



California's Public Interest Energy Research Program Overview

U.S. Department of Energy
Office of Electricity Delivery & Energy Reliability

FY06 Annual Program and Peer Review

San Ramon, CA
May 25, 2006

Laurie ten Hope
Energy Systems Integration and Environmental Office
California Energy Commission



Presentation Outline

- PIER Overview
- Highlights of Energy Systems Integration Program
- Examples of a few Research Successes



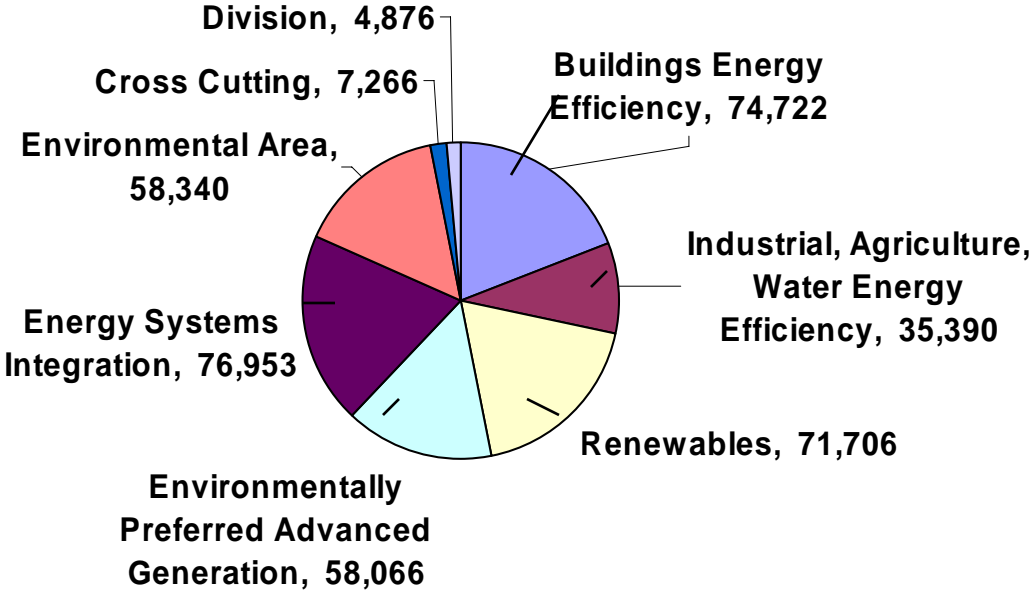
California's Public Interest Energy Research (PIER) Program

- PIER was established in 1997 as part of electricity restructuring
 - Maintains capacity for applied energy research of benefit to electricity ratepayers
 - \$62.5 M annual funding for research provided by surcharge on IOU ratepayers
 - Between 300-400 active projects
- PIER was expanded in 2005 by CPUC rule to include \$12 M of natural gas research
 - Expected to grow to \$24 M by 2009
- Recent Legislation adds transportation



PIER Programmatic Budget Expended (1997 to 2005) (in Thousand Dollars)

PIER Project Dollars by Program Area



Total Project Dollars: \$387,318,732



PIER Completes 2006-2011 Electricity Investment Plan



California Energy Context
California provides clean, affordable, reliable and resilient sources of energy where consumers have choices that meet their needs, businesses prosper, and the state's beauty and environmental integrity are preserved.

PIER Mission Statement

The PIER program provides advanced energy innovations in hardware, software, systems, exploratory concepts, supporting knowledge and balanced portfolio of near-mid-long term energy options for a sustainable energy future in California

PIER Vision Statement

Sustainable energy choices for utilities, state and local government, and large and small consumers in California

PIER Values

Legislative Mandate

- Improves the quality of life of Californians by protecting public health and providing environmentally sound, safe, reliable, and affordable energy services and products
- Undertakes public interest energy RD&D projects that are not adequately provided for by competitive and regulated energy markets
- Advances energy science & technology of value to Californians

Processes

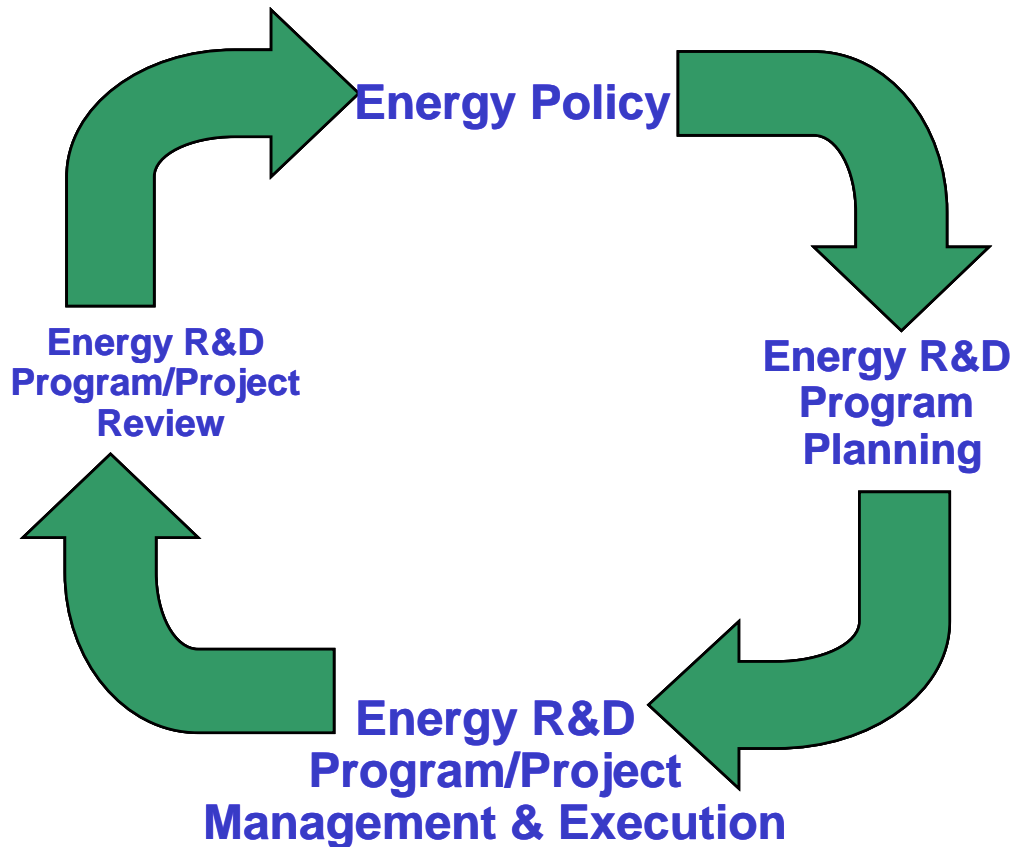
- Responds to energy problems important to Californians
- Informs and responds to state policy
- Provides environmental stewardship and natural resource conservation
- Anticipates energy issues that California will face
- Provides leadership to develop affordable, innovative and useful solutions
- Maintains integrity, objectivity and trust as California's gateway for new energy technologies
- Strives towards excellence in solutions, management and administrative processes
- Attracts, retains and motivates the most talented staff
- Balances a portfolio of incremental, breakthrough and radical innovations

