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NERC White Paper: Recommended Disturbance Monitoring for IBR

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Outline

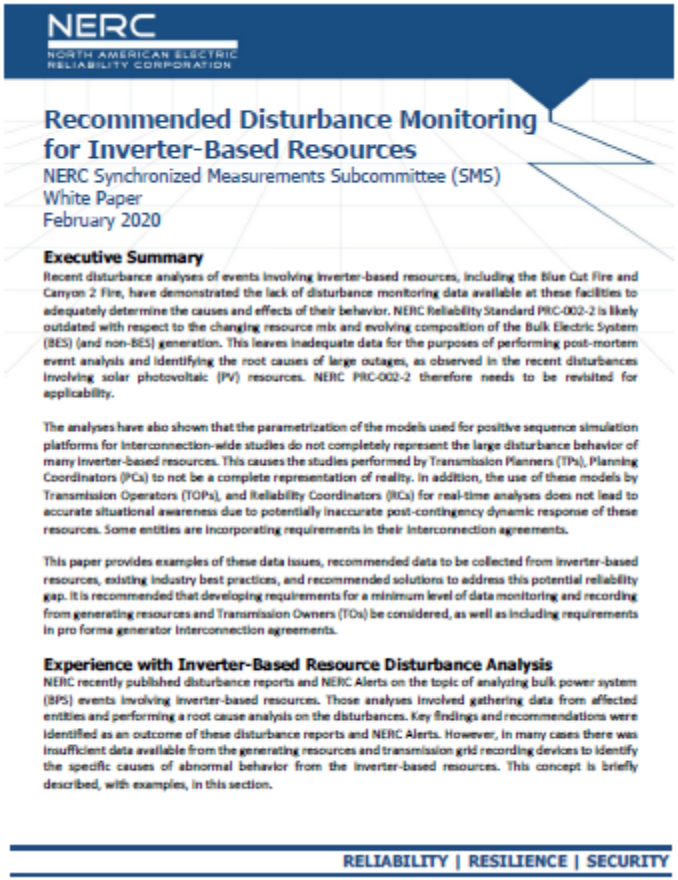
- Background
- Events
- Challenges
- Recommendations
- Summary

Background

- Paper was developed to support recommendations from Canyon 2 Fire and Blue Cut Fire events (*approved 2020*)
  - Identifies potential data issues
  - Recommended data to be collected from inverter-based resources
  - Existing industry best practices
  - Recommended solutions to address this potential reliability gap.

- Insufficient data available from the generating resources and transmission grid recording devices to identify the specific causes of abnormal behavior from the inverter-based resources

- https://www.nerc.com/comm/PC/SMSResourcesDocuments/White_Paper_IBR_Disturbance_Monitoring.pdf



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Recommended Disturbance Monitoring for Inverter-Based Resources

NERC Synchronized Measurements Subcommittee (SMS)
White Paper
February 2020

Executive Summary

Recent disturbance analyses of events involving inverter-based resources, including the Blue Cut Fire and Canyon 2 Fire, have demonstrated the lack of disturbance monitoring data available at these facilities to adequately determine the causes and effects of their behavior. NERC Reliability Standard PRC-002-2 is likely outdated with respect to the changing resource mix and evolving composition of the Bulk Electric System (BES) (and non-BES) generation. This leaves inadequate data for the purposes of performing post-mortem event analysis and identifying the root causes of large outages, as observed in the recent disturbances involving solar photovoltaic (PV) resources. NERC PRC-002-2 therefore needs to be revisited for applicability.

The analyses have also shown that the parametrization of the models used for positive sequence simulation platforms for interconnection-wide studies do not completely represent the large disturbance behavior of many inverter-based resources. This causes the studies performed by Transmission Planners (TPs), Planning Coordinators (PCs) to not be a complete representation of reality. In addition, the use of these models by Transmission Operators (TOPs), and Reliability Coordinators (RCs) for real-time analyses does not lead to accurate situational awareness due to potentially inaccurate post-contingency dynamic response of these resources. Some entities are incorporating requirements in their interconnection agreements.

