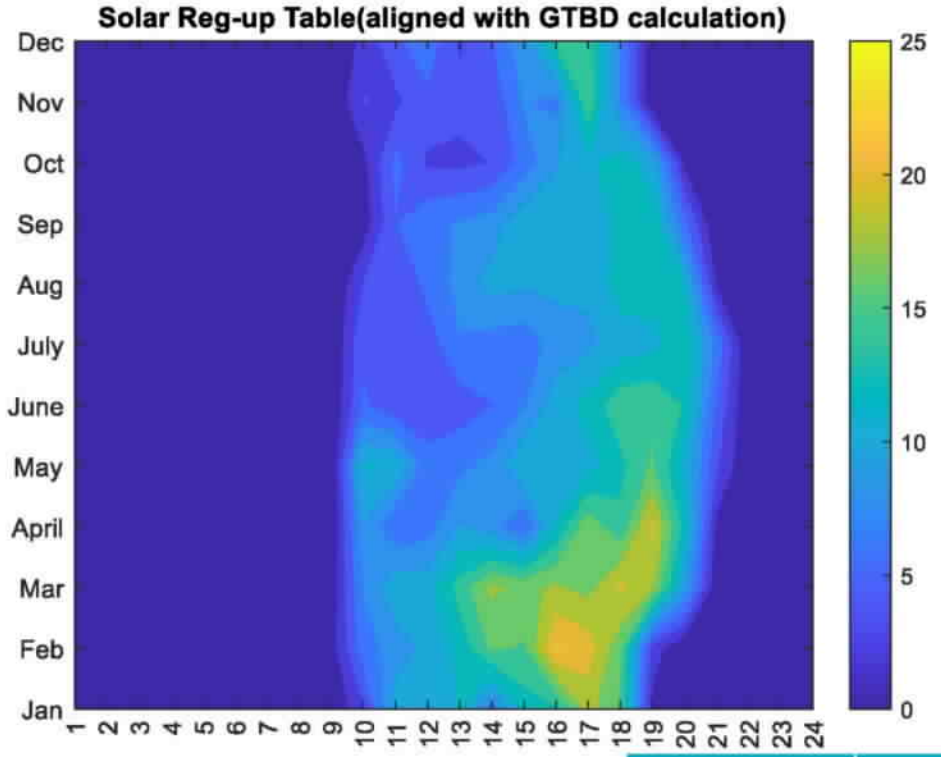
Summary

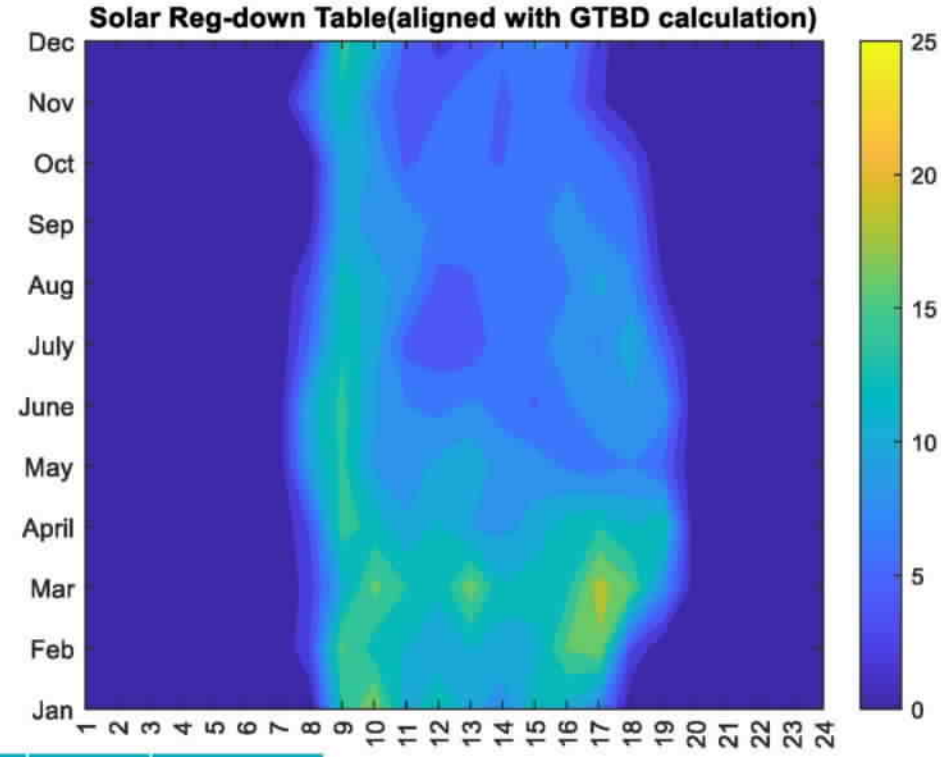
- In summary,
  - ERCOT is not proposing any changes in the methodologies used to compute Regulation Service and RRS requirements for 2023.
  - To align with in ERCOT's 2023 IFRO, minimum RRS-PFR limit for 2023 will change to 1,390 MW.
  - ERCOT is proposing changes in the methodology used to compute minimum Non-Spin requirements in 2023. Specifically,
    - Prior to ECRS: Use 85th to 95th percentile of 10 Hours Ahead (HA) max. net load forecast error
    - After ECRS: Use 75th to 95th percentile of 6 HA hourly avg. net load forecast error
  - Upon its implementation, ERCOT is proposing to compute ECRS requirements as the sum of capacity needed to recover frequency following a large unit trip and capacity needed to support sustained net load ramps.
- ERCOT is requesting TAC's endorsement of the 2023 A/S Methodology.

SUGGESTIONS?

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. *The methodology for 2023 Solar Adjustment tables has been updated to better align it with how 5-minute wind and solar forecasted ramps are currently used in operations.*