Stakeholder Collaboration

- Works with stakeholders to plan research and transfer technology
- Maximizes resources through valuable partnerships
- Funds the best and brightest researchers



The PIER Energy Policy – Energy R&D Cycle Begin with the End in Mind



- PIER R&D is always carried out within the context of CA Energy policy and addresses needs not met by the private sector
- PIER R&D aims to provide advanced technology that improves the lives of Californians, which means that PIER must interact with the marketplace
- PIER R&D planning, management, and evaluation is designed and carried out with the intent of
 - Meeting policy goals, or revising policy goals
 - Engaging with users and manufacturers throughout the R&D process
- PIER R&D addresses critical technical, market, and policy risks.



California Energy Policy Framework

2005 Integrated Energy Policy Report

1. Demand-Side Resources, Distributed Generation and Other Electricity Supplies
2. Integrated Water and Energy Strategies
3. Renewable Resources for Electricity
4. Electricity Needs and Procurement Policies
5. Transmission
6. Natural Gas
7. Transportation Fuels
8. Global Climate Change
9. Border Energy

Energy Action Plan II

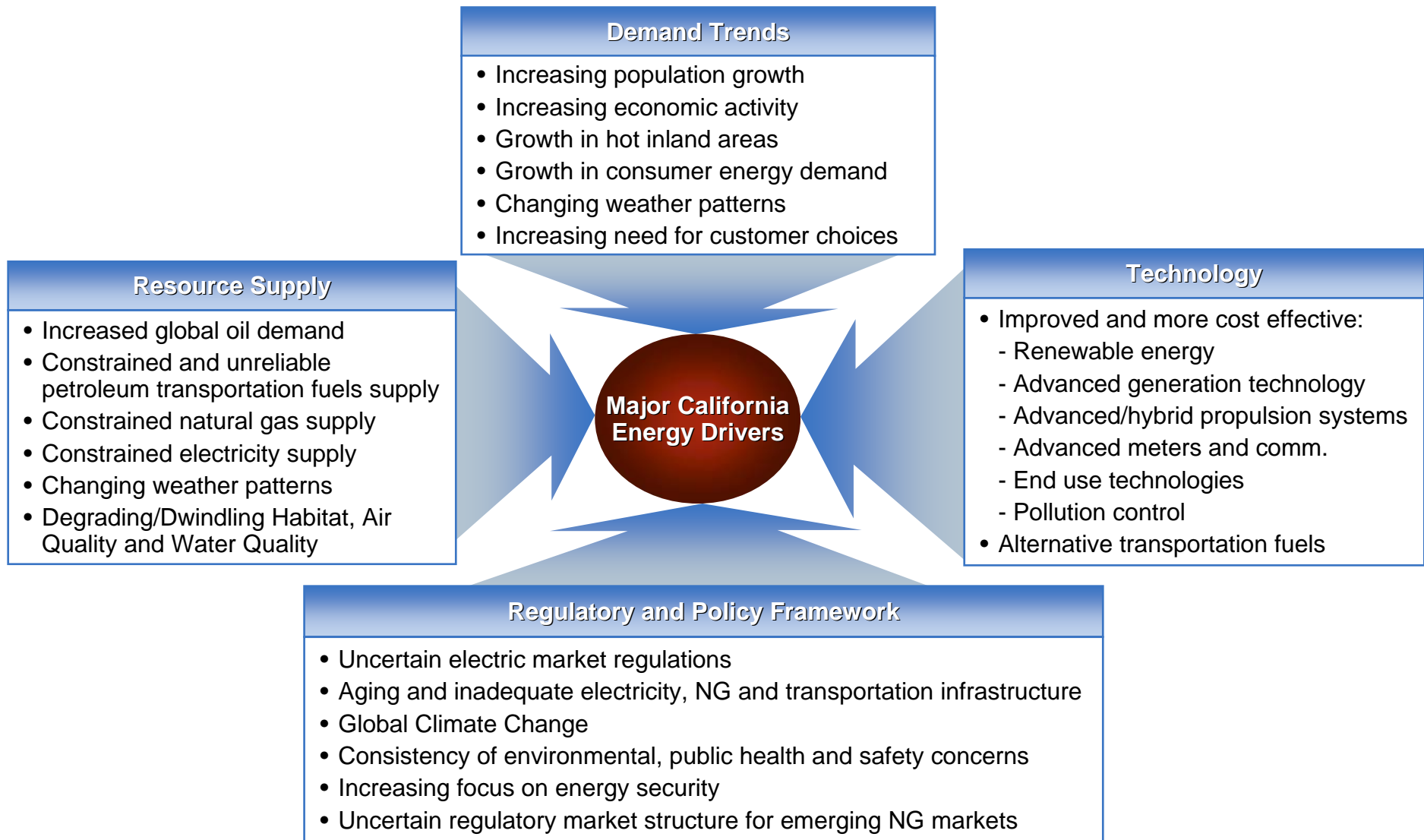
1. Energy Efficiency
2. Demand Response
3. Renewables
4. Electricity Adequacy, Reliability and Infrastructure
5. Electricity Market Structure
6. Natural Gas Supply, Demand, and Infrastructure
7. Transportation Fuels Supply, Demand, and Infrastructure
8. Research, Development, and Demonstration
9. Climate Change



