

Biomass to Bioenergy: California Policy and Action

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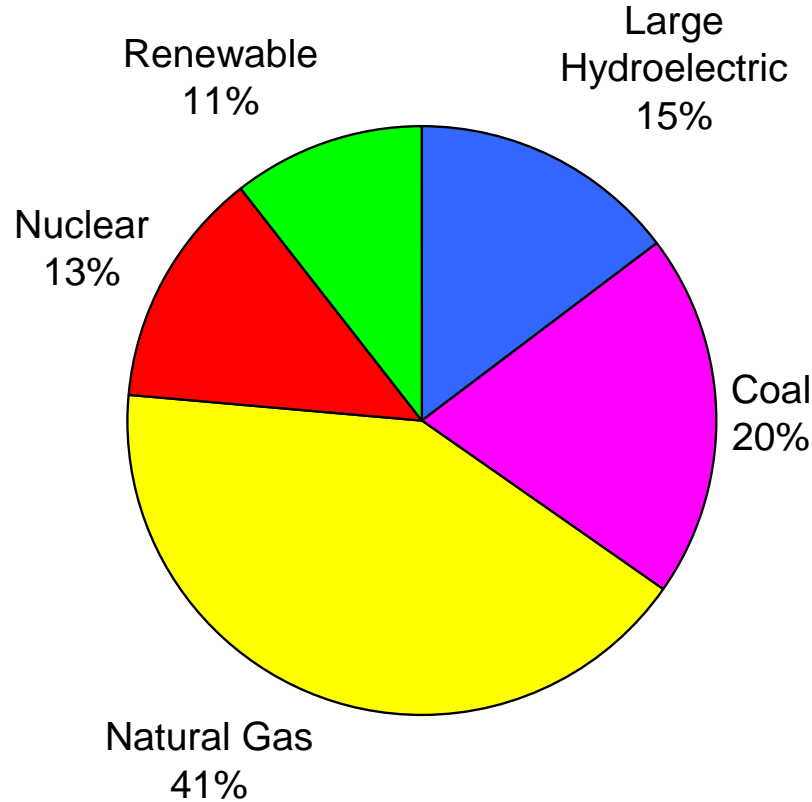
Outline

- California's Energy and Energy Policy Picture
- Current and Future Status of Bioenergy (biopower & biofuel) in California
- Public Interest Energy Research in California
- Biomass Roadmap
- Biomass R&D Projects
- Concluding Remarks



California Electricity Production 2004

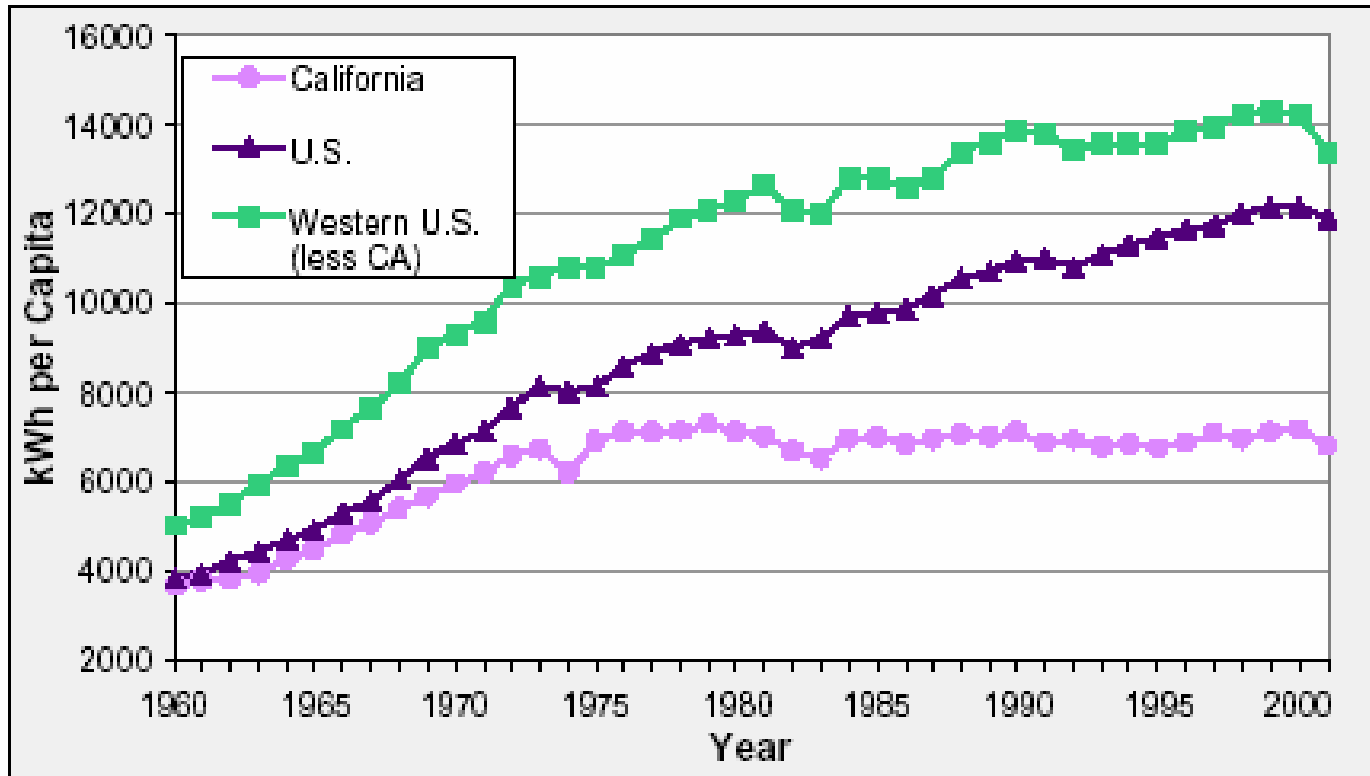
2004 Electricity Consumption ~ 280,000 GWh



