

Power Systems Engineering Research Center: An Overview



**A National Science Foundation
Industry-University Cooperative Research Center**

PSERC Overview

- NSF Industry/University Cooperative Research Center: lead university at Arizona State Univ.
- Collaborative, Industry-Supported, Multi-disciplinary: Power Systems, T&D Technologies, Power Markets and Policies
- 37 industry members, 13 universities, 50+ faculty (many more “in the wings”), 60+ grad students
- Also Federally-Supported Research
 - Consortium for Electric Reliability Technology Solutions
 - Future Grid for Enabling Sustainable Energy Systems

PSERC

Our core purpose:

Empowering minds to engineer
the future electric energy system

What is important to us:

Pursuing, discovering
and transferring knowledge

Producing highly qualified
and trained engineers

Collaborating in all we do

PSERC

What we're working toward:

An efficient, secure, resilient, adaptable, and economic electric power infrastructure serving society

A new generation of educated technical professionals in electric power

Knowledgeable decision-makers on critical energy policy issues

Sustained, quality university programs in electric power engineering

History

- Idea for PSERC began in Aug 1986
- NSF Engineering Research Center proposals – 1994 and 1995
- NSF Industry/University Cooperative Research (I/UCRC) planning meeting - May 1996
- Established with four schools - Dec 1996
- Added one school - Aug 1998
- Added six more in 1999 - 2000
- Re-organized management and added executive director in 2000
- Added two more schools in 2001
- Completed transition to new lead school - Jan 2006
- Became a Phase III I/UCRC - March 2010

Collaborating Universities and Site Directors

- **Arizona State University** - Gerald Heydt
- **University of California at Berkeley** - Shmuel Oren
- **Carnegie Mellon University** - Marija Ilic
- **Colorado School of Mines** - P.K. Sen
- **Cornell University** - Lang Tong
- **Georgia Institute of Technology** - Sakis Meliopoulos
- **Howard University** - James Momoh
- **University of Illinois at Urbana** - Peter Sauer
- **Iowa State University** - Venkataramana Ajjarapu
- **Texas A&M University** - Mladen Kezunovic
- **Washington State University** - Anjan Bose
- **University of Wisconsin-Madison** - Chris DeMarco
- **Wichita State University** - Ward Jewell

Current Industry Members

ABB	Midcontinent ISO
American Electric Power	Mitsubishi Elec. Research Lab
American Transmission Co.	NASA
ALSTOM Grid	National Renewable Energy Lab.
Arizona Public Service	National Rural Elec. Coop. Assn.
BC Hydro	New York ISO
Bonneville Power Admin.	New York Power Authority
California ISO	Pacific Gas and Electric
CenterPoint Energy	PJM Interconnection
Duke Energy	PowerWorld Corp.
EPRI	RTE (France)
Exelon	Salt River Project
GE	Southern California Edison
FirstEnergy	Southern Company
Institut de recherche d'Hydro-Québec (IREQ)	Southwest Power Pool
ISO New England	TVA
ITC Holdings	Tri-State G&T
Lawrence Livermore National Lab	U.S. DOE
	Western Area Power Admin.

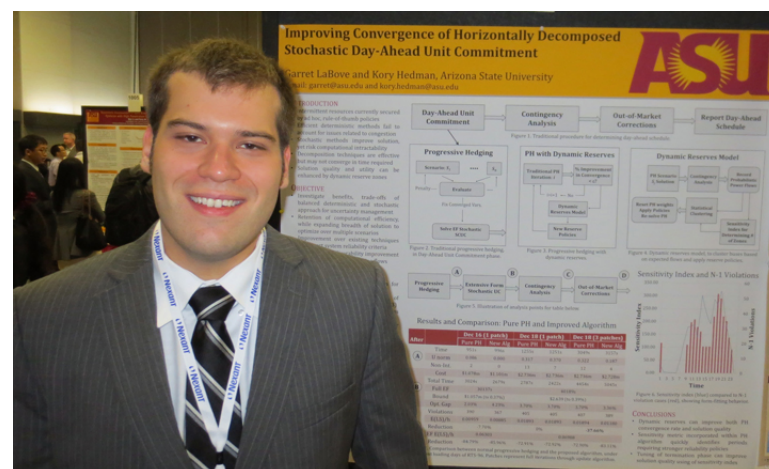
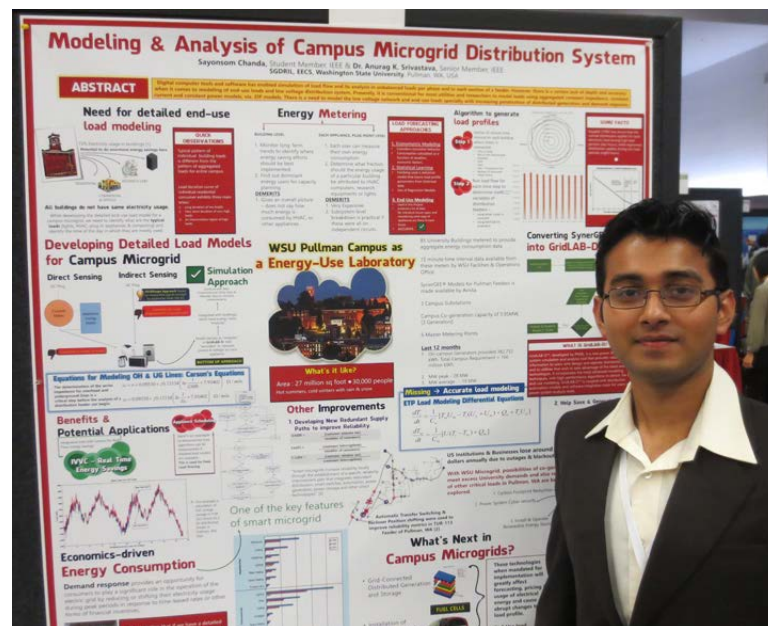
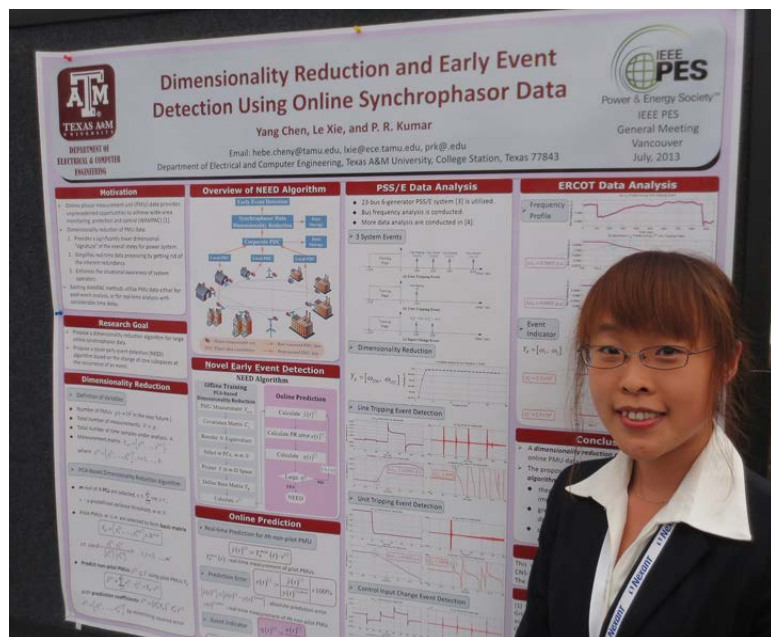
Connecting with our Students