The Five Year Plan Captures Significant Trends & Drivers



25 Trends and drivers grouped into four major categories.





As directed by policy, and incorporating emerging issues from major drivers, PIER identified five key energy issues.



Key Energy Issues Important to California

- Affordable, comfortable and energy-smart choices for daily life and a strong California economy
- Clean and diverse energy supply that optimizes California’s resources
- *Safe, secure and reliable electricity system*
- Environmentally sound electricity system in California
- Clean and diverse transportation system in California



Electricity Five Year Plan



Integrated Electricity System that is Reliable and Secure

PIER Strategic Objectives

1. Enable optimal integration of renewables, distributed generation, demand response, and storage to the power system.
2. Improve capacity, utilization, and performance of transmission and distribution system.
3. Improve cost and functionality of components to integrate demand response, distributed generation, and electricity storage into the system.
4. Improve security and reliability of electricity system.
5. Support improvement of tariffs and regulations for demand response, distributed generation, storage, and renewables.
6. Facilitate transmission siting process.
7. Develop knowledge base for future decision-making and informed delivery, integration, and infrastructure policy relative to electricity.

Primary Solutions

- Increase the intelligence and responsiveness of the transmission and distribution system to more effectively enable optimal integration and use of renewables, demand response, distributed generation, and storage.
- Support integration of intermittent and remotely located renewables into the system.
- Improve cost and functionality of demand response, storage, and distributed generation integration components.
- Analysis of appropriate market mechanisms for renewables, demand response, distributed generation, CCHP, storage, transmission, distribution, and security (rates and tariffs, markets and utility planning, incentives, regulation, financial).
- Provide new technologies and tools to expand capability of existing transmission and distribution (real time ratings and operations, better asset utilization).
- Develop an electric system (cyber and physical) that is resilient to natural and man-made events, self-diagnosing and self-healing.

Secondary Solutions

- Develop a regulatory business case for increased utilization of automation, demand response, renewables, and distributed generation on the distribution system that promotes efficiency and reliability while reducing cost.
- Provide new planning tools and processes for technical and policy participants, which will result in successful and timely expansion of the transmission system through existing and new corridors (economic transactions that result from transmission congestion).
- Develop the analysis and enabling technologies to provide varying levels of electricity service.

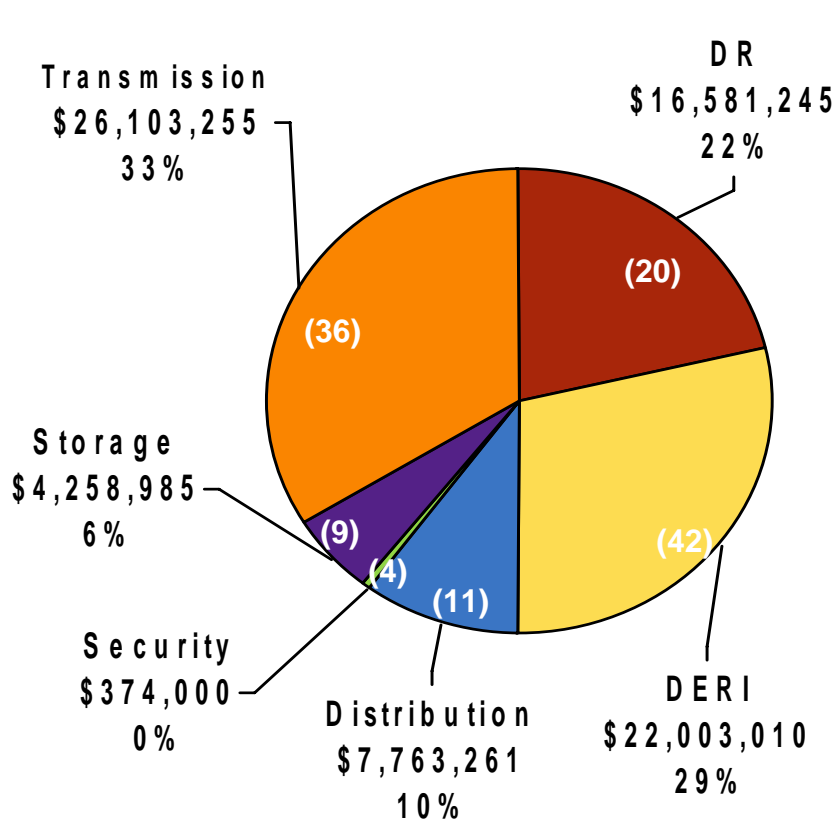
Tertiary Solutions

- Analyze the environmental and economic implications of shifting from solely central station power to distributed generation and central station power.
- Analyze technical and economic interdependencies between electricity and natural gas infrastructure.
- Develop new transparent distribution planning models.

