The Revised IEEE1547 standard

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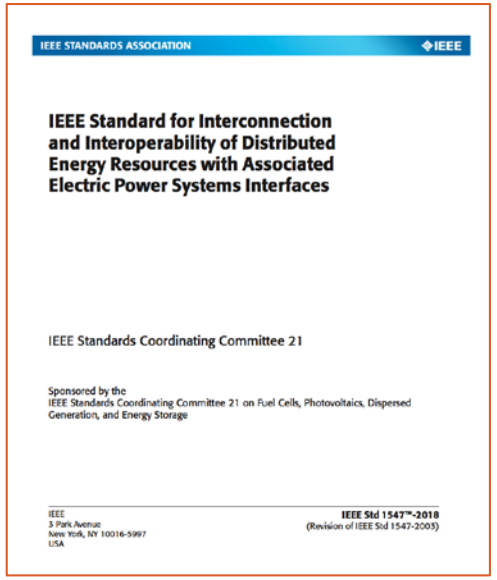
What is IEEE1547?

- A Technical standard for the functional and performance requirements of the Distributed Energy Resources (DER) Interconnections with the Electric Power System
- Document of mandatory and uniform requirements at either the Point of Common Coupling or the DER output terminals
- System Protection and Reliability
  - Interoperability
  - Verification & testing

The IEEE 1547 Interconnection Standard has been revised

IEEE 1547-2003

- A traditional DER paradigm
- DER is passive
- DER provides only energy
- Owners are incentivized to provide as much energy as they can
- No communications
- No control



IEEE 1547-2018

- Smart inverter capabilities so that DER can act like conventional, transmission-connected resources
- DER may now be active
- Two-way communication capabilities required
- Can control power output and provide ancillary services
- Supports bulk system reliability

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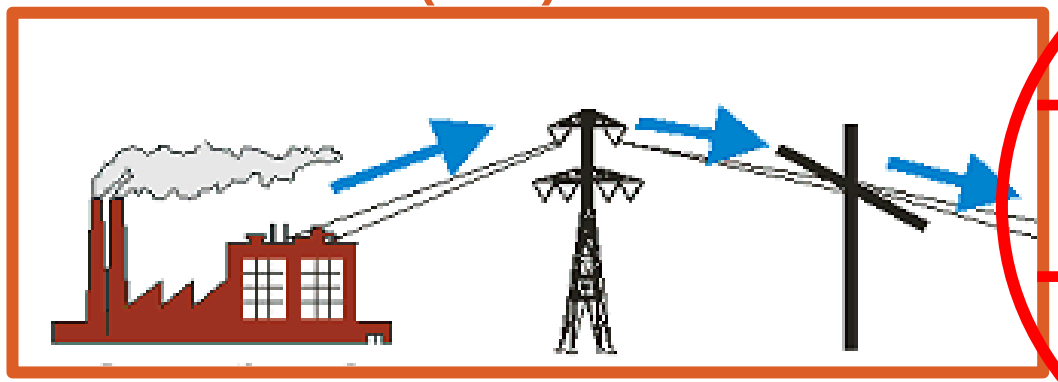
Why IEEE1547?

- Utility has the responsibility to manage the grid
- Prevent Anti Islanding
- Prevent damage to customer equipment
- Prevent Grid mis-operation and maintain reliability
- Enable functions of the DER

What does IEEE 1547-2018 cover?

Area Electrical Power System (EPS)



1547

Power interface

Communication interface

Distributed Energy Resource (DER) – connected to distribution system

Specifies performance of interconnection, not design

Specifies capabilities, not necessarily utilization of capability

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What does IEEE 1547-2018 not cover?

- Upgrades to the grid to support the DER (loading, etc)
- Transfer trip and other protection required to integrate the DER

Risks of not doing

- Misoperation of the Grid, resulting in outages
- Misoperation of the DER
- Power Quality disturbances
- Damage to customer equipment
- Bulk System Stability
- Costly subsequent upgrades!

