Secondary-Use Battery Energy Storage Systems

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ORNL Team:

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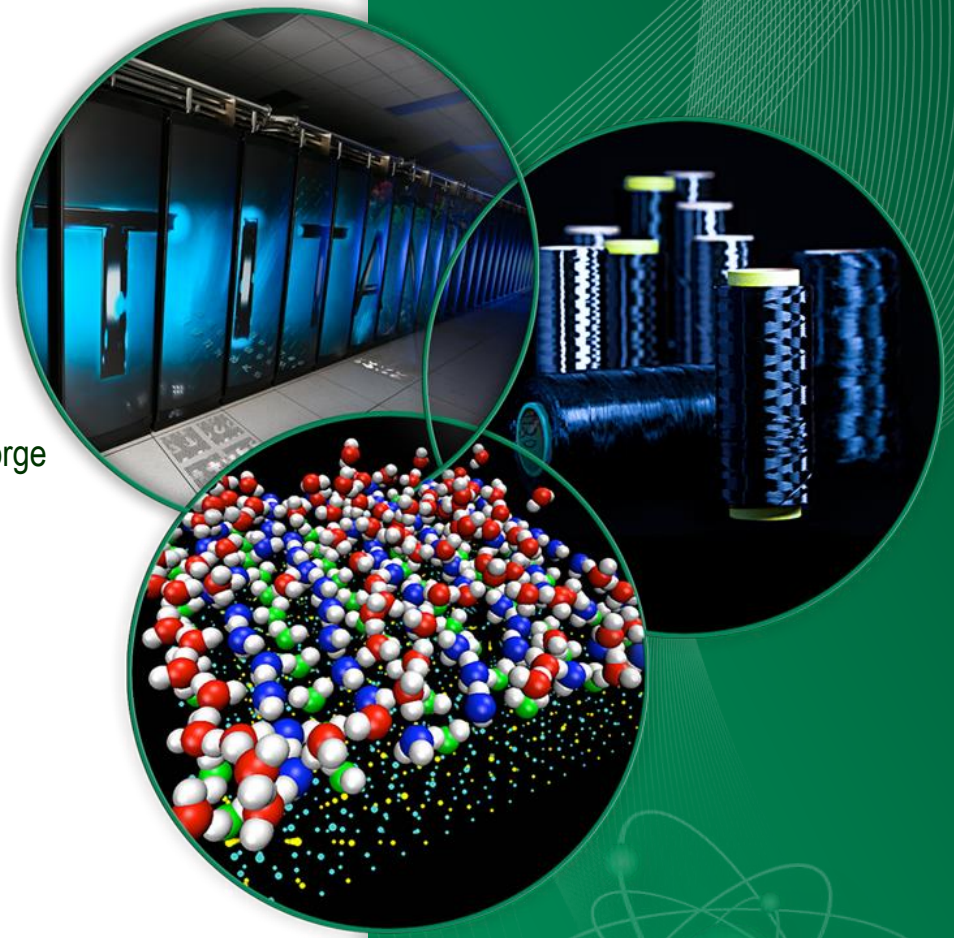
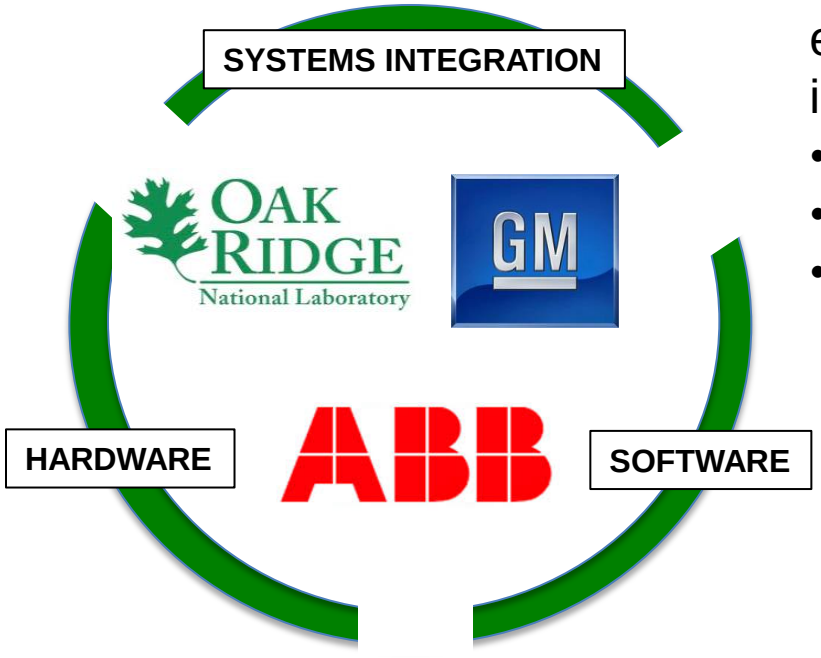


I would like to thank **Dr. Imre Gyuk, Program Manager of the Electrical Energy Storage Program** for DOE's **Office of Electricity** for his support and funding.

Project Overview

- Supporting the industry investigation into vehicle battery **secondary-use** through **testing, demonstration, and modeling.**
  - Potentially a **cost competitive** energy storage technology
  - Validate **reliability and safety** – working with industry to troubleshoot and test systems under operational conditions
  - Examining **regulatory environment** – investigating hurdles that are institutional
  - **Industry acceptance** – build confidence in this technology.

Current Activities



An effective **partnership** that merges equipment, technical know-how, and infrastructure:

- Energy Storage – Used EV Batteries
- Energy Management System
- Electric Grid

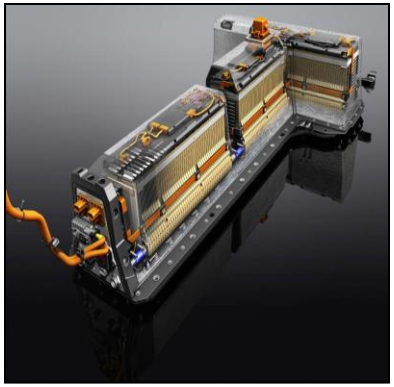
ORNL is testing and demonstrating the technology as a third party.

