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NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

CIGRE NGN Webinar

Impact of Inverter-Based Resources and Distributed Energy Resources on the Bulk Power System

Ryan Quint, PhD, PE
Senior Manager, NERC
September 17, 2020

RELIABILITY | RESILIENCE | SECURITY

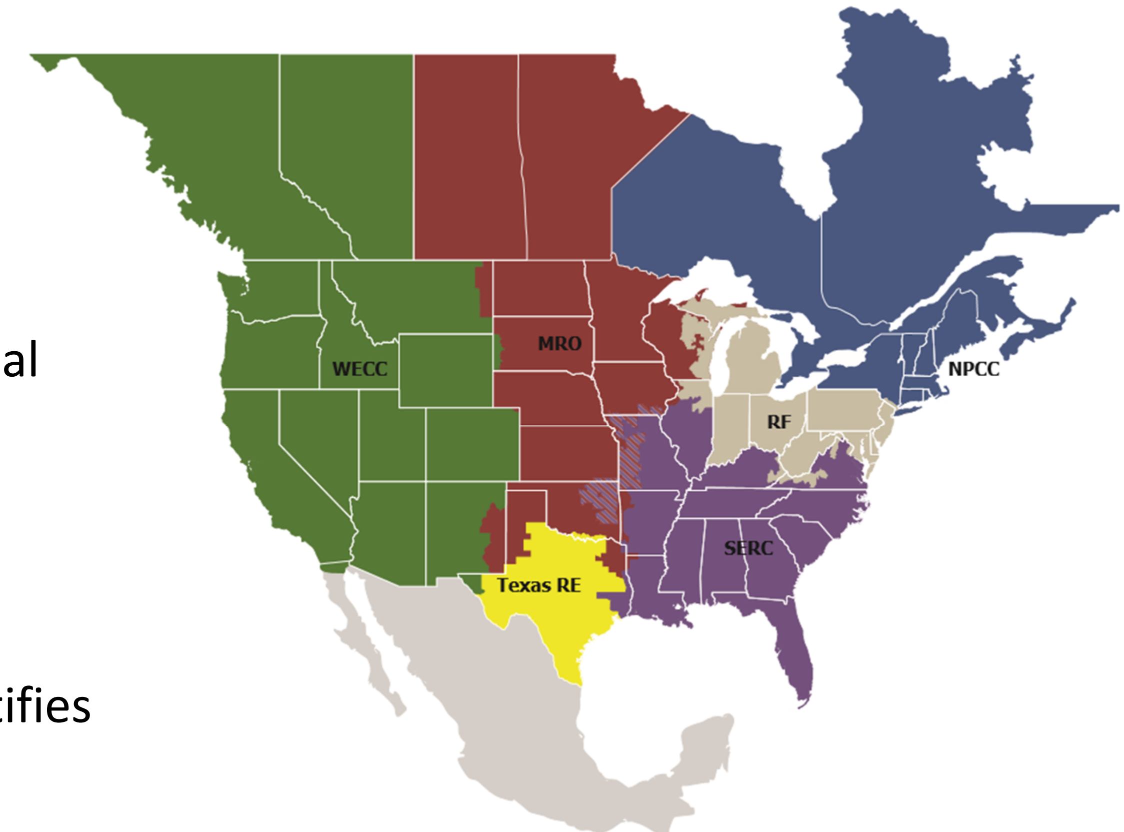



NERC Overview

The vision for the Electric Reliability Organization Enterprise, which is comprised of NERC and the six Regional Entities, is a highly reliable and secure North American bulk power system. Our mission is to assure the effective and efficient reduction of risks to the reliability and security of the grid.

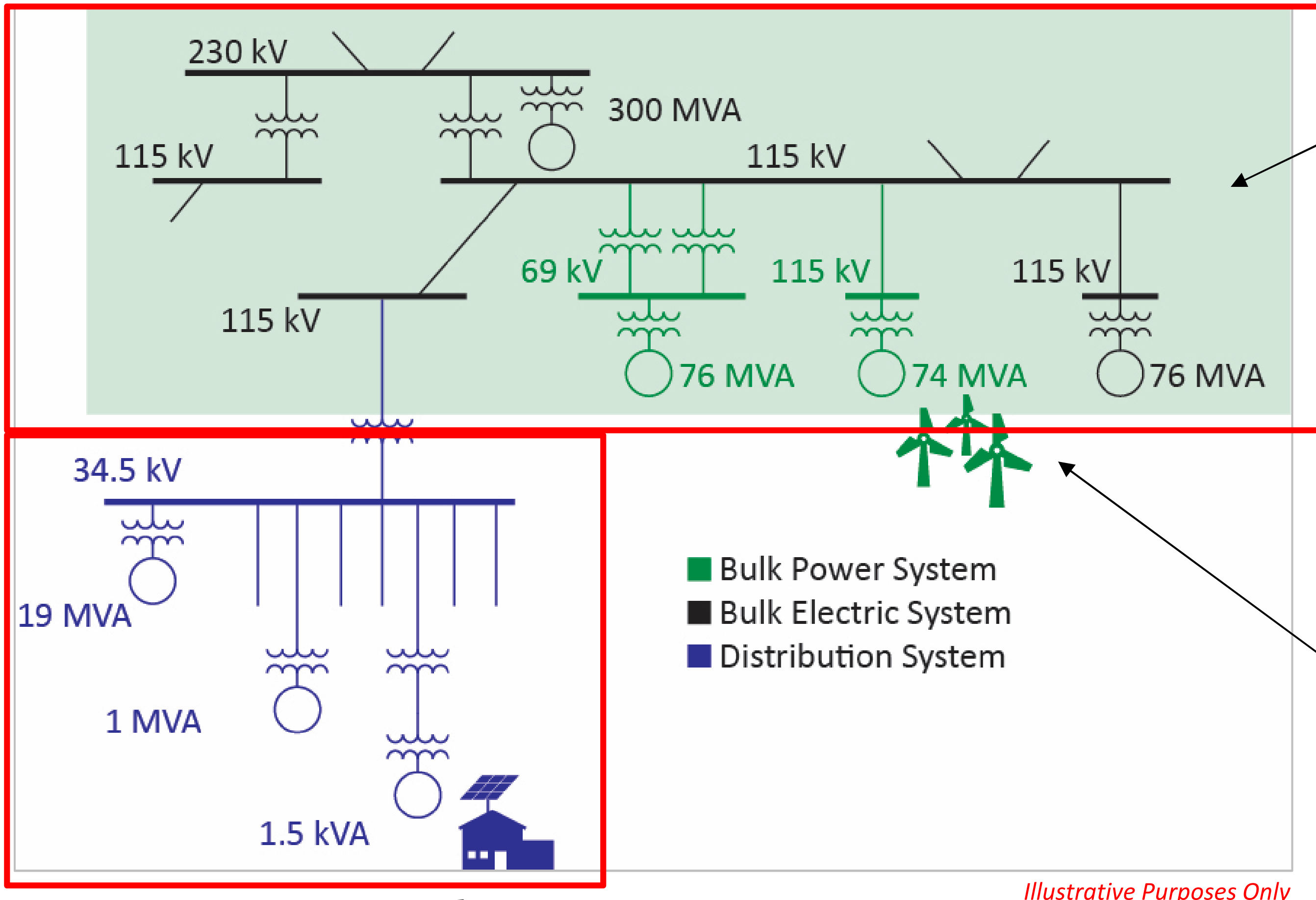
NERC Core Functions:

- Develops and enforces Reliability Standards
- Annually assesses seasonal and long-term reliability
- Monitors the bulk power system through system awareness
- Educates, trains, and certifies industry personnel.



Let's Talk the Same Language

NERC IRPTF



NERC SPIDERWG

NERC Reliability Standards and FERC LGIA/SGIA

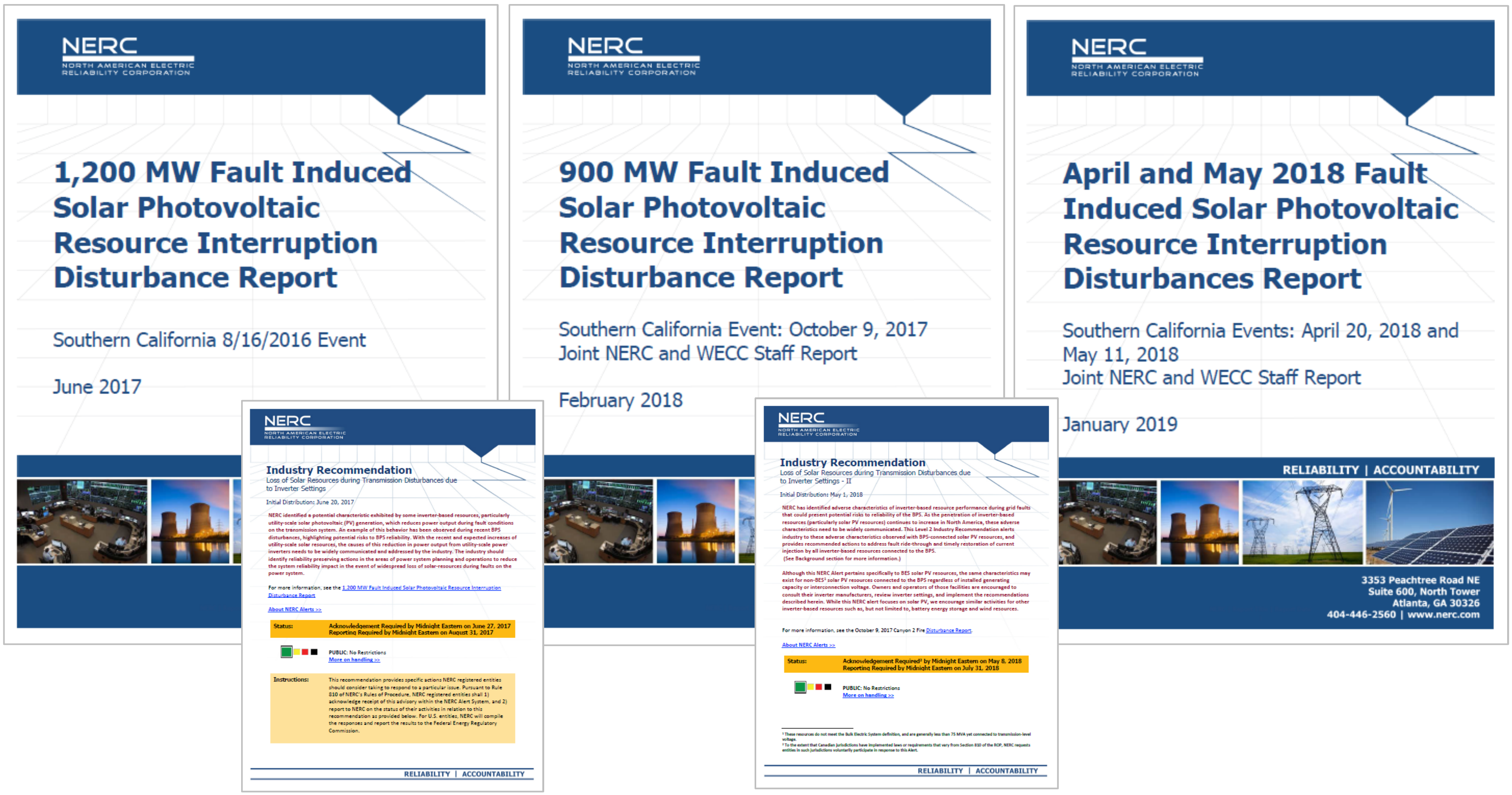
Local Utility Interconnection Requirements and FERC LGIA/SGIA

States Adoption and Implementation of IEEE 1547-2018

NERC Inverter-Based Resource Performance Task Force (IRPTF)

BPS-Connected Inverter-Based Resources

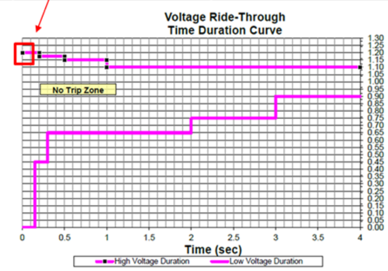
NERC Disturbance Reports and Alerts

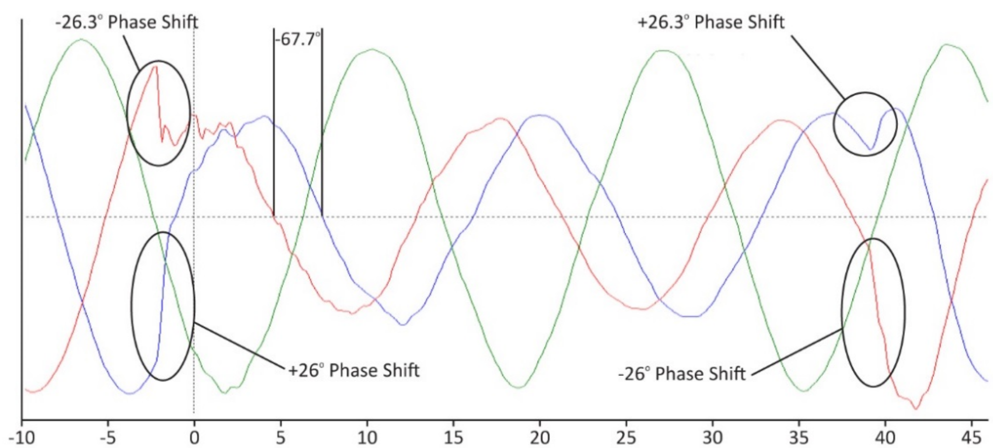


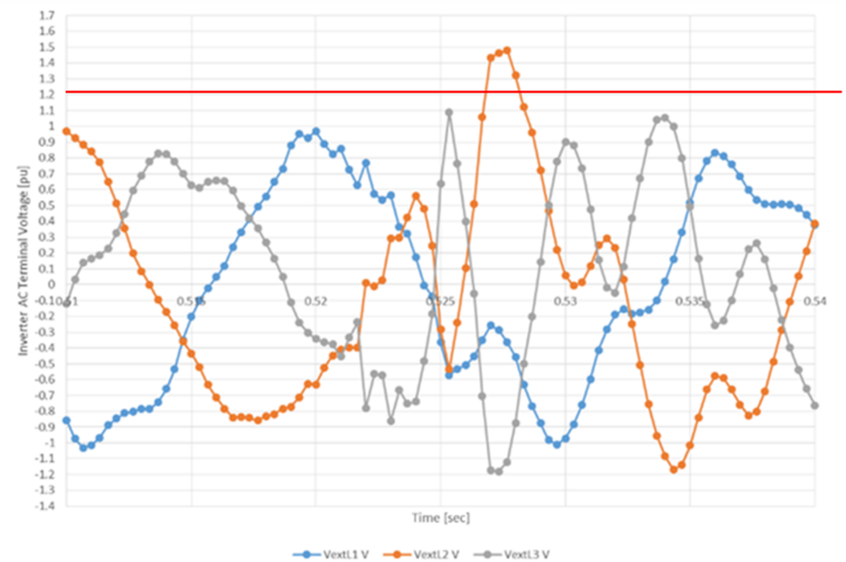
Various Types of Inverter Tripping

- Sub-cycle transient AC overvoltage
- DC reverse current
- Phase lock loop loss of synchronism
- Abnormal frequency (phase jump)

