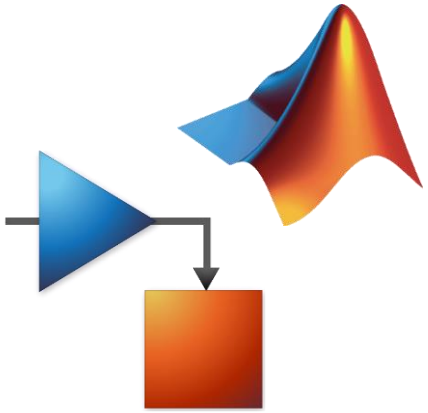
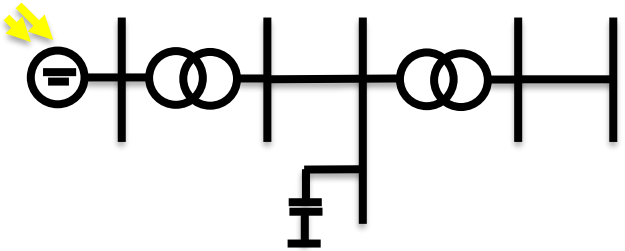
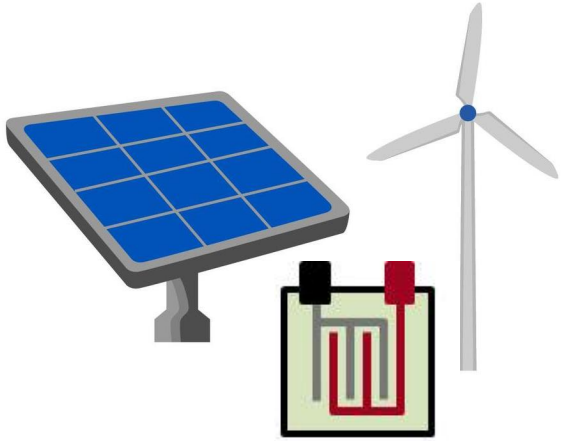
Model Validation (MOD 26/27) for Renewable Systems

Using MATLAB and Simulink







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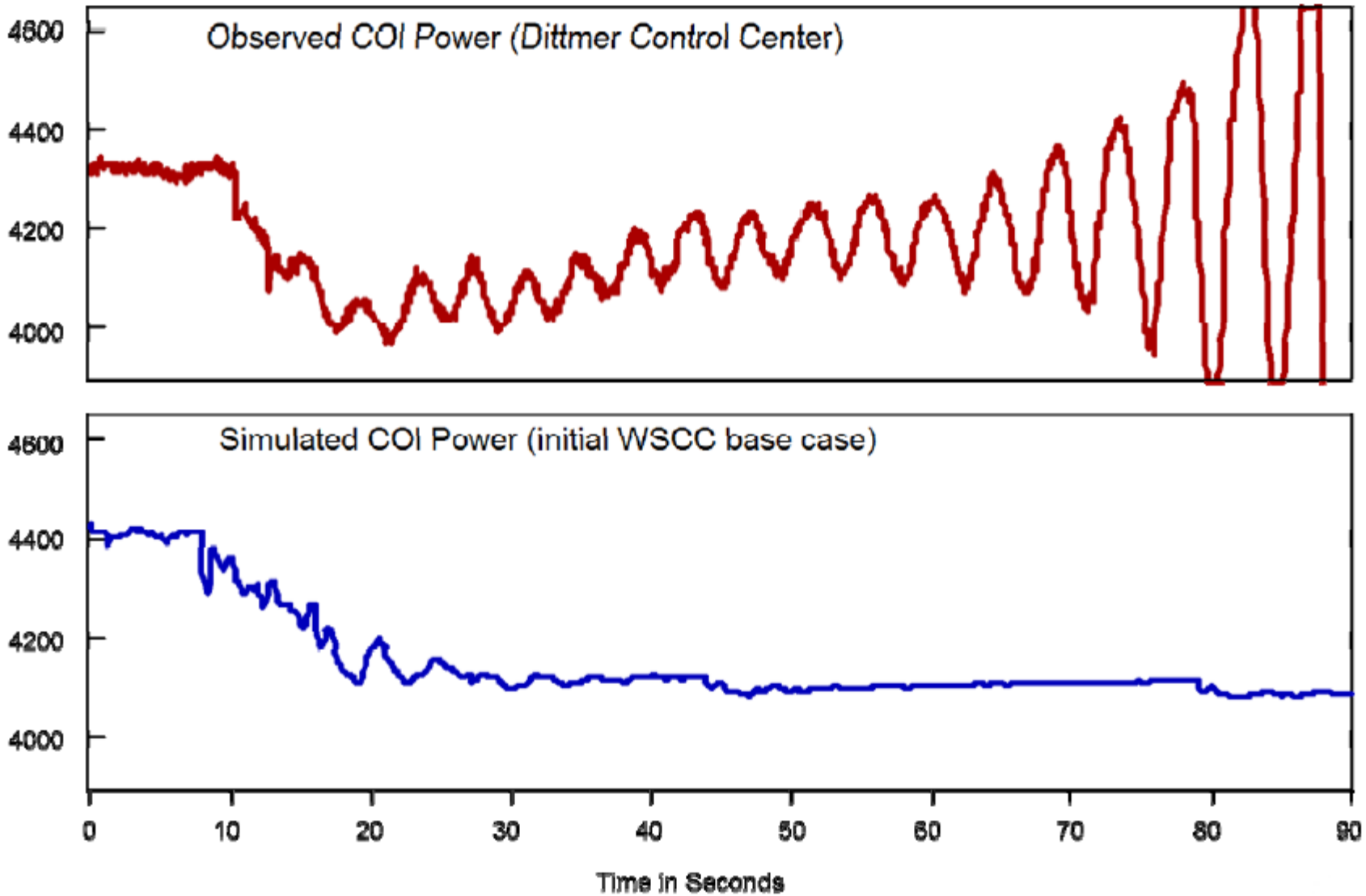
Agenda

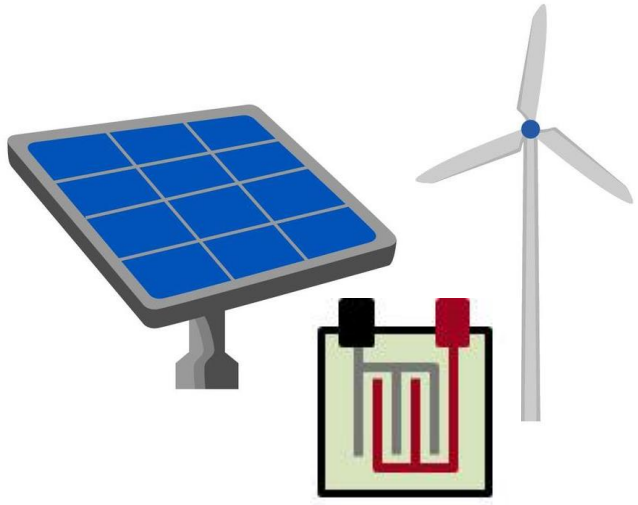
- Introduction to Model Validation
- Building Renewable Energy Models in Simulink
- MOD 26/27 Validation Studies

