

Workshop Agenda



California Energy Commission – PIER

PIER Renewables Program Overview, Gerry Braun

- Introduction
- Strategic Context
- Program Response
- Summary

Technology Roadmap Updates, PIER Renewables Technical Leads

- Biomass, Val Tiangco
- Geothermal, Gail Wiggett
- Solar CSP, Golam Kibrya
- Solar PV, Prab Sethi
- Wind, Pete Spaulding

Comments and Discussion, All Participants



PIER Renewables Program Overview: Strategic Context and New Directions

*Gerry Braun
PIER Renewables Team Lead
California Energy Commission*

***Staff Workshop on PIER Renewables
RD&D Roadmaps***

Sacramento, California
June 3, 2008

Overview Presentation Summary



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- Workshop Agenda
- Program Introduction
 - Team
 - Accomplishments
 - Project Portfolio
 - Planning Process
- Strategic Context
 - Policy
 - Industry
 - Technology
 - Market
- Program Response
 - Mission and Vision
 - Strategy
 - Goals
 - Solicitations
 - Research
- Summary

Introduction: Team



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Program Administration:

Ken Koyama, Energy Generation Research Office Manager

Pete Spaulding, PIER Renewables Supervisor

Technical Program Leads:

Golam Kibrya

Prab Sethi

Valentino Tiangco

Gail Wiggett

Technical Project Managers:

Abolghasem Edalati-Sarayani

Pablo Gutierrez

John Hingtgen

Michael Kane

Hassan Mohammed

Zhiqin Zhang

Introduction: 07/08 Accomplishments – PIER Electricity



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- **Utility-scale: Completed trail-blazing transmission planning research projects :**
 - confirmed feasibility of major contributions to California's RE portfolio targets from intermittent renewables (methodology transferred to CAISO), and
 - identified transmission projects for expanded wind and geothermal supply from the Tehachapi and Imperial Valley resource areas.
- **Community-scale: Completed cutting-edge projects:**
 - demonstrating cost competitive bio-powered micro-grid operation
 - low cost, low emissions landfill gas power generation and Building-, community- and utility-scale
- Issued four RFPs and recommended \$9.4M for requested funding for award in PV, bio-power, geothermal, and renewables integration
- Initiated joint planning between UC Davis and UC San Diego to organize a fourth RE collaborative focused on solar energy

IEUA'S SERVICE AREA IN CALIFORNIA



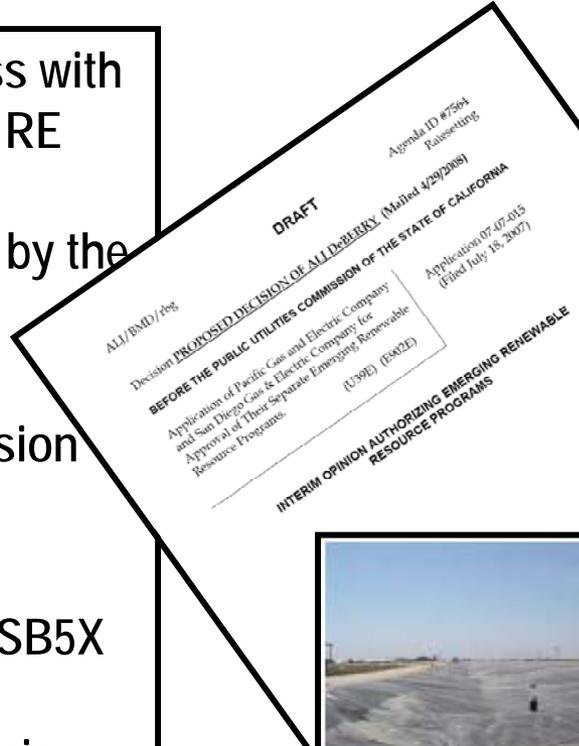
Introduction: 07/08 Accomplishments - PIER NG, GRDA, SB5X



