



# Emerging Technologies for a Clean and Prosperous Future

Utility Energy Forum

May 6, 2011

Laurie ten Hope

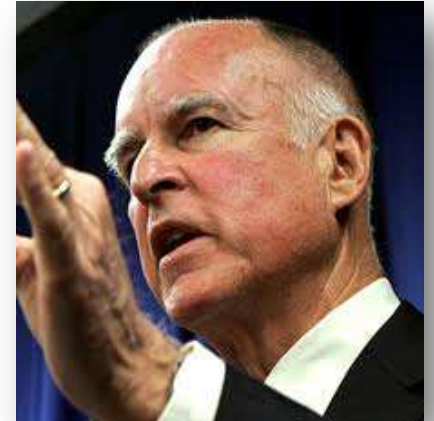
Deputy Director Research and Development



- Governor Brown's energy priorities
- Emerging innovative technologies
- Integration challenges
- Getting to scale with demonstration projects



*Investments in clean energy produce two to three times as many jobs per dollar as gas, oil or coal. My goal is that by 2020, California should produce 20,000 new megawatts of renewable electricity, and also accelerate the development of energy storage capacity. ... At the same time, California should take bold steps to increase energy efficiency.*



Governor Jerry Brown

# Governor's energy goals to stimulate clean energy job growth



- **Build 12,000 MWs of Localized Electricity Generation**
- **Build 8,000 MWs of Large Scale Renewables & Necessary Transmission**
- **Reduce Peak Energy Demands and Develop Energy Storage**
- **Increase Efficiency of Buildings and Appliances**
  - Make new homes and commercial buildings in California “zero net energy”
- **Develop More Combined Heat & Power Projects**
  - Add 6,500 MW over the next 20 years.

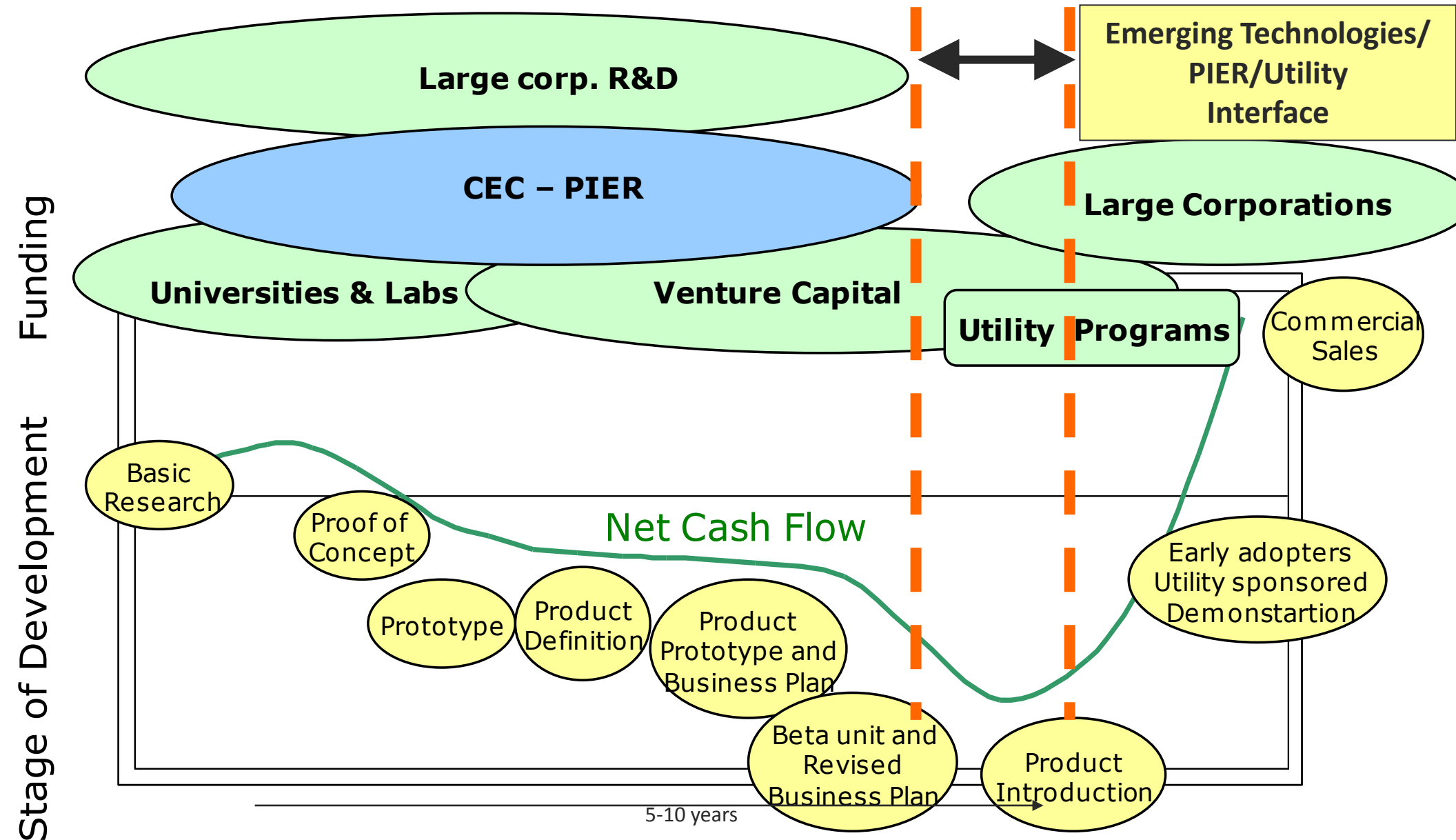
# Research at the California Energy Commission



- Research is key catalyst to achieving energy system transformation
- The Public Interest Energy Research Program (PIER) is the research arm of the Energy Commission. PIER receives about \$86.5M from the public goods charge each year



# RD&D Projects Range from Early Research through Small-Scale Demonstrations





# State Partnership for Energy Efficient Demonstrations (SPEED)



## Demonstration, Field Testing and Customer Feedback

- Established in 2004
- Over 110 demonstrations to date (mainly UC/CSU/CCC, state and local govts)
- Facilitate commercialization of PIER developed technologies
- Pre- and post- installation monitoring and engineering analysis to verify savings
- Future program emphasis on large scale deployment

The screenshot shows a web interface for the PIER project. On the left, there is a sidebar with the PIER logo, the text "TECHNOLOGY DEMONSTRATIONS", and icons for "LIGHTING" and "H/W". The main area features a map of California with green house icons indicating demonstration locations. A pop-up window for "UC Irvine" is displayed, showing two photos of the building and the following details:

**UCI - Engineering Tower**

- Bi-Level Smart Stairwell Luminaire - 38 Installations
- Installation Date: 04/01/2006
- Energy Savings since installation: 153 MWh; 0 therms
- CO<sub>2</sub> Savings: 56 metric tons to date

Below this, there is a "Learn More" section with links to "Case Study", "Technical Specifications", and "LEED". The PIER logo is also present in the bottom right of the pop-up. At the bottom of the page, a yellow banner contains the URL: [http://terradox.com/PublicPages/CIEE/PIER\\_01.aspx](http://terradox.com/PublicPages/CIEE/PIER_01.aspx)

# Examples of Technologies Demonstrated



## Lighting

- Bi level smart lighting
- Dual relay wall switches
- Fixture integrated recessed troffers
- Hybrid smart wall switch
- Integrated classroom and office lighting
- LED down lights
- Simplified daylight harvesting
- Wireless integrated photosensor and motion sensor system



## HVAC

- Variable speed controls for food service exhaust fans
- Wireless constant volume to VAV Conversion
- VAV air handling system controls

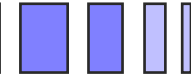




# Game Changer



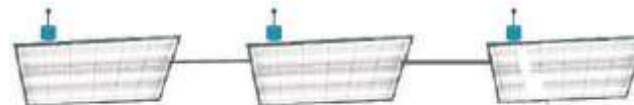
**ADURA**<sup>®</sup>  
TECHNOLOGIES



- Wireless remote control of lighting
- Mesh network
- Easy retrofit to wasteful, inflexible systems
- Allows sophisticated lighting management
- Allows simple occupant control
- The iPhone of lighting controls



Charlie Huizenga  
Zach Gentry  
Josh Mooney



# New Companies & New Green Jobs



“Adura Technologies is a California-based company first conceived at UC Berkeley’s Center for the Built Environment. Our initial funding came from a \$75,000 PIER grant in 2005. Adura has since raised approximately \$20 million in venture funding, employs approximately 35 Californians, returns equity and royalty payments to the financially-strapped University of California system and helps California meet its RPS and carbon abatement targets. Not a bad investment, California.”