What can DER do under the new standard?

Capabilities under IEEE 1547-2018

- Two-way communications: visibility and control
- Control reactive power: voltage regulation
- Control active power: curtail
- Frequency response: increase power if low frequency. Decrease power if high frequency
- Regulation reserves
- Spinning and non-spinning reserves

Comparison of Existing Standards, State / PUC Rules, and Listing / Certification Standards for Distributed Energy Resources

		Interconnection Standards			State/ PUC Rules		Listing/ Certification		
Function set	Advanced Functions Capability	IEEE 1547-2003	IEEE 1547a-2014	IEEE 1547 - 2018*	CA Rule 21 - 2015	HI Rule 14H - 2015	UL 1741	UL 1741(SA) 2016	IEEE 1547.1-201?*
Static	Adjustable Trip Settings		√	‡					Δ
Controlling	Active Power Curtailment			‡					Δ
	Disable Permit Service (Remote Shut-Off)			‡					Δ
	Ramp Rate Control			‡					Δ
Freq. Support	L/H Frequency Ride-Through			‡	‡				Δ
	ROCOF Ride-Through			‡					Δ
	Frequency-Watt	X	√	‡		‡		Δ	Δ
Voltage Support	L/H Voltage Ride-Through (L/H VRT)			‡	‡	‡		Δ	Δ
	Dynamic Voltage Support during L/H VRT			√					
	Voltage Phase Angle Jump Ride-Through			‡					Δ
	Fixed Power Factor	√	√	‡	‡	‡	√	Δ	Δ
	Fixed Reactive Power	√	√	‡			√		Δ
	Volt-Var	X	√	‡	‡	‡		Δ	Δ
	Volt-Watt	X	√	‡		‡		Δ	Δ
	Watt-Var	X		‡					Δ

IEEE Std 1547-2018 is most comprehensive and makes all capabilities mandatory

Testing / Verification is as important as the requirements

** Final requirements not confirmed.*

Legend: **X Prohibited, √ Allowed by Mutual Agreement, ‡ Capability Required, Δ Test and Verification Defined**

