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Virtually Prototyping Power Consumption Using SysML

Alay Shah – Rotorcraft Systems Engineering and Simulation Center

Introduction

Battery Energy Storage Systems (BESS) have gathered popularity for load-leveling power usage. There is a need for a tool that can optimally configure BESS while being flexible enough to accommodate the different usage profiles, components, and configuration with minimal effort.

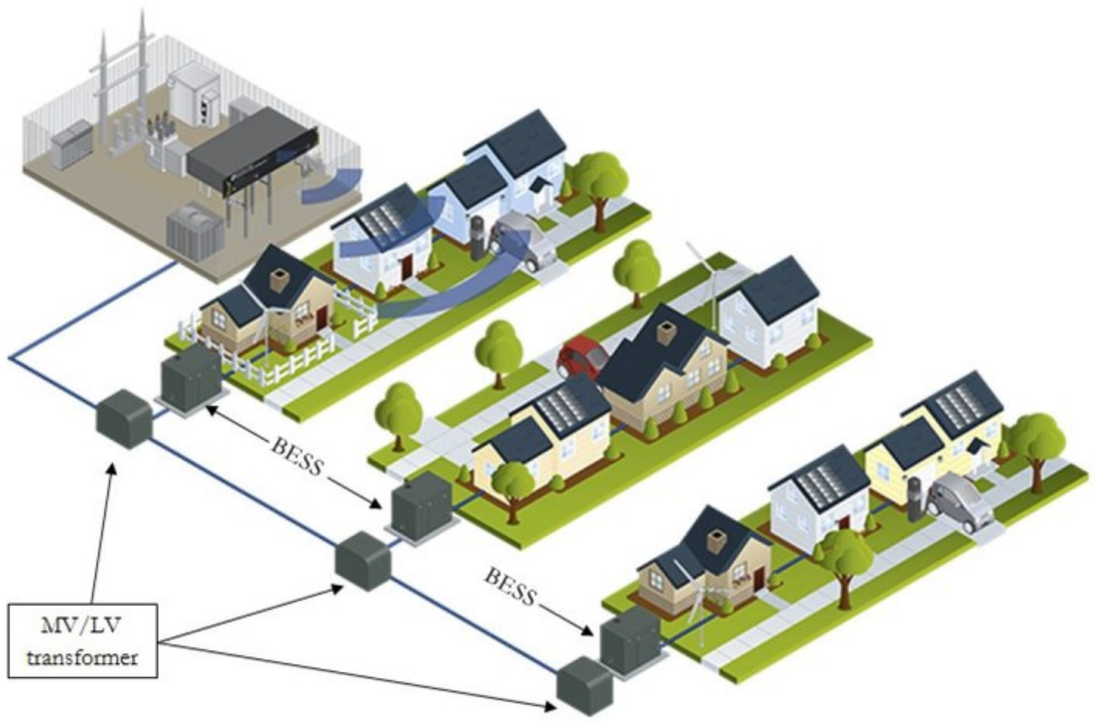

Figure 1: Diagram of BESS

The process developed leverages the abstract modeling ability of SysML to configure a system virtually and then run a simulation which only needs to be configured once with the abstract components. SysML models may also be used to store component specifications, power usage profiles, and rate structures.

Methodology

Create Model with Appliances

Abstract blocks, constraint blocks with relevant calculations (including ROI), and system structure are added to the model. Instance specifications are created.

Model Appliances

Using activity diagrams, the behavior and physics of the components are modeled. A physical testbed is built and verification experiments are conducted.

Run Simulation and Generate Report

The simulations are run on the particular system and the data is used to support determination of an optimum. ROI and other important values are reported.

Key Findings/Results

- SysML in conjunction with this process allow a rapid and flexible means for determining if components are viable in a configuration
- The most effective way to quickly add components by using abstract blocks and instance specifications for details
- Combining this with SysML requirements and simulations allows powerful requirements verification capability

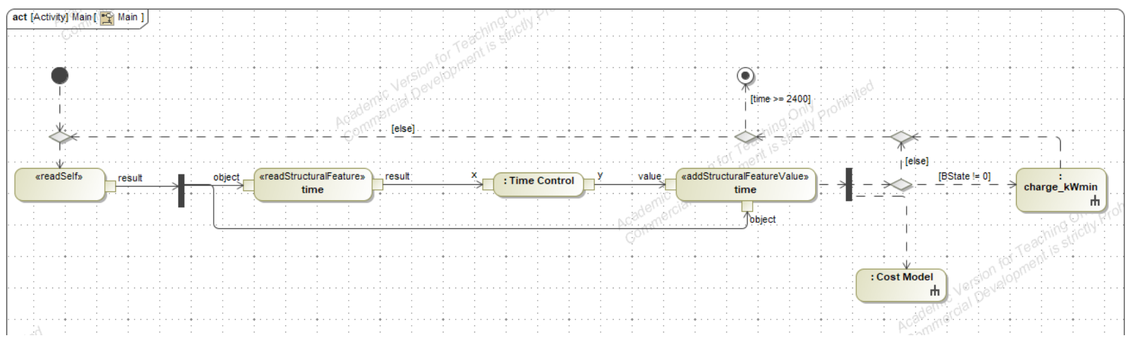

Figure 2: Abstraction Allows A Simulation to Only Be Configured Once

Impact/Conclusions

By leveraging the ability of a model to store data, requirements, calculations, system behavior, and system configurations, the model can quickly run detailed trade studies and create plots which can be inserted into a system-generated report or help determine if performance of a configuration is appropriate.

