CALIFORNIA
ENERGY
COMMISSION

DAIRY POWER PRODUCTION PROGRAM

DAIRY METHANE DIGESTER SYSTEM 90-DAY EVALUATION REPORT BLAKES LANDING DAIRY (STRAUS)

PIER REPORT

WESTERN UNITED RESOURCE DEVELOPMENT, INC.

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Governor
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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, which totals the same amount of a buydown grant paid out over five years.

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 refurbishing an existing, non-operational methane digester system. In 2000, the dairy owner converted a lagoon to an anaerobic digester with a floating cover. In order to complete the system, additional financing was needed for the generator, as well as for heat recovery, gas handling, and interconnection equipment. Grant monies from the DPPP were used to complete the system.

In August, there were 570 cows on the dairy, of which 240 were lactating cows. The cows are housed in freestall barns with a flush system and 660 acres of surrounding pasture land. In addition to the working dairy, there is also a small creamery that is owned and operated by the dairy owner. The creamery produces fluid milk, cream, eggnog, yogurt and butter products.

III. Costs/Funding

In 2000, the dairy owner spent approximately $175,000 to convert the lagoon to an anaerobic digester. At the time of application for DPPP funding, total costs to complete the project were estimated at $135,800. The dairy owner was awarded a buydown grant for the amount of $67,900 to refurbish the digester system. To date, the grant has been paid in full. As of the project startup date of June 2004, the dairy owner had spent approximately $142,257 on project completion. Since June, some unexpected additional expenses have been encountered, including approximately $7,605 for a heating system and an additional $10,000 to $11,500 for expanding the hot water distribution system (piping, pumps, etc. to carry the hot water to where it was needed on the facility), for a total of approximately $161,362 for project completion. Including the $175,000 spent in 2000 on the lagoon and cover, total project costs amount to approximately $336,362. In addition to the DPPP grant, the project was also funded by a $87,361 grant from U.S. EPA, funded through the California Regional Water Quality Control Board and administered by the Marin County Resource Conservation District.

The dairy owner operates the system himself. Monthly operating costs are approximately $100 per month but have reached as much as $800 per month in August due to modifications to the engines and controls (installation of a battery charger and a kW meter on the generator to replace a non-functional amperage meter).

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 April 2002. It was originally expected that the project would be operational by September 1, 2002. However, due to a number of outside obstacles (as explained below), the system was not officially operational until June 1, 2004.

A “grand-opening” event was held at the dairy on May 13, 2004 to celebrate the startup of the system’s ability to generate electricity. Representatives from the California Energy Commission; Marin County Resource Conservation District; the U.S. Environmental Protection Agency; California Regional Water Quality Control Board; Sustainable Conservation; local, county, state and federal elected officials 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.

Another major roadblock to completion of this project was difficulty in obtaining a Rule 21 interconnection permit from PG&E so that the project could generate power parallel with the main grid. PG&E insisted on a $15,000 study before power could be generated on the dairy.

This project was expected to be the first in the state to take advantage of the 2003 net metering law, AB 2228 (Negrete McLeod), which allows the facility to run its meters in reverse as excess electricity is sent back into the grid. Though advantageous, the process to get the legislation passed, as well as the set-up of the interconnection agreement with the utility company, was cumbersome and time consuming.

The dairy owner began the process of acquiring a Rule 21 interconnection permit in February 2003. The interconnection with PG&E for this project was not officially completed until April 2004, after the generator went through a pre-parallel test supervised by PG&E. On April 27, 2004, a letter was sent to the dairy owner giving him "express written permission" to operate the generator in parallel with PG&E's distribution system. The dairy owner attributes the lengthy process to the fact that this was the first interconnection project for PG&E, noting that "there was a huge learning curve" resulting in delays as PG&E processed the application and worked on applying the new net metering rules.

Final details are still being worked out with the utility company with regard to the set-up of net-metering capabilities and re-organization of the account billing on the dairy. Unfortunately, to date, the dairy owner has not financially benefited from the production of power due to these delays. The dairy owner is hopeful that all necessary details will soon be in place for net-metering to begin. It is expected that upcoming utility bills will reflect the use of generated electricity on the dairy. There is no agreement with the utility company to purchase any excess electricity that may be generated.

The digester is wired such that all power generated by the system feeds out through PG&E meters into the electrical grid, and all power used by the dairy facilities is brought back in from the grid through PG&E meters. Five meters for the dairy and the creamery are expected to be net-metered. At this point, it is unclear whether or not the residential meters for the houses on the dairy will be included in net metering.