Biogas can increase renewables and displace natural gas.



Total Electricity Use Per Capita 1960- 2001



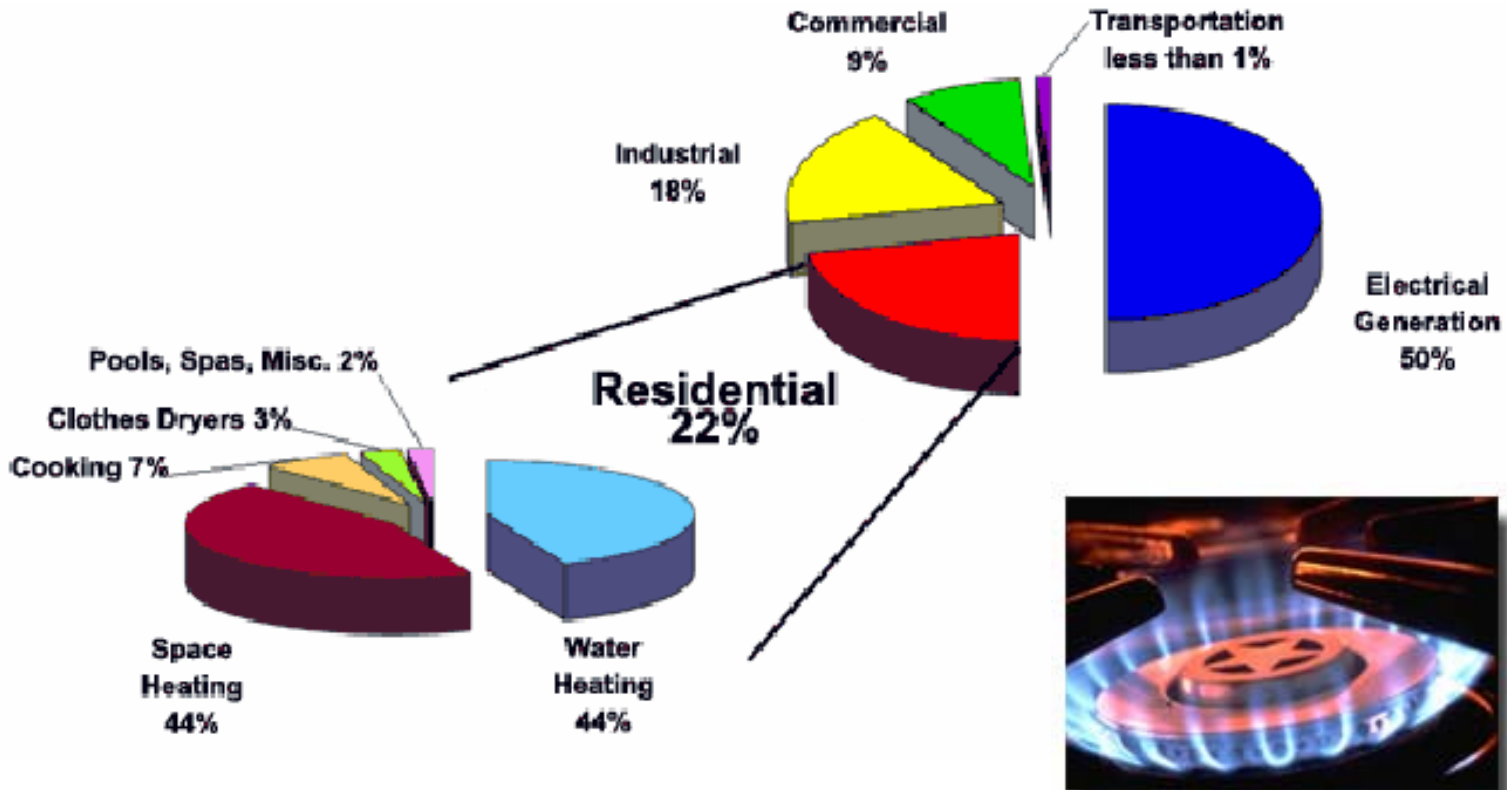
Californians use almost 50 percent less electricity than the U.S. average
Source: Energy Information Agency and California Energy Commission

*Efficiency has reduced the growth of CA electricity use
but new resources are still needed.*



