



“LESSONS LEARNED” ON CALIFORNIA DAIRY DIGESTERS

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California Energy Commission

Public Interest Energy Research (PIER) Program

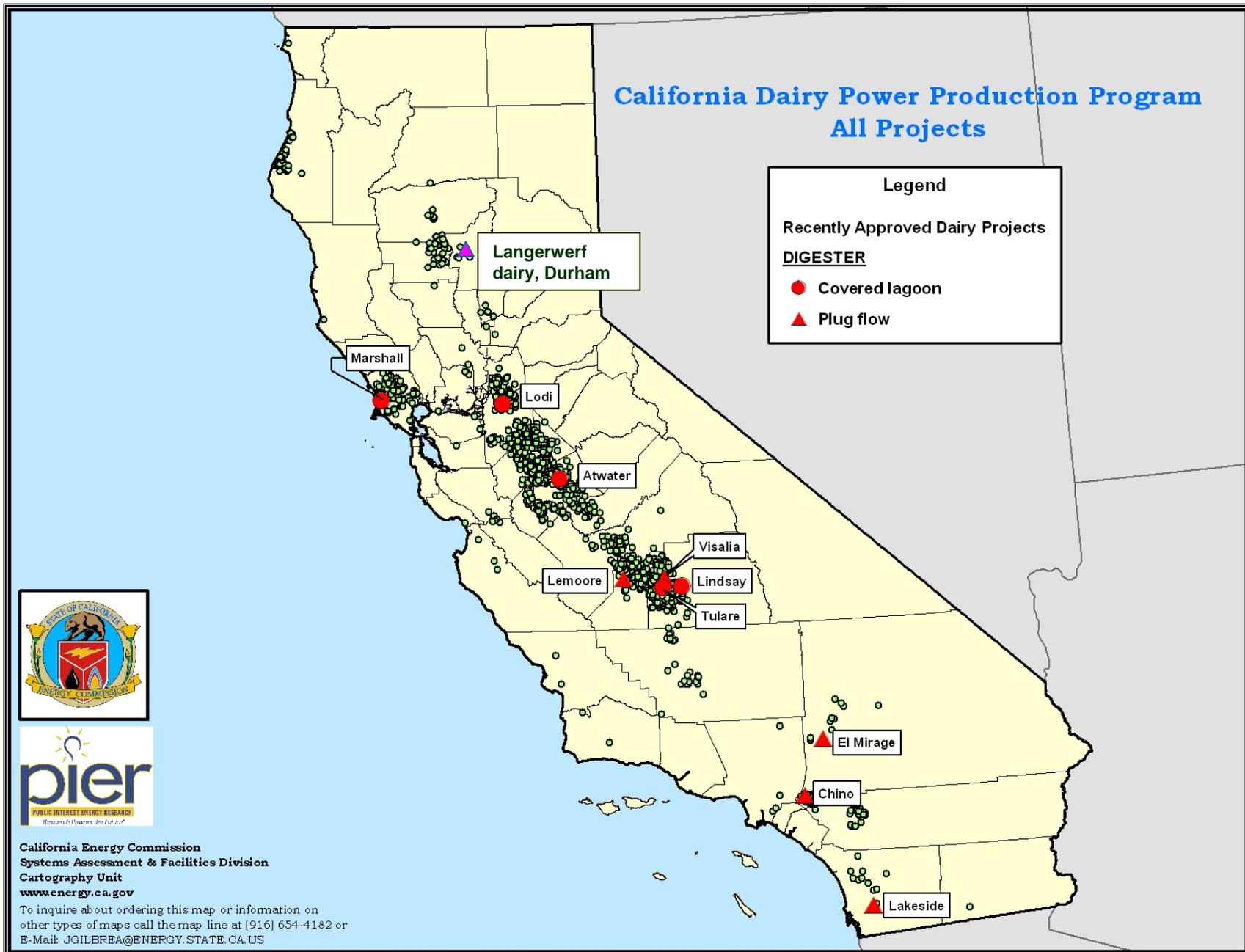
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Outline

- Background
- Dairy digester biogas and electricity production
- Digester cost and economic analysis
- Implementation issues encountered
 - Net metering and interconnection
 - Technical
 - Regulatory
 - Policy
 - Financing
- Conclusions

