

Proposed Regulation Requirements (**Revised**)

Phillip Miskinis

MARKET OPERATIONS

ICAP/MIWG

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Agenda

- Background
- Current Regulation Requirements
- Methodology to Calculate Requirements
- Recap 2010 Wind Study
- Recap 2016 Wind/Solar Study
- 2023 Analysis
- Planned Updates
- Next Steps
- Appendix

Background

- Regulation and frequency response services are necessary for the continuous balancing of resources (generation and NY Control Area interchange) with load, and to assist in maintaining scheduled Interconnection frequency at 60 Hz.
- This service is accomplished by committing qualified resources whose output or demand is raised or lowered (using Automatic Generation Control (AGC)) as necessary to follow moment-by-moment changes in Area Control Error (ACE)
- Regulation and frequency response requirements are established consistent with North American Electric Reliability Council (NERC) criteria. The requirements may vary by hour and by season.
- Regulation requirements are established to address the variability of net load that may occur within a 5-minute dispatch interval.
- A co-optimization process is conducted in the NYISO energy markets to minimize the total cost of energy, operating reserves, and regulation service.
- Costs for regulation service in 2022 totaled \$31.0 million.

Current Regulation Requirements

- The requirements can be found on the NYISO website at:
https://www.nyiso.com/documents/20142/3694424/nyiso_regulation_req.pdf

NYISO Regulation Requirements [MW]

Hour Beg	April-May	June-August	September-October	November-March
0	175	225	175	200
1	175	175	175	175
2	175	175	150	175
3	175	175	175	150
4	225	225	225	175
5	225	250	275	225
6	225	275	300	275
7	225	275	275	275
8	200	275	225	275
9	200	225	225	225
10	200	200	225	200
11	225	200	225	200
12	225	225	275	250
13	200	200	250	225
14	225	200	225	250
15	200	225	225	250
16	200	250	200	275
17	225	275	250	300
18	250	250	275	275
19	275	250	250	250
20	250	250	250	200
21	200	250	250	225
22	200	275	200	200
23	200	275	225	200

Methodology

- **Net load in this context refers to the sum of Load - Wind Generation - Solar Generation**
- **Analysis of the net load variability at different wind/solar penetration levels and forecasted load levels was performed to establish NYCA regulation requirements on a going forward basis**
 - This methodology is consistent with the tracking and recommendations made in the recent *Reliability and Market Considerations for a Grid in Transition Report*
 - Specifically, within *Appendix B: Reliability Gap Assessment*, recommendations include “addressing net load balance variations could be through a substantial increase in the amount of regulation capability that would be scheduled and available for real-time operations”
- **In 2010, NYISO performed an evaluation of the impact of wind resources on net load**
https://www.nyiso.com/documents/20142/1404221/Wind_Generation_Study_Report_Final_Draft_6_10_10.pdf
- **In 2016, NYISO performed another evaluation that considered the impact of both wind and solar resources on net load**
<https://www.nyiso.com/documents/20142/1394495/Solar%20Integration%20Study%20Report%20Final%20063016.pdf>

Recap 2010 study

- The evaluation was of three scenarios combining wind penetration levels of 3,500MW up to 8,000MW in combination with projected load peaks
- The study concluded that at higher levels of installed wind generation the system will experience higher magnitude ramping events and will require regulation requirement increases
- The study effort resulted in collapsing the then regulation requirements from weekday/Sunday requirements into just a daily requirement by season.

Recap 2016 study

- This study considered 6 scenarios combining wind penetration levels of 2,500-4,500MW and solar penetration levels of 1,500 - 9,000MW in combination with projected loads
- The study concluded that the NY bulk power system could reliably manage the net load variability associated with the wind/solar penetration levels studied and detailed the associated regulation requirements
- The study recommended updates to the regulation requirements as thresholds of wind or solar penetration levels are exceeded
 - The first threshold (Threshold 2) is 2,500MW of wind or 1,500MW of solar, and results in recommended increases of the requirement in some hours, as well as recommended decreases in some hours.
 - Recommended decreases are primarily concentrated in summer months, coincident with mid-day high solar production hours.
 - As of June 2020, the total installed wind and estimated rooftop solar in the NYCA was 1,985MW and 1,948MW, respectively
- **With stakeholder approval, the threshold 2 results were approved and implemented on September 1, 2020.**

2023 Analysis

- We analyzed 2 scenarios chosen to represent the projected near-term regulation needs of the NY bulk power system
- These scenarios are modeled to represent the end of year forecasts for wind and solar in the years 2024 (3,000MW Land Based Wind (LBW), 125MW Offshore Wind (OSW), 7,651MW Solar) and 2026 (3,700MW LBW, 125MW OSW, 9,768MW Solar).
- Load assumptions derived from the Gold Book.
 - Study uses the 2018 gross load shape i.e., with the 2018 estimated BTM MW added back in
 - This is then scaled up to the forecasted 2024 and 2026 shapes used in the Gold Book
- Intermittent Power Resource (IPR) capacity is the forecast of resources to be onboarded based on registration paperwork, state regulatory approvals, and interconnection queue.
- We plan to review the regulation requirements more frequently as the grid evolves to accommodate increasing levels of IPR penetration
 - Scenario 1 (3,000MW LBW/125MW OSW/7,651MW solar) indicates regulation requirement increases for most day-time hours in April through October.
 - As of February 2023, the total installed wind and estimated solar in the NYCA was 2,424MW and 4,497MW, respectively.

