Arnold Schwarzenegger
Governor

DAIRY POWER PRODUCTION PROGRAM

DAIRY METHANE DIGESTER SYSTEM 90-DAY EVALUATION REPORT - INLAND EMPIRE UTILITIES AGENCY RP-5 SOLIDS HANDLING FACILITY

PIER FINAL PROJECT REPORT

Prepared For:
California Energy Commission
Public Interest Energy Research Program

Prepared By: Western United Resource Development, Inc.

WESTERN UNITED RESOURCE DEVELOPMENT, INC.

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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 groundwater pollutants associated with storage and treatment of livestock wastes.

The California Energy Commission (Energy Commission), 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, 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 as a buydown grant paid out over five years.

The grant program is overseen by an advisory group consisting 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 the U.S. Environmental Protection Agency AgSTAR Program.

II. Facility Background and Profile

About the Inland Empire Utilities Agency

The Inland Empire Utilities Agency distributes imported water, provides regional industrial/municipal wastewater collection and treatment services, and other related utility services for a 242-square-mile area in the western portion of San Bernardino County. The Agency was formed by popular vote of its residents in June 1950.

The agency services the cities of Chino, Chino Hills, Fontana, Montclair, Ontario, and Upland, as well as the Monte Vista Water District and Cucamonga Valley Water District. Approximately 800,000 people reside in the Agency's service area.

The Chino Groundwater Basin is one of the largest groundwater basins within Southern California, holding more than 5 million acre-feet of water. Water from the Chino Groundwater Basin supplies about 70% of the water needs for residents within IEUA's service area.

The Agency has five water recycling treatment plants. These plants treat about 60 million gallons per day (mgd) of wastewater and produce high quality recycled water. During Fiscal Year 2005-2006, more than 9,000 acre-feet recycled water was used for industrial, agricultural, and landscape irrigation and groundwater recharge.

Located in the city of Chino, IEUA's Regional Plant No. 5 (RP-5) Solids Handling Facility is one of the largest centralized systems in the United States for converting manure into renewable energy. This project currently processes manure from six nearby dairies in an anaerobic digester and produces biogas, which is used to generate electricity at the Chino Basin Desalter #1 facility. The desalter is owned by the Chino Basin Desalter Authority, a joint powers of authority formed among the Jurupa Community Services District, the Santa Ana River Water Company, the cities of Chino, Chino Hills, Norco, Ontario, and the Inland Empire Utilities Agency. The Desalter, located in the city of Chino, treats groundwater with high levels of salts and nitrates through reverse osmosis and ion exchange processes and then safely introduces the highly treated water into the potable water supply. The desalter currently has a capacity to provide more than 14 mgd of drinking water.

Also located in the city of Chino, IEUA's Regional Water Recycling Plant No. 2 (RP-2) processes biosolids from the RP-5 Wastewater Treatment Plant and the Carbon Canyon Water Recycling Facility. Solids are stabilized through anaerobic digestion, dewatered through centrifuges, and processed into compost at the Inland Empire Regional Composting Facility.

About the RP-5 Renewable Energy Digester

The RP-5 renewable energy digester was originally built in 2001 to digest 225 wet tons of manure a day from local dairies to generate 500 kW of electricity to power the Desalter, which creates clean drinking water for nearby communities. The California Energy Commission and USDA-Natural Resources Conservation Service partically funded Phase 1 of the RP-5 renewable energy digester project.

In Phase 1B, partially funded through the California Energy Commission's DPPP, enhancements to the system were made to increase manure processing capacity from 225 wet tons per day to 315 wet tons per day and to improve gas and power production. Prior to Phase 1B improvements, the system was producing only 380 kW of electricity. The Phase 1B expansion was designed to bring the system up to its 500 kW design capacity, as well as to increase total capacity by an additional 443 kW, to bring the total generating capacity to 943 kW. Phase 1B enhancements were completed in March 2006 and included the following additions to the system: bar screen to capture debris at receiving tanks; four top-mounted mixers and recirculation pump station to convert the "plug flow" digester to a "modified mix" digester; grinders; a foam suppression system, pressure/vacuum relief valves and J-tubes to improve system safety; and rotary presses to produce dryer "cake" and reduce power consumption. Also as a part of the Phase 1B system improvement, but not funded by the DPPP, the digester was opened and cleaned out completely.

