

NERC

NORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

NERC Inverter-Based Resource (IBR) Webinar Series:

Session 6: Modeling Part 2 – Model Quality and Model Benchmarking

June 22, 2023

RELIABILITY | RESILIENCE | SECURITY



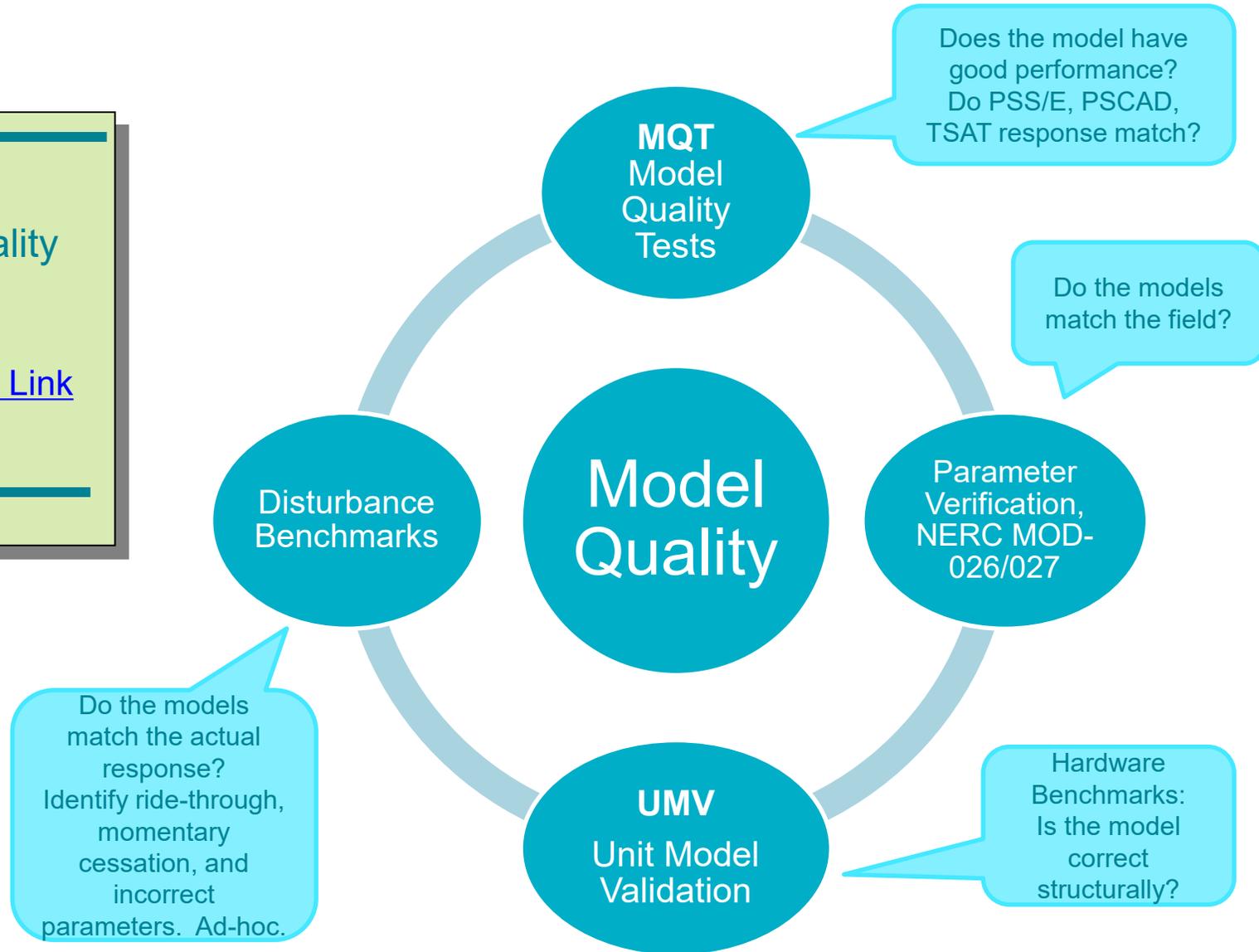
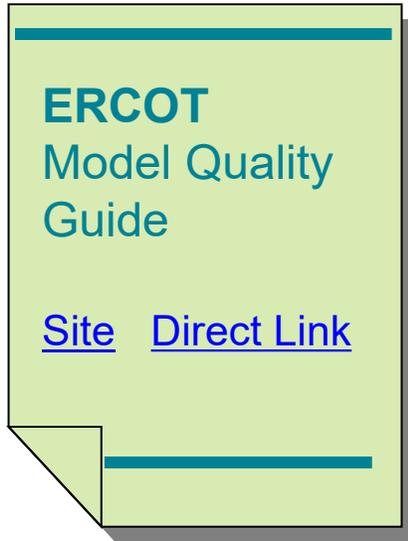


NERC IBR Webinar Series
June 22nd: Model Quality & Benchmarking,
ERCOT Perspective

Jonathan Rose
ERCOT Transmission Planning

June 22, 2023

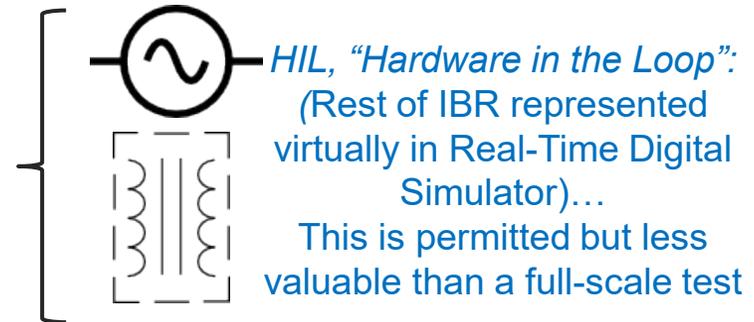
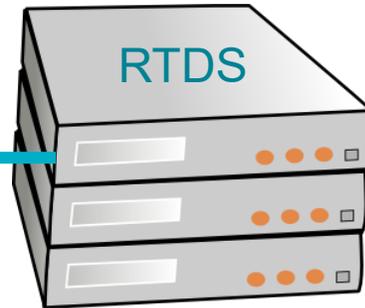
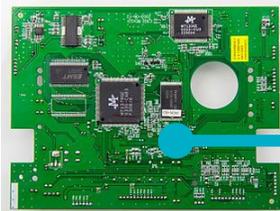
ERCOT's Model Quality Process



UMV, Hardware Benchmarking

- UMV = “Unit Model Validation”
 - Required for new projects after 3/1/21 once during the interconnection process
 - Non-site-specific hardware benchmarking report.
 - Generally performed in OEM’s laboratory using default settings.
 - Usually performed once for a certain model or family of inverters.

Control Board from IBR



- Successes:
 - Identified an inaccurate subsynchronous PSCAD model
 - Has identified a ride through performance model accuracy issue
- Overall, most PSCAD models easily pass the UMV benchmarking

Parameter Verification for Model Accuracy

- Augments MOD-026/027 for stronger model accuracy
 - MOD-026/027 benchmarks model measurements
 - Parameter verification checks that model parameters match equipment settings
- Either PSCAD or PSS/E model acceptable to verify
 - ERCOT requires verification of site-specific / tunable parameters and protection settings



Example:

- *“On 3/1/2023, plant personnel checked plant equipment. These were compared against model parameters.”*

Parameter	Model	Field	Match?
Kiv (PPC)	2.0	2.0	✓
Hz1 (Protection)	58.6	58.9	✗
Tw1 (Stabilizer)	0.02	0.02	✓

(Shortened table for illustration; all tunable / site-specific parameters should be verified.)

Many model inaccuracies are caused by incorrect parameters.

This year, all plants were required to submit verification reports. Several showed at least one inaccurate parameter.