2004 Natural Gas Use in California

2004 Natural gas consumption ~ 228 Bcf

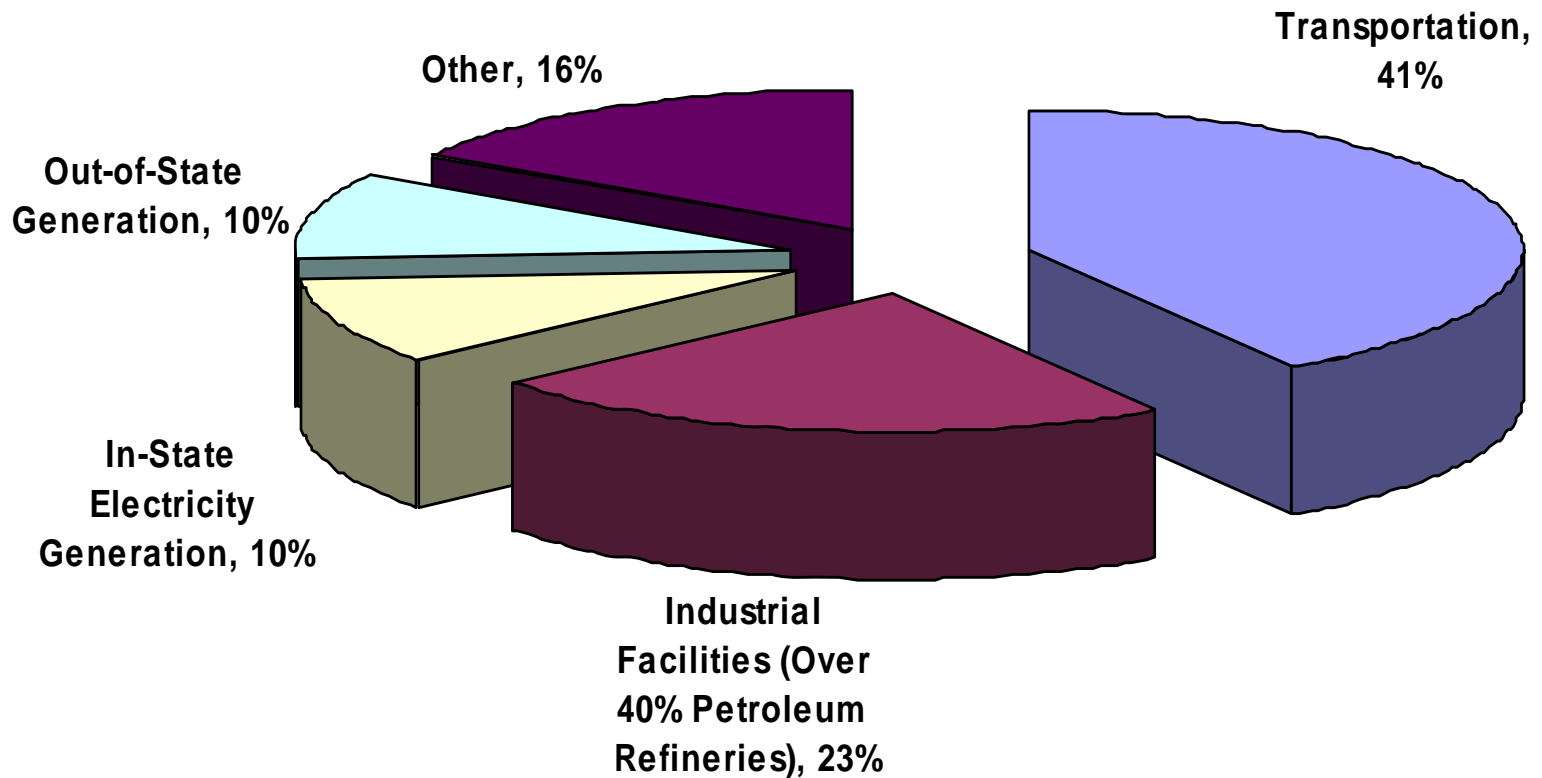


Biogas can displace natural gas broadly in direct uses.