Reality vs. models (WSCC August 10, 1996)

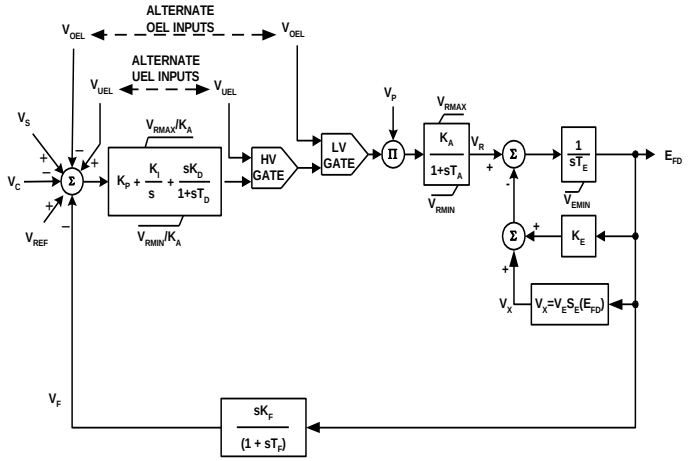


What is Model Validation?

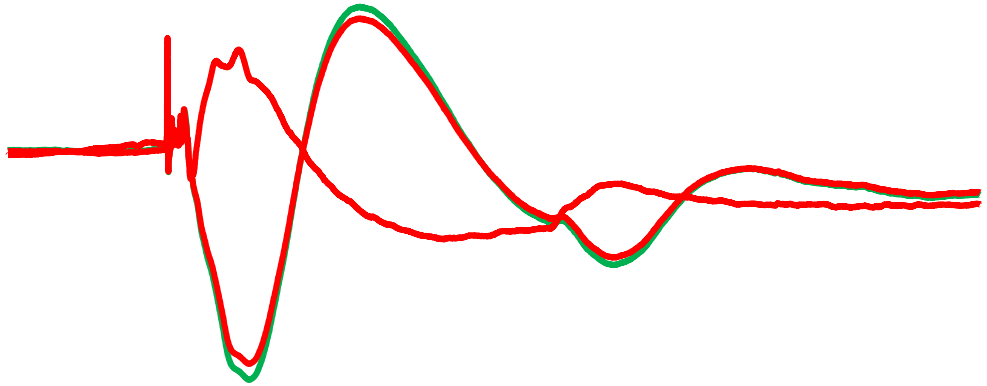
Renewables Field Equipment



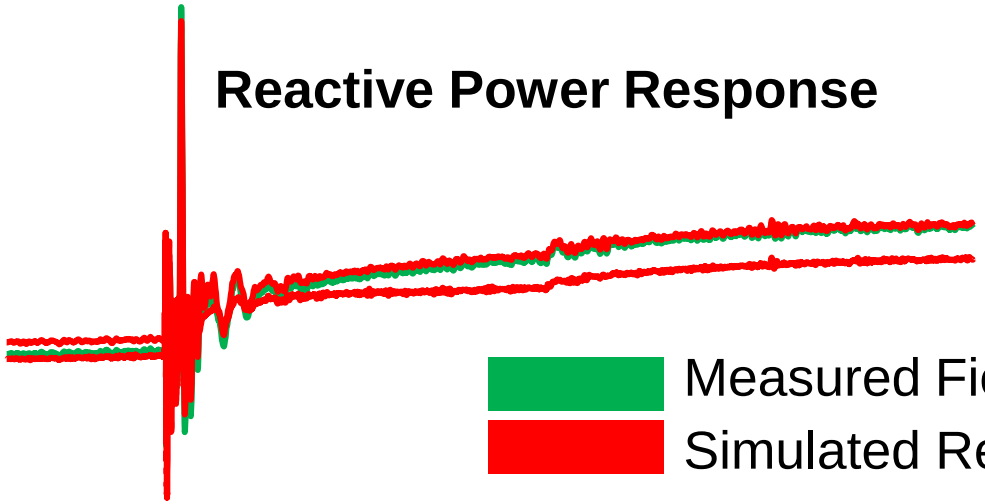
Standardized Models of Equipment



Active Power Response

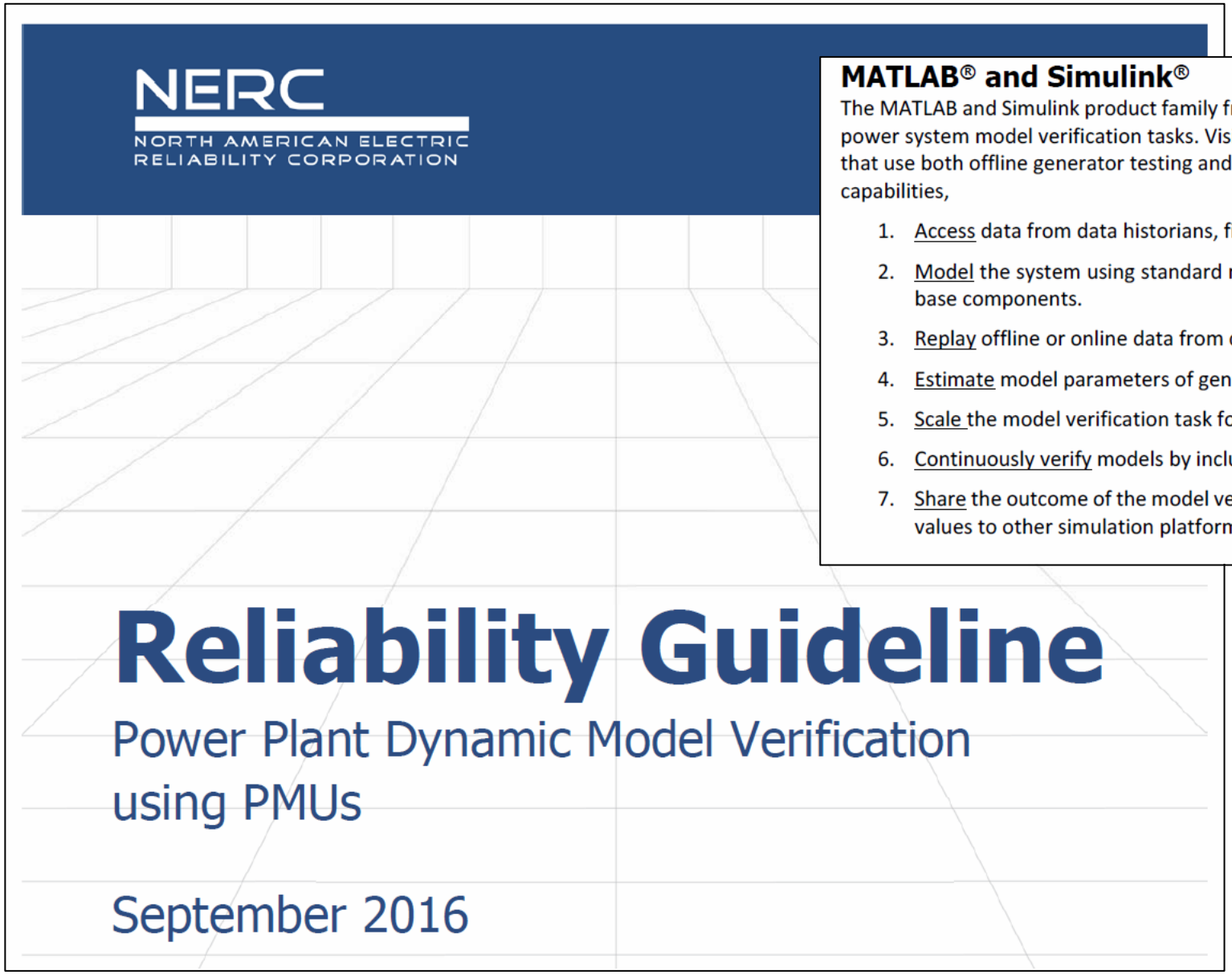


Reactive Power Response



Measured Field Data

Simulated Response



MATLAB® and Simulink®

The MATLAB and Simulink product family from MathWorks provides tools that support automation and scaling of power system model verification tasks. Visit this link to access on-line tutorials. Workflows for model verification that use both offline generator testing and online performance monitoring are established through the following capabilities,

1. Access data from data historians, field instruments, SQL databases, text files, binary files and other APIs.
