

Incident Review

Preparing the Grid for Wind Energy Droughts and Down-Ramps

Primary Takeaways

Wind energy droughts can occur, greatly reducing the output of wind energy resources. Areas of the bulk power system (BPS) with a higher percentage of wind energy output compared to other fuel sources are more vulnerable to these wind energy droughts. Awareness, adequate planning, appropriate operating procedures/processes, accurate weather forecasts, and especially access to dispatchable resources help mitigate these wind energy droughts. These droughts are not a new phenomenon on the grid; a review and supporting analysis of a recent operating period in the footprints of three heavily wind-invested grid operators led to important considerations for areas with high wind energy penetrations.

This document showcases several entities' responses to predicted low-wind conditions. The entities identified the issue, planned ahead, and allotted resources, preventing an energy emergency condition.

Wind Energy Droughts and Their Impacts

A wind energy drought involves a defined period of low wind speed that adversely impacts the wind energy serving the grid. To be a drought, the wind output across a large area must be greatly reduced for a long period of time. The exact definition of this duration and amount varies based on your frame of reference.

Not all resources have the same availability. Nuclear units generally have the highest capacity factors, while wind and solar have much lower capacity factors. For 2023, the Energy Information Administration (EIA) capacity factor for wind units was 33.2% compared to 93% for nuclear units. The capacity factor considers how often a unit type runs and how often the maximum output is maintained. Nuclear units generally run at the maximum output during the entire time between refuel outages. The lower capacity factor for wind energy reflects the significant variability in its output. As a consequence, areas with low-capacity factor resources as a high percentage of their total capacity are more vulnerable to events that reduce the output of those resources. [Table 1](#) shows the U.S. EIA installed capacity for 2023 for each entity.¹ Installed capacity represents the maximum output a generating unit can generate while capacity factor reflects how efficient a unit can produce that output.

¹ <https://www.eia.gov/survey/>

Table 1: Installed Capacity 2023						
RESOURCE	ERCOT		MISO		SPP	
	MW	% TOTAL	MW	%	MW	%
COAL	14330	10.1%	51014	25.7%	21343	21.9%
GAS	66473	46.8%	85444	43.0%	36196	37.1%
HYDRO	569	0.4%	4898	2.5%	3363	3.5%
NUCLEAR	5139	3.6%	12269	6.2%	2069	2.1%
OTH	2955	2.1%	3847	1.9%	433	0.4%
PETROLEUM	814	0.6%	5130	2.6%	2216	2.3%
SOLAR	14900	10.5%	5121	2.6%	481	0.5%
WIND	36855	25.9%	30868	15.5%	31378	32.2%
TOTAL	142033		198591		97479	

Pacific Northwest National Laboratory Study

In order to determine the scope and frequency of energy droughts, the Pacific Northwest National Laboratory (PNNL) participated in an international study (the International Energy Agency Technology Collaboration Program on Hydropower) of wind and solar droughts with a focus on identifying the amount of stored energy resources required to replace the variable energy resources that may become deficient. The 2023 report² defined a wind drought with a duration of four hours and less than 10% of the historical annual wind energy output.

Table 2 summarizes the wind droughts as defined in the referenced PNNL report.

Table 2: Wind Drought Summary (*partial year)						
BA	Parameter	2018	2019	2020	2021	2022
CAISO	Number of Events	37	41	41	26	18*
	Duration of Longest Event (h)	35	42	28	18	12
	Energy Deficit of Longest Event (MWh)	82 k	72 k	44 k	36 k	25 k
ERCOT	Number of Events	3	16	13	27	15
	Duration of Longest Event (h)	13	11	15	11	12
	Energy Deficit of Longest Event (MWh)	100 k	93 k	146 k	120 k	151 k
QUEBEC	Number of Events		45	50	51	46
	Average Duration of Drought (h)		10	10	11	11
	Average Energy Deficit Event (MWh)		12.4 k	12.3 k	12.6 k	12.7 k

As a point of reference for CAISO, the report identified that wind droughts were approximately eight hours in duration on average. This represented an average energy deficit of 15,000 MWh. It is important to note that entities are positioned (with other flexible resources) to manage these types of occurrences to operate the grid in a reliable manner.

² https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-35955.pdf

Based on publicly available data (2022 EIA for CAISO and ERCOT), the report identified the conditions for several grid operators:

- CAISO had a total installed generation capacity of approximately 75,000 MW, of which 43% was natural gas while wind and solar resources accounted for over 30%.
- ERCOT had approximately 135,000 MW of installed generation capacity, of which 48% was natural gas, 26% wind, and 8% solar.
- Hydro Québec (Canada) had an installed capacity of 40,000 MW with 3,700 MW of wind capacity (9%).