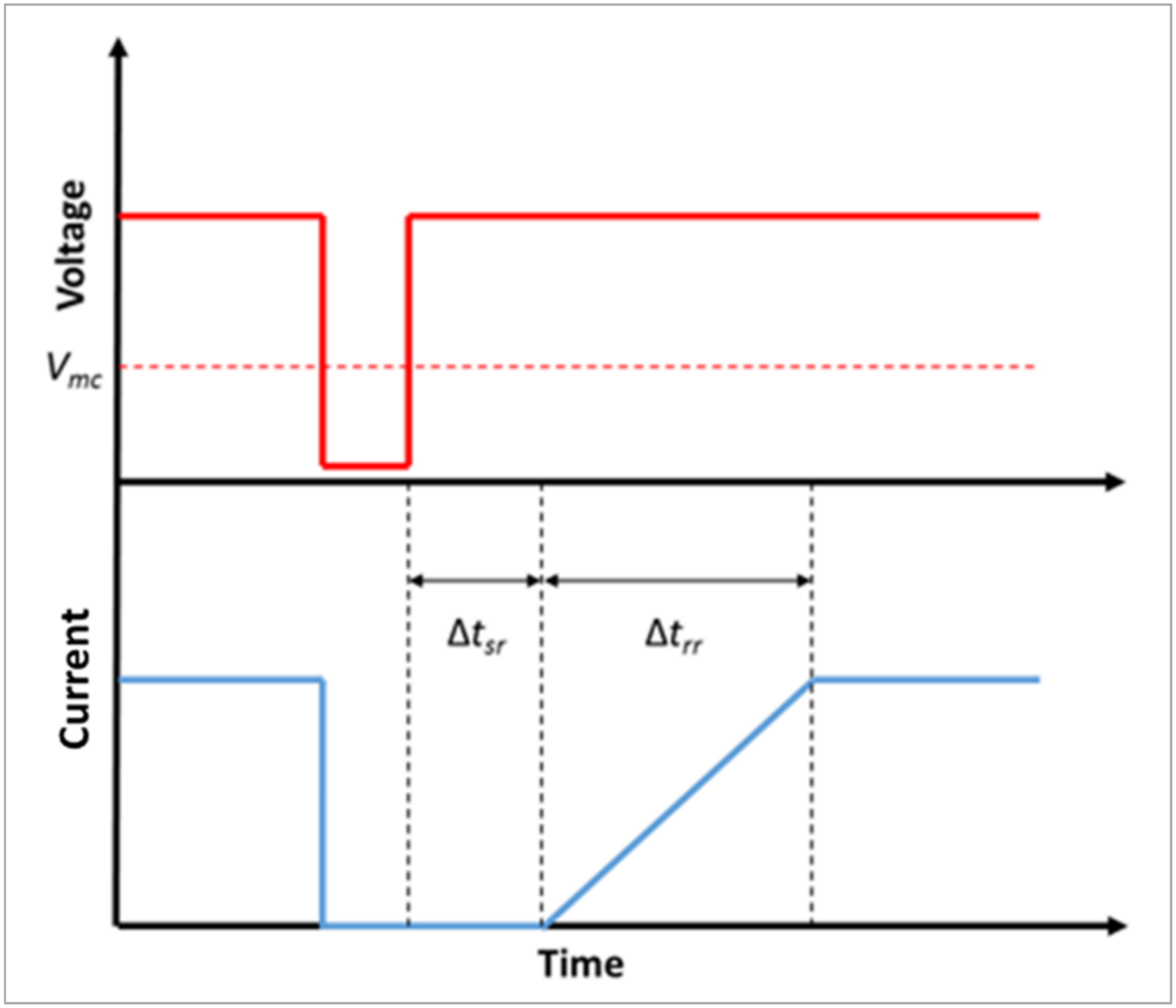
High Voltage Ride Through Duration		Low Voltage Ride Through Duration	
Voltage (pu)	Time (sec)	Voltage (pu)	Time (sec)
≥1.20	Instantaneous Trip	≤0.45	0.15
≥1.175	0.20	≤0.65	0.30
≥1.15	0.50	≤0.75	2.00
≥1.10	1.00	≤0.90	3.00