- Most research funding goes to graduate students (many of whom get recruited.)
- Opportunities to connect with students at PSERC universities
 - Getting recommendations from our faculty
 - Receiving student resume packets
 - Emailing position openings to students
 - Having conversations with students at IAB meetings
 - Meeting students on project teams
 - Advertising your career opportunities web page on PSERC website
- Connecting with students nationwide: PES Careers U.S. & Canada

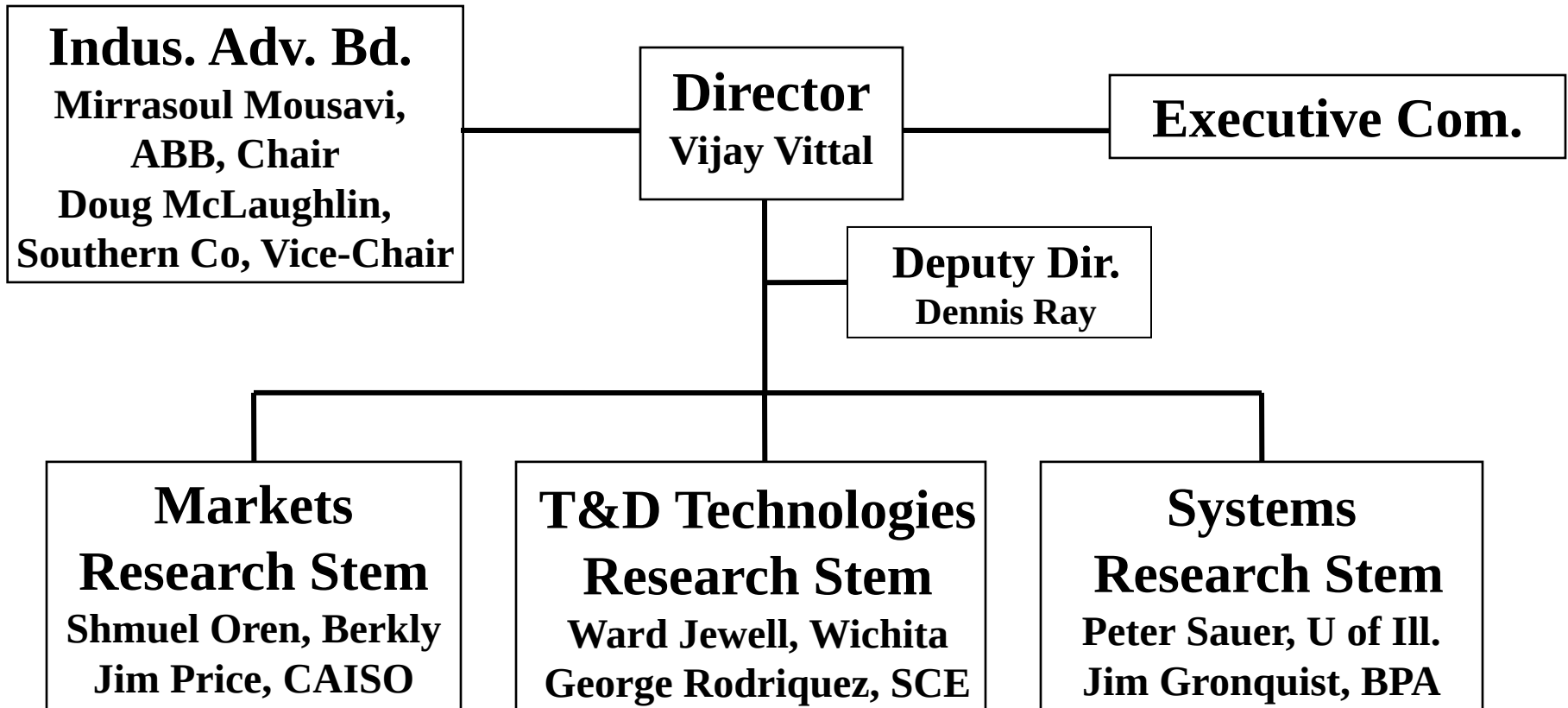
PSERC Students at IAB Meetings



PSERC Students at 2013 IEEE PES GM



Our Organization



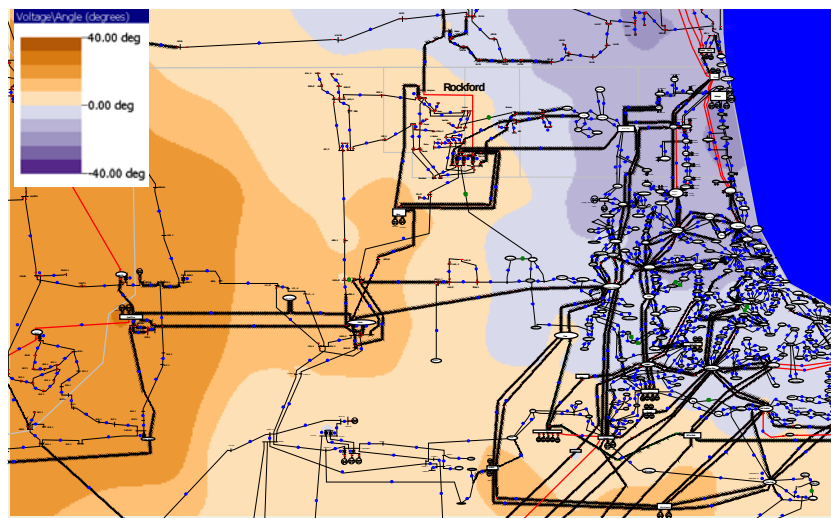
Past and Present PSERC Leadership



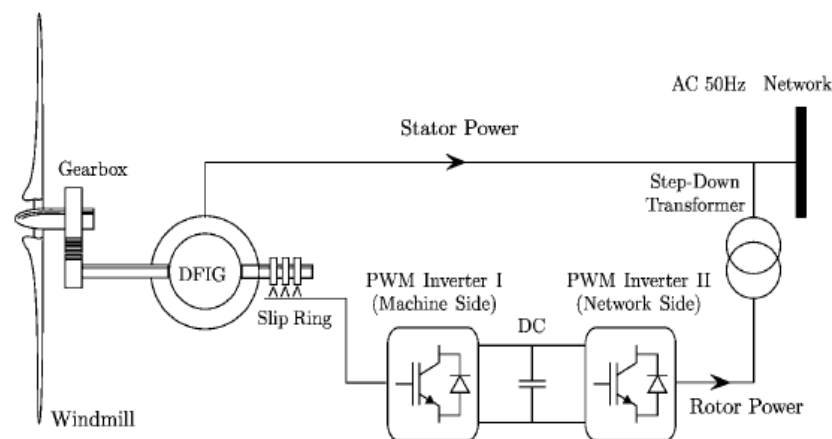
Bob Thomas (Cornell Univ.), Founding Director; Doug McLaughlin (Southern Co.), IAB Vice Chair; Vijay Vittal (Arizona State Univ.), Director; Mirrasoul Mousavi, IAB Chair; Jay Giri (ALSTOM Grid), Past IAB Chair

Systems Research Stem

Systems research focuses on efficient and reliable operation of complex and dynamic power systems



Angle contour results for 13,000 bus Midwest test system. PSERC research is showing how PMU values can be directly combined with existing power flow cases to enhance situational awareness.



