MATLAB EXPO 2017
KOREA

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등록 하기 matlabexpo.co.kr

Power Electronics Design and Simulation with Simscape Power Systems

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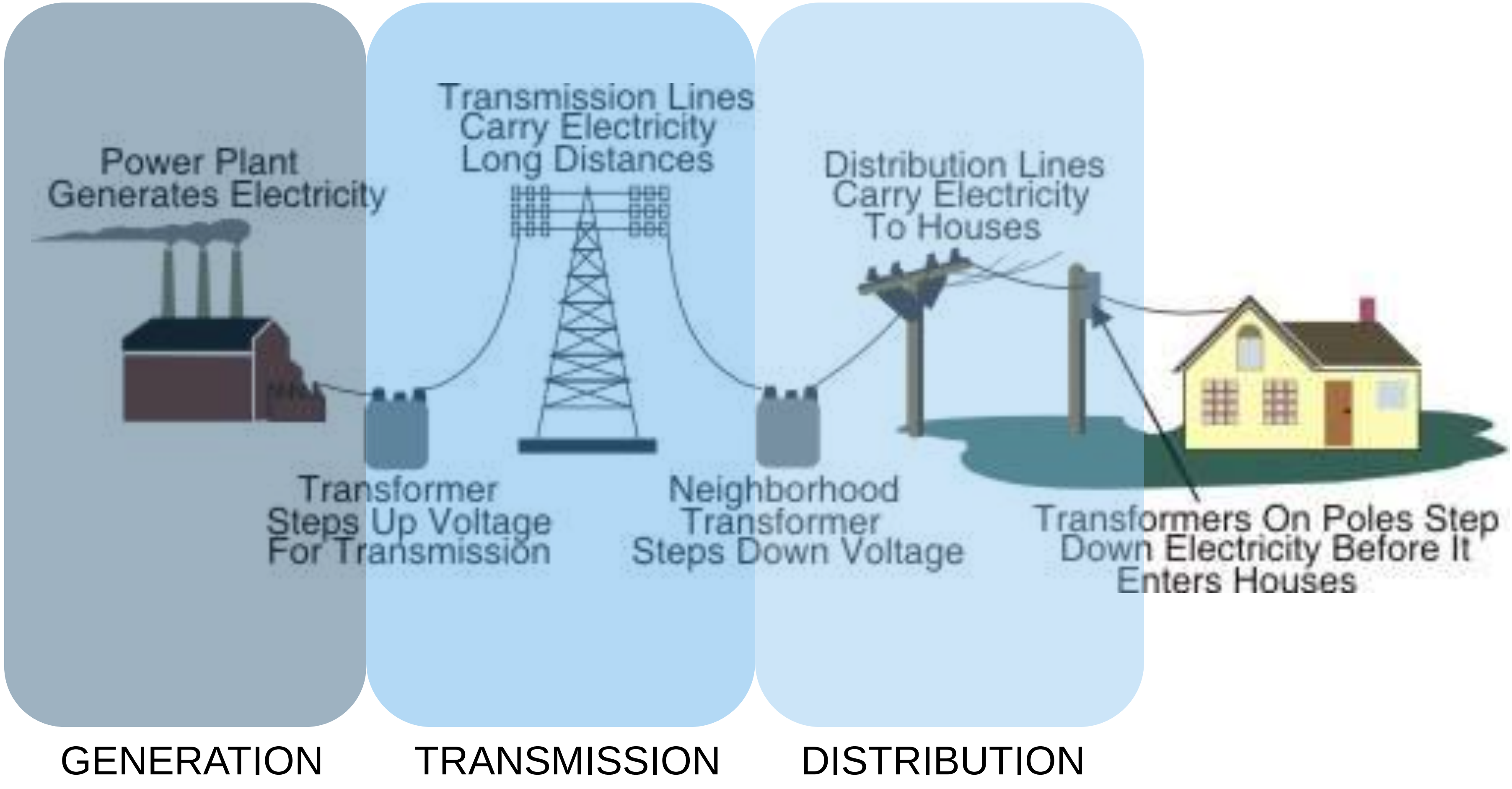
Application Engineer
MathWorks Korea

Electrical Power System



Industry Needs of Power Electronics

- Technology for the control and conversion of electric power
- One of main technology to overcome energy problem
- Key factor is energy conservation through high efficiency

Diverse User in Power Electronics

OMRON

Sandia National Laboratories

Power Electronics

ABB

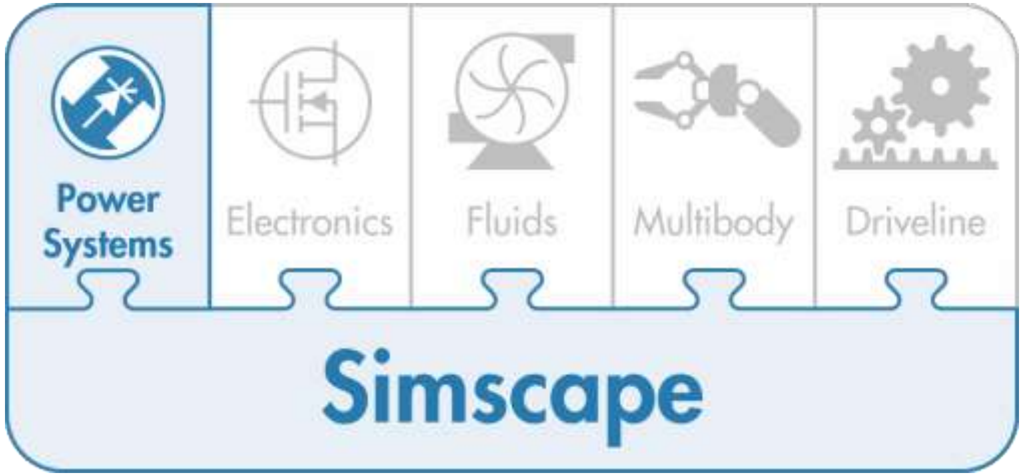
Alstom Grid

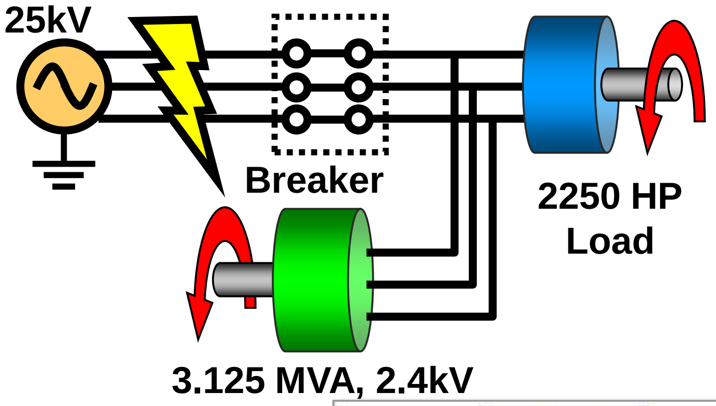
Introduction to Simscape Power Systems

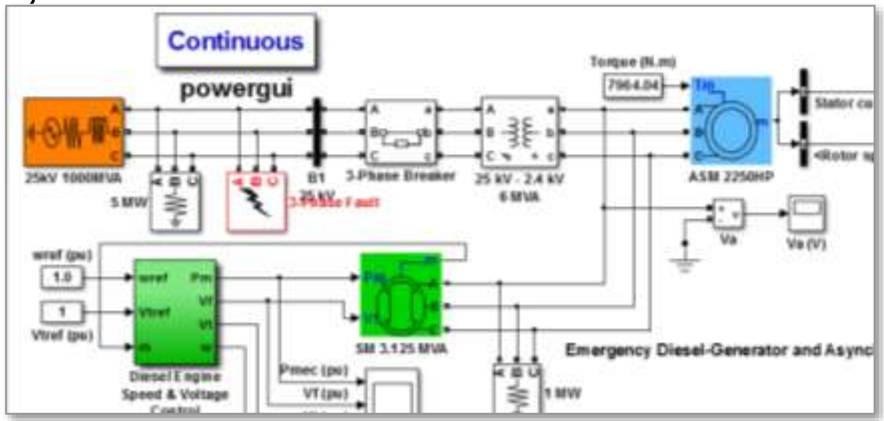
- Enables physical modeling (acausal) of electrical power systems and electric drives

- Electrical system topology represented by schematic circuit

- Used by electrical, system and control engineers to develop plant models and test control systems



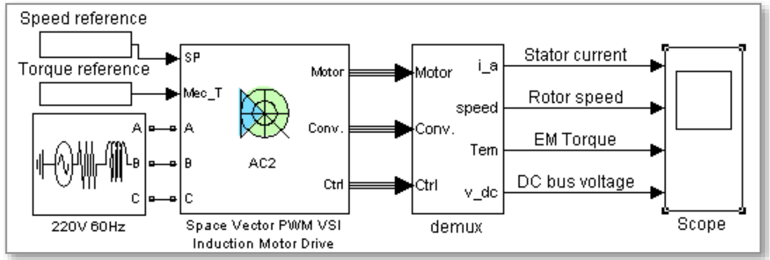


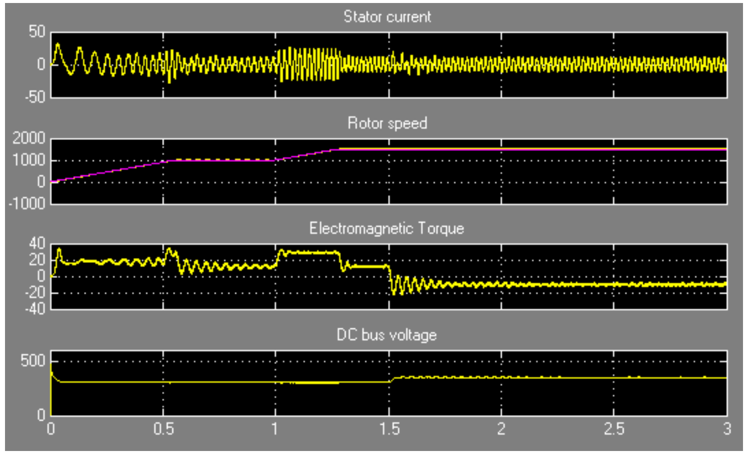


Working with Simscape Power Systems

Simscape Power Systems is a tool for modeling the generation, transmission, distribution, and consumption of electrical power