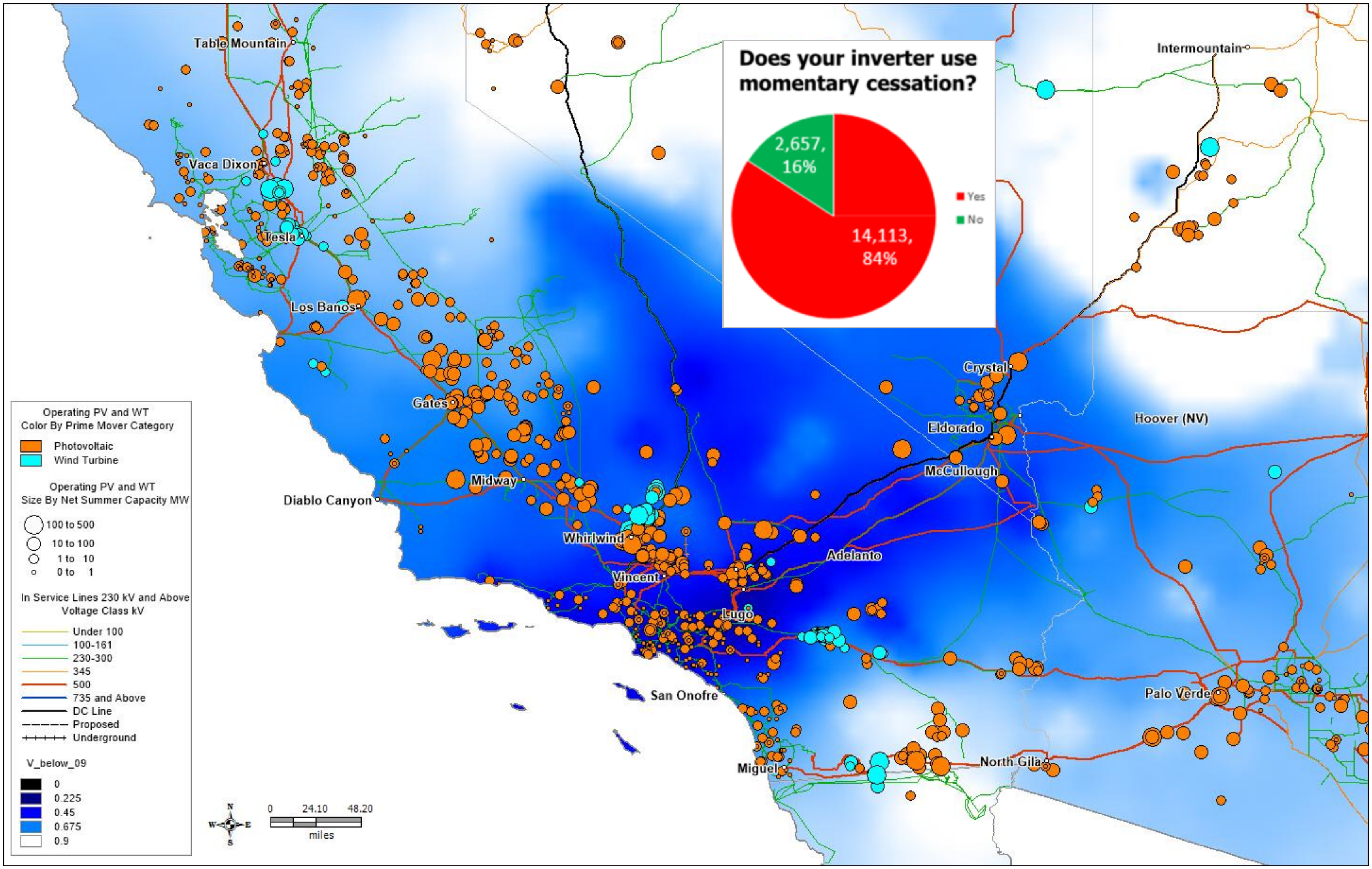




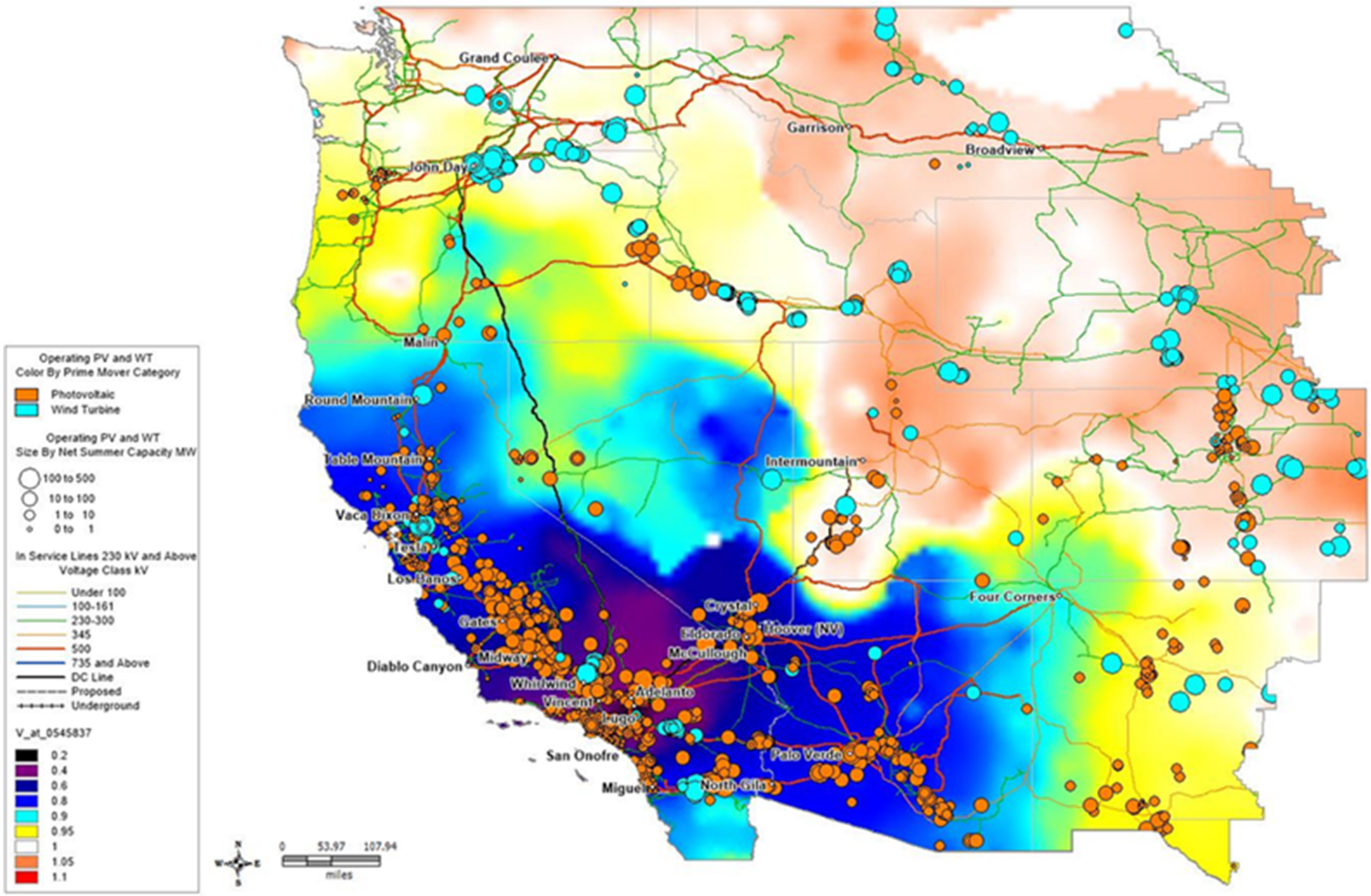
Momentary Cessation – NERC Alert I



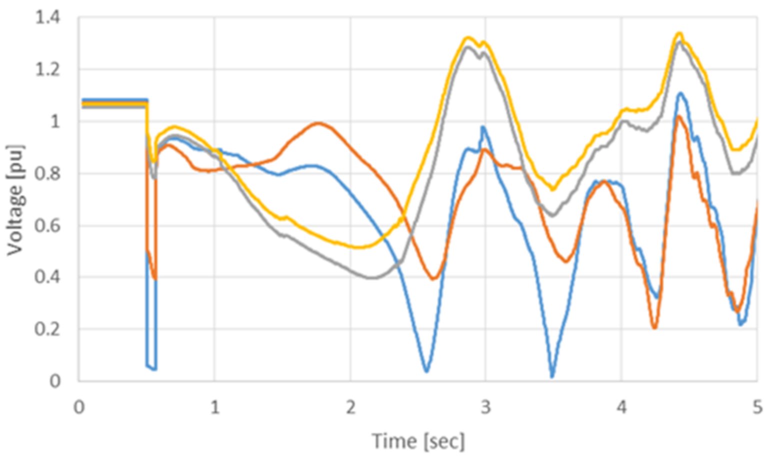
Momentary Cessation – NERC Alert I

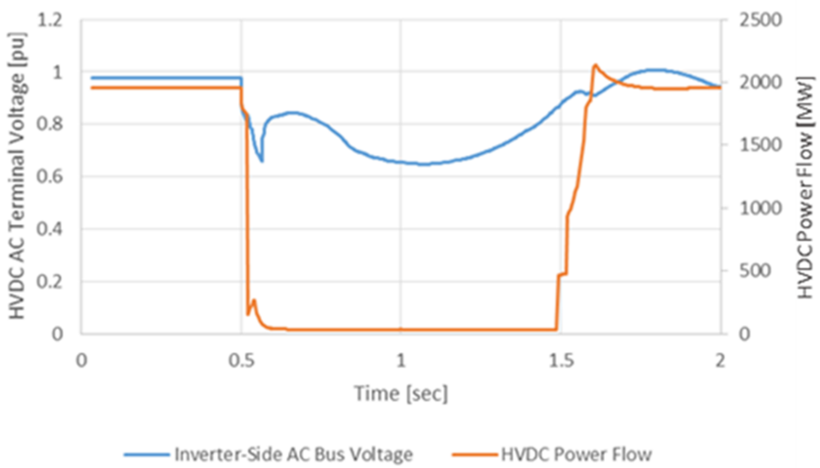


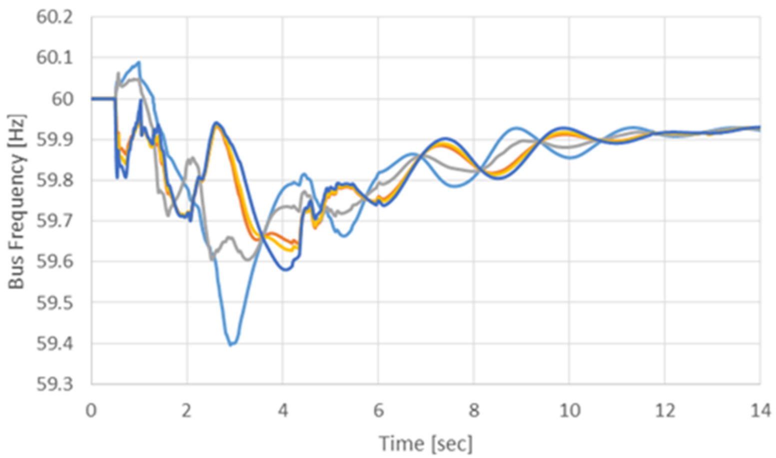
Initial IRPTF Findings

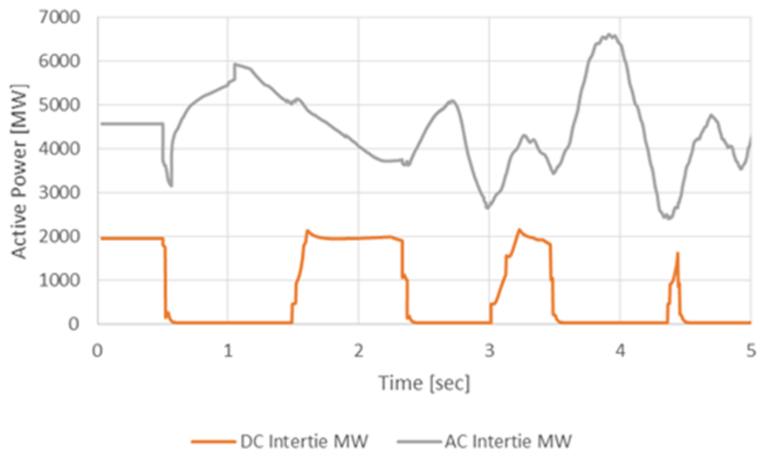


Initial IRPTF Findings

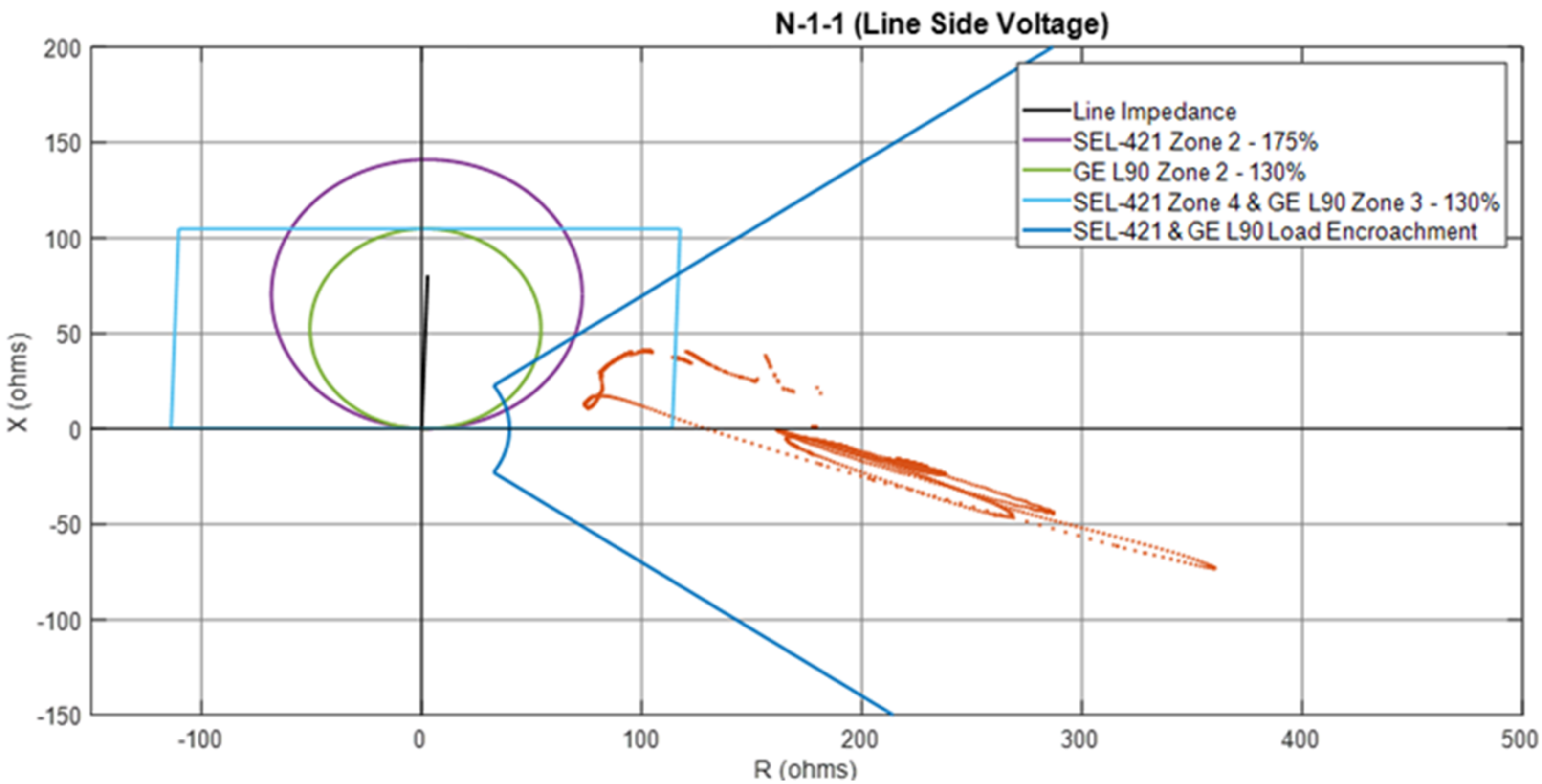




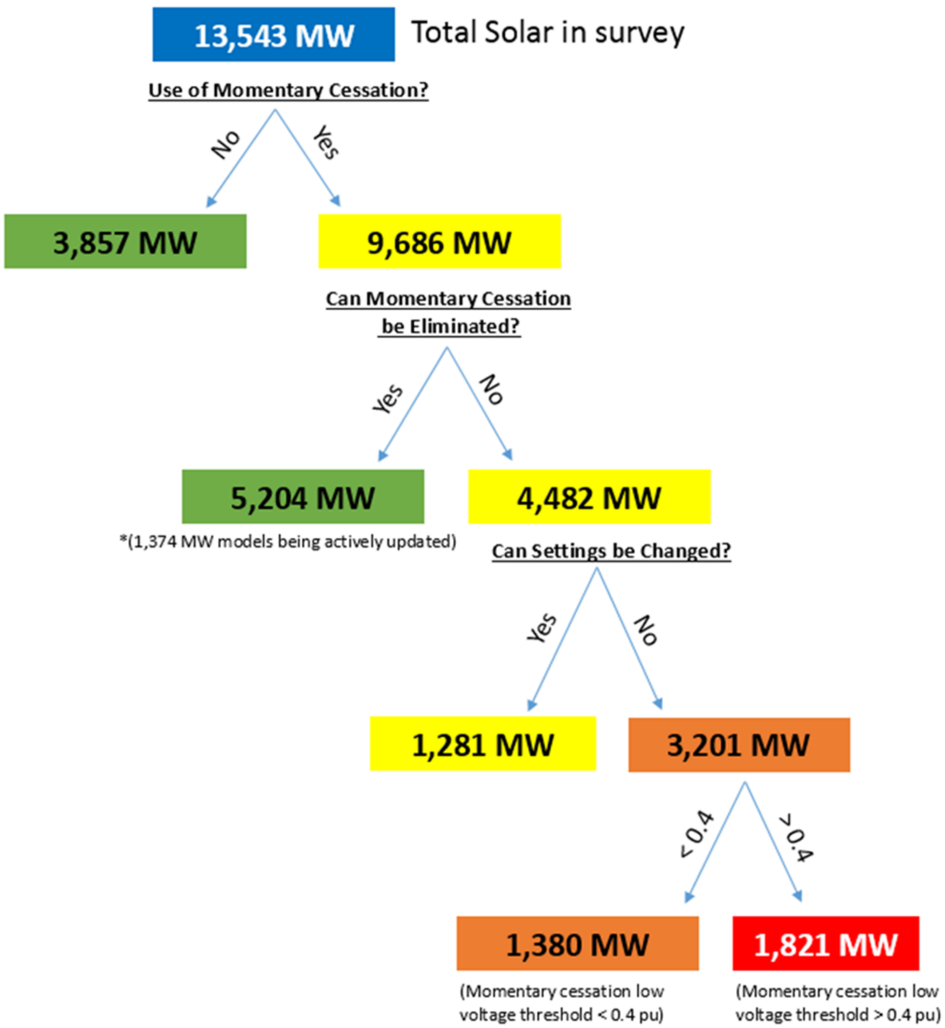




Initial IRPTF Findings



Momentary Cessation – NERC Alert II

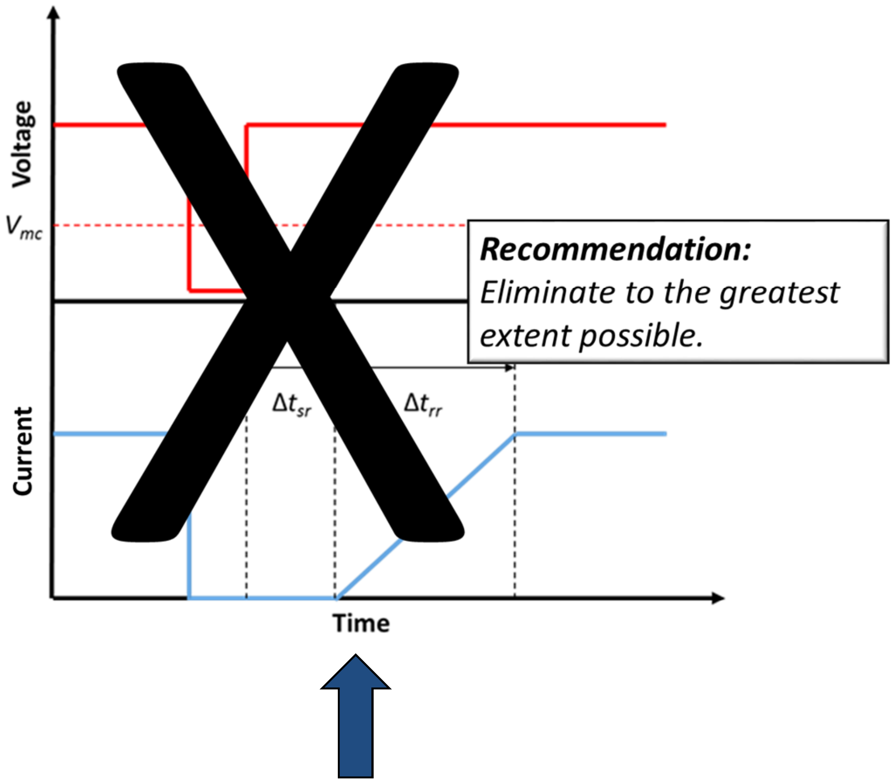


- Most installed inverters used momentary cessation
- More than half of those inverters ***could*** eliminate its use
- But about 3200 MW cannot even change settings
- Of those, about 1800 MW use a MC threshold above 0.4 pu

VERY FEW RESOURCES HAD POSITIVE SEQUENCE RMS MODELS THAT ACCURATELY REFLECTED REALITY

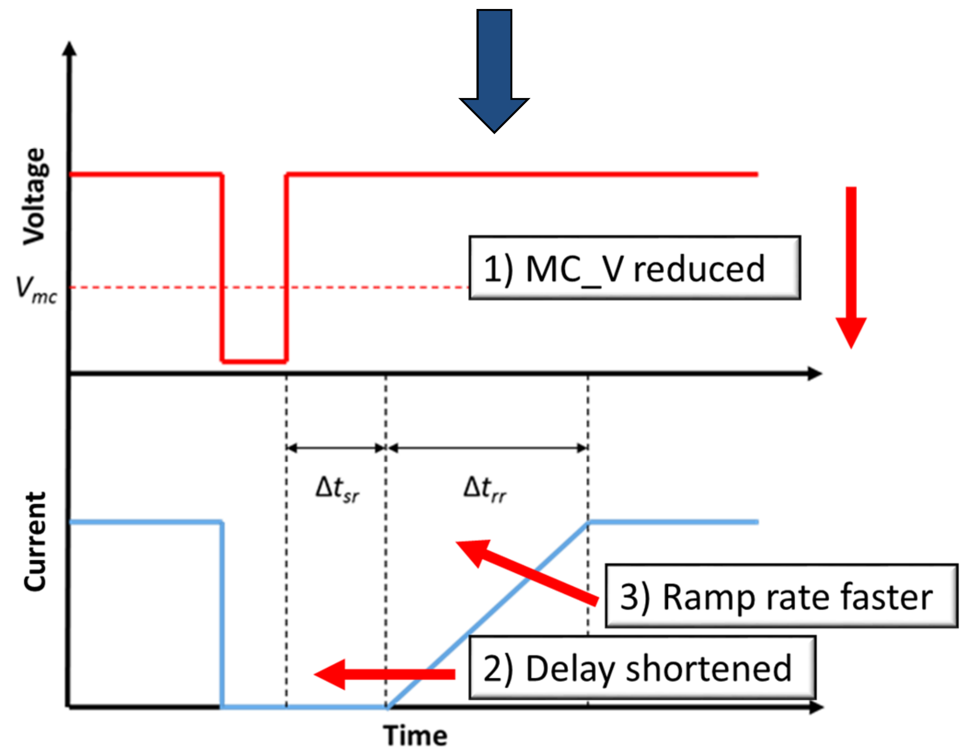
Recommendation for Eliminating Momentary Cessation

- Eliminate momentary cessation to the extent possible



New resources, and resources that can eliminate momentary cessation

Resources that cannot eliminate momentary cessation yet can make modifications



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Let’s Take a Step Back

All we’ve discussed thus far are ***fundamental*** BPS reliability needs…

1) Avoid unnecessary tripping to the extent possible
2) Continue injecting current during abnormal grid conditions

Now What?

Now the question turns to more technical issues…

- What type of behavior is expected from inverter-based resources?
- What type of current injection is recommended?
- What type of current injection is necessary (in some cases)?

NERC Reliability Guideline

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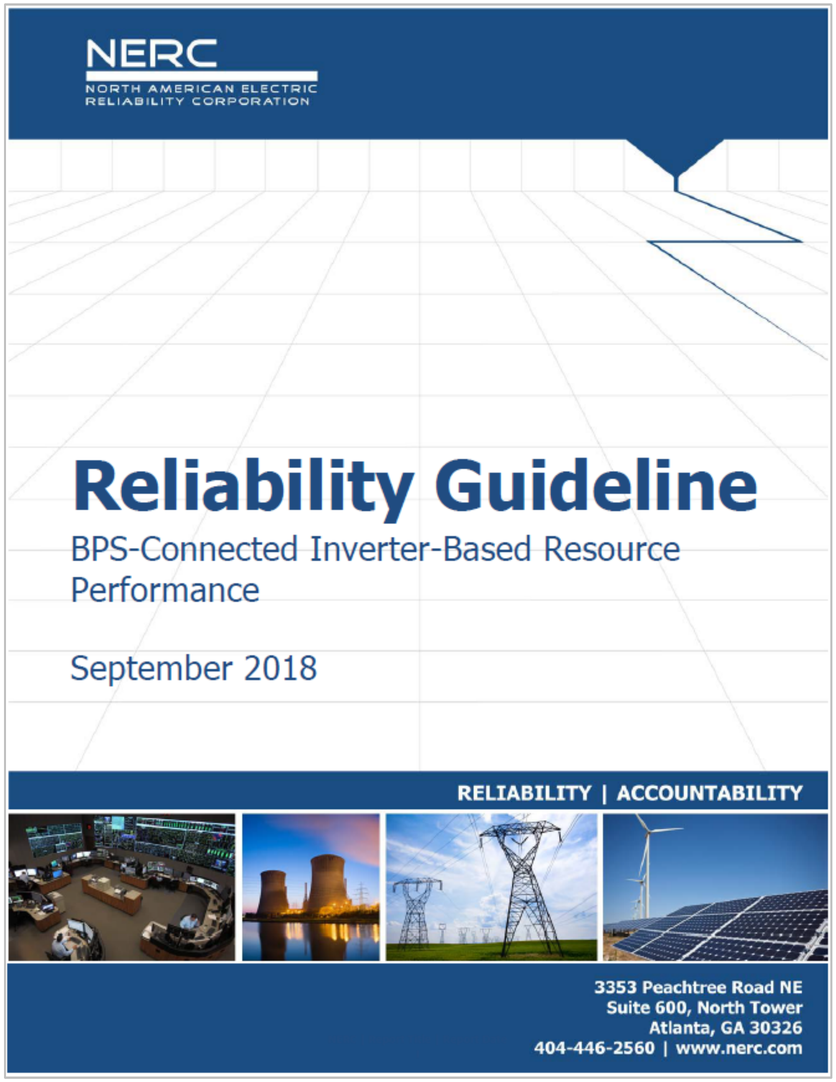