GM/ABB Quote

" The **collaboration** between ORNL, GM, and ABB has been **instrumental** in **confirming** the **opportunity** to utilize automotive **second use batteries** in a grid based application. The high quality of the extended ORNL testing gave us a deeper understanding of design, installation, and operation of energy storage devices. The team used the sophisticated lab environment to examine a wide range of performance scenarios not possible at a single production installation site.“ – General Motors

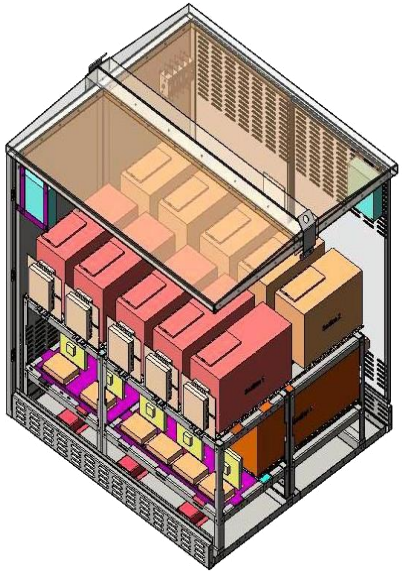
The Technology

GM Chevy Volt Battery



Re-Packaged

ABB Enclosure



Automotive Application

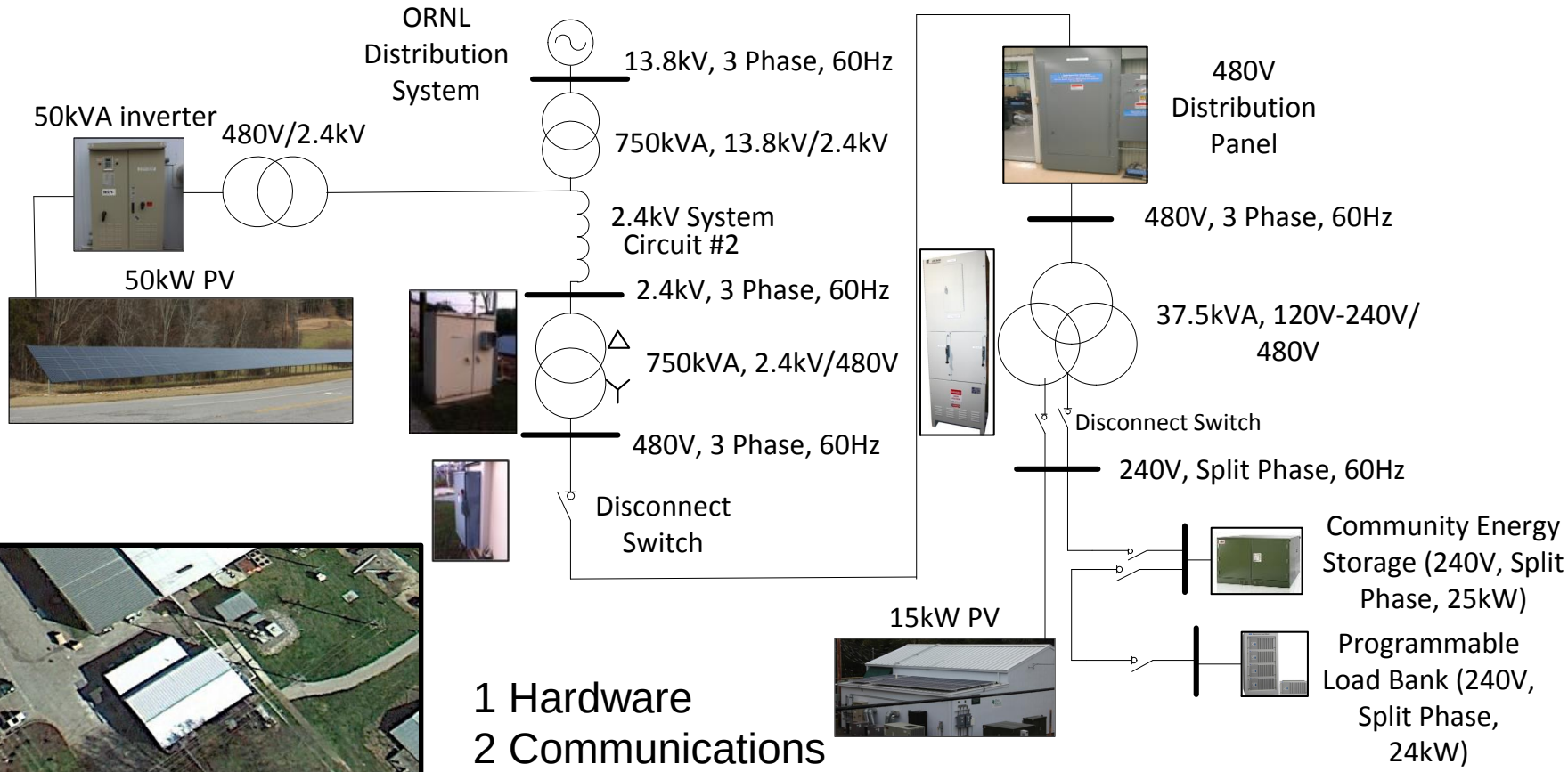
- Capacity for 10 Years in Automotive Application
- Power 111kW
- Liquid Cooled / Heated

Grid Application (25kW/50kWhr)

- Expected capacity for 10 Years of Operation
- 5 Volt Battery Packs
  - 5 kW per Volt Battery
  - Air Cooled/Heated

