IEEE P1547 Update

What we can learn from Germany when revising interconnection standards for Distributed Energy Resources

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Energy and Environment Seminar

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Disclaimer

This presentation and discussion here on IEEE P1547 are individual's views and are not the formal position, explanation or position of the IEEE.

Abstract

This lecture will explore lessons learned from Germany about interconnection and integration of *massive* amounts of distributed energy resources (DERs) into the distribution grid and related impacts on bulk system stability.

Germany has experienced an unprecedented, and unexpected, deployment of small-scale, roof-top solar systems in the past decade and is now serving about one third (!) of its annual electricity consumption by renewable energy from wind, solar, biomass, hydro, etc. In the transitioning process of its power system, called “Energiwende”, Germany has made a number of unfortunate mistakes that can be useful for the U.S. to learn from.

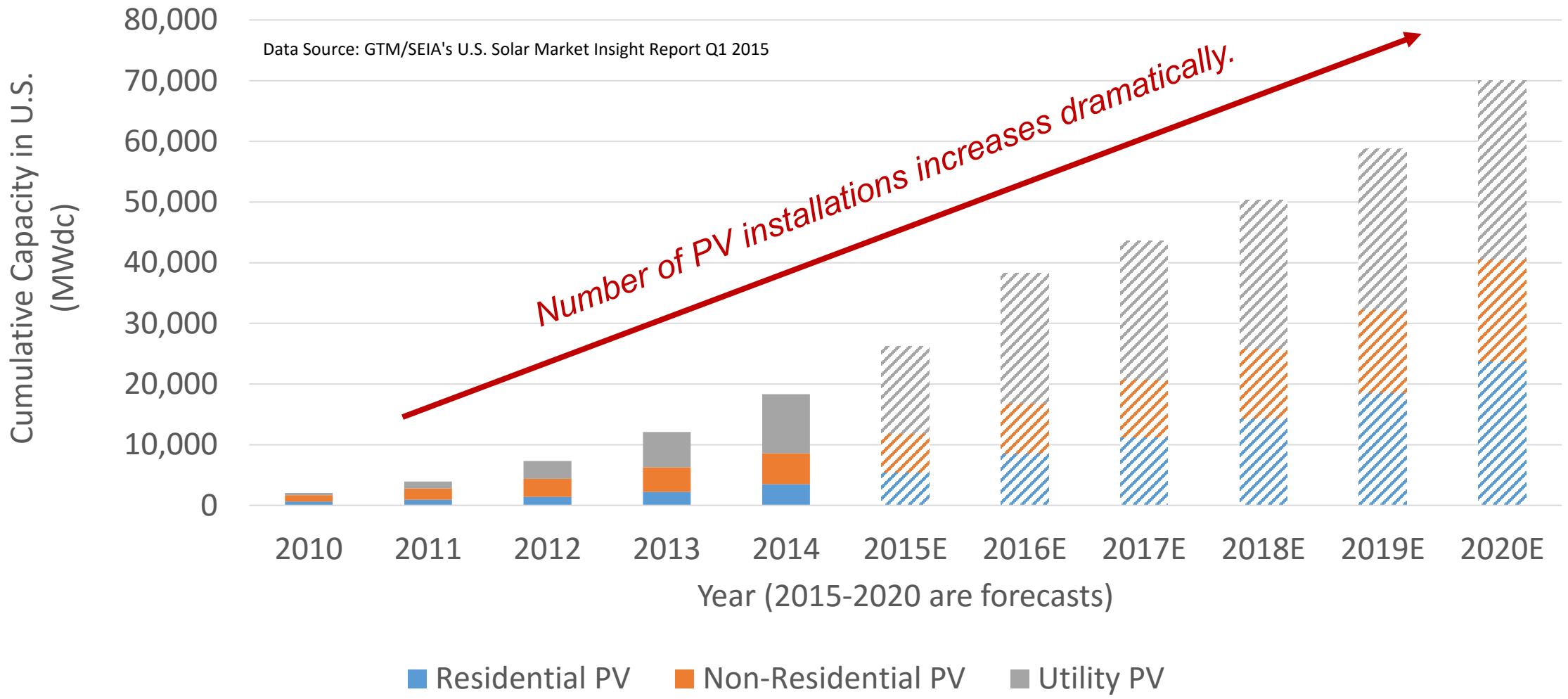
The main interconnection standard for DERs in North America, IEEE Std 1547, is currently being revised and the lecturer who is with the Electric Power Research Institute (EPRI) is involved in a leadership position in that revision process. Revisions to the standard include reactive power capability and voltage control requirements, voltage and frequency ride-through, interoperability and communication capability requirements as well as testing and verification requirements. This lecture will provide an informal report on the status of the revision of IEEE Std 1547 and explain how interested parties may get involved in the process and voting.

Agenda

1. Background and Context
2. Lessons learned from Germany
3. Major Changes in IEEE P1547 in a Nutshell
4. Draft Interconnection and Interoperability Requirements (selected)
   - VAR and VAR-control capability
   - Voltage & Frequency Ride-Through
   - Interoperability and Communication
5. Test and Verification of Requirements
6. How to Get Involved?

Background and Context

The Challenge: Development and forecast of Solar PV in the United States.



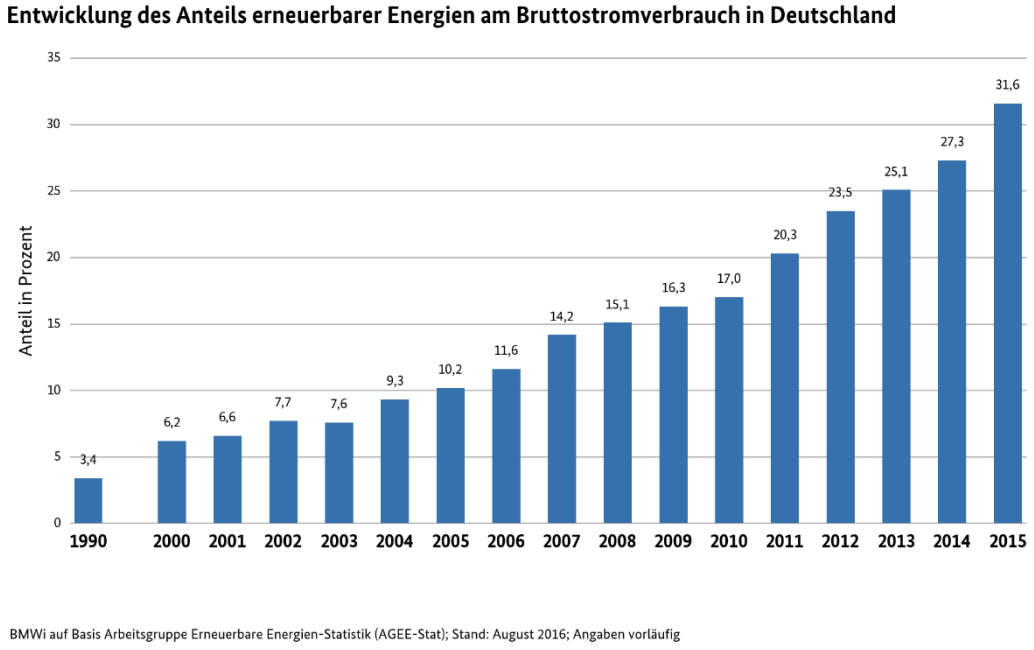
EPRI ELECTRIC POWER RESEARCH INSTITUTE

Background and Context

The Reality: Development of Renewable Energy Sources in Germany.

Share of Renewables in Gross Annual Electricity Consumption

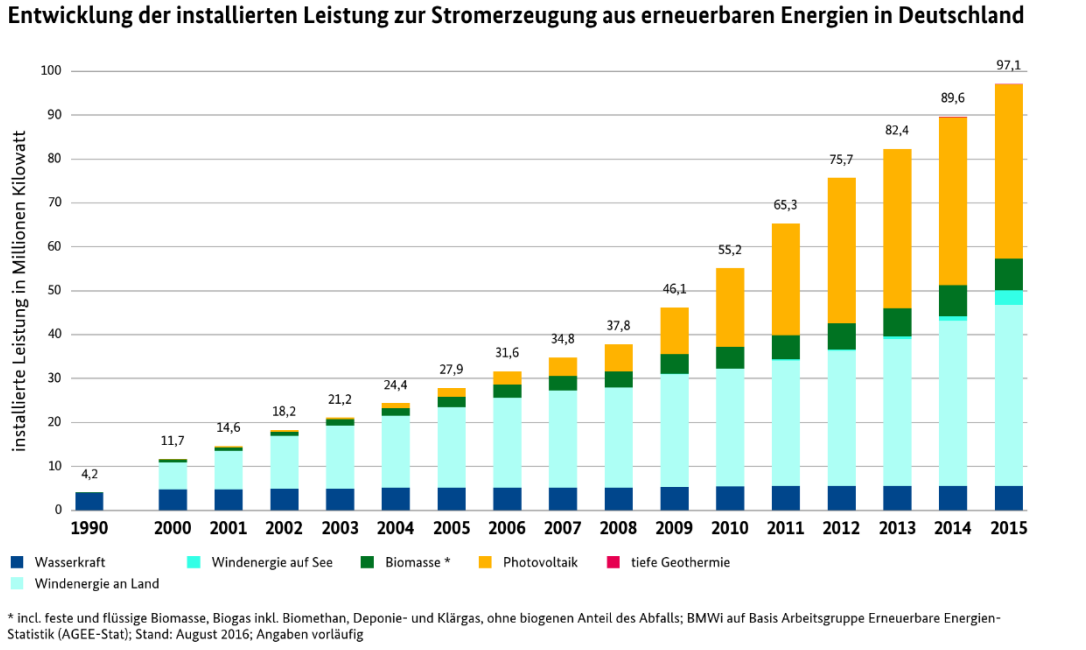
Bundesministerium für Wirtschaft und Energie



BMWi auf Basis Arbeitsgruppe Erneuerbare Energien-Statistik (AGEE-Stat); Stand: August 2016; Angaben vorläufig

Installed Nameplate Capacityof Renewables

Bundesministerium für Wirtschaft und Energie



* incl. feste und flüssige Biomasse, Biogas inkl. Biomethan, Deponie- und Klärgas, ohne biogenen Anteil des Abfalls; BMWi auf Basis Arbeitsgruppe Erneuerbare Energien-Statistik (AGEE-Stat); Stand: August 2016; Angaben vorläufig

Background and Context

The Grid Planning & Operation Challenge with Distributed Energy Resources

- Voltage/Reactive Power
- Power quality: voltage limits/power factor/harmonics
- Frequency/Active Power
- Stability
- Health & Safety: protection coordination/anti-islanding

Background and Context

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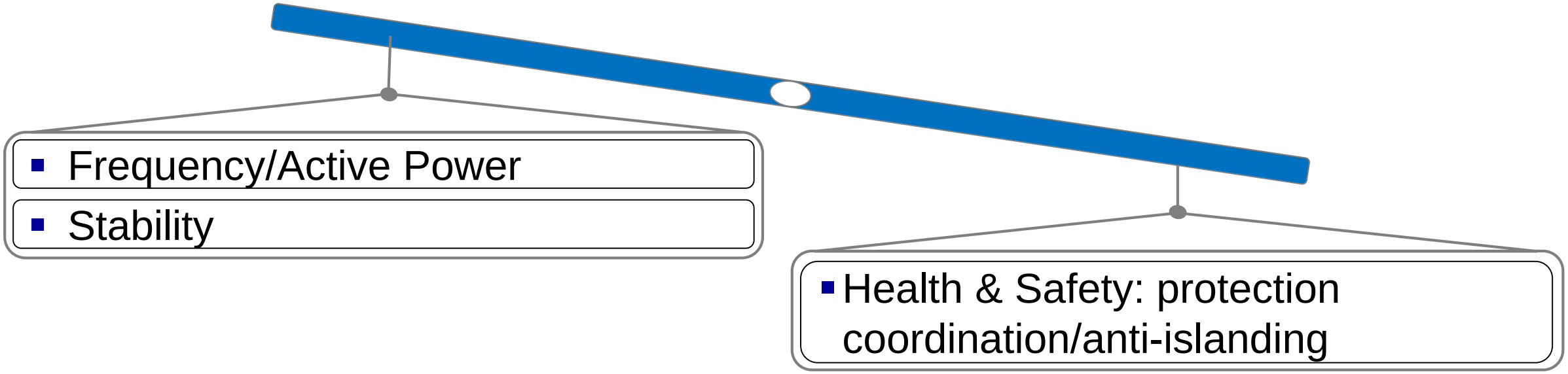


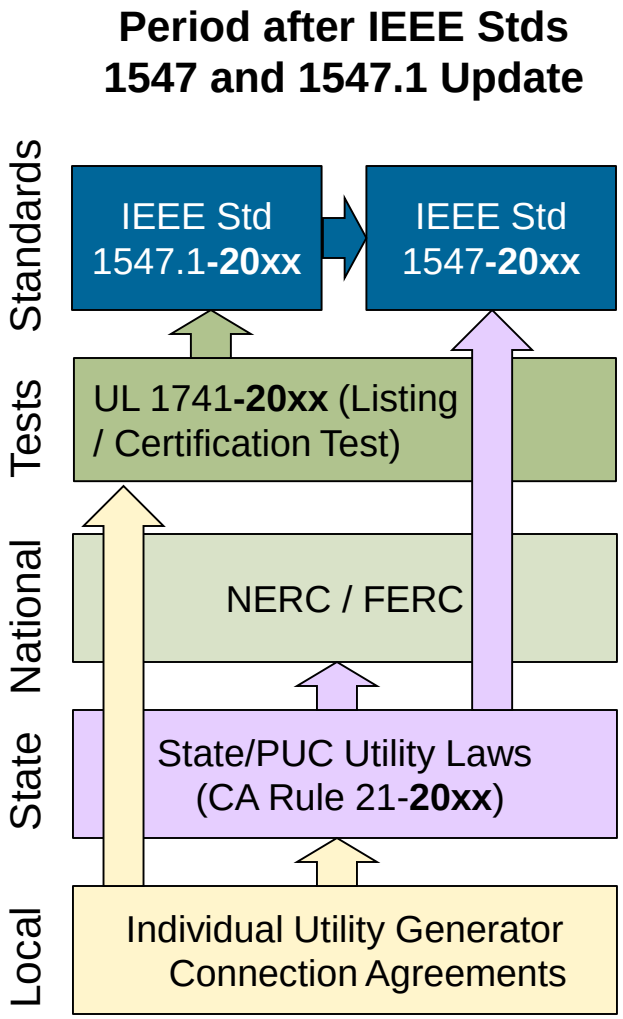
- Frequency/Active Power
- Stability

- Health & Safety: protection coordination/anti-islanding

Interconnection requirements for DERs should adequately address transmission *and* distribution system needs.

Background and Context

Which standards apply <u>after</u> the transitioning period? (Example: California)



<u>Harmonizing Requirements</u> in IEEE Std. 1547 for the Future.

- DER interconnection and system integration focus.
- Technology-agnostic.
- Widely accepted.
- Performance-based requirements.
- Leading technological development and innovation of DER performance.

Lessons learned from Germany

Understanding the transitioning process of the power system as a collaborative learning process.