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NORMAL AND ABNORMAL PERFORMANCE CATEGORIES

NORMAL VS ABNORMAL SYSTEM CONDITIONS

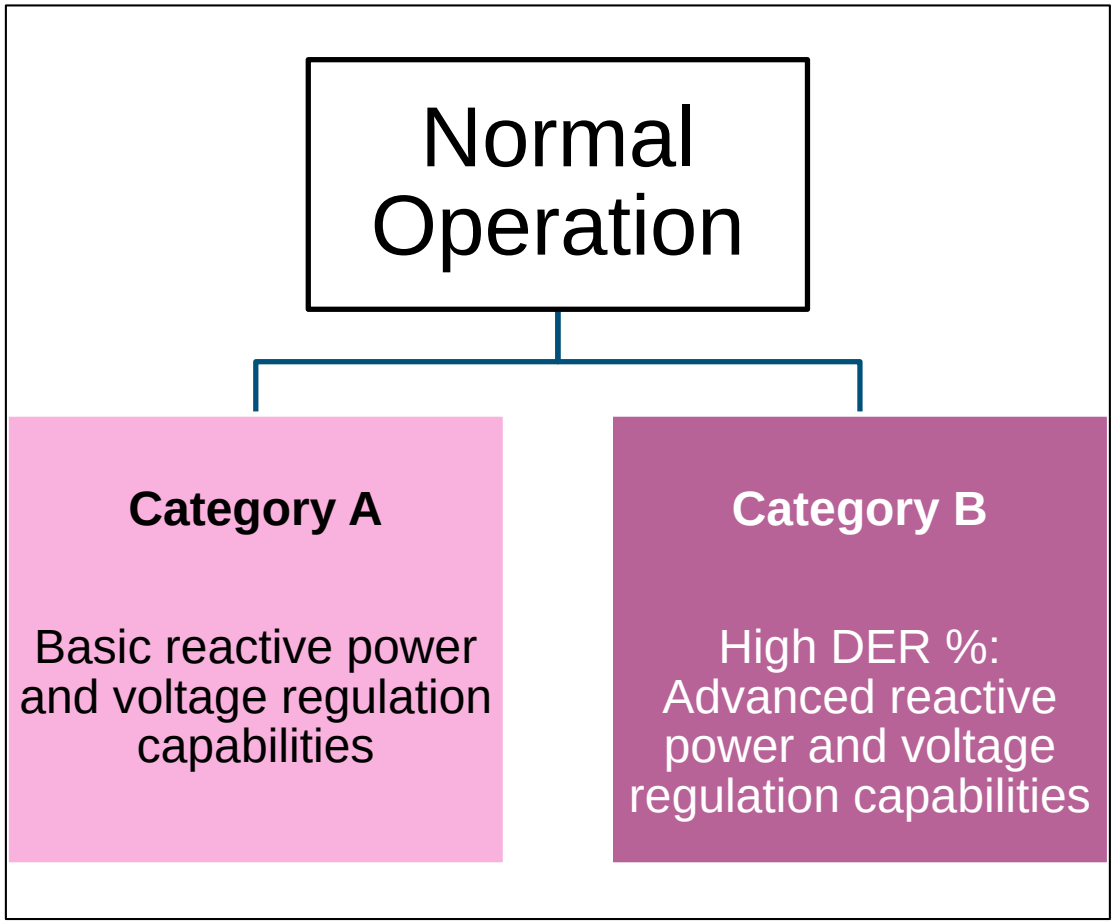
Normal system conditions

- Voltage regulation (88%<V<110%)- reduce the adverse impact on utility asset's lifecycle

Abnormal system conditions

- Ride through- Non steady state faulted or disturbed bulk system- avoid blackouts

Performance categories for Normal Operation
Reactive power and voltage regulation



- Voltage affects the *local* distribution grid and customers
- Can affect costs (e.g., inverter sizing) and benefits (active power output)

Considerations:

- Assign technology-specific normal DER performance categories (e.g., Cat. B for inverters)
- Activate certain functions and specify ‘preferred’ functional settings for a region (e.g., how aggressively the DER tries to manage voltage)

