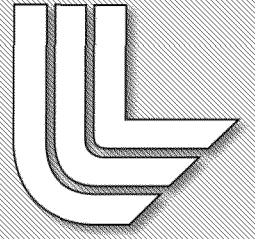


Partnership for 21st Century Energy Systems (P21-CES)

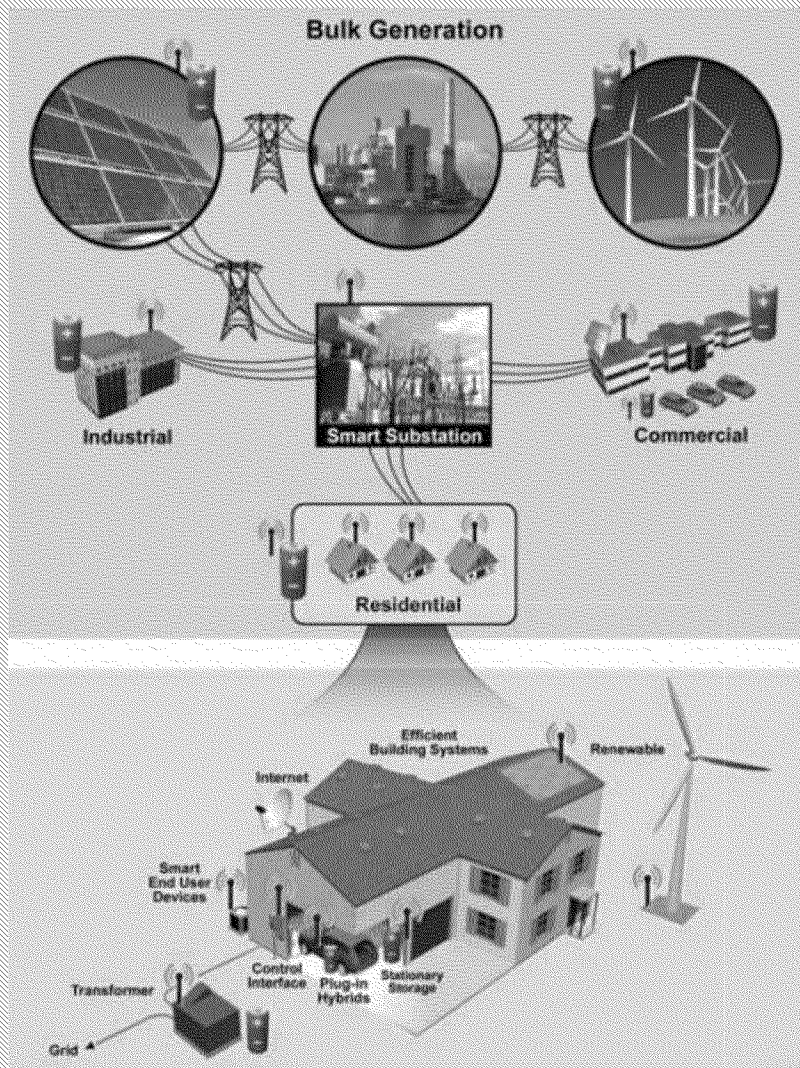
Reducing Risk, Cost, and Uncertainty for the Future Energy System



Jeffrey Stewart and John Grosh
Lawrence Livermore National Laboratory
Daniel Kammen, University of California Berkeley



