# NERC

## **BES to DER: Reliability Perspectives**

Ryan Quint North American Electric Reliability Corporation ESIG Fall Workshop October 2018











### **Blue Cut Fire Disturbance Report**



#### NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION Industry Recommendation Loss of Solar Resources during Transmission Disturbances due Initial Distribution: June 20, 2017 NERC identified a potential characteristic exhibited by some inverter-based resources, particularly utility-scale solar photovoltaic (PV) generation, which reduces power output during fault conditions on the transmission system. An example of this behavior has been observed during recent BPS disturbances, highlighting potential risks to BPS reliability. With the recent and expected increases of utility-scale solar resources, the causes of this reduction in power output from utility-scale power inverters needs to be widely communicated and addressed by the industry. The industry should identify reliability preserving actions in the areas of power system planning and operations to reduce the system reliability impact in the event of widespread loss of solar-resources during faults on the For more information, see the 1,200 MW Fault Induced Solar Photovoltaic Resource Interruption Acknowledgement Required by Midnight Eastern on June 27, 2017 Reporting Required by Midnight Eastern on August 31, 2017 PUBLIC: No Restrictions More on handling >> This recommendation provides specific actions NERC registered entities should consider taking to respond to a particular issue. Pursuant to Rule 810 of NERC's Rules of Procedure, NERC registered entities shall 1) acknowledge receipt of this advisory within the NERC Alert System, and 2) report to NERC on the status of their activities in relation to this recommendation as provided below. For U.S. entities, NERC will compile the responses and report the results to the Federal Energy Regulatory Commission **RELIABILITY** | ACCOUNTABILITY

### **Blue Cut Fire Disturbance Alert**





#### Figure 2: MW susceptible to Erroneous Frequency Calculations



Figure 4: MW cease output during abnormal voltages



### **Canyon 2 Fire Disturbance Report**



#### NERC NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION 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<sup>1</sup> 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<sup>2</sup> by Midnight Eastern on May 8, 2018 Reporting Required by Midnight Eastern on July 31, 2018 **PUBLIC: No Restrictions** More on handling >> <sup>1</sup> These resources do not meet the Bulk Electric System definition, and are generally less than 75 MVA vet connected to transmission-level voltage <sup>2</sup> To the extent that Canadian jurisdictions have implemented laws or requirements that vary from Section 810 of the ROP. NERC request: entities in such jurisdictions voluntarily participate in response to this Alert.

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### **Canyon 2 Fire Alert**





### Modeling Notification: Momentary Cessation



### Existing models largely DO NOT accurately represent installed resource performance

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#### **Modeling Notification**

Recommended Practices for Modeling Momentary Cessation Initial Distribution: February 2018

This Modeling Notification provides Generator Owners who own inverter-based resources, particularly solar photovoltaic (PV) resources, with recommendations for accurately modeling momentary cessation for existing resources that are not able to eliminate its use. Specific modeling requirements and steps to accurately model this behavior in the second-generation positive sequence generic renewable energy system models are provided in the notification.

#### Primary Interest Groups

Generator Owners (GOs), Generation Operators (GOPs), Transmission Planners (TPs), Planning Coordinators (PCs), Reliability Coordinators (RCs), MOD-032 Designees

#### Background

The <u>Blue Cut Fire</u> in August 2016 identified that the vast majority of solar PV resources connected to the bulk power system (BPS) use an operating mode known as momentary cessation. Momentary cessation is an inverter operating state where the power electronic "firing commands" are blocked such that both active current and reactive current go to zero output.<sup>1</sup> The NERC Inverter-Based Resource Performance Task Force (<u>IRPTF</u>)<sup>2</sup> is developing recommended performance specifications for inverter-based resources, including recommendations for momentary cessation. The task force has determined that momentary cessation should not be used for newly interconnecting resources to the BPS and should be eliminated to the greatest extent possible for existing resources on the BPS due to the reliability risk that the operating mode poses.

However, the NERC IRPTF recognizes that older vintages of inverters may require that momentary cessation be used due to design considerations at the time of commissioning. This is considered an equipment limitation that should be reported by the GO to their TP and PC. For these resources, it is critical that momentary cessation be captured with the dynamic models used to plan and operate the BPS. The secondgeneration generic renewable energy system models are, in general, recommended for modeling inverterbased resources in interconnection-wide base cases.<sup>345</sup> These models have some capability to model momentary cessation, and are described in detail in this notification.

<sup>&</sup>lt;sup>5</sup> Some interconnections, for example the Texas Interconnection, allow for more detailed, user-written models in their interconnection-wide cases. This is left to the discretion of the MOD-032 Designees for each interconnection.



<sup>&</sup>lt;sup>1</sup> Momentary cessation is sometimes referred to as "blocking" for this reason.

<sup>&</sup>lt;sup>2</sup> The NERC IRPTF consists of inverter manufacturers, GOs, GOPs, TPs, PCs, Balancing Authorities (BAs), Fast AC Transmission System (FACTS) device manufacturers, renewable energy resource modeling experts, Regional Entities, NERC, and FERC.

