Abstract

Workshop for Research in Electricity Infrastructure Hardening

Florida State University - Center for Advanced Power Systems
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Introduction

The Center for Advanced Power Systems (CAPS) was established at Florida State University (FSU) in 2000 to perform basic and applied research to advance the field of electric power systems technology, with emphasis on application to electric utility and defense industries, and to develop a power systems engineering education program to train the next generation of power systems engineers.

Capabilities and Tools

With Office of Naval Research (ONR) and Department of Energy funding, CAPS has created a research facility especially suited to research, development, demonstration, and testing of power systems, new concepts and approaches to power systems, and new power systems components and machines. The advanced prototype research, test, and demonstration facility, integrated with real-time dynamic hardware-in-the-loop simulation, can test electrical systems, including machines and components up to 5 MW under controlled conditions, very closely approximating intended real-world applications.

Power Systems Analysis and Simulation

- Large Real Time Digital Simulator (RTDS™), specifically for high-fidelity power systems simulation – largest system of its kind in an academic environment – 111 billion floating point operations/sec. – can solve power system simulations at time steps down to 1 micro-second, faithfully representing detailed transient and dynamic electrical behavior of power electronics based devices, such as FACTS, protective relaying behavior and other extremely fast-acting power-system devices and phenomena. Includes large amount of analog and digital I/O for integrating real devices and systems into the simulation.

- Other simulation and analysis tools, including Areva e-terraPlatform™ Energy Management System (EMS) with SCADA and network analysis/state estimation for 2000 buses, PSS/E™, PSCAD/EMTDC™, MATLAB/Simulink™, PSpice™, and others.

Power Systems Test Facility and Labs

- Highly flexible and configurable power systems test bed, with 4160 VAC and 480 VAC experimental buses, and integrated with real-time digital simulation, for testing systems, machines, and components at up to 5 MW power levels; Facility includes variable voltage, variable frequency converters supplying buses, drives, and dynamometers at up to 5 MW.
- Dielectrics test facility for insulation testing – 140kV, 250J impulse generator, DC testing to 140kV, AC testing to 100kV (RMS) at 5 kVA, including partial discharge measurement.
- Cryogenic AC loss measurement and quench propagation for testing high temperature superconducting wires and cables.

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- Power electronics labs and wet lab including fuel cell research.

Experience

- Leading Department of Energy funded multi-institution effort on Electric Power Infrastructure Reliability and Security.
- Leading ONR-funded Electric Ship Research and Development Consortium (ESRDC)
- Developing intelligent reconfiguration, islanding and restoration methods for future grid designs to respond to extreme events such as hurricanes, including modeling of a Florida major municipal power grid to develop and test the concepts.
- Validating and supporting development of voltage control solutions for NW US power system to mitigate grid disturbances surrounding wind farm, includes developing modeling and simulation for portion of Bonneville Power Administration system and new STATCOM device.
- Analysis and testing of fault current limiter behavior.
- Hardware-in-the-loop testing of protective relaying with SEL and Beckwith relays integrated with new wide-area-protection schemes implemented in realistic power system simulation
- Successfully tested 5 MW HTS prototype electric warship propulsion motor for U.S. Navy.

Potential Contributions to Florida Power System Storm Hardening

- Realistic and rapid assessment of a multitude of scenarios for how the Florida power grid can be hardened before, during and after a storm, in terms of system configuration options for electric reliability and robustness, including reactive power needs and maintaining power to vital loads.
- The availability of reactive power to support reconfiguration of undamaged power lines during the storm can be assessed, and for post-storm system restoration; Can assist in locating back-up power and scheduling real and reactive generation under unusual system configurations.
- Realistic simulation and training in preparation for storm season to allow grid operators to achieve detailed understanding of system responses to extremely unusual storm-induced events (faults, special system configurations, reactive power needs, etc.).
- Real-time processing power has potential for rapid evaluation of many reconfiguration options – e.g. a special emergency analytical response center for rapid decision support

About CAPS

CAPS occupies 33,000 square feet of research laboratory, test facility, and office space in Tallahassee's Innovation Park, adjacent to the National High Magnetic Field Laboratory (NHMFL) and the FAMU-FSU College of Engineering. The unique operation at CAPS has provided graduate and undergraduate engineering students the opportunity to work with cutting-edge tools and facilities along with top-flight power-systems researchers. In the short time since its inception, the CAPS power systems program has graduated close to 20 engineers. CAPS staff currently numbers approximately 32 people, with a research team comprised of dedicated and highly skilled researchers, scientists, faculty, engineers, and students, recruited from across the globe, with strong representation from both the academic/research community and industry.