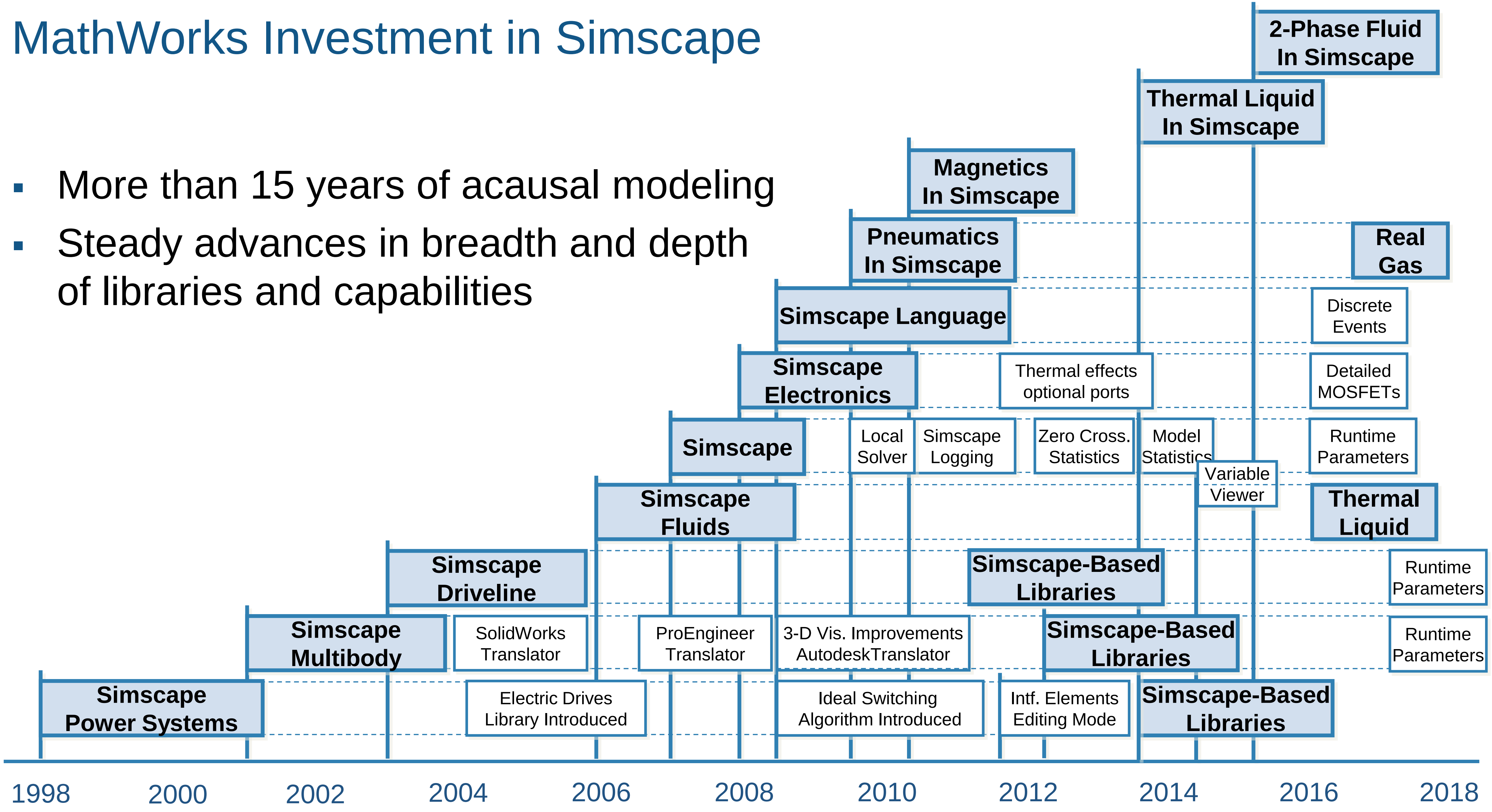
- With Simscape Power Systems you can:
  - Quickly build electrical power system models
  - Model synchronous and asynchronous electric drives
  - Perform common electrical system analysis tasks
  - Develop and test controls
  - Generate code for improved performance





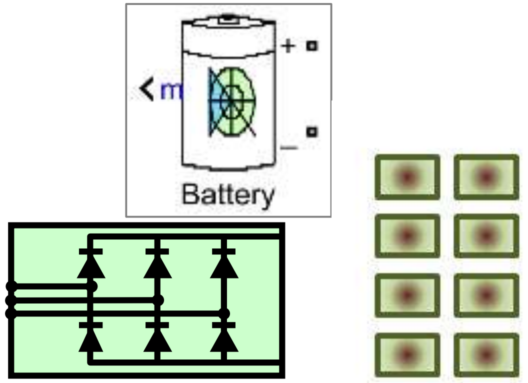
MathWorks Investment in Simscape

- More than 15 years of acausal modeling
- Steady advances in breadth and depth of libraries and capabilities

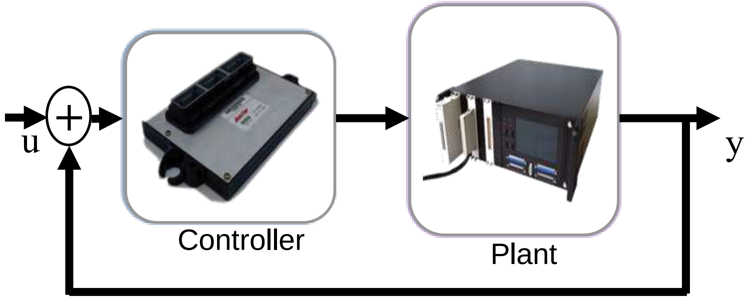


Key Points

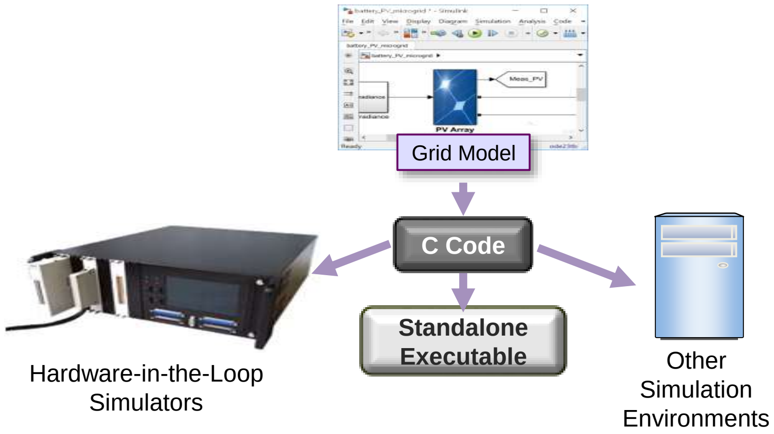
- Physical component models at various levels of fidelity are necessary for Power Electronics



- Modeling the plant and controller in a single environment enables system level optimization



- Deploy the model as C code to other simulation environments, or use it as a standalone executable



Agenda

- Modeling electrical and electronic components
  - Modeling Electrical Circuit : Buck Converter
  - Battery Modeling using Simscape Power Systems
- Designing control algorithms
- Simulating in Real Time
- Summary

