

Existing Practices and Prospective Development of Wastes to Energy in California

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Prepared for Organic Residuals Symposium: Recycling of Non-Hazardous
Organic Residuals to Products and Energy
July 12-14, 2006, Sacramento, California



Wastes (Organic Residuals or Resources) To Energy in California

- Goal of California Energy Commission's Public Interest Energy Research (PIER) Program
- Existing Practices of Wastes to Energy in California
- Prospective Development of Wastes to Energy in California
- Conclusions

Public Interest Energy Research (PIER) Program

- GOAL: To support energy research, development and demonstration (RD&D) projects that will help improve the quality of life in California by bringing environmentally safe, affordable and reliable energy services and products to the marketplace.
 - [Buildings End-Use Energy Efficiency](#)
 - [Energy Innovations Small Grant \(EISG\) Program](#)
 - [Energy-Related Environmental Research](#)
 - [Energy Systems Integration](#)
 - [Environmentally-Preferred Advanced Generation](#)
 - [Industrial / Agricultural / Water End-Use Energy Efficiency](#)
 - [Public Interest Natural Gas Research Program](#)
 - [Renewable Energy Technologies](#)

California Energy Profile



- **Population:** 35,655,404 (2004) ranked 1st
- **Per Capita Income:** \$35,019 (2004) ranked 13th
- **Total Energy Consumption:** 7.9 quadrillion Btu (2001), ranked 2nd
- **Per Capita Energy Consumption:** 227 million Btu (2001), ranked 49th
- **Total Petroleum Consumption:** 78.4 million gallons per day (2002), ranked 2nd
- **Gasoline Consumption:** 42.5 million gallons per day (2002), ranked 1st
- **Distillate Fuel Consumption:** 10.3 million gallons per day (2002), ranked 2nd
- **Liquefied Petroleum Gas Consumption:** 1.7 million gallons per day (2002), ranked 6th
- **Jet Fuel Consumption:** 11.8 million gallons per day (2002), ranked 2nd
- **Natural Gas:** Total natural gas consumption including residual, commercial, industrial, and power industry in California is 2,366,399 MMcf (2004).
- **Electricity:** Total summer capacity is 58,306 MW (2004)

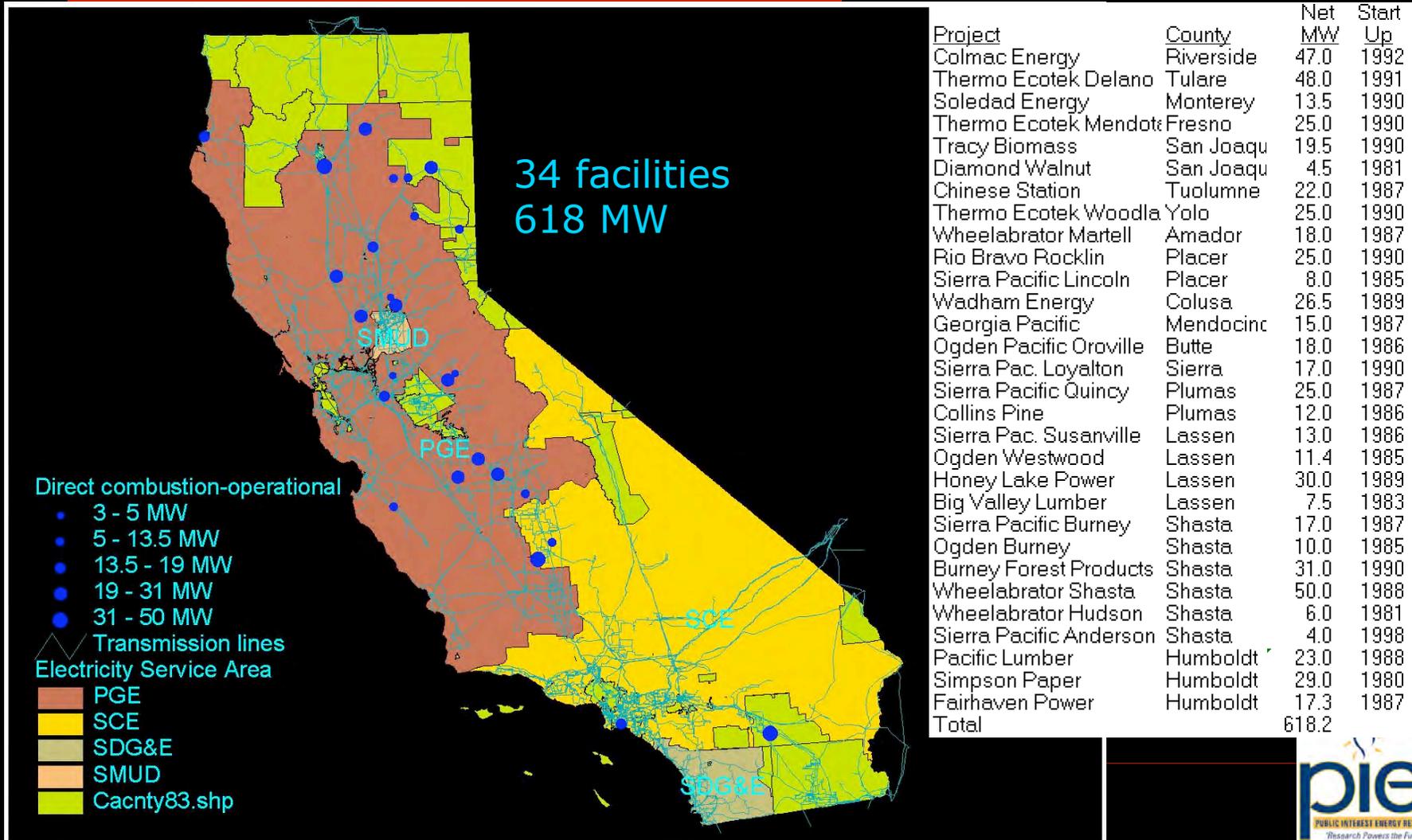
State	Primary Fuel Source	Total Summer Capacity		Net Generation	
		(MW)	Rank	(MWh)	Rank
California	Gas	58,306	2	194,780,355	4

