Harmonizing IBR Interconnection Requirements in the West

Industry Advisory Group

Meeting # 2

Overview of IEEE 2800 and IBR Requirements Plan

June 26, 2025

WIRAB
Western Interconnection Regional Advisory Body

Meeting Logistics

Recording

This meeting is being recorded and **may be posted publicly**. By participating, you consent to your name, voice, and image being part of the recording.

How to Participate

Use the **"Raise Hand"** feature to ask questions or provide input

Feel free to use the **chat** for comments or clarifying questions

We will be using **Slido** later in the meeting to solicit feedback

Audio Etiquette

Everyone came into the meeting muted

Please **mute yourself** when not speaking

If joining by phone, please identify yourself in the chat

Materials & Follow-Up

Slides and materials will be shared after the meeting and available on the webpage

Contact information will be provided at the end for follow-up questions or comments

Outline

Introductions and Background	Recap first meeting
Technical Overview	Overview of IEEE 2800 Explore various adoption strategies used by industry
Interactive Discussion and Q&A	Open Discussion and Slido Polls
Closing and Next Steps	Confirming upcoming meeting dates and schedule Preview of next meeting topics and expected deliverables

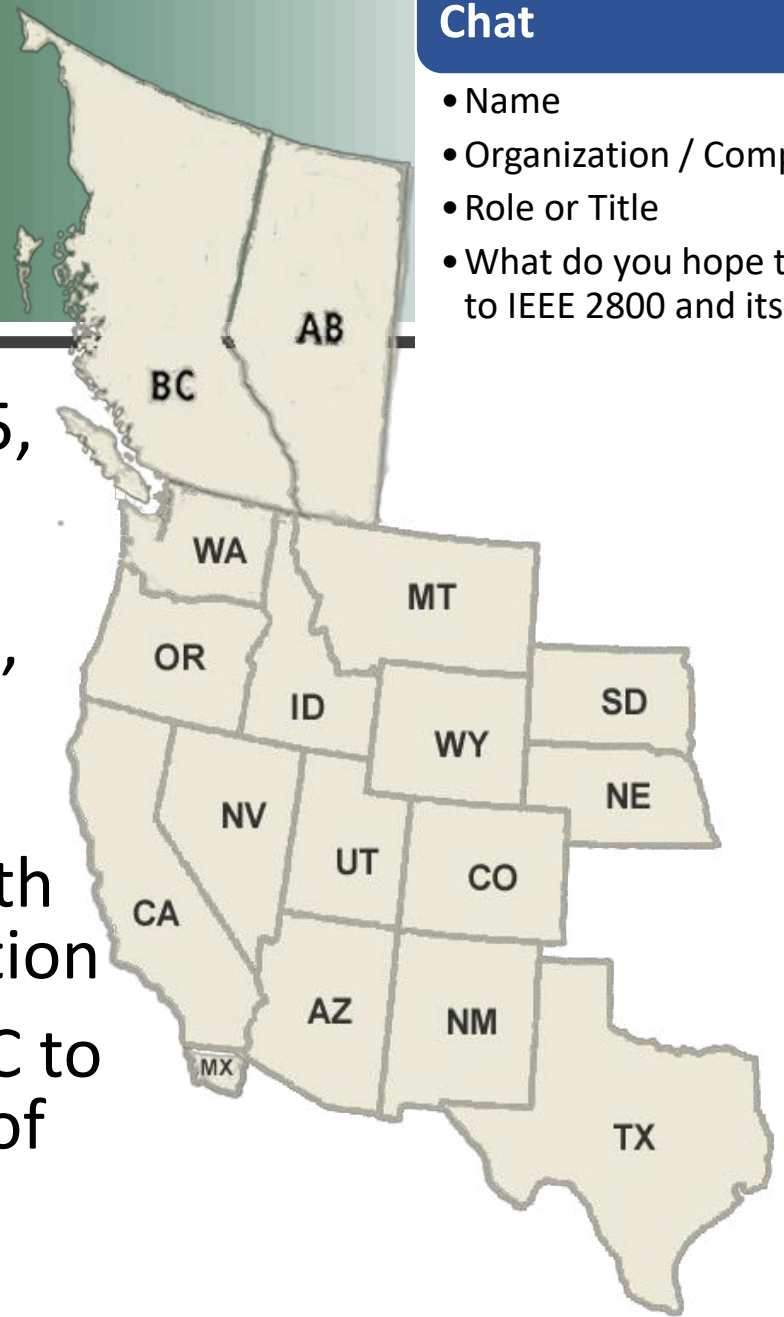
Introductions

Please Introduce Yourself in the Chat

- Name
- Organization / Company
- Role or Title
- What do you hope to learn with regards to IEEE 2800 and its implementation?

Who is WIRAB?

- **Statutory Authority:** Established in 2005, as an independent body with statutory authority under Section 215(j) of the Federal Power Act to Advise FERC, NERC, and WECC on reliability matters in the Western Interconnection.
- **Membership:** All state and provinces with load served in the Western Interconnection
- **Funding:** Assessments approved by FERC to load serving entities under Section 215 of the Federal Power Act.



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WIRAB's 2025 Strategic Initiatives

Please Introduce Yourself in the Chat

- Name
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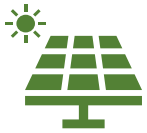
Transmission Planning (WestTEC)

Initiative 1: Advise WECC to work collaboratively with the Western Power Pool and Western stakeholders to develop an investment-grade transmission plan that effectively improves reliability in the Western Interconnection.



Inverter-based Resource Risk

Initiative 2: Advise WECC to work collaboratively with Western regulators and stakeholders to address and proactively mitigate risks associated with the uncoordinated interconnection of inverter-based resources in the Western Interconnection.

Inter-regional Transfer Capability

Initiative 3: Advise WECC regarding a process for ongoing assessments and prudent upgrades for inter-regional transfer capabilities in the Western Interconnection to ensure reliable power flow when the system is stressed.

Extreme Weather Event Analysis

Initiative 4: Advise WECC to conduct a systematic review of recent extreme weather events that have tested the grid, focusing on the challenges of maintaining grid reliability during increased demand, unexpected outages, system stress, and near-miss incidents in the Western Interconnection.

Grid Enhancing Technologies for Reliability

Initiative 5: Advise WECC to assess the reliability implications of innovative grid solutions used to maximize the potential of the existing transmission system as utilities modernize the grid in the Western Interconnection.

Inverter-Based Resource Risk Assessment Report

Please Introduce Yourself in the Chat

- Name
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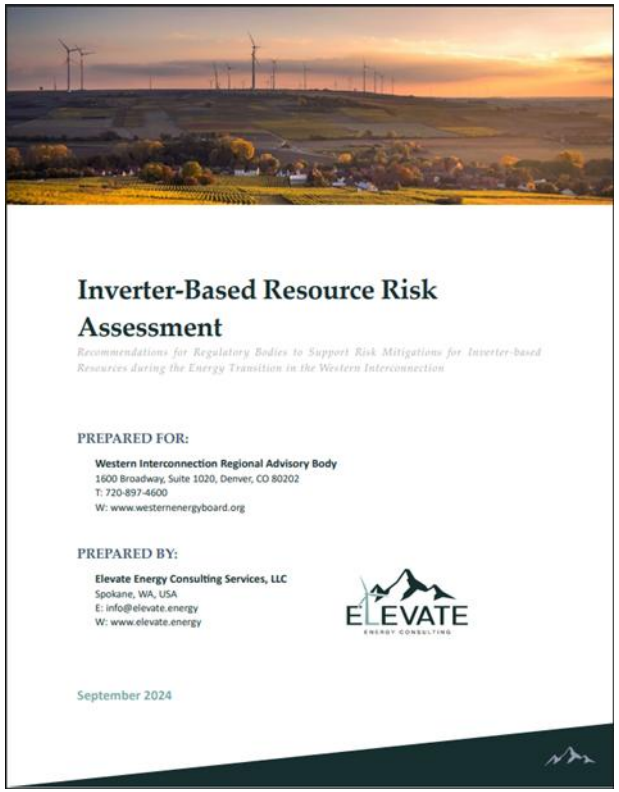
- What do you hope to learn with regards to IEEE 2800 and its implementation?

- **Developed by Elevate Energy Consulting**
- **Report and Recommendations Endorsed by WIRAB in 2024.**
  - WIRAB to collaborate with WECC and other key stakeholders to prioritize and implement the recommendations outlined in this report.
- **Key Recommendation:** Create a standardized template for FIR enhancements, ideally implementing IEEE 2800 standard.



Industry Advisory Group Schedule

Please Introduce Yourself in the Chat

- Name
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- What do you hope to learn with regards to IEEE 2800 and its implementation?

Date	Topics
✔ May 19, 2025 from 3:00 – 4:00 p.m. MT	Introduction, Background, Goals, Timeline
June 26, 2025 from 1:00 – 2:00 p.m. MT	Overview of IEEE 2800 and IBR Requirements Plan
July 17, 2025 from 9:30 – 10:30 a.m. MT	IBR Requirements Enhancements – Industry Experience
August 28, 2025 from 1:00 – 2:00 p.m. MT	Draft Template Review: General Interconnection Requirements
September 25, 2025 from 1:00 – 2:00 p.m. MT	Draft Template Review: Technical Performance Requirements
October 23, 2025 from 1:00 – 2:00 p.m. MT	Draft Template Review: Model & Study Requirements
November 13, 2025 from 1:00 – 2:00 p.m. MT	Draft Template Review: SCADA, Monitoring, Compliance
December 17, 2025 from 1:00 – 2:00 p.m. MT	Final Review & Closeout

Thank You!

Next Industry Advisory Group Meeting

July 17, 2025 at 9:30 AM MT

Eric Baran

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720-897-4600 x 207

WIRAB
Western Interconnection
Regional Advisory Body

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IEEE 2800-2022 Overview

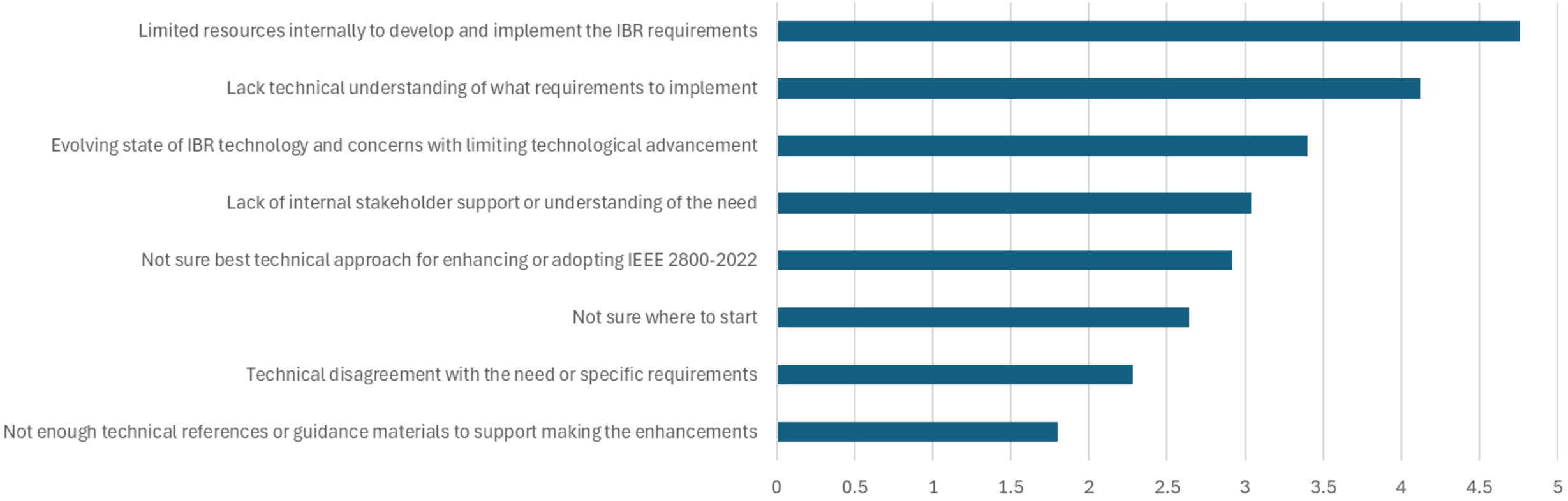
Industry Advisory Group (IAG) Kickoff Meeting

Ryan D. Quint, PhD, PE, *President and CEO*
Kyle Thomas, PE, VP, *Engineering and Compliance Services*
Nick Giffin, PE, *Lead Engineer, Modeling and Studies*

June 26, 2025

Q1: What have been the main challenges and/or barriers for enhancing IBR interconnection requirements?

