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

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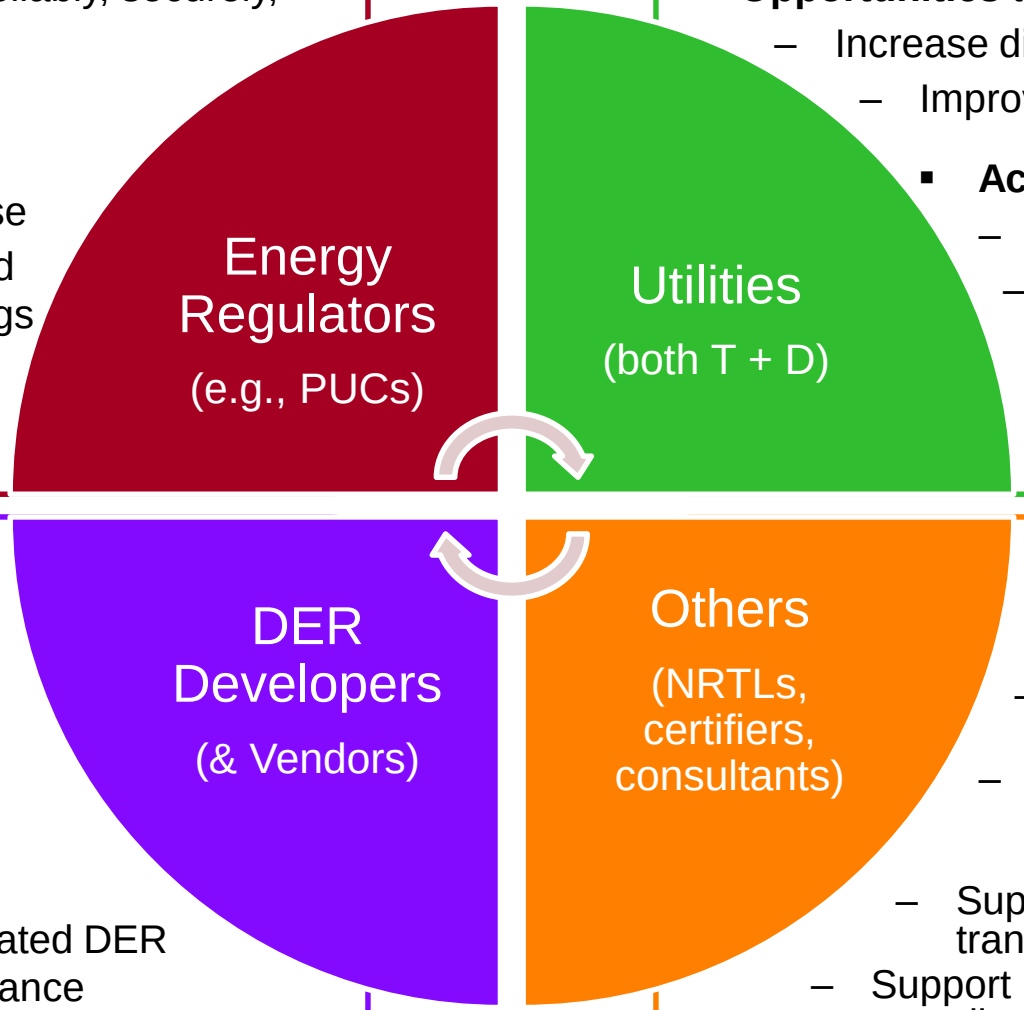
WIRAB Webinar

August 21, 2018

Summary: IEEE 1547-2018 — What Does It Mean for Me?