Planned Updates – Scenario 1

- Here are the regulation requirements for Scenario 1, *i.e.*, 3,000MW LBW, 125MW OSW, 7,651MW solar
 - Green highlighted hours reflect an increase to existing requirement. No highlight means no change to the requirement.
- The NYISO proposes to implement this set of regulation requirements effective June 01, 2023

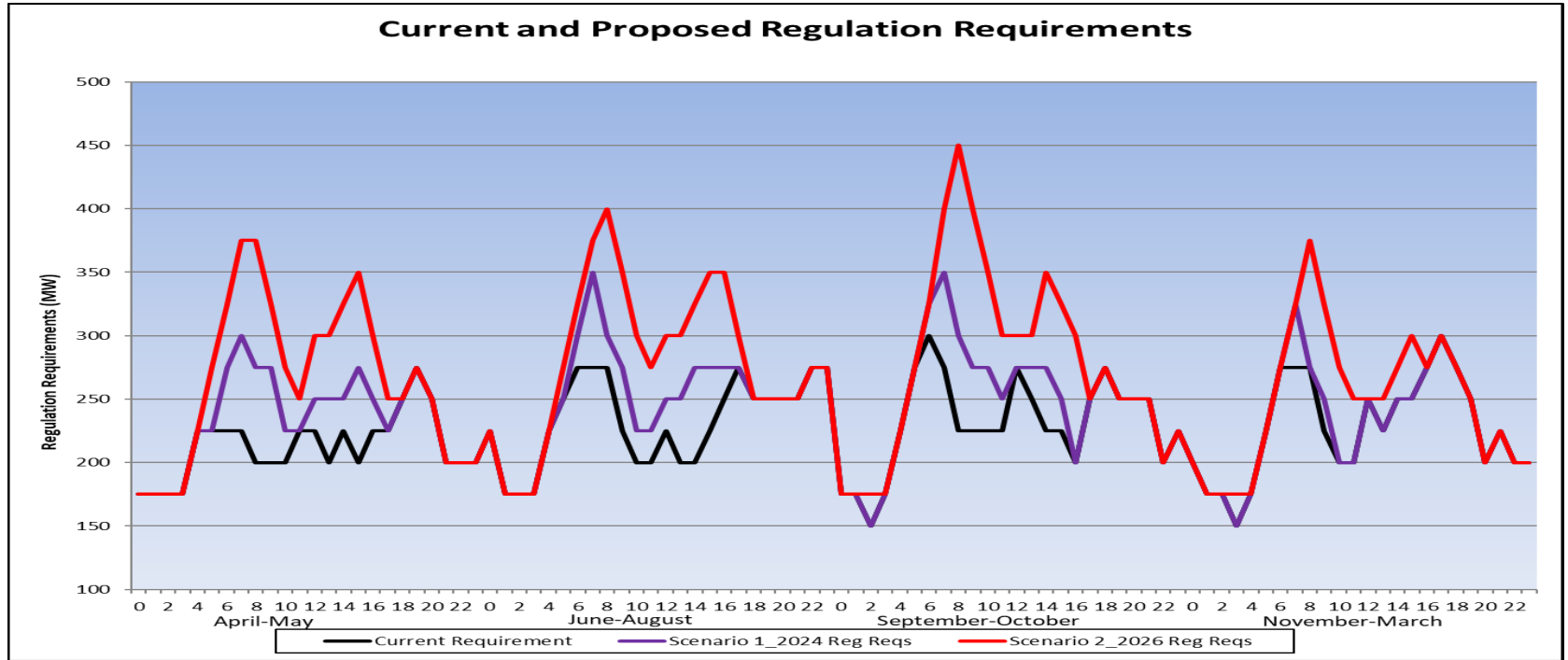
	April-May		June-August		September-October		November-March	
	Current Requirement 3,500MW Wind 3,000MW Solar	Scenario 1 3,000MW LBW, 125MW OSW, 7,651MW Solar	Current Requirement 3,500MW Wind 3,000MW Solar	Scenario 1 3,000MW LBW, 125MW OSW, 7,651MW Solar	Current Requirement 3,500MW Wind 3,000MW Solar	Scenario 1 3,000MW LBW, 125MW OSW, 7,651MW Solar	Current Requirement 3,500MW Wind 3,000MW Solar	Scenario 1 3,000MW LBW, 125MW OSW, 7,651MW Solar
HB								
0	175	175	225	225	175	175	200	200
1	175	175	175	175	175	175	175	175
2	175	175	175	175	150	150	175	175
3	175	175	175	175	175	175	150	150
4	225	225	225	225	225	225	175	175
5	225	225	250	250	275	275	225	225
6	225	275	275	300	300	325	275	275
7	225	300	275	350	275	350	275	325
8	200	275	275	300	225	300	275	275
9	200	275	225	275	225	275	225	250
10	200	225	200	225	225	275	200	200
11	225	225	200	225	225	250	200	200
12	225	250	225	250	275	275	250	250
13	200	250	200	250	250	275	225	225
14	225	250	200	275	225	275	250	250
15	200	275	225	275	225	250	250	250
16	225	250	250	275	200	200	275	275
17	225	225	275	275	250	250	300	300
18	250	250	250	250	275	275	275	275
19	275	275	250	250	250	250	250	250
20	250	250	250	250	250	250	200	200
21	200	200	250	250	250	250	225	225
22	200	200	275	275	200	200	200	200
23	200	200	275	275	225	225	200	200

Planned Updates – Scenario 2

- Here are the regulation requirements for Scenario 2, *i.e.*, 3,700MW LBW, 125MW OSW, 9,768MW solar
 - Green highlighted hours reflect an increase to existing requirement. No highlight means no change to the requirement.
- The NYISO proposes to implement the Scenario 2 regulation requirements in 2025. The NYISO will notify stakeholders in advance of the June 1 implementation. If the Scenario 2 regulation requirements will not be implemented in 2025, the NYISO will notify stakeholders in May 2025.