Total Dairies and Operational Dairy Digesters



Dairy Power Production Program Goals

- Energy Goal:
 - Peaking load reduction
- Technical Goal:
 - Evaluate integrated dairy biogas power systems
- Economic Goal:
 - Provide net economic gain for the dairies
- Environmental goal
 - Reduce GHG emission

Program Frame

- Selected Western United Resource Development (WURD) Inc. as a contractor
- Advisory Committee
 - ✓ California Energy Commission
 - ✓ Western United Resource Development (WURD)
 - ✓ US Environmental Protection Agency (EPA)
 - ✓ California Department of Food and Agriculture (CDFA)
 - ✓ California State Water Resources Control Board (SWRCB)
 - ✓ University of California, Davis (UC Davis)
 - ✓ Sustainable Conservation

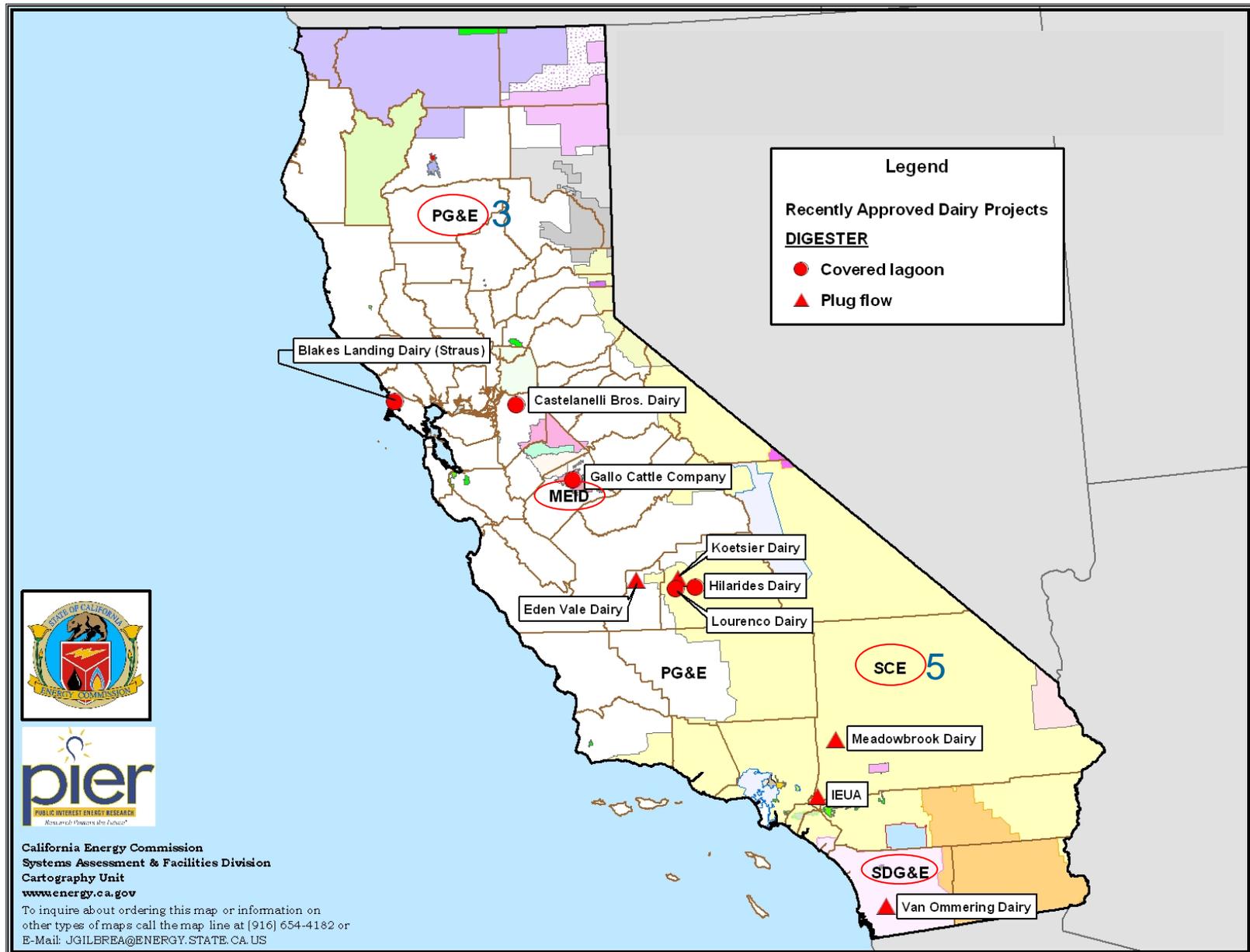
Program Funding

- \$10 million - SB 5x in 2001
 - \$5.8 million awarded to 14 projects in 2002
 - ✓ 10 completed (8 buydown, 2 incentive)
 - ✓ 4 decided to withdraw and 9 new projects awarded in 2006
 - \$1 million - allocated to WURD for administration
 - \$2.8 million – returned to the state in 2003
- Funding pathways
 - Buydown: up to \$2000/kW
 - Incentive: 5.7 cents/kWh for up to five years

SB5x Grant Awarded

Dairy Name	kW Capacity Rated	Total DPPP Grant Awarded	Awarded DPPP Grant at \$/kW
Blakes Landing	75	\$67,900	\$905 ▲
Castelanelli Bros	160	\$320,000	\$2,000
Cottonwood	300	\$600,000	\$2,000
Hilarides	500	\$500,000	\$1,000
Lourenco	150	\$114,779	\$765 ▲
Eden-Vale	180	\$300,000	\$1,667
Koetsier	260	\$190,925	\$734 ▲
Meadowbrook	160	\$262,449	\$1,640
Van Ommering	130	\$244,642	\$1,882
IEUA	563	\$773,175	\$1,373 ▲
Total	2478	\$3,373,870	