- **Opportunities** to integrate DER reliably, securely, and efficiently into the grid
- **Actions required** to
  - Assign performance categories per DER technology and use case
  - Specify "preferred" utility-required profiles for DER functional settings
  - Specify certification for DER equipment and possibly verification for DER facilities

- **Opportunities** to utilize advanced DER capabilities
  - Increase distribution hosting capacity
  - Improve bulk system reliability
- **Actions required** to specify
  - Functional settings ≠ "preferred"
  - Performance categories
  - Communication interface
- **Coordinate across T&D**

- **Opportunities** to interconnect larger amounts of DER
- **Clarity** regarding
  - Interconnection capabilities
  - Reference point of applicability
  - Functional settings
- **Potential need** for more sophisticated DER facility evaluations to verify compliance

- **Opportunities** for new business
  - Testing and certification of advanced DER units
  - Evaluation and verification of DER facilities
  - Support utilities in distribution planning with advanced DER functions
  - Support reliability coordinators in transmission planning with DER
  - Support DER developers in verification / compliance through DER evaluations

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?*
- *Do you want to go beyond leading interconnection requirements like CA Rule 21 and Hawai'ian Rule 14H?*

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*

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3. Collaboratively determine what performance/functional capability is needed from DERs?

- *Voltage regulation – Utilities' and/or DER owners' interest*
- *Ride-through - Reliability coordinators' interest*
- *Communications – Utilities' and Market Operators' interest*

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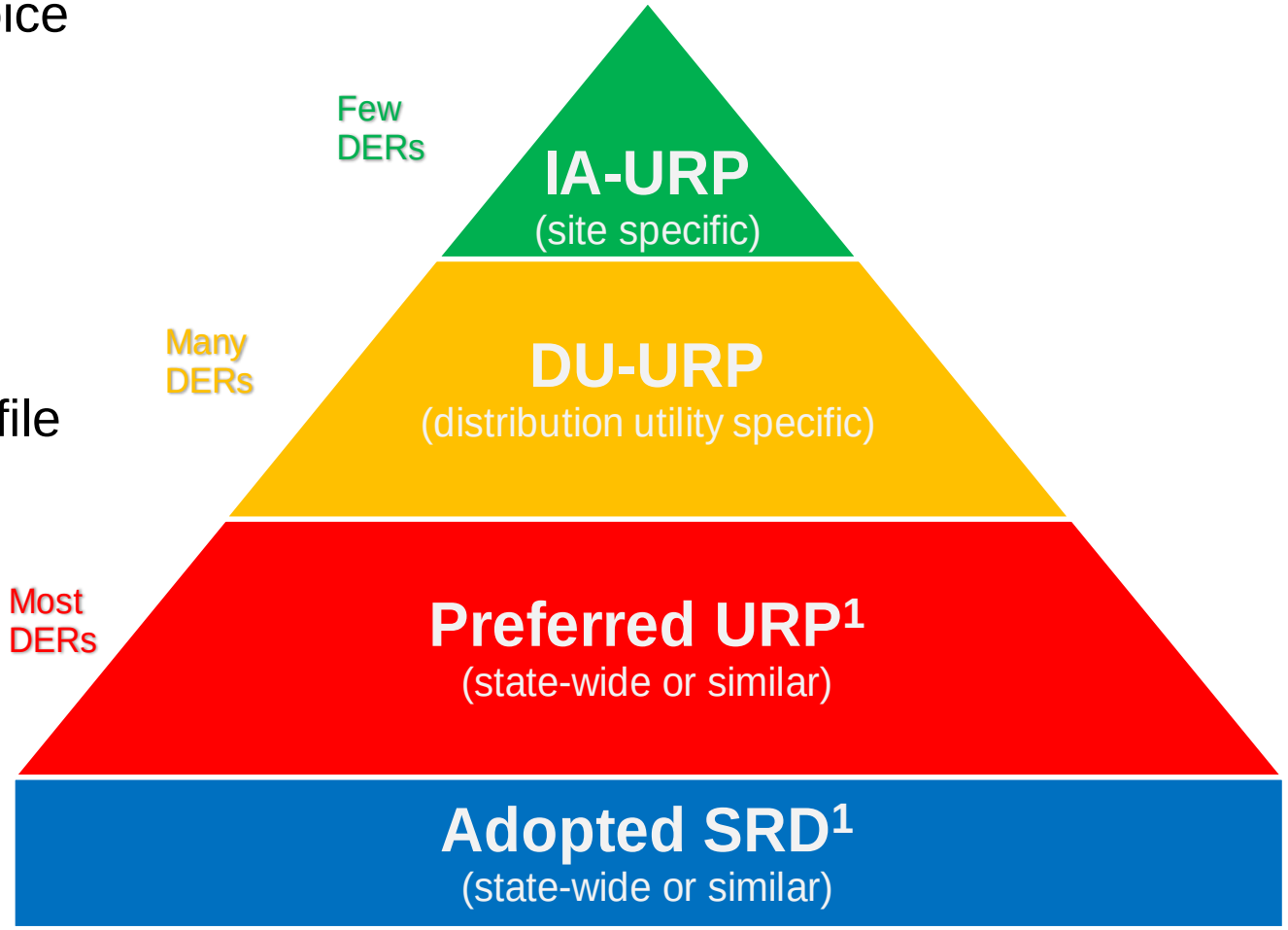
4. Determine ‘preferred’ utility-required profile (URP) for autonomous functions.