- Topics:
  - Eliminate momentary cessation
  - Active power-frequency control
  - Reactive power-voltage control
  - Protection aspects
  - Relation with IEEE 1547 and UL 1741
  - Measurement data and monitoring
  - Other related topics

https://www.nerc.com/comm/PC_Reliability_Guidelines_DL/Inverter-Based_Resource_Performance_Guideline.pdf

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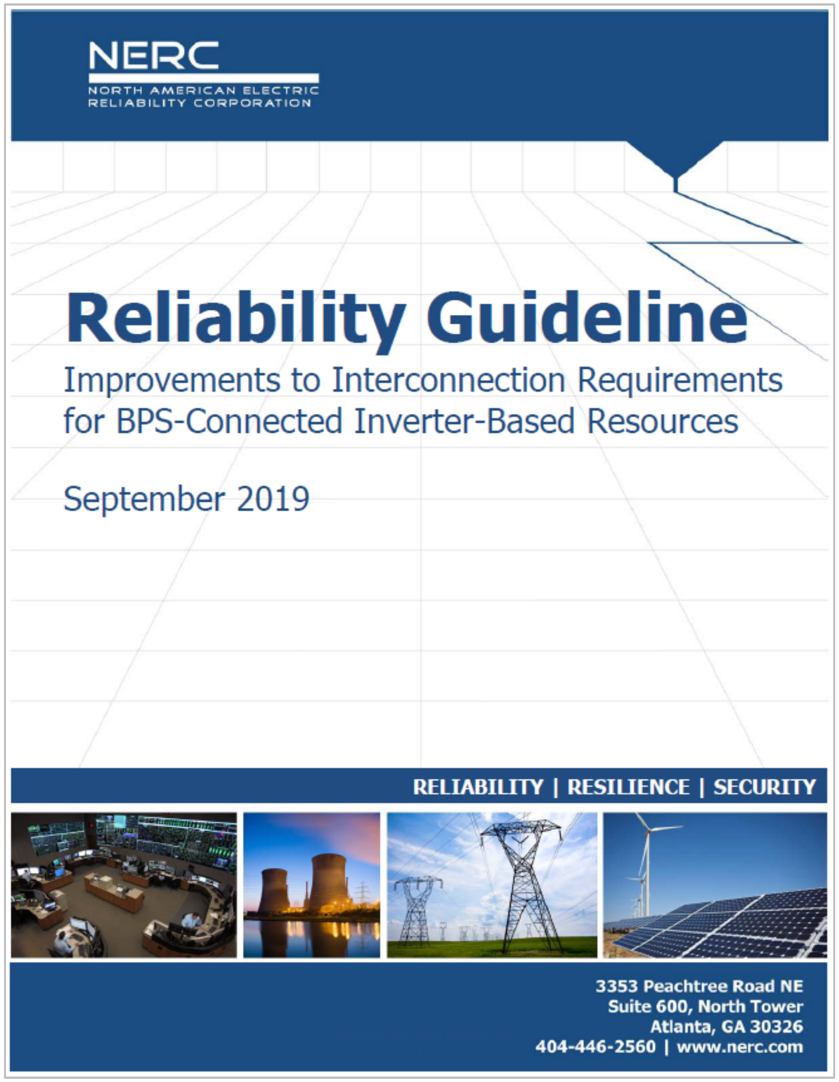
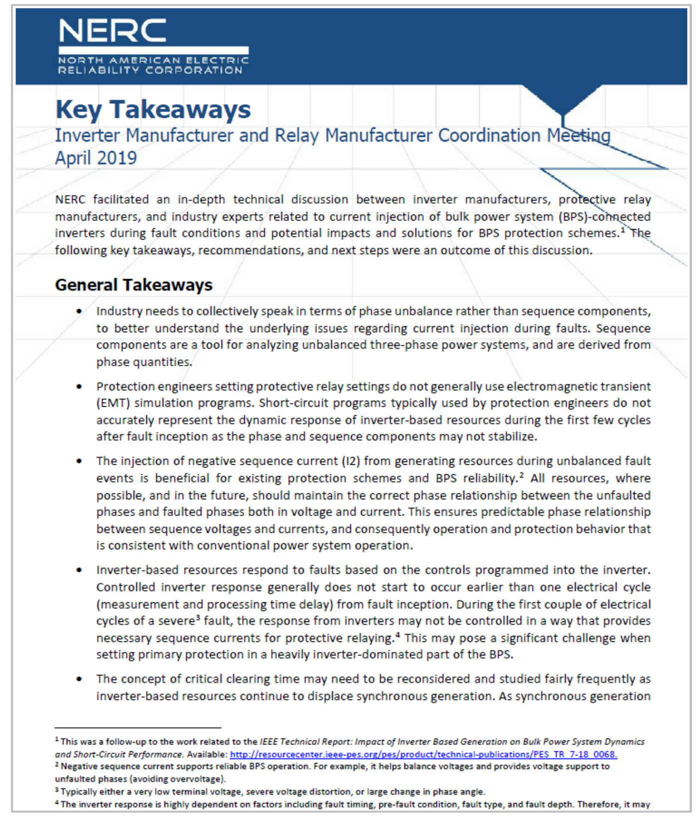
NERC Reliability Guideline



- Clear and consistent performance requirements needed for inverter-based resources
- Building from previous IRPTF guideline on performance recommendations
- Alignment with NERC Reliability Standards FAC-001-3 and FAC-002-2
- Applicability to non-BES resources
- Coordination with IEEE P2800

https://www.nerc.com/comm/PC_Reliability_Guidelines_DL/Reliability_Guideline_IBR_Interconnection_Requirements_Improvements.pdf

Current Injection to Support BPS during Fault Events



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Key Takeaways

Inverter Manufacturer and Relay Manufacturer Coordination Meeting
April 2019

NERC facilitated an in-depth technical discussion between inverter manufacturers, protective relay manufacturers, and industry experts related to current injection of bulk power system (BPS)-connected inverters during fault conditions and potential impacts and solutions for BPS protection schemes.[1] The following key takeaways, recommendations, and next steps were an outcome of this discussion.

General Takeaways

- Industry needs to collectively speak in terms of phase unbalance rather than sequence components, to better understand the underlying issues regarding current injection during faults. Sequence components are a tool for analyzing unbalanced three-phase power systems, and are derived from phase quantities.
- Protection engineers setting protective relay settings do not generally use electromagnetic transient (EMT) simulation programs. Short-circuit programs typically used by protection engineers do not accurately represent the dynamic response of inverter-based resources during the first few cycles after fault inception as the phase and sequence components may not stabilize.
- The injection of negative sequence current (I2) from generating resources during unbalanced fault events is beneficial for existing protection schemes and BPS reliability.[2] All resources, where possible, and in the future, should maintain the correct phase relationship between the unfaulted phases and faulted phases both in voltage and current. This ensures predictable phase relationship between sequence voltages and currents, and consequently operation and protection behavior that is consistent with conventional power system operation.
- Inverter-based resources respond to faults based on the controls programmed into the inverter. Controlled inverter response generally does not start to occur earlier than one electrical cycle (measurement and processing time delay) from fault inception. During the first couple of electrical cycles of a severe[3] fault, the response from inverters may not be controlled in a way that provides necessary sequence currents for protective relaying.[4] This may pose a significant challenge when setting primary protection in a heavily inverter-dominated part of the BPS.
- The concept of critical clearing time may need to be reconsidered and studied fairly frequently as inverter-based resources continue to displace synchronous generation. As synchronous generation

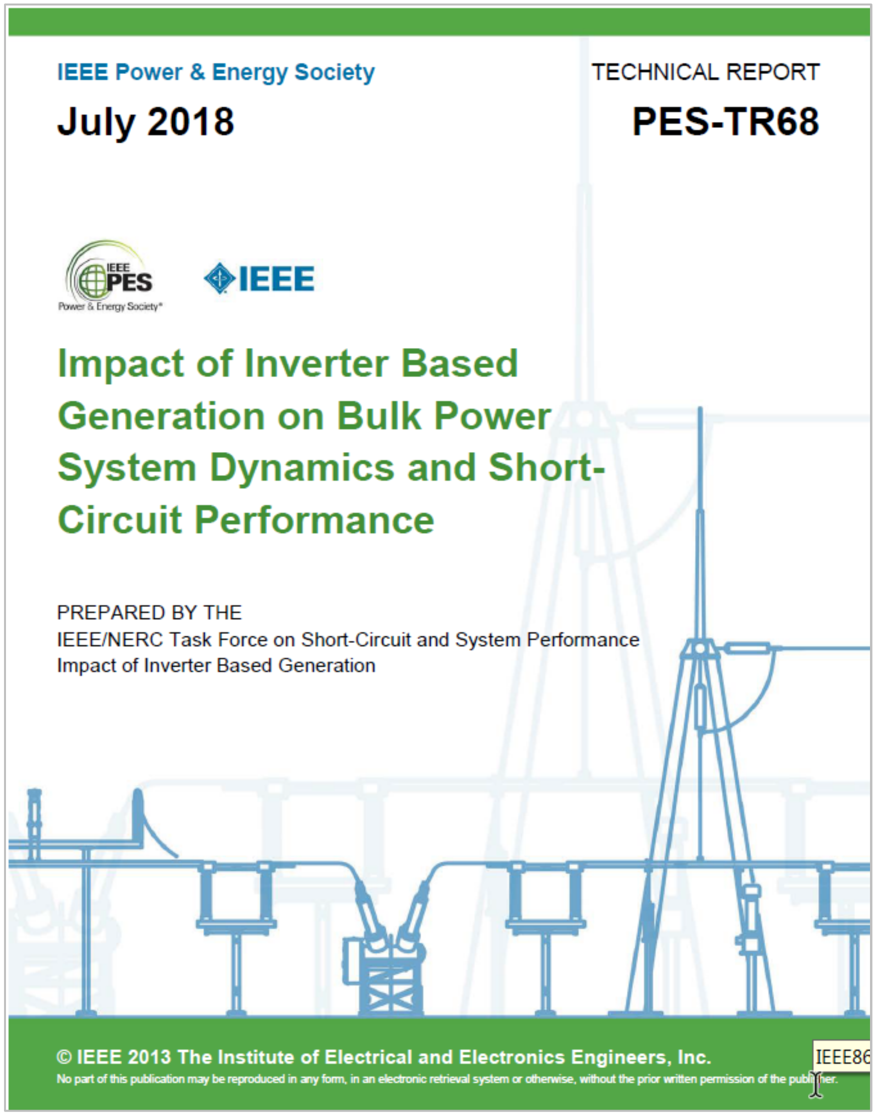
[1] This was a follow-up to the work related to the *IEEE Technical Report: Impact of Inverter Based Generation on Bulk Power System Dynamics and Short-Circuit Performance*. Available: http://resourcecenter.ieee-pes.org/pes/product/technical-publications/PES_TR_7-18_0068.
[2] Negative sequence current supports reliable BPS operation. For example, it helps balance voltages and provides voltage support to unfaulted phases (avoiding overvoltage).
[3] Typically either a very low terminal voltage, severe voltage distortion, or large change in phase angle.
[4] The inverter response is highly dependent on factors including fault timing, pre-fault condition, fault type, and fault depth. Therefore, it may

https://www.nerc.com/comm/PC/IRPTF%20Workshops/Key_Takeaways_April_2019_Inverter_Relay_Manufacturer_Meeting.pdf

Changing BPS Fault Characteristics

Factor	Synchronous World	Inverter-Based World
Fault Current Magnitude	Consistent, High	Consistent, Low
Fault Current Phase Relationship	Consistent, Predictable	Consistent, Unpredictable
Short Circuit Model Accuracy and Certainty	Mature	Immature, Evolving

IEEE PES Technical Report #68


IEEE Power & Energy Society
July 2018
TECHNICAL REPORT
PES-TR68
Impact of Inverter Based Generation on Bulk Power System Dynamics and Short-Circuit Performance
PREPARED BY THE
IEEE/NERC Task Force on Short-Circuit and System Performance
Impact of Inverter Based Generation
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- BPS challenges with increasing penetration of inverter-based resources
- Transmission protection impacts
- Large system stability issues
- Design and control philosophy changes
- Considerations for a future BPS

https://resourcecenter.ieee-pes.org/technical-publications/technical-reports/PES_TR_7-18_0068.html

Interconnection Studies

Available Models

Do we have adequate models to be able to capture the behaviors of inverter-based resources?

Modeling Practices

Are we correctly/reasonably using the models to capture the critical characteristics of inverter-based resources?

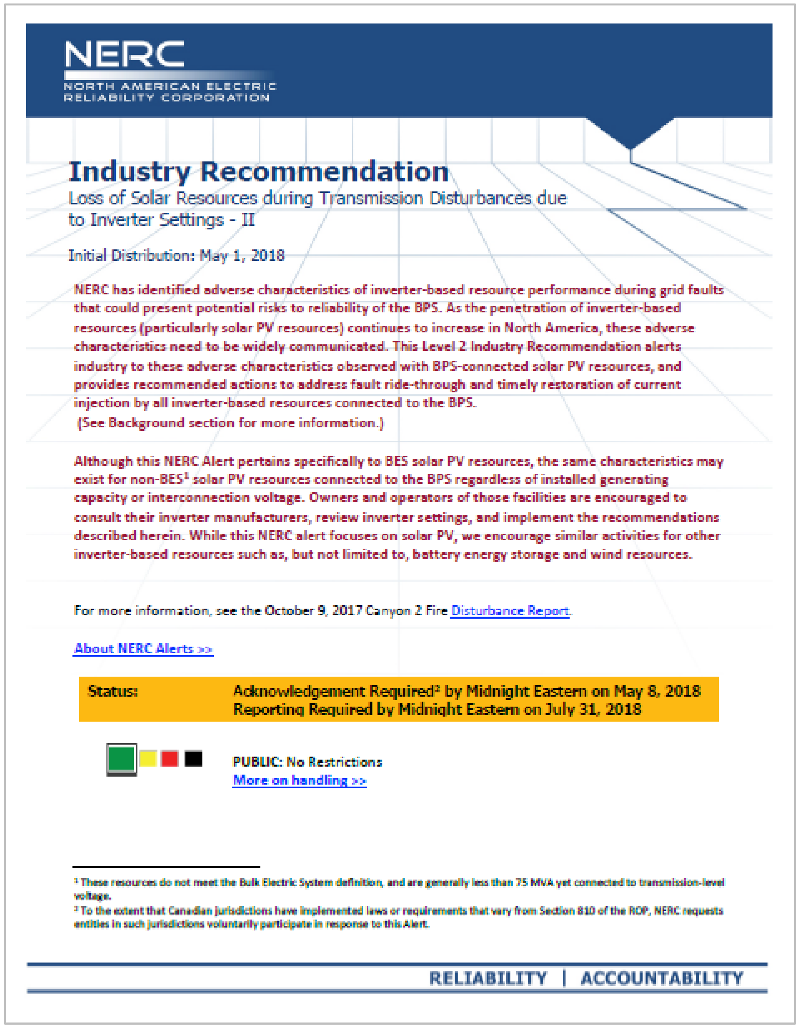
Interconnection Studies

Are sufficient studies being performed to adequately capture potential reliability risks?

Reliable Operation

Are interconnection studies serving to ensure reliable operation of BPS?