Wind Energy Down-Ramps

Another wind speed phenomena that may not be widely known is wind speed down-ramping. During the early deployment of wind energy in the ERCOT footprint, a wind down-ramp event occurred that required the declaration of the equivalent of an Energy Emergency Alert (EEA). At the time of the event (February 26, 2008), the term was Emergency Electric Curtailment Plan (EECP). The event was significant enough that it was documented in a lessons learned report posted by the National Renewable Energy Laboratory (NREL).³ Two notable points of the event were that wind energy reduction occurred two hours sooner than expected (just before evening peak) and that it was faster than expected (8 MW/minute vs. 5 MW/minute).

The ERCOT wind down-ramp event was aggravated by the loss of a thermal unit as well as higher-than-expected loads. ERCOT deployed both spinning and non-spinning reserves and curtailed 1,150 MW of curtailable load to restore grid reliability. One recommendation from the report was to leverage shorter-duration forecasts. At the time, the shortest forecast interval was an hour.

In 2021,⁴ MISO experienced down-ramp events on April 19 and 21 that adversely impacted the operating reserves. On April 19, wind generation dropped 5,000 MW over a 2-hour period. On April 21, 5,000 MW dropped over a 1-hour period; additionally, load increased by 2,000 MW during the same period. As a comparison, during the height of the Elliott storm,⁵ more than 20% of all the generation losses (74,000 MW) occurred in the 6:00 a.m.–6:00 p.m. period on December 23, 2022. That equates to a 1,230 MW outage rate for the 12-hour period.

Another smaller down-ramp event occurred for MISO on January 19, 2025; the wind energy reduction was 1,600 MW per hour. This event coincided with solar ramping down and evening load ramping up. January 19 was part of the system performance review that the Federal Energy Regulatory Commission (FERC)/NERC and the Regional Entities conducted in 2025.⁶ The report contained a table that showed the resource mix for a typical winter hour. The data is summarized in **Table 3** and includes the wind ramp-down hours for that day. The natural gas resources made up the decline of the wind resources.

³ <https://www.osti.gov/servlets/purl/1218412> ; <https://www.ercot.com/news/release/2008-02-27-grid>

⁴ [2021 Spring Quarterly Report MISO](#), [2021 State of Market Report MISO](#)

⁵ https://www.ferc.gov/news-events/news/ferc-nerc-release-final-report-lessons-winter-storm-elliott_p45

⁶ <https://www.ferc.gov/media/report-january-2025-arctic-events-system-performance-review-ferc-nerc-and-its-regional>

Table 3: MISO Down-Ramp Event, January 19, 2025

GEN	TYPICAL WINTER HR		DEMI/ENZO		4:00 p.m. CST		8:00 p.m. CST	
	GEN(MW)	%	GEN(MW)	%	GEN (MW)	%	GEN (MW)	%
NAT GAS	169 k	36.8%	291 k	42.9%	18.3 k	21.6%	31.9 k	34.0%
COAL	94 k	20.5%	132 k	19.5%	27.3 k	32.2%	33.5 k	35.7%
NUCLEAR	94 k	20.5%	97 k	14.3%	11.8 k	13.9%	11.8 k	12.6%
WIND	52 k	11.3%	76 k	11.2%	18.1 k	21.3%	13.9 k	14.8%
SOLAR	11 k	2.4%	5 k	0.7%	8.1 k	9.5%	0	0.0%
OTHER	39 k	8.5%	77 k	11.4%	1.3 k	1.5%	2.8 k	3.0%
TOTAL	459 k		678 k		84.9 k		93.9 k	

From a weather forecast perspective, down-ramps are a predictable occurrence. However, they may occur earlier than expected and often steeper than expected. Even in today’s environment (improved situational awareness tools), it is still a challenge for real-time (RT) operators to recognize that a down-ramp event is occurring. For example, a short-term forecast that runs every five minutes with actual inputs from the Generator Owners may only show relatively small changes from the previous forecast (10:05 a.m. run vs. 10:00 a.m. run). However, the operator may not be focused on the forecast difference to an earlier forecast (10:05 a.m. run vs. 9:00 a.m. run). Having accurate forecasts and sufficient flexible (dispatchable) resources is key to managing these fluctuations in the wind energy portfolio.

Wind speed up-ramps also occur but generally do not pose a reliability challenge since over-generation can be curtailed.

Summary of Incident

In early June 2023, a period of low wind speed occurred, impacting ERCOT, MISO, and SPP. Entities reported low wind energy potential in the weather forecast several days before its occurrence, so they had plenty of time to schedule alternate (primarily fossil) resources. As a result, no emergency actions were required for this period. The entities had processes and procedures in place to detect such occurrences as well as dispatchable resources to mitigate the variability of wind energy.

Figure 1 shows the variability of wind energy for the month of June 2023. **Figure 2** highlights the combined wind output from June 3–7 with dotted lines at 2,000 MW and 25,000 MW. For hour ending 10 on June 6, the combined wind energy generation for the three entities was 1,681 MW. The combined load for hour ending 10 was approximately 157,000 MW, which is significantly lower than the combined load peak of approximately 194,000 MW, which occurred in the afternoon.

