North American Electricity Reliability Organization Inverter-Based Resources & Distributed Energy Resources Disturbances Overview with Reference Material

Key Highlights

- The North American Electric Reliability Organization (NERC) has identified technological advances in inverter-based resources (IBRs) and distributed energy resources (DERs) as having a major impact on our electrical grid.
- NERC provides a variety of useful resources to explain IBRs and DERs and their impacts, including disruptions to electricity systems.
- This advisory provides an overview of NERC's efforts and available resources to benefit cooperatives.

What has changed?

According to the North American Electric Reliability Organization (NERC), "technological advances in inverter-based resources (IBRs), inclusive of distributed energy resources (DERs), are having a major impact on generation, transmission, and distribution systems." These assets are some of the many significant technology changes transforming the North American electric grid.

What is the impact on cooperatives?

As more IBRs and DERs are added to the electric grid, cooperatives personnel will be required to consider changes to how their systems are designed, controlled, planned and operated.

What do cooperatives need to know or do about it?

NERC has many resources available to understand electric grid impacts of these variable non-inertia generation assets. Definitions and examples of generator system types provide context when discussing the differences between IBRs and DERs.

Inverter-Based Resources

IBRs are generation assets that are connected to the Bulk Power System (BPS). NERC assessments identified a reliability gap associated with the increasing integration of IBRs as part of the grid in which a significant level of bulk power system-connected IBR owners and operators are not yet required to register with NERC or adhere to its Reliability Standards. FERC issued an order in 2022 directing NERC

to identify and register owners and operators of currently unregistered bulk power system connected IBRs. Changes to the NERC Rules of Procedure (ROP) with the criteria for registration of these entities was filed with FERC with expected approval in Summer 2024.[1]

As presently proposed, only cooperatives that own or operate non-BES IBRs with aggregate nameplate capacity of greater than or equal to 20 MVA, delivering such capacity to a common point of connection at a voltage greater than or equal to 60 kV, will be impacted. Owners and operators of IBRs greater than 75 MVA connected at 100 kV and above are already subject to registration under the existing Generator Owner (GO) and Generator Operator (GOP) Registry Criteria in the ROP.

NERC has created an IBR Registration Initiative Quick Reference Guide[2] which is a visual dashboard that allows stakeholders to easily locate key project updates and resource documents and will be updated regularly. In addition, NERC developed an IBR Quick Reference Guide[3] for the work that has been done to ensure the continued reliability of the North American power grid.

Distributed Energy Resources

IEEE Standard 1547-2018 defines a DER as "a source of electric power that is not directly connected to a bulk power system (BPS). DER includes both generators and energy storage technologies capable of exporting active power to an electric power system." The NERC System Planning Impacts of DER Working Group (SPDIERWG) uses a similar definition of DER: "Any Source of Electric Power located on the Distribution System."

SPIDERWG developed a DER Quick Reference Guide[4] for the work that has been done regarding DERs to support efforts to the continued reliability of the North American power grid. The most significant impact to distribution cooperatives is providing data as requested by the applicable NERC registered entities identified in NERC Reliability Standards, associated with existing and forecasted distributed energy resource (DER) information for developing system models.

Resources Regarding Loss Events

A main objective of NERC's Event Analysis Program is to share knowledge with industry and other stakeholders identified from incidents, events, and occurrences of interest on the grid. Through this Program and the development of disturbance reports and alerts, NERC shares key findings and recommendations with industry stakeholders. Several widespread IBR loss events have been analyzed. Findings indicate that there are "many systemic performance issues with the inverter-based fleet." Efforts to enhance the performance of IBRs for existing and newly interconnecting projects are underway.

The following reports are specific to IBR loss events:

- **March/April 2022 California Battery Energy Storage System Disturbances**

  These events are unique in that they are the first major events involving BESS facilities. They highlight the need to consider BESS in the same light as any other inverter-based resource, such as solar PV, for their systemic reliability risks.

[1] Tentative decision date of June 27, 2024. NRECA will update this information as it becomes available.
[2] https://www.nerc.com/comm/RSTC/Documents/IBR_Registration_Quick_Reference_Guide.pdf
[3] https://www.nerc.com/pa/Documents/IBR_Quick_Reference_Guide_Activities.pdf
[4] https://www.nerc.com/pa/Documents/DER_Quick%20Reference%20Guide.pdf

- **April 2023 Southwest Utah Disturbance Report**

  This event is the first major widespread solar loss to occur in the Western Interconnection outside of California. Nine solar PV facilities (some with multiple phases) failed to ride through a normally cleared fault on a 345 kV transmission circuit. This resulted in an unexpected loss of 921 MW of generation.

- **June 2022 Odessa Disturbance Report**

  This report provides a comprehensive assessment of a widespread loss of solar PV and synchronous generation caused by a normally cleared fault in the Texas Interconnection that occurred on June 4, 2022.

