Planning Year 2023-2024

Wind and Solar Capacity Credit Report

March 2023

Highlights

- MISO, in accordance with FERC acceptance of the Reliability Availability & Need (RAN) seasonal capacity construct (ER22-495-000), developed four unique seasonal class-average capacity values for wind for Planning Year 2023-2024, those being:

    - 18.1% for Summer 2023
    - 23.1% for Fall 2023
    - 40.3% for Winter 2023-2024
    - 23.0% for Spring 2024

- Solar default seasonal capacity credits in Planning Year 2023-2024 are 50% for all seasons, with the exception of Winter 2023-2024 for which the solar default capacity credit is 5%.

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Executive Summary

Since 2009, MISO has conducted a process to determine the capacity value for the increasing fleet of wind generation in the MISO system. The MISO process, as developed and vetted through the MISO stakeholder community, consists of a two-step method. The first step utilizes a probabilistic modeling approach to calculate the MISO system-wide seasonal Effective Load Carrying Capability (ELCC) values, representing the seasonal capacity contributions of the operational wind fleet in the MISO footprint. The second step employs a deterministic approach using the historical output of each wind resource during seasonal peak demand periods to allocate the MISO system-wide seasonal ELCC values across all operational wind Commercial Pricing Nodes (CPNodes) in the MISO system to determine unique Seasonal Accredited Capacity (SAC) values for each wind CPNode.

Seasonality was introduced to the wind capacity credit study this year to better capture the resource contributions of the wind fleet beyond just the annual, summer-focused peak period. Seasonal ELCC is measured during the LOLE study process in setting Resource Adequacy Requirements, and is also used in accreditation in two ways: the first is to establish the capacity credits a new wind resource will receive in its first year of operation, and the second is to deterministically allocate the total fleet-wide ELCC, per season, across the operational wind fleet on a pro rata basis dependent on their individual performance profiles during identified historical seasonal peak hours. Section 3 describes the details of the deterministic allocation methodology.

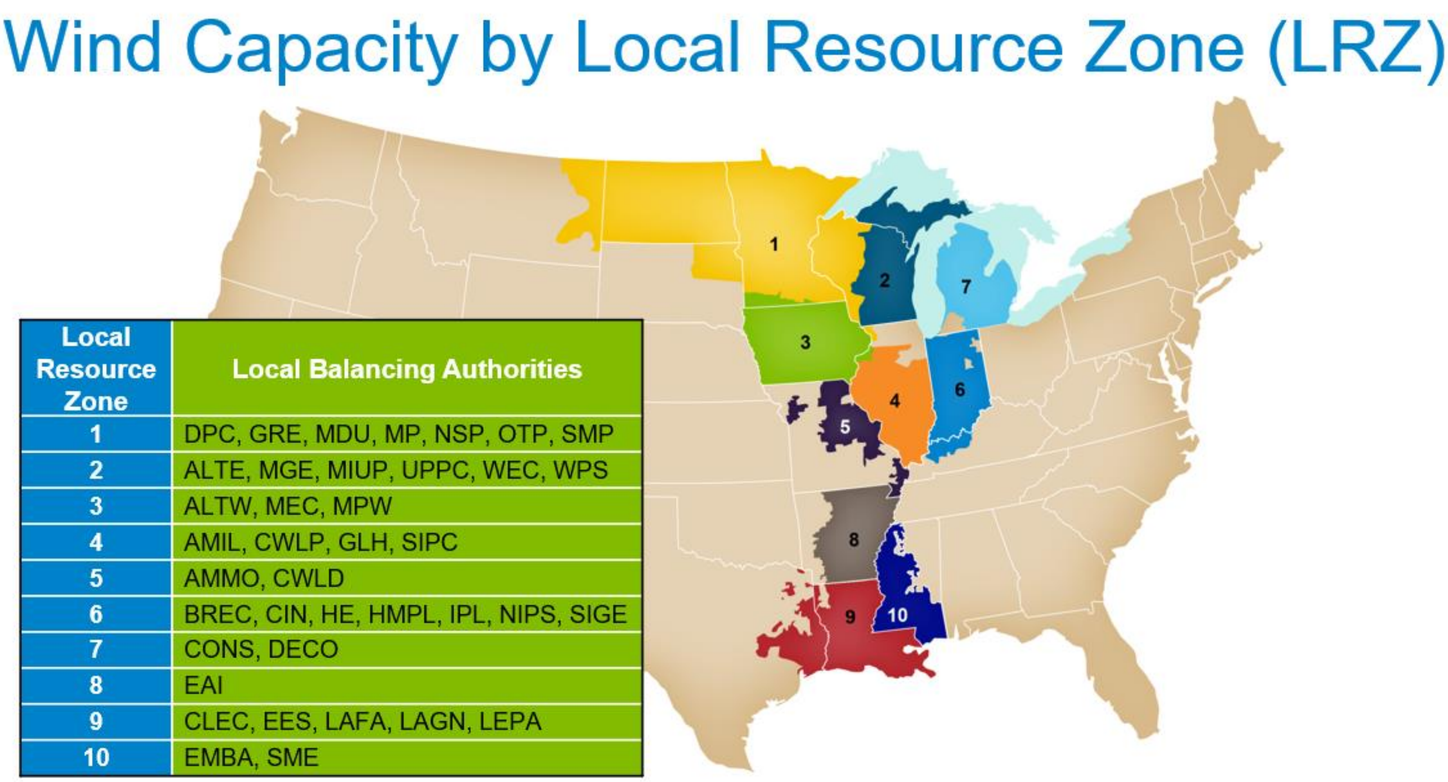
The FERC accepted Intermittent Deliverable ICAP tariff changes from October 2020 results in a slightly higher fleet-wide wind SAC versus the ELCC modeling. This capacity is allocatable for each season of Planning Year 2023-2024. To the extent that the individual wind CPNodes have demonstrated deliverability, SAC may be converted to Zonal Resource Credits (ZRCs) to meet Resource Adequacy obligations.

The capacity credits of the 264 individual wind CPNodes is proprietary information—however, upon request to MISO, the capacity credit details for individual wind CPNodes are available to the associated Market Participants. Figure 1-1 geographically illustrates the ten MISO Local Resource Zones (LRZs).The values shown in Table 1-1 have been combined for LRZs 5 & 6 so that proprietary information would not be revealed. MISO South does not currently have any wind CPNodes in operation.

Solar

New solar resources with less than 30 consecutive days of metered output will receive the default solar capacity credit of 50% for summer, fall, and spring, while the winter solar default capacity credit is 5%. Existing solar resources are accredited based on their performance during specific seasonal peak hours as outlined in Appendix V of the MISO Resource Adequacy BPM-011-r27, which describes how their accreditation will be determined from their average performance during hours ending 15, 16, & 17 for summer, fall, and spring, and hours ending 8, 9, 19, & 20 for winter.

As of December 2022, there are 4,323 MW nameplate of front-of-meter solar resources registered in the MISO system, representing an 85% increase from a year prior. MISO will continue to use a deterministic accreditation methodology for new solar resources until sufficient front-of-meter solar resources are in operation to warrant performance of a solar capacity credit study.