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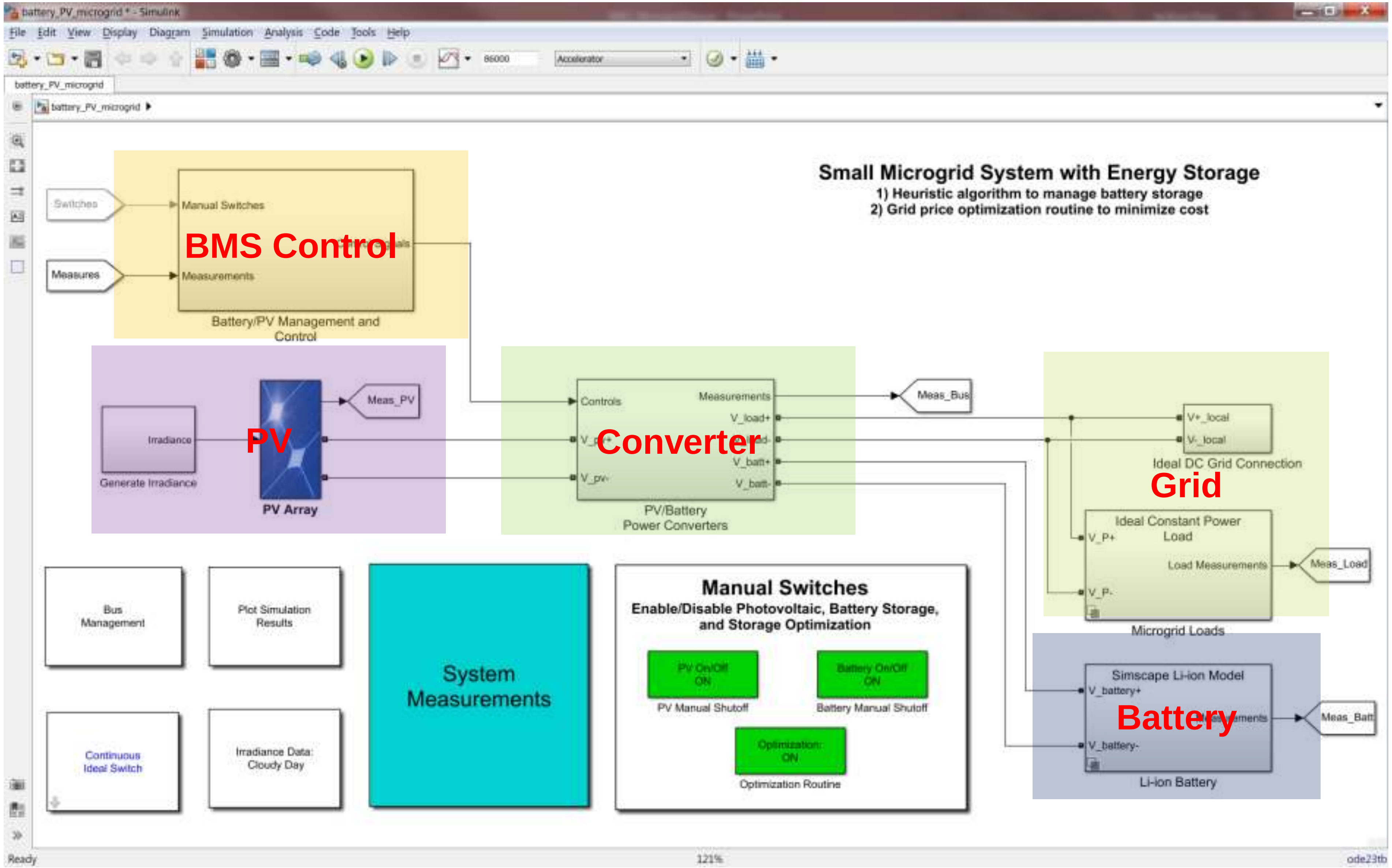
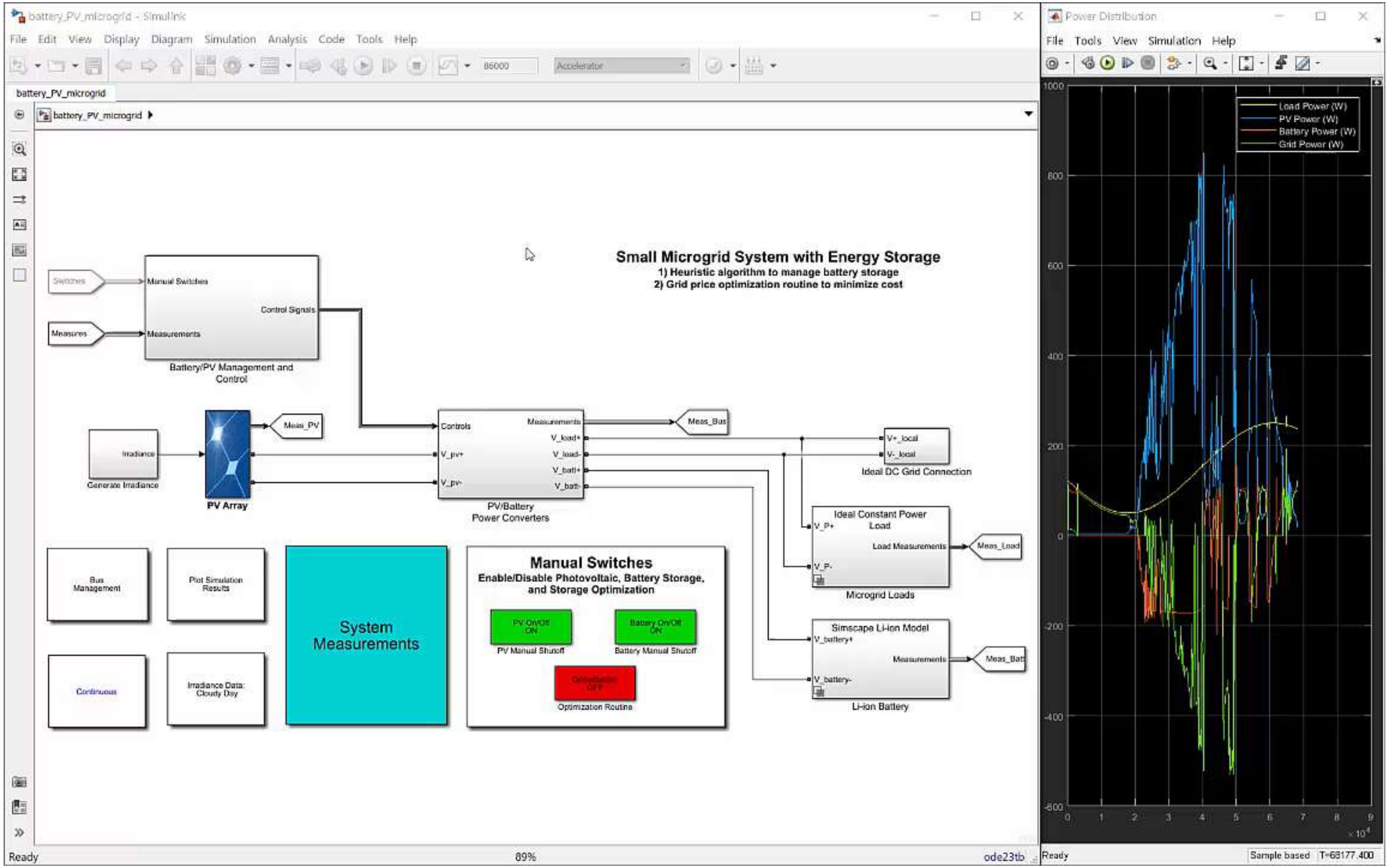
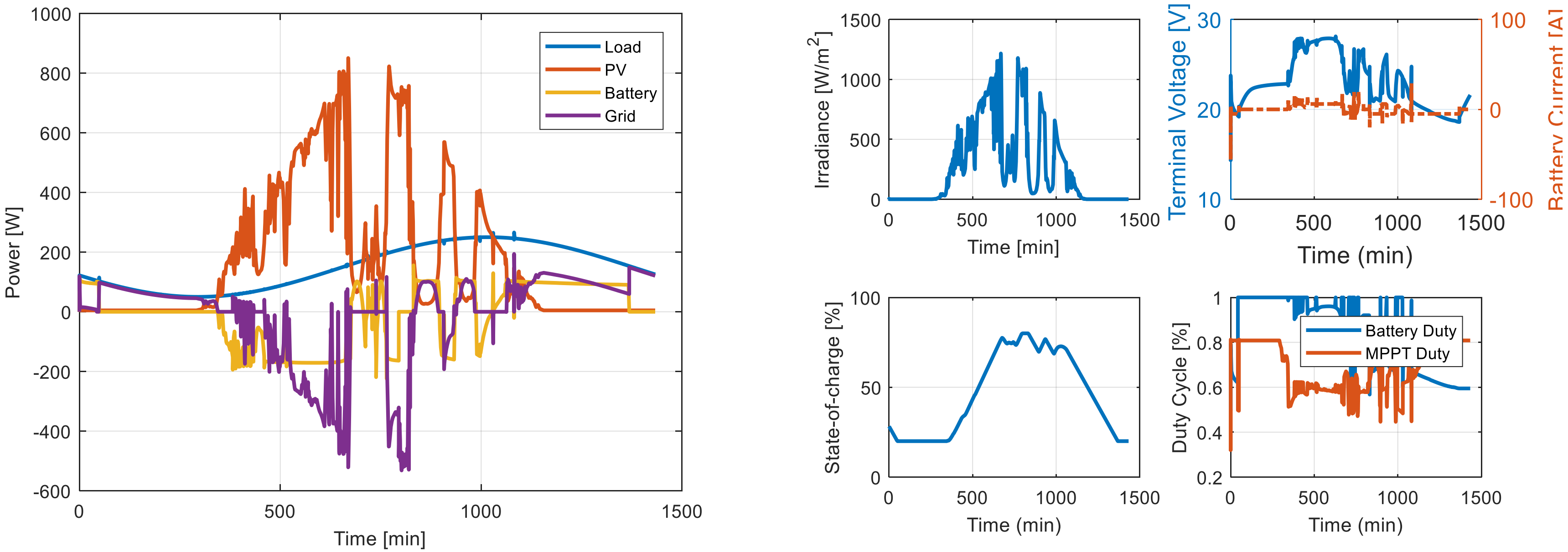
Demo : Small Microgrid System with Energy Storage



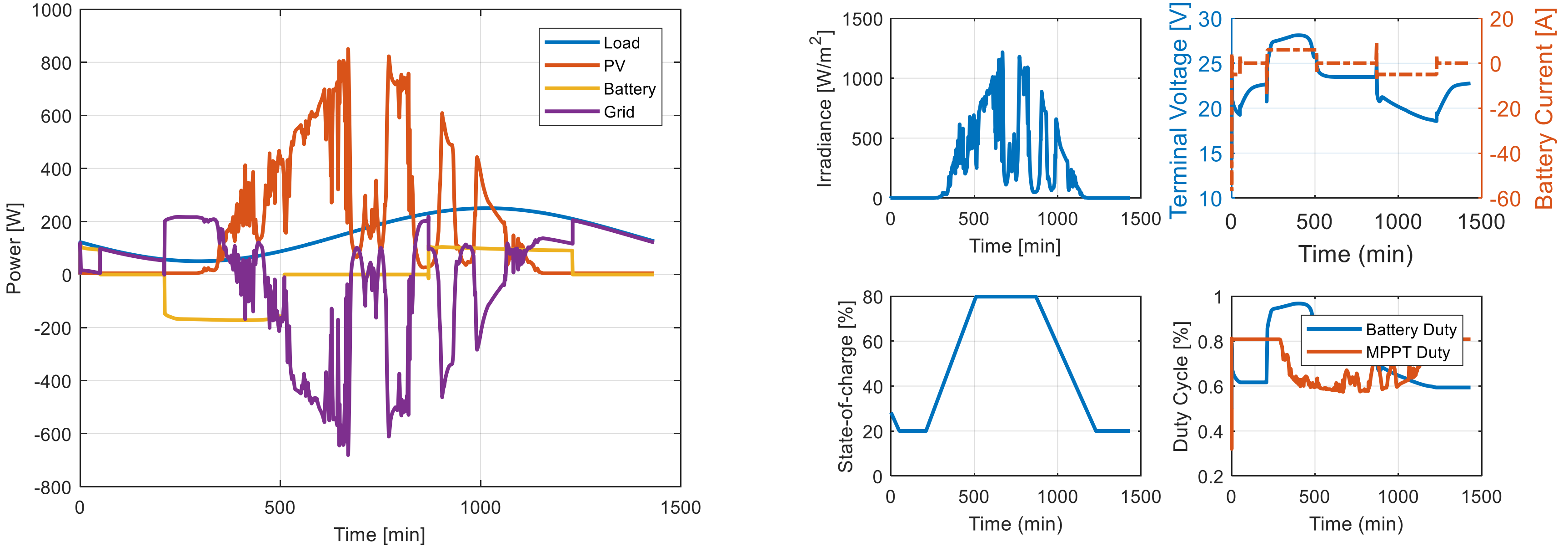
Small Microgrid System with Energy Storage