Zach Gentry, Adura Technologies

Co-founder and Chief Strategy Officer

# Lighting Success



- **Integrated Classroom Lighting System**
- PIER provided funding
- Ferro developed reflective material
- CLTC assisted with design process
- AV, whiteboard, general lighting
- Over 50% energy savings



- **Personal Lighting System**
- Personal control
- 25-60% energy savings



**PLS: Lighting for Tomorrow**

# Wireless Data Center Controls-SPEED



## Data Centers Consume over 9 Billion kWh/year

- Partners: California Franchise Tax Board, Department of General Services, Federspiel Controls, Lawrence Berkeley National Labs
- Purpose: Install data automation software and hardware system that uses wireless sensors and web based software to control computer room air conditioning units.
- Results:
  - Lowered total energy use by 21.3%
  - Saved 475,000 kWh/yr
  - Payback of 3.1 years
  - Bottom-line: \$42,722 per year saved
- Technology Transfer: FTB plans to use this technology in other data centers





# Estimated Energy Savings from PIER SPEED Program



## Direct Savings

- Annual Energy Savings: 2.2 million kWh/yr
- Annual CO2 emissions avoided: 2 million pounds
- Estimated energy cost avoided: \$320,000

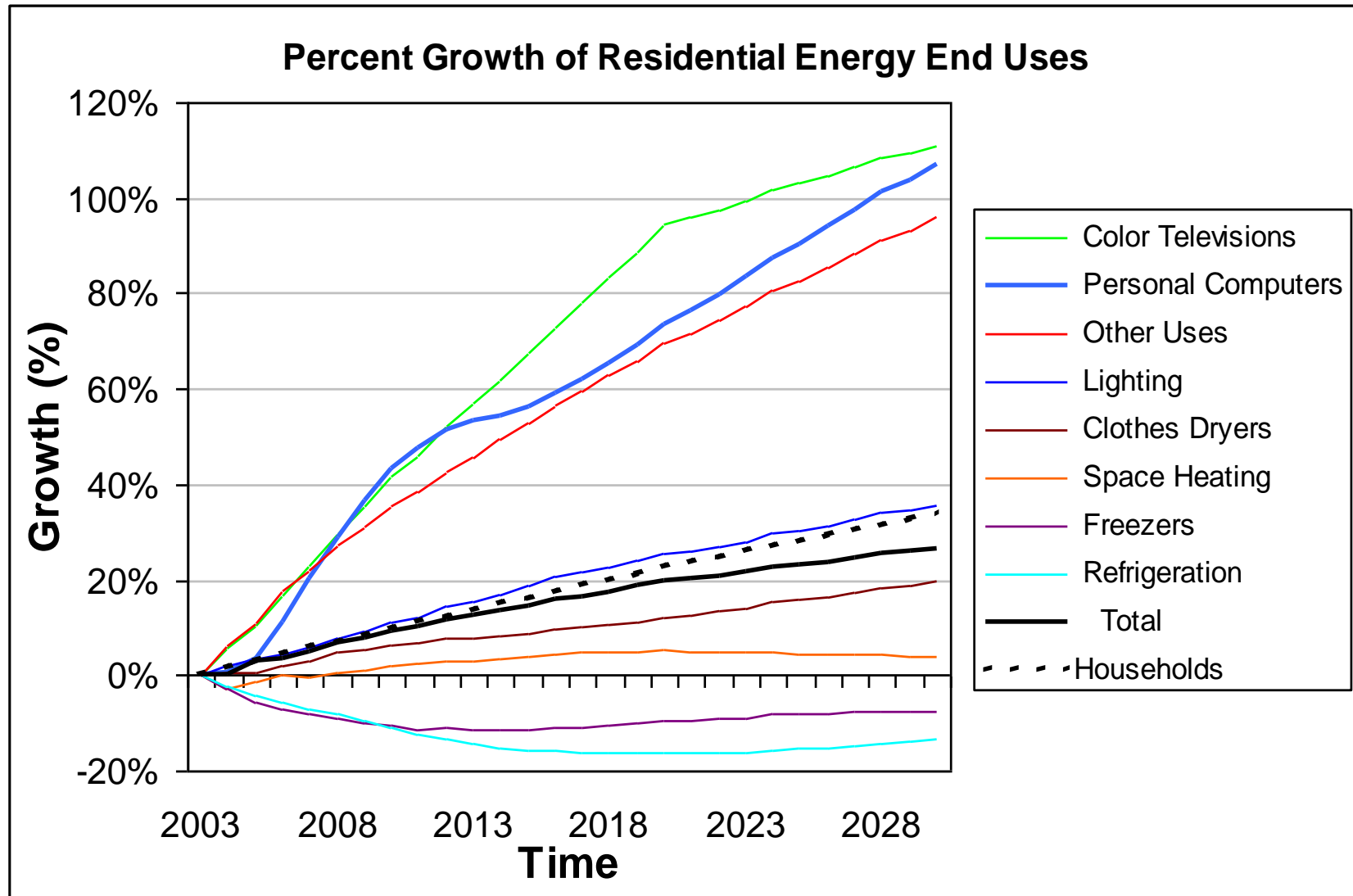
If we assume 15 yr equipment life—  
this results in avoided energy costs of over \$4.8 million

Several third party energy efficiency programs are using PIER  
Technologies—resulting in potential 33 million kWh/yr in savings  
(source: PIER Demonstration Program-Final Report, January 2011)