Local Resource Zone	Local Balancing Authorities
1	DPC, GRE, MDU, MP, NSP, OTP, SMP
2	ALTE, MGE, MIUP, UPPC, WEC, WPS
3	ALTW, MEC, MPW
4	AMIL, CWLP, GLH, SIPC
5	AMMO, CWLD
6	BREC, CIN, HE, HMPL, IPL, NIPS, SIGE
7	CONS, DECO
8	EAI
9	CLEC, EES, LAFA, LAGN, LEPA
10	EMBA, SME

Figure 1-1: MISO Local Resource Zones (LRZs) and Local Balancing Authorities (LBAs)

Planning Year 2023-2024 — Summer										
Metric	MISO	Zone 1	Zone 2	Zone 3	Zone 4	Zones 5 & 6	Zone 7	Zone 8	Zone 9	Zone 10
Registered Max (MW)	28,572	8,233	906	12,659	1,977	1,488	3,310	0	0	0
Total SAC (MW)	5,384	1,745	171	2,360	339	243	525	0	0	0
Average Credit %	17.4%	18.7%	15.5%	17.8%	16.5%	13.8%	15.0%	0.0%	0.0%	0.0%
Wind CPNode Count	264	97	12	96	15	9	34	0	0	0

Planning Year 2023-2024 — Fall										
Metric	MISO	Zone 1	Zone 2	Zone 3	Zone 4	Zones 5 & 6	Zone 7	Zone 8	Zone 9	Zone 10
Registered Max (MW)	27,207	8,233	906	12,125	1,370	1,488	3,085	0	0	0
Total SAC (MW)	6,570	2,111	154	2,970	274	346	717	0	0	0
Average Credit %	23.1%	24.1%	18.3%	23.4%	18.9%	21.2%	23.0%	0.0%	0.0%	0.0%
Wind CPNode Count	255	97	12	92	11	9	34	0	0	0

Planning Year 2023-2024 — Winter										
Metric	MISO	Zone 1	Zone 2	Zone 3	Zone 4	Zones 5 & 6	Zone 7	Zone 8	Zone 9	Zone 10
Registered Max (MW)	28,027	8,233	906	12,459	1,857	1,488	3,085	0	0	0
Total SAC (MW)	11,731	4,087	271	5,347	571	449	1,006	0	0	0
Average Credit %	40.2%	45.3%	29.2%	40.7%	29.2%	29.6%	35.4%	0.0%	0.0%	0.0%
Wind CPNode Count	261	97	12	95	14	9	34	0	0	0

Planning Year 2023-2024 — Spring										
Metric	MISO	Zone 1	Zone 2	Zone 3	Zone 4	Zones 5 & 6	Zone 7	Zone 8	Zone 9	Zone 10
Registered Max (MW)	28,572	8,233	906	12,659	1,977	1,488	3,310	0	0	0
Total SAC (MW)	6,993	2,086	191	3,166	509	342	699	0	0	0
Average Credit %	23.3%	23.6%	21.1%	24.0%	24.9%	21.8%	20.9%	0.0%	0.0%	0.0%
Wind CPNode Count	264	97	12	96	15	9	35	0	0	0

Table 1-1: Distribution of Wind Capacity by LRZ

MISO System-Wide Wind ELCC Study

Probabilistic Analytical Approach

The probabilistic measure of load not being served is known as Loss of Load Probability (LOLP) and when this probability is summed over a period of time, e.g. one year, it is known as Loss of Load Expectation (LOLE). The accepted industry standard for what has been considered a reliable system has been the "no more than 1 day in 10 years" criteria for LOLE. This measure is more often expressed as 0.1 day/year, as one year is the period of time for which the LOLE index is calculated.

Effective Load Carrying Capability (ELCC) is defined as the amount of incremental load a resource, such as wind, can dependably and reliably serve, while also considering the probabilistic nature of generation shortfalls and time-varying electric demand as driving factors to load not being served. ELCC has been used in the determination of capacity value for generation resources as far back as 1966 when L.L. Garver demonstrated the use of loss of load probability mathematics in the calculation of ELCC[1].

To measure the ELCC of a particular resource, the reliability effects need to be isolated for the resource in question from those of all the other sources. This is accomplished by calculating the LOLE of two different cases: one *with* and one *without* the resource. Inherently, the case *with* the resource should be more reliable and consequently have fewer days per year of expected loss of load (smaller LOLE).

[1] Garver, L.L.; , "Effective Load Carrying Capability of Generating Units," Power Apparatus and Systems, IEEE Transactions on, vol.PAS-85, no.8, pp.910-919, Aug. 1966

The new resource in the example shown in Figure 2-1 made the system 0.07 days/year more reliable, but there is another way to express the reliability contribution of the new resource besides the change in LOLE. This way requires establishing a common baseline reliability level and then adjusting the load in the two cases (*with* and *without* the new resource) to this common LOLE level. A common baseline that is chosen is the industry-accepted reliability standard of 1 day in 10 years (or 0.1 day/year) LOLE criteria.

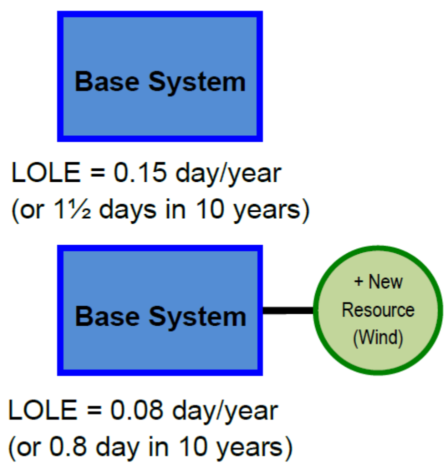


Figure 2-1: Example System *with* & *without* New Resource

With each case being at the same reliability level, as shown in Figure 2-2, the only difference between the two cases is the load adjustment values that were used to reach reliability. The difference between the adjustments for both cases is the amount of ELCC expressed in load or megawatts, which is 300 MW (100 minus -200) for the new resource in this example. This number may be divided by the Registered Maximum Capacity (RMax) of the new resource and then expressed in percentage form. The new resource in the ELCC example system in Figure 2-2 has an ELCC of 30 percent of the resource's nameplate capacity.

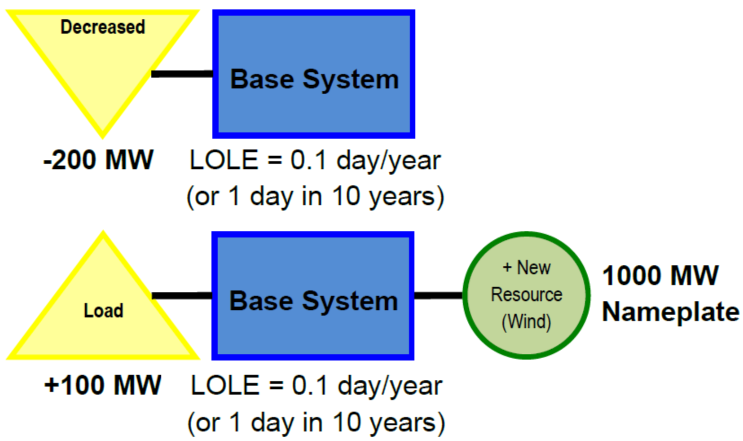


Figure 2-2: ELCC Example System at the Same LOLE

The methodology illustrated in the simple example of Figure 2-2 was utilized as the analytical approach for the determination of the MISO system-wide ELCC of the wind resources in the much more complex MISO system. ELCC is the current industry standard methodology for determining the capacity value of wind[2]—however, MISO is actively exploring alternative methods of accreditation for wind, solar, and other intermittent resource types.

[2] Keane, A.; Milligan, M.; Dent, C.J.; Hasche, B.; D'Annunzio, C.; Dragoon, K.; Holttinen, H.; Samaan, N.; Soder, L.; O'Malley, M.; , "Capacity Value of Wind Power," Power Systems, IEEE Transactions on , vol.26, no.2, pp.564-572, May 2011

LOLE Model Inputs & Assumptions

MISO applies the ELCC calculation methodology by utilizing the Strategic Energy & Risk Valuation Model (SERVM) program by Astrapé Consulting to calculate LOLE values with and without wind resources modeled. This model consists of three major inputs:

1. Generator Forced Outage Rates (EFORd)
2. Hourly Zonal Load Profiles
3. Hourly Zonal Renewable Profiles

Forced outage rates are used for the conventional type of resources in the LOLE model. These EFORd are calculated from the Generator Availability Data System (GADS) that MISO uses to collect historic operation performance data for all conventional resource types in the MISO system.

For the MISO Planning Year 2023-2024 Wind Capacity Credit study, the hourly concurrent load and wind output over the most recent 30 years of data utilized in the LOLE study modeling was used to calculate the seasonal wind ELCC values for the wind fleet in MISO on a system-wide basis.

