INTERCONNECTION INNOVATION e-XCHANGE
U.S. DEPARTMENT OF ENERGY

Forum for the Implementation of Reliability Standards for Transmission (i2X FIRST) | 11/25/25

BERKELEY LAB

EPRI

ESIG

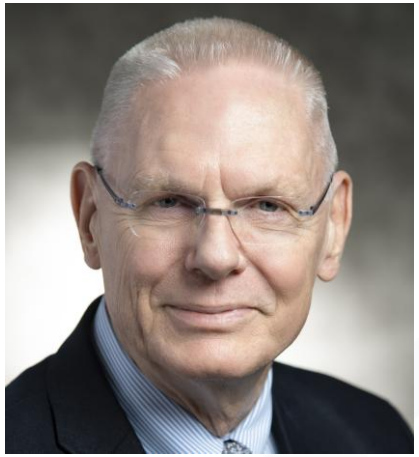
The first half of this meeting call is being recorded and may be posted on ESIG's website. If you do not wish to have your voice recorded, please do not speak during the call. If you do not wish to have your image recorded, please turn off your camera or participate by phone. If you speak during the call or use a video connection, you are presumed consent to recording and use of your voice or image.

Key Goals and Outcomes from i2X FIRST

- To facilitate understanding and adoption of new and recently updated standards relevant for existing and newly interconnecting inverter-based resources.
- The Forum will convene the industry stakeholders to enable practical and more harmonized implementation of these interconnection standards.
- The presentation portion of the meeting will be recorded and posted, and presentation slides will be shared.
- Additionally, the leadership team will produce **a summary of each meeting** capturing:
  - Recommended best practices
  - Challenges
  - Gaps that require future work

Leadership Team

Cynthia Bothwell, Boston Government Services, contractor to DOE



Robert Reedy, Lindahl Reed, contractor to DOE

Will Gorman, Lawrence Berkley National Laboratory

Jens Boemer, Electric Power Research Institute

Julia Matevosyan, Energy Systems Integration Group

Ryan Quint, Elevate Energy Consulting

Summary of the Last Meeting: Challenges with IEEE2800-2022, Planned Revisions

- **Meeting Introduction:** Julia Matevosyan, ESIG
- **Update on IEEE P2800.2:** Andy Hoke, NREL
- **Potential areas and issues for forthcoming IEEE P2800 Revision:** Manish Patel, Silicon Ranch
- **Forthcoming IEEE project authorizations, including a new GFM IBR Recommended Practice:** Jens Boemer, EPRI
- **Q&A and Structured Discussion**, led by Julia Matevosyan, ESIG
  - How to handle IEEE2800 updates in areas that adopted (planning to adopt) IEEE 2800-2022?
  - How to handle identified issues in IEEE2800-2022 until the update come out?
  - What are the expectations with IEEE 2800.2 adoption after it has been approved?

Meeting summary, recording & presentations are posted here

Key Themes from the Last Meeting

- **IEEE P2800.2 Toward Publication:** The initial draft of IEEE P2800.2 Recommended Practice for Test and Verification Procedures for IBRs Interconnecting with Bulk Power received 87% ballot approval and ~800 comments; publication targeted for early 2026.
- **Balancing Prescriptiveness vs Flexibility in Testing and Design:** Draft D4.0 tightens type-testing requirements while preserving flexibility for design and commissioning evaluations.
- **Lessons from IEEE 2800-2022 Implementation:** Clarification needed on reactive capability, voltage/reactive control modes, and ride-through definitions. Misinterpretations and complexity are shaping the next revision cycle to make the standard more practical and consistent with system operator expectations.
- **New GFM-Focused Efforts:** Parallel work includes P2800a (removing barriers to GFM adoption), P2800.1 (equipment-level GFM requirements), and a full 2800-2022 revision.
- **Global Alignment & Regulatory Education:** IEEE–IEC coordination remains aspirational; harmonization lowers cost and complexity. Regulators need better education on evolving technical standards.
- **Ongoing Participation Needed:** IEEE IBRI-WG encourages continued engagement; 2800 series is expected to remain a “living framework” with iterative improvements based on lessons learned.

Upcoming i2X FIRST Meetings – Season 2

1. May 27, 2025, 11 a.m. - 1 p.m. ET – **Season 2 Kick-Off**
2. June 24, 2025, 11 a.m.- 1 p.m. ET – **NERC Milestone 3 Standards**
3. July 22, 2025, 11 a.m.- 1 p.m. ET – **IBR Plant Design Evaluation with Applicable Requirements I**
4. August 26, 2025, 11 a.m.- 1 p.m. ET – **IBR Plant Design Evaluation with Applicable Requirements II**
5. September 23, 2025, 11 a.m.- 1 p.m. ET – **IBR Plant Modeling Requirements and Best Practices**
6. October 21, 2025, 11 a.m.- 1 p.m. ET – **Challenges with IEEE2800-2022, Planned Revisions**
7. **November 25, 2025, 11 a.m.- 1 p.m. ET – Change Management during IBR Plant Interconnection Process and Commissioning, How to Maintain Conformity**
8. December 16, 2025, 11 a.m.- 1 p.m. ET – IBR Plant Commissioning Best Practices I
9. January 27, 2026, 11 a.m.- 1 p.m. ET – IBR Plant Commissioning Best Practices II
10. February 24, 2026, 11 a.m. - 1 p.m. ET – Grid Forming IBR Specifications and Testing Requirements I
11. March 16, 2026 hybrid event during ESIG Spring Workshop: Grid Forming IBR Specifications, Testing Requirements, Lessons Learned

Sign up for all future i2X FIRST Season 2 Meetings here

Follow ESIG i2X FIRST website https://www.esig.energy/i2x-first-forum/ for meeting materials & recordings and for future meeting details & agendas

EMT Trainings – December 2025 & Beyond

DOE i2x / ESIG Electromagnetic Transient Training

WHEN: December 16 - 19, 2025

WHERE: Texas RE's Rio Grande Room, Austin, Texas

MORE DETAILS:

This 3-day in-person training is intended to **enhance the knowledge and ability** of the current workforce through coursework focused **on performing EMT simulations** n the current interconnection and planning paradigm. Training participants will learn **practical methods and best practices that can be leveraged into enhanced study practices across the industry**. These training modules will **focus on the expected day-to-day needs of engineers performing EMT analysis** as well as managing EMT study practices within their organization.

Thanks to Texas Reliability Entity for hosting at their facilities!