NERC Alert II – Modeling Issues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Industry Recommendation

Loss of Solar Resources during Transmission Disturbances due to Inverter Settings - II

Initial Distribution: May 1, 2018

NERC has identified adverse characteristics of inverter-based resource performance during grid faults that could present potential risks to reliability of the BPS. As the penetration of inverter-based resources (particularly solar PV resources) continues to increase in North America, these adverse characteristics need to be widely communicated. This Level 2 Industry Recommendation alerts industry to these adverse characteristics observed with BPS-connected solar PV resources, and provides recommended actions to address fault ride-through and timely restoration of current injection by all inverter-based resources connected to the BPS.
(See Background section for more information.)

Although this NERC Alert pertains specifically to BES solar PV resources, the same characteristics may exist for non-BES[1] solar PV resources connected to the BPS regardless of installed generating capacity or interconnection voltage. Owners and operators of those facilities are encouraged to consult their inverter manufacturers, review inverter settings, and implement the recommendations described herein. While this NERC alert focuses on solar PV, we encourage similar activities for other inverter-based resources such as, but not limited to, battery energy storage and wind resources.

For more information, see the October 9, 2017 Canyon 2 Fire Disturbance Report.

About NERC Alerts >>

Status:	Acknowledgement Required[2] by Midnight Eastern on May 8, 2018 Reporting Required by Midnight Eastern on July 31, 2018

PUBLIC: No Restrictions
More on handling >>

[1] These resources do not meet the Bulk Electric System definition, and are generally less than 75 MVA yet connected to transmission-level voltage.
[2] To the extent that Canadian jurisdictions have implemented laws or requirements that vary from Section 810 of the ROP, NERC requests entities in such jurisdictions voluntarily participate in response to this Alert.

RELIABILITY | ACCOUNTABILITY

- Recommendations:
  - Address existing performance issues
    - Provide updated models for existing equipment settings
  - Identify performance improvements
    - Provide proposed performance improvements via updated model
  - Reliability studies for existing settings and proposed changes
    - Approve proposed changes and coordinate with generators
  - Report updates to Regional Entity

Modeling Issue Simply Put

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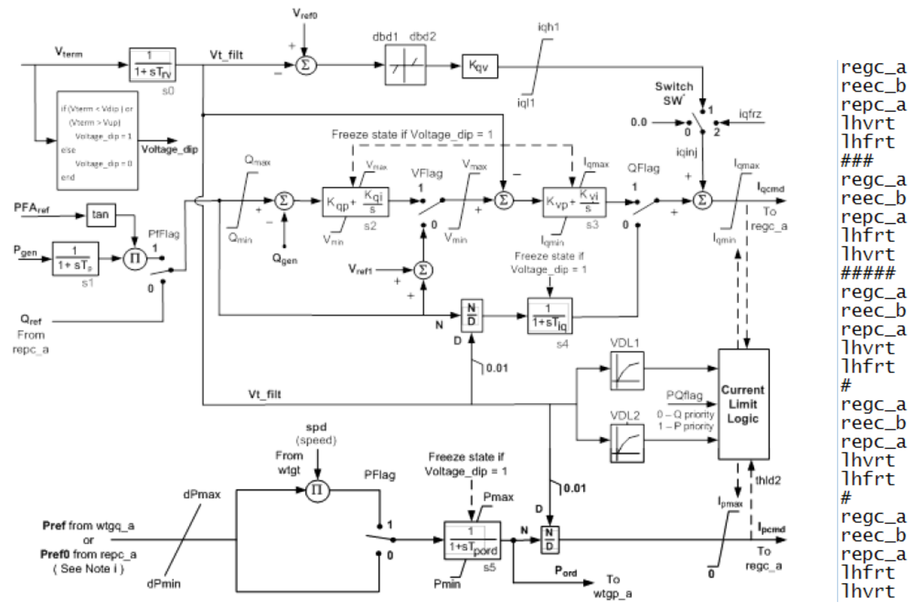
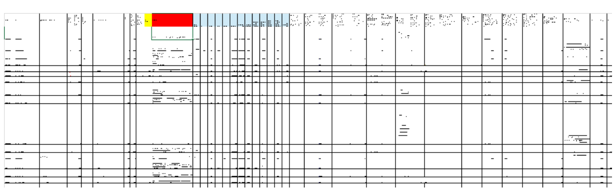
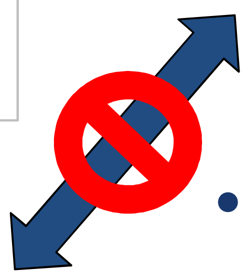
RELIABILITY | ACCOUNTABILITY



[Source: GE PSLF]





- Areas for Modeling Concern:
  - Incorrect models
  - Mismatched NERC Alert and model data
  - Defective or unusable models

Technical Report: BPS-Connected IBR Modeling and Studies

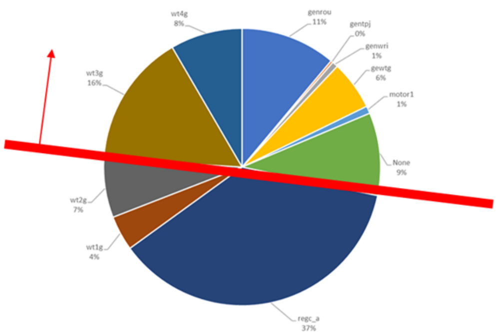
- 19 recommendations related to inverter-based resource modeling, modeling practices, and studies
- Topics:
  - NERC Alert findings – modeling challenges
  - Challenges with relying on MOD-026/-027 test reports
  - Parameterization of dynamic models
  - IRPTF stability study findings
  - Accurate models at time of interconnection

WECC Solar Modeling Advisory Group

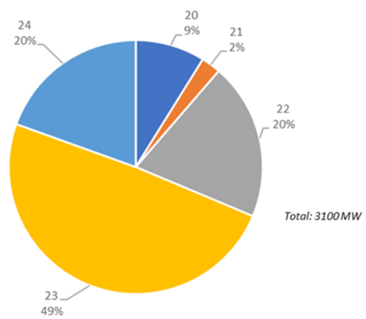
- Address systemic modeling issues in interconnection-wide base cases
- Coordinate with generator owners to educate and support accurate model development
- Accountability to inverter-based resource modeling in interconnection-wide base case

NERC-WECC Joint Report: WECC Base Case Review of IBR Models

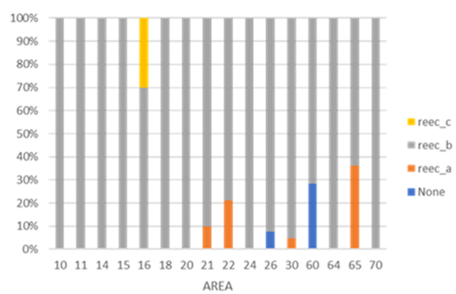
Everything above the line has an incorrect model or no model…

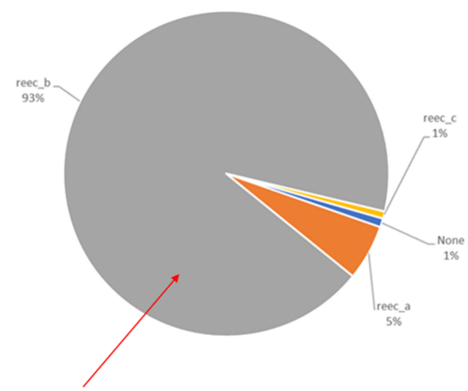


Wind Plant Generator/Converter Models



Wind Plants Modeled with GENROU





Everything is grey is "not acceptable" per WECC modeling list and per EVERY major solar PV OEM…

Reliability Guideline Modeling Recommendations

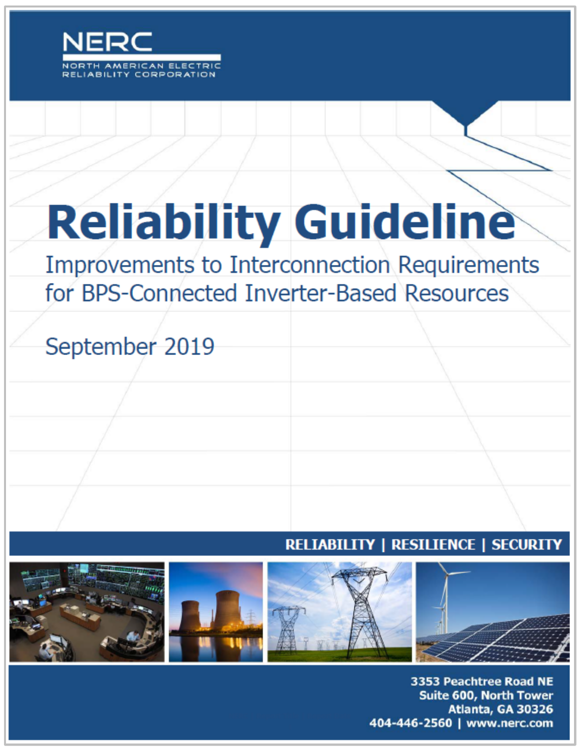


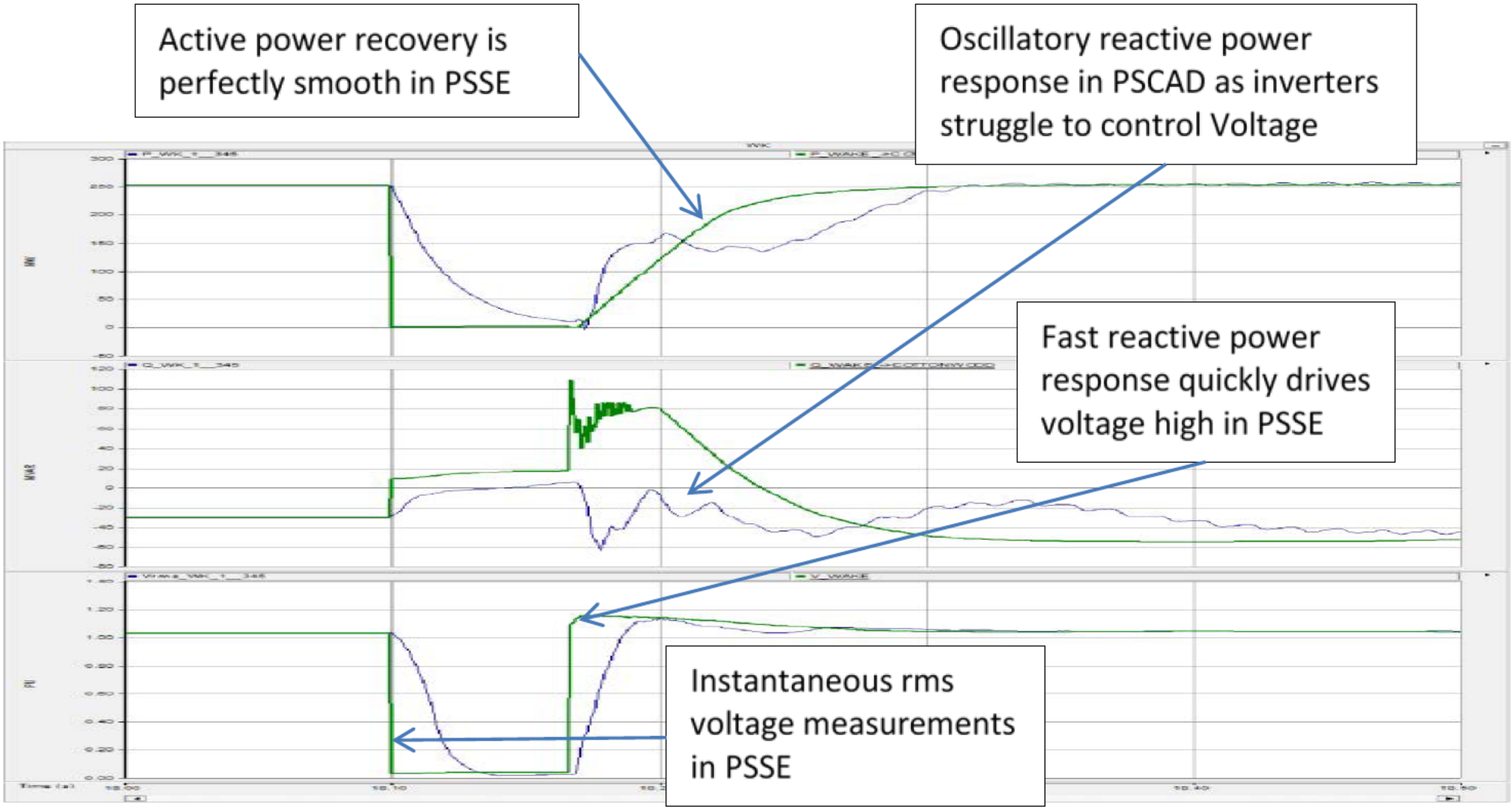
Table 1.2 Recommended Improvements to Modeling Requirements

Topic	Recommended Improvement
Steady-State Modeling	TOs should have clearly documented requirements for steady-state modeling that ensures that sufficient data is gathered to model these resources in local and interconnection-wide powerflow base cases. In most cases, dispersed power-producing resources (i.e., wind and solar PV) should be represented in the powerflow base case using an equivalent representation clearly specified by the TO in their requirements.[32] A single-line diagram showing impedances and equipment ratings should be provided to the TO with the accompanying model. The TO should also ensure that all necessary control settings and ratings used for modeling purposes are collected during this process to ensure accurate controls configuration in the base case.
Positive Sequence Dynamics Modeling	TOs have different requirements based on their local modeling and studies practices, which may differ from any interconnection-wide case creation requirements. The TO may only allow standard "generic"[33] simulation library models with accurate parameters to reflect each specific facility, may require detailed user-defined models, or may require both a detailed user-defined model and a generic model in some cases. Detailed models are often used for local interconnection reliability studies (localized studies as well as interconnection study process studies) while generic models are typically used in the interconnection-wide base cases per MOD-032-1. In any case, the TO should be clear in the types of models that are expected to be provided for the interconnection process. The latest library models used for dynamic simulations should be required; these are updated occasionally by industry stakeholder groups. TOs should refer to the NERC list of acceptable models for more guidance on interconnection-wide modeling.[34]
Short-Circuit Modeling	TOs should have clear requirements regarding how to model inverter-based resources and all generating resources for short-circuit studies. The necessary elements for these short-circuit models should be specified in the requirements including relevant transmission circuits, transformers, collector systems, diagrams and equipment ratings, inverter-level data, and other data for the purposes of modeling. Short-circuit modeling practices are evolving; however, necessary data should be collected to have the information needed for the TO to improve these models as they evolve in coordination with the GO. The current recommendation from IEEE Power System Relaying and Control Committee C24 Working Group is to provide a table of positive and negative sequence current injection for different positive sequence voltage levels for different fault types. Refer to Chapter 3 of this guideline for more information. The GO can obtain this data from the inverter manufacturer, who can provide it with any other necessary short-circuit models and modeling data.