	April-May		June-August		September-October		November-March	
	Current Requirement	Scenario 2	Current Requirement	Scenario 2	Current Requirement	Scenario 2	Current Requirement	Scenario 2
HB	3,500MW Wind 3,000MW Solar	3,700MW LBW, 125MW OSW, 9,768MW Solar	3,500MW Wind 3,000MW Solar	3,700MW LBW, 125MW OSW, 9,768MW Solar	3,500MW Wind 3,000MW Solar	3,700MW LBW, 125MW OSW, 9,768MW Solar	3,500MW Wind 3,000MW Solar	3,700MW LBW, 125MW OSW, 9,768MW Solar
0	175	175	225	225	175	175	200	200
1	175	175	175	175	175	175	175	175
2	175	175	175	175	150	175	175	175
3	175	175	175	175	175	175	150	175
4	225	225	225	225	225	225	175	175
5	225	275	250	275	275	275	225	225
6	225	325	275	325	300	325	275	275
7	225	375	275	375	275	400	275	325
8	200	375	275	400	225	450	275	375
9	200	325	225	350	225	400	225	325
10	200	275	200	300	225	350	200	275
11	225	250	200	275	225	300	200	250
12	225	300	225	300	275	300	250	250
13	200	300	200	300	250	300	225	250
14	225	325	200	325	225	350	250	275
15	200	350	225	350	225	325	250	300
16	225	300	250	350	200	300	275	275
17	225	250	275	300	250	250	300	300
18	250	250	250	250	275	275	275	275
19	275	275	250	250	250	250	250	250
20	250	250	250	250	250	250	200	200
21	200	200	250	250	250	250	225	225
22	200	200	275	275	200	200	200	200
23	200	200	275	275	225	225	200	200

Chart – Regulation Requirements



Next Steps

- OC Approval
- Implementation of Scenario 1 results on June 01, 2023
- Future implementation of Scenario 2 results in 2025 with an advance notice to the marketplace

Appendix

Ancillary Services Manual Section 4.1

Requirements:

- The NYISO establishes the regulation and frequency response requirements consistent with criteria established by North American Electric Reliability Council (NERC), which may vary by hour and by season.
- Should the NYISO determine that it intends to establish regulation and frequency response requirements for any hour that are lower than any requirement for that hour in the seasonal regulation and frequency response requirements published as of March 1, 2004, it shall present, prior to posting, its analysis and the revised requirement to the Operating Committee for approval.
- Should the NYISO determine, for reliability reasons, that it intends to establish regulation and frequency response requirements for any hour that are higher than the requirement for that hour currently in effect, it shall raise the requirement, issue a notice as soon as possible, repost the hourly regulation and frequency response requirements for that season, and discuss its adjusted regulation and frequency response requirement for that hour at the next regularly scheduled Operating Committee meeting.

Section 1: Study Approach

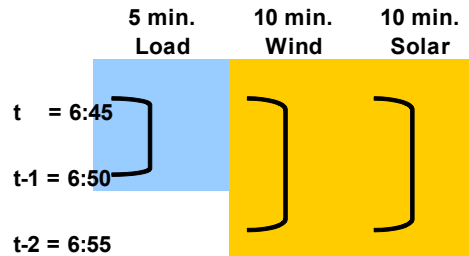
Studied Wind, Solar, and Load levels

- **Wind Data:** Actual 2018 wind data is leveraged to project NYCA wind generation in 5-min intervals at specified penetration levels
- **Solar Data:** Actual 2018 solar data is used to project NYCA solar generation in 5-min intervals at specified penetration levels
- **Load Data:** Actual 2018 5-min load data is leveraged to project NYCA load for 2024, 2026

Scenario	Year	Projected Load Peak (MW)	Projected Wind Penetration (MW)	Projected Solar Penetration (MW DC)
1	2024	33,180	3,000	7,651
2	2026	34,634	3,700	9,768

Sample Set

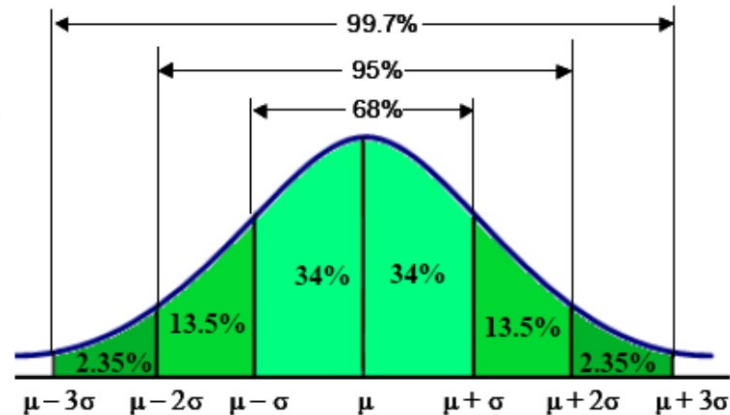
- The coincident wind and load data is evaluated to determine the net load on an interval to interval basis as well as the deltas, or differences, between successive intervals
- 5 minutes of load and 10 minutes of wind and solar output deltas (to account for wind persistence in the first interval of the real-time dispatch) are considered to establish the net load deltas



