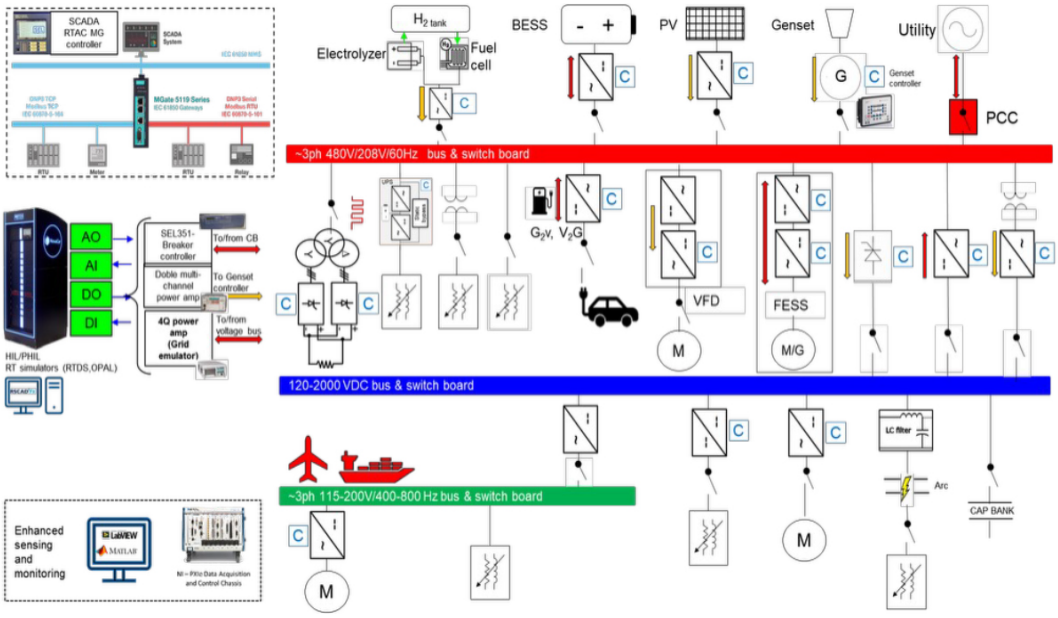
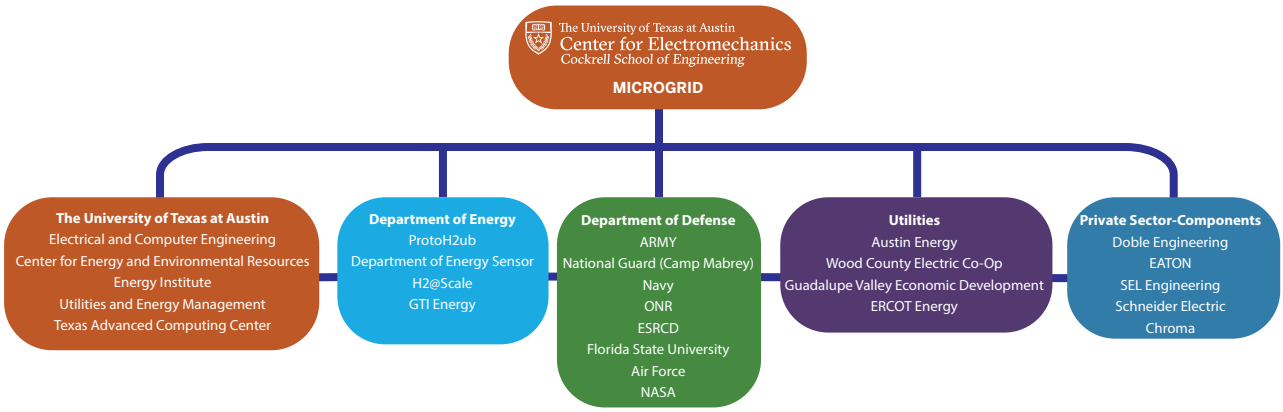
The University of Texas at Austin
Center for Electromechanics
Cockrell School of Engineering

Microgrid Capabilities

Overview: CEM has nearly two decades of power system design experience over numerous projects for the U.S. Navy, Army, and civilian applications. This MW capable microgrid facility has served as a cornerstone for design, test, and validation of a variety of power system control, protection and management techniques. CEM is actively executing a contract to upgrade this facility to provide a flexible infrastructure to accommodate either a 480V AC or a 1kV DC grid architecture. By leveraging multiple Semikron converter units throughout the microgrid, this facility can be readily re-configured to execute either testing on solutions for both utility power systems and DC-based electrified platforms. CEM can support the commissioning of new assets, control solutions, and protection schemes by integrating them into the microgrid and conducting comprehensive testing. Through power hardware-in-the-loop (PHIL) and controller hardware-in-the-loop (CHIL) evaluations within its microgrid facility, CEM ensures that minimum viable prototypes are fully validated and ready for field deployment. To accomplish that CEM is also taking full advantage of a RTDS real-time simulator, to emulate desired assets in the power grid. This interim testing is difficult to accomplish in a manner representing real-world behavior via desktop modeling & simulation alone. This facility is intended to serve as the backbone of numerous sponsored research projects, and as a service center for industry partners to test prototype hardware in a system level environment capable of exercising a full spectrum of mission load sand operational/performance criteria.





