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Revising IEEE Std. 1547 and 1547.1 to Maintain Power System Reliability and Safety with High Penetration of Distributed Generation —Informal report based on IEEE P1547/Draft 5.0 (August 2016)—

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SUMMARY

The main interconnection standard for distributed energy resources (DER) in North America, IEEE Std 1547, is being revised. Originally developed assuming a low penetration of DER, the standard has been broadly adopted in the U.S. to guide the interconnection process. However technological and economic advances, especially within the distributed photovoltaics segment, have led to many cases of high penetration levels in the grid, hence, a need to update the standard. Testing and certification requirements are specified in IEEE Std 1547.1 and are also under revision. This article provides an informal report on the status of the revision of IEEE Stds 1547 and 1547.1. It presents the authors' individual views on the revision efforts and is not the formal position, explanation or position of the IEEE. The specific draft requirements are subject to changes during the standard's balloting process.

KEYWORDS

distributed energy resources (DER); distributed photovoltaics (dPV); grid codes; performance requirements; power system reliability; power quality.

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1. INTRODUCTION

The IEEE Std 1547 (abbreviated '1547' throughout this paper) was sponsored by the IEEE Standards Coordinating Committee 21 (SCC21). This committee covers Fuel Cells, Photovoltaics, Dispersed Generation, and Energy Storage. The standard was published in 2003 as a voluntary, industry standard for interconnecting distributed energy resources (DERs) with electric power systems (EPSs). It was originally developed as a distribution system safety and power quality standard assuming low penetration treating all DG technologies in the same way (technology-neutrality). The standard has been referenced to in the United States (U.S.) Energy Policy Act of 2005 [1] as well as FERC's Small Generator Interconnection Procedures of 2009 [2] and has been broadly adopted in the U.S. Although 1547 is not a legally binding grid code, it has become the primary interconnection standard for DER in North America through adoption by Authorities Governing Interconnection Agreements (AGIAs).
The criteria and requirements put forth in 1547 are applicable to all DER technologies interconnected to EPSs at any typical primary and/or secondary distribution voltages. Hence, 1547 is not structured along distribution voltage levels as it is done in other parts of the world, e.g. in Europe (CENELEC) and particularly Germany (VDE|FNN).
We would like to thank EPRI members for their continued support on IEEE P1547 and P1547.1 activities.
1547 sets grid interconnection performance requirements for DERs. Testing and certification requirements are specified in IEEE Std 1547.1 (abbreviated '1547.1' in this paper). Besides an IEEE 1547.x series of technical standards and informative guidelines, there are a number of other standards, state rules, and grid codes for DERs in the U.S. as shown in Figure 1. Most notable are the California Electric Rule No. 21 on Generating Facility Interconnections (CA Rule 21) [3] that is currently leading 'smart inverter' interconnection requirements in the U.S. and the related UL 1741(SA) for Grid Support Utility Interactive Inverters [4] specifies certification requirements and test protocols.

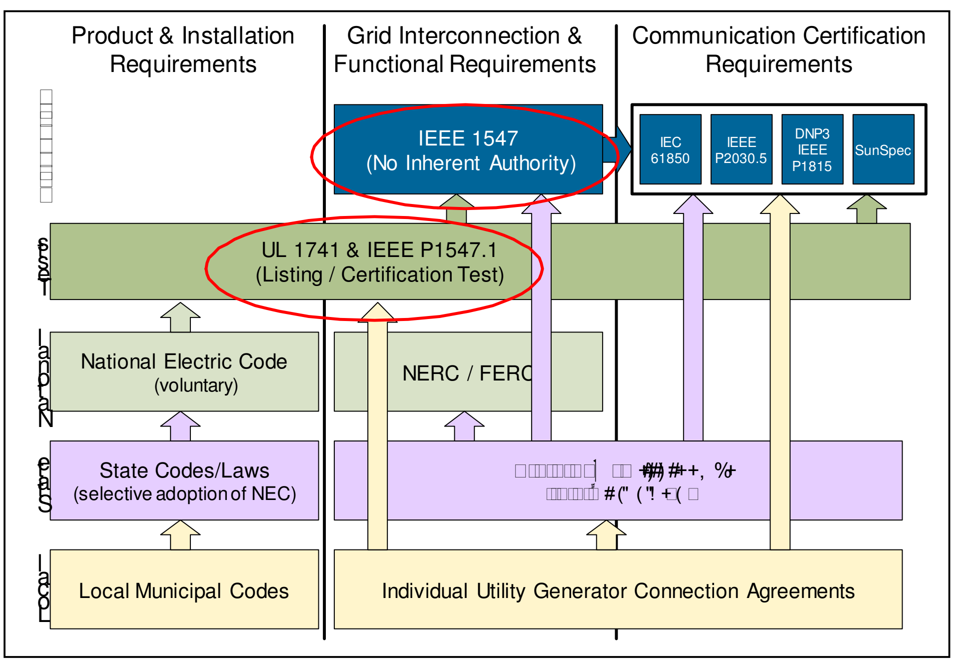

Figure 1. Standards, state rules, and grid codes for DERs in the U.S.

Updating 1547-2003 requirements for higher DER penetrations, SCC21 passed an amendment in 2014. This move, albeit relatively late, aimed to avoid bulk power system reliability risk due to the very narrow voltage and frequency trip requirements. The amendment also *allows* for advanced DER grid support such as steady-state voltage control and disturbance ride-through, it does not *mandate*, nor specify, any requirements. Hence, the full revision of 1547 that started in 2014 aims at filling this gap, see Figure 2. The functional and performance framework leverages, among others, from EPRI's report on common functions for smart inverters [5].