Generic Model Limitations

- Some manufacturers warn generic models do not accurately represent their products
 - Benchmarking with PSCAD can help identify insufficient PSS/E model fidelity

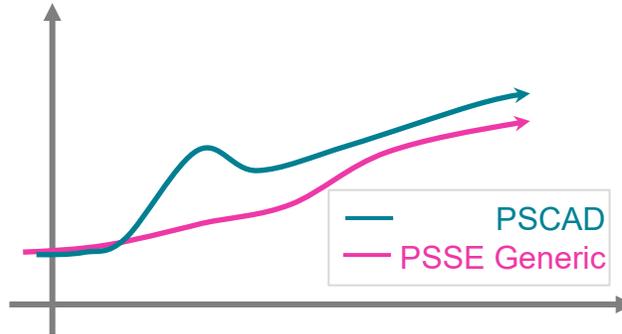
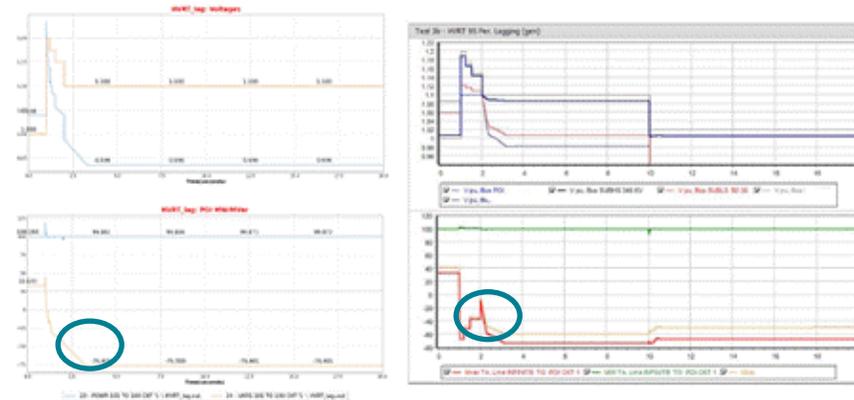


Illustration inspired by an actual situation where generic could not match PSCAD for a large voltage disturbance

Generic models are not always implemented the same across software platforms. Rare differences have been observed between PSLF, PSS/E, TSAT, PowerWorld for models with the same parameters. ERCOT requires the model testing be run in the software platforms we use.

Model Implementation difference for REGC

- Effect of Khv, "small" Volim



PSS/e: VRT

PW: VRT

ERCOT Model Quality Testing



- Generator owners must submit MQT reports with model updates, demonstrating model performance to standard disturbances
- ERCOT compares PSS/E, TSAT, and PSCAD performance for match
- Unit Model Validation (hardware benchmark) requires similar tests plus subsynchronous impedance

(Tests and criteria defined in [DWG Procedure Manual](#) chapter 3.)

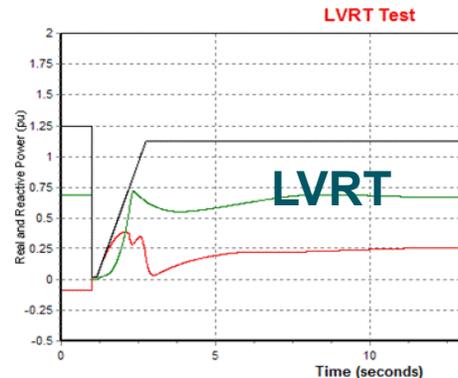
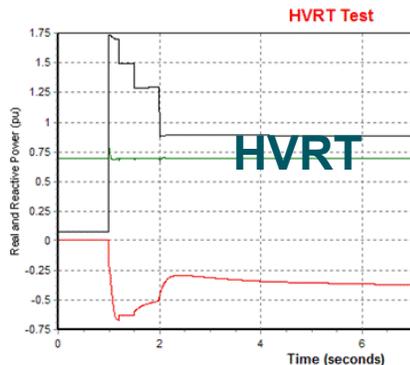
7 Tests for IBRs:

HVRT **LVRT** **Voltage Step (+/-)** **Frequency Step (+/-)** **Short Circuit Ratio**

- PSCAD models also check angle step

5 Tests for Synchronous:

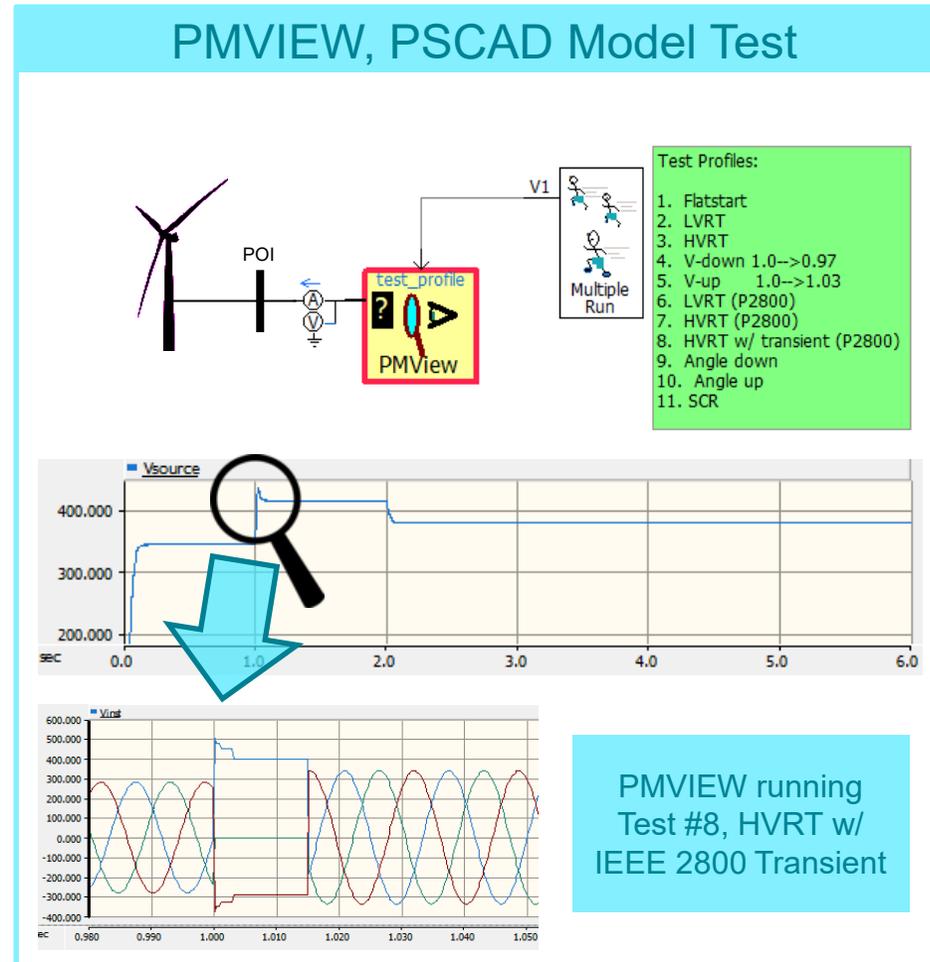
Voltage Step (+/-) **Frequency Step (+/-)** **Fault**



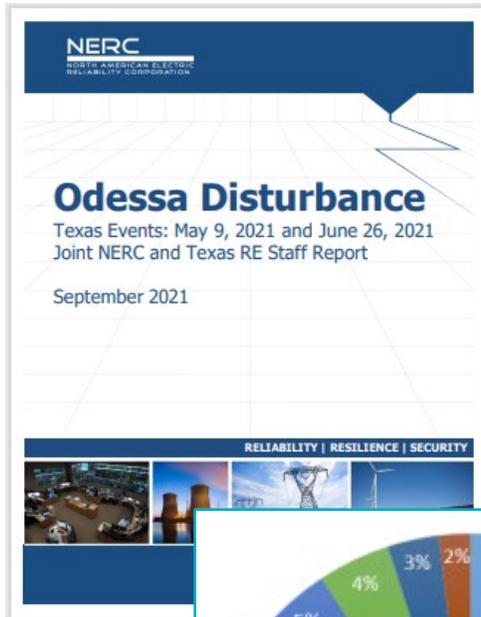
ERCOT will revise tests as needed per rule proposal [NOGRR245](#) to align with [IEEE 2800](#).

