IEEE PES Energy Development and Power Generation Committee

Wind and Solar Power Plant Interconnection and Design Subcommittee

Chairman: Tom Key
Vice Chair: Jens Boemer
Secretary: Nath Venkit

Subcommittee Website:
http://sites.ieee.org/pes-edpgcom-wsppidsc/

Date: **Wednesday July 20, 2022**
Time: **8:00 – 10:00am MT**
Location: IEEE PES 2022 Denver General Meeting

Today's Agenda

1. Welcome and Introductions
   - Review of minutes from Aug 2021
2. Power Plant Design Report (IEEE 2760, 2778, WG plans)
3. Distribution System Interconnection Report (IEEE 1547, .2, .9, Gateway, 2030, C84.1)
4. Bulk System Interconnection Report (2800, P2800.2, PV Mod)
5. Coordination Activities
6. Old Business
7. Future Meeting and Session Plans
8. Review Action items
9. Adjourn

Approval of minutes from Aug 2021

- Virtual meeting held August 4 (minutes attached to invite).
- Any corrections or additions? Speak up or put in chat.
- Motion to approve and a second.
- Assumed to be affirmative unless:
  - voice corrections or additions?
  - chat corrections or additions?

2. Power Plant Design WG Report – Chairman Loren Powers

- Update on WG activities
- Task Force on Wind and Solar Plant Grounding Activities – Rob Schaerer
  - IEEE 2760 Guide completed on wind plant grounding
  - IEEE 2778 Guide completed on solar plant grounding and design
- ~40 (10 virtual) attended the WG meeting on Tuesday July 19
- Looking ahead, other WG Activities/Plans 2023

3. Wind and Solar Plant Interconnection WG – Nath Venkit for Jens Bowmer

- ***Distribution-Connected*** Inverter Based Resources (DER)
- 1547 revision plans (scope/timeline/sponsors) – Dave Narang (NREL), see presentation
- 1547.2 update status – Wayne Stec (Distregen), no update
- P1547.9 project – Mike Ropp (SANDIA)/Charlie Vartanian (PNNL), guide is ready for ballot
- New Sponsored Par**:** Utility Infrastructure DER Gateway (***1547.10***) – Jithendar Anandan (EPRI) - 15 min, see presentation

IEEE Std 1547 Revision Planning
Dave Narang, NREL

Summary of Study Group Activities as of May 2022

IEEE Std 1547 Revision Study Group Summary

- *Study group convened in Q1 2021 to inform the numerous aspects required in the preplanning stages of the next revision.*
- *An important intent was to provide information to interested parties so they can develop their own internal engagement strategies for working group participation and revision implementation.*

1. **Task 1: Develop a draft Project Authorization Request (PAR)** for consideration by SCC21 and co-sponsors.
2. **Task 2: Provide preliminary guidance on important considerations** to be addressed during the next revision life cycle:
   a) Determine co-sponsors (in coordination with other study group)
   b) Develop planned overall timeline of next revision, including working group activity.
   c) Identify needs for coordination with other activities and stakeholders
   d) Determine potential scope of next revision (preplanning for WG review)

Parallel study group started to recruit additional co-sponsors (led by Jens Boemer)

Planned Draft Timeline for 1547 Revision & Implementation

- Current standard (1547-2018) is active until Feb 2028
- Draft timeline for next revision targeting revision published by mid-2025
- Targeted Amendment (if needed) Amendment 1 passed in 2021, no additional critical scope items identified to date that require another amendment
- Revision PAR submitted to IEEE in February 2022

Activity	2021				2022				2023				2024				2025				2026				2027				2028				2029			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1547-2018 active	IEEE Std 1547-2018 Active Status																																			
1547.1-2020 active	IEEE Std 1547.1 Active Status																																			
Next 1547 revision (draft plan)		Study Group, draft PAR				Prep/Preplanning				WG activity					Balloting		Publication																			
Next 1547.1 Revision (draft plan)													Draft PAR					WG activity				Balloting		Publication												
UL 1741 update																										Revised Cert. Std.										
Product updates																												Project updates								
Jurisdictional adoption																														Jurisdictional Adoption						

1547 Revision Co-Standards Committees (joint sponsors)

* Additional (new for next revision)

- Standards Committee 21 (SC21, lead (formerly SCC21))
- Energy Development and Power Generation Committee (PE/EDPG)*
- Electric Machinery Committee (PE/EM)*
- PE/PSCC Power System Communications and Cybersecurity (PE/PSCC)*
- PE/PSRC Power System Relaying and Control (PE/PSRCC)*
- Power and Energy Society Transmission & Distribution Committee (PE/T&D)*
- Power Electronics Society Standards Committee (PEL/SC)*
- Communications Society Power Line Communications Standards Committee (COM/PLC)*

IEEE Std 1547 Revision Planning and Coordination

1. New WG Chair: Mamadou Diong
2. Preparation for next revision cycle (happening now)
3. Ramp up of formal WG activities ~ Q4 2022

Your Support and Participation is Appreciated!

Longer Term Activities (Broader SC21 Efforts)

1. Coordination with other efforts to develop longer-term “roadmap” for future 1547 series revisions/scope
2. Continued outreach and coordination with other efforts and stakeholders on interconnection – related items
3. Coordination with other efforts to provide support/guidance on the successful implementation of the standard (e.g., in current or upcoming state PUC/regulatory dockets or initiatives)
4. Identification of elements that could improve IEEE Std 1547 adoption currently and in the future.

Contacts:

Presenter of this deck.

David.Narang@NREL.gov

Additional contacts:

1547 Revision Chair, Mamadou Diong, Mamadou.Diong@dominionenergy.com

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Sponsor Stds. Coordinator: Jens Boemer, j.c.boemer@ieee.org

Joint Sponsor PELS: Johan Enslin, jenslin@clemson.edu

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Joint Sponsor COM/PLC: Jean-Philippe Faure, jean-philippe.faure@progilon.com

Joint Sponsor PE/ED&PG: Tom Key, tkey@epri.com

Joint Sponsor PE/EM: Kay Chen, ke.chen@siemens-energy.com

IEEE P1547.10 Gateway PAR Update

July 20, 2022

Jithendar Anandan (WG Chair)

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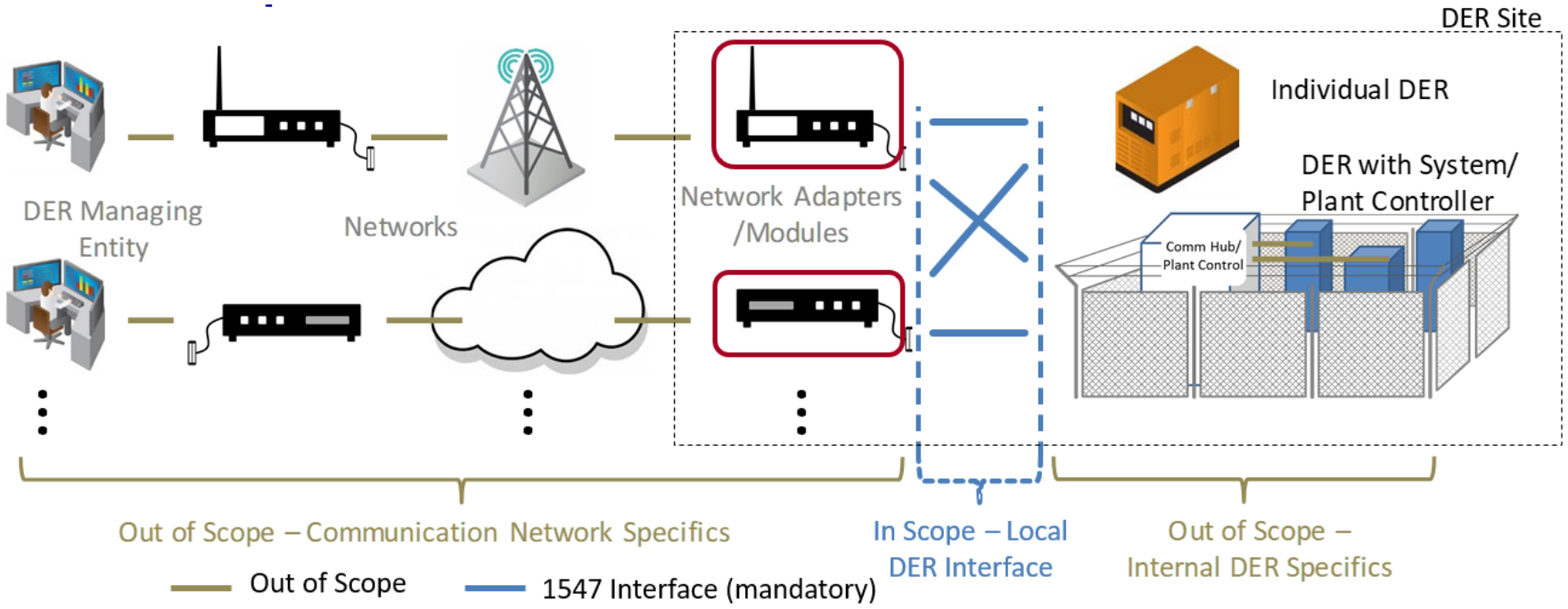
Advancing Technology for Humanity

