

Beyond the Peak: Measuring Outage Severity During Winter Storm Iona

May 21, 2026

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Key Insights

- Winter Storm Iona was an exceptionally large storm system resulting in power outage impacts to nearly **2 million customers** across the United States through multiple extreme weather hazards.
- A new **Outage Severity Index (OSI)** integrated framework was developed to normalize and compare outage impacts using both event peak outage values and **time-integrated** components of outage behavior.
- **Outage Severity Index** showed how different weather hazards create fundamentally different outage profiles by hazard type. These profiles can be used to improve **prediction** and real-time **situational awareness**.
- The greatest outage impacts (longest duration outages) were related to widespread non-thunderstorm winds and ice.

Storm Track and Hazard Overview

Winter Storm Iona was a large storm system that affected much of the eastern two thirds of the US, bringing a combination of cold and warm season hazards. Iona followed closely on the heels of the [March 13 windstorm](#) across the Great Lakes and Midwest, where restoration from that storm was still in progress across Michigan, Ohio, and Pennsylvania. This two-storm combination produced nearly 2 million customer power outages in total, with peak outages reaching 618,000 on March 17, 2026. This two-storm combination produced the highest total number of outages across the US for a weekly period during 2026, although Winter Storm Fern produced longer-duration outages.

Iona was the third most significant outage-producing storm system to affect the US in 2026, and was unique in bringing a combination of both winter and spring hazards across a large area of the country. The storm system developed in western Kansas on March 15, and then tracked east to northeast into the lower Great Lakes region before moving into Canada and then intensifying as it continued north in Canada on March 17 (**Figure 1**). The storm brought blizzard conditions and heavy snowfall to Wisconsin and upper Michigan, where the snow was cold and dry enough to not produce significant power outages. However, a region of freezing rain occurred across southern Wisconsin and Michigan where some of the longest duration outages persisted. At the same time the storm was producing snow and ice on March 15, severe thunderstorms were occurring across the Midwest and Mississippi River Valley. As the storm moved east another round of thunderstorms occurred across the southeast and mid Atlantic states. Widespread winds increased across the northeast and New England as the storm intensified on March 17, causing additional outages.

Iona provides a unique opportunity to examine how the major categories of extreme weather hazards translated into power outage impacts, and how a unified outage severity index can simplify comparisons across hazards to better identify which areas experienced the greatest impacts, and the underlying reasons those impacts were so severe.