Testing Tools

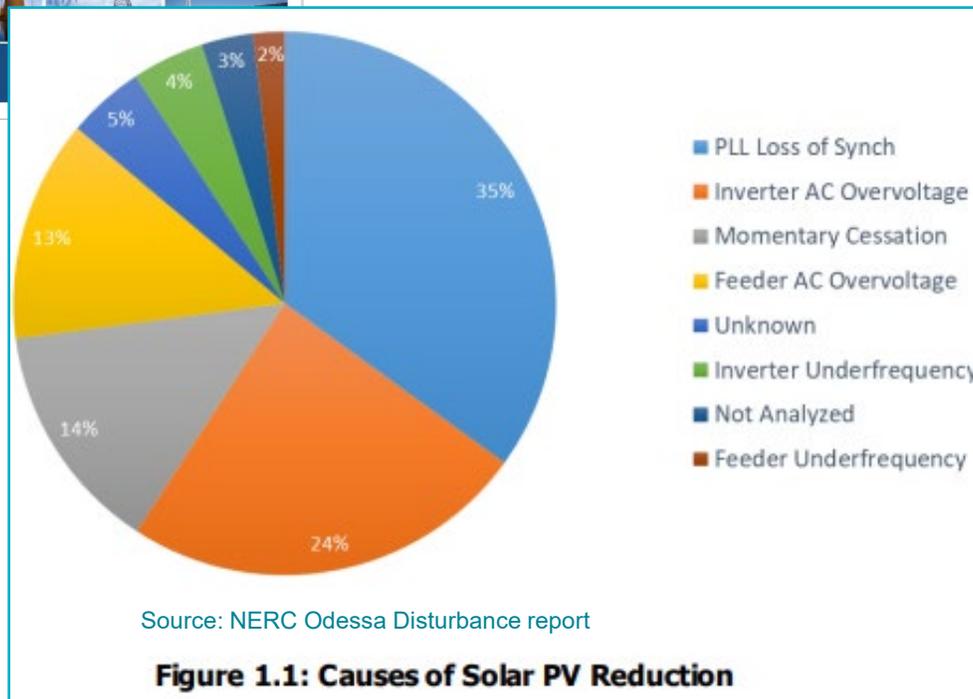
- To facilitate testing, ERCOT publishes two tools. Use of the tools is not required.
 - [DMVIEW](#) for PSS/E and [PMVIEW](#) for PSCAD
 - PMVIEW can also test ERCOT's new rule proposal ([NOGRR245](#)) that aligns with [IEEE 2800](#)



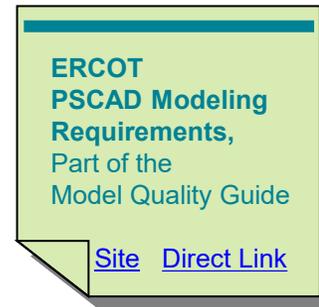
Odessa Event and Ensuring Ride Through



- Many of these model requirements were coming into force when the Odessa event happened. Most of the involved generators had not previously been evaluated under these new model requirements.
- The majority of Odessa ride through issues were caused by inverters tripping
 - PSCAD MQT testing may help identify certain ride-through issues.



These protections/functions should generally be modeled. Refer:



Feeder & other protection should be modeled if may cause tripping. Sometimes such protection is designed for internal faults but is mis-coordinated.

A map of North America, including the United States, Canada, and Mexico, is shown in a light blue color. A darker blue gradient overlay covers the central and eastern parts of the map, where the title text is placed.

Questions and Answers After All Presentations



NERC Inverter-Based Resource (IBR) Webinar Series - Vestas

[Thomas Schmidt Grau](#)

Director, Power Plant Solutions AME

TSGRA@VESTAS.COM

22 June, 2023

Model Quality, Accuracy Benchmarking and Importance

Models are important - also 20+ years later...!



Early Customer Engagement
1-3 years

Simulation models delivered based on Early Customer Engagement and sales documentation



Pre-Sales
1-2 years

Provide Updated Pre-Sales Models, especially if Product Design Description has changed



Post Sales
0-2 years

Support with As-Built/Validated User Written Models based on final source code, parameters and site tests



Post Commission (LD)
+20 years

Continuous model support to customers

Inaccurate Models = No connection = No sales

Models are required through the entire project life cycle, and they become more demanding as markets mature.

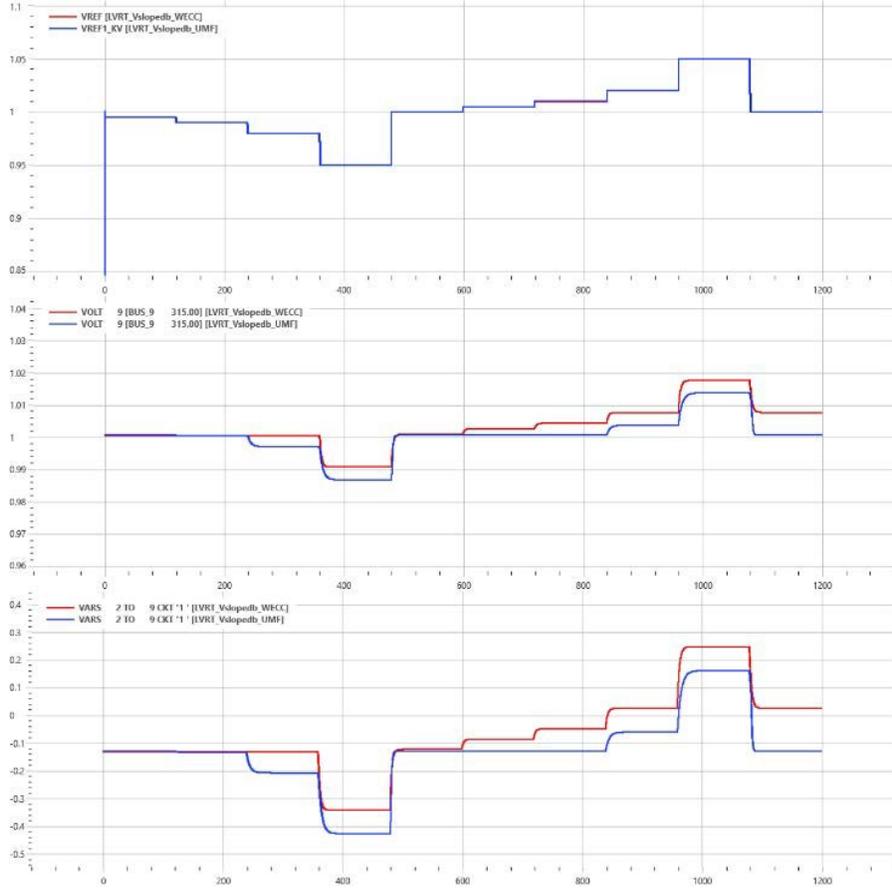
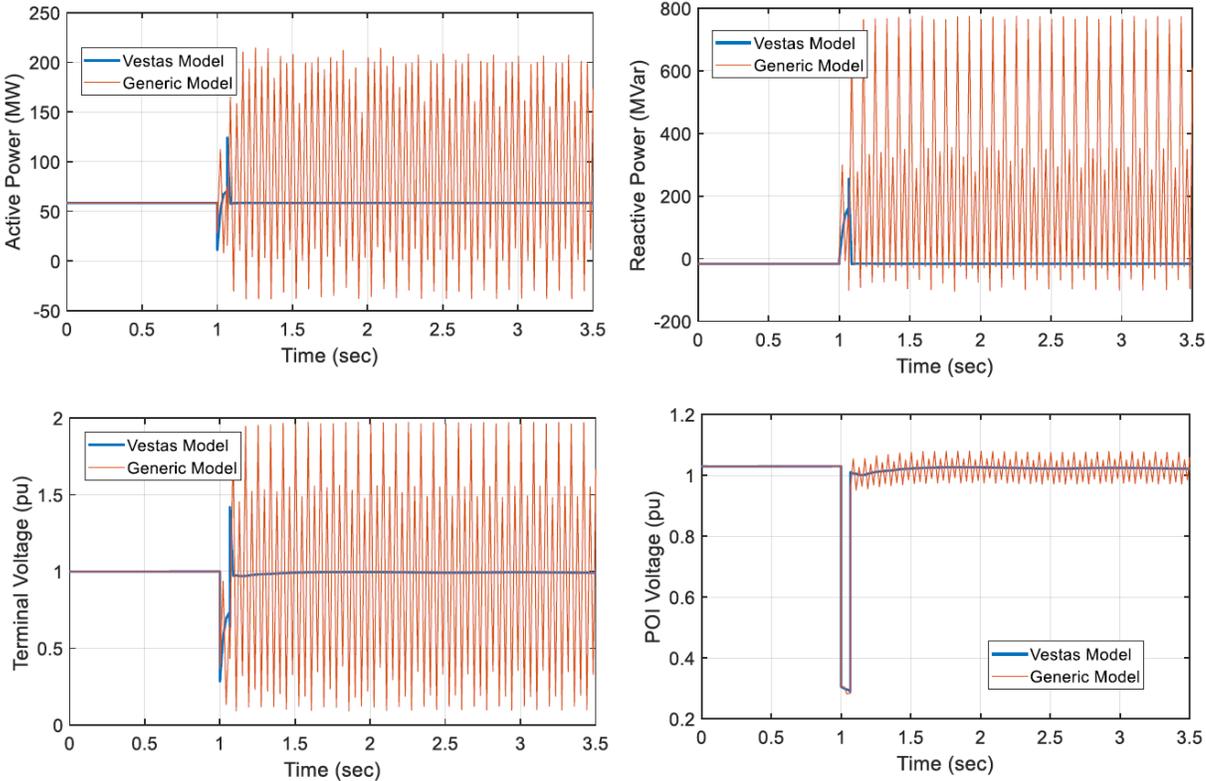
Model Quality, Accuracy Benchmarking and Importance