IEEE 1

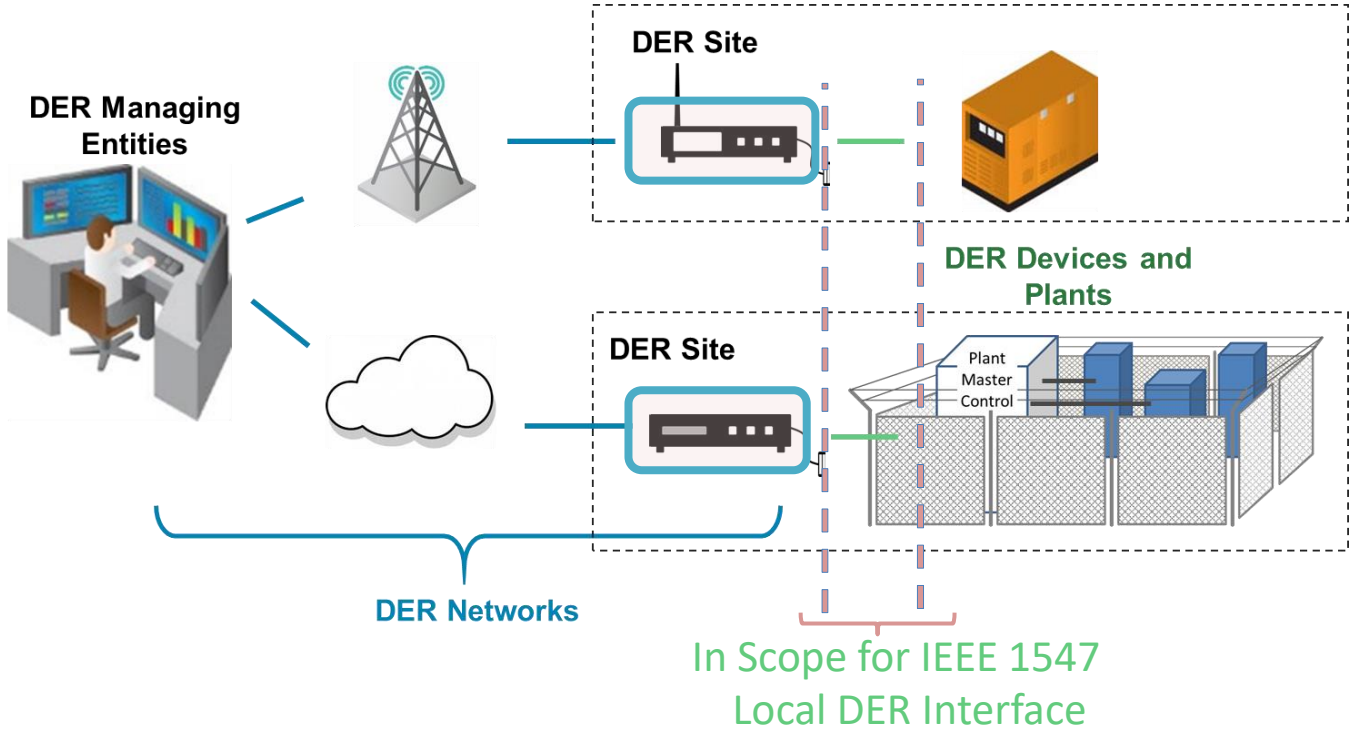


Scope of IEEE 1547 does not include the communication system nor the local network gateway

- Flexibility for utilities to choose any network type
- DER manufacturers can ship a common product not prescriptive of a utility/region
- Companies (DER and network providers) can focus on their core competencies
- Replace/Update communication systems without obsoleting end device

Motivation for a DER Gateway

- A local platform – housing features and logic valuable to the utility
- A ‘logical entity’ – functions can be deployed in a variety of edge control systems
- Unavoidable in most sites as they connect DER onto the network
- A communication protocol translator
- Enables secure integration with utility operations



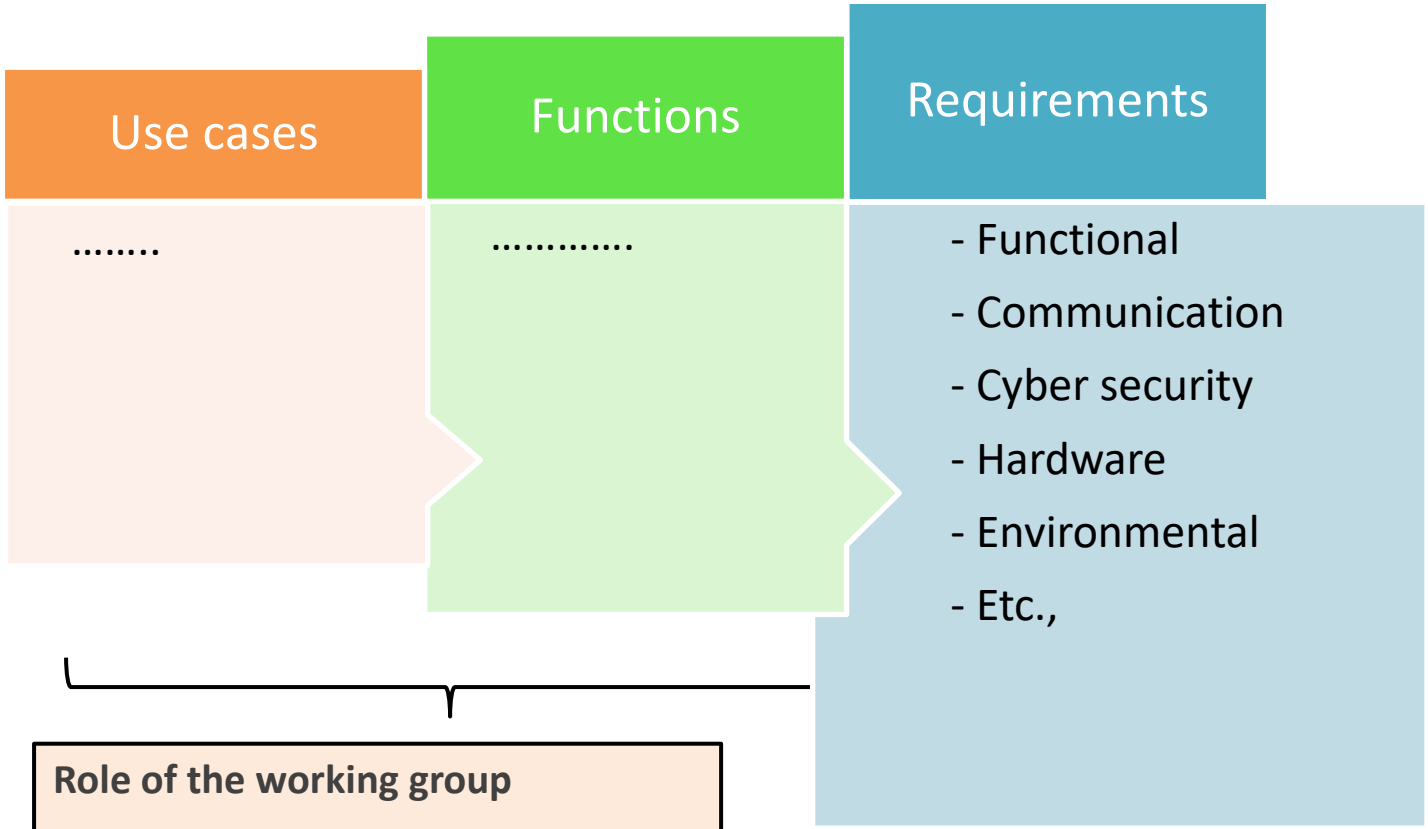
IEEE 1547.10: Gateway Applications Mapped to Potential Joint Sponsors

SCC21 (Main Sponsor and Coordination Role)

IEEE/PES/PSCC (Cyber and Coms)	IEEE/PES/T&D and, possibly, IEEE/PES/PSRC (Utility Perspective)			IEEE/PES/ED&PG (OEM Perspective)
Centralized Manageability	Scheduling (Coordination with next revision of IEEE 1547 and CA SIWG Phase 3)	Real Time "Status" Monitoring	Advanced Notification & Synchronized Actions	Smart Inverter Function Implementation for Legacy DER
Communication Network Performance Monitoring (Coordination with IEEE 1686-2013)	Availability at Night and During Outages	Event Logging & Retrieval	Buffering Monitored Interval Data During Network Outages	Multi-Master Scenarios and Command Prioritization (RBAC)
Communication Protocol Translation (Coordination with IEEE 1815.1-2015)	Transparent Smart Inverter Function Handling	Alarms Logging & Retrieval	Supervision for Voltage Sags	Report Unexpected DER Settings Change
Cybersecurity (Coordination with IEEE 1686-2013 and IEEE P1547.3)	DER Lost Energy Calculation	Logging & Retrieving Interval Data	Continuous Monitoring & Report by Exception	Loss of Master Detection and Reversion of Settings to Defaults

EPRI Working Group

DER Gateway Requirements Development Process



- So far, we conducted 20 working group meetings
- Requirements were presented each week for member review and feedback
- Documented requirements were used to develop the reference design of the gateway

