Power Systems Engineering Research Center

Empowering minds to engineer the future electric energy system

Announcing the PSERC Webinar Series, January – June 2012

Issues in Designing the Future Grid

You are invited to participate in this free public webinar series!

A systematic transformation of today's electric grid is underway. The grid is evolving from a network architecture with relatively few large, hierarchically-connected, tightly synchronized energy resources supplying large, medium, and very many small passive consumers. It is evolving toward a network driven by many distributed and concentrated, highly variable energy resources mixed with large central generation sources, energy storage and responsive users.

The effective transformation of the grid requires decisions based on identification and solution of major operating, planning, workforce, economic and public policy challenges. PSERC is conducting the DOE-funded project "The Future Grid to Enable Sustainable Energy Systems"

- *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*.

As a part of this Future Grid Initiative, PSERC is encouraging discussion on solutions to what can be called "broad analysis" needs. A broad analysis need covers questions that are typically well beyond the scope of typical academic research projects in terms of size and definition. The questions are not strictly engineering ones; they also involve issues of policy, economics, stakeholder perspectives, societal impacts, among others. The broad analysis topics were addressed in a workshop held on December 7. In the future, there will be publicly available white papers, a webinar series (announced here), and a public forum to be held June 27-28 in Washington DC. The topics are:

- The Information Hierarchy for the Future Grid
- Grid Enablers of Sustainable Energy Systems

More information about the Future Grid Initiative: available on the PSERC website.

Public Webinar Series

Who: All interested individuals are invited to participate.

When: The webinars will be on Tuesdays from 2-3 PM Eastern Time on the dates indicated below, except for April 3 when the live webinar will be from noon to 1 PM.

How: We will be using the Adobe Connect 8 webinar platform for the PSERC webinars. You will be watching the presentation slides on your computer from the designated site http://asu.adobeconnect.com/pserc/ and listening to the webinar through your computer's speakers or headphones. You may also listen to the webinar by calling 712-432-0800 (passcode=937250#). Click here for the details and instructions for testing your connection. Links to the archived webinars can be found on the PSERC website.

How much: Free!

Registration: Not required

Questions and feedback: You will be able to send questions via Adobe Connect. You can also send questions by email to pserc@engr.wisc.edu.

Media format: The slides and audio will be available via Adobe Connect. The presentation slides will be available on the PSERC website.

Logistical questions: Send an email to pserc@asu.edu or call 480-965-1643

White papers: Will be posted on the PSERC website when available

Webinar Schedule:

Date	Topic
January 24	High Capacity Interregional Transmission Design: Benefits, Risks and Possible Paths Forward
February 7	Cyber-Physical Systems Security for the Smart Grid
February 21	Future Grid: The Environment
March 6	AMI: Communication Needs and Integration Options
March 20	Primary and Secondary Control for High Penetration Renewables
April 3	Networked Information Gathering and Fusion of PMU Measurements
April 17	Distributed and Centralized Generation
May 22	Standards Associated with Power System Dynamics
June 5	Information and Computation Structures for the Smart Grid

Broad Analysis Topic: The Information Hierarchy for the Future Grid

(led by Peter Sauer, University of Illinois at Urbana-Champaign)

- ***February 7* - *Cyber-Physical Systems Security for the Smart Grid***
  [white paper and slides on PSERC website when available, Dec. 7 Workshop Poster, PDF 763KB | Send Comments]
  Manimaran Govindarasu, Iowa State University. Collaborators: Peter Sauer and Rakesh Bobba, University of Illinois at Urbana/Champaign.

  One thing that virtually all of the information hierarchy components must deal with is cyber and physical security. This white paper focuses on identifying a comprehensive set of cyber security challenges and the need for security at multiple levels of the cyber-physical power system, namely, information security, ICT infrastructure security, and application-level security. It identifies cyber security research issues beyond the traditional IT security issues.

  In particular, the white paper clearly identifies research issues such as: (i) cyber attack risk modeling and risk mitigation, (ii) attack-resilient monitoring, protection and control algorithms, (iii) defense against coordinated cyber attacks, (iv) AMI infrastructure security, (v) trust management and attack attributions, and (vi) simulation models, data sets, test bed evaluations. The white paper articulates the need for going beyond (N-1) contingency criteria to deal with coordinated cyber attacks.