This paper provides examples of these data issues, recommended data to be collected from inverter-based resources, existing industry best practices, and recommended solutions to address this potential reliability gap. It is recommended that developing requirements for a minimum level of data monitoring and recording from generating resources and Transmission Owners (TOs) be considered, as well as including requirements in pro forma generator interconnection agreements.

Experience with Inverter-Based Resource Disturbance Analysis

NERC recently published disturbance reports and NERC Alerts on the topic of analyzing bulk power system (BPS) events involving inverter-based resources. Those analyses involved gathering data from affected entities and performing a root cause analysis on the disturbances. Key findings and recommendations were identified as an outcome of these disturbance reports and NERC Alerts. However, in many cases there was insufficient data available from the generating resources and transmission grid recording devices to identify the specific causes of abnormal behavior from the inverter-based resources. This concept is briefly described, with examples, in this section.

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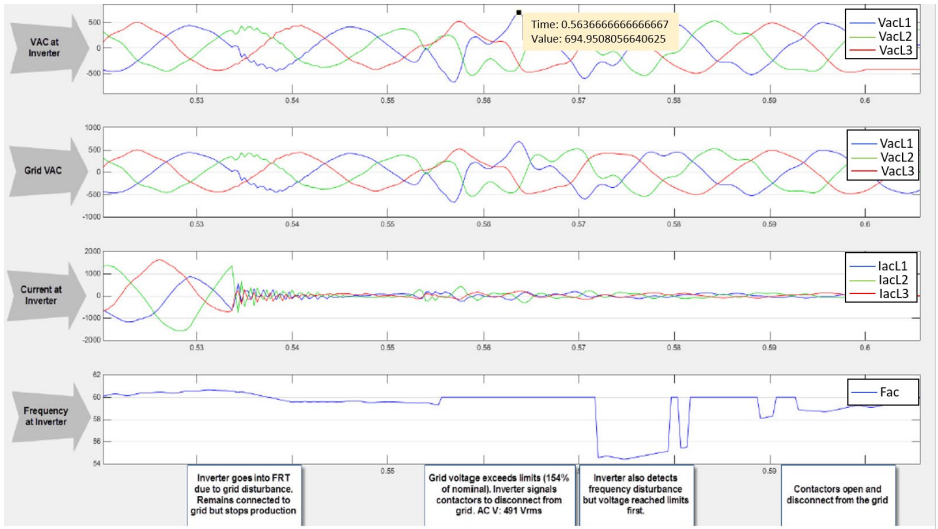
Blue Cut Fire Event

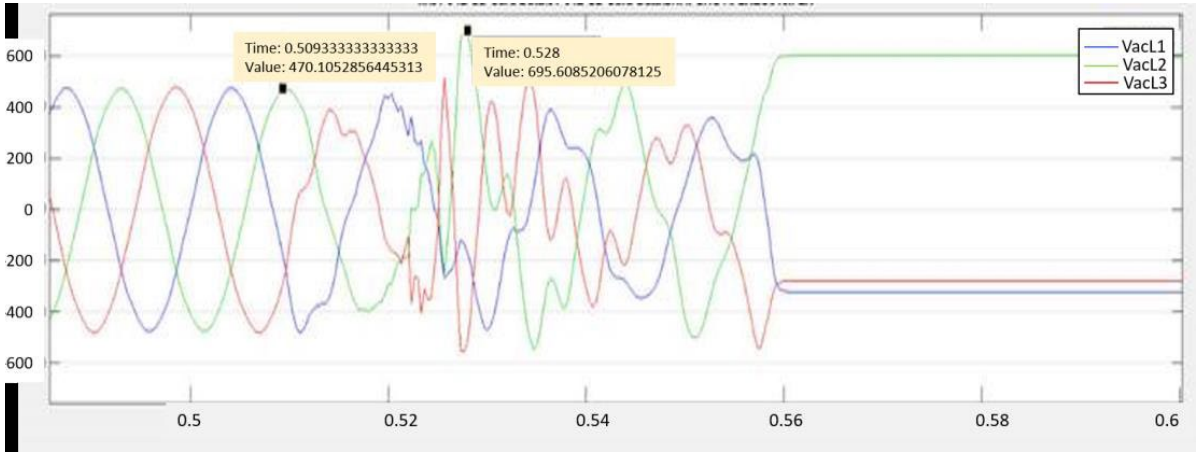
- Number of inverters reported tripping on frequency below 57 Hz (Grid Freq only fell to 59.85 Hz)
- Analyzed DFR data for fault event (26 Degree phase jump)