# Next R&D Target: Plug Loads

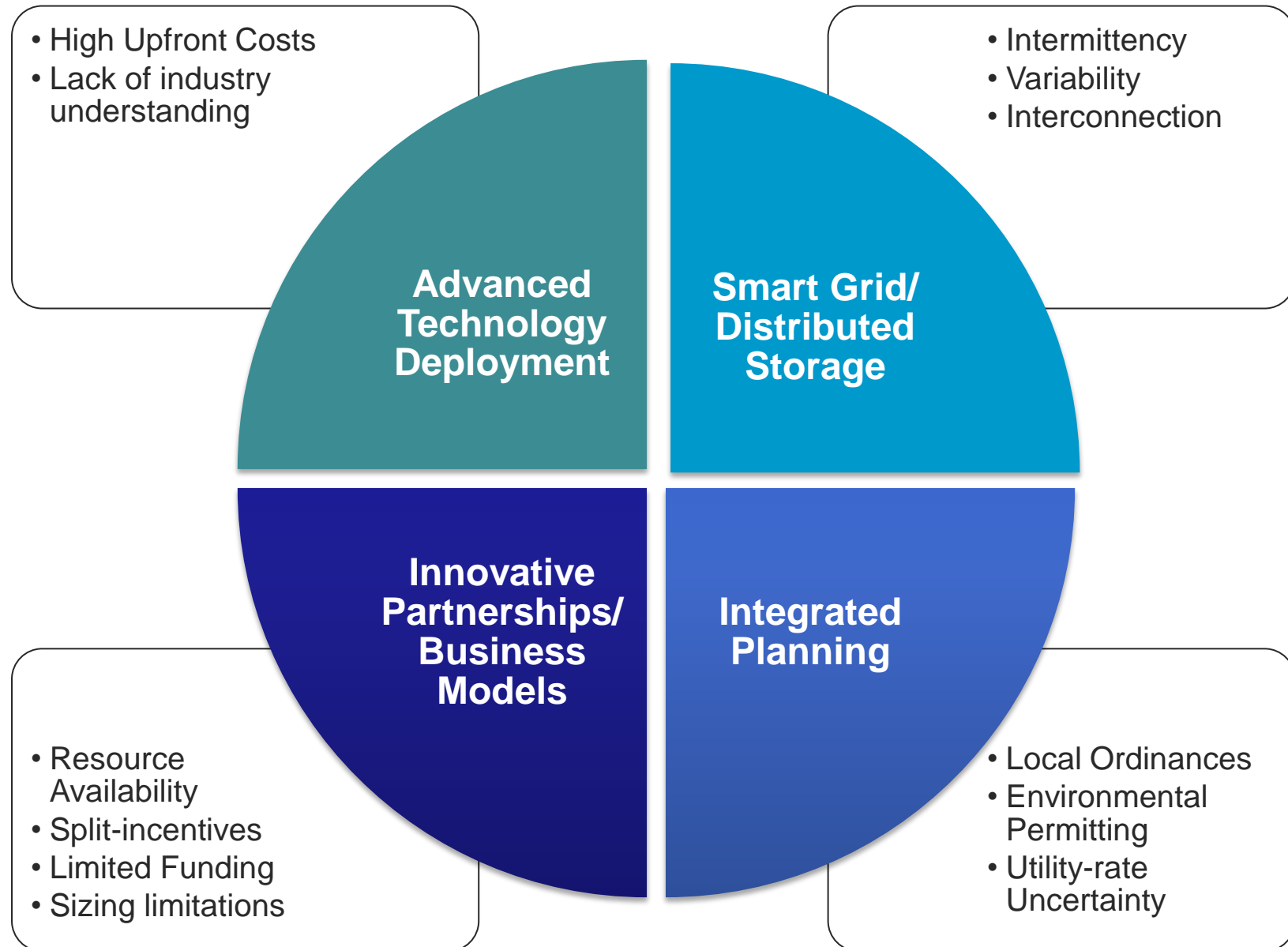


# Plug Load Energy Efficiency Center



- Plug loads –fastest growing energy loads contributing to about 15% of residential and commercial electrical use and could double by 2030
- New Center located at UC Irvine
- Focused on research and development on plug loads –devices that plug into electrical outlets and contain ac/dc power supplies (e.g., consumer electronics)

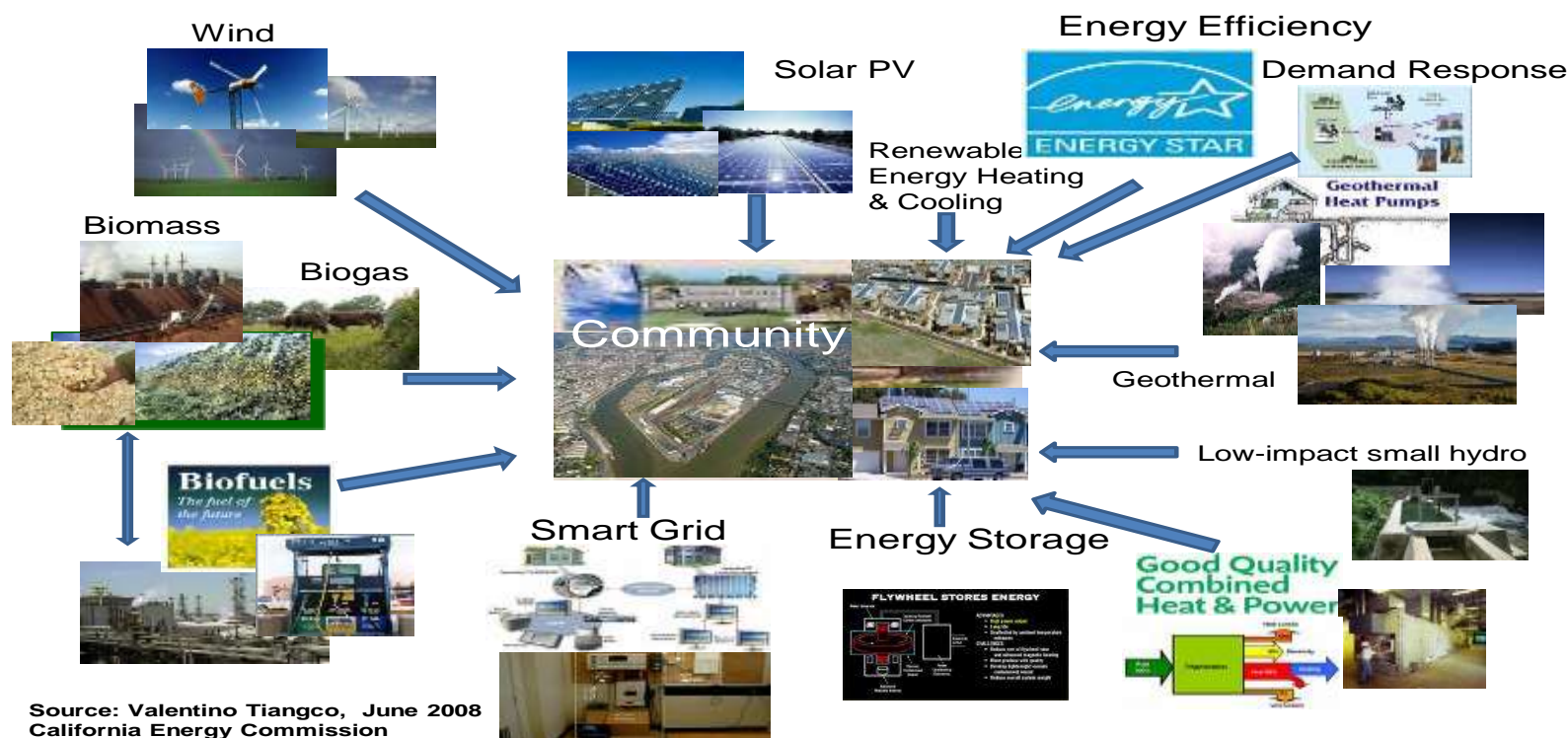
# Renewable Deployment Challenges and Opportunities



# Renewable Communities



## Building Blocks of Renewable-based Energy Secure Communities (RESCO)



- Communities that secure their energy supply (electricity and fuel) through indigenous RE resources
- Use of locally-available renewable resources to meet 100% of communities' energy needs
- 11 unique projects




## Project Objectives

Develop an operational model that integrates three renewable sources available to every community:

- Energy efficiency, solar energy, solid or sewage waste with energy storage
- Integrate to maximize reliability and minimize costs, differentiated by season and time of use.





