Implementing the New IEEE 1547 Interconnection Standard in PJM States

MADRI Meeting #49
March 13, 2018
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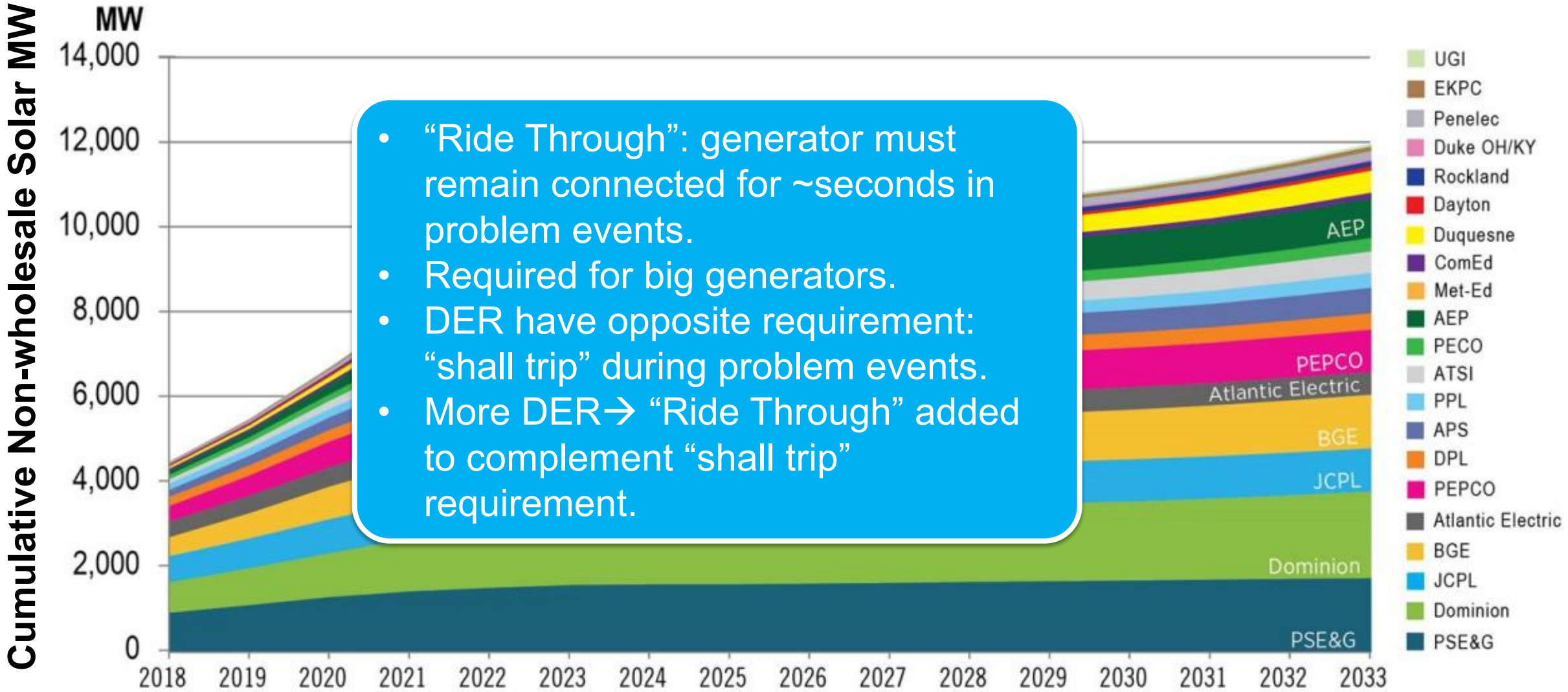
Four Key Messages on DER Ride Through

1. A ride through requirement is good for reliable integration of lots of DER.
   - DER with ride through can improve problem events.
   - DER without ride through can make problem events worse.
   - Ride through currently required in CA and HI.
2. New IEEE 1547-2018 standard for DER interconnection specifies many technical requirements and capabilities: **ride through**, but also: anti-islanding and power quality and voltage regulation etc…
3. IEEE 1547-10218 **ride through** comes in three flavors with lots of adjustability.