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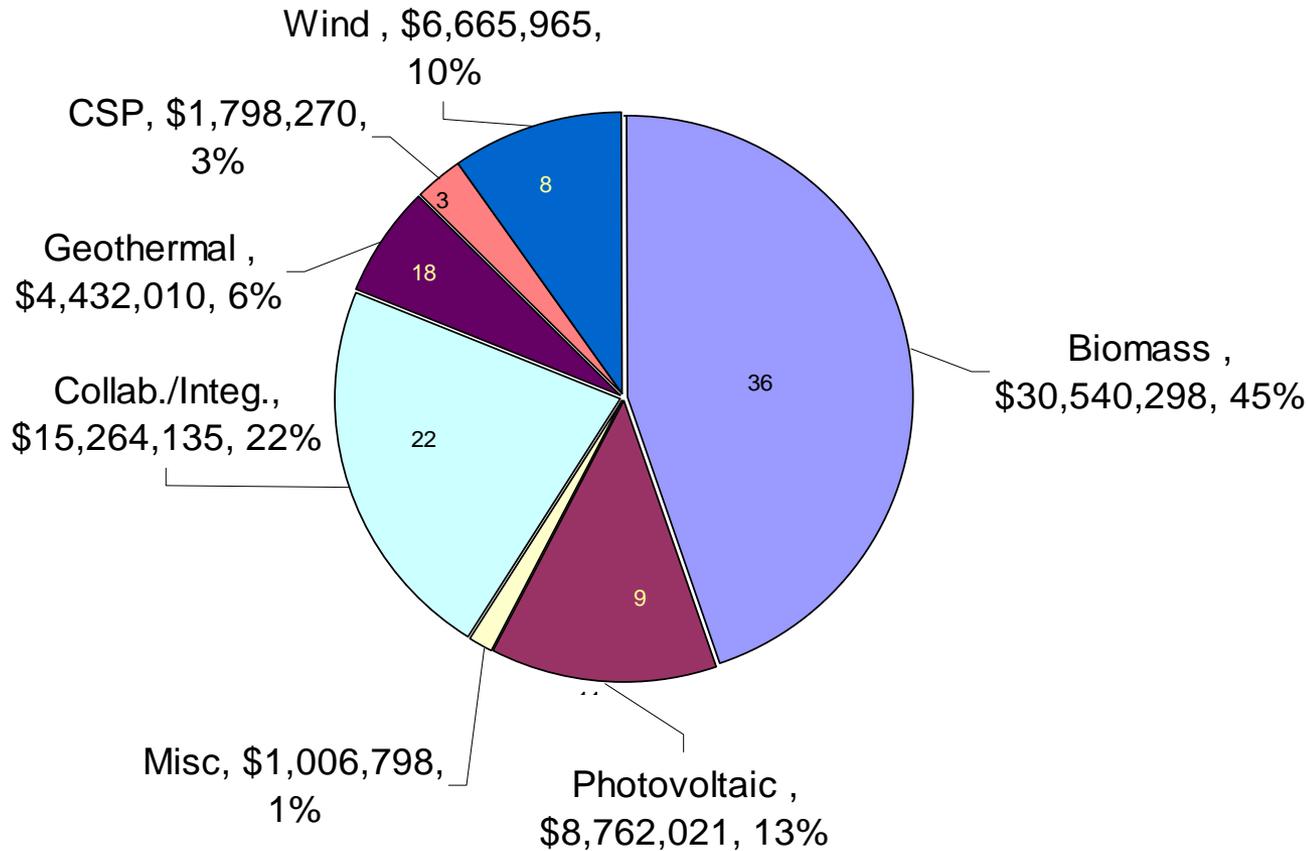
- Initiated a coordination process with California IOUs covering PIER RE and the Emerging Renewable Resources Program proposed by the IOUs.
- Confirmed validity of a new technique for using fluid inclusion gas chemistry to assess a geothermal reservoir
- Completed implementation of SB5X program phase 1 - bio-power systems installed at 10 California dairies
- Executed a competitive procurement combining 06/07 and 07/08 funds to award four new bio-power projects



Introduction: PIER Renewables Portfolio Summary



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108 Projects (Active, Pending and Pending Final Report)

