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NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Reliability Guideline: Electromagnetic Transient (EMT) Modeling for BPS-Connected Inverter-Based Resources – Requirements and Verification Practices

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RELIABILITY | RESILIENCE | SECURITY



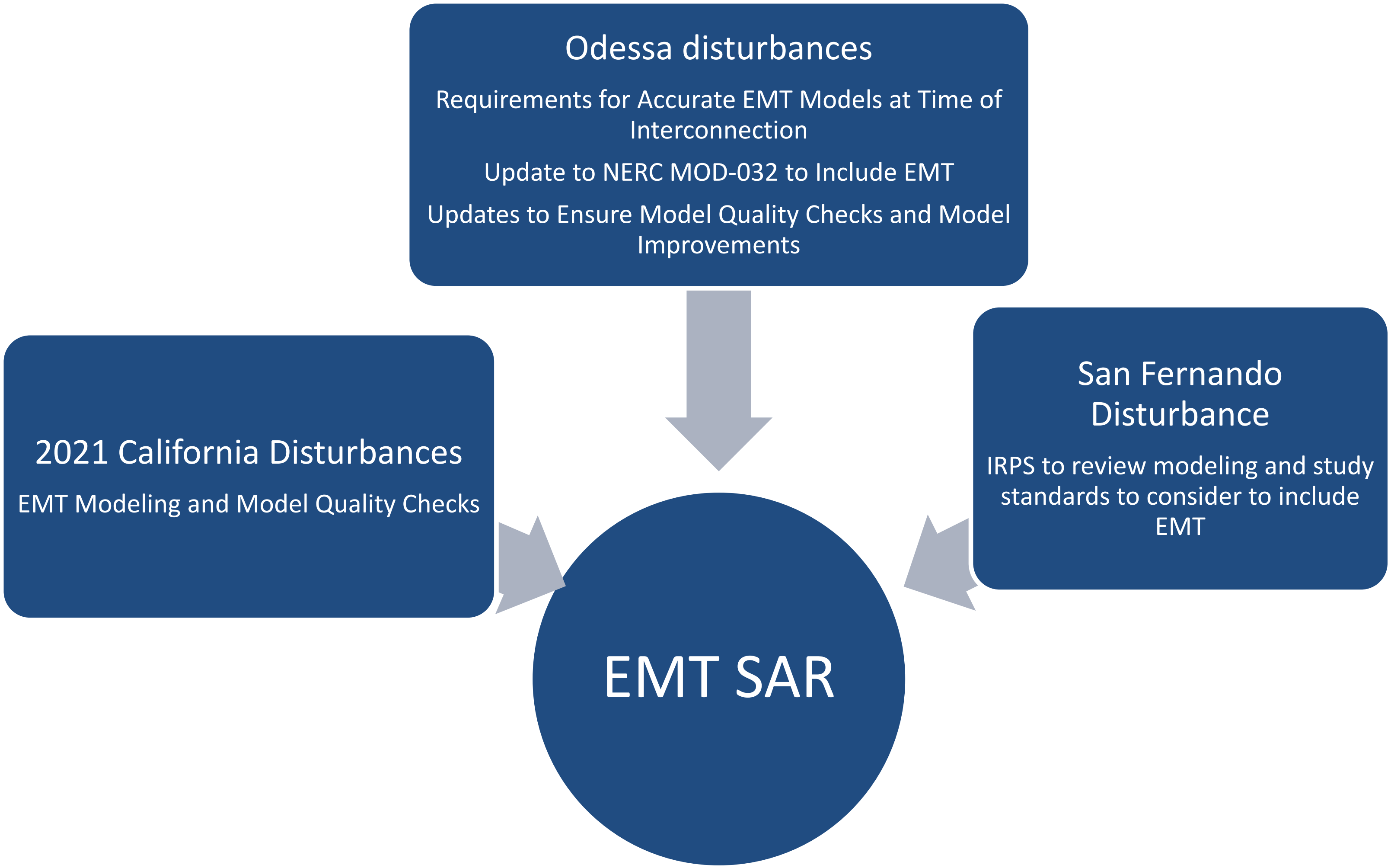

NERC Disturbance Reports

Planned Upcoming Reports:

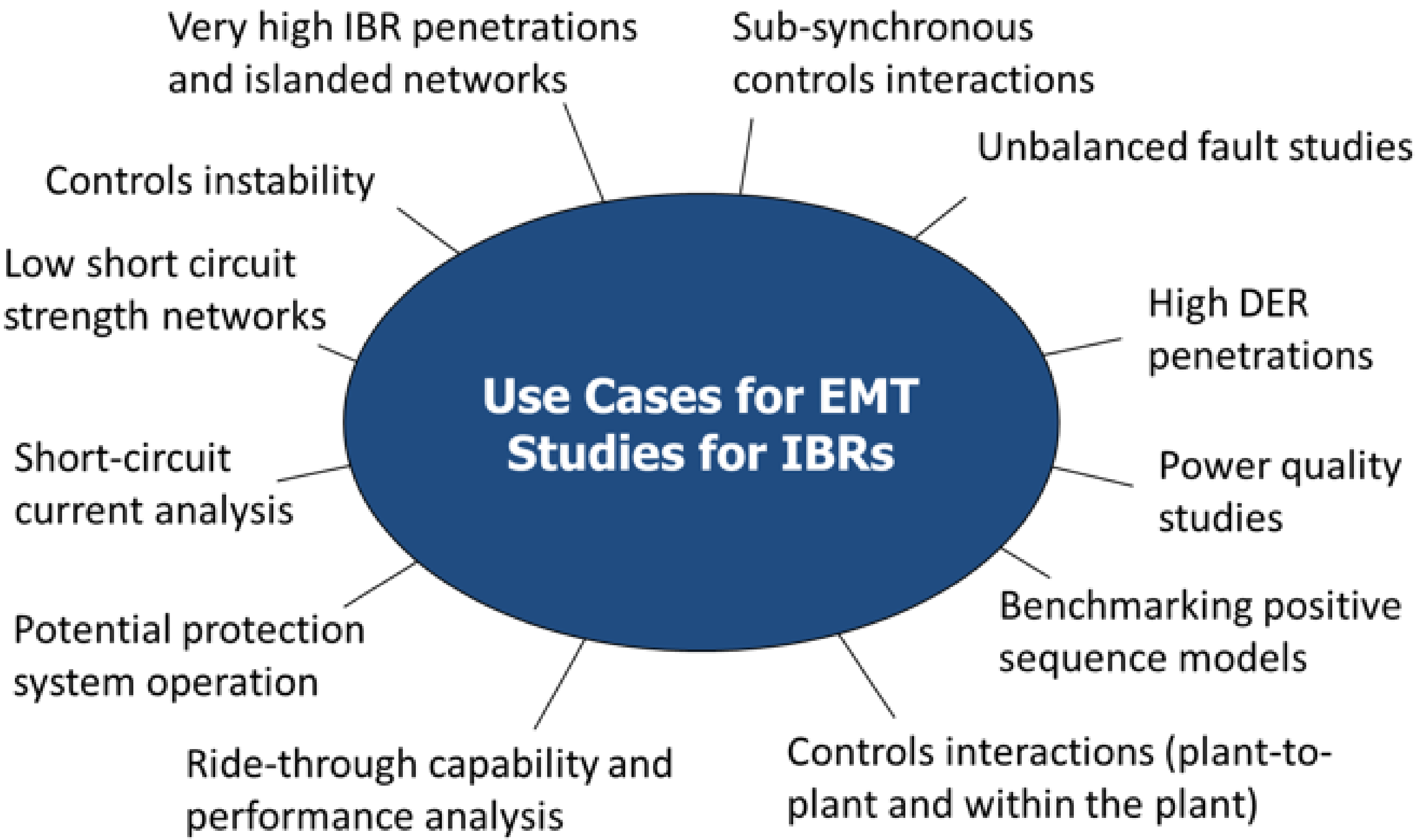
- BESS-Related Events in California in 2022
- Texas Wind-Related Event in Texas in 2022

https://www.nerc.com/pa/rrm/ea/Pages/Major-Event-Reports.aspx

Drivers for EMT SAR



EMT Study Use Cases



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Odessa Modeling Deficiencies

Can the models recreate the cause of reduction?