- **March 2022 Panhandle Wind Disturbance Report**

  This report focuses specifically on a reduction of wind resources across the Texas Panhandle area that occurred on March 22, 2022, and affected up to around 200 miles from the initiating fault. Concerning weather patterns started the evening of March 21, 2022, with severe conditions (freezing rain, snowfall, and high winds) occurring the early morning of March 22, 2022. Generator Operators (GOP) reported wind turbine icing and high wind speed cutoffs during this time period. Two BPS faults occurred the morning of March 22, 2022.

- **June-August 2021 CAISO Solar PV Disturbance Report**

  This report contains the Electric Reliability Organization's (ERO's) analysis of four BPS disturbances with widespread reductions of solar PV output that occurred in the California Independent System Operator (CAISO) footprint between June and August of 2021.

- **May/June 2021 Odessa Disturbance Report**

  This report provides details regarding the initiating event, performance of the BPS-connected solar PV fleet during the event, and additional details around the event. On May 9, 2021, the Texas Interconnection experienced a widespread reduction of over 1,100 MW of solar photovoltaic (PV) resources due to a normally cleared fault on the bulk power system. The event involved facilities across a large geographic area of up to 200 miles from the location of the initiating fault. NERC and Texas Reliability Entity (RE) analyzed this event, in coordination with ERCOT, and have documented the key findings and recommendations in the report.

- **July 2020 San Fernando Solar PV Reduction Disturbance Report**

  This report documents the analysis conducted and provides key findings and recommendations for industry. On July 7, 2020, fault events on the bulk power system occurred in the Southern California area causing around 1,000 MW of BPS-connected solar photovoltaic (PV) to reduce power output and likely some distributed energy resources to also trip off-line. The widespread reduction of power output from solar PV facilities across a relatively large geographic area led NERC and the Western Electricity Coordinating Council (WECC), in coordination with the California Independent System Operator (CAISO) and other affected entities, to perform a detailed analysis of this event. The primary reduction of solar PV output was attributed to momentary cessation with relatively long times to

recovery power to pre-disturbance levels. Multiple facilities also experienced partial tripping of inverters due to AC overcurrent, DC low voltage, and AC low voltage protection.

- **April and May 2018 Fault Induced Solar PV Resource Interruption Disturbances Report**

  This report documents the analysis conducted and provides key findings and recommendations for industry. On April 20, 2018 (Angeles Forest disturbance) and May 11, 2018 (Palmdale Roost disturbance), bulk power system disturbances involved the loss of solar photovoltaic (PV) facilities in response to normally cleared transmission line faults. These events were analyzed by the ERO in coordination with affected entities including the WECC, California ISO, Southern California Edison, affected GOs and GOPs, and inverter manufacturers.

- **October 2017 Canyon 2 Fire Disturbance Report**

  This report contains the ERO analysis of the BPS disturbance that occurred in the Southern California area on October 9, 2017, resulting from the Canyon 2 Fire. On October 9, 2017, the Canyon 2 Fire caused two transmission system faults near the Serrano substation east of Los Angeles. Both faults resulted in the reduction of solar PV generation across a wide region of the SCE footprint.

  Approximately 900 MW of solar PV resources were lost as a result of these events, and six solar PV plants accounted for most of the reduction in generation. In general, the majority of inverter tripping was caused by sub-cycle transient over-voltages and instantaneous protective action at the inverters to disconnect them from the grid. A significant number of inverters also entered momentary cessation during and following the fault events.

- **August 2016 1200 MW Fault Induced Solar PV Resources Interruption Disturbance Report**

  This report contains the ERO analyses of the Blue Cut Fire, a system disturbance that occurred in the Southern California area on August 16, 2016. The fire quickly moved toward an important transmission corridor that is comprised of three 500 kV lines owned by Southern California Edison (SCE) and two 287 kV lines owned by Los Angeles Department of Water and Power (LADWP). By the end of the day, the SCE transmission system experienced thirteen 500 kV line faults, and the LADWP system experienced two 287 kV faults, as a result of the fire. Four of these fault events resulted in the loss of a significant amount of solar photovoltaic (PV) generation. The most significant event related to the solar PV generation loss occurred at 11:45 a.m. Pacific and resulted in the loss of nearly 1,200 MW. There were no solar PV facilities de-energized as a direct consequence of the fault event; rather, the facilities ceased output as a response to the fault on the system.

Additional Resources

The NERC IBR Strategy[5] focuses specifically on BPS-connected IBRs: wind, solar PV, battery energy storage systems, hybrid power plants, high voltage direct current networks, flexible ac transmission system devices, etc.

[5] https://www.nerc.com/comm/Documents/NERC_IBR_Strategy.pdf

NERC also publishes Lessons Learned documents. These are "not intended to establish new requirements under NERC's Reliability Standards or to modify the requirements in any existing Reliability Standards." A brief summary of the lessons learned is provided in the Lessons Learned Quick Reference Guide.[6]

Contact for Questions

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[6] https://www.nerc.com/pa/rrm/ea/Documents/Lessons_Learned_Quick_Reference_Guide.pdf