California Greenhouse Gas Emissions

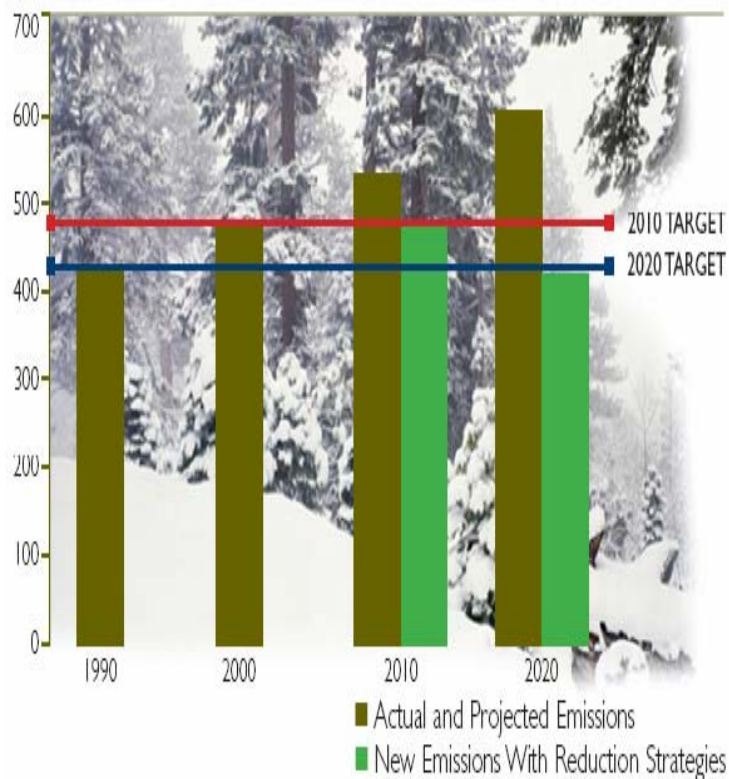
The total GHG emissions for 2004 are ~500 million tons of CO2 equivalent



Biogas can reduce CA GHG emissions.



2006 Legislation Provides New Policy Goals and Urgency for California Energy Sectors



- AB 32 – Global Warming Solutions Act of 2006; aggressive goals for 2020
- SB 1368 – GHG Emissions standards for Municipal Utilities
- AB 2021 – Energy Efficiency for Municipal Utilities
- AB 2160 – Green Building Acquisition Financing for State Facilities
- SB107 – Accelerated RPS Goals
- SB1 – PV and Renewables Goals for New and Existing Residential and Commercial Structures
- AB 2778 – Self-Generation Incentive Program for Fuel Cells and Wind
- SB 1250 – PIER and Renewables Incentive Programs Reauthorized



Legislation Is Not Now Comprehensive

- Integrated Energy Policy Report – 2005
 - Renewable resources
 - ◆ Expand RPS to energy service providers and community choice aggregators
 - ◆ Address transmission constraints preventing access to promising renewable resource areas
 - ◆ Repower aging wind facilities
 - Transportation (renewables related)
 - ◆ Rapid deployment of alternative fuels
 - ◆ Assembly Bill 1007 (Pavley, Chapter 371, Statutes of 2005) signed on September 29, 2005, requiring the Energy Commission to Develop and adopt a State Plan to Increase the Use of Alternative Fuels
- Bioenergy Interagency Working Group mandated by Executive Order S-06-06
 - Access Electricity from Biomass
 - Develop alternate fuels from Biomass
 - Establish a Renewable Fuels Standard, including in-state production
 - Developed an Action Plan
 - Draft Biomass Roadmap in Public Review



Biomass: Opportunity

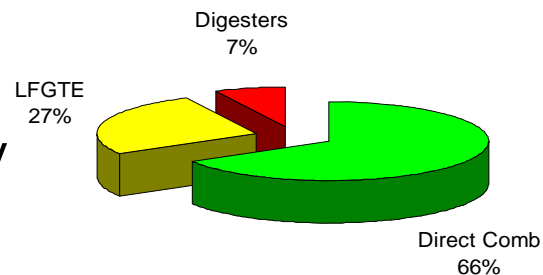
Opportunity

- **Global Energy Security**
- **Economy**
 - Energy Price Stability
 - Balance of Trade
 - National Debt
- **Environment**
- **Fuel Diversity**



California Bioenergy Today

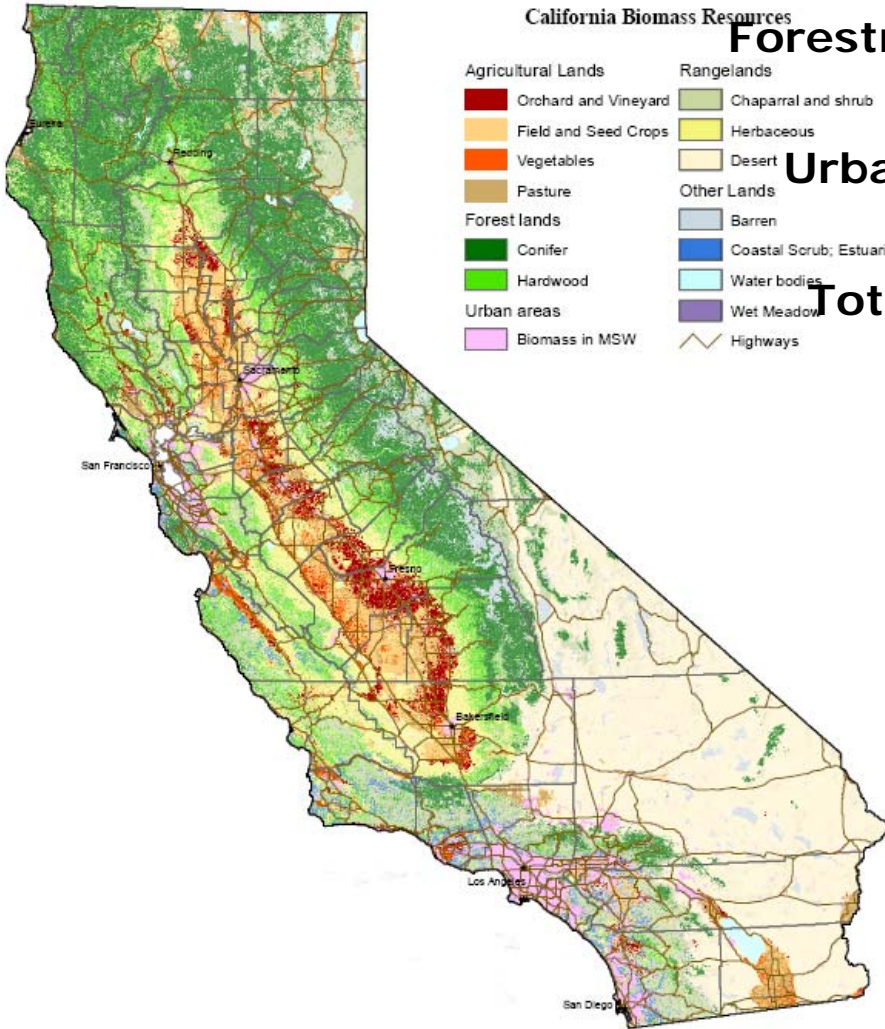
- Biomass Energy Facilities Provide ~1000 MW of Electricity Capacity through
 - Direct Combustion of Forestry, Ag and Urban Biomass
 - Landfill Gas to Energy Facilities Convert Methane Rich Landfill Gas
 - Wastewater and Dairy Biogas Systems Process Biogas Into Useful Energy
- Biofuels - California consumers over 900 million gallons per year of ethanol and over 11 million gallons of biodiesel fuel.



