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NASPI – Chicago
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DOE IIT FOA 767: Synchrophasor Engineering Research and Training

DOE OE Selected 7 Academic-Industry Collaboration Projects

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May 1, 2013 - 1:40pm

The Department of Energy (DOE) has selected seven projects for awards totaling approximately $1.4 million to help colleges and universities better prepare the electricity industry workforce of the future. Use of synchrophasor data from Phasor Measurement Units (PMUs) is considered to be a promising tool to monitor modern electric power systems, and identify and respond to deteriorating or abnormal grid conditions more quickly. Thanks to Recovery Act funding, more than 800 PMUs are being installed at strategic locations across the nation's transmission system. However, only a limited number of professionals, researchers, and students have the knowledge and expertise to understand and analyze the high-speed, time-synchronized data that will be generated by the deployment of these devices.

These awards will provide researchers and students with access to data provided by their utility collaborators and will create an opportunity for academic institutions to collaborate with other stakeholders to expand their graduate and undergraduate engineering curricula in grid dynamics, process simulation, control, and analysis tools. Students and researchers will receive hands-on simulator-based training experience and learn how commercial-scale power plants and systems respond dynamically to grid oscillations and system disturbances, and to stress from high power demands. The awards are also intended to facilitate the development of curricula and skills needed for better understanding of the complex conditions of the smart grid environment.

The seven projects selected for awards are listed below. All of the awards are based on a competitive solicitation and are subject to negotiation.

- **Washington State University (Pullman, WA):** *A Collaborative Educational Program on Synchrophasor Applications for Smart Electric Grid.*
  DOE share $200,000; recipient share $1,173,612.
- **North Carolina State University (Raleigh, NC):** *Development of a Multi-User Network Testbed for Wide-Area Monitoring and Control of Power Systems Using Distributed Synchrophasors.*
  DOE share $200,000; recipient share $50,000.
- **Illinois Institute of Technology (IIT) (Chicago, IL):** *IIT-Industry Collaboration: Synchrophasor Engineering Research and Training.*
  DOE share $200,000; recipient share $50,001.
- **University of Wyoming (Laramie, WY):** *Advancing Synchrophasor Applications and Training through Academic-Industry Collaborations.*
  DOE share $199,978; recipient share $142,160.
- **Virginia Polytechnic Institute and State University (Blacksburg, VA):** *Data Mining and Playback of Hybrid Synchrophasor Data for Research and Education.*
  DOE share $199,995; recipient share $50,024.
- **Texas Tech University (Lubbock, TX):** *Collaborative Industry-Academic Synchrophasor Engineering Program.*
  DOE share $199,951; recipient share $50,000.
- **Clemson University (Clemson, SC):** *Clemson University's Synchrophasor Engineering Education Program.*
  DOE share $200,000; recipient share $50,000.

Overview

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- Partners
  - Schweitzer Engineering Laboratories
  - Commonwealth Edison Company
  - Naperville (municipal) Electric Utility
  - IIT Facilities
- Synchrophasor Data Collection
- Laboratories and Short Course
- Students Looking for Projects
  - Event Detection (abnormal conditions)
  - Data Filtering (reduce storage burden)
  - Modeling (reduce uncertainty)
- Faster than Real-time Dynamics Simulation

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SEL Hardware and Software

- SEL 351 Relays (2 in lab, 35 in three HRDS loops)
  - Distribution Feeder Protection (directional overcurrent)
  - Mirrored Bits (Perfect Power System with POTT - High Reliability Distribution System designed by S&C Electric)
  - IEEE C37.118 Synchrophasors
- SEL 2407 GPS Clock
- SEL 4000 Relay Test System
  - COMTRADE files from IIT 3-ph dynamics simulator
- SEL 5073 Phasor Data Concentrator
- SEL 5078-2 Synchrowave Central Software

Data Collection

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- Illinois Institute of Technology
  - Capturing three-phase voltages and currents (2012)
  - 12 Phasor Measurement Units on campus
  - 250+ analog channels (e.g., phase current, LG or LL voltage; 4 kV cable, 480 V & 208 V building transformers)
  - 60 samples/sec
    - 10M+ values per channel per day
    - 10 GB of data per day
- Naperville Electric Utility (pop. 142k, 57k customers)
  - 138 kV - 12 kV substation (two 138kV lines, ten 12kV feeders)
- Commonwealth Edison Company (3.8M customers)
  - 345 kV substations (distributed throughout 345kV backbone)

