Benefiting from Interagency Funded I/UCRC Supplements: PSERC’s Future Grid Initiative

Research and education to enable renewable energy resources

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Future Grid Initiative

• **PSERC** has embarked on an exciting and challenging research initiative to address national energy challenges associated with the evolution of the electric energy grid. The initiative is funded by DOE’s Office of Electricity Delivery and Energy Reliability and recognized as contributing to DOE’s future grid visioning process.

• A critical component of this initiative is an attempt to encapsulate the engineering building blocks required for the future grid architecture to support an increased penetration of renewable resources – **wind and solar**.
National Energy Challenges

Energy independence, affordability

Energy reliability, security, efficiency

Economic development and job security

Environmental concerns and impact of climate change

Aging infrastructure, technology change, workforce needs
Range of Energy Solution Options

- Renewable resource technologies
  - Energy efficiency
- Demand resources
  - Market solutions
- Nuclear energy technologies
  - Develop domestic resources
  - Improved asset utilization
- Electric transportation
  - Carbon capture and storage
- Energy storage
The Grid as an Enabling Technology

- Power Plant Generates Electricity
- Transmission Lines Carry Electricity Long Distances
- Distribution Lines Carry Electricity To Houses
- Transformer Steps Up Voltage For Transmission
- Neighborhood Transformer Steps Down Voltage
- Transformers On Poles Step Down Electricity Before It Enters Houses

- Substation Batteries 10’s of MW
- Distributed Intelligence and Control
- Storage at Grid Edge 10’s of kW
- Reactive Compensation
- Micro-grids
Overarching Issues

• Given this set of national energy solutions, how does the electric grid infrastructure evolve to accommodate these solutions?
• What elements constitute the building blocks of this evolution?
• Given the large capital investment in the legacy grid, what steps are required to seamlessly transition from the legacy grid to accommodate the elements of the proposed building blocks?
Drivers of the Future Grid

Changing Generation Supply Mix

- T&D additions and changes
- Energy storage
- Enhanced control/communications
- Handling increased uncertainty

Drivers of the evolution/changes

- Renewable resources
- Retirement of aging conventional plants
- Questions regarding nuclear additions
- Carbon regulation

Needed evolution(changes to support this element
Drivers of the Future Grid

Demand Transformation

• Expanding digital economy
• Power quality and reliability needs
• Demand flexibility
• Electric vehicles

Needed evolution/changes to support this element

Drivers of the evolution/changes

• Economic constraints
• Changing customer needs
• Green awareness and demand
• Need for higher reliability and efficiency
Drivers of the Future Grid

Complexity of Grid

- Expanding footprint
- Impact of markets
- Tighter operating limits
- Greater reliance on communication & control
- Need for advanced analytical tools

Drivers of the evolution/changes

- Spatio-temporal constraints
- Computational complexity
- Stochastic nature of variables
- Need to contain cost

Needed evolution/changes to support this element
Drivers of the Future Grid

Infrastructure Vulnerability

- Reduce footprint of disruptions
- Reliability of communication and control
- Reduced duration of disruptions
- Guard against malicious attacks

Needed evolution/changes to support this element

Drivers of the evolution/changes

- Shortage of skilled personnel
- Inadequate analytical tools
- Interdependence of cyber-physical systems
Research Supporting Objectives to Create an Enabling Grid

• Plan and operate grid with increased penetration of renewable resources while meeting any carbon regulation requirements

• Design grid architecture to support renewable penetration and transformation of demand as a resource

• Manage increased dependence on control, communication and cyber-physical systems to handle grid complexity
Research Supporting Objectives to Create an Enabling Grid

• Create analytical tools to account for increased variability and stochastic nature of elements

• Prepare for needed workforce training
Project Objectives

• To investigate the requirements of an electric grid with high penetrations of sustainable energy systems and heavy reliance on cyber systems for sensing and communication

• To stimulate discussion among the academic, industry and government communities on what it will take to shape the future grid for the mid-twenty-first century
Project Elements

• Six Thrust Areas (5 research, 1 workforce)
• Two White Paper Collections
  • The Information Hierarchy for the Future Grid
  • Grid Enablers of Sustainable Energy Systems
• Thirteen Universities; 40 Collaborating Researchers; Industry Advisors/Reviewers
• Public events (more in planning)
  • Dec. 7 public workshop at Berkeley
  • Webinar series on white papers
  • National forum in DC on June 27-28, 2012
  • Session at IEEE PES General Meeting
Renewable Resource Integration

- Control and Protection
- Computation and Uncertainty
- Cyber Physical Systems
- Work Force Training
Process Details

• Funding provided as supplement to IUCRC grant
• Interagency Agreement between NSF and DOE for $5.8M. After overhead, $5.513M distributed to PSERC universities.
• IAA Period: 8/30/2010 – 8/30/2015
• Particular projects identified in interactive process with academic and industry reviews
Value to PSERC

• Research and education funding
• Visibility
• Contributing to national issues/concerns
• Participation in and facilitating national discussions
• Membership
  • Highest attendance ever occurred at last IAB meeting at which the Future Grid Initiative Workshop was held
  • New memberships
  • Strong justification for continuing membership
General Comments

• Interagency supplemental funding provides a way to add agencies as “members” without their signing an IUCRC membership agreement.
• No need for sole source justification
• May not be need for competitive procurement process
• Increases flexibility in agency relationship
• Details at: http://www.nsf.gov/eng/iip/iucrc/mipr.jsp