Inverter-Based Resource Performance Issues Report

Findings from the Level 2 Alert

November 2023

RELIABILITY | RESILIENCE | SECURITY




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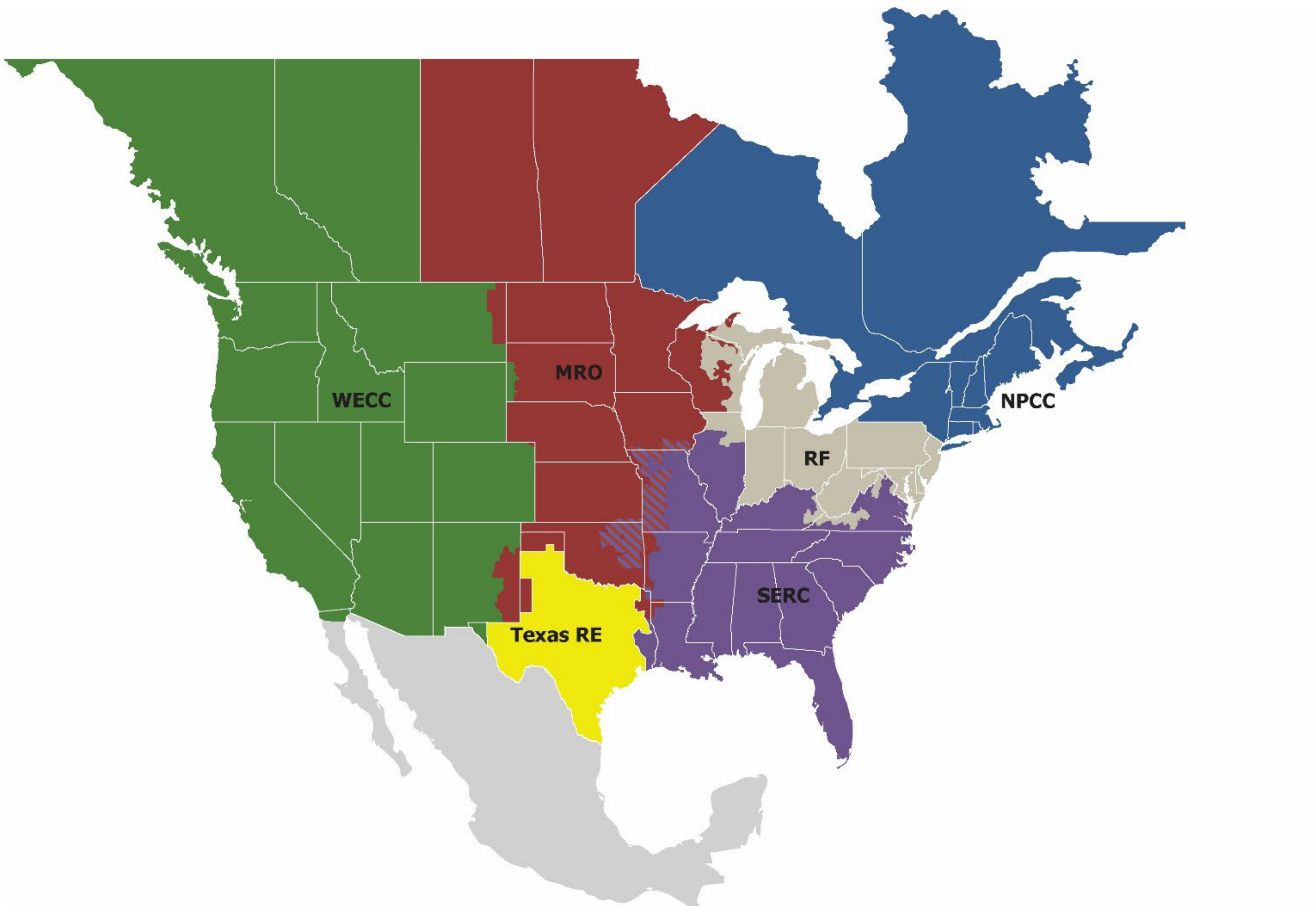
Table of Contents

Preface

Electricity is a key component of the fabric of modern society and the Electric Reliability Organization (ERO) Enterprise serves to strengthen that fabric. The vision for the ERO Enterprise, which is comprised of NERC and the six Regional Entities, is a highly reliable, resilient, and secure North American bulk power system (BPS). Our mission is to assure the effective and efficient reduction of risks to the reliability and security of the grid.

Reliability | Resilience | Security
Because nearly 400 million citizens in North America are counting on us

The North American BPS is made up of six Regional Entities as shown on the map and in the corresponding table below. The multicolored area denotes overlap as some load-serving entities participate in one Regional Entity while associated Transmission Owners/Operators participate in another.



MRO	Midwest Reliability Organization
NPCC	Northeast Power Coordinating Council
RF	ReliabilityFirst
SERC	SERC Reliability Corporation
Texas RE	Texas Reliability Entity
WECC	WECC

Statement of Purpose

Numerous disturbance reports[1] published by the ERO Enterprise provide strong evidence of systemic deficiencies in the performance of inverter-based resources (IBR) during grid events. Furthermore, conclusions include deficiencies in modeling and study accuracy of IBR integration and performance, observed in solar photovoltaic (PV), battery energy storage systems (BESS), and wind resources. However, the performance deficiencies appear to be of greatest risk in BPS-connected solar PV resources. For this reason, NERC issued a Level 2 alert, *Inverter-Based Resource Performance Issues*,[2] in March 2023 to provide strong recommendations for Generator Owners (GOs) of all BPS-connected IBR facilities to improve performance of their resources. The alert also required GOs of BPS-connected solar PV facilities to provide site-specific information via a data submission worksheet (hereafter referred to as "worksheet").[3]

NERC issued a Level 2 alert, *Inverter-Based Resource Performance Issues*, in March 2023 to provide strong recommendations for Generator Owners of all BPS-connected IBR facilities to improve performance of their resources.

