Public Interest Energy Research and Development at the California Energy Commission

The Desert Research Institute
Reno, Nevada July 19, 2002

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Technology Systems Division

California Energy Commission

CALIFORNIA ENERGY COMMISSION

The California Energy Commission is the state's primary energy policy and information agency, charged with ensuring reliable and affordable energy supplies. Created by the Legislature in 1974, the Commission has five major mandates:

- **Forecasting future energy needs**
- **Licensing power plants and related facilities**
- **Promoting energy efficiency**
- **Developing energy technologies and supporting renewable energy**
- **Planning for and directing the state responses during energy emergencies**

BUDGETED RESOURCES FOR 2002/03

564 positions — $ 247.2 million total budget

Operating Budget:

- $ 40.6 million in funding from the electricity surcharge (ERPA)
- $ 9.2 million in funding from the federal government
- $ 5.7 million in General Funds

Programs and Projects:

- $ 71.5 million for Public Interest Energy Research projects
- $ 93.8 million in Renewable Program Funds
- $ 6.7 million in Geothermal Resources Development Account Funds
- $ 4.9 million in Energy Conservation Assistance Account funding for local government projects and programs
- $ 14.8 million in reimbursement and other account funds

Technology Development Continuum
From Innovation to Market

New Energy Idea

Proof of Concept

Technology Development

Demonstrations

Valley of Death
(Need for deployment)

Self Sustaining Market

International Market

PIER Program (RD&D)

Renewable Energy Program

Export Program

Electricity-Related RD&D at the Energy Commission

Research, Development and Demonstration

- PIER
- Geothermal (GRDA) Program

Deployment

- Renewables Program
- Solar Grants (SB 1345)
- Power Source Disclosure Program (SB 1305)

The Power Content Label

POWER CONTENT LABEL

ENERGY RESOURCES	PRODUCT NAME* (projected)	2000 CA POWER MIX** (for comparison)
Eligible Renewable	**56%**	12%
-Biomass & waste	-	2%
-Geothermal	-	5%
-Small hydroelectric	-	3%
-Solar	-	<1%
-Wind	-	2%
Coal	**8%**	16%
Large Hydroelectric	**9%**	19%
Natural Gas	**18%**	35%
Nuclear	**9%**	16%
Other	**<1%**	1%
TOTAL	**100%**	100%

* 50% of Product Name is specifically purchased from individual suppliers.
**Percentages are estimated annually by the California Energy Commission based on the electricity sold to California consumers during the previous year.

For specific information about this electricity product, contact **Company Name**. For general information about the Power Content Label, contact the California Energy Commission at 1-800-555-7794 or www.energy.ca.gov/consumer.

Public Goods Program Legislative History

- AB 1890 (9/96) established a new energy policy (Public Goods Charge) to support renewables market and energy R&D
- SB 90 (11/97) created Renewable Resource Trust Fund to implement program
- AB 995/SB 1194 (9/00) extended program and allocated about $2.0 billion over ten years, starting in 2002

California's

RENEWABLE ENERGY PROGRAM

California's Renewable Energy Program AT A GLANCE

- $540 million in program funding (1998 - 2002)
- Market-based support for supply and demand sides of renewable energy market by providing:
  - Production incentives for existing and new renewable electricity generation
  - Capital cost buydowns to install on-site distributed generation systems
  - Rebates to customers who purchase renewable electricity
  - Consumer education

How the Renewable Energy Program Assists The Market

<table>
<tr><th></th><th>Demand</th><th>Supply</th></tr>
<tr><td rowspan="2">Provider Generation</td><td rowspan="2">Customer Credit</td><td>New Account</td></tr>
<tr><td>Existing Account</td></tr>
<tr><td>Customer Generation</td><td colspan="2">Emerging Account</td></tr>
<tr><td></td><td>Consumer Education</td><td></td></tr>
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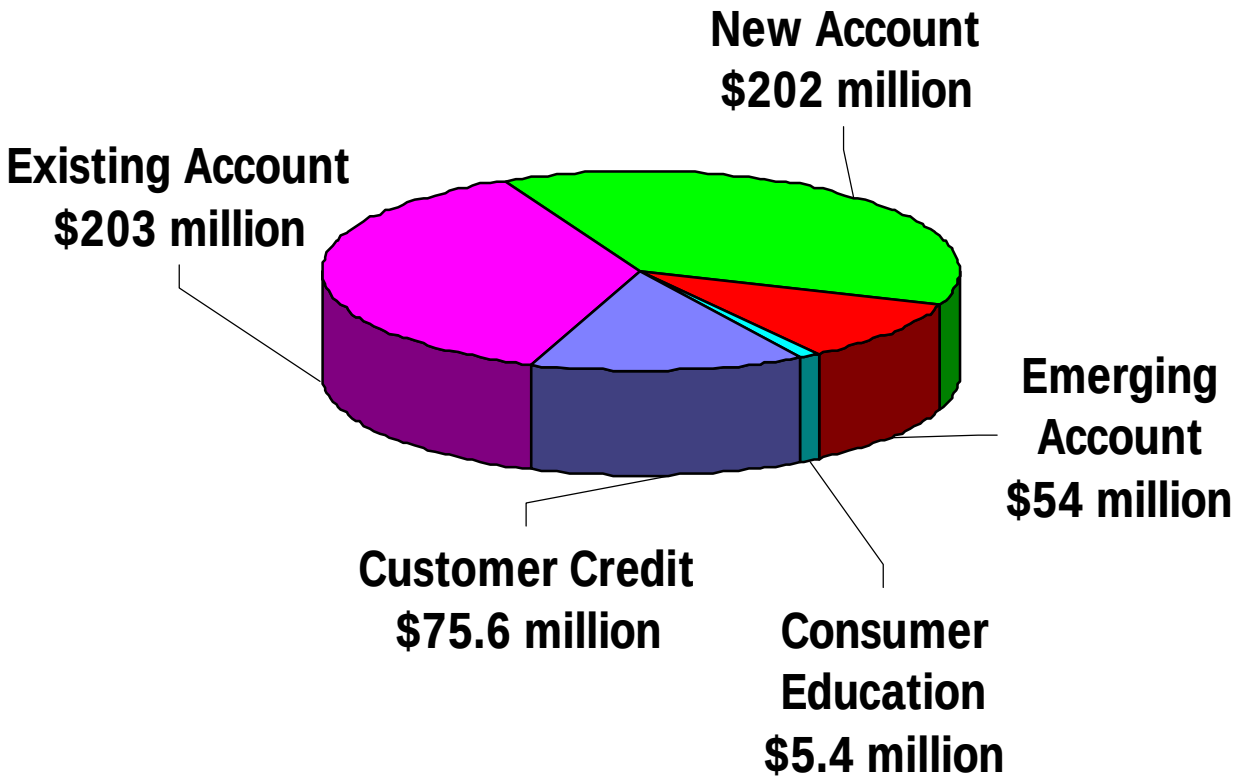
RENEWABLE RESOURCE TRUST FUND
Initial Allocation
$540 Million (1998 - 2002)



Renewable Energy Program
RESULTS

Account	Funds Spent/ Committed	Results
Existing Renewable Resources	$173 million	Support for 4,400 MW of existing renewable capacity
New Renewable Resources	$202 million	1,000 MW of new renewable capacity by 2003
Emerging Renewable Resources	$34 million	3.4 MW of capacity installed (814 systems), 1,600 more systems in pipeline
Customer Credit	$54 million	Customers received rebates for more than 4 billion kWhs of green energy purchased from renewable energy service providers
Consumer Education	$4.6 million	Videos, brochures, public awareness campaign
TOTAL	**$467.6 million**	