How much do you think a Power Plant Controller can impact Current Injection during a Short Circuit Current Study?



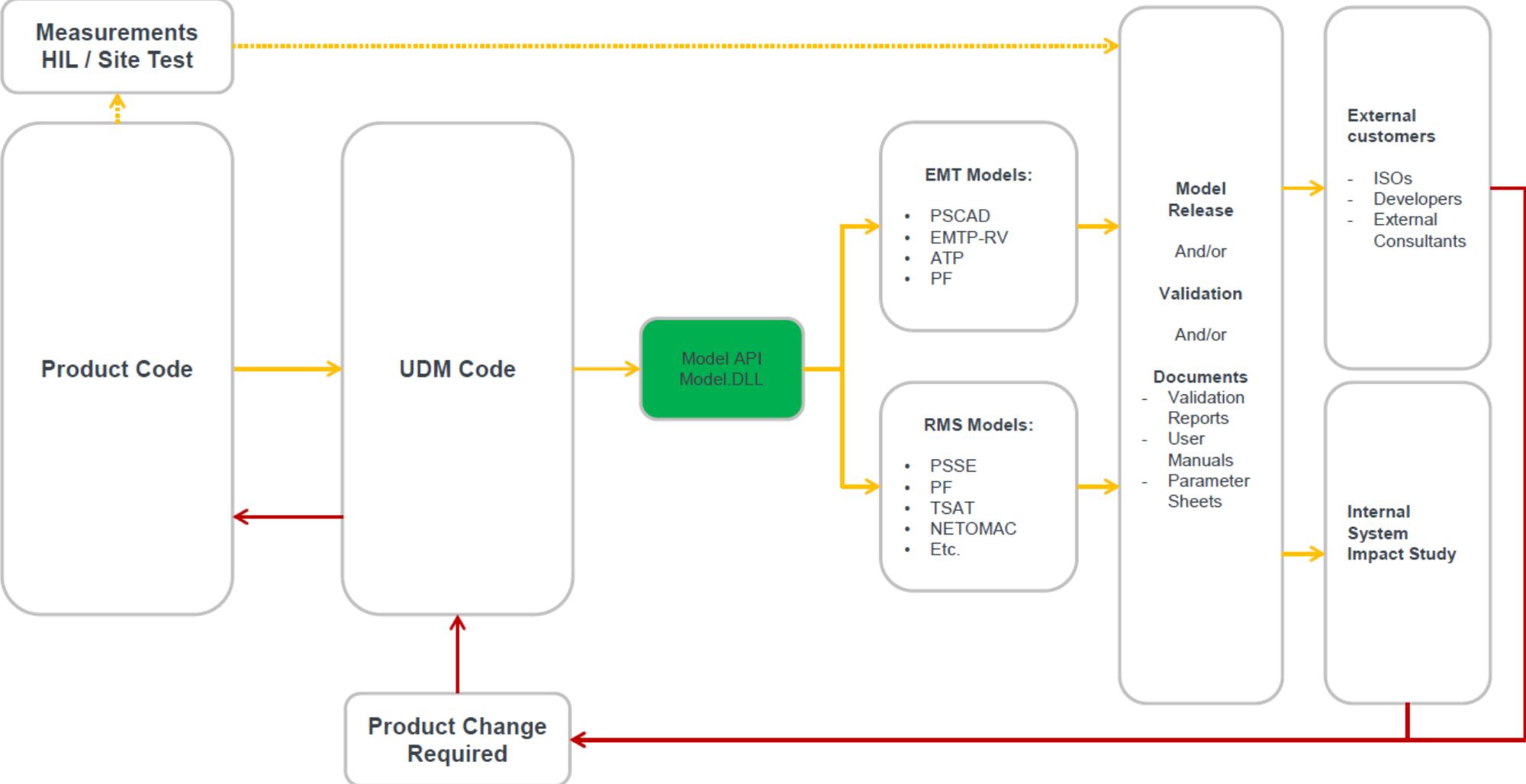
Model Quality, Accuracy Benchmarking and Importance

Why **Accurate** Models Are Needed...!