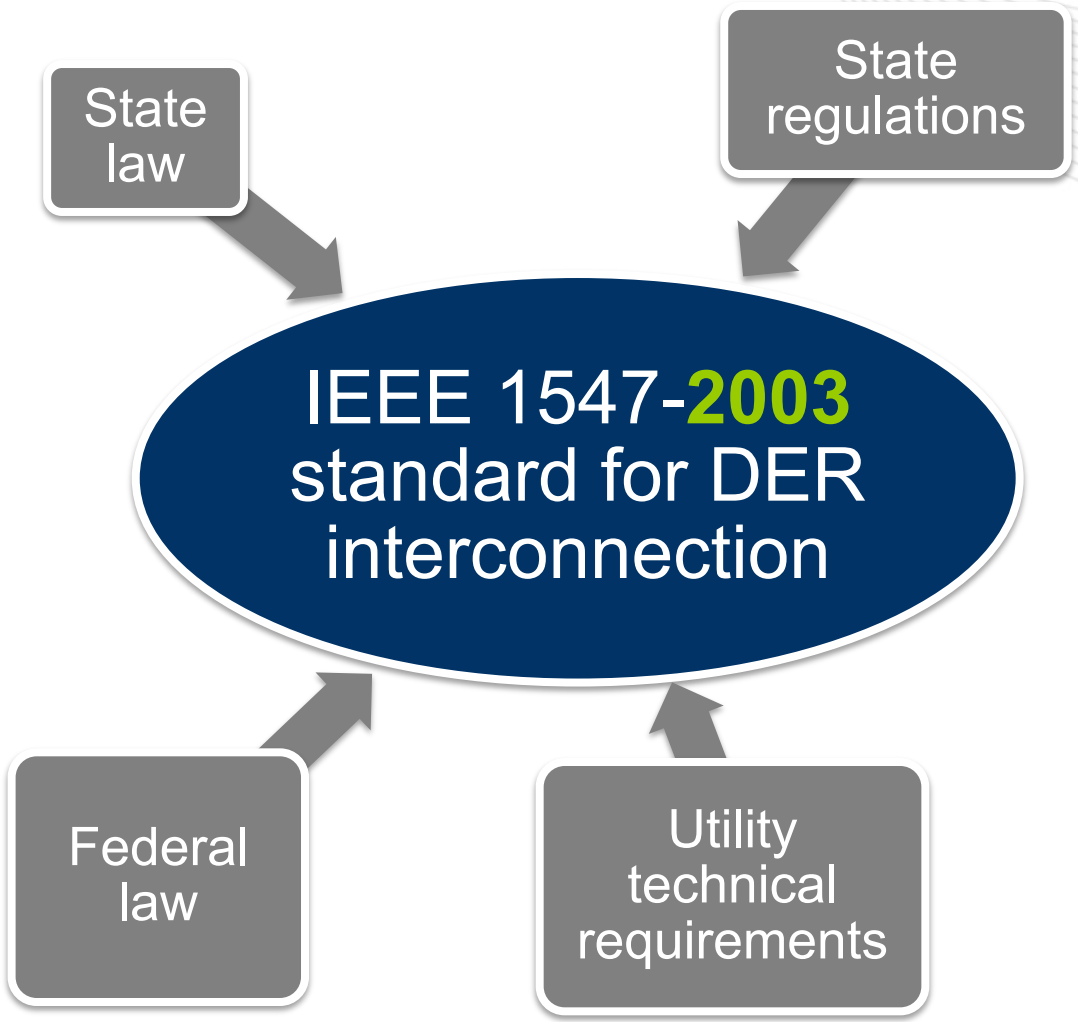
4. ***PJM is working with utilities to facilitate regional consistency in ride through settings for IEEE 1547-2018 for state jurisdictional retail DER.***

More DER deployment in PJM → Ride Through



- "Ride Through": generator must remain connected for ~seconds in problem events.
- Required for big generators.
- DER have opposite requirement: "shall trip" during problem events.
- More DER→ "Ride Through" added to complement "shall trip" requirement.

The Role of IEEE 1547-2003 and "Ride Through"



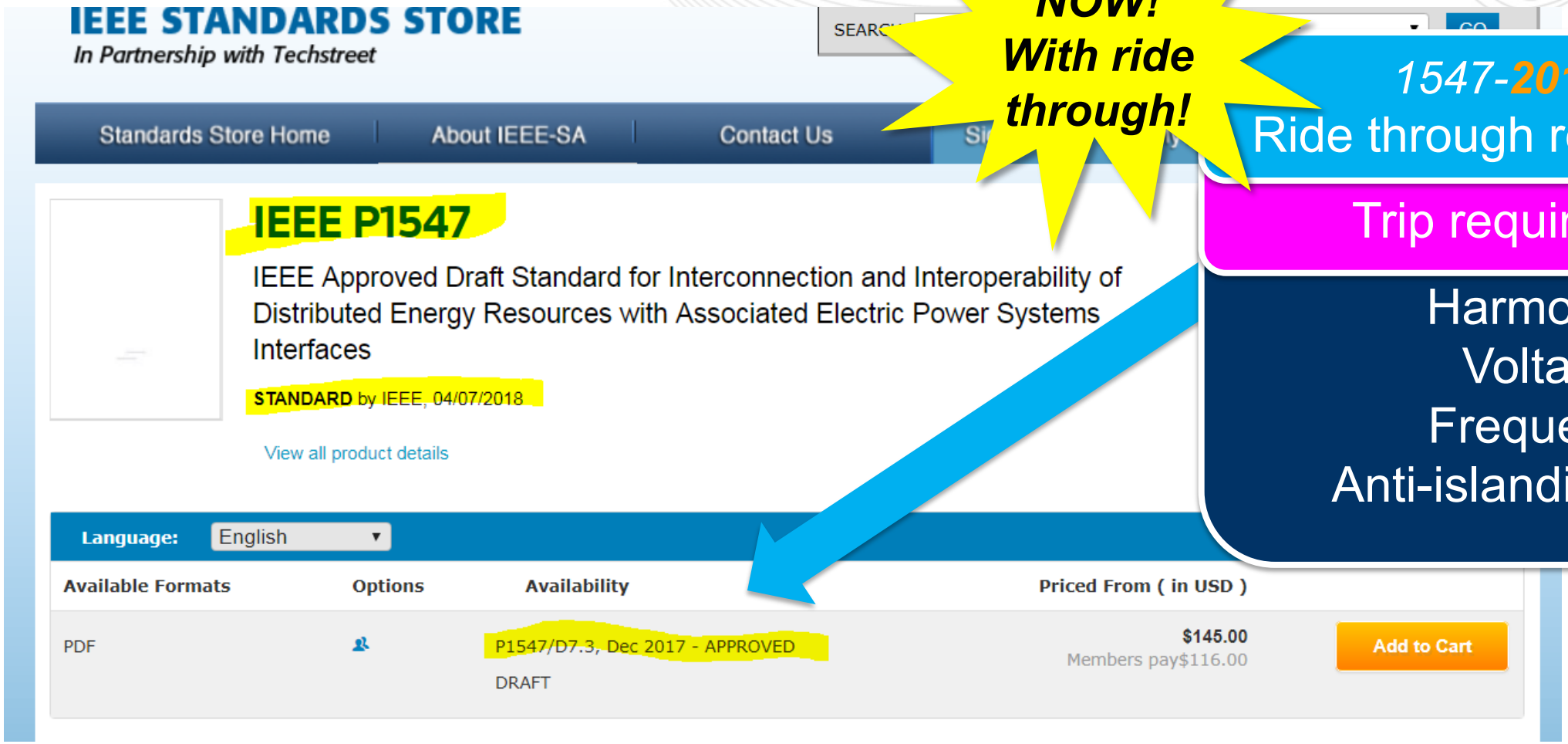
~~1547-2003 ed : Ride through requirements~~

