



Item 8: 2021 ERCOT Methodologies for Determining Minimum Ancillary Service Requirements

Dan Woodfin

Senior Director, System Operations

Urgent Board of Directors Meeting

ERCOT Public

December 08, 2020

Background & Scope

3.16 Standards for Determining Ancillary Service Quantities

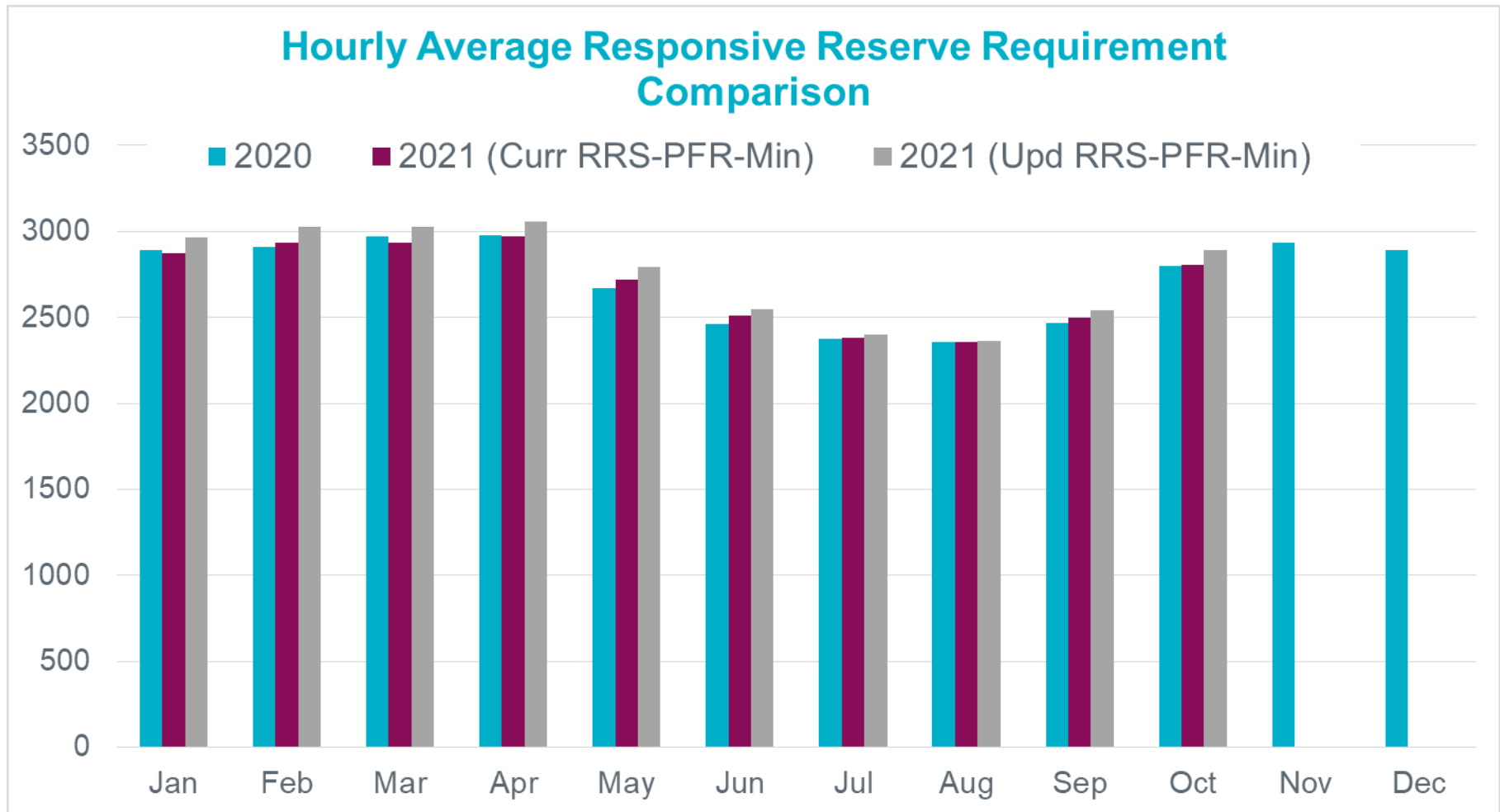
- (2) ERCOT shall, **at least annually**, determine with supporting data, the methodology for determining the quantity requirements for each Ancillary Service needed for reliability...
- (3) The ERCOT Board **shall review and approve** ERCOT's methodology for determining the minimum Ancillary Service requirements...

- ERCOT is not recommending any change to the methodology used for determining Responsive Reserve Service (RRS).
- ERCOT is recommending one change in each of the methodologies used for computing Non-Spinning and Regulation reserves to account for growth in installed PVGR capacity.

Responsive Service Methodology (RRS) - 2021

- ERCOT is not recommending any changes to the methodology used for determining Responsive Reserve Service (RRS).
 - ERCOT is proposing to change the minimum RRS-PFR limit for 2021 to 1420 MW. This change is based on updates to NERC's BAL-003 Interconnection Frequency Response Obligation (IFRO) assessment for 2021. NERC's IFRO analysis for 2021 primarily captures an increase in ERCOT's Resource Contingency Criteria from 2750 MW to 2805 MW.
- The preliminary RRS quantities for January 2021 through October 2021 in subsequent slides have been computed using 2019 and 2020 system inertia conditions and updated RRS table.
 - The RRS table tracks RRS requirements for different inertia conditions. This table was updated for 2021 to use a minimum RRS-PFR limit of 1420 MW.

Hourly Average RRS Comparison

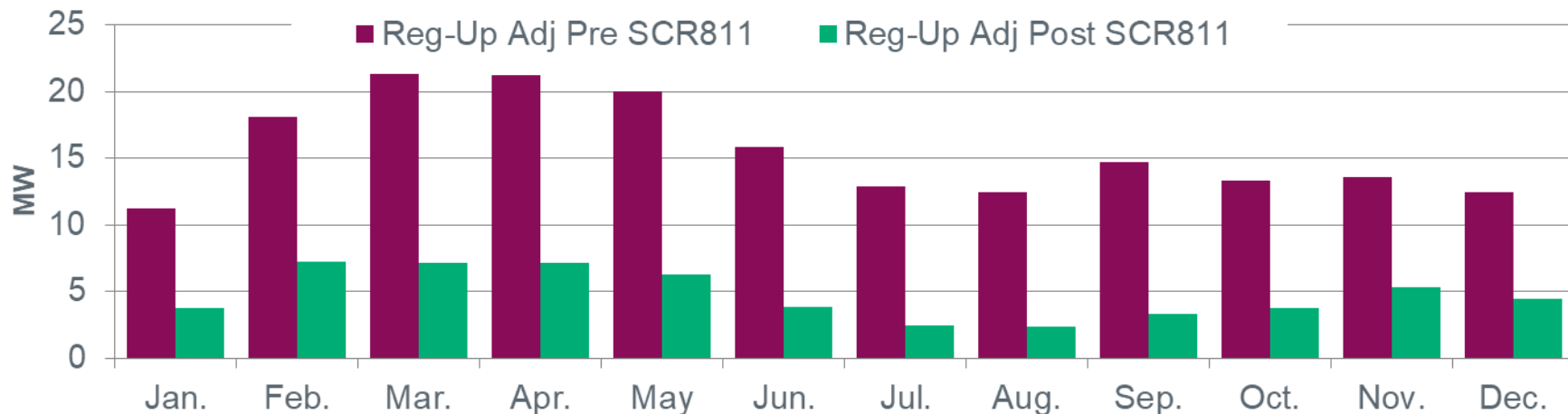


Regulation Service Methodology – 2021

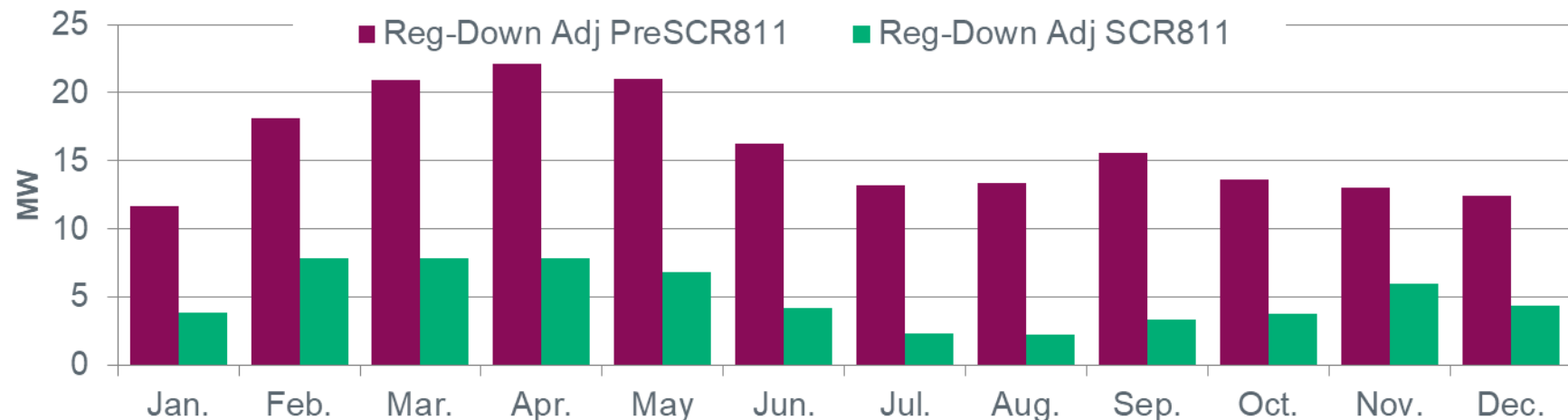
- ERCOT is recommending one change in the methodology used for computing Regulation reserves. Specifically, ERCOT is proposing to create and incorporate Solar Adjustment tables into the Regulation Service Methodology similar to the Wind Adjustment tables.
 - Solar Adjustment tables will track incremental MWs of Regulation needed to account for additional variability per 1000 MW increase in installed solar capacity.
- The preliminary Regulation quantities for January 2021 through October 2021 in subsequent slides have been computed using current methodology (2019 and 2020 five-minute net load variability), updated Wind Adjustment tables and the proposed Solar Adjustment tables.