As of August 2016, the latest draft is IEEE P1547/D5 [6] and the fully revised, final draft IEEE P1547 standard is expected to enter IEEE SA balloting in spring 2017. In parallel, revision of conformance test procedures specified in 1547.1 has commenced in March 2016 and may continue over a period of 1–2 years. These revisions will not enter into effect until the revised 1547 has been adopted by AGIAs and DER vendors and developers have proven compliance of DER units and facilities through 1547.1 by end of this decade.

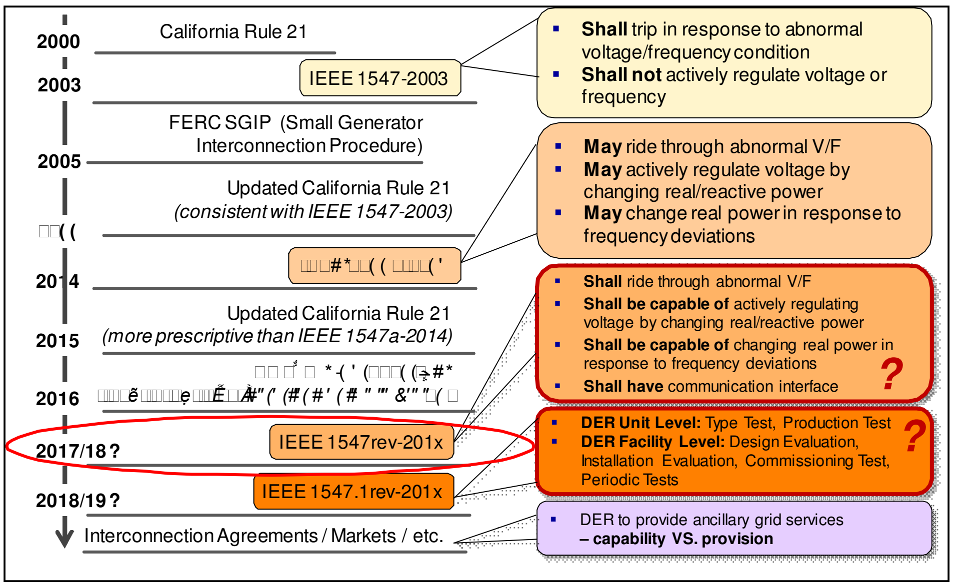

Figure 2. History of IEEE Std 1547, CA Rule 21, and UL 1741

2. A FRAMEWORK FOR FLEXIBLE AND HARMONIZED INTERCONNECTION REQUIREMENTS

2.1. Operating Performance Categories

The technology neutrality of 1547 does not allow for calling out different interconnection requirements for (smart) inverters and rotating machines as it is typically the case for large-scale generating facilities [7]–[8], in state rules [3] and in other parts of the world, e.g. Europe [9]–[10] and Germany [11]. Yet, various DER types differ in their inherent ability to achieve disturbance ride-through performance comparable to requirements imposed on bulk system generation.

Universally requiring high levels of ride-through performance sufficient to meet all bulk system reliability needs might exclude certain types of DER from interconnection. Further, those types of DER that could be excluded by stringent, universally-applied ride-through requirements may provide important societal benefits, e.g., conversion of landfill methane to energy.

Therefore, the draft 1547 provides a *framework* for AGIAs to assign appropriate DER disturbance ride-through performance requirements. It does not impose a single definitive and universal requirement for (smart) inverters and rotating machines. A limited number of groupings of sets of requirements—standardized operating performance categories—specify technical capabilities and settings for a DER under normal and abnormal operating conditions. The former are designated by alphabetical characters (Category A & B) and the latter by Roman numerals (Category I, II & III). This concept is shown in Figure 3.

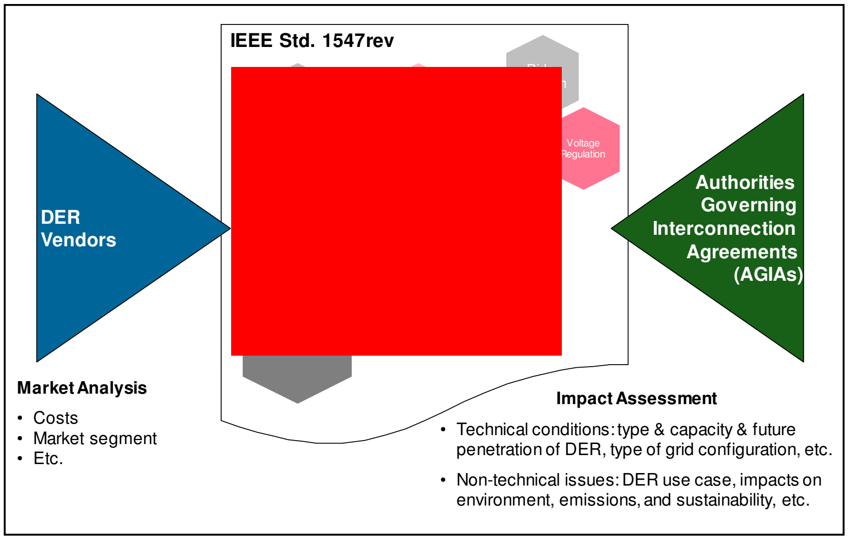

Figure 3. Sets of requirements that specify technical capabilities and settings for a DER under normal and abnormal operating conditions ('performance categories')

2.2. Implementation and Assignment Process

The AGIA will have the discretion to assign performance categories based on technical conditions such as DER technology, application, location, or (expected) penetration levels. The framework is flexible enough so that also non-technical criteria may be considered. An impact assessment and stakeholder process would precede the assignment by an AGIA. Assignments should be firm and legally binding for a certain period in order to guarantee investment and planning security to DER vendors and developers. Where applicable, Distribution Resources Plans (DRPs) may include DER operating performance category assignment.