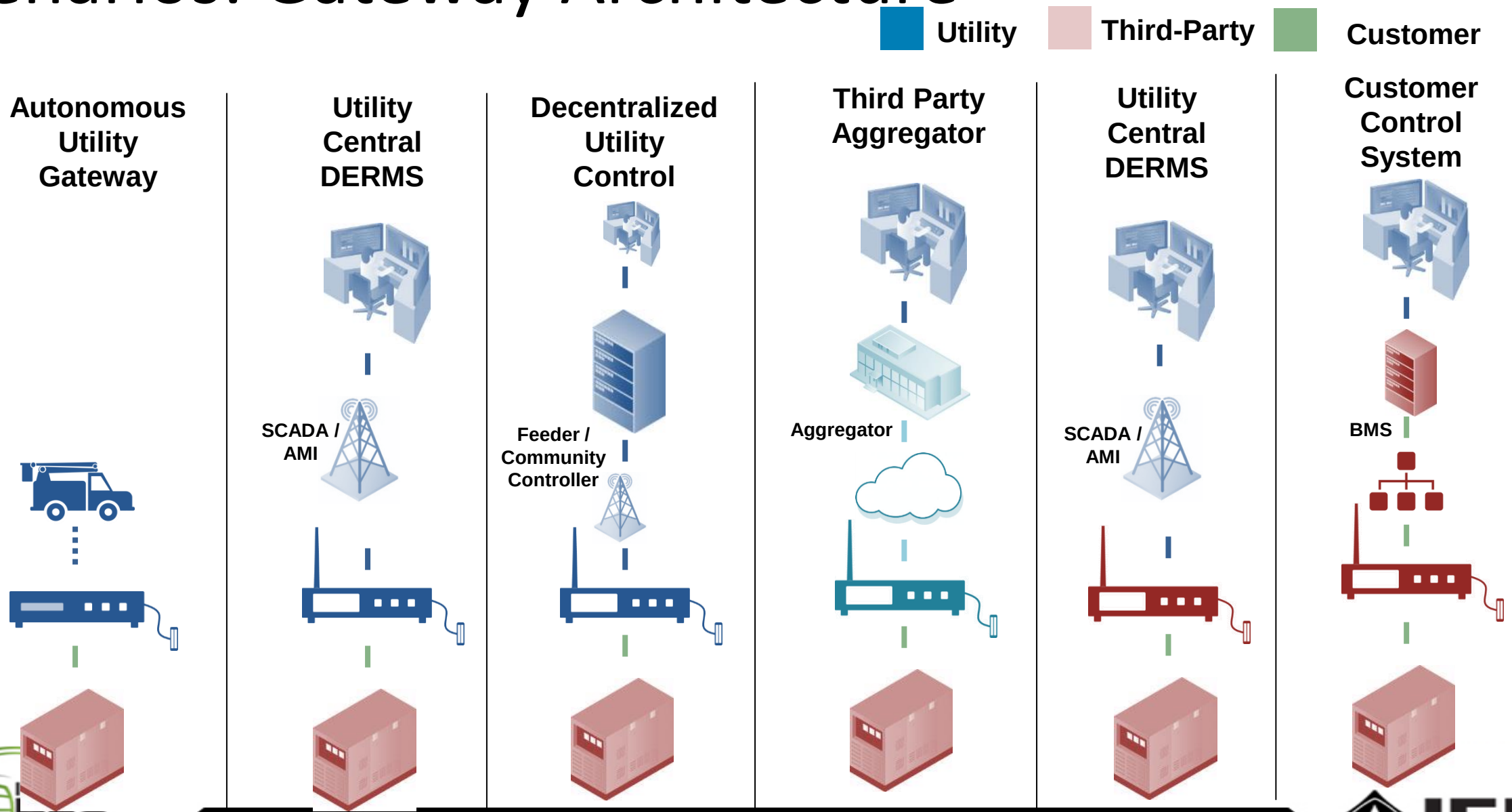
Role of the working group

- Identify gateway use cases
- Define functions for the gateway

EPRI Role

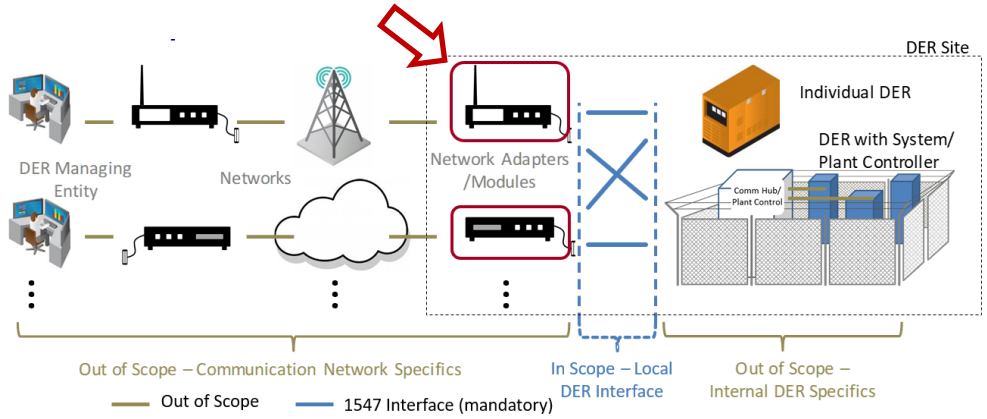
- Develop detailed requirements for identified functions

Scenarios: Gateway Architecture



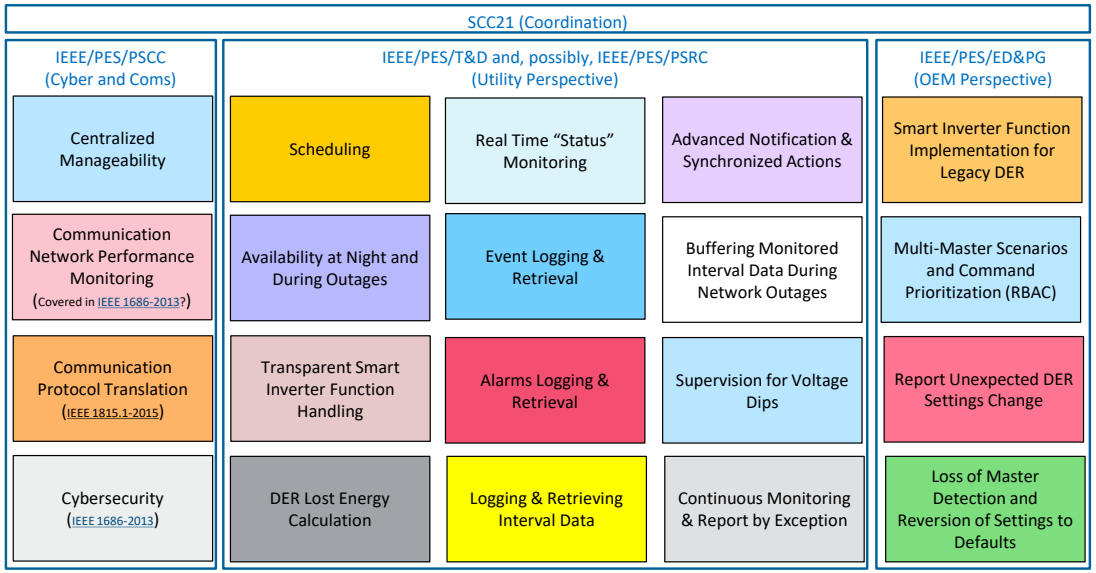
New Activities

Early thoughts on an IEEE 1547.10 PAR for standardizing "DER Gateway"



Potential Benefits of DER Gateways

- Enable secure and seamless integration of DERs into utility control systems (DERMS/ADMS)
- Low-cost platform that host functions and business logics necessary for grid operations
- Enable distributed intelligence at the system edge that enhances grid reliability and safety



- Genesis of joint sponsorship:
  - Presented to IEEE/PES/T&D/DRI WG and IEEE/PES/EDPG in August 2021; both expressed interest
  - Presentations to PSCC P0, T&D AdCom, PSRC IBR Coordination WG and Main Committee at 2022 IEEE JTCM; all expressed interest for joint sponsorship
  - Approved by SCC21 February 25 meeting

THANK YOU!

Jithendar Anandan

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4. Wind and Solar Plant Interconnection WG – Nath Venkit for Jens Bowmer

- ***Bulk System-Connected*** Inverter-Based Resources Activities
  - P2800 Update Trans Interconnection Std – Andy Hoke (NREL) – 5 min, see presentations
  - P2800.2 Certification Tests Standard – Andy Hoke – 15 min
  - Topical Presentation on Loss of Inverter Events, Rich Bauer of NERC, includes recent NOPR on LGIP and SGIP, procedures and agreements updates. Includes cluster studies.

IEEE 2800 and P2800.2 Update to EDPG Wind and Solar Interconnection and Design SC Meeting (IEEE PES General Meeting)

ANDY HOKE, P2800.2 WG CHAIR
ON BEHALF OF P2800.2 OFFICERS: MANISH PATEL, SECRETARY
JENS BOEMER, BOB CUMMINGS, DIVYA CHANDRASHEKHARA,
JULIA MATEVOSYAN, MAHESH MORJARIA, STEVE WURMLINGER, VICE CHAIRS

July 20, 2022

Many slides in this presentation are derived from IEEE 2800 Working Group and Officers: Jens Boemer, Chair; Bob Cummings, Babak Enayati, Ross Guttromson, Chenhui Niu, Manish Patel, Manish Patel, Vice Chairs; Diwakar Tewari, Secretary & Treasurer

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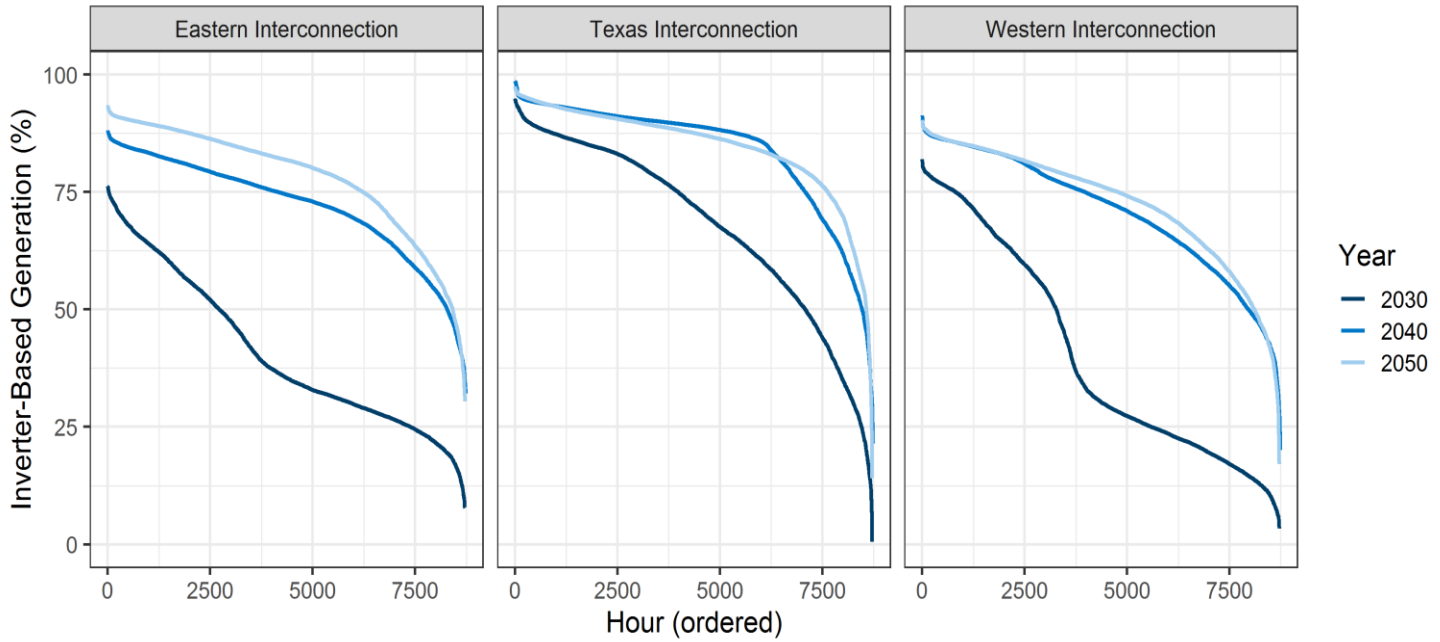
Pace of IBR Interconnections

All major U.S. interconnections are expected to reach peak **instantaneous IBR levels of 75-98%** within the lifetime of IBRs being connected today.