Trip requirements

Harmonics
Voltage
Frequency
Anti-islanding etc…

The current edition of the national standard governing DER behavior does not require ride through.

IEEE 1547-2018 Draft Approved



NOW! With ride through!

1547-2018 ed.:
Ride through requirements

Trip requirements

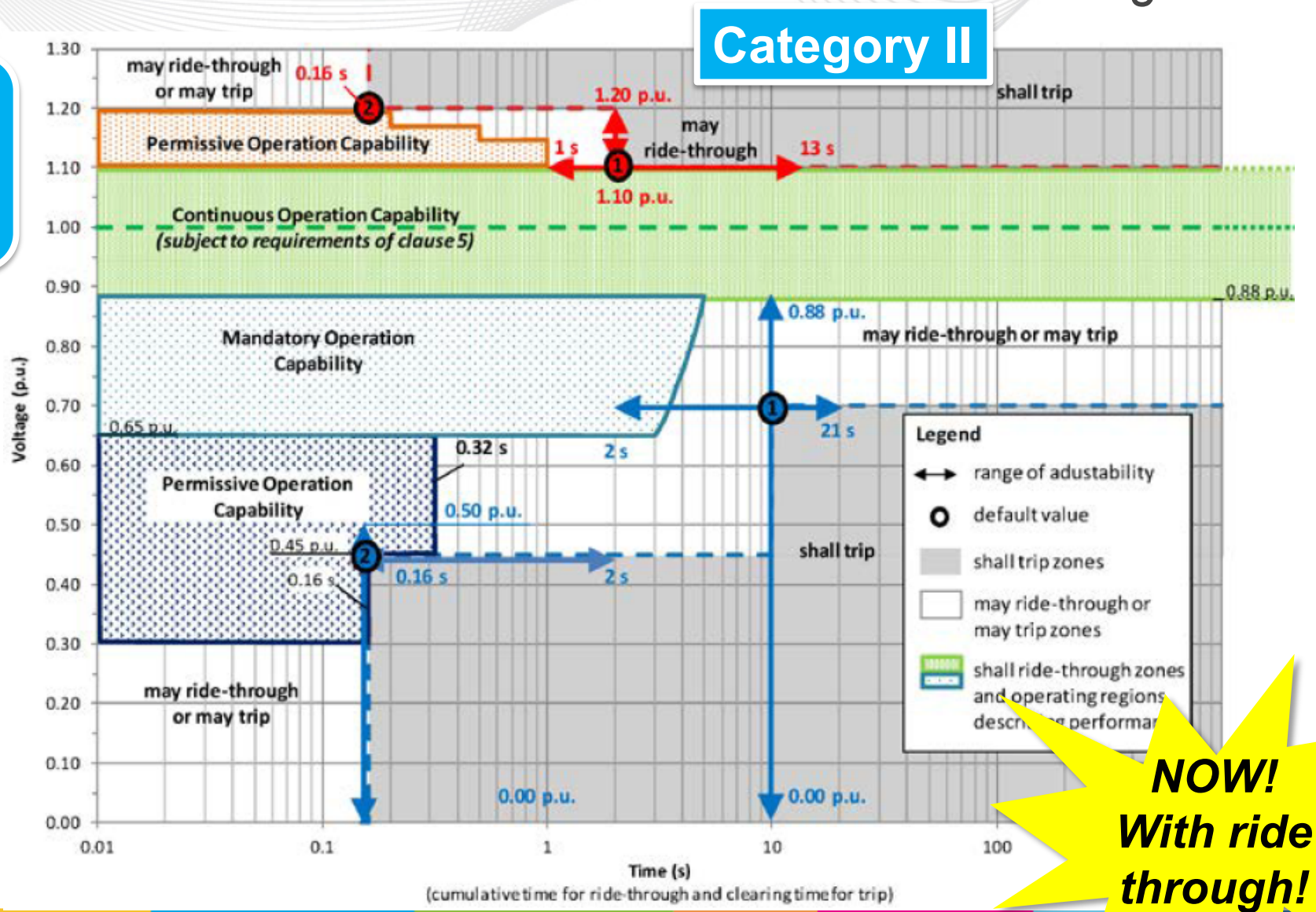
Harmonics
Voltage
Frequency
Anti-islanding etc…

https://www.techstreet.com/ieee/standards/ieee-p1547?gateway_code=ieee&vendor_id=5915&product_id=1983168

Revised 1547-2018 Standard Mandates "Ride Through"

- **3 flavors of "Ride Through"—Category I, II, and III.**

- Default trip settings broadly adjustable.
- Up to Authorities Governing Interconnection Rules (e.g., utilities, local regulators) to specify Category and (optional) modified trip settings



PJM Role in Implementation of New IEEE 1547-2018 Standard

PJM seeks to facilitate regional consistency in 1547-2018 "ride through" for state jurisdictional retail DER.