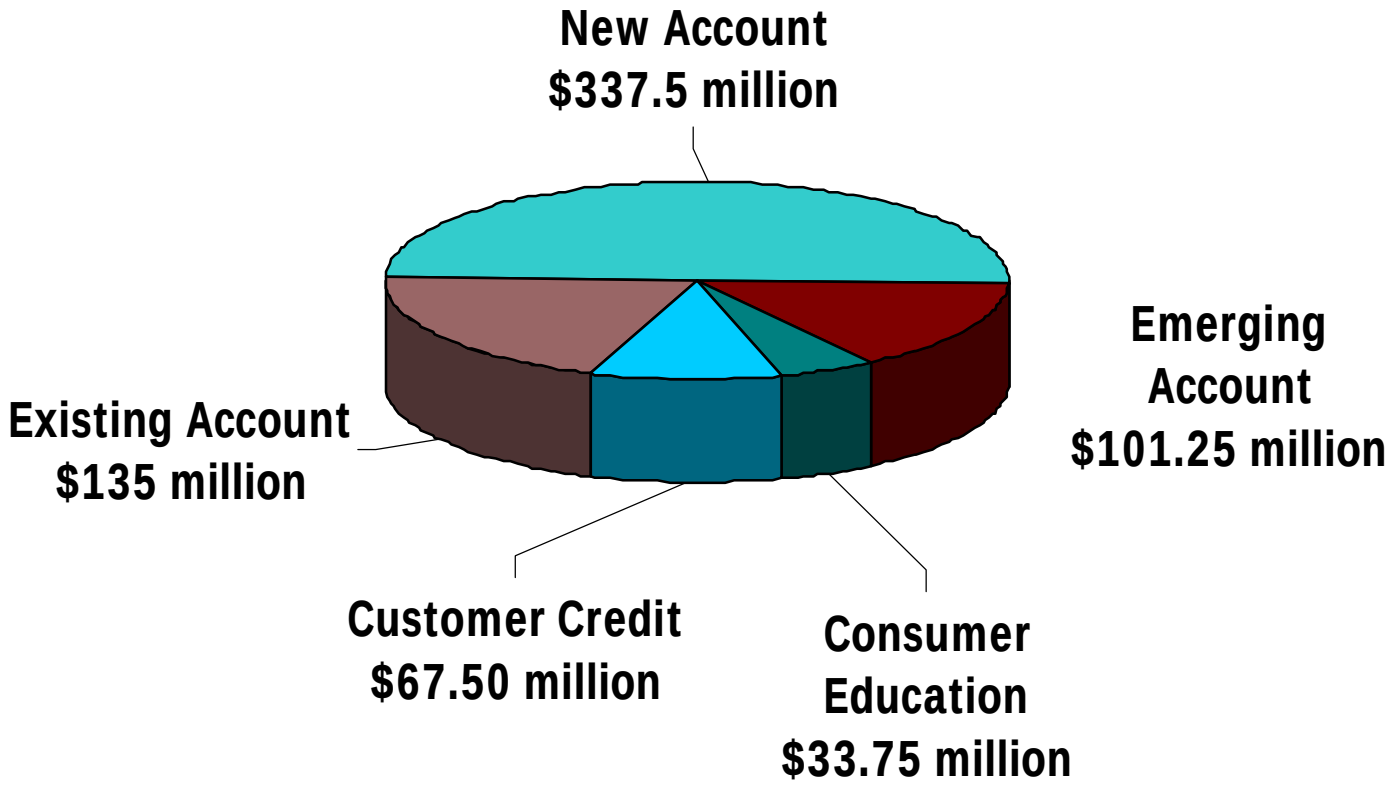
INVESTMENT PLAN
Where We Are Going

- GOAL: Pursue investments in renewable resources to achieve self-sustaining renewable energy supply.
- Investment Plan recommends allocation and distribution of $675 million collected 2002 - 2006.
  - *"Investing in Renewable Electricity Generation in California"*
- Plan establishes numerical targets for ramping up percentage of California's electricity generation from renewables.
  - *12% in 2002* GOAL → *17% by 2006*
- Plan contains built-in flexibility to respond to market changes.

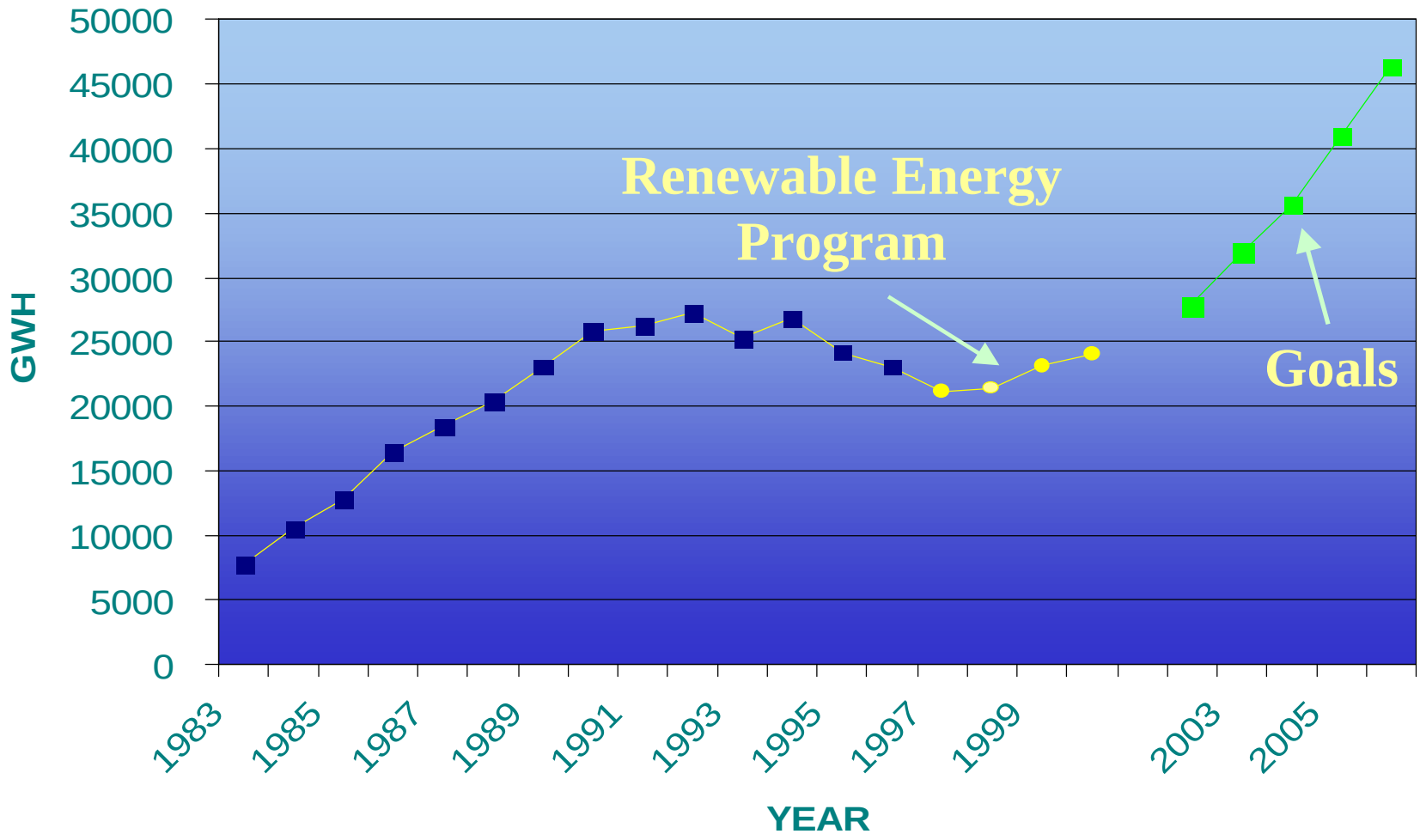
INVESTMENT PLAN
Renewable Energy Consumption Targets

	2002	2004	2006
Emerging	-	-	<1%
Existing	12%	12%	12%
New	1%	3%	5%
Total	13%	15%	17%

INVESTMENT PLAN
Renewable Resource Trust Fund
$1.3 Billion (2002 - 2012)



INVESTMENT PLAN
Renewables Generation Goals



The Geothermal Program

Geothermal Program History

- 1981-Financial & Technical Assistance to Public Entities
- 1992-Expanded Financial Assistance to Private Entities
- Funded direct-use projects
- 1995-Focus shift to R & D projects
  - Establish portfolio of near to long-term projects
  - $13.8M to 17 R & D projects (1995 - 2000)

Geothermal Program Accomplishments

Lake County Sanitation District awarded $1 million for the design and construction of a 26-mile pipeline that will carry secondary treated wastewater to the southeast Geysers steamfield for injection.