**25 respondents*



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Slido Q&A and Polls

- Slido.com
- Join Code: 4350931

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Key Messages

Conclusions

- Adopt IEEE 2800-2022 to mitigate potential grid reliability risks posed by IBRs
- Regulatory changes (FERC Order 2023 and Order 901) do *not* preclude entities from establishing detailed requirements; often do not include the technical details needed for interconnection
- Implementation of IEEE 2800-2022, and the upcoming NERC Milestone 3 and 4 standards, requires careful consideration and decisions – start now

Recommendations

- Transmission providers (or ISO/RTOs) should adopt IEEE 2800-2022 using hybrid integration approach
- Transmission providers (or ISO/RTOs) should develop IBR performance conformity checks as part of interconnection modeling and model quality checks (adopt portions of P2800.2)

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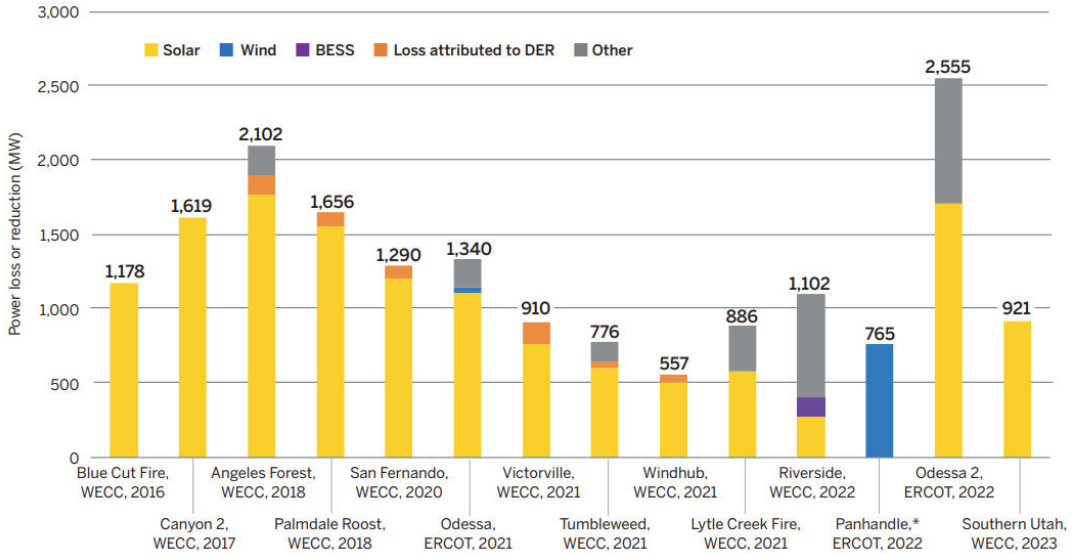
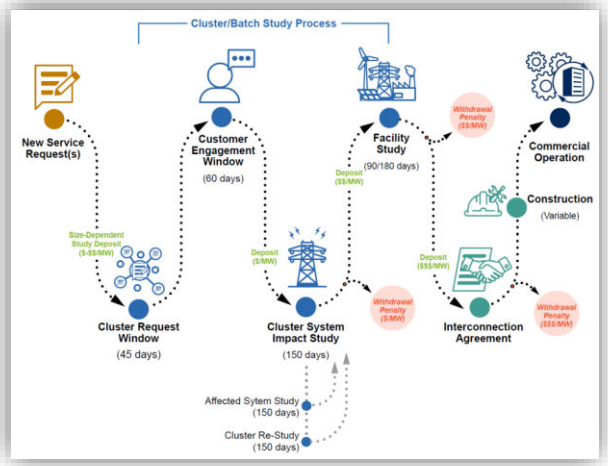
IBR Events Lead to Risk Mitigations



FERC Order 2023



FERC Order 901

185 FERC ¶ 61,042
UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

18 CFR Part 40

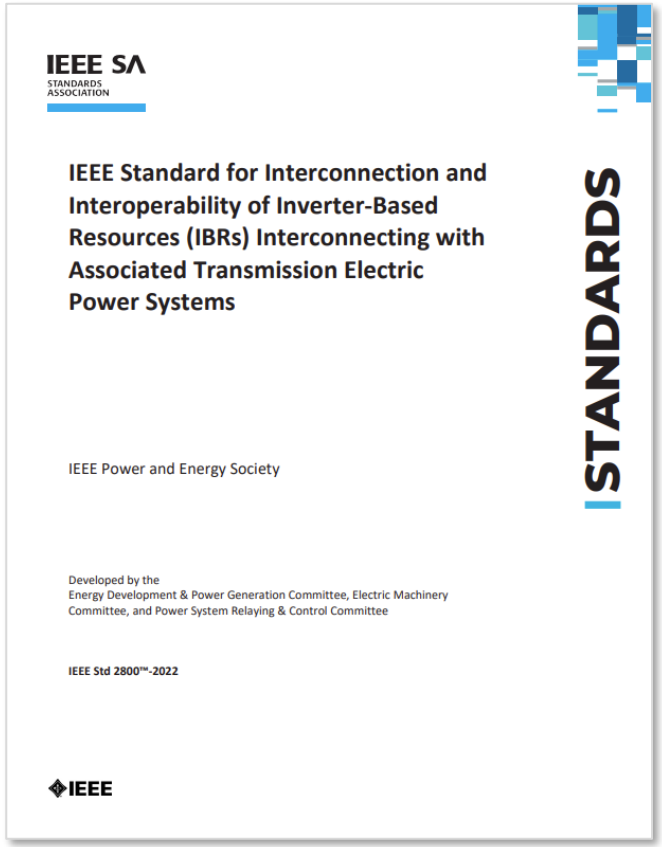
[Docket No. RM22-12-000; Order No. 901]

Reliability Standards to Address Inverter-Based Resources

(Issued October 19, 2023)

IEEE 2800-2022

- **Interconnection Requirements:**
  - Requirements pertaining to the interconnection modeling, study, and reliability decisions for IBRs connecting to the BPS.
- **Capability Requirements:**
  - Requirements that specify the functions, configurations, or performance an IBR plant (or IBR unit(s), where applicable) must be able to provide.
- **Performance Requirements:**
  - Requirements that specify the IBR plant (or IBR unit(s), where applicable) performance and behavior when executing specific function or modes of operation or when responding to changes in grid conditions.



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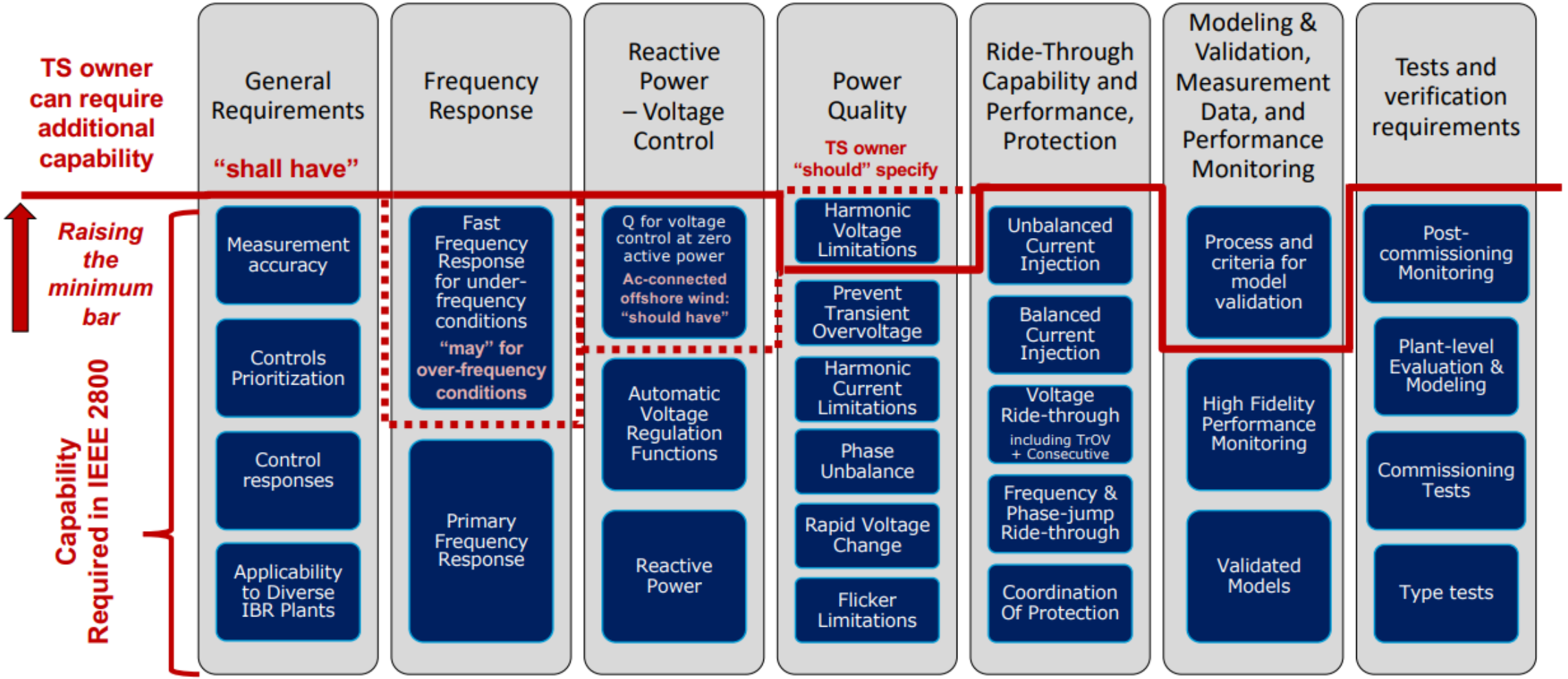
Raising the IBR Requirements Bar