- Most DER is under local jurisdiction, and PJM has very limited authority.
- In general, the distribution utility is the primary technical/utility stakeholder for establishing DER trip and ride through parameters.
- PJM is available to support and coordinate with distribution utility efforts to establish new requirements based on the revised IEEE 1547-2018.
- PJM recognizes that the revised standard establishes an explicit role for PJM: *"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 Support for Technical Consensus on Requirements

Feb 28: Preliminary trial workshop w/ 4 utilities (T and D)

March: Report out on trial workshop

Summer: Workshop w/ for all PJM utilities (T and D)

2018: Ongoing collaboration

2019: Final Documentation of Consensus Ride Through and Trip Parameters

PJM Rules

Distribution Utility Discussions under Local Regulation

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TECHNICAL APPENDIX

Inverter-Based Resource Webinar Series

DATE and TIME	SESSION	REGISTRATION LINK
Wednesday, March 21 2pm – 4pm EST	Inverter Fundamentals – Distributed Energy Resources (DER) and Bulk Power System (BPS) Connected Resources	join the meeting **1-855-797-9485** 640 232 196
Thursday, April 5 2pm – 4pm EST	Distributed Energy Resource (DER) Impacts	join the meeting **1-855-797-9485** 644 957 932
Wednesday, May 2 2pm – 4pm EST	Inverter-Based Resources Connected to the Bulk Power System	join the meeting **1-855-797-9485** 641 929 120
Thursday, May 17 2pm – 4pm EST	Inverter modeling for protection, harmonics, EMT studies, and review of real-world VER related events	join the meeting **1-855-797-9485** 641 686 608
Wednesday, June 13 2pm – 4pm EST	Recommended Performance for Inverter-Based Resources Connected to the Bulk Power System – NERC Reliability Guideline	join the meeting **1-855-797-9485** 644 506 277

http://www.nerc.com/comm/PC/Documents/Inverter_Based_Resources_Webinar_Series_Flyer-draft_02.05.18.pdf

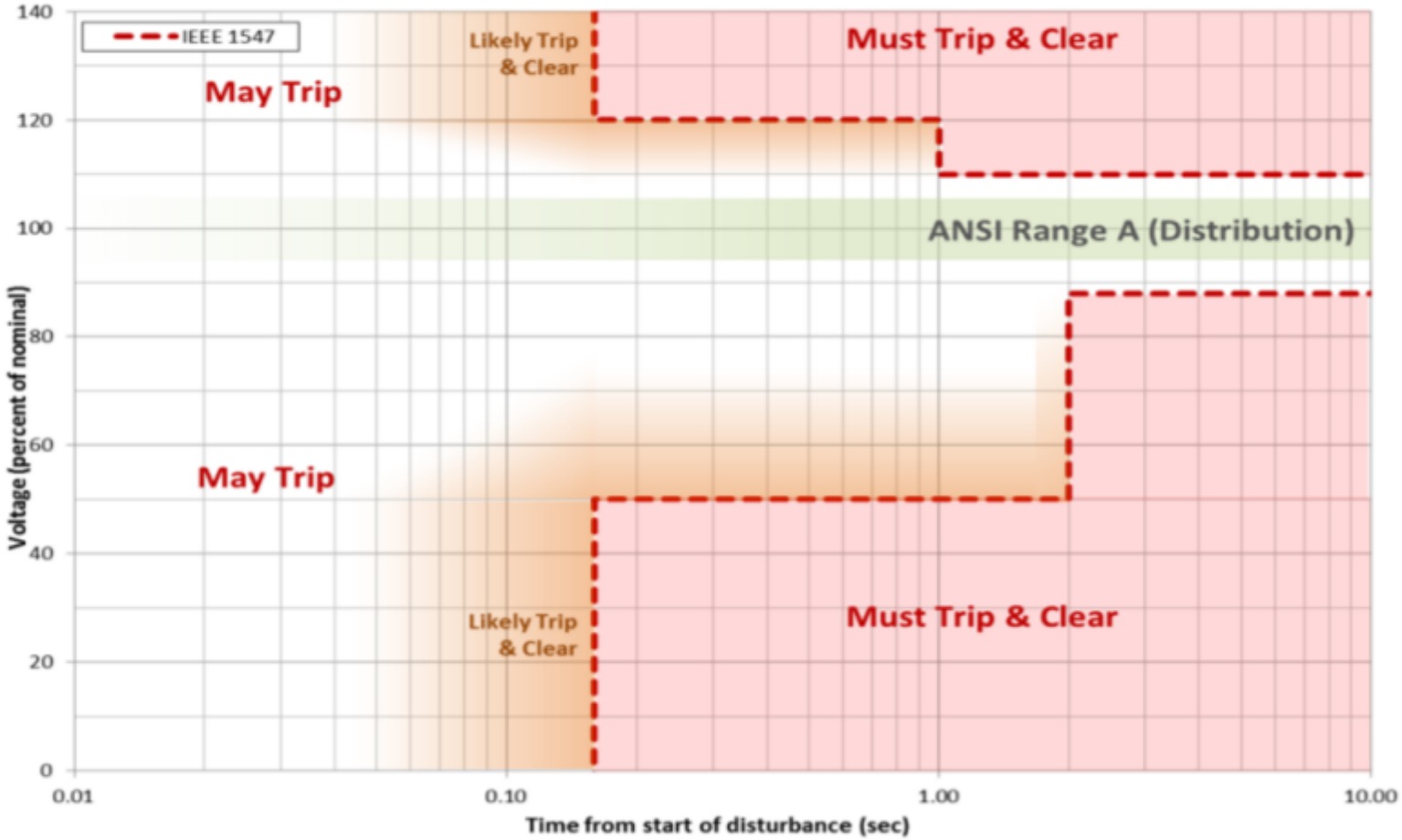
Key DER Integration Topic: “Shall Trip” and “Ride Through”