The goal of this public report is to share these findings widely and drive improvements to IBR fleet performance both for existing resources and for newly interconnecting resources. This report documents key findings and recommendations based on the assessment NERC conducted after the alert. The report provides aggregate information and details the extent of condition of potential risks posed to the BPS.

Summary of Key Findings and Recommendations

This report shows that the voluntary recommendations set forth in NERC guidelines and other publications are not being implemented. The following are key findings based on the analysis NERC conducted using data provided by GOs of BPS-connected solar PV resources:

- Many GOs indicated that they did not have the requested facility data readily available. The information requested in the worksheet is fundamental equipment information that NERC expects would be retained and easily accessible with some assistance from equipment manufacturers if necessary.
- About 5,200 MW of bulk electric system (BES) IBRs have voltage and frequency protection settings within the NERC PRC-024 "no trip zone." NERC recommends that all IBRs, both BES and non-BES, have parameterized protection settings outside of the "no trip zones" based on maximum equipment capabilities so they don't trip when they are needed to remain on the system to preserve reliability. Additionally, more than two-thirds of voltage and frequency protection settings reported are not set based on inverter capability. These findings highlight the increased risk of IBR tripping during normally cleared grid faults.
- About one-quarter of the reported facilities use phase lock loop (PLL) loss of synchronism protection with a trip threshold that results in an increased likelihood of inadvertent tripping during normally cleared grid faults. These protections are not modeled in positive sequence simulations and generally not represented in historical electromagnetic transient (EMT) IBR models, meaning these risks would not be captured in interconnection studies or during annual planning assessments.
- About one-quarter of the reported facilities use a fault ride-through mode that does not adequately support BPS reliability.

[1] Event Reports (nerc.com)

- About one-third of the reported facilities use a "triangle-shaped"[4] facility reactive power capability curve, indicating a significant amount of underused reactive power capability. Underused reactive power capability could negatively affect the provision of essential reliability services like voltage regulation if it is needed during an event.

Refer to **Chapter 3:** for detailed findings and recommendations. NERC's critical recommendations and next steps include the following:

- The NERC Inverter-Based Resource Performance Subcommittee (IRPS) of the Reliability and Security Technical Committee will develop a standard authorization request (SAR) for enhancements to FAC-001 to support the uniform IBR performance requirements established by Transmission Owners (TO). Based on this and other NERC reports, the IRPS should also consider proposing commissioning requirements for GOs of IBRs; the SAR might mention that the standard could be applied at commercial operation to ensure adequate risk mitigation steps occurred during the commissioning process.
- NERC will develop two Reliability Standard Projects, 2020-02 *Modifications to PRC-024* and 2023-02 *Performance of IBRs,* to produce performance and post-disturbance analytical expectations that will address the systemic IBR performance issues and support a more reliable IBR fleet. Both projects are considered high priority given the recent FERC Order No. 901.[5] This report reiterates the criticality of implementing these standards in a timely manner to ensure adequate ride-through performance of IBRs as well as proactive risk mitigation by GOs.
- NERC will issue a Level 2 alert in early 2024 to gather modeling and study information from GOs and TPs. This alert will share recommended practices regarding modeling and study enhancements as well as gather data to assess the extent of condition of possible modeling and study risks. Both the upcoming Level 2 alert on modeling and study practices and this alert on IBR performance issues will inform the contents of a Level 3 alert, providing essential actions for high-risk IBR Issues that will be issued in the first half of 2024.

NERC also recommends continuing to examine how the Federal Energy Regulatory Commission (FERC or Commission) interconnection agreements and procedures could further support the reliable integration of IBRs. The recommendations all align with the intended goals and activities set forth in FERC Order No. 901 regarding enhancements to NERC Reliability Standards for IBRs.

[4] The "triangle shape" reactive power capability curve is based on a ±0.95 power factor (PF) limit that is typically programmed into a plant-level controller and is not often based on the total installed reactive power capability of the facility, artificially limiting the available capability that can be delivered to the BPS.

[5] *Reliability Standards to Address Inverter-Based Resources*, Order No. 901, 185 FERC ¶ 61,042 (2023) [hereinafter FERC Order No. 901]

Chapter 1: Analysis of Alert Data Submissions

NERC sent the Level 2 alert to all GOs and required those who own BPS-connected solar PV resources to submit a data submission worksheet. NERC provided the GOs with detailed background information along with seven recommendations that outlined the approach to identifying and mitigating these risks. The recommendations in the alert (as well as the recommendations in this report) should be applied to all BPS-connected IBRs, including wind and BESS, not only solar PV resources.

The alert had an initial submission deadline of June 30, 2023; however, as of June 26, 2023, NERC had received only 15 worksheet submissions from 13 entities. Due to this unprecedented and unexpected low response rate of approximately 6%, a one-time deadline extension to July 31, 2023, was granted on June 30, 2023.[6] At the close of the extended deadline, NERC received 1,149 responses to the alert, a 97% response rate.[7]

The worksheet questions were intended to gather information regarding the extent of condition for possible solar PV performance and capability deficiencies based on experience from multiple events analyzed by the ERO Enterprise and discussions within industry groups. NERC developed the worksheet with the assumption that GOs would have the requested information available to submit with relative ease[8] in coordination with their respective original equipment manufacturers (OEM) if needed. Feedback from GOs, consultants, and OEMs indicated that many GOs do not retain this information nor do they always have sufficient internal technical expertise to respond to these requests. Thus, GOs are reliant on OEMs and consultants to produce the information upon request, which can create a backlog.