Power industry is making revolutionary end to end changes to the energy system



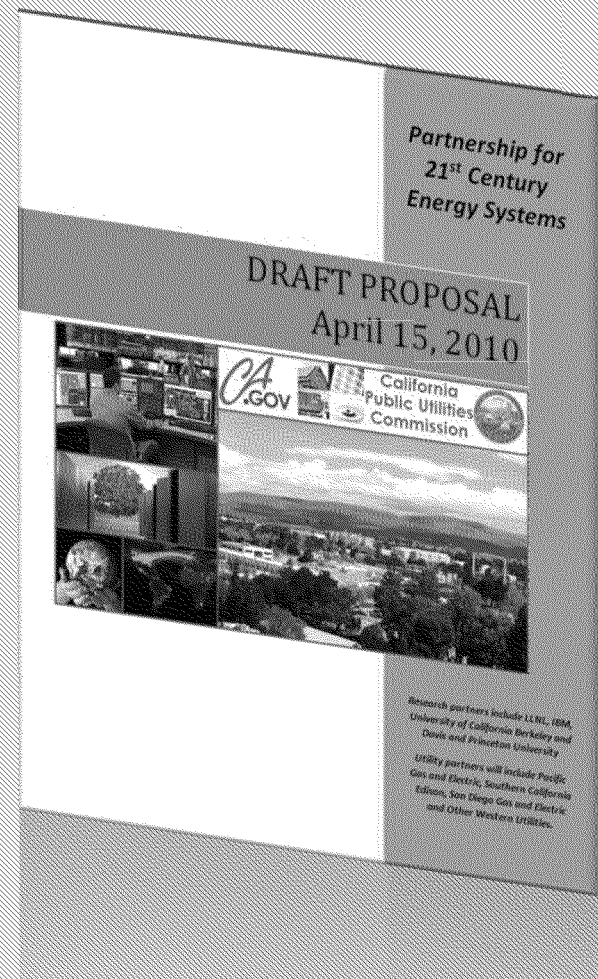
The challenge is integration:

- Renewable integration
- Improving grid operation
- Demand-side management
- Electric vehicles
- Cyber security
- Weather and climate impacts
- Economic viability

P21-CES is proposed to wisely build capabilities to meet energy, policy, and environmental goals

- Develop a predictive modeling and simulation capability to address integration challenges
- Apply world-class HPC to understand scenario impact and to inform tactical and strategic decisions
- Enhance cyber security

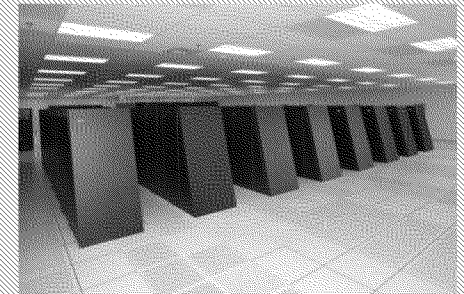
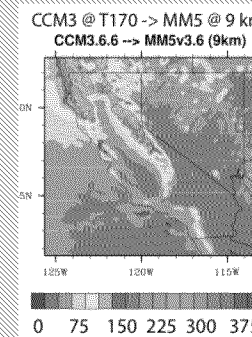
Discover risk, threats and reliability concerns before expensive investments are made



Level of Precision and Speed Necessary to Support Decision Makers Requires HPC

Western region generation planning

- Today: CAISO model 1 hour time steps for a 30-year simulation. 30k actors requires 6 months ... too long for decisions
- LLNL-HPC: Scaling code and algorithms and HPCs could reduce runtime by 100 to 1000
- Future: DSM, Smart Grid, renewables, DG E-Vehicles, 30-year simulation w/ 30m+ actors.

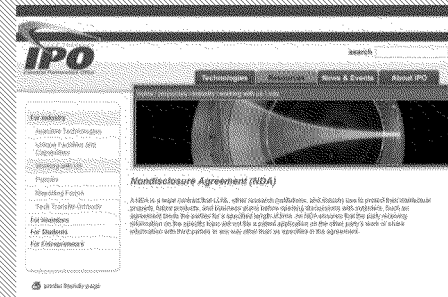
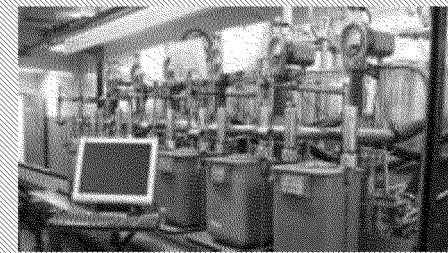
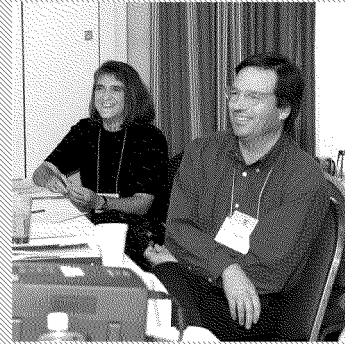


Need World Class HPC

Multi-disciplinary teams required to attack such problems

We will develop a partnership model where hard problems drive research and development

- Utility/CAISO/LLNL staff work at HPC-IC to focus research, **build commonly accepted models**
- LLNL, IBM staff work at power sites for deployment, consulting, red teams, etc.
- Establish agreements to share data and proprietary information, etc.