“Shall Trip”

- Immediately following a grid problem, DER must physically disconnect from the grid.
- ***Purpose***: facilitate and simplify effective distribution system response to grid problems. Simplify safety for lineman “hot work”. Also simplifies controls for certain legacy and other non-inverter DER.

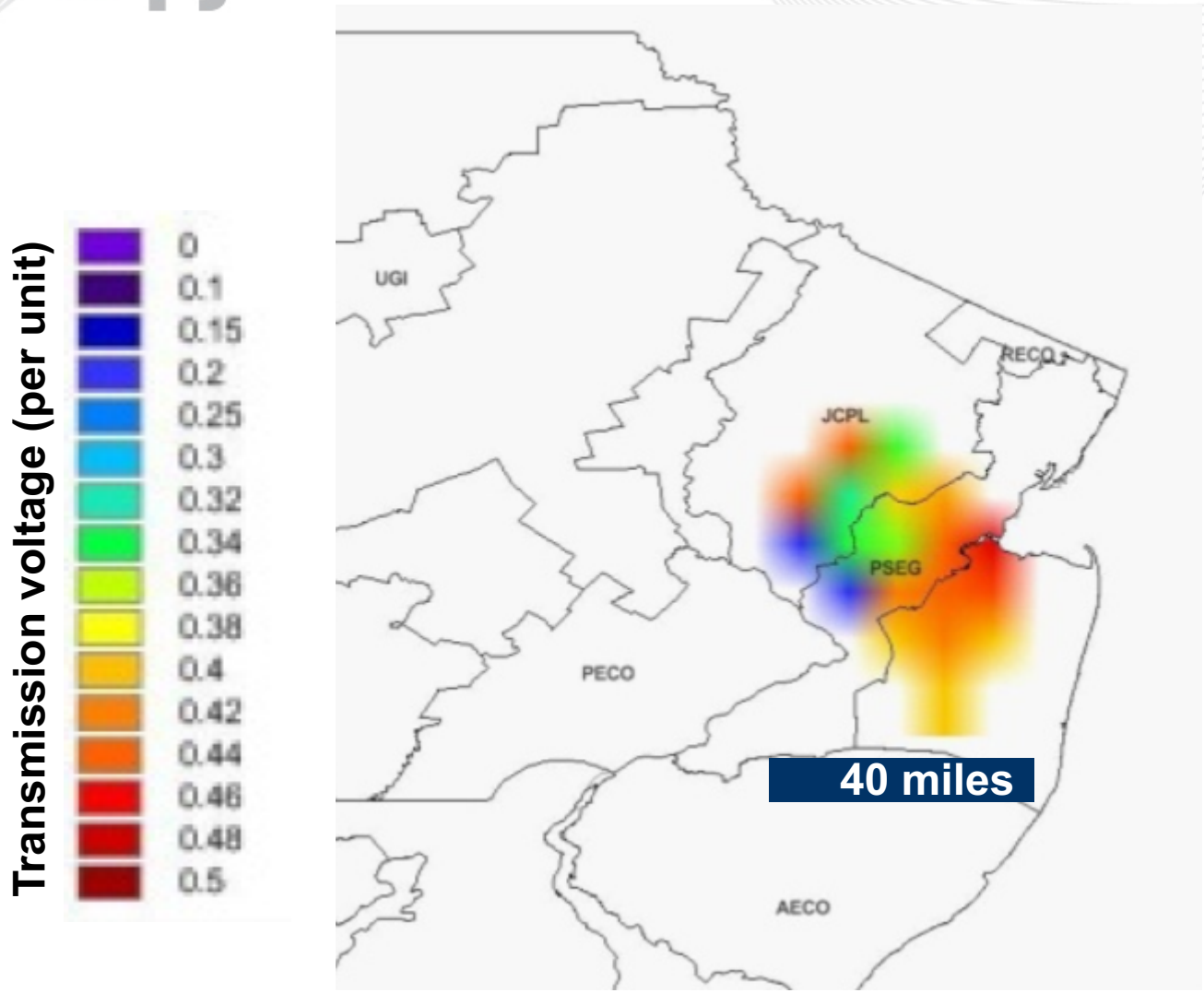
DER and "Shall Trip"

