Inverter-Based Generating Plant Modeling for Simulation

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Why Do Models Matter?

Mathematical representation of plant physical design, including controls, which is designed to replicate real world operation of the plant in simulations integrated into the full transmission system model

Planned Upcoming Reports:
- BESS-Related Events in California in 2022
- Texas Wind Event in Texas in 2022
- Solar PV Related Event in Utah in 2023

Source: NERC Inverter Based Resource (IBR) Webinar: Session 1 (June 6, 2023)

Modeling Process

Initial Models – developed for transmission Interconnection Application

- purpose is to provide the utility a model for use in power system simulations

Model software formats:

- Siemens PTI PSSE – positive sequence rms
- GE PSLF – positive sequence rms
- PSCAD – electromagnetic transient (EMT)

Models include:

- model equivalent inverter and inverter transformer connected through collector system impedance
- main step-up transformer(s)
- protection and control system settings to model plant dynamic performance in simulation

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Modeling Requirements

IC application models are subject to performance checks in simulation

- in the past, utility requirements have varied widely in both number and complexity of requirements

- since passage of IEEE 2800-2022, some utilities have begun to revise requirements to align within performance ranges of this standard

Utilities may specify required performance within available ranges

- voltage control mode may be specified as voltage control, power factor control, or reactive power set point control

- voltage response time typical range is between 1 to 30 seconds, but may be further specified by the utility

- most utilities do not specify voltage control methods, but all specify reactive power capability requirements

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WYSIWYG (What you study is what you get)

NERC is focused on improving quality and accuracy of models

Another focus is assuring accurate and high-quality models are used for interconnection studies

Considering a future framework in which design changes which could theoretically alter a utility's study results **may result in restudies, loss of queue position, or liquidated damages**

Majority of industry realizes that plant designs must evolve during engineering and construction and some hardware changes are unavoidable
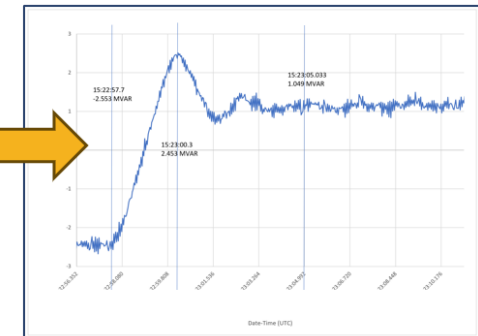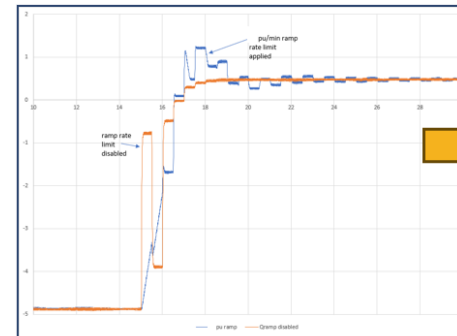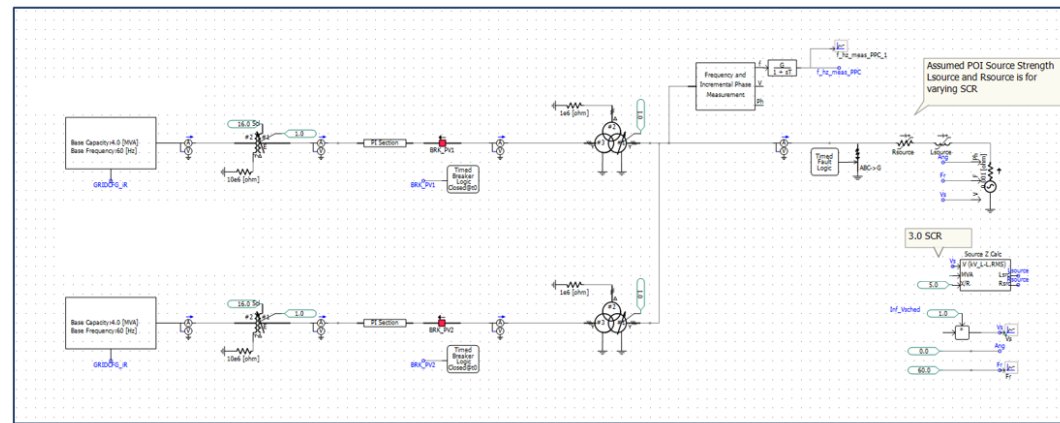
Possible Design Changes

- Inverter manufacturer
- Collector system impedance
- Cap banks
- Protection settings
- Control modes
- Ramp rates

Plant Commissioning Process

Interconnection Agreements may include novel technical requirements

- Revised, refined or additional technical requirements may result in revised control system settings

- Control system changes may also be driven by revised system equivalent impedance data from the utility, resulting in the need to further tune controls

- Care must be taken when reviewing interconnection and operating agreements to avoid technical requirement conflicts

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Model Documentation and Validation

Documentation of as-built equipment is necessary

- Include as-left inverter and power plant controller protection and control settings in model documentation.