This category framework is expected to allow for specification of harmonized interconnection requirements while providing flexibility and lead technology innovation.

2.3. Parameter specification

DER location or evolving grid conditions may require adaptation or continued changes of functional DER parameter values. Therefore, 1547 will require certain parameters to be adjustable within a specified range of adjustability. While default values will be specified in the standard that are deemed to be adequate for the majority of use cases, the distribution system operator (Area EPS Operator) may request other parameter values within the specified ranges.

2.4. Applicability of requirements

The old 1547 standard was written to establish criteria and requirements for interconnection of DERs with the distribution system (Area EPS) the point of common coupling (PCC). Due to its simplicity, the old standard focused on the performance of the 'interconnection system' used to interconnect the DER unit(s). As a matter of fact, however, the old standard was exclusively applied as an equipment standard in the past, with requirements being met by the individual DER unit(s) rather than by the whole DER facility (Local EPS). This concept is changed in the draft 1547.

For easier reference, Figure 4. shows terms and relationships used in the draft 1547 that are important in this context:

- "Distributed energy resources" (DERs) are sources and groups of sources of electric power that are not directly connected to a bulk power transmission system. DER includes both generators and energy storage technologies but not controllable loads used for demand response. An individual DER device inside a group of DER that altogether form a system is a DER unit (DERU).
- The "point of common coupling" (PCC) is the point where a Local EPS is connected to an Area EPS.
- The "point of DER connection" (PoC) is the point where a DER unit is electrically connected in an EPS *and* meets the requirements of the standard exclusive of any load in a DER system. For DER units not able to meet the requirements without supplemental DER devices, the PoC is the point where the requirements of the standard are met by the DER devices in conjunction with supplemental DER devices.
- A "supplemental DER device" is an equipment that is used to obtain compliance with some or all of the interconnection requirements of the standard. Examples include capacitor banks, STATCOMs, harmonic filters that are not part of a DER unit, protection devices, plant controllers, etc.
- "Loads" are devices and processes in a Local EPS that consume electrical energy for utilization, exclusive of devices or processes that store energy with the intention of future return of some or all of the energy to the Local EPS or Area EPS.

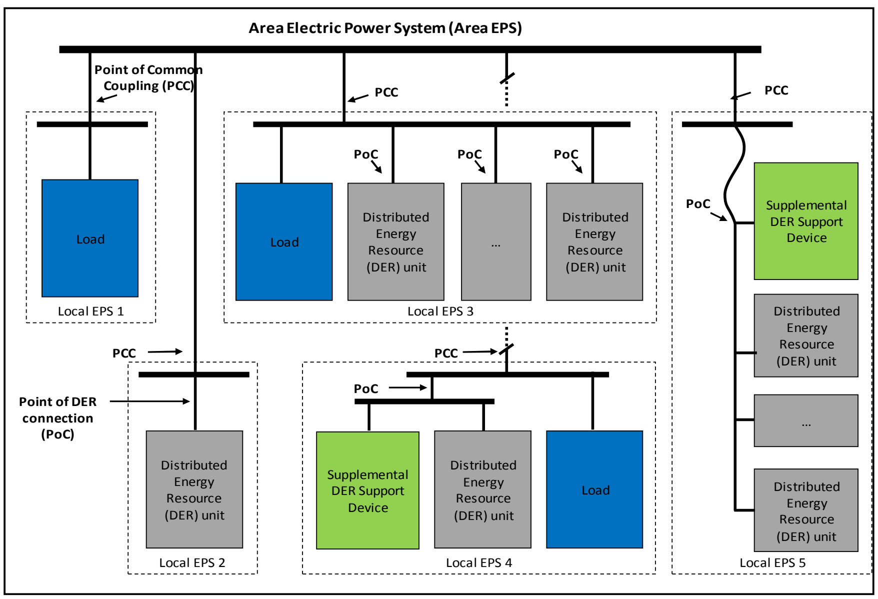

Figure 4. Important terms and relationships in 1547 (author's figure)

The draft 1547 now includes language that aims at maintaining the originally intended scope of the standard while acknowledging the complexities that may arise from the set of new requirements put forth, e.g., reactive power capability or disturbance ride-through capability. Based on the latest draft, DER facilities of significant size that are designed predominantly for exporting their power to the grid will have to meet all 1547 requirements at the PCC. A waiver is included for any facilities below a certain rated capacity threshold (i.e., 500 kW) and for any larger facilities that serve a significant amount of local load (i.e., 10% of the DER rating). DER facilities that meet the criteria of the waiver will be allowed to meet the performance requirements at the point of

DER connection (PoC), i.e., the individual DER units' terminals. Figure 5. shows the decision tree that determines where the new 1547 performance requirements would have to be met. The applicability of the 1547 requirements at either the PCC or the DER units' terminals (PoC) will have a pronounced impact on testing and certification put forth in 1547.1. Discussions on interconnection test specifications and requirements are still ongoing.

