

Energy Birds of a Feather Session
Third CPS PI Meeting, National Harbor, Maryland

CPS Energy Grand Challenges

1. Achieve 20% peak reduction via *demand side management* (equivalent 188 GWatts)—beyond demand response
 - Improving capacity utilization: how to shape demand (saving capital costs later)
 - Engagement of human decision makers/behavior in the process
 - Economic analysis/studies
 - Human interface – feedback from users
 - Hope versus management: virtual power plants, manage the generation side to match the expected reduction
 - How to make it reliable, agile?
 - Integration of renewable sources – supply-following loads via demand management
 - Pervasive health monitoring of the energy system
 - Are market-based mechanisms sufficient? What are the right kind of market designs/interfaces/APIs/etc. More than price signals? Time scales, especially as they get more fine-grained, is a major factor in understanding the system
2. Achieve 50% of energy generation portfolio from renewable sources
 - High fluctuation/non-dispatch
 - New forecasting methods—new approaches are needed, not safety but usage-based (worst case weather events vs. worst case energy demand)
 - Real time weather information/cloud cover/wind intensity
 - Challenges in connecting and processing vast instrumentation for rapid, agile response
 - Agility of back-up generation plans
 - Implications for control loops in highly variable environment
 - Don't forget the natural gas turbines in the generation portfolio
 - Distributed generation (renewables embedded in the distribution system)—distributed techniques needed, solar scales to backyards, but maybe not wind
 - Solar hard to forecast
 - Security and privacy issues
3. Removing human operators from making routine decisions (by 2050?)
 - Operators in the loop for emergency conditions
 - Autopilots for the energy system
 - Better information collection and display for strategic energy decision making
 - AC optimal power control solved in real time
 - Evolution towards a new model of energy buying and selling/aggregation vs. operating a power plant or portfolio of generation capabilities, etc.
 - Capture expertise/intuition of existing operators as they retire and replace with informed automated model-based systems

4. Making Energy Industry as Innovative and Agile as any High Technology Industry
Economic and market models, financial incentives
New technology development, efficiency of operational
“CAD for the utility industry”—testbeds, models, ways to understand the
benefits of new technology before the buy decision
Introduction of competition is essential
Models exist, how to integrate them across scales and scenarios
Smart grid conceptual model
Competition in the “local loop”/distribution net
Understanding the implications of restructuring the markets
What are the right constraints to allow the deconstructed grid

5. Keeping the lights on, no matter what—at reasonable cost
Allow innovation without sacrificing safety and service
Leverage new IT technologies – sensors, information processing, etc.
Big data meets energy for actionable control
RFC like Internet Protocols for evolving energy technology plug-and-play
architecture

CPS Energy Research Community Shared Infrastructure for Scaling

Data—economic data (smart data, results of demand response experiments)
Synchrophasor data from utilities
Load flow from utility
Real-time dynamic data
Failure/fault data
End-to-end data from generator to load (consistent/clean)
Standardized NDA agreements to get data to researchers
Security Compliant Cloud-based Datacenter
Publication of analysis results – move community to a scientific basis
Shared software
Data collection (decoupled from specifics of the environment,
commercial sanitization)
Analysis
Visualization
Large scale realistic test models for a variety of purposes
Testbeds, simulators, emulators; hardware and software components
Different testbeds for different purposes—no single testbed
Smart meters
Renewables
PMUs
How to test for disasters, like blackouts
For control systems
Exchange standards
Ask the meta question of what the open testbed should be
Policy—no money for industry projects without publication of data?

But must be flexible