Model Quality, Accuracy Benchmarking and Importance

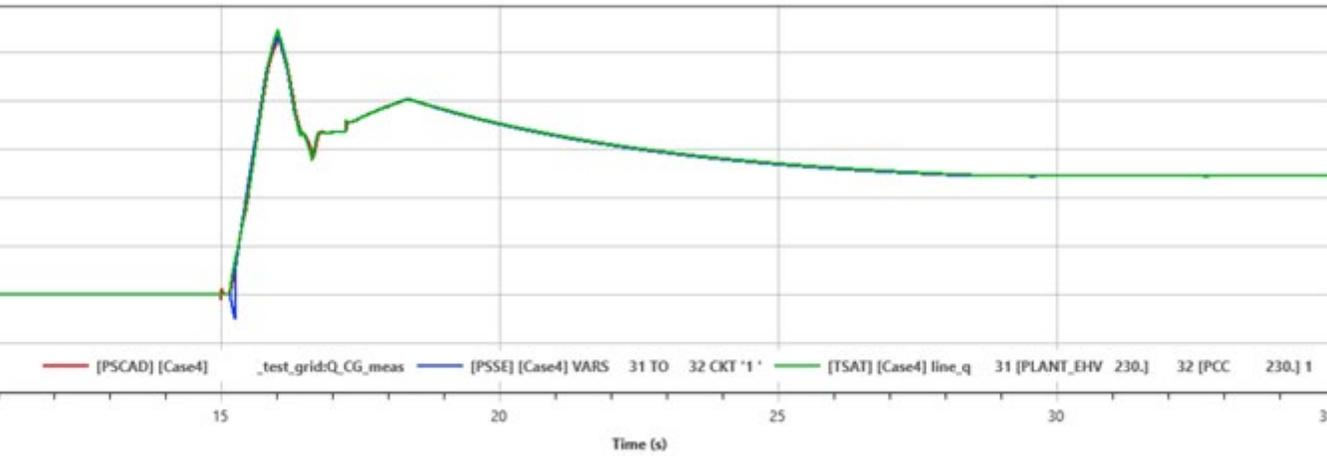
Product To Model – Model To Product



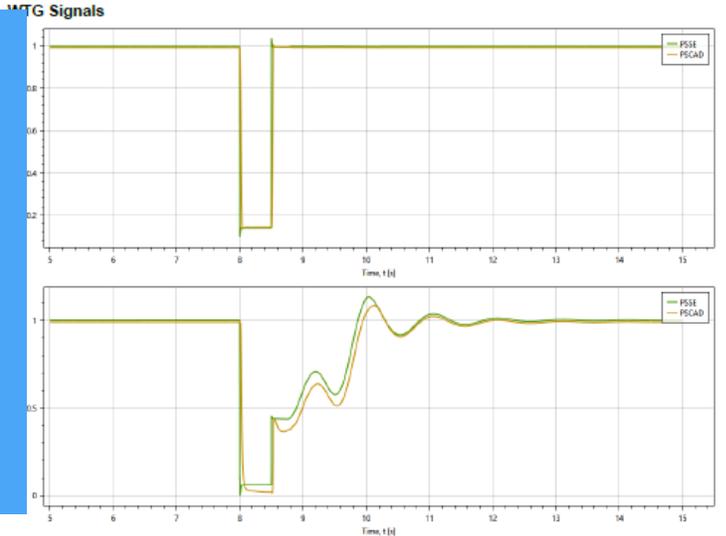
Model Quality, Accuracy Benchmarking and Importance

Model Comparison – It is possible...!

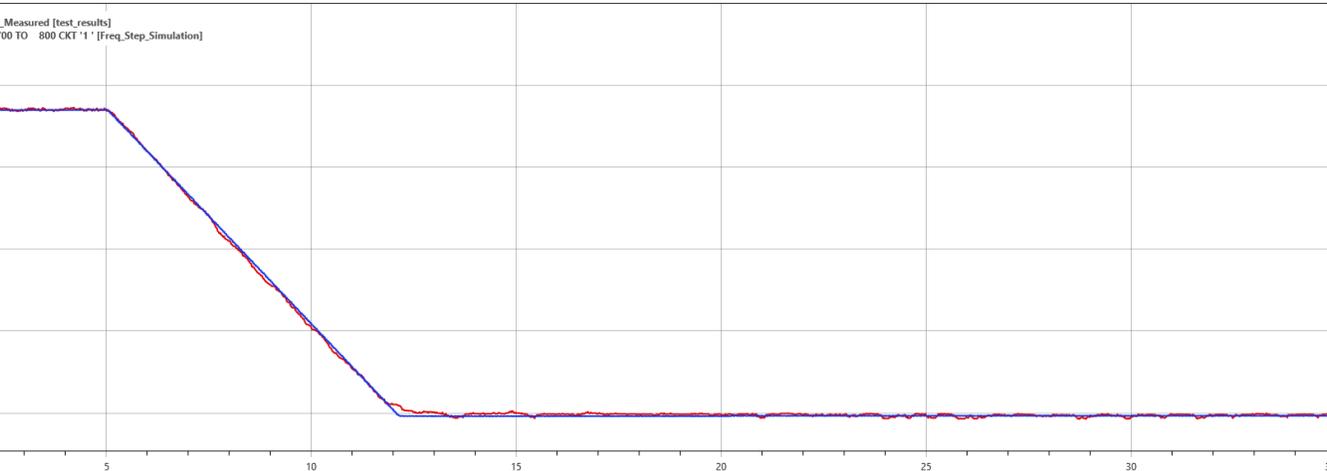
MQT



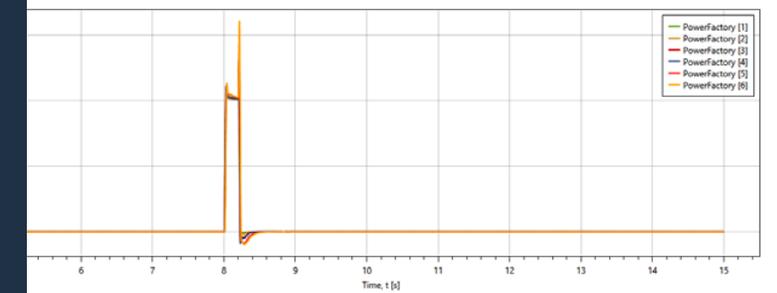
EMT/RMS



MOD Test



Timesteps

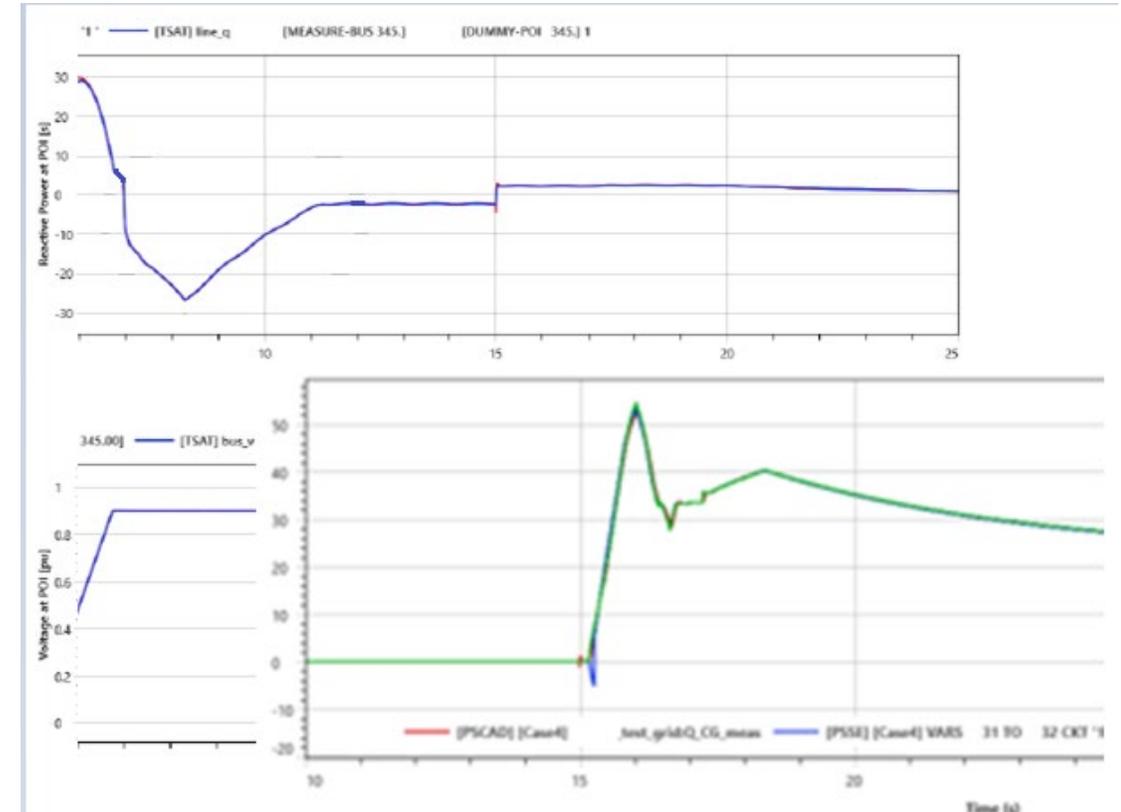


Model Quality, Accuracy Benchmarking and Importance

Important sites gets commissioned as studied

What is being studied – what is actually implemented?