Today Biomass Is Viewed as a Disposal Problem

- Reducing Landfill Capacity
 - About 40 million tons of biomass goes into landfills every year
- Contributing to Air Pollution and Fire Risk
 - Open field burning of crop residues emits more than 100,000 tons of air pollutants annually
 - Wildfires contribute over 1.1 million tons per year at a cost of >\$900 million/year
- Local Concerns
 - California's 1.67 million dairy cows generate odor and health concerns





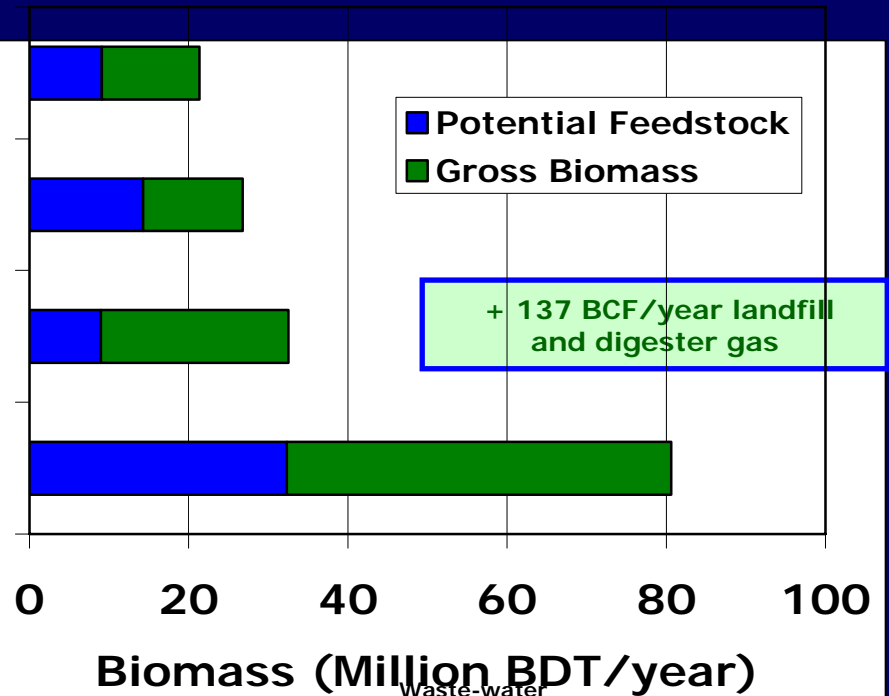
- California Biomass Resources**
- | | |
|--|---|
| Agricultural Lands | Rangelands |
| ■ Orchard and Vineyard | ■ Chaparral and shrub |
| ■ Field and Seed Crops | ■ Herbaceous |
| ■ Vegetables | ■ Desert |
| ■ Pasture | Other Lands |
| Forest lands | ■ Barren |
| ■ Conifer | ■ Coastal Scrub; Estuarine |
| ■ Hardwood | ■ Water bodies |
| Urban areas | ■ Wet Meadow |
| ■ Biomass in MSW | ~ Highways |