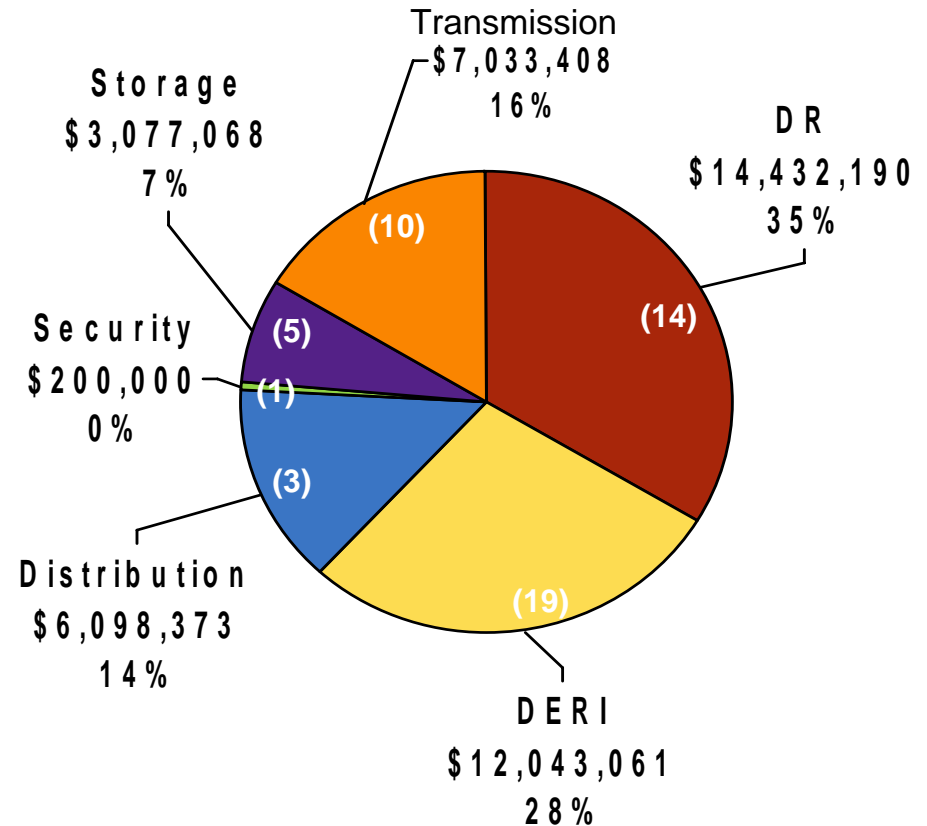


Energy Systems Integration Portfolio

Transmission, DR and DER Integration continue to be predominant areas of investment for ESI.



122 Active & Completed projects totaling \$77,083,756



52 Active projects totaling \$42,884,100



Problem: Fragile Transmission Requires Attention

Western electric power trends create economic, reliability and environmental issues.

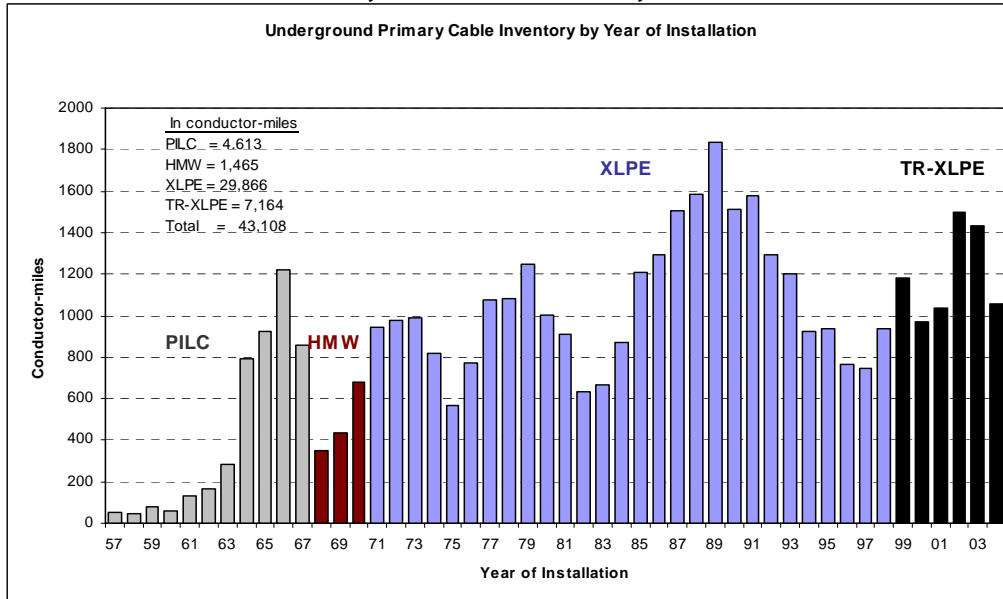
- Difficulty building new transmission:
 - Aging infrastructure is raising concerns about reliability
 - Increases congestion costs
 - Hampers access to low-cost, clean generation
 - Hampers attainment of renewable energy goals
- Power markets, and new generation technologies and electric-consuming appliances, are creating operational uncertainty and instabilities:
 - Impairing operator ability to plan, dispatch and regulate generation
 - Changing the dynamic behavior of the grid, increasing operational risk
- Increasing reliance on interconnection to a large, brittle power grid is:
 - Increasing risk of large wide-spread outages
- Extreme events, e.g., cascading blackouts, “Katrina,” are shaking confidence in institutions’ abilities to provide robust/resilient systems