<sup>&</sup>lt;sup>3</sup> "The second-generation generic renewable energy system models" refer to the latest generic models used to represent inverter-based resources (e.g., regc\_a and reec\_a models).

<sup>&</sup>lt;sup>4</sup> More detailed vendor-specific models may be used for local planning studies. These models may already capture momentary cessation. However, they are generally not allowed or recommended for the interconnectionwide cases. The focus of this guideline is on the generic models used for interconnection-wide modeling, and recommends the use of the second-generation renewable energy system models for this reason.



### **Reliability Guideline: BPS-Connected Inverter-Based Resource Performance**

### Topics:

- 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

<u>https://www.nerc.com/comm/PC\_Reliability\_Guidelines\_</u>
<u>DL/Inverter-Based\_Resource\_Performance\_Guideline.pdf</u>





### Large BES Solar Resources



**Unofficial - Illustration Purposes Only** 



### **BPS-Connected Solar Resources**



**Unofficial - Illustration Purposes Only** 



### What's Out There?





### What's Out There?





### What's Out There?



generation facilities needed to maintain transmission system reliability. The term does not include facilities used in the local distribution of electric energy.

**Unofficial - Illustration Purposes Only** 

#### **RELIABILITY | ACCOUNTABILITY**

DER

1.5 kW



### Inventory



1,186,655	Total Operable Generating Capacity (MW)				
25288	Total PV Nameplate capacity (MW)				
2778	Total number of PV units				
2.13%	Amount of PV MW Generation				
		Total Nameplate			
PV MW	No of Units	Capacity (MW)			
PV<=20	2,518	10,509			
PV>=75	63	6,999			
20 <pv<75< td=""><td>197</td><td>7,780</td></pv<75<>	197	7,780			

2013 MW PV Generation



1,164,022	Total Operable Generating Capacity (MW)				
5389	Total PV Nameplate capacity (MW)				
856	Total number of PV units				
0.46%	Amount of PV MW Generation				
		Total Nameplate			
PV MW	No of Units	Capacity MW			
PV<=20	799	2,746			
PV>=75	9	1,082			
20 <pv<75< td=""><td>48</td><td colspan="2">1,561</td></pv<75<>	48	1,561			



### **NERC SPIDERWG**



- Data collection and sharing
- Modeling
- Monitoring
- Model validation
- Study approaches
- System reliability impacts
- Interested?
  - Send email to Ryan Quint (<u>ryan.quint@nerc.net</u>).



Solicitation for Industry Participation: System Planning Impacts from Distributed Energy Resources Working Group (SPIDERWG)

Click here for: <u>Draft SPIDERWGScope</u> Click here for: <u>SPIDERWG Webpage</u>

#### SPIDERWG Request for Participation -

NERC is announcing the formation of the **System Planning Impacts from Distributed Energy Resc Working Group (SPIDERWG)** to continue its efforts to address the impacts of aggregate distributed e resources (DER) on the bulk power system (BPS). NERC SPIDERWG will focus on developing in recommendations and guidelines for system planning, modeling, and reliability assessments with incr



### Aggregate DER Modeling using DER\_A



	Table X.XXX: Default DER_A Model Parameters							
Param	IEEE 1547-2003 Default	IEEE 1547a-2014 Default	CA Rule 21 Default	IEEE 1547-2018 Default	Sensitivity Guidance	Description		
trv						Transducer time constant [sec]		
dbd1						Lower voltage deadband [pu]		
dbd2						Upper voltage deadband [pu]		
kqv						Proportional voltage control gain [pu/pu]		
vref0					See Note 2	Voltage reference set point [pu]		
tp						Transducer time constant [sec]		
tiq						Q control time constants [sec]		
ddn			$\sim$			Frequency control droop gain (down side)		
dup			~ >			Frequency control droop gain (upper side)		
fdbd1			6			Lower frequency control deadband [pu]		
fdbd2						Upper frequency control deadband [pu]		
femax						Frequency control maximum error [pu]		
femin						Frequency control minimum error [pu]		
pmax						Maximum power [pu]		
pmin						Minimum power [pu]		
dpmax						Power ramp rate up [pu/sec]		
dpmin						Power ramp rate down [pu/sec]		
tpord						Power order time constant [pu/sec]		
imax						Maximum converter current [pu]		
vl0					See Note 1	Voltage breakpoint for low voltage cut-out [pu]		
vl1					See Note 1	Voltage breakpoint for low voltage cut-out [pu]		



- Reliability Guideline: BPS-Connected Inverter-Based Resource Performance: <u>HERE</u>
- Blue Cut Fire Disturbance Report: <u>HERE</u>
- Canyon 2 Fire Disturbance Report: <u>HERE</u>
- NERC Alerts: <u>HERE</u>
- Level 2 NERC Alert Loss of Solar Resources I: <u>HERE</u>
- Level 2 NERC Alert Loss of Solar Resources II: <u>HERE</u>
- NERC IRPTF Webpage: <u>HERE</u>
- NERC SPIDERWG Webpage: <u>HERE</u>
- Reliability Guideline: Modeling DER in Dynamic Load Models: <u>HERE</u>
- Reliability Guideline: DER Modeling: <u>HERE</u>



# **Questions and Answers**



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