Table 1.1 shows the responses broken down by Regional Entity. 217 entities answered "Yes" regarding ownership of one or more BPS-connected solar PV facilities. These entities were required to fill out the worksheet for each BPS-connected solar PV facility. While anecdotal comments indicated that the data was difficult to obtain, all but three entities submitted a worksheet by the extended July 31, 2023, deadline.

Table 1.1: Regional Entity Responses

Answer	MRO	NPCC	RF	SERC	TRE	WECC
No	135	110	171	129	191	196
Yes	8	2	18	59	45	85

Data Submission Quality

Review of the submitted data indicates that GOs are not sufficiently documenting and retaining critical information related to their facilities and may not have a collaborative agreement with their OEMs, posing a risk to BPS reliability. While the majority of worksheets were "complete,"[9] detailed analysis of the data within the worksheets showed significant and numerous instances of misunderstanding the technical details of the information requested. For example, worksheet submissions for solar PV resources in one Regional Entity showed discrepancies when compared to known quantities. Question 12 in the worksheet asked a GO whether their "(…) inverter manufacturer(s) experienced instances of inadvertent tripping at other facilities" with approximately 4,000 MW (~40%) of the region's solar PV resources. The GO answered with "No" but uses equipment that has been documented to be involved in past major disturbances.

[6] NERC Alert: Inverter Based Resource Performance Issues Extended Deadline

[7] It is difficult to determine a precise "response rate" because several entities who were not required to respond, submitted a response.

[8] The data requested in the worksheet is critical facility performance and capability information and is essential for sufficient situational awareness for GOs and the reliable operation of their facilities.

[9] The majority of submitted worksheets had vales in nearly all requested fields.

NERC engaged GOs, equipment manufacturers, and consultants throughout the process to seek feedback on the alert administration and the worksheet submission process and received the following feedback:

- GOs had difficulty populating the worksheet without significant assistance from OEMs or consultants. Multiple GOs relied entirely on OEMs and/or consultants.
- Consultants had difficulty completing the worksheet due to a lack of information from the GOs as well as difficulty obtaining project-specific information from the OEMs.
- OEMs had difficulty supporting the GOs in their alert data submission activities due to reasons like the following:
  - OEMs often lose visibility into the facility after the site is commissioned.
  - Ongoing facility support is dependent on service agreements with OEMs that vary by project and company.
  - Some protection and control settings are configurable by the GOs, so OEMs may not have a record of currently operating parameters.

GOs are responsible for the submission of facility data to TPs and PCs for use in interconnection studies and annual planning assessments. This facility data is used to develop accurate models and submit sufficient documentation for model verification and validation activities. Therefore, the types of data are inherently necessary to maintain and regularly update and submit to TPs and PCs. The findings above raise concerns regarding gaps in understanding and the availability of detailed facility data, casting doubt on the accuracy and quality of the submitted modeling data used in reliability studies.

Chapter 2: Assessment of Alert Data Submitted

NERC assessed the data submitted by applicable GOs of solar PV facilities. This chapter provides the aggregate results of the data and extracts key findings regarding each question asked in the submission worksheet.

Voltage and Frequency Protection Settings

Entities were asked to submit their inverter-level voltage and frequency protection settings. **Figure 2.1** and **Figure 2.2** show the voltage and frequency protection settings, respectively, submitted by entities and compared with the NERC PRC-024 "no trip zone" curves. The following are key findings from the data provided:

- **Protection Settings Inside the PRC-024 Curve:** Numerous protection settings are set within the "no trip zone" as defined in NERC PRC-024. NERC staff analyzed all protection settings that fell within the "no trip zones" to determine if these protections were located at non-BES facilities.[10] Many of the protection settings that fell within the "no trip zone" are located at BES facilities, and these protection settings are marked in red on **Figure 2.1** and **Figure 2.2.** NERC guidance recommends that all IBRs, BES and non-BES, have parameterized protection settings outside of the "no trip zones" based on maximum equipment capabilities. These settings show that numerous BES-connected facilities are at an elevated risk of tripping during BPS disturbances, are not setting their protections based on maximum equipment capabilities, and not following NERC guidance:
  - Approximately 2,260 MW of BES-connected solar PV facilities have protections set inside of the high voltage ride through or low voltage ride through "no trip zones."
  - Approximately 1,293 MW, 590 MW, and 1,789 MW of BES-connected solar PV facilities have protections set inside of the high frequency or low frequency ride through "no trip zones" for the Eastern Interconnection, Western Interconnection, and ERCOT respectively.
- **Protection Settings On the PRC-024 Curve:** Many voltage protection settings were set directly on the PRC-024 curve or at whole numbers, indicating that these settings are not optimizing their ride-through capability. Settings on the PRC-024 curve are a strong indicator that those settings are not based on the maximum equipment capabilities and that the parameterization of these protection settings was performed with PRC-024 compliance in mind, not the maximization of ride-through capability.
- **Inverter-Level Versus Point of Interconnection Level Settings:** The PRC-024 "no trip zone" represents the disturbance at the point of interconnection (POI) that the facility must ride through while the protection settings plotted in **Figure 2.1** are located at the inverter terminals. Voltages at the inverter terminals are often significantly more severe (higher or lower) than those at the POI primarily due to main power transformer tap position and impedance, collector system characteristics, and the status of supplemental reactive power devices. Therefore, voltage protection settings located directly on the PRC-024 curve have a high likelihood for operation during disturbances that are within the PRC-024 curve at the POI in addition to artificially limiting ride-through capabilities. This leaves a potential situation where BES-connected IBRs meet the requirements set forth in PRC-024 but still fail to ride through as expected. This phenomenon is less prevalent during frequency disturbances as system frequency is very similar at the inverter terminals when compared to the POI.