MORE INFO- EMT TRAINING

More EMT Training Opportunities in 2026

- EMT training SPP and their stakeholders, Date: Feb 2026
- Enhanced online version of Dec 2025 EMT training, Date: Feb 2026
- EMT training for practicing engineers, Date: Aug 2026
- EMT getting-started training, online, Date: Sept 2026
- EMT model quality testing and benchmarking training, online, Date: November 2026
- Deeper-dive EMT Training, Date: December 2026

ESIG Interconnection Studies Short Course – Nov 2025

ESIG Interconnection Studies Short Course

WHEN: November 17-19, 2025

WHERE: Manatee Lagoon, 6000 N Flagler Dr, West Palm Beach, FL 33407

MORE DETAILS:

This 3-day in-person training is intended to enhance the knowledge and ability of the current workforce through coursework **focused on best practices** for performing the study work necessary **to interconnect inverter-based resources** to the bulk power system reliably. Training participants will learn practical methods and best practices that can be leveraged into enhanced study practices across the industry. These training modules will **focus on the expected day-to-day needs of engineers performing interconnection studies, model quality tests, or inverter-based resource model and simulation work** as well as managing study practices within their organization.

Thanks to NextEra for hosting at their facilities!

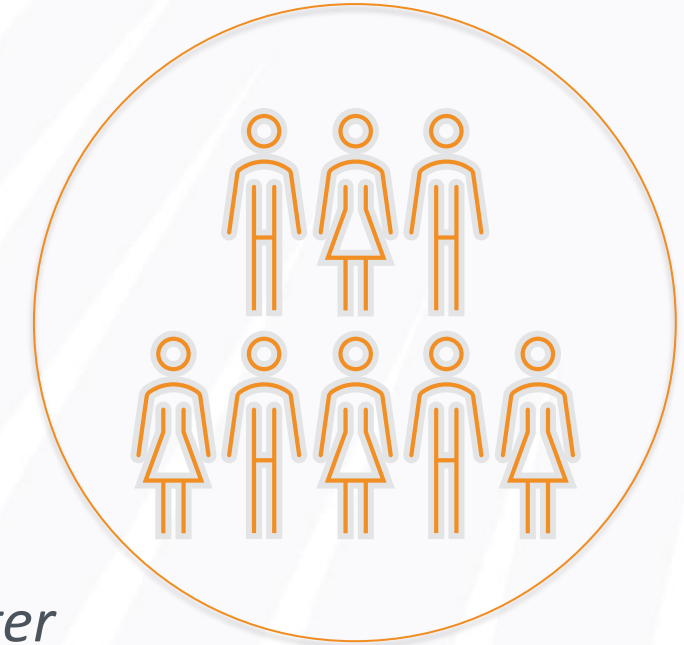
MATERIALS - INTERCONNECTION STUDIES SHORT COURSE

Change Management during IBR Plant Interconnection Process and Commissioning, How to Maintain Conformity – Agenda

- **Meeting Introduction:** Julia Matevosyan, ESIG
- **IBR Developer Perspective:** Katie Iversen, Joseph Perry, Andrew Lopez, AES
- **OEM Perspective:** Miguel Cova Acosta, Vestas
- **EPC Perspective:** Patrick Hart, Mortenson
- **Q&A and Structured Discussion**, led by Julia Matevosyan, ESIG
  - How can IBR plant developers position themselves best for IBR plant change management to reduce or avoid project development delays?
    - Documentation and model management, contracting
  - What can utilities/ISOs/RTOs do to ensure seamless and reliable interconnection for projects that are undergoing a change?

Virtual Meetings Code of Conduct

1. *Assume good faith and respect differences*
2. *Listen actively and respectfully*
3. *Use "Yes and" to build on others' ideas*
4. *Please self-edit and encourage others to speak up*
5. *Seek to learn from others*
6. *Please go to slido to ask questions: **slido.com** and enter event code **FIRST7***



Mutual Respect . Collaboration . Openness

Stakeholder Presentations

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Mutual Respect . Collaboration . Openness

Q & A Session

Interactive Group Discussion Topics

Topic #1: How can IBR plant developers position themselves best for IBR plant change management?

- Please go to slido to make comments and add questions of your own: **slido.com** and enter event code **FIRST7**
- For verbal commentary, please use the raise hand feature and we will call on you
- Additional related / associated questions:
  - How to properly manage documentation and models to ensure smooth project hand over?
  - What to look for when taking over an IBR project?

Topic #2: What can utilities/ISOs/RTOs do to ensure seamless and reliable interconnection?

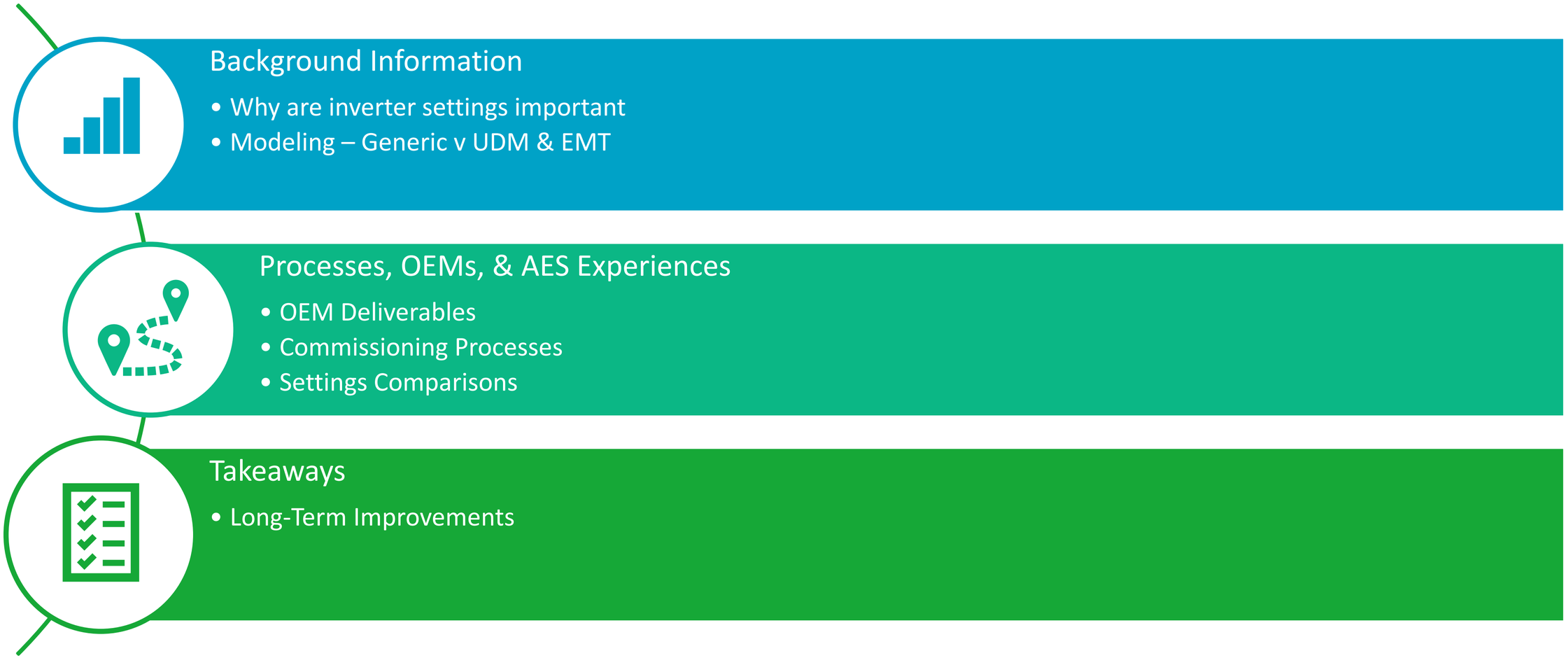
- Please go to slido to make comments and add questions of your own: **slido.com** and enter event code **FIRST7**
- For verbal commentary, please use the raise hand feature and we will call on you
- Additional related / associated questions:
  - What are reporting expectations
  - Can data / model intake be streamlined / automated /standardized to ensure seamless change of management for an IBR project undergoing interconnection process