The health, wealth and safety of California’s citizens are at stake: Cost of congestion (~ \$100s millions/yr); cost of “no kWh” (~ \$billions/yr), environmental costs of 32,000+ miles of HV lines, and ability to meet RPS goal of 20% by 2010



Problem: Today's Distribution System Is Obsolete

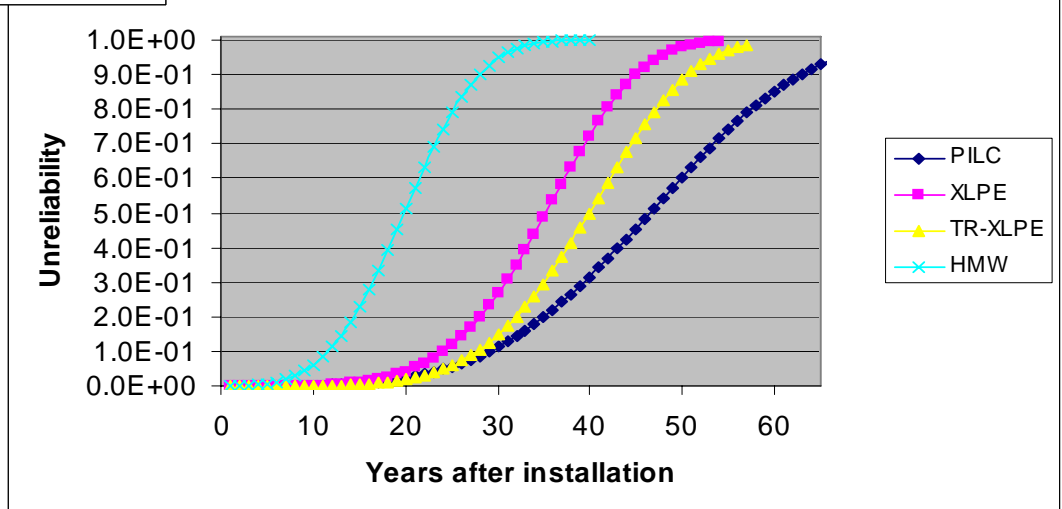
Looming reliability crisis precludes paying attention to next generation of advanced, automated, DR and DG enabling distribution system.



- Undergrounding for aesthetics
- PG&E and SCE have over 60,000 miles of cable installed
- Design practices and cable construction limit useful life
- Average replacement cost \$100/foot
- Techniques to effectively diagnose ineffective – so doing miniscule proactive replacement

- IOUs experiencing 600 UG cable failures per year each
- IOU assessments anticipate this could be >10x worse within 30 years
- Impact to customers - annual minutes of outage likely to double within 30 years

CABLE UNRELIABILITY

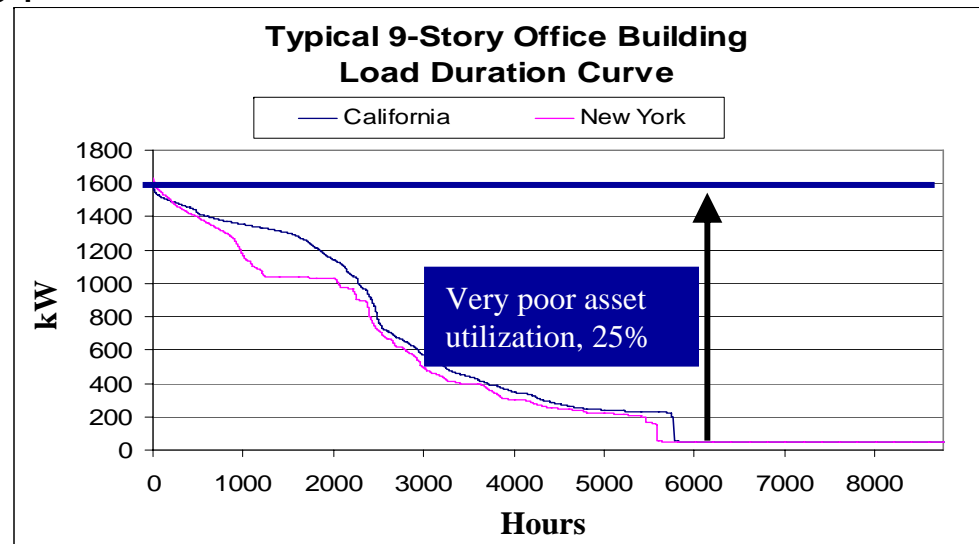
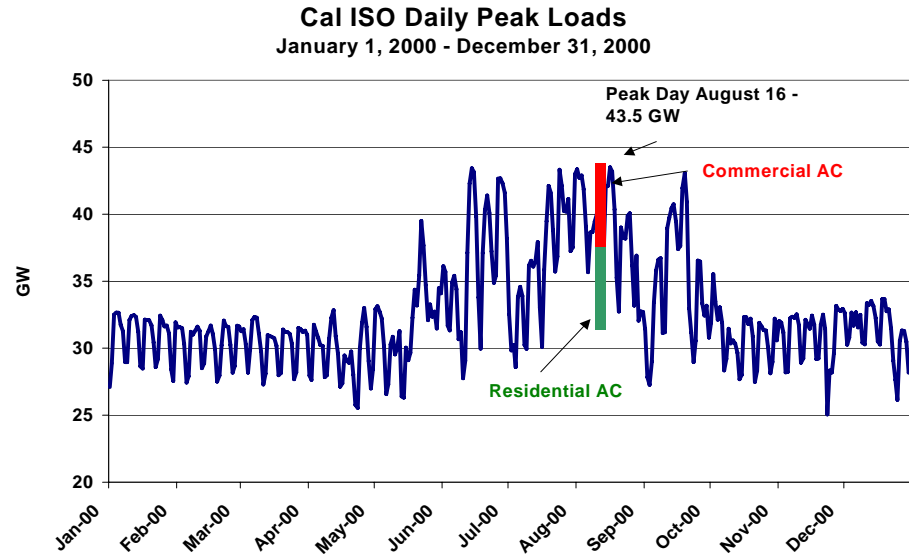




Problem: Load Growth Continues...