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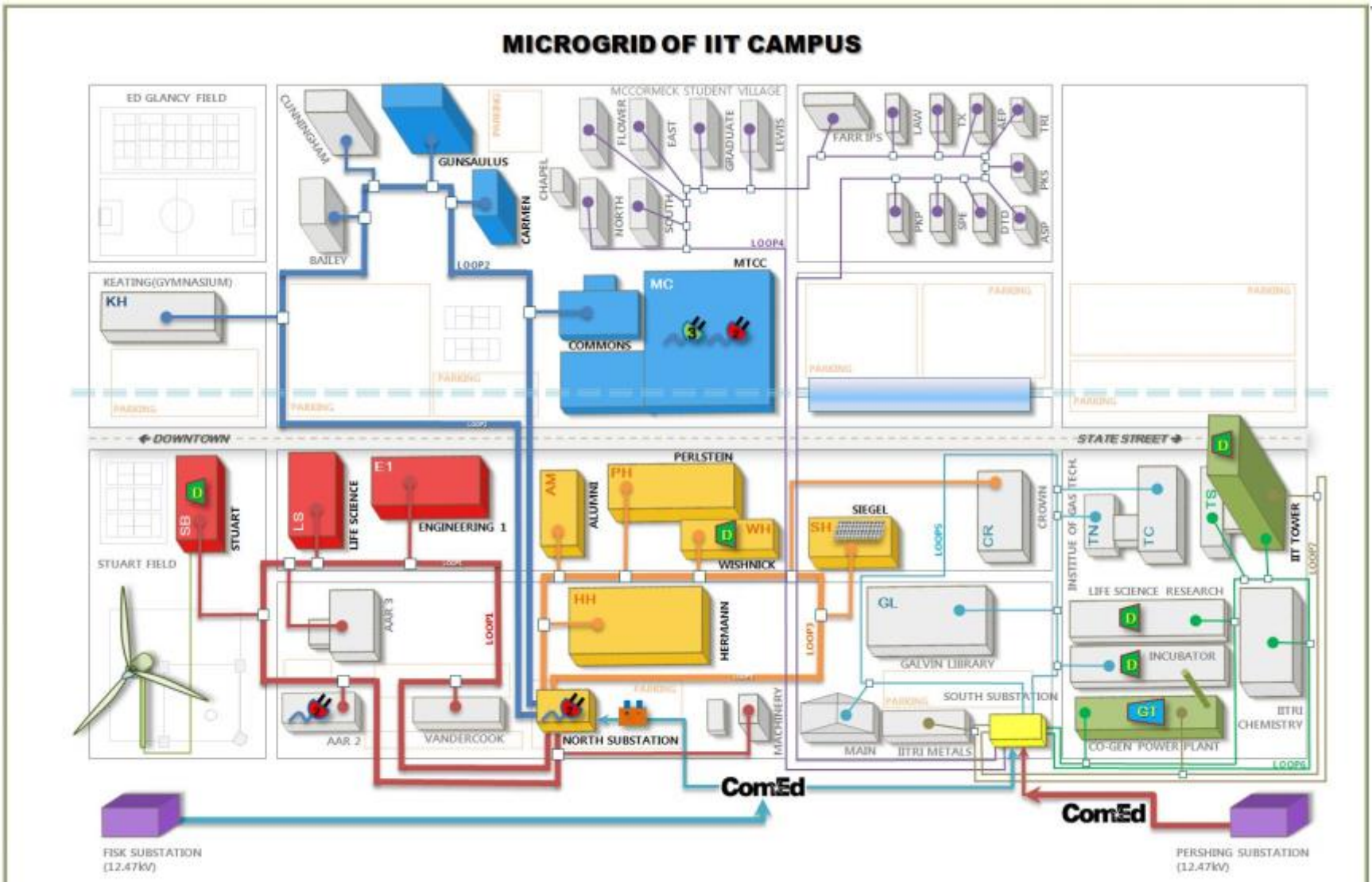
IIT Microgrid