- These plants will need to not just remain online, but contribute to system recovery and reliability.
- IEEE 2800 addresses minimum technical requirements deemed needed from IBRs.



Data from 2021 DOE/NREL Solar Futures Study: https://www.nrel.gov/analysis/solar-futures.html

IBR: inverter-based resources like wind, solar, storage

Insufficient Solar, Wind & Storage Interconnection Requirements

- Diverse & different requirements across various jurisdictions

  …requires more effort and time to address

- Inverter-based resources (IBR) are different from synchronous generators

  …higher (and sometimes lower) capability

- Requirements may not be balanced

  …some too stringent & not taking advantage of new capability

Source: https://www.natf.net/

Recurring Reliability Issues with IBRs

- Unexpected tripping, cessation of active power, oscillations, etc.
- Mis-application of IEEE 1547 standard for Transmission connected resources
- Analysis found **opportunity for standardization** of IBR performance to maintain grid reliability

Source: NERC, 2017-2022

Recurring Reliability Issues with IBRs

Causes of solar PV reduction identified by NERC

PLL Loss of Synchronism, Inverter AC Under- or Overvoltage, Inverter Under- or Overfrequency, Slow Active Power Recovery, Momentary Cessation, Inverter AC Overcurrent, Inverter DC Voltage [Ripple due to AC Voltage] Unbalance, Inverter UPS failure, etc.

NERC Recommendations

- Significant Updates and Improvements Needed to the **FERC Large Generator Interconnection Agreements (LGIA)**

- **Improvements to NERC Reliability Standards** Needed to Address Systemic Issues with Inverter-Based Resources

Source: NERC, 2017-2022

Contextualization within IBR Interconnection Process

Challenges and Opportunities for North America

Existing Step 1: Interconnection Request
Plant-Specific Interconnection Request

- **Insufficient**, diverse, or vague RTO/ISO/TP's technical interconnection requirements (**TIRs**)
- Submission of **any available models,** often **inappropriately configured**
- **Vague model 'acceptance criteria'**

Existing Step 2: Feasibility Study
Plant-Specific Interconnection Screening / Preliminary Review

Limited screening for:

- Grid strength metrics (neither conventional nor advanced)

that could help determine **what type of models and system impact studies** would be needed to reliably connect the IBR.

Existing Step 3: System Impact Study
Plant-Specific Grid Integration & Reliability Impact

- System impact studies often use **insufficient models** that may **not** be **site-specific** and **may be configured with generic** parameters
- May **not represent** IBR units, supplemental IBR devices, and **the IBR plant design** ultimately commissioned in the field

Existing Step 4: Facility Study
IBR Plant Cost Estimation and Determination of Transmission Grid Upgrades

- **No common assessment of IBR plant-level conformity** with regard to RTO/ISO/TP's technical interconnection requirements (TIRs)
- Detailed **IBR plant design may change** after Interconnection Agreement (IA) is executed

IBR Plant Construction
Installation and Building of all Equipment and Structures

- What is built in the field does often not match what had been previously studied/modeled
- **No "as-built" plant-level evaluation**

Existing Step 5: Interconnection Commissioning
Plant-Specific Commissioning & Model Validation/ Verification

- Only a (limited) set of field tests are performed to validate/verify IBR plant model.
  - Limited to small-signal disturbances.
  - Often **no verification of** large-signal disturbances such as **ride-through**

- **Limited collection of field data** to validate/verify IBR plant model.
  - Often not for large-signal disturbances.

Source: EPRI, 2021-2022

IEEE 2800-2022
IEEE Standard for Interconnection and Interoperability of Inverter-Based Resources (IBRs) Interconnecting with Associated Transmission Electric Power Systems

&

P2800.2
Recommended Practice for Test and Verification Procedures for Inverter-based Resources (IBRs) Interconnecting with Bulk Power Systems
Active PAR

IEEE SA: https://standards.ieee.org/ieee/2800.2/10616/
P2800.2 WG: https://sagroups.ieee.org/2800-2/

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Scope of IEEE 2800 Standard

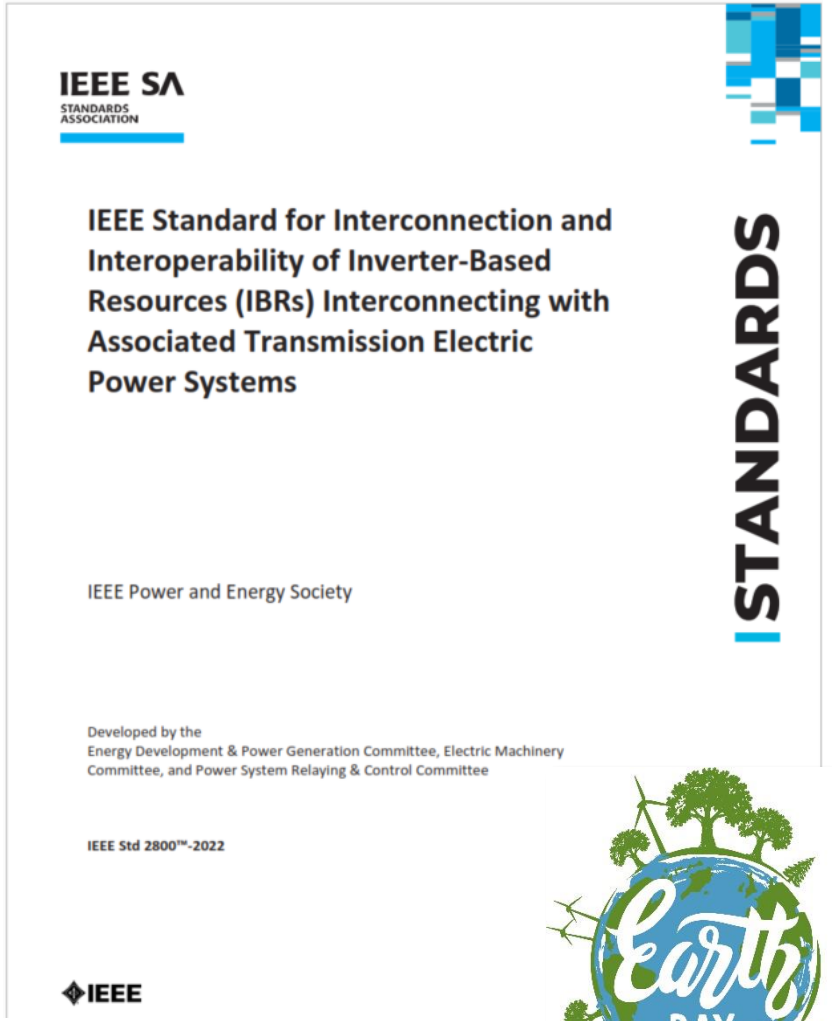
This standard establishes the required interconnection capability and performance criteria for inverter-based resources interconnected with transmission and sub-transmission systems. , , Included in this standard are performance requirements for reliable integration of inverter-based resources into the bulk power system, including, but not limited to: **voltage and frequency ride-through, active power control, reactive power control, dynamic active power support under abnormal frequency conditions, dynamic voltage support under abnormal voltage conditions, power quality, negative sequence current injection, and system protection.**

Applicable to IBRs like wind, solar & energy storage, and any IBR connected via VSC-HVDC.

- "Type 3" wind turbines (doubly-fed induction generators) are in scope
- HVDC-VSC connected resources, e.g., onshore connection point of a VSC-HVDC tie-line interconnecting an offshore resource is also in scope.

Summary of IEEE 2800 Standard

- The standard **harmonizes** Interconnection Requirements for Large Solar, Wind and Storage Plants
- It is a **consensus-based** standard developed by over ~175 Working Group participants from utilities, system operators, transmission planners, & OEMs over 2 years
- It has successfully passed the IEEE SA ballot among 466 SA balloters **(>94% approval**, >90% response rate)
- **Published on April 22, 2022 (Earth Day)**



More Info at https://sagroups.ieee.org/2800/

Available from IEEE at
https://standards.ieee.org/project/2800.html
and via IEEExplore:
https://ieeexplore.ieee.org/document/9762253/

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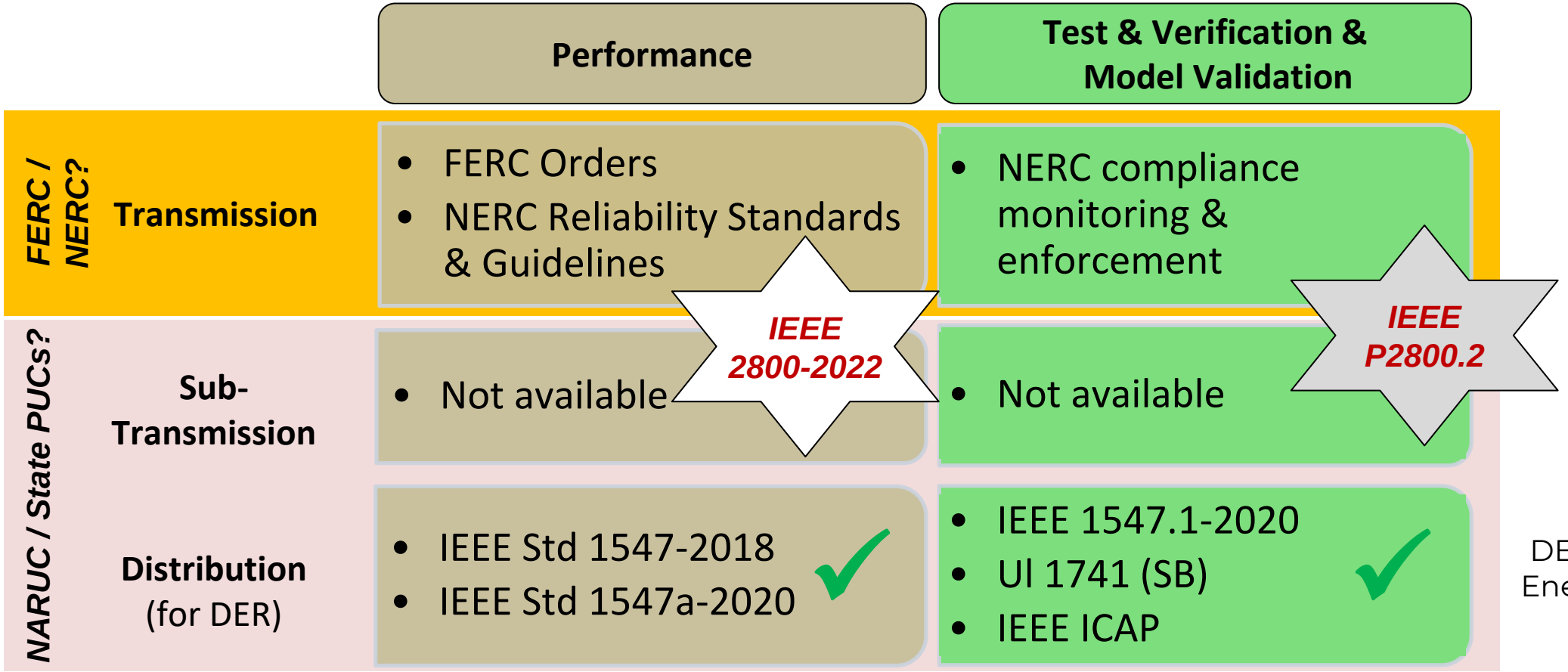
Complementing North American Reliability Standards