Solar Adjustment Tables - 2021

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

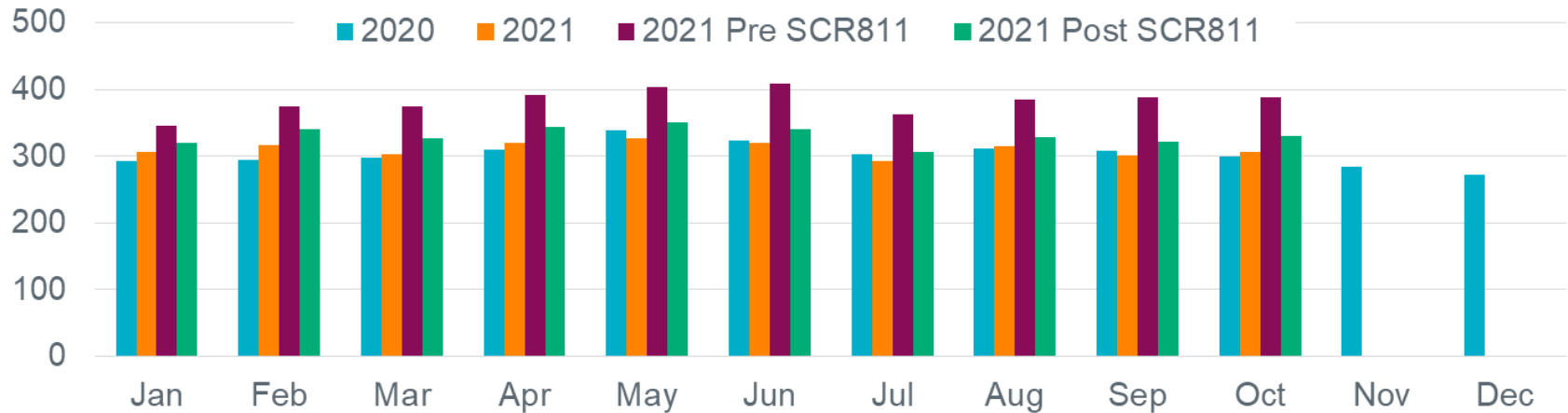


Reg-Down Adjustment per 1000 MW increase in Solar Installed Capacity

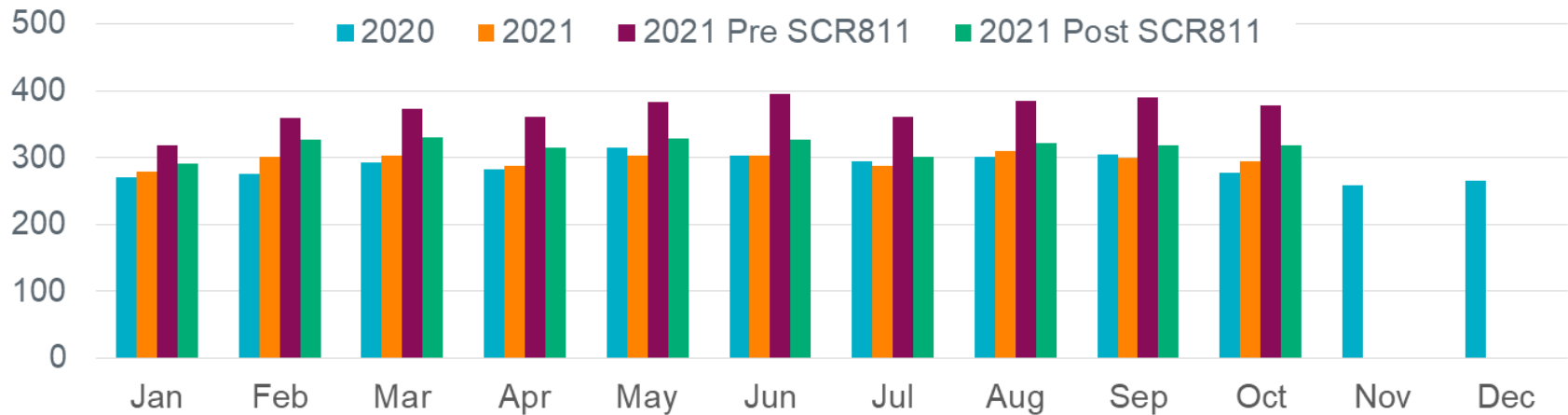


Hourly Average Regulation Comparison

Hourly Average Regulation Up Requirement Comparison



Hourly Average Regulation Down Requirement Comparison

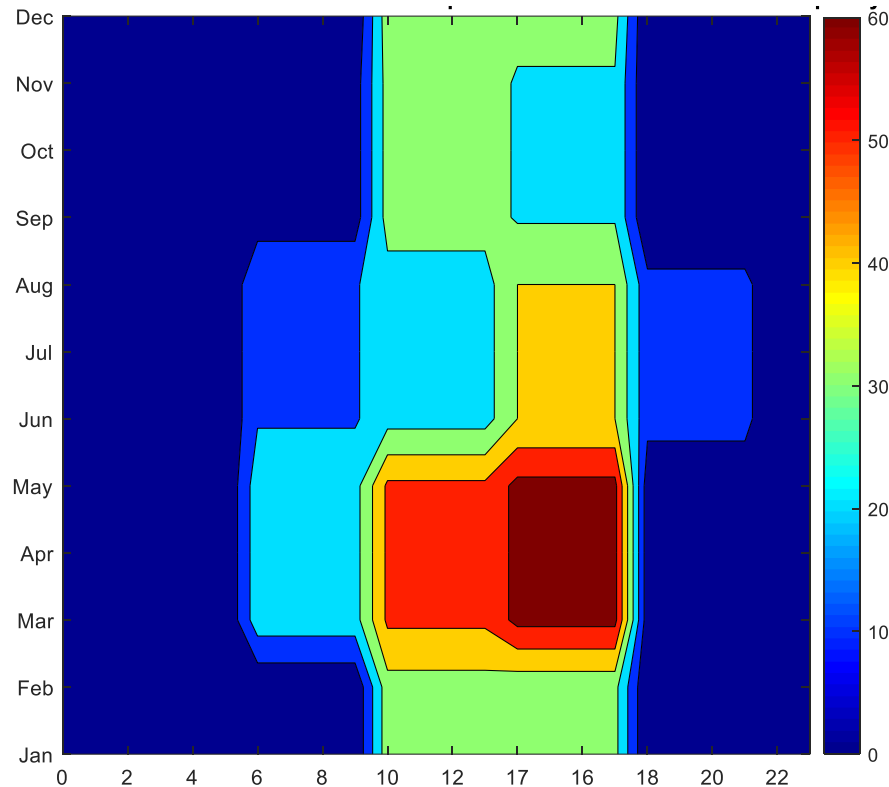


Non Spinning Reserve Methodology (Non-Spin) - 2021

- ERCOT is recommending one change in the methodology used for computing Non-Spin reserves. Specifically, ERCOT is proposing to create and incorporate a Solar Over-Forecast Error Adjustment table.
 - Solar Over-Forecast Error Adjustment Table will track estimated increase in solar over forecast error per 1000 MW increase in installed solar capacity.
- The preliminary Non-Spin quantities for January 2021 through October 2021 in subsequent slides have been computed using current methodology (2018, 2019 and 2020 Net load and Net load Forecast), updated Wind Over-Forecast Error Adjustment table and the proposed Solar Over-Forecast Error Adjustment table.

Solar Over-Forecast Error Adjustment Table - 2021

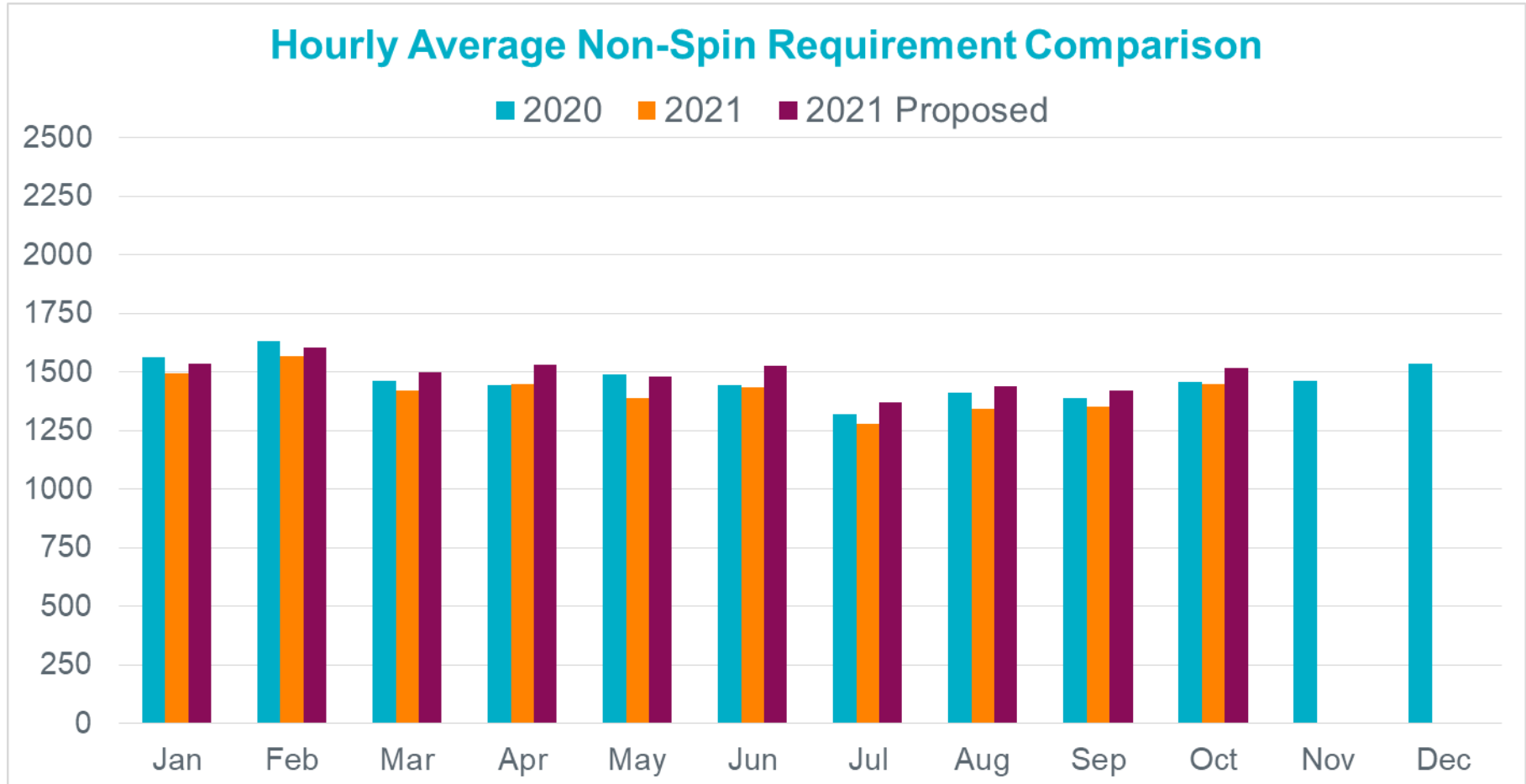
- Solar Over-Forecast Error Adjustment Table track estimated increase in solar over forecast error per 1000 MW increase in installed solar capacity.