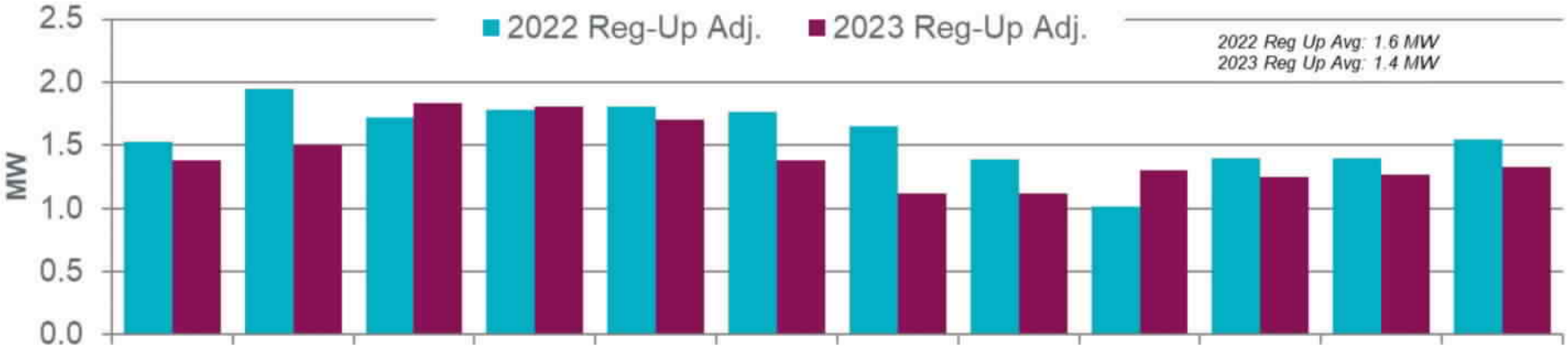


	Min (MW)	Max (MW)	Average (MW)
Reg Up	0	25.4	9.9
Reg Down	0	22.4	8.2

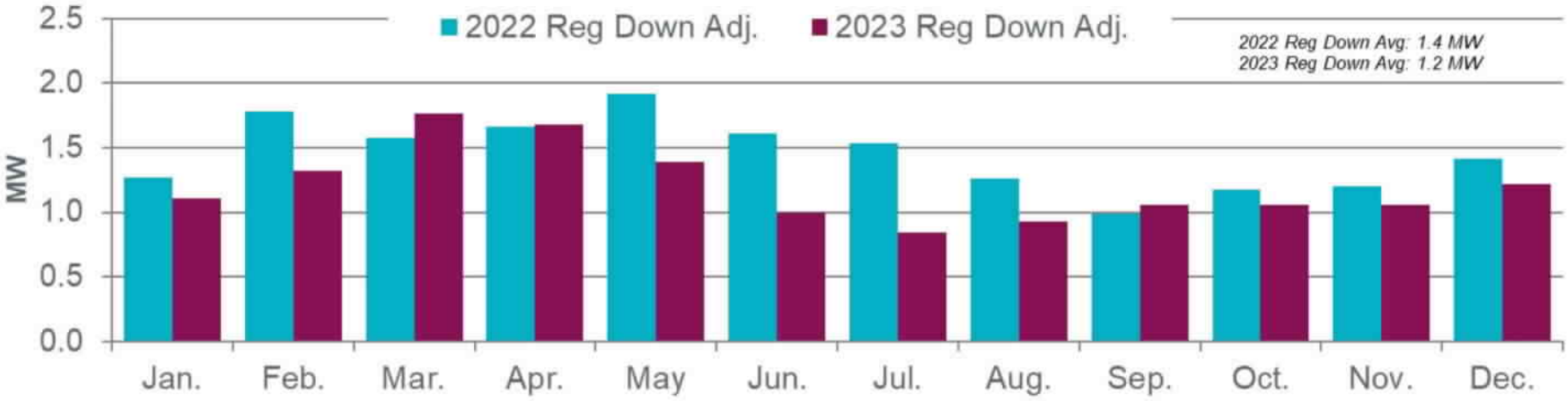
2023 Wind Adjustment Tables

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

Reg-Up Adjustment per 1000 MW increase in Wind Installed Capacity

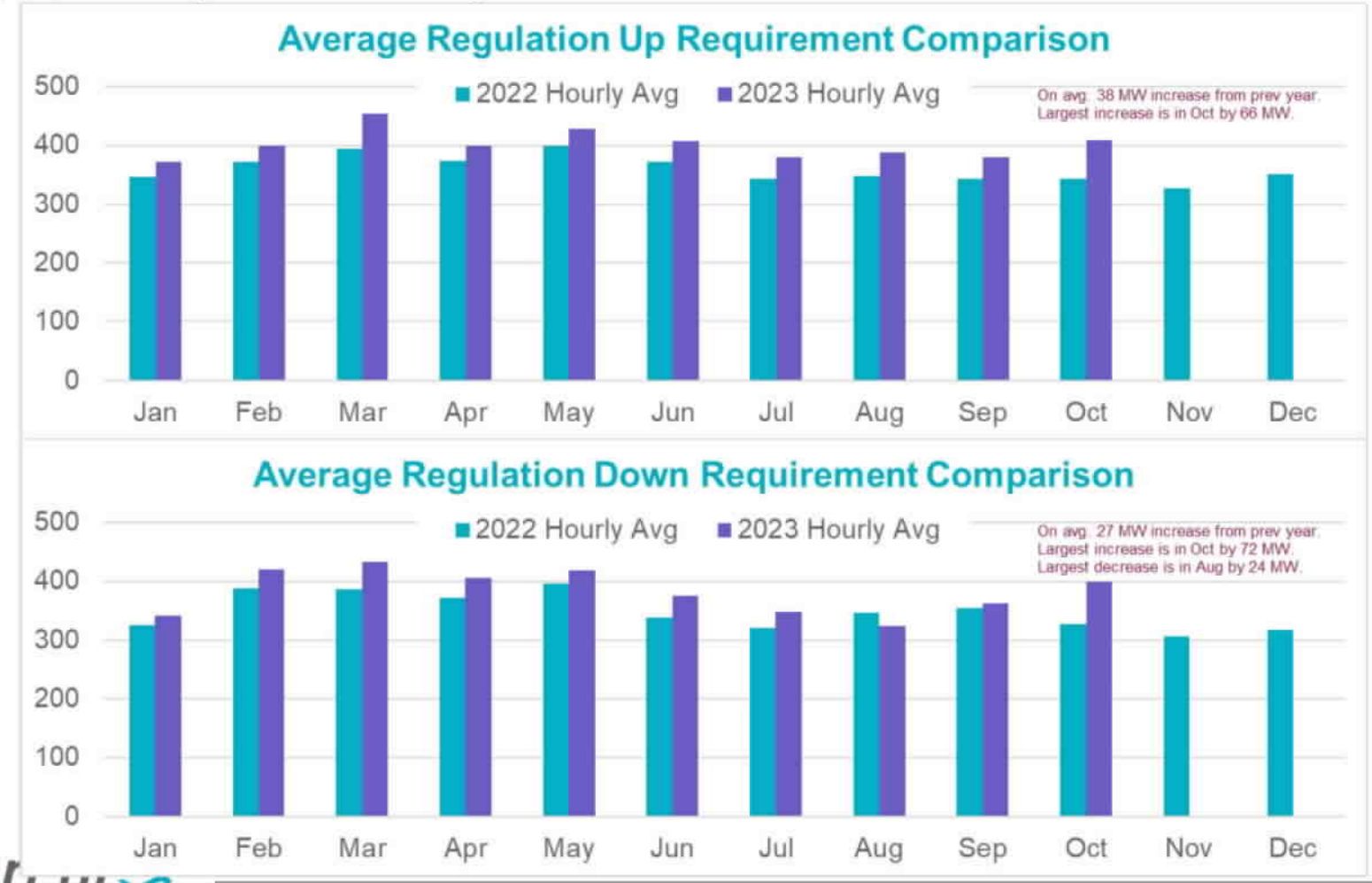


Reg-Down Adjustment per 1000 MW increase in Wind Installed Capacity



Regulation Service Methodology

- ERCOT is not proposing any change to the methodology used to compute the minimum Regulation Service requirements in 2023.
  - The preliminary Regulation quantities have been computed using 2021 and 2022 five-minute net load variability, updated Wind Adjustment and Solar Adjustment tables*.



