

PV Interconnection Issues



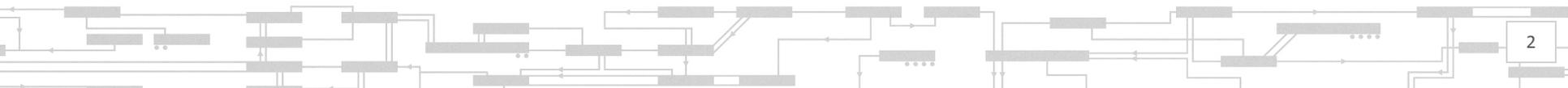
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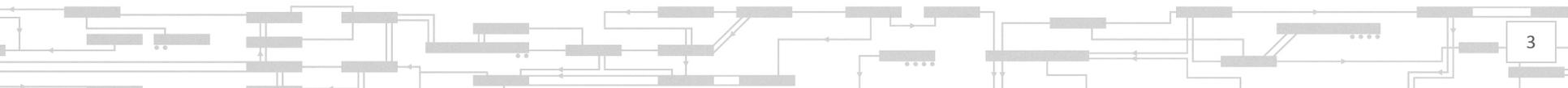
Background

- Distributed Energy Resources (DER) are now poised to reach significant levels in the region. Based on a review of current state policies and goals, a total of approximately 2,400 MW of DER is now anticipated in the region by 2024
- Most DER are anticipated to be solar PV that is inverter-interfaced
- ISO has been working to revise the interconnection requirements for DER to enable their deployment without compromising the reliability of the New England transmission system
- ISO believes that interconnection requirements can be established that satisfy the goals of both Transmission and Distribution systems



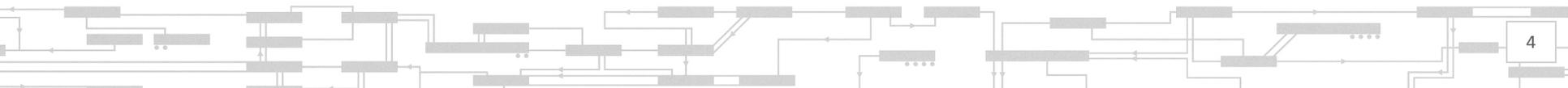
Background

- There are several key issues associated with DER that ISO believes need to be addressed in the short term:
 - Voltage Ride-through
 - Frequency Ride-through
 - Voltage Support
 - Ramp rates
 - Soft-Start Capability
- All of these functionalities could be provided by existing inverter technology in an autonomous manner
- I will provide an update these issues today



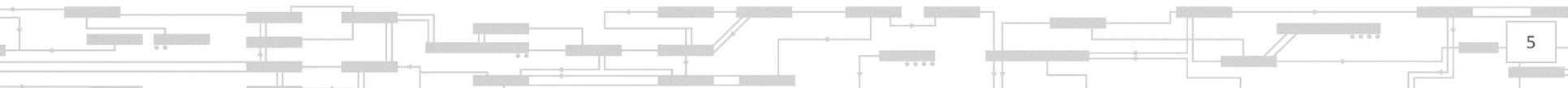
IEEE Interconnection Standards

- State jurisdictional interconnection standards for DER are generally consistent with IEEE Standard 1547-2003
- A revision to IEEE 1547-2003 has been approved and is entitled IEEE 1547a
- IEEE 1547a revises the requirements for responding to voltage and frequency excursions and allows DG resources to regulate voltage if the interconnecting utility approves this mode of operation



Voltage Ride-Through IEEE 1547-2003

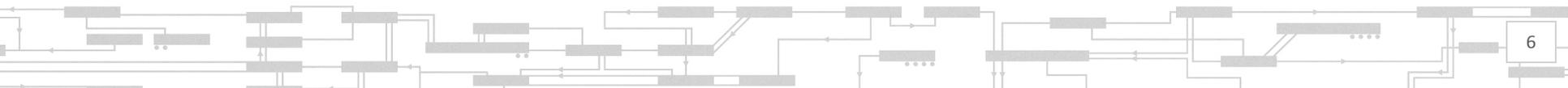
Voltage Range in percent of the nominal voltage at the point of common coupling	Maximum Clearing Times
$V < 50$	0.16 seconds
$50 \leq V \leq 88$	2.00 seconds