Max: 63 MW per 1000 MW additional solar capacity

Mean: 16 MW per 1000 MW additional solar capacity

Hourly Average Non-Spin Comparison



Summary

- Following is a summary of the 2021 Ancillary Service Methodology
 - ERCOT is not recommending any change to the methodology used for determining Responsive Reserve Service (RRS).
 - ERCOT is recommending one change in each of the methodologies used for computing Non-Spin and Regulation reserves to account for growth in installed PVGR capacity.
 - ERCOT is proposing to change the minimum RRS-PFR limit for 2021 to 1420 MW based on updates to NERC's BAL-003 Interconnection Frequency Response Obligation (IFRO) assessment for 2021.
- ERCOT is seeking ERCOT Board of Directors' approval of the 2021 Ancillary Service Methodology as noted above.



Date: December 1, 2020
To: Board of Directors
From: Dan Woodfin, Senior Director, System Operations
Subject: 2021 ERCOT Methodologies for Determining Minimum Ancillary Service Requirements

Issue for the ERCOT Board of Directors

ERCOT Board of Directors Meeting Date: December 8, 2020

Item No.: 8

Issue:

Whether the ERCOT Board of Directors (Board) should approve the proposed 2021 ERCOT Methodologies for Determining Minimum Ancillary Service Requirements (2021 AS Methodology) as presented herein, to be effective January 1, 2021.

Background/History:

Ancillary Services are necessary to maintain the reliability of the ERCOT System. The ERCOT Protocols define these Ancillary Services and charge ERCOT with determining a methodology for the minimum levels of Ancillary Services required. Paragraph (2) of Section 3.16 requires ERCOT to review the methodology at least annually, and paragraph (3) of Section 3.16 requires the Board to review and approve ERCOT's methodology.

ERCOT staff presented the 2020 ERCOT Methodologies for Determining Minimum Ancillary Service Requirements (2020 AS Methodology) to the Board on December 10, 2019, which the Board approved to be effective January 1, 2020 as requested.

The primary changes for the 2021 AS Methodology are related to Regulation Service and Non-Spinning Reserve (Non-Spin) Service. No change has been proposed to the methodology used to compute Responsive Reserve (RRS) Service. The changes are shown in red-line in **Attachment A** and can be summarized as follows:

- Regulation Service
 - Include an adjustment to Regulation Service quantities to account for additional variability due to increase in installed solar capacity.
 - Updates to Wind Adjustment tables that track incremental effect of increase in installed wind capacity on Regulation Service quantities.
- Responsive Reserve Service
 - No change, i.e., same methodology as approved on December 10, 2019.
 - Minimum RRS requirement in the AS Methodology ties to the minimum stated in the Operating Guide.
- Non-Spinning Reserve Service
 - Include an adjustment to account for additional over-forecast uncertainty from projected increase in installed solar capacity.

- Updates to Wind Over-Forecast Error Adjustment Table that track estimated increase in wind over-forecast error per 1,000 MW increase in installed wind capacity.

In addition to the changes proposed in 2021 AS Methodology as outlined above, **Attachment A** updates the minimum level of RRS from Resources providing RRS using Primary Frequency Response to 1,420 MW.

The proposed 2021 AS Methodology will go into effect on January 1, 2021. Upon approval, the minimum Ancillary Service quantities for 2021 will be determined using the 2021 AS Methodology and posted on the Market Information System (MIS) by December 20, 2020.

On November 18, 2020, the Technical Advisory Committee (TAC) unanimously endorsed the proposed 2021 AS Methodology, with an effective date of January 1, 2021.

Key Factors Influencing Issue:

ERCOT is projecting large increases in installed solar capacity in the next two years. ERCOT projects that as solar installed capacity increases there will be larger solar ramps both due to diurnal solar pattern and meteorological variations. ERCOT has observed that as solar installed capacity has increased, the magnitude of 5-minute solar ramps have increased and there have been more instances where Regulation Service has been exhausted. ERCOT expects this reliance on Regulation Service during solar ramps will continue to increase as solar installed capacity increases. In the past, Regulation Service methodology has solely relied on historical net load variability and Wind Adjustment tables to estimate Regulation Service requirements for the future. This creates a possibility of under-estimating Regulation Service quantities actually needed as installed solar capacity increases. To address the potential under-estimation of Regulation Service quantities, the 2021 AS Methodology proposes to create and use Solar Adjustment tables that track incremental amounts of Regulation Service needed to account for additional variability due to actual increase in installed solar capacity.

The proposed changes to the Wind Adjustment tables used to add incremental amounts of Regulation Service quantities is a routine update that ERCOT makes annually based on anticipated growth in installed wind generation in 2021.

ERCOT has observed that increase in solar capacity also tends to increase the MW quantity of solar forecast error whose magnitude varies both by hour and by season. In the past, Non-Spin methodology has solely relied on historical information and Wind Over-Forecast Adjustment table to estimate Non-Spin quantities for future. This creates a possibility of under-estimating Non Spinning Reserve Service quantities as installed solar capacity increases. To address the potential under-estimation of Non-Spin quantities, the 2021 AS Methodology proposes to create and use a Solar Over-Forecast Adjustment table that tracks the incremental increase in Non-Spinning Reserve Service

requirements needed due to projected increase in solar over-forecast error due to future growth in installed solar capacity.

The proposed changes to the Wind Over-Forecast Adjustment table used to add incremental amounts of Non-Spinning Reserve Service quantities are a routine update that ERCOT makes annually and are based on a projected increase in wind over-forecast error due to the anticipated growth in installed wind generation in 2021.

These changes were endorsed unanimously by the Reliability and Operations Subcommittee (ROS), Wholesale Market Subcommittee (WMS) and TAC.

Conclusion/Recommendation:

ERCOT staff recommends that the Board approve the proposed 2021 ERCOT Methodologies for Determining Minimum Ancillary Service Requirements, attached as **Attachment A**, as endorsed by TAC, to be effective January 1, 2021.



ELECTRIC RELIABILITY COUNCIL OF TEXAS, INC.
BOARD OF DIRECTORS RESOLUTION

WHEREAS, after due consideration of the alternatives, the Board of Directors (Board) of Electric Reliability Council of Texas, Inc. (ERCOT) deems it desirable and in the best interest of ERCOT to approve the 2021 *ERCOT Methodologies for Determining Minimum Ancillary Service Requirements*, as set forth in **Attachment A**, as endorsed by the Technical Advisory Committee (TAC), to be effective on January 1, 2021;

THEREFORE, BE IT RESOLVED, that ERCOT is hereby authorized and approved to implement the 2021 *ERCOT Methodologies for Determining Minimum Ancillary Service Requirements*, as set forth in **Attachment A**, as endorsed by TAC, to be effective on January 1, 2021.

CORPORATE SECRETARY'S CERTIFICATE

I, Vickie G. Leady, Assistant Corporate Secretary of ERCOT, do hereby certify that, at its December 8, 2020 urgent meeting by teleconference, the ERCOT Board passed a motion approving the above Resolution by _____.

IN WITNESS WHEREOF, I have hereunto set my hand this ____ day of December, 2020.

Vickie G. Leady
Assistant Corporate Secretary

ERCOT Methodologies for Determining Minimum Ancillary Service Requirements

ERCOT Board approved 12/~~XX10~~/20~~2019~~

Effective Date of 0~~13~~/01/202~~01~~

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Introduction

Paragraph (2) of Protocol Section 3.16, Standards for Determining Ancillary Service Quantities, requires that methodologies for determining the amounts of Ancillary Services to be required by ERCOT must be developed at least annually. Paragraph (3) of Protocol Section 3.16 requires approval of this methodology by the ERCOT Board of Directors.

This document discusses the various Ancillary Services for which requirements are to be developed. Further, detailed methodologies for determining those requirements are included as part of this document.

Specifically, methodologies are required for the determination of the quantities of Regulation Service, Non-Spinning Reserve Service (Non-Spin) and Responsive Reserve (RRS) that are required to maintain system reliability. Those procedures are discussed below.

These procedures are intended for determining each of the Ancillary Service requirements for all months of the upcoming year. This procedure will be performed annually. The Ancillary Service requirements are determined annually and will be posted to the Market Information System (MIS) by December 20th for the upcoming year. If necessary, any additional incremental adjustment to the posted Ancillary Service requirements for a particular month will be made using this procedure and will be posted to the MIS prior to the 20th of each month for the upcoming month. If the AS requirements identified through this process for a particular operating day are found to be insufficient based on the expected operating conditions for that day, ERCOT may make an updated AS requirements posting for that day if the need for incremental adjustments is identified day-ahead and may use the Supplemental Ancillary Service Market (SASM) process for similar adjustments made closer to real-time. For any additional months for which ERCOT is required to provide an Ancillary Service requirement forecast, the forecasted requirement will be set to the historical requirement for the same month of the previous year.

Regulation Service Requirement Details

Introduction

Regulation Service consists of resources that can be deployed by ERCOT in response to changes in ERCOT System frequency to maintain the target ERCOT System frequency within predetermined limits according to the Operating Guides. ERCOT is required to evaluate normal requirements for Reg-Up Service and Reg-Down Service on an annual basis. It is ERCOT's practice to use historical rates of Regulation Service usage to perform evaluation and determine the required quantities for this service. Regulation Service is deployed in order to correct actual frequency to scheduled frequency and to ensure North American Electric Reliability Corporation (NERC) requirements are met.