*Wind and Solar Adjustment tables track incremental MWs of Regulation needed to account for additional variability per 1000 MW increase in installed wind and solar capacity, respectively.

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
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PFR Req. (no LR) (MW)	5960	5563	5200	4892	4622	4329	4114	3920	3744	3522	3314	3139
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**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*
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*RRS quantity is calculated for RCC of 2805 with limit of 60% limit on LRs and min RRS-PFR limit of 1,240 MW.

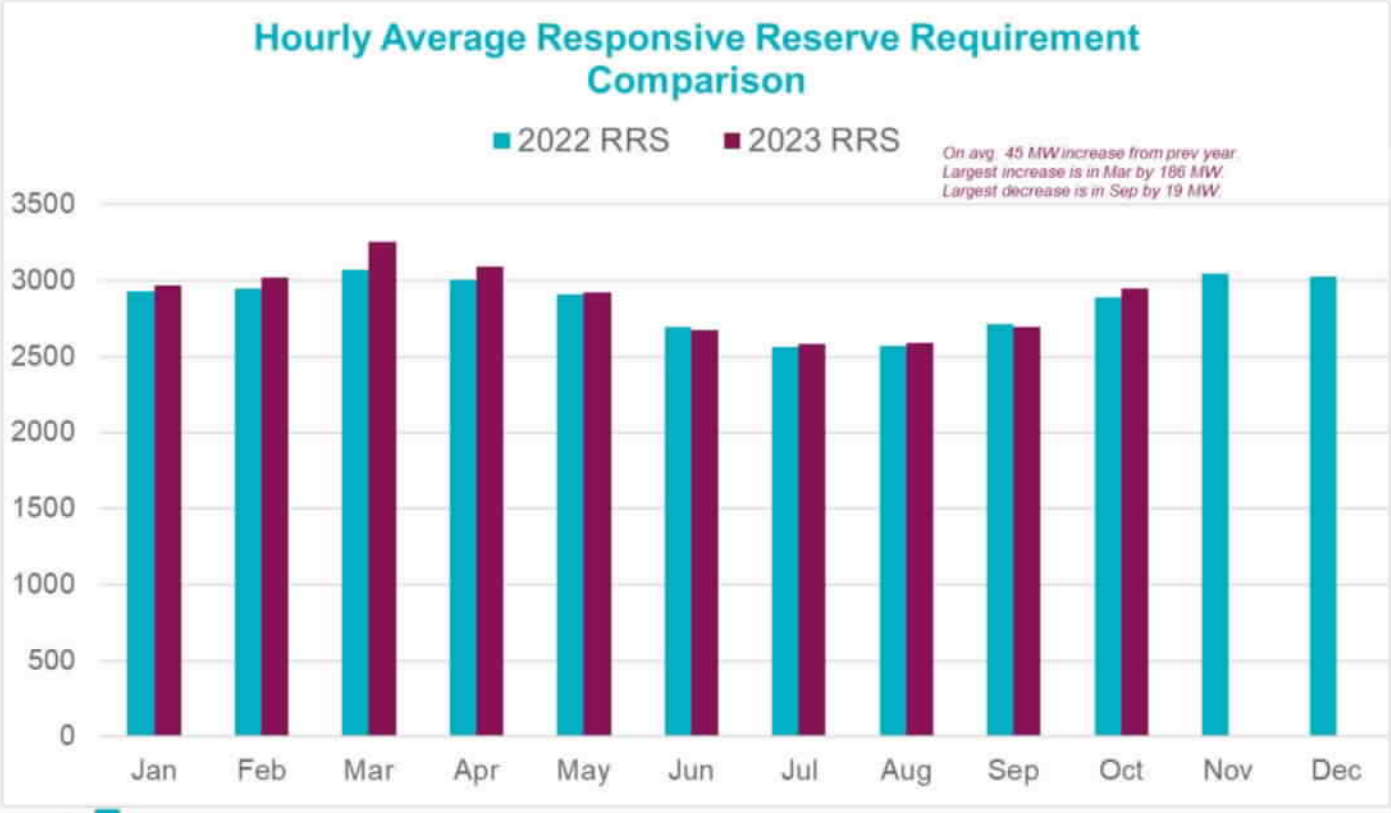
**RRS quantity is calculated for RCC of 2805 with limit of 60% limit on LRs and min RRS-PFR limit of 1,390 MW.