2. Model the system using standard representations of generation equipment and/or build your own from base components.
3. Replay offline or online data from digital fault recorders and/or PMUs through the simulation model.
4. Estimate model parameters of generation and control equipment using formal optimization techniques.
5. Scale the model verification task for multiple generation assets through automated scripting.
6. Continuously verify models by including new events and historical events in the model verification task.
7. Share the outcome of the model verification task through automated reporting and transfer of parameter values to other simulation platforms.

Link to Reliability Guideline document

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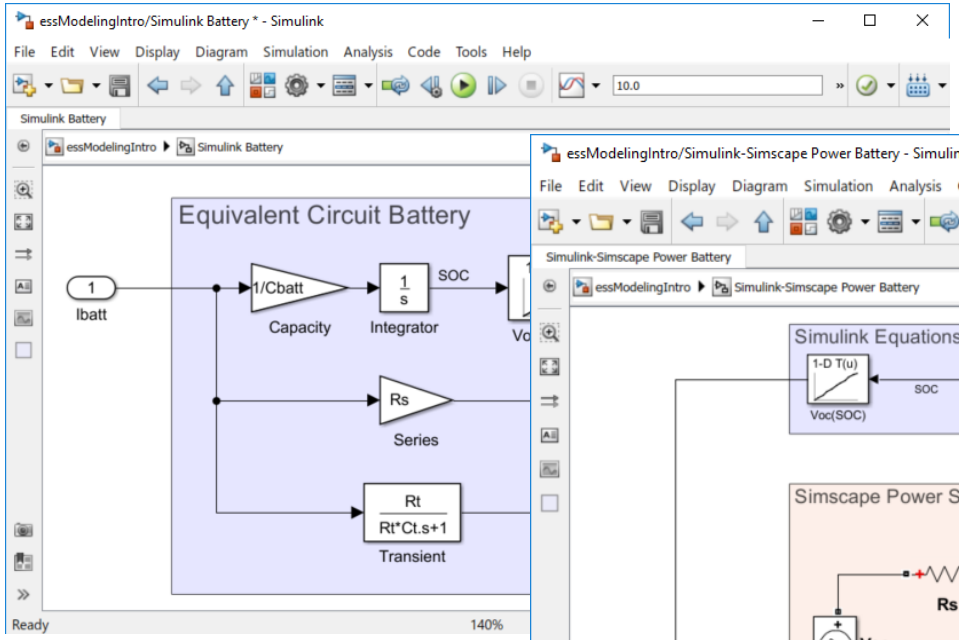
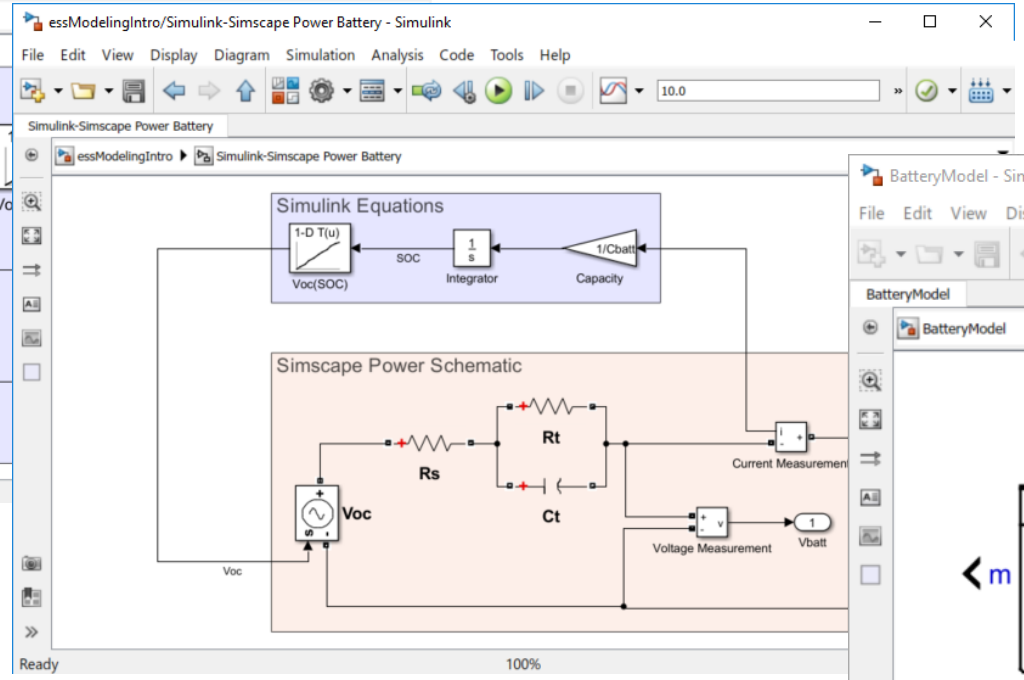
Model Using Fundamental Approaches



