

# IEEE P2800.2 6<sup>th</sup> Working Group Meeting

**ANDY HOKE, P2800.2 WG CHAIR**

**MANISH PATEL, SECRETARY**

**JENS BOEMER, BOB CUMMINGS, DIVYA CHANDRASHEKHARA,**

**JULIA MATEVOSYAN, MAHESH MORJARIA, STEVE WURMLINGER, VICE CHAIRS**

August 29-31, 2023

Some content derived from IEEE 2800 WG and Jens Boemer, 2800 WG Chair

# Please record your attendance

- Please record your attendance at:
  - <https://imat.ieee.org/attendance>
    - -> Select “EDPG Energy Development & Power Generation”
    - -> Select [PE/EDPG/WSPPID/WSPI/WSPI-TV Attendance](#)
- OR
- <https://imat.ieee.org/wg500900043/attendance-log?p=4471000005&t=500900043>
- **Meeting attendance determines eligibility for WG voting membership**
  - Credit for attendance will be given to those who attend at least 2 of 3 days this week
- In lieu of verbal roll call, **please type your name and affiliation in the chat window**
  - IEEE affiliation FAQs: <http://standards.ieee.org/faqs/affiliation.html>

# Acknowledgements and disclaimers

- General disclaimer:
  - The views presented in this presentation are the personal views of the individuals presenting it and shall not be considered the official position of the IEEE Standards Association or any of its committees and shall not be considered to be, nor be relied upon as, a formal position of IEEE, in accordance with IEEE Standards Association Standards Board Bylaws 5.2.1.6.
- Draft standard disclaimer:
  - P2800.2 is an unapproved draft of a proposed IEEE Standard. As such, the document is subject to change, any draft requirements and figures shown in this presentation may change.
- For those working group members whose effort on the standard was partially or fully supported by the U.S. DOE's National Renewable Energy Laboratory, the following statement applies:
  - This work was supported in part by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding provided by U.S. Department of Energy Office of Energy Efficiency and Renewable Energy Solar Energy Technologies Office and Wind Energy Technologies Office. The views expressed in the article do not necessarily represent the views of the DOE or the U.S. Government.

# Working Group Policies and Procedures

- We have the same P&Ps as the 2800 WG, as previously approved by the sponsor, available here:  
[https://sagroups.ieee.org/2800/wp-content/uploads/sites/336/2020/08/EDPGC-Sponsored-WG-P-and-PV2Jan2020\\_IEEE-P2800-WG.pdf](https://sagroups.ieee.org/2800/wp-content/uploads/sites/336/2020/08/EDPGC-Sponsored-WG-P-and-PV2Jan2020_IEEE-P2800-WG.pdf)
  - Introduced at previous WG meetings
  - Link provided in meeting agenda
- Given ~130 WG members total, we have a quorum if 26 members or more are present

# Agenda

- Day 1
  - Call to order and welcome
  - Roll call and declaration of affiliation
    - (via chat window)
  - Approval of agenda and past minutes
  - IEEE patent, copyright, and participant policies.
    - Call for potentially essential patents
  - Subgroup 1: General Requirements
  - Subgroup 2: Type Tests
  - Introduction to P2004 – HIL for power systems applications
- Day 2
  - Subgroup 3: Design Evaluations
  - Subgroup 4: Commissioning Tests and As-built Evaluations
- Day 3
  - Power Quality Task Force
  - Frequency scanning for IBR unit model validation
  - Subgroup 5: Post Commissioning Model Validation, Monitoring, and Periodic Evaluations

US ET	US MT	Tuesday August 29	Wednesday August 30	Thursday August 31
11:00	9:00	Introduction	Subgroup 3 - Design evaluation	Power Quality Task Force
		Subgroup 1: Overall document	Subgroup 3 - Design evaluation	Power Quality Task Force
12:00	10:00	Subgroup 2: Type tests	Subgroup 3 - Design evaluation	Power Quality Task Force
		Subgroup 2: Type tests	Subgroup 3 - Design evaluation*	Frequency scanning for IBR unit model validation*
1:00	11:00	Subgroup 2: Type tests*	Subgroup 3 - Design evaluation	
		Subgroup 2: Type tests	Subgroup 4 - Commissioning and as-built	Subgroup 5: Post-commissioning steps
2:00	12:00	Subgroup 2: Type tests	Subgroup 4 - Commissioning and as-built	Subgroup 5: Post-commissioning steps
		IEEE P2004 - HIL for power systems	Subgroup 4 - Commissioning and as-built	Subgroup 5: Post-commissioning steps
		*15 minute break near here		