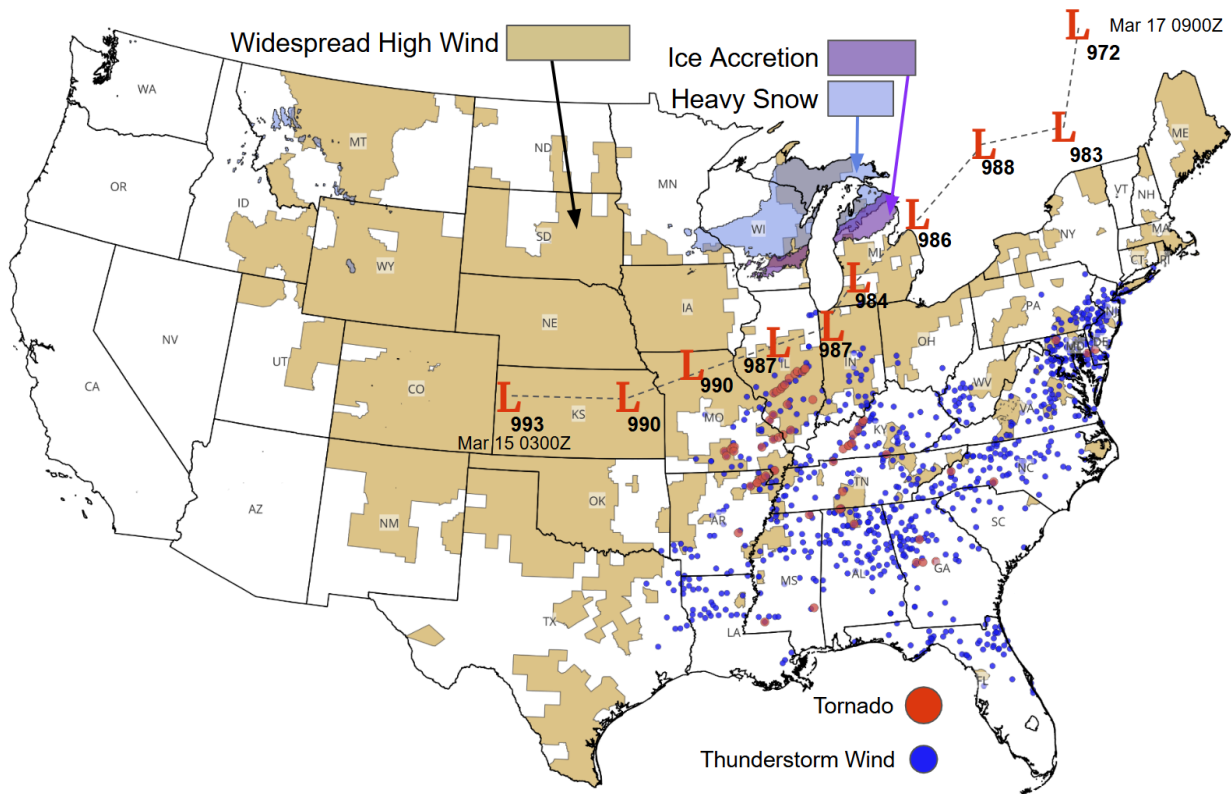


Figure 1. March 15-17, 2026 storm track and observed weather hazard information. Storm intensity annotated by minimum pressure (millibars). Wind data is county-averaged using NOAA URMA. Thunderstorm wind damage and tornado reports NOAA SPC.

Outage Severity Analysis by Hazard Type

Three primary hazard classes associated with this storm system contributed to power outage impacts: widespread synoptic or gradient wind events, freezing rain and ice accretion, and thunderstorm-related hazards. Thunderstorm impacts can be further separated into straight-line wind damage and tornado-related damage, each of which produces distinct outage characteristics based on the intensity, spatial structure, and duration of the hazard. These differing hazard types can lead to substantially different patterns of infrastructure damage, restoration complexity, and overall outage severity.

Figure 2 shows that the majority of peak outage impacts were associated with widespread wind-related hazards, which accounted for 55% of peak customers without power, while only 8%

of peak outages were attributed to ice-related impacts. However, when examining cumulative outage impacts through total customer outage duration, ice-related hazards accounted for 17% of overall impacts, highlighting how ice accretion produces longer restoration times from more significant infrastructure damage and greater logistical challenges. In contrast, thunderstorm-related outages were generally restored more quickly, despite producing significant short-term outage peaks in some areas.

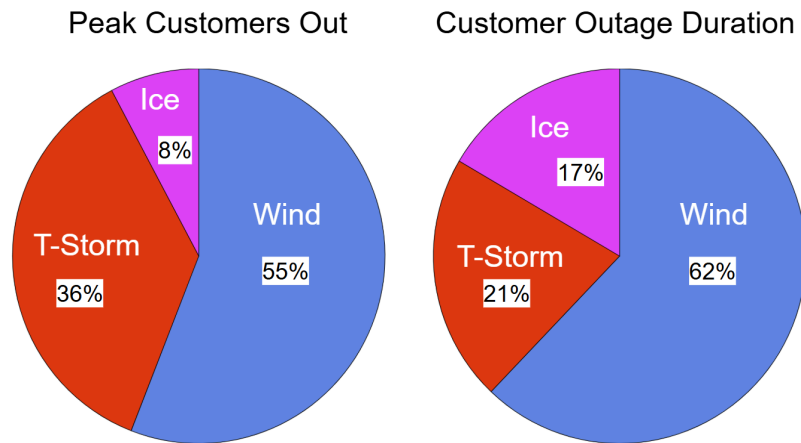


Figure 2. Power outage hazard analysis by primary hazard type. Fraction of total customers affected at peak power by hazard class (left), and customer outage hours relative attribution (right). Wind is associated with a wide-area wind system, whereas thunderstorm (T-Storm) winds are localized wind.

Outage Severity Index

Analyzing outage severity within a major event can be challenging. Both relative and absolute measures exist for evaluating outage impacts, but developing a normalized understanding of how outages evolve over time, and comparing outage performance across local areas, remains difficult. Differences in population density, utility size, infrastructure characteristics, hazard intensity, and restoration complexity can all significantly influence outage behavior, making direct comparisons between regions or hazard types inherently complex.

To compare outage severity across this event, an Outage Severity Index (OSI) was developed to characterize the relative severity of power outages at the county level. The OSI is derived solely from observed outage data and is designed to provide a more normalized framework for comparing outage impacts across different geographic areas and hazard types within the same event.