Current: 4,300 students / 100 acres  
Future: 25,000 students / 815 acres



# 2009 Long Range Development Plan establishes UC Merced's Triple Zero Commitment for Sustainability

UC Merced Tomorrow



LONG RANGE DEVELOPMENT PLAN  
UNIVERSITY OF CALIFORNIA, MERCED

2009 FINAL

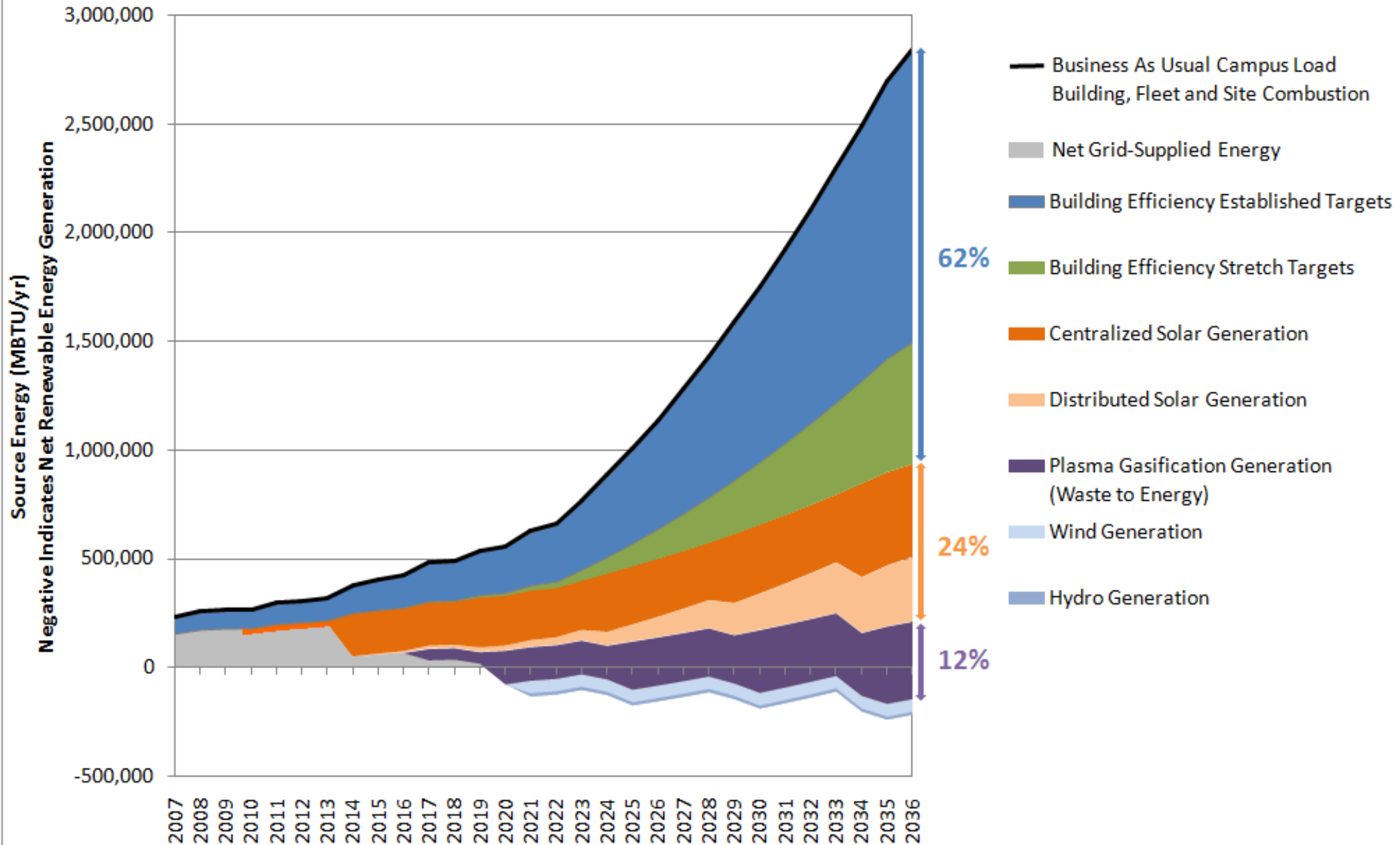
Adopted by the UC Board of Regents March 2009.

- Zero Net Energy by 2020
- Zero Waste by 2020
- Zero Net Greenhouse Gas Emissions by 2020

Implementation through:

- Building Design Standards
- On-campus Renewable Energy
- Systems and Infrastructure Design
- LEED Gold Minimums

## UC Merced Business as Usual Load and "Wedges" to Achieve Zero Net Energy Over Campus Build-out



# Progress To Date - Efficiency



- The energy efficiency protocol is complete and is a web-based "energy performance platform"
- Building commissioning activities are 30% complete

Retrieve [ALC Trend Data](#)

A - How is my energy performance?  
[Benchmark Performance](#)

B - Is consumption rising or falling? What end use is driving changes in consumption?  
[Energy Consumption](#)

C - Are peak demands rising or falling? What end use is driving changes in peak demand?  
[Energy Demand](#)

D - Are central plant efficiencies improving or declining?  
[Plant Efficiencies](#)

E - Are system efficiencies improving or declining?  
[System Efficiencies](#)

F - Are systems operating properly? How much energy is being wasted?  
[System Analysis](#)

G - How can future building energy models be improved?  
[Modeling Input](#)

UNIVERSITY OF CALIFORNIA  
**UC MERCED**

## Energy Performance Platform

UC Merced is currently designing buildings to consume half the energy of university buildings in California.

This goal has been phased in over time, with building energy budgets of 1999 UC/CSU building benchmarks. The campus is currently operating buildings operating below 65% of benchmarks (source energy).

Surpassing efficiency goals has led the campus to strive for a zero net energy building. Merced's building performance, LBNL and UC Merced developed the platform and identifying savings.

### Energy Consumption

Area:

Commodity:

Boundary:

Unit:

Show End Uses? ☒ Yes ☐ No

Divisor:

Filter:

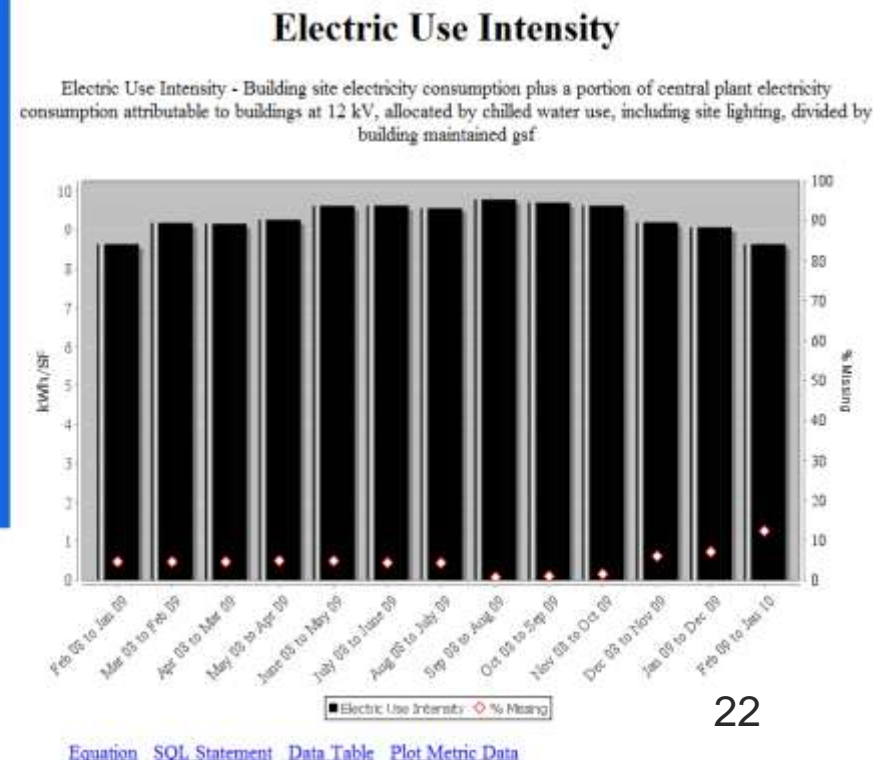
Comparator:

Range:

From:

To:

[Home](#)





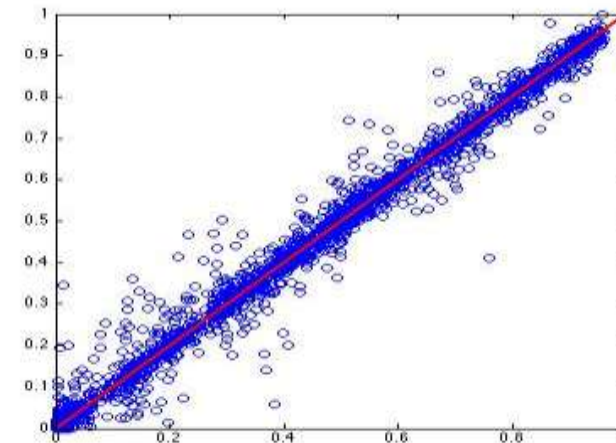
# Progress To Date – Solar Experimentation and Modeling



UC Merced Solar Observatory



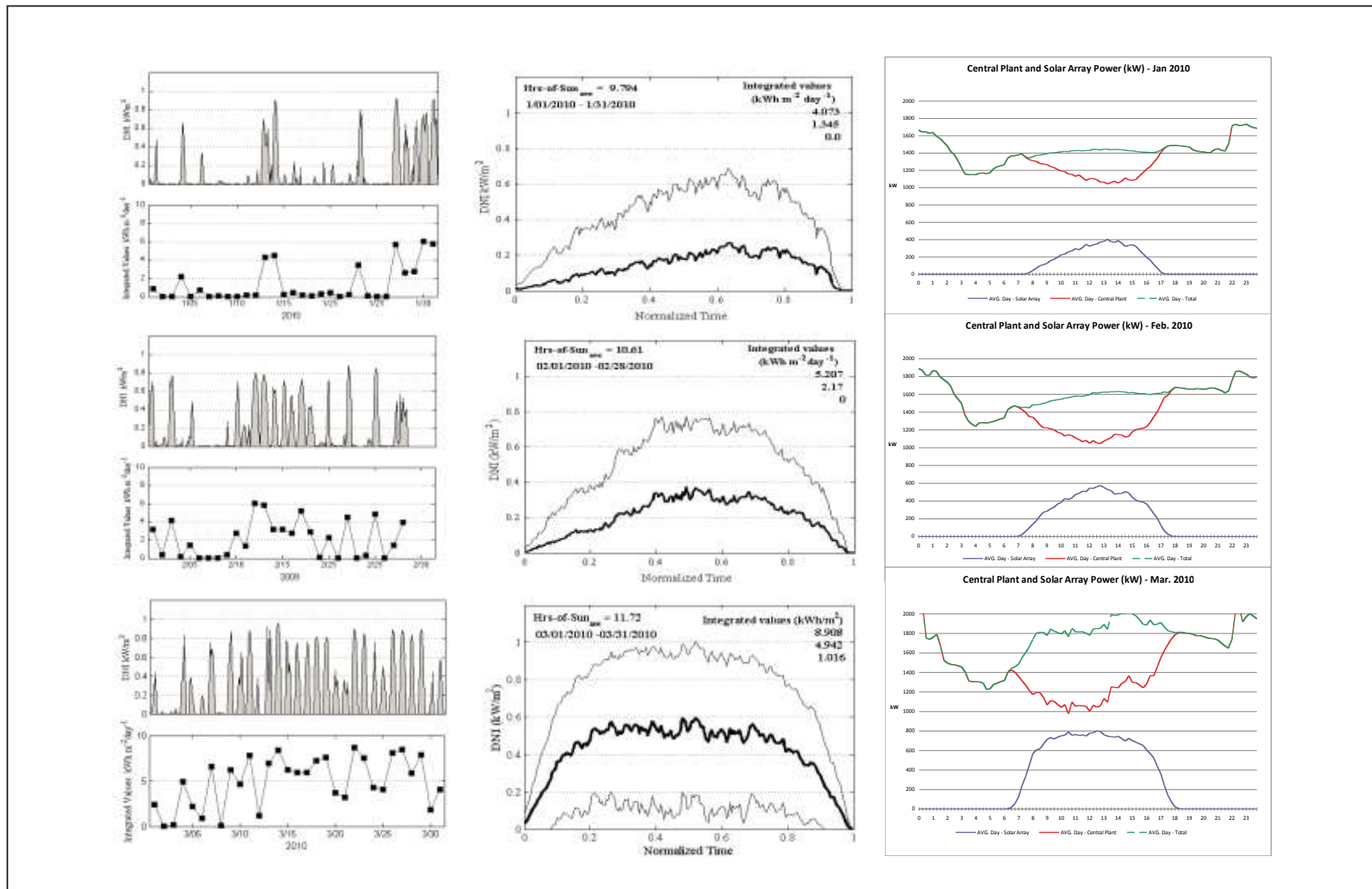
Models





# Progress To Date – Solar data collection and calibration

- Models for forecasting the UC Merced photovoltaic array are being developed and improved

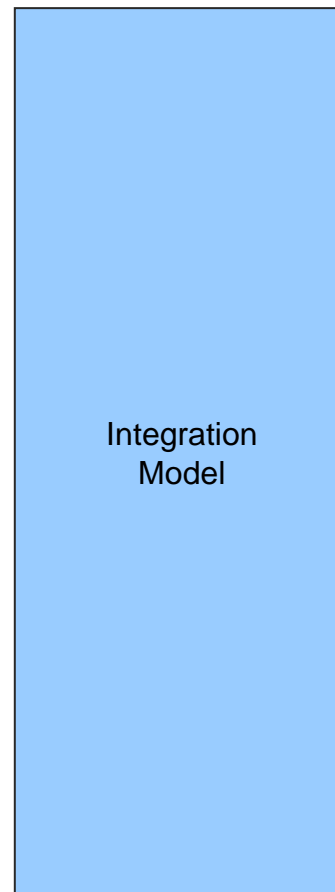
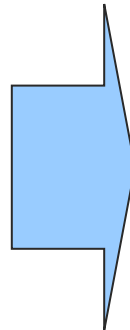


# Progress To Date – Integration



- The basic structure of a neural network model has been defined and data related to generation profiles, costs, and optimization parameters are being prepared for the model.

