WECC

2024 Preliminary Reliability Risk Priorities

April 1, 2024

Table of Contents

Background 3

Risk Priority Development Process 3

RRP Development Timeline 4

Stakeholder Input 4

1. Aridification and associated natural events: drought, heat events, and wildfires 5

2. Changes in load from electrification 6

3. Cybersecurity interruption to operations 8

4. Inverter-based Resources 8

5. Lack of coordinated planning for building out resources and transmission 10

6. Impacts of large loads 11

7. Modeling quality and input validation 12

8. Physical damage or compromise of system assets 13

9. Potential effects of clean energy policies in the West 14

10. Supply chain 14

Background

WECC works on a range of reliability and security risks to the Western Interconnection. To help focus that work and ensure it is addressing issues of high importance and urgency, WECC develops a list of Reliability Risk Priorities (RRP). WECC refreshes the list every other year to account for changes in the political landscape, technology, the environment, and the industry. In 2024, WECC is refreshing the RRP list. This document outlines WECC's process and provides 10 preliminary risk priorities for stakeholder comment and discussion at the Board workshop on April 29, 2024. Please use this link to provide your comments by April 26, 2024: https://forms.office.com/r/wCEe1iAi6j.

Risk Priority Development Process

In 2023, WECC staff and members of the Reliability Risk Committee (RRC) developed and implemented an analytical process to identify, categorize, and analyze risks to the Western Interconnection. This work resulted in the WECC Risk Register, a matrix of risks to the interconnection that has been vetted through a risk analysis process. For the 2024 refresh, WECC is using the Risk Register because it provides a strong, analytical starting point for developing the RRPs.

The Risk Register ranks the risks according to traditional risk analysis principles, such as likelihood and impact. The prioritization of the risks in the RRP process considers broader stakeholder input and other factors like WECC's mission, authority, and ability to effectively address a risk. These factors guide WECC staff as the list is narrowed and brought to stakeholders for further feedback, which ultimately helps the WECC Board in its final determination of Reliability Risk Priorities. WECC uses three considerations in prioritizing the risks: 1) pertinence to the Western Interconnection; 2) possibility for unique work; and 3) opportunity to make a significant contribution.

Pertinence to the Western Interconnection

An RRP should be pertinent to the Western Interconnection. This means the risk not only applies to the West, but it applies in a unique way. While the RRP can be a risk that relates generally across the continent, it should manifest in the West in a distinctive way or have an exceptional impact on the West. Questions to consider include:

- Is the risk pertinent to the Western Interconnection?
- Does the risk manifest in a different way in the West than elsewhere, e.g., because of the Western Interconnection's unique configuration?
- Does the risk affect or could it affect the Western Interconnection in a different way than the rest of the continent?

Possibility for Unique Work

WECC's RRPs should be risks for which WECC can do valuable work to help industry mitigate. This means the work should not duplicate or confuse existing efforts to address the risk. To avoid duplicate work and confusion, WECC considers existing work on a risk in its determination of the RRPs. Risks for which there is considerable work underway may not make good RRP candidates if the work that WECC can do is already being done. Questions to consider include:

- Is there work taking place to address the risk that has direct application to addressing the risk in the West?
- Is existing work effectively addressing the risk in the West?
- Is there additional work that WECC and its stakeholders can do that will be valuable or that can further mitigate the risk?

Opportunity to Make a Significant Contribution

WECC's RRPs need to be issues to which WECC can make a significant contribution through its analytical, regulatory, and engagement functions. Questions to consider include:

- What is WECC doing to address the risk?
- What might WECC do to effectively address the risk?
- What capabilities, authority, perspective, or posture does WECC have that makes it a good choice for addressing the risk?
- Is there work that only WECC can do to address the risk?

RRP Development Timeline

On February 29, 2024, WECC hosted the RRP Workshop. There, stakeholders discussed the risks in the Risk Register considering the three points listed above. WECC asked stakeholders to rank the risks. WECC used that information, as well as input from other discussions about the risks, e.g., at the RRC and MAC meetings, to shape the list of risks in this document.