The index incorporates several key components of outage behavior, including:

- Accumulated customer outage hours
- Peak customers without power
- Peak percentage of customers without power
- Outage duration from peak outage to restoration

- Outage velocity metrics that account for both the rate of damage escalation and the rate of restoration

The OSI weights each of these major factors to derive a value between 0 and 100. Together, these variables capture not only the magnitude of outages, but also the temporal evolution and persistence of impacts throughout the event.

Figure 3 illustrates the spatial distribution of the Outage Severity Index (OSI) across impacted counties during the March 15–22, 2026 event, while also highlighting the diverse set of meteorological hazards responsible for the outages. The event was characterized by a large-scale progression of hazards across the eastern United States, including widespread synoptic wind impacts, freezing rain and ice accretion, severe thunderstorms with straight-line winds, and tornadoes.

The highest OSI values were generally concentrated in regions where prolonged or compounding hazards produced both widespread infrastructure damage and slower restoration times. For example, in northern Michigan ice accretion produced some of the most severe and persistent outage impacts. In contrast, widespread high-wind regions across the northeast produced broad geographic outage footprints with rapid damage escalation. Severe thunderstorm and tornado-related outages often generated intense but more localized impacts, with comparatively faster restoration in many affected areas.

Outage severity cannot be explained by a single variable. Counties experiencing similar numbers of outages may have had substantially different restoration durations, outage growth rates, or percentages of customers affected depending on the dominant hazard type and local infrastructure characteristics. By integrating these dimensions into a normalized framework, the OSI provides a more comprehensive view of outage severity and highlights how different meteorological hazards produce distinct operational and restoration challenges.

March 15-22, 2026 Outage Severity Analysis

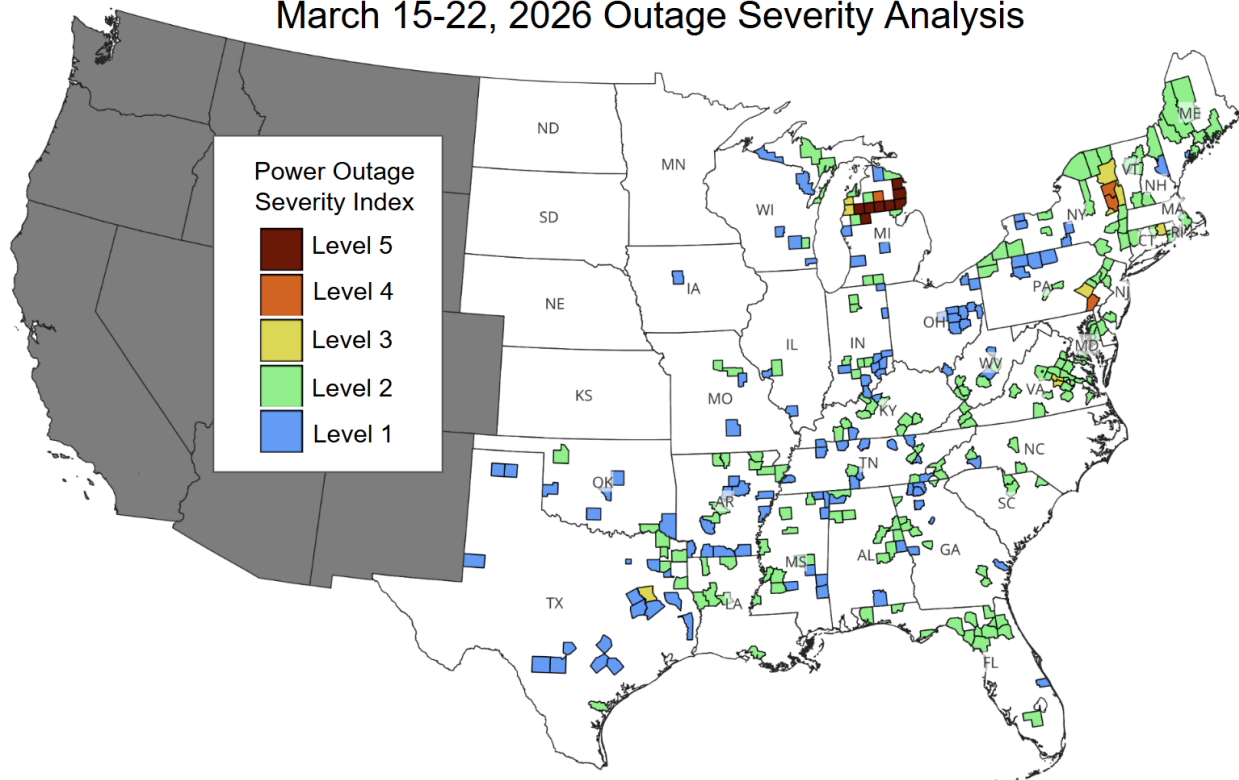


Figure 3. Power outage severity analysis using a county aggregation and normalized during the period March 15-22, 2026.