- *Utility-Required Profiles (URPs)*



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5. Determine DER communication protocol(s).

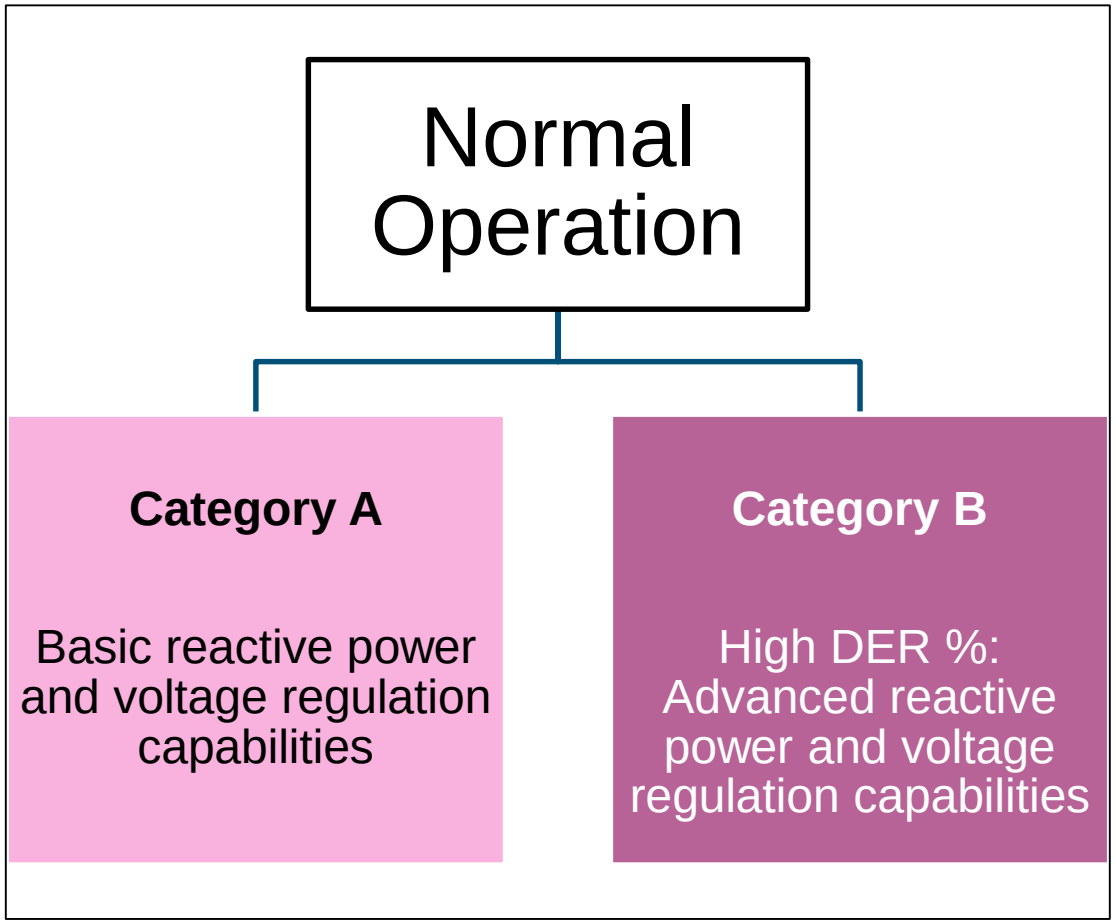
- *SunSpec Modbus*
- *IEEE Std. 1815 (DNP3)*
- *IEEE Std. 2030.5*