Source: ©EPRI

NERC IBR Events and IEEE 2800-2022 Clauses

Protection and Control Issues			Blue Cut Fire	Canyon 2 Fire	Palmdale Roost & Angeles Forest	San Fernando	Odessa 2021	Multiple CAISO Solar Events	Panhandle Wind	Odessa 2022	Southwest Utah	CAISO BESS Events	Applicable IEEE 2800-2022 Clause
Location	Type	Identified Issue	August 2016	October 2017	April and May 2018	July 2020	May and June 2021	June thru August 2021	March 2022	June 2022	April 2023	March and April 2022	
Inverter	Control	Momentary Cessation[1]	X	X	X	X	X	X		X			Clause 7
	Protection	Inst. Frequency	X					X					Clause 7
	Protection	Inst. AC Overvoltage		X	X		X		X	X	X	X	Clause 7
	Protection	DC Reverse Current		X	X						X		Clause 7
	Protection	PLL Loss of Synchronism/Phase Jump		X			X			X	X		Clause 7
	Control	Slow Dynamic Active Power Recovery[1]		X		X	X	X	X				Clause 7
	Protection	AC Undervoltage				X		X					Clause 7
	Protection	Inst. AC Overcurrent				X	X	X		X	X	X	Clause 7
	Protection	DC High/Low Voltage				X						X	Clause 7
	Protection	DC Voltage Unbalance					X	X		X		X	Clause 7
	Control	Incorrect Ride-Through Configuration[1]					X			X			Clause 7
	Protection	DC Overcurrent						X					Clause 7
	Protection	Aux. Equip. (e.g., UPS, Pitch Converter)[2]						X	X				Clause 7
	Protection	Subsynchronous Oscillation							X				Clause 7
	Protection	AC Current Unbalance										X	Clause 7
Plant-Level	Control	Inverter-PPC Interactions[1]		X				X	X	X			Clause 7
	Protection	Feeder Underfrequency					X			X			Clause 9

[1] Controls-related performance issues
[2] e.g., UPS failure, pitch converter failure, etc.

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Authority Governing Interconnection Requirements

Regulatory Authority or Oversight Body:

- Responsible for establishing regulations
- May be stakeholder-based; can be difficult to get expert input
- Mandatory and enforceable compliance obligations
- Lengthy rulemaking processes and timelines

System Operator (ISO/RTO):

- Usually stakeholder-based committees overseeing rulemaking
- Independent organization gathering input from multiple parties
- Can be lengthy rulemaking process
- Options with market rules, guides, procedures, tariff, etc.
- Technical organization with resources to administer process

Transmission Provider (TO):

- Direct control of Facility Interconnection Requirements
- Flexibility and agility to update requirements
- Needs engagement and understanding of interconnection customer perspective
- Have a lot of responsibility in IEEE 2800-2022

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Where to Implement IEEE 2800-2022

IEEE 2800-2022

Controls the pro forma GIAs and GIPs, which is managed by the Office of Energy Market Regulation; very slow public process; not reliability-focused; not open to adopting 2800

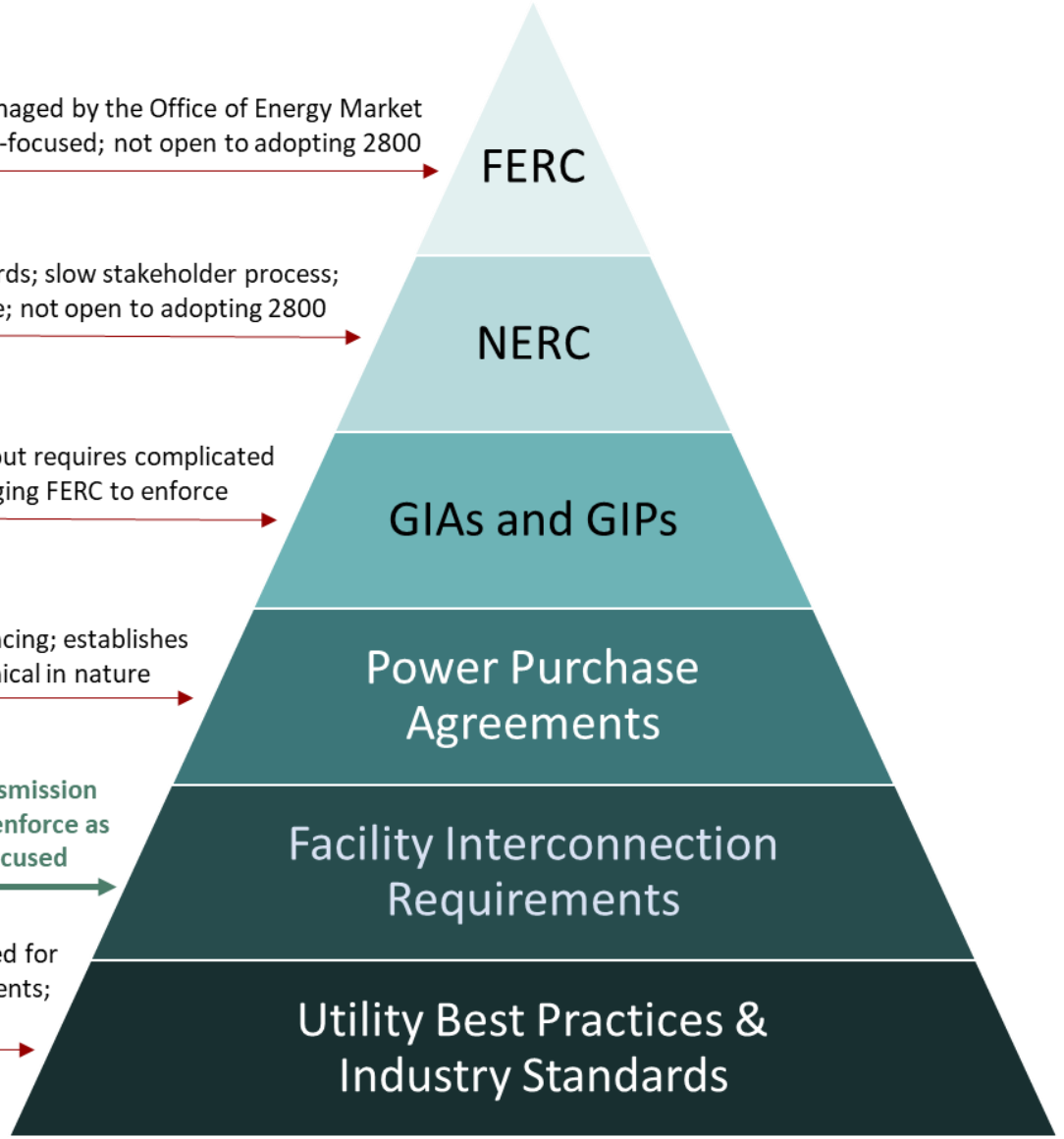
Controls the Reliability Standards; slow stakeholder process; reactive rather than proactive; not open to adopting 2800

Transmission providers can modify pro forma GIAs and GIPs but requires complicated and slow FERC approval; limited flexibility; requires engaging FERC to enforce

Focused on securing long-term pricing and project financing; establishes contractual agreements between parties; non-technical in nature

Requirements mandated by NERC; fully controlled by transmission owner/utility, easily modifiable and adaptable; utility can enforce as well as NERC; intended to be technical and reliability-focused

Limited ability to require or enforce for third-parties; intended for well-established organization exceeding minimum requirements; unsuitable for applying requirements to third-parties



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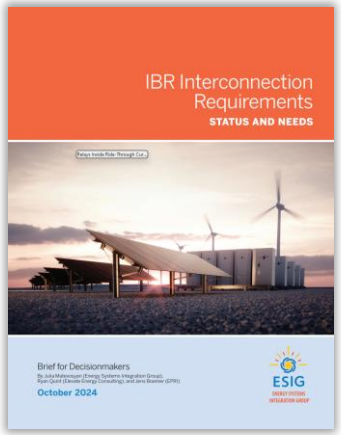
DOE i2X FIRST Initiative – Reference Materials

https://www.esig.energy/i2x-first-season-1/
https://www.esig.energy/i2x-first-forum/
Register for Season 2

IEEE 2800-2022 Adoption Approaches



ESIG Brief: IBR Interconnection Requirements

General Reference
Cite IEEE 2800 in Full

"Point to standard in existing requirements"

- ✓Minimal effort to adopt
- × **Limited system-specific details***
- × Lacks clarity and specificity
- × **Leaves gaps in implementation and understanding**

Detailed Reference
Cite IEEE 2800 Clauses

"Point to specific clauses in existing requirements"

- ✓Targeted enhancements
- ✓Allows phased approach
- × **Limited system-specific details***

Hybrid Integration
Organic Integration

"Point to specific clauses and add clarifying language in existing requirements"

- ✓Targeted enhancements
- ✓Allows phased approach
- ✓Allows adaptation and additional requirements
- ✓**System-specific and clear**
- ✓Enables conformity language additions

Detailed Spec
Recreate Specs of IEEE 2800

"Recreate requirements language entirely"

- ✓Targeted enhancements
- ✓Allows phased approach
- ✓Allows adaptation and tailored solution for specific rules framework
- ✓Enables conformity language
- × **Significant work and duplication for AGIR**
- × Copyright concerns

*** Industry practice has tended not to provide the necessary AGIR-specific details (i.e., functional settings) needed for complete adoption of IEEE 2800-2022.**

Notes: Green text indicates advantages of the adoption method, yellow text indicates limitations, and red text indicates gaps. More important advantages, limitations, and gaps are in bold. AGIR = Authority Governing Interconnection Requirements.

Source: Elevate Energy Consulting.