Planning – Improve decision making and investment strategies

▪ Need

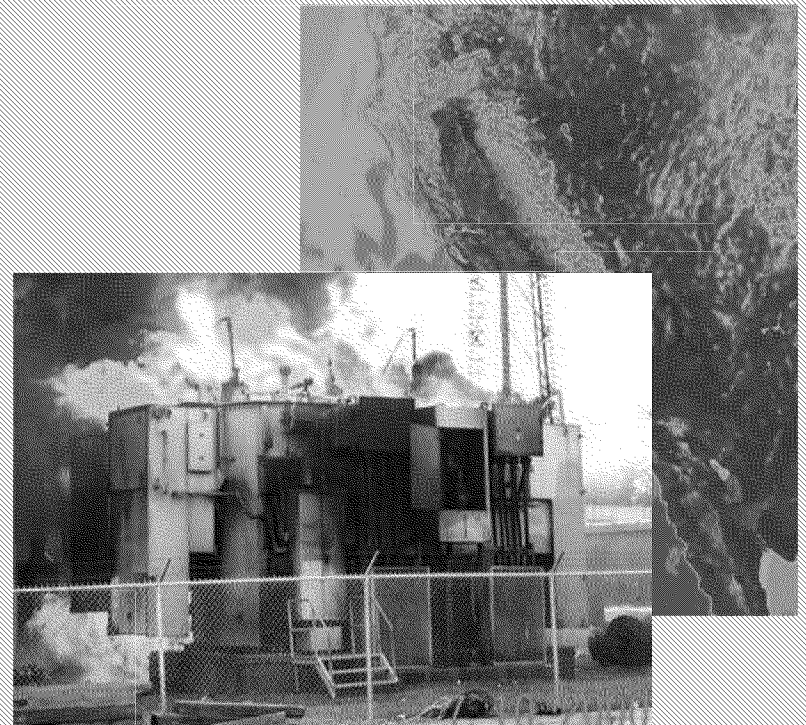
- Reducing uncertainty in technology, climate, and policy
- Current models oversimplify to achieve results in a timely manner

▪ Approach

- Add details (e.g., all transmission lines) into models to achieve greater accuracy
- Enhance code scalability to improve fidelity and resolution
- Incorporate hedging strategies in resources allocation to formally incorporate uncertainty (climate, policy, new technologies)

▪ Benefit

- Optimal resource planning



Modeling can reduce maintenance cost and system failures (e.g., 2006 heat storm)

One week- \$100m+ of avoidable replacements

Grid Operations – Optimize real-time response for a changing grid

▪ Need

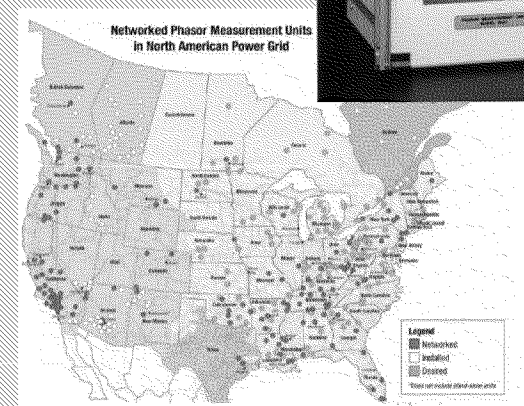
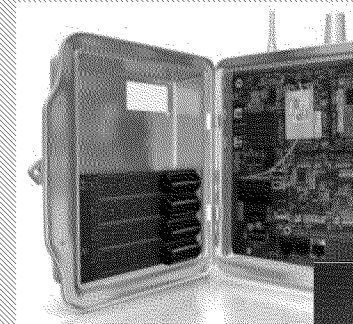
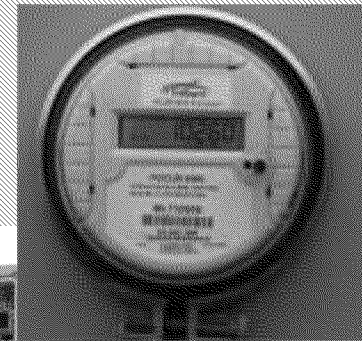
- Enhance situation awareness of information flows
- Predicting grid behavior with +100X data increase some sensors and meters
- Modeling environmental effects on energy systems

