

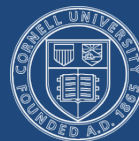


Trustworthy Cyber Infrastructure and Technologies for Active Demand Management

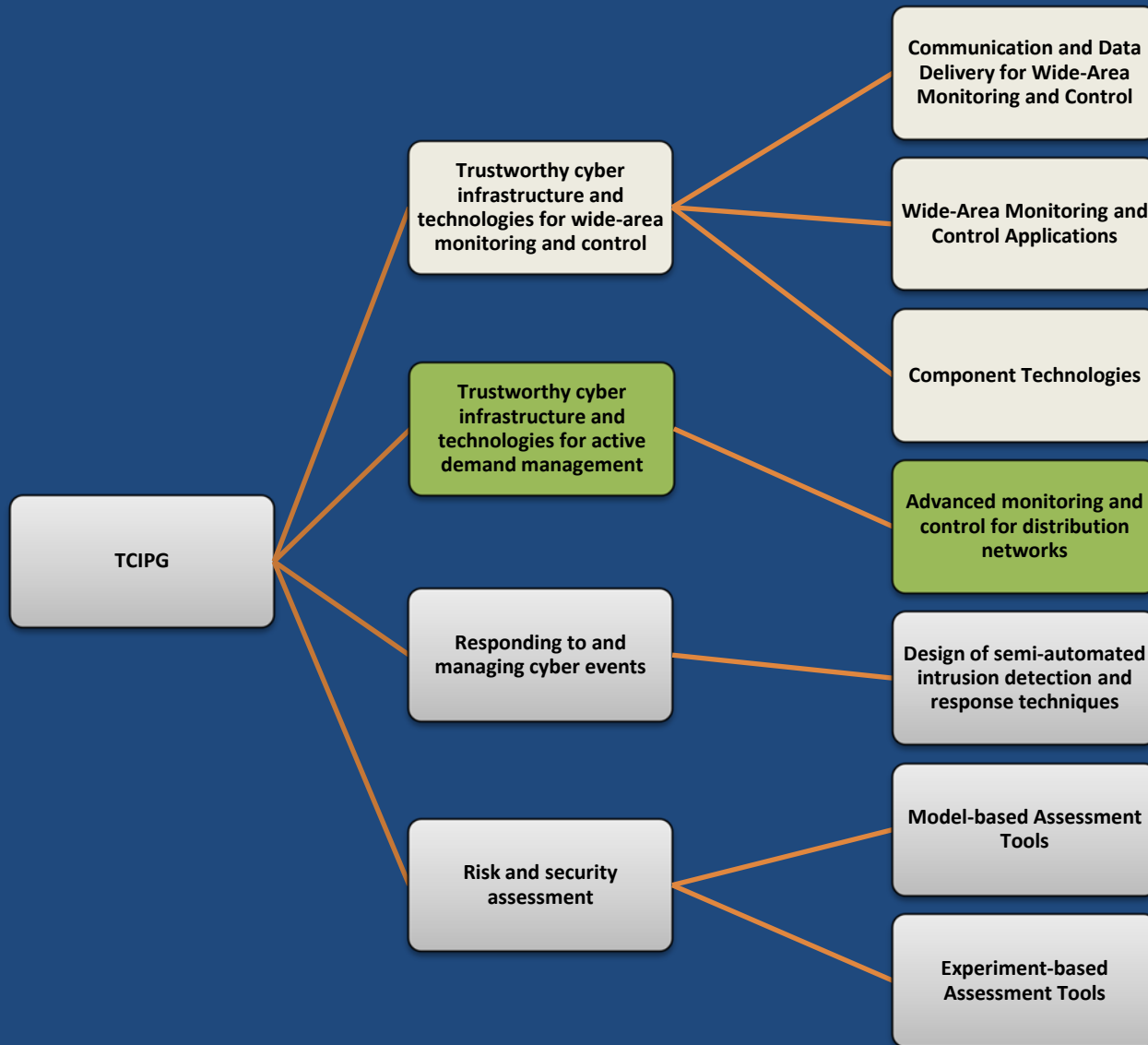
Tom Overbye



UCDAVIS



TCIPG Cluster Arrangement



Cluster Overview

- Electric grid can be divided into three groups: the generation, the wires (T&D), and the demand. Cluster focuses primarily on the demand and the nearby distribution
 - Generation must track load
- For a grid with more renewable, but less controllable generation (e.g., wind and solar PV), more load control will be needed
 - Distributed generation may be embedded in “demand”
 - New loads (electric vehicles) could drastically change demand profile