This document will be out for comment during April 2024. After that, WECC will synthesize the input and share it with the Board of Directors to inform their Board Workshop on April 29, 2024. Following that workshop, WECC will develop a proposed list of RRPs to present to the Board in June for approval.

Stakeholder Input

Stakeholder input on the RRPs is critical to the success of this effort. WECC provides various opportunities for stakeholders to give input, including:

- RRC risks development discussions in 2023;
- RRC risk survey;

- February 28–29, 2024, risk discussion at WECC Technical Committee meetings;
- February 29, 2024, RRP Stakeholder Workshop;
- April 2024 RRP comment period; and
- April 29, 2024 WECC Board RRP Workshop.

In addition to these opportunities, WECC is always grateful to receive input from stakeholders on risks to the Western Interconnection. Stakeholders can send their input to engage@wecc.org.

WECC has developed a preliminary list of RRPs for comment. The preliminary list was developed from the risks in the Risk Register and initial stakeholder feedback. In some cases, WECC combined risks. In addition, the specific names of some risks differ from the names in the register. Below is a description of each of the 10 preliminary risks. The description includes some information about each of the considerations listed above. WECC is asking stakeholders to provide additional information through the form. The list is ordered alphabetically and numbered for ease of reference; the risks are not listed in priority order.

1. Aridification and associated natural events: drought, heat events, and wildfires

The aridification of the West is a scientifically established phenomenon that affects the planning and operation of the bulk power system in the West. Aridification is the gradual, permanent change of a region from a humid or wetter climate to a drier climate. Aridification is a long-term phenomenon with a timespan beyond our current system planning time horizons. However, natural events associated with aridification have a more immediate and tangible effect on the bulk power system. These events include drought, heat events, and increased wildfire activity. In recent years, these events have challenged the planning and operation of the system in the West.

Conditions and Potential Consequences

Severe and extended drought conditions reduce the amount of water in rivers and reservoirs available for power production and plant cooling. The issue affects large hydro systems like the Columbia River and Colorado River systems. It also affects single plants that rely on local water supply for cooling.

Prolonged heat events increase demand. When heat events are widespread, the increased demand can occur across large areas simultaneously, eliminating a key strength of the interconnection: the diversity that allows one area to send unneeded power to another area in need. Extreme heat can reduce the capacity of transmission and generation resources. During the 2020 and 2022 heat waves, prolonged high temperatures affected transmission availability and all classes of generation. Other consequences include:

- Net demand shifts during the day, e.g., peak demand occurring later in the day or early evening when renewable energy is ramping down,

- Old planning frameworks are slow to respond to new extremes and changes in the resource mix,
- Expansion of extreme heat beyond the summer to traditional shoulder months (e.g., June and September),
- Increased surface winds that damage power lines, dry conditions, and rapid wildfire spread, and
- Challenges with seasonal maintenance scheduling.

Potential WECC Contribution

While it is not possible to control aridification or the extreme events associated with it, WECC can help industry better understand the nature and likelihood of these events and their potentially wide impact on reliability in the Western Interconnection. This information can help improve planning and operational practices to better account for risks associated with aridification. WECC is well positioned to answer inquiries like:

- What are the long-term effects of a reduction in hydro capacity across the interconnection, particularly in hydro-dependent areas?
- With the past no longer being a dependable predictor of future weather patterns, how can system planning better account for unpredictable weather?
- How resilient is the system? Is it prepared to withstand and recover from extreme heat events? What lessons have we learned and implemented from recent extreme heat events?
- How have the effects of aridification changed over the last few years, and how are they expected to look in the future based on those trends? How might those trends affect the reliability of the Western Interconnection?

2. Changes in load from electrification

Electrification is the process of converting an energy-consuming device, system, or sector, from non-electric energy sources to electricity. The world is experiencing major changes in how, and when, electricity is consumed. Electrification presents challenges and creates questions that have not been experienced or answered before. Commercial buildings, residential appliances, industrial processes, and electrical vehicles are expected to not only change the magnitude of electricity being consumed, but also challenge our expectations of when demand will peak. Along with these changes come opportunities to encourage specific charging or use patterns through technology or programs that we may not even be aware of yet.