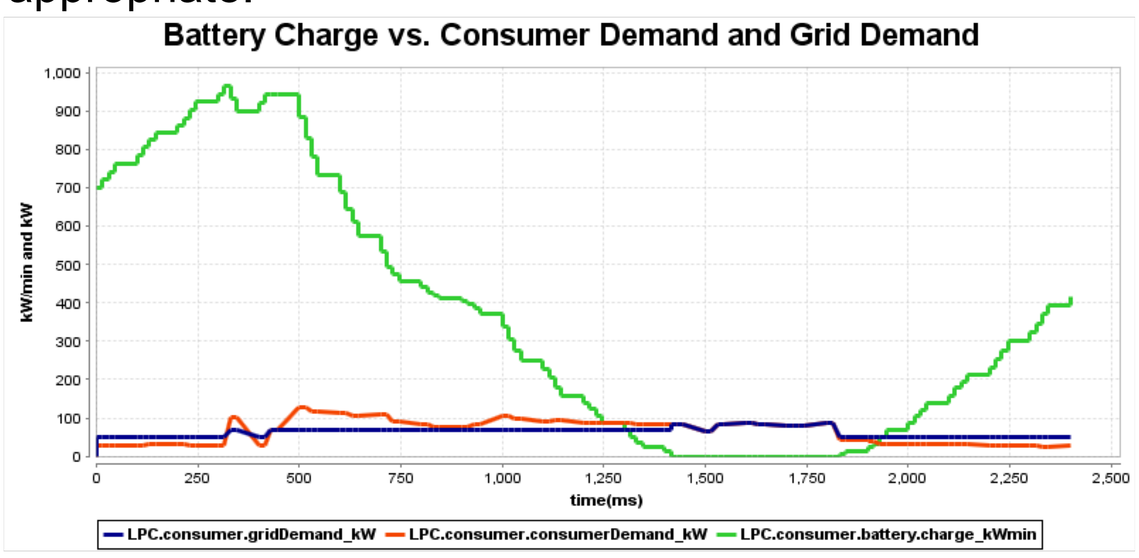

Figure 2: Model-Generated Graph of Load Leveling and Battery Bank Charge

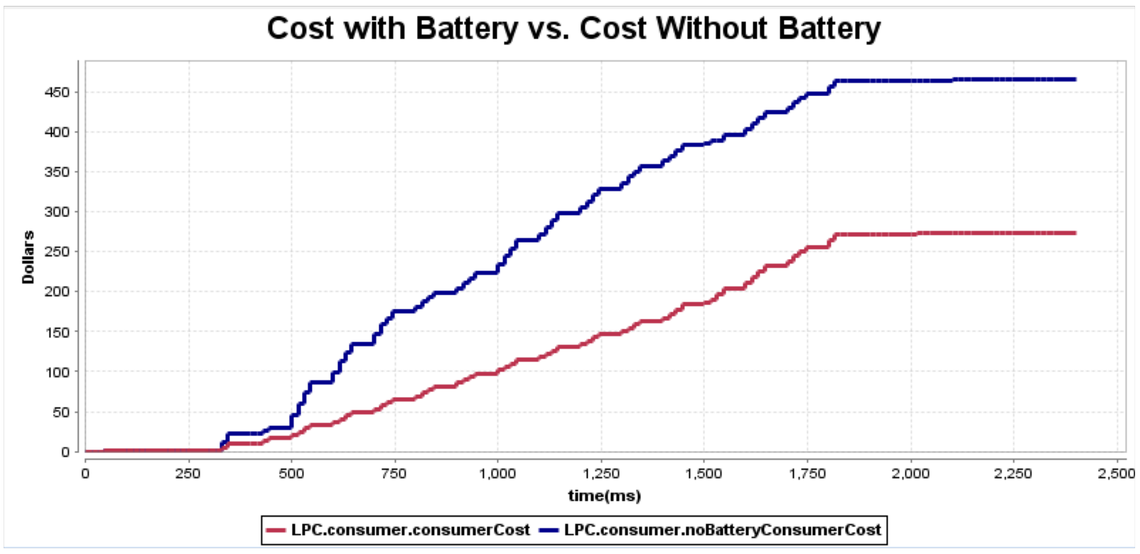

Figure 3: Model-Generated Graph of Cost With and Without Battery Bank

Acknowledgements

I would like to thank my mentor, Jonathan Patrick, as well as Dr. Bill Carswell and Dr. Dale Thomas for their guidance with this project.

Figure 1: https://gnom.upc.edu/en/news/msc-thesis-on-distributed-battery-energy-storage-systems-in-energy-retail-markets

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