10 Digester Locations by Utility Service Areas



10 Digesters Installed under DPPP

Dairy Name	Digester Type	# of Milking Cows
Blakes Landing	Covered Lagoon	245
Castelanelli Bros	Covered Lagoon	1601
Cottonwood	Covered Lagoon	4971
Hilarides	Covered Lagoon	6000
Lourenco	Covered Lagoon	1390
Eden-Vale	Plug Flow	800
Koetsier	Plug Flow	1266
Meadowbrook	Plug Flow	2093
Van Ommering	Plug Flow	480
Inland Empire Utility Agency	Plug Flow	7931



10 Installed Engine Generators under DPPP

Dairy Name	Engine Generator Type	KW Capacity Rated
Blakes Landing	Waukesha	75
Castelanelli Bros	Caterpillar	160
Cottonwood	Caterpillar	300
Hilarides	Caterpillar	500
Lourenco	Caterpillar	150
Eden-Vale	Caterpillar	180
Koetsier	Caterpillar	270
Meadowbrook	Caterpillar	160
Van Ommering	Waukesha	130
Inland Empire Utility Agency	Waukesha	563 Increase



5 Covered Lagoons Installed



TS: less than 2%

Unheated

Surface area: from 0.2 to 7.5 acres

Depth: 12 to 28 ft

Cover material: high-density polyethylene (HDPE)

5 Plug Flow Digesters Installed



TS: 8-12%

Digester temperature: 35°C

Surface area: 0.1- 0.3 acre

Depth: 6 – 12 ft

Engine Generator, Biogas Cleaning, Interconnection, and Flare



Biogas Power Generation (90 day Performance)

Dairy Name	Actual output (kW)	Capacity Factor	Electrical Efficiency	Digester	Developer
Blakes Landing	63	0.84	25%	C. lagoon	Williams
Castelanelli	155	0.97	19%	C. lagoon	RCM
Cottonwood	293	0.98	28%	C. lagoon	Williams
Hilarides	421	0.84	26%	C. lagoon	Roy Sharp
Eden-Vale	70	0.39	19%	Plug flow	RCM
Koetsier	77	0.29	23%	Plug flow	RCM
Meadowbrook	131	0.82	22%	Plug flow	RCM
Van Ommering	71	0.54	20%	Plug flow	RCM