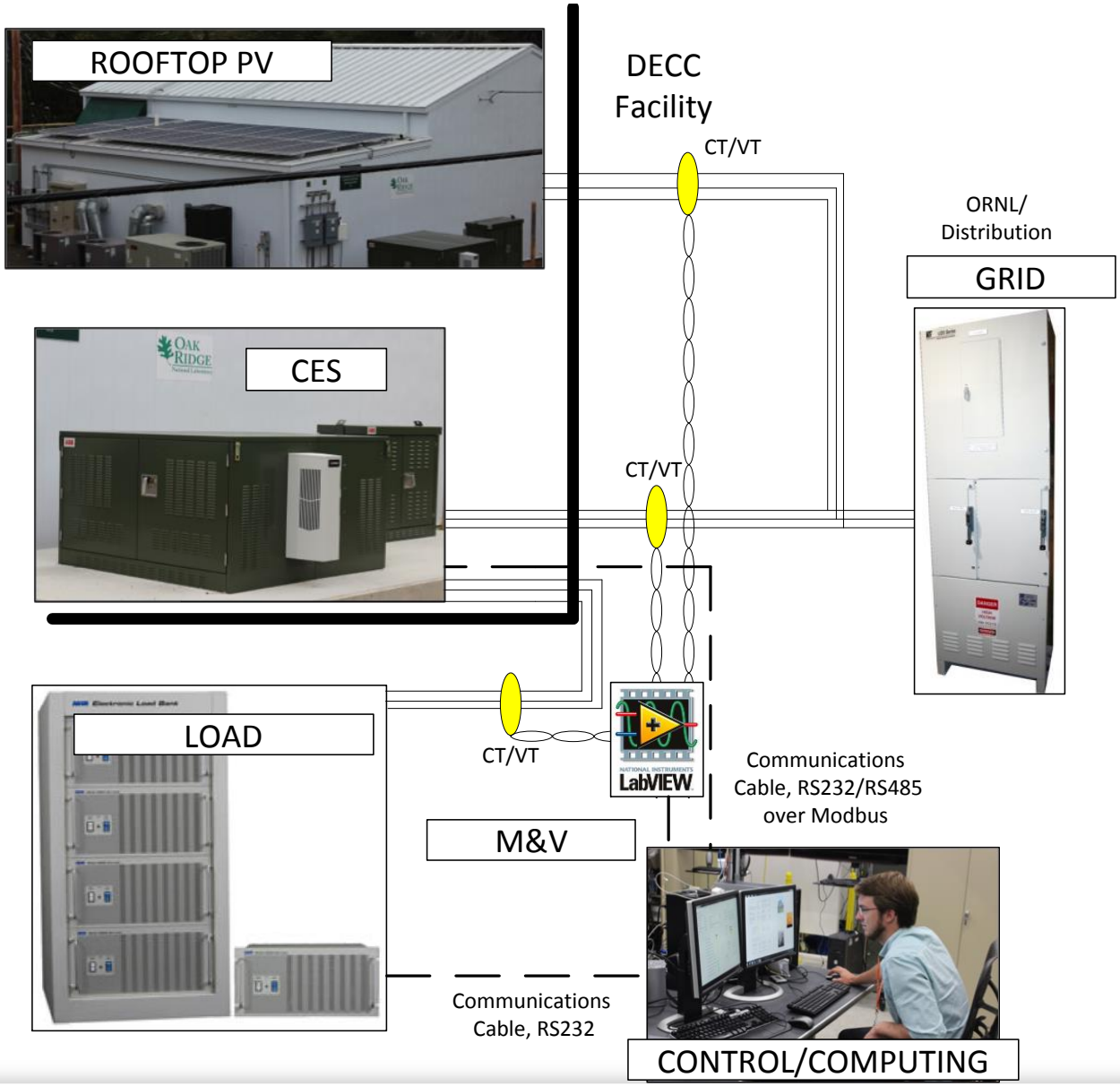
Testing Setup at ORNL

- ORNL objective for testing: Provide **real world** examination **systems integration** and **applications** with the flexibility to capture many different case scenarios.



1 Hardware
2 Communications
3 Controls

Hard/Soft: Communication and Control

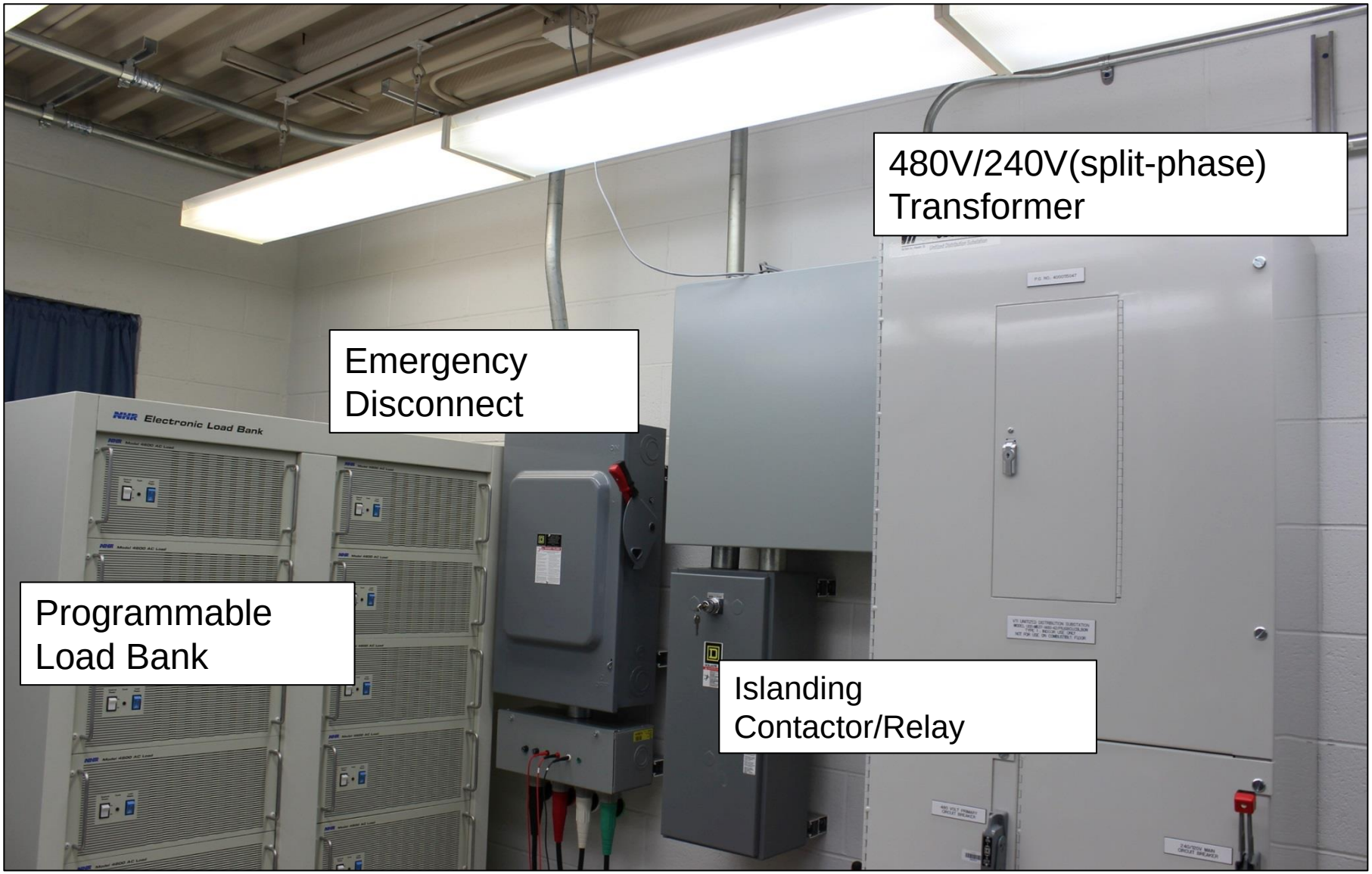


Communications and Control and Measure & Validate

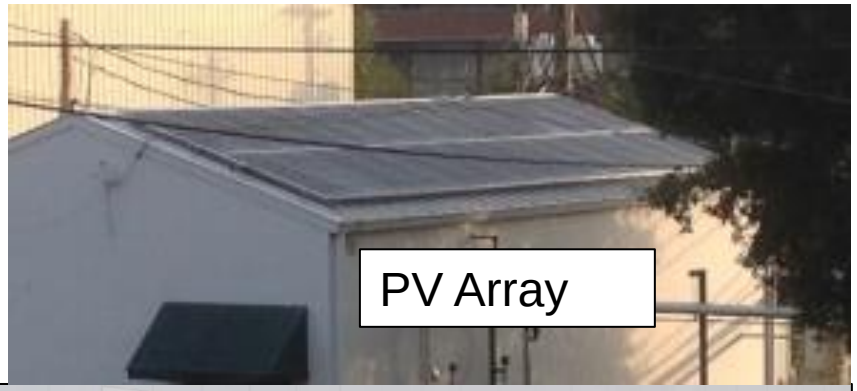
Communications and control done through Serial, Modbus over Serial, and TCP/IP