***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

Responsive Reserve Service (RRS) Methodology

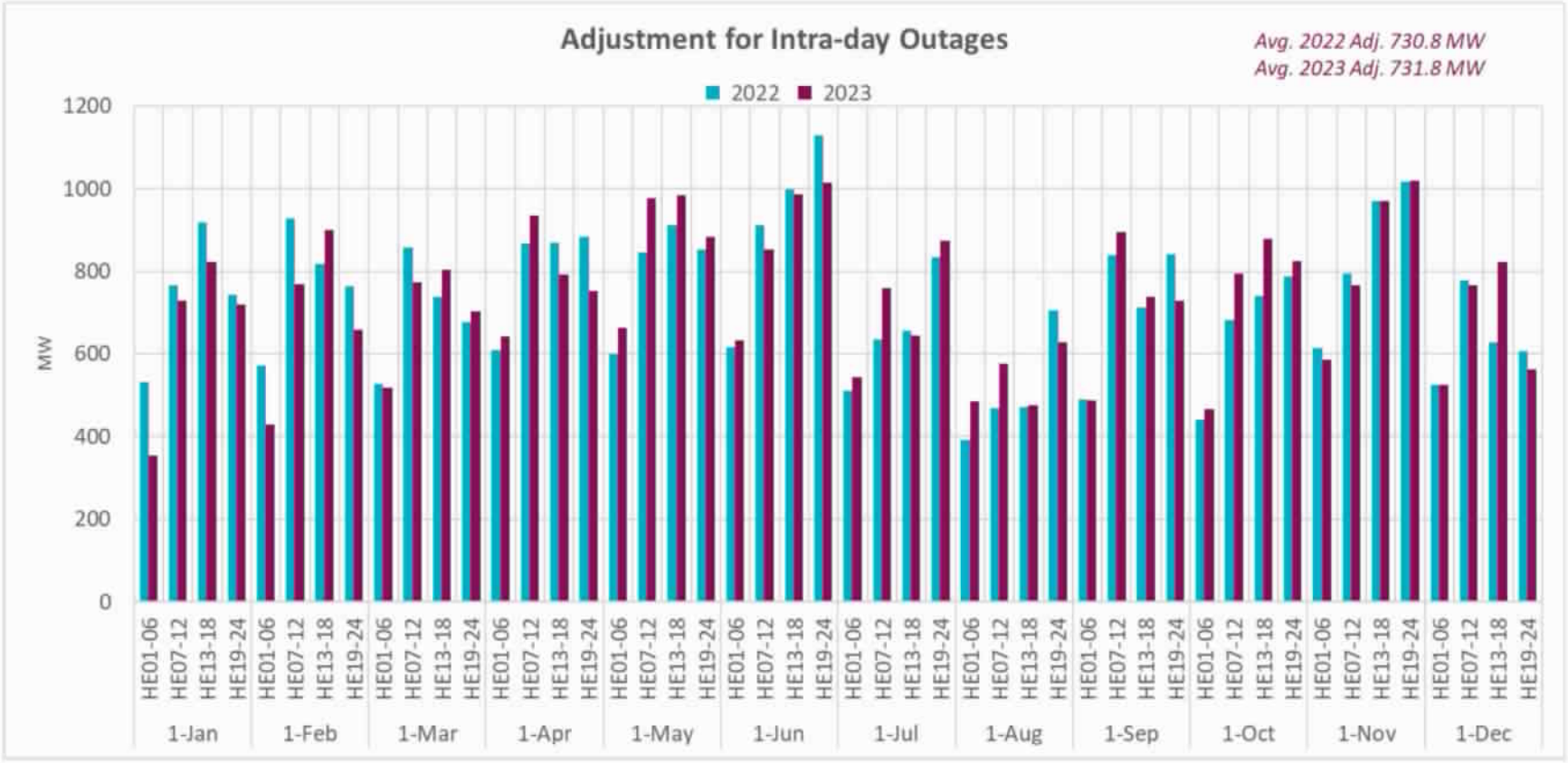
- ERCOT is not proposing any change to methodology used to compute the minimum RRS requirements for 2023.
  - The preliminary RRS quantities have been computed using 2021 and 2022 system inertia conditions and updated RRS table*.
  - NERC's preliminary BAL-003 Interconnection Frequency Response Obligation (IFRO) for Operating Year (OY) 2023 assessment for ERCOT shows an increase in ERCOT's IFRO. To align with ERCOT's 2023 IFRO, minimum RRS-PFR limit for 2023 will change to 1,390 MW.



*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.

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.



ECRS 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	0	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	0	25	21	16
Aug	0	0	0	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: 64 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	0	0	0	0	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	0	0	0	0	150	150	150	150	124	124	124	124	96	96	96	96	0	0
Aug	0	0	0	0	0	0	0	0	0	0	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

PUCT
Judicial Notice
Item No. 17

Version 2.0

TAC Motion: To approve the Combined Ballot as presented (detailed on the "Ballot Details" tab)

Date: December 5, 2022

Prepared by: Cory Phillips

Tally Votes | Clear | Record Vote

TALLY TOTAL

Voting Structure	Motion Passes		Total Abstentions
TAC	2/3 of non-abst TAC Votes = 19		
TAC Vote:	28	0	1
	100%	0%	

Sector / Entity		Representative	Present	Yes	No	Abstain
Consumers	Divide Subsegments? n	**Consumer Vote Total**	1			
City of Eastland	Comm	Mark Dreyfus	y	1		
City of Dallas	Comm	Nick Fehrenbach (Mark Dreyfus)	y	1		
CMC Steel Texas (CMC Steel)	Indu	Garret Kent (Bill Smith)	y	1		
Air Liquide	Indu	Bill Smith	y	1		
Residential Consumer	Resi	Eric Goff	y	1		
Office of Public Utility Counsel (OPUC)	Resi	Nabaraj Pokharel	y	1		
		Segment Vote:	6	6	0	0
Cooperatives						
South Texas Electric Cooperative (STEC)		Clif Lange	y	1		
Golden Spread Electric Cooperative (GSEC)		Mike Wise	y	1		
Lower Colorado River Authority (LCRA)		Emily Jolly	y	1		
Pedernales Electric Cooperative (PEC)		Christian Powell	y	1		
		Segment Vote:	4	4	0	0
Independent Generators						
ENGIE		Bob Helton (Caitlin Smith)	y	1		
Luminant Generation (Luminant)		Ian Haley	y	1		
Calpine Corporation (Calpine)		Bryan Sams	y	1		
Jupiter Power		Caitlin Smith	y	1		
		Segment Vote:	4	4	0	0
Independent Power Marketers						
DC Energy		Seth Cochran	y	1		
Tenaska Power Services (Tenaska)		Jeremy Carpenter	y	1		
Shell Energy North America (SENA)		Resmi Surendran (Seth Cochran)	y	1		
National Grid Renewables (NG Reneweables)		Kevin Hanson	y	1		
		Segment Vote:	4	4	0	0
Independent Retail Electric Providers						
Reliant Energy Retail Services (Reliant)		Bill Barnes	y			a
Demand Control 2		Chris Hendrix	y	1		
AP Gas & Electric (APG&E)		Jay Harpole	y	1		
Rhythm Ops		Jennifer Schmitt	y	1		
		Segment Vote:	4	3	0	1
Investor Owned Utilities						
Oncor Electric Delivery (Oncor)		Collin Martin	y	1		
Texas-New Mexico Power Company (TNMP)		Keith Nix	y	1		
AEP Service Corporation (AEPSC)		Richard Ross	y	1		
CenterPoint Energy (CNP)		Eric Easton	y	1		
		Segment Vote:	4	4	0	0
Municipals						
Garland Power & Light (GP&L)		Dan Bailey				
Denton Municipal Electric (DME)		Jose Gaytan (Bob Wittmeyer)	y	1		
Austin Energy		Alicia Loving	y	1		
CPS Energy		David Kee	y	1		
		Segment Vote:	3	3	0	0
All Sectors Voting Totals						**Total**
		Segment Vote:	**29**	28	0	1

To approve the October 26, 2022 Meeting Minutes as presented
NPRR1132 - To recommend approval of NPRR1132 as recommended by PRS in the 11/11/22 PRS Report as amended by the 12/2/22 ERCOT comments
NPRR1138 - To recommend approval of NPRR1138 as recommended by PRS in the 11/11/22 PRS Report as amended by the 11/30/22 ERCOT comments
NPRR1152 - To recommend approval of NPRR1152 as recommended by PRS in the 11/11/22 PRS Report with a proposed effective date of January 20, 2023 (following PUCT approval)
NPRR1154 - To recommend approval of NPRR1154 as recommended by PRS in the 11/11/22 PRS Report and the 11/29/22 Impact Analysis with a recommended priority of 2023 and rank of 3770
NPRR1128 - To endorse the 10/31/22 ERCOT comments for NPRR1128
OBDRR043 - To endorse the 11/23/22 ERCOT comments for OBDRR043
RRGRR032 - To recommend approval of RRGRR032 as recommended by ROS in the 11/7/22 ROS Report as amended by the 12/2/22 ERCOT comments
NOGRR226 - To recommend approval of NOGRR226 as recommended by ROS in the 11/7/22 ROS Report as amended by the 11/30/22 ERCOT comments as revised by TAC; with a proposed effective date of January 20, 2023 (following PUCT approval)
NOGRR243 - To recommend approval of NOGRR243 as recommended by ROS in the 11/7/22 ROS Report as revised by TAC and the 11/22/22 Impact Analysis
To endorse the 2023 Ancillary Services Methodology as presented by ERCOT

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GENERAL SESSION MINUTES OF THE BOARD OF DIRECTORS MEETING OF ELECTRIC RELIABILITY COUNCIL OF TEXAS, INC.