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IEEE 2800-2022 Adoption Update

Company	Phase (if applicable)	Adoption Approach (End)	Retroactive Application on Legacy IBRs	Reference Point of Applicability (RPA)	Performance and Capability?	Clause 1: Overview	Clause 2: Normative references	Clause 3: Definitions, acronyms, abbreviatio	Clause 4: General requirements	Clause 5: Reactive power—voltag e contro	Clause 6: Active power—freque ncy respon	Clause 7: Response to TS abnormal condition	Clause 8: Power quality	Clause 9: Protection	Clause 10: Modeling data	Clause 11: Measurement data	Clause 12: Test and verification	Grid-forming Requirements
Ameren IL		Hybrid Reference Customization &	✗	POI	✓	○	○	○	○	◗	○	○	○	○	○	○	○	○
Ameren Transmission Company of Illinois (ATXI)	Interim Phase 1 (ahead of MISO)	Detailed Reference & Customization	✗	POI	✓	○	○	○	○	○	○	◕	○	○	●	○		
	Phase 1 (aligned with MISO)	Hybrid Reference Customization &	✗	POI	✓	○	○	○	●	○	○	◕	○	○	○	○		
Bonneville Power Administration (BPA)		Detailed Reference & Customization	✗	POI	✓	○	○	◗	●	●	●	●	◗	◗	●	◗		
Duke Energy		Hybrid Reference Customization &	✗	POI	✓	○	○	◗	◕	●	●	●	◕	●	●	●	◗	○
ERCOT	Phase 1	Hybrid Reference Customization &	✓	POI	✓	○	○	○	◔	●	○	●	○	●	◔	◔	◔	
	Phase 2	Hybrid Reference Customization &	✓	POI	✗	○	○	○	○	○	○	○	○	○	○	◗	○	○
HECO	Stage 3 Hawaii RFP	Hybrid Reference Customization &	✗	POI	✓	○	○	○	◔	●	◕	◗	●	●	●	●	○	
ISO-NE		Detailed Reference & Customization	✗	POM	✓	○	○	●	◕	◕	◕	◕	○	○	○	○	○	○
MISO	Phase 1	Detailed Reference & Customization	✗	POM	✓	○	○	○	◗	○	○	◕	○	○	◔	○	○	
	Phase 2	Detailed Reference & Customization	✗	POM	✓	○	○	○	◗	◕	◕	◕	○	○	◔	◕	○	
NYSRC		Detailed Reference & Customization	✗	POI	✓													
North American Electric Reliability Corporation (NERC)	Milestone 2	Full Specification & Customization	✓	POM	✓	○	○	◔	○	○	○	◕ PRC-029	○		○	◕ PRC-028	◔ PRC-030	○
Natural Resources Department of Canada	SREPs Program	General Reference	✗	POI	✓	○	○	○	○	○	◗	○	○	○	○	○	○	○
San Diego Gas & Electric Co.		Hybrid Reference Customization &	✗	POI	✓	○	○	○	○	◗	◗	◗	◔	◗	◗	◕	◔	○
SaskPower		Hybrid Reference Customization &	✗	POI	✓	○	○	○	○	◕	●	◕	○	○	○	○	○	○
Southern California Edison (SCE)	Phase 1	Detailed Reference & Customization	✗	POI	✓	●	●	●	●	◗	◗	●	●	●	○	○		
Southern Company	Phase 1	Detailed Reference & Customization	✗	POI	✓	○	○	○	◗	●	●	●	◗	●		◕		○
	Phase 2	Detailed Reference & Customization	✗	POI	✓	○	○	◕	◗	●	●	●	◗	●	●	◕	◔	○
	Phase 3	Detailed Reference & Customization	✗	POI	✗	○	○	◕	○	○	○	○	○	○	●	○	◕	○
SPP	Phase1	Detailed Reference & Customization	✗	POM	✓	○	○	○	◗	○	○	◕	○	○	○	●	○	
SRP	Phase 1	Hybrid Reference Customization &	✗	POI	✓	○	○	●	●	●	●	◕	◕	●	●	●	●	○
Tennessee Valley Authority (TVA)	Phase 1	Hybrid Reference Customization &	✗	POM	✓	●	○	●	●	●	◕	●	◕	●	●	●	○	○

Legend: ○ – not adopted | ◔ , ◗ , ◕ , ● – various adoption degrees | ◔ , ◗ , ◕ , ● – various degrees of own specs

Source: DOE i2X (ESIG) EPRI©2025

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Slido Questions

Slido.com

Join Code: 4350931

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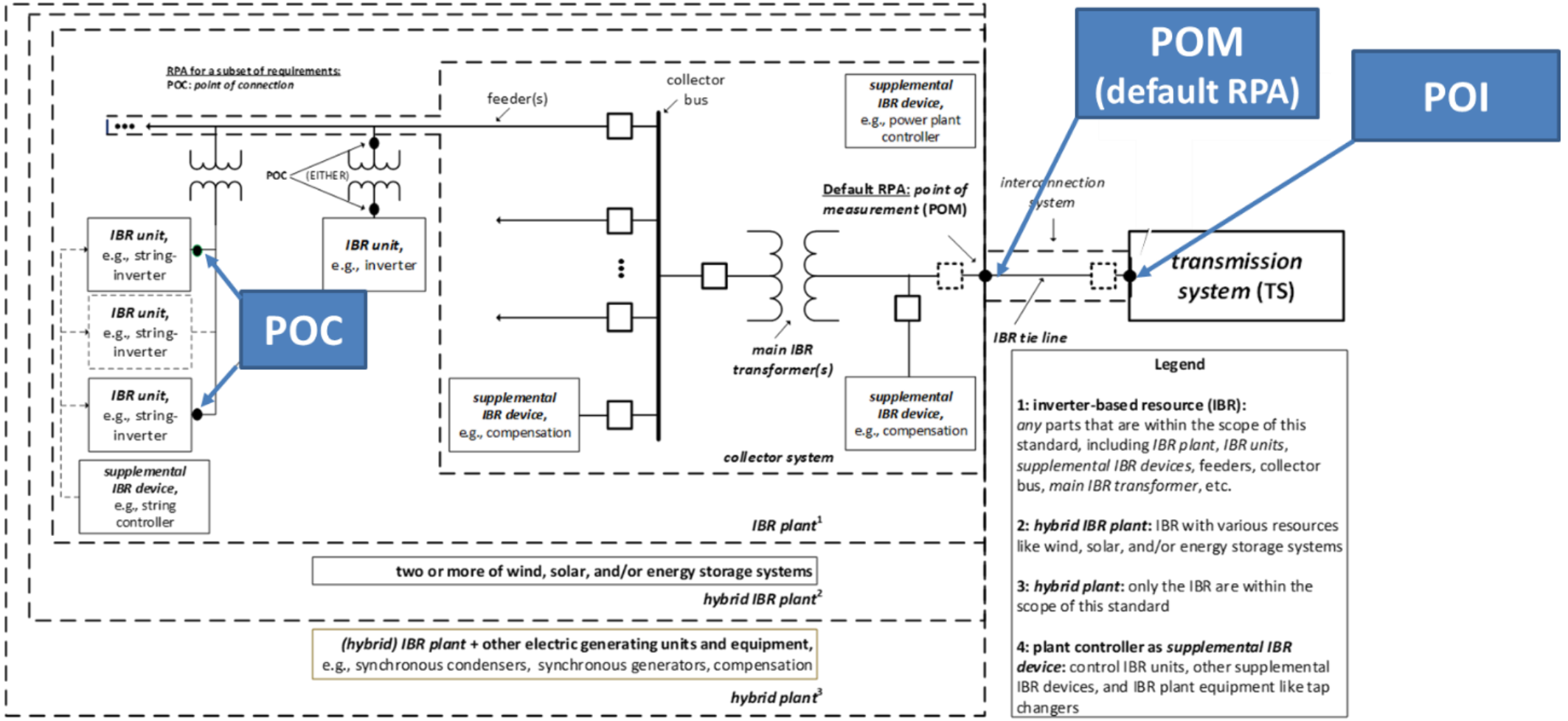
IEEE 2800-2022 Definitions



Source: A. Hoke

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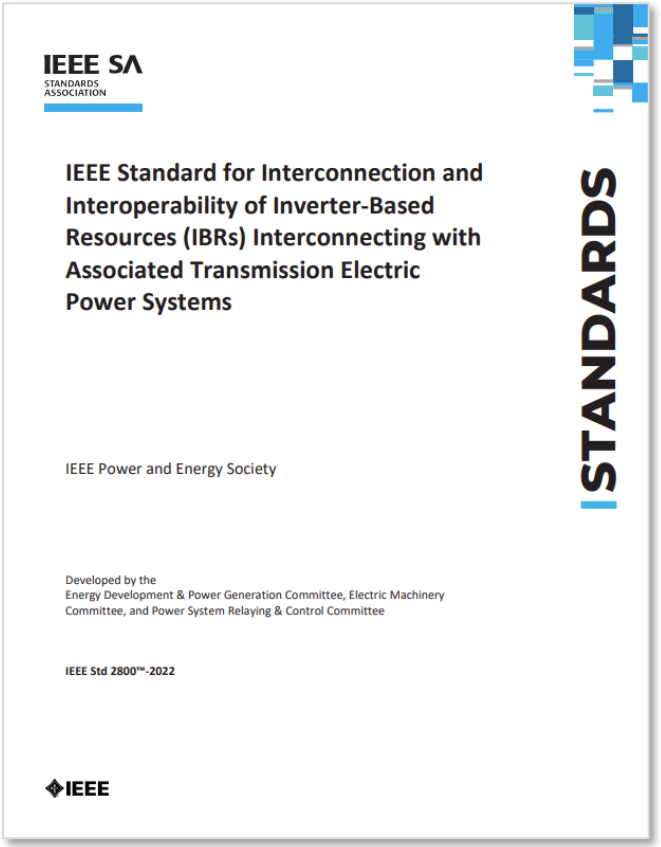
IEEE 2800-2022

- **Clause 4:** General interconnection technical specifications and performance requirements
- **Clause 5:** Reactive power-voltage control requirements
- **Clause 6:** Active power-frequency response requirements
- **Clause 7:** IBR ride-through capability and performance requirements
- **Clause 8:** Power quality requirements
- **Clause 9:** Protection requirements
- **Clause 10:** Modeling data requirements
- **Clause 11:** Measurement data for performance monitoring and validation requirements
- **Clause 12:** Test and verification requirements
- **Annexes:** Informative (non-mandatory) for additional guidance



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IEEE 2800-2022 Adoption Decision Points

- Decision points throughout standard necessary for effective implementation
- AGIR should ensure that all pertinent information made available to interconnection customer and that any areas of vagueness or confusion are clarified by the TS owner/operator
- ***We will go through many of these on future calls!***

Table 6-1. List of Key Decisions for TS Owners and TS Operators

Clause	Review Details
Clause 1. Overview	
1.4 General remarks and limitations ***Authorities governing interconnection requirements*** should adopt this standard with functional responsibilities for entities involved in and coordinating in the IBR interconnection process, i.e., ***TS owner***, ***TS operator***, load balancing entity, IBR owner, IBR operator, and IBR developer, as applicable to the given regulatory framework.	**Key Decision** The TS owner and TS operator should ensure it is clear and documented which entity or entities are the AGIR. In general, this is the entity responsible for maintaining the IBR interconnection and performance requirements.
Clause 3. Definitions, acronyms, and abbreviations	
3.1 Definitions ***authority governing interconnection requirements (AGIR):*** A cognizant and responsible entity that defines, codifies, communicates, administers, and enforces the policies and procedures for allowing electrical interconnection of an inverter-based resource (IBR) to the transmission system (TS). This may be a regulatory agency, public utility commission, municipality, cooperative board of directors, etc., or depending on jurisdiction, ***TS owner*** or ***TS operator*** … This authority may be delegated by the cognizant and responsible entity to the ***TS owner/ TS operator*** or bulk power system operator.	**Key Decision** The TS owner and TS operator should ensure it is clear and documented which entity or entities are the AGIR. In general, this is the entity responsible for maintaining the IBR interconnection and performance requirements. (see Clause 1.4)
⋮	
Clause 5. Reactive power-voltage control requirements within the continuous operation region	
5.1 Reactive power capability The default reference point of applicability (RPA) for the minimum reactive power capability (Qmin) requirements of an IBR plant shall be the point of measurement (POM). Alternate locations for the RPA, such as the POI, may be specified by the ***TS owner***.	**Key Decision** The TS operator should determine if the POM is an applicable RPA for reactive power capability requirements. If alternates such as the POI are needed, then the TS owner must specify accordingly.
5.1 Reactive power capability IBR units shall have the capability to provide reactive power support when the primary energy source is available and not available, and during the transition between these two resource availability states. IBR units shall have the capability to remain in service while not exporting or importing active power, except for importation of active power to cover losses, and to have the reactive power capability as defined as shown in Figure 6 and Figure 7. Note that the type III WTGs may have a reduced reactive power capability when the primary energy source is not available due to the size of the line-side converter. The utilization of this capability shall be under mutual agreement between the IBR owner and the ***TS owner***.	**Key Decision** The TS owner should clearly specify the capability and performance requirements for IBR plants providing reactive power support when the primary energy source (active power) is not available, and during transition from that state and when the primary energy source is available. Technical performance requirements should match any contractual requirements (e.g., PPAs).