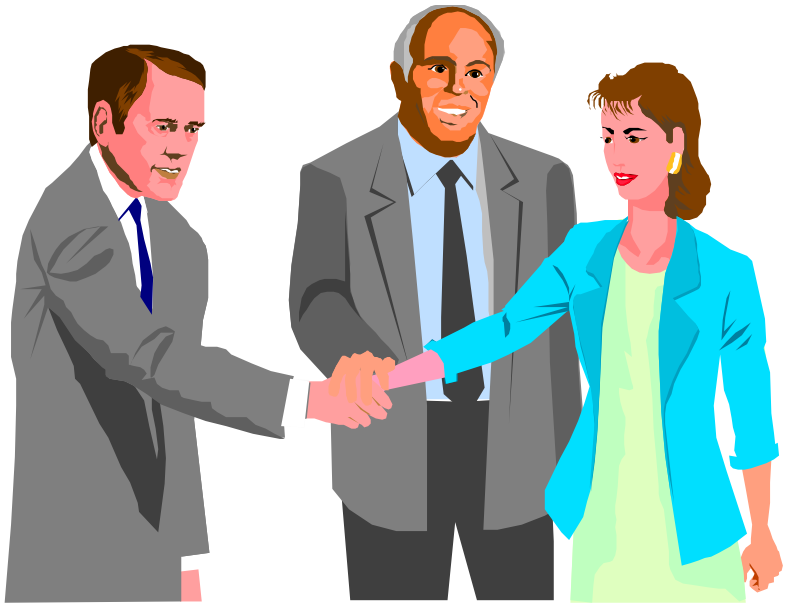
This first effluent injection pipeline project began operations to The Geysers in late 1997. It has already raised field capacity by approximately 45 MW.


pier
PUBLIC INTEREST ENERGY RESEARCH
"Research Powers the Future"

Vision Statement

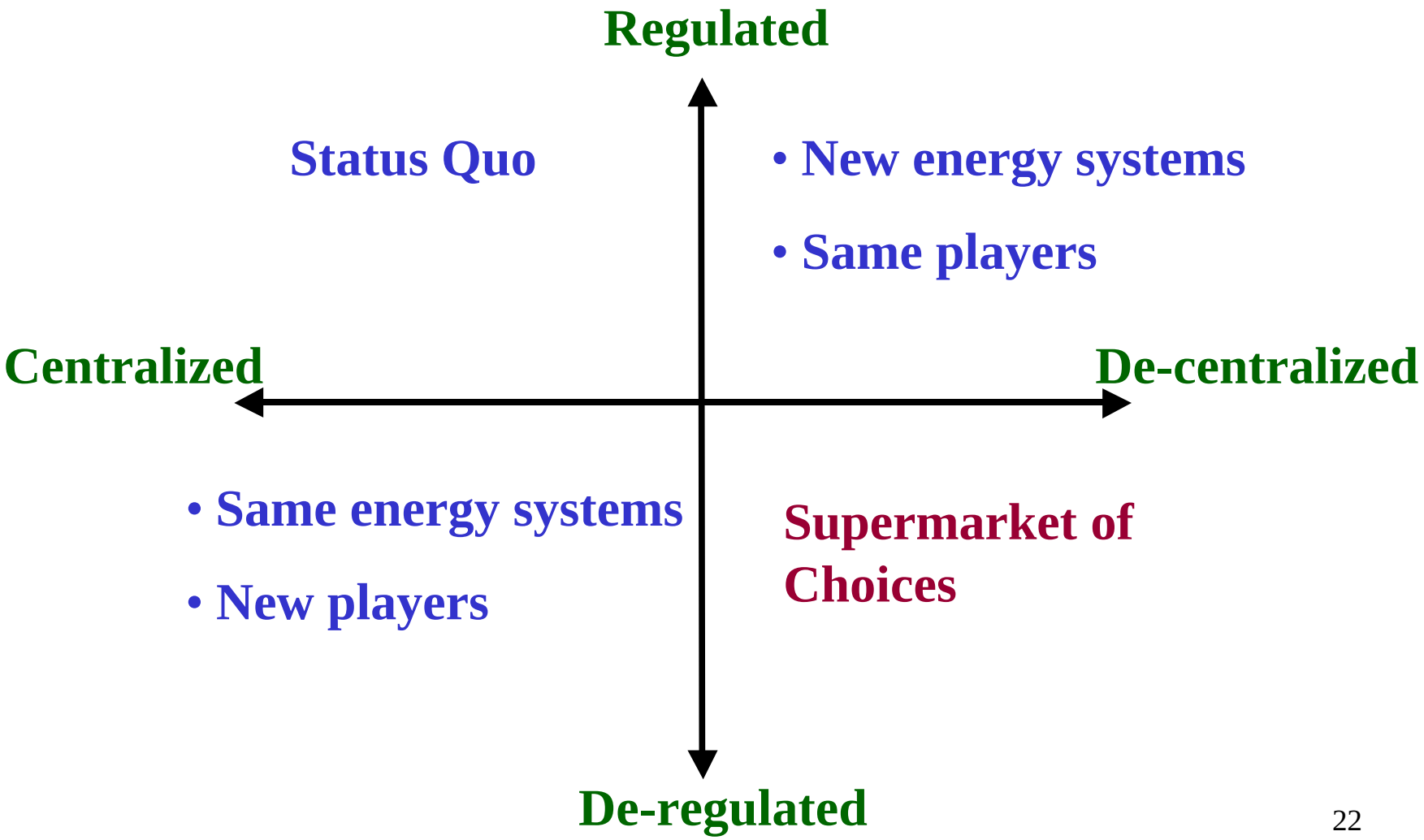
The future electrical system of California will provide a clean, abundant and affordable supply tailored to the needs of "smart", efficient customers and will be the best in the nation.

Tailored, clean, abundant, affordable supply



Smart, efficient customers

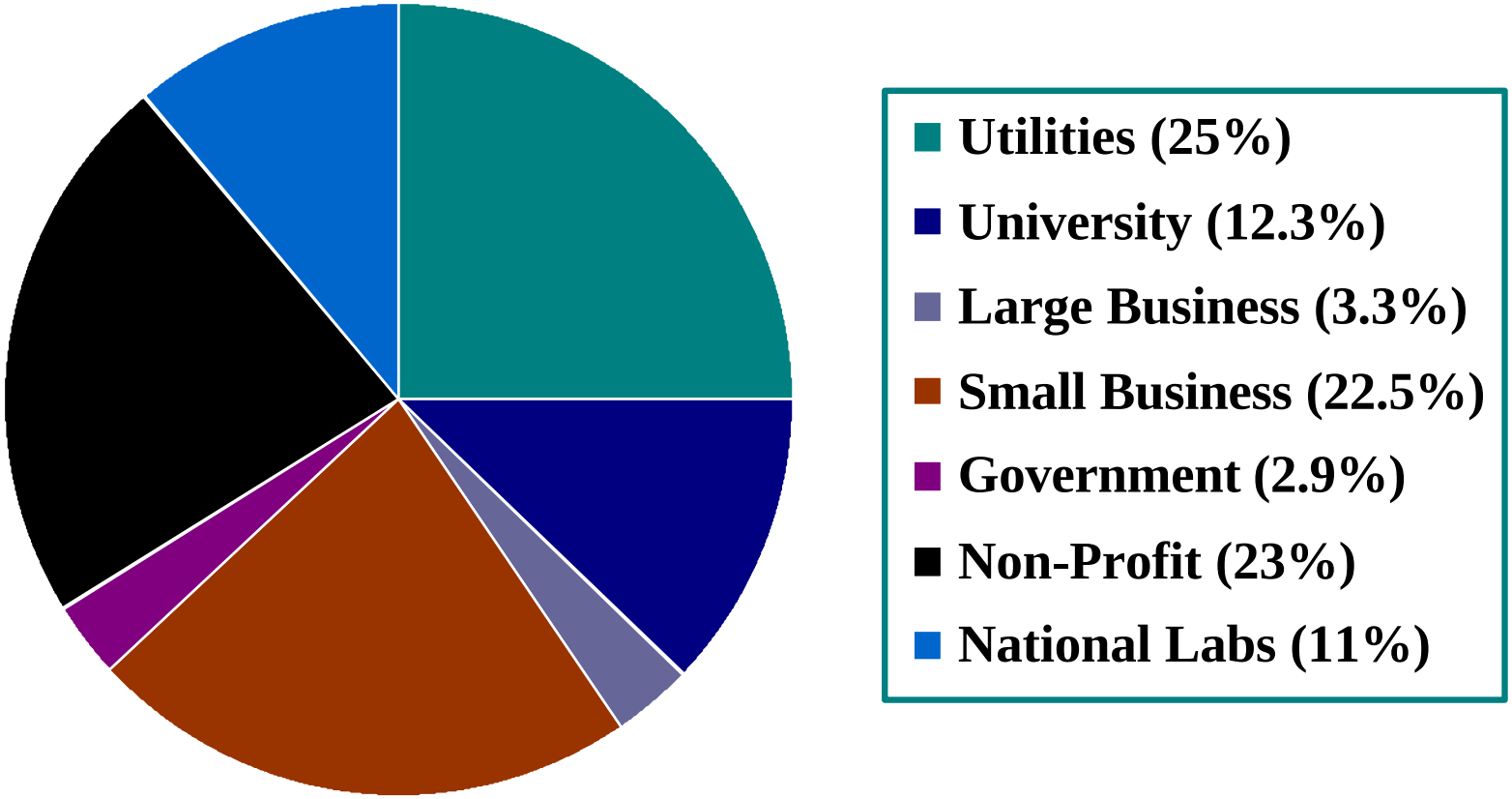
Our R&D Program Must Address Future Market Scenarios