- Normalized campus load
- Chilling plant efficiency by season and TOU
- Cost determinants for all energy sources
- Generation profiles
- Thermal Energy Storage parameters



**Optimized portfolio** based on minimizing cost, greenhouse gas, impact on grid, differentiated by time of use

# SDG&E Borrego Springs Microgrid Project

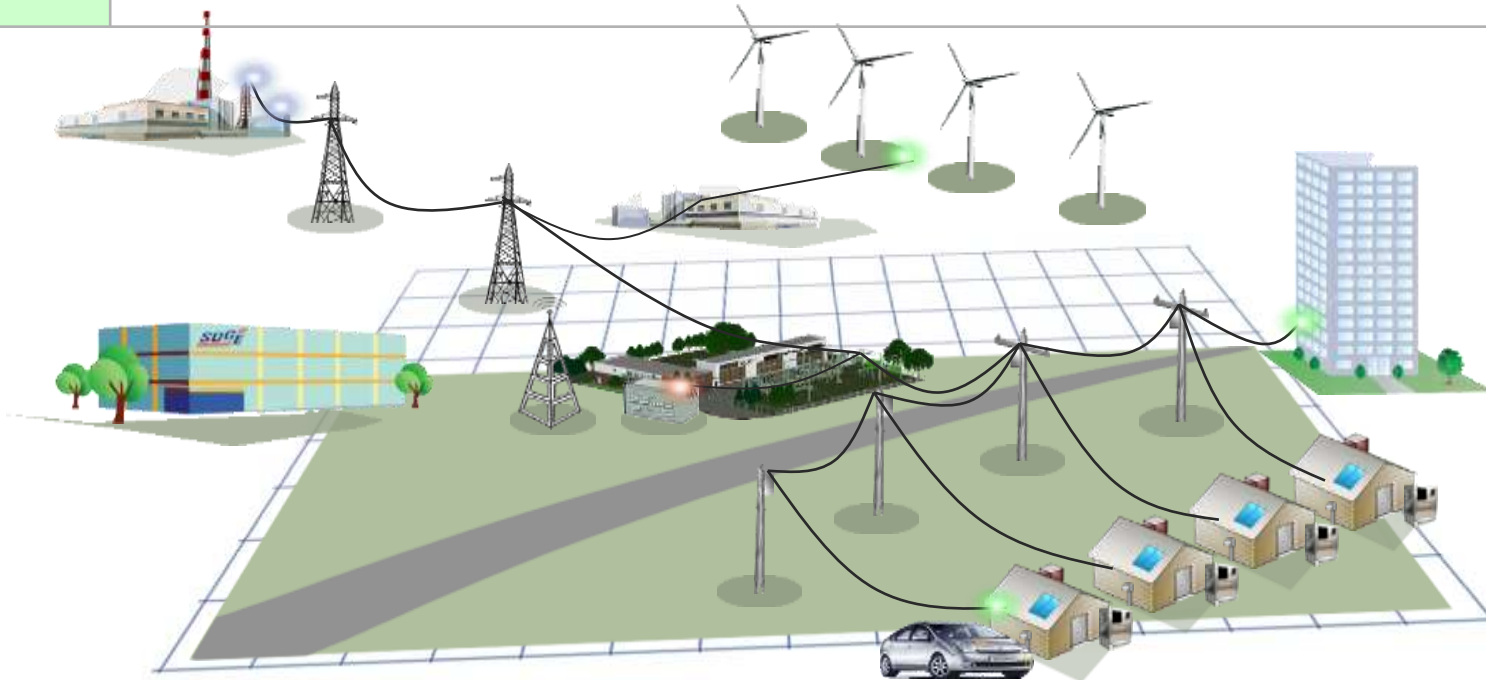


## Budget:

\$15.2M (\$4.1M SDG&E, \$7.5M DOE, \$2.8M CEC, and \$0.8M partners)

## Benefits:

- Reduce the peak load of feeders and enhance system reliability
- Accommodate various generation and storage configurations
- Utilize advanced technologies to integrate and manage distributed resources within the Smart Grid

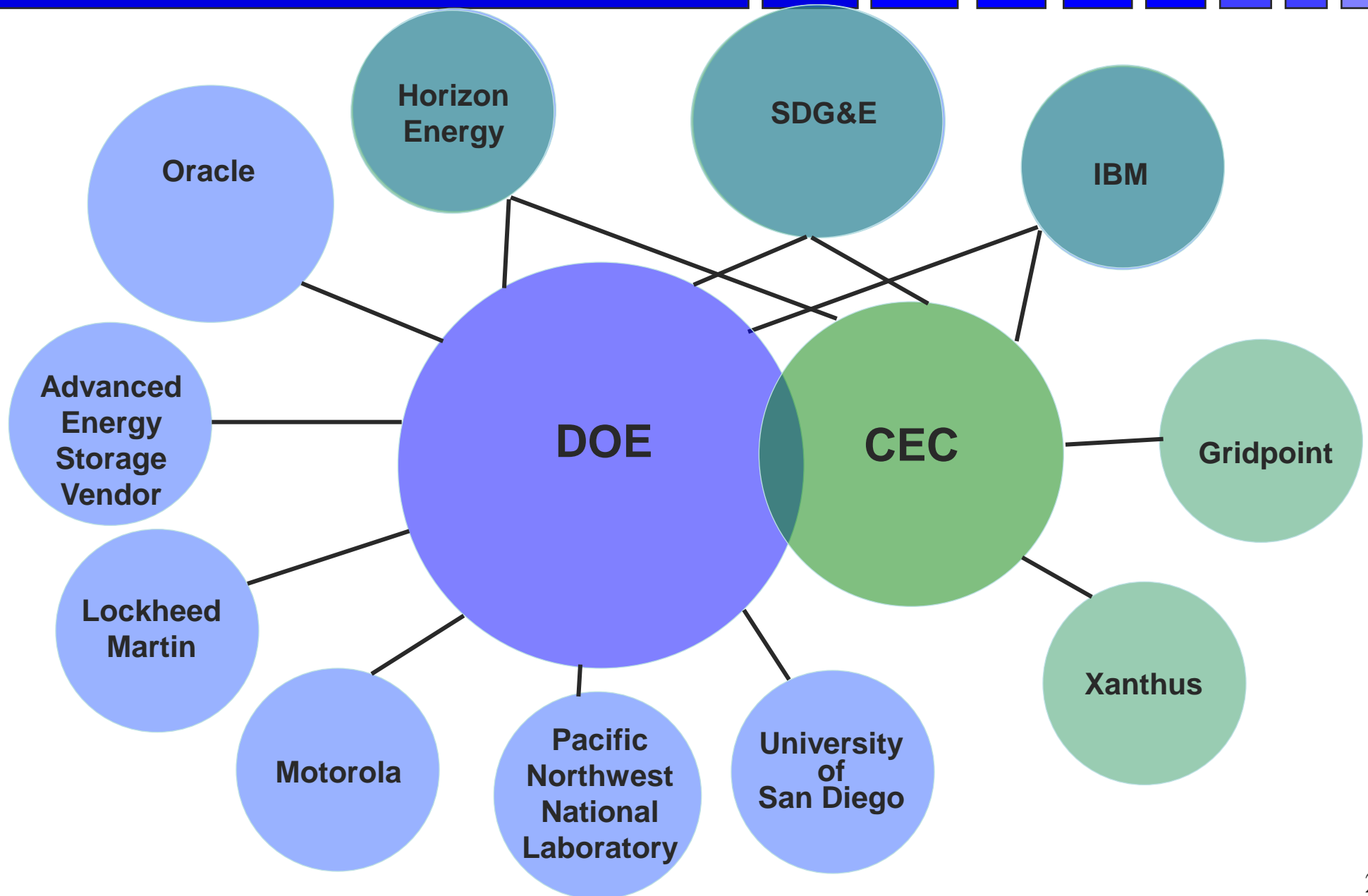


# Borrego Springs Project Objectives



- Achieve > 15% reduction in feeder peak load
- Demonstrate capability of Volt-Amps-Reactive (VAR) management
- Develop a strategy and demonstrate:
  - Integration of AMI into Microgrid operations
  - Self-healing networks through the integration of Feeder Automation System Technologies (FAST)
  - Integration of an Outage Management System/Distribution Management System (OMS/DMS) into Microgrid operations
  - Intentionally island customers in response to system problems
  - Information/tools addressing the impact of multiple DER technologies
  - Demonstrate PCTs to achieve demand response within the microgrid