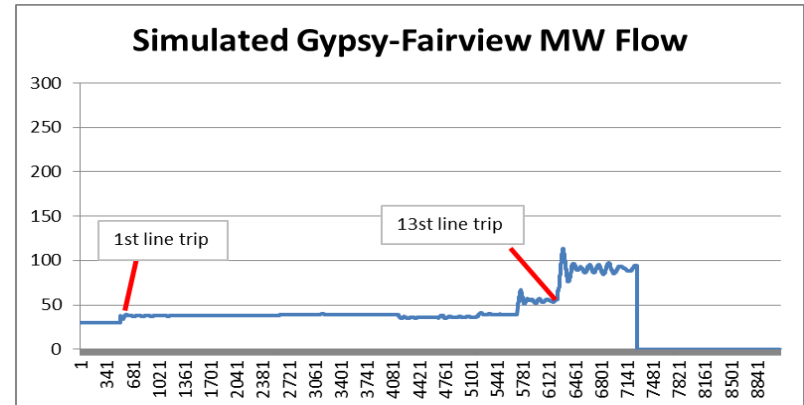
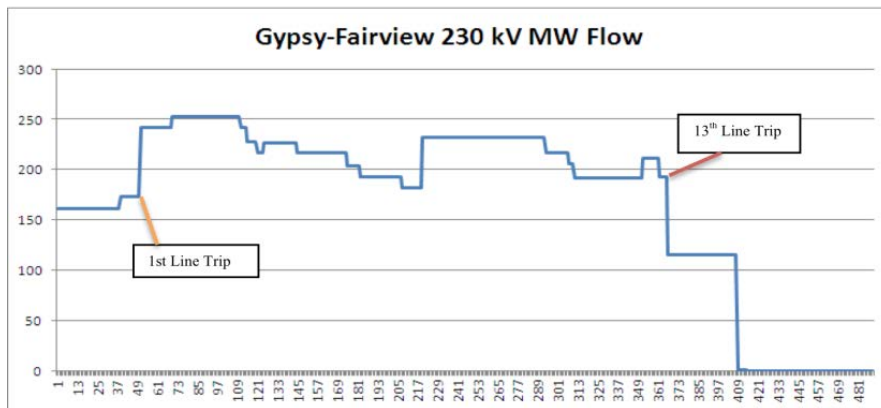
Doubly-fed induction generator. PSERC researchers found that high penetration of wind-powered DFIG's may affect transient stability, frequency response, regulation, voltage response, fault ride-through capability, and load following capability in a power system.

Ongoing Projects – Systems Stem

- Exploiting Emerging Data for Enhanced Load Modeling ([S-49](#))
- Real Time PMU-Based Stability Monitoring ([S-50](#))
- The Application of Robust Optimization in Power Systems ([S-51](#))
- Coordinated Aggregation of Distributed Demand-Side Resources ([S-52](#))
- Seamless Bulk Electric Grid Management ([S-53G](#))
- Towards a Privacy-Aware Information-Sharing Framework for Advanced Metering Infrastructures ([S-54](#))
- Toward Standards for Dynamics in Electric Energy Systems ([S-55](#))
- Stability, Protection and Control of Systems with High Penetration of Converter-Interfaced Generation ([S-56](#))
- Adaptive and Intelligent PMUs for Smarter Applications ([S-57](#))

Recently Completed Systems Projects

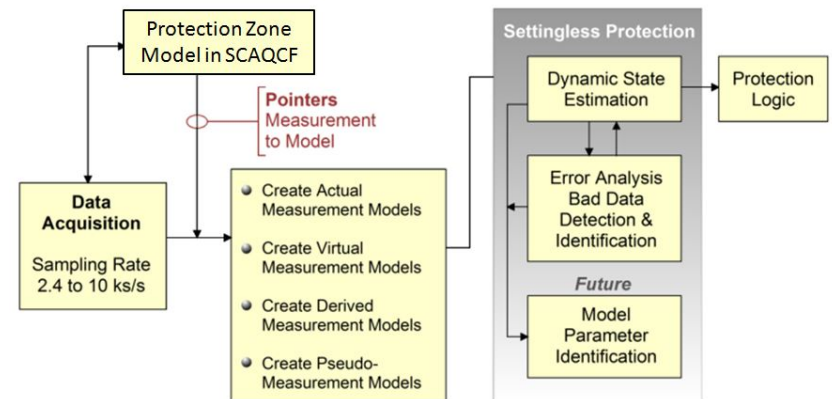
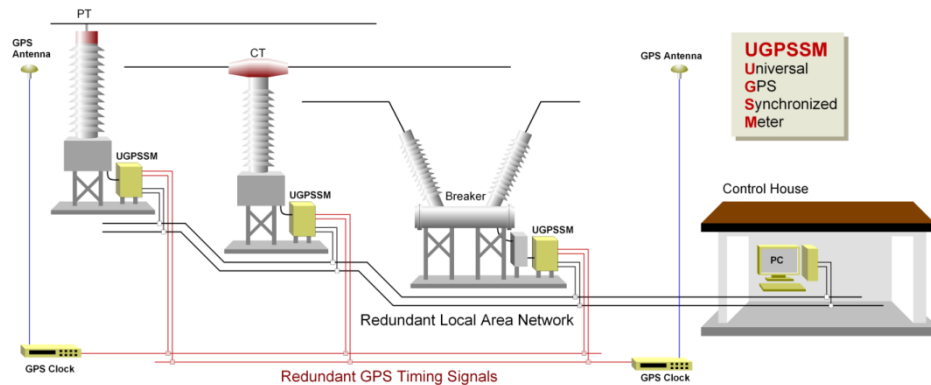
- Data Mining to Characterize Signatures of Impending System Events or Performance from PMU Measurements ([S-44](#))
- Testing and Validation of Phasor Measurement Based Devices and Algorithms ([S-45](#))



In S-44, detailed simulation of islanding during Katrina revealed SCADA errors.

T&D Technologies Research Stem

T&D research improves transmission and distribution systems with technology innovations



Conceptual view of the substation of the future T&D technology research seeks new ways to achieve efficient and reliable power delivery such as by using new monitoring and control technologies in substations, and new applications in energy management systems.