[10] Non-BES IBR facilities are currently not required to meet the requirements in PRC-024, so protections inside of the "no trip zone" at non-BES facilities would not constitute an elevated reliability risk.

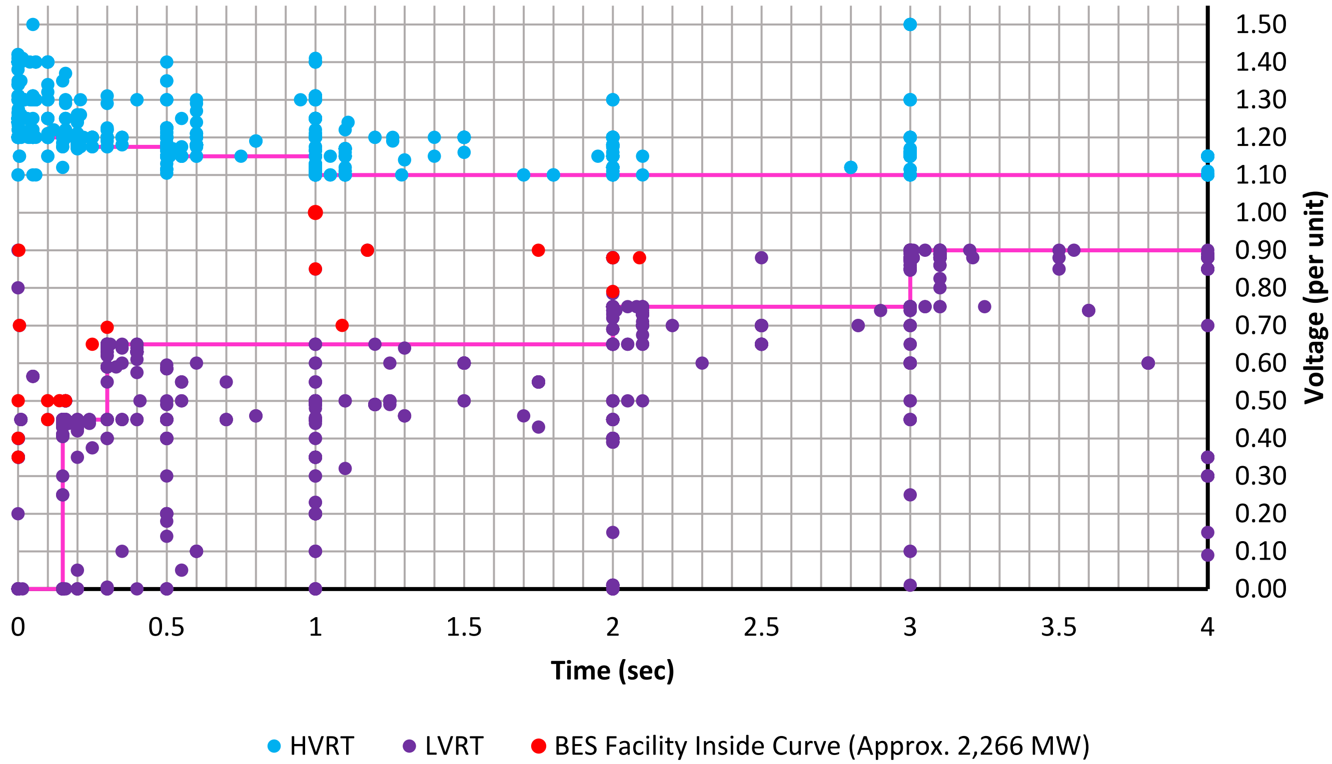


Figure 2.1: Inverter Voltage Protection Settings vs. PRC-024

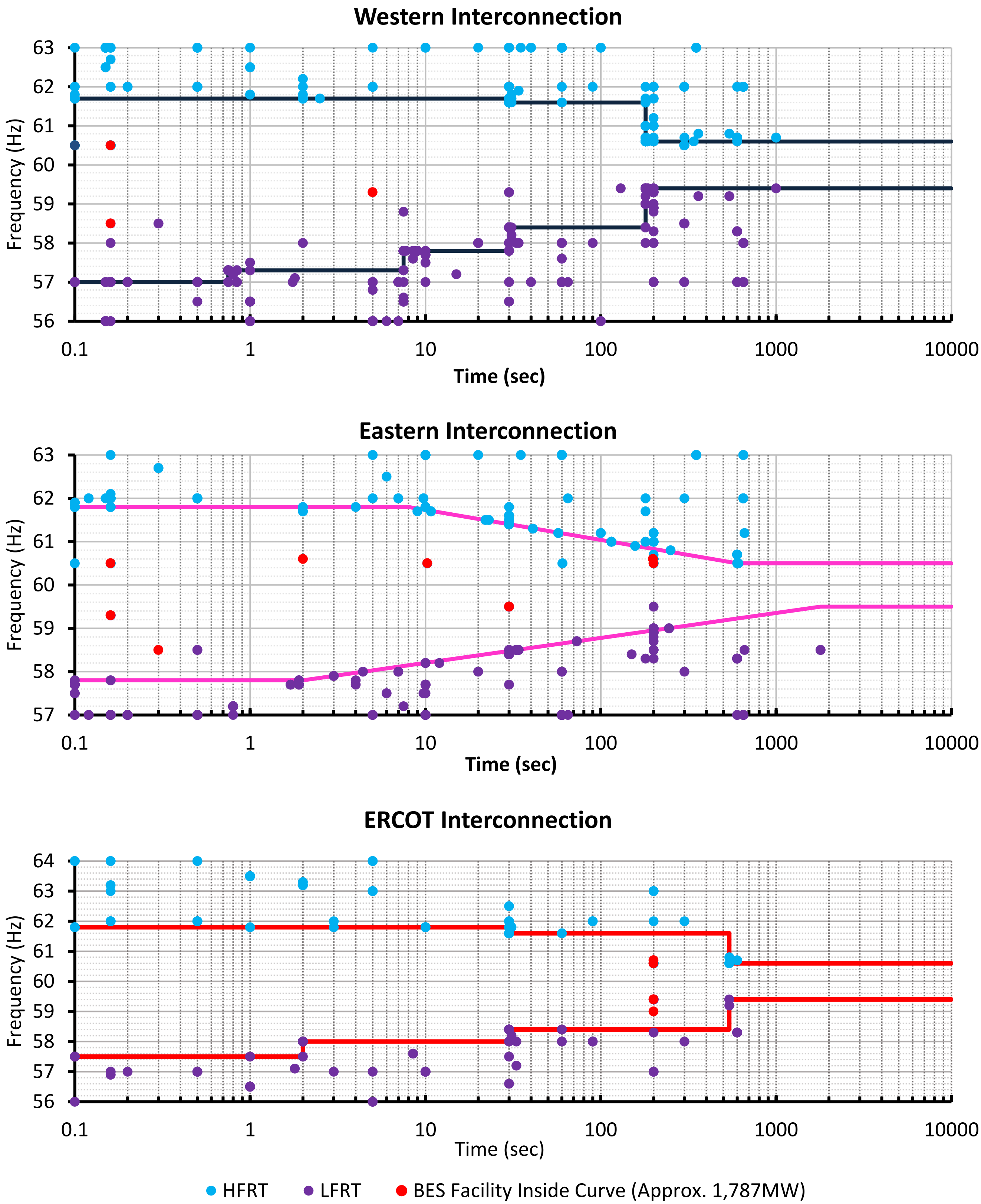


Figure 2.2: Inverter Frequency Protection Settings vs. PRC-024

Protection Settings with Respect to Equipment Capabilities

NERC asked entities whether the inverter voltage and frequency protection settings were based[11] on the maximum capability of the equipment (see **Table 2.1**). Results show that less than one-third of the inverter settings reported are set based on equipment capability, showing that there is significant underused ride-through capability across the BPS and reinforcing the conclusions drawn in the preceding section. This finding raises concerns regarding ride-through performance, the provision of essential reliability services, and BPS reliability, especially at a time when the grid transformation is resulting retirements of substantial amounts of synchronous machines. This finding provides additional evidence that the voluntary recommendations set forth in NERC guidelines and other publications are not being implemented.[12]

Table 2.1: Protection Settings Based on Maximum Equipment Capability

Ride-Through Protection Type	Yes	No	Percent Yes
High Voltage	617	1,399	30.61%
Low Voltage	722	1,209	37.39%
High Frequency	376	931	28.77%
Low Frequency	476	1,021	31.80%
Total	2,191	4,560	32.45%

Protections Set Based on Instantaneous Measurements

Entities were asked to specify whether protection settings operate on instantaneous peak measurements (i.e., single-sample), a sub-cycle measurement with some time delay, or using a filtered root-mean-square (RMS) quantity.

NERC determined the following by analyzing the data:

- High- and low-voltage protection settings, 6% and 5% respectively, use an instantaneous peak measurement quantity. However, only 2% and 0%[13] of high and low voltage protection settings use an instantaneous peak measurement quantity with a sub-cycle time delay that has been shown to be very prone to tripping. While these protections have been observed in multiple events analyzed by NERC, it appears that this risk is relatively low across the BPS.
