Applying IEEE Std 1547-2018: What Public Utilities Commissions Need To Decide and Do

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Road Map to Unplug Benefits of “Advanced DERs”

1. Decide on DER capabilities (i.e., adopt IEEE Std 1547-2018)

2. Update interconnection procedures & screenings

3. Deploy communication infrastructure

4. Integrate DERs into grid operations and markets

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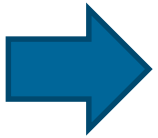
   - Specify ‘preferred settings’ for autonomous functions.



this 1547 panel session

T + D

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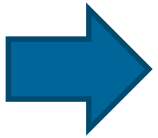

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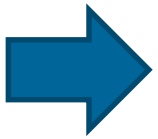
   - Criteria for “fast track”, new supplemental screens.
   - Utilization of autonomous functions: activate certain functions and determine ‘custom settings’.



maximize DER hosting capacity

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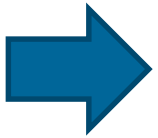

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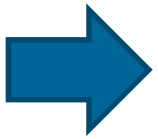

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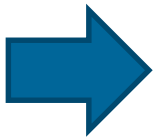
   - Determine when it is time to integrate DER via communications.
   - Select communication networks and architecture.



make the system flexible

T + D

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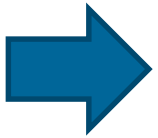

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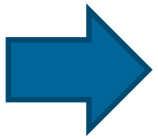

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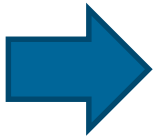

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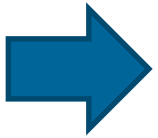
4. Integrate DERs into grid operations and markets
   - Clarify compensation and market rules.
   - Utilization of communication-based functions.



Coordination of T & D fcts/ objectives)

T + D

What you need to decide and do

1. When does this voluntary IEEE standard apply to you?

- *How are your interconnection requirements specified and do they need to be revised?*
- *Do you want to take advantage of advanced capabilities of new DERs going forward?*
- *How many DERs may be installed prior to you adopting the new standard?*

What you need to decide and do

1. When does this voluntary IEEE standard apply to you?
2. Form a stakeholder process! A single voice cannot make these decisions because various stakeholders are affected.

- *Distribution Utilities (Area Electric Power System Operators)*
- *Regulators (Authorities Governing Interconnection Requirements, AGIRs)*
- *DER owners/developers*
- *RTOs/ISOs (Regional Reliability Coordinator)*
- *May need input from DER vendors/equipment manufacturers*

What you need to decide and do

1. When does this voluntary IEEE standard apply to you?
2. Form a stakeholder process! A single voice cannot make these decisions because various stakeholders are affected.
3. Collaboratively determine what performance/functional capability is needed from DERs? Determine ‘preferred settings’ for autonomous functions. Determine DER communication protocol(s).

E.g., for “high” DER penetrations:

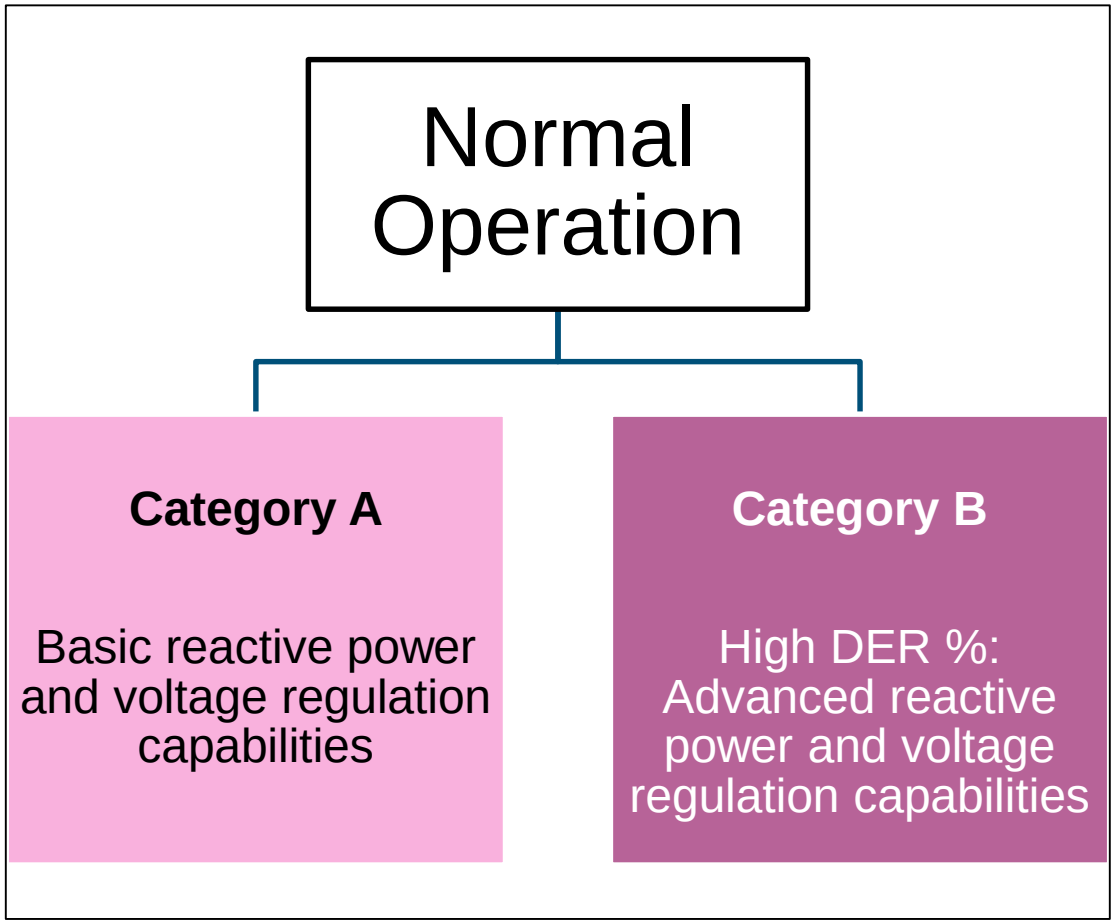
- *Reliability coordinators may want DER to reliably ride through voltage/frequency disturbances*
- *Utilities and/or DER owners may want voltage regulation (so more DER can be packed onto a feeder)*
- *Utilities may want visibility/control (communications)*
- *DER owners may want to sell more than energy*

You need to decide how *stringent* requirements should be for different resources