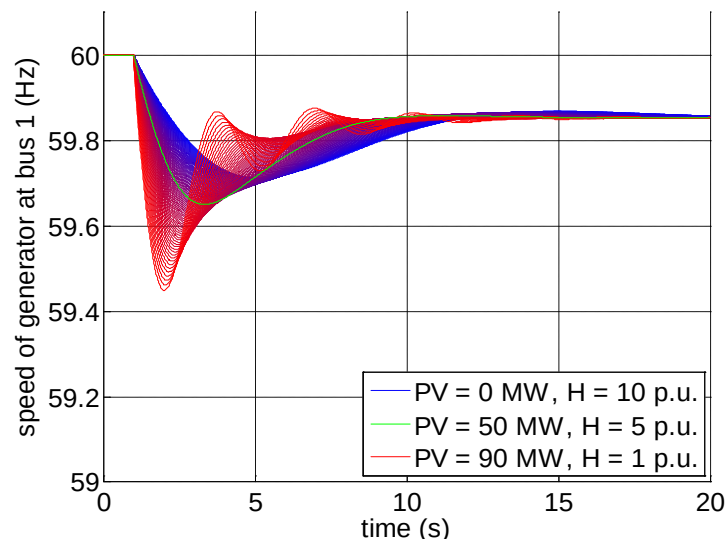
T&D technology research is exploring use of new technologies for protection and control such as setting-less protection.

Ongoing Projects – T&D Stem

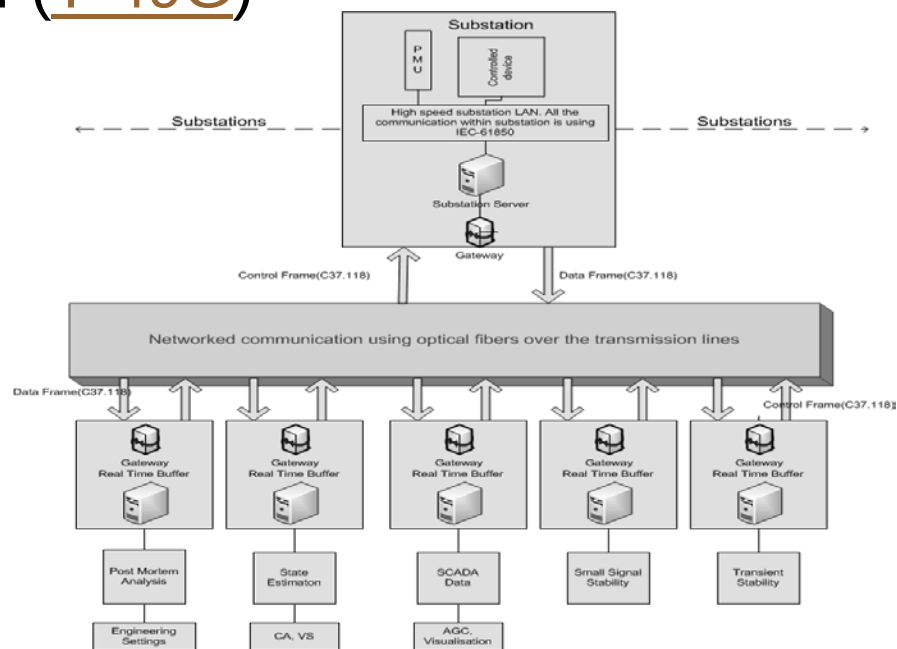
- Making the Economic Case for Innovative HTLS Overhead Conductors ([T-47](#))
- The Economic Case for Bulk Energy Storage in Transmission Systems with High Percentages of Renewable Resources ([T-48](#))
- The Electricity and Transportation Infrastructure Convergence Using EVs ([T-50G](#))
- Systematic Integration of Large Data Sets for Improved Decision-Making ([T-51](#))
- Setting-Less Protection: Laboratory Demonstrations ([T-52G](#))

Recently Completed T&D Projects

- Distribution System Analysis Tools for Studying High Penetration of PV with Grid Support Features ([T-44](#))
- The Next Generation EMS Design ([T-45](#))
- Setting-less Protection ([T-49G](#))



Degradation in inertial response, 4-bus system, due to loss of generation for high PV (T-44)



Centralized communications system (T-45)

Markets Research Stem

Markets research focuses on planning, design and operation of smart markets for a smart electric grid

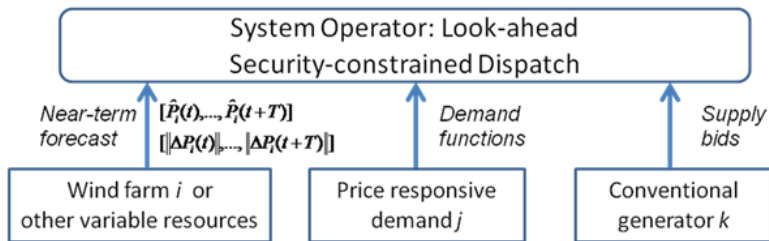
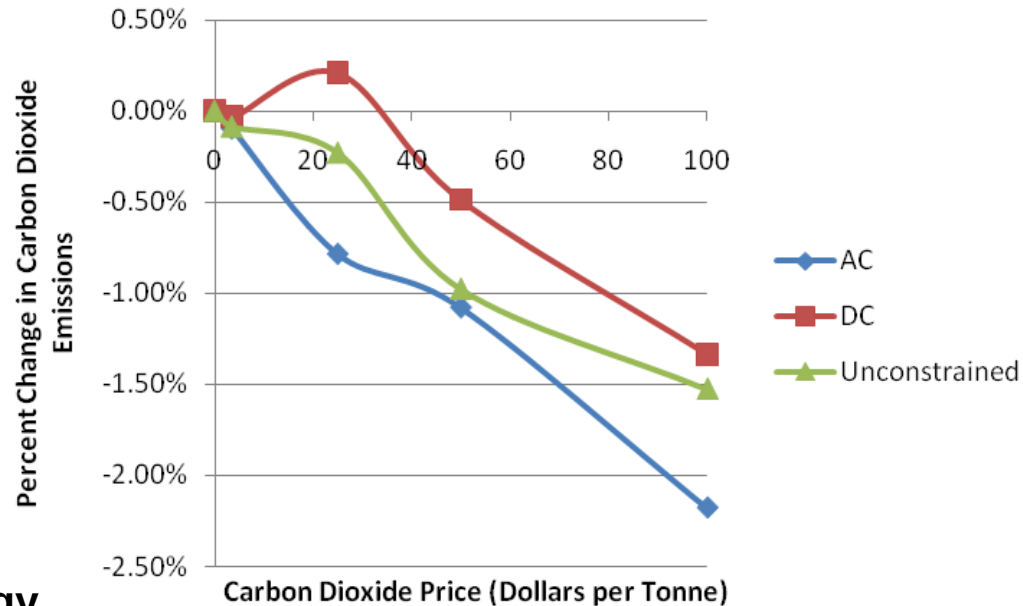