November 25, 2025

Katie Iversen – Sr. Manager, Generation Modeling
Andrew Claude Lopez – Principal Engineer, Generation Modeling
Joseph Parry – Product Solutions Engineer, Solutions Engineering

AES
Validating IBR Settings During Commissioning

Presentation Overview

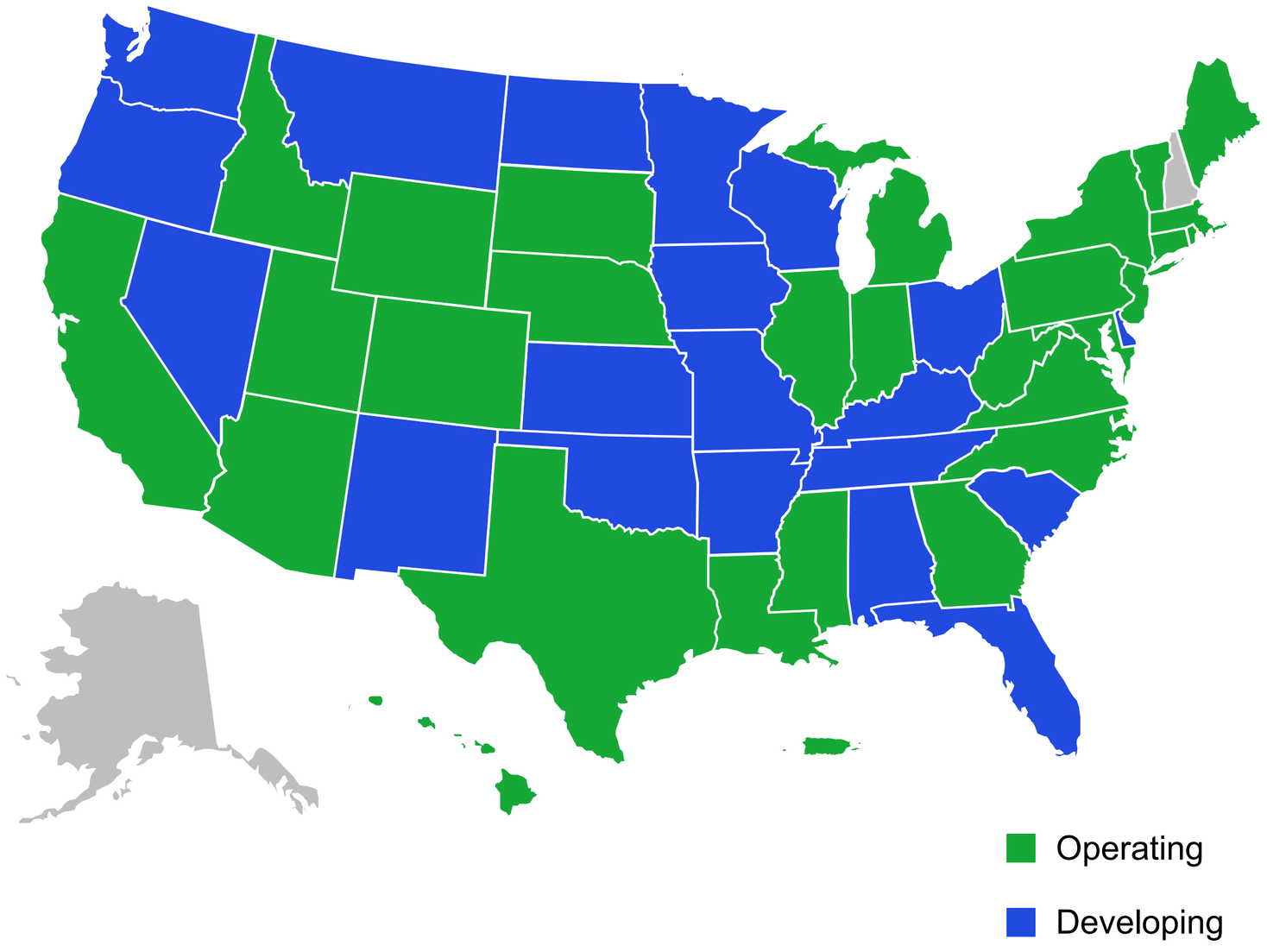


AES' US Businesses portfolio

14.3 GW operating

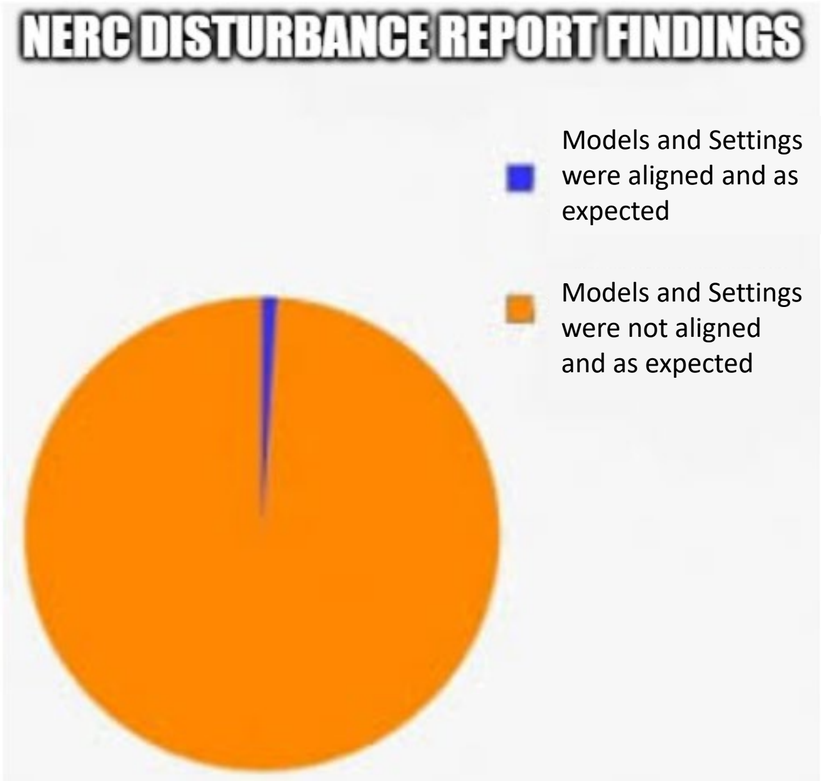
- 6.4 GW solar
- 2.1 GW wind
- 2.5 GW battery energy storage
- 3.3 GW flexible capacity