Source: Energy Information Administration (EIA)

Existing Practices of Wastes (Organic Residuals or Resources) to Energy in California

Feedstock Categories	Technologies	# of Operational Facilities	Existing Power and Fuel Production	Feedstock used
Ag, Urban, and Forest Biomass Residues	Direct Combustion	34	618 MW	4.8 million BDT/yr
Municipal Solid Wastes (MSW)	Transformation/Incineration using MSW disposed annually	3	70 MW	0.9 million wet tons/yr
	Landfill Gas to Energy using MSW disposed annually	NA	10.61 MW	42.1 million wet tons/yr
	Landfill Gas to Energy using MSW historically accumulated	72	255 MW	1000 million wet tons
Waste Tires	Co-generation	6	14 MW	0.07 million BDT/yr
Livestock Manures	Anaerobic Digestion	11	2.2 MW	0.05 million BDT/yr
Sewage Sludge from Domestic Wastewater	Anaerobic Digestion	10	38.5 MW	0.4 million BDT/yr
Food Processing Wastes and Wastewater	Anaerobic Digestion	1	0.075 MW	0.0001million BDT/yr
	Fermentation	2	7.5 million gallons of ethanol	0.075 million BDT/yr
Total		139	1005 MW power + 7.5 million gallons ethanol	

Existing Operational Direct Combustion Facilities using Ag. Urban, and Forest Residuals