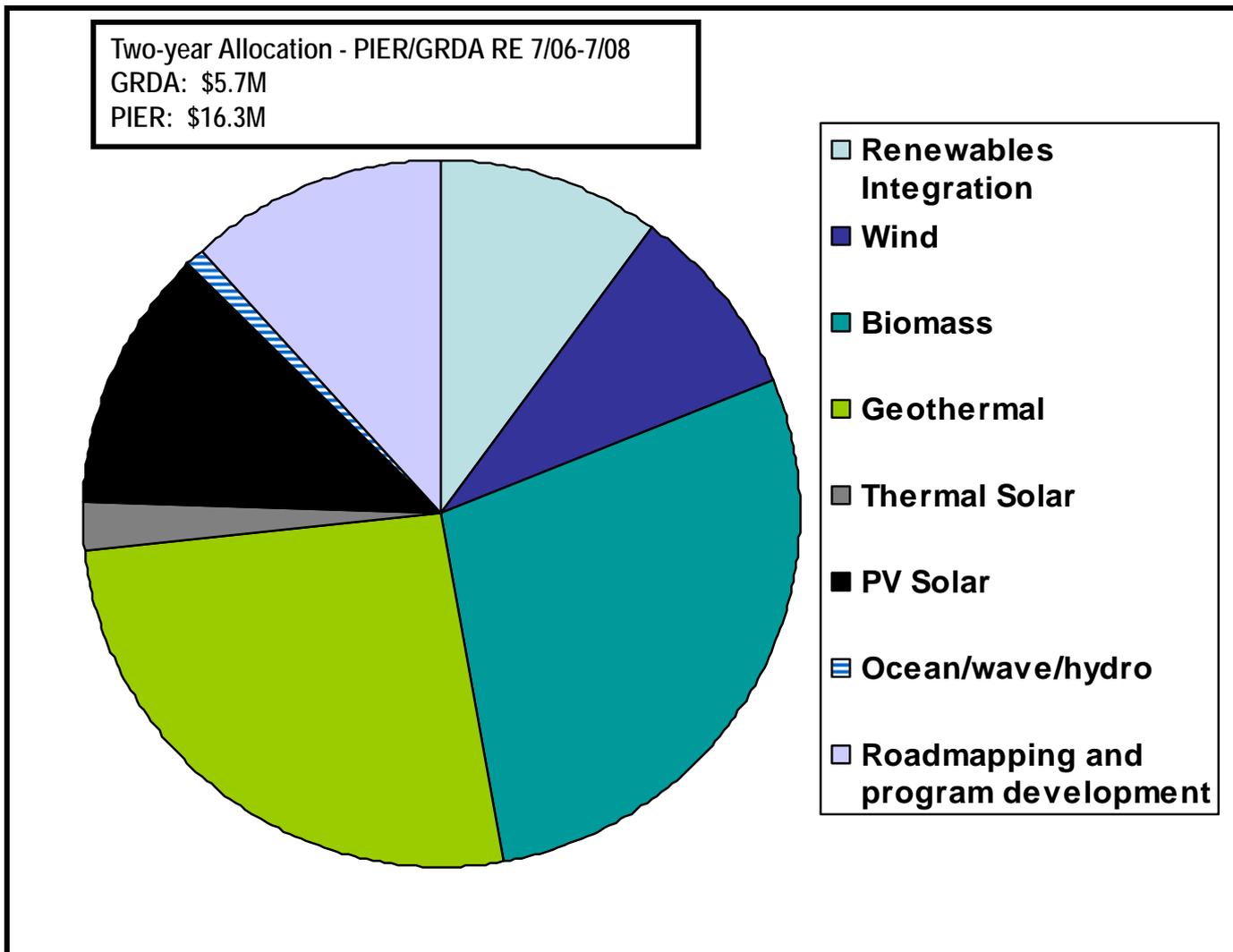
Totaling \$68.5M

Sacramento, California
June 3, 2008

Context: Project Portfolio – Recent Additions



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Introduction: Planning Process and Results



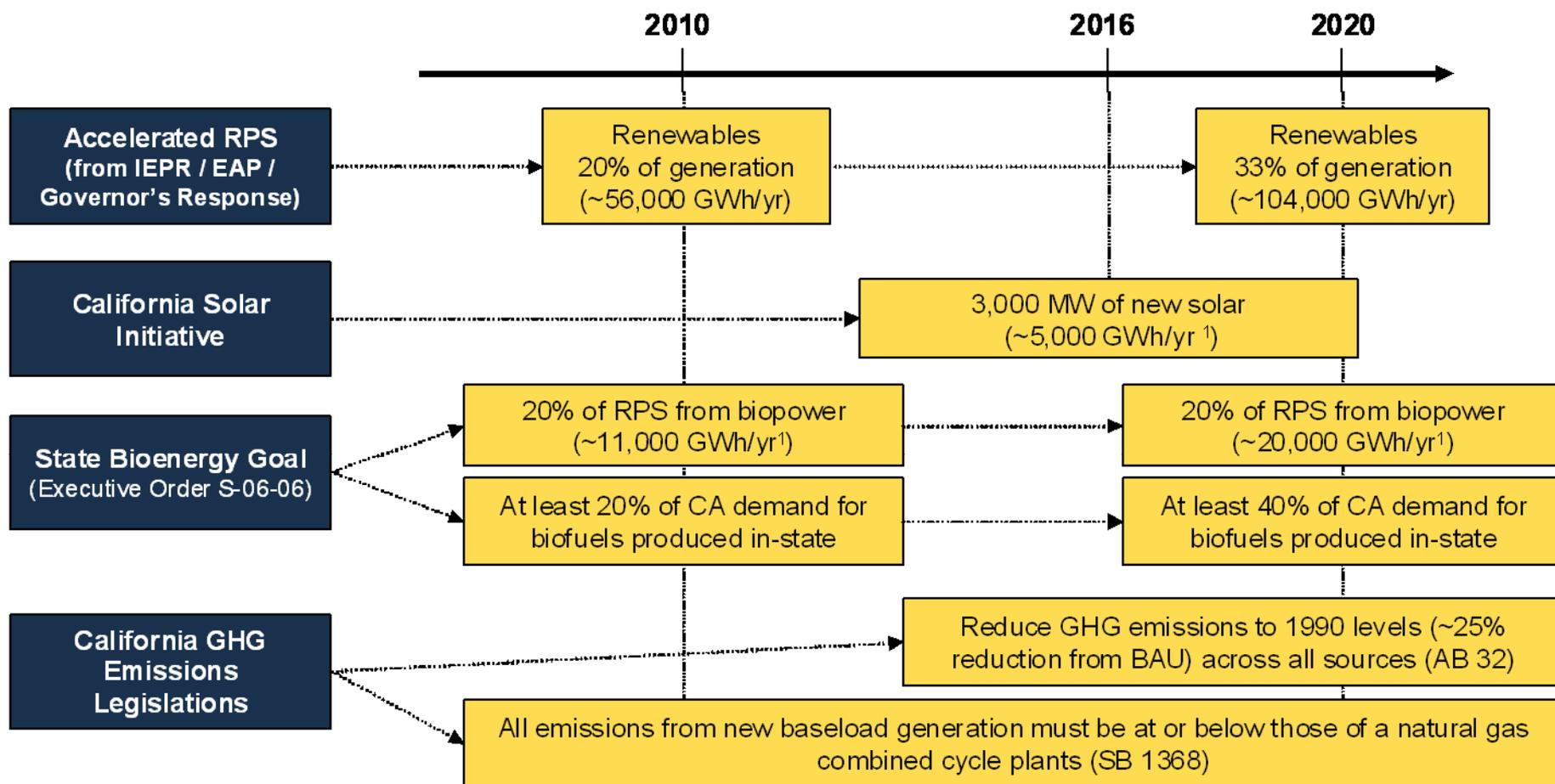
Recent focus group meetings:

- PIER RE, DOE and CSP R&D participants
 - \$400K from DOE to address gaps related to thermal energy storage
- PIER RE team
 - Identified non-critical adjustments in technology area roadmaps
- PIER RE and external advisors
 - focus on near term technology gaps.
- PIER RE and California RE collaboratives
 - Support for multi-year RD&D plans addressing integrated RE deployment
- PIER RE and other CEC and PIER programs
 - Identified several opportunities for collaboration and co-funding

Context: Policies Drive PIER RE R&D Strategy



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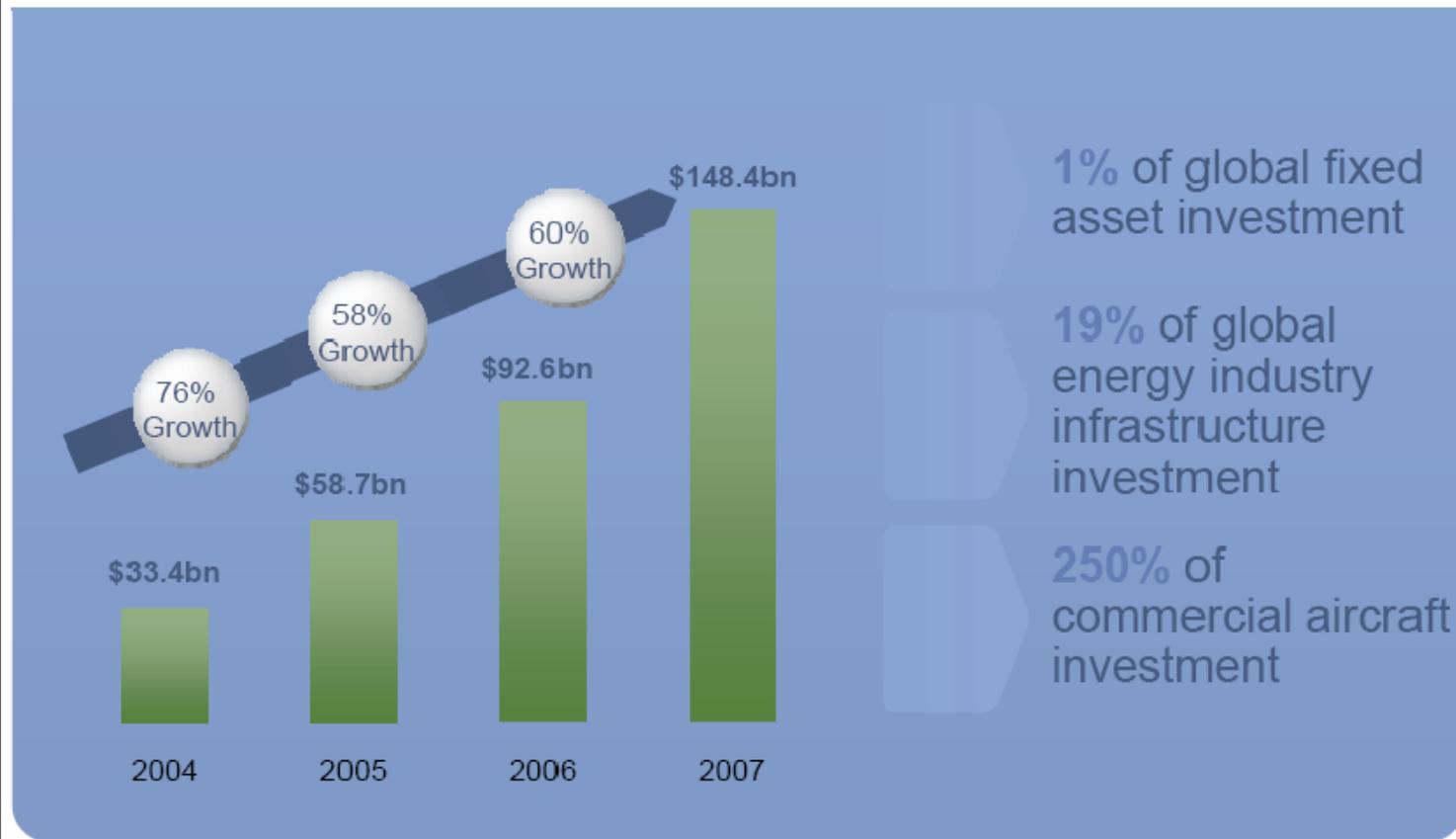
1. Assumed average capacity factors are 20% for solar and 90% for biopower.
 Note: The roadmap also considered detailed policy guidance as stated in the IEPR.