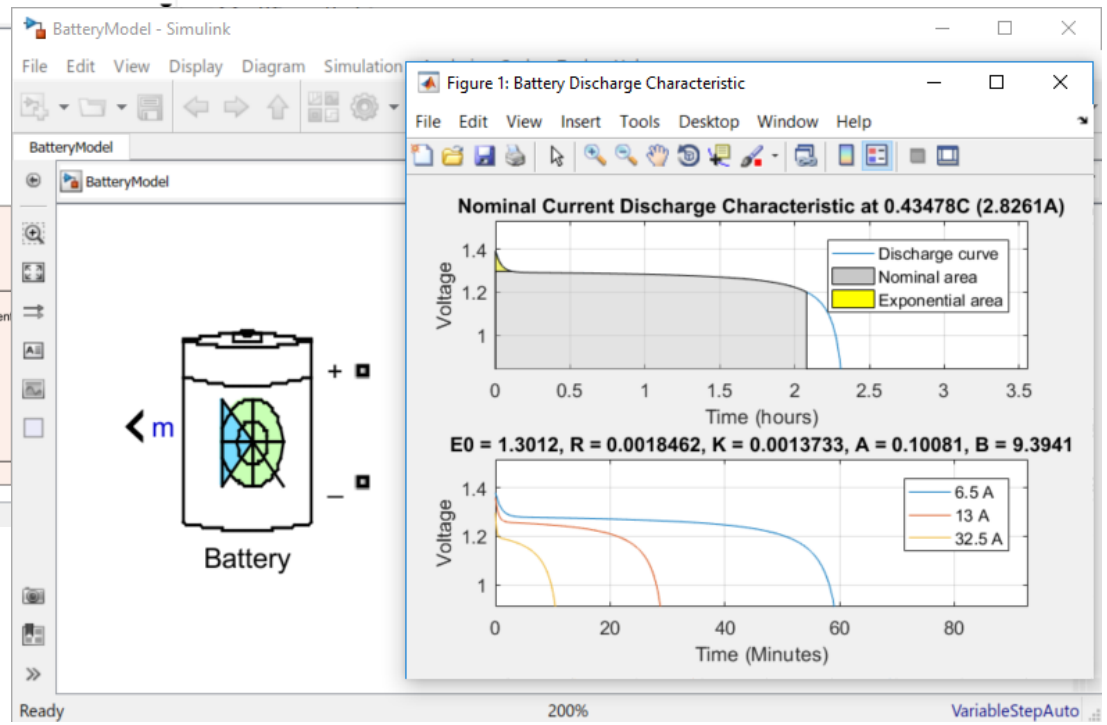
First Principles

Simulink



Physical Components

Simscape



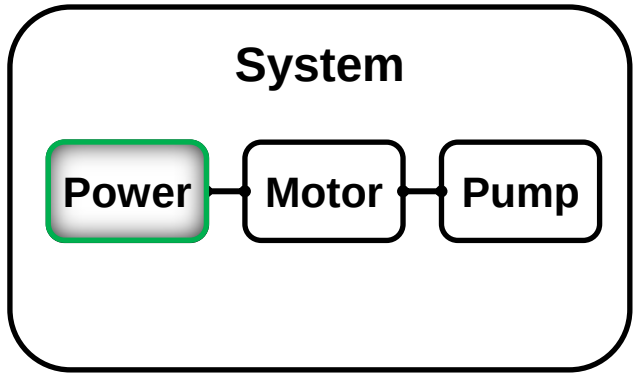
Complete Components

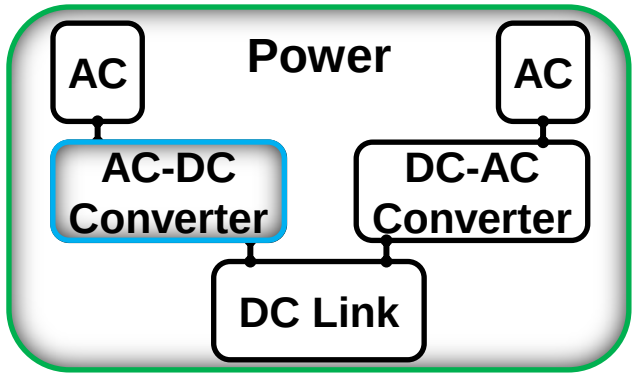
Simscape Electrical

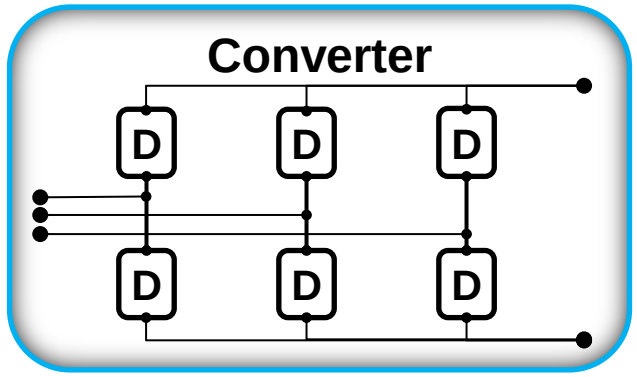
Simscape Electrical Simulation Modes

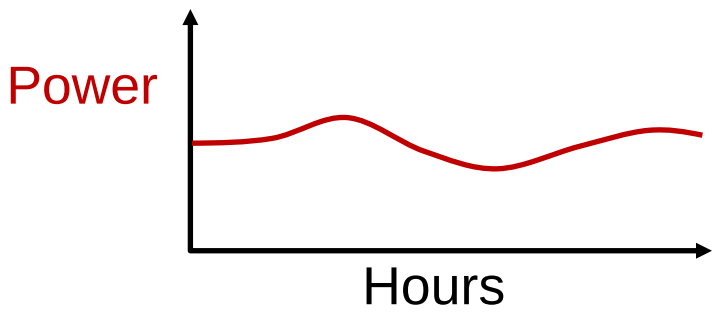
Different Fidelities for Different Tasks

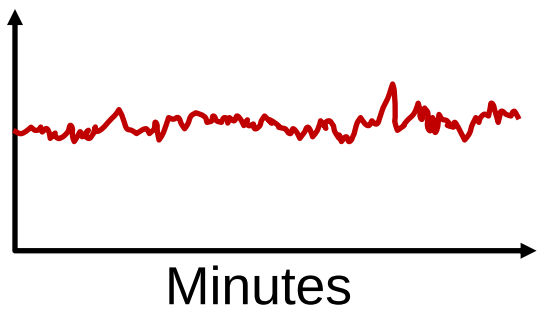
	System-Level Behavior	Component Validation	Component Design
Electrical	Determine power requirements Evaluate system-level response Measure efficiency	Stay within design envelope Effect of switching dynamics	Losses during switching events Analyze & predict fault behavior