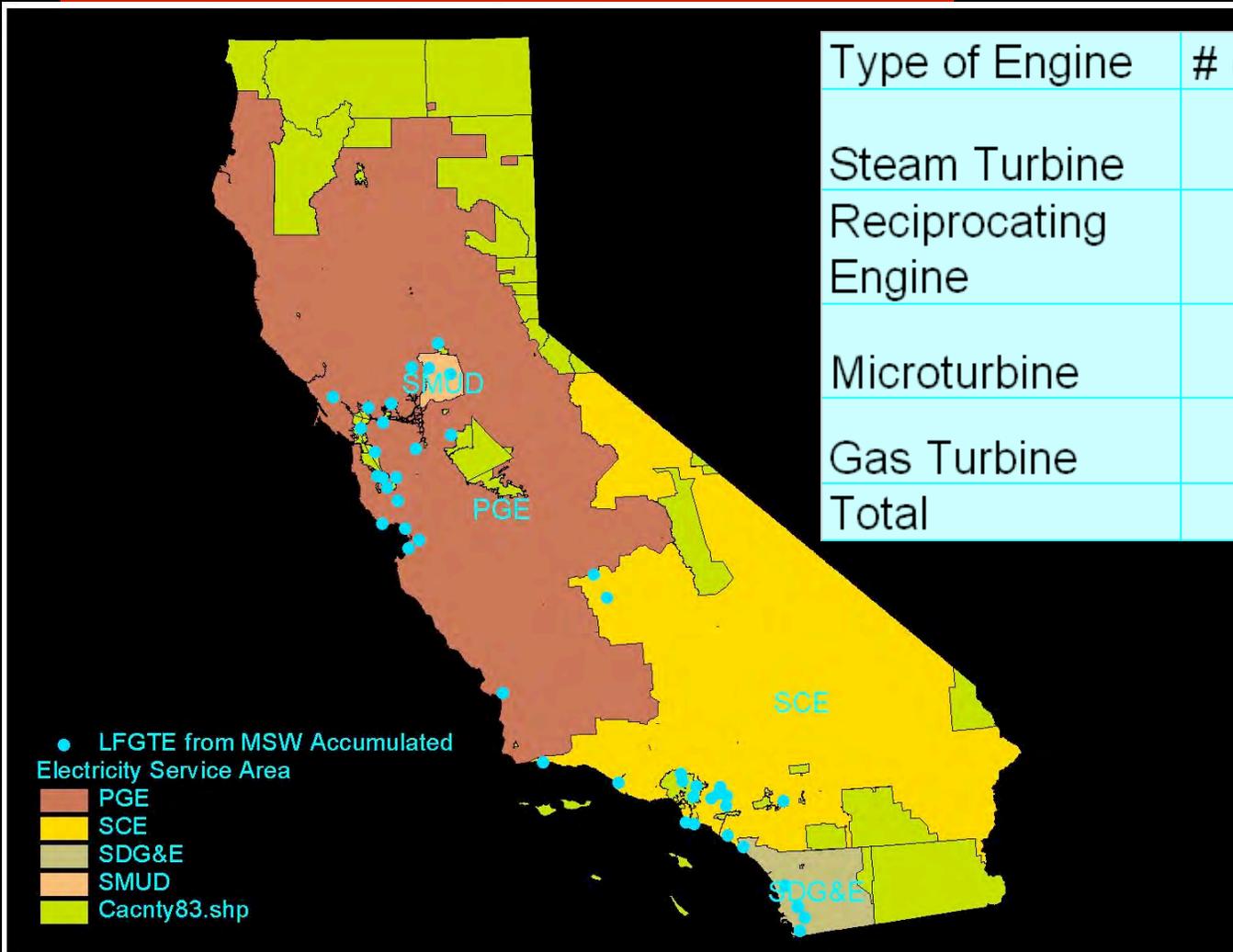


Existing Operational MSW Transformation/Incineration Facilities



1. Southeast Resource Recovery Facility (SERRF), Built in 1988, 36 MW, 1290 Tons/day, Cost: \$108 million
2. The Commerce Facility, 1981, 11.5 MW, 360 tons/day
3. The Stanislaus Resource Recovery Facility, 1989, 22.5 MW, 800 tons/day

Existing Operational Landfill Gas to Energy Facilities using MSW Accumulated



Type of Engine	# of Facilities	MW
Steam Turbine	6	98
Reciprocating Engine	47	125
Microturbine	11	9.5
Gas Turbine	8	22.6
Total	72	255

Existing Waste Tires Co-generation Facilities



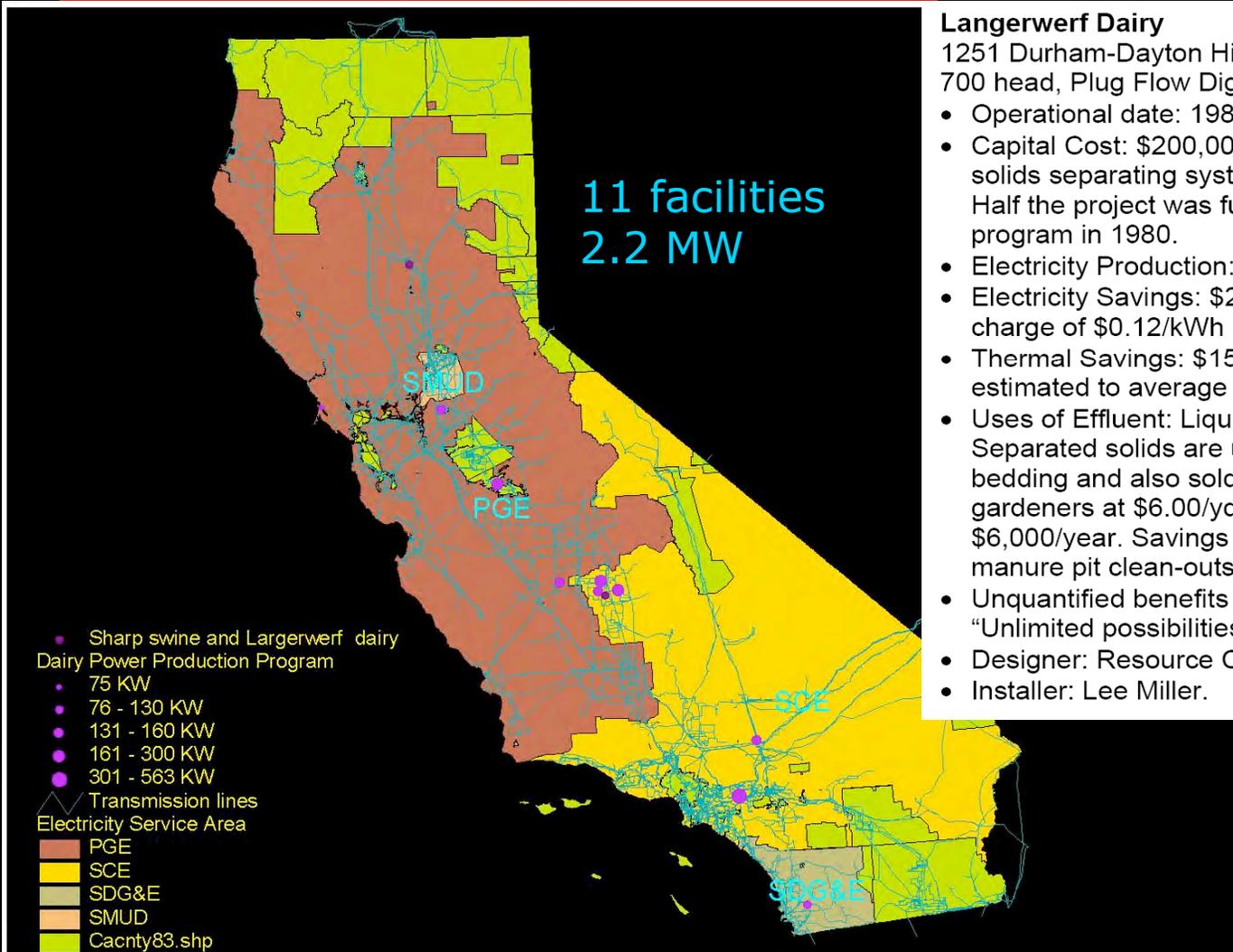
Table 1: Tire Burning Facility Information (2003)