Source: Elevate project with CEATI

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Mutual Agreement Terms in IEEE 2800-2022

- Variations of phrase “mutual agreement” used throughout the standard
- Transmission provider has obligation of specifying performance requirements and maintaining reliability of their portion of the grid
- Interconnection customer has obligation to comply with the established requirements and obligations set forth

- Elevate recommends clarifying language for IEEE 2800-2022 implementation:

> *“Unless otherwise specific, references to any variation of mutual agreement will be determined by the AGIR or the appropriate designed entity (i.e., TS owner or TS operator) to specify. This includes all applicable capability, performance, settings, etc. The IBR owner shall adhere to the specified requirements.”*

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Exemption for IEEE 2800-2022 Conformity

- IEEE 2800-2022 is first of its kind IBR standard
- Major positive step in the right direction
- Expected and planned to undergo revisions
- Some implementation leniency needed (i.e., reasonableness)
- Emerging technologies (e.g., grid forming) should not be limited by adoption of standard requirements

Consider clarifying addition for implementation:

"The interconnection customer (IBR developer) shall comply with all applicable IEEE 2800-2022 clauses adopted herein. Any circumstances where IEEE 2800-2022 requirements cannot be met must be based on equipment hardware limitations. Any request for exemption with supporting documentation must be provided to the AGIR and approved by the AGIR prior to commercial operation."

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Retroactive versus Forward-Looking

- Improve IBR requirements early; avoid retroactive applicability
- Include reasonable implementation periods, particularly for resources going through interconnection process currently
- No *significant* OEM concerns with implementation of IEEE 2800-2022 requirements for future resources, assuming flexibility for conformance testing
- Retroactive application has notable challenges and potentially very high costs
- "Maximization" of existing resource capability and performance (utilization) through software-based updates may minimize reliability risk while minimizing costs to asset owners
- Technical justification (i.e., quantitative study) should be provided for retroactive application of requirements, particularly hardware-based modifications

> *"The application of this standard may be limited to IBR plants for which interconnection requests are submitted after the date by which this standard is enforced by the responsible authority governing interconnection requirements (AGIRs); this standard may not apply to IBR plants that are either already interconnected or for which interconnection requests had been submitted prior to the standard's enforcement date (grandfathering). Any substantial changes in an existing IBR plant, e.g., the "repowering" of a wind power plant, may require retrofitting that IBR plant to meet all of the requirements of this standard."*

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NERC IBR Standards Projects & Relation to IEEE 2800-2022

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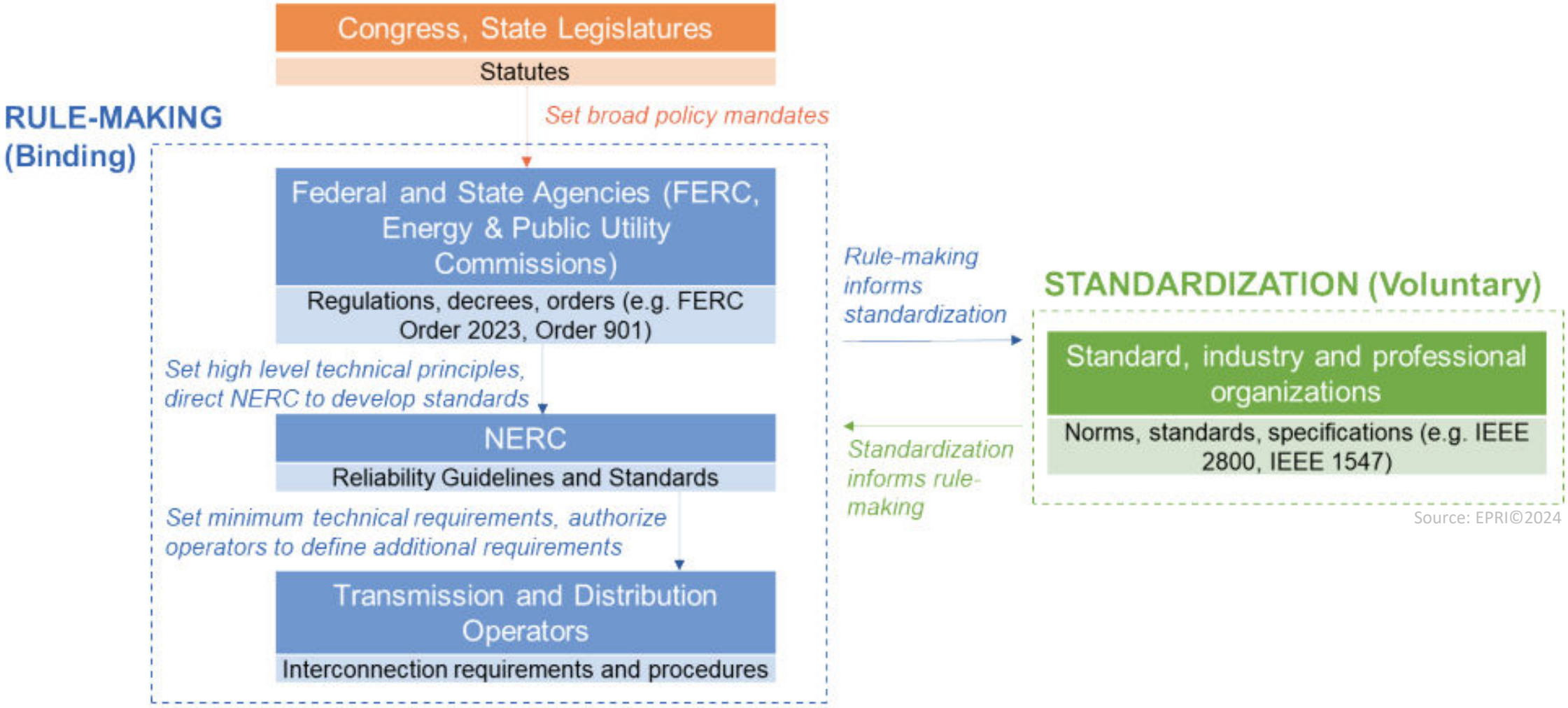
Regulatory Framework and IEEE 2800



Source: EPRI©2024

NERC and FERC Statements on IEEE 2800

NERC Comments on FERC Order No. 2023:

"NERC recommends that the Commission explicitly integrate the requirements and recommendations from IEEE Standard 2800-2022 into the pro forma *interconnection agreements. Specifically, NERC contends that the Commission should prioritize the disturbance ride through, active power–frequency control, reactive power–voltage control, data sharing, and modeling provisions of IEEE Standard 2800-2022. However, NERC states that some transmission system conditions may require inverter control modes, settings, or protections that will not conform to IEEE Standard 2800-2022 region-wide expectations. NERC also argues that transmission providers should be permitted to establish additional performance requirements for specific locations and instances beyond region-wide requirements established under* pro forma *provisions, subject to transparency and public notice."*

FERC Response in FERC Order No. 2023:

"Although we acknowledge the value of IEEE 2800-2022, we decline to incorporate it by reference. IEEE 2800-2022 was developed for a different purpose; it is a voluntary guideline that uses discretionary terms (e.g., "may," "should," "can," or "upon agreement"). It is unclear whether IEEE 2800-2022 would adequately address the problem identified by the Commission because the Commission would have limited authority to enforce these discretionary provisions."

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FERC Order 901 and NERC Work Plan

- **FERC Order 901** directs NERC to submit a detailed standards development plan to address IBR reliability gaps in four areas: a) data sharing, b) model validation, c) performance requirements, and d) planning and operational studies.
- **Milestone 1:** Submission of Order No. 901 Work Plan (Submitted to FERC in January 2024)
- **Milestone 2:** Filing of Standards to Address Performance Requirements and Post-Event Performance Validation for Registered IBRs (Submitted to FERC on November 4, 2024)
  - New NERC Standards PRC-028 (approved by FERC), PRC-029 (waiting for FERC approval), and PRC-030 (approved by FERC)
- **Milestone 3:** Filing of Standards to Address Data Sharing and Model Validation for all IBRs (To be submitted to FERC by 11/4/2025)
  - Project 2020-06 – Verifications of Models and Data for Generators
  - Project 2021-01 – System Model Validation with IBRs
  - Project 2022-02 – Uniform Modeling Framework for IBR
  - Project 2022-04 – Electromagnetic Transient (EMT) Modeling (not officially a Milestone 3 project, but is a related project – not expected to be filed by 11/4/2025)
- **Milestone 4:** Filing of Standards to Address Planning and Operational Studies Requirements for all IBRs (To be submitted to FERC by 11/4/2026)

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NERC PRC-028: IBR Disturbance Monitoring

- Purpose: better data to identify and correct abnormal performance at IBRs
- This standard is applicable to **Generator Owners**

Data Category	Measurement Locations	Data Requirements	Retention Period	Time Synchronization Requirement

Sequence of events recording (SER)	• Circuit breaker position for main transformers, collector bus, and shunt reactive devices
	• IBR unit (i.e., wind turbine or solar or BESS inverter)
		• Breaker operation: open/close
		• Fault code, alarm, and ride-through mode status when trigger by ride-through or tripping
			20 days	• UTC synchronization
				• Accuracy
				  • ± 100 ms (IBR)
				  • ± 1 ms (all others)

Triggered fault recording (FR) data	• High-side of main power transformer(s) • Collector feeder breakers • Shunt dynamic reactive devices	• ≥ 64 samples/cycle • Phase voltage • Phase & neutral current • Three-phase real and reactive power		
Continuous dynamic disturbance recording (DDR) data	• Main transformers (PPC recordings, PMUs, etc.)	• One phase or positive sequence voltage, current, P, Q, voltage frequency • Sampling rate ≥ 960 /second • Output rate ≥ 60 /second		

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Example Comparison of IEEE 2800 and NERC PRC-028-1

Table 1-1. Comparison of IEEE 2800-2022 Requirements for Measurement Data

Measurement Data	IEEE 2800-2022	NERC PRC-028-1	Comments
Plant SCADA Data	✓	✗	Not included in NERC PRC-028.
Unit Functional Settings	✓	✗	Not included in NERC PRC-028.
SER Data (Plant Equipment Status)	✓	!	PRC-028 includes limited plant statuses and significantly shorter retention requirement.
DFR Data	✓	!	PRC-028 has lower sampling rate, shorter measurement duration, and retention requirements
DDR Data	✓	!	PRC-028 has lower retention rate.
Inverter Fault Codes	✓	!	PRC-028 has lower retention rate.
Inverter Dynamic Recordings	✓	✗	Not included in NERC PRC-028.
Power Quality Data	✓	✗	Not included in NERC PRC-028.