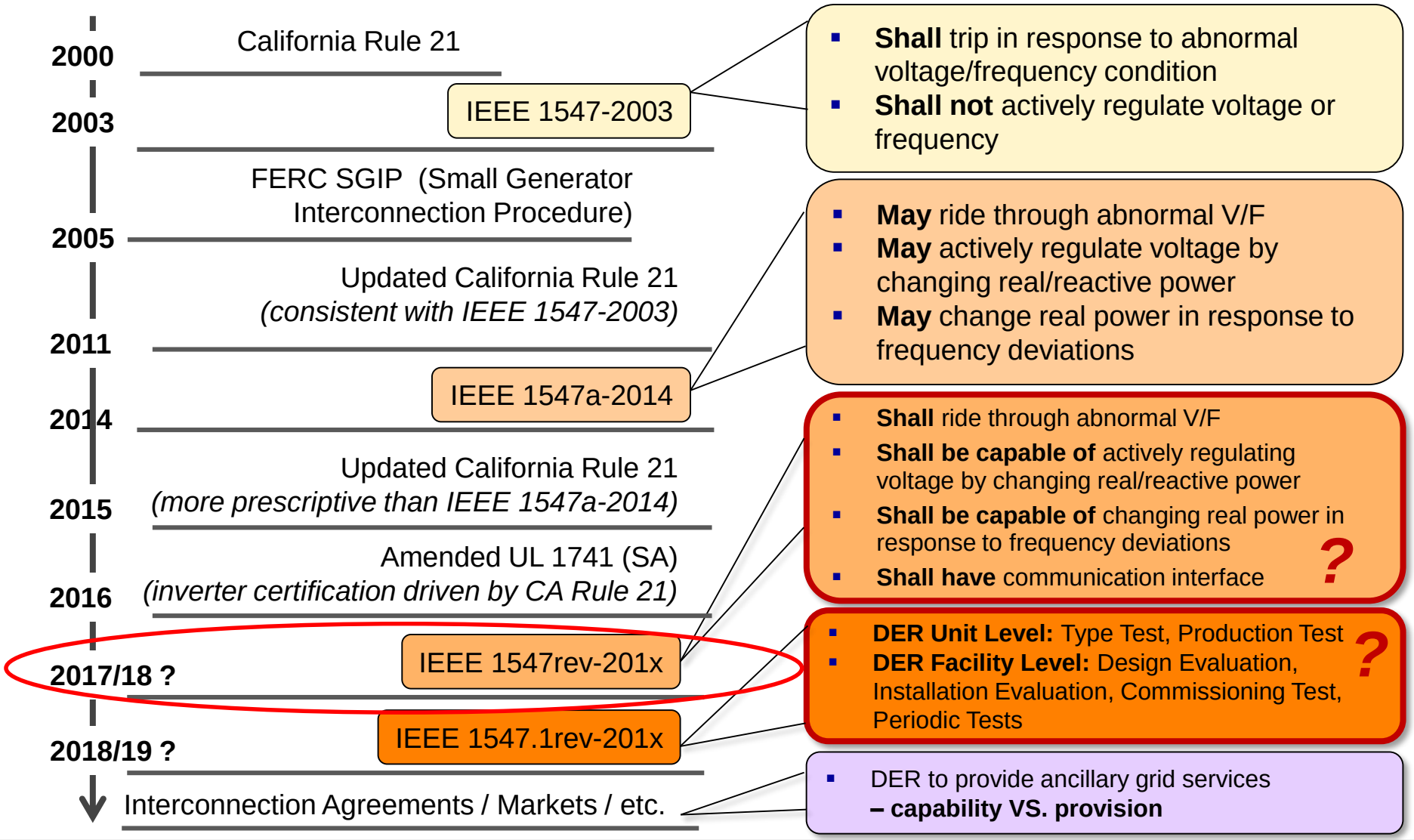
1. Things may go **much** faster than you'd expect.
   - Good solutions from the past may not hold in the future.

2. You cannot **plan** for everything.
   - 2009: German incentive program for improved grid integration of wind power plants.
   - 2012: German legislation to retrofit DERs with (basic) remote control capability.
   - 2012: German legislation to retrofit PV systems with improved frequency settings (so-called “50.2 Hz problem”).
   - 201x: German legislation to retrofit other DERs with improved frequency settings (so-called “49.5 Hz problem”).
   - 2016: It is easy to miss the end point of 'market introduction' of (distributed) renewables (“duck curve problem”).

3. Expect mistakes and make the system **flexible**:
   - Require communication capability.

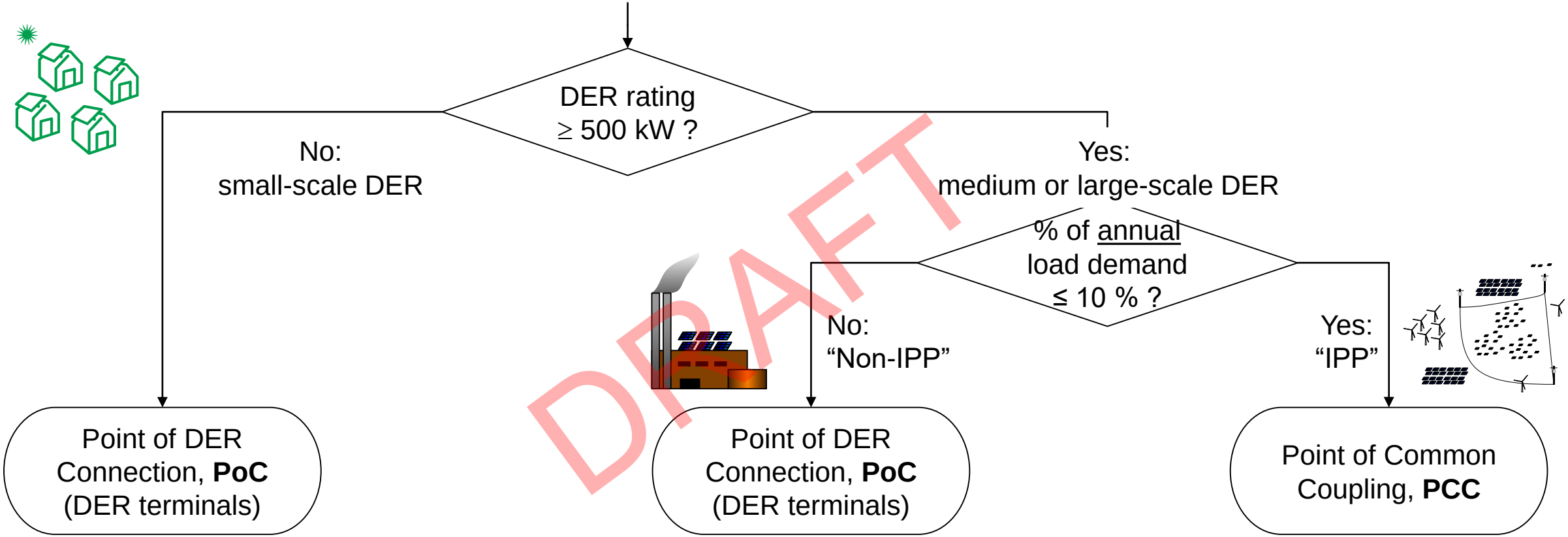
Major Changes in IEEE P1547 in a Nutshell

CA Rule 21 and UL 1741(SA) are leading the way for IEEE Stds 1547 and 1547.1



Major Changes in IEEE P1547 in a Nutshell

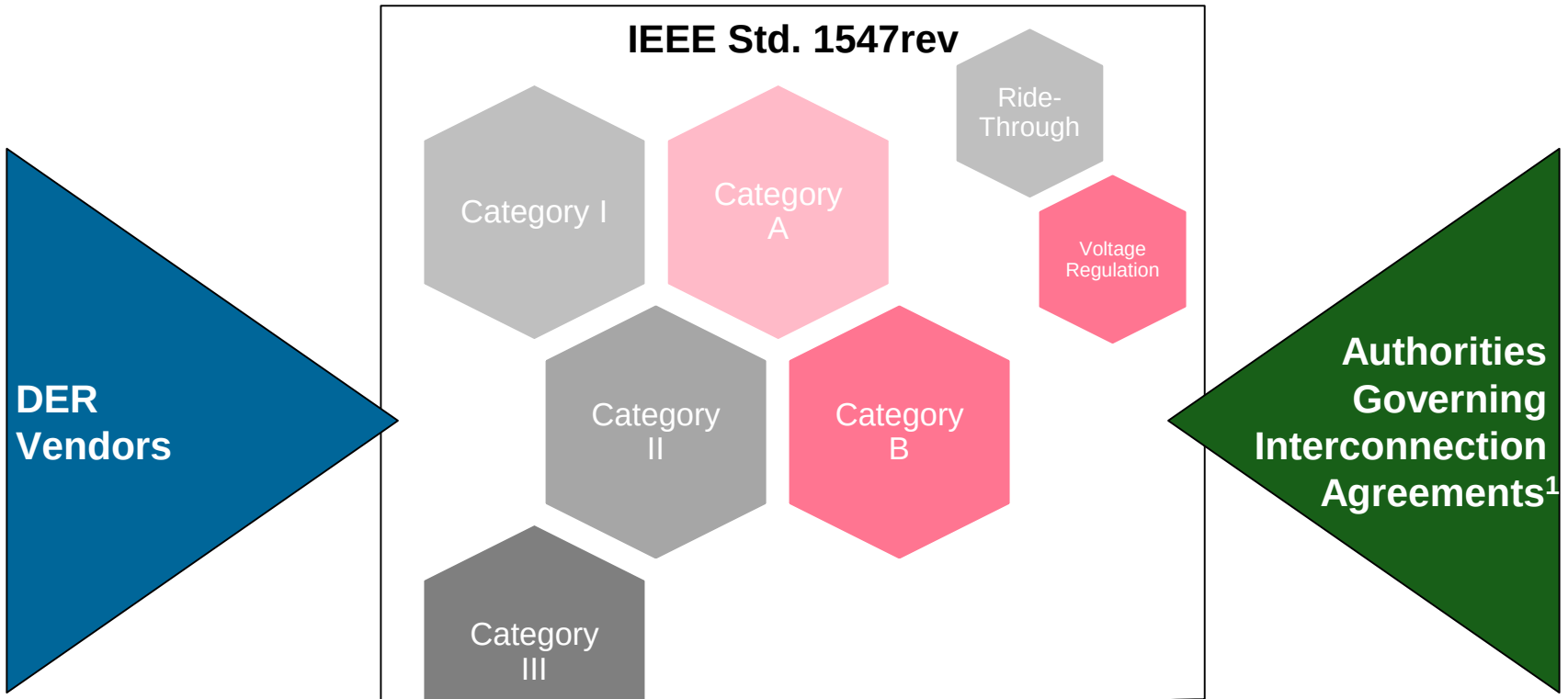
Draft Applicability of Requirements



The reference point has implications for testing & conformance requirements in IEEE P1547 & P1547.1 !!!

Major Changes in IEEE P1547 in a Nutshell

IEEE P1547 Performance Category Approach



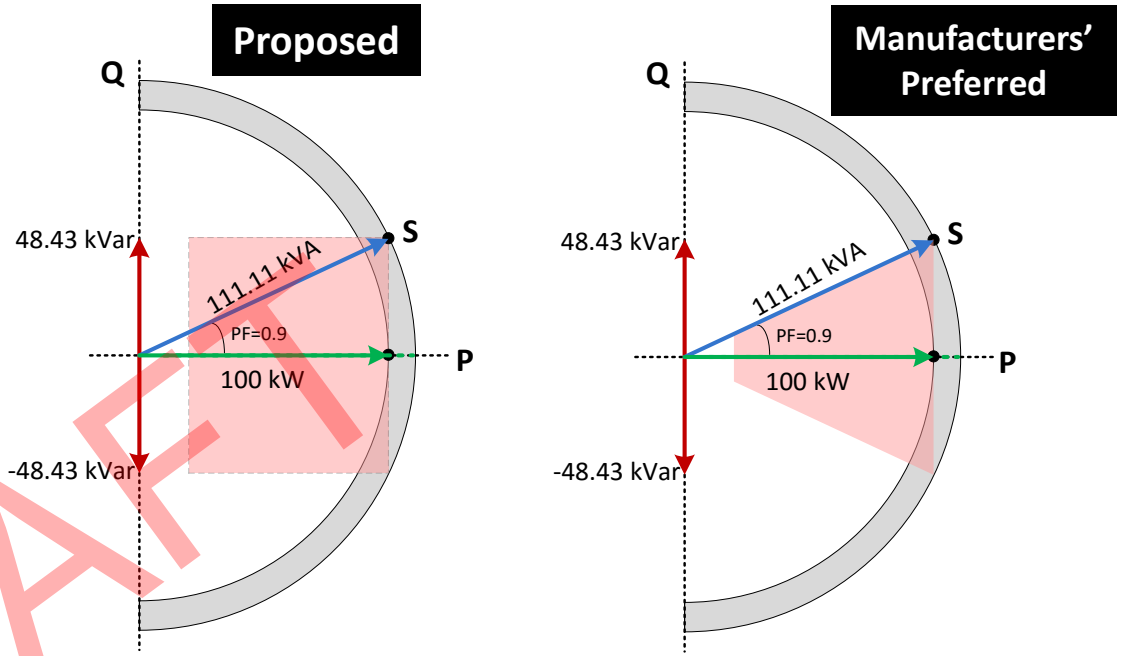
[1] State Regulator, Area EPS or bulk system operator, etc.

VAR and VAR-control capability

Draft Reactive Power Capability Requirements

The DER shall be capable of injecting reactive power (over-excited) and absorbing reactive power (under-excited) equal to the minimum reactive power (kVar) corresponding to the value given in the Table below **at all active power output equal to 20% to 100% of nameplate active power rating (kW)**.

Example for a 100kW Cat B DER



Minimum Reactive Power Injection and Absorption Capability

Category	Injection (Over-Excited) Capability as % of Nameplate Apparent Power (kVA) Rating	Absorption (Under-Excited) Capability as % of Nameplate Apparent Power (kVA) Rating
A (at DER rated voltage)	44	25
B (at ANSI range A)	44	44

VAR and VAR-control capability

Draft Voltage Regulation Control Modes

DER Category	Cat A	Cat B
▪ **Voltage Regulation by Reactive Power Control**		
Adjustable Constant Power Factor	Mandatory	Mandatory
Voltage – Reactive Power (Volt-var)	Mandatory	Mandatory
Active Power – Reactive (Watt-Var) Mode	Optional	Mandatory
Adjustable Constant Reactive Power	Mandatory	Mandatory
▪ **Voltage and Active Power Control**		
Voltage – Real Power (Volt-Watt)	Optional	Mandatory

- The DER shall be capable of activating any of these modes individually.
- Adjustable constant power factor mode with unity power factor setting shall be the default mode of the installed DER unless otherwise specified by the area EPS operator.
- The Area EPS operator shall specify the required voltage regulation control modes and the corresponding parameter settings. Modifications of the settings and mode selected by the EPS operator shall be implemented by the DER operator.

