

# **Executive Forum/Workshop on Physical and Cyber Infrastructure Supporting the Future Grid**

## **Summary**

**Mladen Kezunovic**  
**Texas A&M University**  
**(kezunov@ece.tamu.edu)**



PSERC Webinar  
May 3, 2016

# Outline

- **Background:**
  - Workshop goals
  - Workshop agenda
- Issues of interest:
  - Executives
  - Technical personnel
  - Vendors
  - Federal labs and non-profit
  - Universities
- High Priority Research Areas:
  - Modeling and Analysis
  - Technology and other
- Other Research Areas

# Background

- The forum/workshop was held in the Waterview Conference Center in Arlington VA May 4-5, 2015.
- The PSERC planning committee included, Mladen Kezunovic, Ward Jewell, George Gross, Flora Flygt, Jay Caspary, Mirrasoul Mousavi, Dennis Ray, and Cara Lee Mahany Braithwait
- The discussion addressed key research problems with a 10 year window for solution
- The emphasis was on use-inspired research

# Panels (Day I)

- H. B. “Trip” Doggett, CEO, ERCOT
- Bob Mitchell, CEO, AWC&TDC
- Tony Montoya, CEO, WAPA
- A. Wade Smith, CEO, AEP Texas
- V. Emesih, VP, CNP
- J. Gallagher, Executive Director, NYS Smart Grid Consortium
- M. Wakefield, Director, EPRI
- David Mohre, Executive Director, NRECA
- J. Bebic, Managing Director, GE Energy Consulting
- J. Giri, Director, ALSTOM Grid
- R. Masiello, Innovation Director and Senior VP, DNV GL
- G. Rackliffe, VP, Smart Grids North America, ABB Inc.
- C. Greer, Senior Executive, NIST
- T. Heidel, Program Director, ARPA-E
- P. Khargonekar, Assistant Director, NSF
- J. Mapar, Director, DHL
- D. Ortiz, Deputy Assistant Secretary, DOE
- J. Dagle, Chief Electrical Engineer and Team Lead, PNNL
- I. Husain, Director, FREEDM
- M. O’Malley, Director, UC Dublin
- K. Tomsovic, Director, CURENT
- V. Vittal, Director, PSERC

# Discussions (Day II)

- Breakout Session I:
  - Topic: Modeling and Analysis
  - Moderators, V. Vittal and J. Caspary
  - Participants: over 25
  - Goal: define research problems
  - Outcome: first five and the entire list
- Breakout Session II
  - Topic: Technology and Supplementary
  - Moderators: M. Kezunovic, W. Jewell
  - Participants: over 30
  - Goal: define research problems
  - Outcome: first five and the entire list

# Forum Registration

- Total registration: 95
- Breakdown by category:
  - Industry: 33
  - Government: 17
  - Academia: 45
- Other statistics:
  - PSERC affiliated: 42
  - Non-PSERC affiliated: 53
  - Speakers/panelists: 21

# Outline

- Background:
  - Workshop goals
  - Workshop agenda
- **Issues of interest:**
  - Executives
  - Technical personnel
  - Vendors
  - Federal labs and non-profit
  - Universities
- High Priority Research Areas:
  - Modeling and Analysis
  - Technology and other
- Other Research Areas

# Executive Perspectives: Areas of Concern (Flora Flygt, Moderator)

- HVDC
  - How to create business case which will lead to appropriate cost allocation (some form of socializing)
  - Where is it best deployed? How should it be implemented
  - How to convince regulators to use it?
- Planning/Forecasting – Need:
  - Longer-term, more strategic approach to planning out the system
  - Better wind and solar forecasting in real-time and day ahead
  - To address uncertainties in the planning process

# Executive Perspectives: Areas of Concern

- Demand Response – Need:
  - Visibility into the distribution system
  - Better forecasting tools
  - More defined ancillary services
- Renewables/Distributed Generation
  - How to deal with the ramp rates that are created
  - Increased visibility
  - More defined ancillary services
  - Is storage a solution and do we need a new market construct to accommodate development of storage?

# Technology Application Perspectives (Mladen Kezunovic, Moderator)

- Opening statements (issues of concern)
  - Grid resiliency, real-time customer interaction
  - Cost-effective demand response
  - Distribution visibility and automation
  - Integration of renewables and DGs
  - Role of Distribution Service Providers (DSP)
  - Granular pricing of DSM: hourly, sub-hourly
  - Resiliency of ICT and enabling technologies
  - Standardization for decoupled functionalities
  - Cyberphysical security and privacy

# Technology Application Perspectives

- Research needs (Q/A)
  - Centralized vs. decentralized and who decides
  - How to justify the grid expansion investments
  - How much distributed generation is justified
  - The need for large scale testbeds
  - Market efficiency: centralized vs. decentralized
  - Use of water heaters as a thermal storage
  - Understanding of weather impacts in real-time
  - Market design for participation of DSP
  - How to policy implications of technology

# Technology and Solution Provider Perspectives (George Gross, Moderator)

## ❑ Towards a comprehensive load model

- improved composite load models to represent the flexibility of loads as loads change from passive to active
- model of consumer behavior including the impacts of policies and incentives
- operational needs on load visibility at each point in time and its flexibility characterization

## ❑ Energy storage modeling, management and solution methodologies

- models for effective participation of storage in markets for provision of commodity and ancillary services
- assessment of the economic value of storage for investment
- formulation of operational paradigms
- new schemes to manage inventory
- overcoming scalability issues in mixed integer programming