  Also, it articulates the inadequacy of traditional models and algorithms (that are robust against random naturally occurring faults) to deal with malicious cyber attacks, and hence the need for development novel models and attack-resilient algorithms across generation, transmission, and distribution systems. Finally, the linkage between attack deterrence, prevention, detection, mitigation, and attribution is identified.

- ***March 6* - *AMI: Communication Needs and Integration Options***
  [white paper and slides on PSERC website when available, Workshop Poster, PDF 831KB | Send Comments]
  Vinod Namboodiri, Wichita State University. Collaborator: Visvakumar Aravinthan and Ward Jewell, Wichita State University.

  One of the major components of the smart gird is the interface with the customer. This interface is primarily through the meter connection. This white paper analyzes the current state of communication infrastructure for AMI and informs about the future actions needed to enable consumer participation in the smart grid. It describes the motivation for AMI, surveys the current state of the art and deployment status, and points out technical, policy, and other challenges in moving forward. This white paper focuses on the technical aspects and capabilities of communication technologies being considered for AMI and what future research needs to be done to hasten the realization of benefits attributed to the AMI application scenario.

  On a global scale, the U.S. has made good progress in deploying AMI, lagging behind only some European countries. In terms of actual communications technologies being relied upon, there seems to be greater consensus on how to build HANs than the backhaul links. Further research is required evaluating such options and possible communication architectures. In contrast, information security and privacy needs to be addressed more from a HAN perspective due to involvement of consumers and their data. Future actions needed at a federal level in terms of communication needs and integration options for meeting AMI goals are (i) encouraging more

far-reaching investments in back-haul communication infrastructures, and (ii) developing information security and privacy regulations to protect consumers and guide utility reactions to threats and malicious behavior.

- ***April 3* - *Networked Information Gathering and Fusion of PMU Measurements***
  [white paper and slides on PSERC website when available, Workshop Poster, PDF 300KB | Send Comments]
  Junshan Zhang, Arizona State University. Collaborators: Peter Sauer, University of Illinois at Urbana/Champaign and Vijay Vittal, Arizona State University.

  The emergence of synchronized measurements based on global positioning systems has stimulated a huge effort to utilize this technology for advanced monitoring, analysis, and control. The power grid and the integrated synchrophasor communication network are becoming more and more coupled together, i.e., one system depends on the other to provide proper functionality. This interdependence has motivated us to study the cascading phenomena between the two systems, i.e., in the event of cyber/physical attacks, node failures in the communication/power system may result in a cascade of failures, which can be devastating since they can trigger the failures of many more components in both systems and cumulatively progress into the potential collapse of the entire system. In a recent study, we exploited the topology information to improve the robustness of the entire system against cascading failures, and developed a “regular” allocation strategy that allots inter-network links uniformly across all nodes. Our findings reveal that from a network resilience perspective, the proposed regular allocation of inter-edges yields a significant gain compared to random allocation. We expect that our findings can help understanding and designing the topology of the entire system.

- ***June 5* - *Information and Computation Structures for the Smart Grid***
  [white paper and slides on PSERC website when available, Workshop Poster, PDF 108KB | Send Comments]
  Lang Tong, Cornell University. Collaborators: Salman Avestmehr, Elyan Bitar, Kevin Tang, and Aaron Wagner, Cornell *University; Peter Sauer, University of Illinois at Urbana/Champaign.*

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Broad Analysis Topic: Grid Enablers of Sustainable Energy Systems

(led by Jim McCalley, Iowa State Univ.)

- ***January 24* - *High Capacity Interregional Transmission Design: Benefits, Risks and Possible Paths Forward***
  [white paper and slides on PSERC website when available, Workshop Poster, PDF 582KB | Send Comments]
  Jim McCalley, Iowa State University. Collaborator: Jim Bushnell, University of California, Davis.