▪ Approach

- Extend and scale power flow models for HPC
- Develop network / information models for sensors
- Apply tools and expertise in data analysis
- Integrate environmental conditions

▪ Benefit

- Avoid unnecessary Transmission \$4m per mile and Power Stations (\$500m+ each)
- Improve reliability



Energy Efficiency - Enhancing Energy Measurement and Validation

▪ Need

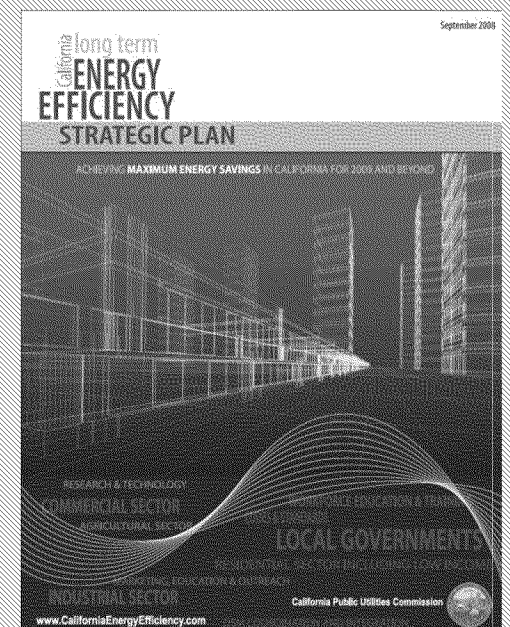
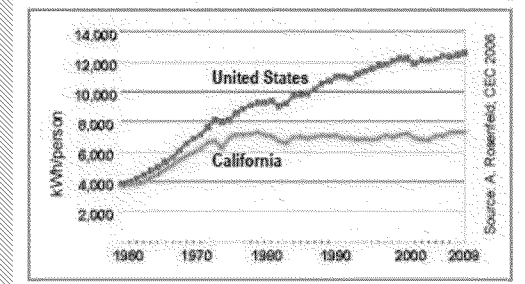
- A consistent and transparent approach to estimating energy savings
- Formal incorporation of uncertainty
- Improved technology performance models and analysis
- S&T capability to evaluate benefits

▪ Approach

- Develop and apply rigorous V&V program to EM&V process
- Iterative learning process for program improvement without retroactive penalties

▪ Benefit

- Increase ratepayers ROI on \$1.5B/yr
- Predictable outcomes for State's energy goals
- Reduce risk to IOUs