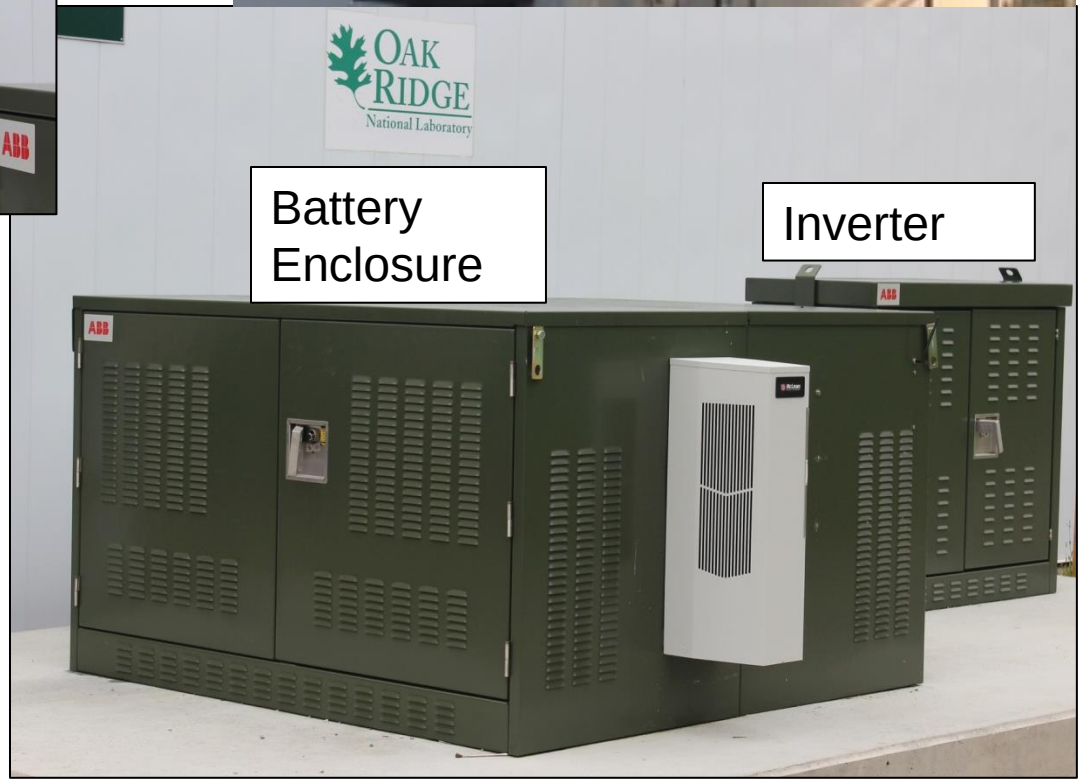
- All integrated through Matlab/Labview

Hardware: Equipment Inside DECC



Hardware: Equipment Outside DECC

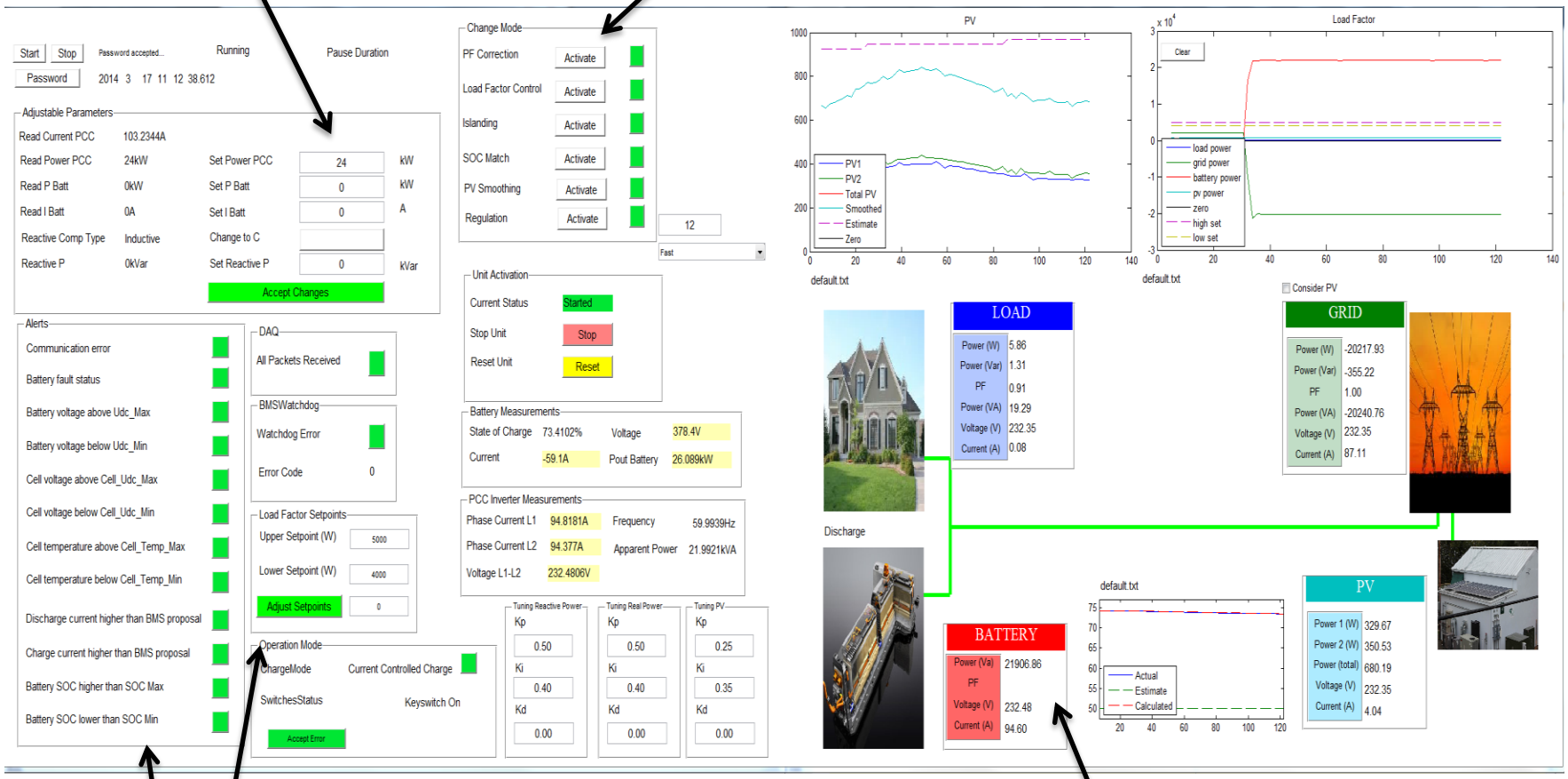




Interface

Manual Control