Context: Global Renewable Energy Industry Growth



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Total Global New Investment in Clean Energy 2004 – 2007



Adjusted for reinvestment. Geared re-investment assumes a 1 year lag between VC/PE/Public Markets funds raised and re-investment in projects.

Source: New Energy Finance, IMF WEO Database, IEA WEO 2007, Boeing 2006 Annual Report

Context: Investment Now Drives RE Technology Innovation

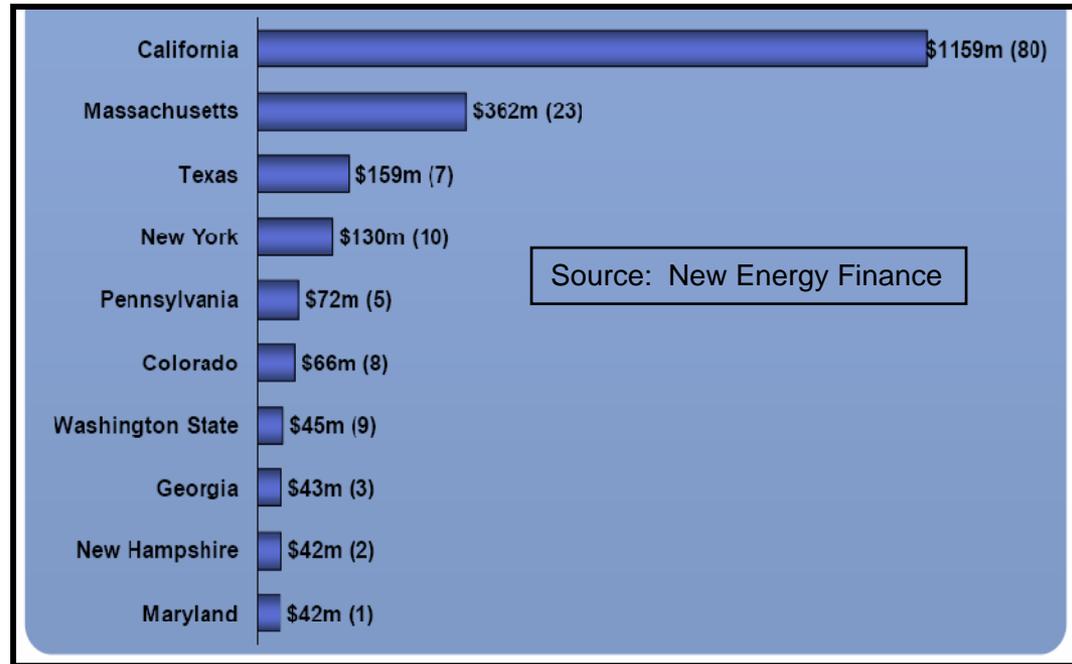


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Non-PIER sources of RE R&D funding include:

- The US Department of Energy's \$0.5B annual RE R&D budget
- An estimated 3-5% of the global renewable energy industry's \$150B annual revenues
- **Global RE VC funding, i.e. nearly \$3.5B in 2007, of which California accounted for ~33%**
- Corporate grants to California and other research universities totaling hundreds of millions
- The California Solar Initiative's \$50M R&D set-aside
- California IOUs request to ramp up collaborative utility RE R&D to a level of ~\$50M per year

