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Sandia National Laboratories

Power Electronics Laboratory for Energy Storage Optimization (PELESO)

Jacob Mueller, M A Moonem, Stan Atcitty

What is PELESO?

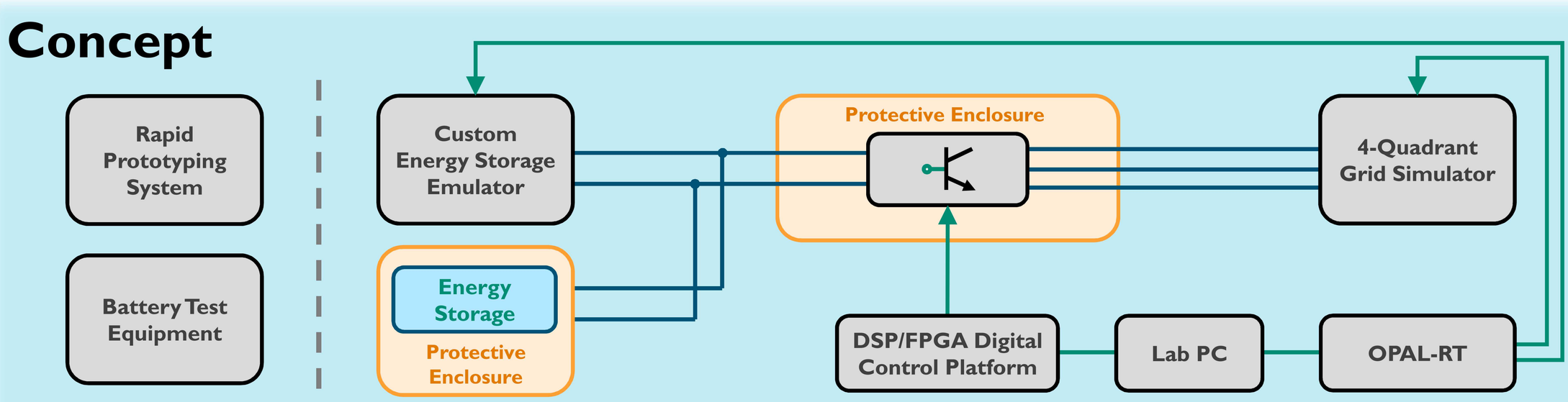
PELESO is a lab environment currently in development at Sandia. The purpose of PELESO is to support an integrated system approach to energy storage system (ESS) research and development. A practical ESS consists of storage devices and power conversion hardware. These components are commonly developed through separate design processes. However, individually optimal components do not necessarily produce an optimal combination. PELESO is built to support research that produces innovative ESS solutions by leveraging expert knowledge of both power electronic and electrochemical subsystems.

Research Objectives

PELESO's core research objective is to improve the **reliability** and **resiliency** of energy storage systems, focusing in two key areas:

1. Advanced modular converter topologies and fault-tolerant hardware configurations
   - Modular, cascaded, multilevel converters
   - Converter-integrated storage architectures
2. Intelligent monitoring and control strategies
   - System-aware procedures for battery management and life-cycle optimization
   - Smart protection systems for rapid fault detection, identification, and isolation

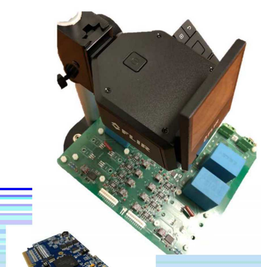
Concept

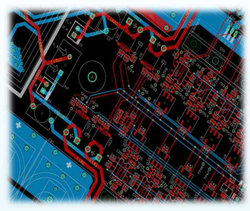


Target Capabilities

Upon completion PELESO will include:

- Fully bidirectional power flow capabilities
- Real-time source control for emulation of practical battery/grid conditions, including faults at both AC and DC interfaces
- Deep instrumentation for electrical and thermal performance assessment
- Easily reconfigurable control platforms
- Protected DC interface for safe inclusion of electrochemical energy storage devices
- Precision battery test instruments for assessing the impact of practical converter behavior on storage device integrity
- Prototyping equipment for rapid deployment of new converter topologies and hardware configurations





Project Timeline

Phase 1 — **Cell-Level Interface**
<50 VDC, <100W
Low-Voltage DC-DC Converters

Phase 2 — **Module-Level Interface**
50-400 VDC, 1kW
High-Gain and ISOP DC-DC Converters

Phase 3 — **Centralized Storage System Interface**
400-1000 VDC, 10kW
2L Inverters (Single and 3-Phase)

Phase 4 — **Converter-Integrated Storage Systems**
>1000 VDC, >30kW
Modular Multilevel and Cascaded Topologies

Acknowledgements

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