PACIFIC REGION CHP APPLICATION CENTER

combined heat & power in a dairy

Joseph Gallo Farms Dairy

700 kW reciprocating CHP system

Project Profile

Quick Facts

Location: Atwater, CA

Capacity: 300 kW Caterpillar 3412 and 400 kW Caterpillar G399 reciprocating engine generators

Fuel: Digester gas (methane)

CHP system:
Process steam for cheese making

Construction Time: 25 months

System Online:
October 2004, upgrade from 300 kW to 700 kW in February 2006

Total Project Cost:
$3,200,000 (including the 400 kW upgrade in February 2006)

Energy Cost Savings:
$800,000/year (electricity and propane)

Expected Payback Time: 3 to 4 years (without incentives)

Funding Sources:
Joseph Gallo Farms;
California Dairy Power Production Program (DPPP);
CA Self-Generation Incentive Program

Project Overview

Joseph Gallo Farms, founded in 1979, accommodates 16,000 dairy cows across five dairies in Merced Country. About 5,000 of them are at the Cottonwood Dairy. Each cow produces about 120 lbs (54 kg) of liquid and solid waste per day, which can result in serious environmental problems. Authorities are struggling with the air and water pollution consequences and are searching for solutions. One can be the installation of an anaerobic digester to produce biogas from manure and allow electricity generation. In 2004 a 44,225,000 gallon (167,400 m^3) lagoon digester with 7 acre surface area (28,000 m^2) in combination with a 300-kW Caterpillar 3412 reciprocating engine were installed at the Cottonwood site.

The digester produces up to 300,000 cubic feet/day (8,500 m^3/d), but only 130,000 cubic feet/day (3,700 m^3/d) are used by the 300-kW Caterpillar engine. To avoid flaring or releasing the remaining fuel to the atmosphere, Josephs Gallo Farms installed a second, 400-kW reciprocating engine in February 2006. With these two engines the system produces 5.6 GWh electricity onsite every year. Furthermore, the Cottonwood dairy also houses a cheese plant which processes around 900,000 lbs (408,000 kg) milk per day. Methane production is accelerated by the addition of warm plant clean up water to the digester.

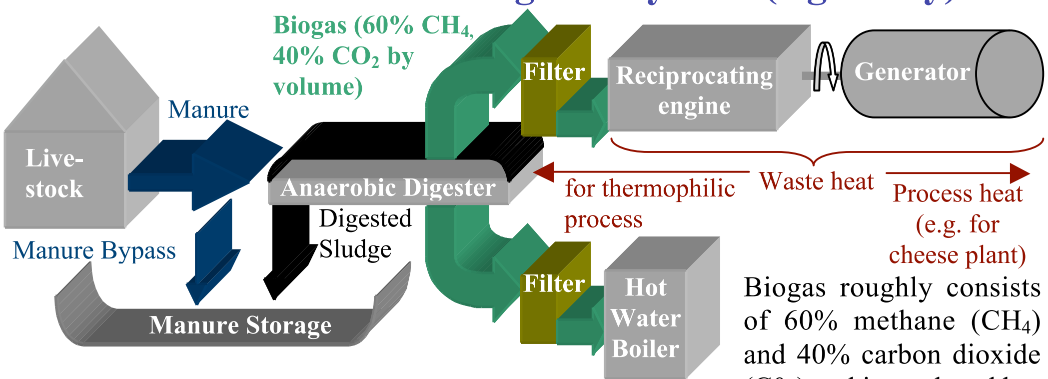
The new 700-kW CHP system, which also uses waste heat for the cheese plant, can offset 55% of the utility-provided electricity (the peak load of the dairy is around 1.6 MW). The exhaust waste heat is used to produce steam for pasteurizing and sterilizing. Additionally, heat from the engine jacket coolant may be used in the future to preheat air for a whey drier.

The dairy operates the entire digester system on its own at a maintenance cost of roughly $150,000 per year. This includes H_2S scrubber materials replacement, weekly electrical equipment and pump motor checks, as well as major engine overhauls every 16,000 hours. Furthermore, the dairy has to change the engine oil every 500 hours and has to perform engine tune ups every 1,000 hours.

Costs & Financial Incentives

Originally, the total project cost was projected at $1,290,000. However, because of higher than expected costs for the manure collection, manure separation, and gas treatment systems and for the grid interconnection, the final project costs were $2,700,000 (without the 400 kW upgrade). To mitigate these costs the farm received a buy-down grant of $600,000 from the California Dairy Power Production Program (DPPP) as well as $238,000 from the CA Self-Generation Incentive Program. Joseph Gallo Farms has also applied for a $400,000 grant for the new 400 kW engine. The purpose of the DPPP program was to stimulate the installation of biologically-based anaerobic digesters for gasification and biogas electricity generation. This program – which expired in March 2004 – contained two types of grants: a) an investment subsidy, which covered up to 50% of the system capital costs, and b) a production incentive of 5.7 cents per kWh of electricity produced.

Schematic of an anaerobic digester system (e.g. dairy)



Biogas roughly consists of 60% methane (CH_4) and 40% carbon dioxide (CO_2) and is produced by bacteria in the absence of oxygen in a covered, impermeable anaerobic digester. Almost any organic material can be processed in this manner, e.g. leftover food, waste paper, grass, etc. Two major processes are available: a) *mesophilic*, which takes place at ambient temperatures between 68°F (20°C) and 104°F (40°C) and b) *accelerated thermophilic*, which needs waste heat to increase the process heat up to 158°F (70°C). With such an anaerobic digester, a lactating dairy cow can generate enough biogas to generate approximately 2.5 kWh electricity every day. However, very important for a well-functioning system is the H_2S scrubber (filter). This reduces the corrosive hydrogen sulfide content in the biogas, which would otherwise reduce the engine lifetime.

Picture above: 400 kW reciprocating engine

Picture below: the 7 acre digester cover

Unlike traditional lagoons that emit methane directly into the atmosphere, digesters capture these emissions. This is very important because of the high methane content of the released gas. Methane is about 20 times more potent as a greenhouse gas than CO_2.

"Steep construction and maintenance costs with bureaucratic hurdles and conflicts with utility providers have prevented many interested dairies from building biogas operations"
Mike Marsh, Chief Executive Officer of Modesto-based Western United Dairymen.

Further information can be found at

Joseph Gallo Farms: http://www.josephfarms.com/
DPPP: http://www.wurdco.com/index.htm
Self-Generation Incentive Program: www.pge.com/suppliers_purchasing/new_generator/incentive/index.html
Methane (Biogas) from Anaerobic Digesters: http://web.archive.org/web/20041124201613/www.eere.energy.gov/consumerinfo/factsheets/ab5.html?print
PRAC: www.chpcenterpr.org Version 1.2, 12/19/06

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