III. Costs/Funding

IEUA applied for incentive payment funding from the DPPP in June 2003 for the modification and expansion of the existing digester system at its RP-5 facility. At the time of application for funding, total project costs were estimated at $1,546,350. The proposed project was for expansion of an existing plug flow digester to accept manure from an additional 4,700 cows (manure equivalent to 1,500 cows); for minor changes to enable the digester to operate at thermophilic temperatures; and for the construction of a mixing chamber to improve the quality of the feedstock entering the digester.

During the course of the review process, project plans were modified to include the following three primary components: (1) the addition of grit and debris removal facilities at the manure receiving tank area; (2) conversion of the plug flow digester to a “modified mix” digester; and (3) expansion of the dewatering facility.

As mentioned above, the Phase 1B expansion was designed to bring the digester system up from its initial production of 380 kW to its originally designed 500 kW capacity, and then to increase the generating capacity by an additional 443 kW for a total increase of 563 kW and a total generating capacity 943 kW. IEUA was awarded an incentive payment grant based on the expected Phase 1B expansion capacity of 563 kW, with incentive payments to be calculated at 5.7 cents per kilowatt-hour of electricity generated by the dairy biogas system above an expected baseline production of 2,829,480 kilowatt hours per year, which correlates to the 380 kW already achieved before the Phase 1B expansion. The grant amount was approved at $773,175, to be paid out over a maximum of five years according to the formula described below.

Because the generators located at the desalter facility can receive gas from more than one source, IEUA agreed to install and maintain an electronically retrievable gas meter to track RP-5 gas production. A dedicated gas meter was installed on the gas line conveying the biogas from the manure digestion RP-5 digester for power generation. IEUA’s grant agreement stipulated that, for incentive payments, electricity generation would be calculated using the following formula: **Electricity generation (kWh) = incremental gas production (cu. Ft.) x 0.0632**, where the 0.0632 factor is calculated assuming a heat value of biogas equal to 600 Btu/cu. ft., power generation efficiency of lean burn internal combustion engine equal to 36 percent, and kWh is equal to 3414.1345 Btu.

Using the biogas-to-electricity conversion formula given above, the daily baseline electricity production of 7,752 kWh has been exceeded on only five days during the 90-day study period April-June 2006 for a total of 3,762 kWh above-baseline electricity production for the period. To date, IEUA has received a total of $214.47 in incentive payments for the 3,762 kWh above-baseline production.

IEUA has spent approximately $3,551,448 to date on project completion, or $2,005,098 over the projected cost of the project. According to IEUA, cost overruns are due to the acceleration of construction in the Inland Empire, one of the fastest growing areas in the United States IEUA reports that due to the high demand for construction workers and supplies, construction costs have nearly tripled since the time of grant application for this project. IEUA has incurred an estimated $2,778,273 in costs above expected DPPP grant funding. Of this, $175,000 was provided by a grant from the California Energy Commission to help the purchase four vacuum tank trailers.

IEUA staff is responsible for the operation of the system. Operating costs include chemicals, labor, electricity, dewatered manure handling, and maintenance. Total operating costs are estimated at $117,059 per month.

IV. Timeline

The grant application was submitted to Western United Resource Development, Inc., in June 2003. During the review process, IEUA modified project plans and submitted revised applications, submitting the final application revision in September 2003. The application was sent for due diligence review on October 3, 2003. After thorough review, the advisory group approved the project for funding in November 2003.

