# Problem Statement

## "DER Ride Through"

***DER Ride Through and Trip Settings and IEEE standard 1547-2018***

**Problem / Opportunity Statement**

As the number of inverter-based Distributed Energy Resources (DER)[1] grows in PJM, primarily solar PV, there is a need for PJM, transmission owners, electric distribution companies, state regulatory agencies, and other stakeholders to coordinate on the inverters' operational performance requirements and potential impacts to Bulk Electric System (BES)[i,ii,iii]. For BES reliability, the key performance requirements for DER are frequency and voltage ride through. Ride through requires resources to stay connected to the system for a very short period of time in the event of a wide area disturbance, rather than trip offline and potentially exacerbate abnormal BES conditions.

Failures of inverter-based resources to properly ride through contingencies have caused unreliable operations in California[iv,v], Texas[vi], and Europe[vii]. In Australia, such a failure to ride through contributed to a system blackout[viii]. In order to mitigate these concerns, ride through requirements for DER have been implemented in areas with high DER deployment, such as California, Hawaii, Germany, and Australia.

A recently revised version of the DER interconnection standard IEEE 1547 now specifies performance requirements that may meet the reliability needs of the Bulk Electric System. The Institute of Electrical and Electronics Engineers, or IEEE, is an international industry organization that, among other things, produces voluntary standards for use by interested parties. The IEEE standard 1547, first developed in 2003, has been widely cited in federal and state law and in distribution utility requirements. The 1547 standard is also cited in PJM requirements for certain wholesale DER whose interconnection fall under FERC jurisdiction[ix,x] (For a more detailed description of the circumstances under which DER interconnect under FERC jurisdiction, see http://www.pjm.com/-/media/committees-groups/committees/mrc/20160617-special/20160617-item-03-jurisdictional-over-interconnection-of-generation-onto-distribution-facilities.ashx).

The former edition of the IEEE 1547 standard specified a single (albeit adjustable) trip requirement, but lacked a ride through requirement. The revised standard, IEEE 1547-2018, offers three different categories of frequency and voltage ride through and trip settings that the authority governing interconnection requirements (e.g., a state regulatory commission) would specify. Even within each of the three categories offered by the standard, there is still an ability to modify the default trip settings within limits. Therefore, with the implementation of the revised standard, new engineering judgements must be made among distribution, transmission, and other stakeholders to establish which performance category (together with optional adjustments) should apply.

PJM recognizes that, in implementation of ride through requirements, a key engineering consideration is the safety of lineworkers facing arc-flash risks while performing hot work on primary distribution lines.

In order to facilitate a smooth transition to the new standard, and to ensure all DER across the PJM RTO support reliability in a predictable way during wide area abnormal conditions, PJM and stakeholders have an interest in coordinating the implementation of ride through and trip settings for DER interconnections.

[1] For the purposes of this effort, Distributed Energy Resource (DER) means a generation resource or electric energy storage resource connected to radial distribution at voltage < 50 kV.

## Problem Statement

There is an opportunity to use the outcome of this technical coordination effort to serve as a requirement for DER that interconnect under FERC jurisdiction[x], as well as, and perhaps more importantly, a technical guidance document that utilities and states can use in their implementation of the ride through and trip requirements of IEEE 1547-2018.