PIER Projects Related to Major Topics Funding (in millions January 2002)

Supply **Renewables, EPAG**	**$82**
Demand **Buildings, Ind/Ag/Water**	**$50**
System / Environment **Energy Systems Integration, Environmental**	**$48**

PIER Research Partners



PIER Public Benefit Objectives

Meeting Ratepayers Needs

- Improve energy cost/value
- Improve environment and public health and safety
- Improve electricity reliability/quality/sufficiency
- Strengthen the economy
- Provide consumer choice

PIER is Currently Divided into Six Subject areas

- Renewable energy
- Environmentally-preferred advanced generation
- Residential and commercial buildings end-use energy efficiency
- Agricultural and industrial demand-side technologies
- Energy-related environmental research and assessment
- Energy systems integration

PIER Buildings Program
Overview

- ***Mission:***

  Improve the energy efficient design, construction and operation of buildings in California through public interest research

- ***Strategy:***
  - **Identify research needs**
  - **Creative, efficient and equitable funding**
    - **Competitive solicitations**
    - **Programmatic approach**
    - **Phase 2**
  - **Participation in national collaborations to avoid duplication and leverage value**
  - **Program evaluation**
  - **Market impact assessment**

PIER Buildings Program Highlights
Berkeley Lamp

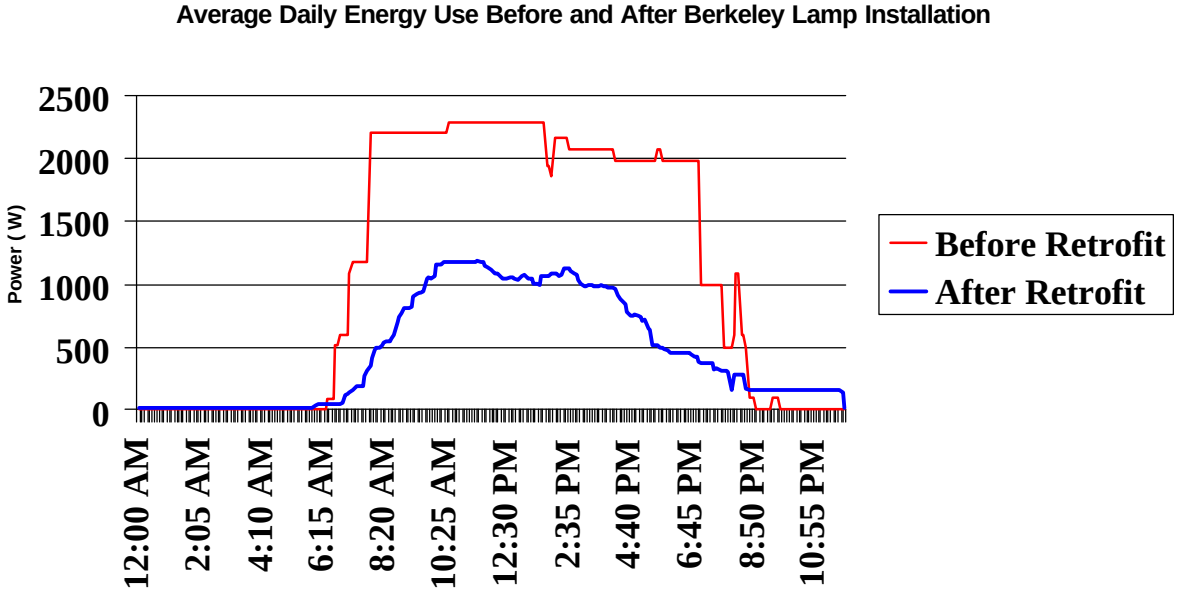
- **Model partnership between CEC/DOE/California utilities**
  - **PIER funded Phase 1 to develop task/ambient lamp concept**
  - **DOE funded Phase 2 to develop specific lamp configuration**
  - **PIER was instrumental in moving technology into the marketplace via coordination with utility Emerging Technology Coordinating Council**

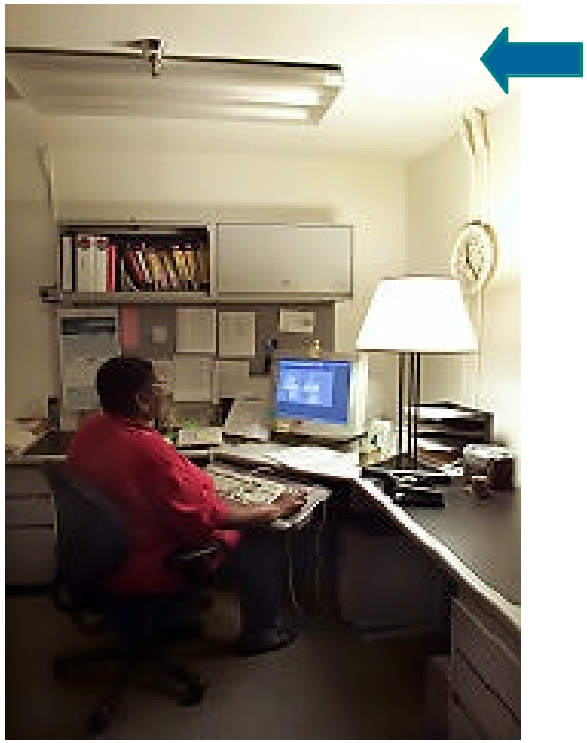
http://www.energy.ca.gov/pier/pr.html

Project is both a technical success and a customer success

PIER Buildings Program Highlights
Berkeley Lamp

- ***Technical Success:*** Validated energy savings





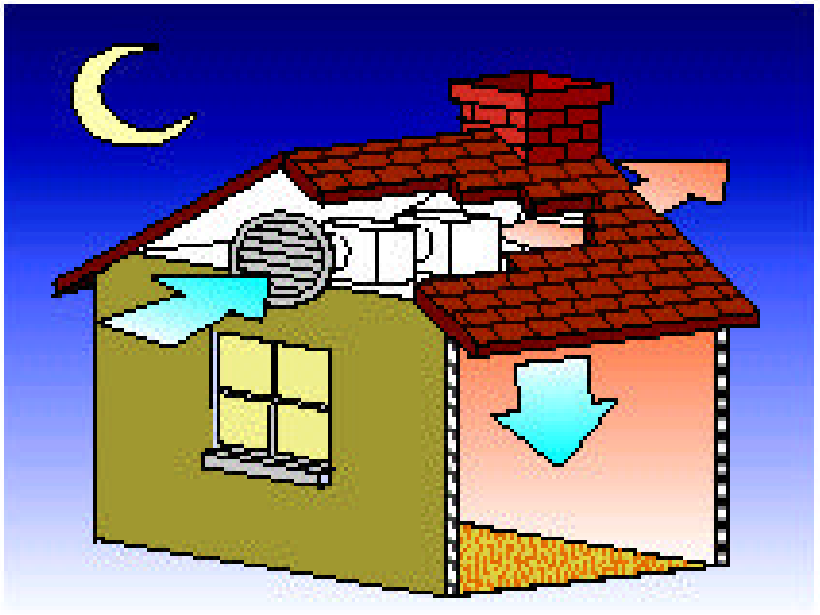
PIER Buildings Program Highlights
Berkeley Lamp