Cyber Security: Prevent, detect, and respond to intrusions and attacks

Needs

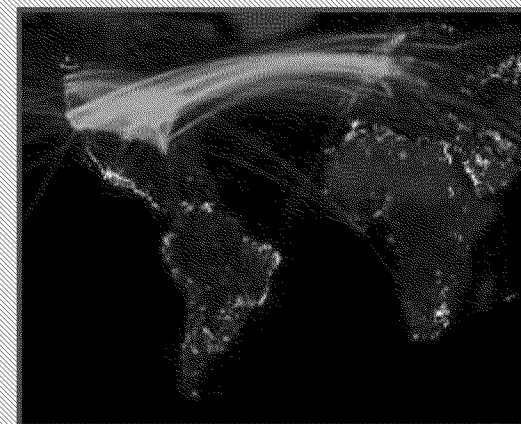
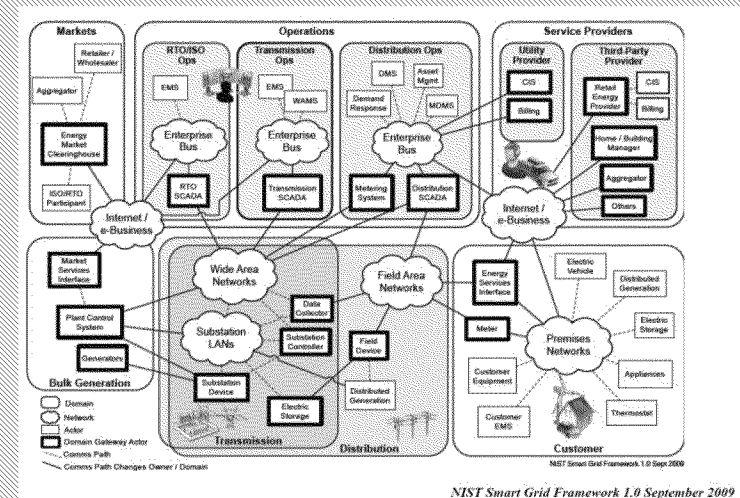
- Cyber defense is becoming increasingly more difficult with growth of SmartGrid
- Tools for situational awareness of IT and SCADA, detecting malware, etc.
- Understanding vulnerabilities and threat

Approach

- Develop an overarching tools strategy
- Facilitate access to data and expertise for processing technologies and threat
- Develop predictive models of cyber attacks on IT, smart meters, etc.

Benefits

- Improve ability to address a wide variety of relevant cyber attacks



Energy Data Center – Providing computing and data for CA power

▪ Need

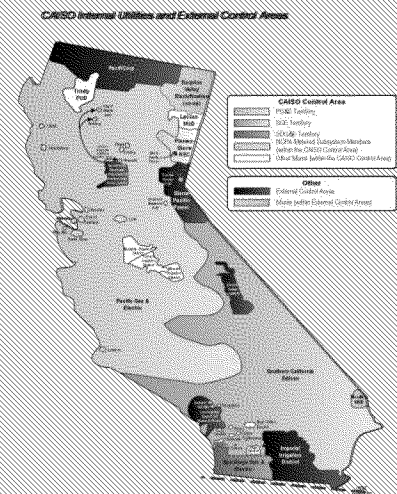
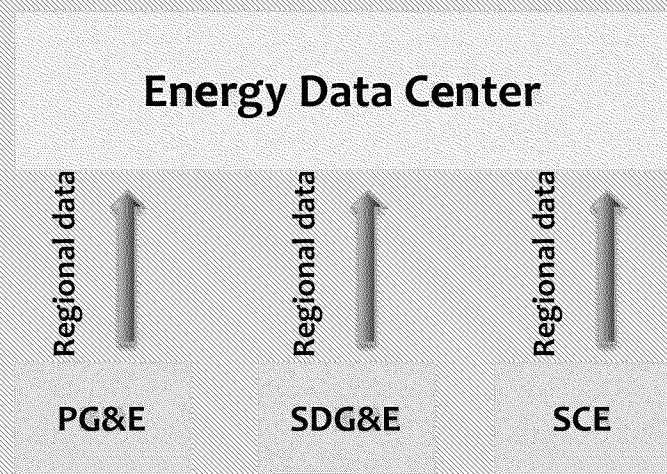
- Computing facility to share and archive data from sensors, conduct systems studies, etc.