- High- and low-frequency protection settings, 37% and 38% respectively, use an instantaneous (unfiltered) measurement quantity. Protection settings with instantaneous measurements have an increased likelihood of inadvertently tripping as the time delay used in the protection decreases. NERC does not have a specific "cutoff" recommendation for protection time delays but does suggest that protection settings are parameterized based on maximum equipment capabilities. 4% of high- and low-frequency protection settings use an instantaneous, unfiltered measurement quantity with a sub-cycle[14] time delay that is very prone to tripping for grid faults. This again indicates a relatively minimal risk to BPS reliability.

[11] The alert recommended that GOs expand inverter ac voltage protection settings in coordination with their OEMs as wide as possible within the inverter equipment capability.

[12] Multiple NERC publications have recommended that inverter- and plant-level protection settings be based on equipment capability to maximize the ability of inverter-based resources to ride through grid faults and provide essential reliability services.

[13] This percentage is rounded down; three protection settings used both instantaneous measurements and a sub-cycle time delay.

[14] While frequency protection that use instantaneous measurements could still be prone to inadvertent tripping even with larger time delays, sub-cycle time delays are used in the analysis to capture extreme cases.

Phase Lock Loop Loss of Synchronism Protection

NERC asked entities about their inverter PLL loss of synchronism protection settings that have resulted in many inverters tripping during past disturbances analyzed by the ERO Enterprise. While enabling this protection function does not necessarily increase the risk of inadvertent tripping, setting the angle threshold too small could result in unnecessary inverter tripping for grid faults (as reported in past NERC guidelines). The percentage of the solar PV fleet with PLL loss of synchronism protection enabled is 45%. NERC has previously recommended at least a 30-degree angle threshold be used to ride through a large percentage of BPS disturbances.

Results show that only 23% of the solar PV fleet use PLL loss of synchronism protections with an angle threshold larger than 30 degrees (the lower threshold of the recommended range). This means that about 22% of the solar PV fleet is at a significantly higher risk of inadvertent tripping as PLL loss of synchronism protections are enabled with angle thresholds lower than those NERC recommends. This is additional evidence that industry is not adopting the voluntary recommendations set forth in NERC reports and reliability guidelines.