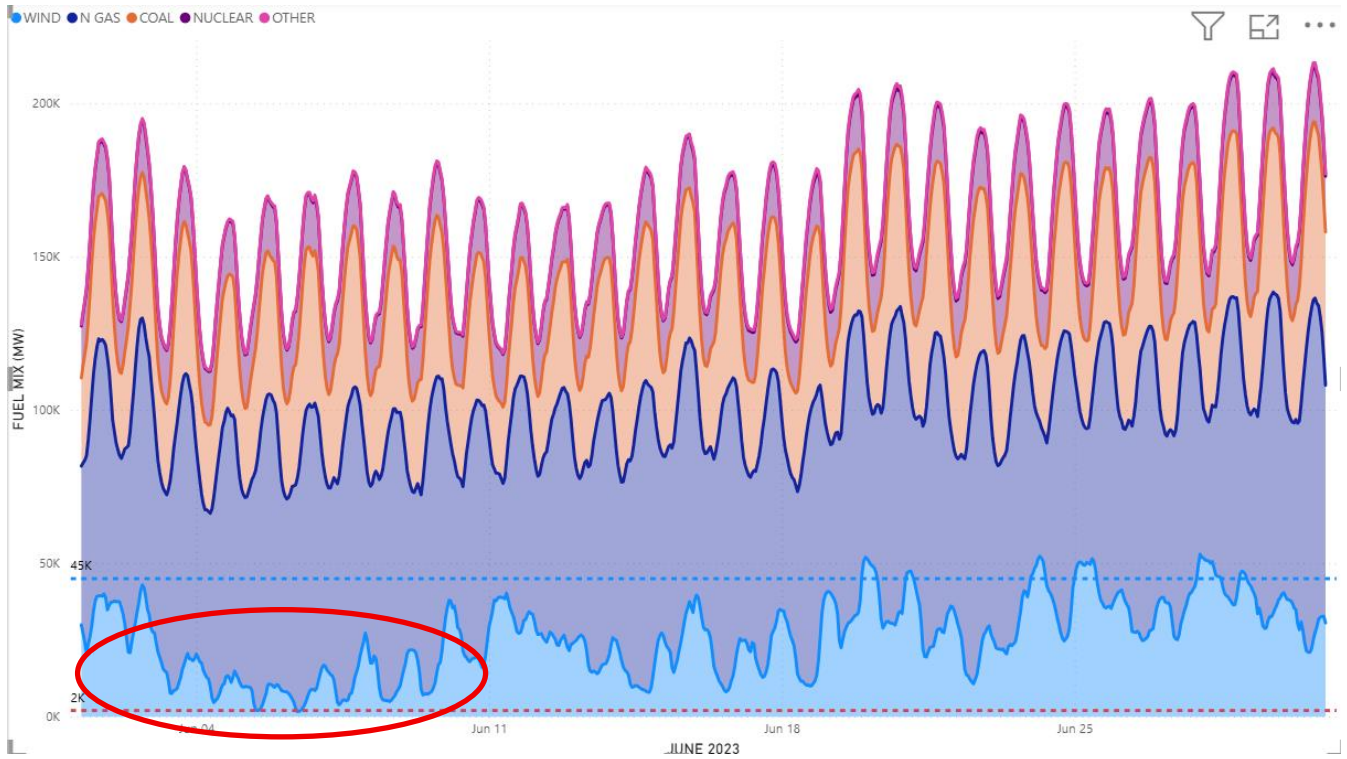


Figure 1: Combined Fuel Mix Generation (MW) for June 2023 (ERCOT, MISO, SPP)