Table 1 summarizes the top 25 counties with the highest Outage Severity Index (OSI) values. The results highlight how the most severe outage impacts were heavily concentrated across portions of northern Michigan, where widespread ice accretion and prolonged restoration challenges produced exceptionally high outage severity scores. Several counties in Michigan experienced peak outage percentages exceeding 80–90% of customers without power, combined with extremely large accumulated customer outage hours.

Outage severity is influenced by more than just the total number of customers affected. Some counties with relatively smaller populations ranked highly due to prolonged restoration durations and very high percentages of customers impacted, while larger population centers with substantial customer outages but faster restoration ranked lower in overall severity.

Additional clusters of high OSI values were observed across New York, Pennsylvania, Connecticut, Virginia, and Mississippi, reflecting the diverse geographic footprint and hazard types associated with the event. These results reinforce the importance of using normalized, multi-dimensional outage metrics to better understand localized impacts and compare outage severity across regions.

Rank	County	State	Outage Severity Index	Peak Percent Out	Peak Customers Out	Customer Outage Hours
1	Roscommon	Michigan	82.9	87%	23,544	1,258,785
2	Alcona	Michigan	79.3	92%	11,946	764,305
3	Missaukee	Michigan	69.4	88%	9,512	493,430
4	Alpena	Michigan	67.1	78%	14,590	647,860
5	Ogemaw	Michigan	61.5	65%	12,217	533,595
6	Wexford	Michigan	57.9	47%	10,094	501,641
7	Iosco	Michigan	52.8	44%	10,302	358,530
8	Osceola	Michigan	51.3	48%	7,309	232,815
9	Warren	New York	46.3	32%	14,594	240,135
10	Crawford	Michigan	44.7	22%	2,714	127,369
11	Chester	Pennsylvania	42.9	10%	22,571	237,638
12	Saratoga	New York	41.4	8%	9,495	151,807
13	Hawaii	Hawaii	40.7	31%	27,172	750,541
14	Berks	Pennsylvania	39.0	8%	16,592	272,254
15	Manistee	Michigan	37.6	45%	8,585	190,757
16	Windham	Connecticut	36.9	11%	6,065	106,586
17	Essex	New York	35.8	14%	3,277	50,028
18	Schenectady	New York	35.2	7%	5,521	80,700
19	Washington	New York	34.1	6%	1,814	30,727
20	Benzie	Michigan	30.9	26%	4,167	60,955
21	Goochland	Virginia	30.8	41%	6,278	52,988
22	Powhatan	Virginia	30.2	29%	4,343	51,225
23	Tolland	Connecticut	29.8	12%	8,102	116,466
24	Halifax	Virginia	29.8	35%	10,793	46,789
25	Grenada	Mississippi	29.8	23%	2,762	57,860

Table 1. Power outage severity analysis during the period March 15-22, 2026, showing the top 25 most severely affected US counties.

Figure 4 illustrates the evolution of power outages by primary hazard type, normalized to the time of peak outages and aggregated at the state level. The curves highlight substantial differences in outage velocity behavior, both in the rate of outage growth during damage escalation and the rate of decline during restoration, across wind, thunderstorm, and ice-related events.

Thunderstorm-related outages exhibited the most rapid outage growth rates, with outages increasing sharply over a relatively short time period leading into peak impacts. However, these events also demonstrated comparatively faster restoration rates, reflecting the localized and shorter-duration nature of many severe thunderstorm impacts. Widespread wind events showed a broader temporal footprint, with outage growth occurring over a longer duration and restoration progressing more gradually as impacts expanded across larger geographic regions.

Ice-related outages displayed a markedly different structure, characterized by slower but persistent outage growth followed by the slowest restoration rates of all hazard types. The prolonged elevated outage levels associated with ice accretion highlight the tendency for ice storms to produce widespread infrastructure damage, difficult access conditions, and long-duration restoration challenges. Although ice accounted for a smaller share of total peak outages during the event, its slower restoration behavior resulted in disproportionately large customer outage duration impacts.

These differing outage velocity signatures provide important context for the Outage Severity Index (OSI). Traditional outage metrics such as peak customers without power capture only the maximum extent of outages, but do not fully represent how rapidly outages escalated or how long impacts persisted. By incorporating outage velocity metrics alongside outage magnitude, duration, and customer impact percentages, the OSI framework better captures the operational severity and lifecycle of outages associated with different hazard types. This allows for more meaningful comparisons between events and helps distinguish hazards that produce short-lived but intense impacts from those that generate prolonged and operationally complex restoration scenarios.