Fault Ride-Through Mode of Operation

NERC asked entities to provide their fault ride-through modes of operation enabled in their inverters with a list of options (see **Figure 2.4**). Key findings from the results provided include the following:

- The orange and burgundy sections of the pie chart (73% of the solar PV fleet in MW) represent a combined active and reactive current injection, NERC's preferred configuration for inverter ride through.[15] This shows that about 73% of BPS-connected solar PV is operating with reasonable and expected control philosophies.
- The green (momentary cessation), yellow (reactive current injection only), and brown (active current injection only) do not align with the fault recovery recommendations in the alert and other NERC disturbance reports. However, these configurations may be artifacts of historical control philosophy, particularly for "legacy" facilities with commercial operation dates further in the past (circa mid-2010's).
- Therefore, about 27% of the BPS-connected solar PV fleet are not configured with recommended ride-through mode settings. As stated above, many of these facilities may be "legacy" and not physically capable of being modified.[16] GOs should ensure that their inverters are configured with the recommended settings set forth by NERC where possible and should also ensure that their dynamic models submitted to the TP and PC accurately reflect this mode of operation. Furthermore, operators need to be informed that this legacy equipment will trip under certain system conditions so the equipment can be modeled in operational contingency cases, ensuring that system impacts from their performance is understood for system events. As with any change to facility performance, updates in control philosophy should be studied by responsible entities prior to making the change in the field.

[15] Both modes of operation involved active and reactive current injections up to inverter limits, with a priority of active or reactive current only upon the inverter reaching its apparent current limit. While reactive current priority it typically preferred, the selection of this setting should be based on system studies and local grid needs.

[16] Consistent with Order No. 901, NERC will be examining whether to include a "limited and documented" exemption for these IBRs from voltage ride through performance requirements. *See* Order No. 901.

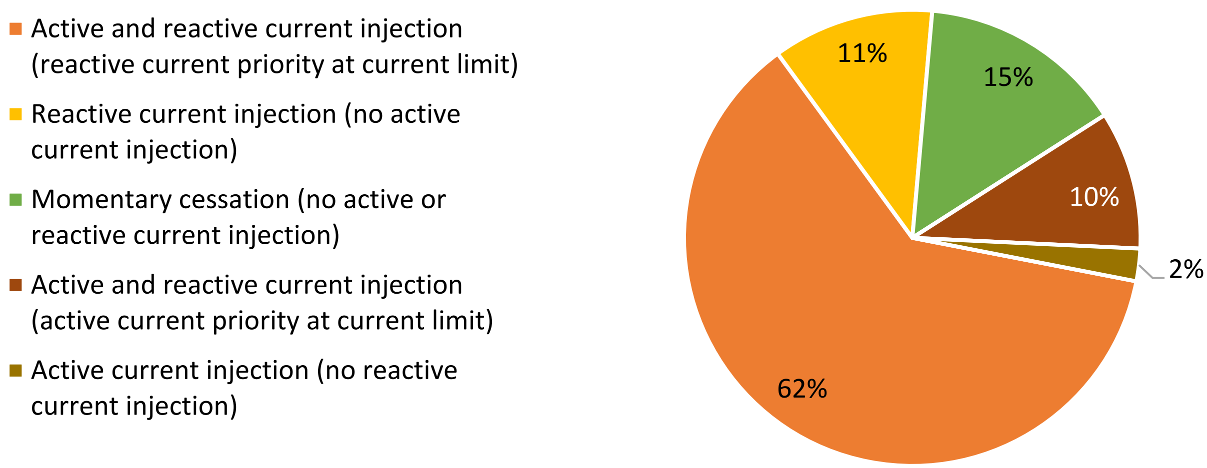


Figure 2.4: Solar PV Fault Ride-Through Configuration

Active Power Output Recovery During Disturbance Ride-Through

NERC asked entities to report the expected time (in seconds) that their facilities will recover their active power to pre-disturbance levels following a fault. NERC has recommended that resources return to pre-disturbance active power output levels within 1-second upon fault clearing unless reliability studies identified a need to slow down the post-fault response. **Figure 2.5** shows the full data set (left) and a zoomed in version for less-than-20-second recovery (right). Results show that about 40% of facilities use a 1-second recovery time; however, many facilities are configured with recovery times significantly exceeding this recommendation to the point that many plants are configured with recovery times in the order of minutes rather than seconds. The risk is that substantial amounts of resources and associated essential reliability services will not be available to support the reliable operation of the bulk power system during system events. The large variance in recovery times indicates of a lack of uniform performance requirements for IBRs connected to the BPS and a failure to adopt NERC guidance.