Table 3.1: Solar PV Tripping and Modeling Capabilities and Practices

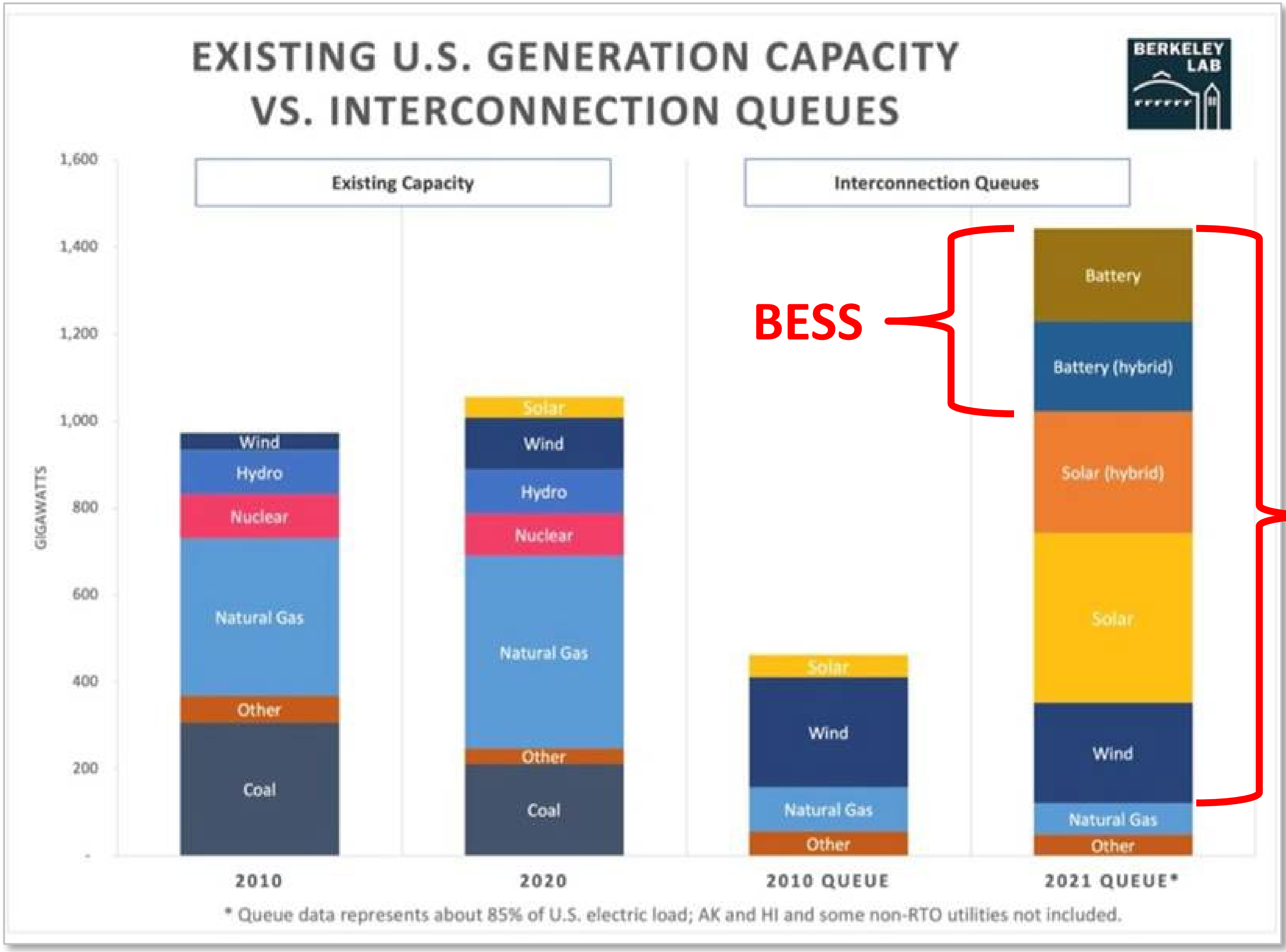
Cause of Reduction	Can Be Accurately Modeled in Positive Sequence Simulations?	Can Be Accurately Modeled in EMT Simulations?
Inverter Instantaneous AC Overcurrent	No	Yes
Passive Anti-Islanding (Phase Jump)	Yes[a]	Yes
Inverter Instantaneous AC Overvoltage	No	Yes
Inverter DC Bus Voltage Unbalance	No	Yes
Feeder Underfrequency	No[b]	No[c]
Incorrect Ride-Through Configuration	Yes	Yes
Plant Controller Interactions	Yes[d]	Yes[e]
Momentary Cessation	Yes	Yes
Inverter Overfrequency	No[b]	Yes
PLL Loss of Synchronism	No	Yes
Feeder AC Overvoltage	Yes[f]	Yes
Inverter Underfrequency	No[b]	Yes