State Level Clean Energy Venture Capital Investment, 2007



Context: Technology Options Depend on Energy System Scale



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✓ = primary application √ = secondary application	Deployment Venues		
	Utility-Scale Renewables	RE Secure Communities	RE Secure Buildings
Technology/ Resource	Utility-scale power plants and bio-refineries	Smaller energy plants exploiting high-quality local resources	Modular systems for building and industrial power, heat, cooling and lighting
Wind Power Plants	✓	✓	
Geothermal Power	✓	√	
Hi Temp Solar Thermal	✓	√	√
Biomass Power	√	✓	√
Ocean/Wave	√	✓	
Solar PV	√	✓	✓
DG Wind		√	✓
Solar Heat & Cooling		√	✓
Direct Geothermal		✓	√
Geothermal Heat Pumps		√	✓
Biofuels	✓	√	√

Large RE Power Plants:

Consumption of natural gas for power generation in California has increased by 65.5%. However:

- RPS targets require new transmission capacity facing long lead times.
- Integration of intermittent renewables will involve choices between additional carbon based generation and utility-scale energy storage.

Local RE Systems:

Do not encounter transmission limitations because they involve deployment in the context of community-scale and building-scale energy infrastructure. However:

- Natural gas displacing solar and geothermal heat uses, i.e. water heating and HVAC, have been minimal.
- There is no demonstrated model for energy planning and action at the community level.

Response: Vision and RD&D Mission

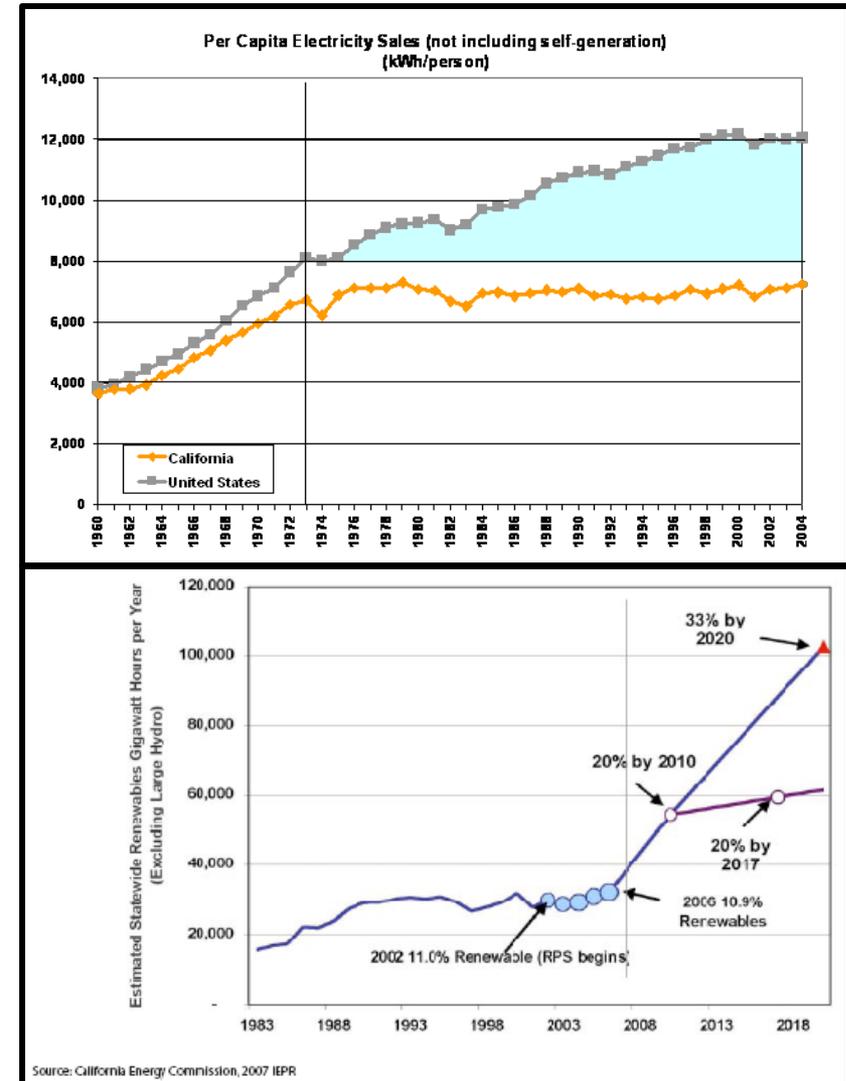


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Vision: RE technologies will be deployed in a more integrated way in the future, at multiple levels of the California energy market.