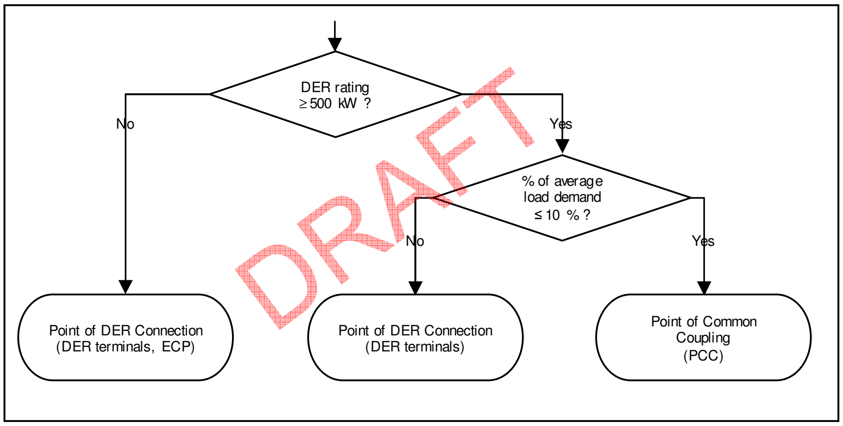

Figure 5. Applicability of draft 1547 requirements decision tree

3. DRAFT GENERAL REQUIREMENTS FOR NORMAL CONDITIONS

Normal operating performance categories A and B will group a set of requirements that specify technical capabilities and settings for a DER under normal operating conditions. Table 1. shows the draft required reactive power capability of the DERs and Table 2. shows the draft required voltage regulation control modes per category. As illustrated in Figure 6. for the voltage–reactive power (volt–var) mode as an example, normal operating control modes are currently specified by pair points with default settings and ranges of adjustability, as outlined in [5].

Table 1. Required Reactive Power Capability of the DER (Draft)

Normal Operating Performance Category	**Injection (Over-Excited) Capability[1]**	**Absorption (Under-Excited) Capability[1]**	**Applicable Voltage Range**
A	44	25	DER rated voltage
B	44	44	ANSI Range A

[1] as % of Nameplate Apparent Power (kVA) Rating

Table 2. Required Voltage Regulation Control Modes (Draft)

Normal Operating Performance Category	**A**	**B**
Voltage Regulation by Reactive Power Control Modes		
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 Modes		
Voltage – Real Power (Volt-Watt)	Optional	Mandatory

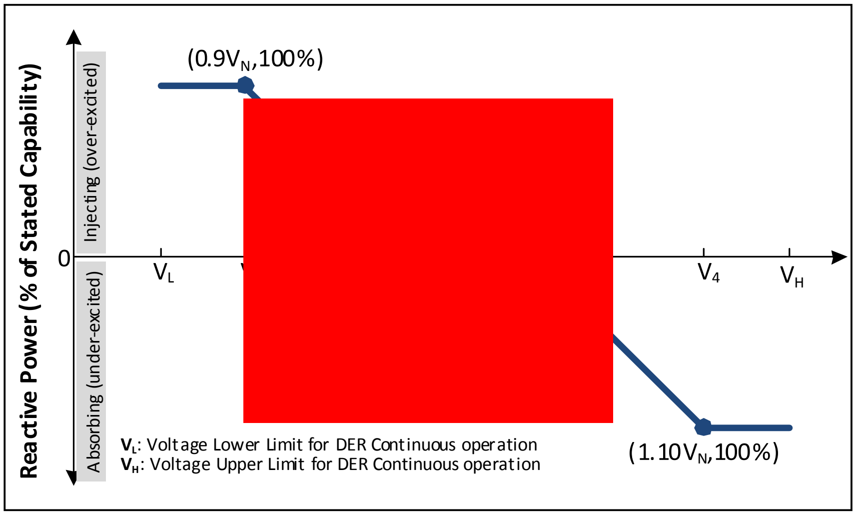

Figure 6. Illustration of voltage–reactive power (volt–var) mode

4. DRAFT REQUIREMENTS FOR RESPONSE TO ABNORMAL CONDITIONS

4.1. Disturbance ride-through

Abnormal operating performance categories I, II, and III will group a set of requirements that specify technical capabilities and settings for a DER under abnormal operating conditions. Table 3. shows the draft required disturbance ride-through capability of the DERs.

Table 3. Required Disturbance Ride-Through Capability of the DER (Draft)

Performance Requirement	**Abnormal Operating Performance Category**	**Foundation**	**Justification**
Voltage Ride-Through (Draft)	I	German grid code for medium voltage-connected DER with rotating machines [12]	• Essential bulk system needs. • Attainable by all state-of-the-art DER technologies.
	II	NERC PRC-024-2[1] [8]	• All bulk system needs. • Coordinated with existing reliability standards. • Considering fault-induced delayed voltage recovery.
	III	CA Rule 21 [3] and Hawaii [13]	• All bulk system needs. • Considering fault-induced delayed voltage recovery. • Distribution system operation.
Frequency Ride-Through (Draft)	All Categories (harmonized)	CA Rule 21 [3] and Hawaii [13]	• All bulk system needs. • Low inertia grids.