Normal and Abnormal Performance Categories

Performance categories for Normal Operation

Reactive power and voltage regulation



Regulators (AGIRs) need to work with:

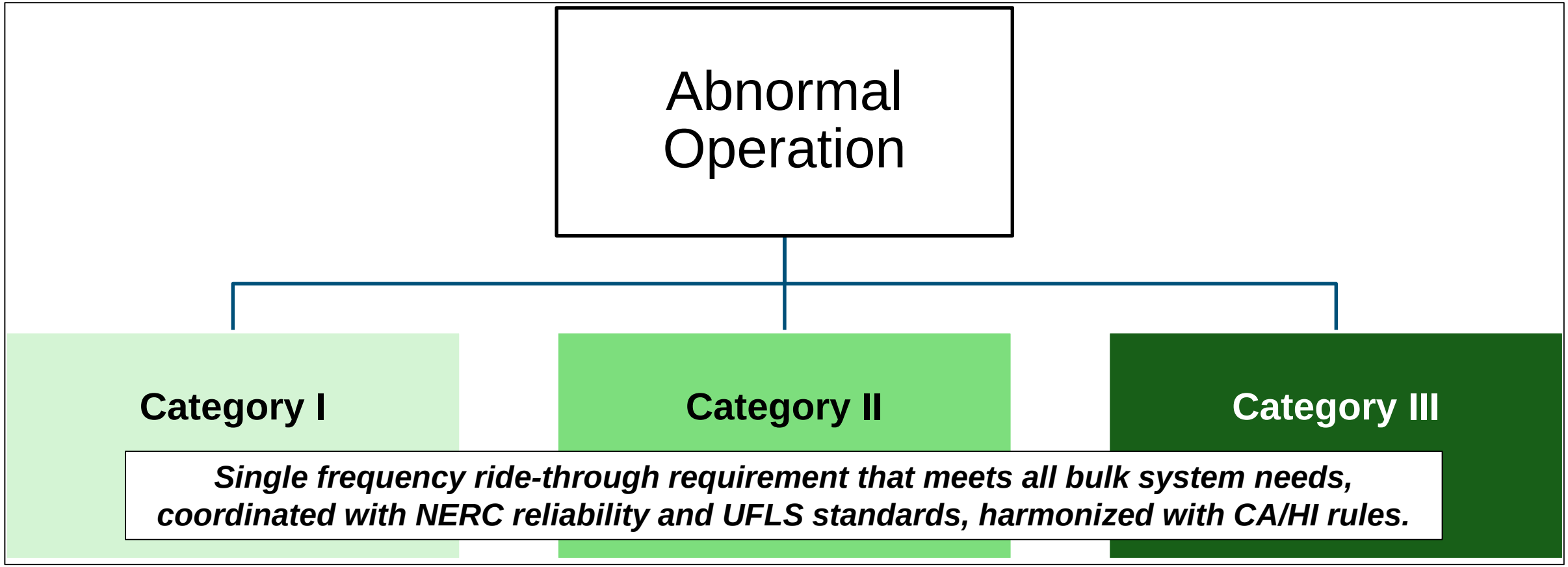
- Distribution utilities, because voltage affects the *local* distribution grid
- DER owners/developers, because this can affect costs (e.g., inverter sizing) and benefits (active power output)