DER: Distributed Energy Resources

Source: EPRI, 2021

Only when <u>adopted</u> by the appropriate authorities, IEEE standards become mandatory

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IEEE Standards Classification and Consensus Building

IEEE 1547

IEEE 1547.1

Standards
documents specifying mandatory requirements (***shall***)

IEEE 2800

Recommended Practices
documents in which procedures and positions preferred are presented (***should***)

IEEE P2800.2

Guides
documents that furnish information – e.g., provide alternative approaches for good practice, suggestions stated but no clear-cut recommendations are made (***may***)

IEEE P1547.2

IEEE P1547.3

IEEE P1547.9

IEEE P2800.1

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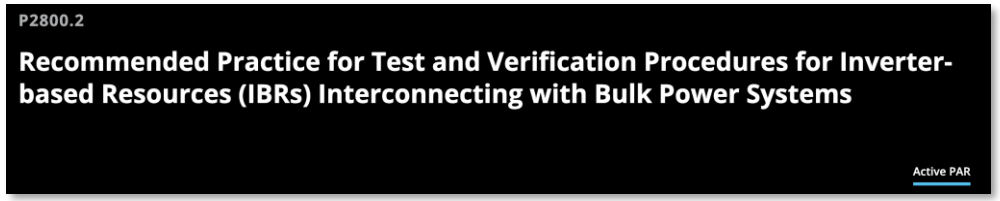
What to expect from IEEE 2800-2022?

- **Provides Value**
  - widely-accepted, unified technical minimum requirements for IBRs
  - simplifies and speeds-up technical interconnection negotiations
  - flexibility for IBR developers & OEMs ➔ not an equipment design standard
- **Specifies**
  - performance and functional capabilities *and not* utilization & services
  - functional default settings and ranges of available settings
  - performance monitoring and model validation
  - type of tests, plant-level evaluations, and other verifications means, but not detailed procedures (➔ *IEEE P2800.2)*
- **Scope**
  - Limited to all transmission and sub-transmission connected, large-scale wind, solar, energy storage and HVDC-VSC

What not to expect from IEEE 2800?

- **No exhaustive requirements for evolving IBR technology solutions**
  - IEEE 2800 applies to all IBRs (including grid-forming ones), but was designed with conventional grid-following IBRs in mind
  - Considers synchronous condensers as ”supplemental IBR devices” but allows for exceptions when used in IBR plants
- **No definition of an interconnection process**
  - This is up to transmission system owners and their stakeholders and regulators
  - IEEE 2800 may be used as *part* of such a process
- **No procedures to verify that IBRs comply with requirements**
  - **Procedures are currently being developed in IEEE P2800.2:**



IEEE SA: https://standards.ieee.org/ieee/2800.2/10616/
P2800.2 WG: https://sagroups.ieee.org/2800-2/

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Capability versus Utilization

Capability:

"Ability to Perform"

- Functions
- Ranges of available settings
- Minimum performance specifications

Examples

- Frequency Response
  - Frequency Droop Response
  - Ramp rate limitations
- Ride-Through
  - Voltage ride-through
  - Current injection during ride-through
  - Consecutive voltage ride-through
  - Frequency ride-through
  - ROCOF ride-through
  - Phase angle jump ride-through

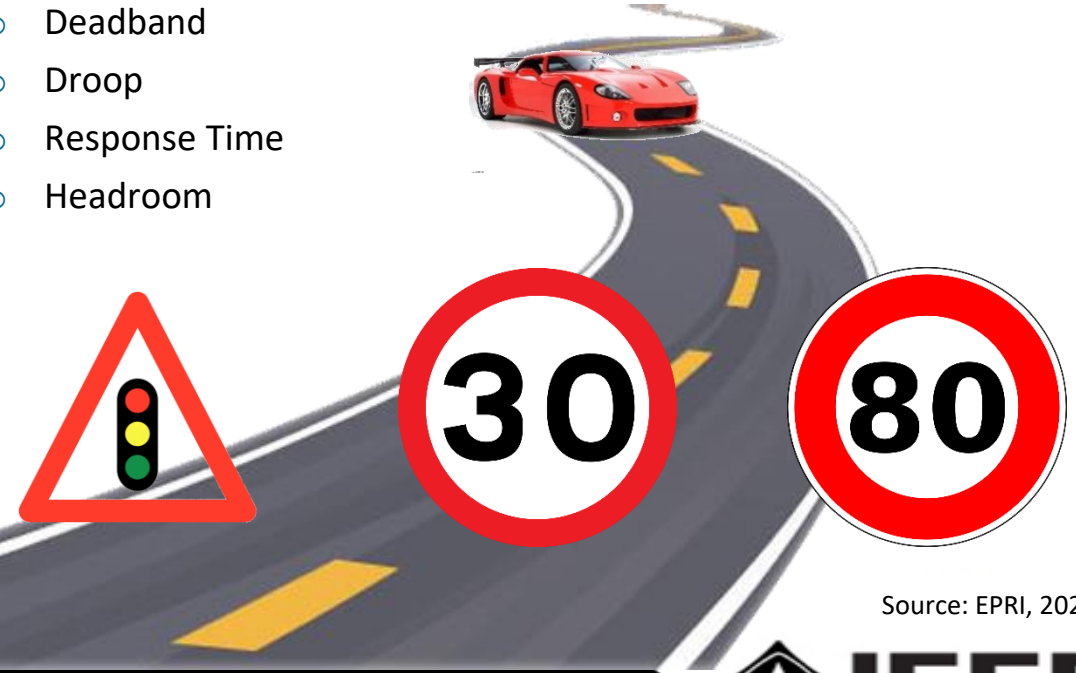
Utilization of Capability:

"Delivery of Performance"

- Enable/disable functions
- Functional settings / configured parameters
- Operate accordingly (e.g., maintain headroom, if applicable)

Examples

- Deadband
- Droop
- Response Time
- Headroom



Source: EPRI, 2021

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Thoughts on Adoption of IEEE 2800

- **Gap Analysis** – comparing existing IC requirements with IEEE 2800 requirements
- Adoption of IEEE 2800 is not contingent upon publication/adoption of IEEE P2800.2 (recommended practice for test & verification procedures)
- Needs consideration of **enforcement date, grandfathering/flexibility** for IBR Plants being built at the time of adoption
- Possible Adoption methods
  - **Full adoption** by simple reference
  - **Full or partial adoption**, clause-by-clause reference, additional requirements

Adoption by ERCOT Inverter-Based Resources Task Force (IBRTF)
Objective, Approach, and Timeline

Objective

Inform strategic ERCOT decision on IEEE 2800 adoption method:

- General reference ('wholesale adoption')
- Detailed reference ('piecemeal adoption – per reference')
- Full specification ('piecemeal adoption – own language')

Timeline by Priority

- Wholesale or High: June – Dec 2022
- Medium: Oct 2022 – Dec 2023
- Low: 2024

Approach

1) EPRI gap analysis
   a. High-level gap analysis: identify where ERCOT has no requirements but IEEE 2800 does
   b. Detailed gap analysis: identify where ERCOT and IEEE 2800 both specify requirements and
      i. Where IEEE 2800 are more specific or more stringent than ERCOT requirements ("<")
      ii. Where ERCOT requirements and P2800 already align in stringency and level of specificity ("~")
      iii. Where ERCOT requirements exceed IEEE 2800 either in stringency or specificity (">")
2) Stakeholder discussion in ERCOT's Inverter-Based Resources Task Force (IBRTF)

Adoption by ISO-NE: Approach and Timeline

- Established a team, brainstorming adoption approaches at this time
- Tentative plan is to develop performance specification using the IEEE Std 2800
- Tentatively seek to implement performance requirements clause by clause, rather than whole adoption for now.
- In future, adoption of IEEE Std 2800 by general reference, i.e., whole adoption, is possible
- Development of verification piece to follow in conjunction or after publication of IEEE P2800.2
- Tentative timeline – Update performance specs by end of 2022
  - Expect to update Planning Procedures and Operating Procedures with IEEE 2800 specifications
  - This is being done in tandem with update of Modeling Procedures

IEEE P2800.2 Motivation

IEEE 2800 contains performance requirements for IBRs, and a table of methods to verify each requirement

- Details of verification methods not included

P2800.2 will develop details through "individual standard" process (like 2800, 1547, 1547.1, etc)

Requirement	RPA at which requirement applies	*IBR unit*-level tests (at the POC)	*IBR plant*-level verifications (at the RPA)						
		Type tests[157]	Design evaluation (including modeling)	As-built installation evaluation	Commissioning tests	Post-commissioning model validation	Post-commissioning monitoring	Periodic tests	Periodic Verification
		Responsible Entity							
		IBR Manufacturer	Developer /TS owner/TS operator	Developer /TS owner/TS operator	Developer /TS owner/TS operator	Developer / IBR Operator /TS owner/TS operator	IBR Operator /TS owner/TS operator	IBR operator /TS owner/TS operator	IBR operator /TS owner/TS operator
6.1 Primary Frequency Response (PFR)	POC & POM	NR[158]	R	R	R	R	D	D	D
6.2 Fast Frequency Response (FFR)	POC & POM	R[159]	R	R	R	R	D	D	D
Clause 7 Response to TS abnormal conditions									
7.2.2 Voltage disturbance ride-through requirements	POC[160] & POM[161]	R	R	R	NR	R	R	D	D
7.2.3 Transient overvoltage ride-through requirements	POM	R	R	R	NR	R	R	D	D
7.3.2 Frequency disturbance ride-through requirements	POM	R	R	R	NR	R	R	D	D
7.4 Return to service after IBR plant trip	POM	refer to line entries for 4.10 (Enter service)							

