Arnold Schwarzenegger
Governor

DAIRY POWER PRODUCTION PROGRAM:

DAIRY METHANE DIGESTER SYSTEM 90-DAY EVALUATION REPORT - Cottonwood Dairy (Joseph Gallo Farms)

PIER REPORT

Prepared For:
California Energy Commission
Public Interest Energy Research Program

Prepared By:

WESTERN UNITED RESOURCE DEVELOPMENT, INC.

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Prepared By:
Western United Resource Development, Inc.
Michael L. H. Marsh, *Chief Executive Officer*
Tiffany LaMendola, *Director of Economic Analysis*
Modesto, California
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Prepared For:
California Energy Commission
Public Interest Energy Research (PIER) Program

Zhiqin Zhang
Contract Manager

George Simons
Program Area Team Lead

Martha Krebs
Deputy Director
ENERGY RESEARCH AND DEVELOPMENT DIVISION

Scott Matthews
Acting Executive Director

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I. Program Background

The purpose of the Dairy Power Production Program (DPPP) is to encourage the development of biologically based anaerobic digestion and gasification ("biogas") electricity generation projects on California dairies. Objectives of the program include developing commercially proven biogas electricity systems that can help California dairies offset the purchase of electricity, and providing environmental benefits by potentially reducing air and ground water pollutants associated with storage and treatment of livestock wastes.

The California Energy Commission (CEC), acting under authority of the Legislative enactment in 2001 of SB5X (Section 5(b)(5)(C)(i)), appropriated and encumbered funding for the Dairy Power Production Program (DPPP). Western United Resource Development, Inc. (WURD) was selected by the Energy Commission as the Contractor for this program.

To date, a total of 14 projects have been approved for grants totaling $5,792,370. The projects have an estimated generating capacity of 3.5 megawatts.

Two types of assistance were made available for the grant program: Buydown grants, which cover a percentage of the capital costs of the proposed biogas system, and incentive payment grants for generated electricity. Buydown grants cover up to 50% of the capital costs of the system based on estimated energy production, not to exceed $2,000 per installed kilowatt, whichever is less. Electricity generation incentive payments are based on 5.7 cents per kilowatt-hour of electricity generated by the dairy biogas system, paid out over five years, which totals the same amount of a buydown grant.

The grant program is overseen by an advisory group comprised of representatives from the California dairy industry; California Department of Food and Agriculture; California Energy Commission; California State Water Resources Control Board; Sustainable Conservation; University of California; and U.S. Environmental Protection Agency AgSTAR Program.

II. Dairy Profile

The dairy owner applied for a buydown grant from the Dairy Power Production Program (DPPP) with the purpose of designing and installing a new covered lagoon digester.

During the 90-day startup period September-November 2004, there were an average of 5,906 cows on the dairy, of which an average of 5,351 were lactating cows, 529 were dry cows and 78 were bulls. The cows are housed in freestall barns and drylots.

A cheese plant is also located on the premises that is owned and operated by the dairy owner. Approximately 900,000 pounds of milk per day is processed at the facility. The biogas produced by the covered lagoon digester is used to fuel an engine-generator to produce electricity for the cheese plant. The estimated 300 kilowatts of electricity generated supplies about 25 percent of the cheese plant's power needs.

III. Costs/Funding

The dairy owner was awarded a buydown grant for the amount of $600,000 to install a new covered lagoon digester system. It was estimated that the total project costs for the system would be $1,289,520, of which the dairy owner was eligible for up to 50 percent, not to exceed $2,000 per installed kilowatt. Though the dairy owner applied for a capacity of 500 kW, the advisory group approved the project for a capacity of 300 kW, making the dairy owner eligible for a maximum of $600,000, slightly less than fifty percent of the total estimated costs for the project. The grant has been paid in full.

The dairy owner also applied for funding from Pacific Gas and Electric Company's (PG&E) Self-Generation Incentive Program for the amount of $240,000. This grant has not yet been received.

As of the project startup date of September 2004, the dairy owner had spent approximately $2,700,000 on project completion, or $1,410,480 over the projected cost of the project. Costs exceeded projections in most areas of the project, particularly in the manure collection and separation systems, the gas treatment and handling system, and the electrical interconnection.