Decisions to be made:

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

Performance categories for Abnormal Operation

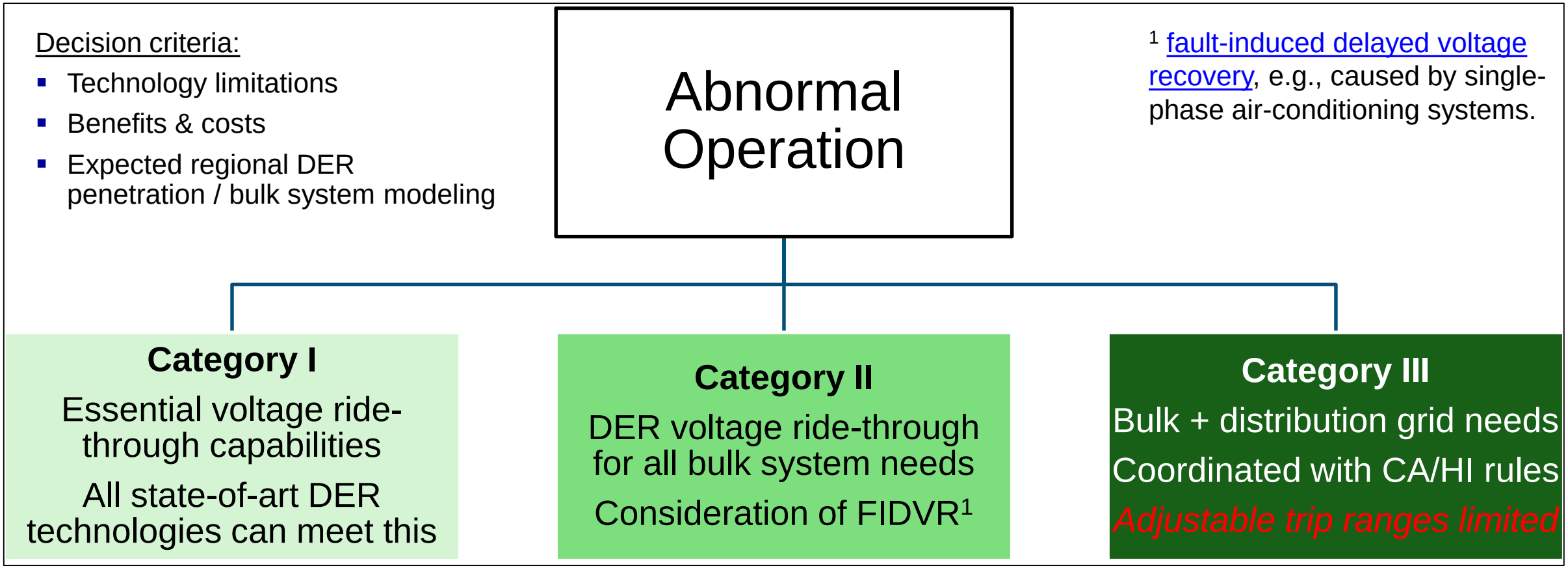
Frequency ride-through



Challenge: Coordination with unintentional islanding prevention

Performance categories for Abnormal Operation

Voltage ride-through



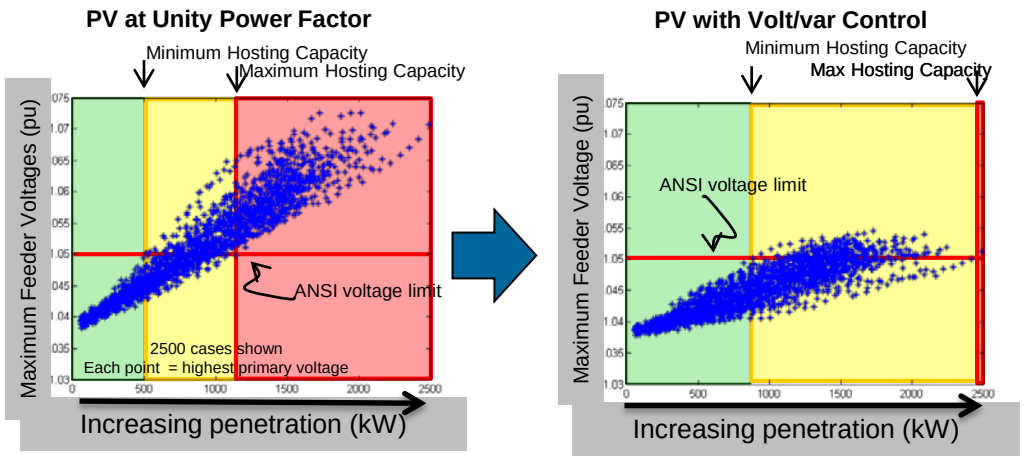
Challenge: Coordination with utility reclosing practices

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

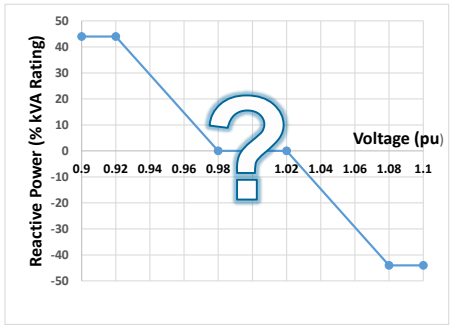
Functional settings, ranges of allowable settings, and default values

What are ranges of allowable settings?