Summary

The Regulation Service requirements are calculated with the expectation that sufficient Regulation Service will be available to cover the 95th percentile of deployed regulation or net load variability. An adjustment may also be made based on historic CPS1 performance.

Procedure

To evaluate Regulation Service requirements, ERCOT will collect historical Resource Asset Registration Form (RARF) information, CPS1 data, Regulation Service deployment data, aggregate output data, and ERCOT system load data. For determining the base Reg-Up requirements for a particular hour, ERCOT will take the largest of the 95th percentile of Reg-Up deployments for the same month of the previous two years, and the 95th percentile of the positive net load (load – wind – solar) changes for the same month of the previous two years. For determining the base Reg-Down requirements, ERCOT will take the largest of the 95th percentile of Reg-Down deployments for the same month of the previous two years and the 95th percentile of the negative net load (load – wind – solar) changes for the same month of the previous two years.

In order to consider the increased amount of wind and solar penetration, ERCOT will calculate the increase in installed wind and solar generation capacity, respectively. Then, depending on the month of the year and the hour of the day, ERCOT will add incremental MWs that are derived using the wind and solar adjustment tables and associated increase in wind and solar generation capacity, to the maximum values determined above. The wind and solar adjustment tables ~~of~~for incremental MWs for Reg-Up and Reg-Down come from the study ERCOT performs annually, using similar techniques as the 2008 GE wind study, but using actual wind and solar data respectively. The increase in wind (or solar) generation capacity will be calculated by taking the total nameplate capacity of wind (or solar) resources in the ERCOT network model at the time of the procurement study and subtracting out the total nameplate capacity of wind (or solar) resources in the ERCOT model at the end of the month being studied from the previous year.

ERCOT will post these monthly amounts for Regulation Service requirements for the upcoming year on the MIS.

If any incremental changes to the annually posted amounts are needed then the revised amounts for the following month will be posted to the MIS prior to the 20th of the current month. ERCOT may include adjustments for hours in a month considering monthly average for CPS1 and 12-

month rolling average CPS1 scores. If it is determined that during the course of the year that the ERCOT monthly average for CPS1 score was less than 140% for a specific month, ERCOT will apply an extra 10% of both Reg-Up and Reg-Down for hours in which the CPS1 score was less than 140%. Additionally, if the ERCOT 12-month rolling average CPS1 score is less than 140%, for the next month ERCOT will procure an extra 10% of both Reg-Up and Reg-Down for hours in which the hourly CPS1 score was less than 140%. This value will increase to 20% if the CPS1 score falls below 100%.

Incremental MW Adjustment to Prior-Year Up-Regulation Value, per 1000 MW of Incremental Wind Generation Capacity, to Account for Wind Capacity Growth																																				
Hour Ending																																				
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												
Jan.	2.02	2.11	2.44	2.22	3.42	4.35	3.04	4.12	8.43	1.73	3.00	5.37	4.14	8.50	3.30	7.18	2.62	4.28	1.13	2.24	4.93	6.51	2.17	7.54	0.12	1.81	4.01	1.74	0.10	2.38	0.74	4.31	1.30	3.03		
Feb.	5.82	3.67	3.27	4.27	5.43	6.67	4.73	4.44	7.30	4.13	6.48	4.24	8.49	3.64	7.28	5.62	2.16	8.24	5.03	9.50	2.34	4.91	4.44	3.23	2.80	6.20	0.06	1.70	9.17	2.14	4.92	2.34	4.25			
Mar.	2.12	3.37	3.83	9.42	4.24	5.20	4.01	2.30	3.83	3.61	4.42	7.41	2.83	9.36	4.76	6.05	9.44	6.83	7.46	3.42	7.18	2.23	9.20	1.33	8.07	4.82	-	2.51	2.27	1.33	9.28	4.92	7.49			
Apr.	4.61	4.92	3.17	3.36	4.13	3.26	2.70	4.31	5.54	8.74	4.94	2.21	5.42	7.36	4.73	3.14	6.37	4.01	8.23	1.81	4.17	2.03	9.20	2.62	5.11	4.72	2.94	0.04	4.27	2.52	7.42	4.24	5.61	2.4		
May	3.24	3.72	7.27	2.52	6.84	7.46	3.33	7.51	3.27	6.76	3.77	6.22	4.63	7.58	5.37	4.56	5.00	9.24	1.12	0.12	2.84	3.21	1.31	8.51	2.73	6.44	3.23	4.26	2.43	6.12	1.31	3.28	0.5			
Jun.	4.02	4.59	5.47	1.66	7.55	1.53	5.23	9.45	6.26	5.51	4.51	1.84	3.76	4.57	7.75	1.45	2.26	2.60	8.26	1.82	5.23	1.20	0.90	9.03	1.82	2.25	-	0.71	5.28	0.72	7.09	6.71	6.6			
Jul.	1.62	8.32	2.29	2.53	3.22	3.42	2.13	3.10	3.77	7.17	1.59	5.62	2.33	9.32	2.60	6.86	2.30	3.50	0.81	5.02	2.11	2.62	0.18	2.01	1.82	0.13	0.60	6.61	1.61	5.54	2.50	3.07	-	0.51	0.83	0
Aug.	2.32	4.38	2.05	3.32	3.53	9.44	4.42	5.44	8.17	3.75	7.12	2.12	9.83	4.28	3.67	3.65	8.04	4.48	1.22	7.07	3.70	8.32	0.41	2.02	0.74	4.91	8.10	1.01	7.05	0.30	4.02	0.60	4.13	1.3		
Sep.	1.23	0.15	2.42	2.22	7.33	2.52	8.24	0.43	0.35	5.09	7.56	1.51	7.03	3.21	1.85	5.43	4.30	1.83	8.06	1.71	0.28	0.11	1.00	9.12	1.21	8.43	2.70	0.50	9.03	0.2	0.30	2.07	0.80	7.04		
Oct.	1.83	2.24	3.03	3.63	3.34	4.73	3.09	3.50	9.32	8.05	0.43	2.53	3.31	2.53	2.17	8.22	4.72	5.07	2.43	3.92	1.60	7.14	2.36	4.38	1.44	4.28	2.61	1.81	1.17	0.41	1.70	4.19	1.32	0.58		
Nov.	2.92	8.19	2.43	4.42	4.62	7.38	2.95	8.31	2.02	1.31	4.55	5.84	7.48	2.82	6.15	3.11	6.19	2.93	3.13	5.33	9.40	3.64	3.53	0.95	1.17	1.90	0.51	1.10	1.42	2.41	3.15	1.19	1.93	2.2		
Dec.	1.42	1.27	2.22	2.23	1.14	1.53	3.01	8.24	0.82	2.92	5.26	4.65	5.83	6.39	1.54	0.39	4.94	5.08	3.92	2.32	8.04	7.12	2.04	2.55	5.32	2.96	3.13	-1.28	-1.10	0.40	1.62	6.06	-	1.71	0	

Incremental MW Adjustment to Prior-Year Down-Regulation Value, per 1000 MW of Incremental Wind Generation Capacity, to Account for Wind Capacity Growth