8000 Metropolis Drive (Building E), Suite 100, Boardroom B
Austin, Texas 78744
December 20, 2022

Pursuant to notice duly given, the meeting of the Board of Directors (Board) of Electric Reliability Council of Texas, Inc. (ERCOT), convened on the above-referenced date.

Meeting Attendance:

Board Members:

Director	Affiliation/Role (if any)	Voting Category
Aguilar, Carlos	N/A	Voting
England, Julie	N/A	Voting
Flexon, Bob	N/A	Voting
Flores, Bill (Vice Chair)	N/A	Voting
Foster, Paul (Chair)	N/A	Voting
Heeg, Peggy	N/A	Voting
Hjaltman, Courtney	Office of Public Utility Counsel, Public Counsel	Voting
Lake, Peter	Public Utility Commission of Texas (PUCT, Commission), Chairman	Non-Voting
Smati, Zin	N/A	Voting
Swainson, John	N/A *(Via Teleconference)*	Voting
Vegas, Pablo	ERCOT President and Chief Executive Officer (CEO)	Non-Voting

Officers and Guests:

Officer/Guest	Role
Black, Robert	ERCOT Vice President of Public Affairs
Bivens, Carrie	Potomac Economics, ERCOT Independent Market Monitor (IMM), Director
Cobos, Lori	PUCT Commissioner
Coleman, Chris	ERCOT Lead Meteorologist
Day, Betty	ERCOT Vice President of Security and Compliance and Chief Compliance Officer

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Glotfelty, Jimmy	PUCT Commissioner
Gordon, David	PUCT Legal Adviser, Commission Chairman Peter Lake
Helton, Bob	Engie North America Inc., Technical Advisory Committee (TAC) Vice Chair
Hendrix, Chris	Demand Control 2 LLC
Hobbs, Kristi	ERCOT Vice President of Corporate Strategy and PUC Relations
Jackson, Kathleen	PUCT Commissioner
Lange, Clif	South Texas Electric Cooperative, Inc., TAC Chair
Levine, Jonathan	ERCOT Assistant General Counsel and Assistant Corporate Secretary
McAdams, Will	PUCT Commissioner
Ögelman, Kenan	ERCOT Vice President of Commercial Operations
Parakkuth, Jayapal	ERCOT Vice President and Chief Information Officer
Rainwater, Kim	ERCOT Corporate Counsel
Rejino, Tara	PUCT Chief of Staff, Commission Chairman Peter Lake
Rickerson, Woody	ERCOT Vice President of System Planning and Weatherization
Rychetsky, Penny	ERCOT Director of Internal Audit
Seely, Chad V.	ERCOT Vice President, General Counsel and Corporate Secretary
Spak, Mara	ERCOT Vice President of Human Resources
Tamby, Jeyant	ERCOT Senior Vice President, Chief Administrative Officer and Chief of Staff
Taylor, Sean	ERCOT Vice President and Chief Financial Officer
Woodfin, Dan	ERCOT Vice President of System Operations

Call General Session to Order and Announce Proxies (Agenda Item 1)
Paul Foster, Board Chair, determined that a quorum was present and called the Board meeting to order at approximately 8:32 a.m.

Chair Foster recognized Peter Lake, Chairman of the PUCT. Chairman Lake called an Open Meeting of the Commission to order to consider matters that had been duly posted with the Texas Secretary of State for December 20, 2022.

Chair Foster highlighted the antitrust admonition and announced that Board member John Swainson had joined the meeting via teleconference for non-voting participation only. Chair Foster also welcomed to the Board new Public Counsel Courtney Hjaltman.

Chair Foster addressed the following Agenda Items in the order below.

Notice of Public Comment, if Any (Agenda Item 2)
Chair Foster announced that on the agenda for the meeting, which was posted publicly on December 13, 2022, ERCOT had provided instructions for members of the public who were interested in commenting in person and that to date no individuals had expressed interest in commenting, which Chad Seely confirmed.

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Consent Agenda; Unopposed Revision Requests Recommended by TAC for Approval (Agenda Items 3, 3.1 and 3.1.1 – 3.1.10)

Chair Foster presented the Consent Agenda. Mr. Seely reviewed the cost impacts of the Revision Requests on the Consent Agenda. Chair Foster entertained a motion to approve the Consent Agenda as follows:

- NPRR1128, Allow FFR Procurement up to FFR Limit Without Proration;
- NPRR1132, Communicate Operating Limitations during Cold and Hot Weather Condition;
- NPRR1138, Communication of Capability and Status of Online IRRs at 0 MW Output – URGENT, and the Revised Impact Analysis;
- NPRR1148, Language Cleanup Related to ERCOT Contingency Reserve Service (ECRS);
- NPRR1152, Remove Requirements to Submit Emergency Operations Plans, Weatherization Plans, and Declarations of Summer/Winter Weather Preparedness – URGENT;
- NPRR1154, Include Alternate Resource in the Availability Plan for the Firm Fuel Supply Service – URGENT;
- NOGRR226, Addition of Supplemental UFLS Stages;
- OBDRR043, Related to NPRR1148, Language Cleanup Related to ERCOT Contingency Reserve Service (ECRS);
- RRGRR032, Related to NPRR1132, Communicate Operating Limitations during Cold and Hot Weather Conditions; and
- SCR821, Voltage Set Point Target Information for Distribution Generation Resource (DGR) or Distribution Energy Storage Resource (DESR).

Board Vice Chair Bill Flores moved to recommend approval of the Consent Agenda as presented, including the Revised Impact Analysis for NPRR1138 and a recommended effective date of January 27, 2023 for NPRR1152 and NOGRR226. Carlos Aguilar seconded the motion. The motion passed by unanimous voice vote with no abstentions.

October 18, 2022 General Session Meeting Minutes (Agenda Item 4)

Chair Foster entertained a motion to approve the October 18, 2022 General Session Meeting Minutes (Minutes).

Peggy Heeg moved to approve the Minutes as presented. Julie England seconded the motion. The motion passed by unanimous voice vote with no abstentions.