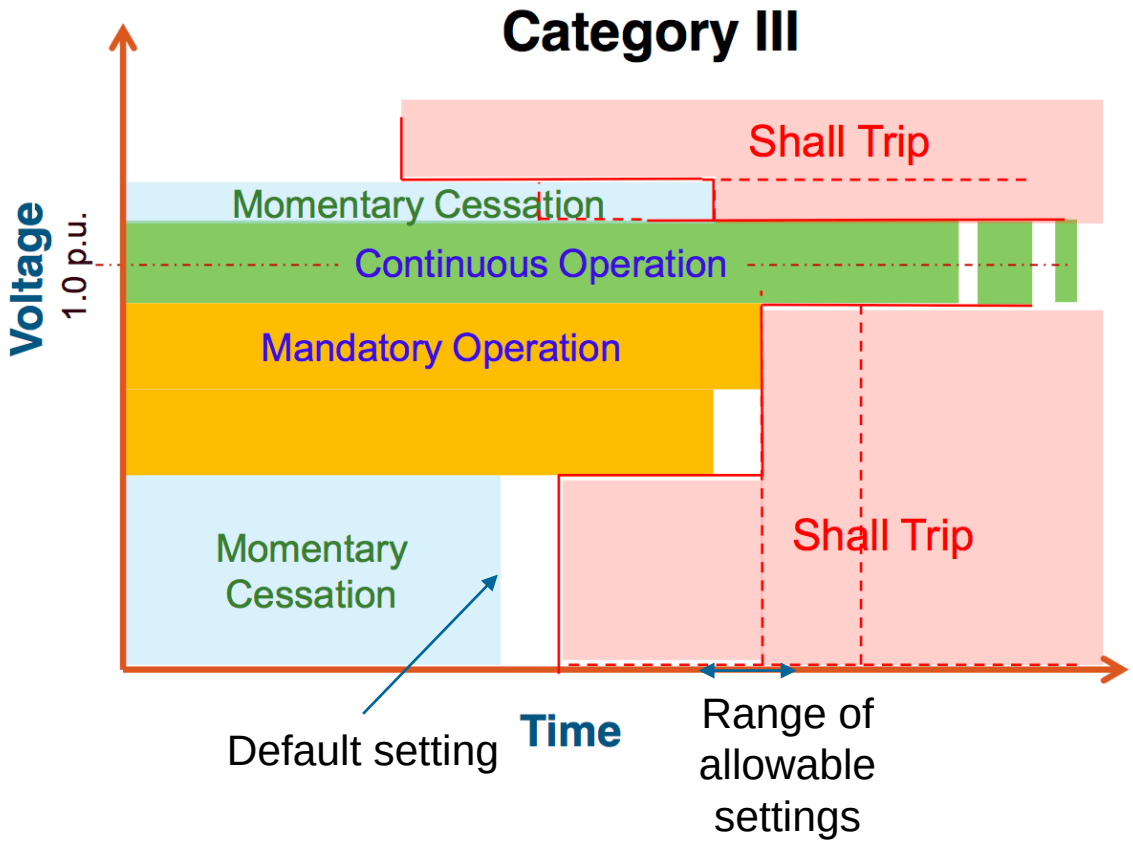
Voltage Reactive-Power Control Settings



- **Increase hosting capacity**
  - by addressing voltage issues with exchange of reactive power.
  - may require feeder-specific settings.



Voltage/Frequency Trip Settings



Leading practices

Leading examples in application of IEEE Std 1547-2018 and moving forward…

Leading examples in application of IEEE Std 1547-2018

Massachusetts

- In early 2017, ISO-NE identified advanced DER requirements as urgent action. >60% of PV in MA.
- EPRI worked with MA's Technical Standards Review Group, tasked by PUC with distribution interconnection requirements. No additional proc.
- Certification with UL 1741SA offers a practical stopgap solution until revised IEEE 1547.1-certified equipment becomes available (~2020).
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PJM

- PJM needs new requirements in 1-2 years
- Most DER is under local jurisdiction, PJM has limited authority. One issue is that regulatory references to 1547 differ between states.
- EPRI is working with PJM to develop a technical consensus *prior to* entering regulatory proceedings: single set of "preferred" ride-through and trip settings, involvement of T & D planners
- Plan is to have final documentation of consensus in 2019. Subsequently, PJM rules and distribution utility discussions under local regulation

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Minnesota PUC

- Very sophisticated, well-structured, and transparent stakeholder process.
- Revised DER interconnection screenings (Phase 1) last year.
- Now working on revision of interconnection requirements (Phase 2) this year.