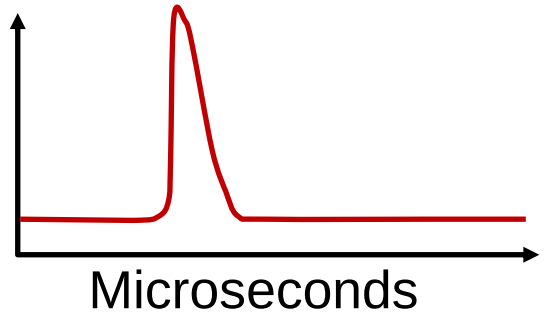






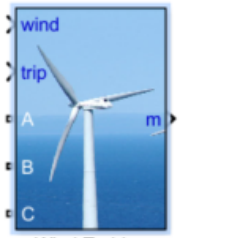




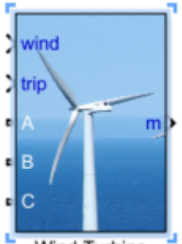


Built-in Renewable Energy Models with Simscape Electrical

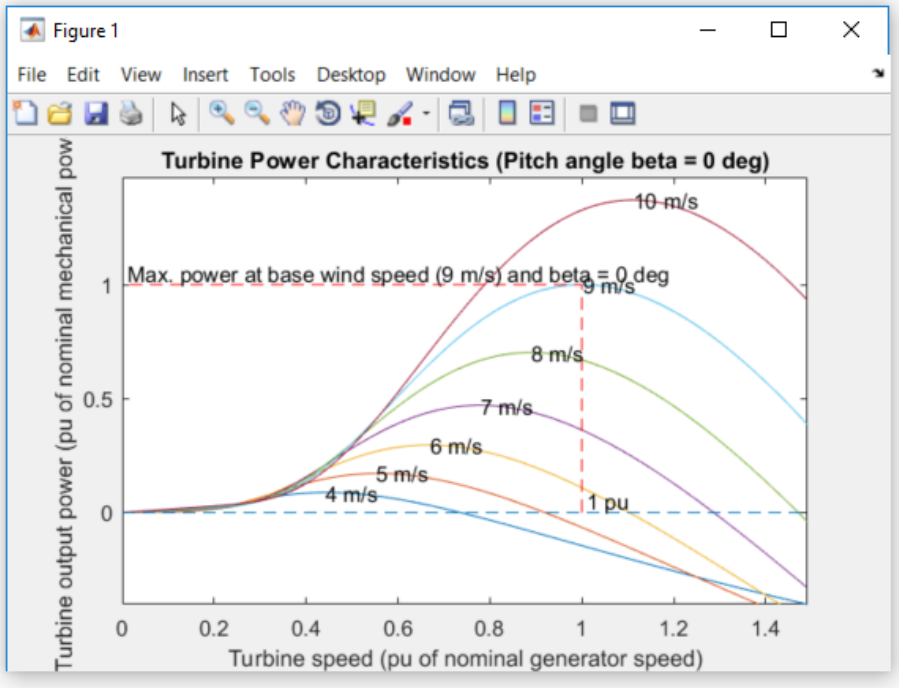
Wind, Solar, Energy Storage, etc.