CEO Update (Agenda Item 5)

Pablo Vegas presented the CEO Update. Mr. Vegas reported on the status of 2022 enterprise Objectives and Key Results (OKRs) and highlighted the Winter 2022/2023 Seasonal Assessment of Resource Adequacy (SARA) and Capacity, Demand, and Reserves (CDR) Report. Mr. Vegas indicated ERCOT is monitoring and preparing for extreme cold weather expected this week, including yesterday issuing an Advisory to prepare for the weather to Market Participants, discussed the weekend Load forecast, and provided an update on ongoing winter weatherization inspections.

Mr. Vegas discussed perspectives on Phase 2 Market Redesign. He highlighted the new Fuel Mix Dashboard on the ERCOT website and recognized the ERCOT teams who worked on this effort. He also highlighted the recent opening of registration for the Large Flexible Load (LFL) Voluntary Curtailment Program scheduled to begin January 1, 2023.

2022-2023 Winter Weather Update (Agenda Item 6)
Chris Coleman presented the 2022-2023 Winter Weather Update. Mr. Coleman, Board members, and PUCT Commissioners in attendance also discussed the extreme cold weather expected this week and the weather forecasts ahead of Winter Storm Uri in 2021.

Confirmation of 2023 TAC Representatives (Agenda Item 7)
Chair Foster presented the 2023 TAC Representatives and entertained a motion for their confirmation.

Mr. Aguilar moved to confirm the 2023 TAC Representatives as presented. Zin Smati seconded the motion. The motion passed by unanimous voice vote with no abstentions.

Independent Market Monitor (IMM) Report (Agenda Item 8)
Carrie Bivens presented the IMM Report. She highlighted certain reports available on the Potomac Economics website. Board members and Ms. Bivens discussed the performance of Non-Spinning Reserve Service and Responsive Reserve Service prices in 2022 compared to other years, trends and forecasts for the Peaker Net Margin, and possible reasons for the increase in implied heat rate.

TAC Report (Agenda Item 9)
Clif Lange presented the TAC Report.

Adjunct Membership Application of Pine Gate Renewables LLC for Membership Year 2023 (Agenda Item 10)
Mr. Seely presented the Adjunct Membership Application of Pine Gate Renewables LLC (Pine Gate) for Membership Year 2023. Chair Foster entertained a motion on Pine Gate's application.

Bob Flexon moved to approve the Adjunct Membership of Pine Gate for Membership Year 2023 as requested. Ms. Heeg seconded the motion. The motion passed by unanimous voice vote with no abstentions.

Finance and Audit (F&A) Committee Report; Acceptance of 2022 System and Organization Control Audit Report (Agenda Items 11 and 11.1)
Vice Chair Flores, F&A Committee Chair, reported that the F&A Committee met yesterday and highlighted items discussed at the F&A Committee meeting, including the 2022 System and Organization Control Audit Report, and reported that the result of the audit was an unmodified "clean" opinion with no reportable exceptions reported during the 2022 examination.

Vice Chair Flores moved to accept the 2022 System and Organization Control Audit Report as recommended by the F&A Committee. Mr. Flexon seconded the motion. The motion passed by unanimous voice vote with no abstentions.

Human Resources and Governance (HR&G) Committee Report (Agenda Item 12)
Ms. Heeg, HR&G Committee Chair, reported that the HR&G Committee met the prior day and highlighted items discussed at the HR&G Committee meeting, including the Proposed Amendments to the ERCOT Bylaws, Proposed Amendments to the Board Policies and Procedures, and Ratification of Officer (Agenda Items 12.1 through 12.3 below).

Proposed Amendments to the ERCOT Bylaws; HR&G Committee Recommendation; Corporate Member Alternative Recommendation (Agenda Items 12.1 and 12.1.1 – 12.1.2)
Ms. Heeg presented the Proposed Amendments to the ERCOT Bylaws and HR&G Committee Recommendation. She reported that the HR&G Committee voted unanimously to recommend that the Board approve the proposed amendments to the Bylaws as presented to the HR&G Committee. Chris Hendrix of Demand Control 2 presented the Corporate Member Alternative Recommendation, and he and Board members discussed the alternative recommendation. Chair Foster entertained a motion on the Bylaws amendments.

Ms. Heeg moved to approve the amendments to the ERCOT Bylaws as recommended by the HR&G Committee. Mr. Aguilar seconded the motion. The motion passed by unanimous voice vote with no abstentions.

PUCT Vote on Amendments to the ERCOT Bylaws
Chair Foster recognized PUCT Chairman Lake. Chairman Lake commented on the proposed amendments' conformance with the Commission's November 10, 2022 statement of input and entertained Commission discussion of the Bylaws amendments. Following discussion, Chairman Lake entertained a motion on the Bylaws amendments. Commissioner Kathleen Jackson moved that the Commission approve the amendments to the Bylaws as approved by the Board. Commissioner Jimmy Glotfelty seconded the motion. The motion passed by unanimous voice vote with no abstentions. Chairman Lake noted that the Commission would file a copy of the approved Bylaws in the appropriate docket.

Proposed Amendments to the Board Policies and Procedures; Ratification of Officer (Agenda Items 12.2 – 12.3)
Ms. Heeg reported that the HR&G Committee had recommended approval of proposed amendments to the Board Policies and Procedures and the ratification of Robert Black as ERCOT Vice President of Public Affairs, effective November 7, 2022, each as presented by ERCOT staff.

Ms. Heeg moved to (i) approve the amendments to the Board Policies and Procedures, and (ii) approve the ratification of Robert Black as ERCOT Vice President of Public Affairs, effective November 7, 2022, each as recommended by the HR&G Committee. Mr. Smati seconded the motion. The motion passed by unanimous voice vote with no abstentions.

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Periodicity of Meetings (Agenda Item 12.4)
Periodicity of Meetings was not discussed at this time.

Reliability and Markets (R&M) Committee Report; R&M Committee Charter; Retirement of Credit Work Group; 2023 ERCOT Methodologies for Determining Minimum Ancillary Service Requirements (Agenda Items 13 and 13.1 – 13.3)
Mr. Flexon, R&M Committee Chair, reported that the R&M Committee met the prior day and highlighted items discussed at the R&M Committee meeting, including the Committee's recommendations regarding the R&M Committee Charter, Retirement of the Credit Work Group, and 2023 ERCOT Methodologies for Determining Minimum Ancillary Service Requirements.

Mr. Flexon moved to (i) approve the R&M Committee Charter, (ii) retire the Credit Work Group, and (iii) approve the 2023 ERCOT Methodologies for Determining Minimum Ancillary Service Requirements, each as recommended by the R&M Committee. Ms. England seconded the motion. The motion passed by unanimous voice vote with no abstentions.

Other Business (Agenda Item 14)
Chair Foster announced that the 52nd Annual Meeting of ERCOT Membership would be held later that day in person and by teleconference.

Executive Session; Vote on Matters from Executive Session (Agenda Item 15)
Chair Foster recessed General Session at approximately 9:50 a.m. and convened Executive Session at approximately 10:08 a.m. Chair Foster reconvened General Session at approximately 12:28 p.m.

Chair Foster entertained motions for two matters discussed during Executive Session.