Facility Name	Facility Address	Tires Burned in 2003
Cement Facilities		
California Portland Cement Company (Colton)	695 South Rancho Avenue Colton, California 92324	2.2 million tires (20,452 tons of tires)
Mitsubishi Cement Company	5808 State Highway 18 Lucerne Valley, California 92356	2.1 million tires (19,415 tons of tires)
Lehigh Southwest (formerly Calaveras Cement Company)	15390 Wonderland Boulevard Redding, California 96003	1.6 million tires (14,978 tons of tires)
California Portland Cement Company (Mojave)	9350 Oak Creek Road Mojave, California 93502	None
Cemex – California Cement, LLC	25220 Black Mountain Quarry Road Apple Valley, California 92307	None
National Cement Company	5 Miles East Of I-5 Off Highway 138 Lebec, California 93243	None
Riverside Cement Company	19409 National Trails Highway Oro Grande, California 92368	None
Cogeneration Facilities		
Stockton Cogeneration Company	1010 Zephyr Street Stockton, California 95206	1.4 million tires (12,845 tons of tires)
Mount Poso Cogeneration Company	36157 Famoso Road Bakersfield, California 93308	<0.1 million tires (395 tons of tires)
Port of Stockton District Energy Facility	2526 West Washington Street Stockton, California 95203	<0.1 million tires (16 tons of tires)
Jackson Valley Energy Partners	4655 Coal Mine Road Ione, California 95640	None
Rio Bravo Jasmin	11258 Porterville Highway Bakersfield, California 93308	None
Rio Bravo Poso	16608 Porterville Highway Bakersfield, California 93308	None
Total Tires Burned in 2003		7.4 million tires (68,101 tons of tires)

Source: CARB

- 13 permitted tire burning facilities
- 6 facilities burned 7.4 million tires (25% of total tires in 2003)
- Estimated power generation: 14 MW