# Technology and Solution Provider Perspectives

- ❑ PMU deployment and data utilization
  - PMU deployment for enhanced protection
  - assurance of fidelity and security of PMU data
  - PMU data verification with operational models
  - usage of PMU data for inertial response estimation for control of storage devices
  - address how far synchronized sampling rate of PMU needs to be pushed
  - PMU data use beyond monitoring: formulation of control actions to ensure the health of the system and eventual decision making; transition from local to wide area control
- ❑ Assessment of cyber security technology to meet the requirements of standards

# Government Perspectives (Jay Caspary, Moderator)

- Scalable hybrid data-driven control strategies
- Integrated risk management tools
- Enhanced modeling / simulation capabilities
- Composable, reconfigurable test beds to address interoperability challenges
- Increased capabilities for demonstration and testing/assessment of new technologies
- Address barriers to entry, i.e, open models
- Better understanding of complex systems
- Newer risk methodologies
- Education of policy makers regarding critical need for R&D

# University and National Lab Perspectives (Ward Jewell, Moderator)

- Controls technology
- Integration of planning, operations, and markets
- Integrating Transmission and Distribution Systems
- Integrate electricity with other energy systems
- Simulating power grid and other supporting infrastructure, including communications systems
- Power electronics
- Communications
- Consumer behavior

# Outline

- Background:
  - Workshop goals
  - Workshop agenda
- Issues of interest:
  - Executives
  - Technical personnel
  - Vendors
  - Federal labs and non-profit
  - Universities
- **High Priority Research Areas:**
  - Modeling and Analysis
  - Technology and other
- Other Research Areas

# Modeling and Analysis

## High Priority Research Ideas

(Vijay Vittal and Jay Caspary)

- How can we better account for uncertainty in operations and planning, especially in the presence of renewable resources – Looks at need for characterizing uncertainty and developing analytical tools which incorporate uncertainty
- Develop methods for scheduling all available resources including traditional generation, intermittent energy resources – Need to develop better short term forecast methods in order to enable better scheduling of variable generation

# Modeling and Analysis

## High Priority Research Ideas

- Develop control algorithms based on real time measurements such as synchrophasors for enhanced grid operation and control – **Incorporation of PMU and other real time measurements in control**
- Measure system inertia including centralized and distributed energy resources in real-time, determine inertia limits, and mitigate low inertia effects – **Need to determine impact of reduced inertia**

# Modeling and Analysis

## High Priority Research Ideas

- Improve wind/solar forecast accuracy for system operation – **Need for improved short term wind and solar forecast**
- High-resolution identification of the load composition, especially with respect to quantifying its flexibility potential, and in what ways it can be provided – **Load composition identification to aid DSM**

# Technology and Supplemental High Priority Research Ideas (Mladen Kezunovic and Ward Jewell)

- Testing and evaluation of future solutions:
  - Need to create real-time simulation-based test beds shared between multiple universities
  - Create scalable and reconfigurable large scale test beds based on multiple hardware-in-the-loop (HIL) technologies
  - Simulation and testing tools for architecture and device large-scale testing.
- Votes = 12

# Technology and Supplemental High Priority Research Ideas

- Resiliency modeling and metrics
  - Model power system resilience with multiple weighted indicators based on electrical, economical, and social aspects
  - Create metric(s) for resilience and rate of return for resilience improvements.
  - Study possible use: investment analysis or to provide incentives to operators for adoption of resiliency measures. Votes = 11
- Increase resiliency of the grid through smart control and smart protection. Votes = 10

# Technology and Supplemental High Priority Research Ideas

- Various ideas with same number of votes= 8
  - Centralized data, large dynamic data sets, model validation and operations
  - No regrets and best transmission system configurations
  - How should we reconfigure the electric power grid to rely more on microgrids
  - Redefine the technical interface between T&D systems to coordinate both systems and integrate DERs efficiently; Design the needed information architecture for integrated T&D oper.

# Outline

- Background:
  - Workshop goals
  - Workshop agenda
- Issues of interest:
  - Executives
  - Technical personnel
  - Vendors
  - Federal labs and non-profit
  - Universities
- High Priority Research Areas:
  - Modeling and Analysis
  - Technology and other
- **Other Research Areas**

# Overall Suggested Research Areas (Mirrasoul Mousavi and Dennis Ray)

- Real-time Measurements for Control and Situational Awareness
  - Enhanced grid operation and control
- Resiliency: managing extreme events and security risks
  - Physical and cybersecurity, metrics for assessment/valuation
  - How to increase resiliency?
- Electricity Markets
  - Simulation test bed/platform for assessing market mechanisms
  - Future of ancillary services: models and frameworks
- T&D System Modeling, Simulation, and Test Beds
  - Collaborative test beds for testing new strategies, hardware, business services, controls, reliability and resiliency actions

Note: The second bulleted items are only examples of research under each category. See the full list of ideas for a comprehensive view.

# Overall Suggested Research Areas

- Integrated T&D Operations and Control
  - Accounting for uncertainty in operations and planning
  - Designs for operating/coordinating an integrated transmission and distribution system
- Information and Computational Technology Needs and Architectures
  - Framework for secure/efficient communication of smart grid data
- DER Modeling and Integration
  - Improve wind/solar forecast accuracy (including ramping)
- Distribution Systems and Microgrids
  - How to reconfigure the grid for more microgrids?
  - Expand uses of PMU data

# Overall Suggested Research Areas

- Power Electronics/FACTS/HVDC/Grid Hardware
  - Advance hardware development
  - Improve modeling such as for power flow control
- Business/Research Models and Technical-Economic Analysis
  - Create incentives for resilience improvement

# Questions

**Mladen Kezunovic**  
**kezunov@ece.tamu.edu**