Reliability Guideline Modeling Recommendations

- **Timing and Quality of Modeling Data Submittals**
  - *Continually updated models during interconnection process*
  - *Assurance of as-built data following commissioning*
- **Steady-State Modeling**
  - *Suitable powerflow representation of inverter-based resources*
- **Positive Sequence Dynamics Modeling**
  - *Suitable dynamic models for local and interconnection-wide studies*
- **Short-Circuit Modeling**
  - *Reasonable short-circuit modeling data available*
- **Electromagnetic Transient Modeling**
  - *Availability and accuracy of EMT models for complex reliability studies*
- **Benchmarking Positive Sequence and EMT Models**
  - *Assurance that dynamic models match suitably for all expected conditions*

Need for EMT Studies and Advanced Engineering



[Source: NERC, Electranix, ERCOT]

Need for EMT Studies and Advanced Engineering

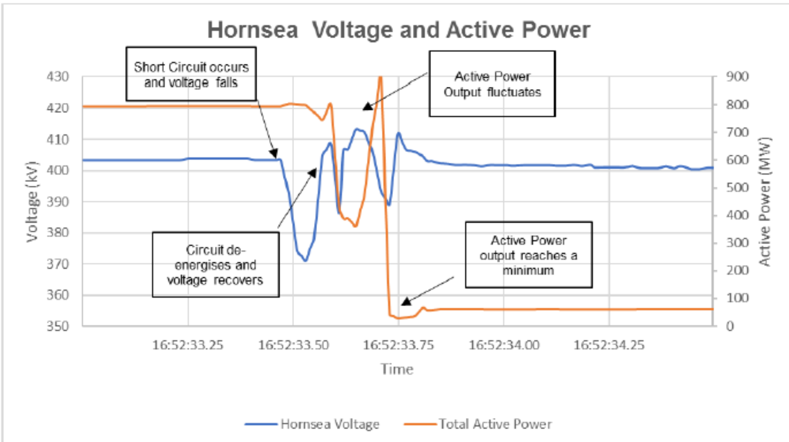


Figure 7 – Voltage and Active Power at Hornsea

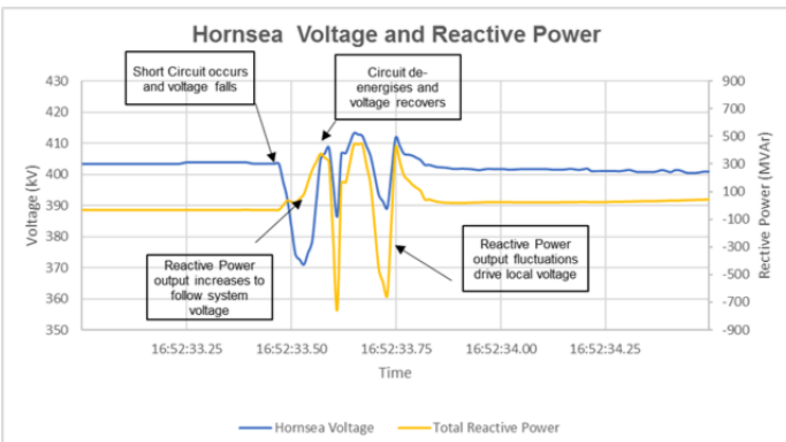


Figure 8 – Voltage and Reactive Power at Hornsea

[Source: Ofgem]

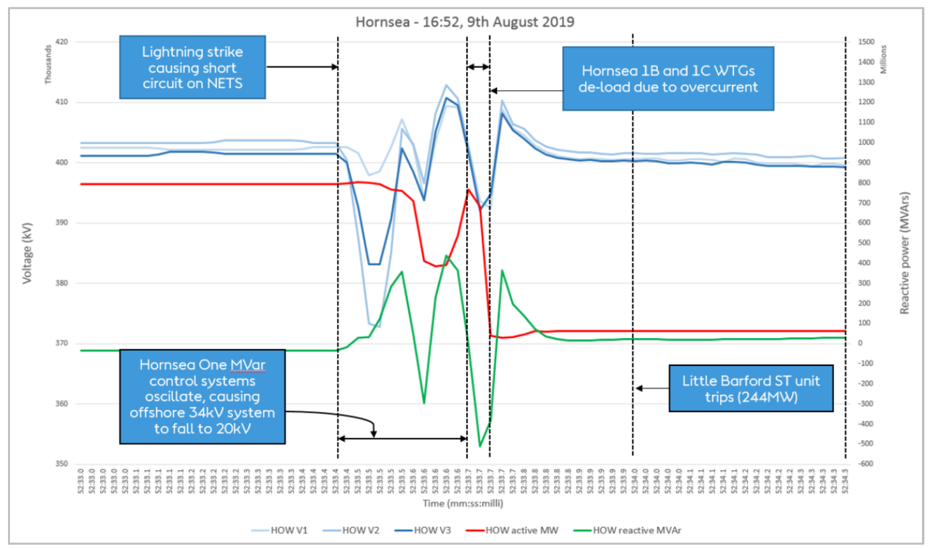
Orsted's report advises the following:

Initially, Orsted understood that the Dynamic Reactive Compensator (DRC) was responsible for the rapid de-load of Hornsea-1. Orsted have since concluded that the DRC worked as designed and was not the cause of the de-load.

The configuration of the Hornsea network, with one SGT and one offshore transmission system user asset (OTSUA Circuit) on outage, was a contributory factor as it created a weak internal network environment. Subsequently Orsted have reviewed and reconfigured their network.

The wind turbine settings were standard settings from the manufacturer. During the incident, the turbine controllers reacted incorrectly due to an insufficiently damped electrical resonance in the sub-synchronous frequency range, so that the local Hornsea voltage dropped and the turbines shut themselves down.

Orsted have since updated the control system software for the wind turbines and have observed that the behaviour of the turbines now demonstrates a stable control system that will withstand any future events in line with Grid Code and CUSC requirements.



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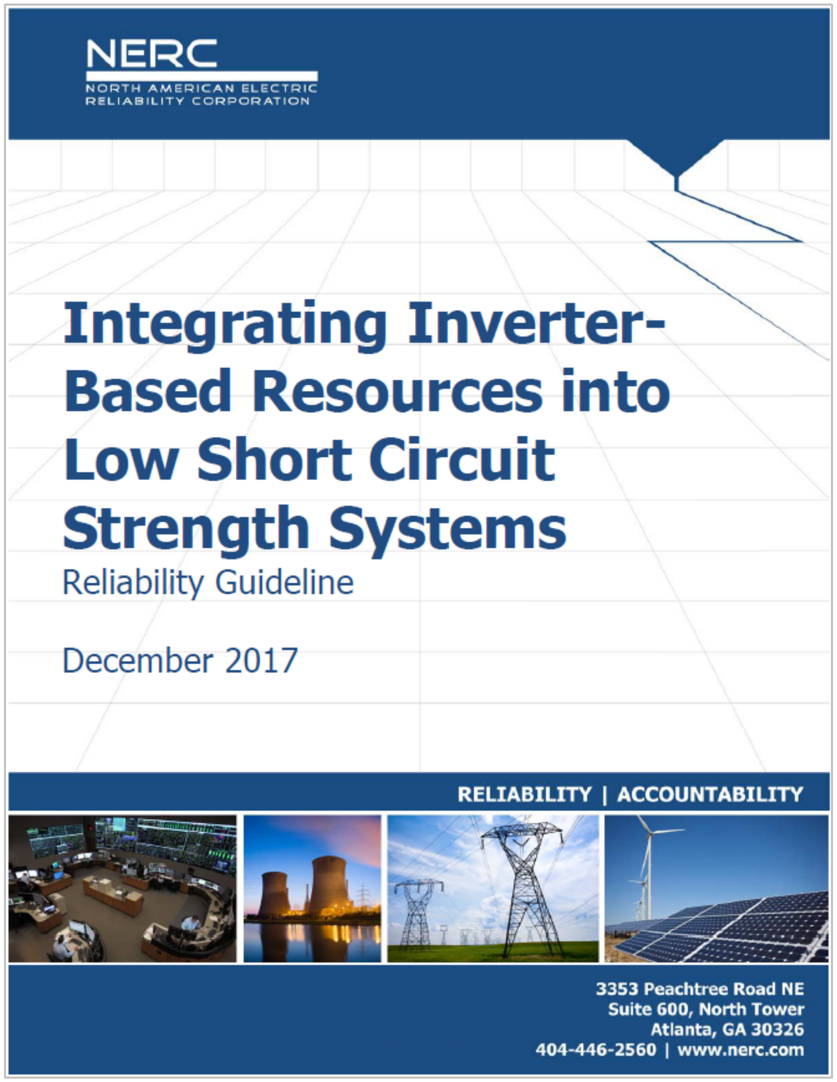

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NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Integrating Inverter-Based Resources into Low Short Circuit Strength Systems

Reliability Guideline

December 2017

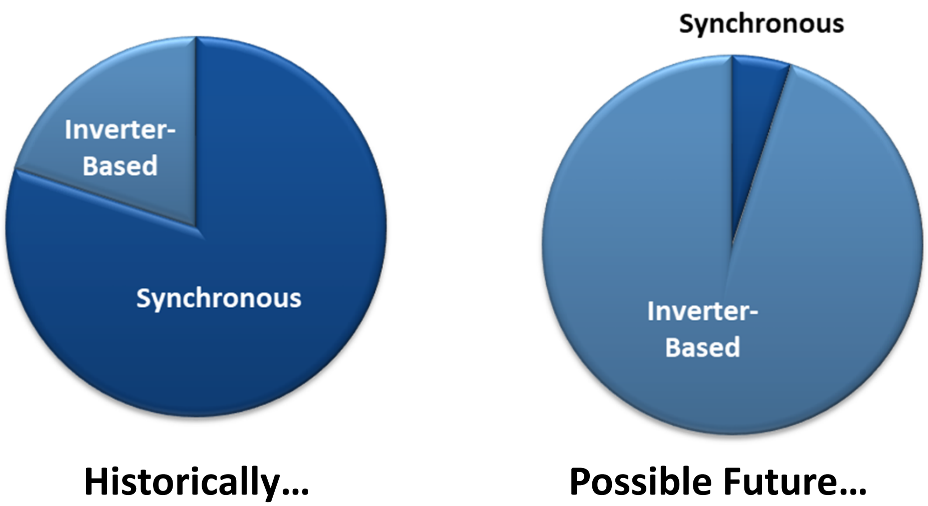
RELIABILITY | ACCOUNTABILITY

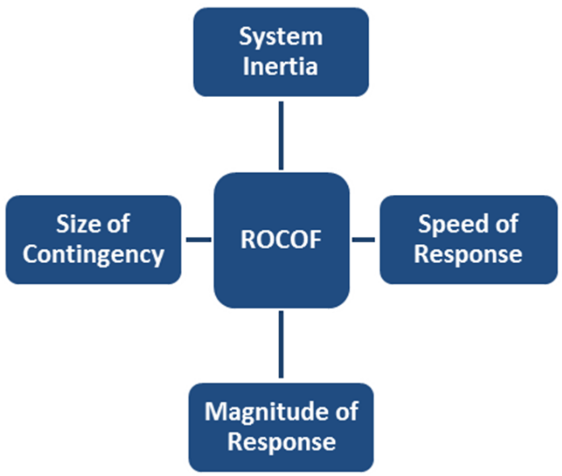
3353 Peachtree Road NE
Suite 600, North Tower
Atlanta, GA 30326
404-446-2560 | www.nerc.com

- System strength concept
  - Low short circuit strength (i.e., “weak grid”)
- Short circuit ratio (SCR)-based metrics
- Issues with low short circuit strength networks
- Planning study considerations
- Need for detailed modeling and studies
- Coordination and solutions to low short circuit issues

https://www.nerc.com/comm/PC_Reliability_Guidelines_DL/Item_4a._Integrating%20_Inverter-Based_Resources_into_Low_Short_Circuit_Strength_Systems_-_2017-11-08-FINAL.pdf

White Paper: FFR Concepts and BPS Reliability Needs





NERC Standards Review

- IRPTF sub-group performed detailed review of NERC Standards and identified any issues with BPS-connected inverter-based resources
  - PRC-002-2 (disturbance monitoring)
  - FAC-001-3 and FAC-002-2 (interconnection requirements and studies)
  - MOD-026-1 and MOD-027-1 (dynamic model verification)
  - TPL-001-4 (clarifications to TPL planning assessments)
  - VAR-002-4.1 (generator voltage control)

- SARs endorsed by RSTC and submitted to NERC Standards Committee

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NORTH AMERICAN ELECTRIC
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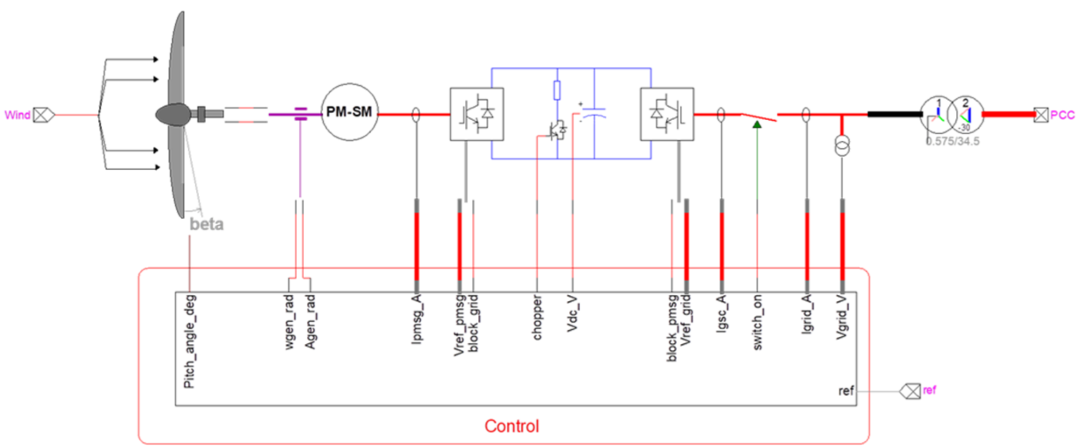
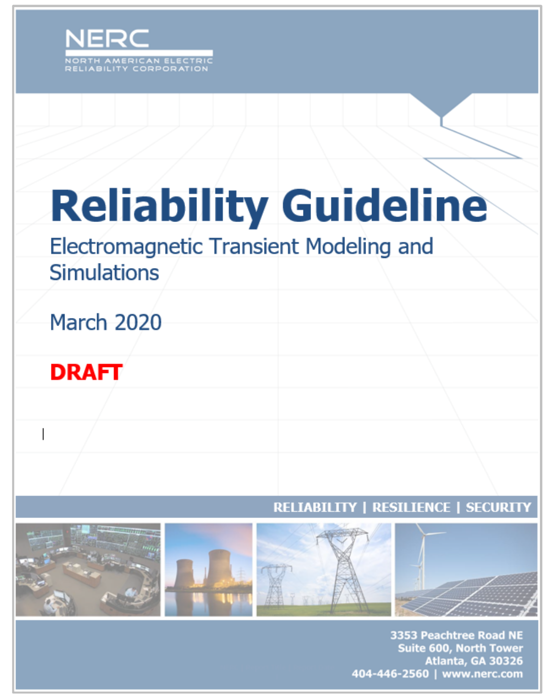
Reliability Guideline: EMT Modeling and Studies

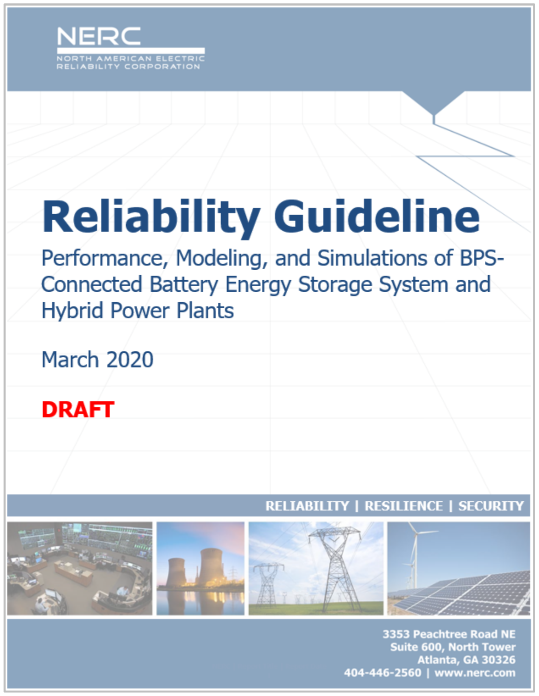
- Increasingly common
- Increasingly important
- Growing industry capabilities and expertise
- Sufficient time to execute studies
- Key aspect of reliable operation of the BPS