Existing Livestock Biogas Power Facilities

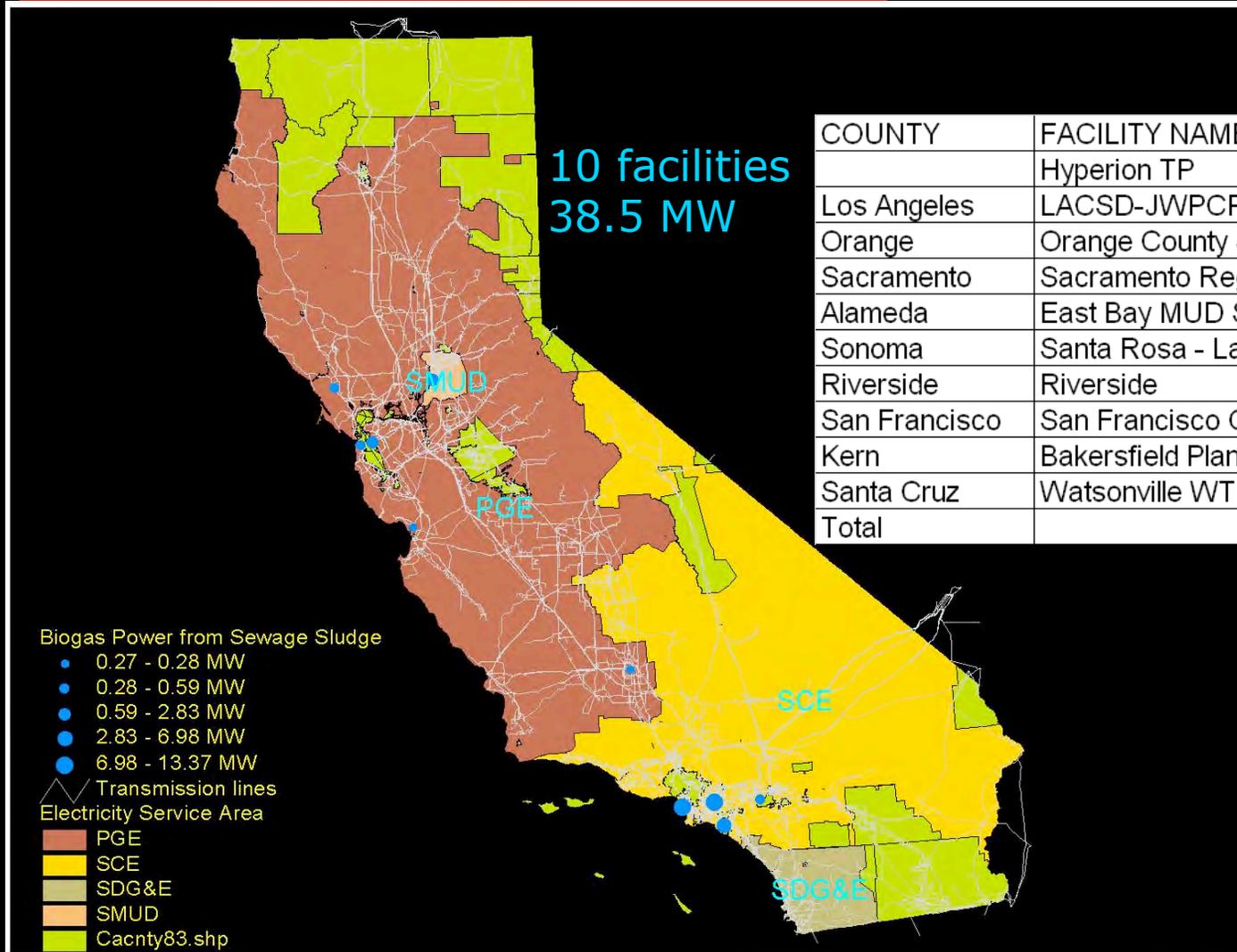


Langerwerf Dairy

1251 Durham-Dayton Highway, Durham, CA 95938
700 head, Plug Flow Digester

- Operational date: 1982
- Capital Cost: \$200,000, which included the digester, solids separating system, and all ancillary equipment. Half the project was funded by CDFA's low interest loan program in 1980.
- Electricity Production: Estimated at 300,000 kWh/yr
- Electricity Savings: \$22,000-\$27,000 at an energy charge of \$0.12/kWh in 1998, with no demand charge.
- Thermal Savings: \$15,000, with water heating savings estimated to average about \$1,000/month.
- Uses of Effluent: Liquid is used on crop irrigation. Separated solids are used for freestall and calf barn bedding and also sold as garden mulch to local gardeners at \$6.00/yd³. Manure solids sales are about \$6,000/year. Savings resulting from reduced number of manure pit clean-outs are estimated to be \$9,000/year.
- Unquantified benefits from fly and odor control. "Unlimited possibilities if you keep your mind open."
- Designer: Resource Conservation Management, Inc.
- Installer: Lee Miller.

Existing Sewage Biogas Power Facilities



COUNTY	FACILITY NAME	Installed MW
	Hyperion TP	13.37
Los Angeles	LACSD-JWPCP	10.93
Orange	Orange County Sanitation Dist.	6.98
Sacramento	Sacramento Regional WTP	2.83
Alameda	East Bay MUD Special District	2.22
Sonoma	Santa Rosa - Laguna WTP	0.59
Riverside	Riverside	0.53
San Francisco	San Francisco Oceanside WPC	0.51
Kern	Bakersfield Plant 3	0.28
Santa Cruz	Watsonville WTF	0.27
Total		38.51

Existing Ethanol and Biogas Facilities using Food Processing Wastes



Golden Cheese Company

- Ethanol: 3.5 million gallons from Cheese whey
- In full operation, the plant consumes 5,000,000 pounds of milk per day and requires 100,000 California milk cows to meet the demand.