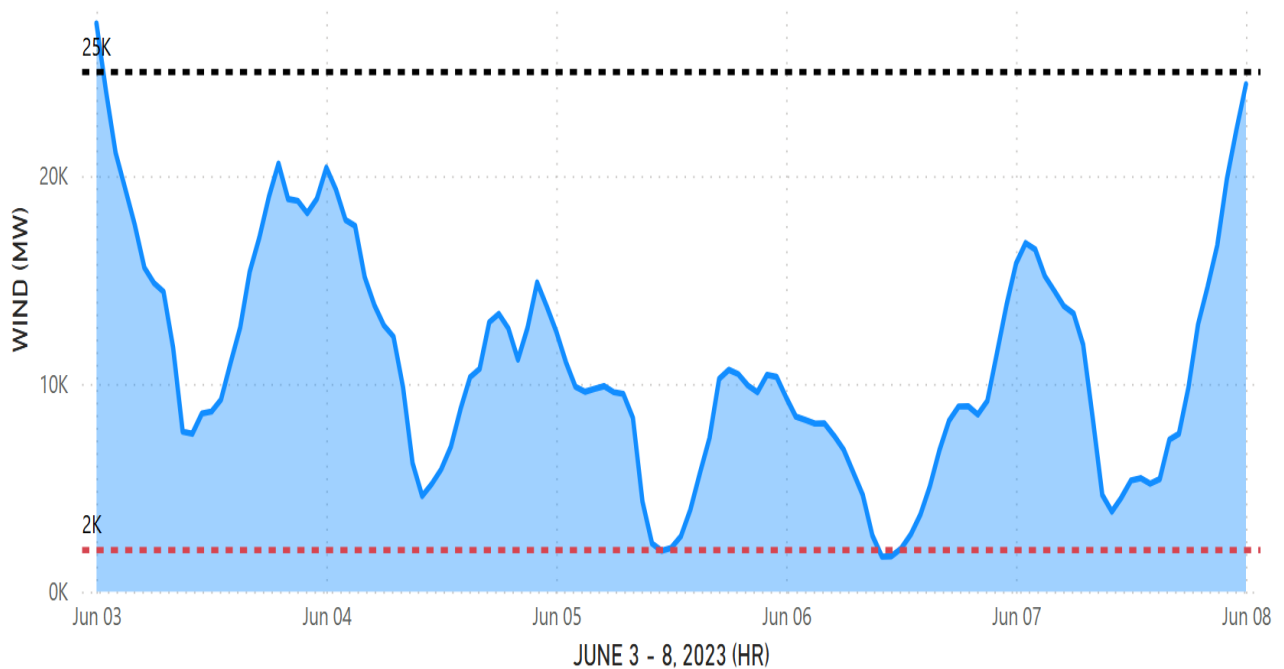


Figure 2: Combined Wind Output (MW) for June 3–7 (ERCOT, MISO, SPP)

Table 4: ERCOT Low Wind vs. High Wind Output Days for June 2023

BAL AUTH	TIME	NET GEN (MW)	COAL (MW)	% COAL	N GAS (MW)	% N GAS	NUCLEAR (MW)	% NUCLEAR	WIND (MW)	% WIND
ERCOT	6/6/2023 10:00	48476	5836	12.0%	27279	56.3%	5018	10.4%	38	0.1%
ERCOT	6/6/2023 11:00	51697	7034	13.6%	28180	54.5%	5021	9.7%	78	0.2%
ERCOT	6/6/2023 12:00	55030	8211	14.9%	30307	55.1%	5021	9.1%	180	0.3%
ERCOT	6/6/2023 9:00	45850	5661	12.3%	27158	59.2%	5017	10.9%	170	0.4%
ERCOT	6/6/2023 13:00	58215	8779	15.1%	33006	56.7%	5020	8.6%	455	0.8%
ERCOT	6/24/2023 5:00	48886	4925	10.1%	16323	33.4%	4653	9.5%	22897	46.8%
ERCOT	6/24/2023 6:00	48553	5004	10.3%	16601	34.2%	4654	9.6%	22196	45.7%
ERCOT	6/24/2023 4:00	49822	4919	9.9%	17454	35.0%	4652	9.3%	22699	45.6%
ERCOT	6/1/2023 1:00	47234	5119	10.8%	16180	34.3%	5021	10.6%	20862	44.2%
ERCOT	6/24/2023 7:00	48495	5077	10.5%	17172	35.4%	4654	9.6%	21369	44.1%

Table 5: MISO Low Wind vs. High Wind Output Days for June 2023

BAL AUTH	TIME	NET GEN (MW)	COAL (MW)	% COAL	N GAS (MW)	% N GAS	NUCLEAR (MW)	% NUCLEAR	WIND (MW)	% WIND
MISO	6/5/2023 11:00	73232	22819	31.2%	36049	49.2%	10456	14.3%	304	0.4%
MISO	6/5/2023 10:00	69523	21220	30.5%	34250	49.3%	10463	15.0%	292	0.4%
MISO	6/5/2023 12:00	76644	24269	31.7%	37783	49.3%	10448	13.6%	513	0.7%
MISO	6/5/2023 9:00	66699	20409	30.6%	32544	48.8%	10470	15.7%	552	0.8%
MISO	6/30/2023 20:00	96257	30403	31.6%	50735	52.7%	11564	12.0%	812	0.8%
MISO	6/20/2023 4:00	62306	14359	23.0%	18784	30.1%	11631	18.7%	16151	25.9%
MISO	6/20/2023 5:00	63297	14280	22.6%	19688	31.1%	11637	18.4%	16325	25.8%
MISO	6/11/2023 3:00	54925	12309	22.4%	17368	31.6%	10204	18.6%	14162	25.8%
MISO	6/11/2023 8:00	54381	12587	23.1%	16505	30.4%	10213	18.8%	13786	25.4%
MISO	6/13/2023 5:00	55891	12135	21.7%	18566	33.2%	10247	18.3%	14009	25.1%