VI. Animal Distribution

On average, from June through August 2004, there were about 580 animals on the dairy, of which about 290 were lactating or dry milk cows, and 207 were heifers. The remainder of the animals were calves and bulls. The cows are housed primarily in freestall barns and pasture. The number of cows housed in the freestall barns fluctuates greatly by season. For instance, in mild weather, the cows are housed primarily on pasture and brought in only for milking. This fluctuation in the number of cows housed in the freestall barns, where the manure is collected, greatly impacts the performance of the digester system.

In the winter, all of the milk cows and dry cows are housed indoors, as well as about 30 of the heifers (springers). Additionally, about 125 of the calves, age 8 months and younger, are indoors.

From March through October, 160 milk cows are on pasture for part of the day. From March through June, they are housed indoors for 13 hours a day. From June through October, they are housed for 18 hours a day.

VII. Manure Collection & Processing

On average, the milking parlor is flushed with approximately 2,400 gallons per day of fresh water, and the freestall barns are flushed with approximately 10,000 gallons per day of recycled water. Again, these numbers will fluctuate given the time of the year and the number of cows on pasture versus in the freestall barns.

An inclined screen is used to separate the solids before entering the 9,000 square foot lagoon. A covered lagoon measuring 150 feet in length, 60 feet wide, and 12 feet deep with a total volume of 72,000 cubic feet, is used to handle manure and recycled water.

Approximately 16,000 gallons of manure and flushed water enter the lagoon on a daily basis. In addition to the 16,000 gallons of manure/flushed water from the dairy farm, approximately 8,000 gallons of creamery wastewater are added per day. Solids from the receiving pit are dumped onto an inclined solids separator to remove wet solids. The solids are composted and land-applied as fertilizer.

VIII. Biogas Utilization System

The screened manure is intermittently charged to a covered-lagoon, psychrophilic digester having a hydraulic retention time of 34 days. At the time of the grant application, it was estimated that the system would produce approximately 20,000 cubic feet/day of biogas. The produced biogas, with an estimated 60% methane, is passed through condensate and sediment traps and used to power a 75-kW (100 hp)-capacity Waukesha engine-generator set. With a system capacity of 75 kW, it was originally estimated that 800 to 900 kWh per day would be generated.

Digester effluent is treated in four storage lagoons in series. Part of the lagoon water is recycled for flushing manure.

IX. Biogas and Energy Production

In the initial design specifications, it was estimated that the digester would produce 20,000 cubic feet of biogas per day from 237 lactating cows. In his original grant application, the dairy owner estimated an electricity production of 800-900 kWh/day with a capacity of 75 kW. Given an estimated average of 850 kWh/day, the engine was assumed to operate about 11 hours per day.

The system was officially operational as of June 1, 2004 and has been producing electricity from biogas on a continuous basis since that date. As anticipated, the generator has been operating approximately 11 hours per day. When the generator is not in operation, the biogas is not flared, but rather, is collected and stored in the covered lagoon.

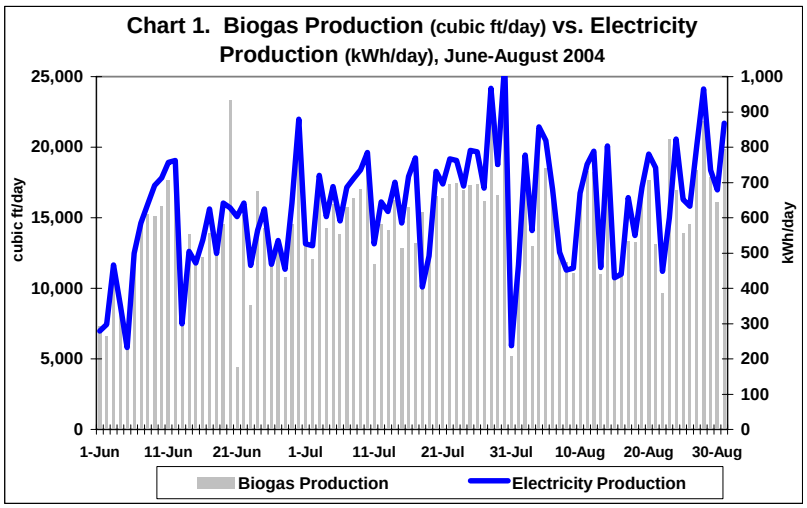
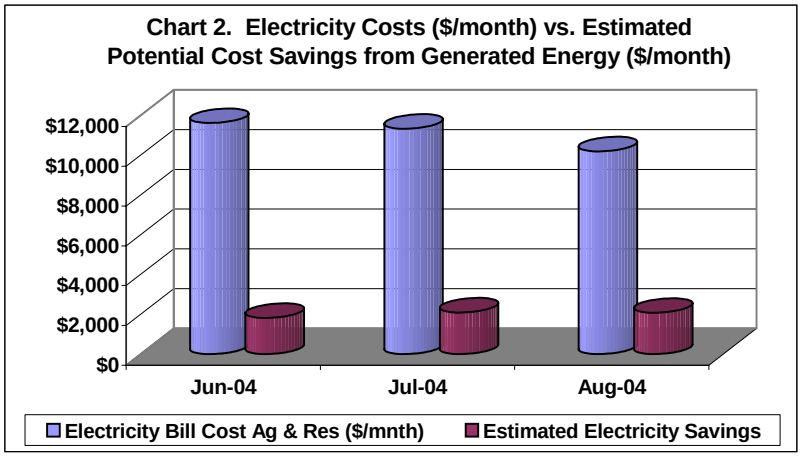