Motivation: PV Output Variation with Clouds

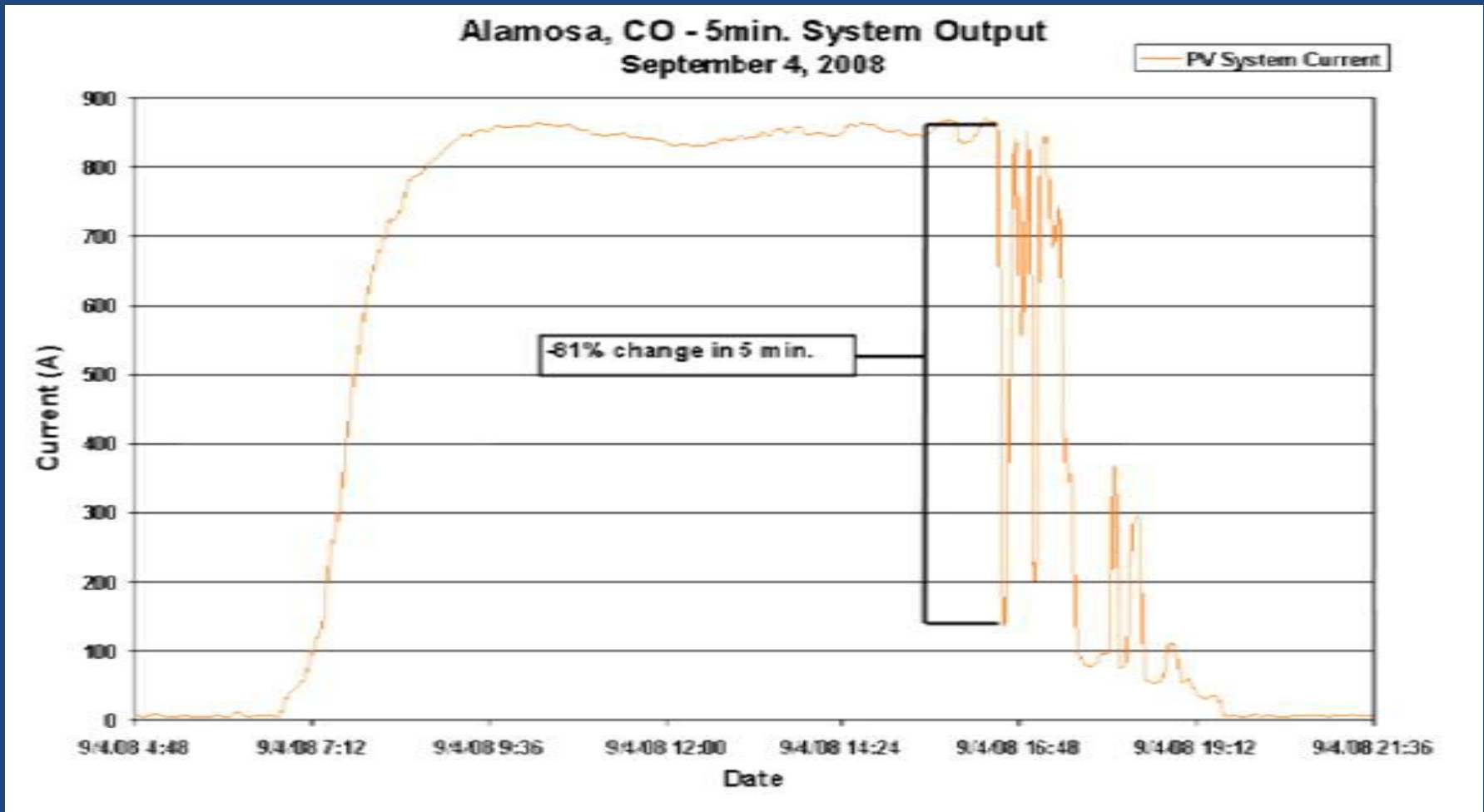


Image Source: Secretary Chu, "Investing in our Energy Future" GridWeek Presentation, Sept. 21, 2009