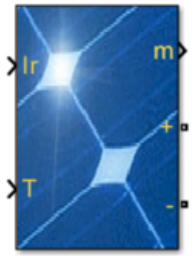


Wind Turbine
Doubly-Fed Induction Generator

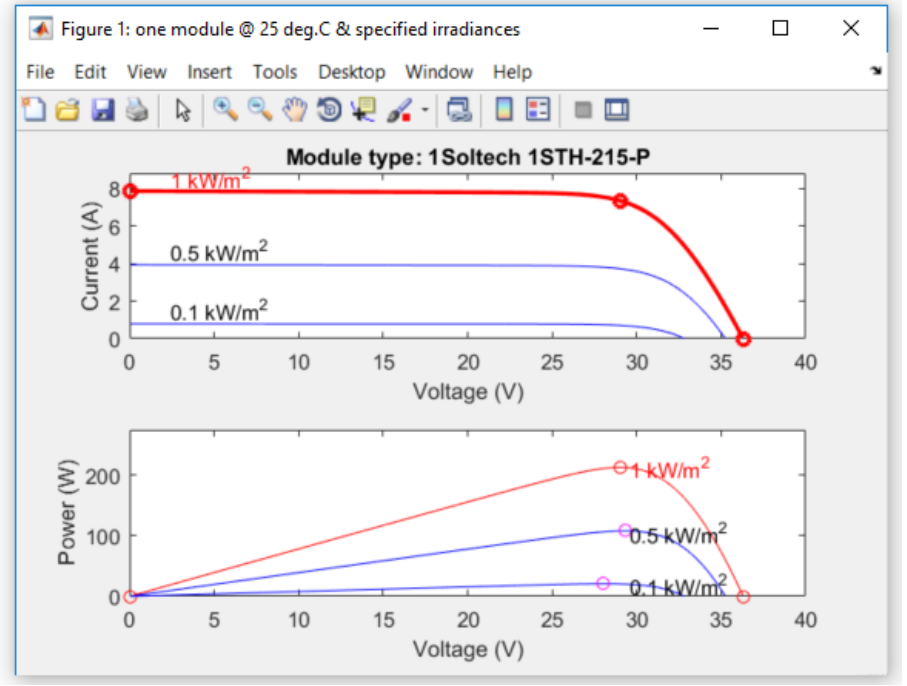


Wind Turbine
Induction Generator



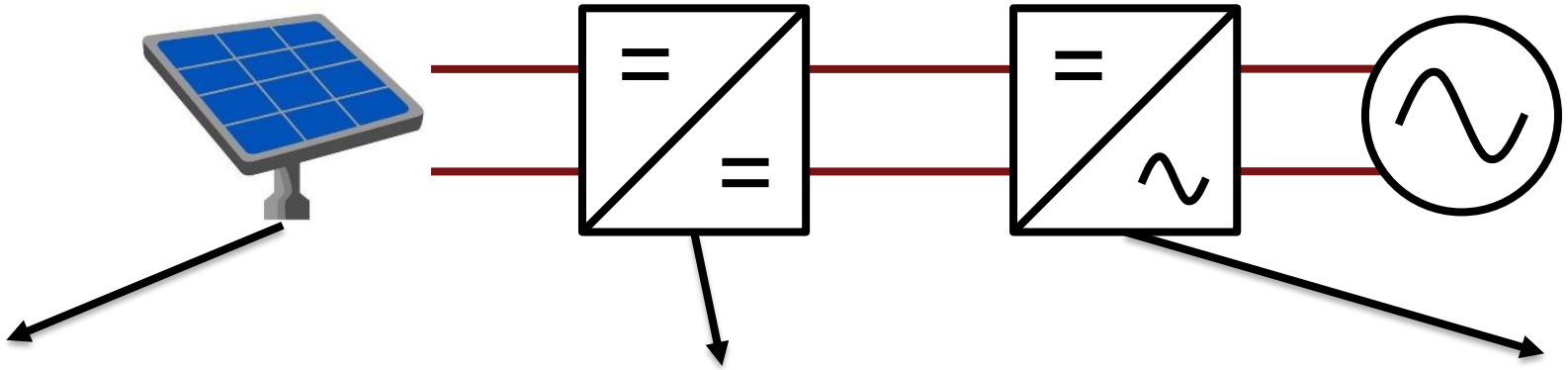


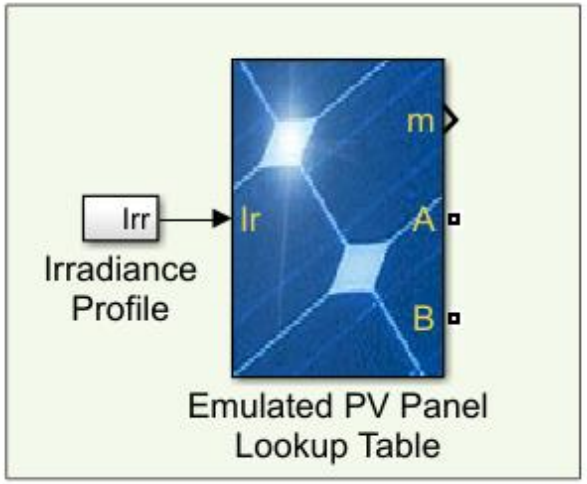
PV Array

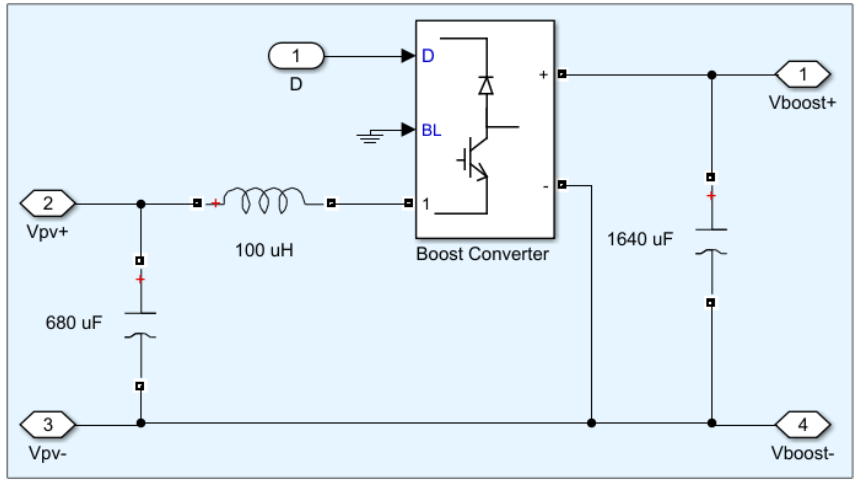


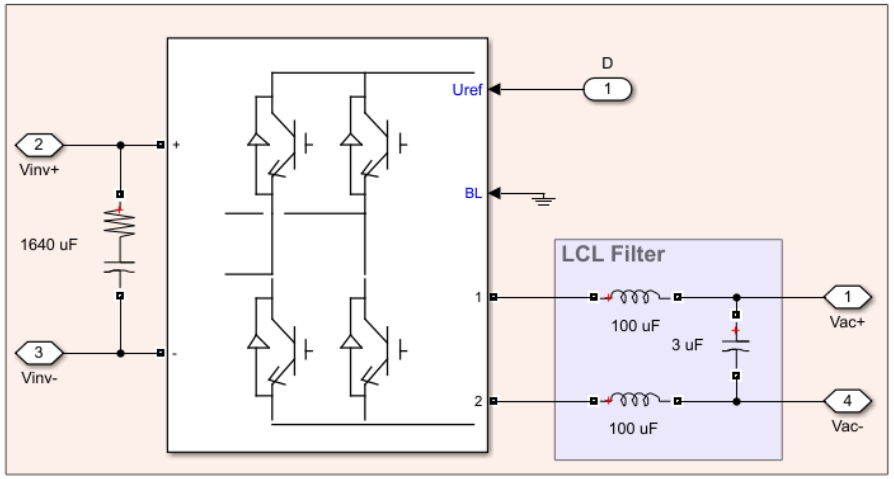
Example Solar Inverter Simulation – For Equipment Design

Inverter Designers Leverage Proprietary Control









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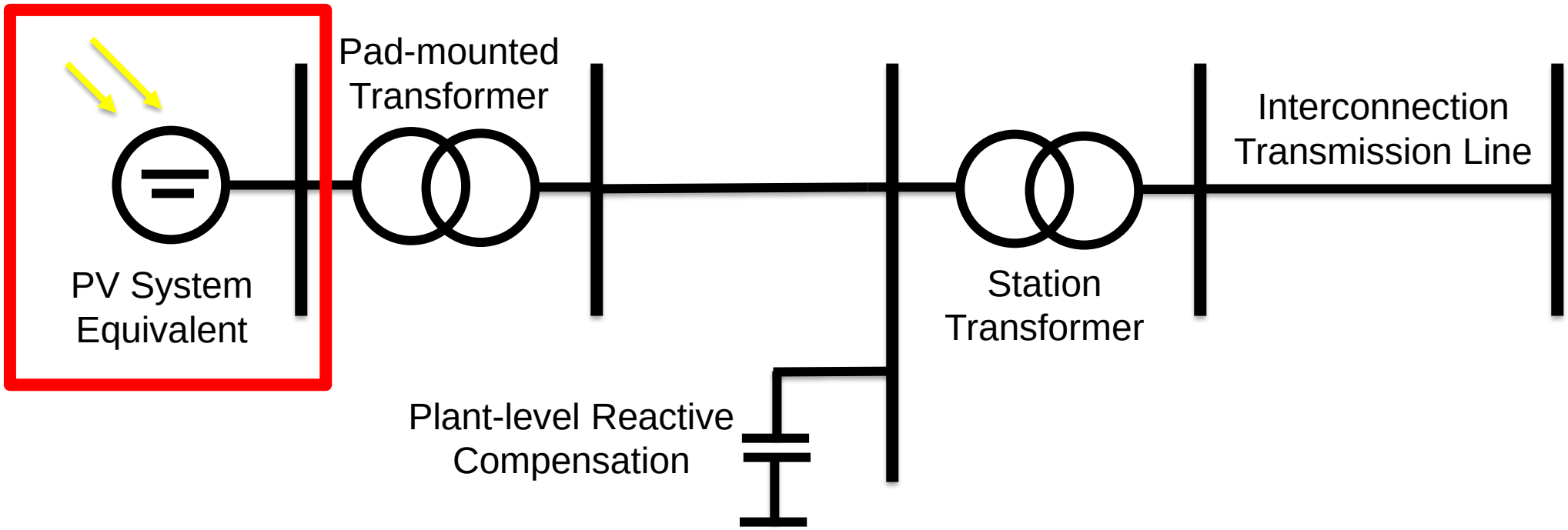
Central Station Solar Plant One-line Diagram and Controls