[1] without stability exception and with extended LVRT duration for 65-88% V_{nom}

[2] exceeds PRC-024-2

The draft 1547 requirements for disturbance ride-through follow EPRI's recommendations on voltage and frequency ride-through performance requirements for DERs to maintain bulk system reliability published in form of a white paper prior to a P1547 working group meeting in May 2015 [18].

As illustrated in Figure 7. for the voltage ride-through requirements for Category II, capabilities are specified by *cumulative time* duration versus voltage curves and default settings with acceptable ranges of adjustability for under- and over-voltage trip functions.

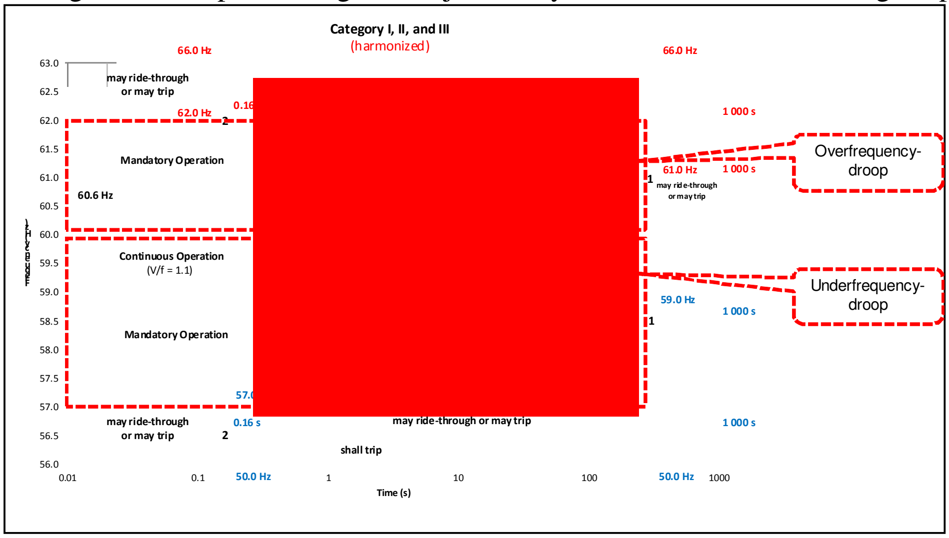

Figure 7. Voltage ride-through requirements for Category II

As illustrated in Figure 8. for the frequency ride-through requirements that are harmonized across all categories, capabilities are specified by *cumulative time* duration versus frequency curves and default settings with acceptable ranges of adjustability for under- and over-frequency trip functions.

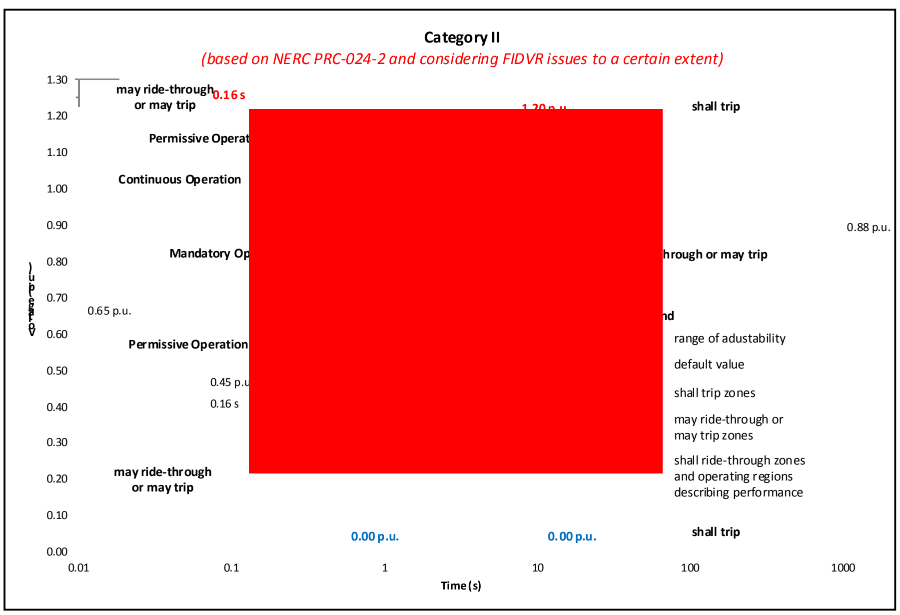

Figure 8. Frequency ride-through requirements for Category II

The draft 1547 also includes requirements for ride-through of consecutive voltage disturbances that may be caused by unsuccessful reclosing. In a nutshell, the maximum number of disturbance sets that DERs of categories I and II have to ride through is two, and DERs of category III is three.

4.2. Frequency response

Furthermore, a frequency-droop (frequency/active power) capability will be required as illustrated in Figure 9. The required capabilities differ slightly between the categories as shown in Table 4. Note that 1547 can only specify the capability and operational response while the actual use case may depend on the regulatory framework, especially when it comes to the provision of reserves for low-frequency droop response. Compared to frequency-droop requirements in other parts of the world, e.g. Europe [9]–[10] and Germany [11], the draft 1547 proposes a deadband with a tight default value and a wide range of adjustability, see as shown in Table 5. This aims at addressing grid operational issues arising from very high future DER penetration levels.