Heuristic Logic



Optimization Logic



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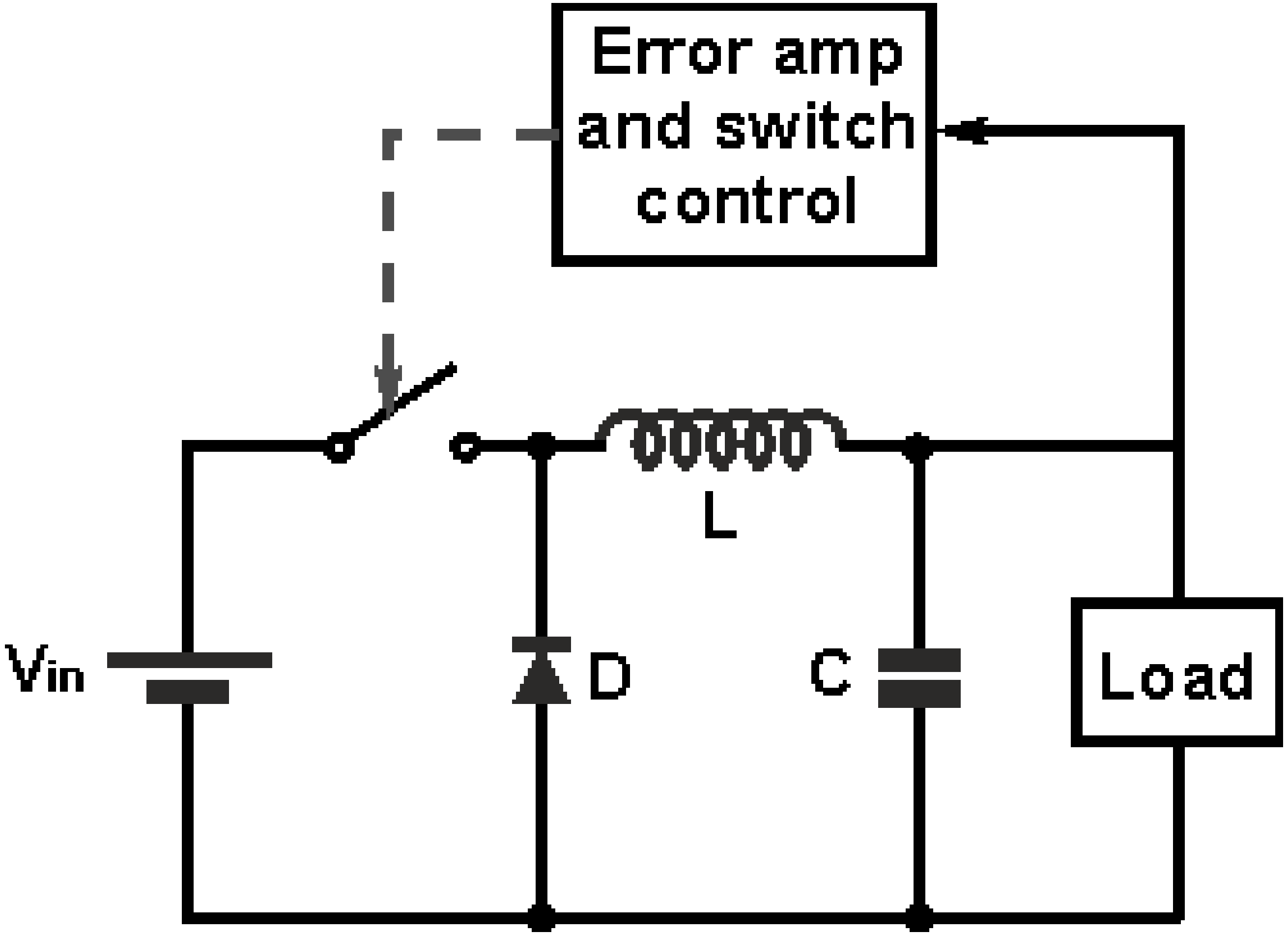
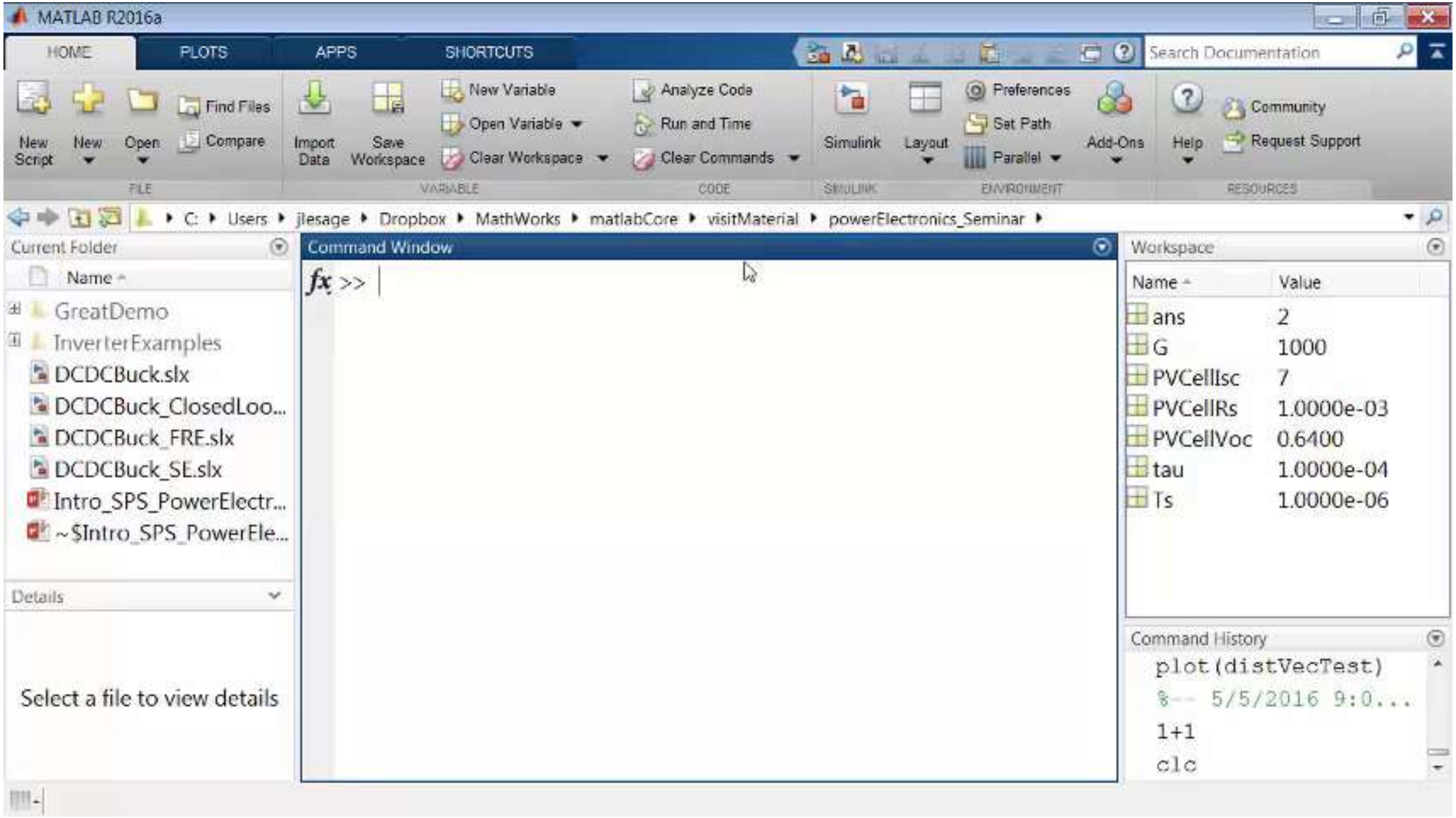
DC-DC Converter (Buck Converter)



High DC Voltage → Low DC Voltage

Modeling Electrical Circuit – Buck Converter



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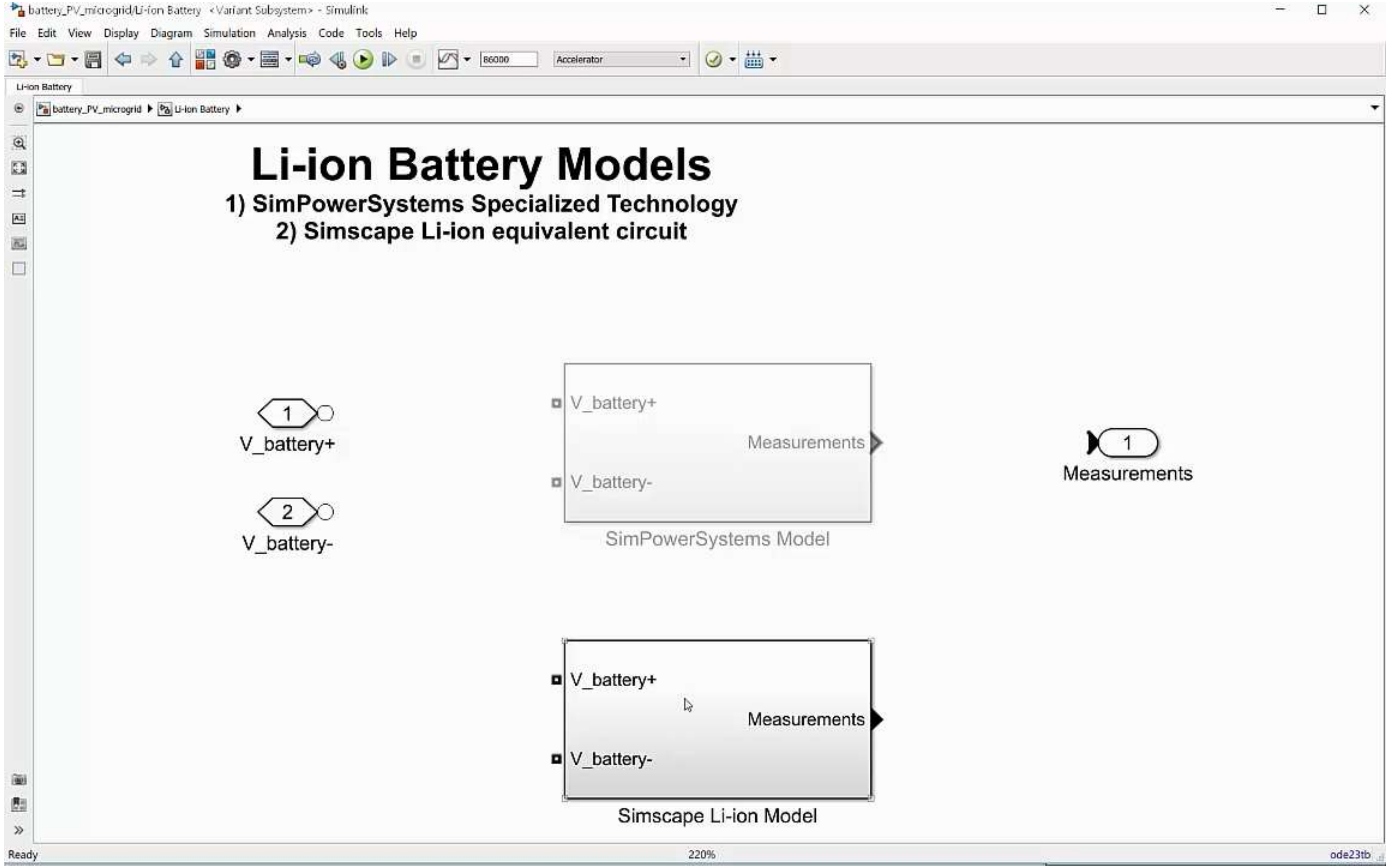
Battery Modeling using Simscape Power Systems