- Data from one of the generator inverter
  - The inverter tripped on transient overvoltage (not detected at the point of interconnection)
  - The inverter also reported a frequency of around 54.5 Hz caused by the distorted waveform during and immediately after the fault event.
- https://www.nerc.com/pa/rrm/ea/1200_MW_Fault_Induced_Solar_Photovoltaic_Resource_/1200_MW_Fault_Induced_Solar_Photovoltaic_Resource_Interruption_Final.pdf

Canyon 2 Fire Event

- Multiple plants reported inverter tripping
- Transient overvoltage that occurred during the on-fault conditions that resulted in inverter tripping.



- DFR data at the POI showed voltage below nominal at the POI (within the PRC-024-2 voltage protection ride-through curve).
- Without the inverter-level oscillography data to analyze, the POI data with (unsynchronized) SERs of tripping provided little information to deduce exactly why the inverters were tripping.
- https://www.nerc.com/pa/rrm/ea/October%209%202017%20Canyon%202%20Fire%20Disturbance%20Report/900%20MW%20Solar%20Photovoltaic%20Resource%20Interruption%20Disturbance%20Report.pdf

Challenges with IBRs

- Lack of Inverter Codes or High Resolution Oscillography Data
  - Many inverter-based resources were not able to provide any inverter fault codes or high resolution oscillography data for detailed analysis.
  - Local storage in a rolling memory that would often be overwritten by new data in just a couple of days.
- Time Skew in Low-Resolution Telemetered Data
  - Example: telemetry system is updated on a four second cycle rate.
  - Data not time synchronized to a GPS clock or similar device
- Slow Manual Process
  - Very challenging and inefficient
  - After the manual review is completed, only a small portion of what actually happened at the resource can be ascertained
  - Measurement requirements are not in the pro forma large or small generator interconnection agreements

Challenges with IBRs (cont'd)

- Inaccurate Models for Simulation
  - Most models did not accurately represent momentary cessation, and used some other form of ride-through settings in the model or used generic default parameters
  - Studies performed do not have a complete representation of reality.

Recommendations

- Modifying NERC Reliability Standard PRC-002
  - Standard goal - "to have adequate data available to facilitate analysis of BES Disturbances."
  - Existing standard focuses on synchronous machine theory – high fault current
  - DDR installations at large unit or plants locations – does not account for aggregate ratings of large areas of wind or solar PV

- Recommended Data Collection
  - Plant Control Settings and Static Values
  - Plant SCADA Data
  - SER Data
  - DFR Data
  - DDR Data
  - Inverter Fault Codes and Dynamic Recordings

Recommendations (cont'd)

- Inaccurate Models for Positive Sequence Simulation
  - Parameters of the models for studies do not completely represent large disturbance behavior
  - Most models did not accurately represent momentary cessation – generic parameters
- Time Synchronization
  - Data needs to be time synchronized to a common time source, both within the plant and with external resources - an accuracy of one millisecond or greater
- Duration of Event Captures
  - Data should include at least 200 milliseconds prior to the trigger and at least 1 second after the trigger.
- Equipment Selection
  - Diverse range of equipment installed at inverter-based resources.
  - Plant-level information can be captured by the plant-level controller itself, by digital relays, PMUs, or DFRs installed at the substation, or other types of measurement devices.

Summary

- Modify NERC Reliability Standard PRC-002-2
  - Currently focuses on short circuit MVA methodology
  - Outdated??
- Adoption of recommended data collection by Inverter Based Resources
  - NERC *Reliability Guideline: BPS-Connected Inverter-Based Resource Performance*
- Modify the pro forma Large and Small Generator Interconnection Agreements
  - The number of solar PV generating resources continues to grow rapidly as well as the installed capacity of those resources.
  - Majority of these resources are not subject to NERC Reliability Standards since they do not meet the size criteria of a BES resource.

Questions and Answers