To date, no requirement for synthetic inertia is proposed.

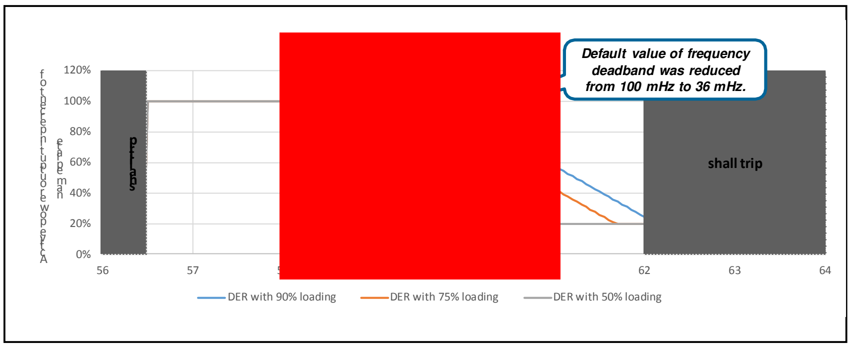

Figure 9. Frequency-Droop (Frequency/Active Power) Capability

Table 4. Required Frequency-Droop (Frequency/Active Power) Capability (Draft)

Requirements of a frequency-droop (frequency/power) operation – Categories I, II, and III		
Abnormal Operating Performance Category	**Operation for Low-Frequency Ride-Through**	**Operation for High-Frequency Ride-Through**
I	optional	mandatory
II	mandatory	mandatory
III	mandatory	mandatory

Table 5. Required Parameters of frequency-droop (frequency/Active power) operation (Draft)

Ranges of adjustability (not a design criteria)			
Parameter	**Category I**	**Category II**	**Category III**
db_{OF}, db_{UF} [Hz]	0.017 – 1.0	0.017 – 1.0	0.017 – 1.0
k_{OF}, k_{UF} [p.u.]	0.03 – 0.05	0.03 – 0.05	0.02 – 0.05

Default settings[1]			
Parameter	**Category I**	**Category II**	**Category III**
db_{OF}, db_{UF} [Hz]	0.036	0.036	0.036
k_{OF}, k_{UF} [p.u.]	0.05	0.05	0.05

[1] Adjustments shall be permitted in coordination with the Area EPS operator.

4.3. Dynamic Voltage Support

Dynamic voltage support (DVS) capability during disturbance ride-through is being considered in the draft 1547 for DERs of category III. Three potential benefits may be justifying to require DERs to support the local voltage with a very fast, voltage-dependent response in reactive and active power output::

- For the DER itself, DVS may positively impact the local voltage and thereby allow DER to ride through less pronounced voltage disturbances.
- For legacy DERs that comply with IEEE Std 1547-2003, DVS from new DERs may increase the local voltage above their under-voltage trip settings and thereby reduce the amount of lost aggregated DER output following voltage disturbances. [14]–[15]
- For distribution systems with large amounts of single-phase induction motors, DVS may improve fault-induced delayed voltage recovery (FIDVR) as shown in Figure 10. [16]–[17]

While interconnection requirements in other parts of the world, e.g. Europe [9]–[10] and Germany [11], tend to specify DVS in a very detailed way—e.g., by voltage-dependent additional reactive current injection (aRCI)—the new 1547 standard may be less prescriptive in order to give some latitude for industry learnings and innovative controls.

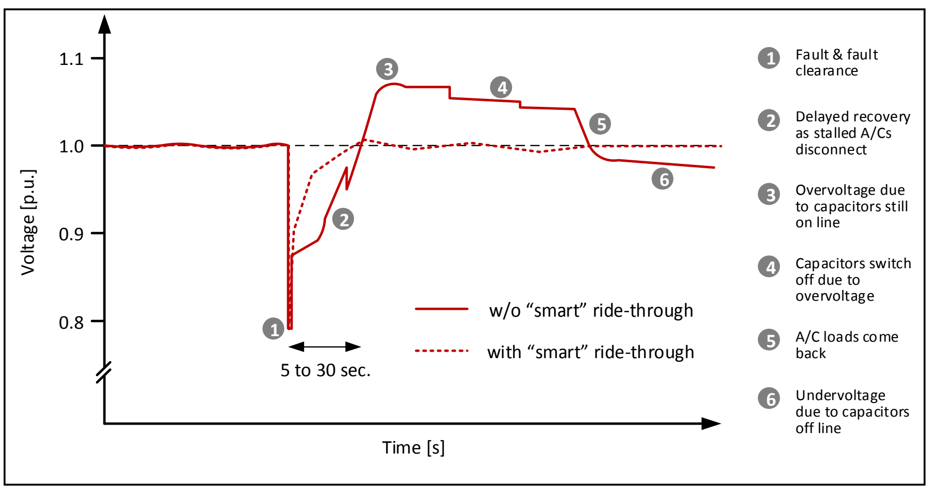

Figure 10. Illustration of potential benefits of dynamic voltage support for distribution systems with fault-induced delayed voltage recovery (FIDVR)

5. PRIORITIZATION OF DER RESPONSES

Many of the new performance requirements put forth in the draft 1547 may be implemented through dedicated functions and control systems. Discussions have indicated that a prioritization of DER responses will have to be specified in order to achieve reliable and safe grid operations.