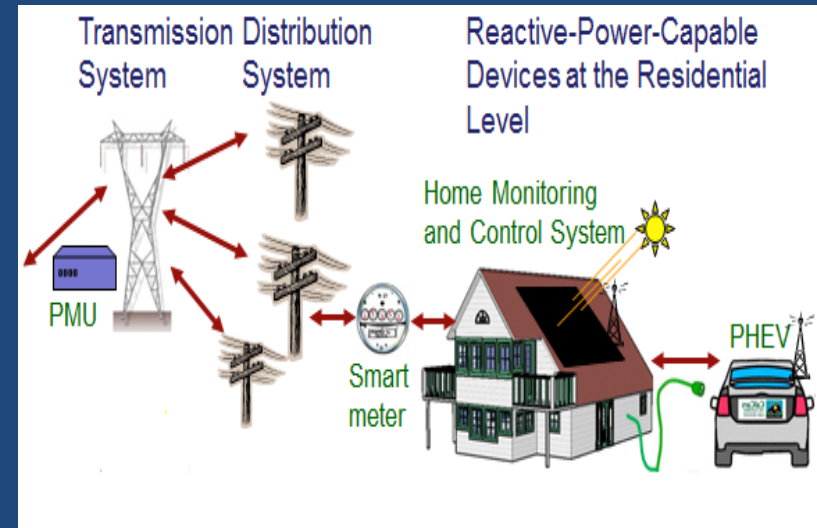
Cluster Problem Areas

- The cluster focuses on making the demand more known and/or controllable
- Cluster addresses many of the Smart Grid core issues
 - Great advances over years in generation and T&D, but end user has been mostly left out
 - Customers require targeted information to help them optimize their electricity usage
 - Making a smarter distribution system and more “active” load could greatly enhance system operations and control, but adds cyber issues



Cluster Objectives

- Objective is to better determine and solve the cyber issues related to making for a more active demand
 - And training students!!!
- Focused on the following:
 - Determining the makeup of the electric demand
 - Methods to protect privacy of customer electric usage
 - Control of distributed real and reactive resources
 - Cyber infrastructure for local communication and control
 - Real-time detection of smart meter security threats

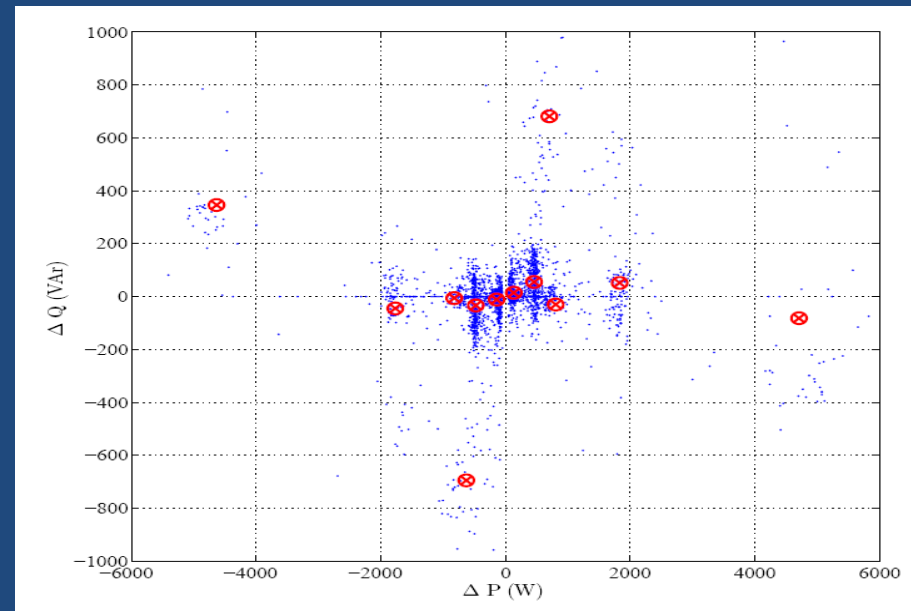
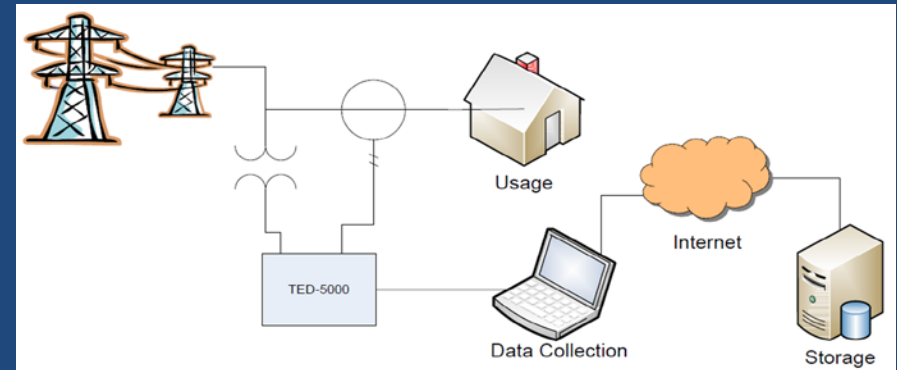