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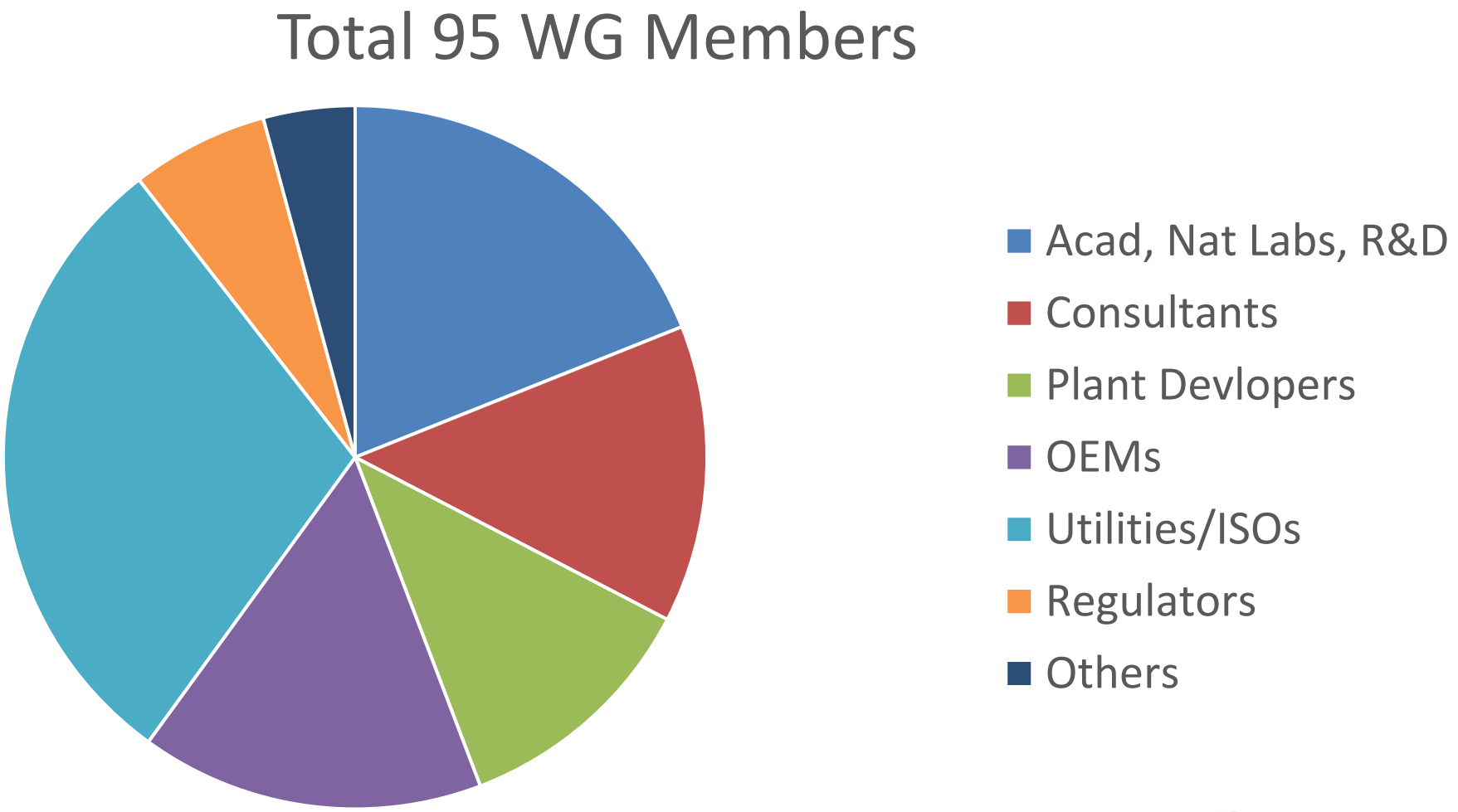
P2800.2 Working Group Membership

- Large, well-balanced WG
- More are welcome



P2800.2 Overview (from PAR)

- Title:
  - Recommended Practice for Test and Verification Procedures for Inverter-based Resources (IBRs) Interconnecting with Bulk Power Systems
- Scope:
  - Define **recommended practices** for test and **verification procedures to confirm plant-level conformance** of IBRs interconnecting with bulk power systems in compliance with IEEE Std 2800
  - Applies to IBRs in transmission and sub-transmission systems
  - May also apply to isolated IBRs interconnected to an AC transmission system via dedicated voltage source converter high-voltage direct current (VSC-HVDC) transmission facilities, e.g., offshore wind farms
  - Specifications for the equipment, conditions, tests, modeling methods, and other verification procedures that should be used to demonstrate conformance with IEEE P2800
- Includes:
  - Type tests (unit level, not full compliance)
  - Design evaluation, including modeling
  - As-built evaluation and commissioning tests
  - Post-commissioning model validation, monitoring, periodic tests, and periodic verifications
- Recommended practice: Uses “should” language, not “shall” language.
  - In recognition that prescribing uniform procedures across all IBR types and utility locations would be very challenging

P2800.2 Key Questions

- How specific should procedures be? How prescriptive?
  - Keep in mind “should”, not “shall”
- Will procedures include quantitative pass-fail criteria? Or rely on expert judgement? A combination?
  - Subgroups to propose
- Can one test procedure cover multiple requirements?
  - Yes. Subgroups to consider
- What other standards do we need to consider?
  - Subgroup leads and WG leadership beginning to compile list of related standards
- For some requirements, will we offer multiple different verification methods?
  - Probably yes. Which ones? (Subgroups to propose)
- Many other subgroup-specific questions

P2800.2 – Paradigm shift?

- Note that key interconnection requirements conformity assessment steps occur *before* commissioning
- Is that a change from your current process?

- Why?
  - Once an IBR is commissioned, it can be costly to fix any issues. Power system changing fast.
- Is this going to be easy?
  - Probably not
- But if we do a good job, P2800.2 (along with other ongoing industry efforts) can:
  - Offer a standardized industry-wide practice for IBR conformance assessment
  - Minimize future need for costly retrofits
  - Help ensure the near-future, highly renewable grid is at least as reliable as today's. (I.e., avoid incidents like Odessa disturbance and Blue Cut event, but much bigger)

IEEE P2800.2 Subgroup Scopes

SG 1

Overall document and general requirements

- Question from 1st WG meeting: Should subgroups be organized by requirement (horizontally) instead of by verification method (vertically)?
- Officers considered and decided to maintain vertical SGs because most SMEs align this way
- Also adding a Power Quality Task Force (horizontal) to provide input to subgroups

Excerpt of 2800 Table 20:

Verification Methods Matrix

SG 2 | SG 3 | SG 4 | SG 5

Requirement	RPA at which requirement applies	*IBR unit*-level tests (at the POC)		*IBR plant*-level verifications (at the RPA)					
		Type tests[152]	Design evaluation (including modeling for most require-ments)	As-built installation evaluation	Commissioning tests	Post-commissioning model validation	Post-commission-ing monitoring	Periodic tests	Periodic verification
		Responsible Entity							
		IBR unit or *supplemental IBR device* manufacturer	*IBR developer / TS owner / TS operator*	*IBR developer / TS owner / TS operator*	*IBR developer / TS owner / TS operator*	*IBR developer / IBR operator / TS owner / TS operator*	*IBR operator / TS owner / TS operator*	*IBR operator / TS owner / TS operator*	*IBR operator / TS owner / TS operator*
4.12 Integration with TS grounding	POM	NR	R	R	NR	NR	NR	D	NR
Clause 5 Reactive Power—Voltage Control Requirements within the Continuous Operation Region									
5.1 Reactive power capability	POM	R	R	R	R	R	D	D	D
5.2 Voltage and reactive power control modes	POM	D	R	R	R	R	D	D	D
Clause 6 Active-Power – Frequency Response Requirements									
6.1 Primary Frequency Response (PFR)	POC & POM	NR[153]	R	R	R	R	D	D	D
6.2 Fast Frequency Response (FFR)	POC & POM	R[154]	R	R	R	R	D	D	D
Clause 7 Response to TS abnormal conditions									
7.2.2 Voltage disturbance ride-through requirements	POC[155] & POM[156]	R	R	R	NR	R	R	D	D
Clause 8 Power quality									
8.2.2 Rapid voltage changes (RVC)	POM	NR	R	R	R	D	R	D	D
8.2.3 Flicker	POM	NR	NR	NR	R	D	R	N/A	D
8.3.1 Harmonic current distortion	POM	R[157]	R	R	R	D	R	N/A	D
~~8.3.2 Harmonic voltage distortion~~	POM	D	D	D	D	D	D	D	D
8.4.1 Limitation of cumulative instantaneous over-voltage	POM	R	R	R	NR	NR	R	NR	NR
8.4.2 Limitation of over-voltage over one fundamental frequency period	POM	D	R	R	NR	NR	R	NR	NR

PQ Task Force

IEEE P2800.2 Initial Structure and Leaders

Subgroup	Vice Chair	Subgroup Chair(s)
2: Type tests	Steve Wurmlinger Stephen.Wurmlinger@sma-america.com	Pramod Ghimire, Michael Ropp
3: Design evaluations	Jens Boemer j.c.boemer@ieee.org	Andrew Isaacs, Alex Shattuck
4: Commissioning and as-built evaluation	Divya Chandrashekhara DKUCH@orsted.com	Chris Milan, Dave Narang
5: Post-commissioning model validation and monitoring, and periodic tests and verifications	Julia Matevosyan julia@esig.energy	Jason MacDowell, Brad Marszalkowski

Lead subgroup and coordinate with other subgroups

Facilitate subgroup calls

Draft specific verification procedures with subgroup input

Most of the detailed work will occur in the subgroups via periodic calls

Chair	Andy Hoke Andy.Hoke@nrel.gov
Secretary	Manish Patel mpatel@southernco.com
Vice Chair	Bob Cummings
Vice Chair	Mahesh Morjaria

Compile drafts; Lead Subgroup 1 (overall document and general requirements)