Biogas and Electricity Production (90 day Performance)

Dairy Name	Daily Biogas Production (Mcf)	Methane Content (%)	Electricity Production (kWh/day)	Availability
Blakes Landing	15	65%	692	0.38
Castelanelli	89	63%	3,104	0.81
Cottonwood	113	63%	5,850	0.81
Hilarides	233	52%	9,268	0.77
Eden-Vale	40	55%	1,253	0.29
Koetsier	44	56%	1,687	0.27
Meadowbrook	81	59%	3,015	0.79
Van Ommering	34	68%	1,341	0.43

Total and O&M Costs

Dairy	Rated Power (kW)	Capital Cost (\$/kW rated)	O&M cost (cents/ actual kWh)	Digester	Developer
Blakes Landing	75	4462	3.9	C. lagoon	Williams
Castelanelli	160	5513	0.6	C. lagoon	RCM
Cottonwood	300	8327	2.9	C. lagoon	Williams
Hilarides	500	2480	0.4	C. lagoon	Roy Sharp
Eden-Vale	180	4460	5.6	Plug flow	RCM
Koetsier	260	5235	4.4	Plug flow	RCM
Meadowbrook	160	4504	0.6	Plug flow	RCM
Van Ommering	130	6437	3.7	Plug flow	RCM
Average		5177	2.8		

- Ave. cost of covered lagoons installed: \$5196/kW rated
- Ave. cost of plug flow digesters installed: \$5159/kW rated

Economic Analysis

Performed by Competitive Energy Insight (CEI) Inc.

Case 1	100% of Power Net Metered		
Case 2	50% of Power Used on Site / 50% Net Metered		
Case 3	100% of Power Used on-Site		
Case 4	Case 3 + 50% of Engine Heat Used for Chilling		
Case 5	Case 3 + 50% of Engine Heat Used for Site Thermal Uses		
Case 6	Case 3 + 100% of Engine Heat Used for Site Thermal Uses		
Case 7	Case 6 + Sell Digester Waste for \$3.00 / Ton		

Economic Analysis

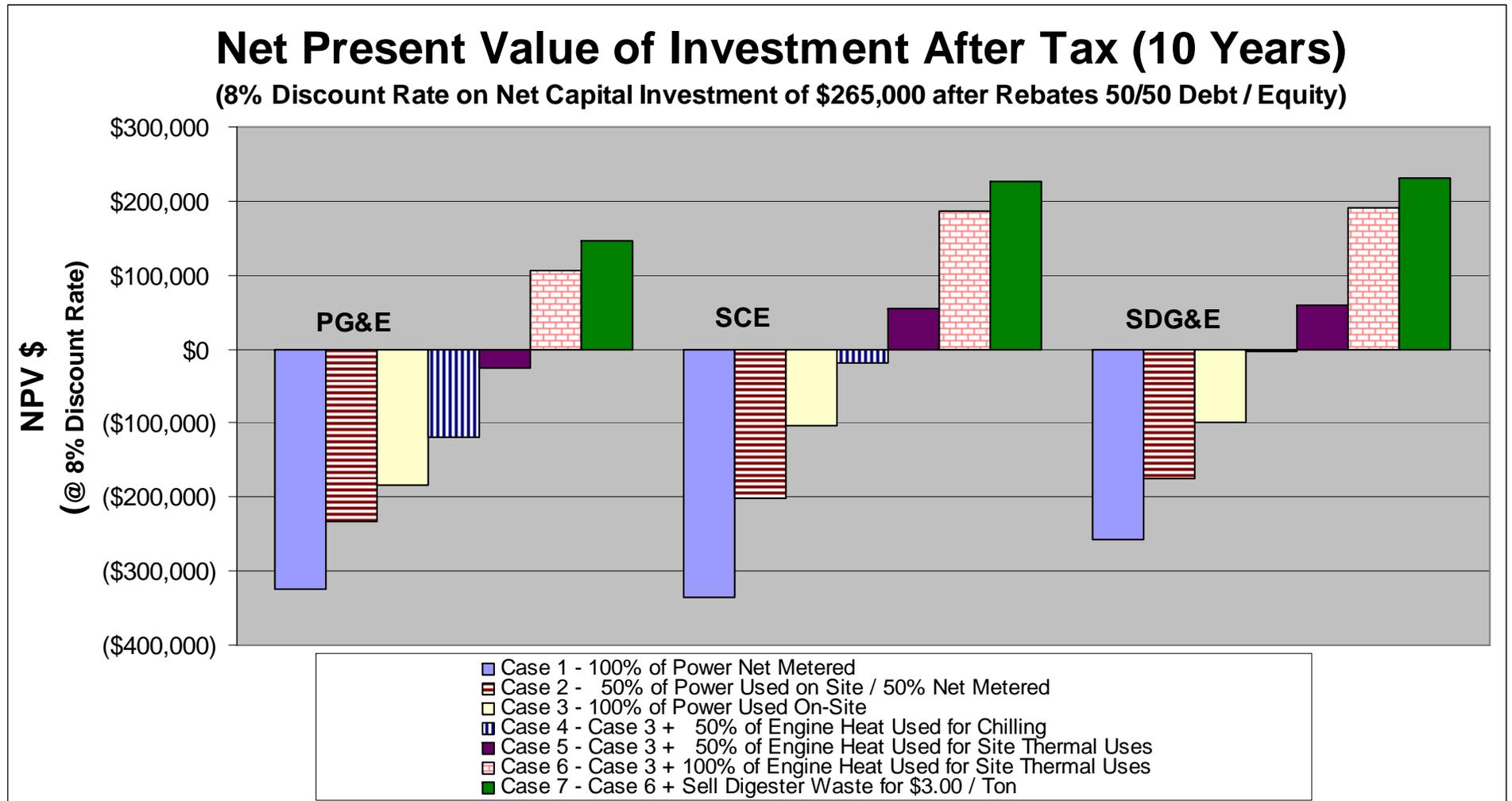
Net Metering Rates (effective on 1/1/06)