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NERC PRC-029: IBR Ride-Through

- Purpose: Ensure IBR voltage and frequency ride-through performance during grid disturbances
  - IBRs to ride through events within defined curves, aligned with IEEE 2800-2022
- Applicable to **Generator Owners**

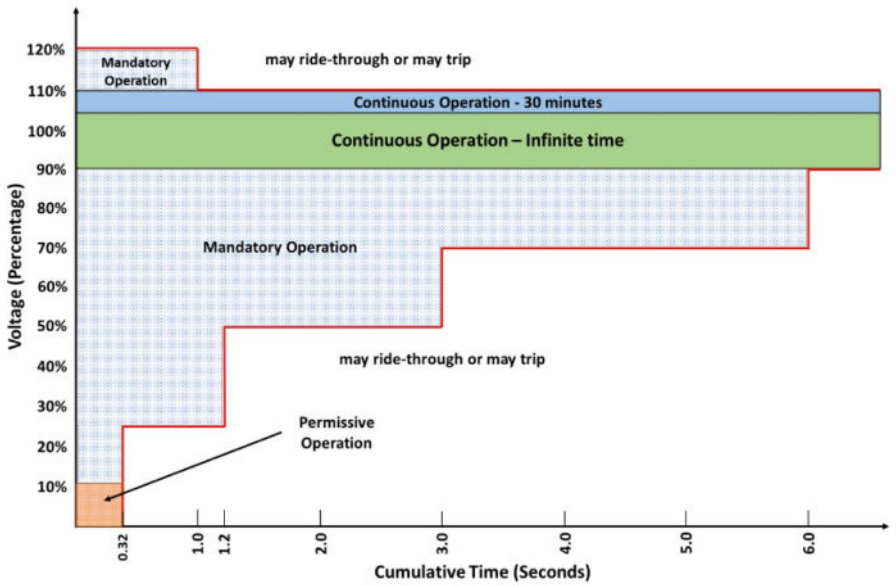

Figure D.7—Voltage ride-through requirements for *IBR plants* without auxiliary equipment limitations interconnecting at any nominal voltage except for 500 kV

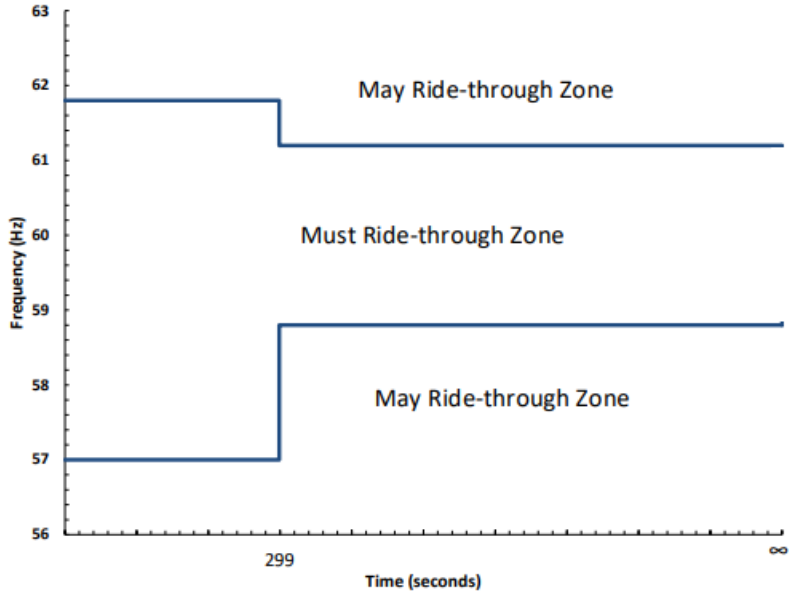

Figure 1: PRC-029 Frequency Ride-through Requirements

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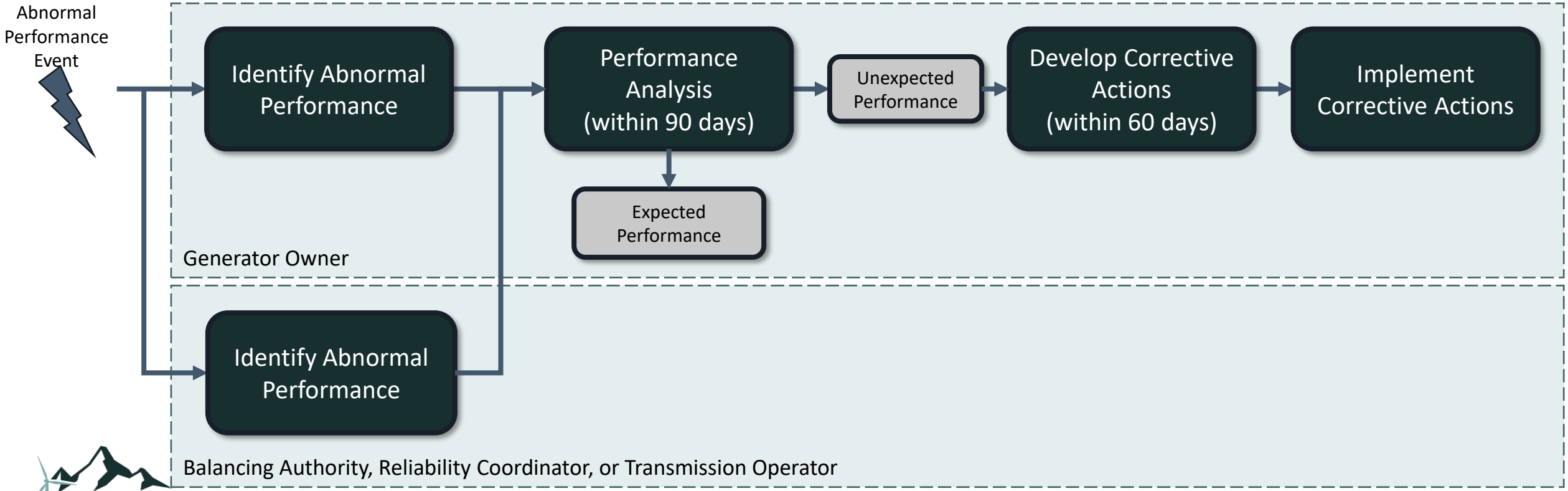
NERC PRC-030: Unexpected IBR Event Mitigation

- Purpose: ensure abnormal IBR abnormal performance is mitigated
- IEEE 2800-2022 does not have specific requirements related to the PRC-030 requirements
- This standard is applicable to **Generator Owners**



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NERC Milestone 3 Work for FERC Order 901

FERC Order 901 Milestone 3 Projects

Project 2020-06 – Verifications of Models and Data for Generators: *Addressing the verification and validation of models for registered inverter-based resources (IBR), unregistered and aggregated IBR, and aggregated distributed energy resources.*

Additional Focus:

- Define terms, such as Model Verification and Model Validation
- Develop process for post-interconnection model validation based on performance data
- Set validation expectations using performance data

Standards Include: MOD-026, MOD-027, FAC-00

Project 2021-01 – System Model Validation with IBRs: *Addressing system-level model verification and validation against actual system operational behavior during disturbances as well as aligning steady state and dynamic representation, where appropriate.*

Additional Focus:

- Develop criteria for performing validation
- Determine minimum study conditions for conducting validation studies
- Develop process to communicate system interconnection-wide model defects to Transmission Planners and other associated entities

Standards Include: MOD-033

Project 2022-02 – Uniform Framework Model Framework for IBR: *Addressing development of a NERC-maintained library consisting of generic IBR model types.*

Additional Focus:

- Establish a uniform framework for data sharing and model development
- Ensure other standards use performance data and library using this framework

Standards Include: MOD-032, TOP-003, IRO-010

Project 2022-04 – Electromagnetic Transient (EMT) Modeling, which addresses the establishment of EMT studies, as appropriate, during the interconnection process, is not a Milestone 3 project, but is being developed concurrently and may have a later filing date.

Standards Include: MOD-032, FAC-001, FAC-002

Source: NERC

Model Verification: The process of confirming that model structure and parameter values represent the equipment or facility design and settings by reviewing equipment or facility design and settings documentation.

Model Validation: The process of comparing measurements with simulation results to assess how closely a model's behavior matches the measured behavior.

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NERC Milestone 4 Work for FERC Order 901

- New SARs for this work just released to RSTC last week (SAR for Planning Studies, SAR for Operational Studies)
- Planning Studies Project
  - Revise TPL-001-5.1 or create a new standard for planning studies to consider:
    - Performance of, and BPS Reliability impacts of, registered and unregistered IBRs individually & in the aggregate, as well as IBR-DERs in the aggregate for all grid stress performance conditions
    - Capture the ride-through performance of IBRs and all other generation resources
- Operation Studies Project
  - RCs and TOPs to include the performance and behavior of all IBRs and DERs in operational planning analysis, real-time monitoring, and real-time assessments
  - BAs to include the performance and behavior of all IBRs and DERs in operational analysis and real-time monitoring
  - Revise or consider revising TOP-001, TOP-002, IRO-002, IRO-017, FAC-011, and PRC-012.

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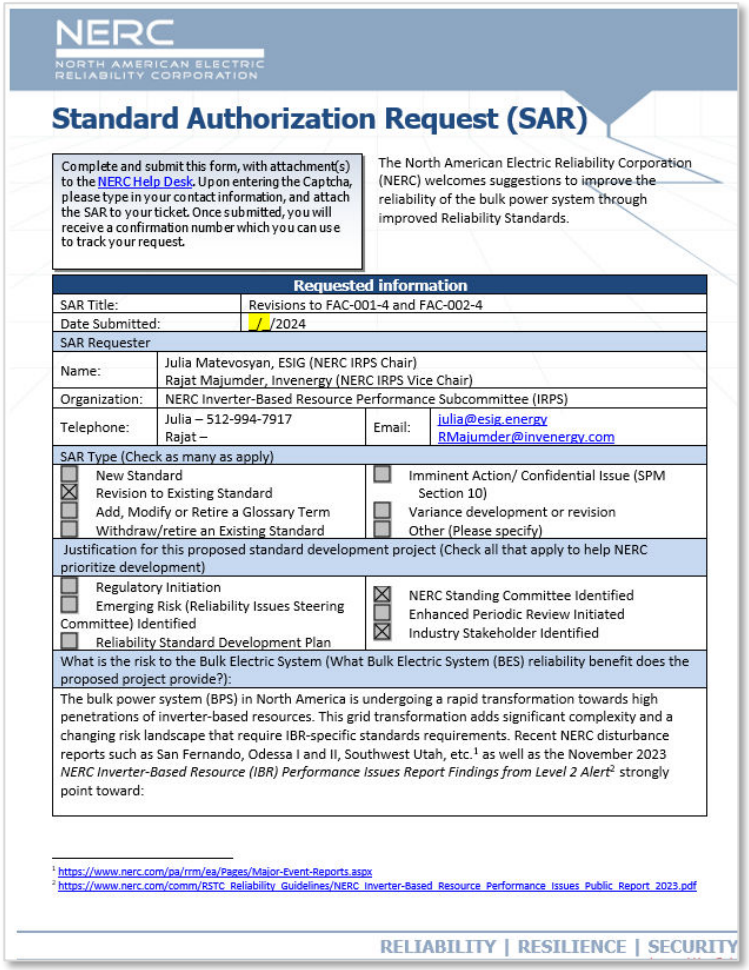
NERC IRPS SAR: Revisions to FAC-001 & FAC-002

- SAR developed by NERC IRPS, endorsed by NERC RSTC and accepted by NERC SC
  - Formal comment period and assigned to Project 2022-04 EMT Modeling
- Proposes to modify NERC FAC-001 and FAC-002
  - Enhancements to interconnection requirements (TOs)
    - **Consistent with IEEE 2800-2022 clauses**
  - Conformance assessments via studies (TPs and PCs)
  - IBR facility commissioning requirements (GOs)
- Goals to harmonize and standardize technical IBR interconnection details, as much as possible



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Standard Authorization Request (SAR)

Complete and submit this form, with attachment(s) to the NERC Help Desk. Upon entering the Captcha, please type in your contact information, and attach the SAR to your ticket. Once submitted, you will receive a confirmation number which you can use to track your request.