Vice Chair Flores moved to select Weaver and Tidwell, LLP as the 2023 System and Organization Control Auditor. Ms. Heeg seconded the motion. The motion passed by unanimous voice vote with no abstentions.

Ms. Heeg moved to approve the personnel matter discussed during Executive Session under Agenda Item ES 2.2.1. Mr. Smati seconded the motion. The motion passed by unanimous voice vote with no abstentions.

Adjournment (Agenda Item 16)
Chair Foster adjourned the meeting at approximately 12:30 p.m.

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Board materials and presentations from the meeting are available on ERCOT's website at https://www.ercot.com/committees/board.

Jonathan M. Levine
Assistant Corporate Secretary

IMM Concerns with the AS Methodology and Recommended Improvements

Presented at:

Wholesale Market Working Group

Carrie Bivens
ERCOT IMM

September 22, 2023

POTOMAC ECONOMICS

Introduction and Summary

- The AS methodology can substantially affect the market outcomes, prices and costs.
  - ✓ These effects are partly due to the fact that resources scheduled for AS are unavailable to the real-time energy markets.
  - ✓ This will no longer be the case after RTC is implemented.
- These effects have never been more apparent than after ERCOT's implementation of the ERCOT Contingency Reserve Service (ECRS).
- ERCOT's decision to nearly double the amount of required online reserves after implementation of ECRS has resulted in:
  - ✓ Shortage pricing for energy and AS when the market is not short;
  - ✓ Substantial challenges managing congestion as fewer MW are accessible for dispatch in real-time; and
  - ✓ Enormous increases in market costs.
- In this presentation, we discuss these results and recommend improvements to the AS methodology.

NPRR863 Business Case

"RRS has been a staple of the current suite of Ancillary Services since the beginning of the Zonal Market. This Ancillary Service has always consisted of two components, a Primary Frequency Response component and a 10-minute energy deployment component, and is a reflection of the technology available at the beginning of the market to provide the service - thermal Generation Resources.

As technology has advanced, changes have been made to RRS to allow new participants to enter the market (e.g. Load Resources), however, the product has always remained a multi-component Ancillary Service which has proven not to be conducive to the entry of new participants, nor is it conducive to the efficient procurement and deployment of Ancillary Services on the ERCOT System."

Rising AS Procurements from 2020 to the Present

- From the conservative operating posture pre-ECRS, ERCOT substantially increased its reserve procurements when it decoupled ECRS and RRS in June 2023, which was not based on any new potential reliability concerns.
  - ✓ The table below shows the typical operating reserves quantities procured during June peak hours before and after the change in operating posture in 2021, as well as before and after the decoupling of ECRS and RRS.
  - ✓ These changes have increased average reserve procurements by almost 5 GW since 2020.

Average Operating Reserve Procurements at Peak Hours (3pm – 8pm) in June

Reserve Class	2020	2022	2023 Pre-ECRS	2023 Post-ECRS
Non-Spinning Reserves	1446	4112	4016	3132
Online Reserves	2353	2800	2800	5331
Responsive Reserve Service	*2353*	*2800*	*2800*	*2800*
ERCOT Contingency Reserve Service				*2531*
Regulation Up	235	379	507	507
Total	**4034**	**7291**	**7323**	**8970**

Concerns with ECRS

- ECRS procurement and deployment criteria decisions reduced supply and significantly raised demand for ancillary services.
  - ✓ This has reduced liquidity in the day-ahead market and resulted in inefficient day-ahead ancillary services price spikes.
  - ✓ The AS costs through August are shown in the table, with ECRS being the highest even though it only started in June.

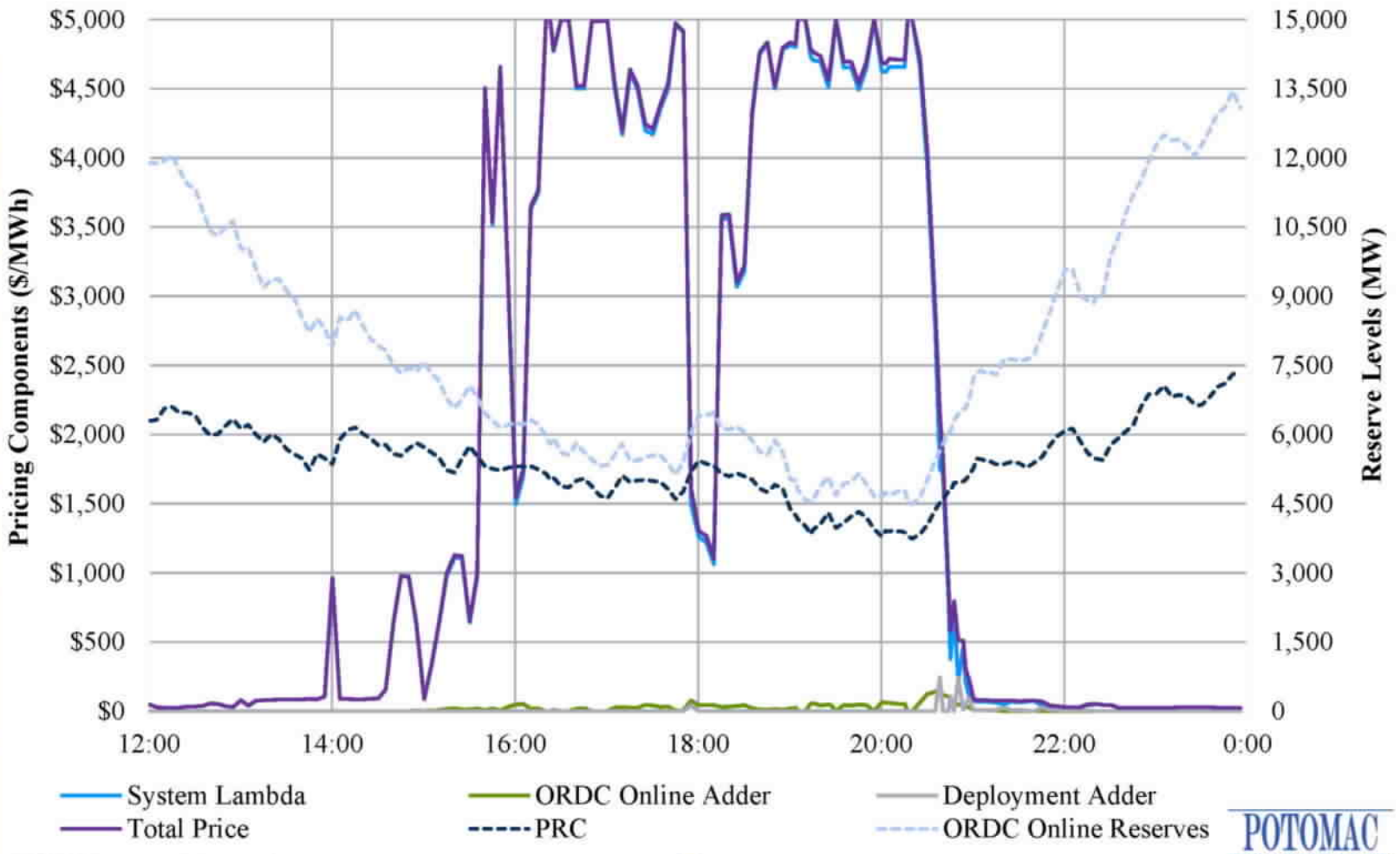
AS Type	AS Cost through Aug 31
ECRS *started 6/10	608,319,544
NSPIN	400,151,045
REGDN	38,627,414
REGUP	97,048,953
RRS	416,373,083

- Although these costs are substantial, they are much lower than the effects of removing the additional reserves from the real-time market dispatch.
  - ✓ This reduces the supply available to manage congestion and meet the system's needs – resulting in sharp increases in real-time energy prices even when reserve levels are high.
  - ✓ We estimate and discuss the magnitude of these increases next.