IEEE 1547 Standard Voltage Sensitivity



Source: Draft NERC IVGTF Task 1-7 report

Importance of “Ride Through

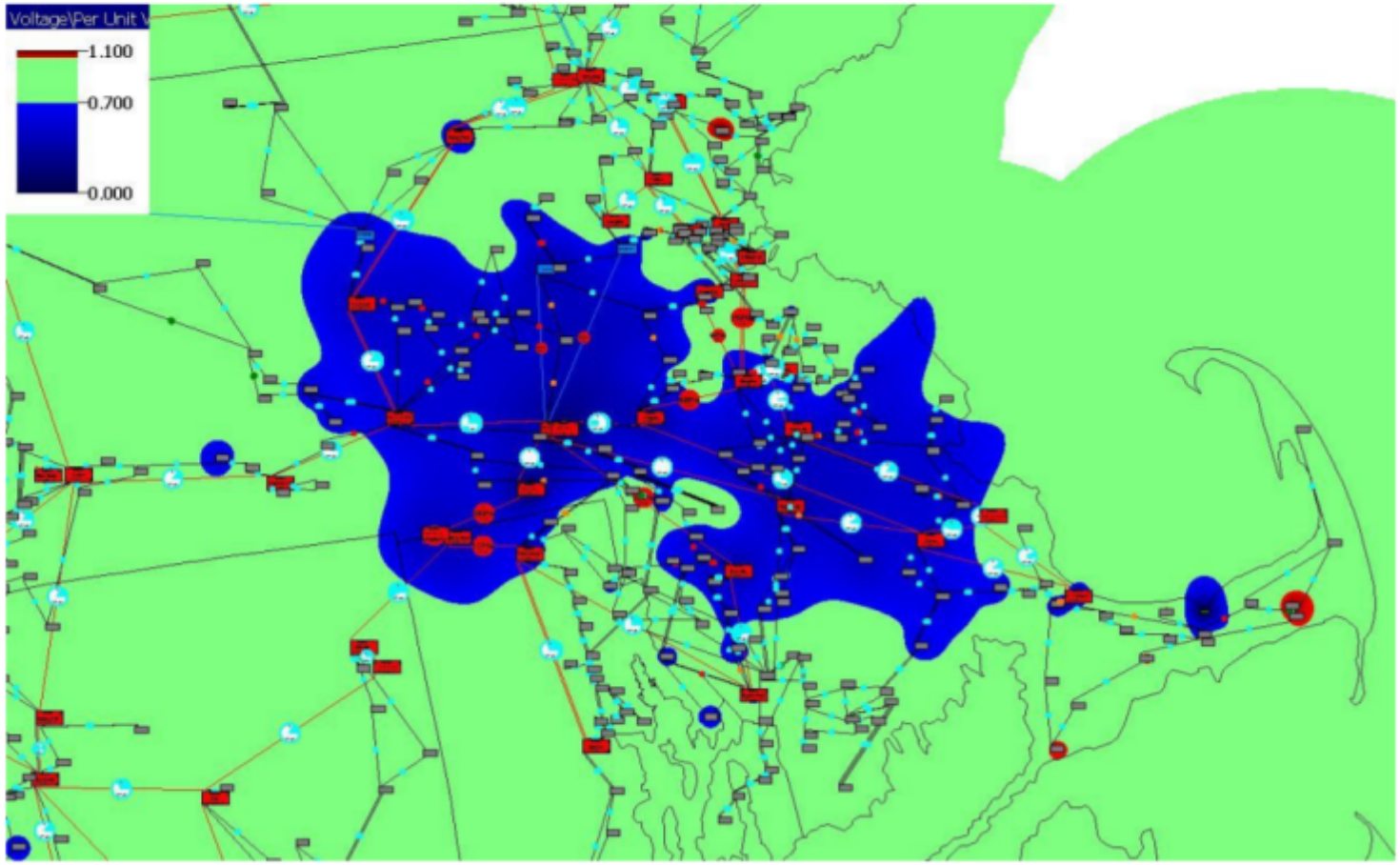


- Generator and line contingencies can cause abnormal conditions, e.g. significantly high or low voltage or frequency.
- “Ride Through” is the capability of a generator to remain connected during abnormal conditions.
- “Ride Through” requirements for large generators are essential for BES reliability.