Voltage & Frequency Ride-Through

Foundations for Voltage & Frequency Ride-Through Requirements

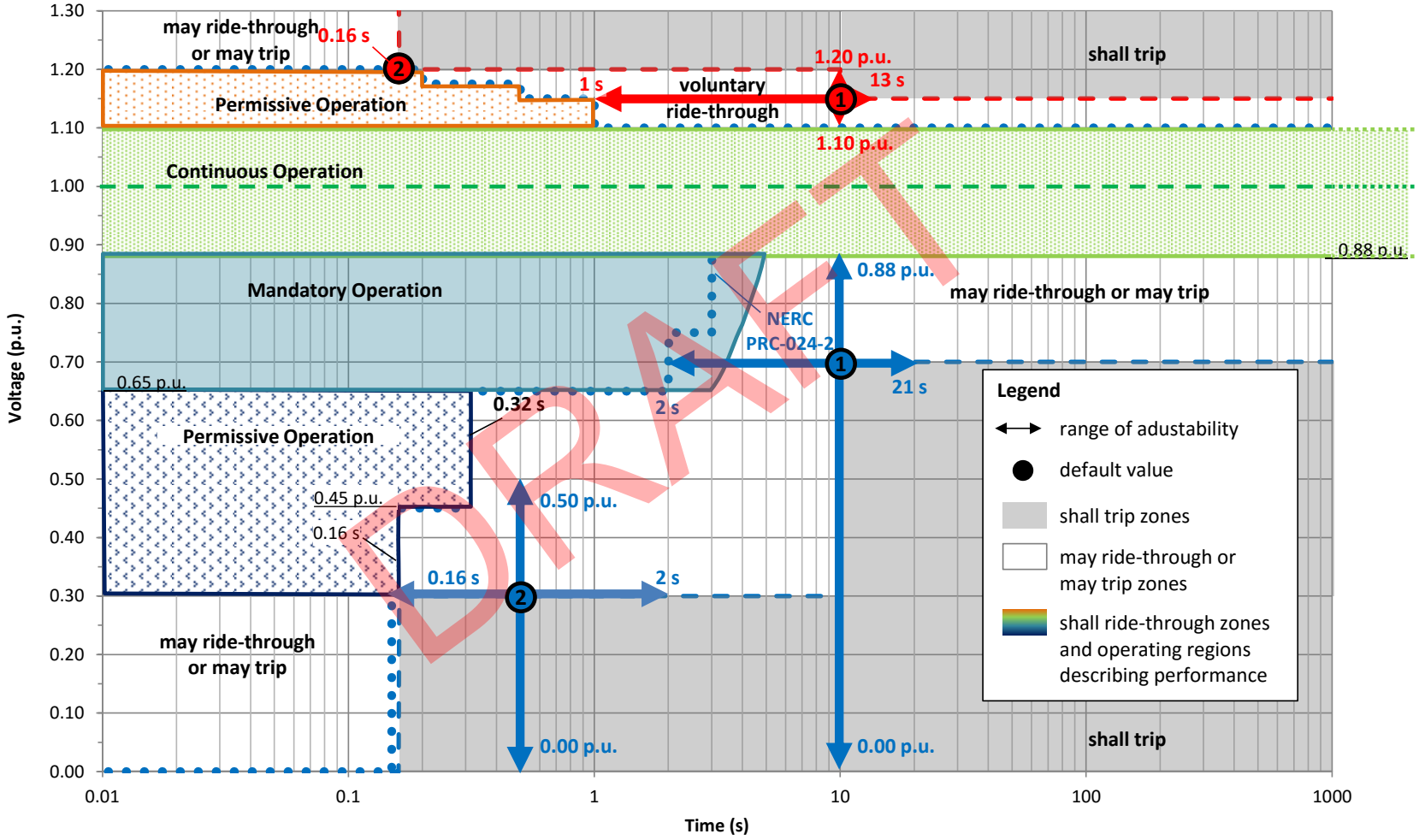
Requirement	Category	Foundation	Justification
Voltage Ride-Through	Category I	German grid code for medium voltage-connected synchronous generator-based DER	• *Essential* bulk system needs. • Attainable by all state-of-the-art DER technologies.
	Category II	NERC PRC-024-2 but w/o stability exception, extended LVRT duration for 65-88% V_{nom} ➢ based on EPRI White Paper (May 2015)	• *All* bulk system needs. • Coordinated with existing reliability standards. • Considering fault-induced delayed voltage recovery.
	Category III	CA Rule 21 and Hawaii, minor modifications	• All bulk system needs. • Considering fault-induced delayed voltage recovery. • Distribution system operation.
Frequency Ride-Through	All Categories (harmonized)	CA Rule 21 and Hawaii, exceeds PRC-024-2 ➢ based on EPRI White Paper (May 2015)	• All bulk system needs. • Low inertia grids.

Voltage & Frequency Ride-Through

Draft Voltage Ride-Through Requirements for Category II

Category II

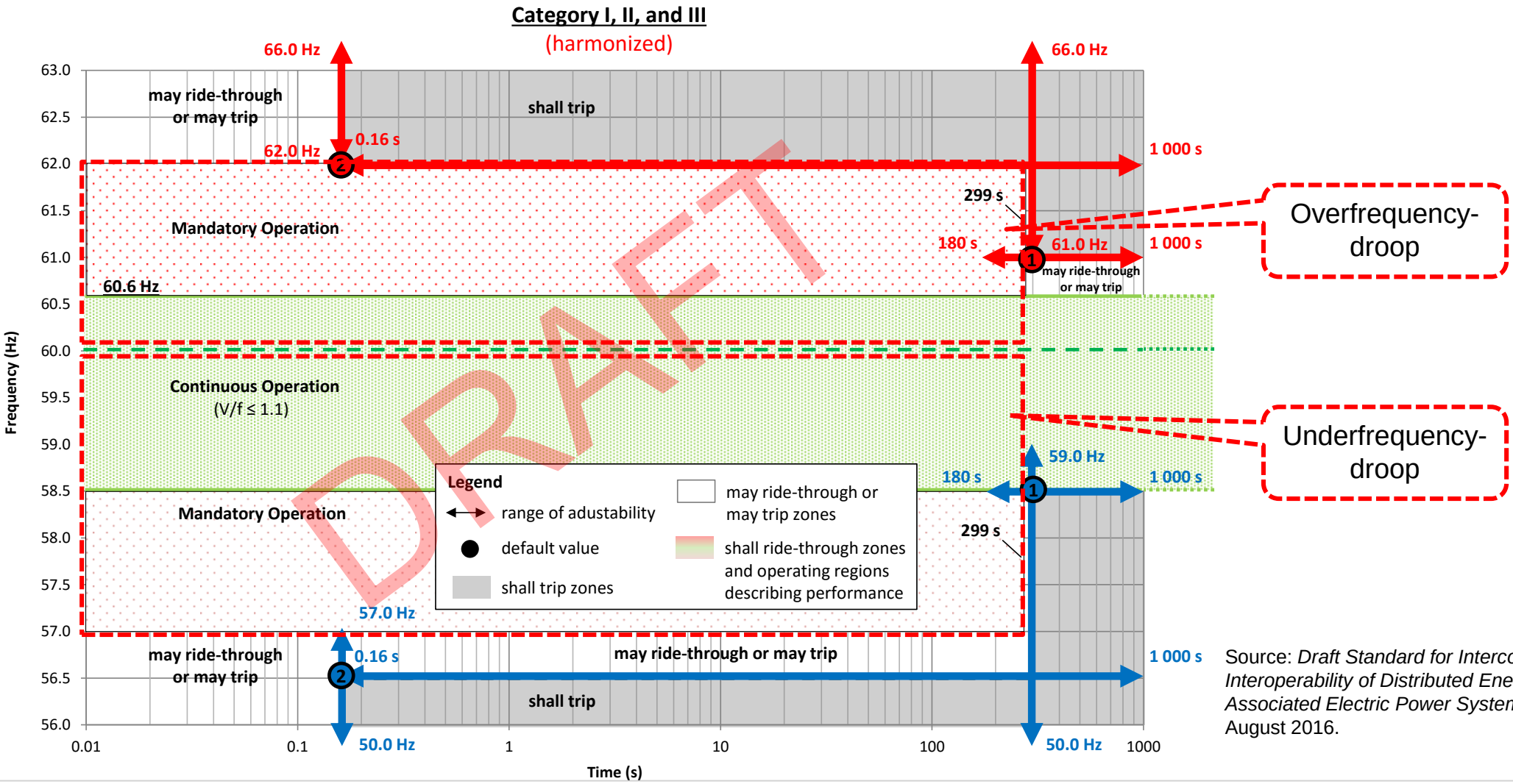
(based on NERC PRC-024-2 and considering FIDVR issues to a certain extent)



Source: *Draft Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems*, IEEE P1547/D5, August 2016.

Voltage & Frequency Ride-Through

Draft Frequency Ride-Through Requirements for All Categories

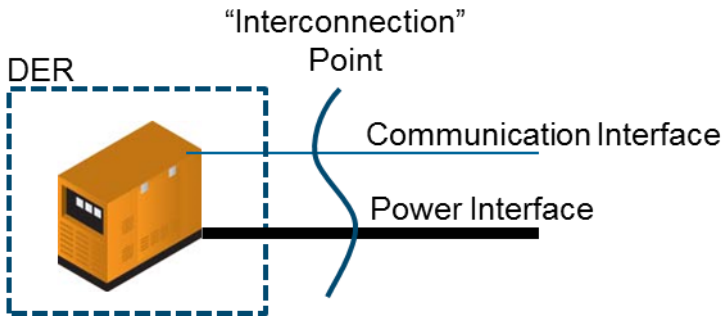


Source: *Draft Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems*, IEEE P1547/D5, August 2016.

Interoperability and Communication

Draft Interoperability and Communication Requirements

Definition and Applicability



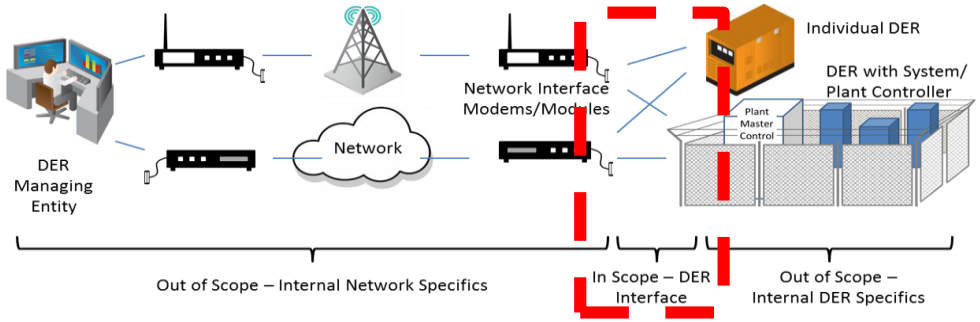
Changes in the IEEE P1547 paradigm:

- The point of interconnection now includes power and communication interfaces.

Definitions from IEEE Std 2030:

- *Interoperability* – the capability of two or more networks, systems, devices, applications, or components to externally exchange and readily use information securely and effectively
- *Interface* – a logical interconnection from one entity to another that supports one or more data flows implemented with one or more data links.

Limited Scope of IEEE P1547



- Only the standards protocols and the hardware interface at the DER interconnection points is within the scope of P1547.
  - Internal network specifics such as the protocols utilized within communication networks are out of scope of P1547.
  - Internal DER specifics such as plant-level communications and controls are out of scope of P1547.

Test and Verification of Requirements

Key characteristics of a proposal to be discussed at the P1547 Working Group meeting October 25-26, 2016

Objectives

- Keep it *simple*.
- Maintain and create *planning security*.
- *Streamline* DER interconnection *processes* by providing Authorities Governing Interconnection Agreements (AGIAs / AHJs) with a conformance framework.

Approach

- Consider applicability of requirements, i.e., PoC vs. PCC.
- Give flexibility as to allow for meeting compliance by means of “Supplemental DER Devices” if individual DER units only partially meet the requirements.
- Use as much “plug-and-play” as possible, rely on type tests where possible, ensure interoperability.
- Prefer cost-effective “DER evaluation” over expensive commissioning test.

Test and Verification of Requirements

The test requirements should give guidance, yet be flexible enough to consider the large variety of actual DER setups in the field:

IEEE Std 1547 Requirement XYZ		Applicability of Requirements	
		Point of DER Connection (PoC)	Point of Common Coupling (PCC)
DER Capability & Conformance	**F**ull no Supplemental DER Support Device needed	Type Test	Type Test + DER Evaluation
	Partial one or more Supplemental DER Support Device(s) needed	Type Test(s) + DER Evaluation	Type Test(s) + DER Evaluation

How to Get Involved?

What are the next steps, is the process to get involved, the rules for voting?

Dates	Event / Action	More information
10/25/16 - 10/26/16	**IEEE P1547 WG meeting** (followed by P1547.1 WG meeting)	Commonwealth Edison, 1919 Swift Drive Oak Brook, IL, 60523 **Register at,** http://www.cvent.com/d/pvqkcm
11/26/16	Initial Pre-Ballot Draft	Show redline changes from Draft 5 Post to iMeetCentral. Review for WG approval at Feb WG meeting
Week of Feb 27, 2017	**IEEE P1547 WG meeting** (followed by P1547.1 WG meeting)	NERC, Atlanta GA
March 2017	Complete Ballot Draft of 1547 Revision	Begin IEEE pre-ballot editorial review process
May 2017	**Balloting**	**6 months estimated minimum duration**
Summer 2017	**IEEE P1547 WG meeting** (followed by P1547.1 WG meeting)	National Grid, Waltham MA

How to Get Involved?

IEEE 1547 is set up as an individual vote, not an entity vote!

What are the next steps, is the process to get involved, the rules for voting?

Activity Level	Interested Stakeholders	IEEE Members	IEEE-SA Members	How to get involved?
I. Participation in Working Group and SubGroups meetings and conference calls	✓	✓	✓	1. Sign up for P1547 ListServ: *send an e-mail to listserv@listserv.ieee.org with the following command in the body of the e-mail:* Subscribe stds-p1547rev lastname, firstname End 2. Contact WG and/or SubGroup Leads & Facilitators *refer to the next slide for further information*
II. Access to WG Draft Standards in the WG repository on iMeetCentral	✓	✓	✓	1. Meet the requirements for P1547 WG membership status, described at WG Membership (attend 2 consecutive Mtgs.) **OR** 1. Register for P1547 WG live meetings, where latest Drafts are provided as needed for meeting participation.
III. Contribute comments on IEEE P1547 in ballot (vote)	✓	✓	✓	1. Join Open Ballot Invitation on myBallot™ by use of IEEE Account **OR** 1. Join Public Review Process by visiting the IEEE-SA Public Review page.
IV. Ballot (vote) on IEEE P1547 **A successful ballot requires a 75% return and 75% approval.**	✗	(✓)	✓	1. Sign up for IEEE SA **Individual Membership** **OR** pay for single ballot 2. Join Open Ballot Invitation on myBallot™ by use of IEEE Account

Click on the links to open these websites.