Conditions and Potential Consequences

The push toward electrification brings up new unknowns for the bulk power system that can bring into question the reliability and resilience of the grid. Transportation electrification, for example, is expected to grow rapidly and—as emphasized by a report by NERC, CMC, and WECC—a "dramatic increase in demand [due to the growth of EVs] will challenge the electric power system in many ways. [The growth is] unprecedented and is taking place at the same time electricity system operators and planners are also focused on integrating rapidly growing levels of inverter-based generation resources, extreme weather impacts, and increasingly malicious security threats."[1]

Electrification will affect the timing, shape, and nature of demand in the interconnection. Electric vehicles and other electrified technologies increase electricity demand. Without proper planning and infrastructure upgrades, a surge in demand could strain the grid.

Though the exact nature and magnitude of those changes is uncertain, they include:

- Shifts in demand to different times of the day;
    - Peak demand shifts to times when peak demand does not currently occur,
- Demand shifts to times of day where demand is currently very low, e.g., charging of electric vehicles at night could increase demand at a time when demand is currently low; and
- Electric vehicle charging stations and smart appliance interfaces must remain resilient to disruptions, such as cyberattacks or natural disasters, to prevent introducing additional risks to the grid.

Potential WECC Contribution

Electrification is largely policy- and customer-driven, with green and clean energy policies in many states and consumer demand for electric vehicles and appliances increasing. WECC can contribute valuable work by answering inquiries such as:

- How might load look in 10 and 20 years under different levels of electrification?
- How can increased or changed demand from electrification affect the interconnection and create reliability concerns?
- How does the West create useful planning datasets and models to study the effects of electrification in the 10-year and long-term time frames?
- Are there reliability benefits to electrification? What can be done now to realize these benefits in the future?
- What characteristics will the future generation portfolio need to adapt to shifts in peak demand through days and seasons?

[1] Grid_Friendly_EV_Charging_Recommendations.pdf (nerc.com)

3. Cybersecurity interruption to operations

Cybersecurity concerns in this category include malware, insider threats, and zero-day exploits. Although not unique to the West, attacks on entities are often targeted and unique to the specific vulnerabilities of that entity. Geopolitical groups will continue to target critical infrastructure as part of cyber-warfare.

Conditions and Potential Consequences

The range of cybersecurity concerns is broad. This risk includes three specific issues:

- Malware: Infection of malicious programs or codes, from any source, on any entity corporate system. Hostile, intrusive, and intentionally nasty, malware seeks to invade, damage, or disable computers, computer systems, networks, tablets, and mobile devices, often by taking partial control over a device's operations.
- Insider threat: A trusted insider uses their authorized access to deliberately or accidentally harm assets. This can result in the unauthorized operation of cyber-assets.
- Zero-day exploit: A computer software vulnerability previously unknown to the entity using the software. Until the vulnerability is mitigated, hackers can exploit it to adversely affect programs, data, additional computers, or a network.

Potential WECC Contribution

Cybersecurity risks are a national concern. However, given the nature of the Western Interconnection and its unique topology, operational patterns, and history, some potential effects of this risk may be unique to the West. WECC works closely with E-ISAC on the national level to coordinate information on cybersecurity risks. In addition to this cooperative work, WECC can contribute by addressing:

- Best practices for insider threat programs;
- Emerging technologies to detect advanced persistent threats; and
- Assessing zero-trust models for effectiveness.

4. Inverter-based Resources

Inverter-based resources (IBR) include wind turbines, solar photovoltaic, and battery energy storage systems. IBRs are facilities connected to the bulk power system that convert DC electricity from renewable sources into AC electricity, which allows power to feed into the grid. Over the next decade, entities in the West plan to add more than 100 GW of IBRs to the system to meet demand under clean and green energy policies.