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:

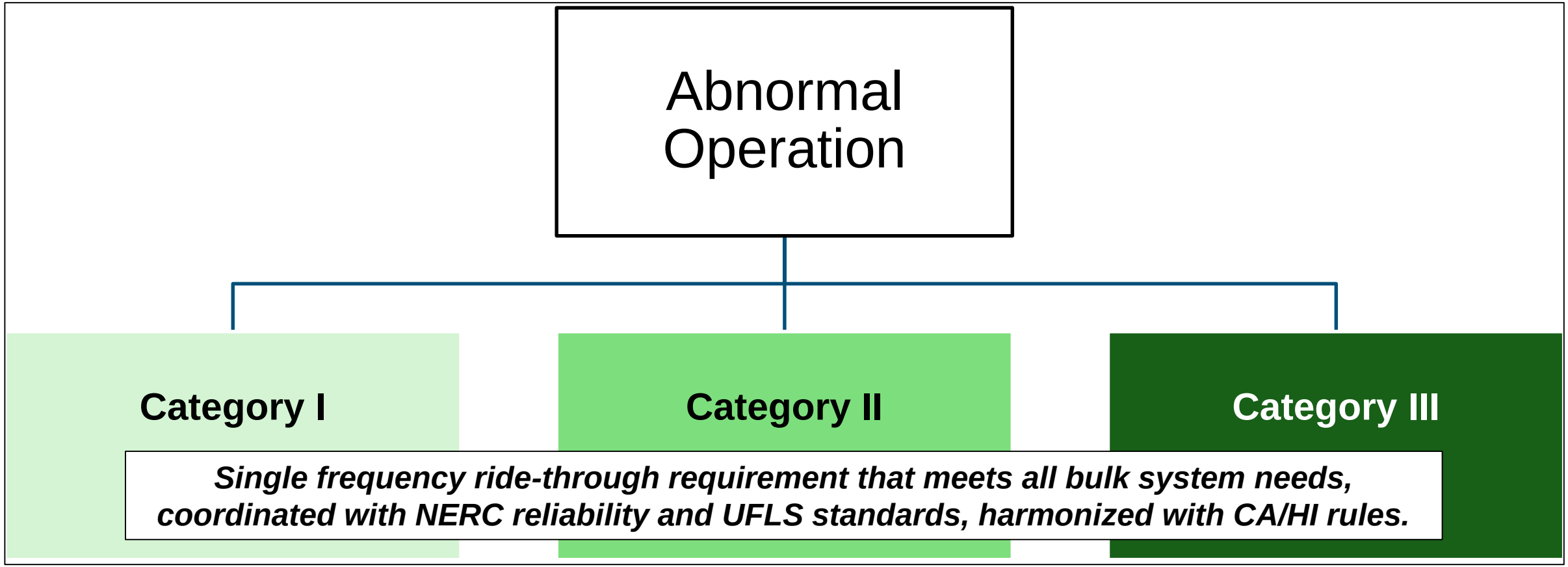
- Distribution utilities, because voltage affects the *local* distribution grid
- DER owners/developers, because this can affect costs (e.g., inverter sizing) and benefits (active power output)