Load growth in C&I, industrial and residential is driving peak loads to extremes on transmission and distribution systems.

- California utilities anticipate spending **Billions** in coming decade as distribution system “turns over,” and to meet growth
- A/C is ~ 1/3 of peak load
- Inefficient asset utilization:
 - Why should we build to the 1% occurring peak load?

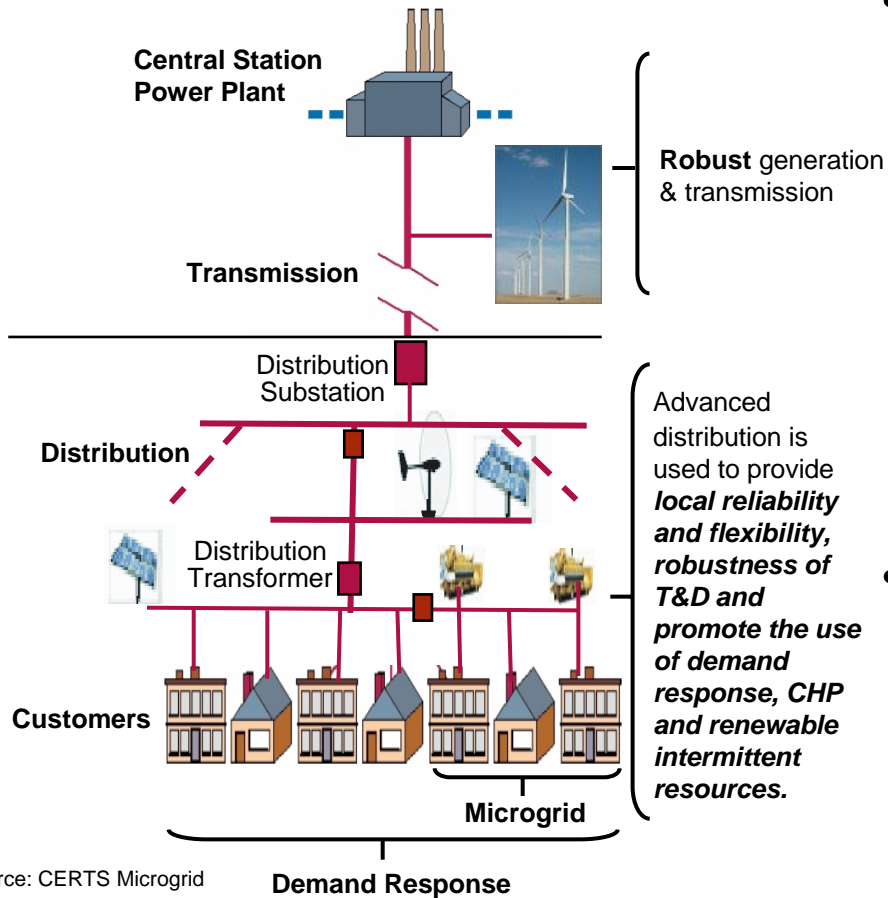


Source: DOE Grid Optimization Study



Solution: Creating A Blueprint for Change

ESI is utilizing systems engineering and looking at the whole system in a holistic fashion.



Source: CERTS Microgrid

- Addressing all these issues necessitates a coordinated effort
 - Integrate EE, DR, DG-CHP, renewables (large and DG), and storage into local energy system designs
 - Demonstrate the benefit to utilities, regulators and ratepayers
 - Optimize integration strategies to target peak load and grid utilization
 - Develop technology-ready T&D infrastructure
- Advances in the T&D system and on the load side can get us to this new vision for the future
 - sensors and monitoring
 - communication and controls
 - intelligent automated systems
 - real time operations of the T&D system

Science and technology can transform the 19th century electricity system into the 21st century information age.



Solution: New Integrated T&D Methodology for DER

Municipal Utility Pilot- Integrating transmission and distribution in a single dataset is practical and adds new insights for utility planners

Research identified the following:

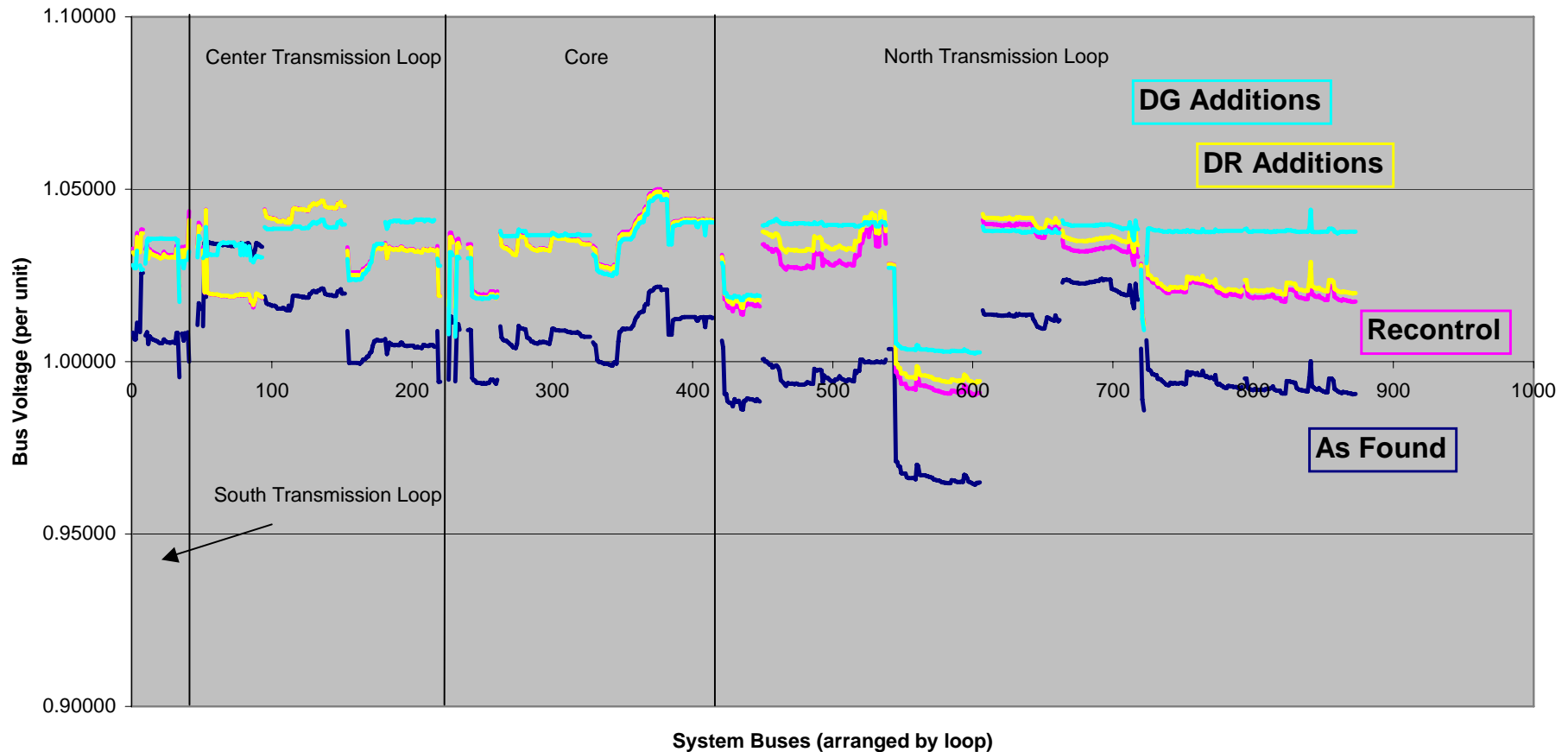
- **Ideal location, size, and dispatch of beneficial DER projects for a given network can be determined.**
- **Network performance (real losses, reactive consumption, voltage profile stability and load-serving capability) can be improved through recontrols and targeted deployment of DER**
- **Local measures have network-wide impacts.**
- **Nonwire solutions can yield significant gains in efficiency and further enhance the performance of a power delivery system**

Presently we're working on the next phase of this research in partnership with Southern California Edison and U.S. DOE to extend it to a system that is 100x bigger and more constrained. Next phase will also validate modeling results with field measurement validation.



Cont'd: New Integrated T&D Methodology Yields Success

Voltage Profile with 318 Ideally-located DG Projects (3 kW - 9 MW, avg 173 kW each)
Actual Summer 2002 Loads and Topology



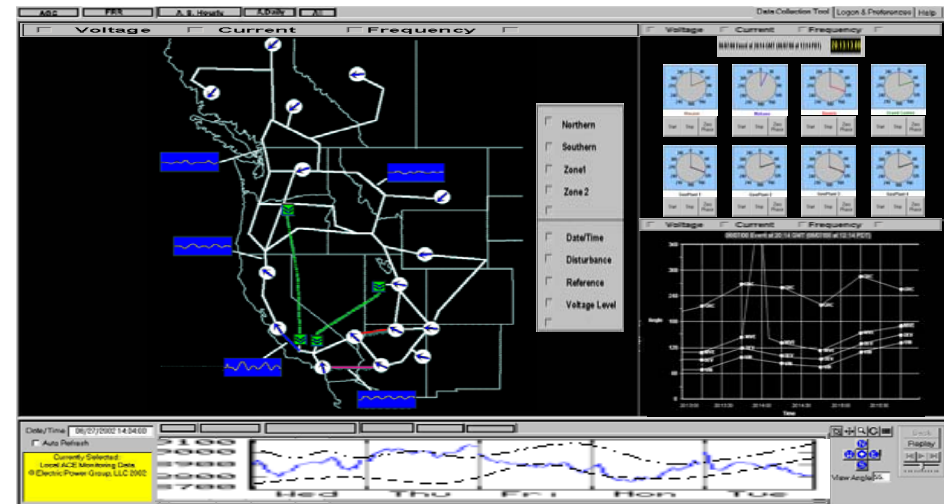
Voltage Profile of 389 Ideally-located DR Projects (customer load reduction of 2-15%) in yellow.