Conditions and Potential Consequences

IBRs offer a clean alternative to fossil fuel generation and are increasingly driving grid transformation in the Western Interconnection, but they are not without their challenges. While the risks can be specific to the type of IBR, there are some overarching risks applicable to all IBRs.

Many existing and new IBR generating facilities fall below existing NERC criteria for registration as a Generator Owner and are not required to follow NERC Reliability Standards. This leaves large parts of the generation fleet unregulated by mandatory standards to maintain reliable operations. In addition, inverter-based facilities that do register may not have to follow all the applicable standards that other generating facilities must, as the language in the standards may not account for this technology. Efforts are underway to address this issue. In October 2023, FERC issued Order 901 directing NERC to develop reliability standards for IBRs. The new standards will address reliability gaps related to data sharing, performance requirements, model validation, and planning and operational studies. In January 2024, NERC released its nearly three-year plan to develop those standards.

Active interconnection and commissioning requirements set and enforced by applicable entities may not provide enough clarity and consistency for IBRs. A critical component of the interconnection process is the commissioning and trial operation period immediately before commercial operation. These activities ensure the plant has been modeled, studied, designed, constructed, and configured to match the expectations and requirements of the local interconnecting utility (and per the interconnection procedures). Industry stakeholders from both generation and transmission have concerns about the commission testing procedures, seeking clarity and consistency on what these processes entail.

Ride-through is a key concern with IBRs. The ability to ride through an event on the system (rather than disconnecting from the system) is critical to system stability, particularly as the number of IBRs grows. IBR-related events in the last decade indicate that, while this is a known issue, the implementation of solutions to the ride-through issue has not been consistent across the industry.

New technology related to IBRs, particularly grid-forming technology, may offer more tools for managing the system and ensuring reliability. However, this technology is not broadly employed on the system except for a few test cases.

Potential WECC Contribution

There are many inquiries WECC can pursue to contribute to the IBR conversation in the West:

- What kind of data and modeling is necessary to accurately study the potential impact of IBRs on system stability in the 10- and 20-year futures?
- What kind of resource adequacy concerns result from large increases in IBRs on the system, in the near- and long-term future?
- How might grid-forming technology, deployed at different levels, help or hinder the system?

- Are the lessons learned from IBR-related events being fully applied by the industry, and if not, what are the residual risks to the system?

5. Lack of coordinated planning for building out resources and transmission

Historically, transmission planning and resource planning have occurred separately. While some individual entities combine the two types of planning, this is not the case on a regional or interconnection-wide levels. Recent events and analyses related to resource adequacy show that resource adequacy is as much a question of resources as it is of transmission. A heat wave in August 2020 and the Bootleg Fire in 2021 demonstrated that under certain circumstances the ability to move power can be as limiting as the availability of that power. Resource and transmission planning are inextricably linked and should be considered jointly on an interconnection-wide basis.

Conditions and Potential Consequences

This risk is persistent on the interconnection-wide level. While entities may be planning their local systems in a coordinated fashion, it is critical that system modeling and analysis at the interconnection level support coordinated planning.

Coordinated planning requires modeling and analysis capabilities that do not now exist, or do not adequately account for the nexus between resources and transmission. The lack of an interconnection-wide capability to study the whole system means we may not have a full understanding of future risks; and if we do, transmission and resource plans may not take advantage of the efficiencies and effectiveness provided by a coordinated plan.

Planning the system also requires accurate information about the future resources, transmission, and demand on the system. This relies on accurate forecasting, which, given current uncertainties about climate, weather, electrification, and technology, requires improvement. For example, as two types of organizations originate transmission projects (current Transmission Owners and Operators, and independent transmission developers), information about transmission projects originated by independent developers may not be submitted to WECC to be included in future studies.

Potential WECC Contribution

As the designated model builder under the MOD-032 standard, WECC has a stake in ensuring the West can conduct coordinated system planning. There are several inquiries WECC can help address to reach this goal:

- How can the West address gaps or inaccuracies in information provided to WECC to build interconnection-wide models?
- What needs to happen to create a West-wide coordinated system planning capability?
- What additional models/cases or changes in currently developed models/cases are needed to help with system planning?