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

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

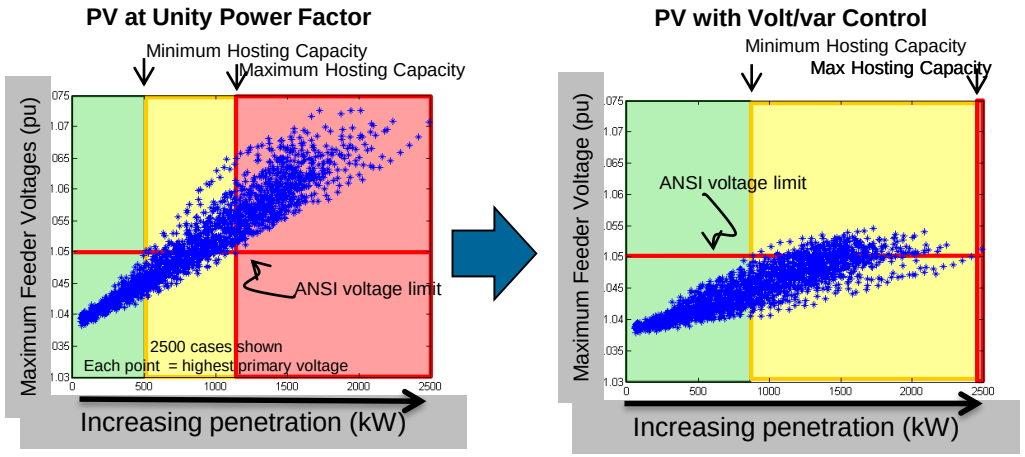
Challenge: Coordination with utility reclosing practices

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

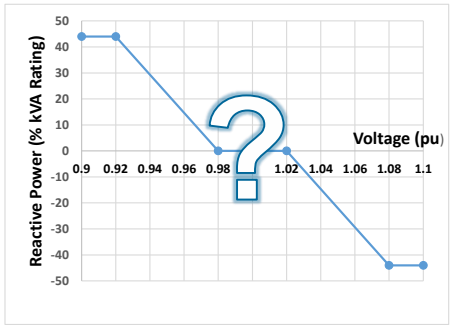
Functional settings, ranges of allowable settings, and default values

What are ranges of allowable settings?