Lead overall WG

Power Quality Task Force	
Co-Lead	Harish Sharma
Co-Lead	Eugen Starschich

Provide input to subgroups on PQ requirements verification

To get involved in IEEE P2800.2:

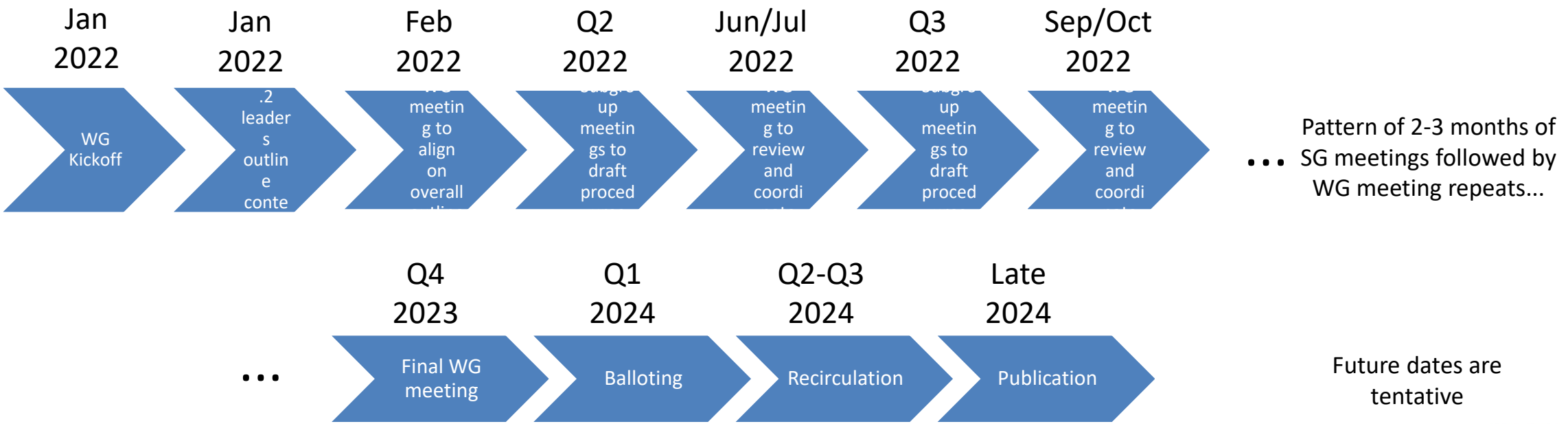
- To join Working Group:
  - If you attended 1/18/2022 kickoff meeting, email Manish Patel: Mpatel@southernco.com; CC Andy.Hoke@nrel.gov
  - If not, attend any two meetings and request membership
- Join listserv for any subgroup or task force of interest (next slide)
- WG member iMeet site: https://ieee-sa.imeetcentral.com/p2800-2/home
- Public website: https://sagroups.ieee.org/2800-2/

IEEE P2800.2 Email Listservs

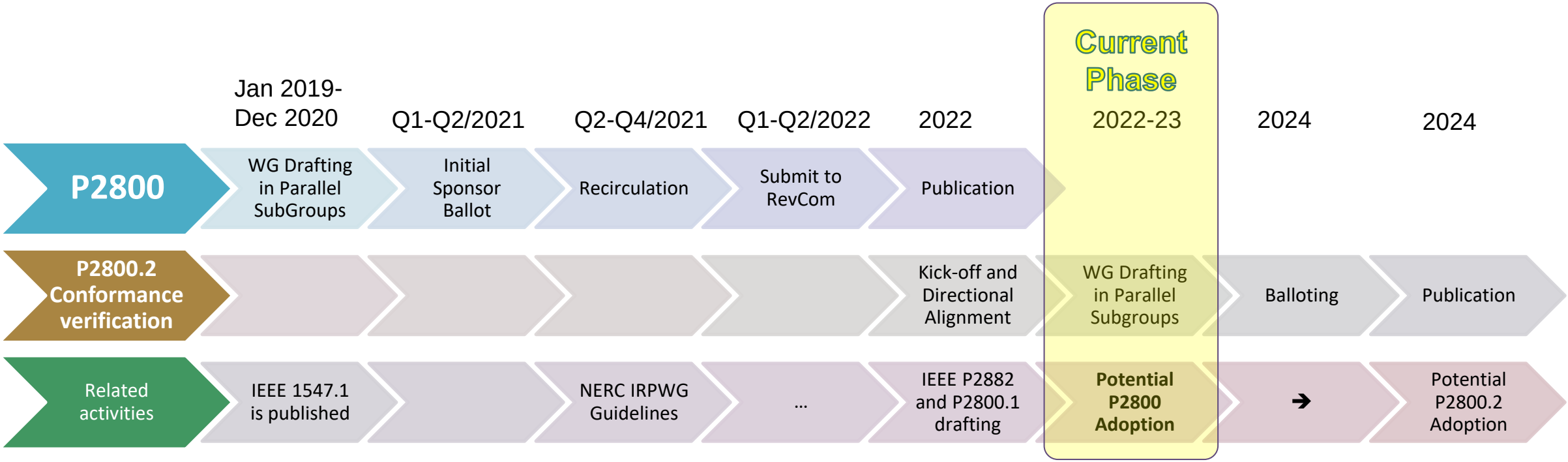
- Overall listserv "P2800-2" will be used to communicate meeting dates, agendas, etc.
- **Each subgroup and PQ task force now has a listserv – sign up to get involved in that group:**
  - Subgroup 1 (overall document): STDS-P2800-2-SG1
  - Subgroup 2 (type tests): STDS-P2800-2-SG2
  - Subgroup 3 (design evaluation): STDS-P2800-2-SG3
  - Subgroup 4 (commissioning and as-built): STDS-P2800-2-SG4
  - Subgroup 5 (post-commissioning): STDS-P2800-2-SG5
  - Power quality task force: STDS-P2800-2-PQTF
- To join a listserv, send an email message to listserv@listserv.ieee.org
  - In first line of email body, write: ***SUBSCRIBE <list name> <Your Name>***
  - For example, "SUBSCRIBE STDS-P2800-2-SG1 Andy Hoke"

Future P2800.2 meetings

- 3-4 per year
- Initially online only
- Will consider in-person meetings with remote option if conditions allow
  - Anyone want to host at their organization? Need meeting room for ~100 people



Anticipated Timeline

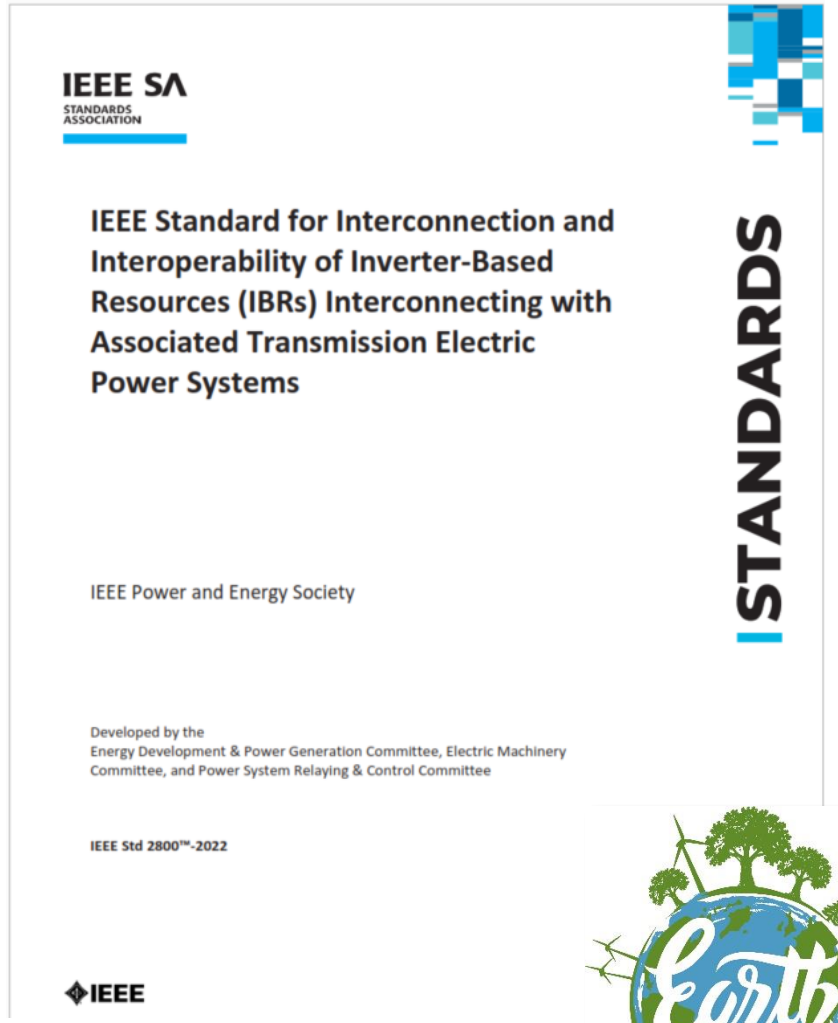


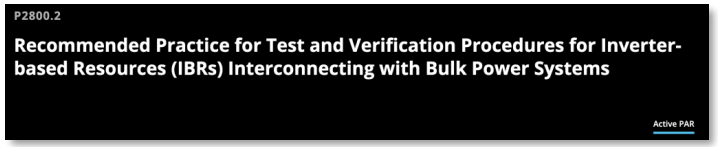
Related standards:

- IEEE P2800.1 – Guide for verification of transmission-connected IR performance (entity project) (inactive?)
- IEC 61400 – WTG engineering verification; significant overlap, coordination needed.
- IEEE P2988 – Virtual synchronous machines.
- P2882 – Guide for model validation for all generation types. Little info/progress so far.