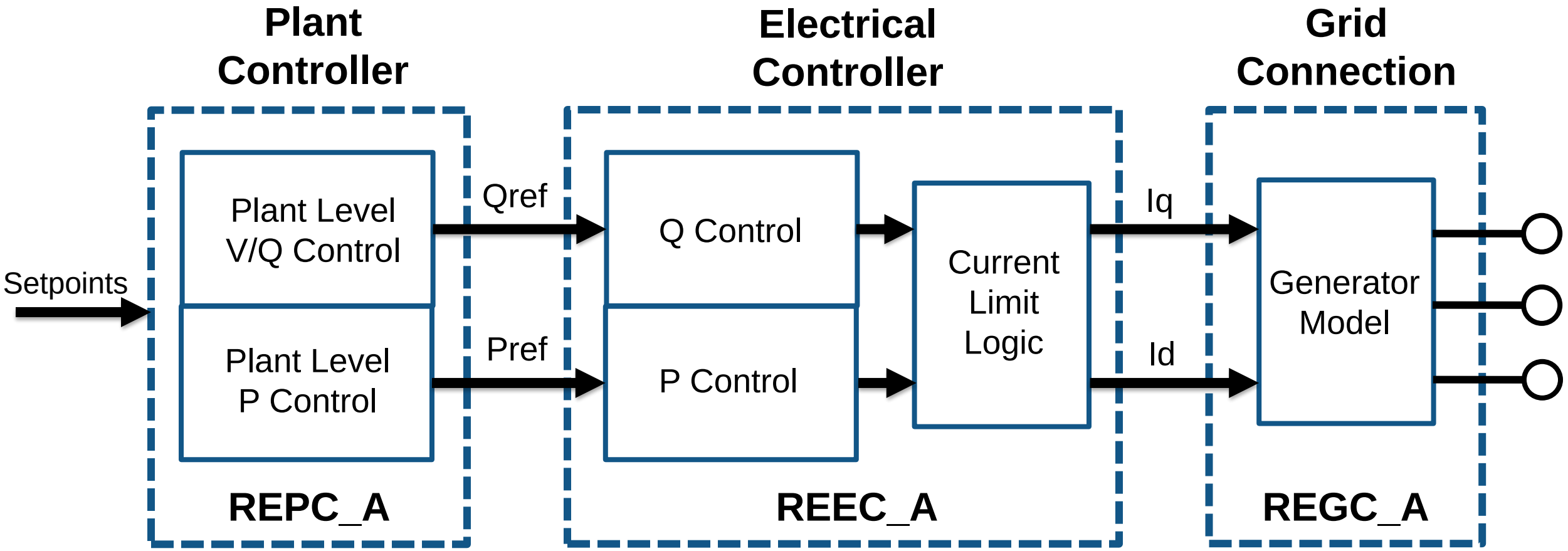
For Grid-scale System-Studies and Validation



System-Level Study

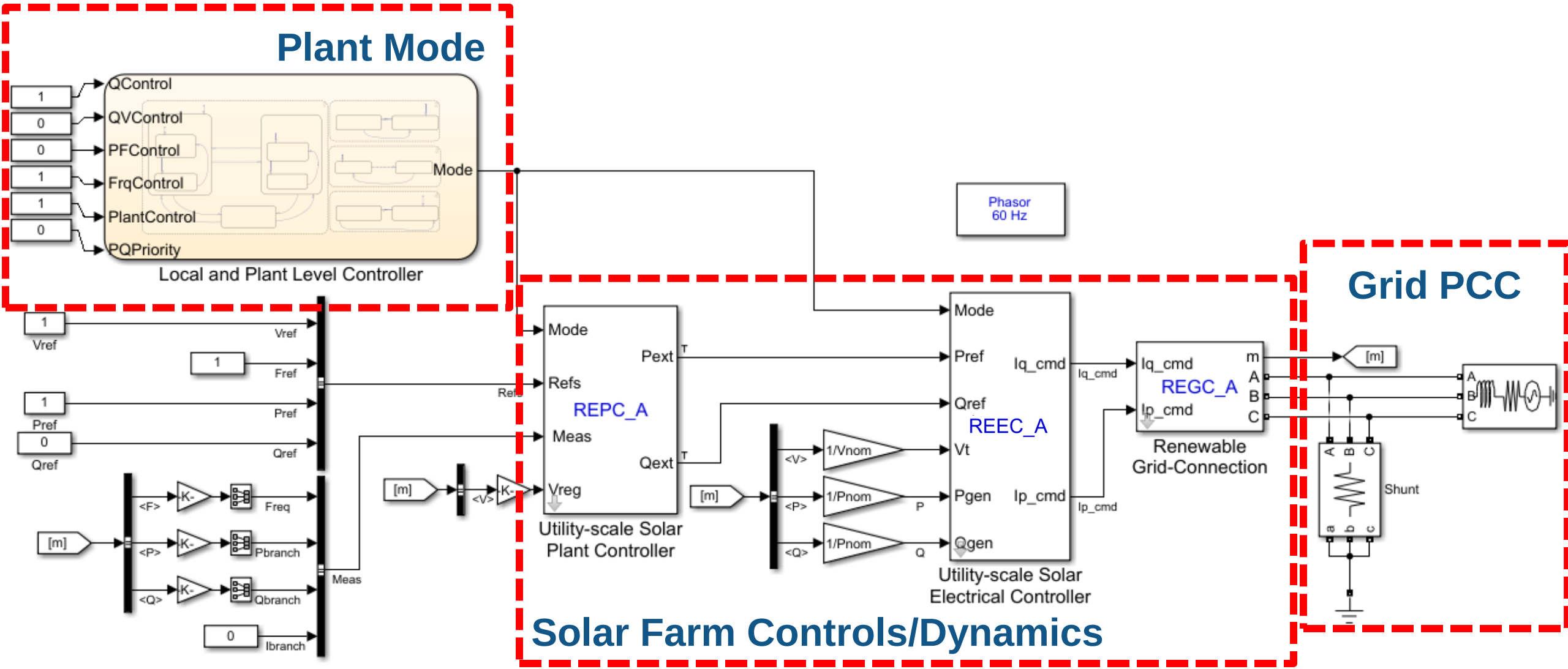
Central Station Solar Plant One-line Diagram and Controls

IEEE Standardized Controls for System-Studies and Validation



Central Station Solar Plant in Simscape Electrical

IEEE Standardized Controls for System-Studies and Validation



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Power Plant Model Validation Workflow