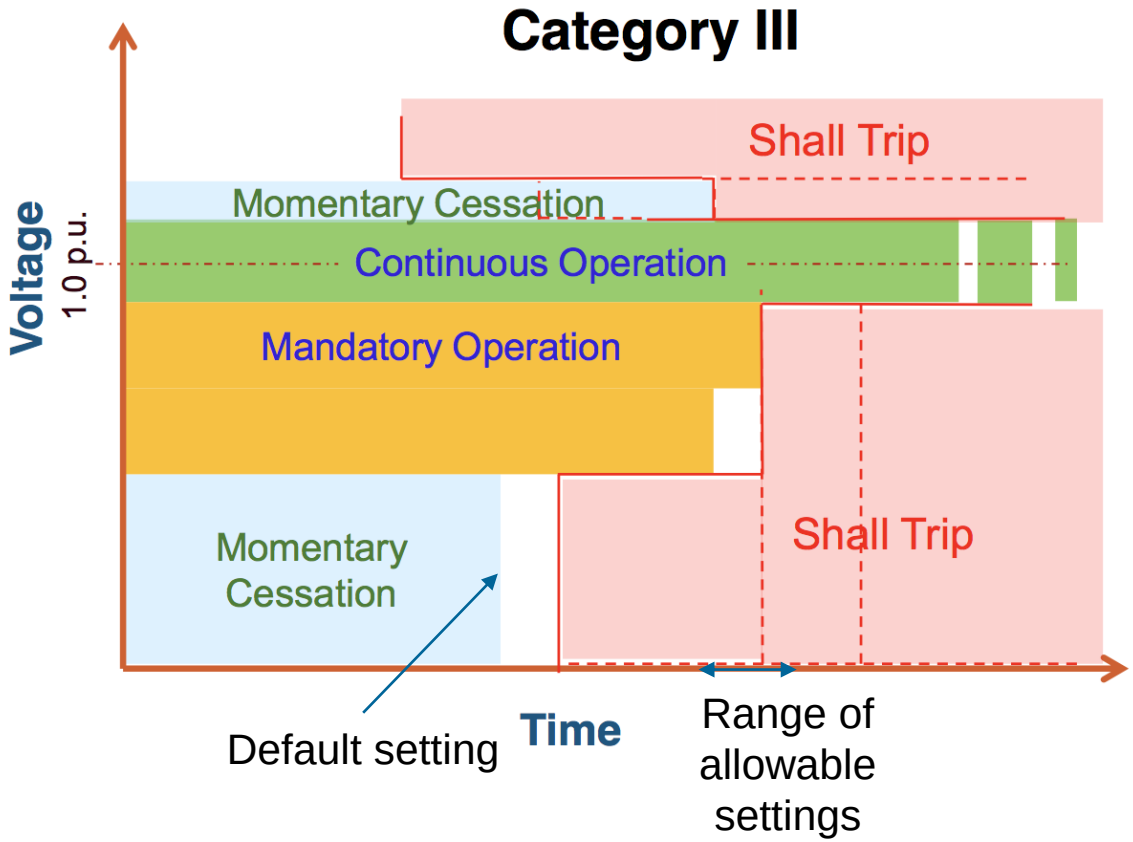
Voltage Reactive-Power Control Settings



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



Voltage/Frequency Trip Settings



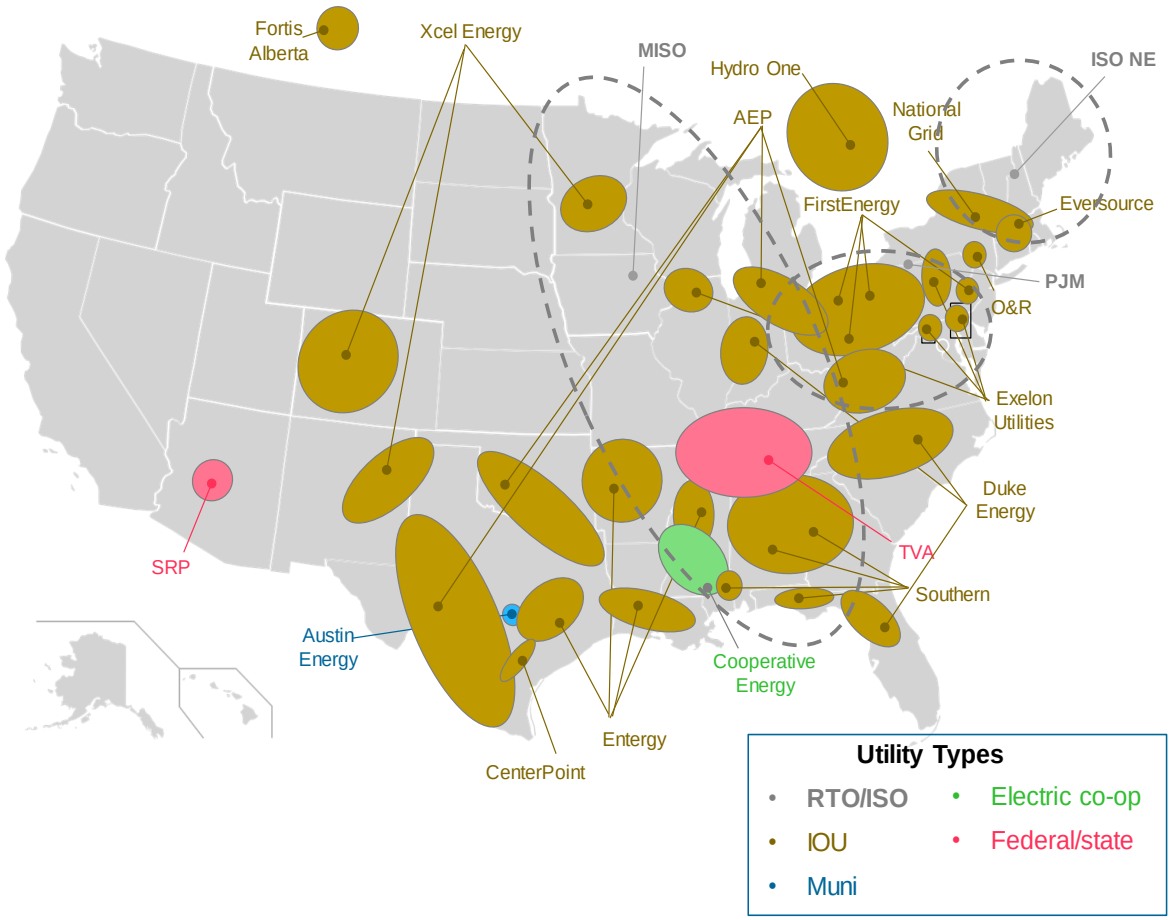
Moving forward…

- 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 opportunities in
  - EPRI project “Navigating DER Interconnection Standards & Practices” (near-term, EPRI members only)
  - IEEE P1547.2 (Application Guide for IEEE 1547) (mid-term, public stakeholders)