Voltage Ride-Through - IEEE 1547a

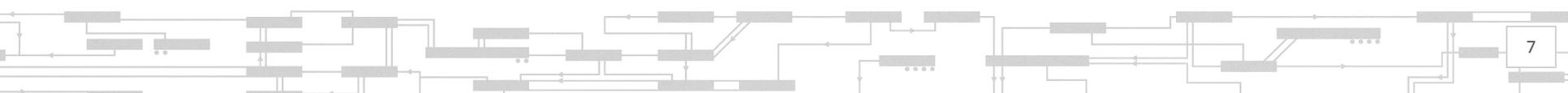
Voltage Range in percent of the nominal voltage at the point of common coupling	Default Clearing Time in seconds	Clearing Time Range in seconds
$V < 45$	0.16	0.16
$45 \leq V \leq 60$	1	1-11
$60 \leq V \leq 88$	2	2-21

Under mutual agreement between the Electric Power System and Distributed Energy Resource operators, other static or dynamic voltage and clearing time trip settings shall be permitted



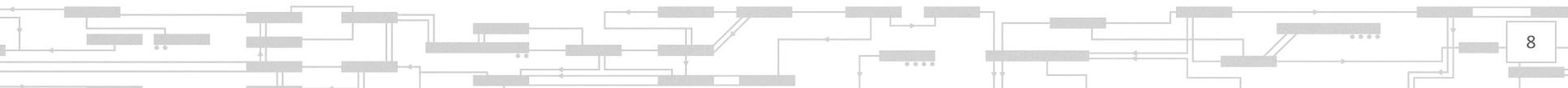
Voltage Ride Through-ISO recommendation is to establish a minimum time for inverter-based generation to stay connected after IEEE 1547 is revised. Until then use 1547a

Voltage Range in percent of the nominal voltage at the point of common coupling	Stay Connected Until (in seconds)
$V < 45$	1
$45 \leq V \leq 60$	1
$60 \leq V \leq 88$	2



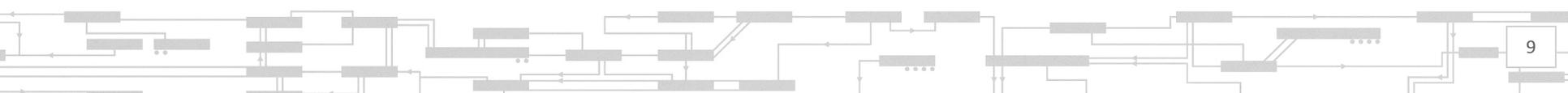
Under Frequency Tripping

- The IEEE 1547a addresses under frequency ride-through requirements
- ISO proposes that the NPCC frequency ride-through requirements be used for DER in New England



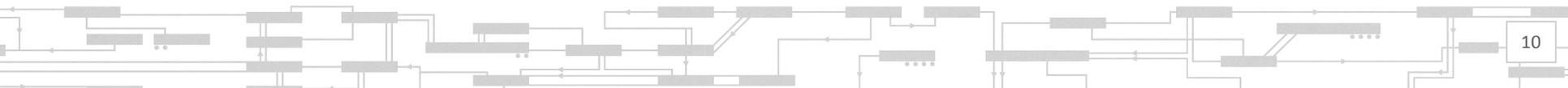
Under Frequency Tripping - IEEE 1547a

Function	Frequency (Hz)	Clearing Time in Seconds	Frequency Range (Hz)	Clearing Time up adjustable up to and including (in Seconds)
UF1	57	0.16	56-60	10
UF2	59.5	0.16	56-60	300
OF1	60.5	2	60-64	300
OF2	62	0.16	60-64	10