Chart 1 compares biogas production to electricity production for the 90-day startup period. The biogas output of the digester steadily increased from an average of about 13,061 cubic feet/day in June to about 15,645 cubic feet/day in July. A similar increase occurred in August, with biogas output reaching an average of 15,659 cubic feet/day. Performance has improved every month, as the system has been fine-tuned for efficiency over time. Additionally, a heat exchange plate that uses reclaimed heat from the engine has been installed in the pond, raising the lagoon temperature from approximately 75 degrees to 85 degrees Fahrenheit. This increase in temperature has resulted in increased biogas production. The heat exchange plate is expected to maintain a year-round psychrophilic temperature range of approximately 75 to 85 degrees Fahrenheit, depending on seasonal outside temperature.

Similarly, electricity production increased from an average of 545 kWh/day in June to 675 kWh/day in July. Electricity production decreased slightly to an average of 663 kWh/day in August. However, electricity production per operational hour of the system increased each month, from 56.5 kW per hour in June to 58.2 kW per hour in July, and then to 58.3 kW per hour in August. The system was operational an average of 10 hours/day in June, 12 hours/day in July and 11 hours/day in August. This is in-line with the estimated 11 hours per day stated in the application. The operating time of the engine is controlled manually. It is turned on around 4:00 or 5:00 a.m., and is shut off for a few hours of quiet time mid-morning. It is turned on again around noon, and runs until about 9:00 p.m., depending on the amount of available biogas.

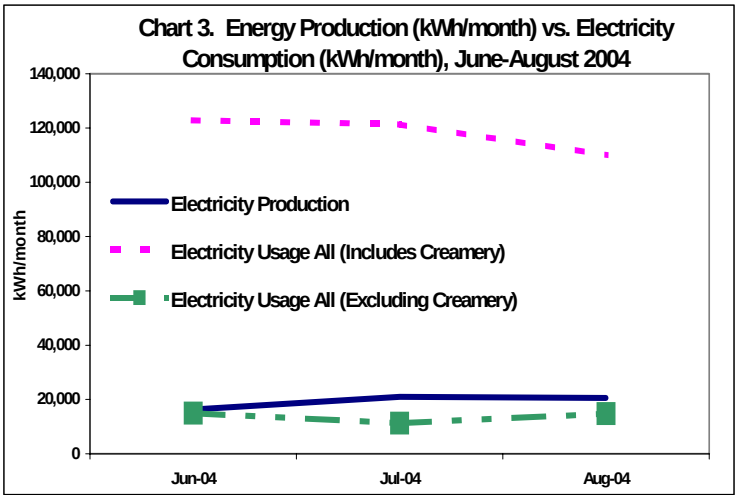
The dairy owner is hopeful that the biogas and electricity production on the dairy will increase over time as an additional barn housing calves as well as increased creamery waste will be added to the system.

Chart 2 compares monthly electricity costs to the estimated potential cost savings from generated electricity (if net metering had been in place) for the 90-day period. On average, including all agricultural and residential electrical usage, the cost of electricity (estimated retail rate) was approximately $0.10 per kW on the dairy. Had the dairy owner been able to utilize net metering during the 90-day period, June through August 2004, a cost savings of approximately $5,837 would have been experienced.[1] This does not take into consideration any possible decrease in generation, distribution or other associated fees. Assuming an average monthly electricity cost savings of $1,946, the estimated payback period for this project is approximately 6.9 years.[2] Unfortunately, net metering at the retail rate is presently prohibited. Therefore, the estimated payback on the project will be extended.