# Last meeting's minutes

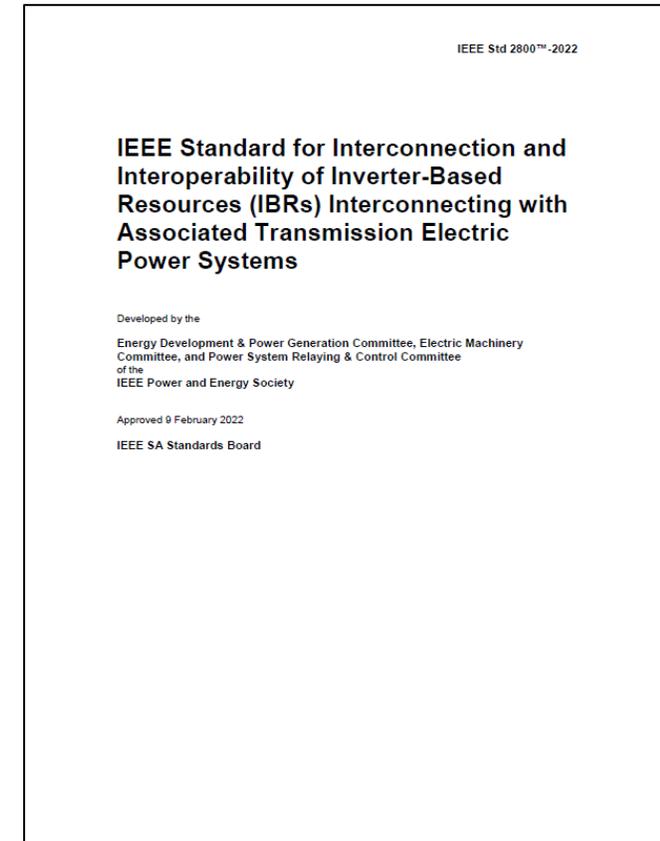
- The minutes of the last WG meeting (April 2023) were posted on iMeet Central shortly after the meeting
- WG members were notified of an opportunity to review the minutes upon posting
- **Call for comments/approval of last meeting minutes**

# IEEE patent policy and legal notices

- IEEE Patent Policy
  - <https://development.standards.ieee.org/myproject/Public/mytools/mob/slideset.pdf>
  - **Call for potentially essential patents**
- IEEE Copyright Policy:
  - <https://standards.ieee.org/content/dam/ieee-standards/standards/web/documents/other/copyright-policy-WG-meetings.potx>
- IEEE Participant Behavior:
  - <https://standards.ieee.org/wp-content/uploads/import/documents/other/Participant-Behavior-Individual-Method.pdf>
- IEEE Privacy Policy - <https://www.ieee.org/security-privacy.html>
- (Links also provided in meeting agenda)

# Status of IEEE 2800-2022

- 94% ballot approval. **Published April 22, 2022.**
- Harmonizes interconnection requirements for large solar, wind, and storage plants (and other inverter-based resources)
- A consensus-based standard developed by over ~175 Working Group participants from utilities, system operators, transmission planners, & OEMs over 2+ years
- IEEE standards are **voluntary until adopted by an appropriate entity**. Such entities are encouraged to consider adoption of 2800 to the extent feasible even before IEEE P2800.2 is complete. Many entities have begun adoption process.



Available at  
<https://standards.ieee.org/ieee/2800/10453/>

# 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** (both meshed and radial)
  - 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 2800
- 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.

# P2800.2 wants to hear from you

- Several P2800.2 leaders have mentioned that they keep hearing from the same handful of voices
  - This puts us at risk of confirmation bias, or of writing a document that only makes sense to a handful of “experts”
- We want to hear from more of you
- That can be:
  - During this WG meeting
  - Via an email or a call to a WG leader
  - Written comments on D0.5 of P2800.2
    - Out for comment until September 7
  - During a subgroup or task force meeting
- The more people we hear from, the better the standard will be