50+ GW in development



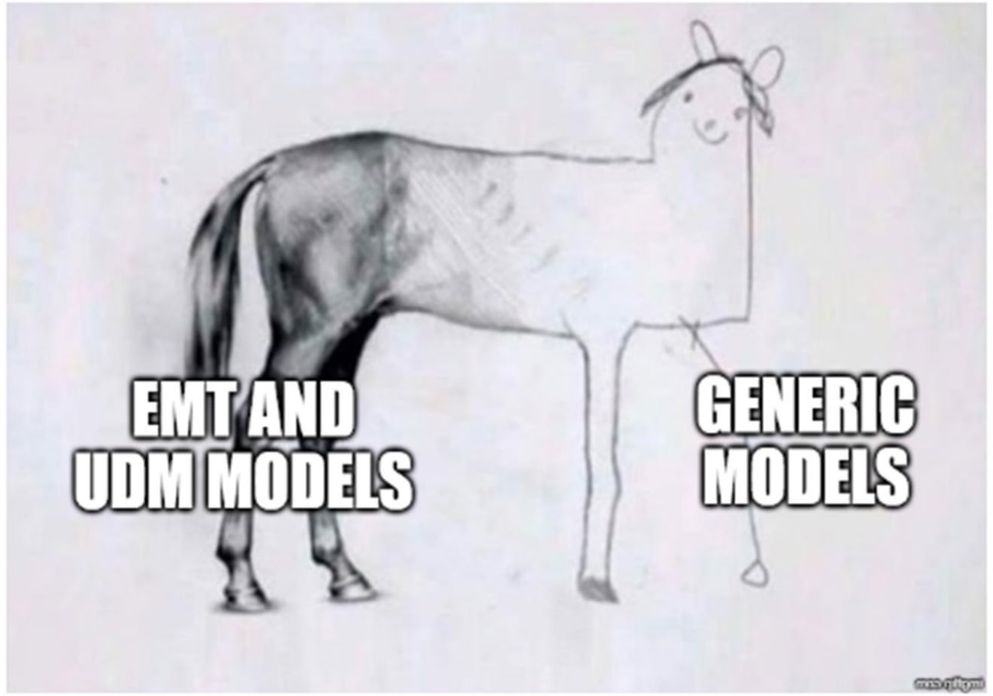
Why is inverter setting commissioning important?

- Grid Reliability
- Developer/Owner Project Success for COD
- Operational Project Success & Compliance
- Productivity & Resource Management



Note this is an estimate and may not be entirely accurate

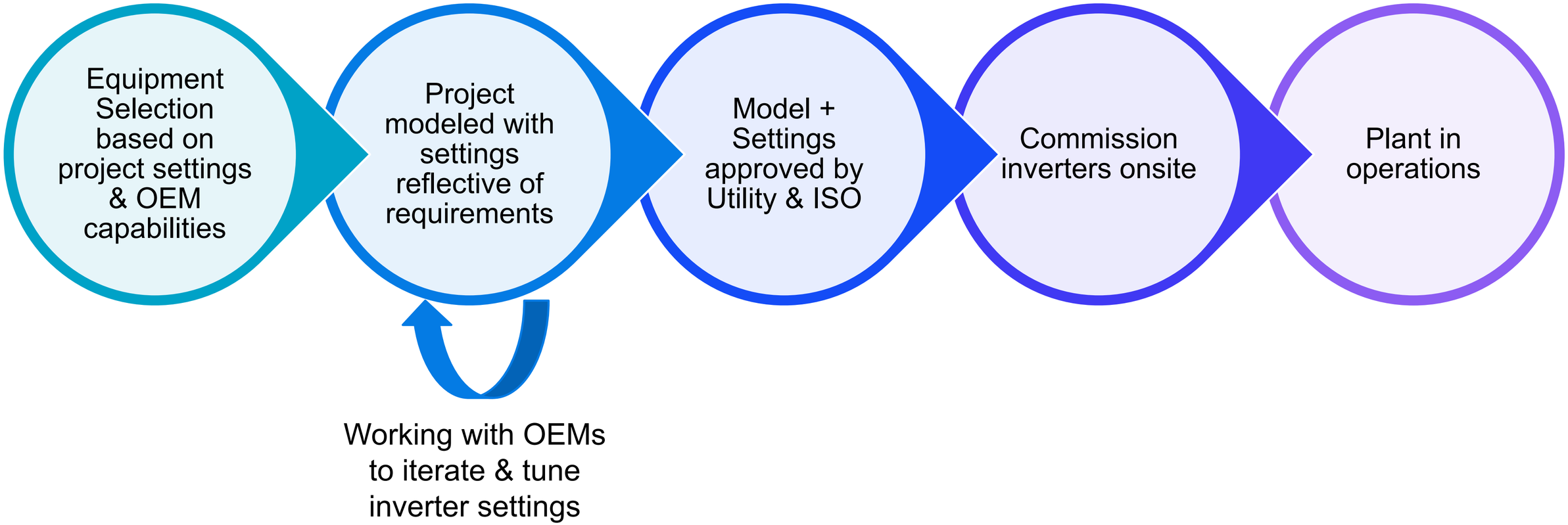
Modeling - Generic vs UDM & EMT



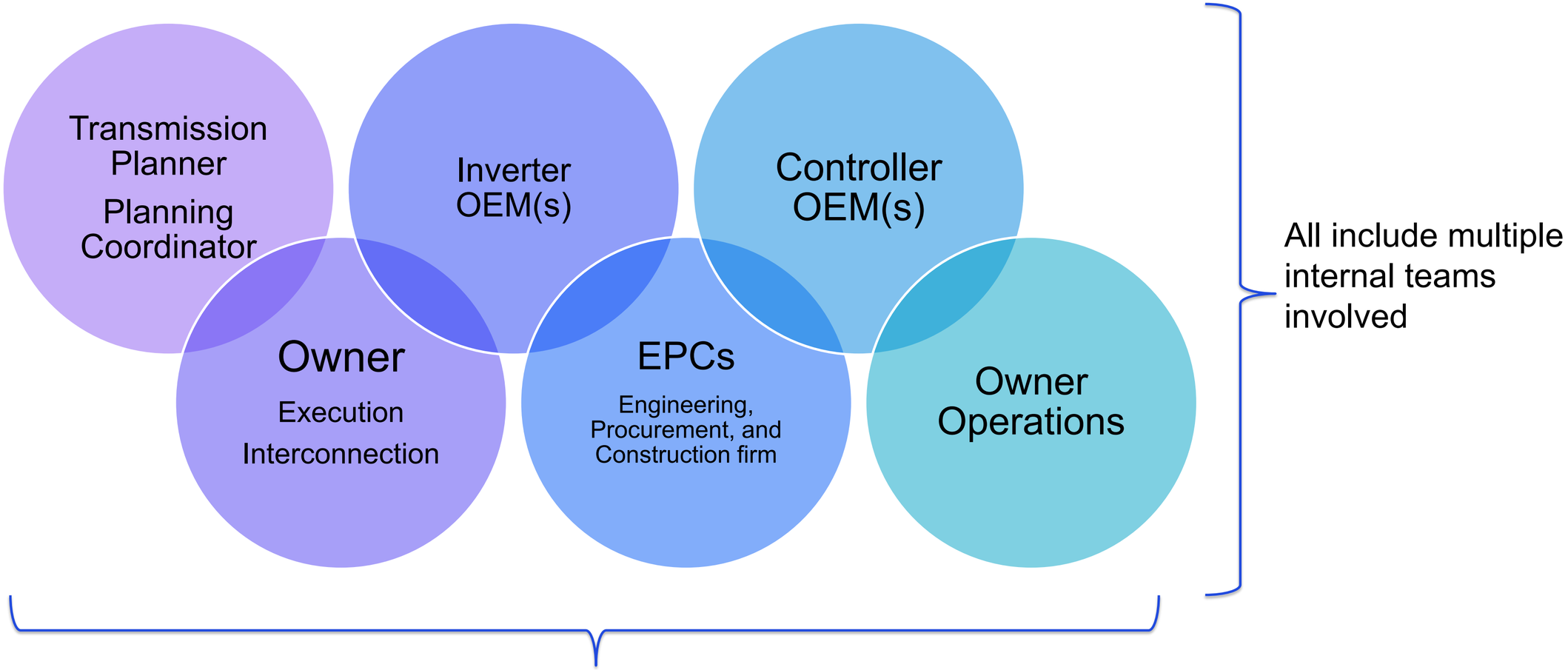
- **Generic models**
  - Do not provide a close correlation to equipment settings
  - Some are correlated others are not