Table 6: SPP Low Wind vs. High Wind Output Days for June 2023

BAL AUTH	TIME	NET GEN (MW)	COAL (MW)	% COAL	N GAS (MW)	% N GAS	NUCLEAR (MW)	% NUCLEAR	WIND (MW)	% WIND
SPP	6/6/2023 10:00	30952	12334	39.8%	15166	49.0%	1978	6.4%	148	0.5%
SPP	6/6/2023 11:00	32770	13073	39.9%	16181	49.4%	1973	6.0%	160	0.5%
SPP	6/6/2023 12:00	34536	13371	38.7%	17384	50.3%	1970	5.7%	362	1.0%
SPP	6/7/2023 11:00	33536	13554	40.4%	16220	48.4%	1975	5.9%	362	1.1%
SPP	6/7/2023 10:00	31821	13155	41.3%	15000	47.1%	1975	6.2%	356	1.1%
SPP	6/24/2023 1:00	32651	7430	22.8%	3430	10.5%	1960	6.0%	19128	58.6%
SPP	6/24/2023 2:00	31200	7026	22.5%	3300	10.6%	1952	6.3%	18232	58.4%
SPP	6/24/2023 3:00	30683	7005	22.8%	3324	10.8%	1941	6.3%	17726	57.8%
SPP	6/24/2023 4:00	30143	6997	23.2%	3445	11.4%	1935	6.4%	17091	56.7%
SPP	6/19/2023 5:00	26832	5791	21.6%	3195	11.9%	1980	7.4%	15209	56.7%

Each entity distributed other resources to address the wind shortfall differently based on their own systems:

- **ERCOT:** Natural gas units made up the difference in the wind energy output (see [Table 4](#)). For the four nuclear units that ERCOT had, one unit was reduced by 22% during the high wind output days. Otherwise, the nuclear and coal units generally maintained the same output during the days with low and high wind output.
- **MISO:** Natural gas and coal offset the difference for MISO ([Table 5](#)).
- **SPP:** Just as with MISO, natural gas and coal offset the difference for SPP ([Table 6](#)).

The net generation was generally the same between the low-wind-energy and high-wind-energy days for MISO and SPP.

For all three entities, on any given day, wind energy can produce more than 20,000 MW in an hourly interval. In March 2025, ERCOT had several hourly intervals above 27,000 MW of wind energy; this represented more than 59% of net generation for that hour. The highest penetration of wind was hour ending 2 on March 12, which was approximately 63%. Additionally, MISO had almost 26,000 MW of wind generation for the hour ending 24 (interval hour at ending at midnight) on December 28, 2025. SPP also exceeded 2,600 MW of wind energy output on December 19, 2025. On other days, these same units can almost stop producing energy. To manage this variability, entities rely on accurate weather forecasts, accurate information from all the generators, and a diverse and flexible portfolio of different fuel types. While wind energy plays an important role in the grid's transformation, it is important to note that a diverse portfolio will always be required.

The entities were able to successfully manage the low-wind event of June 2023 by leveraging accurate forecasts. Entities reported observing the low-wind event several days in advance. This advanced notice provided entities with the time needed to secure and start up units with relatively long (greater than eight hours) startup notifications. As evidenced by the data, coal and natural gas units played a critical role in reliably supporting the grid during these low-wind events. While utility-size battery storage units have a growing presence in grid operations, the technology is not yet available to support extended (greater than four hours), consecutive hourly intervals of low wind energy.

Variable Resource Forecasting

A major factor in preventing an energy emergency condition during this event was good resource forecasting practices by each entity. Not all generating units are dependent on the weather for energy output. These units typically use fossil fuel or nuclear fission. These units have predictable fuel delivery, and changes in weather do not impact energy delivery from those units. Additionally, the larger units, particularly nuclear units, are generally "baseload" units that typically run at full output 24/7. Smaller units, typically natural gas units, are generally considered "dispatchable" (flexible) and have short startup times and short minimum runtimes.

The leveraging of renewable energy is highly dependent on accurate weather forecasts. Load (demand) forecasting has been dependent on weather forecasts for quite some time. The primary weather parameter

that is associated with load forecasting is temperature. Other weather parameters for load forecasting may include humidity, wind speed, and cloud cover. The primary parameter for wind energy potential is wind speed (at the turbine hub height). As with all weather-dependent forecasts, there can be errors associated with them. Recent winter events, like storms Uri and Elliott, highlight the challenges of dealing with (in real-time grid operations) an inaccurate load forecast. In the FERC/NERC/Regional Entity Winter Storm Uri inquiry report,⁹ low wind speed was identified as contributing to the unavailability of wind energy.

Detecting Low Wind Speed Weather Patterns

Recognizing changes in weather patterns is the subject matter expertise of a meteorologist or climate scientist. Meteorologists focus on weather forecasting, while climate scientists focus on historical trends. Both perspectives assist the variable-resource-energy industry.

One key parameter that identifies a potential low wind energy output event is that of atmospheric pressure. This European report¹⁰ correlated atmospheric pressure and low wind energy production events. **Figure 4** highlights the changes in atmospheric pressure that were noticeable several days in advance of the actual low-wind event. As stated in the reference report, “From about 6 days preceding the events the high pressure starts to build, peaking around the event and disappearing 3 days after. Ten-meter winds slacken in the North Sea area about three days before the event and further weakened over a larger area in the following days. Ten-meter windspeeds return to normal strength about three days after the event. These meteorological developments cause a sharp decline in energy production in the days surrounding the event day.”