Figure 1: Implementation of look-ahead dispatch with price responsive demand

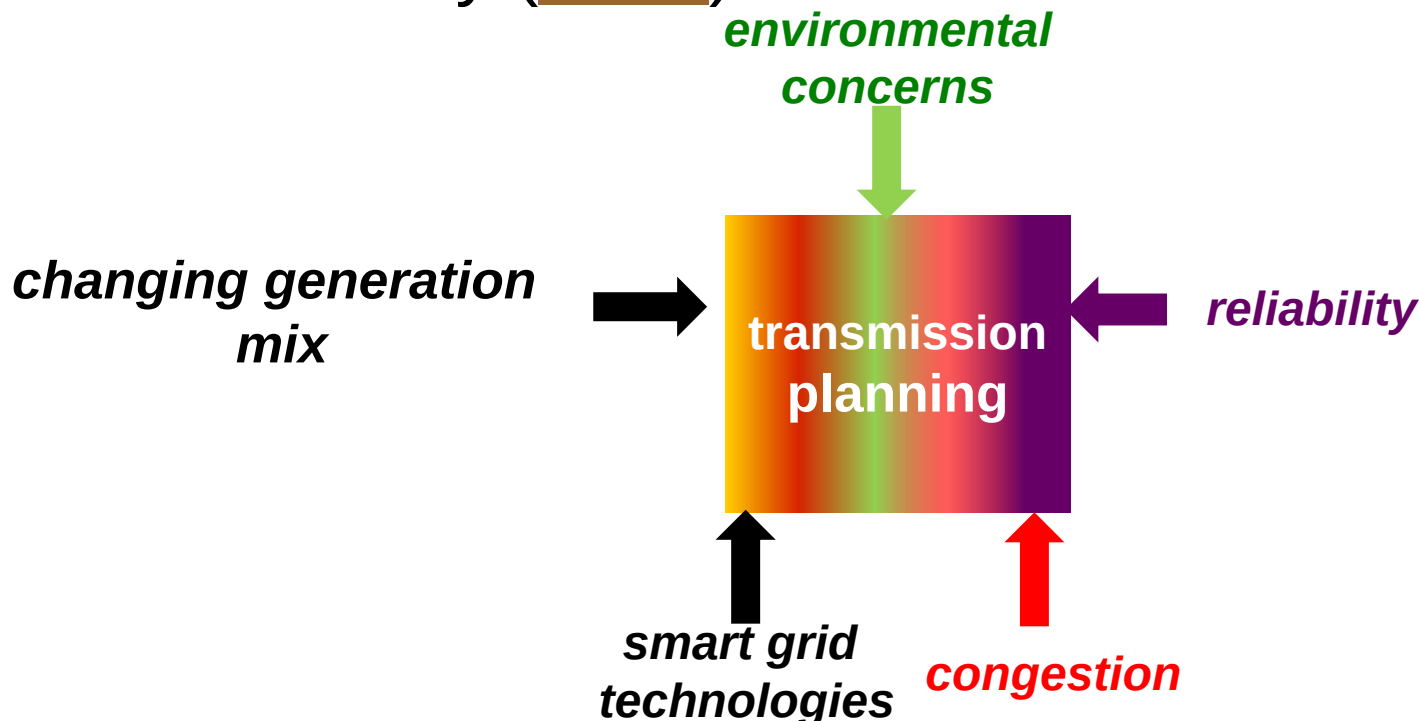
Control of demand-side resources, energy storage, and reserves are being studied to find ways to help operators integrate renewable resources while preserving system security and reliability, and avoiding undesired load interruptions.



PSERC researchers are studying the interaction of carbon emission policies with power system configuration and market design.

Ongoing Projects – Markets Stem

- Constraint Relaxations: Analyzing the Impacts on System Reliability, Dynamics, and Markets ([M-29](#))
- A Framework for Transmission Planning Under Uncertainty ([M-30](#))



Recently Completed Markets Projects

- The Development and Application of a Distribution Class LMP Index ([M-25](#))
- Quantifying Benefits of Demand Response and Look-ahead Dispatch in Support of Variable Resources ([M-26](#))
- Impact of Bad Data and Cyber Data Attack on Electricity Market Operation ([M-27](#))
- Analytical Methods for the Study of Investment Strategies in Compliance with Environmental Policy Requirements ([M-28](#))

Proposals for New Projects in 2014

- New Operation Tools for Improving Flexibility and Reliability of Systems with Variable Resources and Storage Devices
- Markets for Ancillary Services in the Presence of Stochastic Resources
- Load Model Complexity Analysis and Real-Time Load Tracking
- Sparse Sensing Methods for Model-Free Sensitivity Estimation and Topology Change Detection Using Synchro-Phasor Measurements
- Hybrid Time Domain Simulation: Application to Fault Induced Delayed Voltage Recovery
- Reliability Assessment and Modeling of Cyber-Enabled Power Systems with Renewable Sources and Energy Storage

2013 Research Solicitation Process

- Discussions at IAB meetings (Dec. and May)
- Summer workshop (July 9-11) finalized the research solicitation
- Proposals received Sep. 16 for new projects in 2014
- Industry and academic reviews by October 8
- Executive Committee and Director recommendations to IAB by early November
- Industry makes final recommendations after proposal presentations at Dec. 4-6 meeting
- Final review by Executive Committee and decision by Director soon thereafter. Projects begin in June 2014 when funding is available.