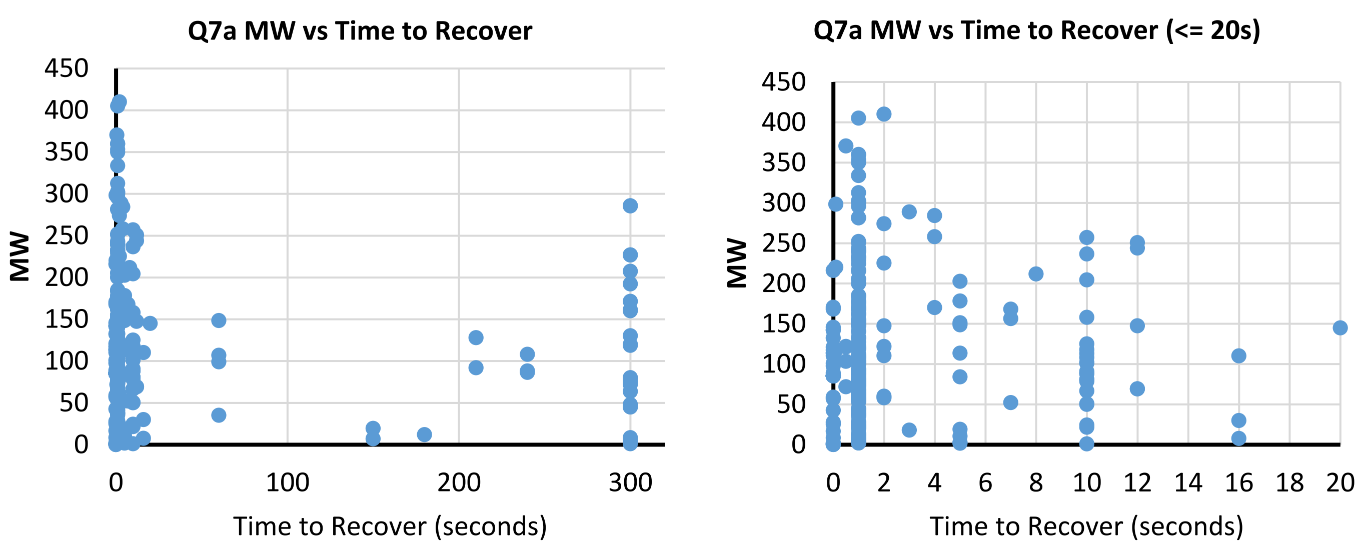


Figure 2.5: Post-Fault Recovery Time by Facility Size

Facility Reactive Power Capability

Entities were asked to provide data regarding the reactive capability for individual inverter types as well as an overall facility composite capability curve at nominal voltages. NERC reviewed the data received and calculated power factors of the data points provided to categorize and identify the resources with a “triangle” shaped facility composite capability curve (i.e., a capability curve limited to a 0.95 power factor at all active power levels) instead of those based on the maximum capability of the installed equipment. A “triangle” shaped facility composite capability curve indicates that the reactive capability of the facility cannot exceed a designed power factor limit defined within plant control settings that is artificially limited.

The breakdown of resources with a triangle-shaped capability curve versus those with a capability curve more indicative of using the full reactive capability of the resource across all active power levels (i.e., more of a rectangular, slanted rectangular, or oval shape) shows that 35% have a “triangle” capability curve, potentially leaving significant reactive power capability unused within these resources. NERC has strongly recommended that no artificial limitations be placed on reactive power capability at IBR facilities to ensure the maximum amount of essential reliability services are leveraged from these resources, especially during events that can impact the reliable operation of the bulk power system.

Dynamic reactive power is an essential reliability service and necessary for maintaining BPS reliability and resilience. Modern solar PV inverters have reactive capabilities exceeding ±0.95 PF at their terminals, so they should be able to provide reactive power at the point of interconnection in excess[17] of ±0.95 PF. Artificially limiting the reactive capability at solar PV facilities (or any facility) can significantly reduce the overall reactive capability of the BPS, which is essential to support system voltage. **Figure 2.6** shows an anonymized PV facility with a non-triangle shaped capability with an overlaid 0.95 power factor curve. The shaded red area shows the unused (lost) reactive capability if this facility was artificially limited to 0.95 power factor across all active power levels.

The steady-state and dynamic reactive capability of an IBR facility should at least meet the ±0.95 power factor capability at the maximum power output; however, the facility reactive power capability should not be artificially limited at any active power level. This will help maximize the amount of voltage support provided to the BPS, particularly at any active power output level less than maximum rating.

[17] Collector system losses will reduce the total amount of capacitive reactive power supplied to the BPS.