NEM Bio Net Metering Rate, ¢/kwh¹	PG&E	SCE	SDG&E
Off-Peak	2.2 – 2.3 ¢	3.1 ¢	6.5 ¢
Mid-Peak	3.1 – 3.2 ¢	6.9 – 8.4 ¢	6.5 ¢
On-Peak	3.6 ¢	11.6 ¢	8.9 ¢

- 1. Ranges shown indicate Winter - Summer Periods.

Economic Analysis - NPV

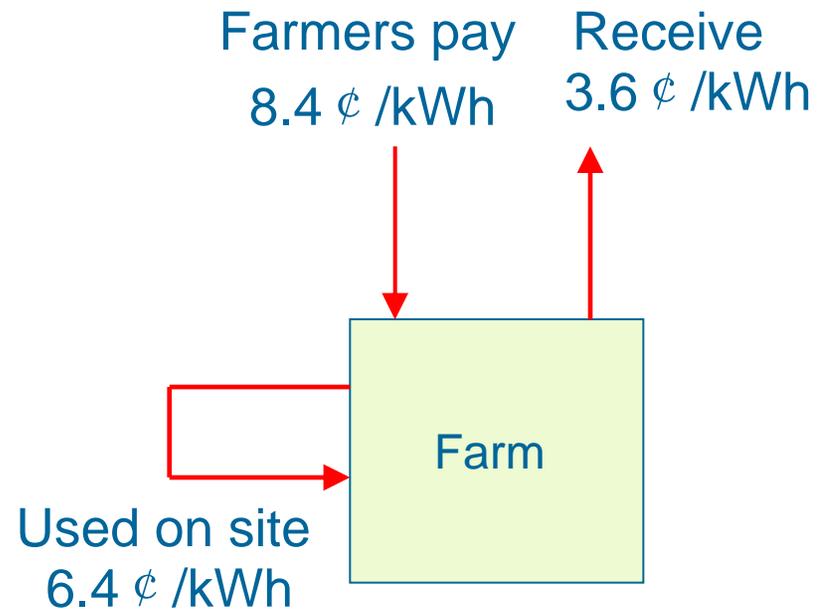
Net Energy Meter Biogas Digester Generators