MISO System-Wide Seasonal Wind ELCC Results

Table 2-1 details the results of the LOLE study modeling ELCC analysis. Fleet-wide wind ELCC is calculated by multiplying the seasonal ELCC percentages by the allocatable fleet-wide wind RMax from the seasonal deterministic allocation. More details regarding the LOLE study analysis can be found in the LOLE Study Report published annually in November.

	LOLE Adjustments			
Season	**Wind Included**	**Wind Removed**	**Fleet-wide RMax**	**ELCC**
Summer	-2,650	2,000	25,632	18.1%
Fall	-8,000	-2,000	25,944	23.1%
Winter	-6,700	4,700	28,260	40.3%
Spring	-10,000	-3,500	28,260	23.0%

Table 2-1: LOLE Study ELCC Modeling Results

As a result of FERC accepting the Intermittent Deliverable ICAP tariff changes (FERC Docket #ER20-2005), a slightly higher fleet-wide wind SAC is allocatable, determined as the resulting SAC total from the summation (at the resource level) of the larger of two fleet-wide allocation methodologies, with and without curtailments added to settled output during each of the 24 sampled peaks for each seasonal allocation lookback. Section 3 describes the details of those enhancements to the allocation methodology. The amount of SAC at each CPNode that can qualify for the seasonal Planning Resource Auction under Module E-1 is subject to the deliverability procured for each resource.

Details of Wind Capacity by CPNode

Correlated Peak Load and Wind Output

Fleet-wide wind ELCC, calculated by multiplying the seasonal wind ELCC % determined from the LOLE study modeling by the total nameplate of the front-of-meter (CPNode) wind fleet, is allocated across the existing and in-operation front-of-meter wind resources based on their historical performance during seasonal peak. A selection of the top 8 coincident system unique-day peak hours for each Planning Year over a period of the most recent 3 Planning Years is the basis for the 24 sample points for each seasonal allocation lookback. Tables 3-1, 3-2, 3-3, and 3-4 are a listing of the total system wind output at the time of each of the 24 daily peak loads pertaining to each seasonal allocation.

Hour Ending EST of Daily Peak	Wind Registered Max (MW)	Estimated Curtailment (MW)	Wind Output at Daily Peak Load [1] (MW)	Wind Output % of Registered Max at Daily Peak Load [1]	Daily Peak Load (MW)	Year	Planning Year Daily Peak Rank
7/2/20 15:00	21,792	344	3,099	14.2%	111,654	2020	8
7/6/20 15:00	21,888	317	1,800	8.2%	112,068	2020	6
7/7/20 15:00	21,987	416	3,149	14.3%	112,641	2020	5
7/8/20 14:00	21,987	274	8,352	38.0%	114,027	2020	2
7/9/20 15:00	21,987	513	6,250	28.4%	114,002	2020	3
7/17/20 16:00	21,987	508	11,807	53.7%	113,079	2020	4
8/24/20 16:00	22,837	411	6,898	30.2%	116,795	2020	1
8/25/20 15:00	22,837	526	7,232	31.7%	111,690	2020	7
7/26/21 16:00	25,696	1,045	8,116	31.6%	116,756	2021	5
7/27/21 16:00	26,056	111	5,154	19.8%	116,458	2021	7
7/28/21 16:00	26,206	443	9,510	36.3%	118,082	2021	2
7/29/21 15:00	26,206	157	5,672	21.6%	116,538	2021	6
8/10/21 15:00	26,599	220	6,621	24.9%	117,595	2021	3
8/23/21 16:00	26,599	167	3,169	11.9%	116,375	2021	8
8/24/21 15:00	26,599	1,741	9,794	36.8%	118,259	2021	1
8/25/21 16:00	26,599	171	2,452	9.2%	117,173	2021	4
6/14/22 16:00	28,572	2,286	18,763	65.7%	117,202	2022	5
6/15/22 15:00	28,572	3,487	17,079	59.8%	115,709	2022	6
6/21/22 16:00	28,572	1,302	15,624	54.7%	120,684	2022	1
7/5/22 16:00	28,572	405	6,678	23.4%	115,684	2022	7
7/19/22 16:00	28,572	1,512	17,436	61.0%	118,466	2022	3
7/20/22 16:00	28,572	1,280	19,213	67.2%	118,718	2022	2
7/21/22 15:00	28,572	309	9,650	33.8%	117,210	2022	4
7/22/22 16:00	28,572	190	6,518	22.8%	115,560	2022	8
System-Wide Average Peak Metric Capacity Factor				**31.4%**			
Note [1] **Curtailed MW have been added to settlement MW**							

Table 3-1: Historical Wind Output Correlated with Summer Peak

Hour Ending EST of Daily Peak	Wind Registered Max (MW)	Estimated Curtailment (MW)	Wind Output at Daily Peak Load [1] (MW)	Wind Output % of Registered Max at Daily Peak Load [1]	Daily Peak Load (MW)	Year	Planning Year Daily Peak Rank
9/3/19 16:00	19,565	1,026	12,357	63.2%	102,334	2019	6
9/10/19 16:00	19,565	280	2,934	15.0%	104,342	2019	2
9/11/19 15:00	19,565	172	5,232	26.7%	106,370	2019	1
9/12/19 15:00	19,565	594	9,181	46.9%	102,421	2019	5
9/16/19 16:00	19,565	119	5,452	27.9%	103,862	2019	3
9/17/19 15:00	19,565	819	10,382	53.1%	103,093	2019	4
9/18/19 15:00	19,565	212	7,293	37.3%	101,878	2019	7
9/20/19 15:00	19,565	709	9,479	48.4%	101,351	2019	8
9/1/20 14:00	23,395	425	6,377	27.3%	91,656	2020	3
9/2/20 16:00	23,395	198	7,983	34.1%	94,939	2020	2
9/3/20 15:00	23,545	1,786	16,536	70.2%	95,623	2020	1
9/4/20 15:00	23,545	293	8,479	36.0%	86,451	2020	6
9/7/20 16:00	23,545	1,103	10,061	42.7%	85,845	2020	7
9/8/20 14:00	23,545	1,039	10,450	44.4%	87,926	2020	5
9/9/20 16:00	23,545	275	7,149	30.4%	88,334	2020	4
11/30/20 19:00	25,341	204	7,533	29.7%	85,800	2020	8
9/7/21 16:00	27,207	2,227	19,070	70.1%	95,553	2021	3
9/13/21 16:00	27,207	0	8,813	32.4%	94,462	2021	5
9/14/21 14:00	27,207	188	7,779	28.6%	94,292	2021	6
9/16/21 16:00	27,207	2,582	16,405	60.3%	94,781	2021	4
9/17/21 16:00	27,207	126	5,554	20.4%	95,582	2021	2
9/19/21 16:00	27,207	3,858	16,085	59.1%	93,797	2021	7
9/20/21 16:00	27,207	3,931	18,063	66.4%	97,236	2021	1
9/27/21 16:00	27,207	92	4,688	17.2%	92,161	2021	8
System-Wide Average Peak Metric Capacity Factor				**38.6%**			
Note [1] **Curtailed MW have been added to settlement MW**							