Agriculture

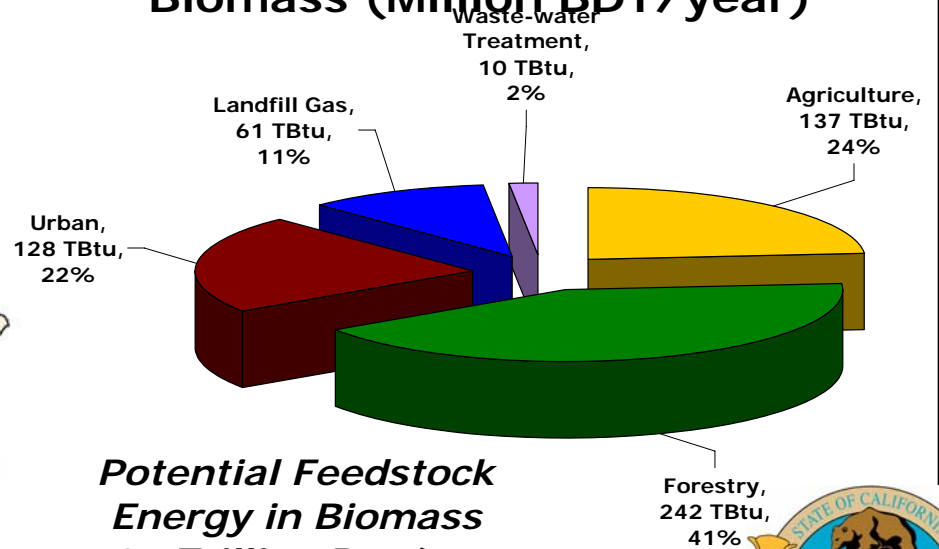
Forestry

Urban

Total



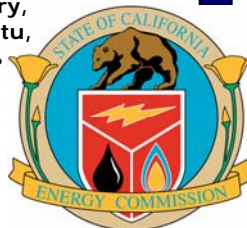
Biomass (Million BDT/year)



0 20 40 80 120 160 200 Miles

Data sources: CDF FVEG 2002 Version 2
DWR Land Use 1994 - 2004, National Land Cover Data, 2002

California Biomass Resources



Total Categorical Bioenergy Potentials in California

Category	Biomass (Million BDT/year)	Energy in Product (Trillion Btu/year)	Total Capacity
Electricity CHP Heat	32	118 (35 TWh) 230	4,650 MWe 9,050 MWt
Heat	32	350	11,700 MWt
Biochemical Biofuel	32	188	1.5 BGY gasoline equivalent
Thermochemical Biofuel	27*	250	1.7 BGY diesel equivalent
Biomethane	5 + Landfill gas and WWTP	106	106 BCF/y methane
Hydrogen (bio + thermal)	32	305	2.5 Million tons/y

* Tonnage for thermochemical biofuel assumed to be constrained by moisture content

Current California consumption:

16 billion gallons gasoline + 4 billion gallons diesel = 2,500 Trillion Btu/year direct energy content

300 TWh/y electrical energy = 1,024 Trillion Btu/year direct energy



Biomass: Opportunity and Challenge

Opportunity

- **Global Energy Security**
- **Economy**
 - Energy Price Stability
 - Balance of Trade
 - National Debt
- **Environment**
- **Fuel Diversity**

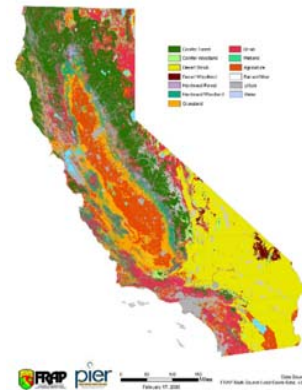
Challenge

- **Biomass Cost**
 - Feedstock
 - Conversion
 - Delivery
- **RD&D Breakthroughs**
- **Permitting**
- **Policy**



State Action Plan Objectives

1. Establish California as a market leader in technology innovation, sustainable biomass development, and market development for bio-based products.
2. Coordinate research, development, demonstration, and commercialization efforts across federal and state agencies. ----Develop biomass roadmap.
3. Align existing regulatory requirements to encourage production and use of California's biomass resources.
4. Facilitate market entry for new applications of bioenergy including electricity, biogas, and biofuels.
5. Maximize the contributions of bioenergy toward achieving the state's petroleum reduction, climate change, renewable energy, and environmental goals.



Public Interest Energy Research (PIER) Program

- **IOU Ratepayer-funded program launched in 1997**
- **Addresses electricity, natural gas, and transportation sectors**
- **\$80M annual budget; nearly \$400M in projects**
- **A leader in no/low-carbon technology and global climate change research programs**
 - Efficiency and Demand Response
 - Renewables
 - Clean Fossil Fuel Generation – Distributed Generation, Combined Heat & Power
 - Transportation
 - Energy Systems Research – Transmission and Distribution, Grid Interconnection
 - Environmental Impacts – Air, Water, Climate, Communities
- **Strong emphasis on collaborations**
 - Avoid duplication/builds on past work/ensures relevance
 - Regular coordination with IOUs via the Emerging Technology Coordinating Council to transition research to the marketplace
 - State Agency Partnerships (DGS/DOF, ARB, T-24,CDF,DFA,CalEPA, IWMB)
 - Market Partnerships (California builders, Collaborative for High Performance Schools, California Commissioning Collaborative, major equipment manufacturers)
 - Use California Capabilities (Universities, National Laboratories, High Technology Companies)
 - Leverage/complement Federal Investments