- Model validation is checked through comparison of online step test performance against simulated step test performance.

- Post-commissioning model validation will involve recorded grid event performance for comparison against event simulation performance.

Model Validation
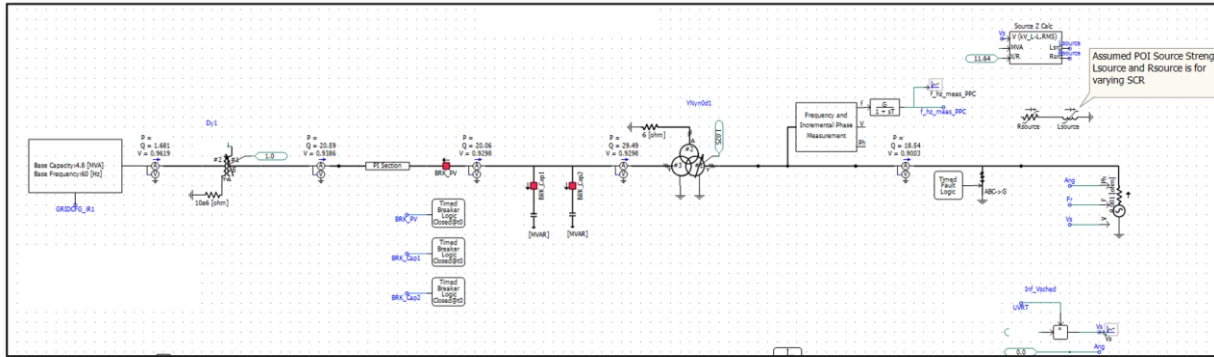
- Review protection settings against requirements to ensure coordination

- Develop accurate models for use in simulation to test performance

- Ensure metered data available

- Utilities use simulations to check compliance prior to COD, and measured test and event response after COD for validation.

Simulations only as useful as the data used to build the model!

Model validation is necessary.
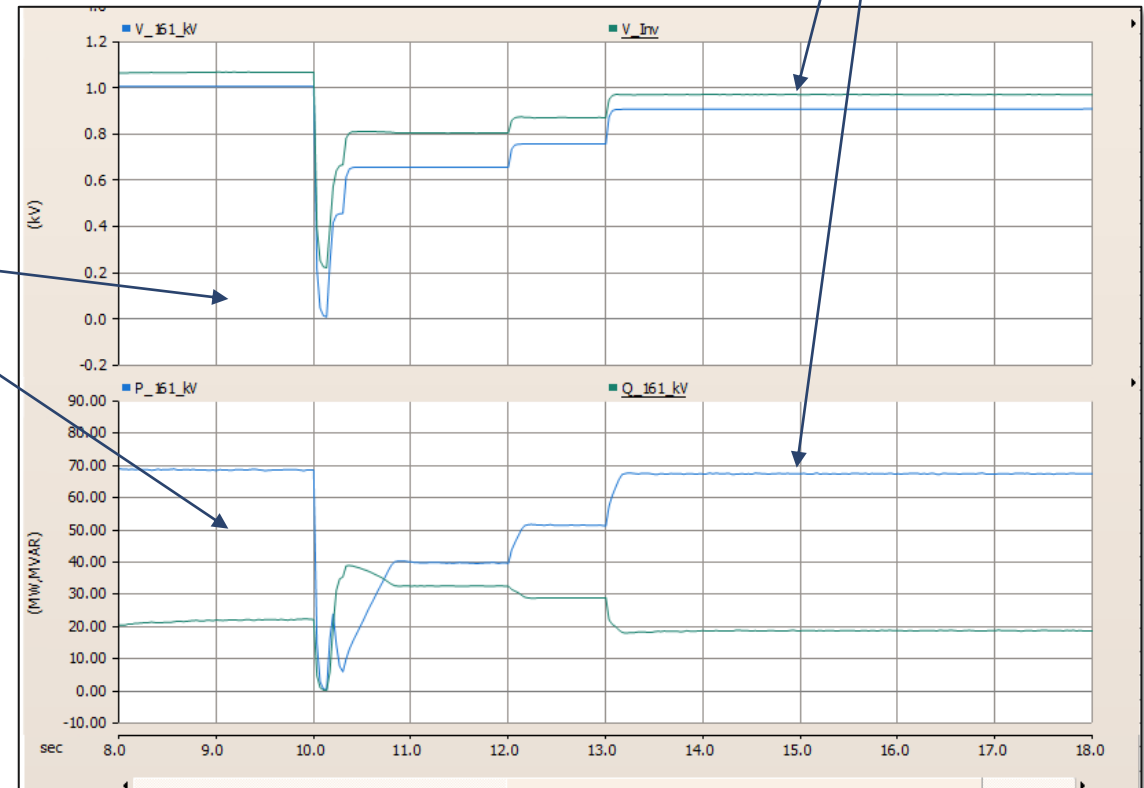
Thank you!

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