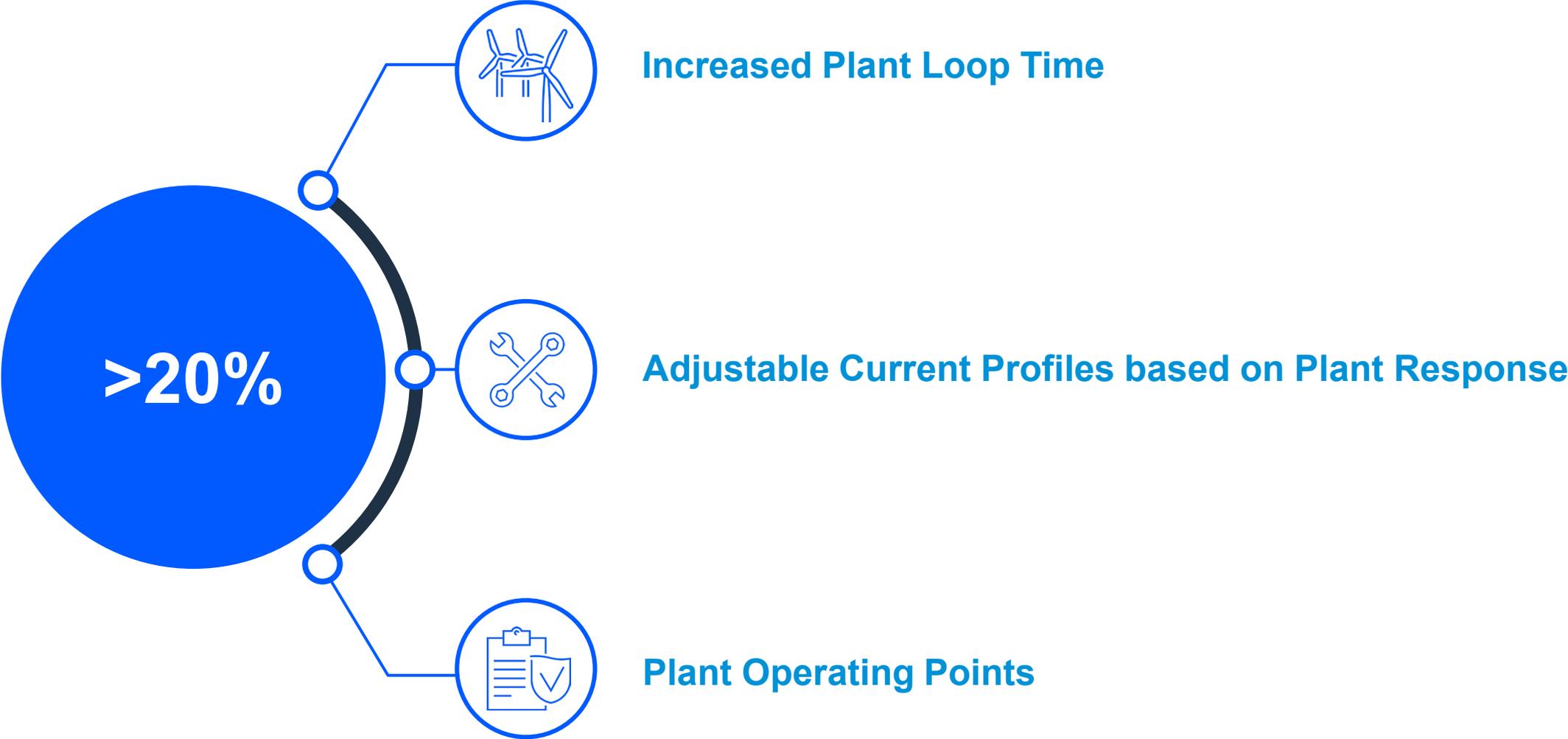
From Planning to Operation – Models and studies must be updated and assets commissioned as studied.



28 August 2023

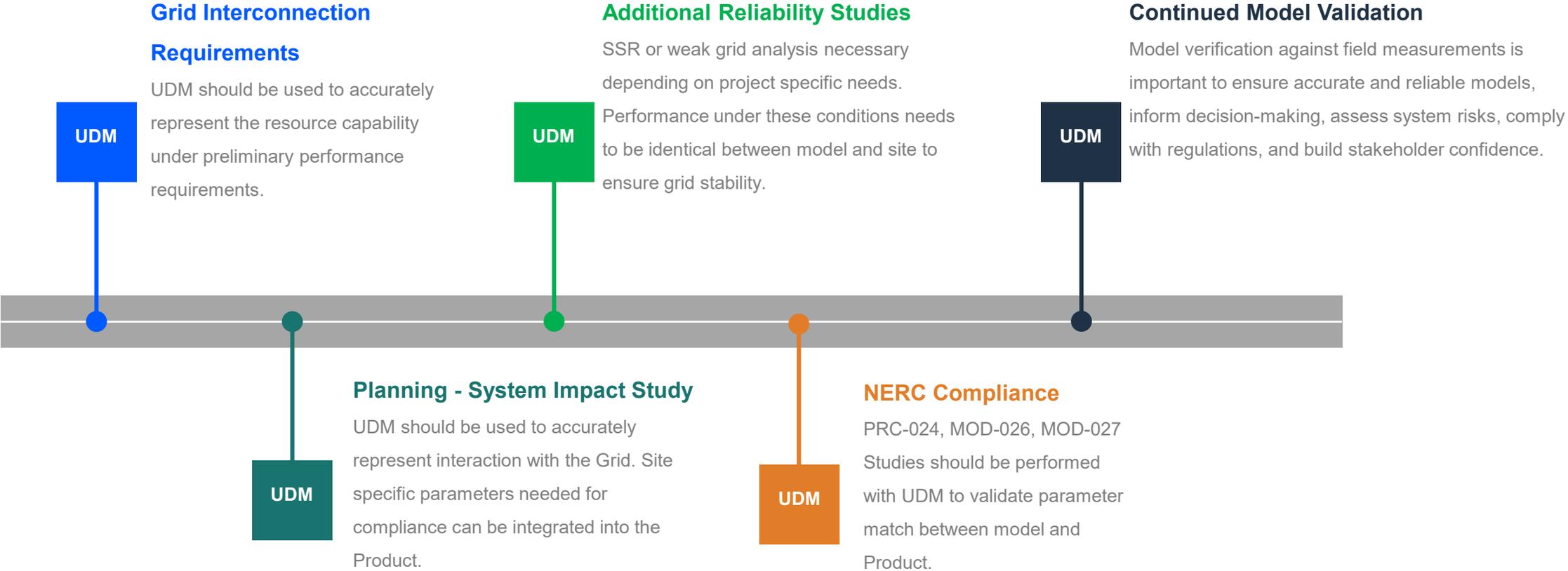
Model Quality, Accuracy Benchmarking and Importance

Short Circuit Current – Answer...



Model Quality, Accuracy Benchmarking and Importance

Accurate models are needed through out the entire value chain



Model Quality, Accuracy Benchmarking and Importance

IEEE2800 Is Coming – Are we Prepared...?

Do we know, what we don't know?

- Majority of the Operational challenges are not captured up-front
- Risk of renewable assets causing reliability issues due to poor tuning
- Majority of **queue** studies are based on obsolete technology. Technology changes faster than lead time on studies
- Detailed Models ≠ No Necessarily Accurate Models



Taking Accountability

- How can OEMs support the utilities to provide proper information for Planning and Reliability Studies?
- Technology improvement and tuning can significantly reduce transmission cost and improve grid stability – How to involve OEMs more frequently?
- How can we support “Material Modification” process to enable and support increased penetration in the Grid?