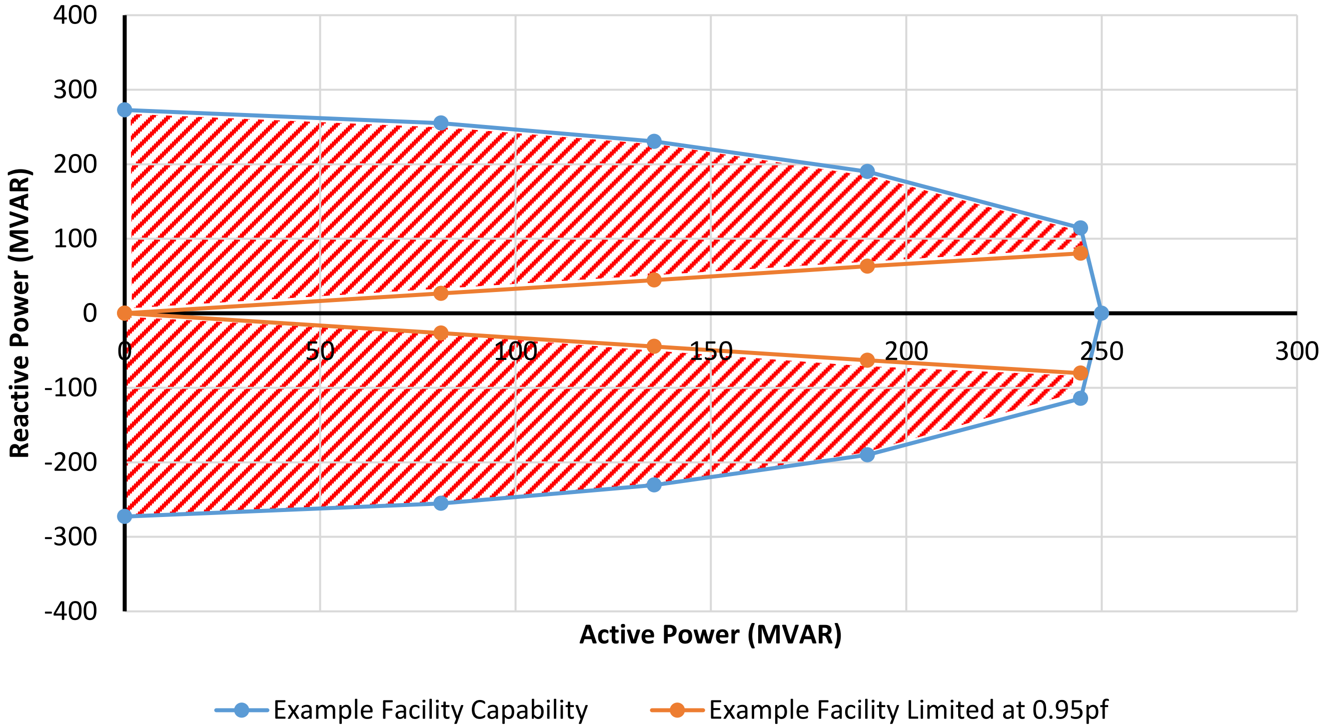


Figure 2.6: Example of Lost Reactive Capability

Chapter 3: Detailed Key Findings and Recommendations

This report provides evidence that many GOs and GOPs are not acting on voluntary NERC recommendations, but they are performing only the minimum as explicitly stated in FERC orders, regional requirements, and NERC Reliability Standards. However, following only these minimums (or disregarding the minimums entirely) can result in the loss of substantial amounts of resources and essential reliability services during events when they are needed the most. The following are a list of key findings and recommendations based on the assessment NERC conducted outlined in Chapter 2:. These findings are also considered in the context of ongoing IBR risk mitigation activities and the broader energy transition to ensure high-priority risk mitigations are established effectively, efficiently, and with appropriate agility.

- **Key Finding #1:** The equipment capability and performance deficiencies identified in this analysis stem from a lack of uniform performance requirements across North America. NERC has strongly recommended that significant enhancements to interconnection requirements be established by TOs per the existing FAC-001 standard; however, experience has proved numerous times (as reported in past reports) that TO interconnection requirements significantly lack the specificity and clarity to ensure reliable performance of inverter-based resources.
    - **Recommendation:** The NERC Inverter-Based Resource Performance Subcommittee (IRPS) has a work plan item focused on drafting a SAR for enhancements to FAC-001 to ensure that sufficient uniform performance requirements are established by industry to mitigate these risks moving forward.
- **Key Finding #2:** The equipment capability and performance deficiencies identified in this analysis will also be mitigated by two high-priority NERC Reliability Standard projects currently underway: Project 2020-02 Modifications to PRC-024 and Project 2023-02 Performance of IBRs. Revisions of PRC-024-3 are intended to ensure a comprehensive performance-based ride-through standard where plants are fully expected to ride through grid disturbances and provide essential reliability services. Project 2023-02 proposes a new standard to require the analysis of unexpected or unwanted performance issues at IBR facilities and to mitigate them when identified. This will put in place a more proactive approach to risk mitigation rather than relying on large-scale events analyzed by the ERO to initiate action within industry.
    - **Recommendation:** Both NERC Reliability Standard projects are considered a high priority and set forth expectations that the final version of the standards will address systemic IBR performance issues and support a more reliable and resilient IBR fleet.
- **Key Finding #3:** This analysis uncovered systemic deficiencies in the availability and understanding of facility information. Facility commissioning is a significant milestone prior to facility energization and should verify that what was studied in the interconnection process is being placed in-service. NERC recommends that the IRPS consider the findings in this report, other NERC reports (namely the recent California Battery Energy Storage Report),[18] and Order No. 901 and then draft a SAR that ensures that facility data (modes of operation, settings, controls, protections, etc.) matches the performance requirements and what was studied during the interconnection process. It is imperative that these three elements (i.e., studies, as-built settings, and performance requirements) and related directives from FERC in Order No. 901 are aligned prior to commercial operation. A NERC Reliability Standard could be developed that applies to GOs upon commercial operation that requires proof of this verification process (and for any subsequent change thereafter). The NERC IRPS can determine the most effective and efficient way to incorporate this into the suite of NERC Reliability Standards.
    - **Recommendation:** NERC recommends that the IRPS consider this report in the context of all other NERC reports and Order No. 901 and develop a SAR for endorsement by the NERC Reliability and Security Technical Committee that introduces commissioning requirements for GOs of IBR facilities.

[18] NERC BESS Disturbance Report

- **Key Finding #4:** Reactive power capability appears to be underused according to data provided. The controls should be modified to ensure that these resources can be counted upon like synchronous machines to support reliability beyond minimum requirements as system conditions change quickly, and the need for essential reliability services fluctuates through system events. The underuse of reactive power capability could affect the ability of solar PV facilities to provide essential reliability services like voltage regulation.
  - **Recommendation:** NERC recommends examining opportunities to pursue greater use of reactive power capability.
- **Key Finding #5:** The performance deficiencies outlined herein should be addressed prior to commercial operation during the interconnection modeling and studies process. The findings related to significant quantities of IBRs not meeting NERC recommendations or other best practices raises continued and elevated concerns regarding the quality, fidelity, and accuracy of the models used for studies in the interconnection process and during the annual planning process.
  - **Recommendation:** A Level 2 alert will be issued in early 2024 to gather modeling and study information from GOs and Transmission Providers. This alert will share recommended practices regarding modeling and study enhancements as well as gather data to assess the extent of condition of possible modeling and study risks. Both the upcoming Level 2 alert on modeling and study practices and this alert on IBR performance issues will inform the contents of a Level 3 alert providing essential actions for high-risk IBR issues that will be issued in the first half of 2024.

The recommendations all align with the intended goals and activities set forth in FERC Order No. 901 regarding enhancements to NERC Reliability Standards for IBRs.[19]

[19] FERC Order No. 901