Do the models recreate the cause of reduction?

Table 3.4: Review of Solar PV Facilities

Facility ID	Reduction [MW]	Cause of Reduction	Positive Sequence Model Capable?	EMT Model Capable?
Plant B	133	Inverter phase jump (passive anti-islanding) tripping.	Unknown*	Unknown
Plant C	56	Inverter phase jump (passive anti-islanding) tripping.	Unknown	Unknown
Plant E	159	Inverter ac overvoltage tripping.	Unknown*	Unknown
Plant U	136	Inverter ac overvoltage tripping; feeder underfrequency tripping.	Unknown	Unknown
Plant F	46	Unknown.	Unknown	Unknown
Plant I	196	Inverter phase jump (passive anti-islanding) tripping.	Unknown	Unknown
Plant J	106	Inverter dc voltage imbalance tripping.	Unknown	Unknown
Plants K + L	130	Momentary cessation/inverter power supply failure.	Unknown	Unknown
Plant M	146	Inverter dc voltage imbalance tripping; incorrect inverter ride through configuration.	Unknown	Unknown
Plant N	35	Unknown.	Unknown	Unknown
Plant O	15	Unknown.	Unknown	Unknown
Plant P	10	Inverter ac overcurrent tripping.	Unknown*	Unknown
Plant Q	12	Inverter ac overcurrent tripping.	Unknown	Unknown
Plant R	261	Inverter ac overcurrent tripping.	Unknown*	Unknown
Plant S	94	Inverter dc voltage imbalance tripping.	Unknown*	Unknown
Plant T	176	Inverter ac overcurrent tripping; feeder underfrequency tripping.	Unknown*	Unknown