The dairy handles operation of the system. Operating costs are approximately $5,000 per month. Costs include oil changes, inspections and routine maintenance. The pump motors and electrical equipment are checked weekly. Every 500 hours, the engine-generator receives an oil change; every 1,000 hours a tune-up; every 8,000 hours a minor overhaul; and every 16,000 hours a major overhaul.

IV. Timeline

The original application was submitted to Western United Resource Development, Inc. on December 14, 2001. After thorough screening and due diligence review of the application, the advisory group approved the project for funding in May 2002. It was originally expected that the project would be operational by October 1, 2002. However, due to a number of outside obstacles (as explained below), the system was not officially operational until September 1, 2004.

A "grand-opening" event was held at the dairy on October 21, 2004 to celebrate the startup of the system's ability to generate electricity. The event drew over 150 individuals from air quality regulators and energy officials to dairy industry leaders. Representatives from the California Energy Commission; the U.S. Environmental Protection Agency; California Regional Water Quality Control Board; Sustainable Conservation; local, county, state and federal elected

officials; local dairymen; and the grant administrator Western United Resource Development were on hand for the ceremony held by the dairy owner.

V. Outside Obstacles

Low milk prices have had a significant impact on participants in the program. Beginning in late 2001, low milk prices began to put a strain on a dairy farmer's ability to obtain funds to invest in methane digester projects. Prices received by dairy farmers were at the lowest levels witnessed in over 25 years. Though dairy markets are typically cyclical in nature, producers experienced more than 20 months of extremely low prices. These low prices were, in most months, below a dairy producer's cost of producing milk.

A lengthy permitting process also caused delays in starting and completing the project. The major permits required were from the Merced County Department of Environmental Health for lagoon construction and from the San Joaquin Valley Air Pollution Control District for the generator engine.

The interconnection process was also quite lengthy and expensive, causing additional delays and cost overruns. Although this project will not take advantage of net metering, as all the power produced by the biogas system will be used on site to provide power to the cheese plant, the system is interconnected and synchronized with the PG&E power provided to the cheese plant.

VI. Animal Distribution

On average, from September through November 2004, there were 5,906 animals on the dairy, of which 5,880 were lactating or dry milk cows; the remaining animals were bulls. The lactating cows are housed primarily in freestall barns and feed aprons where they spend approximately 15 hours each day. They spend approximately 6 hours per day in drylots and the other 3 hours in the milking parlor. The dry cows spend approximately the same time in the freestall barns and feed aprons; but spend 9 hours in drylots.

VII. Manure Collection & Processing

The milking parlor/sprinkler pen, freestall barns and feed aprons are all flushed daily with either fresh water or recycled cheese plant wastewater. On average, a total of approximately 1,300,000 gallons of water is used per day, including 600,000 gallons of cheese plant wastewater. Approximately 60% of the manure generated on the dairy is collected and sent to the digester. Nutrients in the cheese plant wastewater increase biogas production by an estimated 40%.

VIII. Biogas Utilization System

A system of concrete trenches collects the waste. Flushed manure slurry is conveyed to a receiving pit. It is then passed through a 50-foot high inclined screen or "separator" to separate manure solids. The separated, dry solids are used for animal bedding or are composted for land

application as fertilizer. Dilute, screened manure is piped to a 1200' x 250' x 24' deep covered lagoon digester with an approximate capacity of 44,225,000 gallons. The unmixed, unheated digester receives approximately 1,300,000 gallons per day and has an estimated hydraulic retention time of 34 days. A high-density polyethylene material covers the lagoon, and natural microbial action converts the nutrients in the manure into methane.

Slurry filled pipes are used to hold the cover down and channel the gas to collection pipes located under the cover. Rainwater is channeled on top of the cover and is pumped to an overflow lagoon. The overflow lagoon measures 540' x 1200' x 24' with a capacity of approximately 94,464,000 gallons.

The captured biogas is channeled to a pipeline where it is piped approximately 4,750 feet or 9/10 of a mile to the engine-generator. In the grant application, it was estimated that the system would produce 240,000 cubic feet per day of biogas with a methane content of 60%. Produced biogas is used to power a 300-kW-capacity Gen-Tec Model MCTG-420 generator powered by a Caterpillar Model G3412TA engine. Digested manure water flows to a secondary storage lagoon from which it is pumped into the ranch irrigation system for application to crops.