After project approval, it took several months to negotiate the terms and details of the grant agreement. The grant agreement was executed in April 2004, with an eight-month project schedule and an expected completion date of December 31, 2004.

In June 2004, IEUA notified WURD that rather than proceeding with a design/build approach, a design/bid/build approach would be used. IEUA explained that the bidding process would provide a project of higher quality by allowing IEUA to decide the type of equipment and construction material during the design phase. IEUA noted that the time frame for the project would have to be extended to allow for the bidding process and also explained that the construction period would have to be extended slightly. IEUA indicated that the eight-month project schedule would have to be extended to 13 months and requested that the project completion date be extended to May 31, 2005. Upon approval by the Energy Commission, WURD granted this extension.

In November 2004, IEUA notified WURD that the consultant performing the design work did not submit the design work on time, delaying the scheduled completion of the design work. This pushed the expected project completion date back to July 31, 2005. Later in November 2004, IEUA requested authorization for a change in manure collection equipment. With the consent of the Energy Commission, this request was approved, along with a project extension to August 31, 2005.

Project construction began on March 21, 2005. In May 2005, IEUA reported that heavy spring rains had interrupted construction work and notified WURD that this would likely affect the construction schedule and delay the completion date.

Construction of the Phase 1B expansion project was essentially completed by August 31, 2005. In November 2005, IEUA reported that as the digester was started up in September 2005, it was observed that a third of the digester tank volume was full of grit. An attempt was made to remove the grit by pumping out the sludge. However, the grit was too heavy, and pumping did not solve the problem. It was then necessary for IEUA to open up the digester and have the grit cleaned out. This project was expected to be complete by mid-December 2005, at which time the digester could start receiving manure. IEUA also reported in November 2005 that an attempt to use a static screen to remove rocks and debris during manure delivery was not successful, so a new screening facility was undergoing construction and was expected to be completed by mid-December 2005.

In February 2006, IEUA reported that the digester system was in startup mode and had begun receiving manure on December 19, 2005. IEUA noted that the digester began producing biogas with 55% to 60% methane content at the end of January 2006, and that it was expected that the digester would operate at capacity at mesophilic phase by March 1, 2006, with the temperature projected to reach a thermophilic range by the end of March 2006.

In May 2006, IEUA reported that the digester was still producing biogas with 55% to 60% methane content, noting that operation at thermophilic range was expected by June 2006. Although the digester was not yet operating at full capacity or temperature, for DPPP reporting purposes, an official startup date of April 1, 2006, was set to allow a 90-day period of data collection for this report.

V. Digester System Processes

Manure Collection and Processing

During the 90-day study period April-July 2006, six dairies provided manure for the RP-5 digester. Combined, these dairies reported populations of approximately 9,843 total cows, of which 7,931 were lactating, 1,431 were dry, and 481 were heifers. The participating dairies averaged 1,322 lactating cows, 239 dry milk cows, and 80 heifers each, for a total average of 1,641 cows per dairy. The dairies pay tipping fees of $8.10 per load to IEUA to have the manure taken off site, amounting to an average of $1,550 per month combined. In most cases, not all the manure generated at each dairy is sent to RP-5. Actual collected manure figures are noted below.

At the dairies, manure is collected daily from the feed lanes using a HoneyVac vacuum tanker truck. The manure is discharged into a small holding tank on the dairy for pickup and transport to the RP-5 digester by a vacuum nurse tanker. Manure trucks are weighed at the RP-5 facility both upon arrival and once the manure is extracted from the truck. The scale is connected to an electronic control panel inside the RP-5 office facility. All incoming manure is tested for solids content and logged on a daily basis.

Manure holding tank

The RP-5 digester facility was initially designed to handle 225 wet tons of manure per day, with a total solids content of 12%, equivalent to 27 dry tons. As result of the Phase 1B modification and enhancement, the digester capacity was increased to 315 wet tons of manure per day (total solids content of 12%, equivalent to 37.8 dry tons).