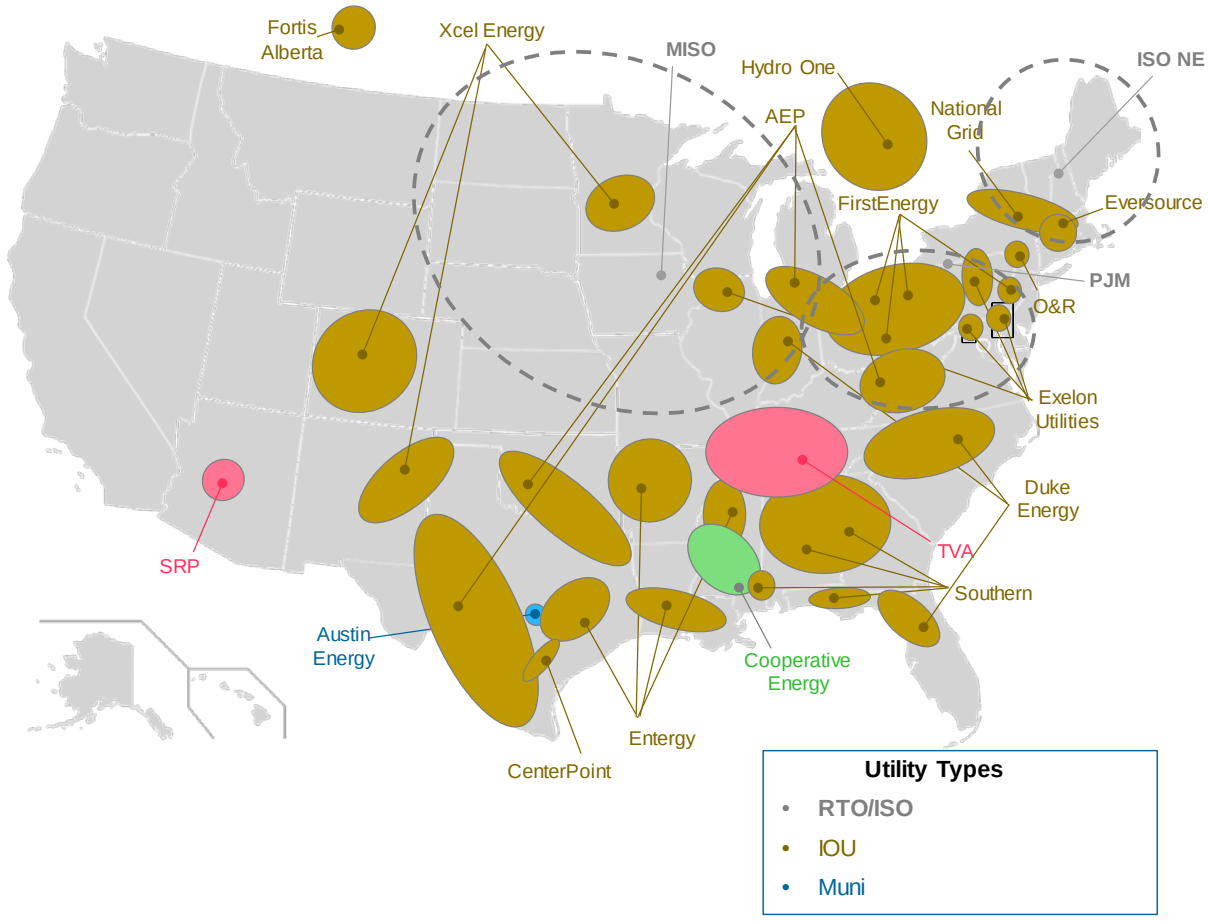
Moving forward…

- Need for education and knowledge transfer prior to opening formal proceedings:
  - Distribution and transmission owners/planners
  - State regulators, policymakers

- May use a stopgap solution for equipment certification while IEEE P1547.1 (test & verification procedures) still being revised
  - Adopt parts of IEEE 1547-2018 with UL 1741 SA-certified “grid support utility interactive” inverters

- Collaborative learning in IEEE P1547.2 (Application Guide for IEEE 1547) and EPRI project “Navigating DER Interconnection Standards & Practices”

Utilities interested in the application of IEEE Std 1547-2018 in the short- or near-term