The latest draft proposes the following priority list:

- DER tripping requirements take precedence over any other performance requirements.
- DER ride-through requirements take precedence over all other performance requirements, with the exception of tripping requirements, unless terminated by the detection of an unintentional island. False detection of an unintentional island does not justify non-compliance with ride-through requirements.
- The frequency-droop (frequency/active power) response requirements take precedence over all other performance requirements, with the exception of tripping and ride-through requirements.
- All remaining performance requirements shall have equal priority.
- When multiple control modes are active simultaneously, the DER performance must be the aggregate of the prescribed responses of the active modes. For any two requirements that set DER response in the same direction, the larger of the two requirements shall apply. For any two requirements that set DER response in the opposite direction, the summation of the two requirement shall apply.

6. REQUIREMENTS FOR MEASUREMENT ACCURACY

Historically, 1547 defined no minimum requirements for measurement or performance accuracy. Manufacturers were required to simply state the measurement and performance accuracy of their DERs. As performance accuracy is indirectly considered in the pass/fail criteria that will be put forth in 1547.1, the draft 1547 only specifies minimum requirements for manufacturer-stated measurement accuracy as shown on the left of Table 6. for slow responses and on the right of Table 6. for fast responses of DER.

Table 6. Minimum Requirements for Manufacturer Stated Measurement Accuracy (Draft)

	Slow Response*			**Fast Response***		
Parameter	**Minimum Measurement Accuracy**	**Sensing Speed**	**Range**	**Minimum Measurement Accuracy**	**Sensing Speed**	**Range**
Voltage	(+/- 1% V_{nom})	5 cycles	50% to 120%	(+/- 1% V_{nom})	[5 cycles]	50% to 120%
Apparent Current	(+/- 2% $I_{max\ rated}$)	10 cycles	0% to 110%	(+/- 2% $I_{max\ rated}$)	10 cycles	0% to 110%
Frequency	10 mHz	60 cycles	50 to 66 Hz	100 mHz	5 cycles	50 to 66 Hz
Active Power	(+/- 5% P_{rated})	10 cycles	20% < P < 100%	N/A	N/A	N/A
Reactive Power	(+/- 5% Q_{rated})	10 cycles	20% < Q < 100%	N/A	N/A	N/A
Power Factor	(0.05 Pf_{rated})	10 cycles	20% < P < 100%	N/A	N/A	N/A
Time	1%	N/A	5 s to 10 min	2 grid cycles	N/A	100 ms < 5 s

*Reference condition for all parameters in this table are voltage THD < 2.5% and individual voltage harmonics of the simulated utility odd harmonic limits in Table 3 of IEEE Std 1547.

7. DRAFT REQUIREMENTS FOR INTEROPERABILITY, COMMUNICATIONS, INFORMATION MODELS, AND PROTOCOLS

The structural transformation of today's power system towards an Integrated Grid [19] with Connectivity [20] requires interoperability and communication *capability* from DERs. This would allow DERs to exchange information with the grid operator, an aggregator, or third parties securely and effectively. While the actual roll-out of the communications infrastructure that is needed to utilize this capability may occur in different regions of North America in very different time frames and formats, mandating DERs to have the capability for interoperability and communications would be an enormous enabler of future opportunities.

Learnings from countries like Germany, where no standardized interoperability and communication requirements had been specified in the past, show that the revision of 1547 provides for a *historic opportunity* to pave the way into a future where power and information exchange are truly integrated. Hence, the draft 1547 includes draft language to standardize requirements for interoperability, communications, information models, and protocols at the interconnection point of DERs, see Figure 11. The interconnection point for DER previously involved only the power connections, but going forward it involves both power and communications.

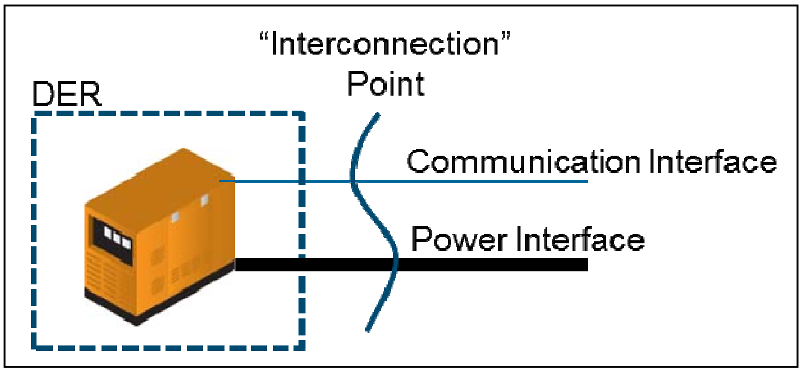

Figure 11. The point of interconnection now includes power and communication interfaces

The draft 1547 states that the distribution system operator could specify which of the following levels of interoperability support a DER would have to provide: (a) monitoring *and* management enabled, (b) monitoring enabled, (c) no interoperability support.

Working group discussions continue to evaluate the possibility of requiring a universal capability for monitoring (read) and management (write) support from *all* DERs covered by 1547, independent of rating, technology, etc. A decision is taken by the working group in late October 2016.

Furthermore, the draft 1547 limits the diversity of information models and communication protocols used for the information exchange at the DER interconnection point to *existing* standards. Which standards to use is limited to a set of default options, or could be others as specified by the grid operator. The draft standardization requirements are limited to the DER interface while the networks specifics (on the left) as well as the internal DER specifics (on the right) are out of scope of 1547, see Figure 12. In other words, the 1547 requirement defines only the interface at the DER, without limiting the technology or language of communication network.