During the 90-day study period April-June 2006, manure collected from the participating dairies averaged 3,272 wet tons per month or 108 average daily wet tons (it should be noted that 100% of the manure on each facility is not collected, therefore wet tons of manure should be the primary focus, not cow numbers). The solids content of the collected manure averaged 16% during the study period. The monthly collected manure figures are included in Table 1 below.

The volume of manure delivered to RP-5 is below the expected 315 wet tons per day due to the fact that the facility is still in its startup phase. Manure delivery will be increased when the digester temperature reaches the thermophillic range.

Table 1. Collected Manure for Use at RP-5 (wet tons)

	Monthly Total	Daily Average	Solids Content Average (%)
Apr-06	3,409	114	16.01
May-06	3,265	105	16.43
Jun-06	3,141	105	15.90
Average	3,272	108	16.11

Digester System

At the RP-5 facility, each incoming load of manure is unloaded into a screening facility to ensure the removal of rocks and debris; it then flows into Mix Tank 1, the primary receiving pit. The collected debris is deposited onto a conveyer from which it is hauled off to landfill. As mentioned above, during unloading, a single grab sample from each load of manure is collected and analyzed for total solids. The manure in the primary receiving pit is mixed and kept in constant suspension so that solids do not settle to the bottom. Here, water is added to obtain a targeted 12% solids content. The diluted manure is then transferred to Mix Tank 2, and from there it is fed into the digester. A sludge flow meter is located at each mix tank.

The RP-5 digester is a plug-flow design converted to a modified-mix design, in which the digesting manure flows down one side of a divided trough and back up the other side, completing a loop. During its flow, manure is mixed by four top-mounted mixers and is recirculated back to the front of the digester after being heated by five shell and tube heat exchangers. The mixers keep sludge in suspension, thereby keeping it in contact with bacteria that break down the manure. This improves manure digestion and increases gas production.

Plug flow digester

The digester measures approximately 195 feet long and 60 feet wide with a depth of 16 feet. The volume of the digester is about 1,100,000 gallons, or 145,800 cubic feet. The digester maintains a slurry depth of approximately 13.5 ft. Though not yet achieved, the expected feed rate is 315 wet tons per day of manure. Target solids content going into the digester is 11% to 12%. The design hydraulic retention time (HRT) in the digester ranges from 15 to 21 days. The design temperature is in the thermophilic range, with a target operating temperature of 125°F to 130°F.

Three recirculation pumps are used to pump the manure from one end of the digester, through five heat exchangers, and then back to the other end of the digester. Hot water recovered from the desalter facility cogeneration plant is used in the heat exchangers to heat the manure and thus raise the temperature of the digester. A stand-by boiler is located on-site to serve as backup to the cogeneration plant.

Gas System

Gas produced in the digester passes from the digester headspace to the effluent tank headspace. A foam suppression system is in place above the effluent tank ceiling to prevent foam from entering and clogging the digester gas line. The foam suppression system was one of the system improvements funded through the DPPP. Condensate from the digester gas is removed by a water trap prior entering into the gas scrubber.

A steel line carries biogas to an iron sponge. The gas scrubber is a packed bed reactor that uses iron oxide impregnated wood chips as the process media to remove hydrogen sulfide from the gas stream. The gas scrubber installed at RP-5 consists of two separate reaction chambers. The unit is designed for top-to-bottom lead-lag flow. The gas flows into the top of the first box, out the bottom of the first box, into the top of the second box, and out the bottom of the second box before leaving the system. The hydrogen sulfide levels at the outlet of the digester, the outlet of the lead iron sponge box, and the outlet of the lag iron sponge box are monitored and recorded every week to comply with the South Coast Air Quality Management District sulfur emission requirements and to determine when the media should be changed in the lead box. Normal manure biogas contains 2,500-2,600 parts per million (ppm) hydrogen sulfide. The iron sponge scrubs the biogas to less than 40 ppm hydrogen sulfide levels. The spent iron sponge is landfilled off site.