IX. Biogas and Energy Production

In the initial design specifications, it was estimated that the digester would produce 240,000 cubic feet of biogas per day from 5,081 lactating cows. In the original grant application, the dairy owner estimated an electricity production of 3,386,149 kWh/year, or 9,277 kWh/day, with an engine capacity of 500 kW. Given an estimated average of 9,277 kWh/day, the engine was assumed to operate approximately 18.55 hours per day. However, because grant funding was provided for a capacity of 300 kW, an estimated power production of 5,565 kWh/day is assumed.

Although biogas was produced as early as May 2004, the system was officially operational as of September 1, 2004 and has been producing electricity from biogas on a continuous basis since that date. Initially, all biogas produced was flared until the generator was installed and fully operational and the utility electrical interconnection was completed. To date, metered biogas is being used to fuel the 300 kW generator. However, it is estimated that about 55% of the total biogas currently produced is being flared. Because the digester is producing more biogas than needed to fuel the current generator, the installation of a second generator is planned, which will boost output to 700 kilowatts and thereby use all available biogas production.

Chart 1 compares metered biogas production (not including amount flared) to electricity production for the 90-day startup period. The biogas output of the digester decreased slightly from an average of about 115,770 cubic feet/day in September to about 114,390 cubic feet/day in October. A similar decline occurred in November, with biogas output falling to an average of 96,527 cubic feet/day. It is expected that performance will improve in following months, as the system is fine-tuned for efficiency over time.

Electricity production increased from an average of 6,485 kWh/day in September to 6,521 kWh/day in October. Electricity production declined slightly to an average of 5,356 kWh/day in November. Electricity production per operational hour of the system stayed fairly constant, decreasing slightly from 299.2 kW per hour in September to 298.9 kW per hour in October, but then fell to 272.3 kW per hour in November. The system was operational an average of 22 hours/day in September, 22 hours/day in October and 19 hours/day in November. This is an improvement over the estimated 18.55 hours per day assumed in the application. All electricity produced by the system is used to meet the electrical needs of the on-site cheese plant.

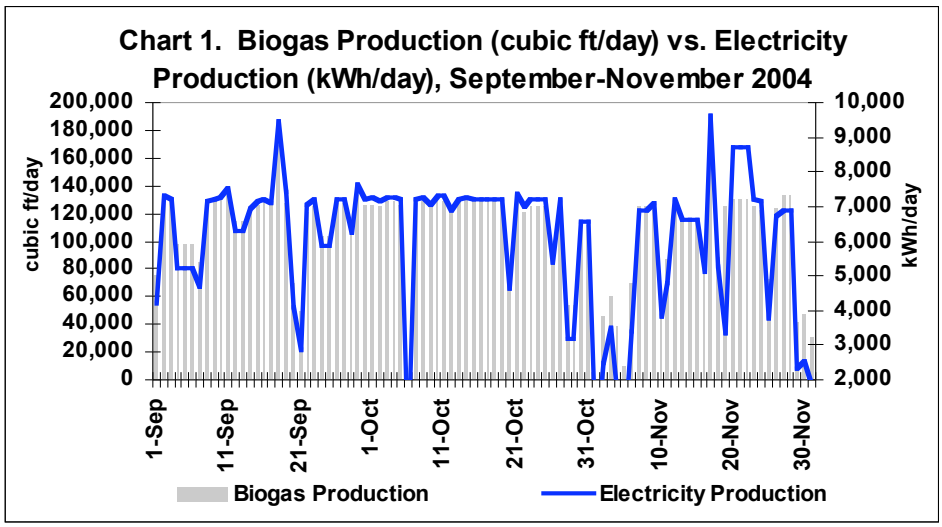
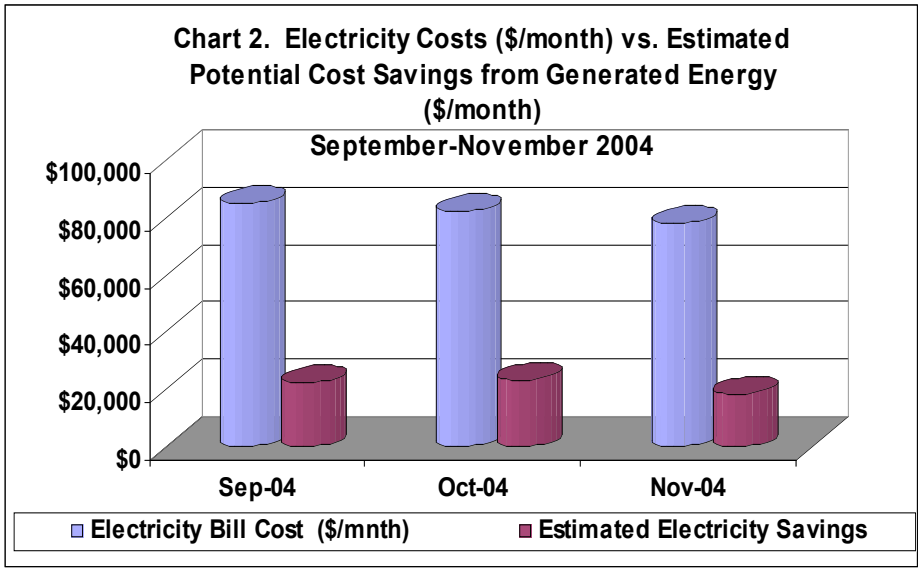