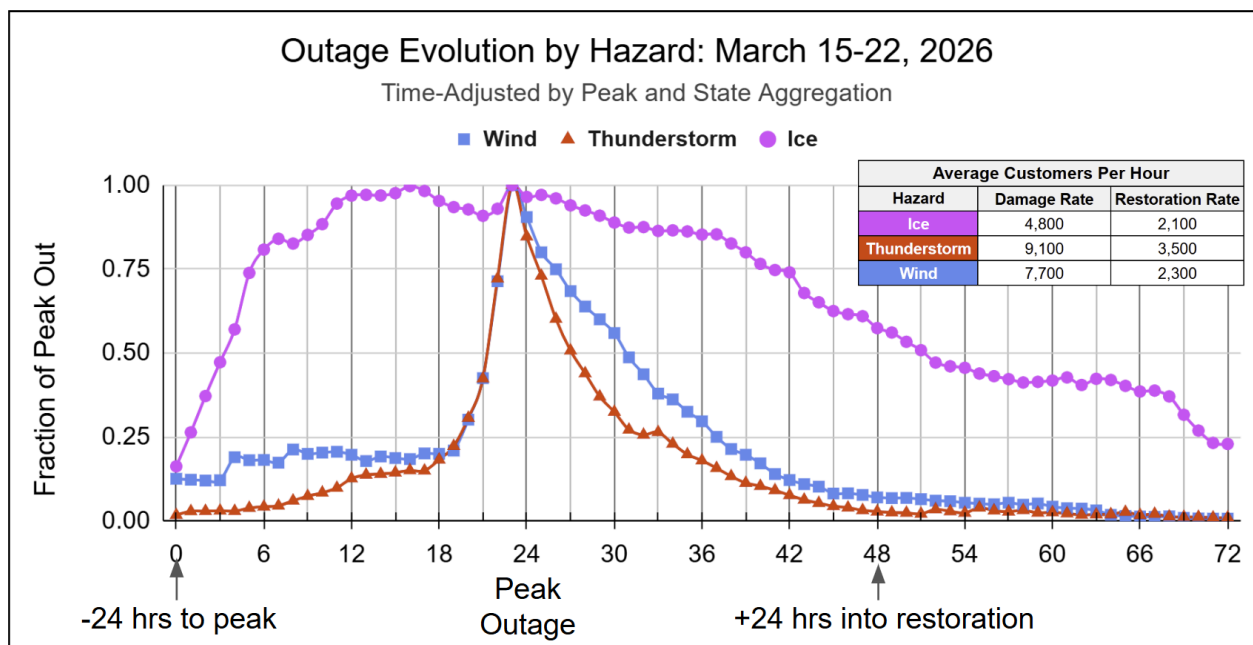


Figure 4. Power outage time series showing damage and restoration by state aggregation adjusted to time of peak by primary hazard.

Summary for Utilities and Regulators

Winter Storm Iona produced a highly **complex** and **broad** power outage event across much of the central and eastern United States, driven by the interaction of **multiple hazards** including widespread winds, freezing rain and ice accretion, severe thunderstorms, and tornadoes. The event demonstrated how different hazards can produce fundamentally different outage behaviors, restoration challenges, and infrastructure impacts.

Widespread wind hazards accounted for the majority of peak outages, while **ice-related** impacts produced disproportionately longer restoration and greater accumulated customer outage hours. Thunderstorm-related outages featured rapid outage growth but comparatively faster restoration, highlighting the importance of including the **time history** of outage evolution in addition to traditional outage metrics such as peak outages.

To better characterize outage impacts across regions and hazard classes, an **Outage Severity Index (OSI)** framework was developed using observed outage data aggregated at the county level. The OSI integrates **multiple dimensions** of outage behavior, including outage magnitude, customer percentages affected, duration, and outage velocity profile characteristics related to the front of the event (outage growth) and the backside of the event (restoration performance). This normalized approach helps distinguish between short-duration but intense outage events and prolonged, operationally complex restoration scenarios.

This type of multi-dimensional outage analysis provides a framework for improving post-event assessment, resilience planning, and operational benchmarking across utilities and regions. As power outage and hazard datasets continue to improve in spatial and temporal resolution, normalized outage severity frameworks such as the OSI can help support more **consistent comparisons** between events, improve understanding of **hazard-specific grid vulnerabilities**, and contribute toward more standardized approaches for measuring outage severity and restoration performance.