X. Energy Usage

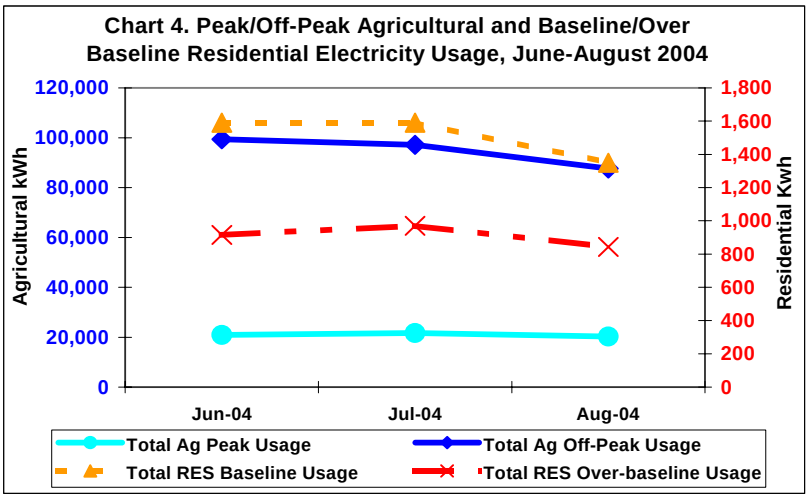
On average, approximately 114,314 kWh/month or 3,647 kWh/day of electricity is needed to supply the electric needs on-farm. This includes all agricultural, residential and creamery plant demands. Excluding the creamery demands, the average agricultural and residential needs are approximately 9,941 kWh/month. Chart 3 compares electricity



[1] This uses an average retail rate of $0.1112 per kWh for June, $0.0986 per kWh for July and $0.0951 per kWh multiplied by the energy production for each month.

[2] Assuming $161,362 in total refurbishment costs. This does not take into consideration offsets in propane costs. Using a total cost of $336,362, which includes the $175,000 originally spent prior to grant funding, the estimated payback period is increased to 14.4 years.

usage for all agricultural and residential needs and electricity usage for agricultural and residential needs, excluding the creamery, to electricity production for each month.



The agricultural (including creamery) and residential electricity usage are treated as separate accounts by the utility and are billed to the dairy owner in different fashions. The agricultural meters are billed on a "time-of-use" basis, while the residential meters are billed on a "continuous service" basis. The agricultural accounts outline peak and over-peak usage, while the residential bills outline usage in reference to an established baseline. Chart 4 compares the peak/off peak usage for the agricultural accounts and the baseline/over-baseline usage for the residential accounts. For the agricultural accounts, electricity usage is primarily in the off-peak hours, with 82% of the usage falling in this category. For the residential accounts, most of the usage falls within the designated baseline, with 62.4% of total usage within the baseline category.

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 June 2004 through August 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 20,000 cubic feet/day of biogas from 237 lactating cows, or 84 cubic feet/day of biogas per cow. The daily biogas production was estimated to result in electricity generation of 3.38 to 3.80 kWh per cow per day. For the 90-day period studied, the design calculations were not quite matched, with an average biogas production of 60 cubic feet/day per cow for 247 lactating cows, resulting in an average electricity generation of 2.54 kWh per cow per day. Chart 5 compares the average cubic feet of biogas production per day and per cow for June, July and August 2004.

As noted above, the average electricity generation was 628 kWh per day compared to an originally estimated 800 to 900 kWh per day.

The major problems faced thus far with the operation of the digester system have been in sealing the cover and cooling the engine. Because the project is still in the startup phase, some system adjustments and improvements have been required. Also, there have been a few design issues that have required changes. For example, the owner needed to replace the fan switch and vent the generator room differently, as venting affects how well the generator functions. The heat exchanger was changed to make it more sanitary and efficient. Additionally, a new separator was installed in December to keep the solids from entering the digester pond. However, since the pond already contained some solids, it has taken some time for the solids to move through the system. This situation has gradually improved, and appears to have been resolved as of August. It was also discovered that a faulty pipe had been allowing some gas to escape; this has recently been repaired. The dairy owner continues to monitor system performance and to make modifications as necessary. Additionally, the generator is very loud, so the dairy owner plans on taking steps to reduce the noise level.