6. Impacts of large loads

Large loads are utility customers that consume large amounts of electricity. These include data centers and cryptocurrency mines. The number of such facilities has increased significantly in recent years with the advent of artificial intelligence and cloud computing. These facilities constantly consume large amounts of electricity—their consumption does not spike at certain times of the day, for example. This can make planning for these loads less complex, but utilities must be able to supply power to these customers around the clock. As the resource mix continues to move away from traditional baseload power sources, accommodating these loads with more intermittent resources will be necessary to avoid reliability issues.

Conditions and Potential Consequences

Traditional approaches to resource adequacy may not adequately reflect the changes or increases in demand, as well as the increasing variability in supply and weather, that we are likely to see over the next decade. This can lead to a misperception of the future and inadequate projections of capacity requirements, resulting in energy emergency shortfalls and, ultimately, load loss. According to the WECC 2022 Western Assessment of Resource Adequacy, the Planning Reserve Margin Indicator (PRMI) for the West increased from 16.9% in 2021 to 18.3% in 2023 due to increasing demand and variable energy resources on the interconnection over the next 10 years and may require entities to plan for more reserves or take other actions to account for this increase. In other words, the increased variability is requiring greater reserves to ensure that utilities remain energy sufficient.

Potential WECC contribution

WECC's work on resource adequacy and system stability give it an interconnection-wide view of future resource issues. WECC can do valuable work by addressing questions that include:

- What trends are emerging?
- What types, locations, and sizes of large loads are planned to be added to the system over the next 10 years?
- What are the different types of large loads and the unique risks or challenges associated with each type of load?
- What are the potential effects on reliability of increases in large loads, particularly data centers?
- What modeling gaps exist, and what kind of modeling requirements and capabilities are needed?
- How should the industry account for unexpected increases of large-load in its forecasting?
- Does the unpredictability of cryptocurrency mining loads require a different approach altogether?

7. Modeling quality and input validation

Modeling is the process of building computer models of energy systems to analyze and better understand them. Studying how assets on the grid will respond to disturbances or other changes helps mitigate and prevent reliability issues on the bulk power system.

Conditions and Potential Consequences

As the grid continues to transform from traditional baseload generation to more inverter-based resources, it is important to understand how these assets perform under a range of conditions and circumstances. In recent years, the unpredictable performance of inverter-based resources has resulted in multiple large-scale disturbances on the bulk power system. These disturbances have exhibited systemic performance issues that have caused unexpected loss of inverter-based generation, with the potential to cause widespread outages. While these disturbances have not been frequent, they have been occurring for nearly a decade. One of the issues behind their recurrence is the absence of modeling and validation of the actual performance of inverter-based resources. This is due in part to the reluctance of manufacturers to share data, citing its proprietary nature as well as a lack of mandatory reporting requirements. This has led to model quality issues—simulations do not adequately represent how inverter-based resources will respond during transients and fault studies. This, in turn, has created a lack of confidence in planning studies and can lead to unforeseen responses in real-time operations such as loss of generating resources or load shedding. In addition, due to this inadequacy, the effectiveness of the Western Interconnection Underfrequency Load Shedding (UFLS) plan could not be verified in the 2022 UFLS assessment due to factors related to voltage support that are potentially caused by inaccuracies with the inverter-based models.

Potential WECC contribution

WECC creates system-wide models in its role as the designated model builder under the MOD-032 standard. It also conducts interconnection-wide and regional studies of transmission and resource adequacy and system stability. WECC can continue its valuable work by addressing inquiries such as:

- What does the interconnection need to improve the quality of IBR modeling?
- What improvements to model inputs WECC receives from entities are necessary to ensure the accuracy of models?
- How can demand forecasts be improved?
- How can actual system operating conditions that more accurately reflect the changes caused by grid transformation be used in the transmission model development process?
- What kind of Electro Magnetic Transient (EMT) models and standardized modeling practices (data collection, model quality checks, etc.) are needed in the West?