Parallel Products

Ethanol: 4 million gallons from waste beer, brewers yeast, outdated soda syrup and fruit juices, waste ice cream, spent alcohol and wine from retail business and industry.

Potential Wastes to Energy in California using Existing Technologies

Feedstock Categories	Technologies	Feedstock used/Total	Total feedstock available	Potential Power and Fuel Addition
Ag, Urban, and Forest Biomass Residues	Direct Combustion	34%	14.3 million BDT/yr	1200 MW
Municipal Solid Wastes (MSW)	Transformation/Incineration using MSW disposed annually	2.1%	0.9 - 43 million wet tons/yr	0 - 3274 MW
	Landfill Gas to Energy using MSW disposed annually	100%	43 - 0 million wet tons/yr	10.61 - 0 MW
	Landfill Gas to Energy using MSW historically accumulated	100%	1000 million wet tons	252 - 0 MW for limited yrs
Waste Tires	Co-generation	25%	0.28 million BDT/yr	42 MW
Livestock Manures	Anaerobic Digestion	1.39%	3.6 million BDT/yr	156 MW
Sewage Sludge from Domestic Wastewater	Anaerobic Digestion	50%	0.80 million BDT/yr	38.5 MW
Food Processing Wastes and Wastewater	Anaerobic Digestion	0.20%	0.05 millin BDT/yr	37.43 MW
	Fermentation	5%	1.5 million BDT/yr	142.5 million gallon ethanol/yr
Total				5000 MW (assume transformation consumes all of the MSW disposed annually) + 142.5 million gallon ethanol/yr

Other Fuel Options from Wastes to Energy

- Ethanol: gasification or fermentation using lignin-cellulosic material
- Methanol: gasification
- Biodiesel
- Bio-oils (pyrolysis)
- Syngas
- Hydrogen
- Others

Existing and Prospective Development of Wastes to Energy under the PIER Program

- Dairy Power Production Program
- Valley Fig Grower (VFG) Biogas Digester
- Commerce Energy Co-Digestion of Dairy manure and Food Processing Wastes
- Inland Empire Utility Agency European Designed Complete Mix Anaerobic Digesters

Dairy Power Production Program

Drivers

❖ Energy

- Electricity and heat
- Fuel

❖ Environment

- Increasing concerns over odor, water, air, and land qualities

❖ Legislation

- Legislation addressed peak electricity demand problems in 2001 by directing \$10 million SB5x fund to develop commercially proven biogas electricity systems that can help California dairies offset the purchase of electricity and providing environmental benefits

Dairy Power Production Program (10 projects awarded)

Dairy Name	Cows	Type of System	kW	Total cost
Hilarides Dairy	6000 heifers	Cov'd lagoon	250	\$1,500,000
Gallo Cattle Company	5081	Cov'd lagoon	300	\$1,289,520
Blakes Landing Dairy	237	Cov'd lagoon	75	\$135,800
Castelanelli Bros. Dairy	1600	Cov'd lagoon	160	\$772,925
Koetsier Dairy	1500	Plug flow	260	\$381,850
Van Ommering Dairy	600	Plug flow	130	\$489,284
Meadowbrook Dairy	1900	Plug flow	160	\$524,898
Calif Polytechnic State University Dairy	175	Cov'd lagoon	30	\$75,000
Lourenco Dairy	1258	Cov'd lagoon	150	\$229,557
Inland Empire Utilities Agency	4700	Plug flow	563	\$1,546,350
Eden-Vale Dairy	770	Plug flow	150	\$661,923