- $\Delta \text{Net Load} = \Delta \text{Load}(t-(t-1)) - \Delta \text{Wind}(t-(t-2)) - \Delta \text{Solar}(t-(t-2))$
where t, t-1 and t-2 represent 5 minute intervals

Variability

- The standard deviation of the net load deltas, a measure of how dispersed the observations are relative to the mean, is the measure of variability
- For each hour of each month, the net load delta variability corresponding to a 3-sigma level is calculated to determine the NYCA regulation requirement
- A 3-sigma level incorporates 99.7% of the net load deltas



Additional Background

- **The monthly regulation requirements were validated for consistency with the current seasonal definitions as follows:**
 - April – May
 - June – August
 - September – October
 - November – March

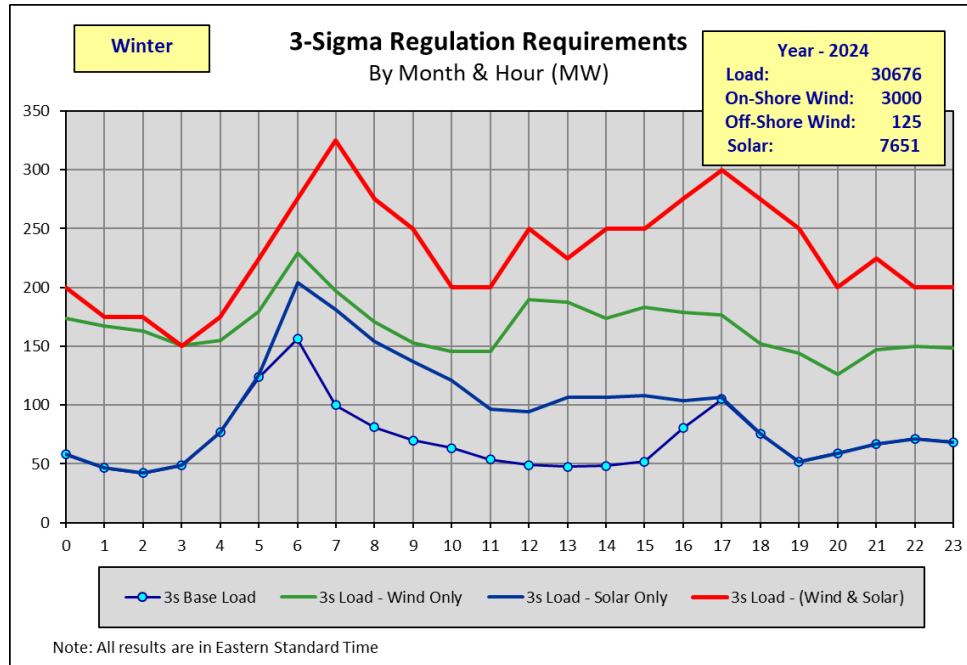
Section 2: Study Considerations

Data Validation

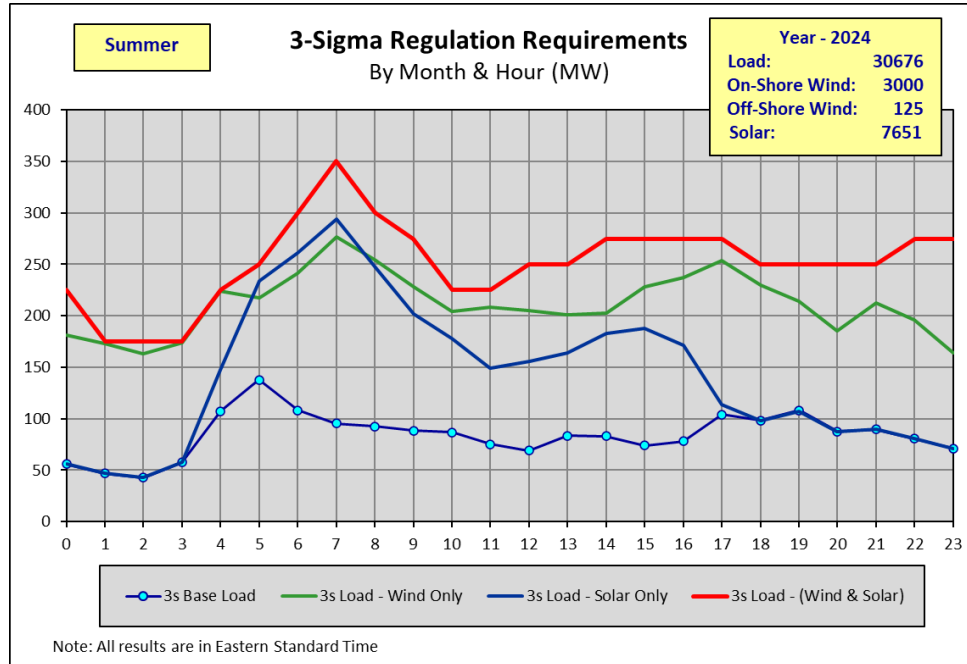
- **As part of the validation of the results, 5 adjustments were made to the raw study results as follows:**
 1. Regulation requirements set to 25MW increments
 2. Limited hour to hour regulation ramping to 50MW in order to minimize unnecessary real-time energy pricing volatility
 3. Limited the hourly change as we progress from current requirement through each scenario to 75MW