Thank You



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**Questions and Answers After All
Presentations**

T E S L A

Tesla BESS Modelling & Studies Experience - Global Perspective

Prashant Kansal
Power Systems Engineering Lead

LAST EDITED
June 19, 2023



Power Systems Team

- Responsible for developing power systems models for grid interconnection and BoP design
- Supporting and **performing** interconnection studies globally

Tesla Megapack



Tesla Power Systems Models

- PSCAD, PSSE, Power Factory
TSAT (User Defined)
- PSLF (Generic)
- ASPEN (Generic)

Grid Operators



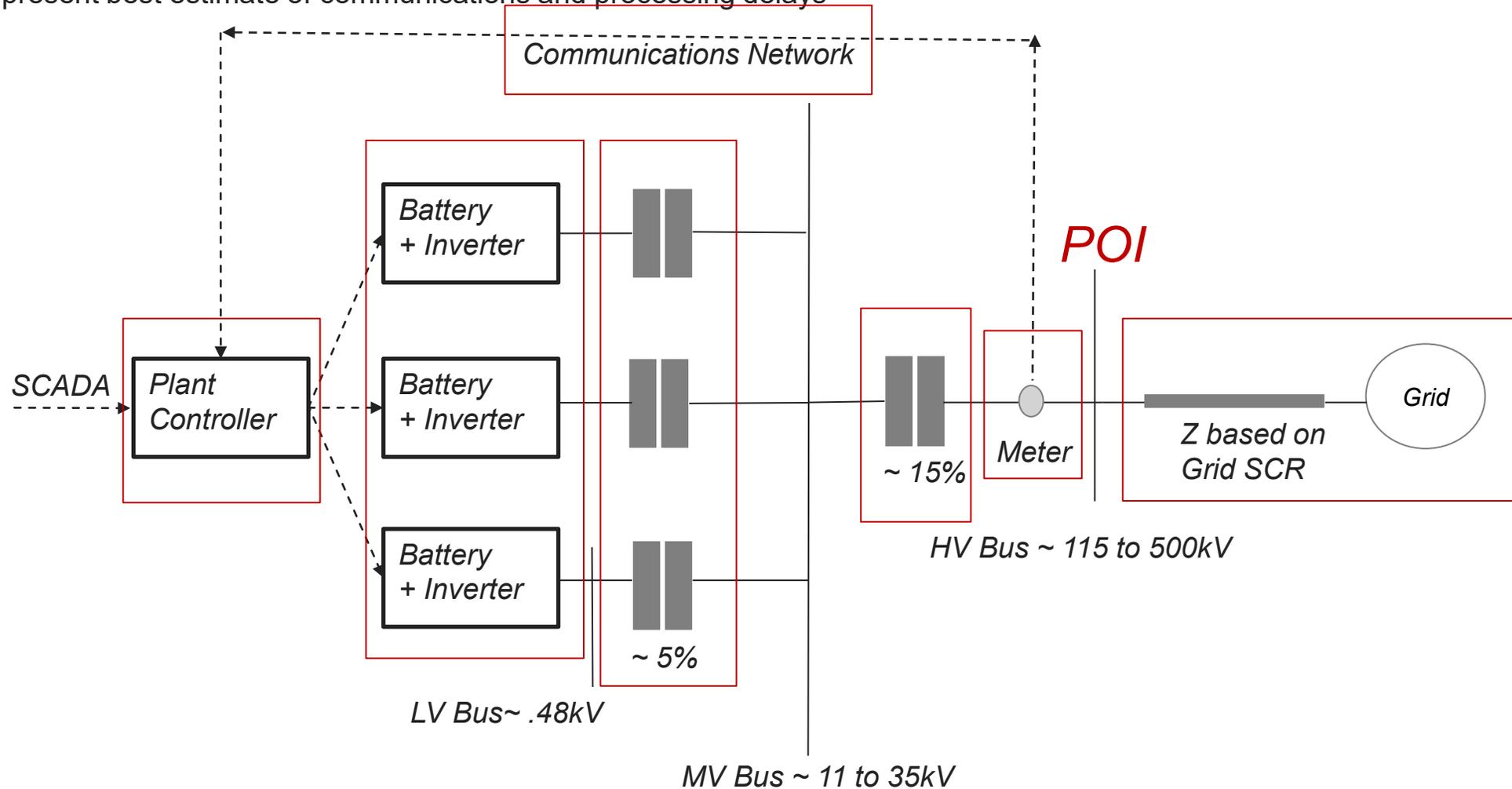
<https://www.tesla.com/megapack>

<https://www.nytimes.com/2018/07/20/business/energy-environment/california-energy-grid-jerry-brown-plan.html>

BESS Layout and Models

Overall layout

- Aggregating distributed response is a fun problem to solve!
- Ideal to represent best estimate of communications and processing delays



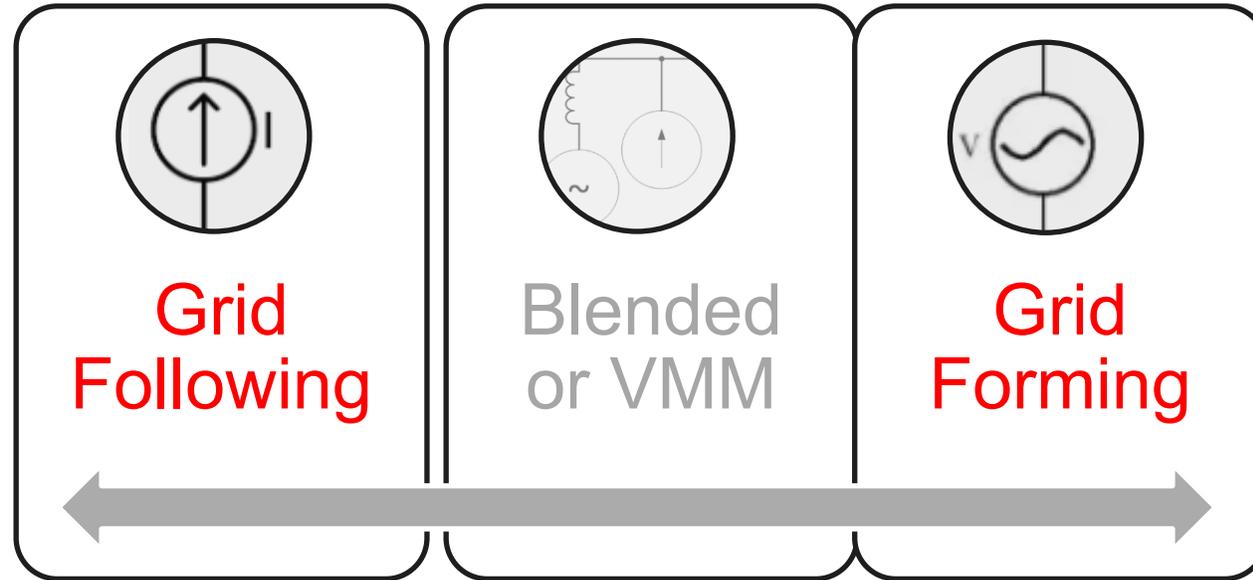
Controls

Plant level controls

- Typical control functions targeted to meet command at POI:
 - **Real Power**
 - Direct power command based on the grid operator dispatch signal
 - **Reactive Power**
 - Direct reactive power command
 - Site voltage reference control based on POI voltage and Vref target
 - Power factor control based on real power command and targeted power factor
 - **Site Compensation**
 - Both real and reactive commands have the compensation added to meet the site real and reactive losses in balance of plant
- Additional control functions that can be enabled:
 - **Real Power:** Freq/watt function, Ramp limits, Operator power limits
 - **Reactive Power:** Volt-Var, Ramp limits, Operator power limit
 - **Voltage and Frequency reference:** Grid forming controls

Controls

Modes of operations - BESS



VMM (Virtual Machine Mode): Dispatch ability of current source & instantaneous response of voltage source

Product and Project Model

Product Model

- Ensure controls and setting options match the product
- Product – EMT - RMS unit model benchmarking required in some regions