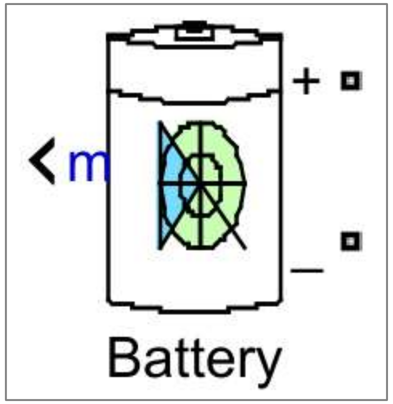


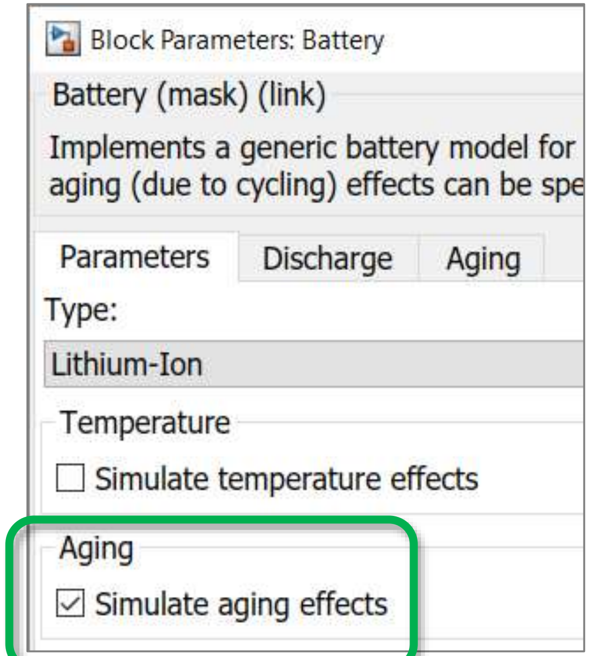
Simscape Power Systems ST

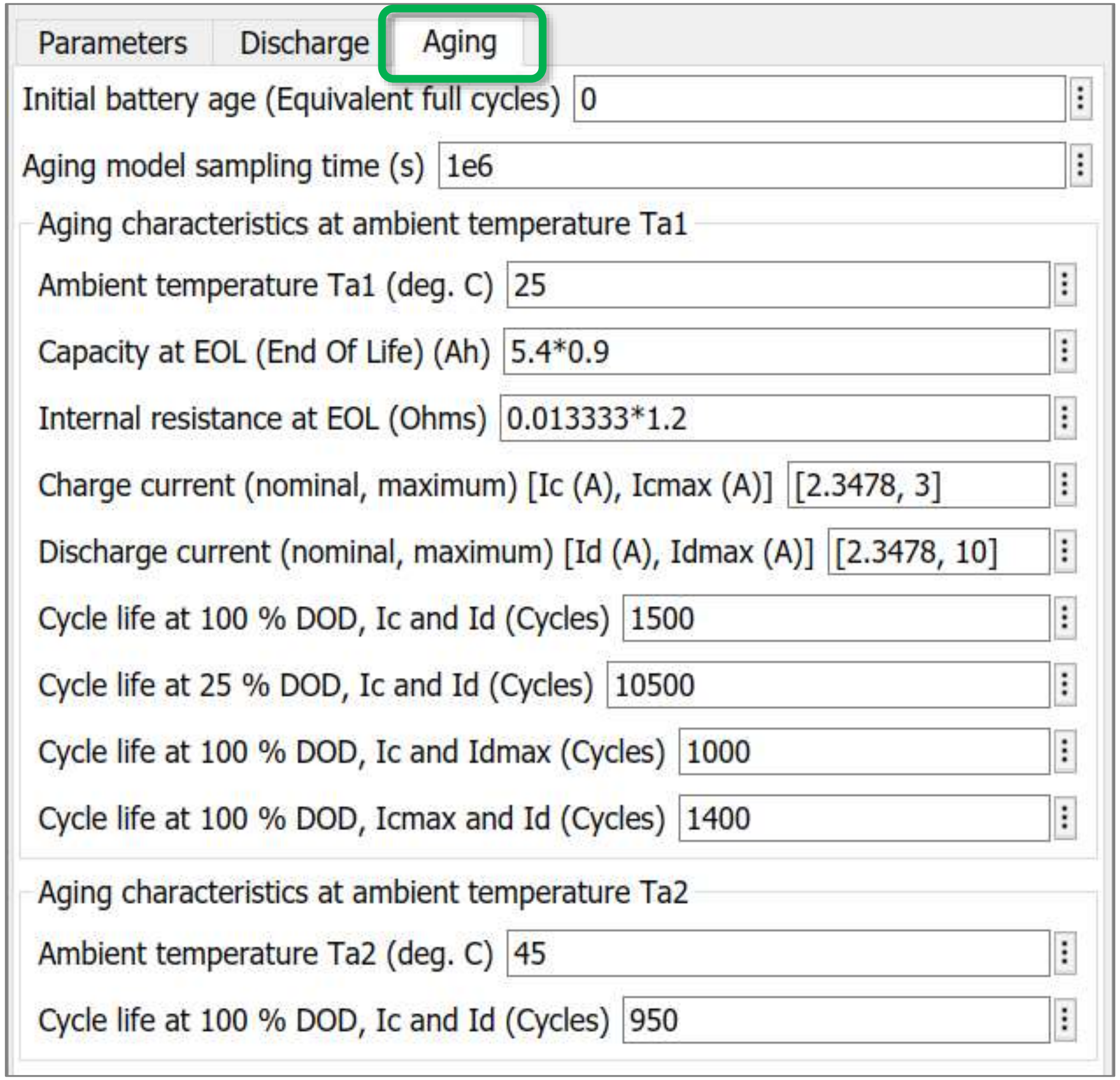
Lithium-Ion Battery Aging Model

R2017a New Feature

- Model the lifetime performance of a battery storage system
  - generic aging model with parameters tha t can be obtained from manufacturer dat asheets or simple experiments







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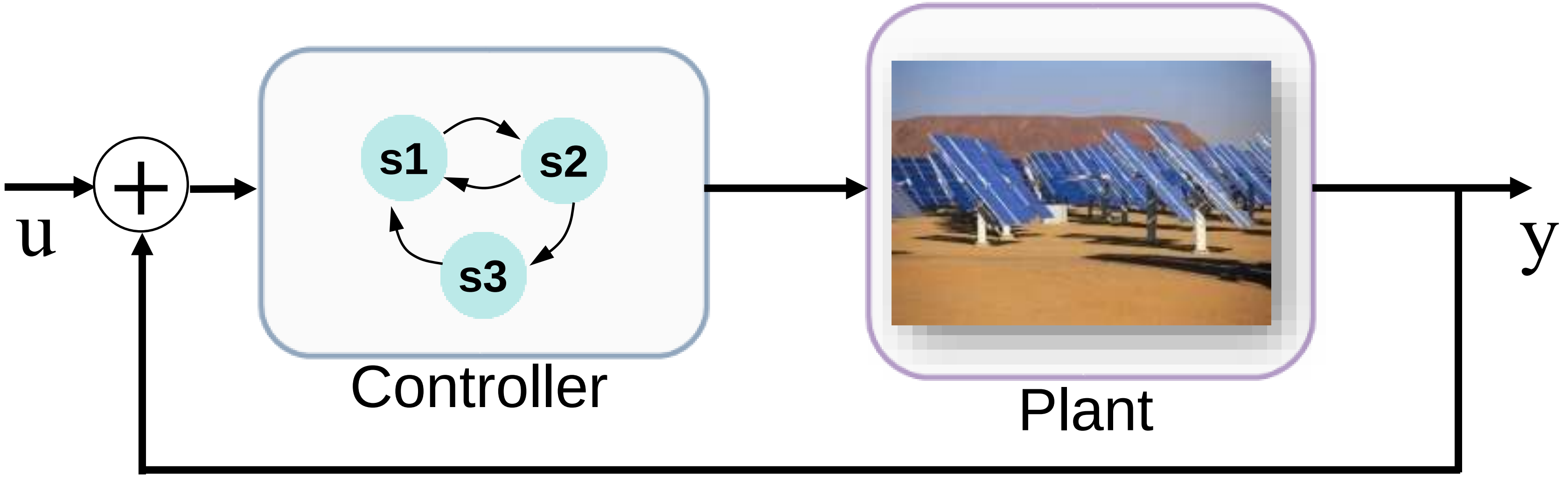
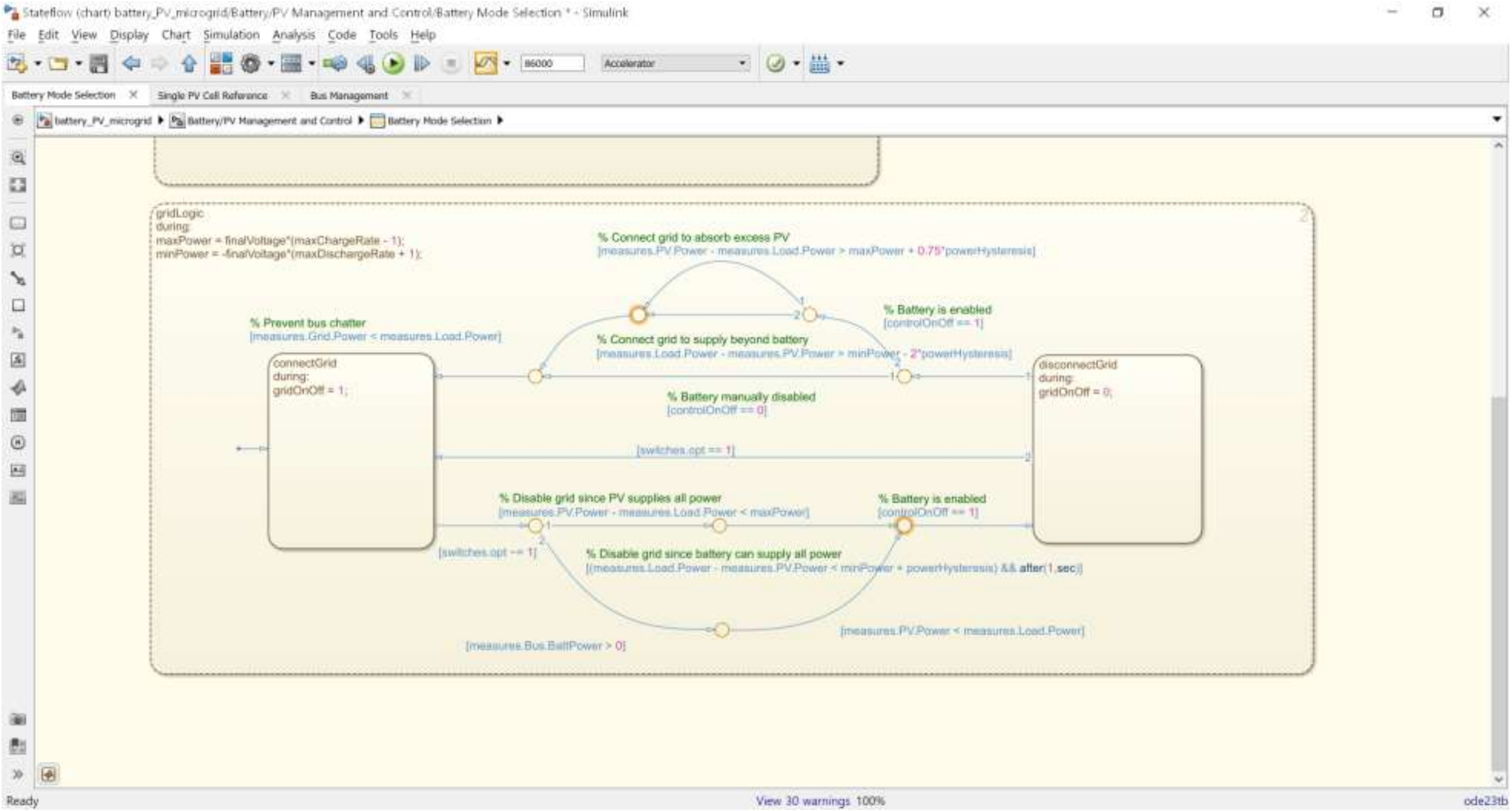
Designing control algorithms