After the impurities are removed, the digester gas is diverted either to an onsite gas compressor or, if needed, to a contained-flame flare. Gas is flared only when the engine or compressor is down or during system maintenance. The flare is controlled by digester pressure and is automatically activated. The flare operates at lower pressure than the pressure/vacuum relief valves, which function only in the event of a flare failure or gas line blockage. An automated meter is located at the flare to measure the amount of biogas flared. Manual meter readings are taken daily to verify electronic readings.

From the scrubber, gas is conveyed to a gas tank and from there flows to a compressor where the gas is compressed to 60 to 70 psi to supply continuous fuel of sufficient volume to operate the engine-generators. The compressed digester gas flows to a second 30,000-gallon gas storage tank from which it flows to the desalter facility. A biogas meter is located at this second tank to measure biogas from RP-5 going to the engine-generators at the desalter facility located approximately one mile away.

Gas tank

The primary fuel of the two Waukesha engine-generators at the Desalter plant is the digester gas supplied from the RP-5 Solids Handling Facility and the digested gas from the RP-2 facility. If sufficient digester gas is not available, a natural gas/air blending unit at RP-2 supplies the required make-up fuel. This combination of fuel is compressed into storage vessels, metered, and transported from the digesters to the desalter engines via the gas system. RP-5 and RP-2 share a common gas line to the engine-generators. If the generators are down, gas from RP-2 is diverted and is not sent to the generators. The drop in outgoing pressure at RP-2 causes a vacuum that pulls gas from RP-5 through the common line to the RP-2 facility where it is used to fuel either a boiler and/or engine-generator for power production at that facility.

As previously mentioned, useful heat is recovered from the engine jacket water system. This coolant water is circulated through a plate and frame heat exchanger. The operating temperature range of the engine loop is 180ºF to 200ºF. The hot water is piped underground to the RP-5 facility to heat the digester contents.

Plate and frame heat exchanger

Other Systems

The digester has two Pressure-Vacuum Relief Valves (PVRVs) intended to prevent damage to the digester cover due to overpressure or overvacuum conditions. These emergency valves automatically release when pressure reaches critical levels. Two J-tubes act as an additional emergency relief system allowing pressure to escape when needed.

The biofilter consists of wetted wood shavings used for odor removal. The air in the receiving building is ducted underground to the biofilter.

Digested Sludge

After approximately 15 to 21 days of hydraulic retention time, the digested manure slurry overflows into an effluent tank. Polymer is added to the digested sludge to aid in the dewatering process. The material is then separated into a liquid stream and a solid fraction through a rotary press. The liquid fraction is then discharged to a brine line for subsequent treatment in a wastewater treatment plant before being discharged to the ocean in accordance with permits. The dewatered "press cake" (32-35% total solids) is loaded in to a trailer, conveyed to a composting facility, and ultimately applied to land. IEUA currently pays hauling fees to have the dry manure removed; however the agency is researching other applications that may generate income.

VI. Biogas Production

As mentioned above, the primary fuel of the two Waukesha engine-generators at the desalter plant is the digester gas supplied from the RP-5 and RP-2 facilities. A flow meter at the desalter measures total incoming biogas, including the biogas from RP-5 and blended gas from RP-2 (generated from biosolids sludge from a wastewater plant, blended with natural gas and air to maintain proper composition and quantity). Compressed natural gas is also available at the Desalter facility to aid in ignition of either engine-generator. Gas is metered separately from the RP-5 and RP-2 biogas.

At the time of application, IEUA provided biogas production figures at the RP-5 plug-flow facility (before modifications) for the period September 2002 through August 2003. Average daily biogas production was reported at 148,885 cubic feet of biogas per day. This was compared to a total capacity to produce 185,000 cubic feet per day. As explained above, through the DPPP, IEUA made three main modifications to the digester. The modifications were expected to increase total biogas production from the RP-5 facility by 192,698 cubic feet per day. This was based on an estimated increase of 107,914 cubic feet/day attributable to expanded capacity and larger manure collection, as well as 84,784 cubic feet/day attributable to the proposed digester modifications. Using the original biogas capacity figure, this would bring estimated total biogas capacity figures (after modification) to 372,698 cubic feet of biogas per day.