Section 3: Study Results

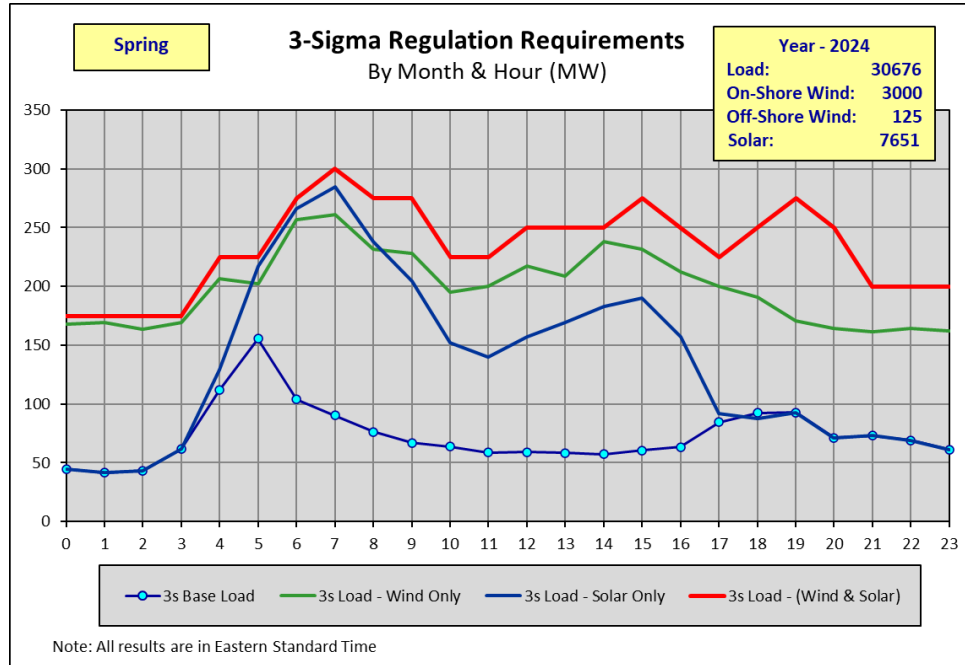
Scenario 1-2024



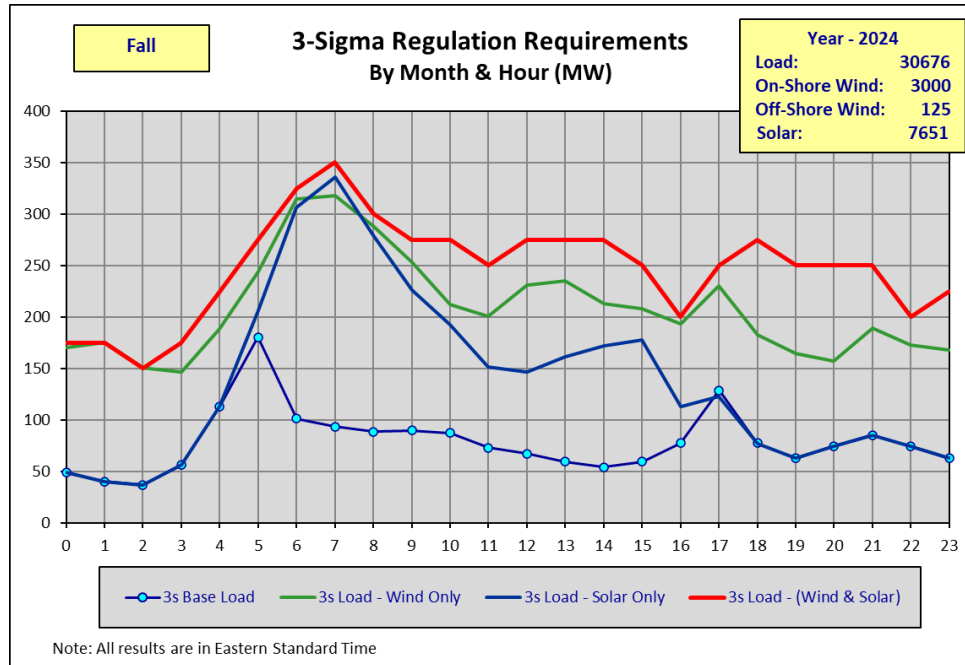
Scenario 1-2024



Scenario 1-2024



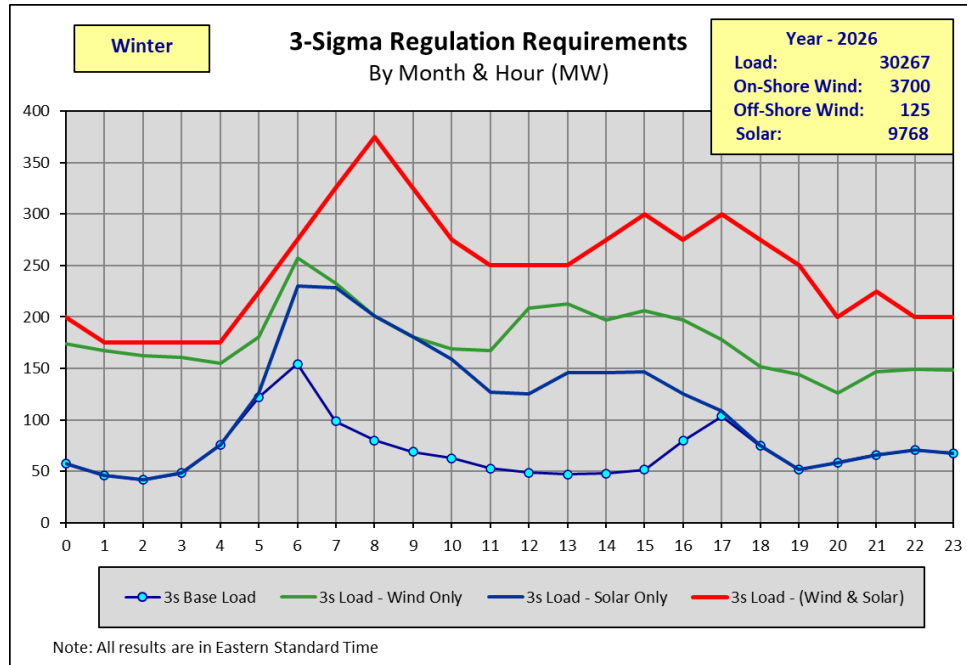
Scenario 1-2024



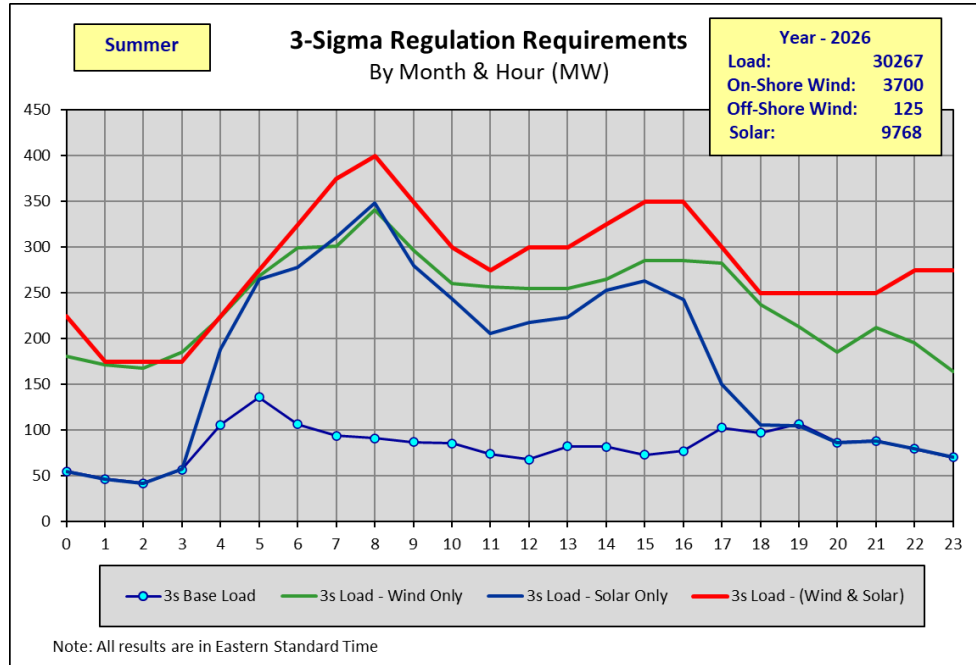
Scenario 1 - 3 Sigma Tables

Winter	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
3 σ Base Load	58	47	42	49	77	124	156	100	81	70	64	54	49	48	48	52	81	105	76	52	59	67	71	69
3 σ Load - Wind Only	174	167	163	151	155	179	230	197	171	153	145	146	190	187	174	183	179	176	152	144	126	147	150	149
3 σ Load - Solar Only	58	46.6	42.2	48.8	77.1	125	204	181	155	137	121	96.4	94	106	107	108	104	107	75.6	52.1	59.2	66.9	71.3	68.6
3 σ Load - (Wind & Solar)	200	175	175	150	175	225	275	325	275	250	200	200	250	225	250	250	275	300	275	250	200	225	200	200
Summer	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
3 σ Base Load	56	47	43	58	107	138	108	95	92	88	87	75	69	84	83	74	78	104	98	108	88	90	81	71
3 σ Load - Wind Only	181	173	163	174	224	217	241	277	254	228	204	208	205	201	203	228	237	253	230	214	185	212	196	164
3 σ Load - Solar Only	56	47	42.7	58	147	234	261	294	248	202	178	149	156	164	183	188	171	113	97.9	107	87.7	89.6	80.7	71.1