Chart 2 compares monthly electricity costs of the cheese plant to the estimated cost savings from generated electricity for the 90-day period. On average, September-November 2004, the cost of electricity (total retail rate) was approximately $0.1152 per kW for the cheese plant.

For the 90-day startup period, September through November 2004, an estimated cost savings of approximately $64,202 was experienced.[1] Assuming an average monthly electricity cost savings of $21,401, the estimated payback period for this project is approximately 7.2 years from electricity generation alone.[2] The planned addition of another generator will further reduce the estimated payback period.



[1] This uses an average total rate of $0.1152 per kWh multiplied by the energy production for the September-November 2004 period.

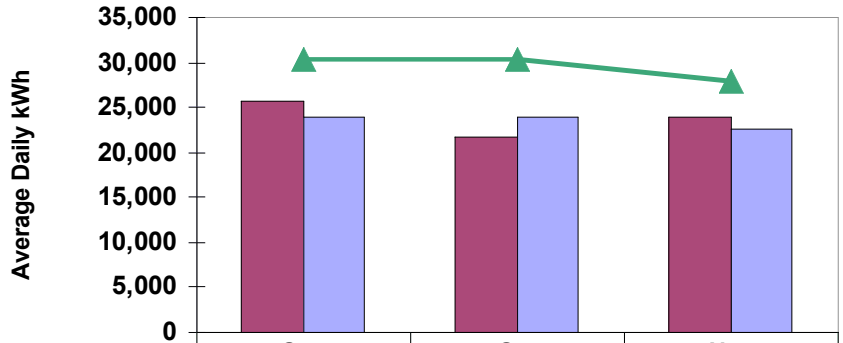
[2] Assumes $1,860,000 in "out-of-pocket" net project costs to the dairy owner. This takes into account the $600,000 grant received from WURD and $240,000 grant applied for from PG&E. This does not take into consideration offsets in propane costs. Using a total cost of $2,700,000, the estimated payback period is increased to 10.5 years.

X. Energy Usage

On average, September through November 2003, the cheese plant used 735,200 kWh/month, or 23,760 kWh/day, of electricity. This compares to metered electrical usage of an average of 709,200 kWh/month, or 23,403 kWh/day, for the 90-day startup period of September through November 2004. The reduction in electricity purchased from the utility (26,000 kWh/month, or 357 kWh/day) is explained by the usage of the power produced onsite. Electrical production averaged 185,798 kWh/month, or 6,121 kWh/day, for the period September through November 2004. However, this production was partially offset by increased usage due to increased cheese production at the cheese plant. Cheese production was up an estimated 20-25% for the 2004 period over the same period in 2003. Chart 3 compares average daily electricity usage for the September through November period in 2003 to the same period in 2004. The total daily usage for the 2004 period can be determined by adding the daily power usage (as metered by the utility) to the daily power produced (as metered by the dairy owner) in each month.