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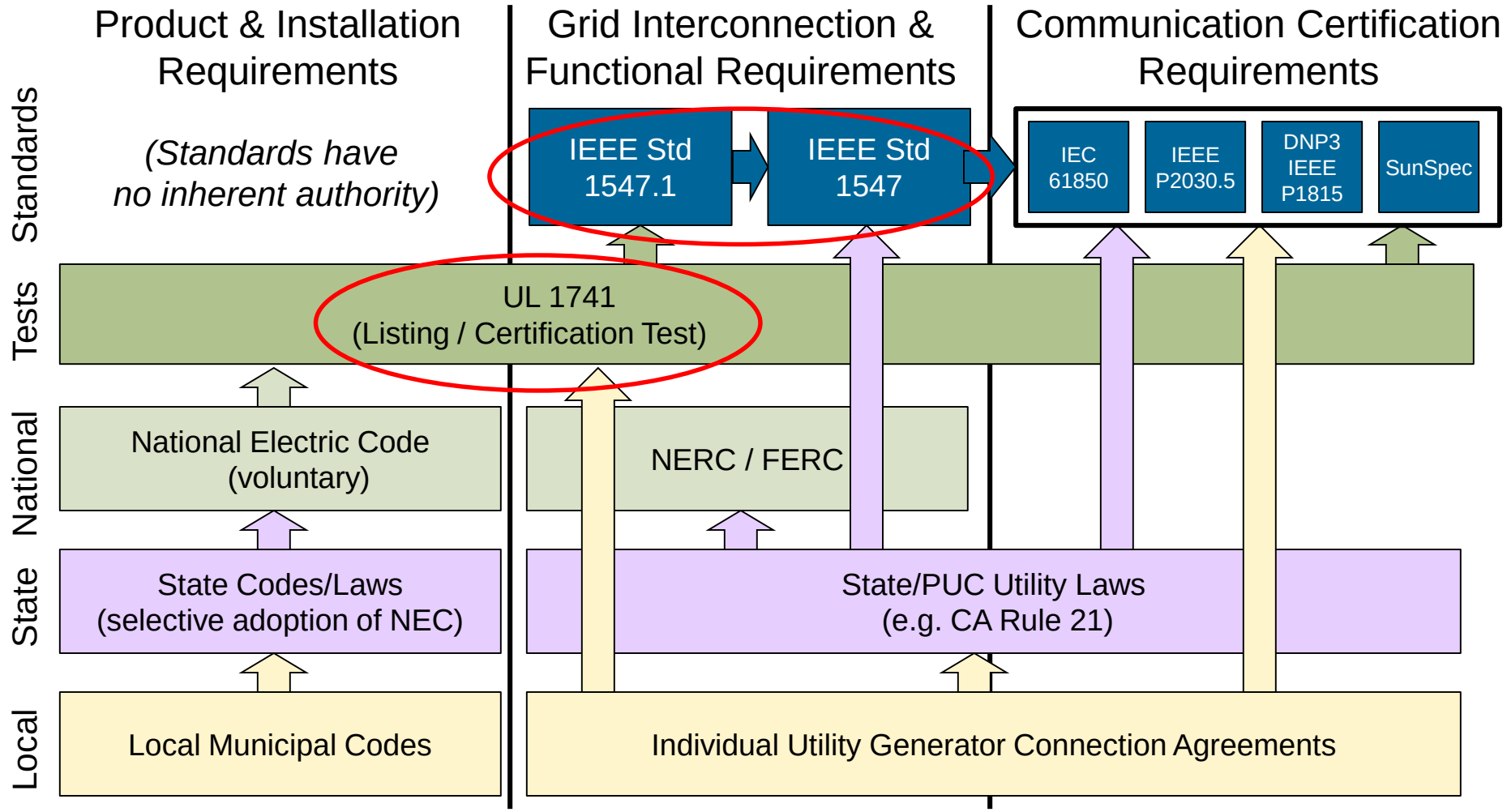
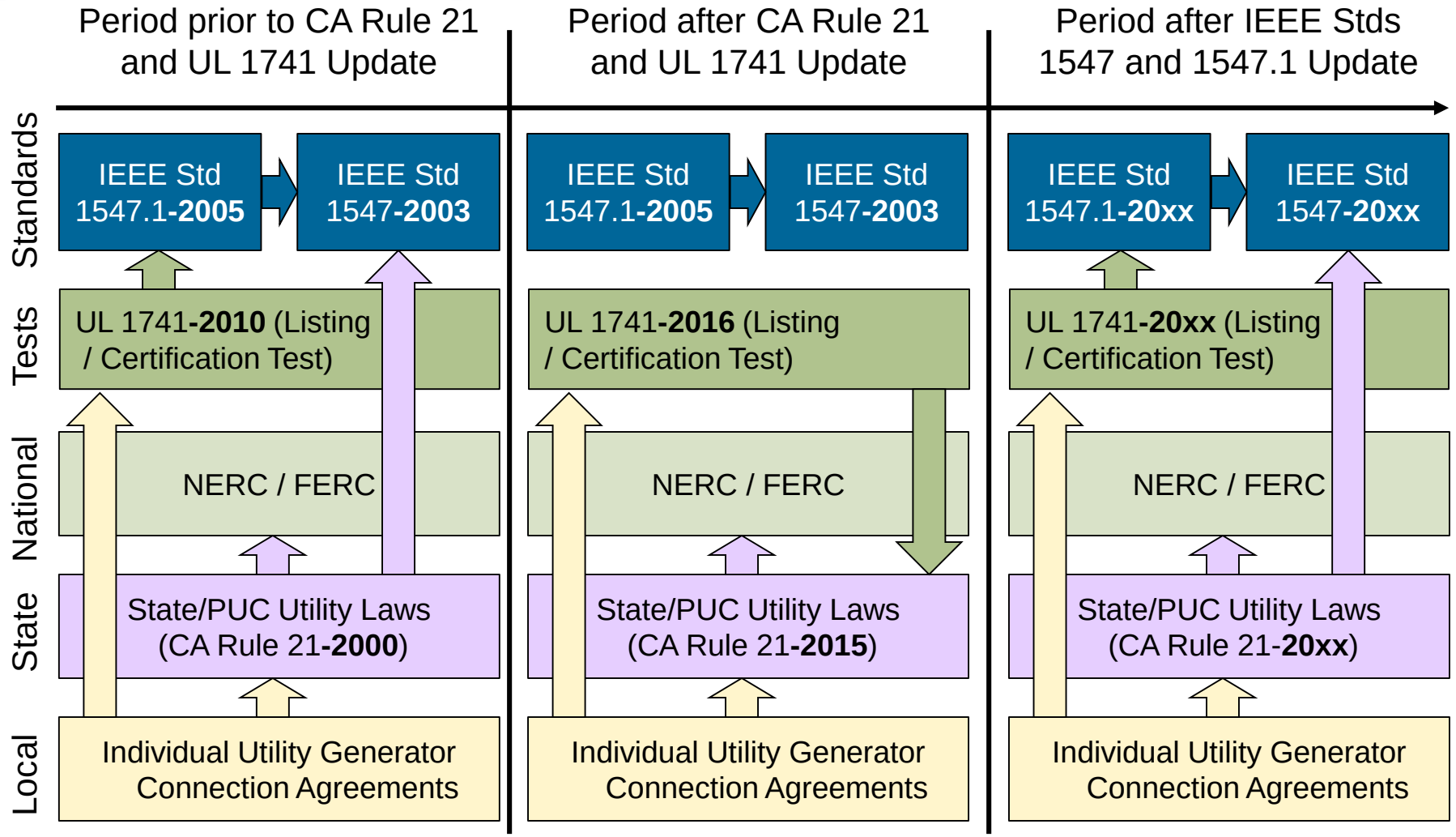
Jens C. Boemer – (206) 471-1180 – jboemer@epri.com

Backup
(General)

Role of IEEE Std 1547



Which standards apply during the transitioning period? (Example: California)



UL1741 New Supplement for Grid Support Utility Interactive Inverters

- Anti-Islanding
- L/HVRT
- L/HFRT
- Must Trip Test
- Normal Ramp Rate
- Soft-Start Ramp Rate
- Specified Power Factor
- Volt-Var Mode

- Other/ Optional
  - Frequency Watt
  - Volt Watt

Important Dates:

- Apr 11, 2016 – To UL1741 STP for ballot
- May 20, 2016 – Ballot ends

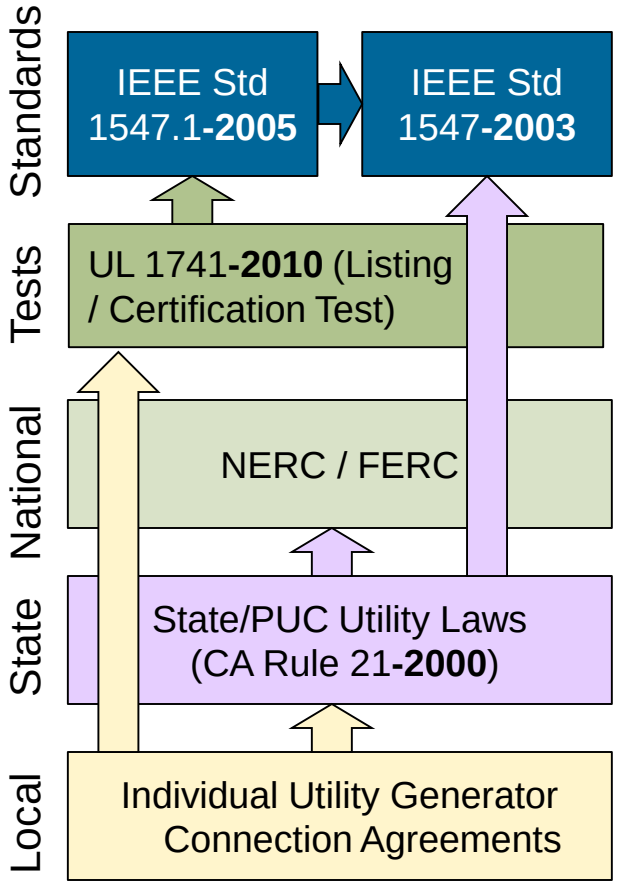
  (If obtain a consensus ballot on the first pass)
- Days/Weeks later – All comments resolved and SA published
- Recirculation of revised document early August
- Effective September 2016 (in general), June/July 2017 – Likely CA Rule 21 effective date for UL1741 SA

Source: Estimate based on informal conversation (not official UL schedule)

Background and Context

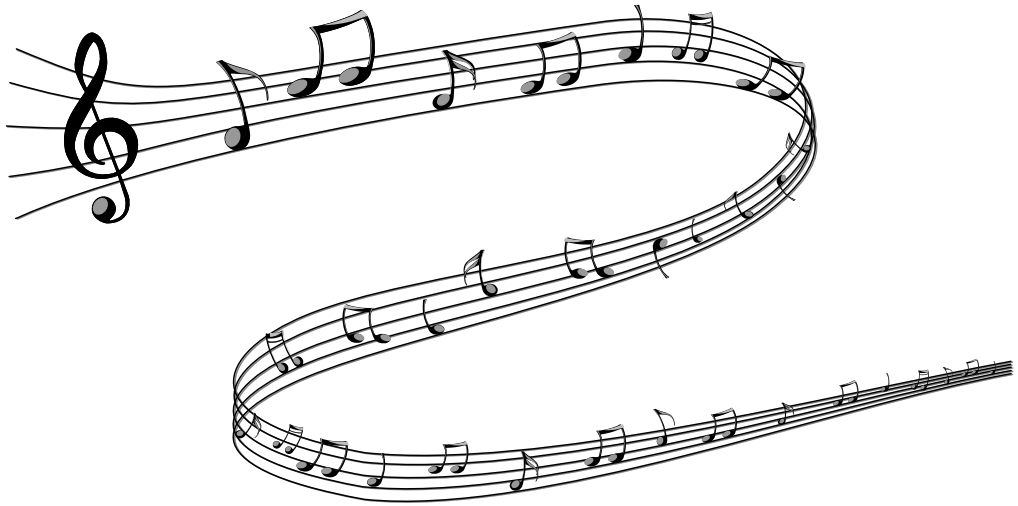
Role of IEEE Std 1547

Period prior to CA Rule 21 and UL 1741 Update



Harmony in the "Good Old Days" when Distributed Energy Resources were insignificant:

- DER interconnection focus.
- Technology-agnostic.
- Equipment standard / UL listing.
- **But: "Get out of the way" principle.**



Background and Context

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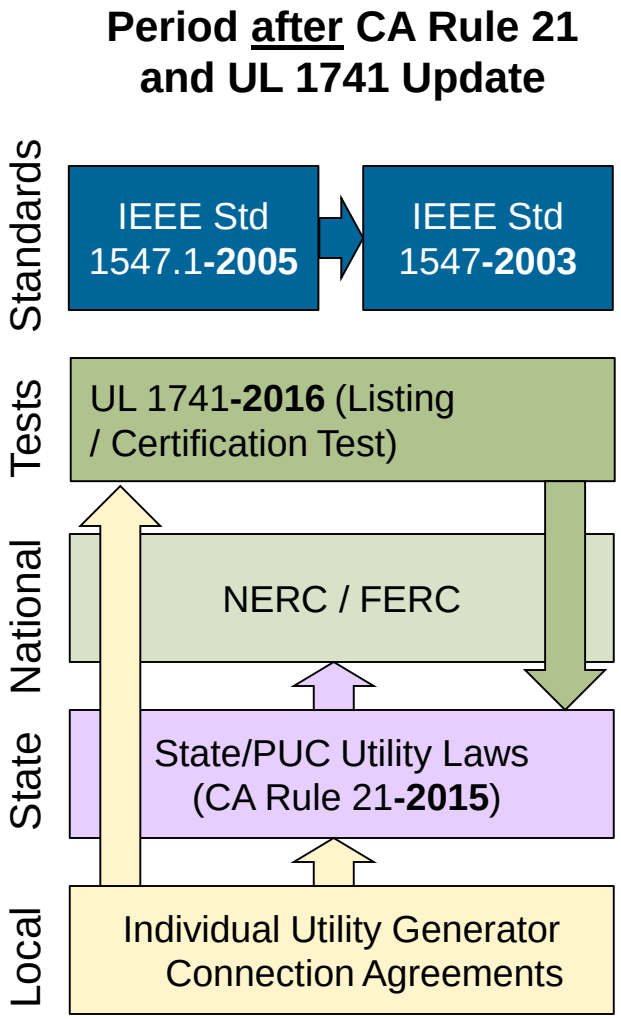
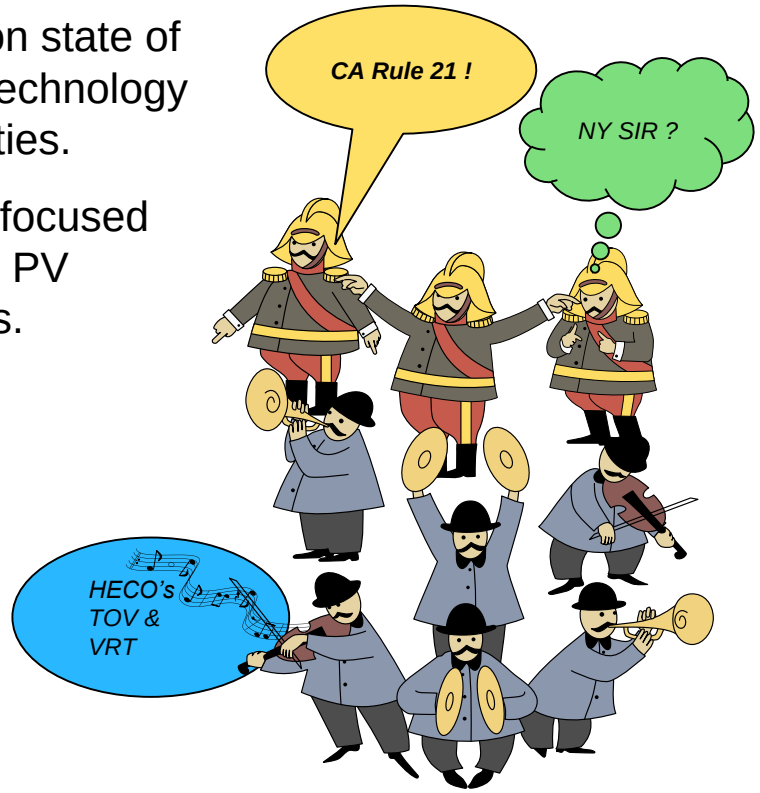


Today's Disharmony in a World of Uncertainty:

- Technology-specific requirements.
- Based on state of the art technology capabilities.
- Heavily focused on solar PV inverters.