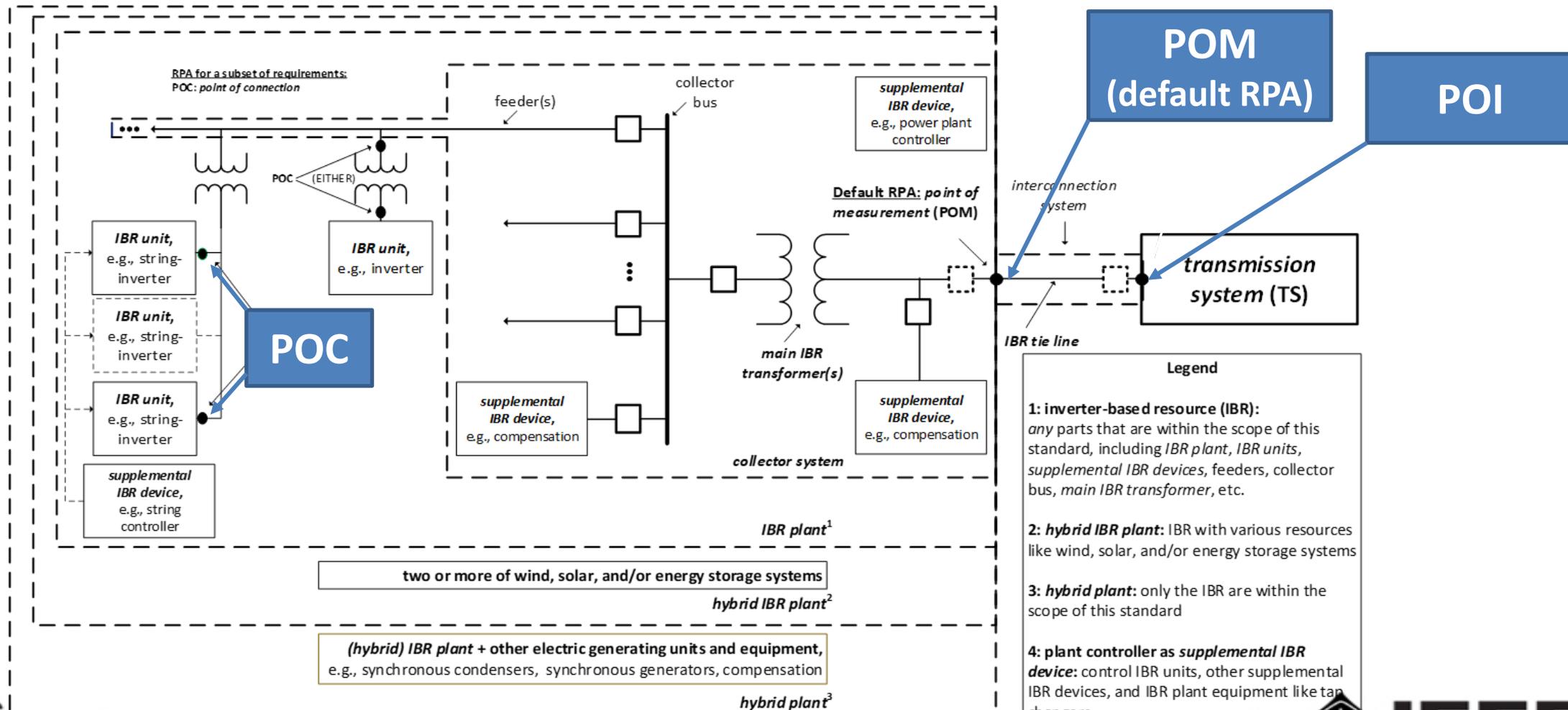


## P2800.2 – Relationship to the IBR interconnection process

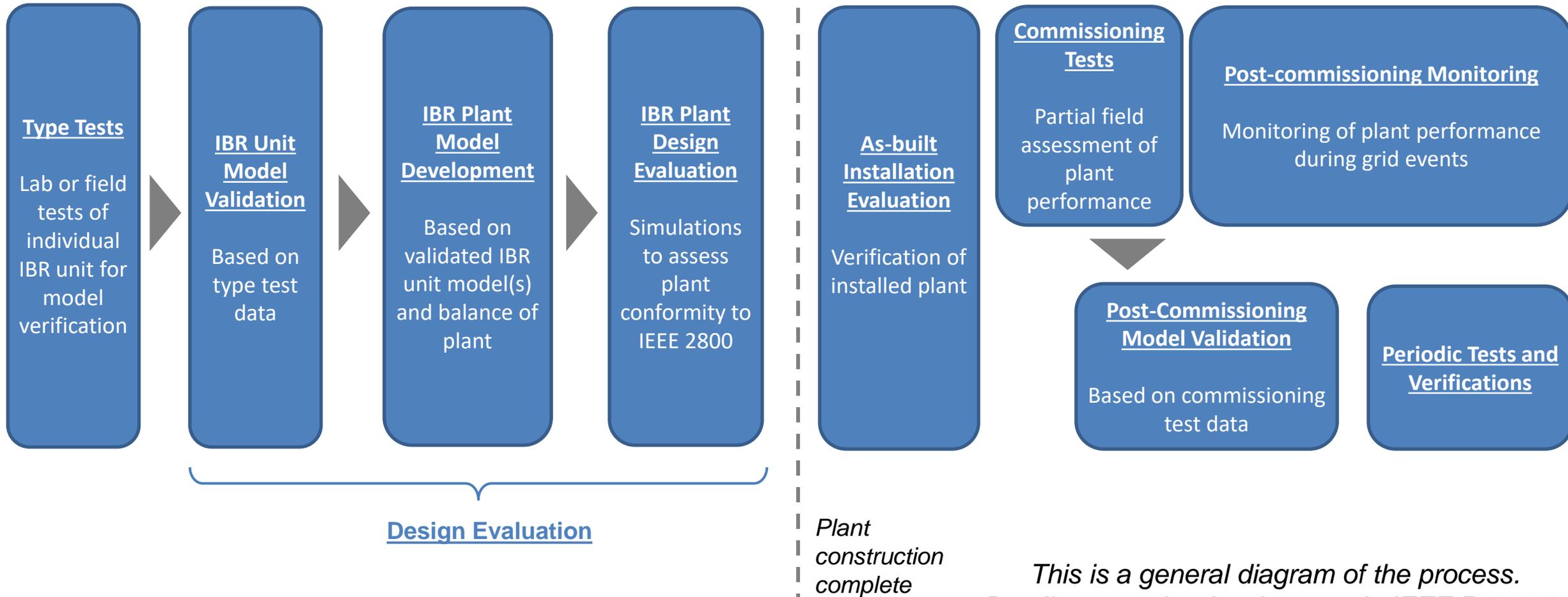
- Defining (or re-defining) an interconnection process is not in the scope of IEEE P2800.2
- Procedures recommended by P2800.2 are intended to be used as part of an interconnection process:
  - P2800.2 type tests can inform interconnection process
  - P2800.2 design evaluation, commissioning tests, and post-commissioning model validation can occur during interconnection process (along with other steps not in scope of P2800.2)
- In an early meeting, we agreed that in P2800.2, our job is (only) to **write procedures to verify that IBRs conform to IEEE 2800**
  - Important discussions related to interconnection that do not relate to *IEEE 2800 conformance verification* can take place *primarily outside* P2800.2
  - By providing standardized procedures, we are taking a major step to improve the interconnection process (without trying to fix everything)

# Role of P2800.2 in IEEE 2800 Adoption

Almost all requirements of IEEE 2800 apply at Point of Measurement (POM) by default



# Overview of conformity assessment steps in IEEE P2800.2



*This is a general diagram of the process. Details are under development in IEEE P2800.2. Some variations permitted.*

# IEEE P2800.2 Subgroup Scopes

**SG 1**  
Overall document and general requirements

Excerpt of 2800 Table 20: Verification Methods Matrix

**Power Quality Task Force**

Requirement	RPA at which requirement applies	SG 2	SG 3	SG 4		SG 5			
		Type tests	Design Evals.	Commissioning and As-built		Post-commissioning model validation, monitoring, etc.			
		IBR unit-level tests (at the POC)		IBR plant-level verifications (at the RPA)					
		Type tests <sup>152</sup>	Design evaluation (including modeling for most requirements)	As-built installation evaluation	Commissioning tests	Post-commissioning model validation	Post-commissioning 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 <sup>153</sup>	R	R	R	R	D	D	D
6.2 Fast Frequency Response (FFR)	POC & POM	R <sup>154</sup>	R	R	R	R	D	D	D
Clause 7 Response to TS abnormal conditions									
7.2.2 Voltage disturbance ride-through requirements	POC <sup>155</sup> & POM <sup>156</sup>	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 <sup>157</sup>	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