Booming Interconnection Queue



Source: LBNL

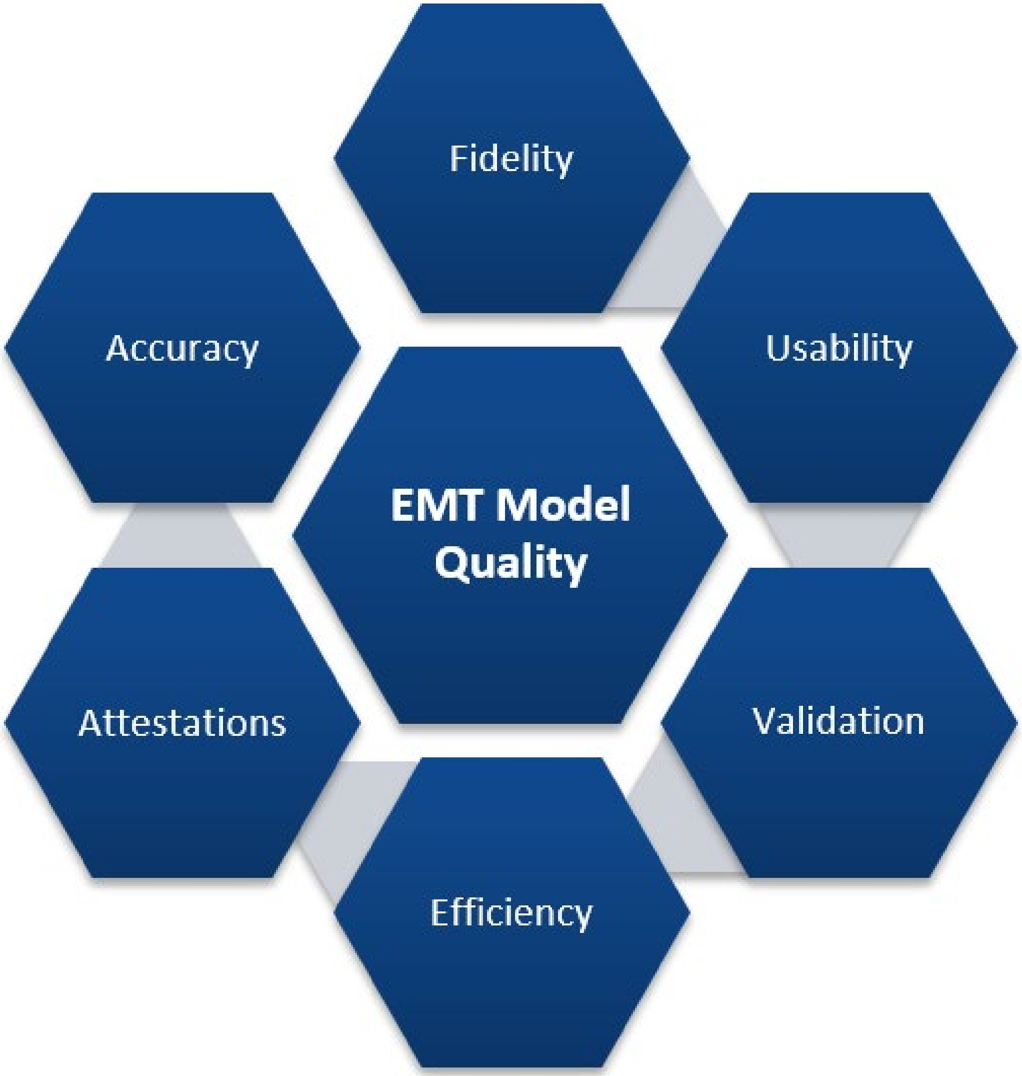
Why EMT Guidelines?

- EMT models can be utilized to capture previously unstudied performance:
  - Majority of grid faults are unbalanced
  - Control instability and interaction with other IBRs
  - Causes of IBR trip/output reduction from recent disturbance reports
    - Instantaneous inverter AC overcurrent and overvoltage
    - Inverter DC unbalance protection
    - Unbalance current protection
- To address gaps identified in recent disturbance reports
    - Models not matching facilities
    - Inability to reproduce unreliable performance reported – trips, output reduction
- Reference for TPs and PCs as they begin performing or coordinating EMT studies during the interconnection study process or during planning assessments