Cluster Activities (with more details in posters)

- **Ongoing**
 - Development of the information layer for the V2G framework implementation
 - Smart Grid enabled distributed voltage support
 - Specification-based IDS for smart meters
- **New Starts**
 - Password changing protocol
 - Trustworthy framework for mobile smart meters
- **Completed**
 - Non-intrusive load shed verification
 - Agent technologies for active control applications

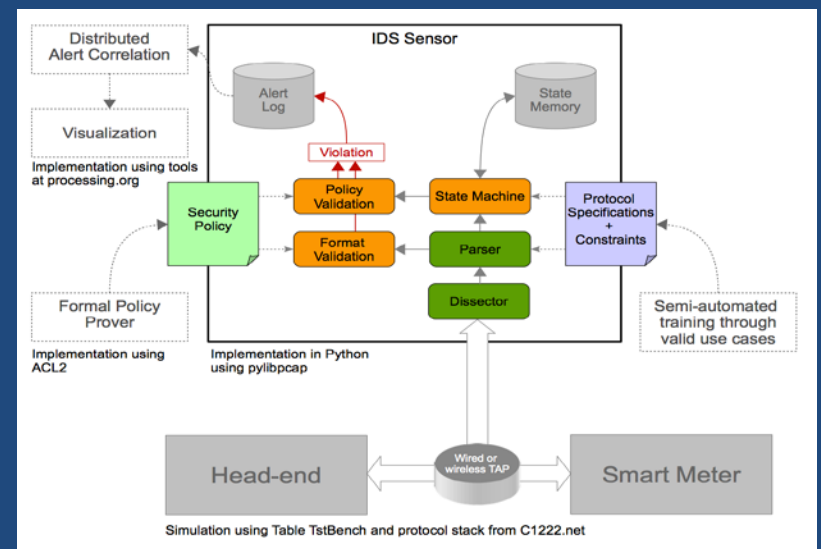
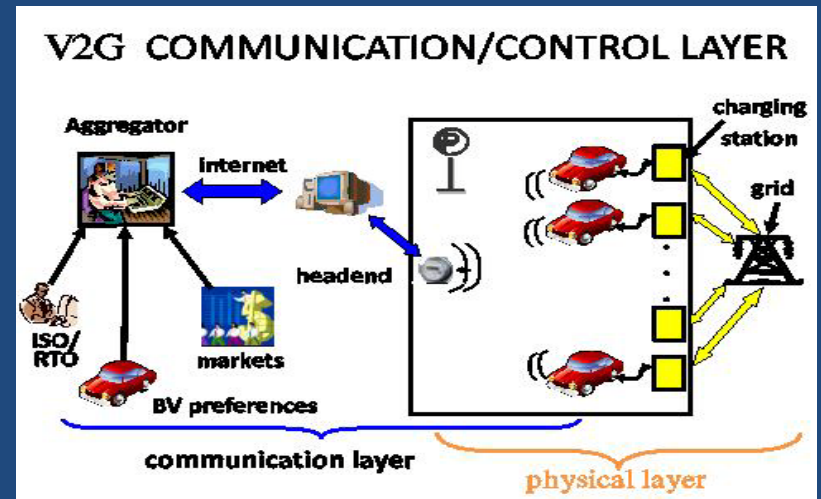
Cluster Accomplishments and Impacts

- Developed and published algorithms for non-intrusive load monitoring to determine the composition of the electric load
 - Knowing individual loads can help with demand management
- Developed and published algorithms for the utilization of energy storage to mask electric usage patterns to help protect privacy