Simulating plant and controller **in one environment** allows you to **optimize system-level performance**

– Automate tuning using optimization algorithms
– Accelerate process using parallel computing

Defining Control Logic for Battery Management System



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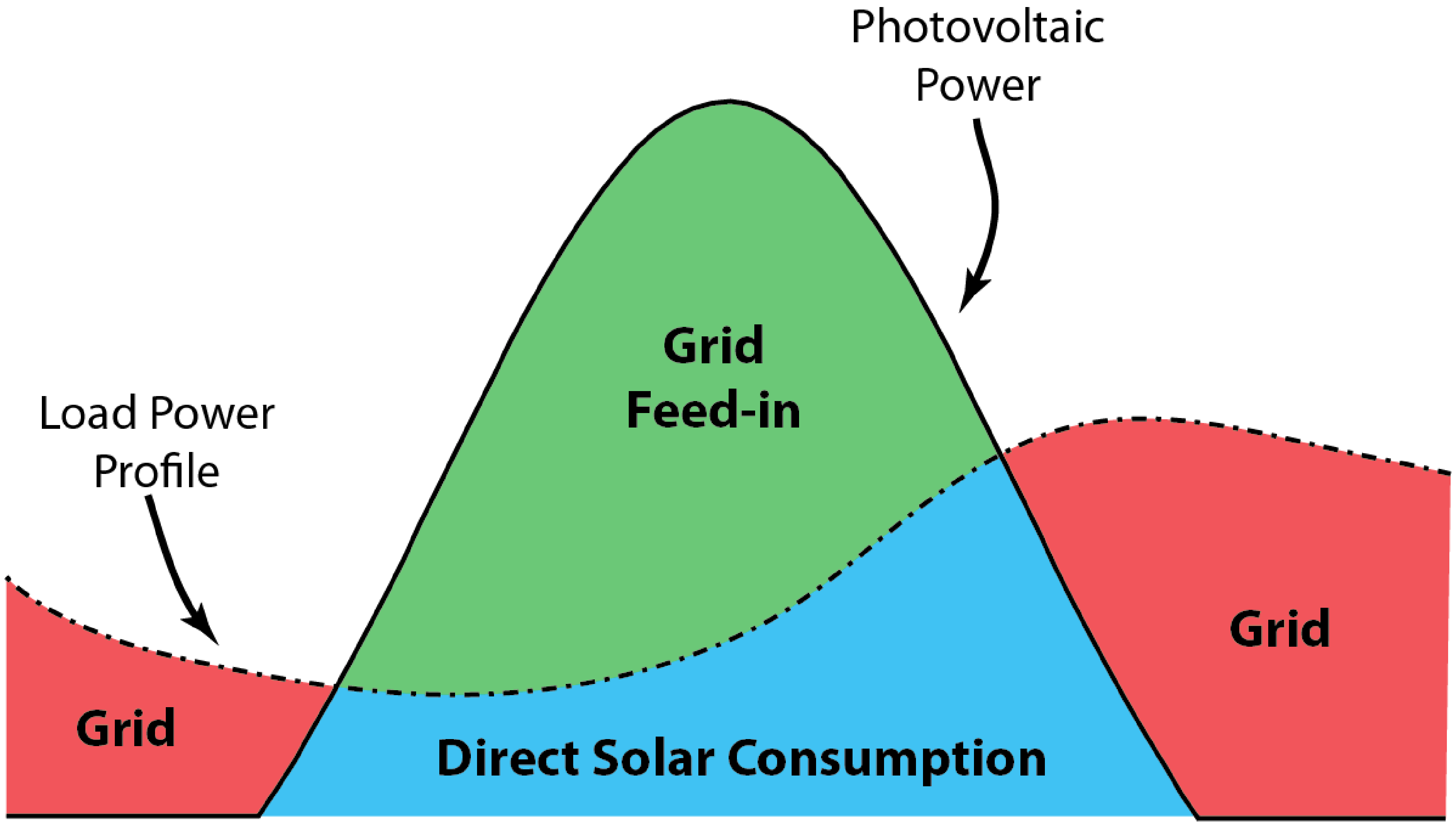
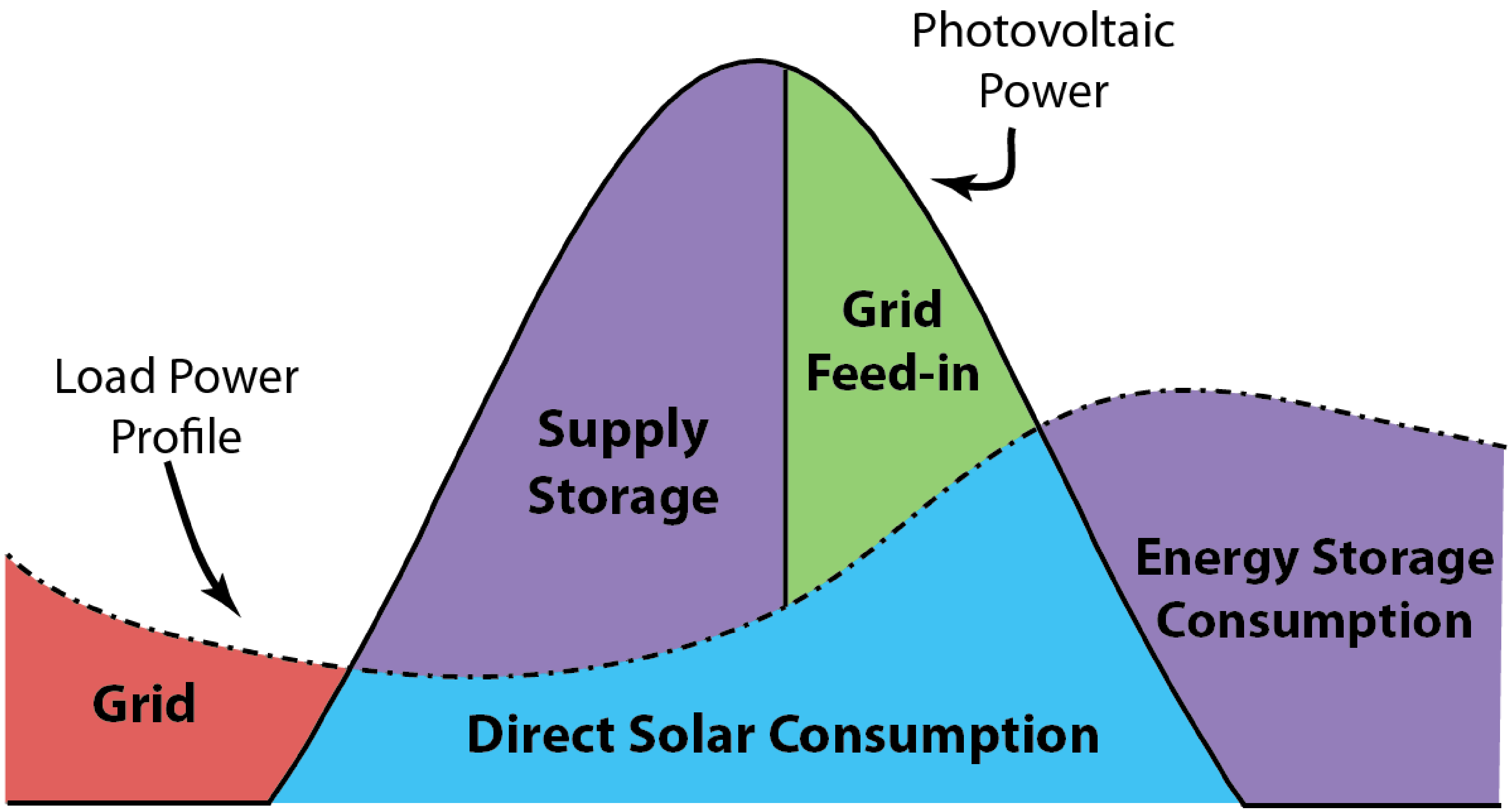


Adapted from: Smart EnergySystems Website
http://www.smart-energy.ag/products/ac-gekoppelte-speicherlosung-smartenergy-ac/?lang=en