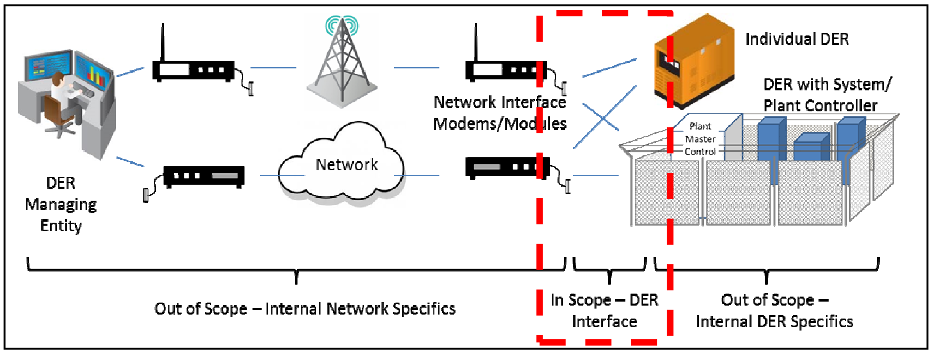

Figure 12. Limited scope of draft 1547 requirements for interoperability, communications, information models, and protocols

Communication interoperability involves multiple layers, including the application, network, and electrical/physical aspects. Standardized lower layers provide physical compatibility and reduce the need for electricians onsite, custom wiring, adapters etc. Standardized upper layers provide software compatibility and avoid the need for protocol translation, reducing software complexity.

In many cases there is a natural combination of standards at each layer that are commonly used together. Examples of such logical combinations of *practical* options for communication interoperability are shown in Figure 13. Allowing for a small number of well-defined options gives vendors flexibility and is still achievable for third-party aggregators/integrators.

Application	DNP3	IEEE 2030.5	SunSpec Modbus
Transport	TCP	TCP	N/A
IP Layer	IP	V#	
p *(" * (#&	Ethernet	Ethernet	RS-485
	Twisted Pair/RJ-45	Twisted Pair/RJ-45	Twisted Pair/ RJ-45/CTA-2045

Figure 13. Logical combinations of communication interoperability

Discussions on interoperability, communications, information models, and protocols are continuing as their implications for the various industry stakeholders, including DER vendors, developers, and utilities may be substantial.

8. OTHER DRAFT REQUIREMENTS UNDER REVISION

Further to the draft requirement outlined above, a number of other draft requirements are under discussion:

- Requirements for power quality: admissible dc injection, rapid voltage changes, flicker, odd and even harmonics, inter-harmonics, temporary and transient overvoltage.
- Enter service: required voltage and frequency criteria, synchronization, return to service after trip (including intentional delay and a capability to receive a blocking signal from the grid operator), maximum active power ramp for restore output.

- Interconnection test specifications and requirements: design tests, production tests, interconnection installation evaluation, commissioning tests, periodic interconnection tests: It is the working group's consensus that 1547 should only specify "what" and "when" requirements must be tested, while 1547.1 should detail "how" and "by whom" requirements be tested.
- Simulation and modeling data requirements.

Especially the discussions on the last two bullets are vigorously continuing as their implications for the various industry stakeholders, including DER vendors, developers, and utilities may be substantial.

9. CONCLUSIONS

The primary interconnection standard for distributed energy resources in North America, IEEE Std 1547, is being revised. Originally developed assuming a low penetration of DER, the revised standard will include a number of new performance requirements to maintain reliable and safe grid operations with high penetration of DERs. Testing and certification requirements are also planned to be updated and will be specified in IEEE Std 1547.1 as soon as possible.

Maintaining technology-neutrality, the draft 1547 does not impose a single definitive and universal requirement for (smart) inverters and rotating machines. A limited number of groupings of sets of requirements—standardized operating performance categories—specify technical capabilities and settings for a DER under normal and abnormal operating conditions. If successfully balloted in its current form, the new 1547 would provide a *framework* for Authorities Governing Interconnection Agreement (AGIAs) to assign appropriate DER disturbance ride-through performance requirements. This framework will allow for specification of harmonized interconnection requirements while providing flexibility and lead technology innovation.

Although well along, there is still a lot of work to complete the update of 1547 and 1547.1. Since IEEE Std 1547 is set up as an individual vote, not an entity, the authors want to encourage all industry stakeholders to engage in working group discussions and to join the upcoming IEEE P1547 balloting pool [21]. The requirements for IEEE and IEEE-SA membership as it relates to 1547 involvement, and detailed instructions on how to get involved into 1547 are summarized in Table 7.

ACKNOWLEDGMENT

We would like to thank the Chairs and Secretary of the IEEE P1547 Working Group for their permission to use the latest draft of the standard for this informal status update. Note that the paper presents the authors' individual views on IEEE P1547 and P1547.1 and is not the formal position, explanation or position of the IEEE. Draft specifications outlined in this paper are subject to changes during the standard's balloting process.

We would also like to thank EPRI members for their continued support on IEEE P1547 and P1547.1 activities.

Table 7. Requirements for IEEE and IEEE-SA Membership and Instructions on how to Get Involved into 1547

Activity Level	Interested Stake-holders	Membership		How to get involved?
		IEEE	IEEE-SA	
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
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 two consecutive meetings) **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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