Summary & Conclusion

- IEEE Std 2800™ **harmonizes** minimum Interconnection Requirements for Large Solar, Wind and Storage Plants
  - Expected to mitigate most reliability issues identified by NERC
- As a voluntary IEEE standard, it **requires adoption** by the appropriate authorities to become mandatory
  - Adoption is not contingent on IEEE P2800.2
- Drafting of **conformance procedures** has commenced under IEEE P2800.2
  - ***Get involved:***





IEEE SA: https://standards.ieee.org/ieee/2800.2/10616/
P2800.2 WG: https://sagroups.ieee.org/2800-2/

Available from IEEE at
https://standards.ieee.org/project/2800.html
and via IEEExplore:
https://ieeexplore.ieee.org/document/9762253/

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https://sagroups.ieee.org/2800-2/

IEEE 2800-2022

Available from IEEE at https://standards.ieee.org/project/2800.html
and via IEEExplore: https://ieeexplore.ieee.org/document/9762253/

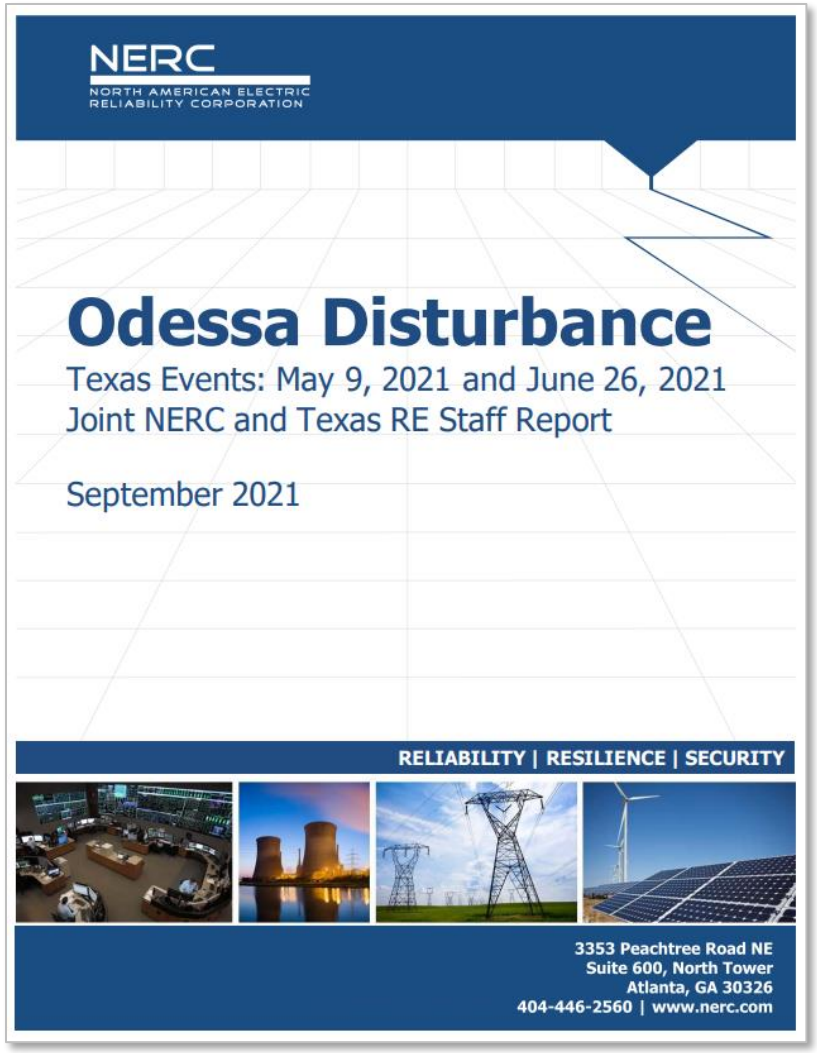
NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

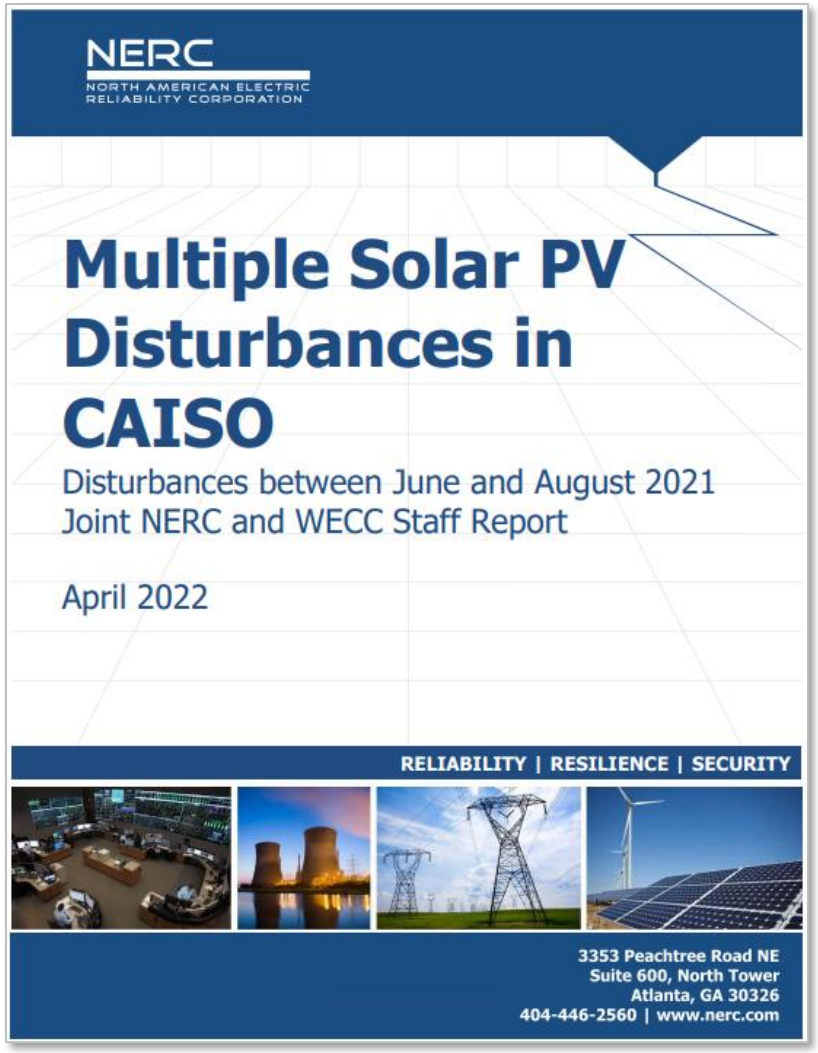
Recent Bulk Power System Disturbances

RELIABILITY | ACCOUNTABILITY




Recent Disturbance Reports





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Recent Disturbance Reports

Table ES.1: Overview of Disturbances		
Disturbance and Name	**Initiating Fault Event**	**Description of Resource Loss***
June 24, 2021 "Victorville"	Phase-to-Phase Fault on 500 kV Line	Loss of 765 MW of solar PV resources (27 facilities) Loss of 145 MW of DERs
July 4, 2021 "Tumbleweed"	Phase-to-Phase Fault on 500 kV Line	Loss of 605 MW of solar PV resources (33 facilities) Loss of 125 MW at natural gas facility Loss of 46 MW of DERs
July 28, 2021 "Windhub"	Single-Line-to-Ground Fault on 500 kV Circuit Breaker	Loss of 511 MW of solar PV resources (27 facilities) Loss of 46 MW of DERs
August 25, 2021 "Lytle Creek Fire"	Phase-to-Phase Fault on 500 kV Line	Loss of 583 MW of solar PV resources (30 facilities) Loss of 212 MW at natural gas facility Loss of 91 MW at a different natural gas facility

* All events occurred in afternoon (12:00 and 4:00 p.m. Pacific)

This Year

- CAISO Solar Loss events this year
  - 3/9/2022 300MW
  - 4/6/2022 >500 MW
  - 5/6/2022 >500MW
- ERCOT losses this year
  - 3/22/2022 (wind) 409 MW
  - 6/4/2022 2400 MW – Odessa 2

FERC Activity

- **Interconnection Process NOPR issued June 16th**
- **Updates to process needed, particularly in the areas of modeling data required and studies required**
- **Commission Testing improvements needed**

Note that the Sub Committee intends to contribute comments on both SGIP and LGIP NOPR

179 FERC ¶ 61,194
UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

[Docket No. RM22-14-000]

Improvements to Generator Interconnection Procedures and Agreements

(June 16, 2022)

AGENCY: Federal Energy Regulatory Commission.

ACTION: Notice of Proposed Rulemaking.

SUMMARY: The Federal Energy Regulatory Commission (Commission) is issuing a Notice of Proposed Rulemaking (NOPR) proposing reforms to its *pro forma* Large Generator Interconnection Procedures, *pro forma* Small Generator Interconnection Procedures, *pro forma* Large Generator Interconnection Agreement, and *pro forma* Small Generator Interconnection Agreement to address interconnection queue backlogs, improve certainty, and prevent undue discrimination for new technologies. The reforms are intended to ensure that the generator interconnection process is just and reasonable and not unduly discriminatory or preferential. The Commission invites all interested persons to submit comments on the proposed reforms, including proposed revisions to the *pro forma* interconnection procedures and agreements, and in response to specific questions.

DATES: Comments are due **[INSERT DATE 100 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]** and Reply Comments are due **[INSERT DATE 130 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]**.

Questions

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rich.bauer@nerc.net

5. Coordination

- Ben York presented on activities of the Distributed Resources Integration, Working Group under PES Distribution SC

About Distributed Resources Integration (DRI), Ben York EPRI

- Under the T&D Subcommittee…active since 2001
- Mission is DER interaction with distribution system planning, operations, protection, etc.
- Going through a bit of refocusing process after leadership changes

General Thoughts on Wind/Solar Interconnection for Distribution

- Still seeing a lot of uncertainty - leads to extra cost and slower interconnections especially as circuits get more crowded.
- Some uncertainty is born out of utility practice - multiple generations of technology, non-DER friendly equipment standards
- Some of this is born out of a lack of clarity on the vendor side…either through lack of understanding of utility needs, unusual, hidden, or specific equipment requirements

6. Old Business

- Webmaster http://sites.ieee.org/pes-edpgcom-wsppidsc/
- None

7. New Business

- Questions on the scope of Gateway, P1547.10. Is it only distribution? Is there possible confusion for transmission-connected DER? Action item is to for SC leadership and PAR leadership to discuss and resolve. Revisit scope regarding what isn't in the scope.

8. Future Meetings and Sessions Plans

- IEEE Joint Technical Working Group meeting, Jan 8-12, Jacksonville Florida and 2023 Summer Meeting July 16-20, in Orlando FL.
- Both WG and TF meetings and panel sessions are planned.

9. Adjourned 10 am July 20, 2022