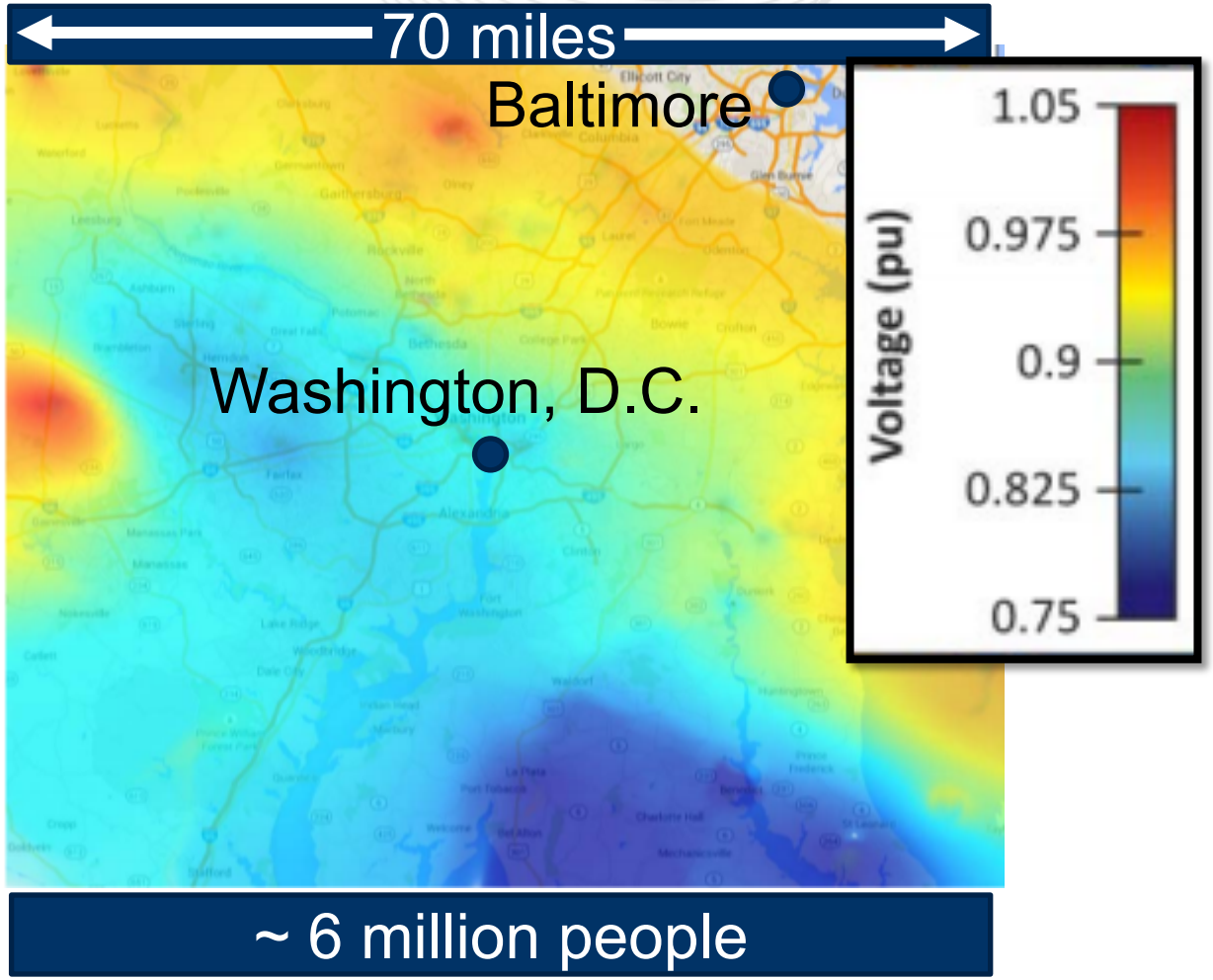
Source: http://www.nerc.com/comm/PC/Integration%20of%20Variable%20Generation%20Task%20Force%20I1/IVGTF17_PC_FinalDraft_December_clean.pdf

Evidence of DER “Shall Trip” Under Transmission Faults: **Modeled Wide Area Undervoltage**

Low Voltage for 345 kV Fault in Massachusetts



Evidence of DER "Shall Trip" Under Transmission Faults:
Actual Wide Area Undervoltage



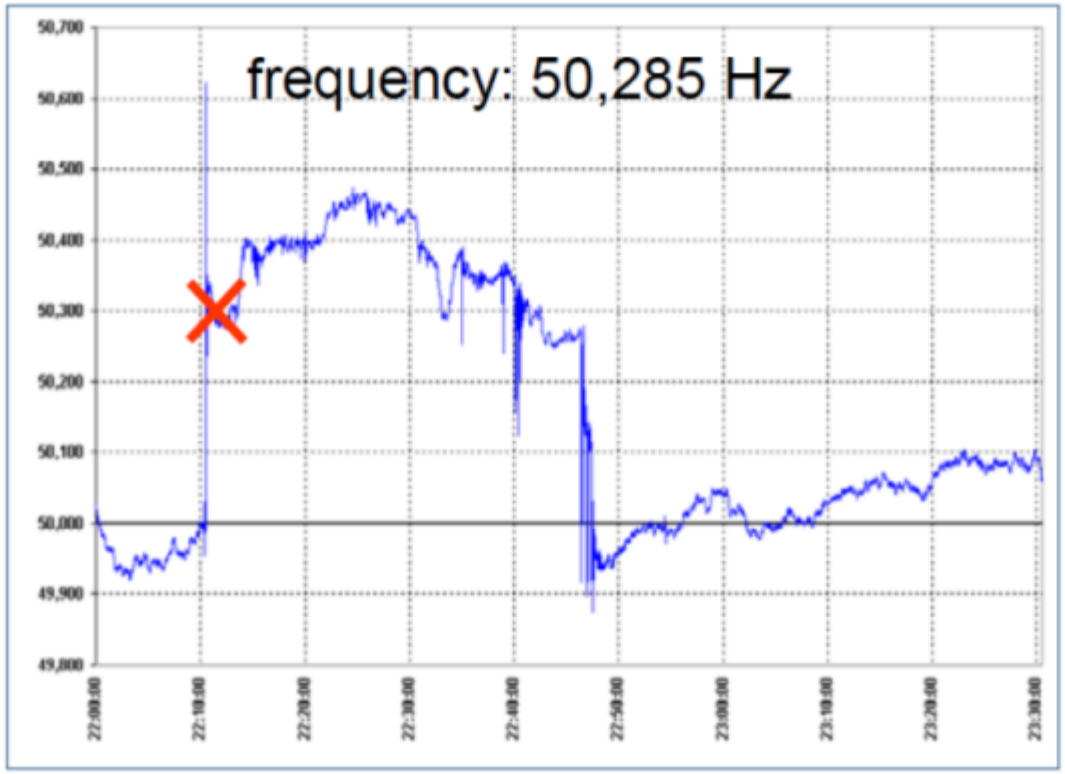
http://www.nerc.com/pa/rrm/April%202015%20Washington%20DC%20Area%20LowVoltage%20Disturban/Washington_DC_Area_Low-Voltage_Disturbance_Event_of_April_7_2015_final.pdf