Mission: Since the collapse of California utility funded RE RD&D in the 90s, PIER RE has generated and managed a portfolio of projects in several RE technology areas. Its mission continues to evolve according to policy direction:

- Early – advance science and technology, create RE and efficiency options
- Recent – support deployment according to RPS deployment targets
- Proposed – support deployment according to AB 32 targets as well



Continue portfolio approach to support electric sector policy goals, i.e. RPS, Bio-energy, and CSI, while sharpening focus and specifically addressing AB 32:

- Fill gaps in externally funded RE R&D results as they apply in California’s electricity markets.
- Increased emphasis on natural gas displacement at all market levels
- Stronger emphasis on exploiting renewable resources at the community level, e.g. bio-waste streams, multi-MW PV, multi-MW wind and direct geothermal
- Response to IEPR recommendations for buildings:
 - Newly constructed buildings net-zero by 2020
 - Newly constructed commercial buildings net-zero by 2030
- Consistent, timely response by four RE collaboratives to R&D gaps not addressed by competitively sourced pilot projects and demonstrations

Response: Align Goals and Structure



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Program Goal: Pilot, model and technically enable cost-effective and high penetration integration of:

- Utility-scale RE power plants and related energy storage in the high voltage grid
- Thermal and electric RE systems and related energy storage in community and building energy infrastructure

Target Area Goals:

Development and Demonstration:

- Utility-Scale Renewables: Enable accelerated and optimized utility-scale RE deployment
- Renewable Energy Secure Communities: Demonstrate cost-competitive RE-based community-scale energy systems
- Renewable Energy Secure Buildings: Demonstrate integration of multiple RE technologies for net zero buildings

Research:

- Collaboration and Integration: Identify technology gaps and lay groundwork for related development and demonstration

Organize around target area goals!

Response: Utility-scale Renewables Solicitation

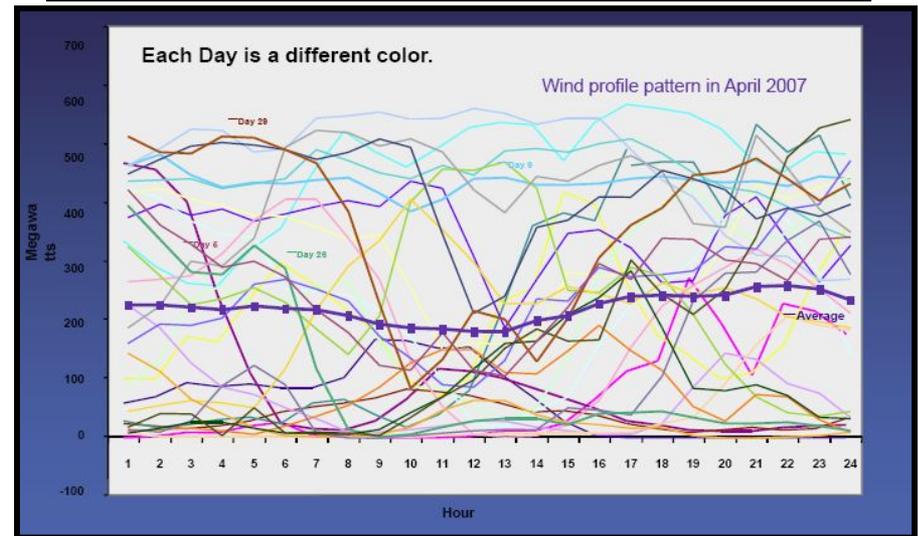
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Goals:

- Understand economic resource and storage mix in renewable resource zones
- Demonstrate thermal storage solutions via system research experiments
- Transfer forecasting tools and methods to renewable energy industry and transmission system owners and operators

Strategy:

- Involve major renewable industry companies and California utilities



Response: RE Secure Communities Solicitation



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Goals:

- Refine and pilot the net zero communities relying 100% on mostly local renewable resources and minimizing the need for additional transmission capacity to deliver renewable electricity.
- Mix of baseload and other renewables, e.g. bio-waste energy, PV and Wind
- Integrate with programs encouraging efficiency, demand response, solar and ground source heating and cooling, and community scale energy storage.

Strategy: Work with (smart) communities, including university campuses and community choice aggregation candidates