Table 3-2: Historical Wind Output Correlated with Fall Peak

Hour Ending EST of Daily Peak	Wind Registered Max (MW)	Estimated Curtailment (MW)	Wind Output at Daily Peak Load [1] (MW)	Wind Output % of Registered Max at Daily Peak Load [1]	Daily Peak Load (MW)	Year	Planning Year Daily Peak Rank
12/10/2019 19:00	21,043	262	6,127	29.1%	91,169	2019	8
12/11/2019 8:00	21,043	422	7,245	34.4%	91,963	2019	6
12/17/2019 19:00	21,243	309	9,847	46.4%	92,787	2019	5
12/18/2019 8:00	21,243	381	6,699	31.5%	94,342	2019	3
12/19/2019 8:00	21,243	324	7,628	35.9%	94,690	2019	2
1/21/2020 8:00	21,876	338	11,693	53.5%	93,942	2020	4
2/14/2020 8:00	22,226	352	13,510	60.8%	95,527	2020	1
2/21/2020 8:00	22,226	901	18,208	81.9%	91,339	2020	7
2/11/2021 19:00	26,289	193	7,575	28.8%	94,421	2021	7
2/12/2021 19:00	26,289	201	5,234	19.9%	95,959	2021	5
2/13/2021 19:00	26,289	212	7,433	28.3%	94,116	2021	8
2/14/2021 19:00	26,289	172	5,556	21.1%	98,984	2021	2
2/15/2021 19:00	26,289	673	7,522	28.6%	102,601	2021	1
2/16/2021 9:00	26,289	286	4,910	18.7%	98,271	2021	3
2/17/2021 9:00	26,289	202	4,330	16.5%	97,927	2021	4
2/19/2021 8:00	26,289	203	3,059	11.6%	95,620	2021	6
1/7/2022 8:00	28,027	143	4,496	16.0%	98,678	2022	3
1/11/2022 8:00	28,027	2,168	19,900	71.0%	94,706	2022	6
1/20/2022 19:00	28,027	611	5,532	19.7%	96,542	2022	4
1/21/2022 8:00	28,027	2,122	16,123	57.5%	99,575	2022	2
1/26/2022 8:00	28,027	1,738	15,401	54.9%	99,614	2022	1
1/27/2022 8:00	28,027	692	19,637	70.1%	93,715	2022	8
2/4/2022 9:00	28,027	1,291	15,513	55.4%	95,688	2022	5
2/14/2022 8:00	28,027	1,639	11,773	42.0%	93,727	2022	7
System-Wide Average Peak Metric Capacity Factor				**36.3%**			
Note [1] **Curtailed MW have been added to settlement MW**							

Table 3-3: Historical Wind Output Correlated with Winter Peak

Hour Ending EST of Daily Peak	Wind Registered Max (MW)	Estimated Curtailment (MW)	Wind Output at Daily Peak Load [1] (MW)	Wind Output % of Registered Max at Daily Peak Load [1]	Daily Peak Load (MW)	Year	Planning Year Daily Peak Rank
3/5/2020 8:00	21,926	2,255	17,992	82.1%	77,575	2020	7
3/6/2020 8:00	21,926	226	9,163	41.8%	79,499	2020	5
3/16/2020 10:00	21,926	285	2,848	13.0%	78,856	2020	6
3/18/2020 12:00	21,926	371	1,971	9.0%	77,244	2020	8
5/25/2020 17:00	22,295	250	3,053	13.7%	82,642	2020	4
5/26/2020 16:00	22,295	576	7,032	31.5%	91,170	2020	1
5/27/2020 15:00	22,295	364	4,206	18.9%	88,832	2020	2
5/28/2020 14:00	22,295	3,168	16,221	72.8%	83,454	2020	3
5/20/2021 16:00	26,180	2,340	15,087	57.6%	87,257	2021	5
5/21/2021 15:00	26,180	2,490	16,781	64.1%	88,334	2021	4
5/22/2021 17:00	26,180	126	7,772	29.7%	86,784	2021	6
5/23/2021 16:00	26,180	259	7,305	27.9%	84,217	2021	8
5/24/2021 16:00	26,180	2,299	15,937	60.9%	94,356	2021	2
5/25/2021 15:00	26,180	2,142	19,078	72.9%	97,593	2021	1
5/26/2021 16:00	26,180	137	5,810	22.2%	90,046	2021	3
5/27/2021 14:00	26,364	1,300	14,326	54.3%	85,225	2021	7
5/10/2022 17:00	28,572	287	9,725	34.0%	93,499	2022	6
5/11/2022 16:00	28,572	4,079	18,468	64.6%	99,438	2022	3
5/12/2022 16:00	28,572	4,195	20,496	71.7%	103,051	2022	1
5/13/2022 15:00	28,572	1,975	9,866	34.5%	96,644	2022	4
5/19/2022 16:00	28,572	1,958	19,810	69.3%	90,203	2022	8
5/20/2022 16:00	28,572	3,907	19,883	69.6%	92,432	2022	7
5/30/2022 17:00	28,572	967	19,669	68.8%	95,473	2022	5
5/31/2022 16:00	28,572	2,403	19,025	66.6%	102,193	2022	2
System-Wide Average Peak Metric Capacity Factor				**45.9%**			
Note [1] **Curtailed MW have been added to settlement MW**							

Table 3-4: Historical Wind Output Correlated with Spring Peak

Deterministic Analytical Technique

To account for the diverse generation profile of numerous wind CPNodes throughout the MISO system (264 front-of-meter wind resources as of June 2022), a deterministic approach that accounts for historical performance during unique-day system peak demand hours is used to equitably allocate the seasonal fleet-wide wind SAC to all of the registered and in-service wind CPNodes. While evaluation of all CPNodes captures the benefit of the geographic diversity, it is also important to assign the capacity credit of wind at the individual CPNode locations to recognize the capacity contributions of each individual wind resource. In a market, it is important to convey where wind resources tend to provide more capacity value, and how the location and corresponding relative performance of each wind CPNode relates to the contribution of wind ELCC to system-wide reliability.

For Summer 2023, the system-wide wind seasonal ELCC percentage value of 18.1 multiplied by the in-service wind registered maximum capacity (RMax) of 28,572 MW results in 5,172 MW of allocatable system-wide seasonal wind capacity. New wind CPNodes that do not have historical output data would receive the class-average seasonal wind capacity credit of 18.1 percent. The seasonal allocation lookback period for Summer 2023 included the top 8 coincident system peaks for Summer 2020, Summer 2021, and Summer 2022.

For Fall 2023, the system-wide wind seasonal ELCC percentage value of 23.1 multiplied by the in-service wind registered maximum capacity (RMax) of 27,207 MW results in 6,285 MW of allocatable system-wide seasonal wind capacity. New wind CPNodes that do not have historical output data would receive the class-average seasonal wind capacity credit of 23.1 percent. The seasonal allocation lookback period for Fall 2023 included the top 8 coincident system peaks for Fall 2019, Fall 2020, and Fall 2021.

For Winter 2023-2024, the system-wide wind seasonal ELCC percentage value of 40.3 multiplied by the in-service wind registered maximum capacity (RMax) of 28,027 MW results in 11,295 MW of allocatable system-wide seasonal wind capacity. New wind CPNodes that do not have historical output data would receive the class-average seasonal wind capacity credit of 40.3 percent. The seasonal allocation lookback period for Winter 2023-2024 included the top 8 coincident system peaks for Winter 2019-2020, Winter 2020-2021, and Winter 2021-2022.

For Spring 2024, the system-wide wind seasonal ELCC percentage value of 23.0 multiplied by the in-service wind registered maximum capacity (RMax) of 28,572 MW results in 6,572 MW of allocatable system-wide seasonal wind capacity. New wind CPNodes that do not have historical output data would receive the class-average seasonal wind capacity credit of 23.0 percent. The seasonal allocation lookback period for Spring 2024 included the top 8 coincident system peaks for Spring 2020, Spring 2021, and Spring 2022.

Seasonal fleet-wide wind capacity is distributed across the individual allocatable wind CPNodes under two allocation techniques, or resource-share calculations: one with curtailments and one without curtailments added to each individual wind resource's output during seasonal peak. These two techniques yield two slightly different capacity values for each wind resource with each resource being granted the larger of the two allocated capacity values. A wind resource's allocatable portion of the fleet-wide wind capacity is referred to as its Total SAC.

The next step is to determine how much of the Total SAC each wind resource is granted from the resource-share calculations is eligible to be converted into ZRCs—but before that can be calculated, the demonstrated deliverability of the wind resource must be known. Deliverability is determined in accordance with Module E-1 (section 69A.3.1.g) of the MISO Tariff. At a high level, deliverability of a wind resource is quantified as the combination of existing Network Resource Interconnection Service (NRIS) and Energy Resource Interconnection Service with a valid Transmission Service Request (ERIS w/ TSR). TSRs can be either in the form of Network Integration Transmission Service (NITS) or Point-to-Point (PTP). TSRs must contain Scheduling Rights that are active for the entire season(s) a wind resource would be converted into ZRCs for.