3 σ Load - (Wind & Solar)	225	175	175	175	225	250	300	350	300	275	225	225	250	250	275	275	275	275	250	250	250	250	275	275
Spring	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
3 σ Base Load	45	41	43	62	112	156	104	90	76	67	64	59	59	58	57	60	63	84	92	93	71	73	69	61
3 σ Load - Wind Only	168	169	164	169	207	202	257	261	232	228	195	200	218	209	238	231	212	200	191	171	164	161	164	162
3 σ Load - Solar Only	45	41.4	43.2	62	129	217	266	285	238	205	152	140	157	169	183	190	157	92.1	87.8	92.7	71.3	73.1	68.9	61.2
3 σ Load - (Wind & Solar)	175	175	175	175	225	225	275	300	275	275	225	225	250	250	250	275	250	225	250	275	250	200	200	200
Fall	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
3 σ Base Load	49	40	37	56	113	180	101	93	89	90	87	73	67	59	54	59	77	129	78	63	74	85	74	63
3 σ Load - Wind Only	170	175	151	147	189	244	315	318	288	253	212	201	231	235	213	208	193	230	182	165	157	189	173	168
3 σ Load - Solar Only	49	40.3	37	56.2	113	207	306	336	279	226	193	152	147	161	172	177	113	122	77.3	62.8	74.5	85.2	74.3	62.7
3 σ Load - (Wind & Solar)	175	175	150	175	225	275	325	350	300	275	275	250	275	275	275	250	200	250	275	250	250	200	200	225