Concerns with ECRS

- The ~2500 MW increase in online reserve procurements from ECRS has moved these MWs behind the High Ancillary Services Limit (HASL) and resulted in:
  - ✓ Pricing artificial shortages when total reserve levels are high; and
  - ✓ Negative impacts to congestion management, as more MWs that are needed to manage congestion are reserved for ECRS or RRS (e.g., see the results on July 10)
- The next figure illustrates the artificial shortage pricing, showing prices and reserve levels on June 20 shortly after ECRS implementation.
  - ✓ Real-time prices are more difficult to predict as artificial tightness caused by removing these AS resources from the dispatch is episodically mitigated by the operator deployments.
  - ✓ This interferes with day-ahead market decisions, decisions to self-commit resources in real time, and resource offers – all of which are based on expectations of real-time prices.

High Reserves, High Prices
June 20th



POTOMAC ECONOMICS

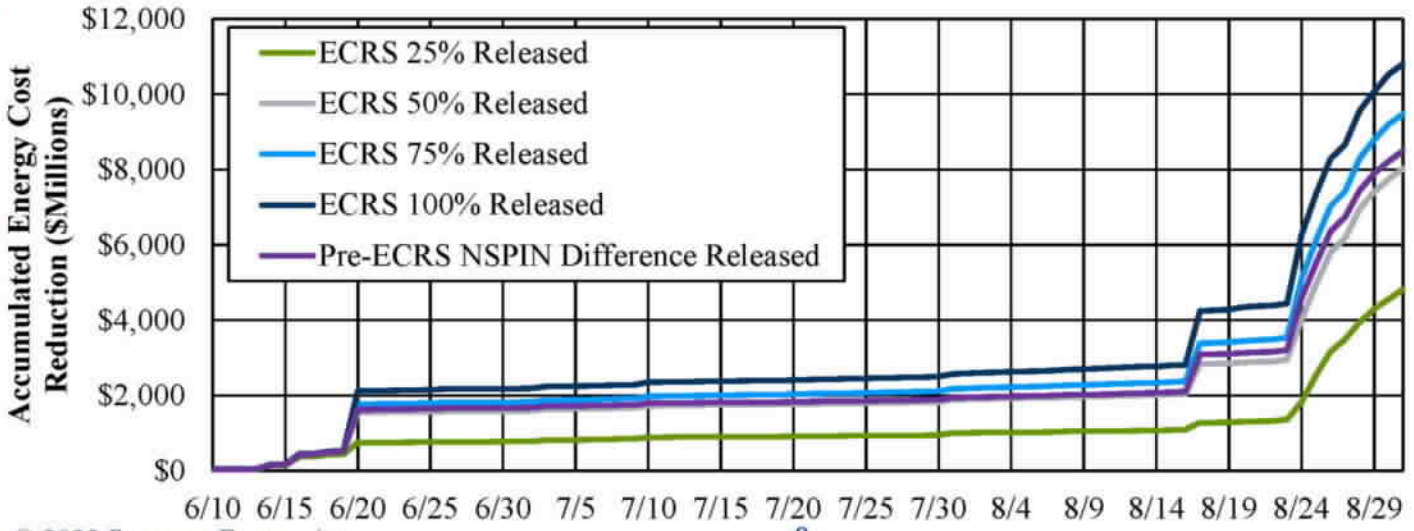
Real-Time Market Impact of ECRS

- To estimate the effects of the artificial scarcity created by ECRS, the IMM simulated the real-time energy market with reconstructed offer curves with lower ECRS procurements (i.e., releasing various amounts of ECRS).
  - ✓ Aggregate offer curves were constructed from generators' LASL to HASL using Step 1 SCED energy offer curves
    - The simulation does not model congestion, ramp limitations, CLR dispatch, or the power balance penalty curve.
    - The input MW quantity to be cleared was the generation requirement of the original SCED execution.
  - ✓ Once a baseline scenario was done, incremental 25% releases of ECRS were modeled in subsequent scenarios and energy cost reductions from the baseline were calculated.
  - ✓ Real-time deployments of ECRS were maintained such that no additional ECRS capacity was released if deployments exceeded the release percentage.
  - ✓ An additional scenario was run that only released amounts of ECRS such that held ECRS and post-ECRS NSPIN amounts were equal to pre-ECRS NSPIN procurement.

Simulated Energy Cost Increases from Higher Online Reserve Procurements: June 10 - August 31, 2023

ERCOT's increase in online reserve procurements with the introduction of ECRS likely raised real-time market energy value by ~$8-10 billion in three months. Additional costs continue to accumulate, notably in early September.

	25% Released	50% Released	75% Released	100% Released	Pre-ECRS NSPIN Difference Released
June	-$774,345,448	-$1,587,969,782	-$1,823,128,056	-$2,183,715,958	-$1,670,295,524
July	-$230,429,049	-$303,797,235	-$356,456,936	-$388,845,385	-$272,166,972
August	-$3,818,750,565	-$6,132,111,308	-$7,303,871,948	-$8,236,831,344	-$6,557,867,403
Total	**-$4,823,525,063**	**-$8,023,878,324**	**-$9,483,456,940**	**-$10,809,392,687**	**-$8,500,329,899**



POTOMAC ECONOMICS

AS Methodology Recommendations

- A holistic review of AS is needed, <u>including reconsidering MWs needed for frequency recovery by ECRS</u>.
  - ✓ The IMM is concerned about overlap of ECRS and RRS, as well as excess AS procurement overall.
- We offer the following initial recommendations based on the 2023 methodology (will update when the 2024 proposal is published):
  1. Reduce the frequency recovery MW procurement for ECRS.
  2. Remove the 2,800 MW floor on RRS.
  3. Change the non-spin 6-hour ahead error requirement to 3-hour ahead.
  4. Use 10-minute ahead net load errors for ECRS methodology.
  5. Reduce ECRS duration requirement back to one hour – requiring that resources providing ECRS be able to deploy for at least two hours effectively reduced energy storage resource participation by half.