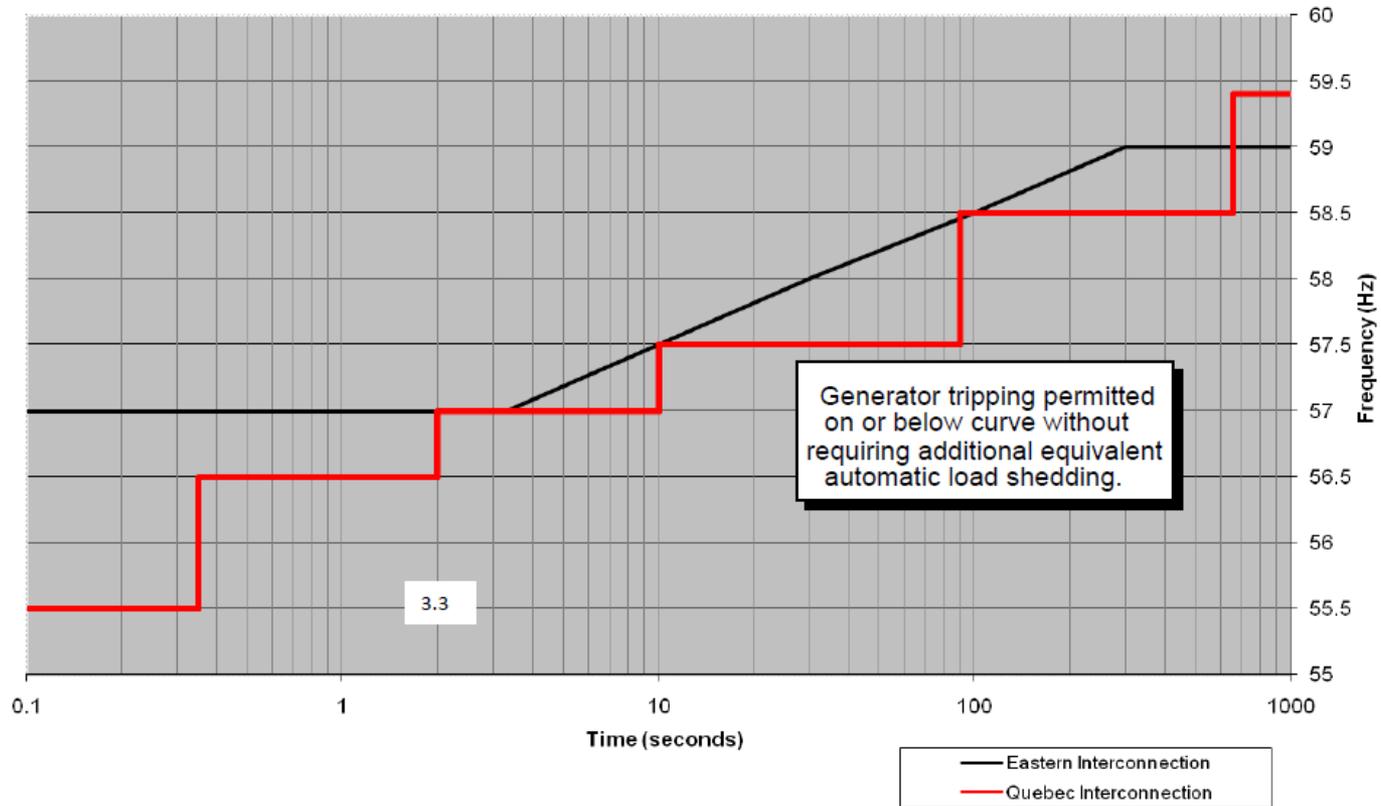
Under Frequency Tripping - NPCC

- NERC includes the requirements for generators to ride through frequency excursions in its standard PRC-006-NPCC-1
- NERC requirements are to only allow tripping below the curve on the next page (See R13)
- ISO recommends that DER have under frequency tripping settings that satisfy NPCC requirements



Under Frequency Tripping - NPCC

Figure 1
Standards for setting underfrequency trip protection for generators



Questions