Solution: Research Prevents Serious Problem on California Transmission System

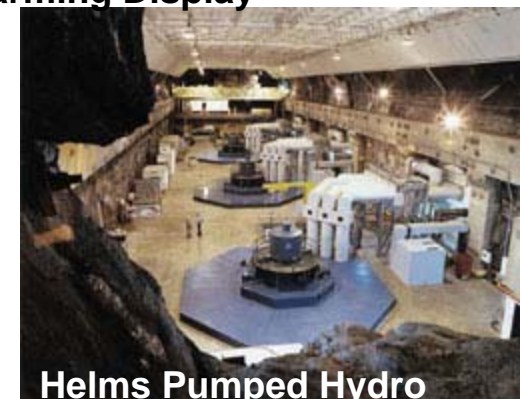


- **TRP Research Project –Real-Time Dynamics Monitoring System (CERTS RTDMS)**
 - Develop & test phasor measurements applications for grid monitoring, alarming & control
 - RTDMS is a first-ever-in-the-western-interconnection Real-Time display of phasor data



Real time Phasor-based Monitoring & Alarming Display

- **The Event – Prevented Serious Transmission Voltage Problem**
 - April 19th, Reliability Coordinator used RTDMS display to flag serious grid voltage problem
 - Problem resolved by dropping two Helms pumps



Helms Pumped Hydro

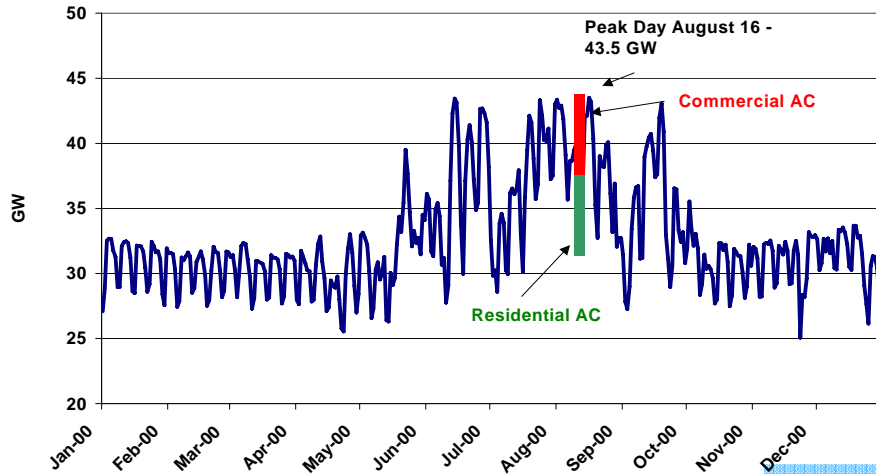
CAISO, project host, used RTDMS R&D system to detect & analyze grid potential problem.



Solution: CA. Pursuing Two Distinct Demand Response Resources

AC is the low hanging fruit to attain 5% peak reduction by 2007.

Cal ISO Daily Peak Loads
January 1, 2000 - December 31, 2000

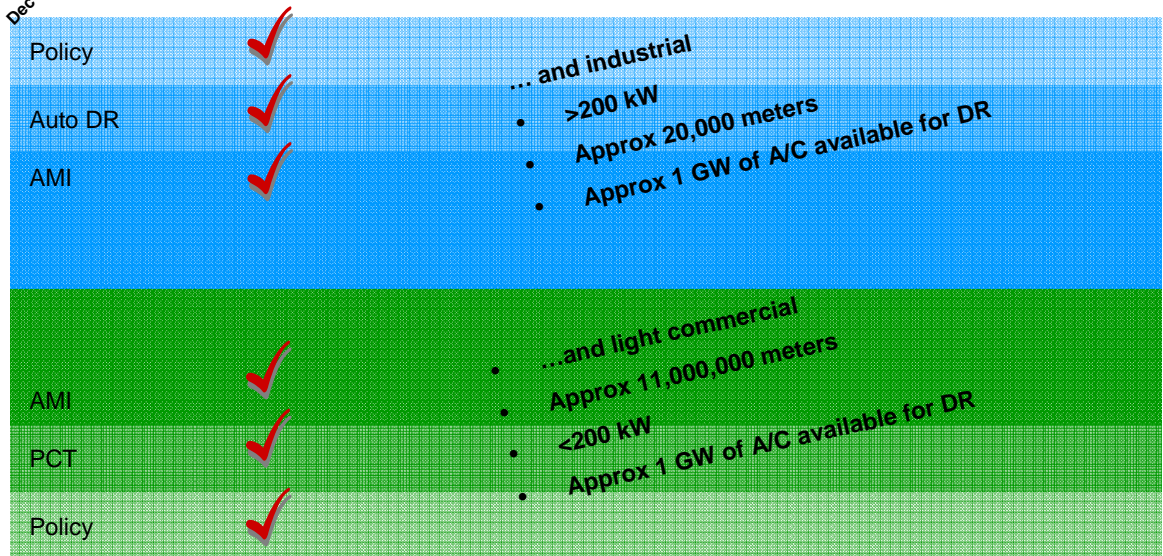


For *commercial and industrial customers*, we're pursuing auto-DR that sends load dispatch signals to their EMS that subsequently executes preplanned shed strategies.

>200 kW, ~20,000 meters, ~8 GW of A/C

Commercial

For *residential and light commercial customers*, we're pursuing programmable communicating thermostats that automatically respond to AC load reduction dispatch signals.



Residential

<200 kW, ~11,000,000 meters, ~8 GW of A/C



Value of Partnerships



PIER actively engages others in the definition, development, funding, evaluation and market adoption of technology research. We welcome your comments and participation.

For more information about working with PIER:

Laurie ten Hope at ltenhope@energy.state.ca.us

PIER Program at www.energy.ca.gov

Referenced Documents available on CEC Website:

- *Public Interest Energy Research Program 2007-2011 Electricity Research Investment Plan*
- *Integrated Energy Policy Report 2005*
- *Energy Action Plan II*