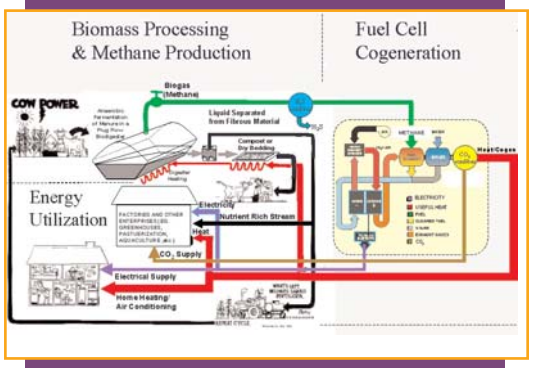
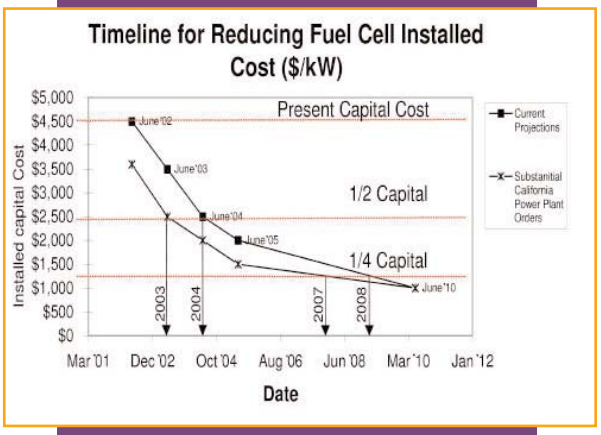
DAIRY FARM FUEL CELL SYSTEMS



Conceptual diagram of a fuel cell cogeneration system on a dairy farm with integrated recourse recovery and the potential for adding value-added processes like greenhouses.



Timeline showing the averaged cost estimates ($/kW) of fuel cell systems for current projections and a substantial order case.

OBJECTIVES

The objectives of this project were to determine the technical and economical feasibility of fuel cells for energy conversion on the dairy farm.

DESCRIPTION OF SYSTEM

The case study farm, AA Dairy in Candor, New York, currently produces biogas from anaerobic digestion of manure from 500 milking cows with plans to double its milking herd. A 250 kW molten carbonate fuel cell (MCFC) would replace AA Dairy's 130 kW 3306 Caterpillar diesel engine-generator set (genset) which produces about 613,000 kWhelec/yr. Heat from the fuel cell will be recovered to maintain the digester temperature at about 100°F but because of the higher quality of heat, additional thermal applications would include: floor deicing, barn office temperature control and absorption-refrigeration of milk.

OUTCOME

Technically, there are no insurmountable challenges to biogas-based fuel cell systems, only hurdles of economics and fuel cell availability. With about 2,549 m3/day (90,000cf/d) of biogas from 1000 cows, the generating capacity of a MCFC would far exceed the energy needs of AA Dairy. H_2S and moisture content must be reduced to less than 10 ppm with iron sponge or other off-the-shelf technologies for MCFC operation. 40-45% CO_2 in biogas will replenish the fuel cell's carbonate electrolyte. Compared to diesel gensets, fuel cells will reduce greenhouse gas (GHG) emissions (over 90% less CO, NO_x, SO_x, and particulates) with less noise.

Economically, the fuel cells cannot currently compete with diesel gensets on 1000 cow dairies. However, future opportunities exist with a 250 kW MCFC resulting in 2.7 GWh/yr of electricity. One scenario, based on a drop in today's MCFC price to ¼ of the present capital cost and on a $0.09 buying and selling electricity price, suggests discounted payback of 3 years, life-cycle benefit of over $1.3 million, and 21% increase in net farm income.

With anticipated increased demand for fuel cells, driven by concerns about GHG reductions and energy efficiency improvements, the described scenario is projected to become reality by 2007-2010.

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