Set of pre-programmed controls

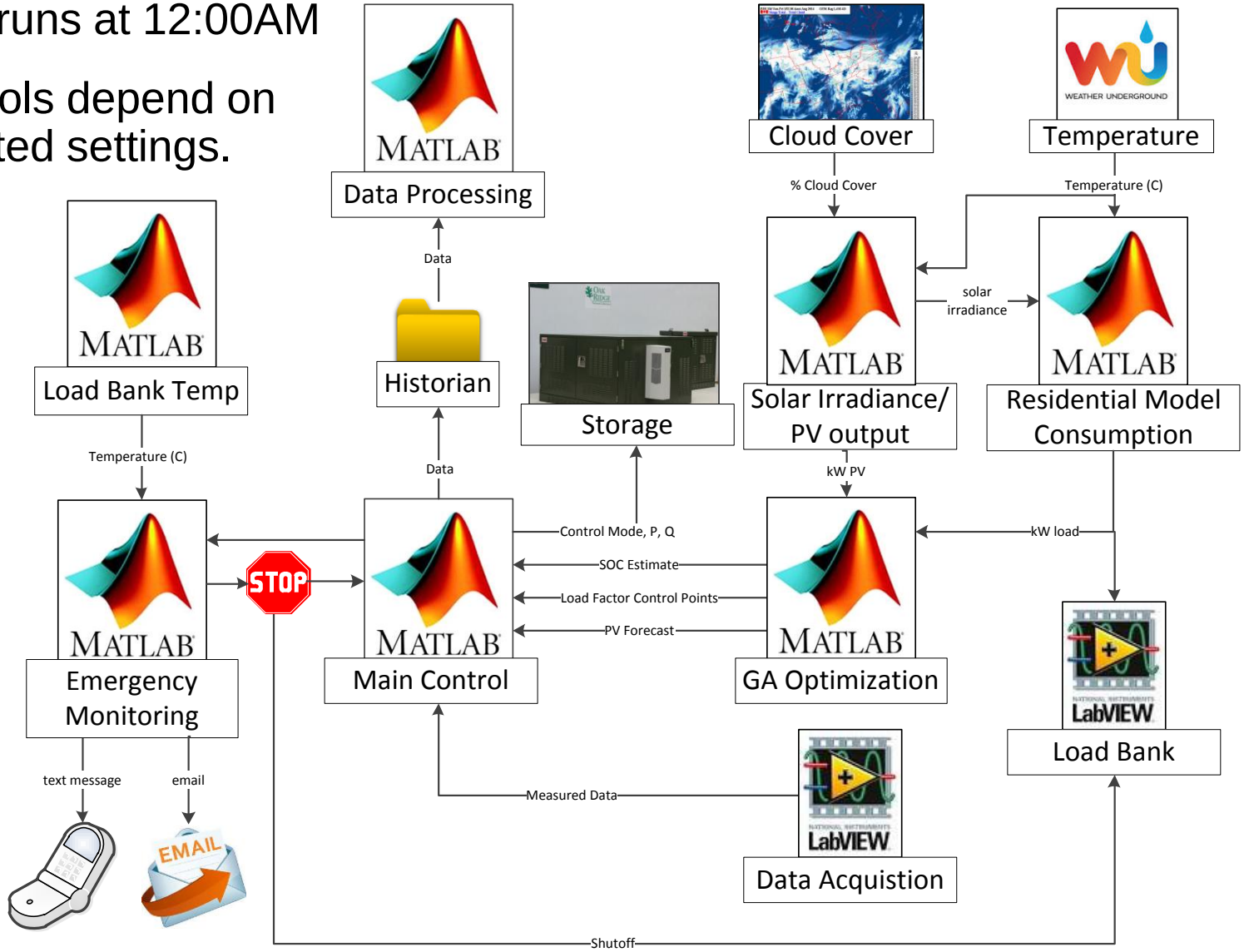


CES Alarms

State display

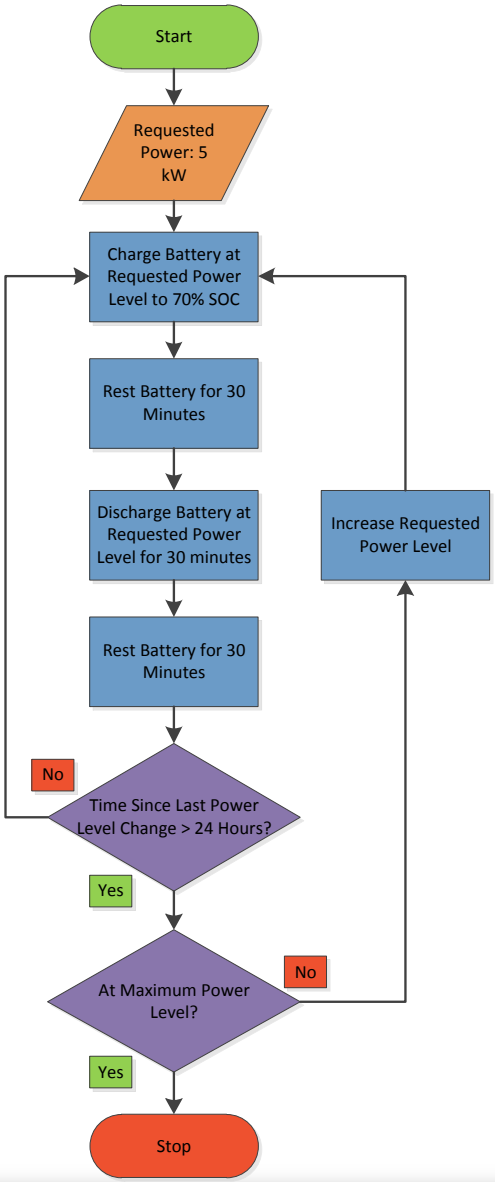
Controls and Programs

- Auto-runs at 12:00AM
- Controls depend on selected settings.