IIT North Substation: September 2012 Peak Week

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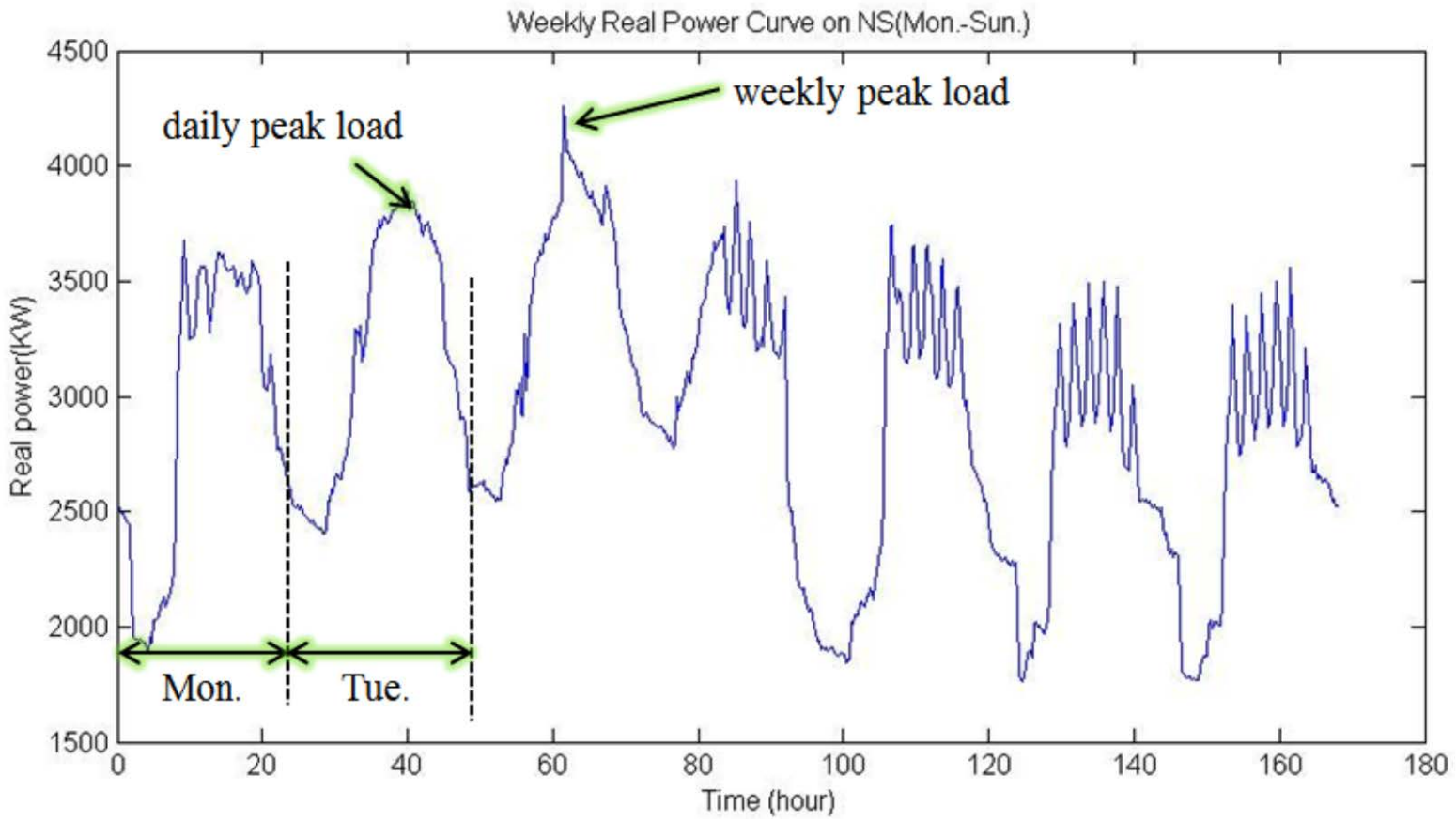