# Project Partners



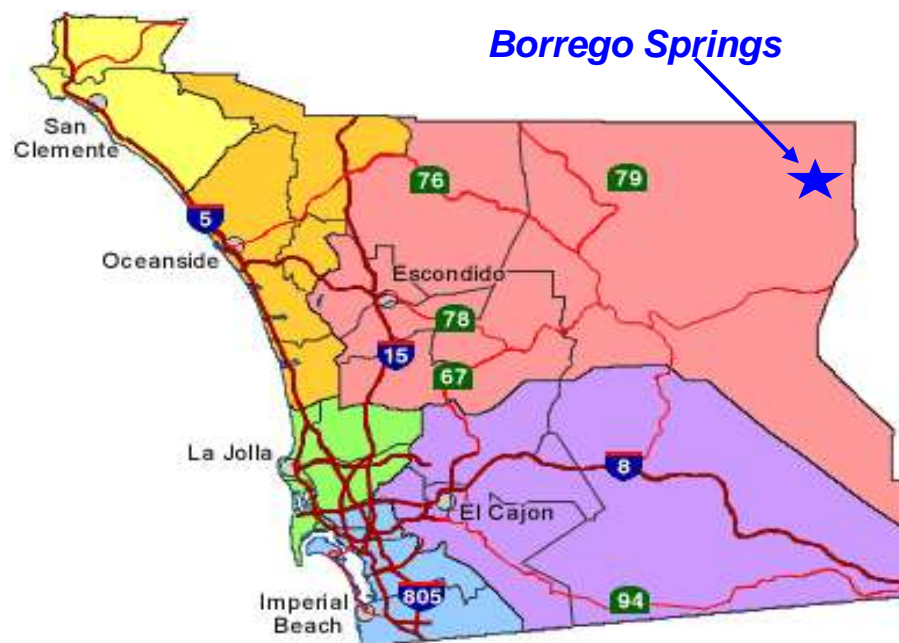


# Site Selection – Borrego Springs, CA

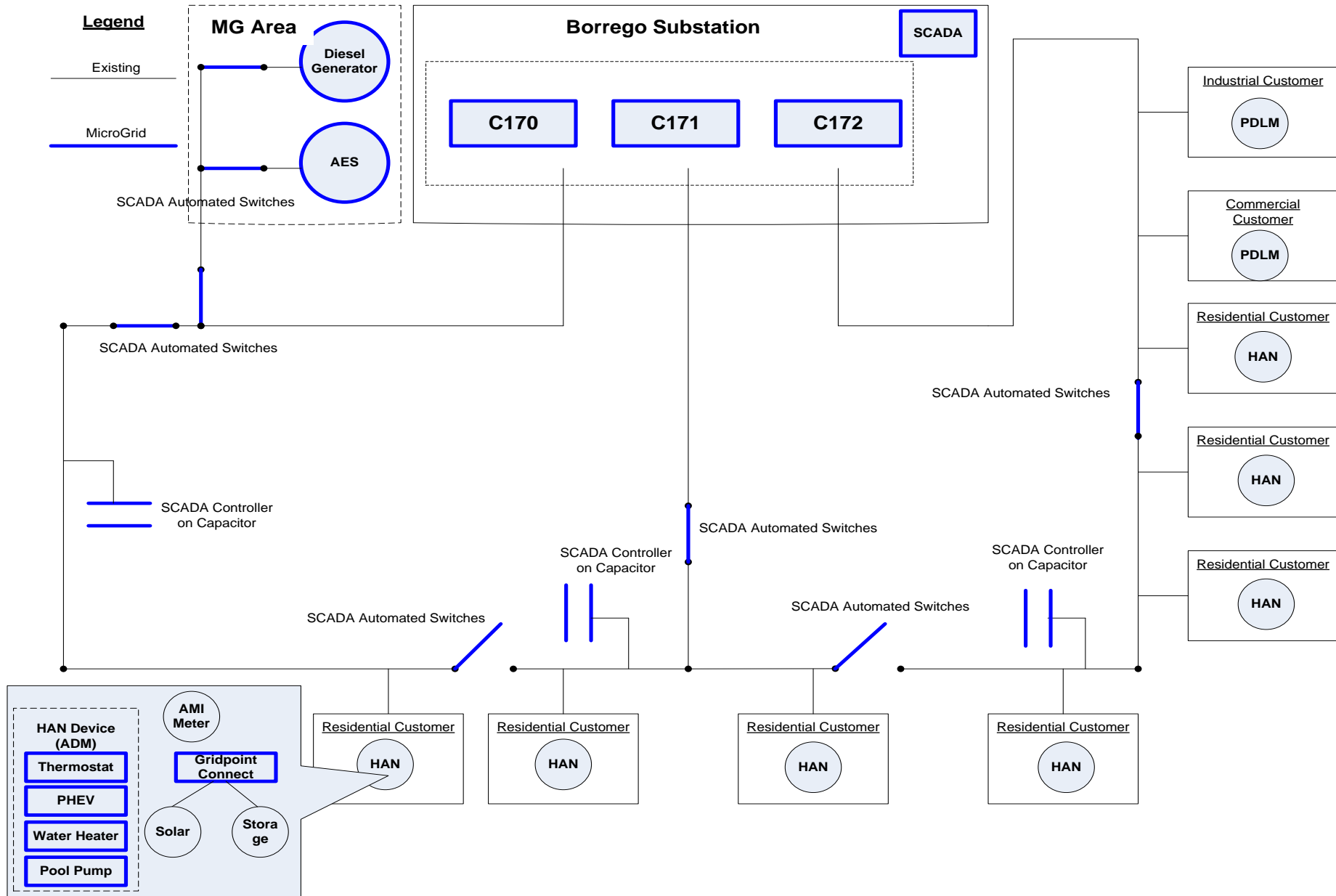


## Key Strengths:

- High concentration of customer-owned solar generation
- Potential to realize advanced reliability enhancements
- Opportunity to demonstrate self-sufficient circuit
- Extendable to service territory



# Borrego Substation Conceptual Circuit Illustration



# Distributed Energy Resource (DER) and Advanced Energy Storage



- *Utility-owned distributed generation will simulate customer-owned renewable generation*
  - two 1.8 MW diesel generators owned by SDG&E
  - 200 hours per generator per year
- *Advanced Energy Storage will supplement Distributed Energy Resources*
  - 1.0 MW Power Output
  - 6.0 MW-Hr of Energy
  - Potential future applications

# Feeder Automation System Technologies (FAST)



- *Automated switching technology will improve reliability by enabling circuit operations without human intervention*
- *Microgrid Controller technology will integrate with the Distribution Management System while balancing the distributed energy resources and energy demand in the Microgrid control area*