Backup
(IEEE P1547 Draft 5)

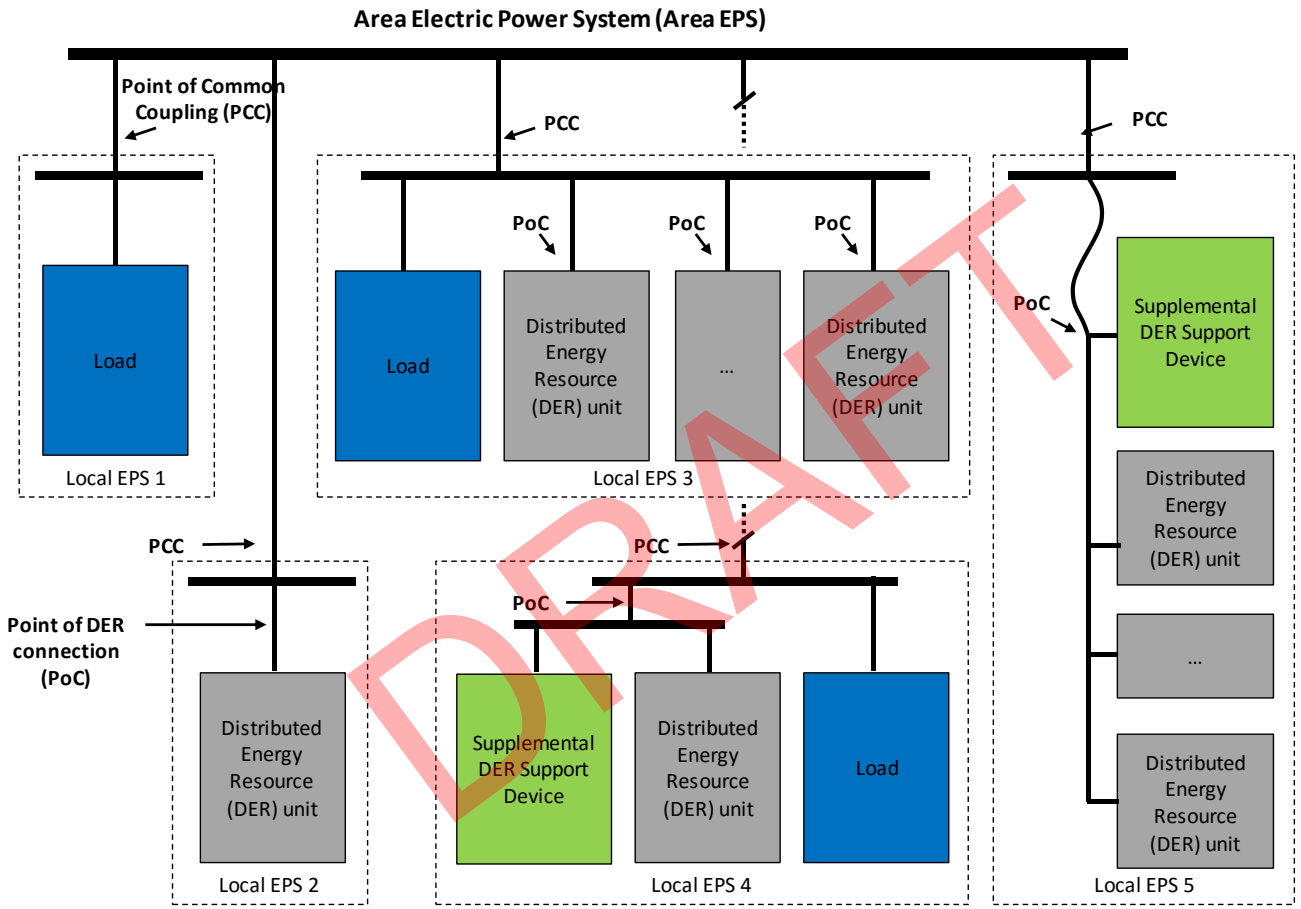
IEEE P1547 Working Group Organization

Group	Code	Scope	Subgroup Lead, (WG Vice Chair)	Alt. Lead	Facilitator(s)
F1	OD	Overall Document	D. Narang, NREL, **WG Chair**	C. Vartanian, MEPPI, **WG Secretary**	J. Boemer, EPRI
F2	GR1	Voltage regulation	B. Enayati, NationalGrid	J. Berdner, enphase	A. Huque, EPRI
F3	GR2	Response to abnormal grid conditions	J. Berdner, enphase	B. Enayati, NationalGrid	J. Boemer, EPRI R. Walling, WES
F4	IIAMS	Interoperability & Communication	B. Fox, SUNSPEC	B. Seal, EPRI	F. Cleveland W. Stec
F5	SI	Special Interconnections, islanding, microgrids, storage, etc.	C. Vartanian, MEPPI		L. Casey, Google M. Ropp, NPPT M. Coddington, NREL D. Mungovan, ConEd R. Bravo, SCE
F6	IST	Interconnection/Interoperability Test Specifications and Requirements, Modeling and Simulation	M. Siira, comrent		W. Stec M. Ropp, NPPT J. Piekarz, NG
F7	PQ	Power quality, Area EPS microgrids	B. Enayati, NationalGrid		Chris Rowe, Enphase

Click on the names to contact these individuals via email.

Major Changes in a Nutshell

Draft Figure 1 and Related Normative Definitions



There is a large variety of actual DER setups in the field. Figure 1 aims at illustrating five examples to explain certain concepts.

- **point of common coupling (PCC)** – The point where a Local EPS is connected to an Area EPS.
  - NOTE—See Figure 1.

- **point of distributed energy resources connection (point of DER connection—PoC):**
  The point where a DER unit is electrically connected in an EPS and meets the requirements of this standard exclusive of any load present in the respective part of the Local EPS.
  - NOTE—See Figure 1.
  - NOTE—For (a) DER unit(s) that are not self-sufficient to meet the requirements without (a) supplemental DER device(s), the point of DER connection is the point where the requirements of this standard are met by DER (a) device(s) in conjunction with (a) supplemental DER device(s) exclusive of any load present in the respective part of the Local EPS.

- **supplemental DER device:**
  An equipment that is used to obtain compliance with some or all of the performance requirements of this standard.
  - NOTE—Examples include capacitor banks, STATCOMs, harmonic filters that are not part of a DER unit, protection devices, plant controllers, etc.
  - NOTE—Communications gateways are not included in this definition.

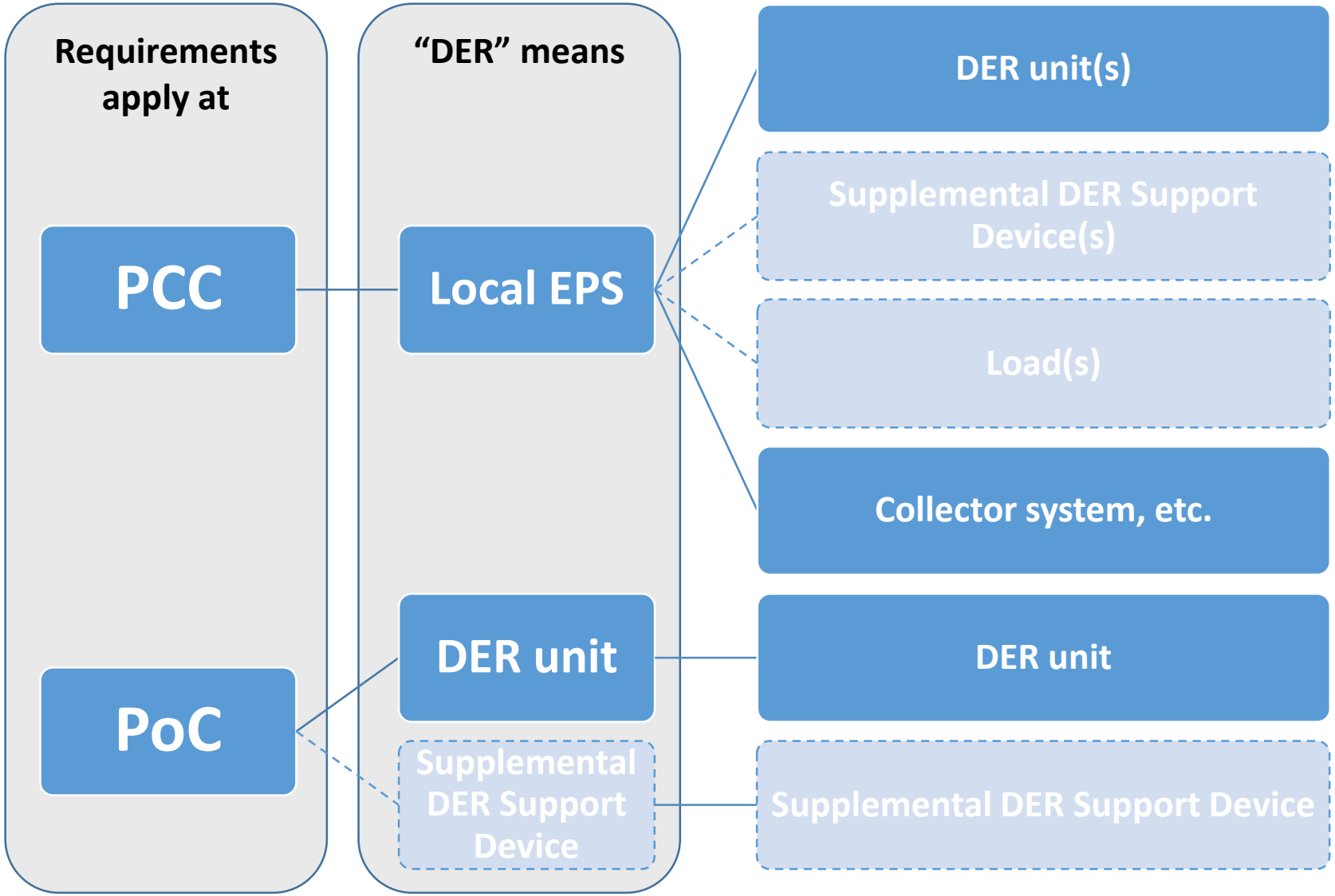
Major Changes in a Nutshell

Notes to Draft Figure 1

- NOTE—The example of **Local EPS 1** includes **only load**. Any requirements for this Local EPS are outside the scope of this standard.
- NOTE— The example of **Local EPS 2** includes **only DER**. Depending on the DER rating, requirements of this standard apply either at the PCC or the PoC. The DER unit in this example is able to meet requirements at its terminals without any supplemental DER device; the PoC coincides with the DER unit's terminals.
- NOTE— The example of **Local EPS 3** includes **both a DER unit and load**. Depending on the DER rating and the % of average load demand, requirements of this standard apply either at the PCC or the PoC. The DER unit is able to meet requirements at its terminals without any supplemental DER device; the PoC coincides with the DER unit's terminals.
- NOTE— The example of **Local EPS 4** includes **a DER unit, a supplemental DER device, and load**. Depending on the DER unit's rating and the % of average load demand, requirements of this standard apply either at the PCC or the PoC. The DER unit is not able to meet requirements at its terminals without any supplemental DER device; the PoC is the point where the requirements of this standard are met by the DER unit in conjunction with the supplemental DER device exclusive of any load, if present, in the respective part of the Local EPS.
- NOTE— The example of **Local EPS 5** includes **two (or more) DER units** and **a supplemental DER device** but **no load**. Depending on the aggregate DER units' rating, requirements of this standard apply either at the PCC or the PoC. The two (or more) DER two units are not able to meet requirements at their terminals without any supplemental DER device; the PoC is the point where the requirements of this standard are met by two (or more) DER units in conjunction with the supplemental DER device exclusive of any load, if present, in the respective part of the Local EPS.

Major Changes in a Nutshell

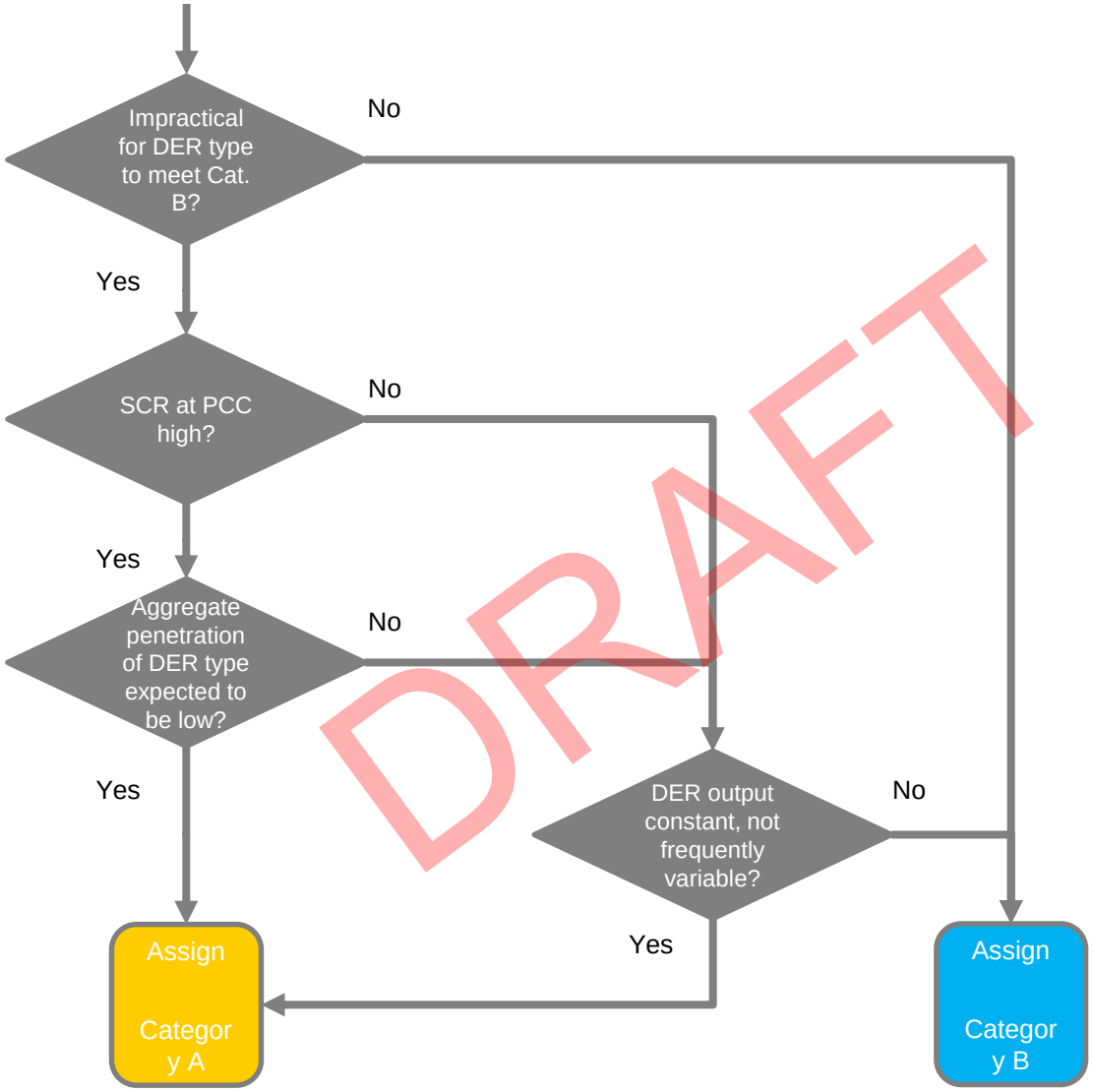
Use of “DER” term in IEEE P1547



- “DER” is a generic term for which performance requirements are specified in P1547.
- Its meaning may change for various DER setups:
  - DER is aggregate DER and/or supplemental units, loads, and collector system that relate to the PCC.
  - DER is a single unit in applications without multiple units or supplemental DER that relate to the PoC.