In November 2004, electricity usage was primarily in off-peak hours, with 59% of the usage falling in this category. About 31% of the electricity usage on the dairy fell within the partial-peak category, with the remaining 10% in peak usage.

Chart 3. Electricity Usage Comparison, 2003 to 2004



	Sep	Oct	Nov
Average Daily 2003 Usage	25,720	21,675	23,884
Average Daily 2004 Usage	23,817	23,817	22,575
Average Daily 2004 Usage and Production	30,302	30,338	27,931

XI. System Performance

The performance of the system thus far has been in line with expectations. Table 1 compares the system design performance calculations with the actual performance for the 90-day period September 2004 through November 2004. Given that these are considered startup months and the data covers a very short period of time, these should be considered preliminary results.

In the initial design specifications, it was estimated that the digester would produce 240,000 cubic feet/day of biogas from 5,081 lactating cows, or 47.2 cubic feet/day of biogas per lactating cow. The daily biogas production was estimated to result in electricity generation of 1.10 kWh per cow per day (based on a 300 kW engine capacity). For the 90-day period studied, the design calculations were fairly well matched, with an average biogas production of 241,990 cubic feet/day, or 45 cubic feet/day per cow for 5,351 lactating cows (includes the amount flared, estimated at an additional 55% of total biogas production). Metered biogas production

resulted in an average electricity production of 1.14 kWh per cow per day. Chart 4 compares the average cubic feet of total and metered biogas production per day and per cow for September, October and November 2004.

The average electricity production was 6,121 kWh per day compared to the estimated 5,565 kWh per day (assuming a 300kW engine capacity). Electrical production is expected to increase significantly (more than double) with the addition of a second generator.

Table 1: Digester Design and Actual Performance

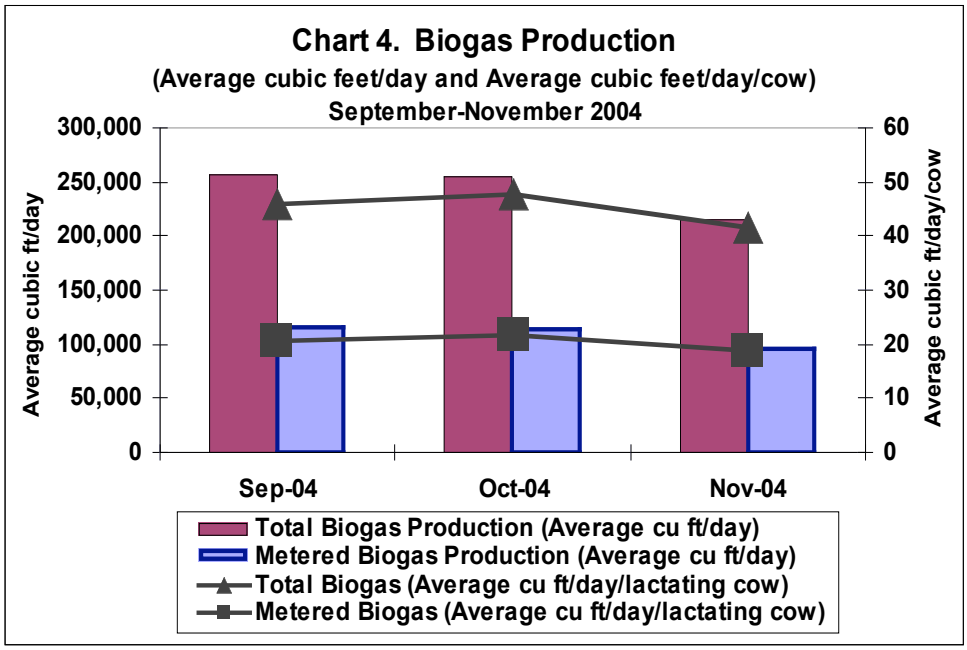
	Design	**Actual September – November 2004 Average**
Cows (lactating)	5,081	5,351
Manure Slurry		
Total gallons per day	483,000	1,300,000
Digester Specifications		
Type	Covered Lagoon	Covered Lagoon
Digester Feeding Mode	Intermittent 2X per day	Continuous
Retention Time (days)	57	34
Gas Production		
Total Biogas (cubic feet per day)	240,000	108,896 metered; approximately the same amount is flared for a total of 241,990
Per cow (per day)	47.23	20 metered 45 total (metered and flared)
Electrical Output		
Generator Capacity (kW)	500 in application 300 approved	300 700 planned
Generator Availability (operational hours/day)	18.55	21
Total (kWh/year)	3,386,149 for 500 kW 2,031,225 for 300 kW	2,334,095 for 300 kW
Average per day (kWh)	9,277 for 500 kW 5,565 for 300 kW	6,121 for 300 kW
Total per cow (kWh/day)	1.83 for 500 kW 1.10 for 300 kW	1.14 for 300kW