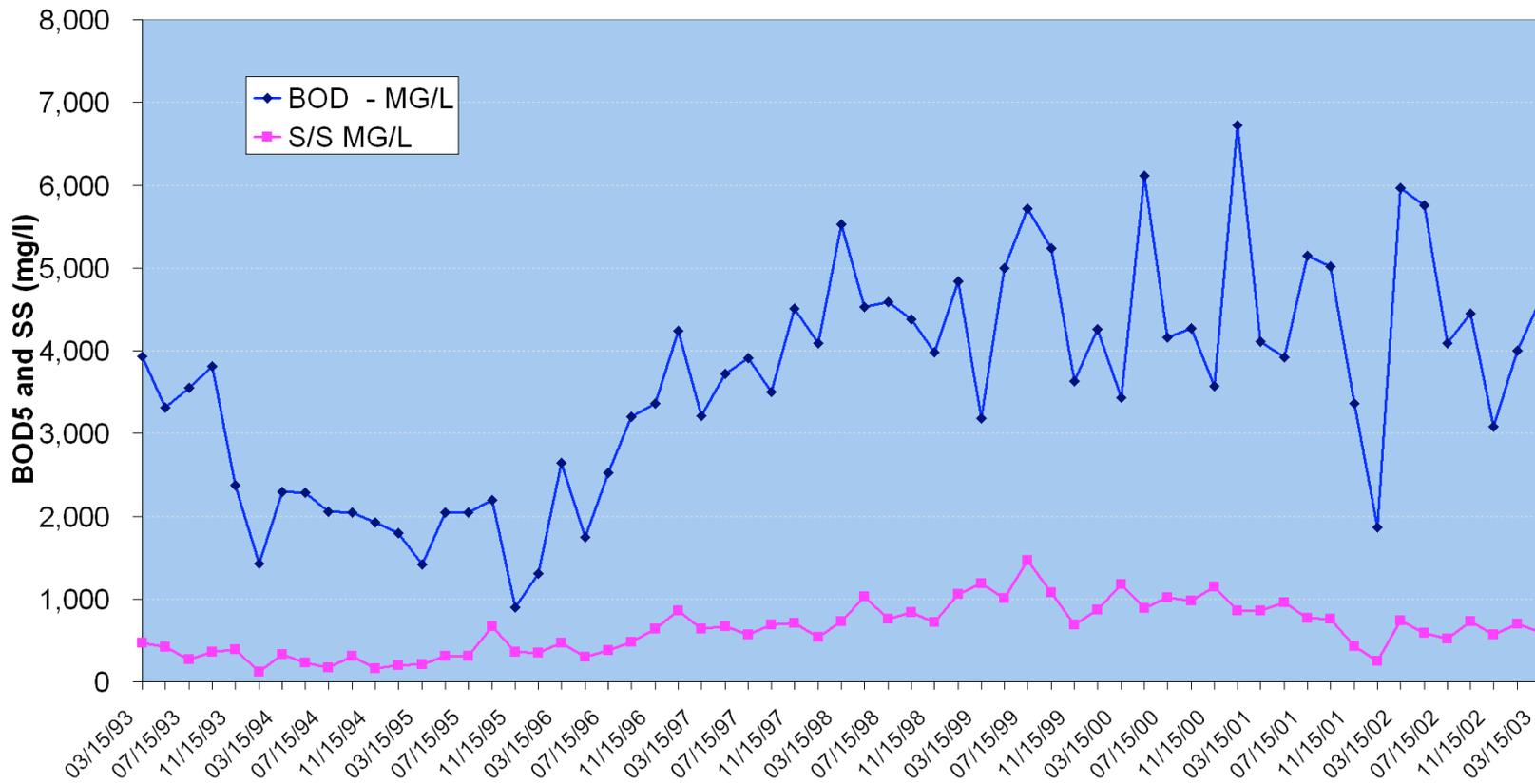
Valley Fig Growers Biogas Project

Fig Washing Process

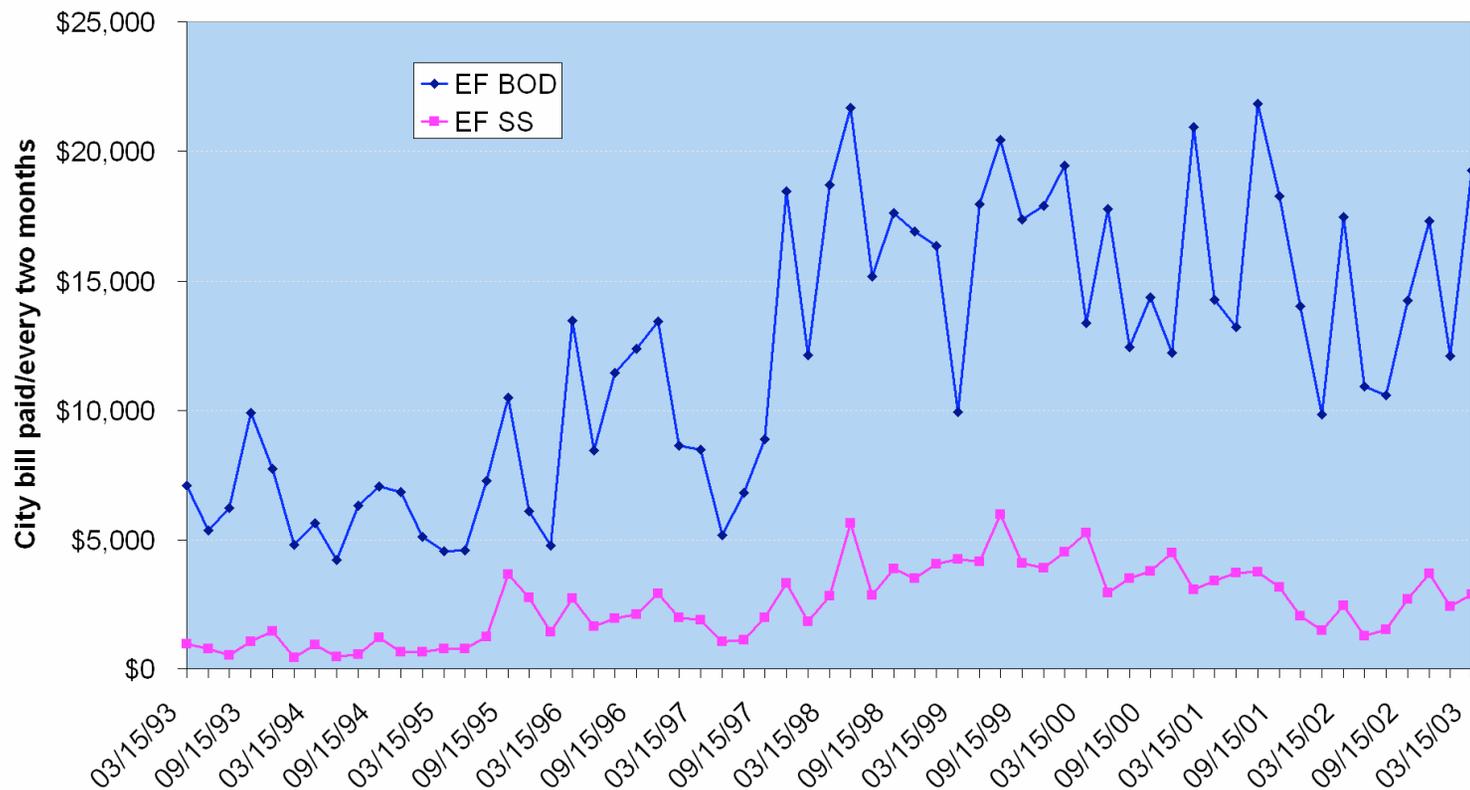


- An average of 45,000 gallons of fresh water is used each day for fig washing process
- Wastewater generated have BOD₅ concentrations ranged from 1000 – 6500 mg/l and SS concentrations ranged from
- 100 – 1500 mg/l (1993-2003)
- Valley Fig is currently paying over \$100,000 each year to discharge the wastewater to the city sewer

Valley Fig Growers Biogas Project BOD5 and SS from



Valley Fig Growers Biogas Project City Bill Paid in Every Two Months



Valley Fig Growers Biogas Project Biogas Energy Anaerobic Digester



- The California Energy Commission's PIER Renewables Program awarded the VFG biogas project in 2002
- The total project cost is about \$1.2 million in which \$476,000 is funded by the CEC
- Install a biogas system including a covered lagoon and Ingersoll Rand 75 kW micro-turbine
- Reduce city sewer fees
- Capture and use biogas
- Generate electricity
- Capture and use waste heat

Commerce Energy Co-Digestion of Dairy manure and Food Processing Wastes



Manure or Food Waste Hauling Truck

Food Waste Storage Tanks

Dairy Manure/Food Waste Digester (#4)



Biological Gas cleaning

Inland Empire Utility Agency European Designed Completed Mix Anaerobic Co-digestion system