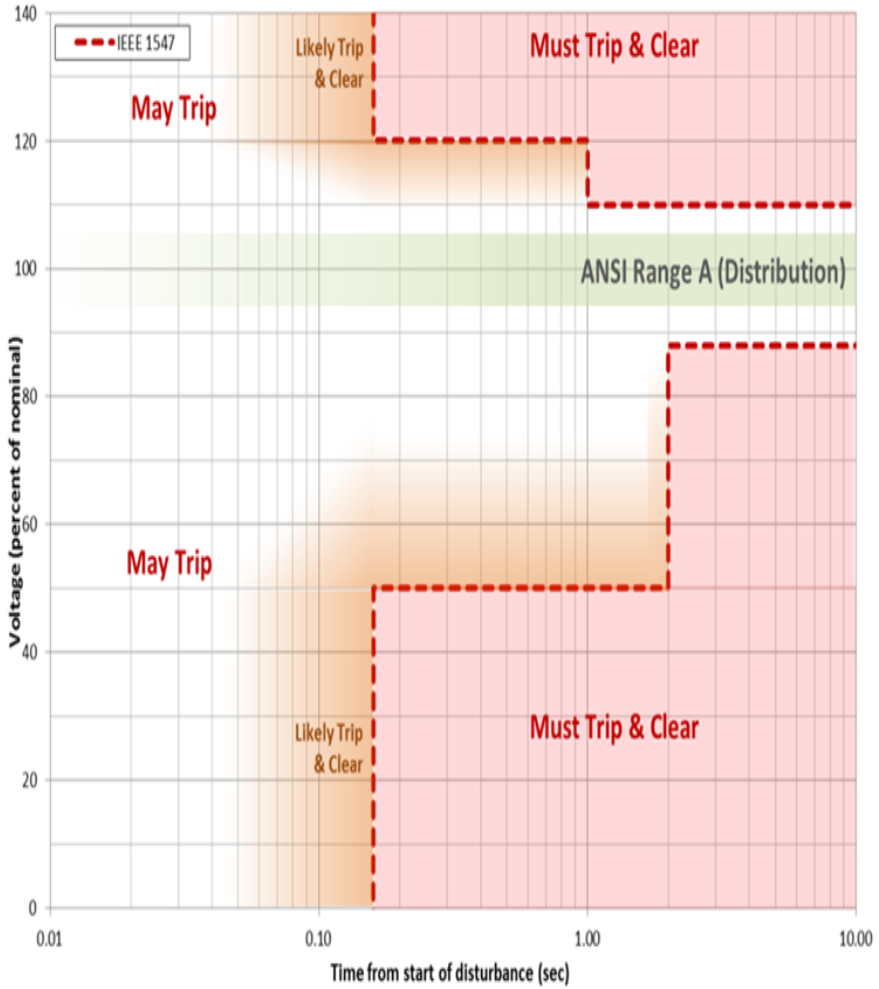
VAR and VAR-control capability

Example for Assignment of Voltage Regulation and Reactive Power Categories to DER



Voltage Trip Requirements

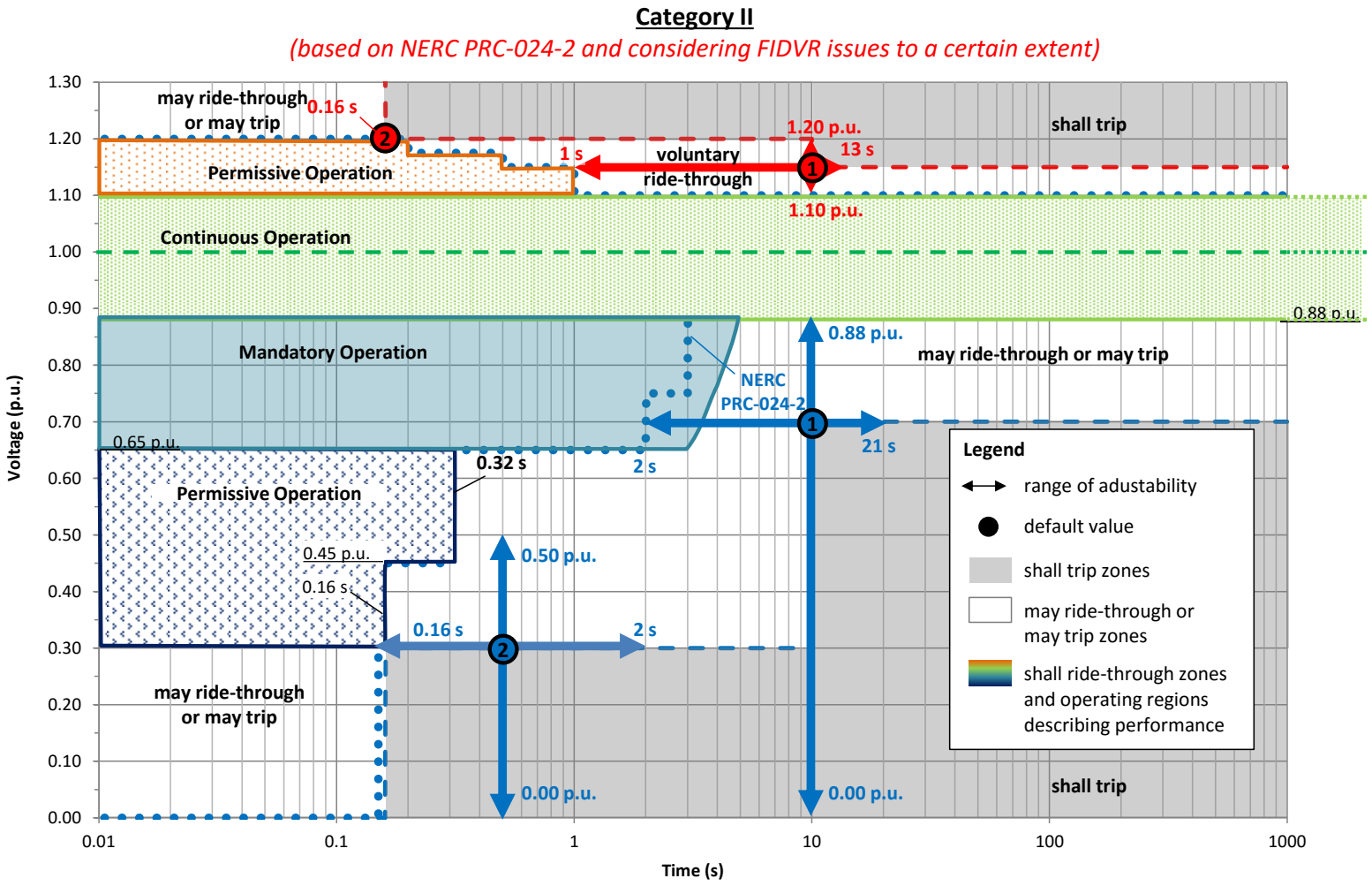
IEEE Std 1547-2003



Source: NERC, “Performance of Distributed Energy Resources During and After System Disturbance: Voltage and Frequency Ride-Through Requirements,” North American Electric Reliability Corporation, 2013.

Voltage Ride-Through Requirements

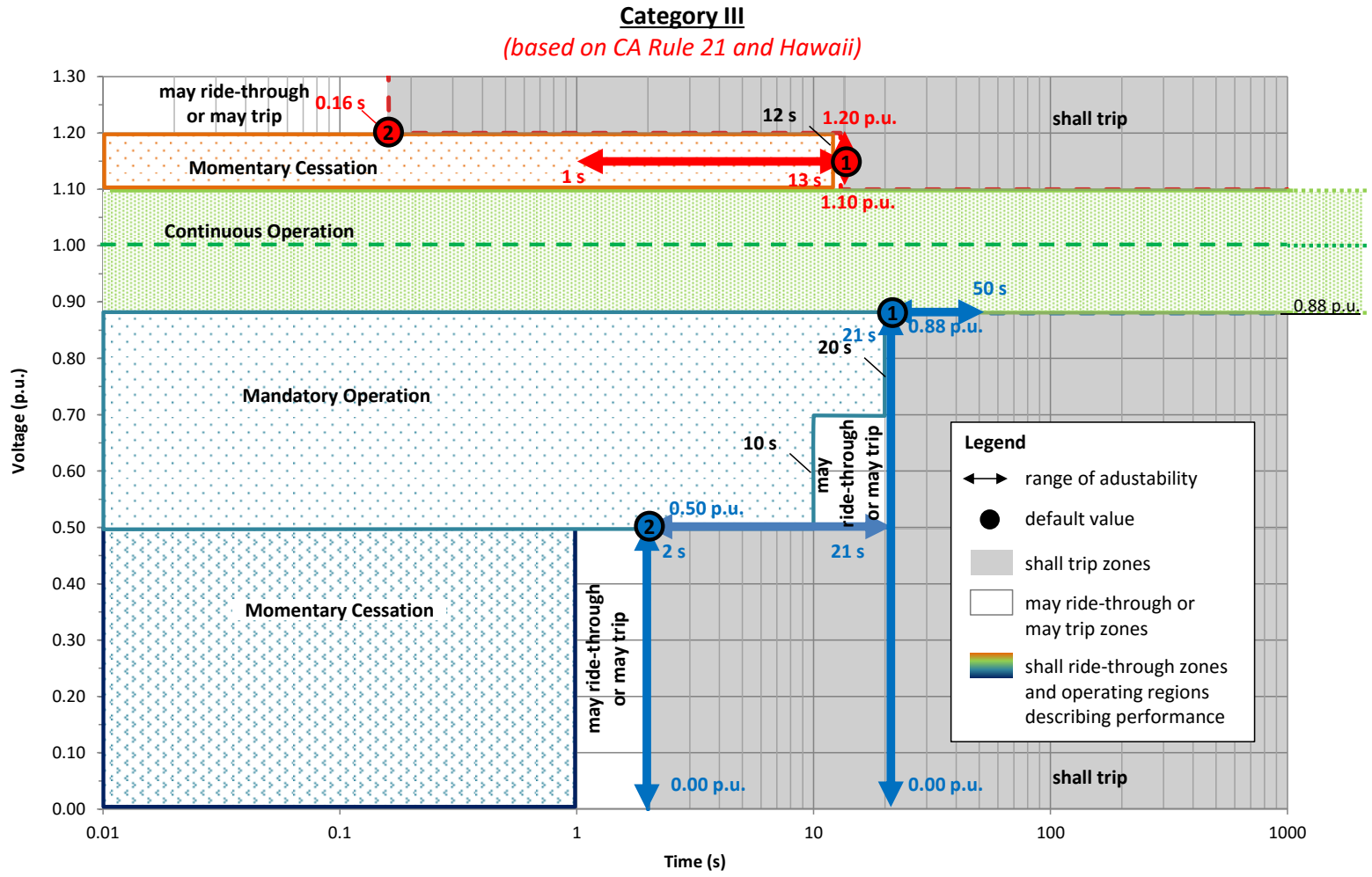
IEEE P1547 Draft 3 (January 2016) – Category II



Source: *Draft Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems*, IEEE P1547/D3, 2016.

Voltage Ride-Through Requirements

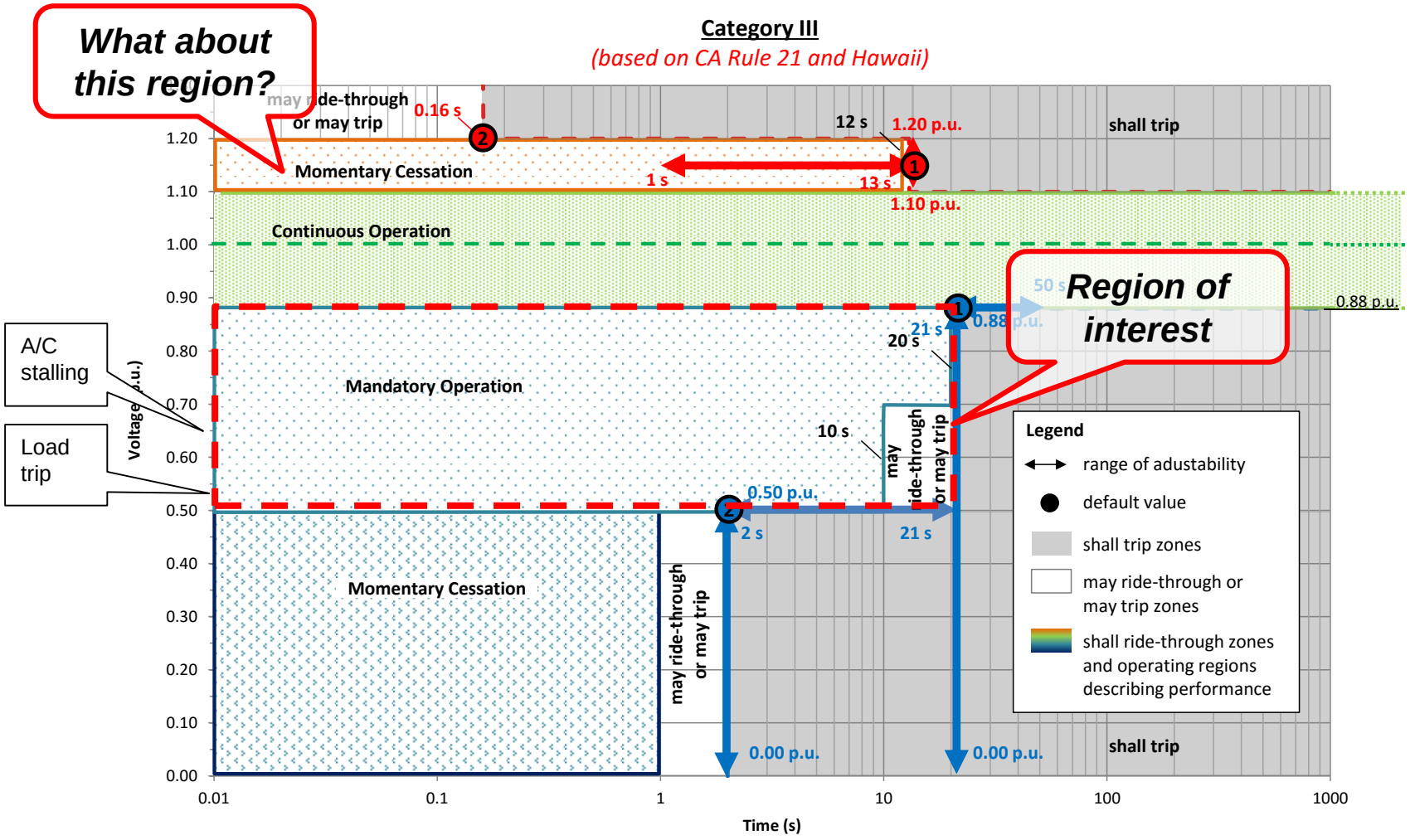
IEEE P1547 Draft 3 (January 2016) – Category III



Source: *Draft Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems*, IEEE P1547/D3, 2016.

Voltage Ride-Through Requirements

Dynamic Voltage Support



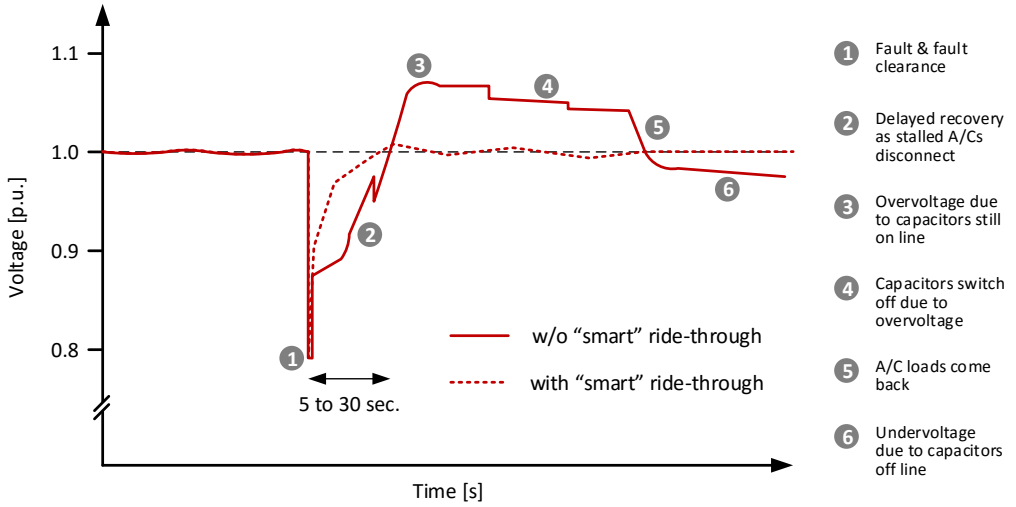
Source: *Draft Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems*, IEEE P1547/D3, 2016.

Dynamic Voltage Support

Considerations for 'Dynamic Voltage Support' from DER

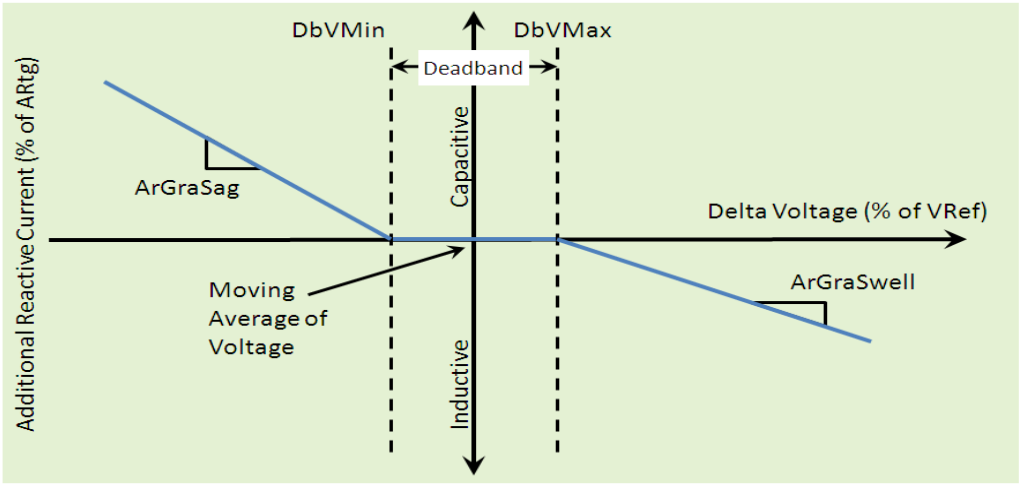
Support *during* disturbances?