For this report, the modified system was officially operational as of April 2006. It must be recognized that the 90-day period studied was a startup phase and not representative of anticipated future performance of the system. Specifically, the targeted temperature of the digester facility has not yet been met, and thus biogas levels have not reached expectations.

For the 90-day study period April through June 2006, biogas from RP-5 represented approximately 39% of total biogas to the generators at the desalter facility on average. Biogas from RP-2 represented an average of 46%. Natural gas from RP-2 represented 11%, and natural gas at the desalter facility averaged 5%. Actual metered gas figures from each location is represented in Table 2 below.

Table 2. Biogas Utilized from RP-5 and RP-2 Facilities (cubic feet)										
	RP-5 Biogas to Generators	RP-2 Biogas to Generators	RP-2 Natural Gas to Generators	RP-5 Digester Gas to RP-2	Natural Gas at Desalter	Total Biogas (all sources) utilized by engines	%RP-5 Biogas	%RP-2 Biogas	%RP-2 Natural Gas	%Natural Gas at Desalter
Apr-06	2,501,966	3,229,380	964,620	0	437,600	7,133,566	35%	45%	14%	6%
May-06	2,339,774	2,775,420	489,780	0	201,800	5,806,774	40%	48%	8%	3%
Jun-06	2,951,809	3,325,813	745,087	0	309,315	7,332,024	40%	45%	10%	4%
Avg							39%	46%	11%	5%

Biogas from RP-5 used by the generators declined slightly from April to May 2006 from 2,501,996 cubic feet of biogas to 2,339,774 cubic feet, respectively. However, utilized biogas increased in June to 2,951,809 cubic feet. Biogas measured an average 83,399 cubic feet/day in April 2006, 75,477 cubic feet/day in May 2006, and 92,244 cubic feet/day in June 2006.

Flared biogas from RP-5 decreased each month from 1,699,011 cubic feet in April, to 802,801 cubic feet in May, then to only 177,547 in June 2006. On average, 40% of the total biogas produced at RP-5 was flared in April 2006. Flared biogas declined May to 26% and fell again in June to only 6% of the total biogas produced at the RP-5 facility.

VII. Energy Production

The two engine-generators produce electricity that is used to power the groundwater desalination equipment at the desalter facility. The desalter creates clean drinking water for nearby communities. Engine No.1 is a 1,000 kW capacity Waukesha 7042 generator. Engine No.2 is a 850 kW capacity Waukesha 5790 generator. Control panels at each engine monitor safety and shutdowns. An air fuel controller measures oxygen in the exhaust and activates fuel valves to maintain emissions compliance. Though IEUA is not currently exporting surplus electricity, switchgear is located at each generator due to plans to do so in the future.

As explained above, before Phase 1B improvements, the system was producing 380 kW from biogas generated at the RP-5 facility. The Phase 1B expansion was designed to bring the current system up to its 500 kW capacity as well as increase capacity by an additional 443 kW to bring the RP-5 total generating capacity up to 943 kW.