Hour Ending																								
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
Jan.	<u>2.00</u> - <u>3</u>	<u>0.21</u> - <u>3</u>	<u>0.71</u> - <u>9</u>	<u>0.61</u> - <u>1</u>	<u>0.20</u> - <u>0</u>	<u>1.1</u> - <u>1.7</u>	<u>0.92</u> - <u>6</u>	<u>=</u> <u>0.12</u> - <u>5</u>	<u>-4.1</u> - <u>0.3</u>	<u>-0.7</u> - <u>3.3</u>	<u>3.14</u> - <u>3</u>	<u>1.51</u> - <u>3</u>	<u>1.7</u> - <u>0.1</u>	<u>1.52</u> - <u>4</u>	<u>0.62</u> - <u>0</u>	<u>0.41</u> - <u>8</u>	<u>0.8</u> - <u>0.7</u>	<u>2.11</u> - <u>2</u>	<u>6.38</u> - <u>4</u>	<u>3.86</u> - <u>0</u>	<u>2.22</u> - <u>3</u>	<u>1.52</u> - <u>9</u>	<u>3.11</u> - <u>5</u>	<u>2.7</u> - <u>0.4</u>
Feb.	<u>2.23</u> - <u>8</u>	<u>1.20</u> - <u>9</u>	<u>1.40</u> - <u>4</u>	<u>0.31</u> - <u>2</u>	<u>0.81</u> - <u>4</u>	<u>0.21</u> - <u>2</u>	<u>0.92</u> - <u>6</u>	<u>2.20</u> - <u>6</u>	<u>1.1</u> - <u>1.2</u>	<u>0.3</u> - <u>0.6</u>	<u>2.51</u> - <u>8</u>	<u>2.60</u> - <u>9</u>	<u>4.71</u> - <u>0</u>	<u>0.70</u> - <u>6</u>	<u>1.81</u> - <u>7</u>	<u>1.81</u> - <u>8</u>	<u>2.51</u> - <u>6</u>	<u>0.12</u> - <u>5</u>	<u>6.74</u> - <u>8</u>	<u>8.25</u> - <u>0</u>	<u>4.93</u> - <u>9</u>	<u>4.43</u> - <u>0</u>	<u>3.42</u> - <u>7</u>	<u>2.72</u> - <u>0</u>
Mar.	<u>2.71</u> - <u>6</u>	<u>4.31</u> - <u>4</u>	<u>4.8</u> - <u>0.4</u>	<u>2.10</u> - <u>3</u>	<u>0.80</u> - <u>7</u>	<u>=</u> <u>0.31</u> - <u>1</u>	<u>1.91</u> - <u>8</u>	<u>2.70</u> - <u>5</u>	<u>1.01</u> - <u>9</u>	<u>6.33</u> - <u>6</u>	<u>4.92</u> - <u>4</u>	<u>1.80</u> - <u>6</u>	<u>2.01</u> - <u>3</u>	<u>=</u> <u>0.31</u> - <u>2</u>	<u>2.41</u> - <u>6</u>	<u>2.72</u> - <u>0</u>	<u>4.53</u> - <u>0</u>	<u>3.03</u> - <u>3</u>	<u>=</u> <u>0.63</u> - <u>2</u>	<u>6.46</u> - <u>4</u>	<u>7.16</u> - <u>1</u>	<u>8.04</u> - <u>6</u>	<u>2.14</u> - <u>7</u>	<u>2.83</u> - <u>8</u>
Apr.	<u>2.3</u> - <u>0.6</u>	<u>2.80</u> - <u>4</u>	<u>2.7</u> - <u>0.3</u>	<u>1.30</u> - <u>3</u>	<u>3.20</u> - <u>3</u>	<u>2.40</u> - <u>4</u>	<u>-0.9</u> - <u>0.3</u>	<u>-2.7</u> - <u>0.5</u>	<u>2.00</u> - <u>6</u>	<u>1.00</u> - <u>6</u>	<u>=</u> <u>0.90</u> - <u>6</u>	<u>0.90</u> - <u>3</u>	<u>0.60</u> - <u>8</u>	<u>2.31</u> - <u>5</u>	<u>0.61</u> - <u>5</u>	<u>2.73</u> - <u>0</u>	<u>4.03</u> - <u>7</u>	<u>8.25</u> - <u>6</u>	<u>6.15</u> - <u>5</u>	<u>9.26</u> - <u>0</u>	<u>6.25</u> - <u>4</u>	<u>5.84</u> - <u>3</u>	<u>4.74</u> - <u>1</u>	<u>1.41</u> - <u>1</u>
May	<u>3.0</u> - <u>1.5</u>	<u>0.00</u> - <u>6</u>	<u>-0.1</u> - <u>0.3</u>	<u>0.9</u> - <u>0.5</u>	<u>2.3</u> - <u>0.7</u>	<u>2.3</u> - <u>1.0</u>	<u>-1.1</u> - <u>1.6</u>	<u>0.30</u> - <u>9</u>	<u>0.70</u> - <u>3</u>	<u>0.6</u> - <u>1.5</u>	<u>-0.8</u> - <u>0.2</u>	<u>2.7</u> - <u>0.5</u>	<u>1.0</u> - <u>0.8</u>	<u>1.90</u> - <u>2</u>	<u>2.71</u> - <u>3</u>	<u>6.43</u> - <u>9</u>	<u>3.34</u> - <u>3</u>	<u>3.55</u> - <u>6</u>	<u>0.65</u> - <u>7</u>	<u>6.84</u> - <u>2</u>	<u>4.85</u> - <u>2</u>	<u>4.44</u> - <u>6</u>	<u>6.53</u> - <u>2</u>	<u>4.51</u> - <u>5</u>
Jun.	<u>2.11</u> - <u>5</u>	<u>=</u> <u>1.20</u> - <u>2</u>	<u>0.0</u> - <u>1.5</u>	<u>-0.8</u> - <u>2.4</u>	<u>-1.1</u> - <u>2.0</u>	<u>0.9</u> - <u>1.6</u>	<u>-1.6</u> - <u>1.9</u>	<u>-0.5</u> - <u>0.1</u>	<u>0.6</u> - <u>0.6</u>	<u>-1.2</u> - <u>1.8</u>	<u>-0.2</u> - <u>1.5</u>	<u>-0.5</u> - <u>1.4</u>	<u>2.3</u> - <u>0.1</u>	<u>1.61</u> - <u>0</u>	<u>3.02</u> - <u>0</u>	<u>4.73</u> - <u>6</u>	<u>5.25</u> - <u>6</u>	<u>4.66</u> - <u>3</u>	<u>5.25</u> - <u>1</u>	<u>3.52</u> - <u>8</u>	<u>7.25</u> - <u>4</u>	<u>4.76</u> - <u>1</u>	<u>1.05</u> - <u>1</u>	<u>6.13</u> - <u>3</u>
Jul.	<u>1.0</u> - <u>0.2</u>	<u>-1.3</u> - <u>0.2</u>	<u>-0.6</u> - <u>1.5</u>	<u>-1.3</u> - <u>1.9</u>	<u>-2.0</u> - <u>2.6</u>	<u>0.2</u> - <u>1.9</u>	<u>-0.5</u> - <u>1.3</u>	<u>1.4</u> - <u>0.7</u>	<u>1.1</u> - <u>0.4</u>	<u>-2.6</u> - <u>1.5</u>	<u>-0.7</u> - <u>1.3</u>	<u>-0.7</u> - <u>0.5</u>	<u>1.51</u> - <u>3</u>	<u>1.52</u> - <u>9</u>	<u>4.13</u> - <u>4</u>	<u>5.43</u> - <u>1</u>	<u>4.74</u> - <u>1</u>	<u>5.43</u> - <u>6</u>	<u>3.33</u> - <u>6</u>	<u>2.92</u> - <u>8</u>	<u>5.45</u> - <u>4</u>	<u>3.66</u> - <u>1</u>	<u>4.64</u> - <u>8</u>	<u>2.00</u> - <u>5</u>
Aug.	<u>0.7</u> - <u>0.6</u>	<u>-1.8</u> - <u>1.1</u>	<u>-2.4</u> - <u>2.1</u>	<u>-2.7</u> - <u>1.9</u>	<u>-1.7</u> - <u>1.8</u>	<u>-1.4</u> - <u>1.2</u>	<u>-0.7</u> - <u>0.7</u>	<u>-0.8</u> - <u>0.6</u>	<u>=</u> <u>0.30</u> - <u>4</u>	<u>-1.3</u> - <u>1.3</u>	<u>-0.7</u> - <u>1.3</u>	<u>=</u> <u>0.30</u> - <u>5</u>	<u>=</u> <u>0.41</u> - <u>0</u>	<u>3.21</u> - <u>2</u>	<u>5.22</u> - <u>1</u>	<u>9.82</u> - <u>5</u>	<u>8.82</u> - <u>9</u>	<u>6.32</u> - <u>6</u>	<u>6.64</u> - <u>0</u>	<u>7.65</u> - <u>0</u>	<u>5.66</u> - <u>4</u>	<u>4.75</u> - <u>7</u>	<u>2.74</u> - <u>5</u>	<u>1.31</u> - <u>4</u>
Sep.	<u>-1.5</u> - <u>1.2</u>	<u>-0.6</u> - <u>1.5</u>	<u>-1.7</u> - <u>1.3</u>	<u>-0.4</u> - <u>1.4</u>	<u>-1.3</u> - <u>1.0</u>	<u>-1.2</u> - <u>0.7</u>	<u>-0.4</u> - <u>0.4</u>	<u>-1.2</u> - <u>1.0</u>	<u>2.80</u> - <u>8</u>	<u>0.00</u> - <u>3</u>	<u>-0.8</u> - <u>0.4</u>	<u>=</u> <u>0.10</u> - <u>4</u>	<u>2.10</u> - <u>2</u>	<u>0.60</u> - <u>9</u>	<u>2.31</u> - <u>8</u>	<u>2.42</u> - <u>1</u>	<u>4.33</u> - <u>9</u>	<u>2.23</u> - <u>4</u>	<u>3.94</u> - <u>5</u>	<u>6.35</u> - <u>5</u>	<u>6.35</u> - <u>6</u>	<u>4.84</u> - <u>7</u>	<u>2.13</u> - <u>9</u>	<u>2.6</u> - <u>0.9</u>
Oct.	<u>0.30</u> - <u>8</u>	<u>1.2</u> - <u>0.2</u>	<u>-1.5</u> - <u>0.1</u>	<u>0.0</u> - <u>0.4</u>	<u>0.8</u> - <u>0.5</u>	<u>0.4</u> - <u>0.5</u>	<u>=</u> <u>1.70</u> - <u>6</u>	<u>=</u> <u>1.00</u> - <u>3</u>	<u>=</u> <u>0.31</u> - <u>1</u>	<u>3.31</u> - <u>0</u>	<u>1.1</u> - <u>0.2</u>	<u>0.90</u> - <u>0</u>	<u>3.2</u> - <u>0.2</u>	<u>=</u> <u>0.90</u> - <u>1</u>	<u>4.51</u> - <u>0</u>	<u>8.51</u> - <u>0</u>	<u>11.21</u> - <u>5</u>	<u>5.80</u> - <u>7</u>	<u>6.14</u> - <u>5</u>	<u>7.55</u> - <u>7</u>	<u>2.75</u> - <u>1</u>	<u>1.73</u> - <u>1</u>	<u>2.12</u> - <u>2</u>	<u>6.72</u> - <u>8</u>
Nov.	<u>0.81</u> - <u>8</u>	<u>0.90</u> - <u>5</u>	<u>0.40</u> - <u>5</u>	<u>0.70</u> - <u>5</u>	<u>1.60</u> - <u>1</u>	<u>1.70</u> - <u>4</u>	<u>0.52</u> - <u>5</u>	<u>0.0</u> - <u>0.8</u>	<u>-3.4</u> - <u>3.1</u>	<u>-0.1</u> - <u>1.6</u>	<u>3.00</u> - <u>2</u>	<u>1.41</u> - <u>8</u>	<u>1.62</u> - <u>5</u>	<u>1.01</u> - <u>5</u>	<u>2.40</u> - <u>6</u>	<u>1.90</u> - <u>9</u>	<u>0.71</u> - <u>2</u>	<u>1.01</u> - <u>2</u>	<u>9.15</u> - <u>4</u>	<u>3.55</u> - <u>5</u>	<u>4.04</u> - <u>8</u>	<u>2.23</u> - <u>8</u>	<u>1.92</u> - <u>3</u>	<u>4.32</u> - <u>1</u>
Dec.	<u>3.06</u> - <u>4</u>	<u>2.11</u> - <u>3</u>	<u>=</u> <u>1.52</u> - <u>6</u>	<u>0.32</u> - <u>9</u>	<u>=</u> <u>0.70</u> - <u>8</u>	<u>0.3</u> - <u>0.7</u>	<u>1.91</u> - <u>2</u>	<u>0.80</u> - <u>0</u>	<u>-5.5</u> - <u>3.4</u>	<u>-2.0</u> - <u>2.2</u>	<u>3.33</u> - <u>2</u>	<u>3.53</u> - <u>1</u>	<u>1.93</u> - <u>1</u>	<u>1.00</u> - <u>7</u>	<u>1.40</u> - <u>9</u>	<u>1.21</u> - <u>4</u>	<u>0.91</u> - <u>0</u>	<u>3.53</u> - <u>0</u>	<u>8.87</u> - <u>3</u>	<u>5.85</u> - <u>5</u>	<u>4.96</u> - <u>0</u>	<u>1.46</u> - <u>4</u>	<u>1.73</u> - <u>9</u>	<u>=</u> <u>0.45</u> - <u>7</u>