Historic output has been tracked for each wind CPNode over the top 8 seasonal peak hours for the most recent 3 Planning Years for a total of 24 sampled peaks pertaining to each seasonal lookback period. The average capacity factor for each CPNode during all 24 (*8 hours x 3 Planning Years*) historical seasonal peak hours is called the *Peak Performance Capacity Factor* (also referred to as the $PKmetric_{CPNode}$) for that CPNode. The capacity factor over those 24 hours and the RMax of each CPNode are the basis for allocating the fleet-wide wind capacity to the allocatable CPNodes. If the market start date of the CPNode was after the start of the seasonal allocation lookback period, the average capacity factor over the years it was in operation is used.

The Total SAC for a wind resource is distributed into two categories for the purpose of determining the amount of capacity eligible for conversion into Zonal Resource Credits (ZRCs), either convertible SAC or undeliverable SAC. To calculate convertible SAC, which is eligible to be converted into ZRCs, a *Deliverability Adjusted Capacity Factor* is first applied. The *Deliverability Adjusted Capacity Factor* uses historical peak observances of a wind resource and is calculated by 'capping' historical wind output during peak load observances to the resource's demonstrated deliverability and then dividing by the resource's RMax. The *Peak Performance Capacity Factor* utilizes identical historical peak observances divided by the resource's RMax, but does not cap those observances by the resource's demonstrated deliverability.

$$\text{Convertible SAC} = \text{Total Interconnection SAC} * \frac{\text{Deliverability Adjusted Capacity Factor}}{\text{Peak Performance Capacity Factor}}$$

The remaining Total SAC that is left after calculating convertible SAC is considered the undeliverable SAC.

Optionally, the undeliverable SAC can become eligible to be converted into ZRCs by procuring firm Transmission Service. Figure 3-1 represents the conversion of SAC to ZRCs at the resource level as a block diagram.

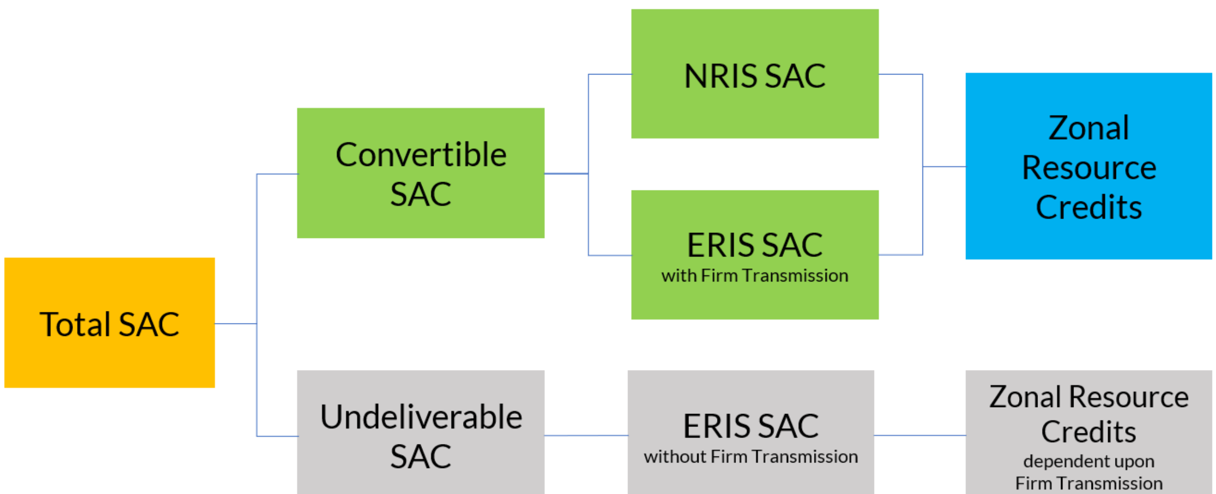


Figure 3-1: Block Diagram of Conversion of Total Seasonal Accredited Capacity to Zonal Resource Credits

Each wind resource will have unique Convertible SAC values generated based on its past performance and deliverability, which indicates the level of firm Transmission Service necessary to obtain a given level of ZRCs. The resource-specific deliverability curves (described on the following page) illustrate how much SAC is convertible at varying amounts of deliverability.

An example and further explanation are shown in Figure 3-2 below:

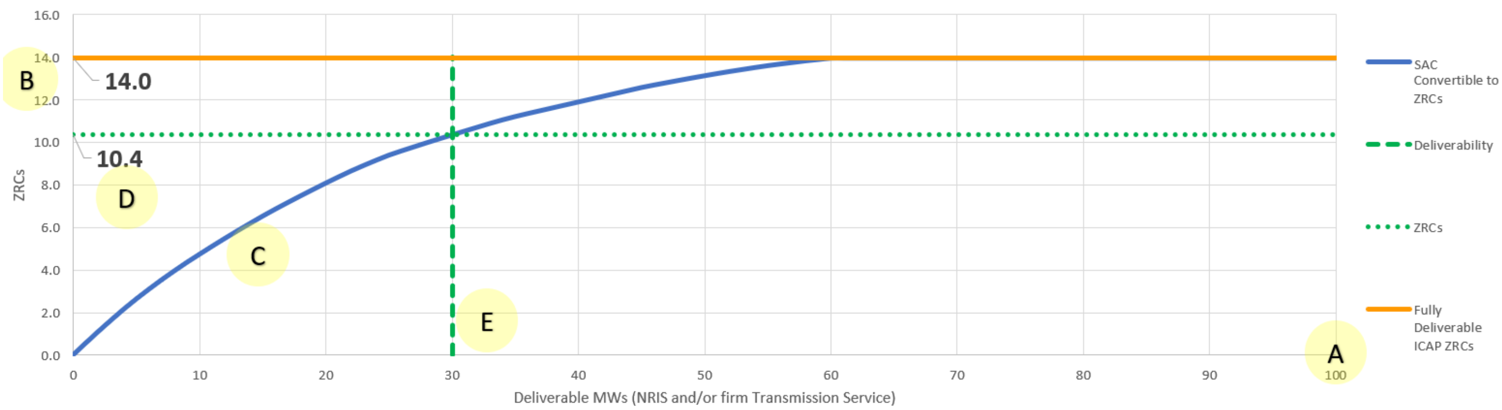


Figure 3-2: ZRC Deliverability Curve Chart

Where:

A: Equals the registered maximum output of the resource (RMax). In this example, this resource is 100 MW.

B: Total SAC that can potentially be converted into ZRCs. This also represents the share of the fleet-wide ELCC capacity. This value is based on the size and performance of the resource.

C: This is the Convertible SAC function which is the resource's Total SAC multiplied by the ratio of its *Deliverability Adjusted Capacity Factor* divided by its *Peak Performance Capacity Factor*. Convertible SAC varies depending on the amount of demonstrated deliverability of the resource.

D: This is the resulting Convertible SAC value for a corresponding demonstrated deliverability amount in MW.

E: This is the example Deliverable value. The point at which E intersects C provides the amount of ZRCs the Market Participant would obtain based on the size, performance, and demonstrated deliverability of the resource. Undeliverable SAC is the difference between Total SAC and Convertible SAC.

Wind CPNode Equations

Registered Maximum (RMax) is the MISO Commercial Model term for the nameplate capacity of a resource. The relationship of the wind capacity rating to a CPNode's RMax value and Capacity Credit percent is expressed as:

$$(\text{Wind Capacity Rating})_{\text{CPNode n}} = \text{RMax}_{\text{CPNode n}} \times (\text{Capacity Credit \%})_{\text{CPNode n}} \quad (1)$$

Where $\text{RMax}_{\text{CPNode n}}$ = Registered Maximum nameplate capacity of the wind facility at the CPNode n. The right most term in expression (1), the $(\text{Capacity Credit \%})_{\text{CPNode n}}$, can be replaced by the expression (2):

$$(\text{Capacity Credit \%})_{\text{CPNode n}} = K \times (\text{PKmetric}_{\text{CPNode n}}\%) \quad (2)$$

PKmetric is a capacity factor calculation, measuring performance over the unique-day system peak demand hours for each seasonal lookback period for each of the two resource-share allocation techniques.