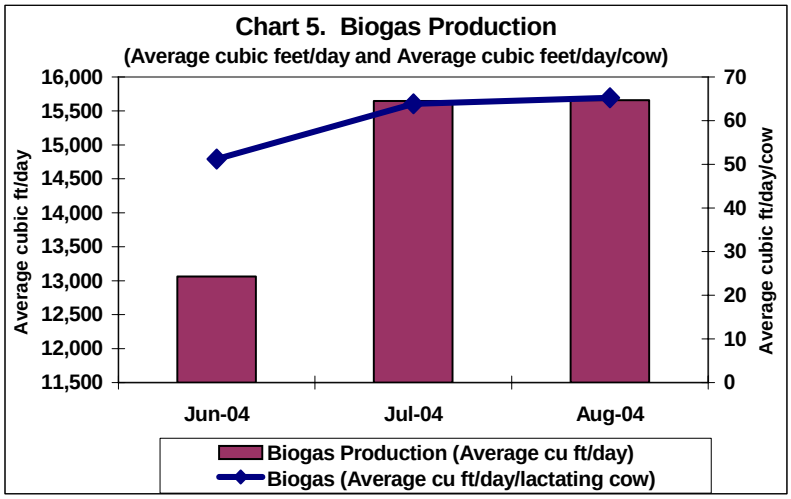


Table 1: Digester Design and Actual Performance

	Design	Actual June 2004 – August 2004 Average
Cows (lactating)	237	247
Manure Slurry (incl. wash water & creamery waste)		
Total gallons per day	20,000	20,000
Digester Size		
Total volume (cubic feet)	72,000	72,000
Retention Time (days)	34	34
Gas Production		
Total (cubic feet per day)	20,000	14,789
Per Cow (per day)	84	60
Electrical Output		
Generator Capacity (kW)	75	75
Generator Availability (operational hours/day)	11 to 12	11
Total (kWh/year)	~300,000	229,220
Total per day (kWh)	800 to 900	628
Total per cow (kWh/day)	3.38 to 3.80	2.54

XII. Heat Utilization

Recovered heat has been used since the beginning of August in the milking barn to heat water for washing equipment and for cleaning cows. Recovered heat is also being used to heat the digester lagoon. This recovered heat will replace an unspecified amount of the propane needs on the dairy. At the time of application, the dairy owner estimated a savings of approximately $6,000 per year due to the reduction in propane usage. On average, June through August 2004, 243 gallons per month of propane were used on the dairy, with an average cost of $341 per month (with a maximum of $453 in July). In total, 729 gallons were used during the 90-day period, with a total cost of $1,024. The average cost per gallon was $1.39 during this period, although in August the cost per gallon increased to $1.59 from $1.29 during June and July. Clearly, any offset in propane usage will result in reduced costs to the dairy. An estimated savings of $6,000 per year would result in a savings of approximately $500 per month. Given the current costs of propane at $1.59, this could be achieved with a 314 gallon per month reduction in propane usage. Assuming the dairy owner is able to achieve his goal of propane costs savings equating to $500 per month, the estimated payback period for this project would be reduced to 5.5 years.[3]

The actual costs savings will be more evident in the months to come. In addition to current uses, the dairy owner hopes to eventually offset propane for residential use as well. Under current conditions, the dairy owner is expecting to see a monthly propane cost savings of approximately $341 per month. It should also be noted that before publication of this report, the dairy owner received a propane bill for September. The cost of propane had increased to $1.71 per gallon, and usage had dropped to 181 gallons. Given the much higher cost of propane and potential for increased offsets, estimated cost savings would be greatly enhanced.

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.

[3] Estimates include $1,946 in monthly electricity savings and $500 in monthly propane savings. This is compared to a total project cost of $161,362. Using a total cost of $336,362, which includes the $175,000 originally spent prior to grant funding, the estimated payback period is increased to 11.5 years.

Table 2: Qualitative Questions

Questions Ranked 1-4, with 1=poor and 4=excellent	June 2004	July 2004	August 2004	Average
1. **Ease in operating the biogas production and biogas to electricity systems**	3	3	3	3.00
2. **Extent to which system gives advantage to your dairy manure management**	3	4	3	3.33
3. **Extent to which the system helps with odor control**	4	4	4	4.00
4. **Extent to which the system helps with reducing water use for manure management**	4	4	4	4.00
5. **Extent to which system helps address electricity issues important to your dairy operation**	3	3	4	3.33
6. **Overall satisfaction with the system so far**	3	3	3	3.00
7. **Any other comments or recommendations?** June 2004: "Some problems with sealing cover." July 2004: "Sealing cover; some problems cooling engine."				