2013 Summer Workshop



Additional Membership Funds

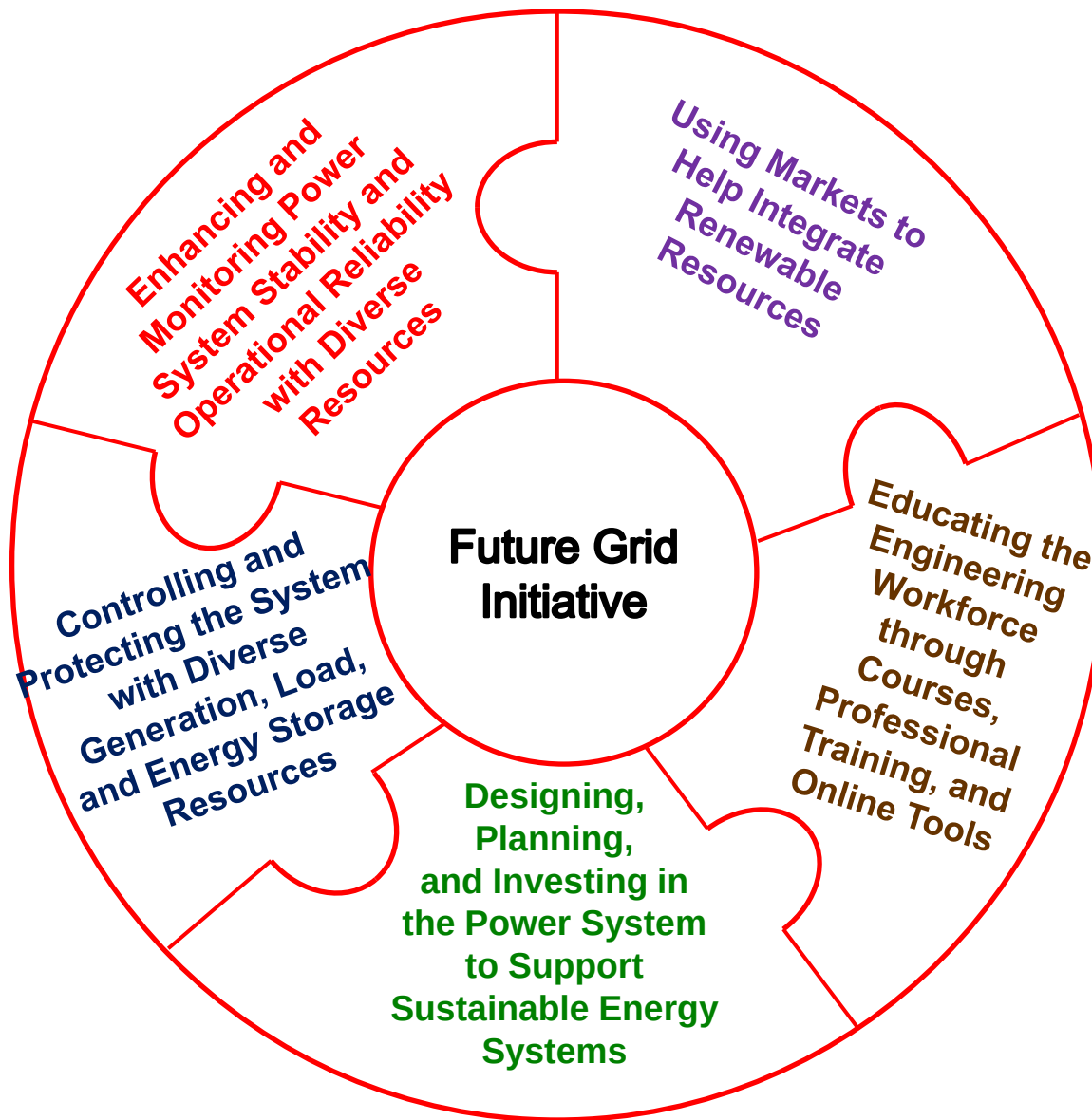
- Members can contribute beyond the standard membership fee.
- These projects can be developed without going through the solicitation process
- Approval is given by Director based on consistency with PSERC's research program.
- Additional membership fund projects are treated like other PSERC projects (for example, results are shared with other PSERC members and semi-annual reporting is required).

Leveraged Research

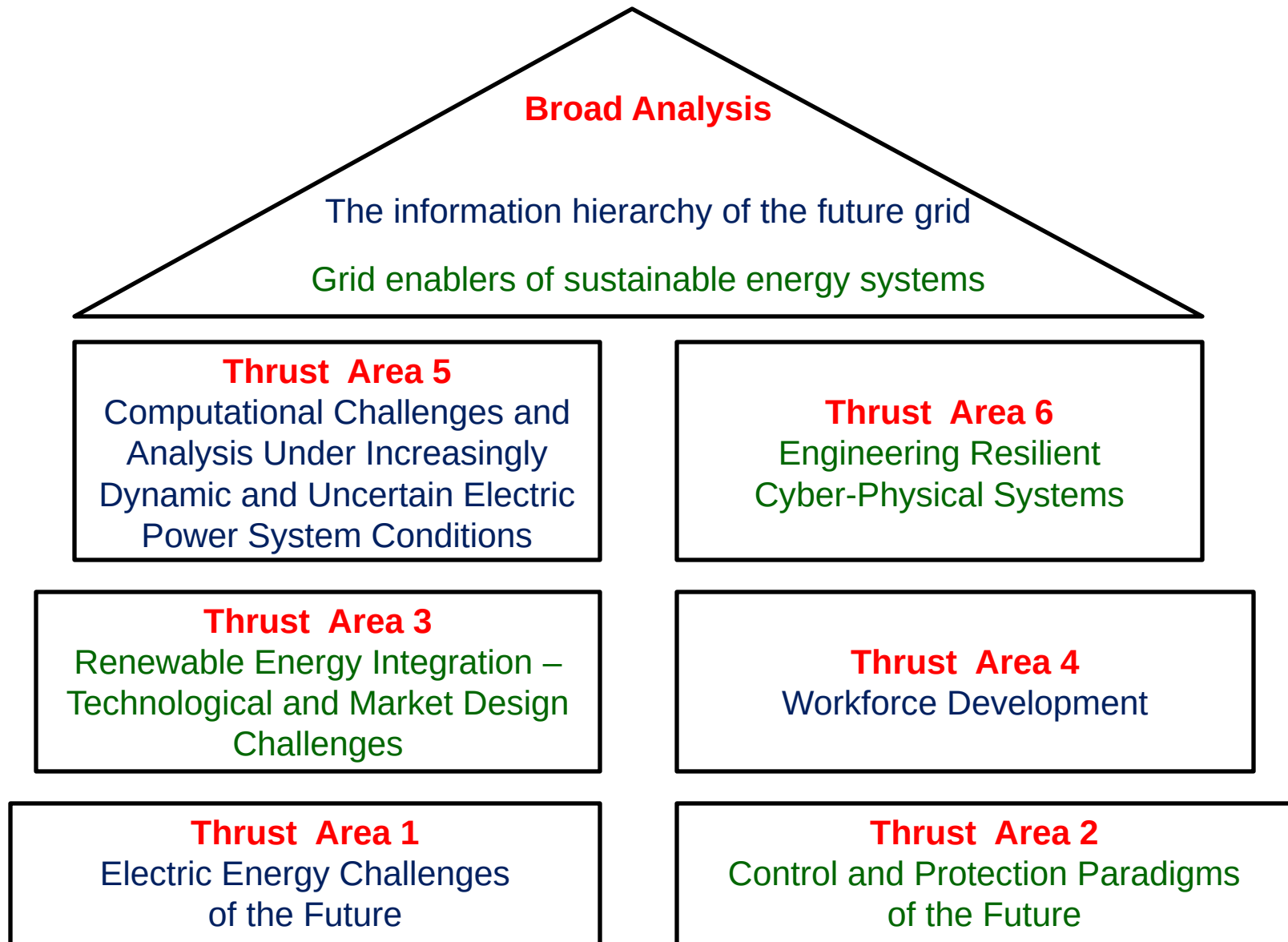
- Future Grid for Enabling Sustainable Energy Systems - DOE funded
- Consortium for Electric Reliability Technology Solutions - DOE funded

PSERC projects can become seed projects for new research funding.