- **EMT and UDM Models**
  - Relate closely to equipment settings
  - Important to have requirements for performance and model/simulation requirements and reviews

High Level: Inverter Setting Life Cycle



Major parties involved across the project process



Establishing deliverables for inverter OEMs across the portfolio

To address **variability across OEMs** models, platforms, file types, etc. AES is requesting deliverables for proper **documentation of, approval of & visibility to inverter parameters** on our projects.

Inverter Settings Statement & Parameter Mapping

- ✓ Parameter statement is published after model is studied AND **approved**
- ✓ Converts model and inverter settings into a digestible list
- ✓ Parameter map required to commission as-studied

Onsite Parameter Verification Process

- ✓ Verify that approved parameters are uploaded onsite
- ✓ Integrate into AES and vendor commissioning activities
- ✓ Maintains records for approved parameters

SCADA Integration

- ✓ Improves operations, reliability & compliance data visibility
- ✓ Creates opportunities for setting alarms and history

Reduce friction by identifying key milestones for documentation

Utility Accepted Model

Modeling Studies

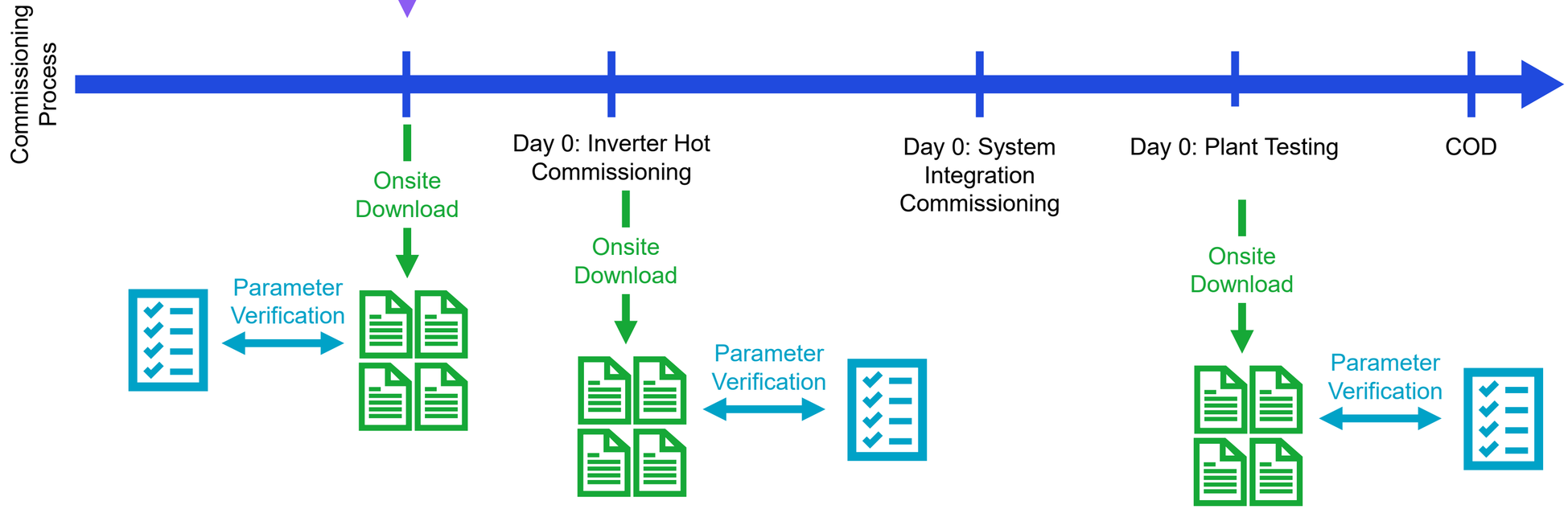
While studies are conducted & model is refined there is no need to track changes to inverter parameters.