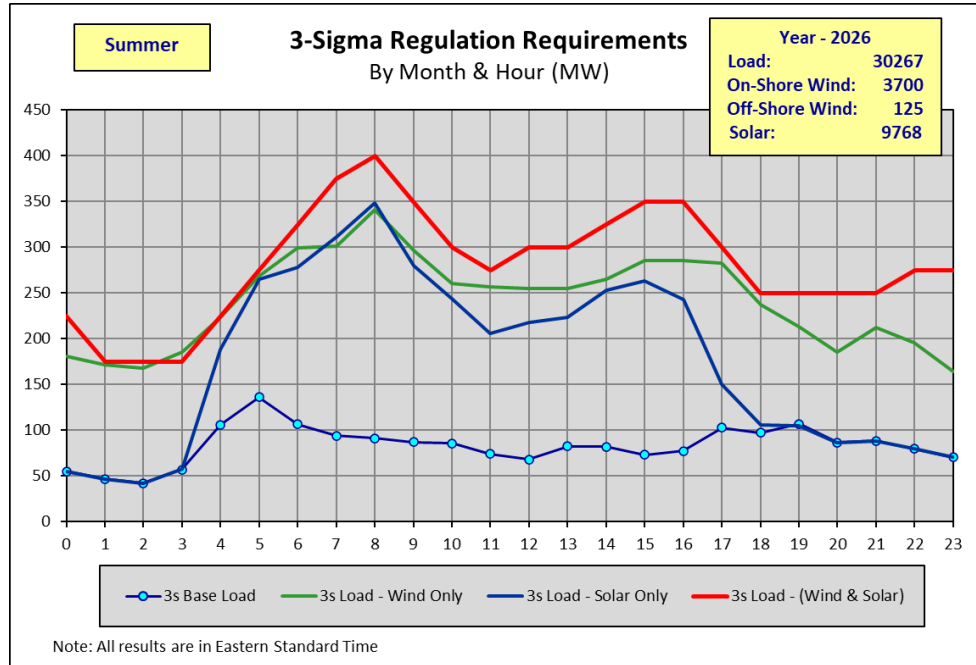
Scenario 2-2026



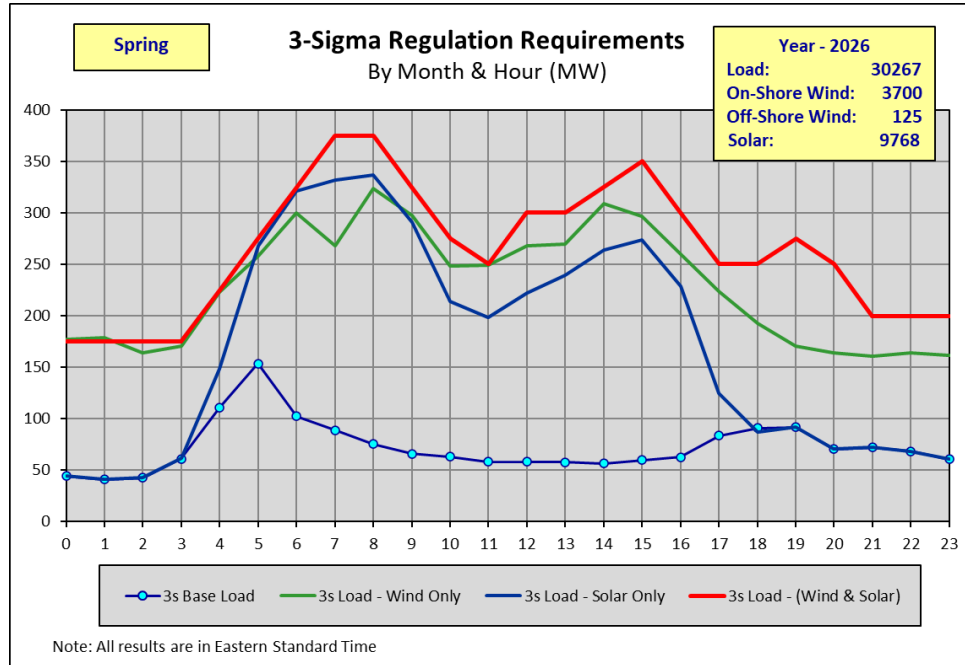
Scenario 2-2026



Scenario 2-2026



Scenario 2-2026








Scenario 2 – 3 Sigma Tables

Winter	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
3 σ Base Load	57	46	42	48	76	122	154	99	80	69	63	53	48	47	48	51	80	104	75	51	58	66	70	68
3 σ Load - Wind Only	174	167	163	160	155	180	258	233	201	180	169	167	209	213	197	206	197	178	152	144	126	147	149	148
3 σ Load - Solar Only	57	46	41.6	48.1	76	126	230	229	201	180	159	127	125	146	146	146	125	109	74.7	51.4	58.4	66.1	70.4	67.8
3 σ Load - (Wind & Solar)	200	175	175	175	175	225	275	325	375	325	275	250	250	250	275	300	275	300	275	250	200	225	200	200
Summer	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
3 σ Base Load	55	46	42	57	106	136	107	94	91	87	85	74	68	82	82	73	77	103	97	107	87	88	80	70
3 σ Load - Wind Only	181	171	168	185	223	269	299	301	341	296	261	257	255	254	265	285	285	283	237	213	185	212	196	164
3 σ Load - Solar Only	55	46.4	42.1	57.5	188	265	278	311	348	280	244	206	218	224	253	263	243	150	106	105	86.6	88.4	79.6	70.2
3 σ Load - (Wind & Solar)	225	175	175	175	225	275	325	375	400	350	300	275	300	300	325	350	350	300	250	250	250	250	275	275
Spring	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
3 σ Base Load	44	41	43	61	111	153	102	89	75	66	63	58	58	57	56	60	63	83	91	92	70	72	68	60
3 σ Load - Wind Only	177	179	164	170	223	258	300	268	324	298	248	250	268	269	309	297	260	224	193	170	164	161	164	162
3 σ Load - Solar Only	44	40.8	42.6	61.4	148	268	321	332	337	291	214	198	222	239	264	274	229	125	87.1	91.5	70.3	72.1	68.1	60.4
3 σ Load - (Wind & Solar)	175	175	175	175	225	275	325	375	375	325	275	250	300	300	325	350	300	250	250	275	250	200	200	200
Fall	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
3 σ Base Load	48	40	36	55	112	178	100	92	87	89	86	72	66	59	53	59	76	127	77	62	74	84	73	62
3 σ Load - Wind Only	170	175	171	146	190	201	249	315	404	327	271	249	276	292	274	262	218	233	182	164	157	188	172	168
3 σ Load - Solar Only	48	39.9	36.4	55.4	112	227	226	368	442	313	264	214	204	232	249	256	151	120	76.2	61.9	73.5	84	73.4	61.9
3 σ Load - (Wind & Solar)	175	175	175	175	225	275	325	400	450	400	350	300	300	300	350	325	300	250	275	250	250	200	200	225