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Main Uses:

I. Funded fundamental research
II. Service center for academic or private sector to test prototype products
III. Workforce and army training and qualification

Clients: DoE, DoD, Academic Research, Private

Main applications: General MG, floating/ specific MG (see next slide), H2 related, HIF tests

Voltage levels: Segmented zones, shared grounding, labeled busbars

I. AC: 480/277V, 208/120V
II. DC: 120, 250V, 270V, 600V, 2000V

Frequencies: 60Hz, 400/800 Hz

Current levels: TBD

Power levels: Up to 1MW. for most applications: 5-100KW.

Load types: DC, AC, pulsed

Key components: Sources, loads, converters, switchgears, buses, circuit breakers, control room, SCADA, sensors, DAQ, RT simulators

HIL capabilities: Real-time links, RTDS & OPAL-RT simulators accessible to test bays

Modular: Modular equipment skids with quick-connects

Reconfigurable Setup: Use of universal junction boxes, smart switchgear

Central Control Room: Client/Visitor Friendly, Representative look with clear displays and diagrams, SCADA and RT simulators

Control Room – Safety is always of primary concern at CEM. Dedicated control rooms are present in both the low lab area within the main building, and adjacent to the pulsed power test area. Fiber networking connects test equipment to the control rooms for real-time monitoring of test events and electrical isolation.

Power Electronic Building Block converters (PEBB) - The PEEB power converter concept is to create a single modular electronic power package that can be easily modified to create a variety of different power converter packages. These power converter types include AC to DC (passive and active rectification), DC to AC (inverter, DC to DC step up (boost), and DC to DC step down (Buck). The Center for Electromechanics employs 10 PEBB converter modules. These modules are made up of a Semikron Semistak RE power converter assembly. That feature an IGBT based Skiip 4 intelligent power module (IPM) in a three-phase half-bridge configuration.

Digital Real-Time Simulator - The lab features both an RTDS (Real-Time Digital Simulator) Novacor 2.0 and an OPAL-RT real-time simulator, enabling highfidelity, real-time simulation of complex power systems. These platforms facilitate closed-loop interaction with physical controllers and relays, supporting the development, validation, and de-risking of advanced control systems under realistic operating conditions. When operated in HIL (Hardware-in-the-Loop) mode, the simulators execute power system models in real time to support rigorous controller design and testing. The system is supported by a suite of power amplifiers for CHIL (Controller Hardware-in-the-Loop) applications, including both Doble F6150 and Omicron 256 plus amplifiers, as well as the GTNET card communication protocol modules for interfacing with controllers and protection relays, such as Woodward genset controllers and the SEL-351 protection relay. These interfaces support both analog I/O and digital communication protocols such as IEC 61850, Modbus, and others.

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Protection and Control Testing- The lab features a SEL-351 Protection system, and SEL-AXION-2240 RTAC controller, to test for testing realistic system conditions-fault currents, breaker operations, communication events, and SCADA interactions, and verify that the relay trips at the right time, check transient stability and the RTAC interprets and forwards data accurately, and the overall protection scheme behaves as expected under both normal and abnormal scenarios. This approach reduces commissioning risk, prevents mis operations, validates settings and logic, and ensures that both devices integrate reliably with the rest of the grid's protection and automation architecture.

Genset Controller - With the Woodward easygen generator controller connected, dynamic events such as load changes, faults, islanding, synchronization, and frequency/voltage disturbances can be simulated, and observe how the Woodward controller regulates the genset while the SEL-351 provides protection and the RTAC manages communications and supervisory logic. This end-to-end setup ensures that the generator responds correctly to trips, dispatch commands, and system transients, while also confirming that the relay and RTAC accurately coordinate with the genset during both normal and emergency operations. It allows to verify the behavior of the entire microgrid or plant control scheme before commissioning, significantly reducing integration risks and improving overall system reliability.

Power Switching, Filtering and Fault Introduction - To allow for switching and line filtering, there are 8 modular three phase 1600Amp isolation contactor and 130uH inductor sets to be utilized at the optimal point in the test circuit. A large capacitor bank has been added for additional filtering options. The capacitor bank consists of 100 capacitors, each rated for 500uF at 2000Volts. The capacitor bank can be divided into smaller sections for best performance as determined by the desired test parameters. With the capability of switching in different capacitive and inductive values, the test circuit and filtering are easy to modify to meet testing goals. Additional high current and high voltage breakers are utilized to introduce short circuit faults in the test circuits. The three phase breakers consist of two 3000Amp, 4000 Volt units. The breakers combined with different test loads allow for short circuit fault tests from a few to hundreds of amps all depending on the circuit oper-ating voltage and the selected fault load. Control software has been implemented on the control circuits to detect the short circuit faults and interrupt the current flow. Additional standalone circuits have been developed to detect and locate the system faults.

Hardware for performing DC series fault tests includes electrodes, linear motor, and containment system. DC series fault tests can be performed at different bus voltag-es as well as different current levels from a few to hundreds of amps. The ability to perform many different types and levels of tests illustrates the flexibility of the micro-grid system at CEM.

For more information, please contact:
Shannon Strank
Deputy Director
s.strank@cem.utexas.edu
512-232-1690