Peak Demand Shift using Energy Storage



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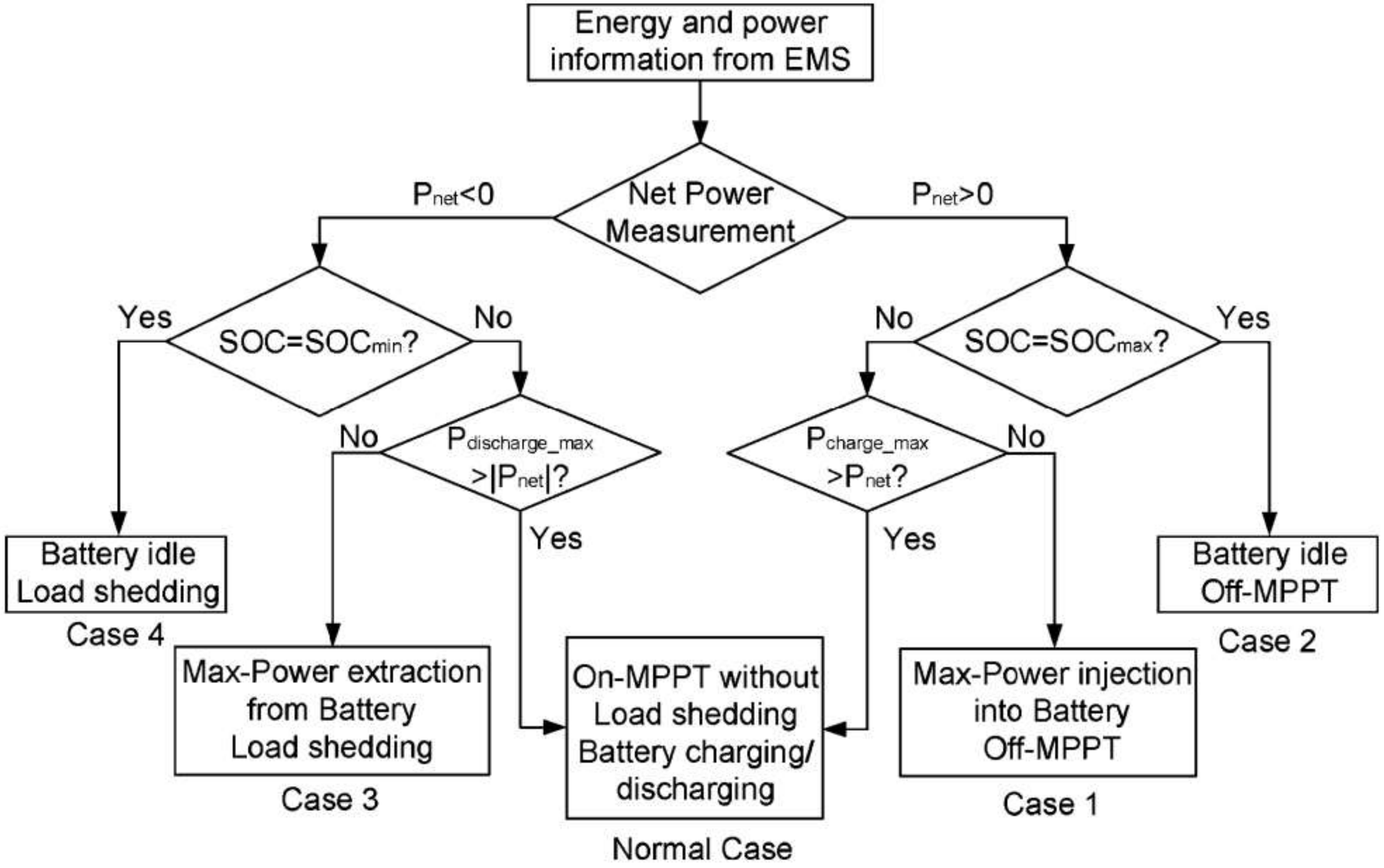
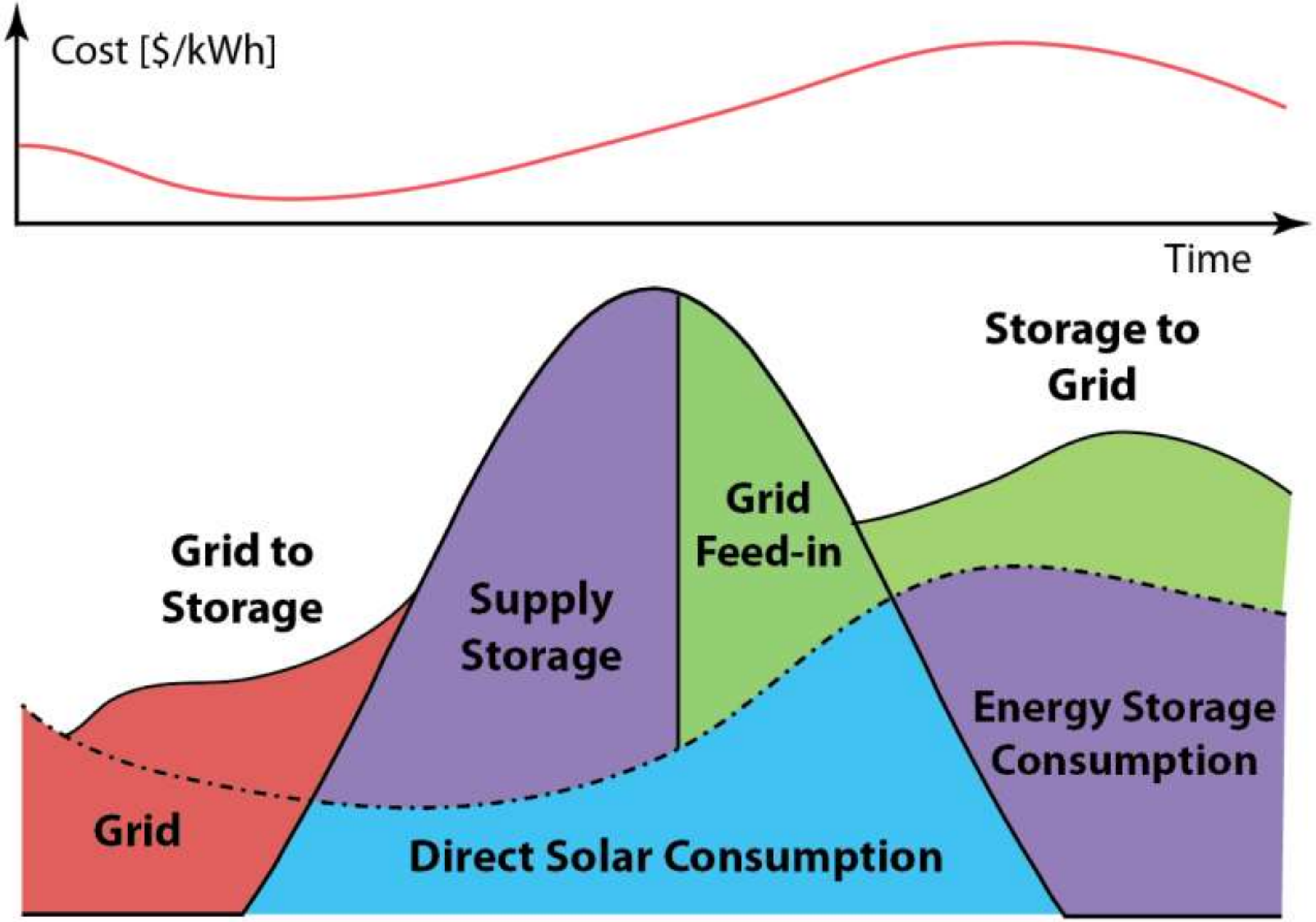
Implementation of Energy Management Logic



Ref: Liu 2011 - A Hybrid AC/DC Microgrid and Its Coordination Control

Factoring in Variable Electricity Cost



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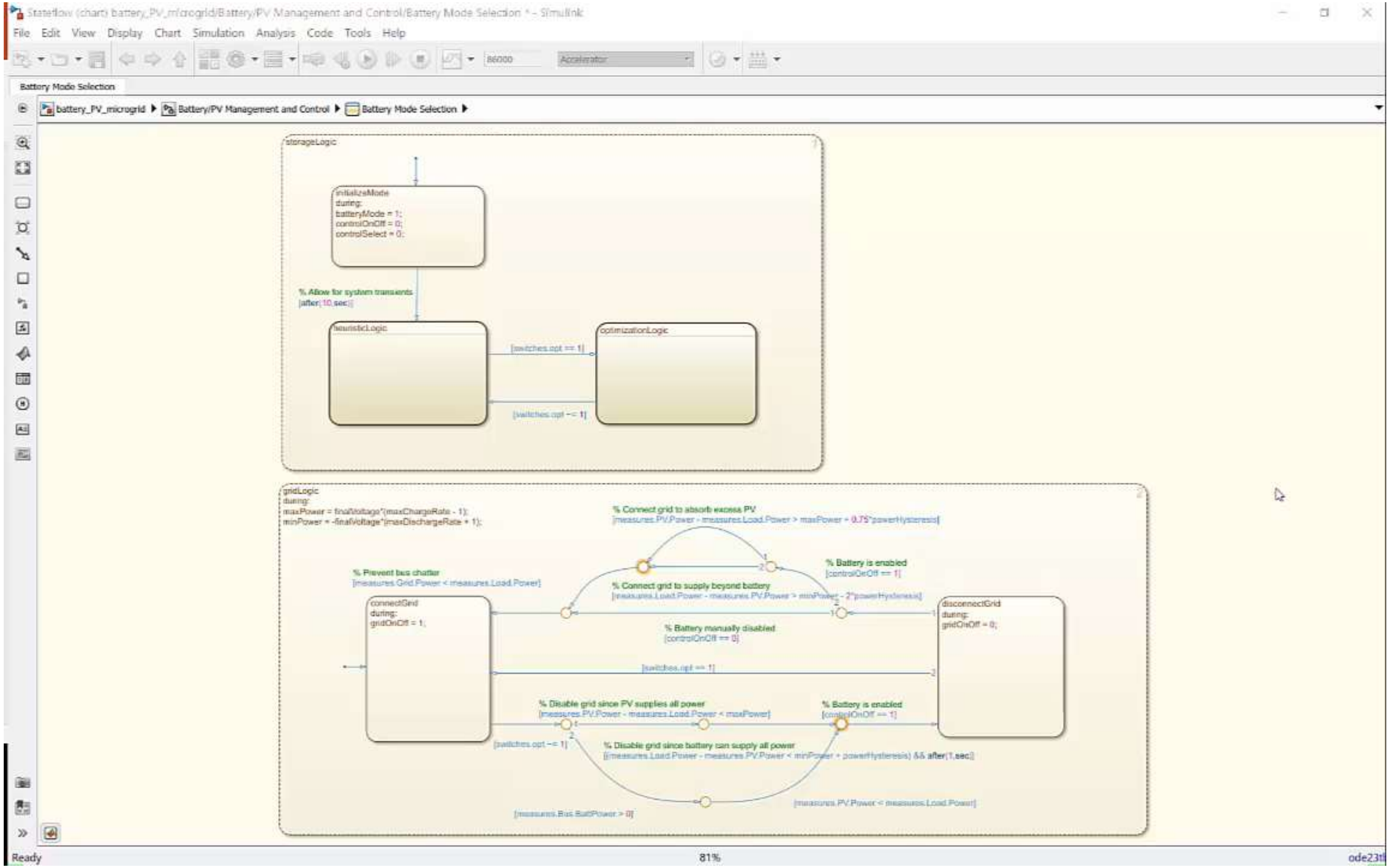