PIER Goals Are Solution- Focused and Include Biomass

General Goal

- “Develop and help bring to market, energy technologies that provide increased environmental benefits, greater system reliability, and lower system costs”

Specific Goals

- Develop and help bring to market
 - “Advanced transportation technologies that reduce air pollution and greenhouse gas emissions beyond applicable standards, and that benefit electricity and natural gas ratepayers.
 - “Increased energy efficiency in buildings, appliances, lighting, and other applications beyond applicable standards, and that benefit electric utility customers.
 - “Advanced electricity generation technologies that exceed applicable standards to increase reductions in greenhouse gas emissions from electricity generation, and that benefit electric utility customers.
 - “Advanced electricity technologies that reduce or eliminate consumption of water or other finite resources, increase use of renewable energy resources, or improve transmission or distribution of electricity generated from renewable energy resources.”



California Biomass Roadmap

Vision: Sustainable biomass resources energize a healthy and prosperous California through the environmentally beneficial production and use of renewable energy, biofuels, and bioproducts.

Priority Areas

- Resource access and feedstock markets and supply
- Market expansion, access, and technology deployment
- **Research, development, and demonstration**
- Education, training, and outreach
- Policy, regulations, and statutes

RD&D

1. Resource Base, Sustainability and Access
2. Bioscience/Biotechnology
3. Thermochemical
4. Feedstock Processing
5. Systems Analysis
6. Knowledge/Information Resources



PIER Biomass R&D Projects



Forest Residue

- **Contractor:** Hetch Hetchy/SFPUC (McNeil/Community Power Corporation)

Goals:

- Conduct a technology demonstration project of a **15 kW_e** biomass gasifier using forest biomass

Status:

- 15 kW unit installed & connected to the grid & being tested
- All power is sold back to Truckee Donner Public Utility District (first utility interconnection for BioMax)
- Capture waste thermal energy for heating the office building
- Emissions: NO_x 30.1 ppm (@6.2 % O₂), CO = 2.1 ppm, THC = 4.1 ppm



- **Contractor:** Community Power Corporation

Goals:

- Design, develop and demonstrate a **50 kW_e** modular gasification system for grid interconnection, and combined heat and power using forest residue.
- Improve cost competitiveness of the biomass energy conversion technologies and reduce environmental risks and costs of California's electricity.

Status:

- 50 kW gasifier and other components are being shop tested
- The gasifier system will be field tested starting July 2007



Landfill Projects

Makel's HCCI: (homogeneous charge compression ignition) Low NOx Generator – Butte County Landfill

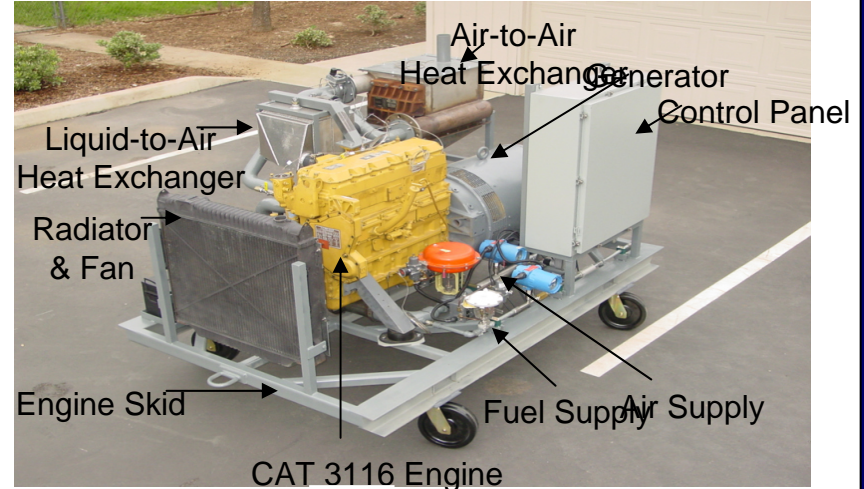
Contractor: Makel Engineering

Goals:

- System efficiency of 35% operating on LFG
- System NOx emission of less than 5 ppm

Status:

- Prototype is built and being tested using landfill gas
- Max Brake Thermal Efficiency = 35%
- NOx Emissions = Less than 5 ppm (@15% O₂)



SCS & Ingersoll-Rand's MicroTurbine – Burbank Landfill

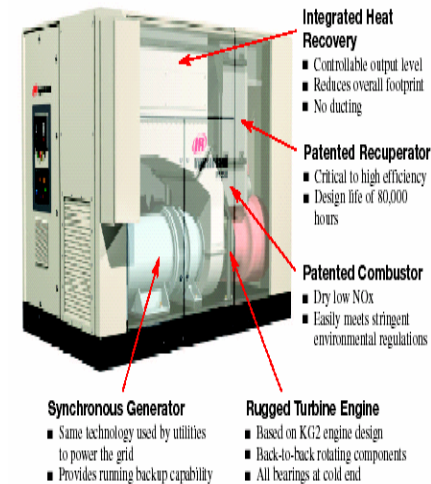
Contractor: SCS Engineers

Goals:

- **Market introduction of a 250 kW microturbine for landfill gas use**
- **Reduce LCOE < \$0.048/kwhr**
- **Reduce capital cost to \$800/kW**

Status:

- The microturbine has operated for one year
- Has shown reduced installation and operation cost.
- Final Results are being evaluated



Instead of natural gas, the above 250kW Microturbine will run on landfill gas to generate electricity.