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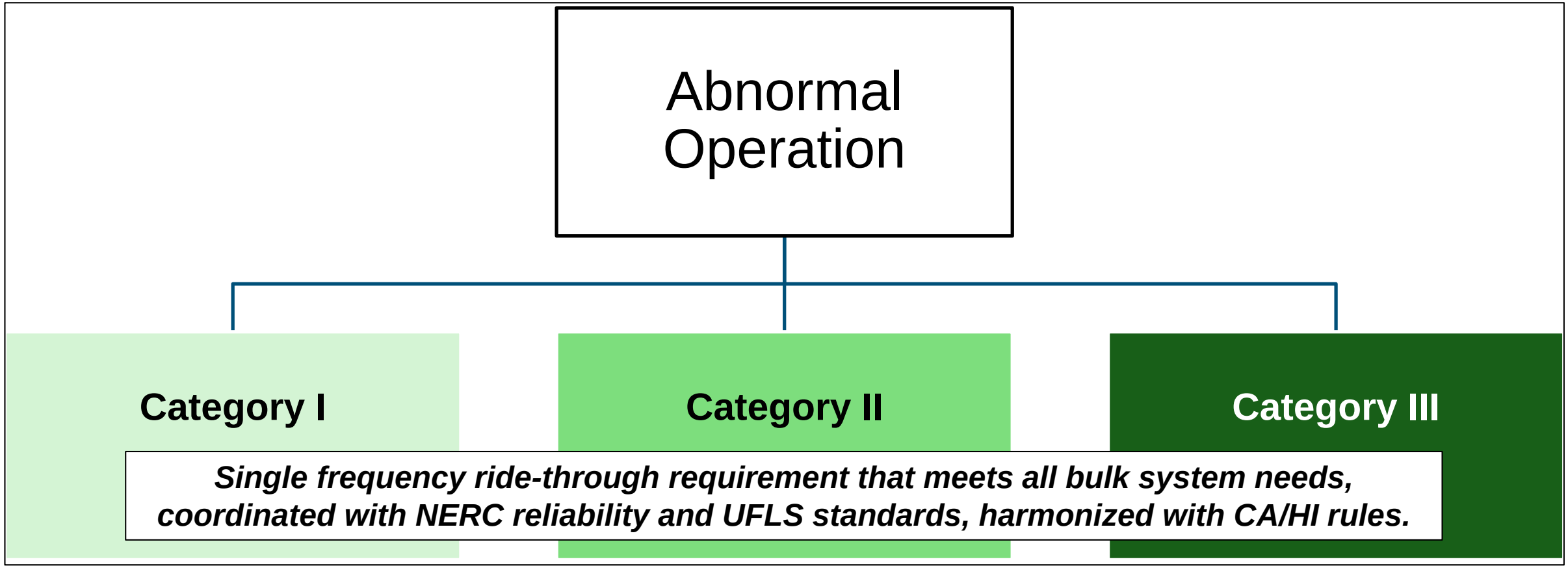
Performance categories for Abnormal Operation

Frequency ride-through



Challenge: Coordination with unintentional islanding prevention

Performance categories for Abnormal Operation

Voltage ride-through

Decision criteria:

- Technology limitations
- Benefits & costs
- Expected regional DER penetration / bulk system modeling

Abnormal Operation

[1] fault-induced delayed voltage recovery, e.g., caused by single-phase air-conditioning systems.

Category I

Essential voltage ride-through capabilities

All state-of-art DER technologies can meet this

Category II

DER voltage ride-through for all bulk system needs

Consideration of FIDVR[1]

Category III

Bulk + distribution grid needs

Coordinated with CA/HI rules

Adjustable trip ranges limited

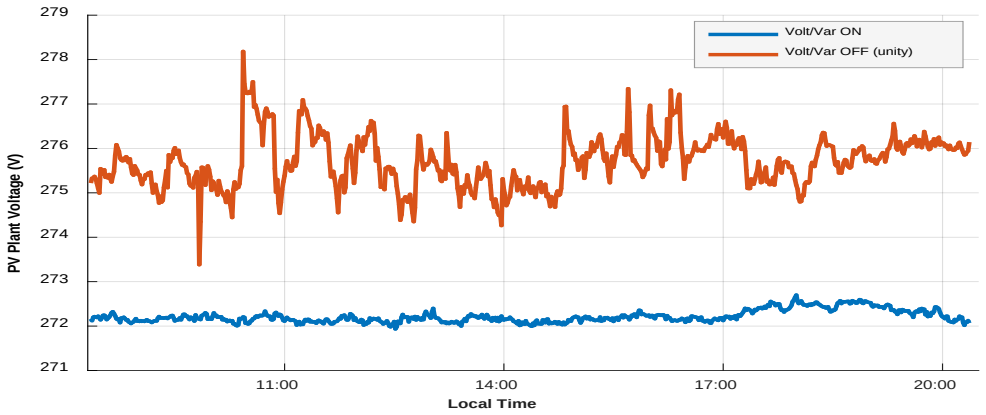
Challenge: Coordination with utility reclosing practices

You may need to coordinate functional settings between distribution and transmission utilities

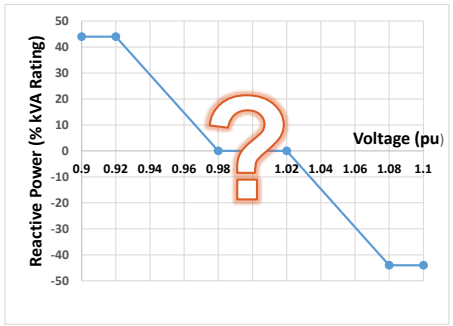
FUNCTIONAL SETTINGS, RANGES OF ALLOWABLE SETTINGS, AND DEFAULT VALUES

What are ranges of allowable settings?