Incremental MW Adjustment to Four-Year Up-Regulation Value, per 1000 MW of Incremental Solar Generation Capacity, to Account for Solar Capacity Growth (Effective between Jan 1, 2021 and May 31, 2021)																								
Incremental MW Adjustment to Four-Year Down-Regulation Value, per 1000 MW of Incremental Solar Generation Capacity, to Account for Solar Capacity Growth (Effective between Jan 1, 2021 and May 31, 2021)																								
Hour Ending Hour Ending																								
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
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
Jan.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-6.0	12.0	13.0	23.0	25.0	27.0	42.0	42.0	46.0	40.0	5.0	0.0	0.0	0.0	0.0	0.0
Feb.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	48.0	49.0	23.0	28.0	27.0	30.0	40.0	30.0	9.0	-5.0	0.0	0.0	0.0	0.0	0.0
Mar.	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.8	2.1	24.1	36.5	37.6	38.0	40.9	52.1	55.1	62.9	53.5	25.4	6.1	0.0	0.0	0.0	0.0
Apr.	0.0	0.0	0.0	0.0	0.0	0.0	0.9	11.0	43.3	52.5	45.5	45.3	40.6	43.4	47.0	44.0	38.5	19.3	4.3	-0.5	0.0	0.0	0.0	0.0
May	0.0	0.0	0.0	0.0	0.0	0.0	-0.3	-1.8	1.9	27.0	37.4	39.8	37.5	41.1	53.3	55.6	62.9	66.4	57.1	29.4	4.4	0.0	0.0	0.0
Jun.	0.0	0.0	0.0	0.0	0.0	0.0	1.5	14.8	47.6	56.5	50.8	48.1	43.1	44.4	43.6	45.5	46.6	39.1	19.8	1.0	-0.5	0.0	0.0	0.0
Jul.	0.0	0.0	0.0	0.0	0.0	0.0	-0.4	-3.8	0.0	24.8	33.1	36.3	35.6	39.5	46.8	55.9	62.3	66.0	63.4	39.6	9.0	0.5	0.0	0.0
Aug.	0.0	0.0	0.0	0.0	0.0	0.0	1.8	19.6	53.4	55.6	48.4	46.0	42.3	40.6	43.3	48.3	50.0	48.5	29.5	3.9	-0.9	-0.1	0.0	0.0
Sep.	0.0	0.0	0.0	0.0	0.0	0.0	-1.1	-5.8	4.1	23.3	31.5	37.6	36.9	38.4	45.1	51.1	54.3	53.9	53.5	40.0	15.1	1.6	0.0	0.0
Oct.	0.0	0.0	0.0	0.0	0.0	0.0	3.0	23.1	49.4	49.4	44.1	44.4	41.8	39.3	42.4	45.3	45.4	44.0	27.6	6.3	-1.0	-0.3	0.0	0.0
Nov.	0.0	0.0	0.0	0.0	0.0	0.0	-1.5	-8.4	0.8	13.2	16.8	20.0	24.5	28.1	35.0	42.0	47.6	48.8	49.1	40.3	20.6	2.9	0.0	0.0
Dec.	0.0	0.0	0.0	0.0	0.0	0.0	3.3	25.8	49.8	41.5	30.6	27.6	24.1	25.6	29.8	34.3	34.3	35.4	24.9	5.8	-2.1	-0.3	0.0	0.0
Jan.	0.0	0.0	0.0	0.0	0.0	0.0	-1.5	-9.5	-5.5	8.8	10.3	15.6	20.1	25.2	31.6	37.8	40.3	38.9	40.4	35.6	17.6	2.3	0.0	0.0
Feb.	0.0	0.0	0.0	0.0	0.0	0.0	2.4	20.0	42.8	52.8	25.8	20.4	17.9	22.1	27.4	31.5	31.8	30.1	18.9	-1.5	-3.9	-0.6	0.0	0.0
Mar.	0.0	0.0	0.0	0.0	0.0	0.0	-1.0	-7.8	-10.0	6.0	10.9	18.3	17.5	21.9	31.1	39.3	42.0	40.8	43.6	34.0	11.6	1.1	0.0	0.0
Apr.	0.0	0.0	0.0	0.0	0.0	0.0	1.6	16.5	45.4	58.8	26.4	20.1	18.8	21.0	25.8	32.8	35.5	31.0	14.3	-4.4	-2.4	-0.1	0.0	0.0
May	0.0	0.0	0.0	0.0	0.0	0.0	-0.4	-3.8	-5.8	12.6	19.1	22.1	23.8	31.9	38.3	42.8	49.4	49.4	45.5	22.6	4.1	0.0	0.0	0.0
Jun.	0.0	0.0	0.0	0.0	0.0	0.0	0.6	9.8	40.9	49.0	35.0	30.3	30.6	34.4	34.0	36.8	36.9	29.6	8.9	-2.5	-0.6	0.0	0.0	0.0
Jul.	0.0	0.0	0.0	0.0	0.0	0.0	-1.4	-2.6	13.4	19.8	21.0	21.3	28.3	36.0	40.3	49.4	46.5	36.3	10.4	0.5	0.0	0.0	0.0	0.0
Aug.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.5	33.9	48.3	39.9	32.4	25.9	27.9	29.9	35.0	32.0	17.5	0.5	-1.6	-0.1	0.0	0.0	0.0
Sep.	0.0	0.0	0.0	0.0	0.0	0.0	-0.3	-0.9	2.4	20.6	25.0	26.4	25.6	33.5	44.0	44.8	51.3	34.0	16.0	2.3	0.0	0.0	0.0	0.0
Oct.	0.0	0.0	0.0	0.0	0.0	0.0	2.3	16.8	47.8	49.1	36.3	30.3	25.6	28.8	32.3	29.0	14.4	2.0	-0.9	-0.1	0.0	0.0	0.0	0.0
Nov.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-4.0	18.0	19.0	21.0	23.0	36.0	44.0	44.0	62.0	35.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dec.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	53.0	48.0	28.0	31.0	31.0	29.0	30.0	34.0	13.0	-3.0	0.0	0.0	0.0	0.0	0.0	0.0

Incremental MW Adjustment to Prior-Year Up-Regulation Value, per 1000 MW of Incremental Solar Generation Capacity, to Account for Solar Capacity Growth (Effective between MMM XX June 1, 2021 and Dec 31, 2021)																								
Hour Ending																								
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
Jan.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.0	5.0	6.0	10.0	12.0	14.0	15.0	12.0	4.0	1.0	0.0	0.0	0.0	0.0	0.0
Feb.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	4.3	13.8	18.4	17.4	16.0	17.3	23.3	22.3	22.0	14.0	4.6	0.8	0.0	0.0	0.0	0.0
Mar.	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.3	5.6	12.6	15.4	15.4	16.6	16.6	18.1	17.9	18.0	16.8	13.0	5.4	0.6	0.0	0.0	0.0
Apr.	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.6	3.4	12.0	13.3	13.5	14.5	15.0	16.9	21.4	19.3	18.8	16.1	7.1	0.9	0.0	0.0	0.0
May	0.0	0.0	0.0	0.0	0.0	0.0	-0.3	-1.4	3.4	14.0	13.0	11.1	12.9	14.4	14.5	17.3	17.0	14.8	12.6	6.1	1.0	0.0	0.0	0.0
Jun.	0.0	0.0	0.0	0.0	0.0	0.0	-0.4	-1.9	1.8	7.1	7.0	5.3	6.1	7.3	8.9	10.3	12.4	10.8	9.9	5.3	1.8	0.3	0.0	0.0
Jul.	0.0	0.0	0.0	0.0	0.0	0.0	-0.5	-3.0	-1.4	2.1	2.1	2.8	5.0	6.5	8.3	8.9	8.3	7.3	6.9	3.5	1.1	0.1	0.0	0.0
Aug.	0.0	0.0	0.0	0.0	0.0	0.0	-0.4	-2.6	-2.6	2.6	2.6	3.0	3.4	5.8	9.1	10.8	8.8	7.0	5.8	2.6	0.5	0.0	0.0	0.0
Sep.	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-1.4	-2.1	4.5	7.3	6.4	5.5	8.0	11.1	11.8	12.1	10.0	5.9	1.1	0.0	0.0	0.0	0.0
Oct.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.5	-0.5	4.8	8.1	7.3	7.9	10.5	13.4	11.9	12.6	9.6	5.1	0.8	0.0	0.0	0.0	0.0
Nov.	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.1	3.8	10.8	13.0	11.6	12.8	16.9	22.5	18.6	12.9	4.4	1.0	0.0	0.0	0.0	0.0	0.0
Dec.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.0	7.0	10.0	10.0	10.0	15.0	18.0	16.0	18.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0

Incremental MW Adjustment to Prior-Year Down-Regulation Value, per 1000 MW of Incremental Solar Generation Capacity, to Account for Solar Capacity Growth (Effective between ~~MMM XX~~ June 1, 2021 and Dec 31, 2021)