# Subgroup 1 material

- Cleaned up some language in Clause 1. Removed some unnecessary language.
- Added new subclause 4.2: Overview of Conformity Assessment Process
  - Includes updated version of information handoffs flow chart, as introduced at last WG meeting

# Next steps in SG1

- Address topics that cut across multiple subgroups
- Develop any general content needed (Clause 4)
- Incorporate definitions and references as they arise in other subgroups
- WG priority is filling in the details of the conformity assessment procedures in Clauses 5-11 (i.e., SG2-SG5, PQ Task Force)

# Subgroup 1 – Overall document: Logistics

- Plan
  - Biweekly meetings (as needed), Mondays, 10am Mountain Time
- Leads
  - Andy Hoke ([andy.hoke@nrel.gov](mailto:andy.hoke@nrel.gov))
  - Manish Patel ([mpatel@southernco.com](mailto:mpatel@southernco.com))
- How to get involved, join listserv, send an email message to [listserv@listserv.ieee.org](mailto:listserv@listserv.ieee.org)
  - In first line of email body, write: **SUBSCRIBE STDS-P2800-2-SG1 <Your Name>**
  - For example, “**SUBSCRIBE STDS-P2800-2-SG1 Andy Hoke**”

# Subgroup 2

- Discussion led by Steve Wurmlinger, Pramod Ghimire, Mike Ropp

# 10 minute break – Back at 5 minutes past hour

- Subgroup 2 (Type Tests) continues next

- Reminder: record your attendance in iMat:

<https://imat.ieee.org/wg500900043/attendance-log?p=4471000005&t=500900043>

# Agenda – Day 2

- Day 1
  - Call to order and welcome
  - Roll call and declaration of affiliation
    - (via chat window)
  - Approval of agenda and past minutes
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		*15 minute break near here		

# Welcome to Day 2 of IEEE P2800.2 WG meeting

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# Subgroup 3 – Design Evaluations

# 7 minute break – Back 5 minutes past hour

- Subgroup 3 (Design Evaluation) continues next
- Reminder: record your attendance in iMat:

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# Subgroup 4 – Commissioning and As-Built

# Agenda – Day 3

- Day 1
  - Call to order and welcome
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		*15 minute break near here		

# Welcome to Day 3 of IEEE P2800.2 WG meeting

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# Power Quality Task Force

Excerpt of  
2800 Table 20:  
Verification  
Methods Matrix

**PQ Task  
Force**

Requirement	RPA at which requirement applies	SG 2	SG 3	SG 4		SG 5				
		IBR unit-level tests (at the POC)  Type tests <sup>152</sup>	Design evaluation (including modeling for most requirements)	As-built installation evaluation	Commissioning tests	IBR plant-level verifications (at the RPA)				
						Post-commissioning model validation	Post-commissioning 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 <sup>153</sup>	R	R	R	R	D	D	D	
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Clause 7 Response to TS abnormal conditions										
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8.3.1 Harmonic current distortion	POM	R <sup>157</sup>	R	R	R	D	R	N/A	D	
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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	

# 6 minute break – Back 40 minutes past hour

- Frequency scanning is next
- Reminder: record your attendance in iMat:

<https://imat.ieee.org/wg500900043/attendance-log?p=4471000005&t=500900043>

# Frequency scanning for IBR unit model validation

# 4 minute break – Back 45 minutes past hour

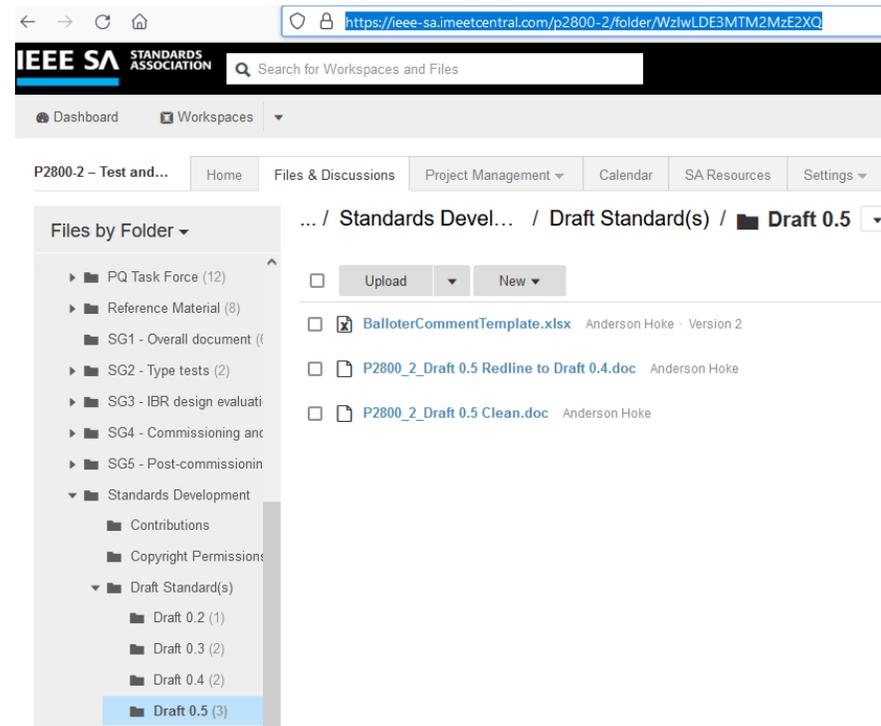
- Subgroup 5 is next
- Reminder: record your attendance in iMat:

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# Subgroup 5 – Post-Commissioning Model Validation, Performance Monitoring, and Periodic Tests

# Wrap-up and Next Steps

- Please join any subgroup or task force aligned with your interest/knowledge
  - Join listserv, and send a note to the lead so they are aware
  - Consider volunteering to draft procedures/content in that subgroup
- Draft 0.5 is available for comment by WG members until September 7
  - <https://iee-sa.imeetcentral.com/p2800-2/folder/WzlwLDE3MTM2MzE2XQ>
  - Prioritize directional comments and technical comments. Editorial comments not requested at this time.
  - Use comment spreadsheet. **Page/line numbers from D0.5 Clean**
  - Email completed spreadsheet to Manish and Andy



# Save the date for next WG meeting

- **December 12-14, 2023**
- Similar format to this week's meeting
- Fully remote, three half-day sessions

# To get involved in IEEE P2800.2:

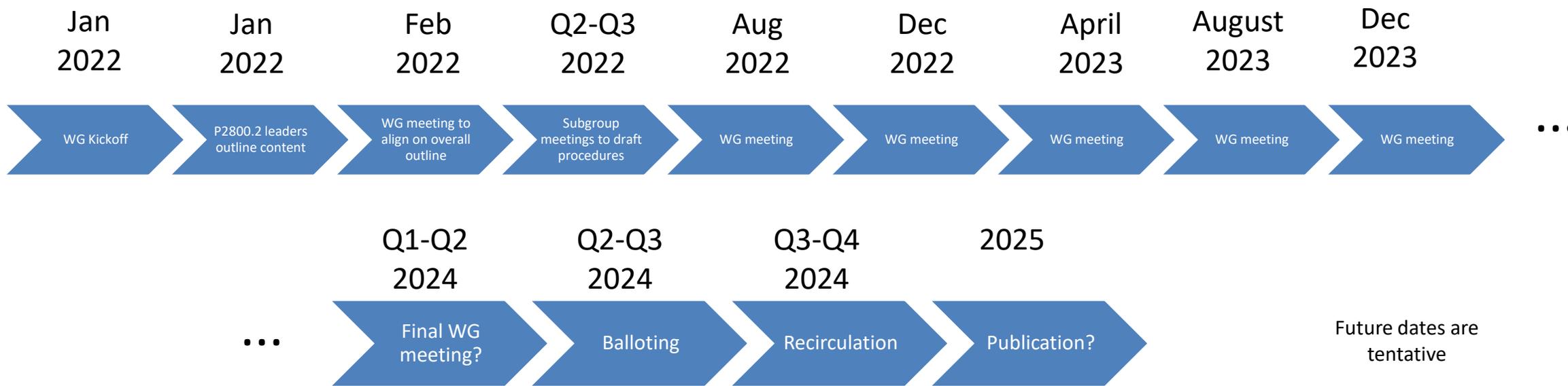
- To join Working Group:
  - If you have attended two WG meetings and want to be a WG member, email Manish Patel: [Mpatel@southernco.com](mailto:Mpatel@southernco.com); CC [Andy.Hoke@nrel.gov](mailto:Andy.Hoke@nrel.gov)
  - If not, attend two meetings and request membership
- Join listserv for any subgroup or task force of interest
- WG member iMeet site: <https://ieeesa.imeetcentral.com/p2800-2/home>
  - Contains draft documents, subgroup documents, references, etc.
- Public website: <https://sagroups.ieee.org/2800-2/>