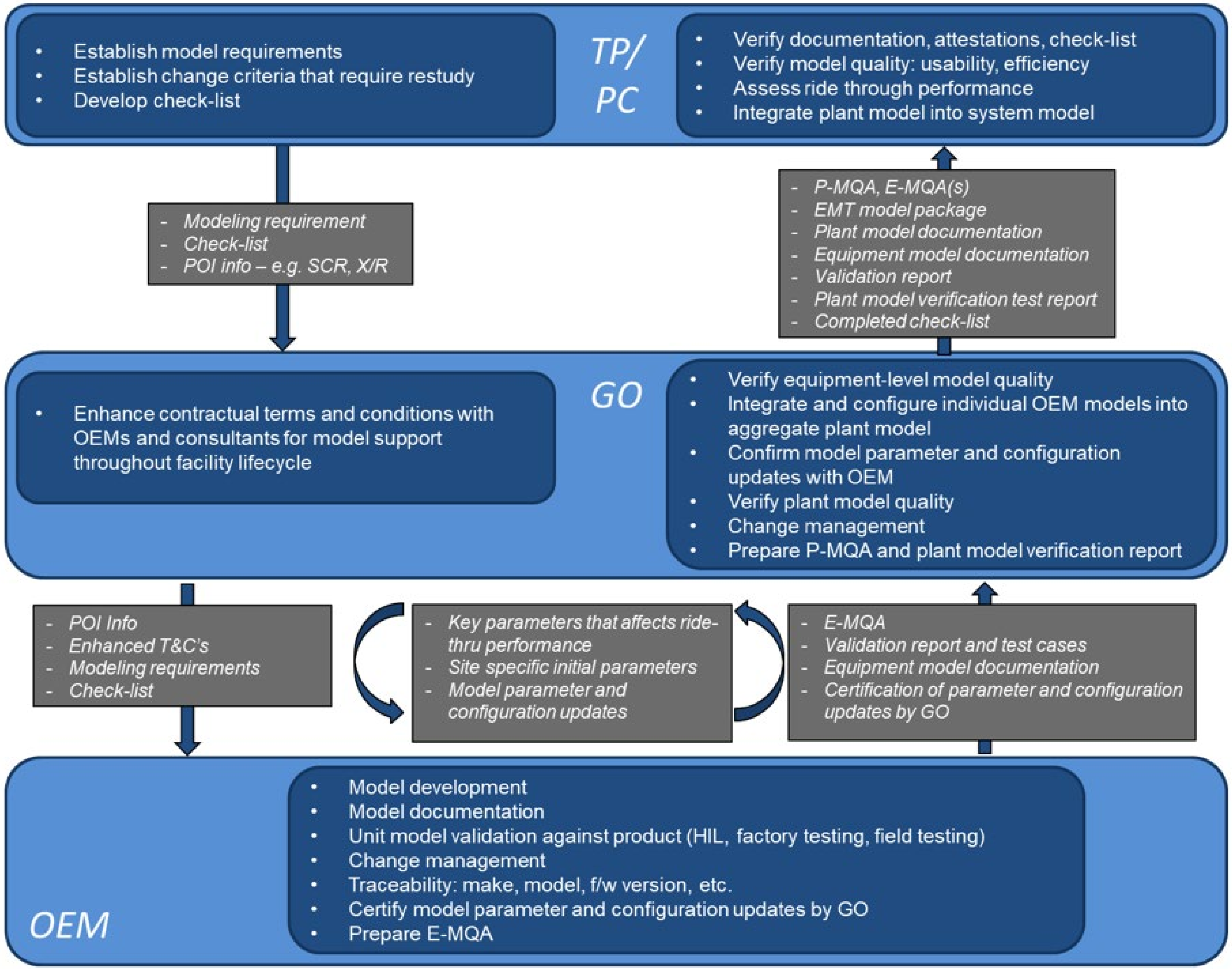
Main Takeaways

- Guidance for EMT modeling requirements, model quality checks, and model verification practices
  - Guidance to help industry close current EMT modeling knowledge gaps
  - Guidance to give industry a foundation of knowledge for new modeling requirements and practices
- Guidance to make EMT models *available* to TPs and PCs for the purposes of reliability studies – interconnection studies per FAC-002 and planning assessments per TPL-001
- Model quality, model verification, and performance issues are addressed both during interconnection studies and during annual case creation and planning assessments
  - Guidance to help industry close current gaps between interconnection studies and installed equipment