Generator Modeling

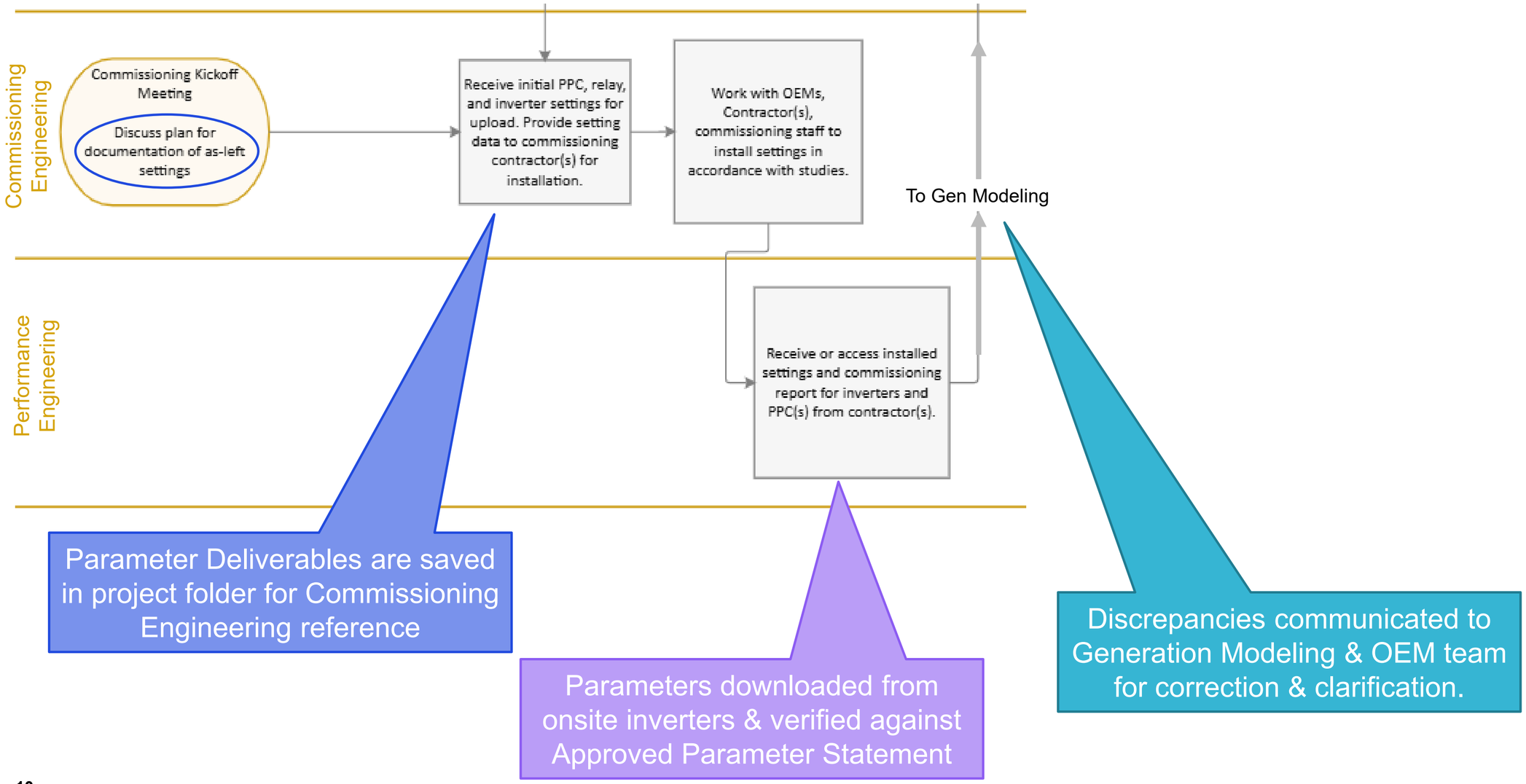
OEM

Commissioning Engineer

Project Engineer



Integrating these improvements into established process



AES Success Story: Identifying & understanding discrepancies

Sample Parameter Names

Droop Value
Enable/Disable
Operating Mode
Ride Through Voltage 1
Ride Through Time 1

Approved Model Inverter Setting Values

Value	Unit of M
3	
1	
2	
0.8	p.u.
1000	ms

Download of onsite inverters

PCS1 M1	PCS2 M1	PCS3 M1	PCS4 M1	PCS5 M1	PCS6 M1
3	2	2	2	2	2
1	0	0	0	0	0
2	1	1	1	1	1
0	0	0	0	0	0
2500	2500	2500	2500	2500	2500

Identifying discrepancies from Approved Model to Onsite Settings

Average	Differences	pa
2.166667	**-0.833333333**	
0.166667	**-0.833333333**	
1.166667	**-0.833333333**	
0	**-0.8**	
2500	**1500**	

1. By pulling the parameter name, value & index from the parameter file, we can quickly pull the values from the onsite inverters
2. Simply take the average of onsite values & subtract from Approved Model value
3. These discrepancies are reviewed with Gen Modeling for correction with the OEM

Longer Term Takeaways

	Industry Stakeholder
Standardize grid reliability settings & setting file types	OEMs, Industry Orgs & Developers
Improve Interconnection Processes and Reviews of UDM and/or EMT models	Transmission Planners & Planning Coordinators
Access to inverter settings and setting change alerts	OEMs, Industry Orgs, Comms, Developers
Change management for firmware & software updates	OEMs, Owners

Thank you!

Change of Management during IBR Plant Interconnection Process and Commissioning: How to Maintain Conformity

Miguel A. Cova Acosta
Director – Grid Solutions

25 November 2025

End-to-End Grid Compliance Across the Project Lifecycle

From Early Project Development to Lifetime Grid Support and Product Roadmap

Project Development

- GridHunt for PoI identification
- Preliminary conceptual eBoP design
- Grid Connection application

Sales

- Grid risk management
- Value engineering

Construction

- Projects execution (WTG, PPC)
- Grid Compliance Tests

Service

- Grid Compliance along project lifetime
- After-Sales Grid solutions
- Site troubleshooting in relation to Grid

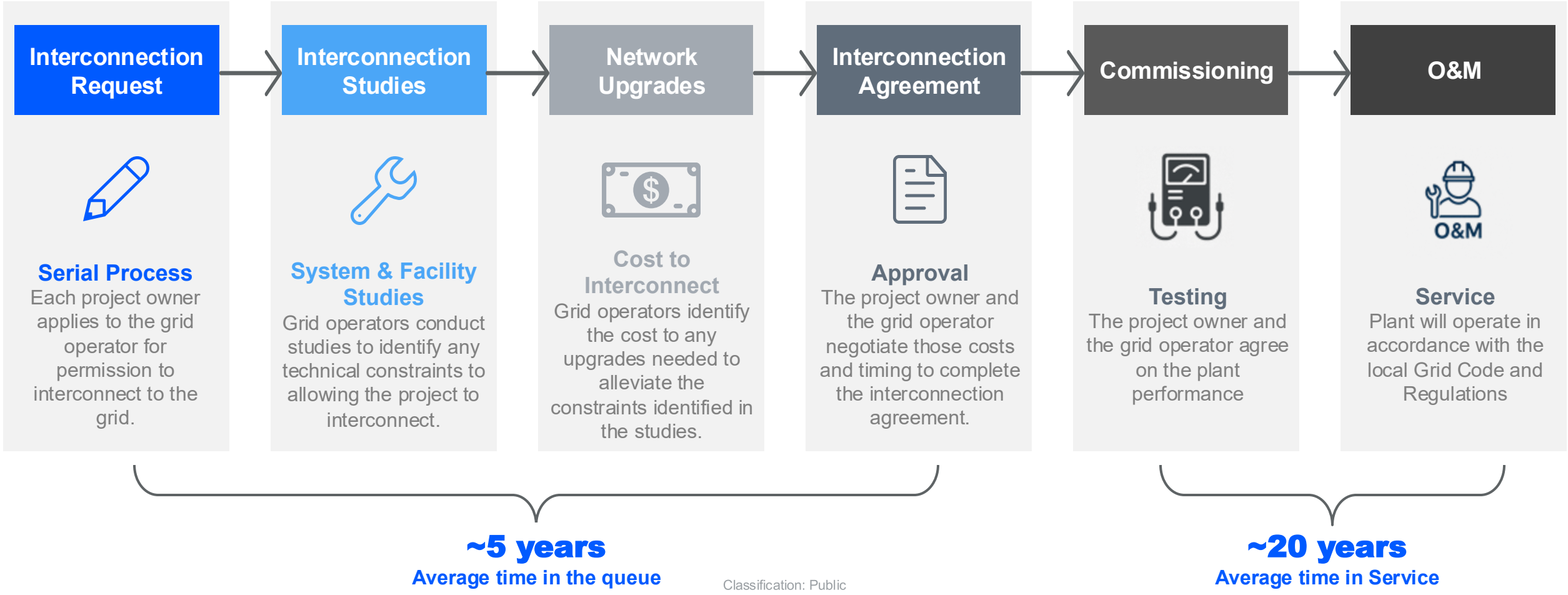
Product Management – Grid Roadmap

- Electrical Grid Connection Requirement Collection
- Regional Grid Working Groups & TSO/ISO interaction
- Customer and Sales Training
- Grid/Plant Products Value-Based Pricing