# Microgrid Controller



## Distribution Management System

Microgrid  
Master Controller

SCADA System

### Distributed Energy Resources

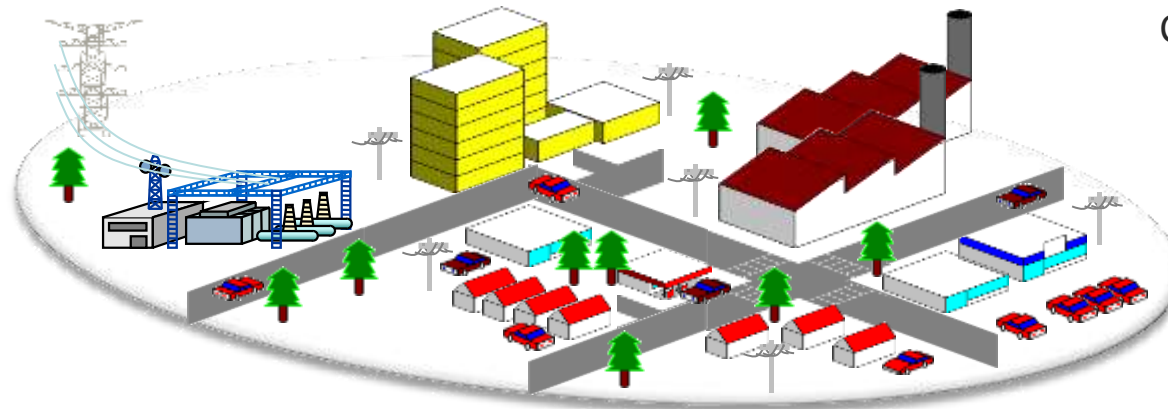
Utility-scale Energy Storage  
Rooftop PV Solar  
*Micro-turbines*  
Building Energy Storage  
Community Energy Storage  
Distributed Generation  
Home Energy Manager  
PEVs  
*Ground PV Solar Array*

### Information

Electricity Pricing  
DER status  
Demand Response Programs  
Network status  
Community Objectives  
Load and Resource Profiles

### Grid Resources

Capacitor Banks  
Voltage Regulators  
Automated Switches  
Power Electronics  
Communications





# DoD Emerging Tech Demos: Navy Energy Vision



## Energy Security

***Energy security is critical to our success. We will safeguard our energy infrastructure and shield ourselves from a volatile fuel supply.***

### We will:

- Deploy the 21<sup>st</sup>-century “Great Green Fleet”
- Aggressively reduce our reliance on fossil fuels
- Secure a sufficient, reliable, and sustainable energy supply



## Environmental Stewardship

***Environmental stewardship is our responsibility. We will reduce the environmental impacts of our energy use, lead in reducing greenhouse gas emissions, and promote sustainability.***

### We will:

- Swiftly adopt cutting-edge low carbon technologies
- Consider carbon emissions in our daily operations and our procurements
- Replace energy from fossil fuels with energy from alternative and renewable sources



## Energy Efficiency

***Energy efficiency increases our combat effectiveness. We will expand our tactical reach and minimize operational risks, saving time, money, and lives. We all take responsibility for energy efficiency.***

### We will:

- Incentivize industry to be more efficient
- Accelerate energy efficient technologies through greater investment in FDT&E
- Adapt operational policies and doctrine to value energy as a strategic asset

# Smart Grid Initiative at Beale AFB



## Beale Air Force Base – Air Combat Command

The 9<sup>th</sup> Reconnaissance Wing provides combat support for potential deployment in response to theater contingencies. The 9<sup>th</sup> Reconnaissance Wing is composed of more than 3,000 personnel in four groups at Beale and multiple overseas operating locations.

# Microgrid Demonstrations at Beale AFB



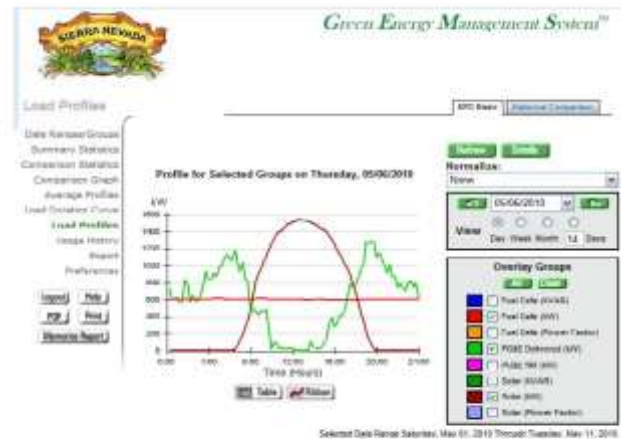
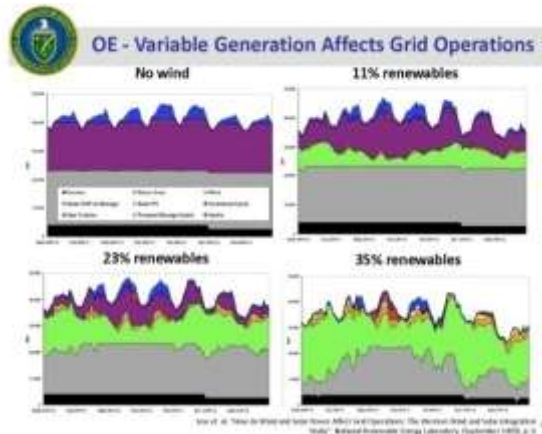
## ***Air Force Bases Areas Reviewed for Opportunity:***

- Integrated Energy-Environmental-Asset-Cost Management, Process Efficiencies & Technologies
- Lighting & Commercial Buildings-Related Technologies
- Residential Energy Efficiency
- Power Engineering & Distribution
- Cyber Security
- Demand Response & Demand Response Automation
- Renewable Energy & Bio-energy
- Energy Storage
- Western Area Power Administration (WAPA)
- Stimulus Funding Team

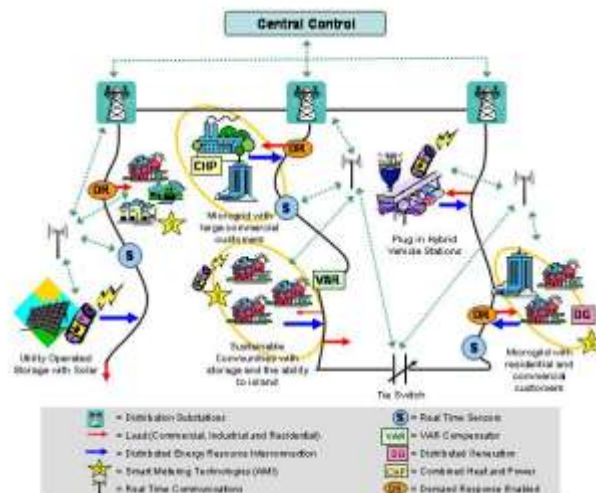
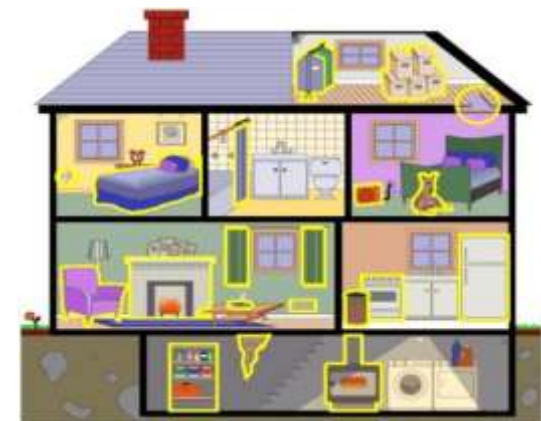
***Similar Opportunities are being explored with the Navy, San Diego***



# Energy Assurance Challenges and Opportunities



*Innovative and responsive solutions in energy, asset and supply chain management brought to you by the Glens Group [www.glensgroup.com](http://www.glensgroup.com)*



## Smart Grid



# Summary



- Research fosters innovation and results in new technologies that save energy and money
- Research spawns new companies and jobs
- Demonstration programs provides opportunity for partners to test drive new technologies
- Group purchasing program provides avenue for volume pricing on selected PIER technologies
- For information on the PIER Program:  
<http://www.energy.ca.gov/research/index.html>







**Thank You**

**Questions?**

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