The North American Electric Reliability Corporation (NERC) welcomes suggestions to improve the reliability of the bulk power system through improved Reliability Standards.

Requested information			
SAR Title:	Revisions to FAC-001-4 and FAC-002-4		
Date Submitted:	_/_/2024		
SAR Requester			
Name:	Julia Matevosyan, ESIG (NERC IRPS Chair) Rajat Majumder, Invenergy (NERC IRPS Vice Chair)		
Organization:	NERC Inverter-Based Resource Performance Subcommittee (IRPS)		
Telephone:	Julia – 512-994-7917 Rajat –	Email:	julia@esig.energy RMajumder@invenergy.com

SAR Type (Check as many as apply)

- ☐ New Standard
- ☒ Revision to Existing Standard
- ☐ Add, Modify or Retire a Glossary Term
- ☐ Withdraw/retire an Existing Standard
- ☐ Imminent Action/ Confidential Issue (SPM Section 10)
- ☐ Variance development or revision
- ☐ Other (Please specify)

Justification for this proposed standard development project (Check all that apply to help NERC prioritize development)

- ☐ Regulatory Initiation
- ☐ Emerging Risk (Reliability Issues Steering Committee) Identified
- ☐ Reliability Standard Development Plan
- ☒ NERC Standing Committee Identified
- ☐ Enhanced Periodic Review Initiated
- ☒ Industry Stakeholder Identified

What is the risk to the Bulk Electric System (What Bulk Electric System (BES) reliability benefit does the proposed project provide?):

The bulk power system (BPS) in North America is undergoing a rapid transformation towards high penetrations of inverter-based resources. This grid transformation adds significant complexity and a changing risk landscape that require IBR-specific standards requirements. Recent NERC disturbance reports such as San Fernando, Odessa I and II, Southwest Utah, etc.[1] as well as the November 2023 *NERC Inverter-Based Resource (IBR) Performance Issues Report Findings from Level 2 Alert*[2] strongly point toward:

[1] https://www.nerc.com/pa/rrm/ea/Pages/Major-Event-Reports.aspx
[2] https://www.nerc.com/comm/RSTC_Reliability_Guidelines/NERC_Inverter-Based_Resource_Performance_Issues_Public_Report_2023.pdf

RELIABILITY | RESILIENCE | SECURITY

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IEEE P2800.2 Brief Overview

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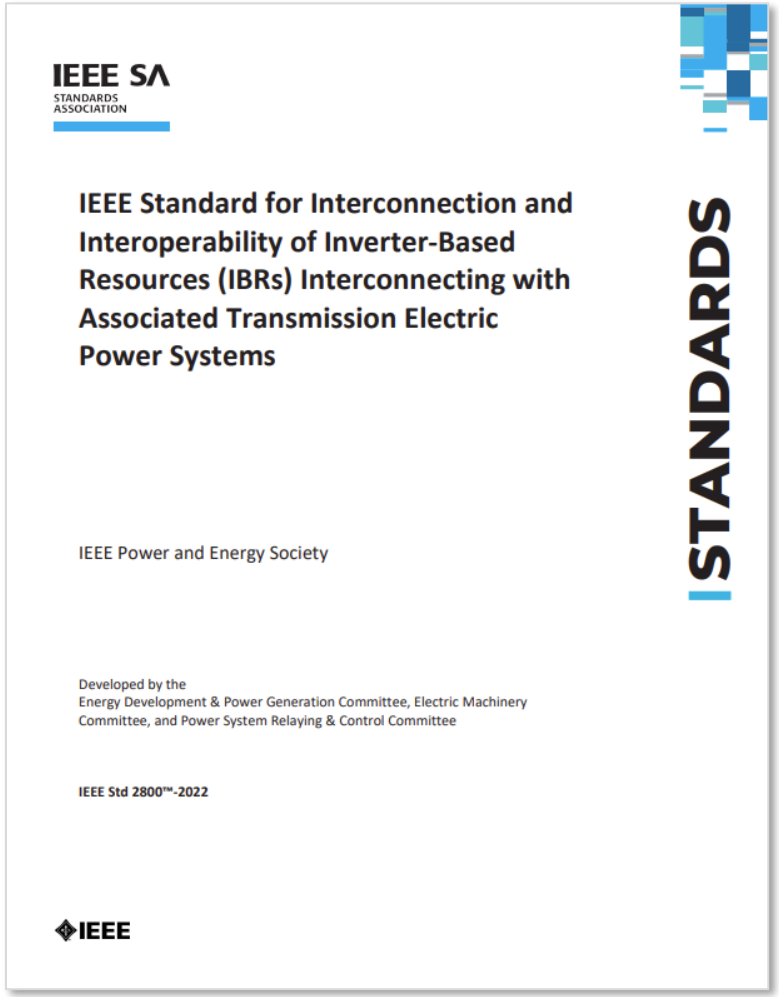
IEEE P2800.2 – Work in Progress


IEEE SA
STANDARDS ASSOCIATION

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

IEEE Power and Energy Society

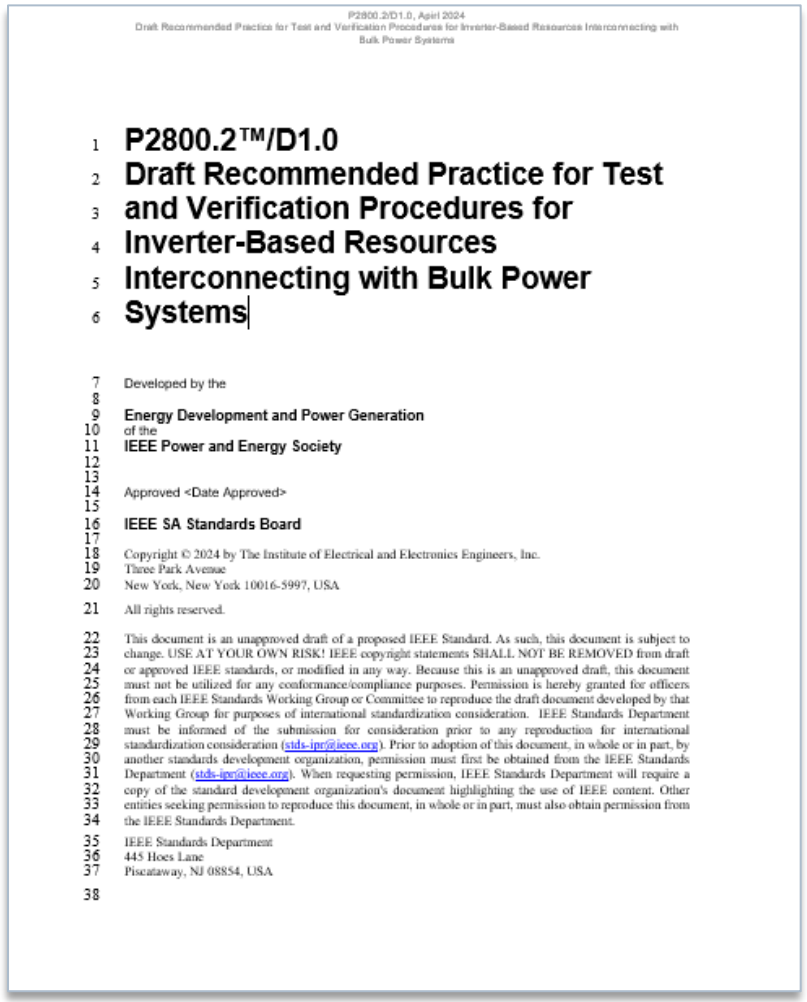
Developed by the
Energy Development & Power Generation Committee, Electric Machinery Committee, and Power System Relaying & Control Committee

IEEE Std 2800™-2022

IEEE

STANDARDS

THE WHAT


P2800.2/D1.0, April 2024
Draft Recommended Practice for Test and Verification Procedures for Inverter-Based Resources Interconnecting with Bulk Power Systems

P2800.2™/D1.0
Draft Recommended Practice for Test and Verification Procedures for Inverter-Based Resources Interconnecting with Bulk Power Systems

Developed by the

Energy Development and Power Generation
of the
IEEE Power and Energy Society

Approved <Date Approved>

IEEE SA Standards Board

THE HOW

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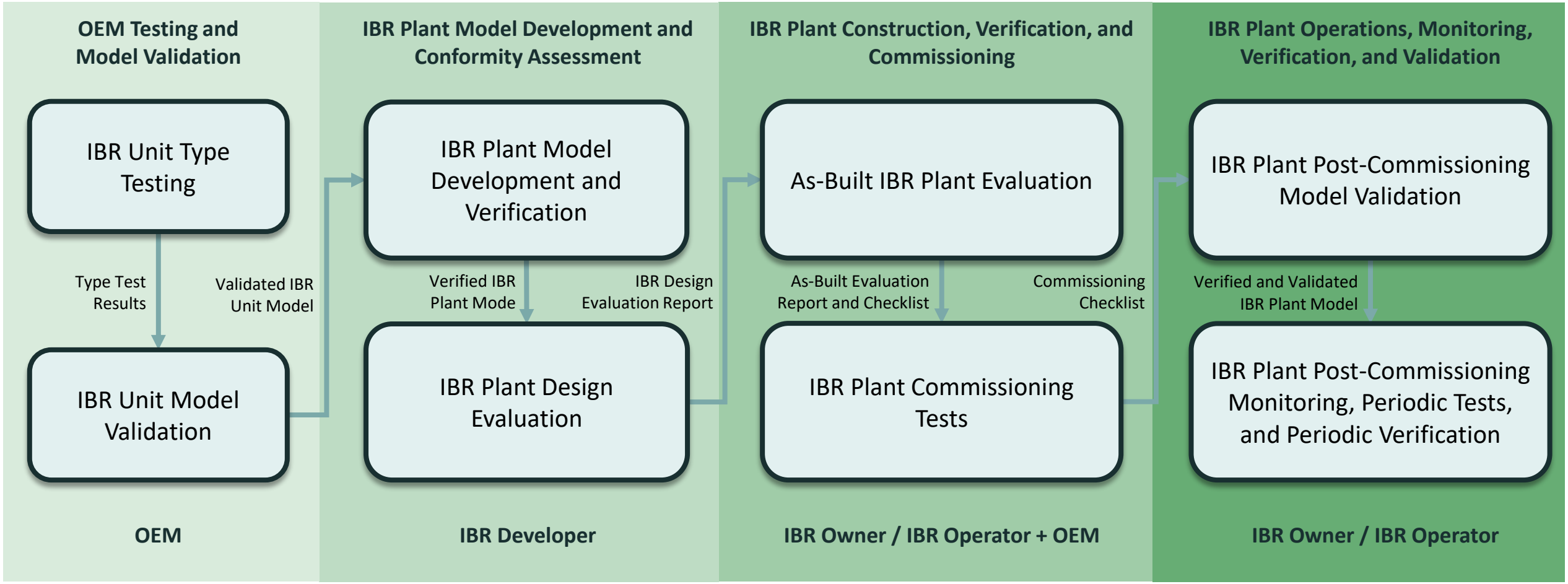
IEEE P2800.2 IBR Plant Performance Conformity Assessment