Vestas

Interconnection Process Overview

From Initial Request to Long-Term Operation



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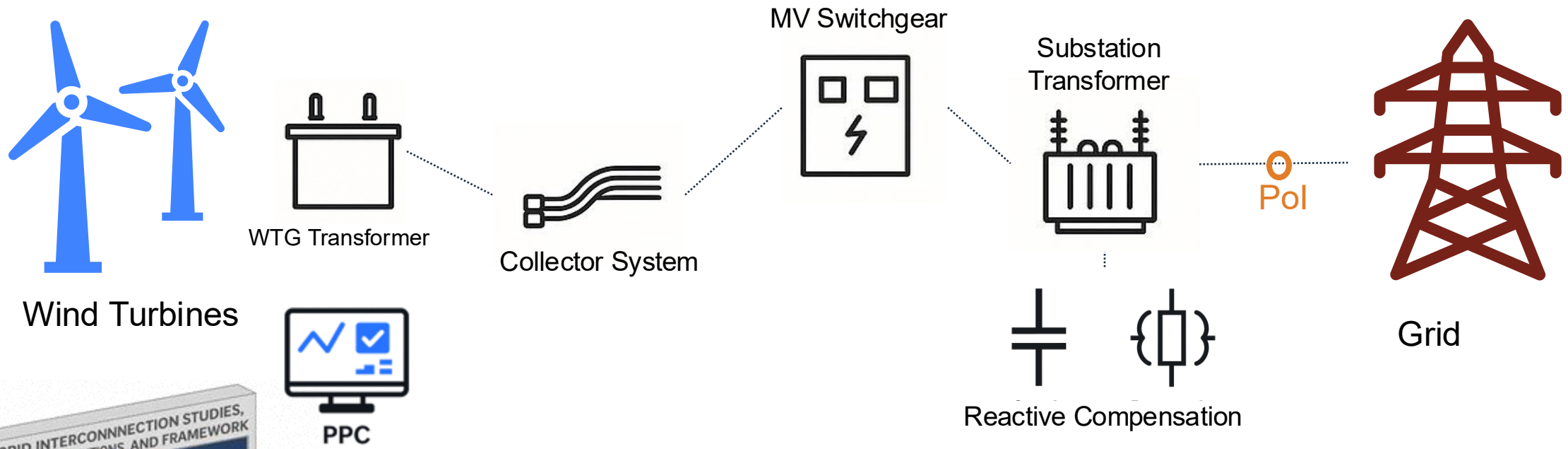
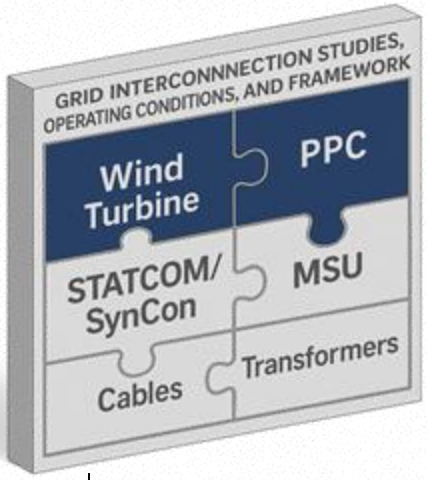
Where Grid Code Should Be Applicable?

Who is responsible for it?





- **Grid codes apply at the Point of Interconnection (PoI), not at individual WTGs.**
- **Meeting requirements at the WTG terminals does *not* guarantee compliance at the PCC**, because the **collector system** and its characteristics sit in between.
- **Long radial feeders, weak grid conditions, low inertia, series compensation, control interactions, etc.** can significantly change the electrical response observed at the PoI.

Vestas

What Can Go Wrong During Change of Management?

Early-Stage Design & Specification Misalignment

- Functional Design Specification not reviewed /understood
- Over-simplified grid studies
- Missing features or unrealistic assumptions
- Customer decisions driven by commercial urgency, not technical reality
- Purchased configuration does not match the actual grid needs

Communication, Handover & Coordination Gaps

- Sales → engineering → construction → O&M handoffs
- Customers not informed of consequences of deviating from the FDS
- Failure to elevate design changes early
- Grid operator assumptions not aligned with OEM
- New project owners requesting changes that were never contracted

Technical Configuration & Model/Parameter Drift

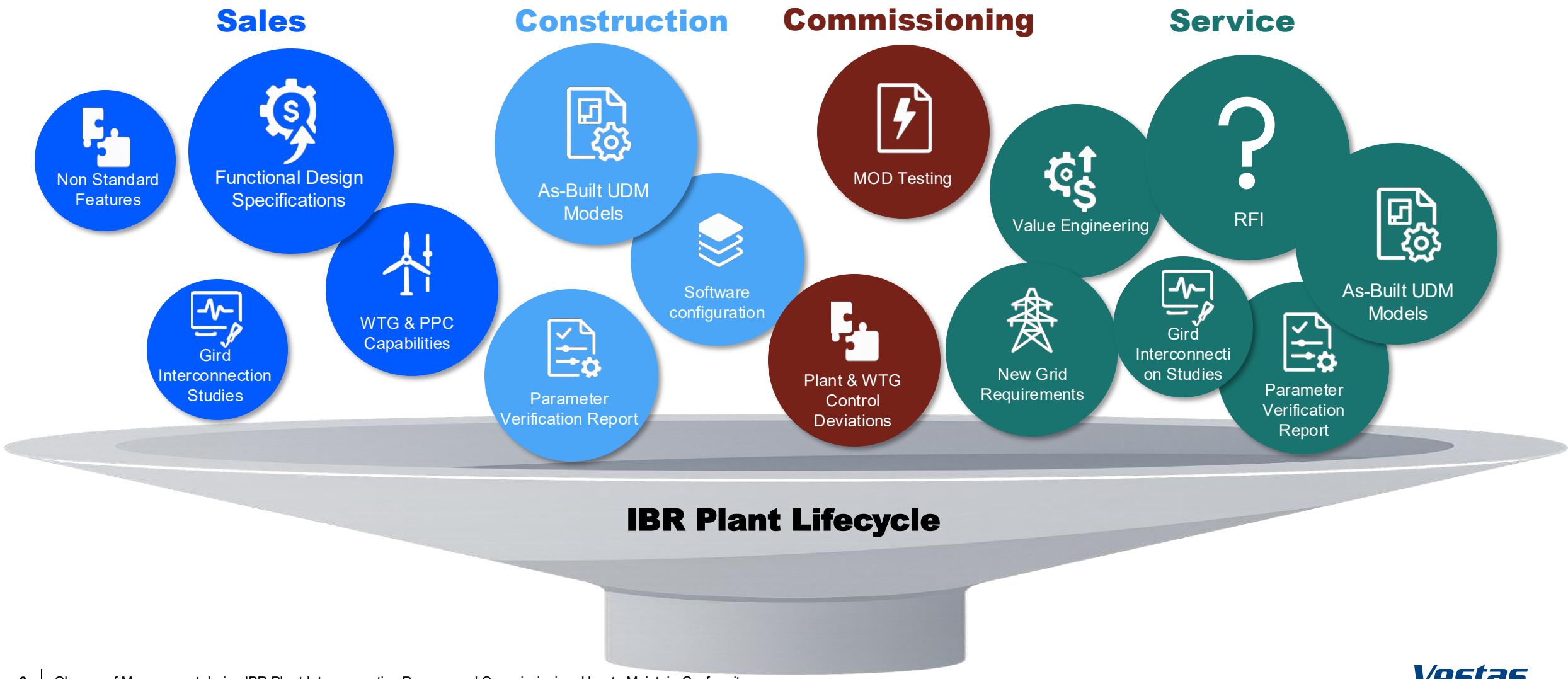
- Differences between EMT/RMS models and site configuration
- Firmware updates applied unevenly across WTGs
- Deviations between “as-sold,” and “a-built”
- Control architecture inconsistencies when the customer asks for new capabilities
- Conflicts discovered only at energization (PPC behavior, voltage control, VAR limits)