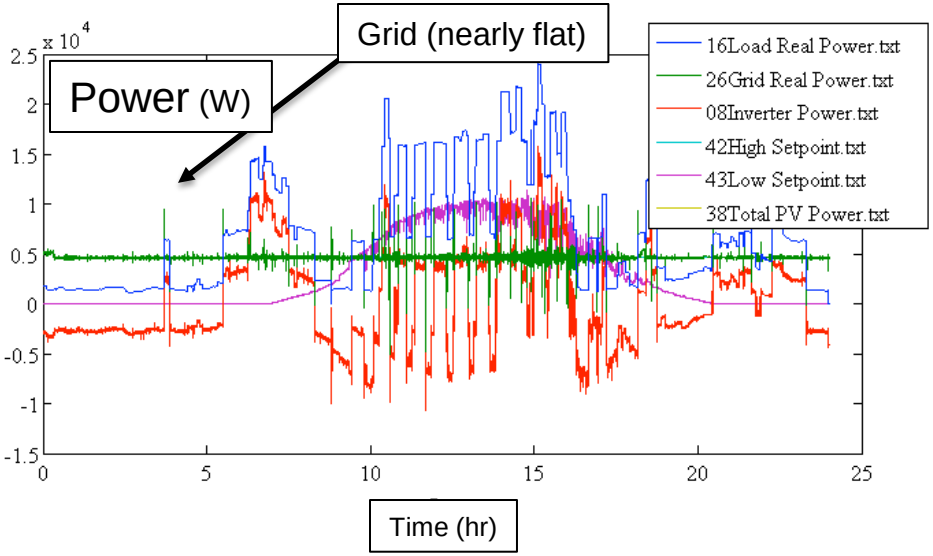


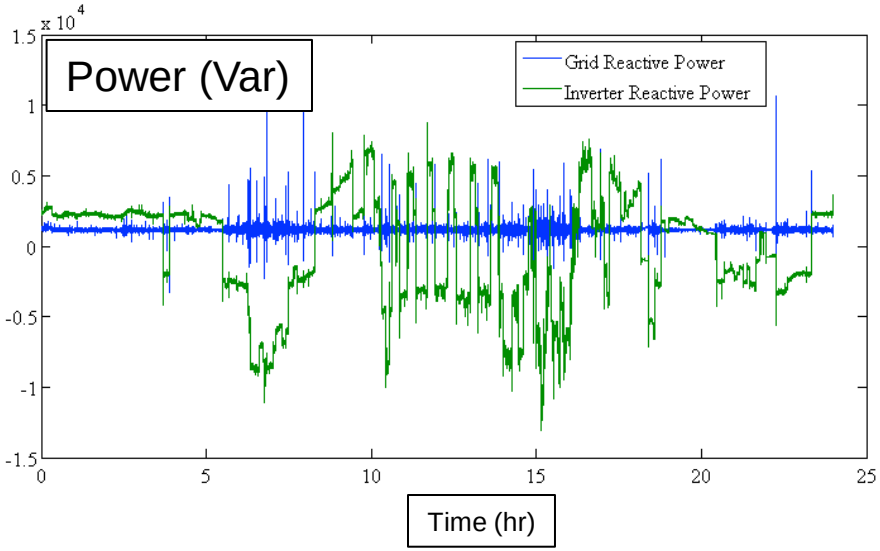
Testing Procedure (Systems Tests)

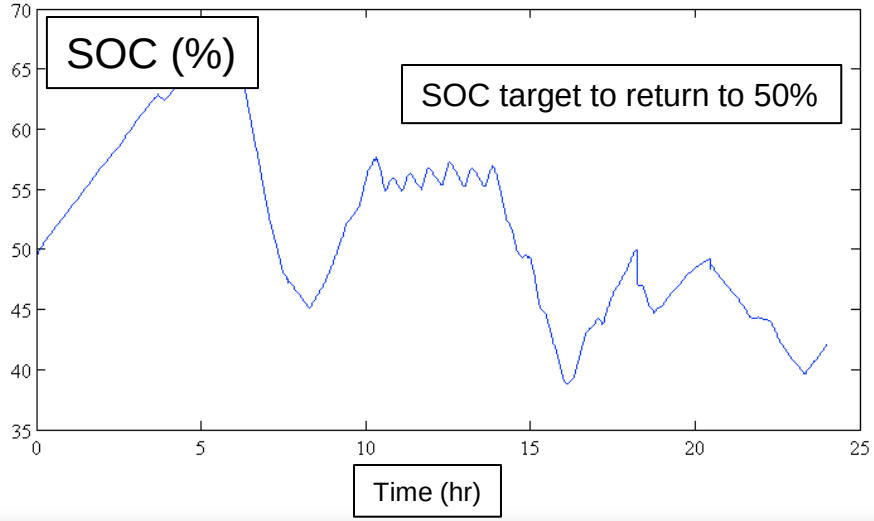
- Objectives:
  - Obtain standard metrics (round-trip efficiency/ensure within bounds of standards)
  - Demonstrate application examples
- Standard Metrics:
  - Round-trip efficiency
  - Harmonics, etc.
- Applications
  - Load factor,
  - Power factor,
  - Renewable Integration,
  - Islanding

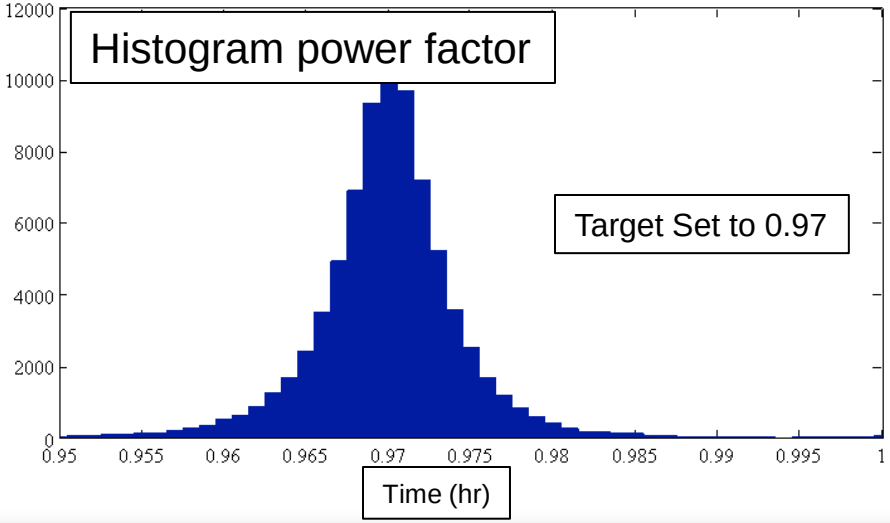


Multiple Value Streams: Stacking Benefits (Load Factor/Power Factor, Renewable Integration)