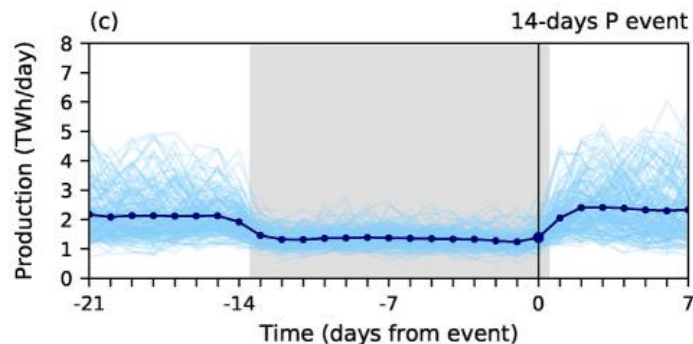


Figure 4: Time Series of Total Energy Production for Low Wind Energy Production

Similar observances for North America have also been studied and documented. A 2016 report from Earthzine¹¹ documents an extended low wind speed event that occurred from June 2013 through April 2015. The key driver for this low-wind event was also associated with high pressure over the western part of North America. **Figure 5** shows the low wind speed for the first half of 2015.

⁹ [2021 Cold Weather Event page 183](#)

¹⁰ [Meteorological Conditions Leading to Low Variable Energy Production](#)

¹¹ <https://earthzine.org/a-new-kind-of-drought-u-s-record-low-windiness-in-2015/>

From a grid operations perspective, the low wind energy events did not present any significant challenges. The market monitor¹² for ERCOT reported a “relatively low wind year” even though wind provided 12% of the wind generation; refer to **Figure 6**. For SPP,¹³ there was a 44% increase (from 2014 to 2015) in wind capacity but only a 14% increase in generation. The SPP market monitor report explained the modest wind energy increase as many units coming on-line in the middle of the year and stated that the first year is mostly a trial period before full operation. For CAISO, the second-quarter 2015 market monitor report referenced an increase in wind generation. The report¹⁴ noted one exception on June 8 where it mentioned observing lower-than-expected wind resources. The annual report for CAISO notes that wind generation decreased slightly. In 2015, wind energy contributed approximately 5% to CAISO’s system.

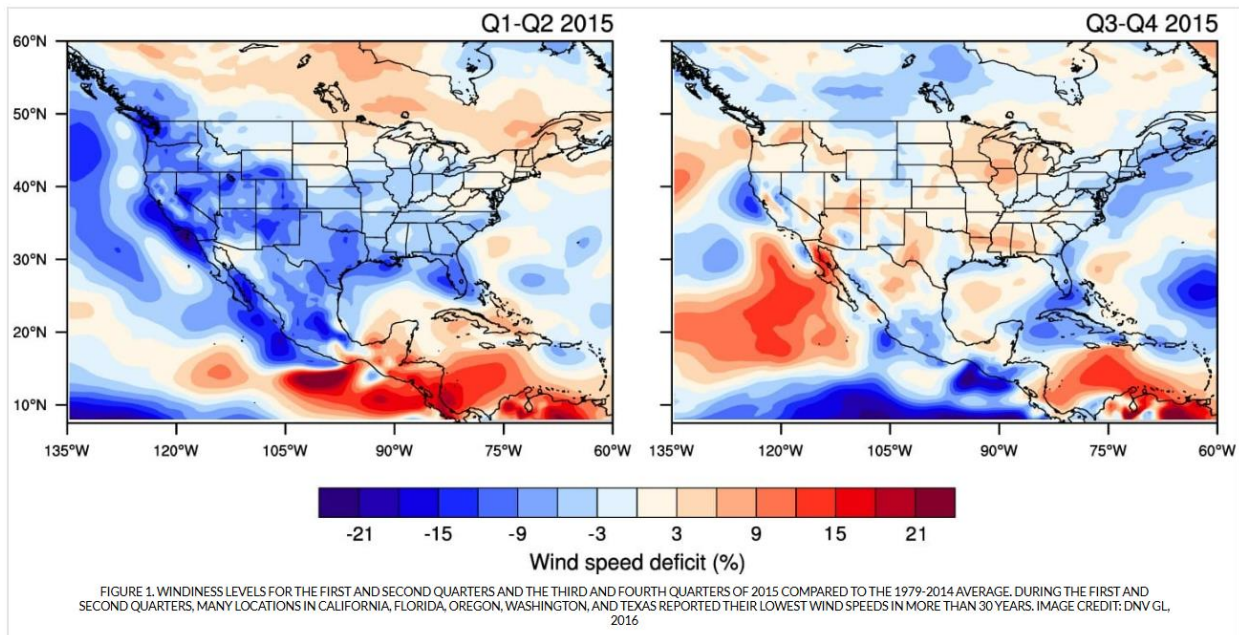


Figure 5: Wind Speed Deficit

¹² <https://www.potomaceconomics.com/wp-content/uploads/2017/01/2015-ERCOT-State-of-the-Market-Report.pdf>