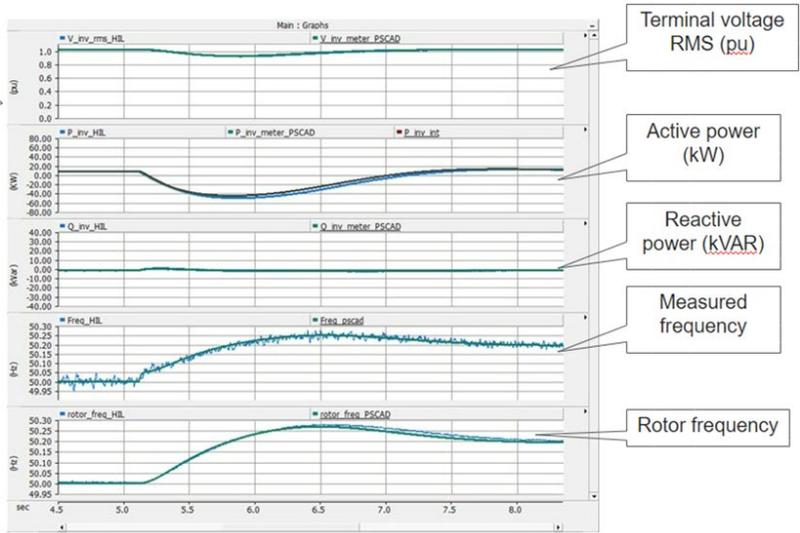
Project Model

- Ensure BoP is correctly represented
- Ensure right controls settings are selected to meet the grid code requirements
- EMT/RMS project model benchmarking required in some regions
- Site to model benchmarking required in some regions during or post commissioning

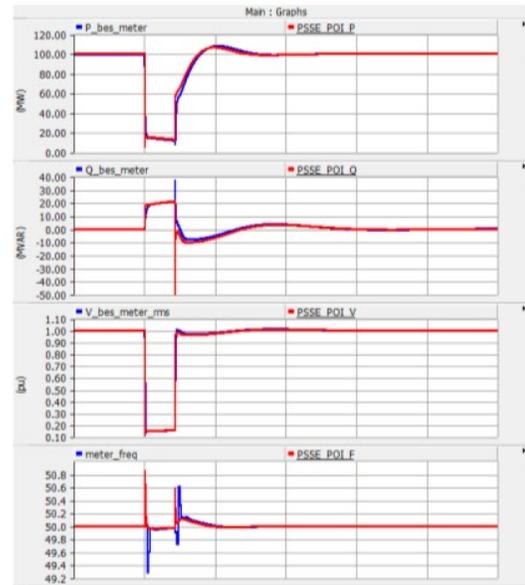
Model Benchmarking

Product – Model - Site

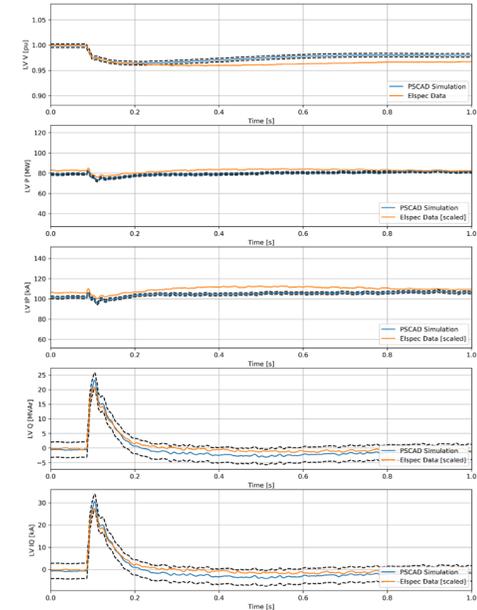
Legend:
Blue: HIL
Green: PSCAD



Product (HIL) to Model



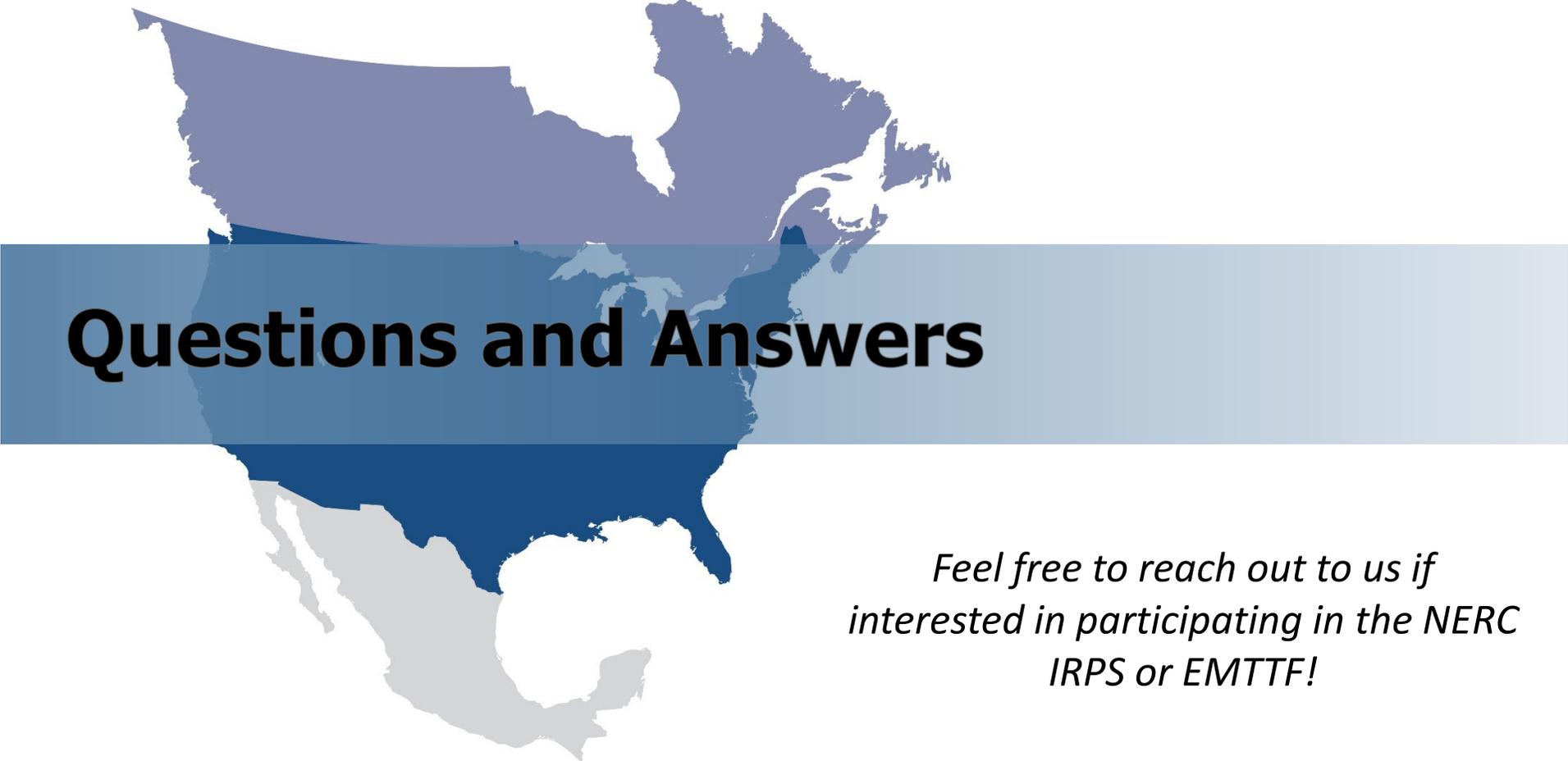
Model to Model



Model to Site

Open questions for the industry

- Definition of good benchmark
 - 10% magnitude, 1 cycle? For what step change?
 - Is it same for product – model and model-site?
- Default settings by OEM to speed up interconnection
 - Should OEMs provide project specific settings development?
- Definition of partial plant behavior
 - Ideal behavior if meter or plant or inverter communication is lost
 - Partial site behavior – prioritize reactive power or curtail the whole site?
 - It can impact other controls settings so its important to define these before start of interconnection studies
- Relay and meter (used for controls) backbox model
- Could we define self-stabilizing controls, settings, and a processes to minimize modelling and studies delay?
 - First principles thinking on the final outcomes and where we can be more efficient



Questions and Answers

*Feel free to reach out to us if
interested in participating in the NERC
IRPS or EMTTF!*