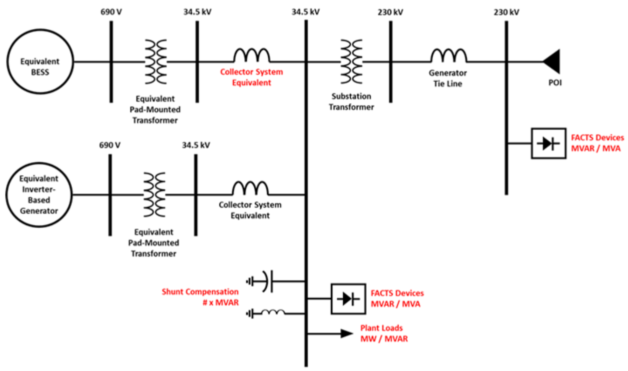




Reliability Guideline: BESS and Hybrid Plant Performance and Modeling

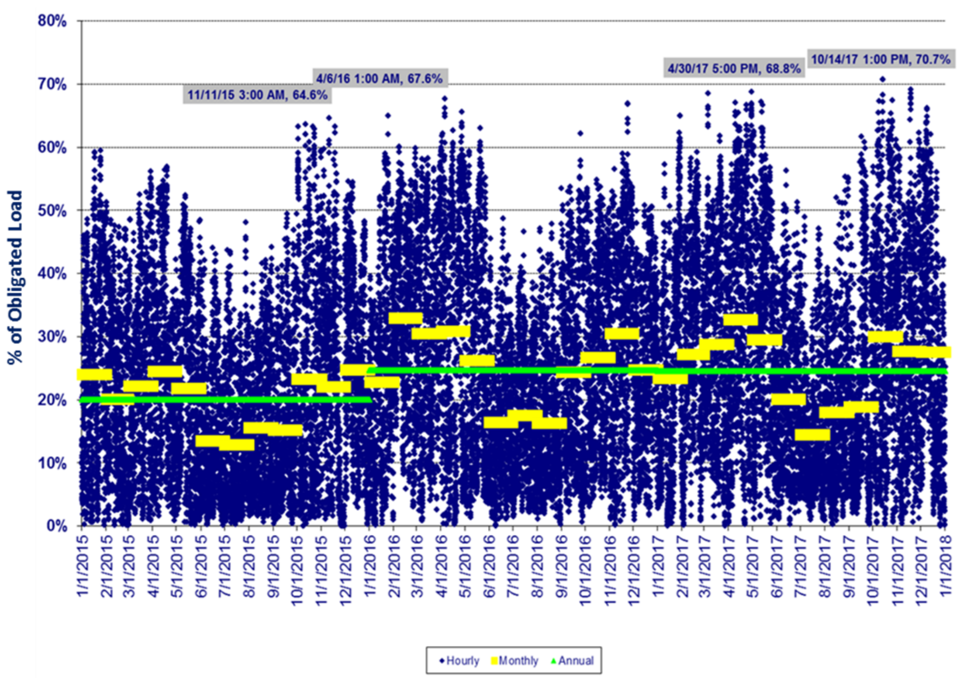
- Interconnection queues flooded with requests from BESSs and hybrids
- Recommended performance – need for clarity and consistency
- Growing complexity with planning studies:
  - How do we model?
  - How do we set dispatch assumptions?
  - How do we execute studies?
  - How do we handle increasing uncertainty?

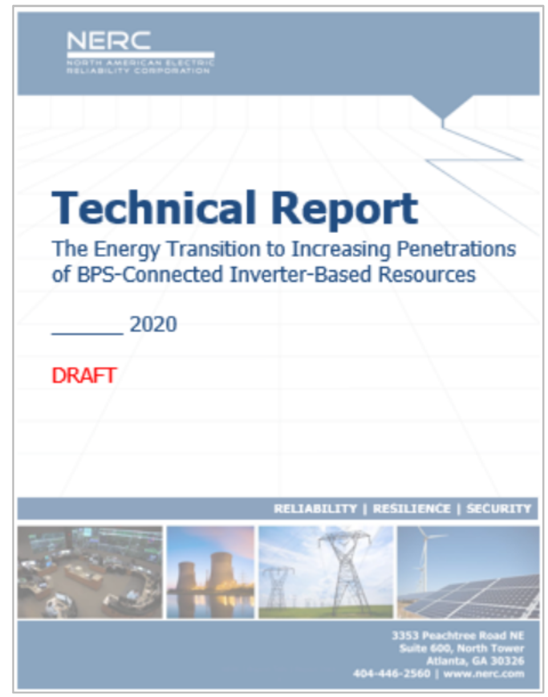




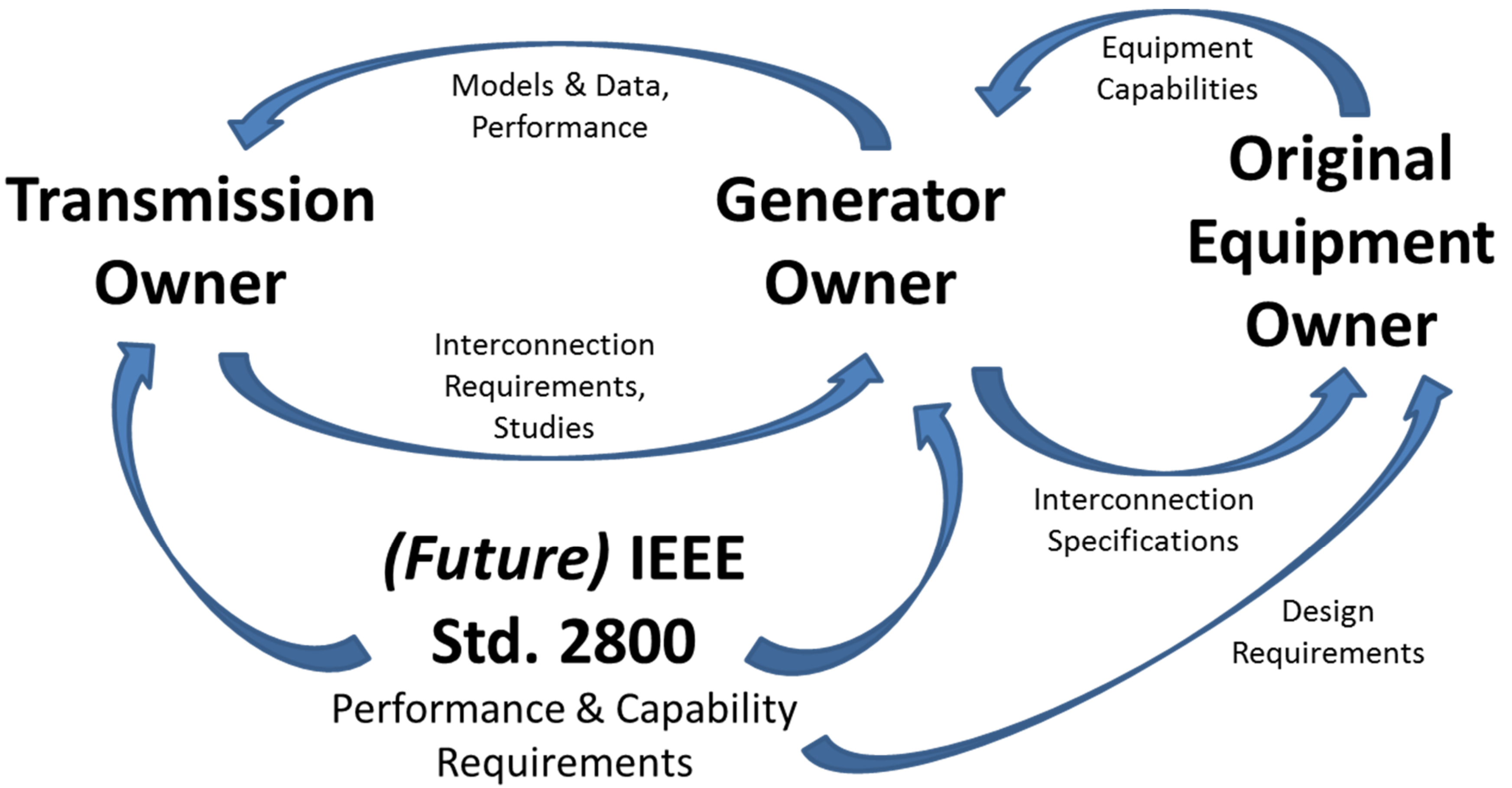
Technical Report: Energy Transition to High Penetrations of IBRs

- Changing nature of the grid
  - What challenges will we face?
  - What solutions do we have available?
  - Where are our gaps?





Coordination between Transmission, Generation, and OEM

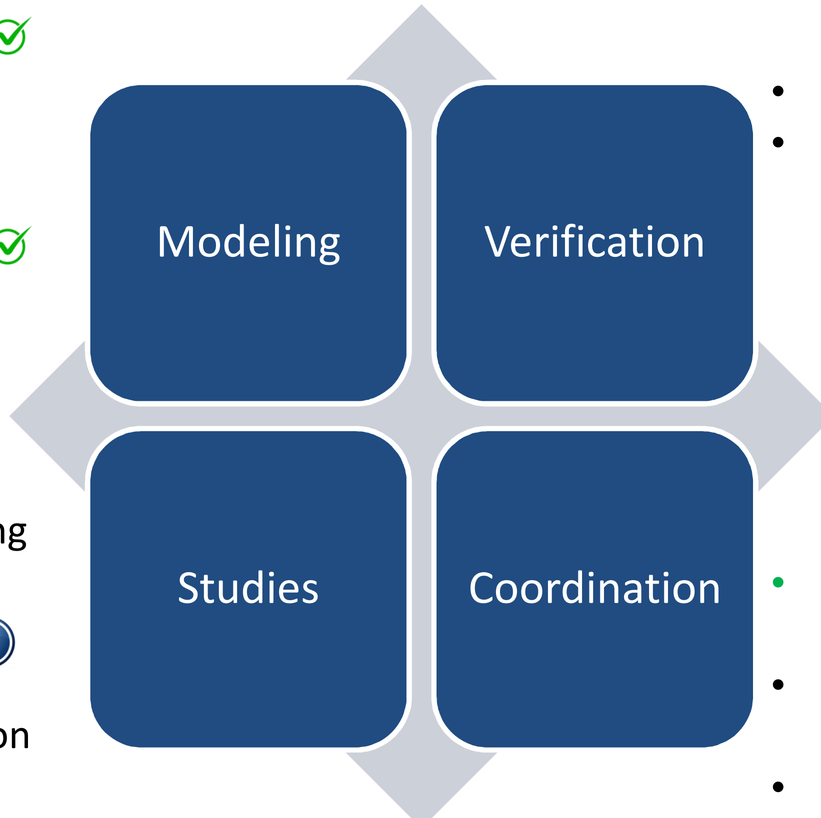


NERC System Planning Impacts of Distributed Energy Resources Working Group (SPIDERWG)

Aggregate Impacts of Distribution-Connected Energy Resources

What Else is SPIDERWG Up To?

- DER Modeling Survey
- **DER_A Parameterization Guideline** ✓
- **DER Data Collection Guideline** ✓
- **MOD-032-1 Review/SAR** ✓
- **Modeling Notification** ✓



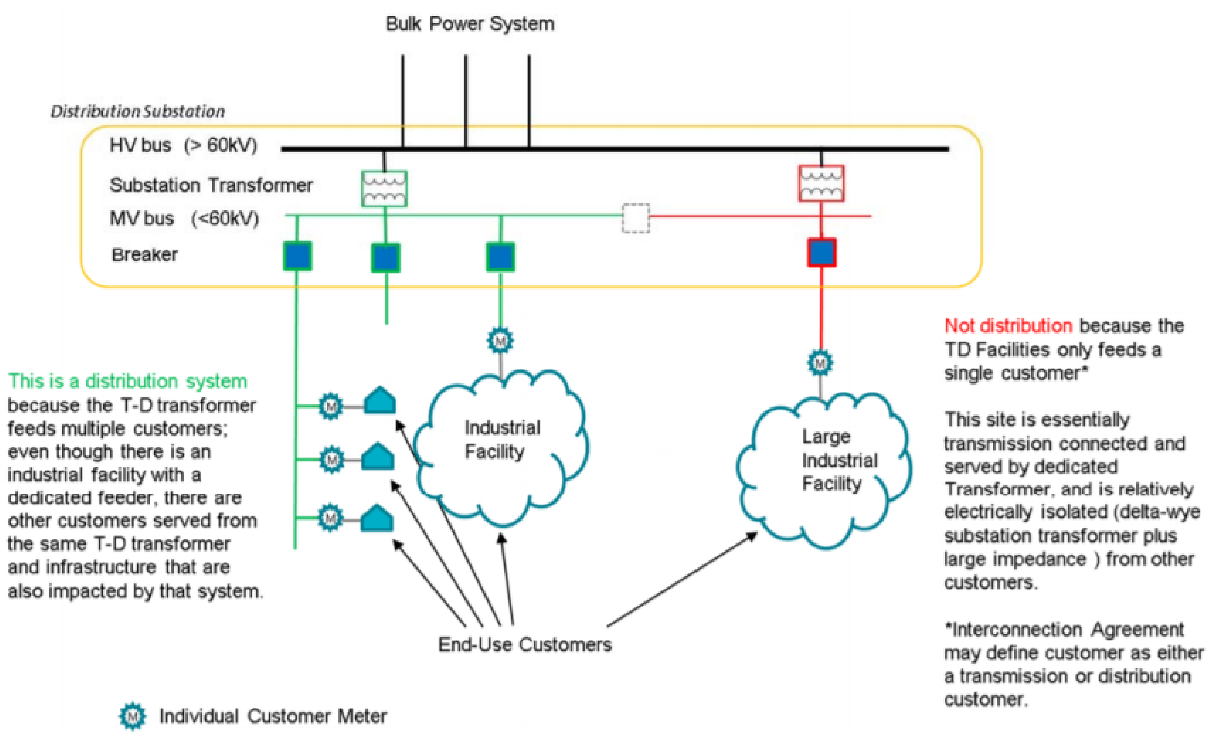
- DER Verification Guideline
- DER Forecasting Practices Guideline

- Guideline on BPS Planning Practices with DER
- **White Paper: TPL-001 Standard Review** (!)
- Recommended Simulation Improvements
- Guidance on UFLS and UVLS
- White Paper: Beyond Positive Sequence

- **IEEE Std. 1547-2018 Review and BPS Recommendations** ✓
- Guideline on Communicating across T-D Interface
- Education Materials
- Coordination of Terminology
- NERC Standards Review
- Tracking DER Growth

SPIDERWG Working Definition of DER

- **DER:** Any source of electric power located on the distribution system.