Model Quality



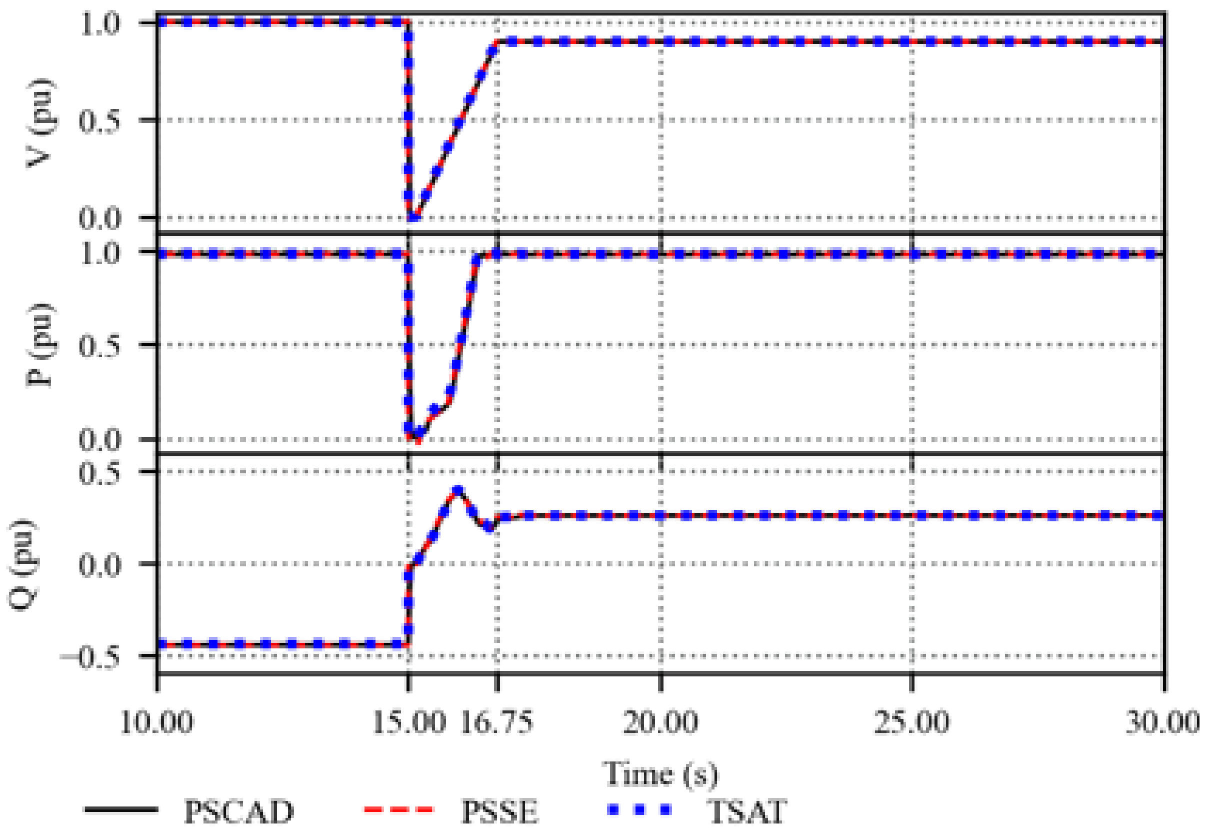
Model Verification



EMT Benchmarking vs Positive Sequence

- Transmission Planers and Planning Coordinators should establish clear and consistent EMT model benchmarking requirements in their interconnection study process requirements
  - Necessary to ensure EMT models match actual performance
- Model benchmarking should be performed for any modifications to actual plant settings, performance, or applicable model updates
- Model verification is necessary to ensure studied performance can be put into operation at comissioning

EMT Benchmarking vs Positive Sequence



Resourcing for Future EMT Studies

- Transmission Planners and Planning Coordinators should develop engineering expertise in EMT modeling and studies
  - EMT studies are expected to be performed much more frequently
  - Expertise will be needed to perform and review EMT studies and results
- Academic Institutions with power engineering programs should improve curricula regarding EMT modeling and studies
  - Assist in raising industry knowledge floor for EMT modeling and concepts
- Research institutions and national laboratories should consider developing educational materials

Part One of a Two Part Guideline

EMT Modeling (Part I)

- Requirements Development
- Quality Verification
- Benchmarking with Positive Sequence Model
- EMT Study Use Cases

EMT Studies (Part II)

- Screening Techniques
- Scope Development
- Study Processes
- Study Execution
- Other relevant topics
  - Legacy facilities
  - Synchronous generation and network models
  - IEEE 2800-2022

EMT Task Force - Purpose

- To support and accelerate industry adoption of EMT modeling and simulation in their interconnection and planning studies of BPS-connected IBRs
- Provide guidance and references materials to TPs and PCs to more adequately assess BPS impacts and reliability risks of interconnecting IBRs.
- Develop technical documents to support BPS planning under increasing penetrations of BPS-connected IBRs
- To participate in the EMTTF, reach out to aung.thant@nerc.net or alex.shattuck@nerc.net

Industry Efforts

Tackling IBR Reliability Challenges

- NERC IRPS
  EMT Modeling Guidelines and Task Force
- Significant Enhancements to NERC Standards
- Increased Engineering Resources
- Improvements in Power Electronics hardware, controls
- Improvements to FERC GIAs and GIPs
- Industry Adoption of NERC Reliability Guidelines
- Enhanced Interconnection Requirements

Questions and Answers

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