- ***Customer Success:***
  - **Responds to user preferences**
  - **Demonstrations in 10+ organizations**
    - **City of Berkeley**
    - **CEC**
    - **Lawrence Berkeley Lab**
    - **SMUD, and SCE**
    - **U.S Coast Guard**
    - **UC Berkeley**
    - **Large State building (DGS)**
    - **200 rooms at Hilton**
    - **Marriott**
    - **VA hospital (FEMP)**

PIER Buildings Program Highlights

Night Breeze

Provides ventilation and cooling at night, reducing or eliminating the need for air conditioning during the day



PIER Buildings Program Highlights
Night Breeze

- ***Customer Benefits:***
  - **Improves comfort**
  - **Reduces energy use and peak demand**
    - **Reduce new home energy use in coastal and transition climates by as much as 5.8 GWh/yr and demand by up to 139 MW/yr**
  - **Eliminates the need to open and close windows, improving security and reducing noise from the outside**
  - **Higher indoor air quality, filters outside air**

PIER Buildings Program Highlights
Night Breeze

- ***Market Connections - Part 1***
  - **Clarum Homes**
    - **Demo house in Watsonville with no other air conditioning**
  - **Centex Homes**
    - **Demo house in Los Olivos development in Livermore**
    - **Downsized air conditioner by 1 ton compared to other similar house models**

PIER Buildings Program Highlights
Night Breeze

- ***Market Connections - Part 2***
  - **Brochure developed and distributed**
  - **Showcased on *ABC World News Tonight***

PIER Buildings Program
Future Successes

- Development of Comprehensive Lighting Research Portfolio
  - Phase 2 Berkeley lamp (torchiere)
- Development of Cool Colored Roofing Materials
- Development of California Optimized Air Conditioner
- Development of production scale electrochromic windows

RD&D for Industry, Agriculture & Water

MISSION:

Facilitate technology development and deployment for cost effective energy efficiency, power quality, reliability, availability and energy load reduction solutions for industrial facilities and processes, agricultural operations, and water and wastewater treatment facilities.

RD&D for Industry, Agriculture & Water

Technology

Redesigned fumehood for cleaning contaminated indoor air

Benefits

- **Saves up to 50% of the energy**
- **Applicable in electronics fabrication, pharmaceuticals, biomedical and chemical industries**
- **30,000 fumehoods in California**
- **Potential to save $30 million per year in California**

RD&D for Industry, Agriculture & Water

Technology:

Use of ozone & membrane technology for food processing

Benefits:

- **0.2 MWH of electricity saved per year at the plant**
- **8.5 million gallons of water saved per year at each plant**
- **Eliminates the need for chlorine for disinfecting**

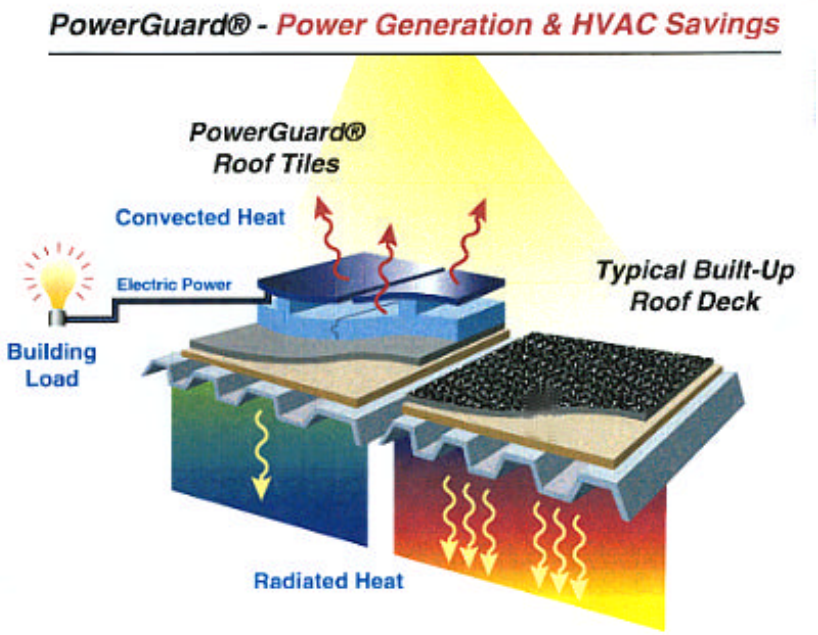
PIER Renewables: Overview

- **Mission**
  - **Developing tomorrow's renewables**
    - **Electricity that is cleaner, more diverse and reliable, safer, and affordable**
    - **Enhances choices and opportunities**
- **Objectives**
  - **Maximize value**
    - **Targets of opportunity; multiple benefits; system integration**
  - **Lower costs**
    - **Improved performance; better costs**
  - **Expand applications**
    - **Renewable DG; strategic bulk power**
  - **Pursue major advances**
    - **Breakthroughs for tomorrow**

PIER Renewables: Successes

- **PowerLight's PowerGuard**
  - **The cool electric roofing solution**
    - **Reduces air conditioning loads**
    - **Generates electricity during hot summer peaks**
- **Yolo County's Advanced Bioreactor Landfill**
  - **Reinventing California's landfill electricity options**
    - **Doubles to triples landfill electricity generation**
    - **Reduces groundwater pollution**
    - **Extends landfill life**
- **Wind Turbine Company's (WTCs) Low Cost Wind Turbine**
  - **Harnessing 5000 MW of untapped wind potential**
    - **Opens development of California's lower speed wind areas**
    - **Targeting wind costs to $0.025/kWhr**

PowerLight's PowerGuard



While California is known for its hot dry summers, that same solar resource provides a clean, safe and reliable way to generate electricity

PowerLight's insulated 30 year roof system reduces building air conditioning loads while it's PV surface generates electricity during hot and expensive peak summer hours

The PowerLight Success

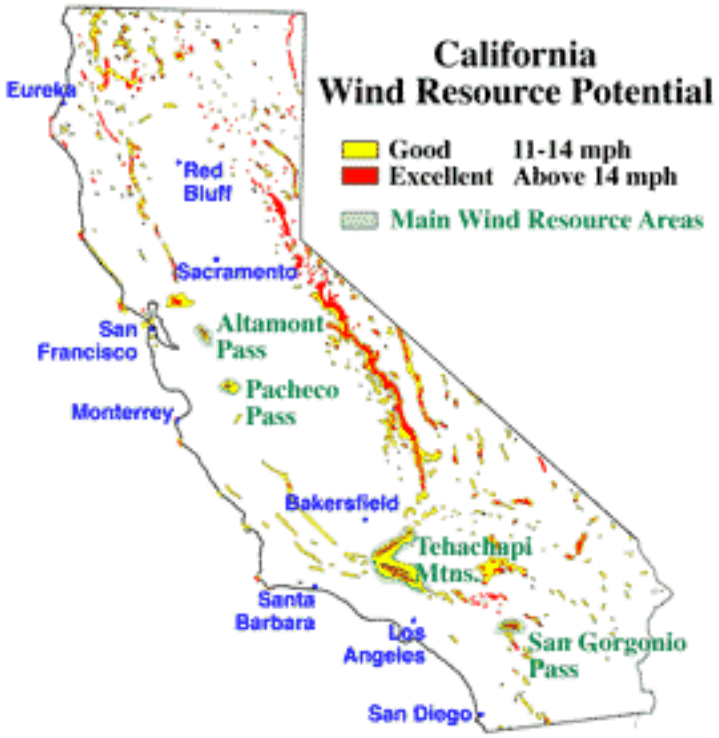
Accomplishments

- **Development of PowerGuard initiated nationwide interest in building integrated PV systems that provide high value to electricity customers by offering:**
  - **Reduced air conditioning loads**
  - **Electricity that offsets peak prices**
  - **Extended roof life (30 years)**
  - **Protection from electricity price volatility**
- **Through innovative techniques, reduced the manufacturing costs of BIPV by 57 percent**
- **In April 2000, PowerLight opened its own 18,000 square-foot solar powered manufacturing facility in Berkeley and can contribute 20 megawatts per year of BIPV systems**