Engine generator

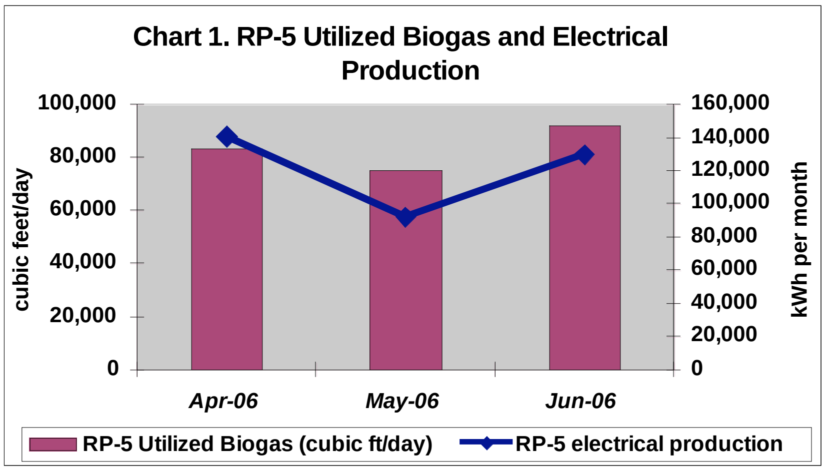
In initial design specifications, it was estimated that the planned modifications to the digester would produce enough biogas to support an additional 563 kW and produce an additional 3,880,680 kWh per year. This, combined with the 380 kW capacity already reached, would put total capacity at 943 kW. Assuming the generators would run 18.9 hours per day (or at 79% capacity), total potential electrical generation could reach 6,505,286 kWh per year, or an estimated 17,823 kWh per day.

Table 3. RP-5 Electrical Production (kWh)			
	Engine #1	Engine #2	**Total**
Apr-06	0	140,867	**140,867**
May-06	0	92,184	**92,184**
Jun-06	2,899	126,961	**129,860**
Average			**120,970**

Table 3 shows electrical production from RP-5 biogas for the 90-day startup period. Electricity production totaled 140,867 kWh in April 2006 but fell to 92,184 kWh in May 2006. Electricity production increased to 129,860 kWh in June 2006. As mentioned above, more biogas was used during June 2006 as less was flared. Additionally, system downtime was reduced significantly each month during the 90-day study period, totaling 655 hours in April, 295 hours in May and 180 hours in June. Downtime occurred for a number of reasons including, but not limited to the performance of routine and unexpected maintenance.

Chart 1 compares utilized biogas production (not including flared biogas) to electricity production for the 90-day startup period of April through June 2006.

The use of the generated electricity at the Desalter facility is estimated to generate cost savings at the rate of $0.08 per kWh offset. Electricity generated from total RP-5 biogas resulted in cost savings of $11,551 for April 2006, $7,559 for May 2006, and $10,388 for June 2006, for an average offset of $9,833 for the 90-day study period attributable to RP-5 biogas. As previously mentioned, RP-5 electrical production averaged 120,970 kWh per month for the study period. This is below the Phase 1B baseline of 380 kW capacity or estimated 237,790 kWh per month. It should be noted, therefore, that the offset savings noted above cannot be attributed to Phase 1B system enhancements.



To date, IEUA has spent approximately $3,551,448 on Phase 1B completion. Because the system was not running at full temperature or capacity during the study period, an actual payback period estimate for Phase 1B cannot be determined at this time.

If the expected 563 kW capacity from the Phase 1B expansion is realized, estimated monthly electrical production attributable to Phase 1B could reach 324,682 kWh per month (at estimated 79% capacity), and estimated savings from Phase 1B electrical production alone would be closer to an average of $25,975 per month. If realized, the estimated payback on the Phase 1B expansion would be approximately seven years. This simple payback estimate includes both electrical and thermal cost savings as well as both the DPPP and Energy Commission grants. IEUA expects the system to be running at full capacity by the end of August 2006.

VIII. Energy Usage

The desalter uses on average 1,095,796 kWh per month of electricity. During the study period, total energy produced from RP-5 biogas represents 11% of the total electrical usage at the desalter facility. At this time, no electricity can be attributed to the RP-5 Phase 1B expansion, as the system is not yet running at full capacity.

Desalter facility

The RP-5 facility uses on average 96,680 kWh per month. There is no offset of electrical usage at this site.

Therefore, the net offset of electricity purchased from the utility is approximately 24,290 kWh (the offset at the desalter facility less the electrical usage at the RP-5 facility).