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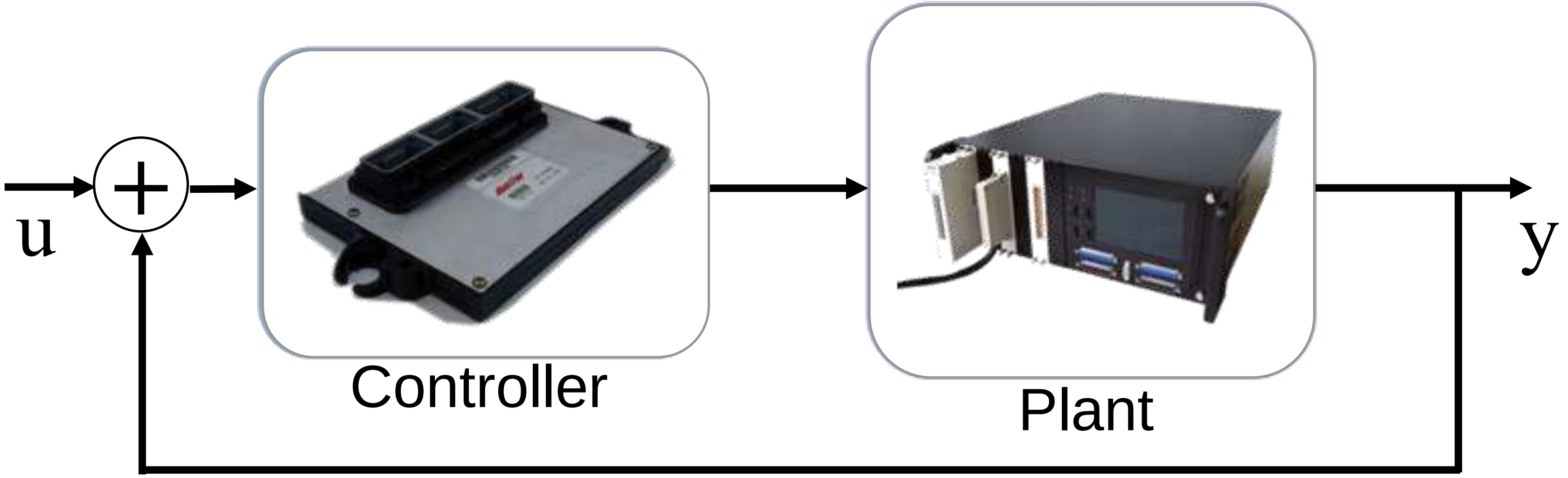
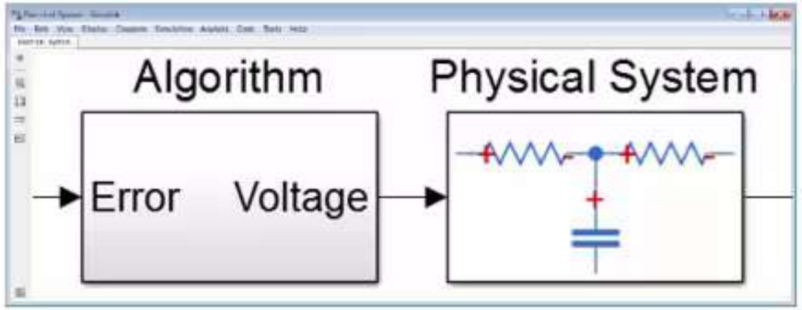
Detect Integration Issues Earlier



Controls engineers and domain specialists can work together to **detect integration issues in simulation**

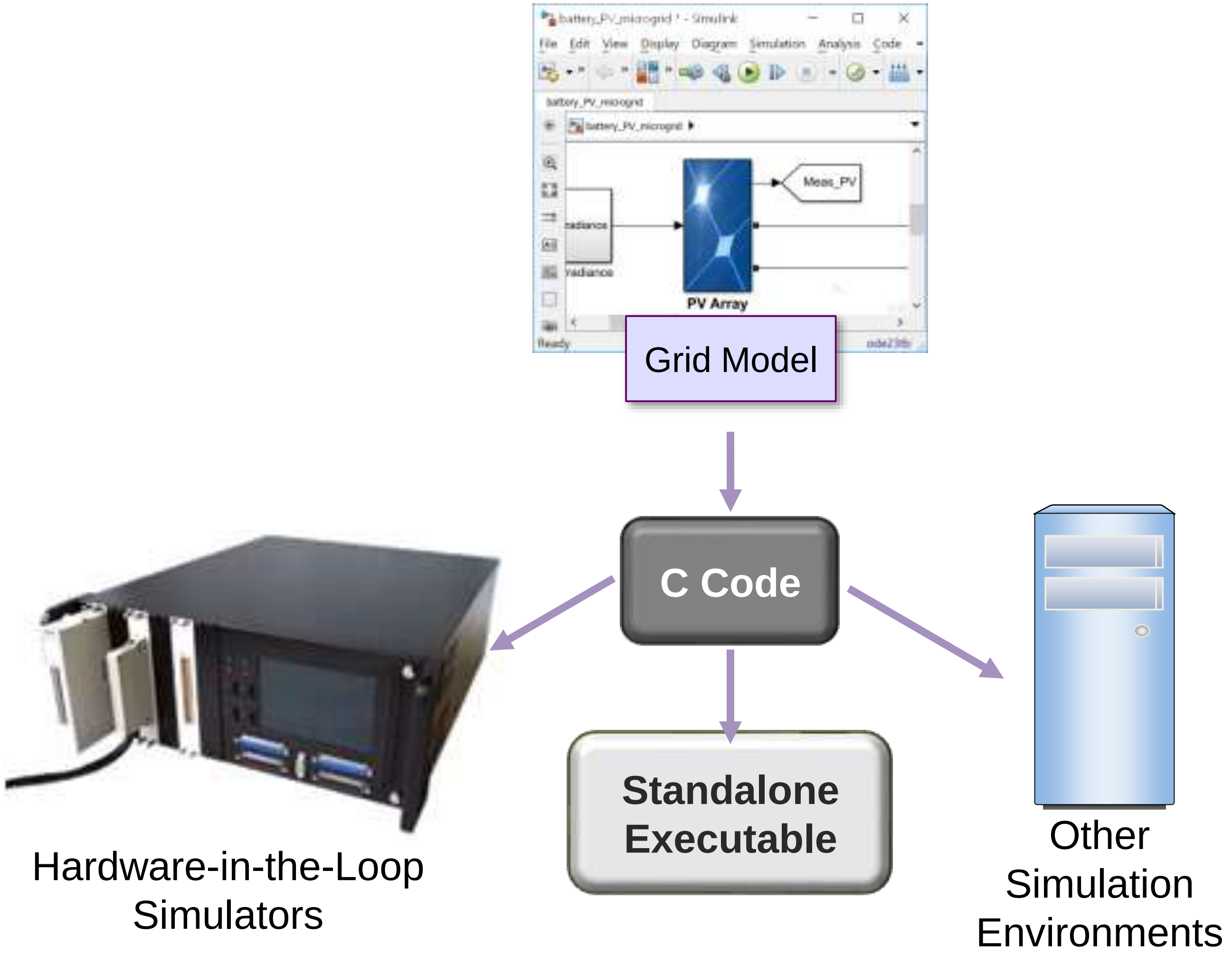
- Convert models to C code for HIL tests
- Share with internal users with fewer licenses
- Share with external users while protecting IP

Process-in-the-Loop (PIL) & Hardware-in-the-Loop (HIL) Simulation



Integrate Your Models into Other Simulation Environments

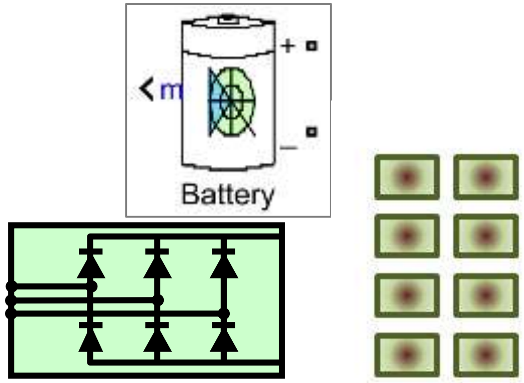
- Model can be converted to C code
  - Run in real-time to test controller hardware (HIL)
  - Standalone executable (parameter sweeps)
  - Integration with other simulation tools

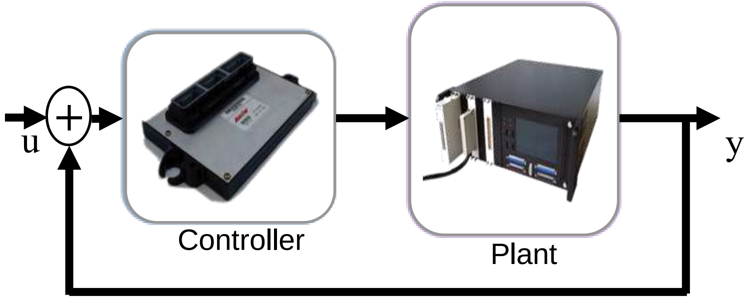


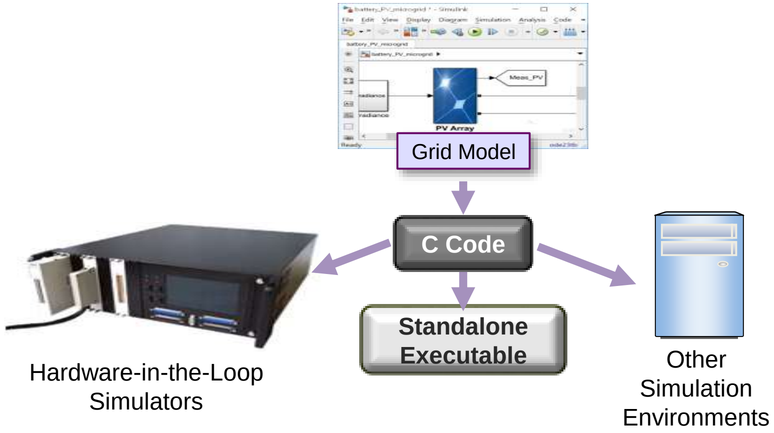
Deploy the model as C code to other simulation environments, or use it as a standalone executable

Summary

- Physical component models at various levels of fidelity are necessary for Power Electronics
- Modeling the plant and controller in a single environment enables system level optimization
- Deploy the model as C code to other simulation environments, or use it as a standalone executable







Q&A