CEC's Role

- **Funded by both the CEC's ETAP and PIER, PowerLight has grown from a one person company with receipts of $40,000 to a company of over 70 employees and receipts over $10 million per year**

WTCs Low Cost Wind Turbine



Wind parks supply over 1600 MW of California's electricity capacity. An additional 5000 MW of new wind is undeveloped due to lower wind speeds that are too expensive to harness

Capable of generating electricity at low cost in lower wind speed areas, WTC's unique wind turbine will help harness California's untapped wind potential

The WTC Success

Accomplishments

- **Represents a novel approach that's leading the drive to making low-wind resources market competitive**
  - **Target cost is $0.025/kWhr. WTC"s current design at $0.035/kWhr**
  - **Novel design lowers maintenance and increases turbine life**
  - **POC tests verified performance over range of wind speeds**
  - **500 kW system being deployed in commercial setting at Fairmont, CA**
- **Has been instrumental in the development of a new class of low-wind speed turbine efforts at DOE/NREL**

CEC's Role:

- **A higher risk effort, PIER funding is playing a critical role in bringing this new class of wind turbine technology to market**

WTC's 500 kW turbine being installed at Fairmont CA

Environmentally-Preferred Advanced Generation (EPAG) Program

Focus:

- **Near-term: very clean ARICE and industrial gas turbines for DG, and standardized performance reporting.**
- **Longer-term: "zero" emission fuel cells, steam turbines, high efficiency hybrids and combined heat & power, and H_2 fuels for DG and central generation.**

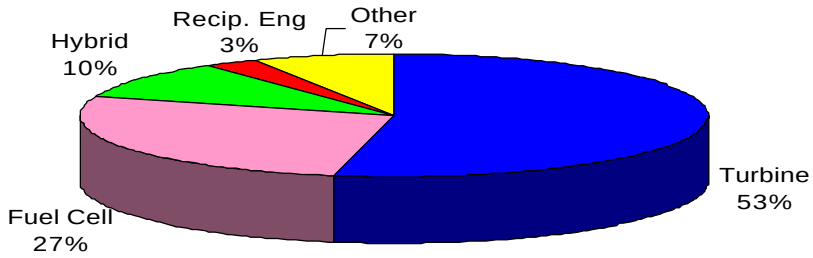
Benefits:

- **Develop and demonstrate siteable DG technologies;**
- **Accelerated technology commercialization;**
- **Eliminate the formation vs. cleaning up emissions; and**
- **CA technology leadership (DOE, National Labs, ASERTTI, and other states)**

EPAG Program

Successes

- **Commercial products that benefit ratepayers to market;**
- **Collaboration/coordination with industry and other R&D organizations;**
- **Technology expertise for CPA, ARB, ISO, DOE, ASERTTI; and**
- **25 projects funded, 6 projects completed.**



EPAG Funding

Gas Turbine Semi-Radiant Burner - Alzeta Corporation

Description:

- **Gas turbine combustor that allows fuel to be premixed with large quantities of air prior to combustion**

Benefits:

- **Lower NO_X emissions without SCR;**
- **Cheaper than post-combustion clean-up systems;**
- **Allows deployment of smaller turbines for DG; and**
- **CEC is receiving royalties from Alzeta**

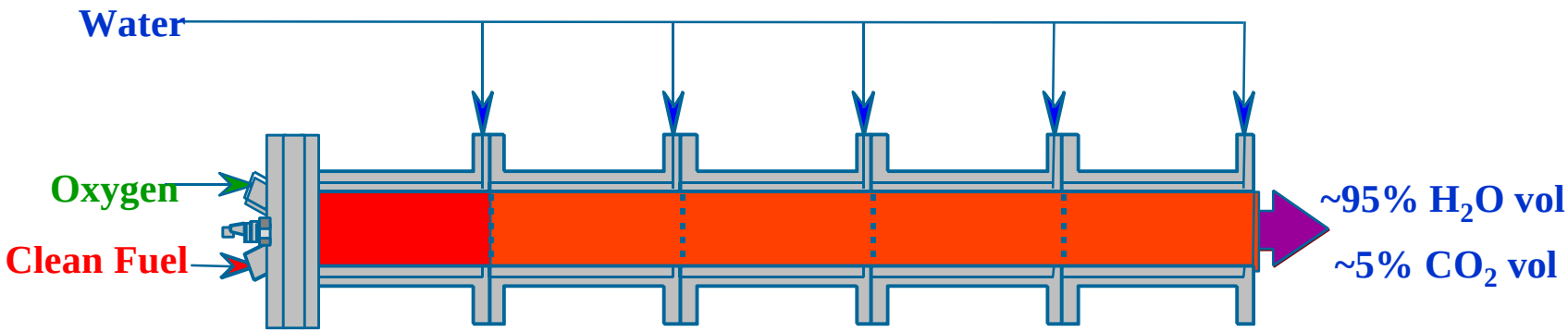
Zero-Emission Gas Generator - Clean Energy Systems, Inc.

Description:

High temperature, high pressure, steam turbine generation system based upon rocket engine technology.

Benefits:

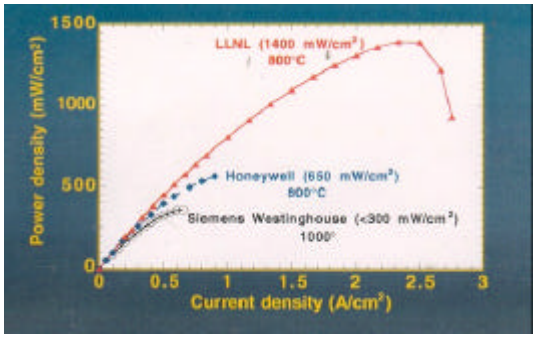
- High efficiency generation;
- Emissions of only water and CO_2; and
- Emitted CO_2 sequestered for possible commercial application.



Reduced-Temperature SOFC - Lawrence Livermore National Lab

Description:

- High efficiency, planar Solid Oxide Fuel Cell (SOFC) with reduced operating temperature.



Benefits:

- Reduction in SOFC manufacturing costs;
- A DG technology that can be sited in buildings in urban areas; and
- Electricity generation with water & carbon dioxide as the only emissions.

PIER Environmental Area

Mission:

Develop cost-effective approaches to evaluating and resolving environmental effects of energy production, delivery, and use in California, and explore how new electricity applications and products can solve environmental problems.