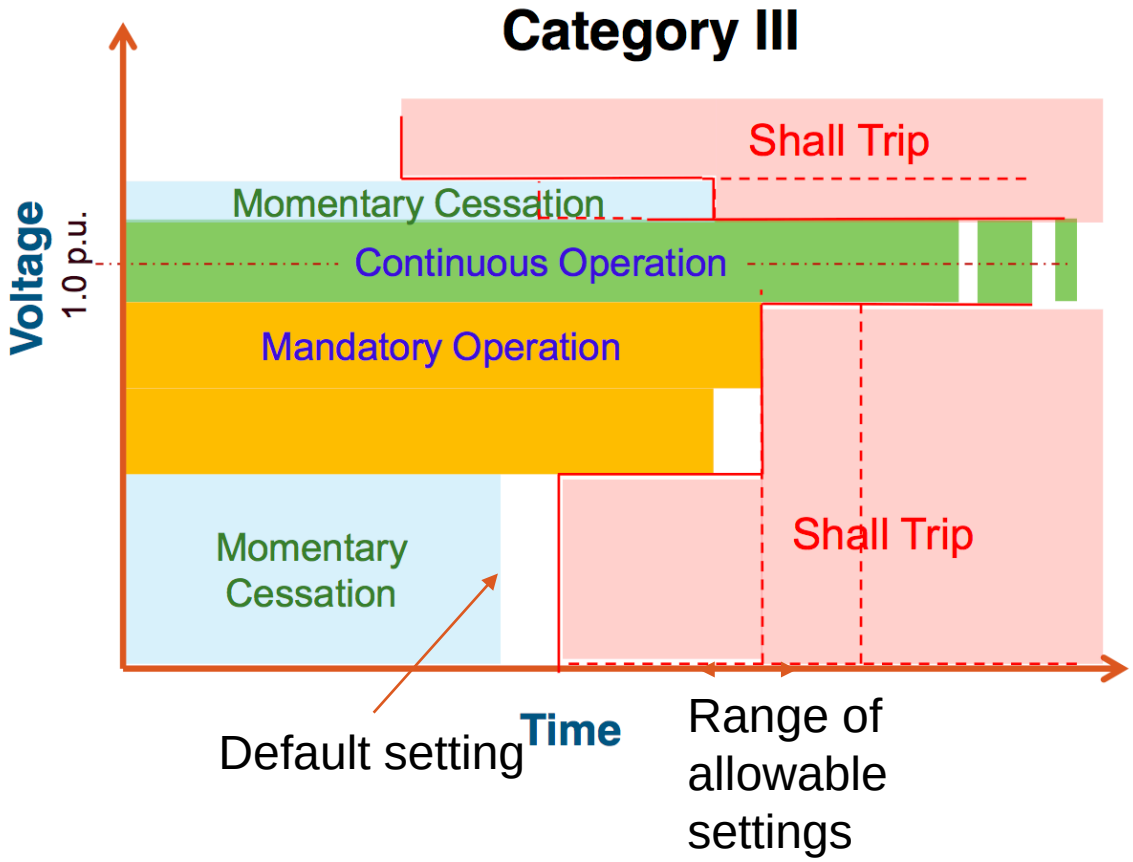
Voltage Reactive-Power Control Settings



- addressing voltage issues with exchange of reactive power.
- may require feeder-specific settings.



Voltage / Frequency Trip Settings



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Thank you

Questions?

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