¹³ https://www.spp.org/documents/41597/spp_mmu_state_of_the_market_report_2015.pdf

¹⁴ https://www.caiso.com/documents/2015_secondquarterreport-marketissues_performance-august2015.pdf,
<https://www.caiso.com/documents/2015annualreportonmarketissuesandperformance.pdf>

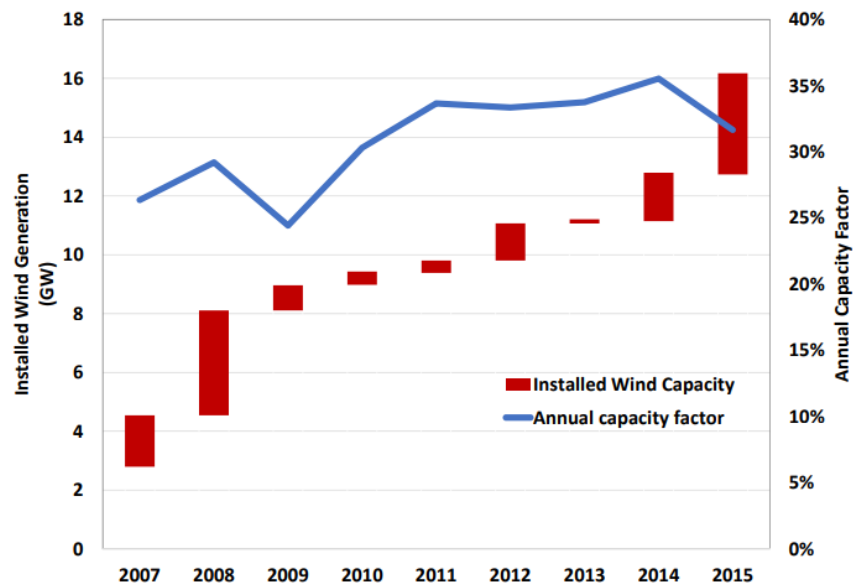


Figure 6: 2015 ERCOT Market Monitor Wind Generation Capacity Factor

Other Similar Events

In September 2021, the Department of Meteorology and Climate Science of San José State University (SJSU) led a study to review very large-scale weather patterns for potential low-wind and solar energy impacts. These large weather patterns may be larger than a given Balancing Authority (BA) footprint. The term described in the report is “synoptic scale,” which represents a range of 620 miles to 1,500 miles wide.¹⁵ For comparison, the average width of California is 250 miles with the widest point of approximately 370 miles. For Texas, the east-west width is approximately 770 miles, and the north-south length is approximately 800 miles.

One of the objectives of the SJSU report¹⁶ was to analyze the historical weather patterns associated with wind and solar droughts in the western part of North America. For the SJSU report, the term “drought” referred to the time frame of one week with low wind (and/or solar) energy output. The report highlighted two weather patterns that aggravated significant grid emergencies. The first one, “a thermal ridge over the western half of the United States,” occurred in August 2020 and corresponded to the operator-initiated load shed events in California.¹⁷ The second one, a “persistent trough over the central United States,” occurred in February 2021, which corresponded to Winter Storm Uri. These weather patterns are like “El Niño” and “La Niña” (recognizable weather patterns) and are further detailed in the National Centers for Environmental Information Monthly Climate Reports.¹⁸ Both grid review reports indicated lower-than-expected wind energy; however, there was no focus on why the wind energy forecasts were inaccurate.

¹⁵ <https://www.noaa.gov/jetstream/synoptic>

¹⁶ <https://link.springer.com/article/10.1007/s42452-021-04794-z#ref-CR35>

¹⁷ <https://www.cao.com/Documents/Final-Root-Cause-Analysis-Mid-August-2020-Extreme-Heat-Wave.pdf>

¹⁸ <https://www.ncei.noaa.gov/access/monitoring/monthly-report/synoptic/202102>

Future Considerations

The impact of these low-wind/down-ramp occurrences in each BA will depend on the amount of wind energy in the footprint, the availability of dispatchable resources to make up the differences, and demand at the time of the event.

Table 7 shows the generation mix for the late afternoon of January 19, 2025. It includes entities with wind generation that were part of the 2025 system performance review.¹⁹ It is important to note that the “OTHER” generation category includes petroleum, hydro, and storage resources. As previously stated, the down-ramp that occurred in the MISO footprint on January 19 had no adverse impact on MISO’s ability to reliably operate the grid during one of the coldest evenings in January.