Yolo County's BioReactor

- **Contractor: SMUD/Yolo Co.**
- **Goals:**
 - **Successful demonstration of bioreactor concept at full-scale**
 - **Accelerate decomposition of waste by 2/3rds normal timeframe**
 - **Document economic viability**
- **Project Site:**
 - **Yolo County landfill**
- **Status:**
 - Collected data shows that landfill bioreactor can accelerate organic portion of the solid wastes decomposition and methane recovery rates 4 to 7-fold as compared with conventional operation
 - The project has documented technical data needed to establish environmental and renewable energy benefits to help facilitate regulatory acceptance



Valley Fig Growers' Anaerobic Digester for Food Wastes

- **Contractor: Valley Fig Growers**
- **Goals:**
 - ***Demonstrate successful use of ADT for pre-treatment of food processing wastewater***
 - ***Save ~ \$100,000/yr in waste discharge costs paid by VFG***
 - ***Demonstrate CHP application of microturbine at site***
- **Project Site:**
 - **Valley Fig (Fresno)**
- **Status:**
 - Installed a covered lagoon that reduces BOD and SS by over 90% and generates 25 to 65 kW of electricity for use on-site
 - Save an annual cost of \$100,000 that VFG currently pays to the Fresno city
 - Reduce greenhouse gas (methane) emission at 148 tons per year
- **Awards Received**
 - A Certificate from the City of Fresno in recognition of the merits of biogas digester installed
 - An Honor Award in CELSOC's (Consulting Engineers and Land Surveyors of California) 2007 Engineering Excellence Award Competition



UC Davis' High Solids Digester

- **Contractor: UC Davis & OnSite Power**
- **Goals:**
 - Scale up, test and demonstrate APS high solids digester
 - ◆ 3 tpd size at UC Davis
 - ◆ 25 tpd at Norcal Waste
 - Methane generation rate > 6 ft³ CH₄/lb of VS
 - Achieve CARB 2007 NOx goals
- **Project Site:**
 - UC Davis & City of Industry
- **Status:**
 - Digester construction is almost complete
 - Public Opening on October 24, 2006



Dairy Power Production Program

- ◆ California is home to about 1.67 million milking cows – 18% of US milking cows
- ◆ CA dairies produce more than 27 billion pounds of milk, 1.25 billion pounds of cheese and generate \$3 billion in annual sales
- ◆ Represent a significant bioenergy resource
- ◆ Engine generators at 10 CA dairies



Dairy Name	Engine Generator Capacity (kW)	Engine Model
Straus	75	Waukesha 817
Castelanelli	160	Caterpillar 3406
Cottonwood	300	Caterpillar G3412TS
Hilarides	125*4	Caterpillar G342
Lourenco	150	Caterpillar 353
Eden-Vale	180	Caterpillar 3406
Koetsier	135*2	Caterpillar G342
Meadowbrook	160	Caterpillar 3406TA
Van Ommering	130	Caterpillar 3406
IEUA	1000	Waukesha 7042
	850	Waukesha 5790



PIER Commerce Energy Program

Codigestion of Food Wastes with Biosolids and Dairy Manure

- **Goal**

- Demonstrate pilot and full-scale systems to address lack of knowledge of the relationship between various co-digestion feedstocks and gas production

- **Results**

- Optimization data on co-digestion of food wastes with sewage sludge and dairy manure were collected
- System performance data on biogas yield and power generation were collected
- Preliminary environmental performance data on air and water benefits were collected
- A model that predicts the biogas yield on co-digestion was developed



Inland Empire Utility Agency (IEUA)



Inland Empire Utility Agency (IEUA) Centralized Digester

- **Goals:**
 - Successful demonstration of cost-effective European centralized digester
 - Ability to co-process food wastes and dairy manure
 - Use lean burn engine to generate 1.5 MW of electricity
- **Project Site:**
 - Chino Basin (IEUA site)
- **Status:**
 - Design is completed
 - Under Construction



Concluding Remarks

- California is serious about Bioenergy
- The Bioenergy Interagency Working Group and its member agencies are focused on making CA biomass resources part of the State's energy future
 - Planning and implementation of policy drivers
 - Resolving potential barriers to renewables development
 - Developing the next generation of biomass to energy conversion systems that will help make California's electricity and transportation fuels more cost competitive, reliable, safer and cleaner
 - Working closely and cooperatively with key stakeholders to meet California's special needs and take advantage of unique opportunities



Thank You

Additional information

The Energy Commission's web site has extensive information on the ongoing bioenergy work in California at:

http://www.energy.ca.gov/bioenergy_action_plan

http://www.energy.ca.gov/2005_energypolicy/