Where the K value for each seasonal allocation technique was found by obtaining the PKmetric at each CPNode over the applicable seasonal allocation lookback period, and solving expression (3):

$$K = \frac{\text{ELCC}}{\sum_{1}^{n} (\text{RMax}_{\text{CPNode n}} \times \text{PKmetric}_{\text{CPNode n}})} \quad (3)$$

Total SAC is the greater-of value when comparing the two resulting Capacity Credit % values from both resource-share allocation techniques.

Table 3-5 lists the K values for each season under each of the two allocation techniques, curtailments included and curtailments not included.

Season	Technique 1: with Curtailments	Technique 2: without Curtailments
Summer	0.5220657	0.5702296
Fall	0.5619222	0.6174309
Winter	1.0442400	1.1252316
Spring	0.4652654	0.5299292

Table 3-5: Seasonal K Values by Allocation Technique

This results in the sum of the MW ratings calculated for the CPNodes equal to the system-wide summer ELCC SAC of 5,172 MW. The values in (3) pertaining to Technique 1 for Summer 2023 are:

$$ELCC = 5{,}172 \text{ MW}$$

$$\sum RMax_{CPNode\ n} \times PKmetric_{CPNode\ n} = 9{,}906 \text{ MW}$$

$$\text{Therefore: } K = 0.5220657 = 5{,}172 / 9{,}906$$

Wind CPNode Capacity Credit Results

Figures 3-3, 3-4, 3-5, & 3-6 show how the system-wide seasonal wind ELCC percentages compare with the individual seasonal wind capacity credit percentages for the 264 active wind CPNodes, as of the 2nd quarter of 2022. This reflects implementing the deterministic allocation formulas referred to earlier in this section to allocate the fleet-wide seasonal wind capacity credit across the CPNodes based on their individual performance during seasonal peak. The wind CPNodes have been sorted by their individual capacity credit percentages. The capacity credit percentage is applied to each wind resource's RMax to provide the maximum amount of SAC that is convertible to ZRCs in each seasonal auction period of the 2023-2024 Planning Resource Auction. Each wind resource's demonstrated deliverability is considered when determining its respective amount of SAC that qualifies for Zonal Resource Credits.

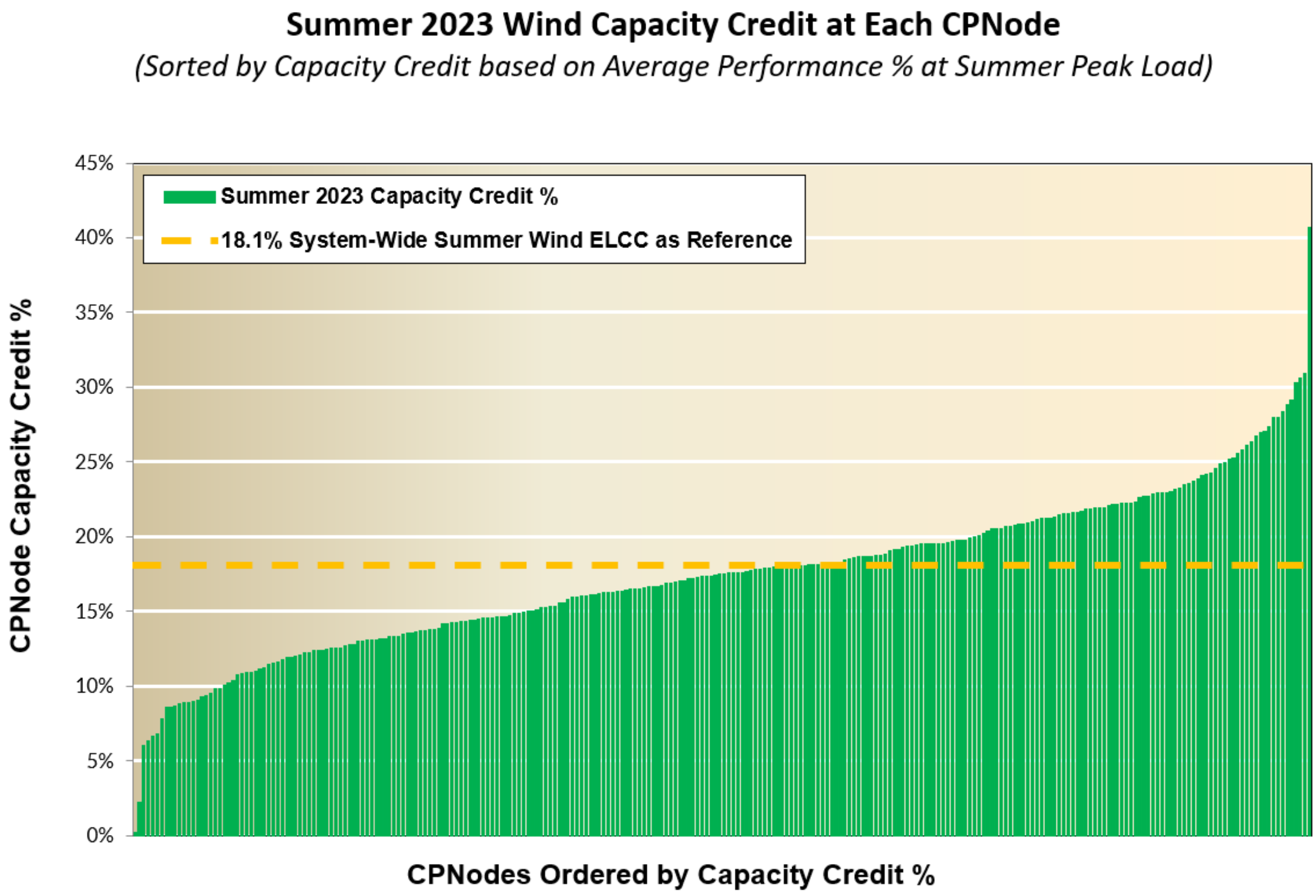


Figure 3-3: Summer 2023 Wind CPNode Capacity Credits

The individual $PKmetric_{CPNode}$ of the wind CPNodes ranged from 0.5% to 71.4%. The individual Summer 2023 wind capacity credit percentages ranged from 0.3% to 40.7%, by applying expression (2) using the applicable Summer 2023 K value pertaining to the resource-share allocation technique resulting in the higher Total SAC value for each wind CPNode.