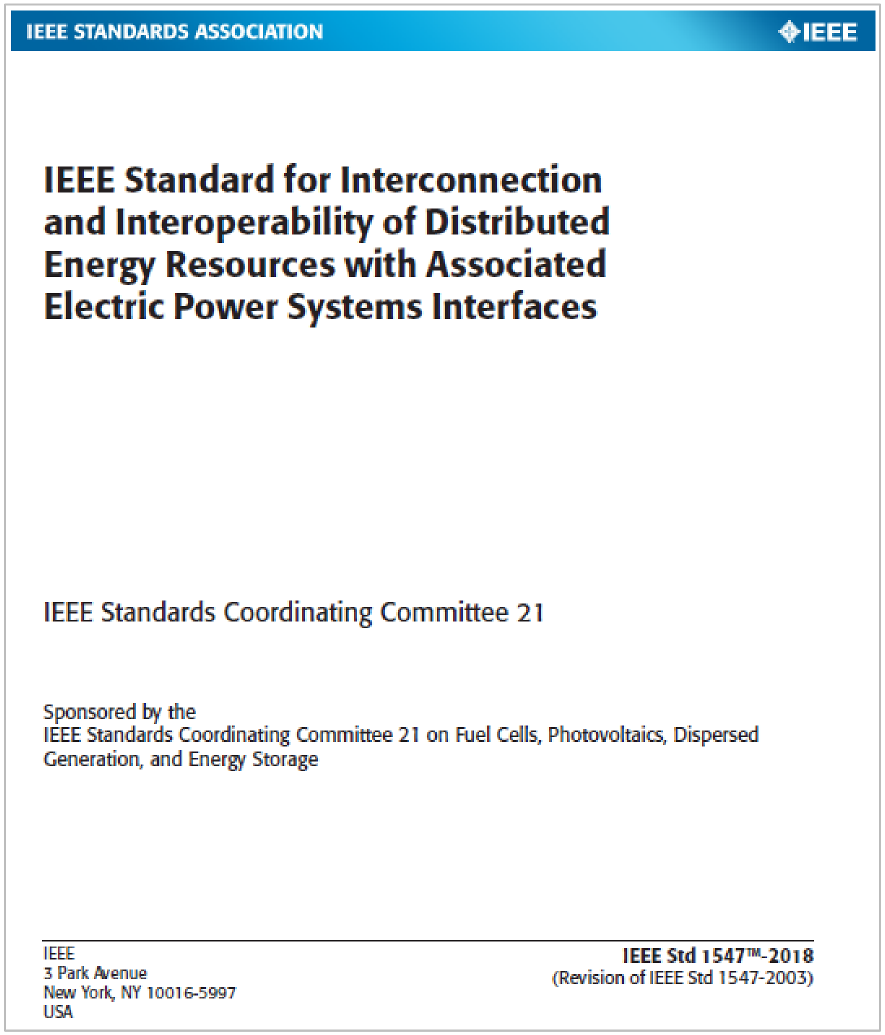
Distributed Demand Modifying Resource

Distributed Energy Resources + **Load Modifiers**

Distributed Energy Resources:
- Distributed Generation
- Energy storage
  - (including bi-directional EVs)

Load Modifiers:
- Demand response
- Time of use rate impacts
- Managed EV charging
- Energy efficiency
- CVR or Cap banks? (VARs?)

NERC SPIDERWG Guideline



IEEE STANDARDS ASSOCIATION IEEE

IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces

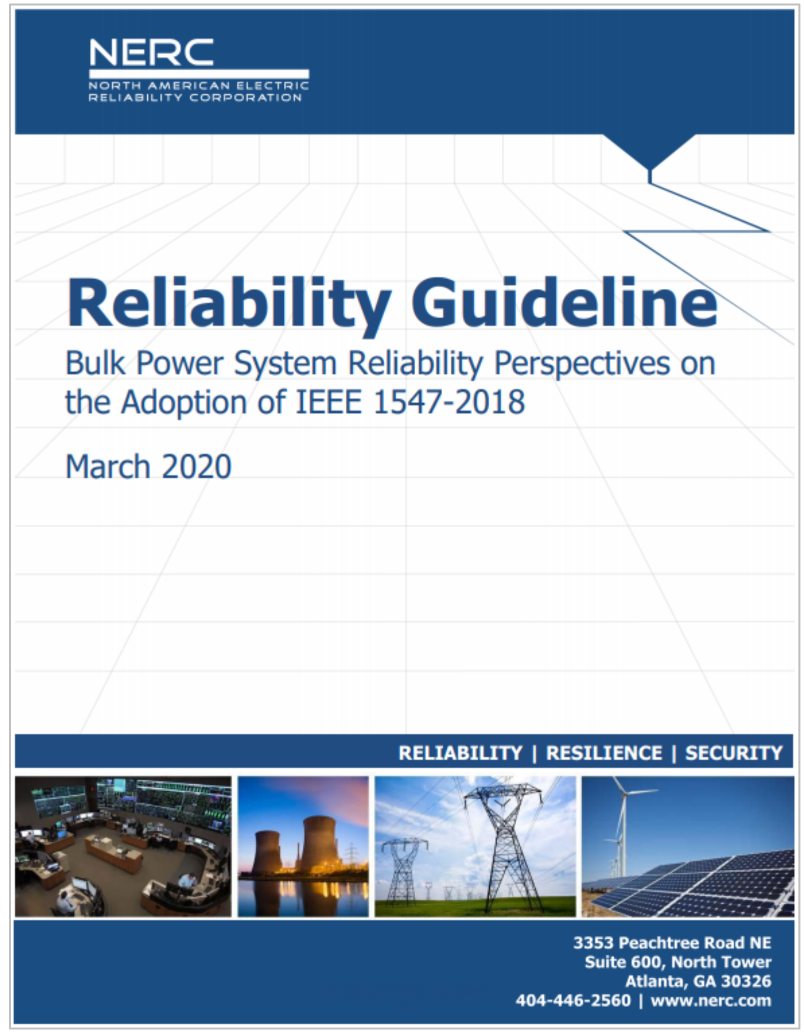
IEEE Standards Coordinating Committee 21

Sponsored by the
IEEE Standards Coordinating Committee 21 on Fuel Cells, Photovoltaics, Dispersed Generation, and Energy Storage

IEEE
3 Park Avenue
New York, NY 10016-5997
USA

IEEE Std 1547™-2018
(Revision of IEEE Std 1547-2003)

Source: IEEE SA



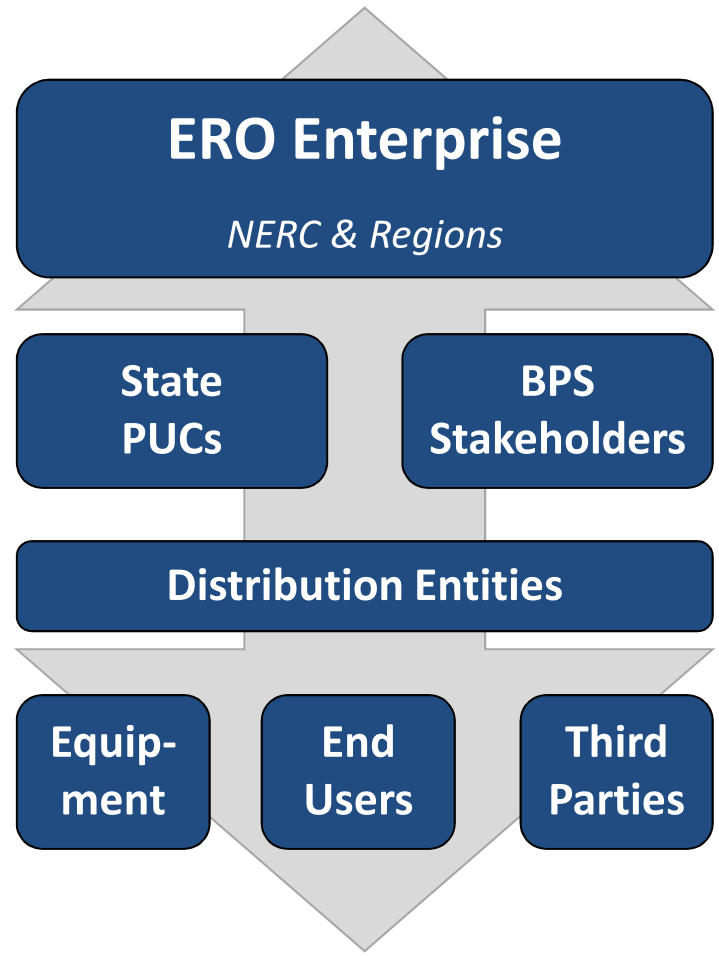
NERC Recommendations to NARUC and States regarding IEEE 1547-2018

- ***Aggregate*** amounts of DER can and will impact the BPS
  - NERC Goal: provide support where needed in this area; ensure BPS reliability
- Adoption of IEEE 1547-2018
  - Encouraged, from BPS perspective
  - Coordination led by ***AGIRs*** (e.g., States), engagement from RCs
- Educational materials abound
  - NERC SPIDERWG, NERC Reliability Guideline, EPRI reports, etc.
- Coordination necessary for successful IEEE 1547-2018 implementation (BPS perspectives needed in some areas)
  - DER Category Selection
  - Voltage Tripping
  - Voltage Ride-Through
  - Frequency Tripping
  - Frequency Ride-Through
  - Restore Output
  - Frequency-Droop
  - Phase Angle Change Ride-Through
  - Enter and Return to Service
  - Unintentional Islanding
  - Intentional Islanding
  - Interoperability

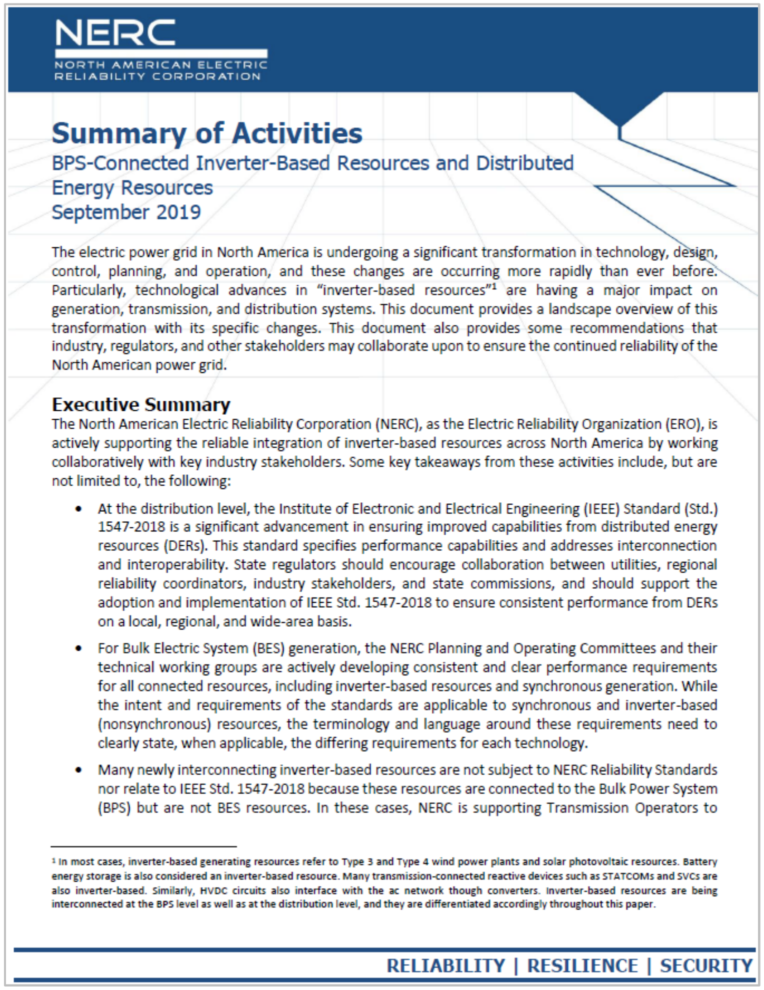
Coordination with Regions

- ***Question:*** *How best can we coordinate between NERC, the Regions, and our stakeholders?*

- **My Answer:** "Make It Personal"
  - NERC Guidelines providing clear recommendations for areas where industry will need to *dig in* moving forward
  - Providing unified guidance for industry-wide modeling, simulation, planning, data collection, and other practices
  - HOWEVER … you all know your system best!
    - What is the highest priority issues in your footprint?
    - What emerging risks could be coming?
    - Have those been articulated to the Region and to NERC?
      - Why? Because we want to help address them together!



Summary of Activities: Key Takeaways


NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Summary of Activities

BPS-Connected Inverter-Based Resources and Distributed Energy Resources
September 2019

The electric power grid in North America is undergoing a significant transformation in technology, design, control, planning, and operation, and these changes are occurring more rapidly than ever before. Particularly, technological advances in "inverter-based resources"[1] are having a major impact on generation, transmission, and distribution systems. This document provides a landscape overview of this transformation with its specific changes. This document also provides some recommendations that industry, regulators, and other stakeholders may collaborate upon to ensure the continued reliability of the North American power grid.

Executive Summary

The North American Electric Reliability Corporation (NERC), as the Electric Reliability Organization (ERO), is actively supporting the reliable integration of inverter-based resources across North America by working collaboratively with key industry stakeholders. Some key takeaways from these activities include, but are not limited to, the following:

- At the distribution level, the Institute of Electronic and Electrical Engineering (IEEE) Standard (Std.) 1547-2018 is a significant advancement in ensuring improved capabilities from distributed energy resources (DERs). This standard specifies performance capabilities and addresses interconnection and interoperability. State regulators should encourage collaboration between utilities, regional reliability coordinators, industry stakeholders, and state commissions, and should support the adoption and implementation of IEEE Std. 1547-2018 to ensure consistent performance from DERs on a local, regional, and wide-area basis.
- For Bulk Electric System (BES) generation, the NERC Planning and Operating Committees and their technical working groups are actively developing consistent and clear performance requirements for all connected resources, including inverter-based resources and synchronous generation. While the intent and requirements of the standards are applicable to synchronous and inverter-based (nonsynchronous) resources, the terminology and language around these requirements need to clearly state, when applicable, the differing requirements for each technology.
- Many newly interconnecting inverter-based resources are not subject to NERC Reliability Standards nor relate to IEEE Std. 1547-2018 because these resources are connected to the Bulk Power System (BPS) but are not BES resources. In these cases, NERC is supporting Transmission Operators to

[1] In most cases, inverter-based generating resources refer to Type 3 and Type 4 wind power plants and solar photovoltaic resources. Battery energy storage is also considered an inverter-based resource. Many transmission-connected reactive devices such as STATCOMs and SVCs are also inverter-based. Similarly, HVDC circuits also interface with the ac network though converters. Inverter-based resources are being interconnected at the BPS level as well as at the distribution level, and they are differentiated accordingly throughout this paper.

RELIABILITY | RESILIENCE | SECURITY

- Distribution System
  - State regulator and local utility adoption of IEEE 1547-2018
  - Coordinated stakeholder engagement
- Bulk Power System
  - Majority of newly interconnecting IBR
  - Improvements to Transmission Owner interconnection requirements (FAC-001-3)
  - IEEE P2800 standard development
  - Coordination with FERC staff to facilitate changes to pro-forma LGIA and SGIA
  - Mitigation of emerging reliability issues
- Bulk Electric System
  - NERC IRPTF developing guidelines and reviewing NERC Reliability Standards
  - Ensuring clear and consistent requirements

https://www.nerc.com/comm/PC/Documents/Summary_of_Activities_BPS-Connected_IBR_and_DER.pdf

Related Activities – Get Involved!

- NERC Inverter-Based Resource Performance Task Force (here)
- NERC System Planning Impacts from DER Working Group (here)
- Reliability Guidelines (here)
- Guideline: Recommended Performance for BPS-Connected IBR (here)
- Guideline: Improvements to Interconnection Requirements (here)
- Guideline: BPS Reliability Perspectives on the Adoption of IEEE 1547-2018 (here)
- Guideline: Parameterization of the DER_A Model (here)
- Blue Cut Fire Disturbance Report (here)
- Canyon 2 Fire Disturbance Report (here)
- Palmdale Roost and Angeles Forest Disturbance Report (here)
- NERC Alert: Loss of Solar Resources I (here)
- NERC Alert: Loss of Solar Resources II (here)
- Summary of ERO Activities for IBRs and DERs (here)
- IEEE P2800 (here)
- NERC-WECC Report: WECC Base Case Review of Inverter-Based Resources (here)
- Report: BPS-Connected Inverter-Based Resource Modeling and Studies (here)
- White Paper: FFR Concepts and BPS Reliability Needs (here)
- NERC List of Acceptable Models (here)
- SPIDERWG Working Definitions for DER (here)

Questions and Answers

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