Evidence of DER "Shall Trip" Under Transmission Faults: **Actual Transmission Clearing Times**

- Normal transmission fault clearing times are 9 cycles = 150 ms
  - Which would not trip a DER with 160 ms "Ride Through" requirement
- However, with failed primary relay, delayed clearing times can range from 300 – 500+ ms
  - Which **would** trip a DER with 160 ms "Shall Trip" requirement
- Moreover, DER can see continued undervoltage during transmission reclosing operations, which could be accumulated for the purposes of trip logic.

Evidence of DER “Shall Trip” Under Transmission Faults: **Actual Overfrequency During Regional Grid Break Up**

Figure 10: High Frequency in Eastern Portion of the UCTE System Following the Nov. 2006 Breakup[23]



Worldwide Evidence Of Need for “Ride Through”

- **South Australia blackout** due (in part) to failure to ride through of consecutive voltage disturbances.
- **Western Interconnection:** frequency problems from trips on errors in ride through control circuits.
- **ERCOT**: Frequency problems due to inadequate ride through of consecutive voltage disturbances.
- **Germany blackout of 2006**: blackout and delayed restoration made worse to due lack of DER ride through.
  $250 million spent to retrofit >300,000 solar units.

CONCLUSION: “RIDE THROUGH” is critical (in addition to “SHALL TRIP”)

Key DER Integration Topic: "Shall Trip" and "Ride Through"

"Shall Trip"

- Immediately following a grid problem, DER must physically disconnect from the grid.
- ***Purpose***: facilitate and simplify effective distribution system response to grid problems. Also simplifies controls for certain legacy and other non-inverter DER.

"Shall Ride Through"

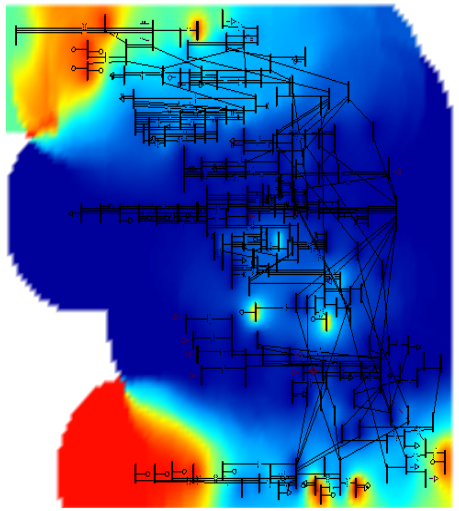
- Immediately following a grid problem, DER must continue to supply the grid. DER must NOT disconnect from the grid.
- ***Purpose***: avoid regional stability problems due to loss of large numbers of DER.

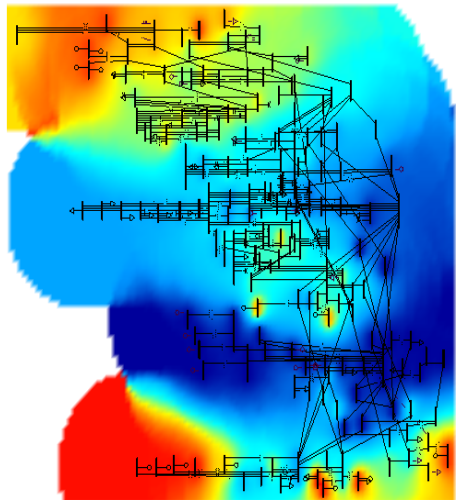
Under high DER deployment, both "Shall Trip" and "Shall Ride Through" are important!

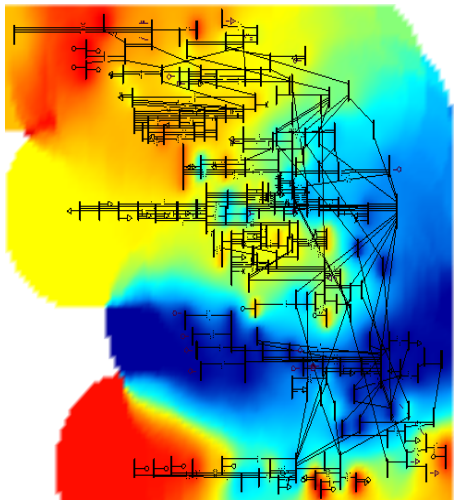
PJM Simulation of Benefit From Ride Through

	Many DER Ride Through: OFF	No DER	Many DER Ride Through: ON
LOAD AT RISK FROM GRID EVENT	***2,600 MW***	***1,600 MW***	***750 MW***

← *Grid event worsened* — *Grid event improved* →







Blue, teal, and green are abnormally low voltage, which puts load at risk.