EPRI ELECTRIC POWER RESEARCH INSTITUTE

Together…Shaping the Future of Electricity

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Extra slides

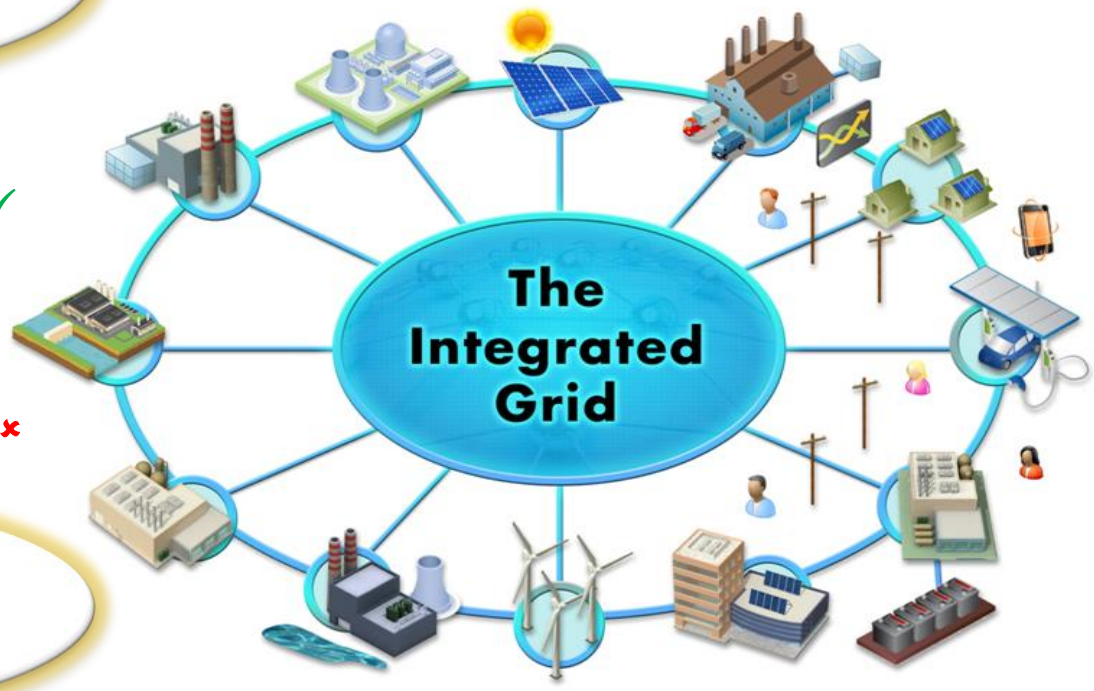
Scope of 1547 Session

In Scope

Out of Scope

Interconnection & Communication Capability

Examples
- IEEE Std 1547-2018 ✓
- IEEE Std 2030.5 (SEP2) ✓
- IEEE Std 1815 (DNP3) ✓
- SunSpec Modbus ✓
- IEC 61968-5 Distributed Energy Optimization ✗
- IEEE p2030.11 (DERMS) ✗



Informed Policy & Regulation

Examples
- IEEE Std 1547-2018 adoption (voluntary industry std)
- Assigning normal & abnormal performance categories
- Potential customer impacts & benefits from utilization of DER new capabilities

Grid Modernization

Examples
- Communication infrastructure
- Federated Architecture for DER
- Reclosing practices

Integrated Planning & Ops

Examples
- DER modeling in T & D
- DER visibility & control
- ADMS/DERMS ↔ SCADA
- DER interconnection procedures & screening

Compensation & Markets

Examples
- Compensation rules
- DER in wholesale markets
- Markets at distribution level

Example of assigning performance categories for Abnormal Operation

DER Type		DER Application Purpose						
		Retail Self Generation	Combined Heat and Power	Waste Fuel Recovery	Renewable Energy	Merchant Generation[a]	Critical Backup[b]	Peak Shaving
		A	B	C	D	E	F	G
1	Engine or turbine driven synchronous generator	Category I	**Category I**	Category I	Category I	Category I	Category I	Category I
2	Wind turbines (all types)	Category II	N/A	N/A	Category II	**Category II**	N/A	N/A
3	Inverters sourced by solar PV	Category II[c]	N/A	N/A	**Category II[c]**	Category II[c]	N/A	N/A
4	Inverters sourced by fuel cells	Category I	Category I	Category I	Category I	Category II	Category I	N/A
5	Synchronous hydrogenerators	Category I	N/A	N/A	Category I	Category I	Category I	N/A
6	Other inverter applications	Category II	Category II	Category II	Category II	Category II	Category II	N/A
7	Inverters sourced by energy storage	Category II	N/A	N/A	N/A	Category II	Category II	Category II
8	Other synchronous generators	Category I	Category I	Category I	Category I	Category I	Category I	N/A
9	Other Induction generators	Category II	Category II	Category II	Category II	Category II	Category II	Category II

NOTE a—Merchant generation in this table is intended to characterize DER facilities installed for the express purpose of exporting power, and is not intended to imply only FERC-jurisdictional generation or other regulatory definitions.

NOTE b—Only applies to critical backup generation interconnected to the Area EPS for the purposes of periodic testing. If backup generation is also used for merchant generation or other purposes, the performance requirements of those purposes apply.

NOTE c—Category III should be required where DER penetration on a distribution feeder exceeds [% VALUE TO BE SPECIFIED BY AGIR], or on the distribution system supplied from a given distribution substation bus exceeds [% VALUE TO BE SPECIFIED BY AGIR].

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**