Cost is assumed at: $\$265000/150\text{kW} = \$1,767/\text{kW}$ rated

Net Metering and Interconnection Issues

- The price farmers pay for the power they purchase
- The price farmers receive for the power they produce
- The price farmers receive for the power they produce and used on site
- The length of the rate contract
- The cost of utility interconnect



On Peak Rates under PG&E

Cost of Utility Interconnect

Dairy Name	Cost of Utility Interconnect	Cost of Utility Interconnect at \$/kW rated	Utility
Blakes Landing	\$15,335	204	PG&E
Castelanelli	\$54,391	340	PG&E
Cottonwood	\$71,436	238	MEID
Hilarides	\$21,341	43	SCE
Lourenco	\$22,138	148	SCE
Eden-Vale	\$52,270	290	PG&E
Koetsier	\$6,413	25	SCE
Meadowbrook	\$11,253	70	SCE
Van Ommering	\$37,435	288	SDG&E
IEUA	\$2,493	4	SCE

Average Cost of Utility Interconnect

SCE	PG&E	SDG&E	MEID
\$12,728	\$40,665	\$37,435	\$71,436

Technical Issues

- Optimization
 - OLRs (organic loading rates)
 - Digestion environment
 - Biogas and power production
 - Digester gas cleaning process
- Technology advancement
 - Only covered lagoon and plug flow digesters are applied
 - High rate UASB (Upflow Anaerobic Sludge Blanket) reactor may be considered to replace the covered lagoons
 - Heat pumps may be considered to enhance overall energy efficiency

Regulatory Issues

- Air permits
 - Air pollutant reductions have not been recognized and engine emissions have not been fully quantified
- Water permits
 - Environment impact statement
 - Land application
 - Reduction on BOD (Biological oxygen demand), SS (suspended solids), and pathogen have not been recognized and fully quantified

Policy Issues

Policies

- SB5X, AB29X, and AB970 (peak load reduction)
- SB1078 (RPS goal: 20% by 2010)
- AB 2778 (SGIP)
- AB32, AB1925, SB1368, SB700 (GHG reduction)

Implementation

- Net metering and interconnection
- Federal production tax credits (PTC)
- GHG reduction

Financing Issues

- None of the farmers applied bank loan for the digesters installed under DPPP
- Most digesters installed under DPPP show poor return on investment
- Future financing may become a challenge without sufficient grants and incentives

Dairy Owners ('Masters of Methane Digesters') Feedback

Dairy	Digester	Developer	Ease in operation	Manure manage.	Odor control	Address electricity issues
Blakes Landing	C. lagoon	Williams	2.8	3.7	4.0	3.2
Castelanelli	C. lagoon	RCM	3.6	2.9	3.9	1.8
Cottonwood	C. lagoon	Williams	2.0	2.0	2.0	4.0
Hilarides	C. lagoon	Roy Sharp	4.0	4.0	na	4.0
Eden-Vale	Plug flow	RCM	2.8	3.5	2.5	1.0
Koetsier	Plug flow	RCM	2.0	3.0	3.0	1.0
Meadowbrook	Plug flow	RCM	2.9	3.8	3.2	3.3
Van Ommering	Plug flow	RCM	1.9	3.0	4.0	3.0
All Dairies			2.8	3.2	3.2	2.7

Ranked 1-4, with 1=poor and 4=excellent; na = no answer

Conclusions

- Net metering and utility interconnect have great impacts on existing digesters and future development
- Most digesters installed have not proven to be cost effective
- Grant and incentives are necessary
- There are needs to
 - enhance digester overall efficiency and technology advancement
 - further understand economic, technical, and environmental performance

Reports Published at the Energy Commission's Website

- Ten Dairy Power Production Program 90-day Evaluation reports (Western United Resource Development)
- Anaerobic Digester Implementation Issues (Resource Strategies Inc.)
- Evaluation of Policy Impacts On the Economic Viability of California-Based Combined Heat and Power From a Project Owner's Perspective (Competitive Energy Insight Inc.)
- Dairy Methane Digester System Program Evaluation report (WURD, available soon)
- Resource Potential and Barriers Facing the Development of Anaerobic Digestion of Animal Waste in California (Mark A. Moser, 1997)

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