Hour Ending																								
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
Jan.	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>6.0</u>	<u>11.0</u>	<u>8.0</u>	<u>8.0</u>	<u>9.0</u>	<u>12.0</u>	<u>13.0</u>	<u>15.0</u>	<u>9.0</u>	<u>2.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>
Feb.	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>1.3</u>	<u>9.3</u>	<u>18.0</u>	<u>21.0</u>	<u>18.4</u>	<u>17.4</u>	<u>19.0</u>	<u>23.1</u>	<u>24.6</u>	<u>21.6</u>	<u>12.0</u>	<u>3.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>
Mar.	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.1</u>	<u>2.1</u>	<u>10.9</u>	<u>16.8</u>	<u>18.6</u>	<u>18.3</u>	<u>18.4</u>	<u>16.3</u>	<u>18.5</u>	<u>21.5</u>	<u>20.8</u>	<u>15.9</u>	<u>9.4</u>	<u>1.9</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>
Apr.	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.1</u>	<u>2.1</u>	<u>10.0</u>	<u>14.8</u>	<u>16.6</u>	<u>16.8</u>	<u>17.4</u>	<u>15.0</u>	<u>16.9</u>	<u>21.4</u>	<u>21.8</u>	<u>18.3</u>	<u>13.5</u>	<u>4.3</u>	<u>0.5</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>
May	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.1</u>	<u>2.1</u>	<u>9.6</u>	<u>15.3</u>	<u>15.8</u>	<u>15.4</u>	<u>14.5</u>	<u>12.6</u>	<u>12.8</u>	<u>15.3</u>	<u>17.8</u>	<u>16.1</u>	<u>12.5</u>	<u>3.9</u>	<u>0.3</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>
Jun.	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.3</u>	<u>2.0</u>	<u>5.9</u>	<u>8.0</u>	<u>7.4</u>	<u>6.6</u>	<u>7.0</u>	<u>8.4</u>	<u>9.6</u>	<u>11.1</u>	<u>12.6</u>	<u>12.1</u>	<u>8.9</u>	<u>1.9</u>	<u>-0.5</u>	<u>-0.1</u>	<u>0.0</u>	<u>0.0</u>
Jul.	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.1</u>	<u>1.3</u>	<u>4.0</u>	<u>4.4</u>	<u>3.5</u>	<u>2.9</u>	<u>4.0</u>	<u>5.9</u>	<u>6.6</u>	<u>7.5</u>	<u>7.6</u>	<u>6.5</u>	<u>3.6</u>	<u>-0.5</u>	<u>-0.8</u>	<u>-0.1</u>	<u>0.0</u>	<u>0.0</u>
Aug.	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.8</u>	<u>4.0</u>	<u>5.0</u>	<u>3.5</u>	<u>3.3</u>	<u>3.6</u>	<u>5.4</u>	<u>6.0</u>	<u>6.9</u>	<u>8.5</u>	<u>6.5</u>	<u>1.8</u>	<u>-1.5</u>	<u>-0.5</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>
Sep.	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.4</u>	<u>3.5</u>	<u>6.6</u>	<u>5.9</u>	<u>6.5</u>	<u>7.8</u>	<u>9.3</u>	<u>10.6</u>	<u>10.8</u>	<u>10.9</u>	<u>8.1</u>	<u>1.4</u>	<u>-0.9</u>	<u>-0.1</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>
Oct.	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.5</u>	<u>4.8</u>	<u>8.6</u>	<u>9.1</u>	<u>8.6</u>	<u>8.5</u>	<u>10.0</u>	<u>11.8</u>	<u>11.8</u>	<u>10.1</u>	<u>6.8</u>	<u>1.0</u>	<u>-0.1</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>
Nov.	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.1</u>	<u>2.4</u>	<u>11.3</u>	<u>14.3</u>	<u>15.3</u>	<u>15.4</u>	<u>15.1</u>	<u>18.3</u>	<u>20.8</u>	<u>17.6</u>	<u>9.4</u>	<u>2.6</u>	<u>0.1</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>
Dec.	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>9.0</u>	<u>6.0</u>	<u>10.0</u>	<u>11.0</u>	<u>11.0</u>	<u>14.0</u>	<u>18.0</u>	<u>15.0</u>	<u>10.0</u>	<u>1.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>

Non-Spinning Reserve Service (Non-Spin) Requirement Details

Introduction

Non-Spinning Reserve Service (Non-Spin) consists of Generation Resources capable of being ramped to a specified output level within 30 minutes or Load Resources that are capable of being interrupted within 30 minutes and that are capable of running (or being interrupted) at a specified output level for at least one hour. Non-Spin may be deployed to replace loss of generating capacity, to compensate for Load forecast and/or forecast uncertainty on days in which large amounts of reserve are not available online, to address the risk of net load ramp, or when there is a limited amount of capacity available for Security-Constrained Economic Dispatch (SCED).

Historically, the need for Non-Spin has occurred during hot weather, during cold weather, during unexpected changes in weather or following large unit trips to replenish reserves.

The periods when load is increasing and wind is decreasing requires other generation resources to increase output or come online quickly to compensate for the sudden net load increases. As a result, net load ramp risk should be accounted for in the determination of Non-Spin requirements. While net load forecast analysis may cover reserves required for forecast uncertainty, it may not necessarily cover exposure to the loss of generation and net load ramp risk. Due to this risk, it may be necessary for ERCOT to have additional reserves available during high risk using a variable percentile to protect against forecast uncertainty.

Examples of circumstances when Non-Spin has been used are:

- Across peak hours during spring and fall months when hotter than expected weather with large amounts of capacity offline resulted in Energy Emergency Alert (EEA) events;
- Afternoons during summer seasons when high loads and unit outages outstripped the capability of base load and normal cyclic units;
- Cold weather events when early morning load pickup outpaced the ability of generation to follow;
- Major unit trips when large amounts of spinning reserve were not online; and
- During periods when the wind decreased and load demand increased.

Summary

Analysis for Non-Spin requirements are conducted using data from the same month of previous three years. For the purpose of determining the amount of Non-Spin to purchase for each hour of the day, hours will be placed into four hour blocks. The net load uncertainty for the analyzed days for all hours which are considered to be part of a four hour block will be calculated and a percentile will be assigned to this block of hours based on the risk of net load ramp. The same calculation will be done separately for each block. The Non-Spin requirement for the month for each block

is calculated using the assigned percentile (based on risk of net load ramp) block minus the average Reg-Up requirement during the same block of hours.

ERCOT will post the monthly amounts for Non-Spin requirements for the upcoming year on the MIS.

Procedure

ERCOT will determine the Non-Spin requirement using the 70th to 95th percentile of hourly net load uncertainty from the same month of the previous three years. Net load is defined as the ERCOT load minus the estimated un-curtailed total output from Intermittent Renewable Resource (IRR), which includes both Wind-powered Generation Resources (WGRs) and Photo-Voltaic Generation Resources (PVGR) at a point in time. The forecast of net load is computed by subtracting the aggregate IRR High Sustained Limits (HSLs) in the Current Operating Plans (COPs) from the Mid-Term Load Forecast (MTLF). The COPs and MTLF used are the updated values as of three hours prior to each Operating Hour. The net load uncertainty is then defined as the difference between the net load and the forecasted net load.

The risk of net load ramp is determined based on the change in net load over an hour divided by highest observed net load for the season. The fixed value of percentile ranging between 70th percentile and 95th percentile will be assigned to the net load forecast uncertainty calculated previously. Periods where the risk of net load ramp is highest will use 95th percentile compared to 70th percentile for periods with lowest risks.

ERCOT has seen significant growth in installed wind and solar capacity from one year to the next; an increase in wind and solar capacity also tends to increase the MW quantity of forecast error in their respective forecasts. Hence, ERCOT's reliance on historical wind and solar forecast errors alone creates a possibility of under-estimation of the Non-Spin requirement.

To address this, ERCOT will include the impact of increase in over-forecast error from the expected growth in wind and solar generation installed capacity into the future Non-Spin requirement. The net wind impact is calculated by a multiplication of the projected wind capacity growth between the same month of current year and the next year, and incremental MW adjustment to Non-Spin value per 1000 MW of incremental wind generation capacity. The incremental MW wind adjustment to the Non-Spin value per 1000 MW increase in wind installed capacity is calculated as the change in 50th percentile of the historical wind over-forecast error for 4-hour blocks of each month in the past 5 years, which is then normalized to per 1000 MW of installed wind capacity. The net solar impact is calculated by a multiplication of the projected solar capacity growth between the same month of current year and the next year, and incremental MW adjustment to Non-Spin value per 1000 MW of incremental solar generation capacity. The incremental MW solar adjustment to the Non-Spin value per 1000 MW increase in solar installed capacity is calculated as the change in 50th percentile of the historical solar over-forecast error for 4-hour blocks of each month in the past 3 years, which is then normalized to per 1000 MW of installed solar capacity. The tables below reflect the additional Non-Spin adjustments per 1000 MW of installed wind and solar capacity.

ERCOT will purchase Non-Spin such that the combination of Non-Spin and Reg-Up Services cover the uncertainties of net load forecast errors depending on the net load ramp risk.

Incremental MW Adjustment to Non-Spinning Reserve Service, per 1000 MW of Incremental Wind Generation Capacity