IX. System Performance

The performance of the system during the 90-day startup phase has been below design expectations. Table 4 compares the system design performance calculations with the actual performance for the 90-day period April through June 2006. 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 372,698 cubic feet/day of biogas from 315 wet tons of manure/day. The daily biogas production was estimated to result in electricity generation of 543,828 kWh per month (assuming 79% capacity). This is based on an estimated total capacity of 943 kW, which includes the additional 120 kW to bring the existing capacity (at time of application) up to 500 kW, plus an additional 443 kW from the digester modifications. As explained above, for the 90-day period studied, the design calculations for biogas were not matched, with an average biogas production of 113,189 cubic feet/day for an average electricity generation of 3,977 kWh per day. Again, it must be noted that not only did biogas levels fall short of expectations during this initial startup phase (due to temperature issues explained above), but an average 24% of the available biogas was also flared and consequently not used for electricity production during the study period. As explained, flared biogas reached 40% of total available biogas from RP-5 for April 2006.

Table 4: Digester Design and Actual Performance

	Design	Actual April - June 2006 Average
Manure Slurry		
Wet tons per day (collected from participating dairies)	315	108
Digester Inflow (gallons per day)	100,719 gallons at 12% total solids	34,532 gallons at 12% total solids
Digester Specifications		
Type	Plug-flow converted to modified mix	Plug-flow converted to modified mix
Digester Feeding Mode	Continuous	Continuous
Retention Time (days)	15.4	15 to 21
Gas Production		
Total (cubic feet per day) – utilized and flared	372,698	113,189
Per Wet Tons of Manure Collected (per day)	1,183	1,048
Electrical Output		
Generator Capacity from RP-5 biogas (kW)	943 kW Application included 120 kW to bring existing facility up to expected 500 kW plus 443 kW additional production.	943 kW
Generator Availability (operational hours/day)	18.9	11.55 (2.17 in April, 14.5 in May & 18 in June)
Total (kWh/year)	6,525,937 (based on 943 kW at 79% capacity)	1,451,645
Total per day (kWh)	17,879	3,977
Total kWh/day per cubic feet of biogas	0.048	0.035

As noted above, having completed the Phase 1B system enhancements, the facility can now treat approximately 315 wet tons of dairy manure through the “modified mix” digester. IEUA is now undertaking a new phase of additional construction, known as the Phase 2 expansion, to allow treatment of an additional 300 wet tons of dairy manure and 90 wet tons of food waste. This is expected to provide an additional 1,500 kW of generated power above the current 943 kW. The Phase 2 expansion, scheduled to be complete in December 2006, is partially funded by the California Energy Commission, with remaining funds provided by IEUA and the Department of Energy.

X. Additional Cost Savings or Income

Use of Recovered Heat

The digester system is considered a closed-loop system in that recovered heat from the desalter generators is pumped back to the digester where it is run through heat exchangers to raise the temperature of the digester and thereby increase gas production. IEUA estimates cost savings attributed to the use of recovered heat at $5,114.

Tipping Fees

The dairies that participate in the IEUA manure collection program pay tipping fees of $8.10 per load to IEUA to have the manure taken off site. These tipping fees amount to an average of $1,550 per month of income to IEUA for their services.

XI. Qualitative Feedback

On a scale from one to four, IEUA was asked to rate its experience in a number of areas concerning the digester project. The specific questions, along with monthly and average rankings, are included in Table 5.

Table 5: Qualitative Questions

Questions Ranked 1-4, with 1=poor and 4=excellent	**April 2006**	**May 2006**	**June 2006**	**Average**
1. **Ease in operating the biogas production and biogas to electricity systems**	3	3	3	3
2. **Extent to which system helps address electricity issues**	3	3	3	3
3. **Overall satisfaction with the system so far**	3	3	3	3
4. **Any other comments or recommendations?**	na			

na = no answer