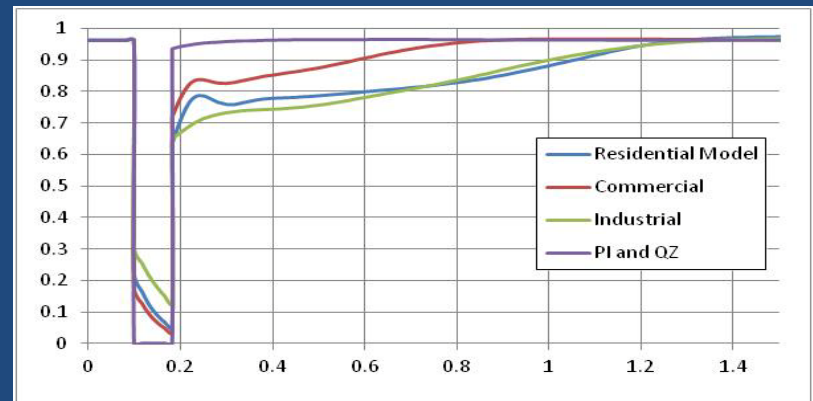
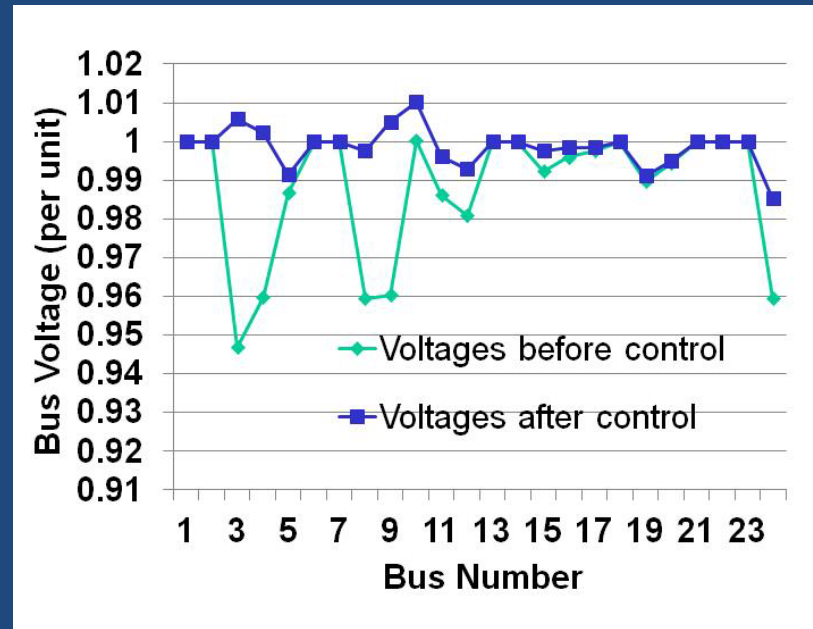
Cluster Accomplishments and Impact, cont.

- Developed a comprehensive framework for the communication between electric vehicles and a load aggregator
- Developed and implemented a prototype specification-based meter intrusion detection infrastructure; in discussion with Fujitsu, EPRI and Itron



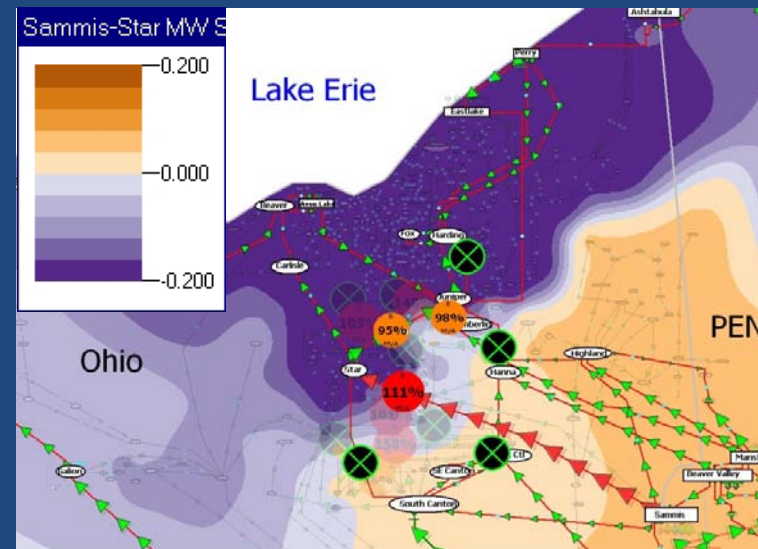
Cluster Accomplishments and Impacts, cont.

- Developed and published a framework for the control of distributed reactive power devices
 - Working with AEP, ComEd, and PowerWorld on new dynamic load models
 - Participating in the WECC Renewable Energy Modeling Task Force, which includes distributed generation considerations



Cluster Directions for Coming Year

- Determine the response time needed for active demand control for both real and reactive power to assess security and real-time requirements
- Address issues associated with the security & scalability of the cyber infrastructure for electric vehicles
- Develop scalable password changing protocol for large numbers of distribution system devices
- Work on technology transfer of real-time detection of smart meter security threats
- Development of a trustworthy framework for mobile smart meters such as those envisioned for electric vehicles



Questions and Discussion