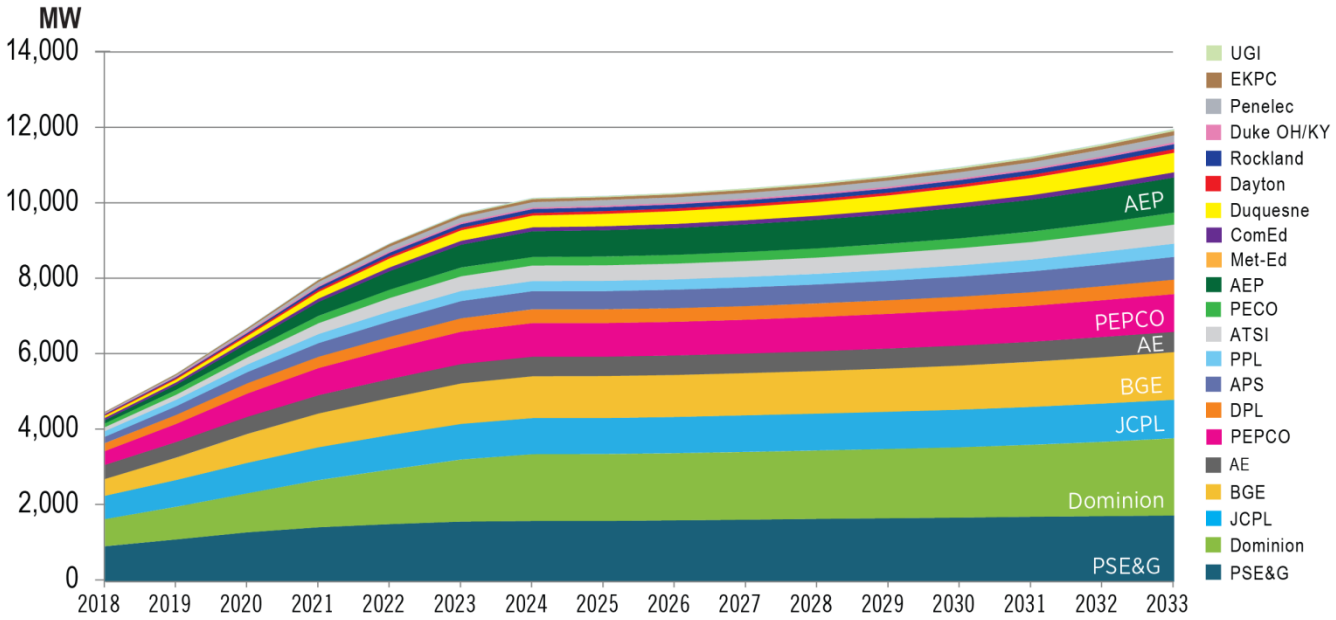


**Figure 1. Forecast of non-wholesale solar PV in PJM by Transmission Zone. Source: IHS Markit and PJM.**

[i] EPRI, 2015, Recommended Settings for Voltage and Frequency Ride-Through of Distributed Energy Resources, *available at* https://www.epri.com/#/pages/product/3002006203/?lang=en

[ii] NERC, 2013, Performance of Distributed Energy Resources During and After System Disturbance: Voltage and Frequency Ride-Through Requirements

[iii]E.g., *IEEE standard 1547-2018*, clause 6.4.1, *Mandatory Voltage Tripping Requirements*. "Area EPS operators may specify values within the specified range subject to the limitations on voltage trip settings specified by the regional reliability coordinator." PJM is the reliability coordinator for its footprint.

[iv] NERC, 2017. 1,200 MW Fault Induced Solar Photovoltaic Resource Interruption Disturbance Report. Available at https://www.nerc.com/pa/rrm/ea/1200_MW_Fault_Induced_Solar_Photovoltaic_Resource_/1200_MW_Fault_Induced_Solar_Photovoltaic_Resource_Interruption_Final.pdf

[v] NERC, 2017. 900 MW Fault Induced Solar Photovoltaic Resource Interruption Disturbance Report. Available at https://www.nerc.com/pa/rrm/ea/October%209%202017%20Canyon%202%20Fire%20Disturbance%20Report/900%20MW%20Solar%20Photovoltaic%20Resource%20Interruption%20Disturbance%20Report.pdf

[vi]NERC, 2017. Loss of Wind Turbines due to Transient Voltage Disturbances on the Bulk Transmission System. Available at https://www.nerc.com/pa/rrm/ea/Lessons%20Learned%20Document%20Library/LL20170701_Loss_of_Wind_Turbines_due_to_Transient_Voltage_Disturbances.pdf

[vii] Ecofys, 2011. Impact of Large-scale Distributed Generation on Network Stability During Over-Frequency Events & Development of Mitigation Measures. Available at https://www.ecofys.com/files/files/ecofys_ifk_2011_50_2_hz_summary.pdf

[viii]Australia Energy Market Operator, 2017. Black System South Australia 28 September 2016. Available at http://www.aemo.com.au/-/media/Files/Electricity/NEM/Market_Notices_and_Events/Power_System_Incident_Reports/2017/Integrated-Final-Report-SA-Black-System-28-September-2016.pdf

[ix] Manual 14G Attachment C: Small Generator (10 MW or Less) Technical Requirements and Standards

[x] Namely: wholesale DER that 1) seek interconnection to a distribution facility over which there is a prior FERC-jurisdictional service; or 2) wholesale DER that are PURPA Qualifying Facilities intending to make wholesale sales into the PJM market.