- short-circuit contribution
- dynamic reactive current injection (DRC)
- fast voltage control / fast-responding closed-loop voltage regulation
- control loops typically operate in the sub-second time frame, often within a few cycles.



Support *after* disturbances?

- dynamic reactive support
- control loops typically operate in the 1 s … 10 s time frame



Further research required to adequately justify and specify requirements.

Voltage & Frequency Ride-Through

Draft Frequency-Droop Capability Requirements for All Categories

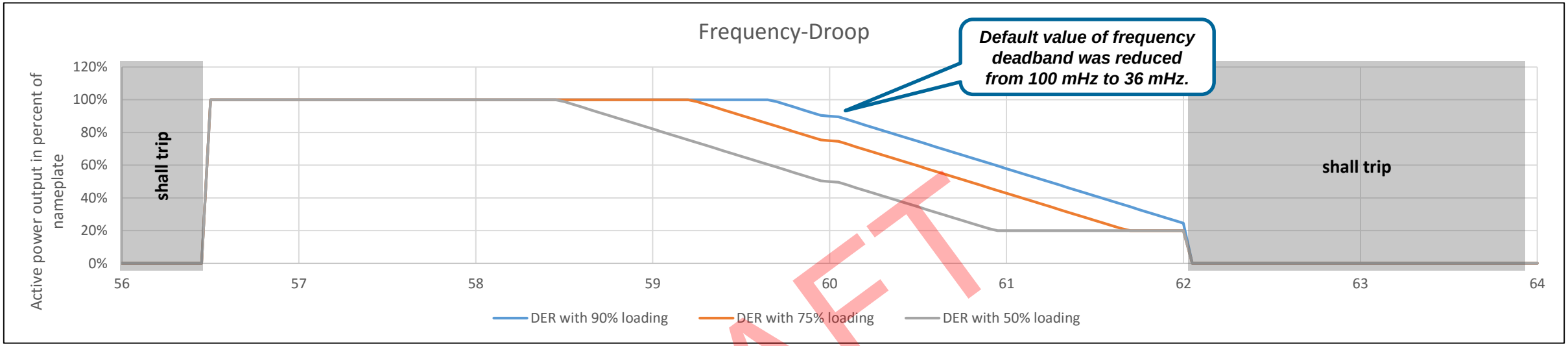


Table 17 – Parameters of frequency-droop (frequency/power) operation for DER of Category I, Category II, and Category III

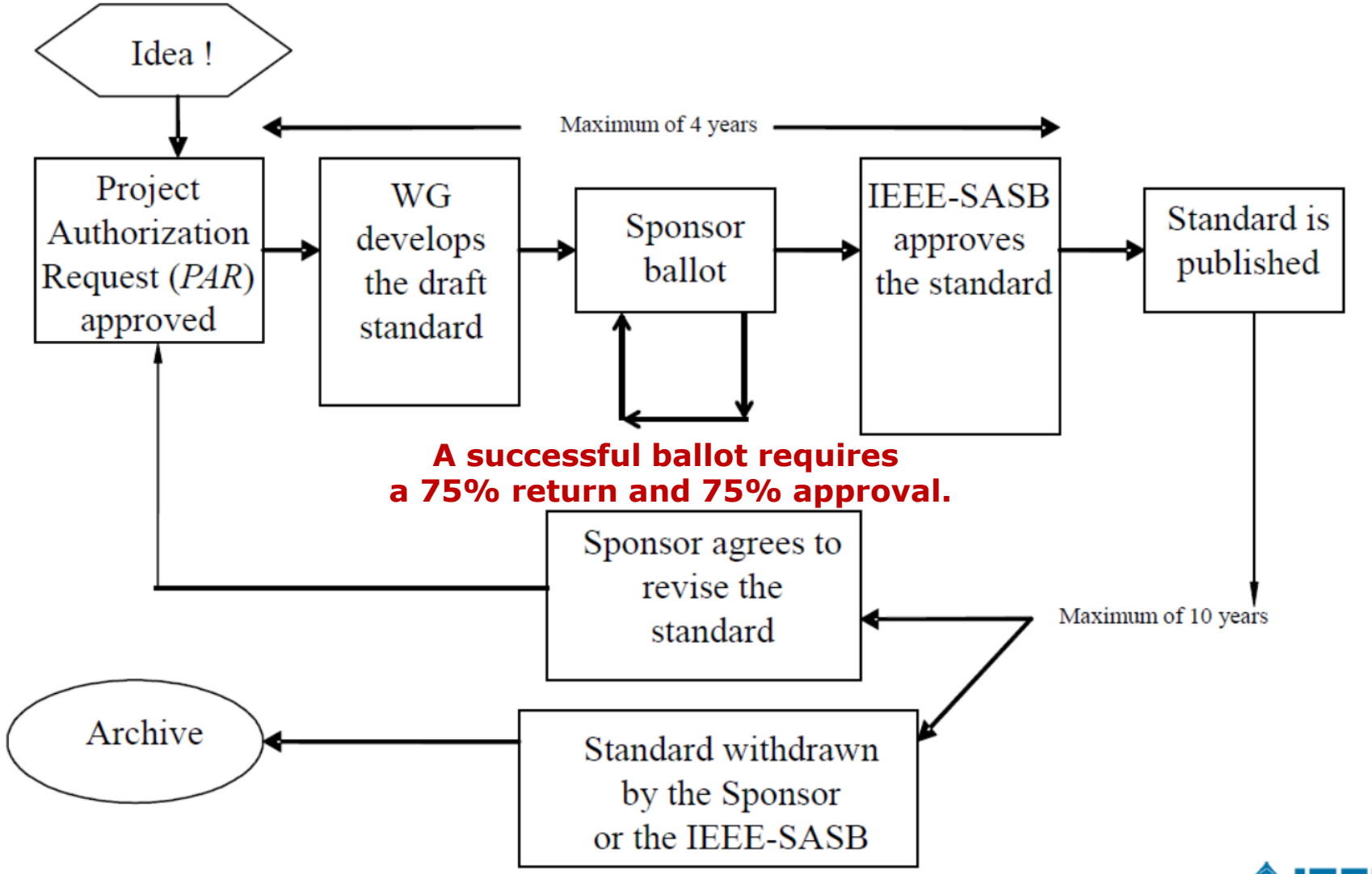
Parameters of frequency-droop (frequency/power) operation – Category I, Category II, and Category III						
Parameter	**Ranges of adjustability** (not a design criteria)			**Default settings[1]**		
	Category I	**Category II**	**Category III**	**Category I**	**Category II**	**Category III**
db_{OF}, db_{UF} [Hz]	0.017 – 1.0	0.017 – 1.0	0.017 – 1.0	0.036	0.036	0.036
k_{OF}, k_{UF} [p.u.]	0.03 – 0.05	0.03 – 0.05	0.02 – 0.05	0.05	0.05	0.05
[1] Adjustments shall be permitted in coordination with the Area EPS operator.						

What is the process to get involved, the rules for voting? - Participation in IEEE Standards

- IEEE
  - IEEE Standards Association
    - Standards Coordinating Committee 21
      - IEEE 1547 “Series of Interconnection Standards” Working Group
        - IEEE 1547-yyyy (where yyyy is the year of the revision)
        - IEEE 1547.n (where n designates one of a set of related standards and recommended practices developed by the working group)

- Participation
  - IEEE 1547 is based on Individual Membership
    - https://www.ieee.org/membership_services/membership/membership_standards.html
  - Voting membership in the working group is based on participation
    - “Letter ballots” are the normal process for achieving consensus within the WG
  - Sponsor Ballot – final phase of balloting, open to all IEEE-SA, not only the WG.
    - Voting on the sponsor ballot requires the individual to have IEEE-SA membership. No WG participation requirement.
    - Request to join sponsor ballot, cast vote, and submit comments at https://development.standards.ieee.org

IEEE Standards Development Lifecycle



Standards Process Overview: http://standards.ieee.org/develop/overview.html

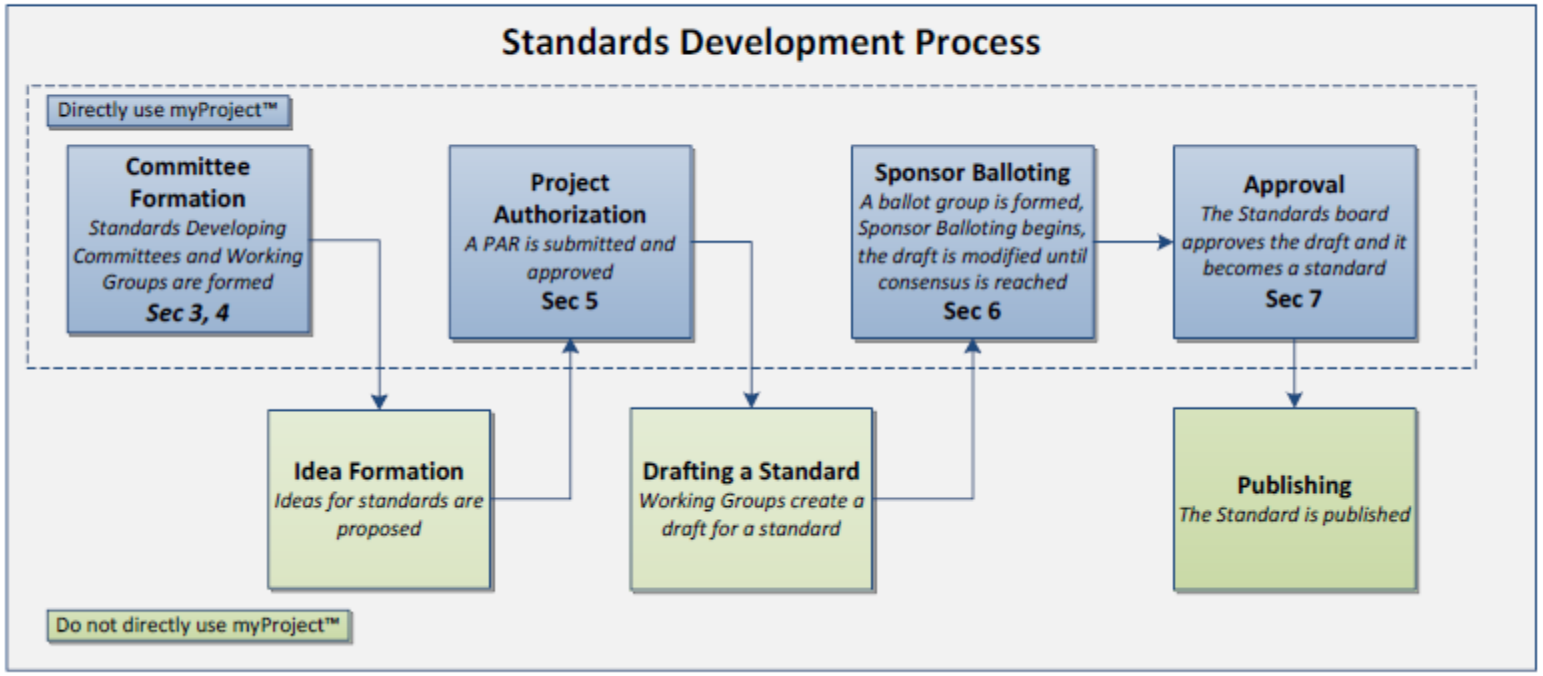
IEEE Advancing Technology for Humanity

Source: http://grouper.ieee.org/groups/scc21/docs/EPEC20151026-1547-2030-Final.pdf

EPRI ELECTRIC POWER RESEARCH INSTITUTE

IEEE-SA, Standards Balloting

How myProject™ is used in the standards development process:



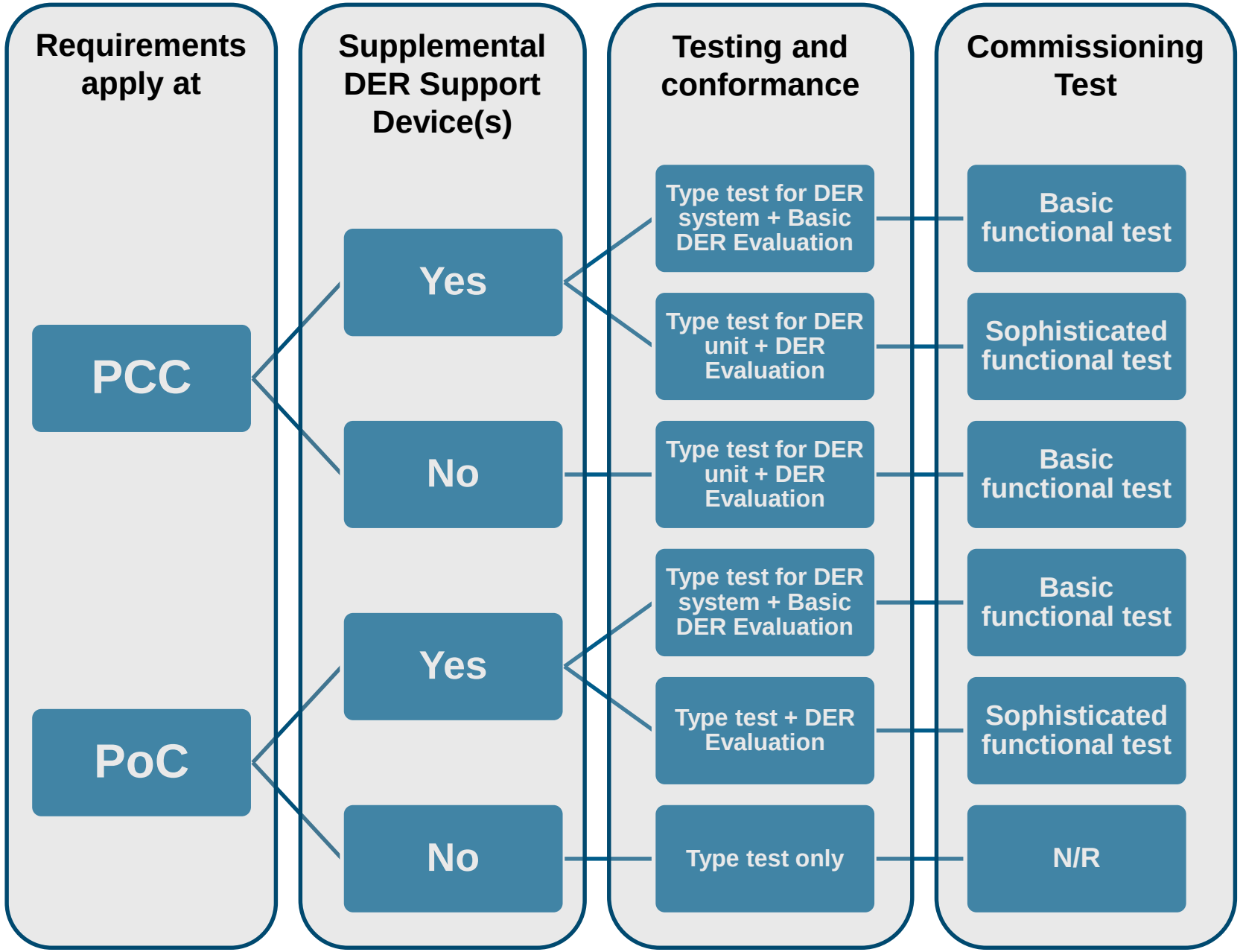
Backup
(EPRI Proposal for section 5, Testing & Conformance)

Revised Definitions of Test Types (revised 10/4)

- **NTRL (implementation / audit)**
  - **Type Test** – Tests of one device or combination of devices forming a system made to a certain design to show that the design meets certain specifications (performance requirements and/or communications capabilities) or provide information that can be used to verify compliance. In case of a combination of devices forming a system, this test shows that the devices are able to operate together as a system (→ interoperability).
  - **Production Test** - Tests conducted on every unit of equipment prior to customer delivery to demonstrate that they meet the design specifications and applicable standards.