1 Access Test Data

Files

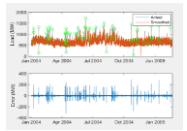
Databases

PMUs

2 Preprocess Data

Format Data for Easy Import

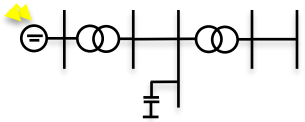
Clean up Noisy Data



Import Current Parameters

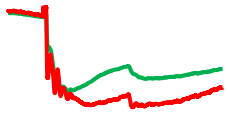
3 Develop Power System Model

Build Renewable Model



Voltage/Frequency Replay for Data

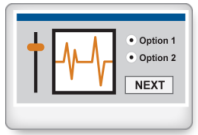
Setup and Run Loadflow



4 Model Validation for Power Systems

Manual Tuning of Parameters

Setup Parameter Estimation



Parameters for Automated Tuning

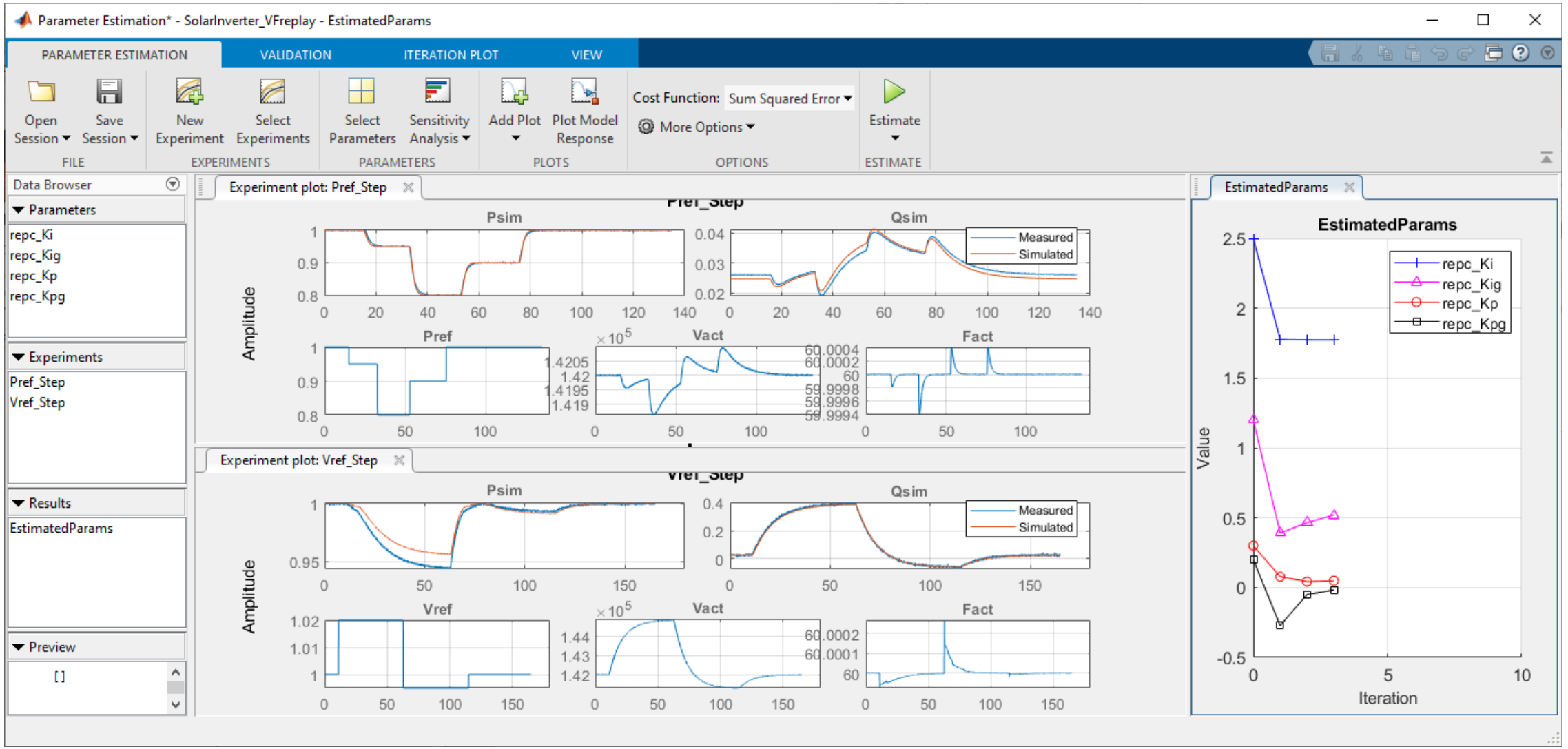
5 Leverage Calibrated Models

Export Parameters for Other Tools

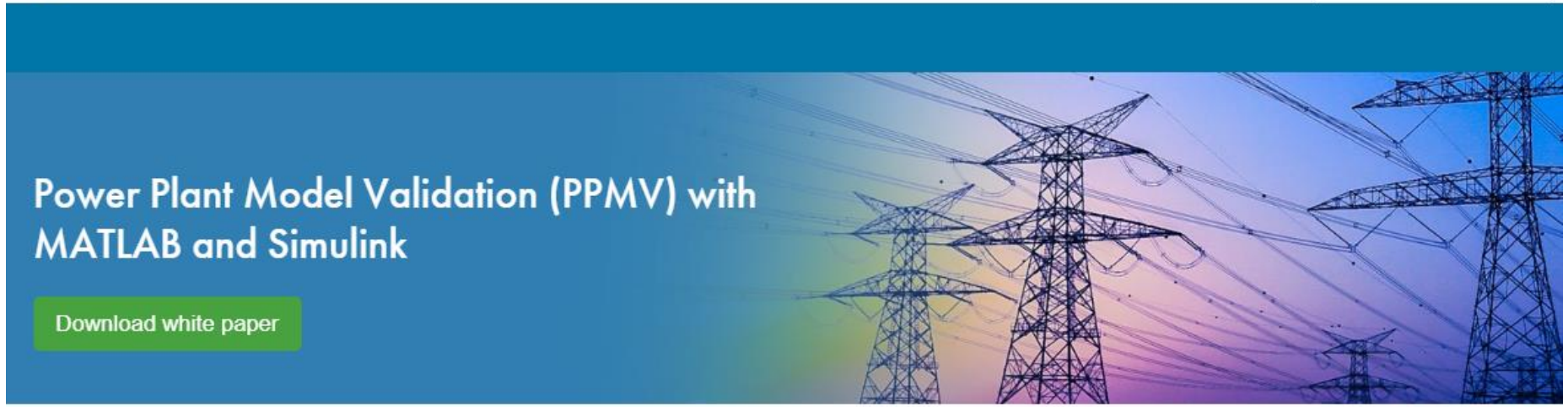
Regulatory Compliance

Digital Twin of Renewable System

Parameter Estimation for Multiple Grid Tests



MathWorks



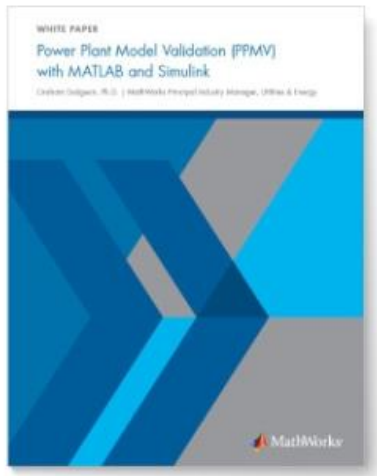
Learn how to create a workflow for power plant model validation using manual and automated techniques. This approach to PPMV is especially important when required by technical regulations such as NERC MOD-026.

Explore PPMV as applied to online performance monitoring of grid events using PMU data and a workflow that includes both manual adjustments and automated techniques.

Through a gas plant case study, you will learn how to:

1. Replay measured data through your simulations
2. Gain insight into response discrepancies through both VF and PQ replay
3. Use automated parameter sensitivity to assess and rank the influence of system parameters on system response
4. Fine-tune your system response using both manual adjustments and automated parameter estimation

Download this white paper to learn how you can efficiently perform PPMV with MATLAB® and Simulink®.



https://www.mathworks.com/campaigns/offers/power-plant-model-validation.html