The most significant problems to date are related to the gas processing and handling systems. The gas purifier (H_2S scrubber) required replacement and relocation to achieve required performance. The gas system was also modified to allow for constant pressure to the generator and to permit constant operation at the maximum load (300kW). Also, an additional electrical relay was installed (PG&E had overlooked the requirement for this relay when the interconnection was approved). Finally, an accumulating gas meter was installed. The dairy owner continues to monitor system performance and to make modifications as necessary.

XII. Heat Utilization

Waste heat is used to preheat water for the cheese plant boiler and to create steam. The steam is used in pasteurizing the milk and whey, and in cleanup and sterilization operations. The dairy owner expects that the recovered heat will reduce propane usage by approximately 149,000 gallons per year, further reducing operating costs.

At the time of application, the dairy owner estimated a savings of approximately $200,000 per year due to the reduction in propane usage. On average, September through November 2004, about 63,921 gallons per month of propane were used at the cheese plant at an average cost of $69,708 per month (with a maximum of $79,888 in November). In total, 191,763 gallons were used during the 90-day period, with a total cost of $209,123. The average cost per gallon was $1.07 during this period, although in October, the cost per gallon increased to $1.12 from $0.96 during September. Costs stayed at $1.12 per gallon in November.



Clearly, any offset in propane usage will result in reduced costs to the dairy. An estimated savings of $200,000 per year would result in a savings of approximately $16,667 per month, or $548 per day. Given the current costs of propane at $1.12, this could be achieved with a 14,881 gallon per month reduction in propane usage. Assuming the dairy owner is able to achieve the goal of propane costs savings equating to $16,667 per month, the estimated payback period for this project would be reduced to 4.1 years.[3] The combined electrical and propane monthly costs savings equates to approximately $38,068 per month, or $1,269 per day.

Actual monthly propane usage increased by 5,891 gallons per month September through November 2004 compared with the same period in 2003, as demand from increased cheese production more than offset savings from heat recaptured off the generator engine. As mentioned previously, it is estimated that cheese production was up 20-25% in 2004 over the same period in 2003. This greatly impacts propane usage, as propane is needed to create steam for pasteurization.

[3] Estimates include $21,401 in monthly electricity savings and $16,667 in monthly propane savings. Assuming $1,860,000 in "out-of-pocket" net project costs to the dairy owner. This takes into account the $600,000 grant received from WURD and the $240,000 grant applied for from PG&E. Using a total cost of $2,700,000, the estimated payback period is increased to 5.9 years.

XIII. Dairy Owner Qualitative Feedback

On a scale from one to four, the dairy owner was asked to rate his experience in a number of areas concerning the digester project. The specific questions, along with their monthly and average rankings, are included in Table 2.

Table 2: Qualitative Questions

Questions Ranked 1-4, with 1=poor and 4=excellent	**September 2004**	**October 2004**	**November 2004**	**Average**
1. **Ease in operating the biogas production and biogas to electricity systems**	2	2	2	2
2. **Extent to which system gives advantage to your dairy manure management**	2	2	2	2
3. **Extent to which the system helps with odor control**	2	2	2	2
4. **Extent to which the system helps with reducing water use for manure management**	2	2	2	2
5. **Extent to which system helps address electricity issues important to your dairy operation**	4	4	4	4
6. **Overall satisfaction with the system so far**	3	3	3	3
7. **Any other comments or recommendations?**				