# IEEE P2800.2 Email Listservs

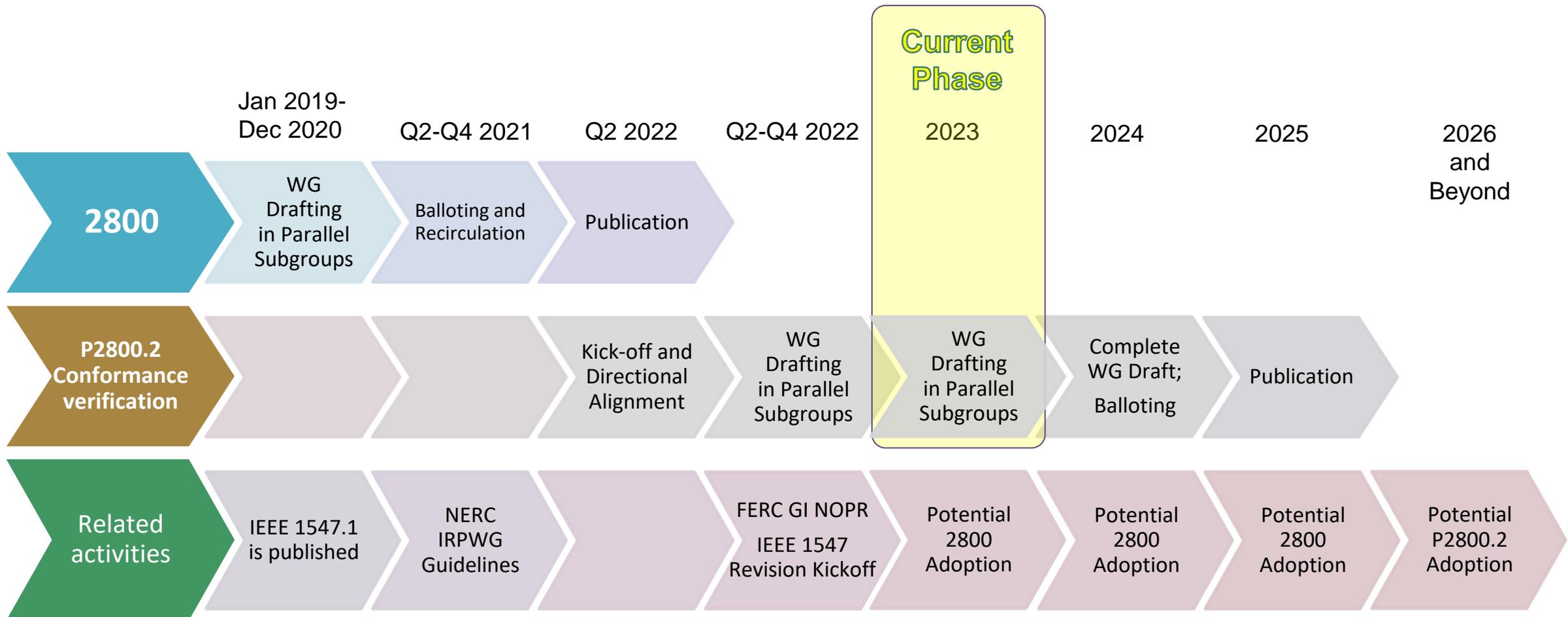
- Overall listserv “P2800-2” will be used to communicate meeting dates, agendas, etc.
- Each subgroup and PQ task force each have listserv – sign up to get involved in that group:
  - Overall Working Group: P2800-2
  - Subgroup 1 (overall document): STDS-P2800-2-SG1
  - Subgroup 2 (type tests): STDS-P2800-2-SG2
  - 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](mailto: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**”

# P2800.2 WG Timeline



# Potential Adoption Timeline



# P2800.2 Call for Participation

- Recruiting participation from industry in general
- Especially need those with knowledge of best practices in designing, studying, interconnecting, commissioning, and operating large IBRs
- Utilities, project developers, consultants, IBR manufacturers, PPC manufacturers, labs, etc.