Future Grid Initiative Themes

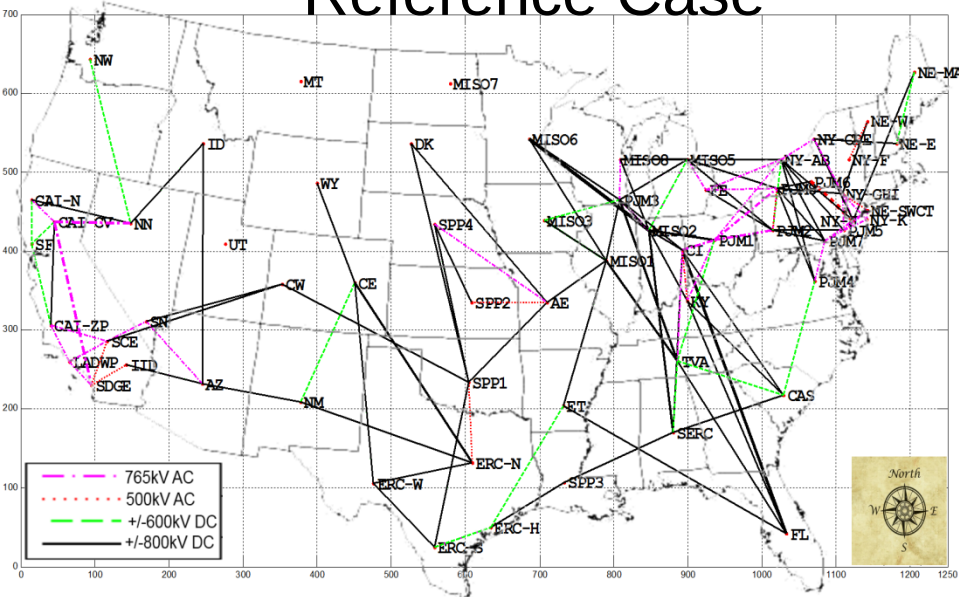


Future Grid Initiative Organization

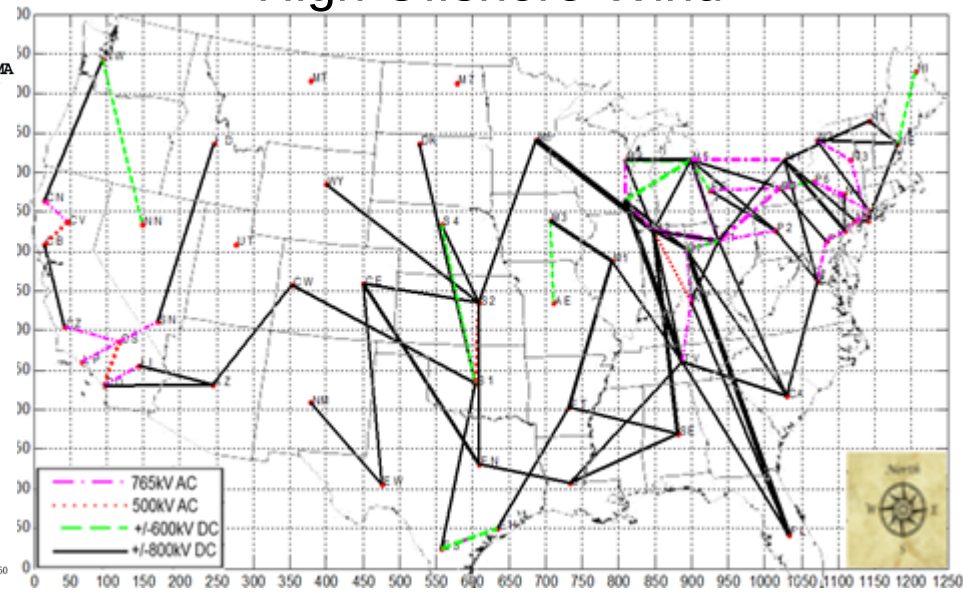


Transmission Overlay for Different Futures

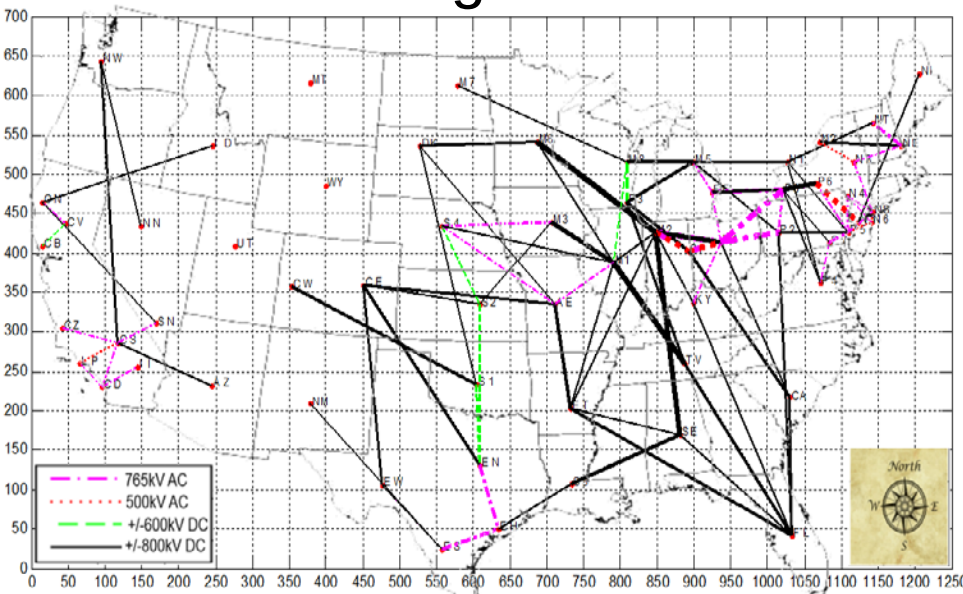
Reference Case



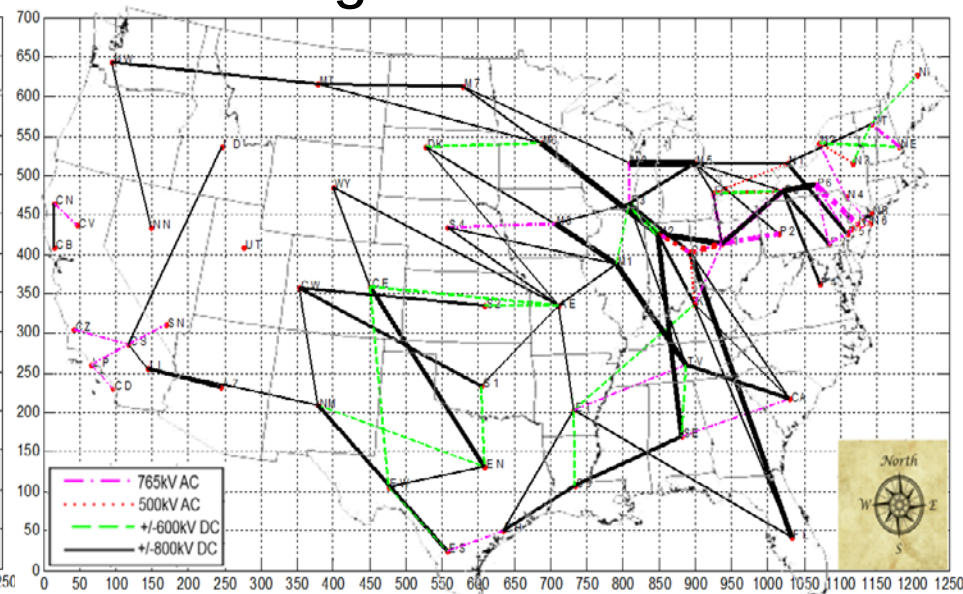
High Offshore-Wind



High Solar



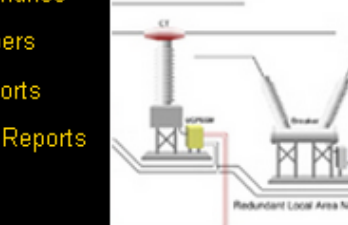
High Geothermal



2013 Research in Consortium for Electric Reliability Technology Solutions (CERTS)

- Area: Reliability and Markets, and Load as a Resource
 - Tools for Future Grid Engineering and Market Environments
 - Stochastic Planning, Operations and Markets Analysis
 - Demand-Side Markets, Environmental Dispatch, and Reliability
- Area: Automated Reliability Reports and Implementation
 - Post Disturbance Transmission Performance Metrics and Model-less Approach Validation, Prototype and Field