8. Physical damage or compromise of system assets

Physical attacks of infrastructure related to the bulk power system have been on the rise in recent years. These attacks rose 77% in 2022, according to the U.S. Department of Energy, and in 2023 the Department of Homeland Security warned that domestic violent extremists "have developed credible, specific plans to attack electricity infrastructure since at least 2020, identifying the electric grid as a particularly attractive target."

Conditions and Potential Consequences

With more than 7,300 power plants, 160,000 miles of high-voltage power lines, and more than 55,000 substations in the U.S., the electric grid is difficult to defend from physical attack. Although the primary reason for such attacks is theft, and the consequences are limited to financial loss for the owner of the facility targeted, there is a risk for a targeted physical attack aimed at disrupting operations and harming the bulk power system. Due to financial constraints, most electric infrastructure is unattended and lacks sufficient physical controls to protect against unauthorized access and malicious physical attack. As a result, once they have gained access, threat actors can exploit hardware and software systems and disrupt operations.

In addition, there is the threat of physical damage by electromagnetic pulses (EMP), which are brief bursts of electromagnetic energy that can cause significant surges in voltage resulting in the disruption of electric grids, systems, and devices. The U.S. Department of Homeland Security has developed a strategy for preventing and mitigating these attacks and has worked with the private sector to foster increased resilience to EMPs.

Potential WECC contribution

Physical security risks are coordinated at the national level through E-ISAC. In the West, the topology, geography, and remoteness of many BES assets make physical security concerns somewhat unique here. WECC works closely with E-ISAC on the national level to coordinate information on physical security risks. In addition to this cooperative work, WECC can also contribute by addressing inquiries such as:

- What are the potential impacts to the stability of the system of physical damage or physical attacks?
- What unique or critical infrastructure may be potential targets?
- Do we need to develop a better strategy for resilience to such attacks?
- Could entities at risk of attack better coordinate and share information related to the risk?

9. Potential effects of clean energy policies in the West

Energy policy intended to combat climate change can drive changes to the operation and planning of the bulk power system and can create an environment that introduces risks to reliability and resilience.

Conditions and Potential Consequences

Legislatures in several western states have enacted policies intended to curb greenhouse gas emissions. This has led to rapid changes to the resource mix, eliminating traditional baseload generating sources such as coal and natural gas in favor of more intermittent, renewable power sources such as wind and solar. These changes, which are expected to continue, have influenced the planning and operation of the bulk power system with the potential to introduce increasing levels of risk to reliability and resilience.

Potential WECC contribution

- What concerns with forecasting do these policies create?
- How have these policies affected the performance of the bulk power system? How might that change in the future?
- How can WECC help inform policymakers on how aggressive energy policies affect reliability?

10. Supply chain

In the electric industry, the supply chain refers to the entire system of producing and delivering electricity, from sourcing raw materials used in solar panels and power plant maintenance to the final delivery of electricity to the customer through transformers and meters. Constraints in the supply chain began to affect the electric industry during the COVID-19 pandemic and have persisted. They have affected the industry in many ways.

Conditions and Potential Consequences

In addition to the pandemic, global events and shortages of raw materials and labor have affected the supply and cost of new equipment throughout the industry in recent years. This has made procuring new equipment and maintain existing equipment difficult. The constraints have forced entities to prioritize between starting new projects and conducting maintenance on existing or failed equipment, leading to project delays and the inability to add new customers. These constraints could eventually affect the reliability of the bulk power system. Policies set by regulators (e.g., clean energy goals) could exacerbate the problem as new generation and infrastructure are needed to meet these goals, leading to more demand for products or materials that are in short supply or not readily available.

Potential WECC contribution

- What potential reliability concerns do supply chain disruptions cause?

- How can WECC ensure the risk of supply chain issues to reliability is known and addressed?

WECC appreciates your input on this preliminary list of 2024 Reliability Risk Priorities. Please use the comment form to provide your input by April 26. 2024.