Proposed Regulation Requirements

- Key to Tables

	Increase in Requirement				
	Decrease in Requirement				
	Requirement modified to eliminate >50MW delta in consecutive hours				
	Requirement modified to eliminate >75MW hourly delta in successive scenarios				
	Requirement modified to eliminate a reduction in hourly requirement in successive scenarios				

For Approval: Scenario 1 Regulation Requirements

	April-May		June-August		September-October		November-March	
	Current Requirement	Scenario#1	Current Requirement	Scenario#1	Current Requirement	Scenario#1	Current Requirement	Scenario#1
HB	3,500MW Wind 3,000MW Solar	3,000MW LBW, 125MW OSW, 7,651MW Solar	3,500MW Wind 3,000MW Solar	3,000MW LBW, 125MW OSW, 7,651MW Solar	3,500MW Wind 3,000MW Solar	3,000MW LBW, 125MW OSW, 7,651MW Solar	3,500MW Wind 3,000MW Solar	3,000MW LBW, 125MW OSW, 7,651MW Solar
0	175	175	225	225	175	175	200	200
1	175	175	175	175	175	175	175	175
2	175	175	175	175	150	150	175	175
3	175	175	175	175	175	175	150	150
4	225	225	225	225	225	225	175	175
5	225	225	250	250	275	275	225	225
6	225	275	275	300	300	325	275	275
7	225	300	275	350	275	350	275	325
8	200	275	275	300	225	300	275	275
9	200	275	225	275	225	275	225	250
10	200	225	200	225	225	275	200	200
11	225	225	200	225	225	250	200	200
12	225	250	225	250	275	275	250	250
13	200	250	200	250	250	275	225	225
14	225	250	200	275	225	275	250	250
15	200	250	225	275	225	250	250	250
16	225	275	250	275	200	200	275	275
17	225	250	275	275	250	250	300	300
18	250	250	250	250	275	275	275	275
19	275	275	250	250	250	250	250	250
20	250	250	250	250	250	250	200	200
21	200	200	250	250	250	250	225	225
22	200	200	275	275	200	200	200	200
23	200	200	275	275	225	225	200	200

- The weighted average across all hours for the year shows the regulation requirements increase by 15MW from current requirements

For Approval: Scenario 2 Regulation Requirements

	April-May		June-August		September-October		November-March	
	Current Requirement	Scenario 2	Current Requirement	Scenario 2	Current Requirement	Scenario 2	Current Requirement	Scenario 2
HB	3,500MW Wind 3,000MW Solar	3,700MW LBW, 125MW OSW, 9,768MW Solar	3,500MW Wind 3,000MW Solar	3,700MW LBW, 125MW OSW, 9,768MW Solar	3,500MW Wind 3,000MW Solar	3,700MW LBW, 125MW OSW, 9,768MW Solar	3,500MW Wind 3,000MW Solar	3,700MW LBW, 125MW OSW, 9,768MW Solar
0	175	175	225	225	175	175	200	200
1	175	175	175	175	175	175	175	175
2	175	175	175	175	150	175	175	175
3	175	175	175	175	175	175	150	175
4	225	225	225	225	225	225	175	175
5	225	275	250	275	275	275	225	225
6	225	325	300	325	325	325	275	275
7	225	375	350	375	350	400	325	325
8	200	375	300	400	300	450	275	375
9	200	325	275	350	275	400	250	325
10	200	275	225	300	275	350	200	275
11	225	250	225	275	250	300	200	250
12	225	300	250	300	275	300	250	250
13	200	300	250	300	275	300	225	250
14	225	325	275	325	275	350	250	275
15	200	350	275	350	250	325	250	300
16	225	300	275	350	200	300	275	275
17	225	250	275	300	250	250	300	300
18	250	250	250	250	275	275	275	275
19	275	275	250	250	250	250	250	250
20	250	250	250	250	250	250	200	200
21	200	200	250	250	250	250	225	225
22	200	200	275	275	200	200	200	200
23	200	200	275	275	225	225	200	200

Our mission, in collaboration with our stakeholders, is to serve the public interest and provide benefit to consumers by:

- Maintaining and enhancing regional reliability
- Operating open, fair and competitive wholesale electricity markets
- Planning the power system for the future
- Providing factual information to policymakers, stakeholders and investors in the power system