Response: RE Secure Buildings Solicitation



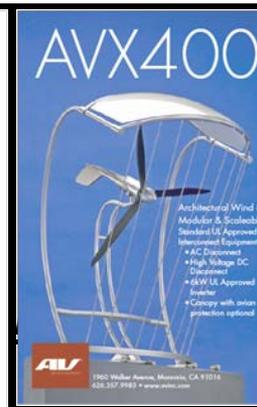
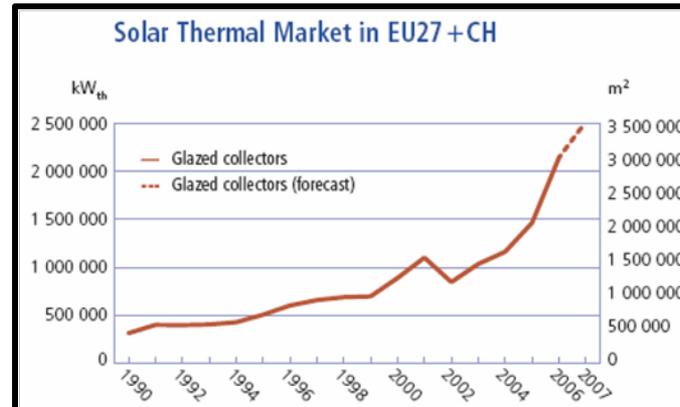
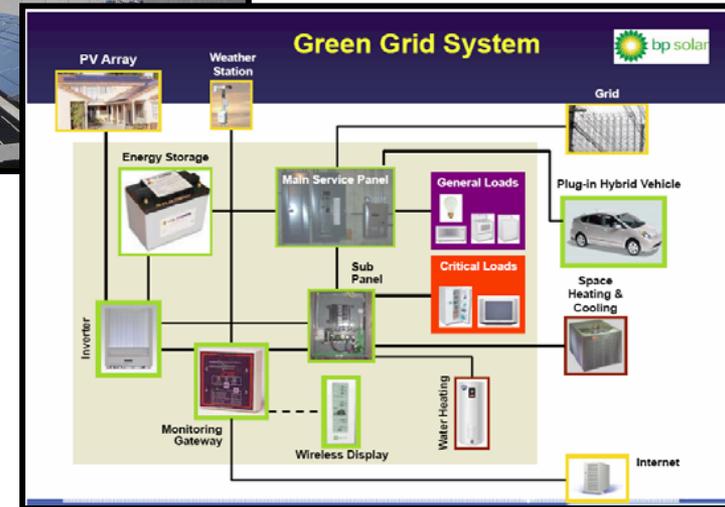
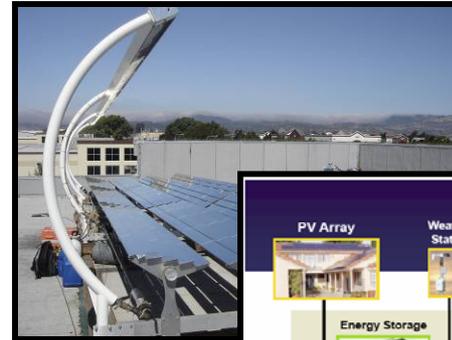
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Goals:

- Mitigate barriers to rapid deployment of available building integrated RE options*
- Develop standards and related testing that qualifies emerging technologies, e.g.:
 - outdoor testing of next generation PV
 - grid-tied inverters testing

Strategy: Work with facility managers, homebuilders, manufacturers, and utilities.

*PV, solar heating, solar water heating, and solar cooling, modular wind and emerging storage solutions, including plug-in hybrids



Response: Trail-blazing Research by RE Collaboratives



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• Current Roles

- Wind (launched 2002)
 - Annual forum
 - R&D agenda focused on integration
 - Also track CA wind generation
 - Training and education
- Biomass (launched 2003)
 - Annual forum and 500 member
 - Diverse R&D agenda now addressing sustainability standards
- Geothermal (launched 2004)
 - Annual forum
 - 380 members
 - Diverse agenda now focusing on resource assessment
- Solar (now prepared for launch)
 - Address CSP, PV, hot water, heating and cooling

Future role if stabilized and able to leverage non-PIER funds:

- Identify demonstration opportunities and help lay groundwork for solicitations
- Assist RD&D planning and development of future program thrusts
- Major study support and follow up, e.g. Intermittency Analysis Project
- Resource assessments, e.g. geothermal resource assessment upgrade
- Technology forecasts, e.g. future performance and cost for major commercial options
- State of the art and industry best practice analyses, e.g. wind forecasting and storage
- Preliminary research and feasibility investigations, e.g. biomass power plant efficiency upgrades
- Design tools and other technical support of deployment, e.g. ground source heat pumps
- Aggressive, complementary technology transfer efforts
- Emerging technology collaboration, e.g. ocean energy

- Renewable energy sources have a potentially dominant role in addressing climate change mitigation targets on the supply side of the energy sector in California
- This creates a near term need to pilot appropriate mixes of renewable sources, efficiency measures and storage (thermal as well as electrical) at all levels of the market, taking advantage of smart grid capabilities as they are deployed.
- On-going PIER Renewables studies, near term solicitations and research agendas are being targeted accordingly.
- The program faces major challenges as it prepares to move into uncharted territory while also delivering timely and important results from its existing project portfolio.
- RE “collaboratives” will be supported to fill research gaps.