▪ Approach

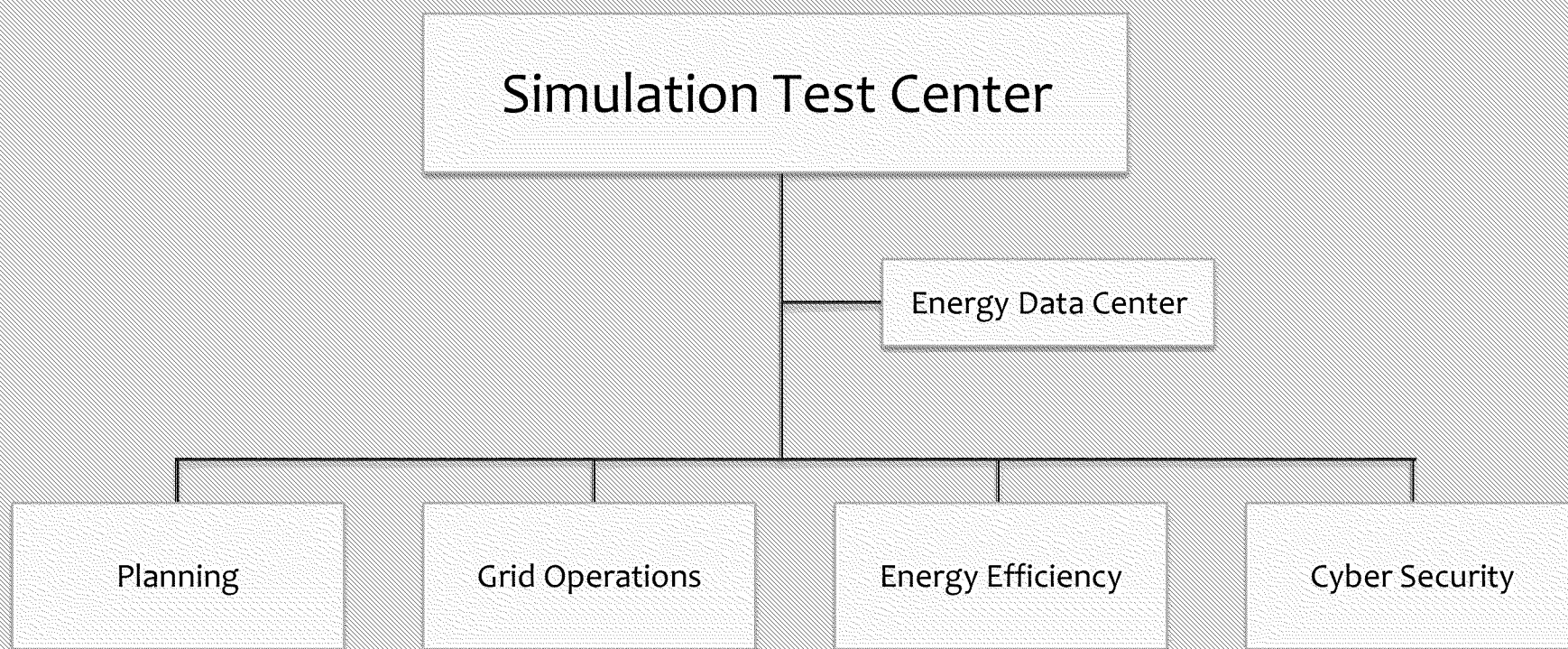
- Utilize computing, storage, expert staff at LLNL and the HPC Innovation Center
- Warehouse data for planning studies, design experiments, and cyber security analysis
- Leverage LLNL and IBM leadership in HPC technology, data storage, clusters, technology, real-time computing

▪ Benefit

- Build state-wide view of grid through sharing of data on protected systems
- Enable utilities access of state-of-the-art HPC systems for simulations and analysis



The P21-CES will create a Simulation Test Center to bring together technology teams and industry experts



The P21-CES will enable critical energy usage information to be processed, evaluated and reported to decision makers in the seconds and minutes needed to act, all under a secure environment enabled by the center's cyber security protocols.

More Focused and Leveraged Partnership than Previous State Efforts

California Institute for Climate Solutions

- \$60 Million Per Year from CA-IOUs
- Funds CA Universities and CA Labs

P21-CES

- \$20 Million Per Year from Ca-IOUs
- Support to partners and any University or National lab
- Improved DOE co-Funding opportunities for demonstrations and regional analysis (50/50 goal)
- Has LLNL and IBM support

Next Steps

- Identify IOU point of contact (today)
- LLNL Individual visits to each IOC (June)
- LLNL meeting with CPUC (June)
- Joint meetings with IOUs and CPUC (July/August)
- Launch Activities (Oct 2010)