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Slido Questions

Slido.com

Join Code: 4350931

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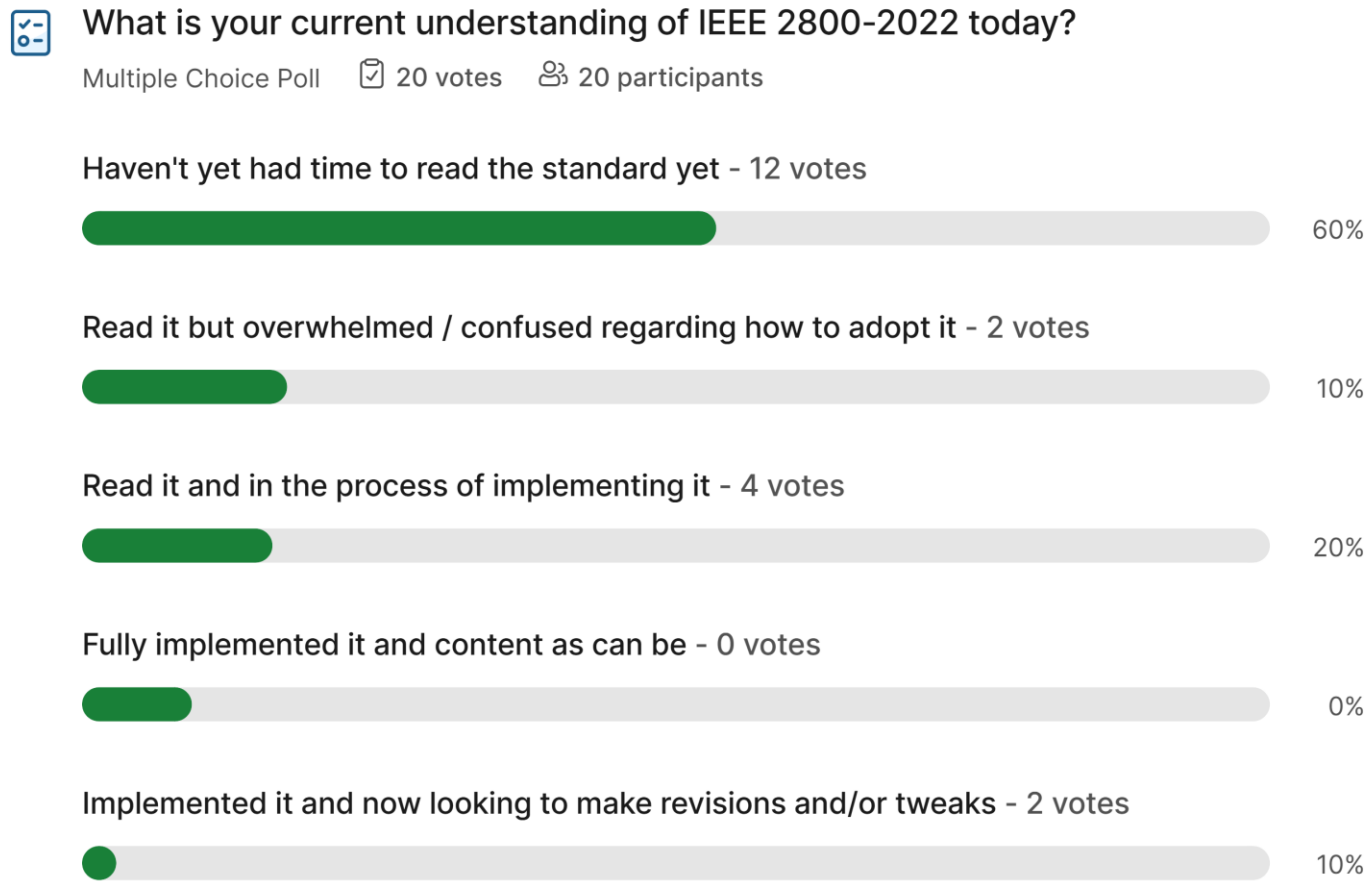
Slido Q1: What is your current understanding of IEEE 2800-2022 today?



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Slido Q2: What are your biggest questions regarding IEEE 2800-2022 adoption and implementation?

- I believe there is value in requiring GFM. MISO identity areas of 2800 that may conflict with 2800. Understanding the significance of the impacts and if exemptions are needed, is a question that we are needing to make time for next.
- Protection requirements for Transmission connected IBR vs distribution connected IBR
- Using the hybrid approach, how do we know what detail information to include if we lack the expertise and knowledge to set a specific requirement?
- To define more detailed performance requirements, are performance studies necessary? Are positive sequence simulations sufficient, or should we conduct more advanced studies like EMT to determine the appropriate requirements
- What part of inverter behavior described in IEEE 2800 is the best argument for EMT modeling?
- Are there certain details that require collaboration between TOs and other regulatory agencies?
- Don't have personnel to dig into this. Too many high priorities.
- Best place to adopt seems to be adding IEEE 2800 requirements into the FAC-001 FIR document. But how to do that? Go throughout the whole document and add requirements throughout? Standalone document with reference to it in the FIR? Or full document as an attached appendix at end?
- Any plans to update for Grid Forming IBRs?

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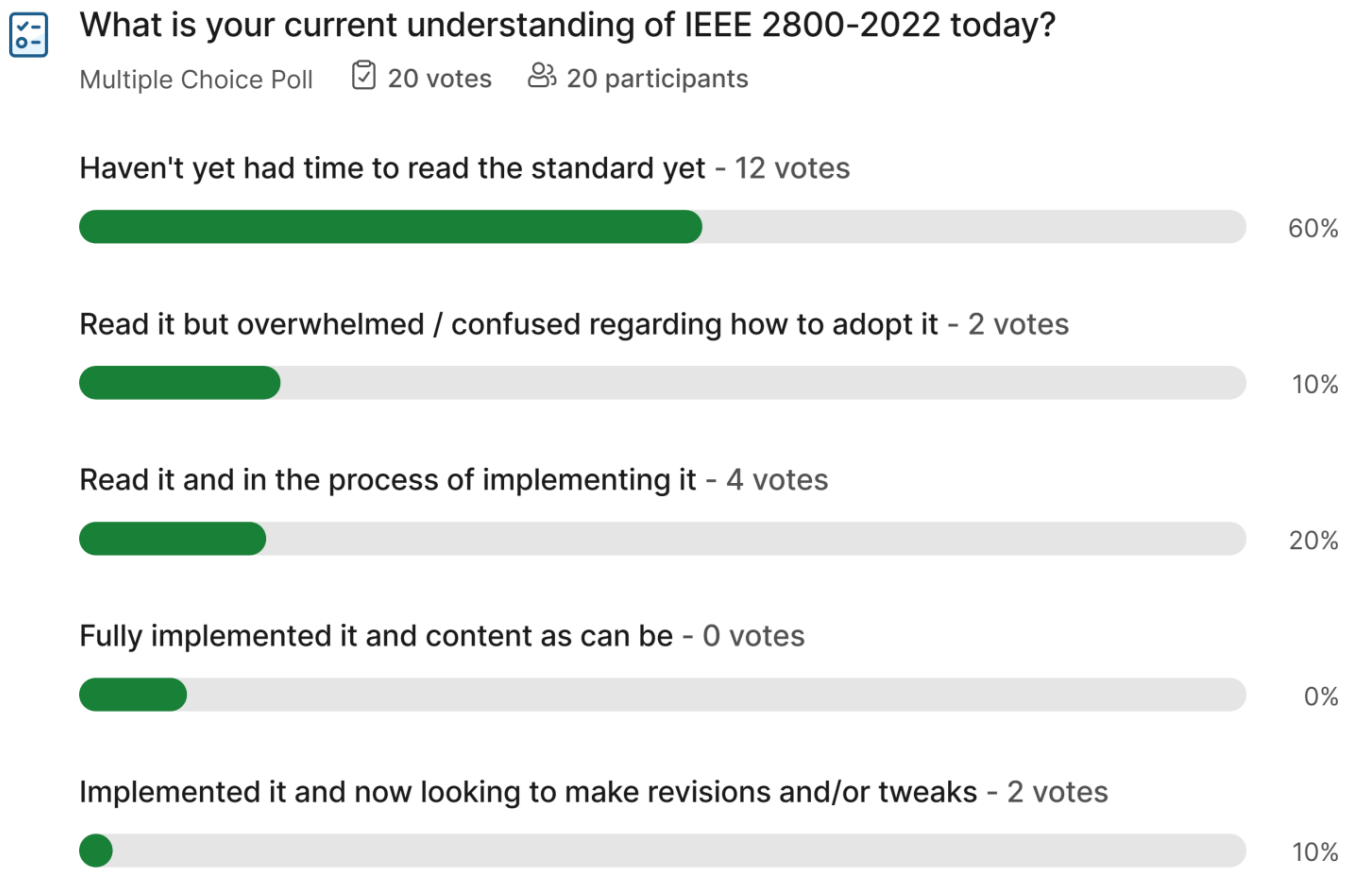
Slido Q3: What is the status of IEEE 2800-2022 implementation for your organization today?



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Slido Polls and Questions

- **Questions at beginning:**
  - Where is everyone at with understanding IEEE 2800-2022?
    - Haven’t read it
    - Read it but confused
    - Read it and implementing it
    - Fully implemented

- **Questions at the middle:**
  - Which IEEE 2800-2022 adoption strategy is preferred?
    - General Reference
    - Detailed Reference
    - Hybrid Integration
    - Detailed Spec
  - Have you adopted IEEE 2800-2022, and if so which adoption strategy did you use?
    - Free form response

- **Questions at the end:**
  - What are biggest questions on IEEE 2800-2022?
    - Free form or multiple choice here?

- **Notes/reminders:**
  - For questions/discussions we can’t get to during the meeting, come back to it and capture it for the project plan going forward.

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