PIEREA
Near-term Research

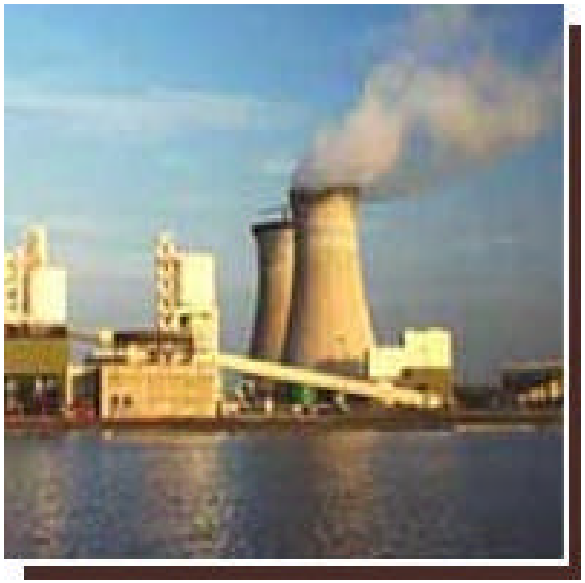
- **Air Quality - improve understanding of electricity systems and explore strategies to mitigate impacts**
- **Water Resources - minimize impacts of electricity and address water supply, water quality, aquatic and biota issues**
- **Land Use and Habitat - address wildlife interaction with utility structures**
- **Global Climate Change - improve understanding of impacts and develop adaptation strategies**

Dry Cooling Spray Enhancement

"Whiskey's for drinking, water's for fighting about"

- Mark Twain

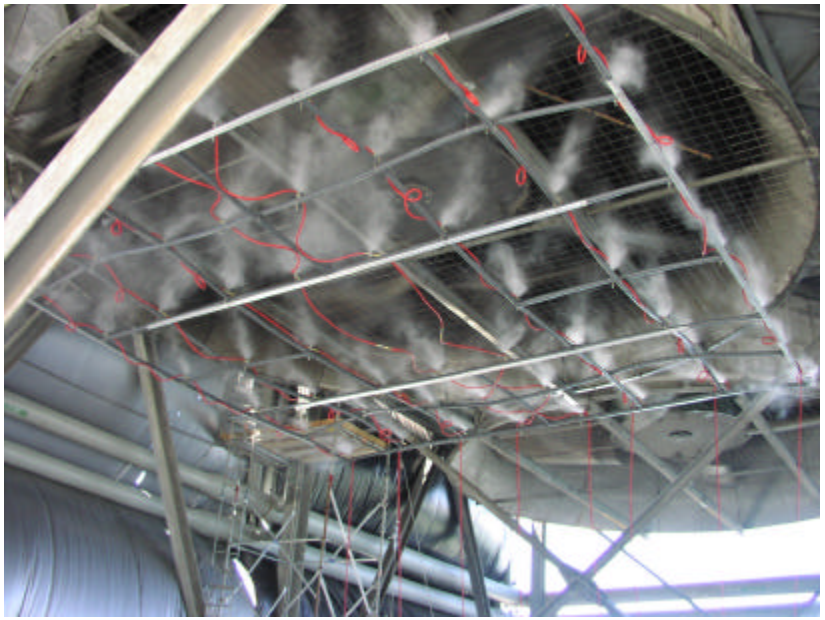
Dry Cooling Spray Enhancement



Problem:

- Water shortfalls predicted to reach 2.4 million acre-feet in 2020
- Power plants reduce amount of water available for other uses (residential, commercial, agriculture)
- Dry cooling alone decreases efficiency

Dry Cooling Spray Enhancement



Project:

The Commission is funding the development of a hybrid system that couples traditional dry cooling with spray nozzles to improve efficiency

Dry Cooling Spray Enhancement

Benefits:

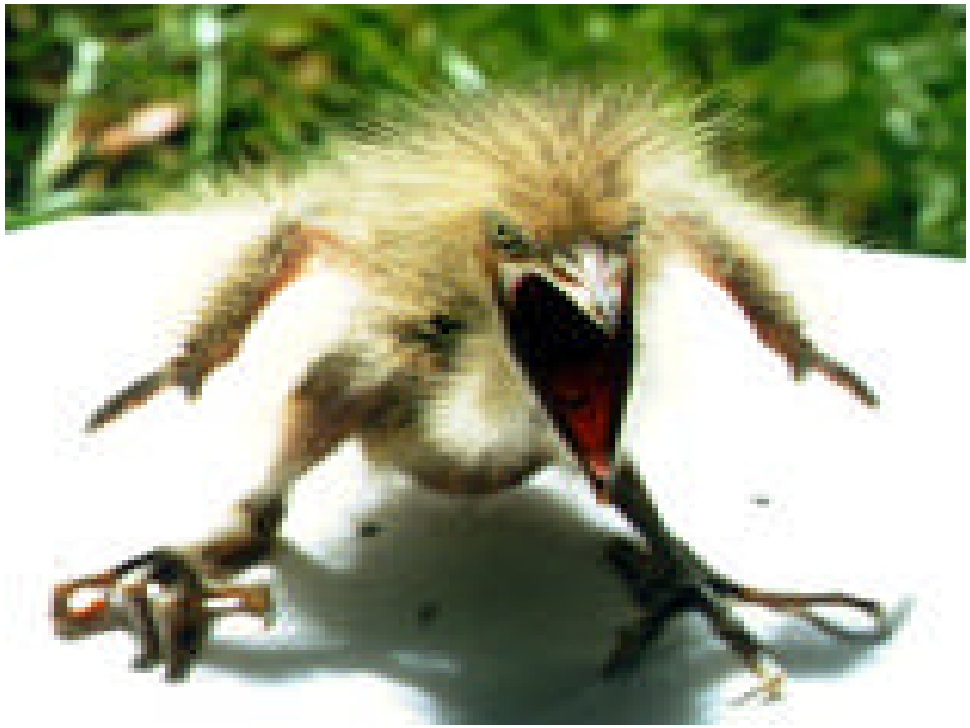
- **Reduce regional impacts**
- **2.8 mil gal/day water savings from a 500 MW power plant**
- **Spray enhancement provides a 7-14 MW increase at Crockett on a hot day**

Avian Mortality

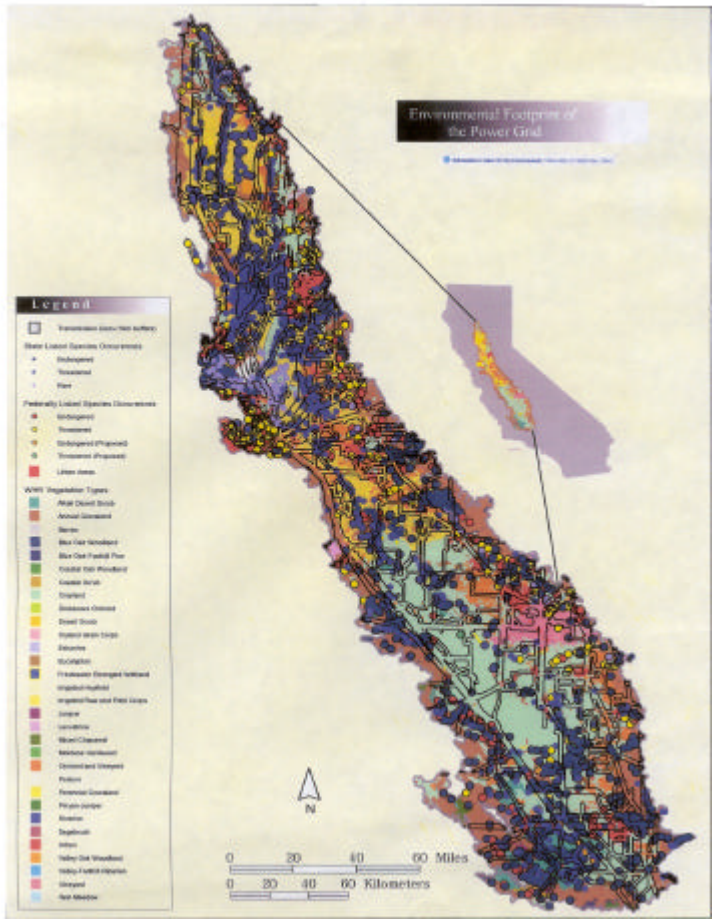
Problem:

Avian electrocutions not only cause a significant number of deaths, but also result in 25% of all power outages equating to a $ 2 billion loss to the CA economy