  For renewables, the levelized cost of energy production can double or even triple as one moves from one part of the country to another. Furthermore, unlike coal, natural gas, and uranium which may be moved electrically or in other ways (rail and truck, or for natural gas, by pipeline), the only way to move renewable energy is by electric transmission. These two attributes of renewables, the heavy influence of location on their economic viability, and their complete dependence on electric transmission for energy transfer, increases the need for interregional transmission in future scenarios where renewables comprise an increased percentage in the national generation portfolio. We define a national transmission overlay as a high capacity, multi-regional transmission grid that spans all three interconnections, designed as a single integrated system to provide economic and environmental benefits to the nation. The objective of this paper is to identify benefits to building a national transmission overlay, to lay out essential elements to facilitate continued dialogue on this topic, and to frame possible paths by which it could be realized. A preliminary study illustrated that a national transmission overlay, under high renewable penetration and low CO2 emissions, could result in a significant cost-reduction over a 40-year period, while increasing infrastructure resilience and flexibility.

- ***February 21* - *Future Grid: The Environment***
  [white paper and slides on PSERC website when available, Workshop Poster, PDF 1.54MB | Send Comments]
  Ward Jewell, Wichita State University. Collaborators: Lindsay Anderson, Cornell University; Judy Cardell, Smith College; Marija Ilic, Carnegie Mellon.

  The objective of this white paper is to present the significant near- and long-term unresolved environmental issues relevant to the future electric grid and to summarize the technologies that will help resolve them. These issues include greenhouse gas mitigation, climate change adaptation, and availability of water for electric generation. Technologies that may help resolve the critical issues include fuel switching (coal to natural gas), carbon capture and storage, nuclear fission generation, renewable technologies, energy storage, energy efficiency improvements for transmission/distribution systems and end users, and demand response.

- ***March 20* - *Primary and Secondary Control for High Penetration Renewables***
  [white paper and slides on PSERC website when available, Workshop Poster, PDF 88KB | Send Comments]
  Chris DeMarco, University of Wisconsin-Madison. Collaborators: Bernard Lesieutre and Yehui Han, University of Wisconsin-Madison.

  The growing penetration of renewable generation technologies coupled to the grid through power electronic interfaces, and the potential for future growth of electrical storage similarly coupled through power electronics, raise new opportunities and challenges for primary and secondary control in the electric power system. In this context, the objective of this paper is to fundamentally re-examine the long-standing premises of primary and secondary control in the grid. We also

consider both the capabilities of the new “control actuators” available to us (i.e., renewable generation, supplemented by power electronic coupled storage), as well as the wider system objectives to be achieved by the control. We believe that this approach will offer solutions far superior to simply trying to force new generation and storage technologies to behave like the old.

- ***April 17 - Distributed and Centralized Generation***
  [white paper and slides on PSERC website, Workshop Poster, PDF 443KB | Send Comments]
  James Momoh, Howard University. Collaborator: Sakis Meliopoulos, Georgia Institute of Technology.

  The objective of the paper is to identify the strengths and weaknesses associated with centralized generation (CG) and distributed generation (DG) infrastructure for the future electric grid system, including environmental impact. This will involve the development of indices for an economical scale study of DG relative to CG, and consider which is the most cost-effective to accommodate new markets. In order to assess the robustness of DG and CG under different load conditions, different indices for measuring the combination of CG/DG with respect to its capability and resilience to handle unforeseen events. The paper also provides a national roadmap towards identifying the right path forward in terms of which combination of DG resources and CG would make sense.

- ***May 22 - Standards Associated with Power System Dynamics***
  [white paper and slides on PSERC website when available, Workshop Poster, PDF 89KB | Send Comments]
  Marija Ilic, Carnegie Mellon University. Collaborators: Ian Dobson, University of Wisconsin-Madison; Gabriella Hug, Carnegie Mellon University.

  The power system needs to have suitable operational reliability standards for determining the operational specifications of renewable generation such as wind turbines in how they interact with the interconnection. This includes specifications of:

  - dynamic and static voltage performance (such as acceptable voltage sag, voltage recovery time following disturbances, reactive power consumption/support characteristics)
  - inertial characteristics (what kind of inertial response is needed, why)
  - small-signal damping performance (frequency response specifications, phase characteristics, damping performance under diverse operating conditions.

  The objective of this work is to facilitate design specifications and protocols for enabling more flexible management of diverse energy resources without endangering system stability.