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



Together…Shaping the Future of Electricity

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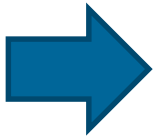
Extra slides

Road Map to Unlock Benefits of "Advanced DERs"

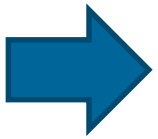
1. Decide on DER capabilities (i.e., adopt IEEE Std 1547-2018)
   - Specify DER performance & functional capabilities / categories.
   - Specify DER communication protocol(s).
   - Specify 'preferred settings' for autonomous functions.



this 1547 panel session

T + D

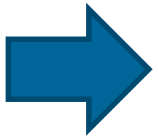
2. Update interconnection procedures & screenings
   - Criteria for "fast track", new supplemental screens.
   - Utilization of autonomous functions: activate certain functions and determine 'custom settings'.



maximize DER hosting capacity

D

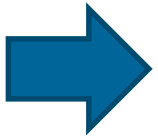
3. Deploy communication infrastructure
   - Determine when it is time to integrate DER via communications.
   - Select communication networks and architecture.



make the system flexible

T + D

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

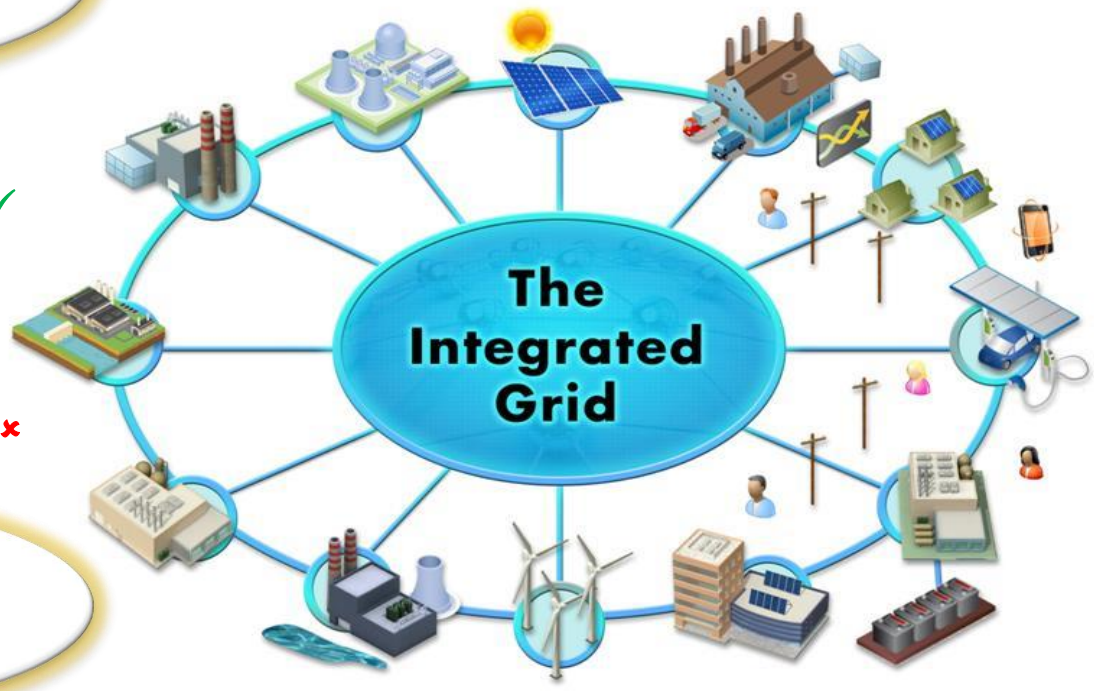
Scope of 1547 Session

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								
Freq. Support	L/H Frequency Ride-Through				‡				
	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**

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).
- Completed Preferred Utility-Required Profile (URP) in Feb 2018. Now working with utilities, regulators, muni's, and co-ops in each state to implement it.

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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.