Where to find current PSERC research information
at www.pserc.org

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Calendar 2003 Blackout News Future Grid Initiative Webinars Sep. 17: <i>Measurement-Based Estimation of Linear Sensitivity Distribution Factors and Applications</i> (Archived Webinar Announcement Slides) Oct. 1: <i>Retail and Wholesale Power Market Operations under Increased Penetration of Price-Responsive Demand</i> (Announcement) Oct. 15: <i>A New Method for Estimating Maximum Power Transfer and Voltage Stability Margins to Mitigate the Risk of Voltage Collapse</i> (Announcement) Archived Tech Talks on the PSERC Future Grid Initiative	An efficient, secure, adaptable, and electric power infrastructure serving society	Research Future Grid Initiative Research Program Project Summaries White Papers Public Reports Members Only Reports Papers CERTS Research Software Tools	Working toward  PSERC is working to find new uses of PMU data (S-44, S-45, S-55, S-57, T-45).  PSERC assists the IEEE PES Scholarship Plus Initiative and maintains PES Careers
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Calendar

[2003 Blackout News](#)

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[Webinars](#)

Sep. 17: *Measurement-Based Estimation of Linear Sensitivity Distribution Factors and Applications* (Archived Webinar | Announcement | Slides)

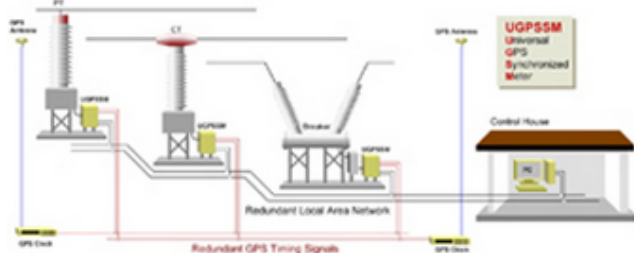
Oct. 1: *Retail and Wholesale Power Market Operations under Increased Penetration of Price-Responsive Demand* (Announcement)

Oct. 15: *A New Method for Estimating Maximum Power Transfer and Voltage Stability Margins to Mitigate the Risk of Voltage Collapse* (Announcement)

[Archived Tech Talks on the PSERC Future Grid Initiative](#)

What we are working toward

An efficient, secure, resilient, adaptable, and economic electric power infrastructure serving society



PSERC is working to find new uses of PMU data (S-44, S-45, S-55, S-57, T-45).



PSERC assists the [IEEE PES Scholarship Plus Initiative](#) and maintains [PES Careers](#)

A new generation of educated technical professionals in electric power

- [Project Proposals](#)
- [Project Descriptions](#)
- [Project Websites](#)
- [Stem Committees](#)
- [Reports \(Members only\)](#)
- [Student Profiles](#)
- [Governance](#)
- [Meetings and Workshops](#)
- [Member Directory](#)
- [Collaboration Tools](#)

Other PSERC Activities

- Networking at industry-university meetings and sharing ideas at the summer workshop
- Getting information conveniently thru webinars
 - > 400 PDH awarded in spring. Attendance: 300-500.
- Receiving PSERC communications
 - Industry Listservs (<http://www.pserc.org/listserv.aspx>)
 - Industry, Public, HR, Student, Faculty
 - Website (<http://www.PSERC.org>)
 - Get your log-in credentials for individuals at (http://www.pserc.org/new_member.aspx)
- Having personal site visits by our researchers
- Leveraging national workforce initiatives

PES Careers

**Connecting Power
and Energy Engineering
Students with Their
Future Employers**



- Landing page: www.pes-careers.org
- Students: A free service to quickly connect with employers offering jobs, coops, and internships today.
- Employers: A free and easy way to recruit the best and brightest electrical engineering students.
- Maintained by PSERC

Upcoming Meeting

IAB meeting, Howard University, Washington DC,
Dec. 4-6



Presentations and
Posters



Keynote Addresses



Networking

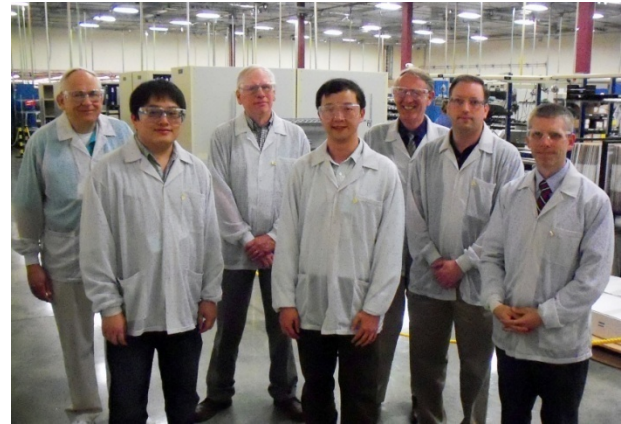
PSERC IAB meeting at the Univ. of
Wisconsin-Madison, May 2013

PSERC – A One-Stop Shop for Accessing Multiple Universities

- Membership in PSERC provides access to experienced researchers at schools in the U.S. that have strong electric power engineering programs.
- Membership provides access to a large pool of well-trained students.

Collaboration is Key

- PSERC meets its mission using collaboration within communities of interest
 - Between universities
 - Between industry / university members
- Collaborating working groups include:
 - Stem committees
 - Project teams
- Partnership in:
 - Identifying issues and needs
 - Creating, choosing, and implementing projects
 - Disseminating results



Developments in leading-edge technologies are discussed at semi-annual PSERC meetings. Here meeting attendees are touring a power electronics manufacturing facility.

Project Collaboration

- Collaboration is valued!
- Industry participation in PSERC projects is encouraged.
 - It's never too late for an industry colleague to be added to a project.
 - There is no additional financial cost.
 - Time commitment is typically low.
- Research teams are encouraged to have periodic conference calls with industry advisors to discuss their project work.

PSERC's Value

- Opportunities for collaboration with leading researchers in power engineering and markets (young engineers have been excited about these opportunities!)
- Leveraged research funding with low overhead on industry membership fees
- Networking with others in industry, universities and government
- Business opportunities for commercialization of intellectual property
- Early access to results of innovative research and research publications

PSERC's Value

- Information source for sound policy-making
- High quality education for power engineering students
- Easy contact with students exploring job opportunities
- Easy contact with faculty willing to provide recommendations on how to find the best students
- Education and professional development such as through webinars (with PDH credit for professional licensing) and on-site seminars