Goal: To design, build, and operate a centralized, cost effective, European designed completed mix anaerobic co-digestion system at IEUA RP5 to produce 1.5 MW biogas electricity to be used on site

Digester Information

- ❖ Number of Digesters: 2
- ❖ Digester Diameter: 62 ft. (18.8 m)
- ❖ Digester Height: 55.5 ft. (16.9 m)
- ❖ Volume of each tank: 1,100,468 gallons
- ❖ Detention time: 25 days
- ❖ Top Mounted Agitator: One per tank



Inland Empire Utility Agency European Designed Completed Mix Anaerobic Co-digestion System

Expected Results

- ❖ Use the results collected under co-digestion of food processing waste with dairy manure (Commerce Energy PIER program)
- ❖ Process 300 tons/day of dairy manure and 90 tons/day of food processing waste to produce biogas power 1500 kW to be used on site
- ❖ Compare the technical and economical results of the European designed digester with the existing plug flow digester at Regional Plant 5 of IEUA
- ❖ Complete the project by February 2007

Conclusions

Resources: Tremendous resources available

Technologies: Unlimited options

Need:

- ❖ Existing Technologies
 - ✓ Straightforward policies acknowledging the true motivations for renewable energy and fuels
- ❖ New Technologies
 - ✓ Validated data on fundamental research results at different scales
 - ✓ Dedicated people to work on
 - ✓ Long term study
 - ✓ Shift from waste management to resource management philosophies