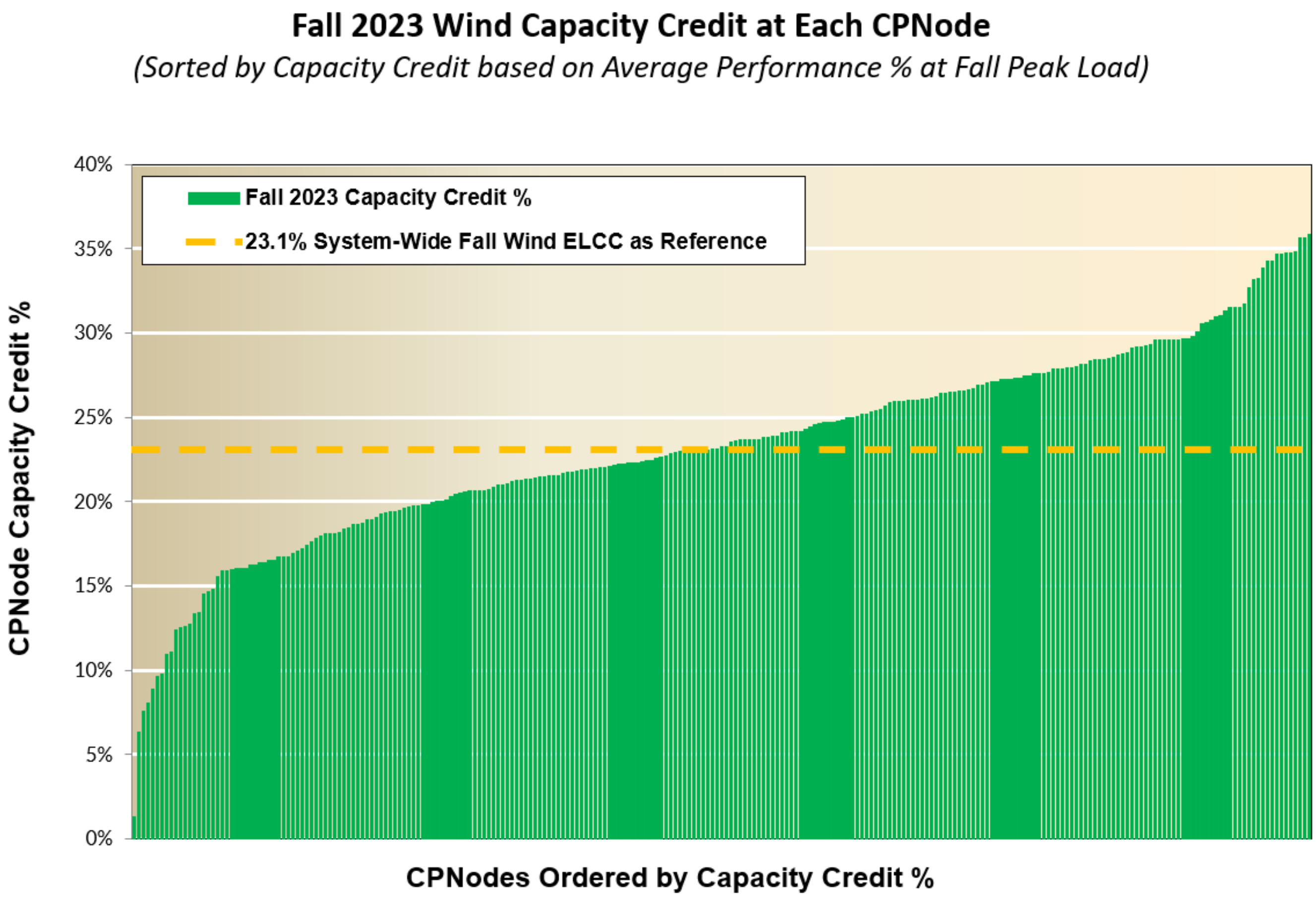


Figure 3-4: Fall 2023 Wind CPNode Capacity Credits

The individual $PKmetric_{CPNode}$ of the wind CPNodes ranged from 2.3% to 58.0%. The individual Fall 2023 wind capacity credit percentages ranged from 1.3% to 35.8%, by applying expression (2) using each wind CPNode's applicable Fall 2023 K value pertaining to the resource-share allocation technique resulting in the higher Total SAC value for each wind CPNode.

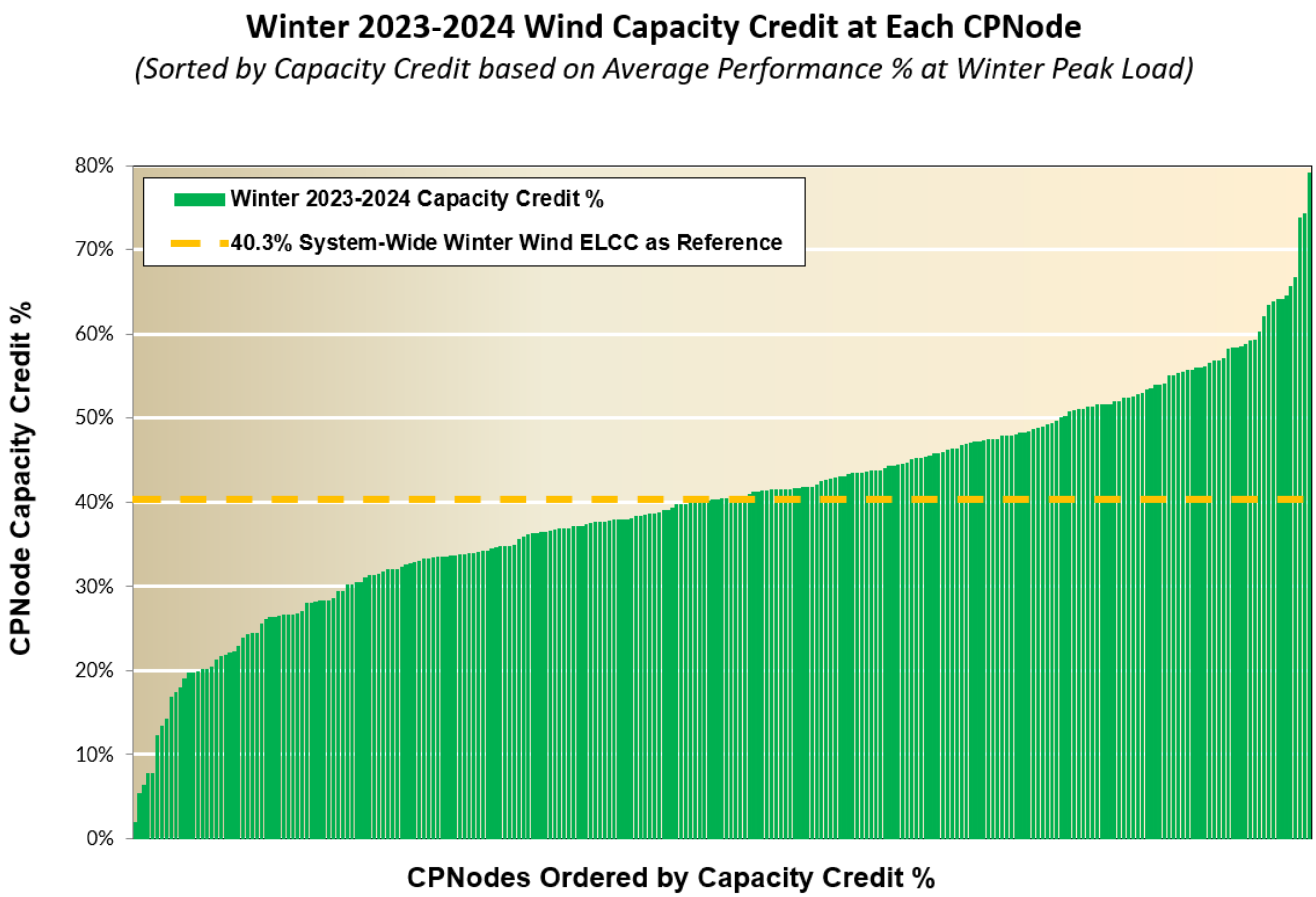


Figure 3-5: Winter 2023-2024 Wind CPNode Capacity Credits

The individual $PKmetric_{CPNode}$ of the wind CPNodes ranged from 1.9% to 71.1%. The individual Winter 2023-2024 wind capacity credit percentages ranged from 1.9% to 74.3%, by applying expression (2) using each wind CPNode's applicable Winter 2023-2024 K value pertaining to the resource-share allocation technique resulting in the higher Total SAC value for each wind CPNode.