Human, Training & Operational Factors

- New engineers (OEM, EPC, TSO, or customer) who are not familiar with previous agreements
- Lack of training on new PPC versions or WTG firmware
- Misinterpretation of control settings on site
- Staff/IE turnover during commissioning
- O&M teams inheriting a plant they did not configure

Vestas

OEM Deliverables Across the Full Plant Lifecycle



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Key Takeaways

Rigorous early-stage electrical design is essential to project success.
Foundational documents—such as the Functional Design Specification—and initial grid studies must be treated as authoritative engineering references. Insufficient attention at this stage leads to the majority of technical conflicts encountered later in the process.

Consistency between analytical models and the physical plant is a prerequisite for conformity.
Any divergence between EMT/RMS models, turbine/plant control architectures, or implemented parameters introduces risk and can directly compromise grid-code compliance during commissioning.

Most challenges during interconnection arise from coordination gaps rather than technical limitations.
Misalignment of expectations or information across EPCs, OEMs, asset owners, and grid operators often results in rework, delayed energization, or conflicting design decisions.

Continuity and competency across all teams have a major influence on commissioning outcomes.
Transitions between project owners, rotating utility engineers, or personnel unfamiliar with updated control features can introduce configuration inconsistencies even when the original design was robust.

OEM engagement throughout the full lifecycle minimizes deviation and supports design integrity.
Direct involvement from early contracting through commissioning and O&M ensures alignment between study assumptions, delivered control capabilities, and real plant behavior.

Grid compliance is a sustained engineering activity, not a one-time event.
Maintaining conformity requires ongoing verification that documentation, models, firmware, and field settings remain synchronized as the project progresses and as system conditions evolve.

Vestas

Wind. It means the world to us.™

Thank You

i2X FIRST

IBR Plant Change of Management: an EPC Perspective

Mortenson

About Mortenson

An EPC that serves multiple industries:

- Serves the US Market
- Energy Storage: 9 years, 40+ projects, 27 GWh deployment
- Wind: 30 years, 270+ projects, 39+ GW deployment
- Solar: 15 years, 100+ projects, 12+ GW

We’re not your standard EPC

- Actively engaged with developers and OEMs to design solutions and improve project outcomes
- Highly focused on compliance

Mortenson

Maintaining Compliance through Transitions

Pre vs. Post Commercial Operational Date (COD)

- Pre-COD = more work, higher timeline risk, but outcome may be better aligned with the business long term
- Post-COD = receiving a finished project, but effort to align with new requirements or business practices is higher
- In both cases documentation is critical

If Pre-COD

- Understand project specific requirements
  - LGIA, existing contract requirements
  - Obtain documentation on existing exemptions
- Lean heavily on EPC to maintain trajectory
- Identify potential gaps
  - Hardware, firmware and software limitations
  - Metering locations (i.e., for NERC PRC-028)
  - Communication Protocols (and potential limits)

If Post-COD

- Don’t assume project meets existing requirements
  - Review LGIA and commissioning test results, verify compliance independently.
- Identify existing gaps for future compliance
  - Metering locations to support event recording (i.e., for NERC PRC-028)
- Is equipment under warrantee?
- Are LTSAs in place?
- Do the critical OEMs still exist?

Maintaining Compliance through Transitions

Best practices for each category of risk:

OEM Compliance

Verify NERC compliance:

- Ride through capability of IBR units
- Reactive power capability for operational corner points
- Active Power performance
- Recording capabilities
  - Sources (metering)
  - Logging and retention (data store)
- Confirm protective relays and anti-islanding features align with TSO requirements

Equipment procured earlier may be incompatible with newer requirements.

Operational Compliance

Know how to operate the facility

- Facilities are becoming more complex (hybrids, mulit-phase, co-located).
- Verify that the facility has a Control Narrative, and that it meets the needs of the facility.
- Critical Documentation:
  - Control Narrative
  - Commissioning Test Plan and Results
  - Operation Manuals for IBRs and supplemental IBR equipment (PPCs)
  - Maintenance Manuals
- Cyber Security: interfaces and protection
  - Firewalls? Jump servers?
  - What external access is available?

Consider maintaining current operator!

Financial Performance

Is equipment designed for profit?

- Verify ratings, degradation estimations, and capacity factors
- For storage determine
  - Energy/Power Overbuild
  - Expected derating conditions
  - Are there augmentation options?

Is equipment performing as expected?

- Does Operational Data Analysis exist?
- Equipment performance, online
  - Fault performance
  - Serial defects on equipment (HVAC, Power module failures)
  - Offending units?
- Are there outstanding RCAs?

Mortenson

Maintaining Compliance through Transitions

Buyer Actions:

- Perform a compliance gap analysis. Compare facility design and operational practices against NERC and IEEE standards
- Stricter Cyber Security requirements are on the way, is the facility capable of transitioning to new rules?
- Engage OEMs early. Obtain models, determine whether firmware installed on site is compliant. Review whether new firmware is needed by IBR suppliers.
- Engage EPC early. In Pre-COD transitions, the EPC can help maintain expected schedules.
- Plan for Upgrades. If hardware cannot meet requirements, and exemptions are not an option, budget for inverter replacements or control system upgrades.