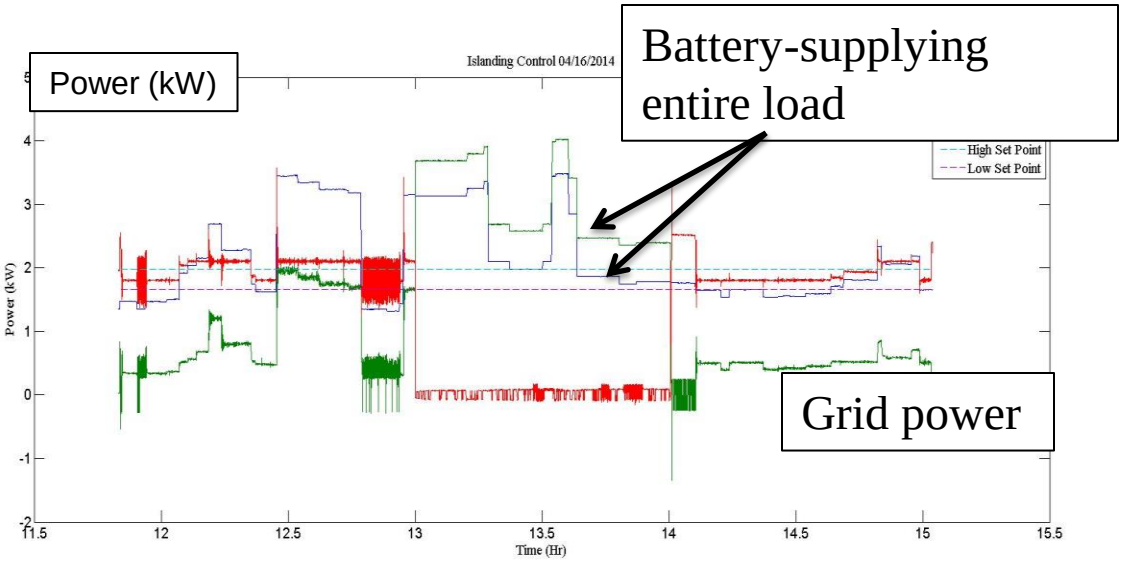


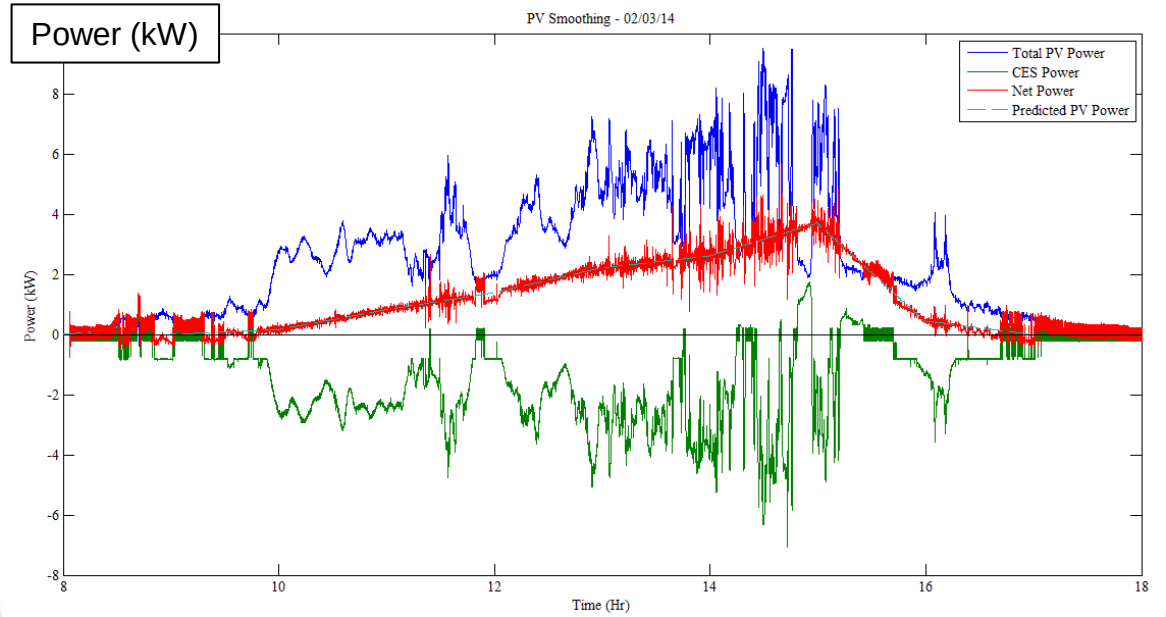




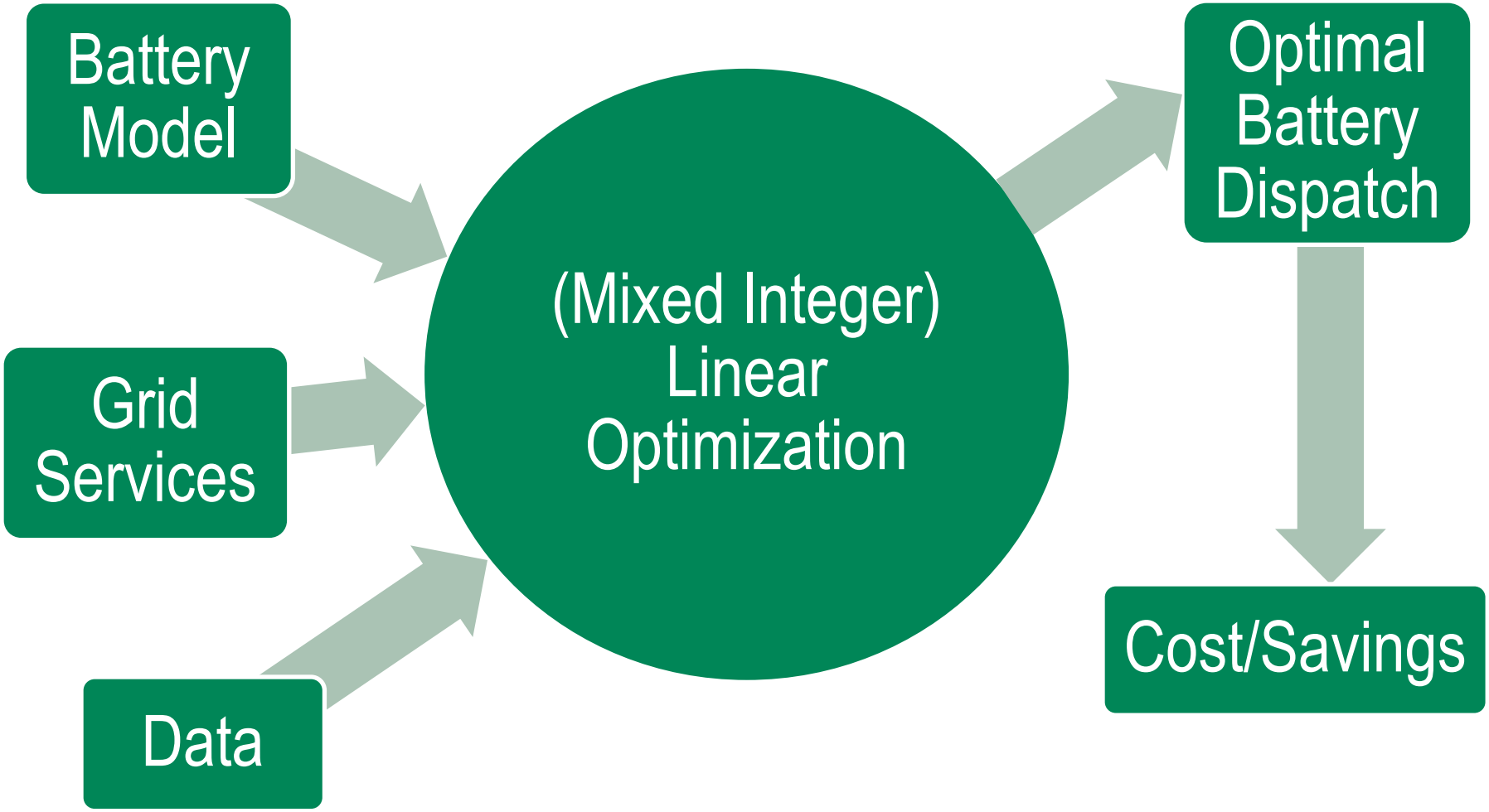


Other Applications: Off-grid and PV Smoothing





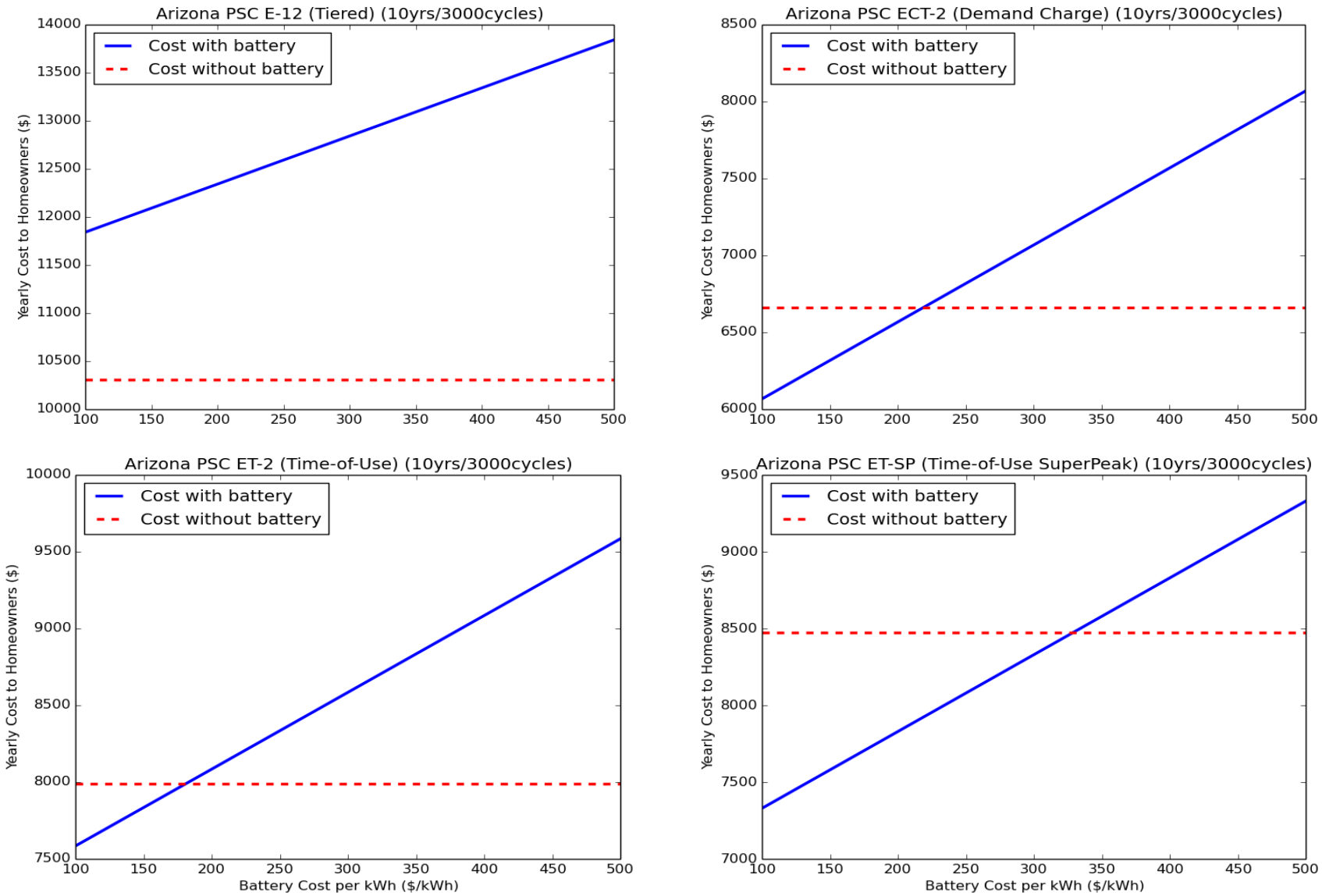
Initial Economic Approach



Initial Economic Results

- Arizona Public Service Company residential rate structures
- Year-long simulated load for 3 homes
- Dispatch the battery to minimize the homeowners' cost
- Utilized efficiencies of real system, 10year/3000 cycle battery

Initial Economic Results

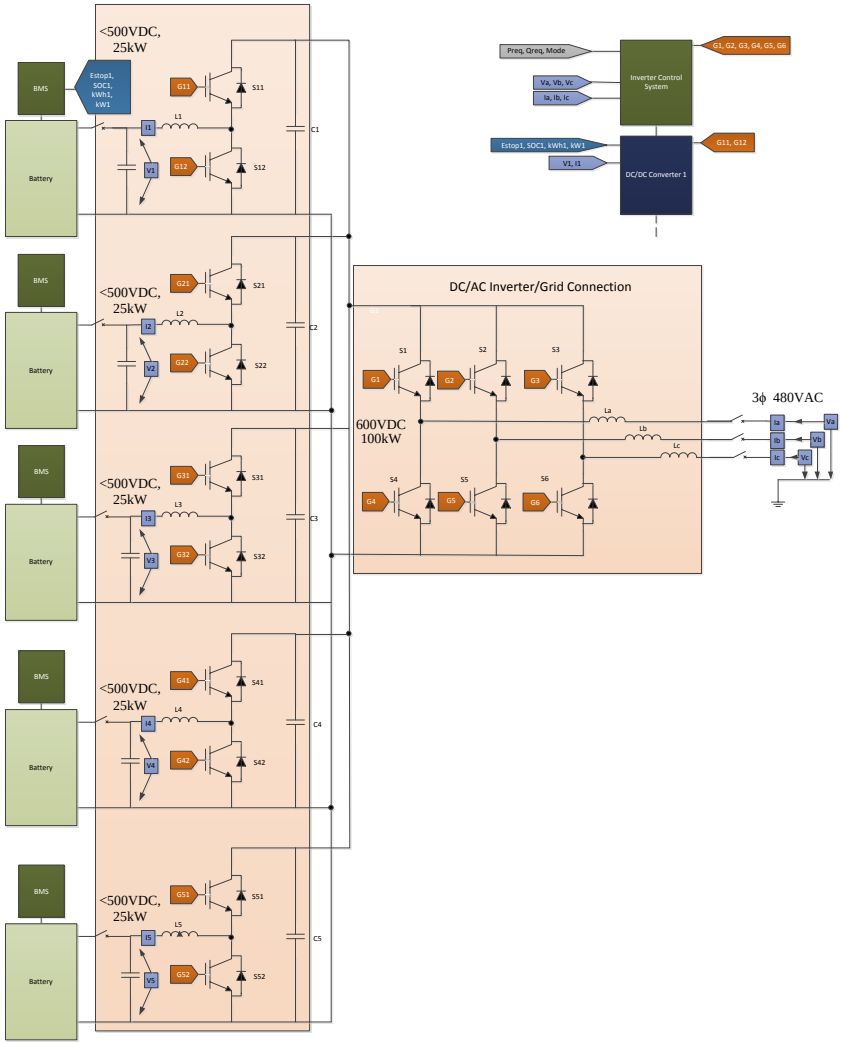


ORNL Summary/Conclusions

- Developed controls and applications ES testing
- Demonstrated and tested ABB/GM secondary-use battery storage.
- Drafted a report on initial testing procedures (currently in review.)
- Obtained and evaluated PNNL optimization toolbox for ES.
- Developing models for distributed control of energy storage.

Future Tasks

- Continued testing of ABB/GM.
- Modeling and economics assessment for DES.
- Optimization of DES dispatch
- Development of refurbished secondary use ES with ATC New Technologies partners.



Special thanks to Dr. Imre Gyuk for his dedication and support to ORNL and ES industry.

Questions?

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