Midway Airport Air Temperature: September 2012 Peak Week

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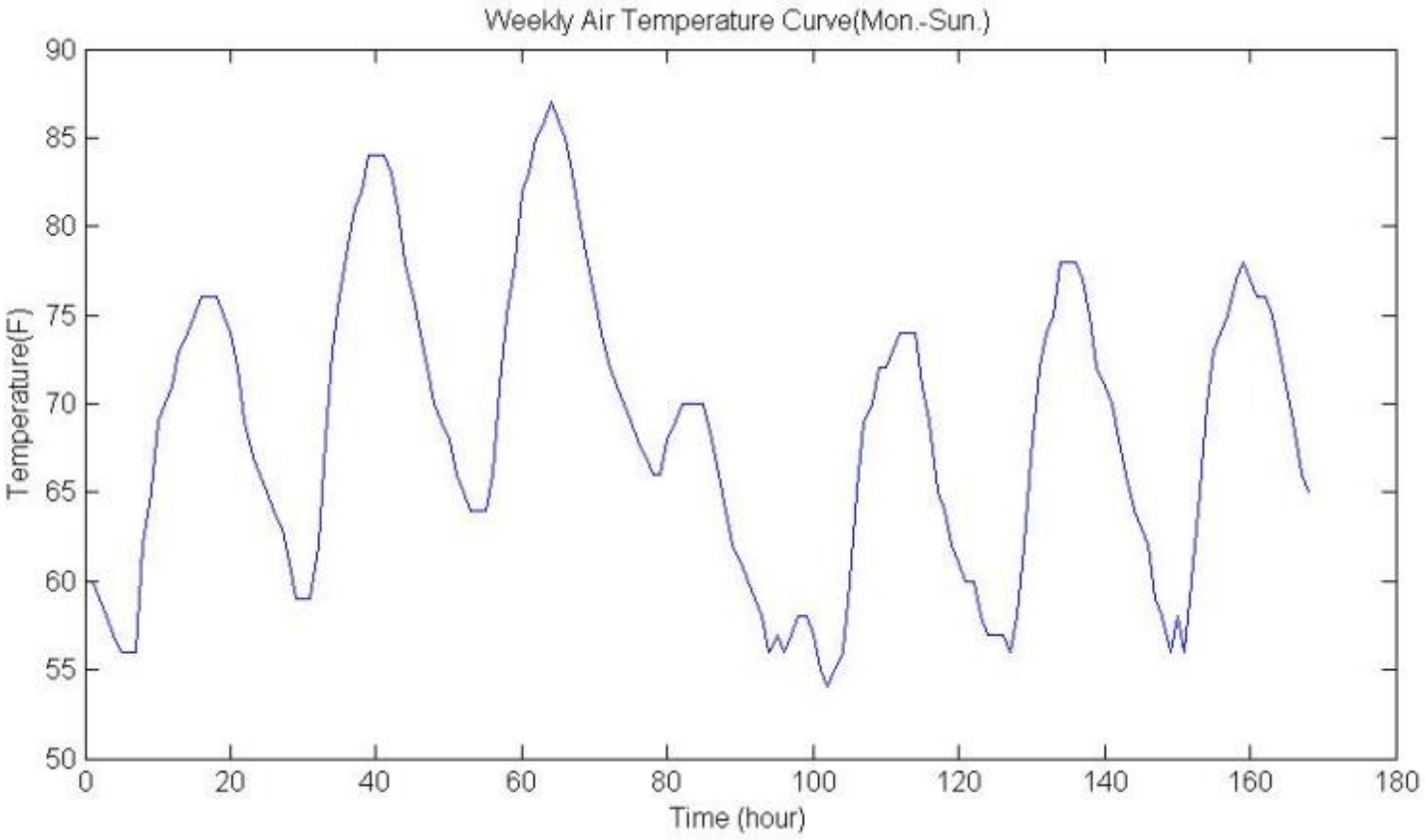

Undergrad Labs and Grad Short Course

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- Fundamentals of Power Engineering
  - Junior-level required course
  - Existing Lab: transformers, machines, three-phase lines, system simulation via PowerWorld
  - *New SEL Synchrophasor Experiments: three-phase state, transformer monitoring, symmetrical faults*
- Power System Analysis
  - Senior-level elective course
  - Existing Lab: system simulation via Siemens PTI PSSE
  - *New SEL Synchrophasor Experiments: unbalanced faults, dynamics*
- Synchrophasor Short Course
  - Graduate-level, continuing education course
  - IEEE C37.118, synchrophasor hardware, synchrophasor applications
  - **What topics would you suggest?**

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Potential Student Projects

- Analyze "normal" data stream
  - Develop event detection & data filtering apps
  - Look for close-calls and non-trip events
  - Investigate eminent failure pre-cursor information
  - Monitor transformers (LTC settings)
  - Compare PMU data to smart meter data (energy, voltage, CVR)
- Study "events"
  - Estimate fault locations (e.g., URD branched circuits)
- Model validation
  - Validate dynamics data
  - Validate distribution network models
  - Develop and validate load models
- **If you have synchrophasor data, then we'd like to work with you!**

Faster than Real-Time Dynamics Simulation

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- DOE IIT FOA 729 Project
  - IIT, Argonne National Laboratory, Electrocon, Alstom Grid, McCoy Energy, ComEd, AltaLink, TVA
- 3-phase unbalanced dynamics simulator
  - Detailed generator models (incl. Over-Excitation Limiters), control devices (e.g., SVC), load models
  - Protection models (via CAPE) incl. special protection schemes
  - 1-phase induction motors with rotor-stall feature (e.g., FIDVR)
  - High performance computing (tightly-coupled parallel computing)
- **Seeking more utilities: validate models, investigate relay protection interactions with system dynamic performance**

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Thank you!

I look forward to your feedback (Short Course, Student Projects, Faster than Real-Time Dynamics Simulation)

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