	TYPICAL WINTER HR		DEMI/ENZO		ERCOT		ISONE		MISO		PJM		SPP	
GEN	GEN(MW)	%	GEN(MW)	%	GEN (MW)	%	GEN (MW)	%	GEN (MW)	%	GEN (MW)	%	GEN (MW)	%
NAT GAS	169k	36.8%	291k	42.9%	19.8k	34.6%	5.54k	48.2%	18.3k	21.6%	44.6k	39.1%	9.9k	27.7%
COAL	94k	20.5%	132	19.5%	6.6k	11.6%	0.0	0.1%	27.3k	32.2%	25.7k	22.5%	16k	45.1%
NUCLEAR	94k	20.5%	97	14.3%	5.1k	8.9%	3.3k	29.0%	11.8k	13.9%	33.5k	29.4%	2.k	5.7%
WIND	52k	11.3%	76	11.2%	5.5k	9.7%	0.2k	1.7%	18.1k	21.3%	7.7k	6.8%	6.1k	17.3%
SOLAR	15k	2.4%	5	0.7%	21k	36.7%	0.0	0.4%	8.1k	9.5%	1.1k	1.0%	0.5k	1.5%
OTHER	39k	8.5%	77	11.4%	-0.9k	-1.4%	2.4k	20.6%	1.3k	1.6%	1.5	1.3%	1k	2.6%
TOTAL	463k		678		57.2k		11.5k		84.9k		114.1k		35.4k	

Wind is an increasing component of the reduced carbon generation resource mix that is growing on the North American grid. Relying more on this resource requires integrating certain operating considerations to ensure reliable service of increasing loads. Low-wind periods like those described in this document could place operating entities in precarious situations going forward. Whether the situation involves a wind down-ramp, or a polar vortex, an integral component to these considerations is an accurate weather forecast. The weather forecast is a critical business asset that supports both the supply (renewable resource) and demand (load) of energy. In order to improve their operating posture, entities depending on wind as a sizable portion of their generation portfolio should review/contemplate the following considerations:

- The unit commitment process, regardless of energy resource type, relies on accurate resource capability (MW output) and availability (start/stop limitations, output de-rates) information supplied by the Generator Operator to the BA. As seen in Uri and Elliott as well as events associated with wind, timely notification of resource availability is critical. Like a cold-weather advisory, create a notification process for the wind generator owners. This will provide an opportunity for the wind generator owners to re-validate the information submitted for the unit commitment process.
- Consider a flexibility needs assessment to prepare for situations when there is a forecast of an extended low wind energy event. For Europe, it is estimated that, on average, this type of event could last up to 10 days.²⁰

¹⁹ [Winter Reliability Assessment November 2025](#)

²⁰ [EPRI Resource Adequacy Forum October 2025](#)

- Establish parameters that categorize and communicate low-wind events based on duration and reduced energy potential. This will provide an opportunity to educate all stakeholders on these phenomena.
- Establish parameters that categorize and communicate potential down-ramp energy events based on weather patterns, regardless of energy resource. During the review of Winter Storm Elliott, it was often reported that the cold front came in earlier and faster than expected. This “earlier/faster” weather pattern change impacts multiple aspects of energy delivery.
- Perform a backcast review of variable resource energy output where energy was significantly lower than expected and compare it to the actual weather patterns at that time. This will enable the entity to develop a repository of historical events both for future system events and training opportunities for newer employees.
- Have more than one variable resource forecast provider. This allows one to see which forecast performed better in different scenarios. Additionally, having more than one supplier of critical business information supports business continuity needs.
- Add a meteorologist to the staff. This person will be able to forecast and document weather patterns that cause variable resource challenges for the entity. Alternatively, partner with the Department of Energy (DOE) labs to leverage their expertise with weather pattern modeling.

As a related energy drought consideration, the recent solar eclipses represent a unique energy drought. The April 2024 solar eclipse (see [Figure 7](#)) was predicted years in advance, and the grid operators had adequate time to prepare and position the grid so that it did not become an electrical event.²¹ The considerations for wind energy variability also apply for solar.

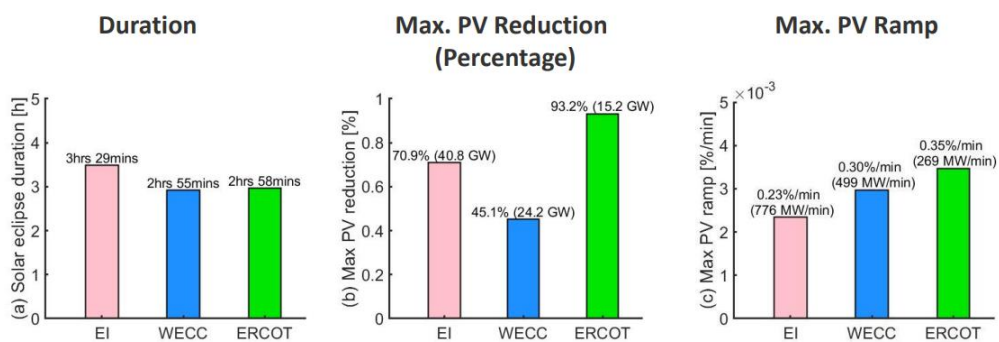


Figure 7: 2024 Solar Eclipse Impact on Interconnections

For more information, contact:
NERC – [Event Analysis](#)

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²¹ [April 2024 Solar Eclipse](#)