Stakeholder Consultation



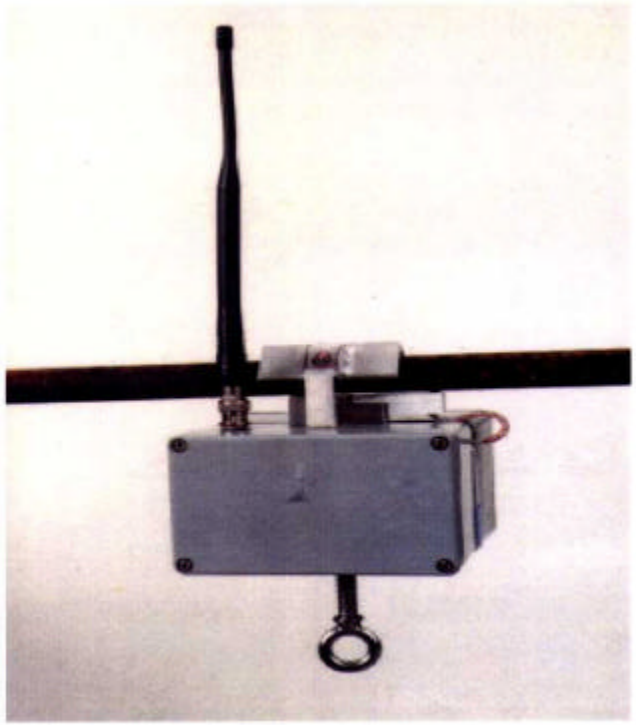
Avian Mortality



Project:

- **Developing ways to identify problem areas and help direct retrofitting and mitigation efforts**
- **Designing and testing automated monitors to identify high-fatality areas**

Avian Mortality



Bird Strike Monitor

Study Benefits:

- Reduce cost of identifying problem areas
- Increase in electricity reliability
- Reduce avian fatalities
- Mitigation of $2 billion loss to CA economy

Climate Change Adaptation

Problem:

California is unprepared for the likely physical, economic and societal disruptions of climate change

Climate Change Adaptation

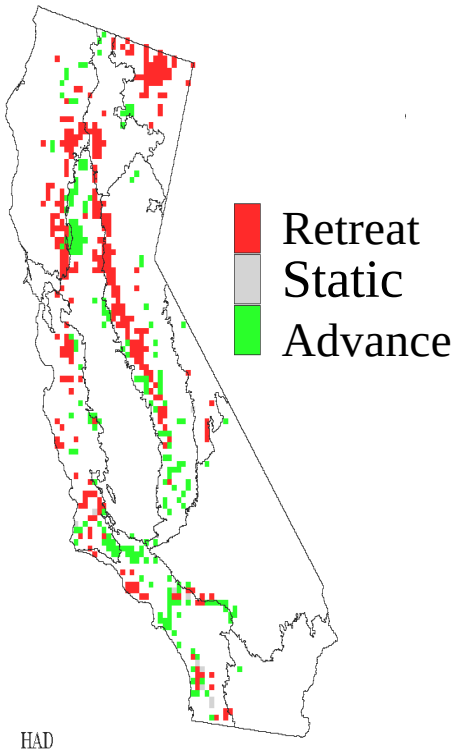
R&D is needed to define impacts and adaptation strategies on a regional scale:

- **Process:** engage other state agencies (e.g. ARB, DOF, DWR) and scientific communities to define major unknowns

- **Product:** "roadmaps" that define research agenda in the topics of: water, forestry/agriculture, public health, economic impacts, regional climate modeling

Climate Change Adaptation

Mixed Evergreen Woodland



Benefits:

- **Provide science-based analyses for policy-makers**
- **Identify and prioritize R&D**
- **Leverage limited funding**
- **Develop data and analysis for strategic planning**
- **Establish linkages between impacts and strategies**

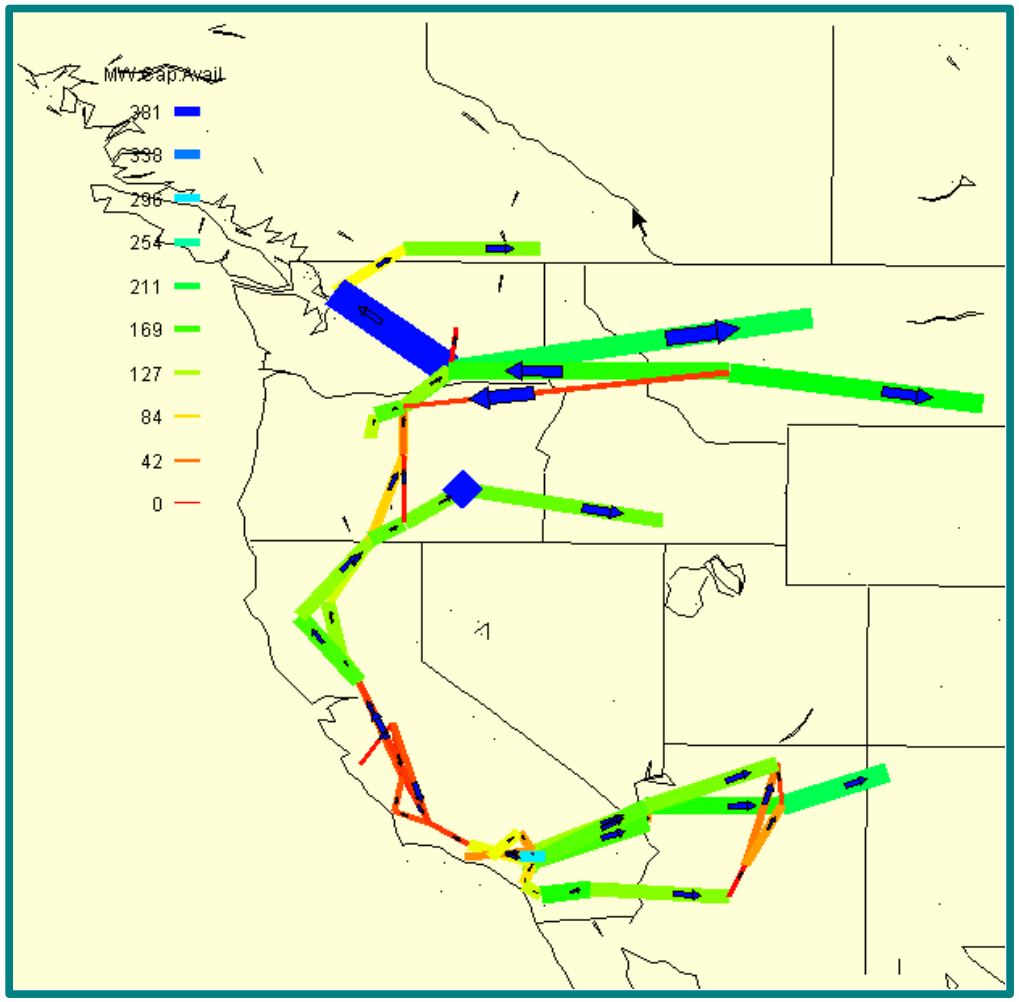
Energy Systems Integration

- **Mission:** Develop integrated infrastructure where electricity transactions are more effective, efficient and reliable
- **Program Objectives:**
  - **Improve efficiency and reliability of transmission system**
  - **Effectively integrate distributed energy resources into grid**
  - **Optimize demand response to electricity prices and system contingencies**
  - **Develop other strategic systems and enabling technologies**

Dynamic Transmission Line Rating

- **Congestion cost $169M on Path 15 in 4th Qtr 2000**
- System monitors line's tension in real-time
- Path 15 demonstration indicating greater than 39 MW's increased capacity
- Environmental benefit through delay/avoidance of new transmission corridors

Volts Amps Reactive (VAR) Management Tools



- **Could have prevented 1996 blackout of West Coast which cost California $100s of millions**
- Presents real-time info on system conditions in readily understood forms
- Accelerates initiation of corrective actions by 30 minutes or more
- Active demonstration at the CAISO

Technical Support for DG Interconnection Standards

- **Reduces average cost of interconnection fees to consumers by 37%**
- Supports Rule 21 by resolving technical safety issues
- Establishes technology & size neutral review process
- Identified testing and certification requirements
- Enables insertion of new generation (e.g. renewables) into the grid