Revised Definitions of Test Types (revised 10/4)

- **Someone else (*see next slide*)**
  - **DER Evaluation**
    1. **Design Evaluation** (Desk Study) – Evaluation at time of interconnection request to verify that the composite of the individual partially-compliant DERs forming a system as designed meets the interconnection and interoperability requirements at the applicable reference point, i.e. Point of DER Connection (PoC) or Point of Common Coupling (PCC). This evaluation is usually done off-site before equipment is delivered and installed.
    2. **As-built Installation Evaluation** (On-Site) - Evaluation at time of commissioning to verify that the composite of the individual partially-compliant DERs forming a system as delivered and installed meets the interconnection and interoperability requirements at the applicable reference point, i.e. Point of DER Connection (PoC) or Point of Common Coupling (PCC). This evaluation **does not require testing**.
  - **Commissioning Test** – Tests and/or verifications on one device or combination of devices to confirm that the system as designed, delivered and installed meets the interconnection and interoperability requirements at the applicable reference point, i.e.
    - Point of DER Connection (PoC) : Basic functional test
    - Point of Common Coupling (PCC) : Sophisticated functional test
  - **Periodic Test** – Tests and/or verifications, according to a scheduled time period or other criteria, that confirm that one device or combination of devices meets the interconnection and interoperability requirements at the applicable reference point, i.e. Point of DER Connection (PoC) or Point of Common Coupling (PCC).

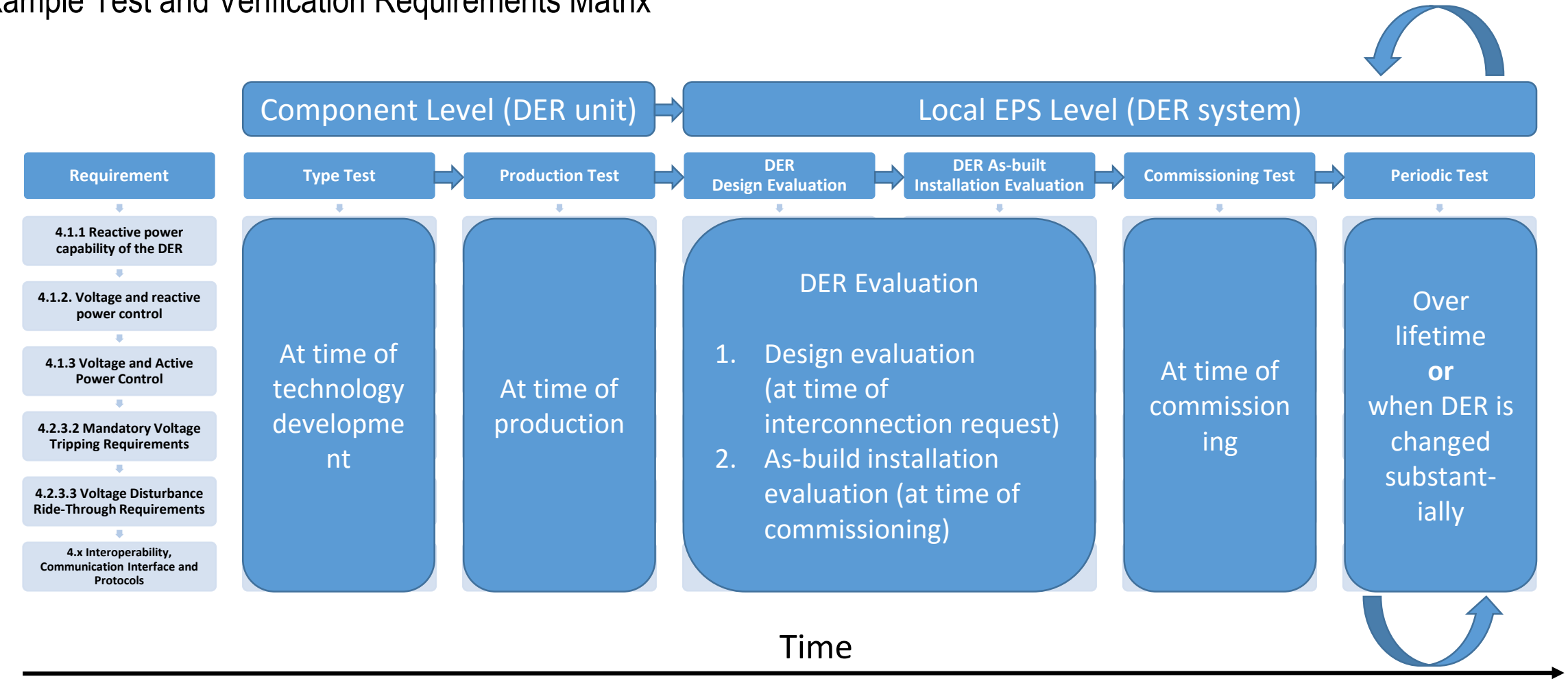


Certificates in Germany

unit	facility	eval.
./.	./.	./.
✓	✓	✓
✓	✓	✓
./.	./.	./.
./.	./.	./.
✓	✗	✗

Test and Verification of Requirements

Example Test and Verification Requirements Matrix



Legend:

F – for **full** conformance of DER unit, **P** – for **partial** conformance of DER unit, **N/R** – Not Required

Test and Verification of Requirements

Who may conduct the design & installation (field) evaluation?

Candidates

- The DER developer
- The Area EPS operator / utility
- The Authority Governing Interconnection Agreements (AGIA)
- An independent third party

Challenges

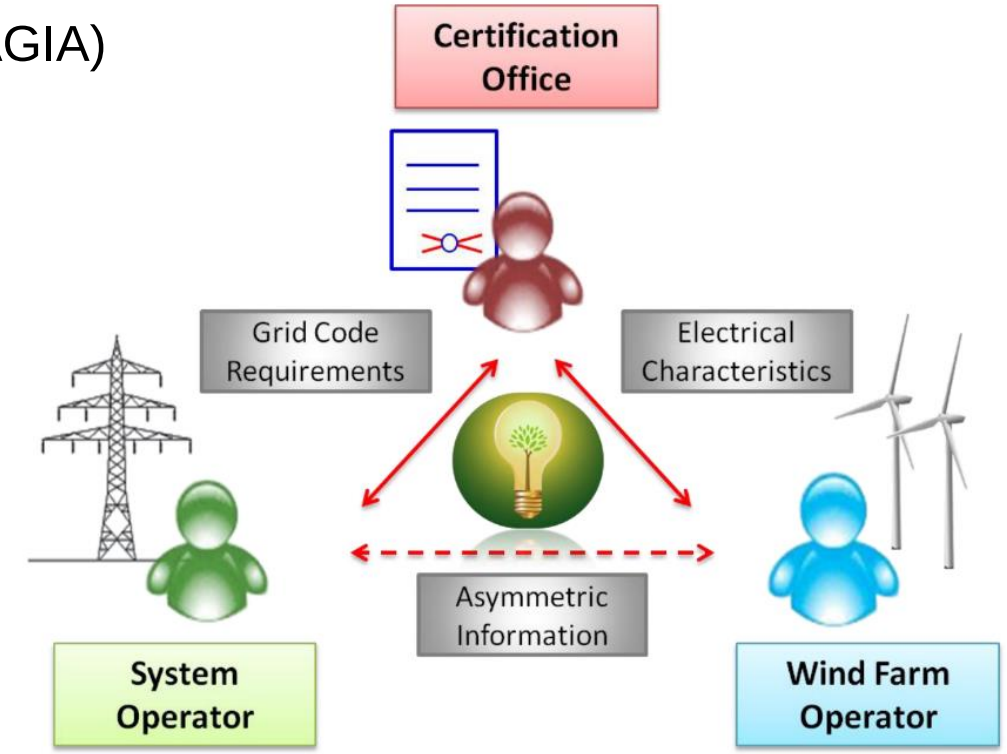
- Different business objectives among parties
- Conflicts of interest
- “System reliability” is a public good

Proposal

- Assign responsibilities in a flexible way
- Use “may” / “or” rather than “shall” language

➢ “Area EPS operator **or** DER operator **or** third party”

Example Germany:
Three mayor players in the certification process for grid integration.



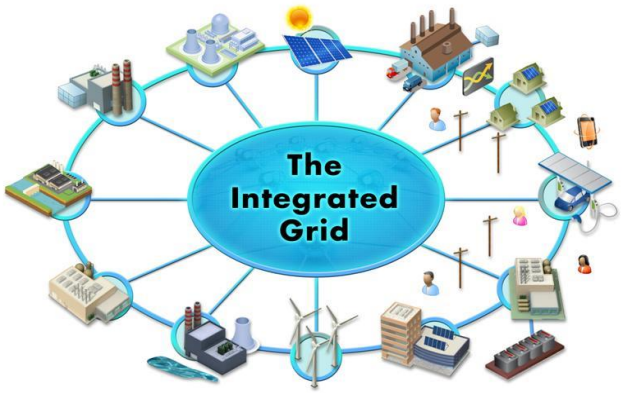
Source: J. Langstädtler, B. Schowe-Von der Brelie, and F. Kalverkamp, “Certified wind power plants as a dependable solution for effective system integration,” in World Wind Energy Conference, 2012.

Backup
(Interoperability and Communication)

Why is interoperability in IEEE 1547 PAR?

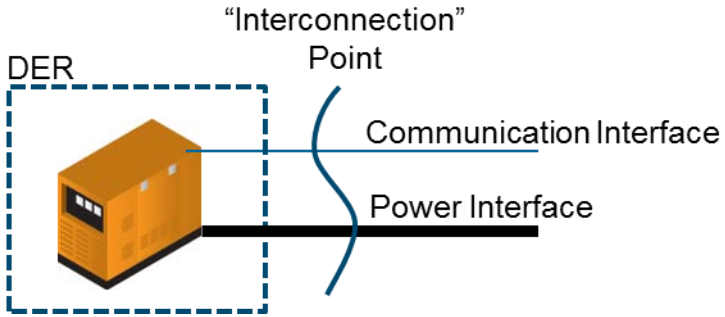
Supports the direction of grid transformation:

- The Integrated Grid
- Connectivity
- Billions of Distributed Energy Resources Future
- Learning from the mistakes made by Germany



➢ Standards help to reduce costs and create interoperability

- IEEE 1547 is an “Interconnection” standard
- The point of interconnection now includes power and communication interfaces



What is in the Current IEEE 1547 Draft (V5)

A DER shall provide interoperability support at one of the following levels:

- monitoring and management enabled
- monitoring enabled
- no interoperability support

The interoperability support level required shall be allowed to be specified by the EPS operator.

The information models and communication protocols used for the information exchanges shall be standards mutually agreed upon by the Local and Area EPS operators. Examples of such communication standards are provided in Annex MIC. For the purpose of ensuring or increasing interoperability, it is recommended that Area EPS operators develop and coordinate detailed profiles and guidelines for the implementation of the agreed upon information models, communication protocols, and the data to be exchanged.

Interoperability and Communication

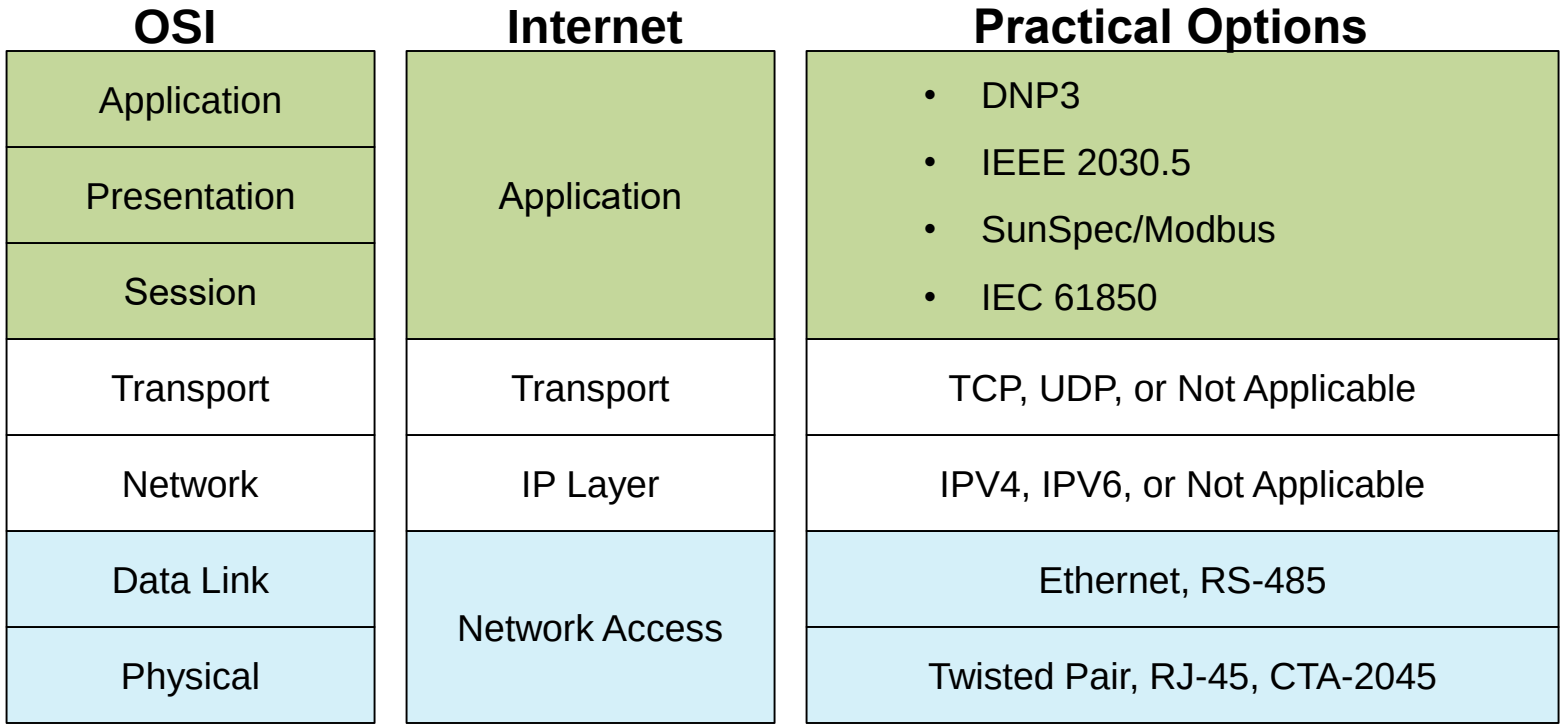
Logical Combinations

Application	DNP3	IEEE 2030.5	SunSpec Modbus
Transport	TCP	TCP	N/A
IP Layer	IP	IPV6	
Network Access	Ethernet	Ethernet	RS-485
	Twisted Pair/RJ-45	Twisted Pair/RJ-45	Twisted Pair/ RJ-45/CTA-2045

- Allowing for a couple of well-defined options gives vendors more flexibility and is still achievable for aggregators/integrators.

Specifying Communication Interoperability

Multiple Layers Involved



- Lower layers provide physical compatibility. They avoid the need for electricians onsite, custom wiring, adapters
- Upper layers provide software compatibility. They avoid the need for protocol translation reduce software complexity.

Interoperability and Communication

Powering Communication Devices

- Not a concern for *large-scale* DER
  - Electrician will go onsite
  - Dedicated cabinet, backup battery, power supply
- A major concern for *small-scale* DER
  - Where to get power?
  - Expense of conduit, electrician
- Communication interfaces can include power for the communication devices:

USB 3.0
5V @ 900[mA]

PoE
44V at 350[mA]

CTA-2045
AC line @ 50[mA]
3.3V@750[mA]