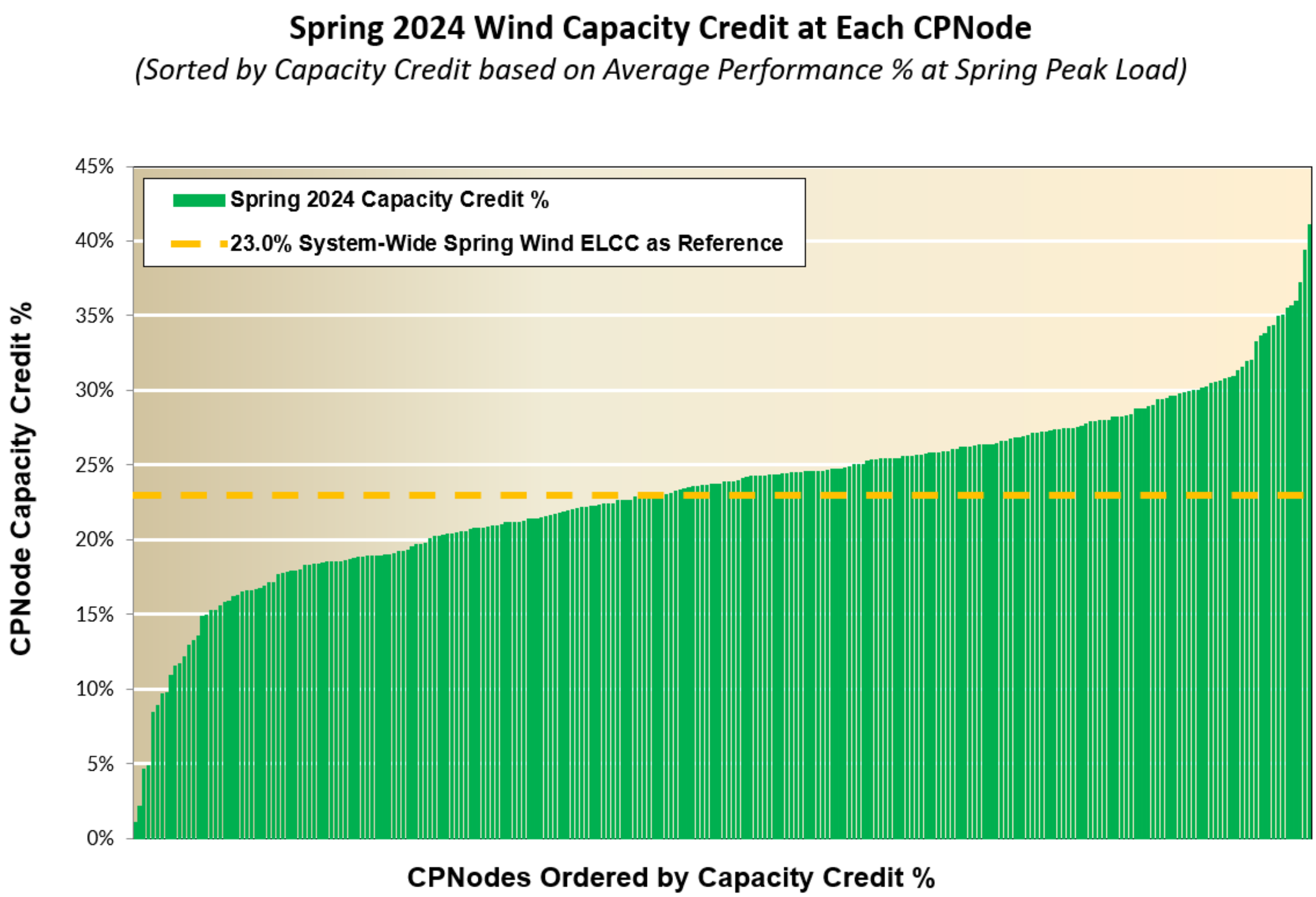


Figure 3-6: Spring 2024 Wind CPNode Capacity Credits

The individual $PKmetric_{CPNode}$ of the wind CPNodes ranged from 2.0% to 77.5%. The individual Spring 2024 wind capacity credit percentages ranged from 1.1% to 41.1%, by applying expression (2) using each wind CPNode's applicable Spring 2024 K value pertaining to the resource-share allocation technique resulting in the higher Total SAC value for each wind CPNode.

Appendix

Deliverability Curve for New Wind Resources

This curve applies to new CPNode wind resources that are registering with MISO, that do not have an entire season of metered production data, and that wish to participate in the annual capacity auction held at the beginning of April, known as the Planning Resource Auction (PRA). This curve is included in the Module E Capacity Tracking (MECT) tool for Market Participants to utilize for determining the conversion of Seasonal Accredited Capacity (SAC) to Zonal Resource Credits (ZRCs) based on the wind resource's deliverability.

Market Participants can use this to curve to calculate how much of a new wind resource's registered maximum capacity (RMax) will be convertible to Zonal Resource Credits (ZRCs) for utilization in the PRA. A new wind resource will first have the class-average seasonal wind capacity credit (for example, 18.1% for Summer 2023) applied to its RMax to get to a Total SAC value. This represents the full amount of MW that are potentially convertible to ZRCs, dependent on the amount of Total Deliverability the resource has been studied for and/or requested. Along with the new wind resource's RMax, Market Participants will also need to supply the resource's total demonstrated deliverability, the combination of the resource's Network Resource Interconnection Service (NRIS) and Energy Resource Interconnection Service in conjunction with a valid Transmission Service Request (ERIS w/ TSR).

The deliverability curve for new wind resources represents normalized capacity factors during system peak demand hours of resources in the deterministic allocation process of the 2022 wind capacity credit study. This results in a total of 40 sampled hours of wind output correlated with system peak demand at the resource level. This resource-level production data has been normalized as percentages of nameplate capacity (or RMax) to establish capacity factors on peak for each resource, and then those observances are sorted from lowest to highest to establish a capacity factor duration curve using a 2nd-order polynomial trend fit.

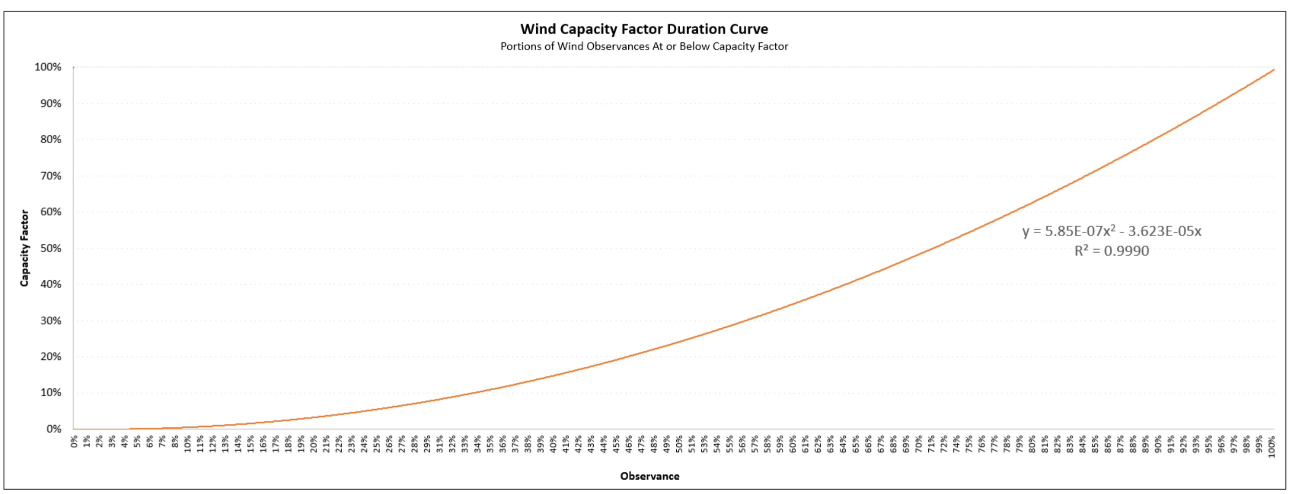


Figure 4-1: Fleet-wide SAC-to-ZRC Deliverability Curve for New Wind Resources

References

- MISO Tariff
  - Module E-1 - Resource Adequacy
- MISO Business Practices Manual
  - BPM 011 - Resource Adequacy
- FERC Filing & Order Acceptance
  - Intermittent Deliverable ICAP
    - Docket Nos. ER20-2005-000, ER20-2005-001
  - Seasonal Resource Adequacy Construct
    - Docket Nos. ER22-495-000, ER22-495-001