Hour Ending																								
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
Jan.	<u>3742</u>	<u>3742</u>	<u>3743</u>	<u>3743</u>	<u>3743</u>	<u>3743</u>	<u>3744</u>	<u>3744</u>	<u>3744</u>	<u>3744</u>	<u>3038</u>	<u>3038</u>	<u>3038</u>	<u>3038</u>	<u>2933</u>	<u>2933</u>	<u>2933</u>	<u>2933</u>	<u>4045</u>	<u>4045</u>	<u>4045</u>	<u>4045</u>	<u>374</u> ₂	<u>3742</u>
Feb.	<u>3742</u>	<u>3742</u>	<u>3743</u>	<u>3743</u>	<u>3743</u>	<u>3743</u>	<u>3744</u>	<u>3744</u>	<u>3744</u>	<u>3744</u>	<u>3038</u>	<u>3038</u>	<u>3038</u>	<u>3038</u>	<u>2933</u>	<u>2933</u>	<u>2933</u>	<u>2933</u>	<u>4045</u>	<u>4045</u>	<u>4045</u>	<u>4045</u>	<u>374</u> ₂	<u>3742</u>
Mar.	<u>3947</u>	<u>3947</u>	<u>4148</u>	<u>4148</u>	<u>4148</u>	<u>4148</u>	<u>4050</u>	<u>4050</u>	<u>4050</u>	<u>4050</u>	<u>2936</u>	<u>2936</u>	<u>2936</u>	<u>2936</u>	<u>2937</u>	<u>2937</u>	<u>2937</u>	<u>2937</u>	<u>4046</u>	<u>4046</u>	<u>4046</u>	<u>4046</u>	<u>394</u> ₇	<u>3947</u>
Apr.	<u>3947</u>	<u>3947</u>	<u>4148</u>	<u>4148</u>	<u>4148</u>	<u>4148</u>	<u>4050</u>	<u>4050</u>	<u>4050</u>	<u>4050</u>	<u>2936</u>	<u>2936</u>	<u>2936</u>	<u>2936</u>	<u>2937</u>	<u>2937</u>	<u>2937</u>	<u>2937</u>	<u>4046</u>	<u>4046</u>	<u>4046</u>	<u>4046</u>	<u>394</u> ₇	<u>3947</u>
May	<u>3947</u>	<u>3947</u>	<u>4148</u>	<u>4148</u>	<u>4148</u>	<u>4148</u>	<u>4050</u>	<u>4050</u>	<u>4050</u>	<u>4050</u>	<u>2936</u>	<u>2936</u>	<u>2936</u>	<u>2936</u>	<u>2937</u>	<u>2937</u>	<u>2937</u>	<u>2937</u>	<u>4046</u>	<u>4046</u>	<u>4046</u>	<u>4046</u>	<u>394</u> ₇	<u>3947</u>
Jun.	<u>4050</u>	<u>4050</u>	<u>3947</u>	<u>3947</u>	<u>3947</u>	<u>3947</u>	<u>3643</u>	<u>3643</u>	<u>3643</u>	<u>3643</u>	<u>2530</u>	<u>2530</u>	<u>2530</u>	<u>2530</u>	<u>2527</u>	<u>2527</u>	<u>2527</u>	<u>2527</u>	<u>3232</u>	<u>3232</u>	<u>3232</u>	<u>3232</u>	<u>405</u> ₀	<u>4050</u>
Jul.	<u>4050</u>	<u>4050</u>	<u>3947</u>	<u>3947</u>	<u>3947</u>	<u>3947</u>	<u>3643</u>	<u>3643</u>	<u>3643</u>	<u>3643</u>	<u>2530</u>	<u>2530</u>	<u>2530</u>	<u>2530</u>	<u>2527</u>	<u>2527</u>	<u>2527</u>	<u>2527</u>	<u>3232</u>	<u>3232</u>	<u>3232</u>	<u>3232</u>	<u>405</u> ₀	<u>4050</u>
Aug.	<u>4050</u>	<u>4050</u>	<u>3947</u>	<u>3947</u>	<u>3947</u>	<u>3947</u>	<u>3643</u>	<u>3643</u>	<u>3643</u>	<u>3643</u>	<u>2530</u>	<u>2530</u>	<u>2530</u>	<u>2530</u>	<u>2527</u>	<u>2527</u>	<u>2527</u>	<u>2527</u>	<u>3232</u>	<u>3232</u>	<u>3232</u>	<u>3232</u>	<u>405</u> ₀	<u>4050</u>
Sep.	<u>3242</u>	<u>3242</u>	<u>3345</u>	<u>3345</u>	<u>3345</u>	<u>3345</u>	<u>3243</u>	<u>3243</u>	<u>3243</u>	<u>3243</u>	<u>2632</u>	<u>2632</u>	<u>2632</u>	<u>2632</u>	<u>2629</u>	<u>2629</u>	<u>2629</u>	<u>2629</u>	<u>3139</u>	<u>3139</u>	<u>3139</u>	<u>3139</u>	<u>324</u> ₂	<u>3242</u>
Oct.	<u>3242</u>	<u>3242</u>	<u>3345</u>	<u>3345</u>	<u>3345</u>	<u>3345</u>	<u>3243</u>	<u>3243</u>	<u>3243</u>	<u>3243</u>	<u>2632</u>	<u>2632</u>	<u>2632</u>	<u>2632</u>	<u>2629</u>	<u>2629</u>	<u>2629</u>	<u>2629</u>	<u>3139</u>	<u>3139</u>	<u>3139</u>	<u>3139</u>	<u>324</u> ₂	<u>3242</u>
Nov.	<u>3242</u>	<u>3242</u>	<u>3345</u>	<u>3345</u>	<u>3345</u>	<u>3345</u>	<u>3243</u>	<u>3243</u>	<u>3243</u>	<u>3243</u>	<u>2632</u>	<u>2632</u>	<u>2632</u>	<u>2632</u>	<u>2629</u>	<u>2629</u>	<u>2629</u>	<u>2629</u>	<u>3139</u>	<u>3139</u>	<u>3139</u>	<u>3139</u>	<u>324</u> ₂	<u>3242</u>
Dec.	<u>3742</u>	<u>3742</u>	<u>3743</u>	<u>3743</u>	<u>3743</u>	<u>3743</u>	<u>3744</u>	<u>3744</u>	<u>3744</u>	<u>3744</u>	<u>3038</u>	<u>3038</u>	<u>3038</u>	<u>3038</u>	<u>2933</u>	<u>2933</u>	<u>2933</u>	<u>2933</u>	<u>4045</u>	<u>4045</u>	<u>4045</u>	<u>4045</u>	<u>374</u> ₂	<u>3742</u>

Incremental MW Adjustment to Non-Spinning Reserve Service, per 1000 MW of Incremental Solar Generation Capacity

Hour Ending																								
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
Jan.	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>36</u>	<u>36</u>	<u>36</u>	<u>36</u>	<u>33</u>	<u>33</u>	<u>33</u>	<u>33</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>
Feb.	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>36</u>	<u>36</u>	<u>36</u>	<u>36</u>	<u>33</u>	<u>33</u>	<u>33</u>	<u>33</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>
Mar.	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>26</u>	<u>26</u>	<u>26</u>	<u>26</u>	<u>52</u>	<u>52</u>	<u>52</u>	<u>52</u>	<u>63</u>	<u>63</u>	<u>63</u>	<u>63</u>	<u>4</u>	<u>4</u>	<u>4</u>	<u>4</u>	<u>0</u>	<u>0</u>
Apr.	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>26</u>	<u>26</u>	<u>26</u>	<u>26</u>	<u>52</u>	<u>52</u>	<u>52</u>	<u>52</u>	<u>63</u>	<u>63</u>	<u>63</u>	<u>63</u>	<u>4</u>	<u>4</u>	<u>4</u>	<u>4</u>	<u>0</u>	<u>0</u>
May	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>26</u>	<u>26</u>	<u>26</u>	<u>26</u>	<u>52</u>	<u>52</u>	<u>52</u>	<u>52</u>	<u>63</u>	<u>63</u>	<u>63</u>	<u>63</u>	<u>4</u>	<u>4</u>	<u>4</u>	<u>4</u>	<u>0</u>	<u>0</u>
Jun.	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>19</u>	<u>19</u>	<u>19</u>	<u>19</u>	<u>26</u>	<u>26</u>	<u>26</u>	<u>26</u>	<u>40</u>	<u>40</u>	<u>40</u>	<u>40</u>	<u>13</u>	<u>13</u>	<u>13</u>	<u>13</u>	<u>0</u>	<u>0</u>
Jul.	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>19</u>	<u>19</u>	<u>19</u>	<u>19</u>	<u>26</u>	<u>26</u>	<u>26</u>	<u>26</u>	<u>40</u>	<u>40</u>	<u>40</u>	<u>40</u>	<u>13</u>	<u>13</u>	<u>13</u>	<u>13</u>	<u>0</u>	<u>0</u>
Aug.	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>19</u>	<u>19</u>	<u>19</u>	<u>19</u>	<u>26</u>	<u>26</u>	<u>26</u>	<u>26</u>	<u>40</u>	<u>40</u>	<u>40</u>	<u>40</u>	<u>13</u>	<u>13</u>	<u>13</u>	<u>13</u>	<u>0</u>	<u>0</u>
Sep.	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>5</u>	<u>5</u>	<u>5</u>	<u>5</u>	<u>34</u>	<u>34</u>	<u>34</u>	<u>34</u>	<u>29</u>	<u>29</u>	<u>29</u>	<u>29</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>
Oct.	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>5</u>	<u>5</u>	<u>5</u>	<u>5</u>	<u>34</u>	<u>34</u>	<u>34</u>	<u>34</u>	<u>29</u>	<u>29</u>	<u>29</u>	<u>29</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>
Nov.	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>5</u>	<u>5</u>	<u>5</u>	<u>5</u>	<u>34</u>	<u>34</u>	<u>34</u>	<u>34</u>	<u>29</u>	<u>29</u>	<u>29</u>	<u>29</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>
Dec.	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>36</u>	<u>36</u>	<u>36</u>	<u>36</u>	<u>33</u>	<u>33</u>	<u>33</u>	<u>33</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>

Responsive Reserve (RRS) Requirement Details

Nodal Operating Guide Section 2.3.1.1, Obligation, sets the minimum RRS requirement for all hours under normal conditions. ERCOT will procure amounts of RRS that vary by hour of the day and by month. These RRS amounts will be published by month in six separate blocks covering four hour intervals. These amounts will be based on expected diurnal load, solar and wind patterns for the month, will cover 70% of historic system inertia conditions for each block of hours for the month, and will use the equivalency ratio for RRS between Load Resources and Generation Resources to establish the conditions for each block of hours. The equivalency ratio will be used to establish the total reserves assuming the Day-Ahead Market (DAM) will use a one to one equivalency ratio. The minimum level of RRS procured from Resources providing RRS using Primary Frequency Response shall be determined for each month by ERCOT through the use of studies and shall not be less than 1, ~~420~~450 MWs. The remaining capacity required for RRS will be procured from all Resources qualified to provide RRS including Load Resources. The maximum amount of RRS that can be provided by Resources providing Fast Frequency Response (FFR) is limited to 450 MW. DAM will limit the combined RRS procured from Load Resources controlled by high set under frequency relay and Resources providing FFR to 60% of the total RRS requirement. ERCOT may increase the minimum capacity required from Resources providing RRS using Primary Frequency Response if it believes that the current posted quantity will have a negative impact on reliability or if it would require additional Regulation Service to be deployed. ERCOT will procure additional 200 MW of RRS for each percent of Reserve Discount Factor (RDF) when ERCOT estimates RDF to be less than 1. This adjustment will only apply for those 4-hour blocks where the 85th percentile of weighted average temperature is greater than 95°F. RDFs are reviewed and adjusted based on the generators performance during an unannounced test. RRS amount will be published as a monthly requirement along with the equivalency ratio for each four hour block. Additionally, ERCOT will make incremental adjustments to account for Resources operating in synchronous condenser fast response mode providing RRS. This adjustment will only apply to those 4-hour blocks when system inertia is typically expected to be less than 250 GW*s. ERCOT will post these monthly amounts for the upcoming year on the MIS. These annually published amounts are the minimum quantity that will be procured in the DAM for each hour of the year.

Self-arranged RRS used to fulfill a Qualified Scheduling Entity's (QSE's) RRS requirement will be limited to 60% from Resources providing FFR and Load Resources excluding Controllable Load Resources.

If the percentage level for Resources providing FFR and Load Resources, excluding Controllable Load Resources, specified in the Protocols is changed, that change will be reflected in these requirements.