

### Controlling Municipal Energy Costs

(based on articles by Lyn Corum and Lori Lovely, *Distributed Energy*, Nov-Dec 2006, pages 16-26)

#### Fact:

Treating and pumping water and wastewater ranks near top of energy needs for municipalities across the United States.

#### Example:

According to the California Energy Commission, 56% of energy usage by municipalities is spent on water and wastewater treatment facilities.

#### Consequence:

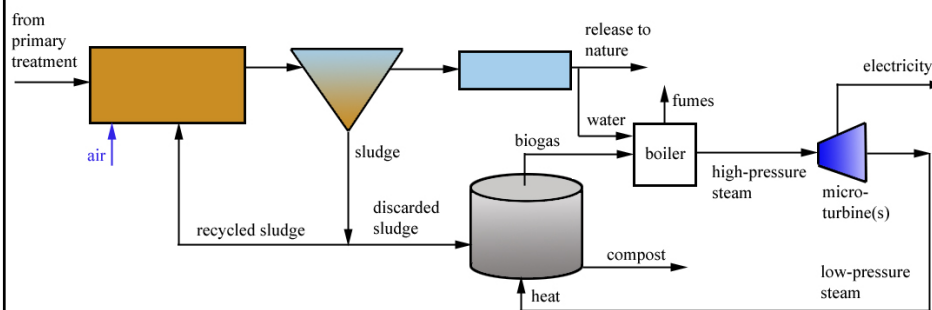
Energy efficiency in water and wastewater facilities translates into substantial savings benefiting agencies and taxpayers.

#### Energy source:

Anaerobic digestion of secondary-treatment sludge generates plentiful biogas.

In California, out of 242 sewage treatment plants, already 10 generate 38 MW from biogas, and another 12 burn biogas to produce hot water to heat digesters.

What about the 220 others?



Biogas emanating from digester = methane ( $\text{CH}_4$ ), hydrogen sulfite ( $\text{H}_2\text{S}$ ) and some siloxane (from personal care products)

Electricity is used to power pumps.

*Variations:*

1. Combust gas directly in the microturbine(s)
  - + no need for boiler
  - corrosion of turbine blades by sulfur (from H<sub>2</sub>S)
  - deposition of SiO<sub>2</sub> (from siloxane)→ need to scrub the biogas before passing it through the turbines
2. Pass biogas in fuel cells (molten carbonate type)
  - more electricity, less heat)
3. Simply burn the biogas and use the heat (no electricity co-generation)
4. Complement energy source with solar

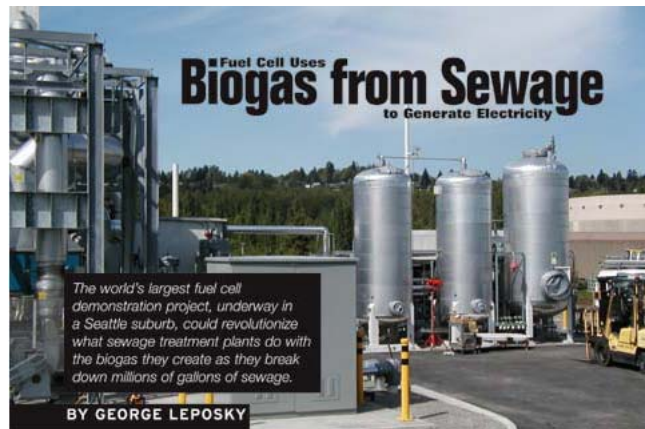
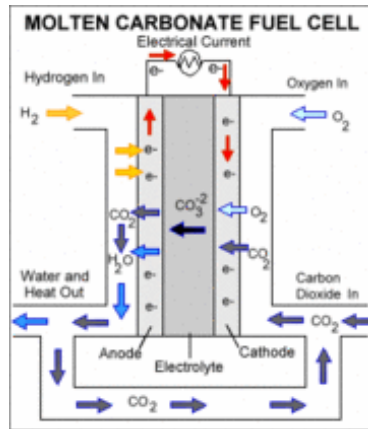


PHOTO: KING COUNTY

The fuel cell, located at the South Treatment Plant in Renton, WA, can consume about 154,000 cubic feet of biogas a day to produce up to 1 MW of electricity. That's enough to power 1,000 households, but it is being used instead to help operate the plant.

The fuel cell's electric output will save the Wastewater Treatment Division (WTD) of King County's Department of Natural Resources and Parks about \$400,000 a year—money that otherwise would be spent to buy electricity from the local utility.

(George Leposky – [http://www.forester.net/de\\_0511\\_fuel.html](http://www.forester.net/de_0511_fuel.html))



([http://en.wikipedia.org/wiki/Molten-carbonate\\_fuel\\_cell](http://en.wikipedia.org/wiki/Molten-carbonate_fuel_cell))

**Molten-carbonate fuel cells (MCFCs)** are high-temperature fuel cells, that operate at temperatures of 600°C and above. They have the highest efficiencies of any type fuel cell, including solid-oxide fuel cells, proton-exchange membrane fuel cells and phosphoric-acid fuel cells and are not subject to the high-temperature material issues that affect solid-oxide technology. (Excerpted from Wikipedia)

Performance of fuel cell at King County wastewater treatment plant:

- Continuous operation since 2004
- Currently generating 1 MW (90% of the time) and can easily be upgraded to 1.5 MW
- Efficiency in generating electricity: 43% to 47%
- With heat recovery, efficiency increases to 65%

Initial cost: \$23.9 million



([http://www.fossil.energy.gov/programs/powersystems/fuelcells/fuelcells\\_moltencarb.html](http://www.fossil.energy.gov/programs/powersystems/fuelcells/fuelcells_moltencarb.html))

Other places where fuel cells are used in wastewater treatment facilities:

Los Angeles (downtown & Palmdale), Santa Barbara (El Estero), New York (Yonkers)



(<http://www.city.albertlea.org/wastewat.htm>)

Albert Lea facility in Minnesota:

12 million gallons/day of sewage

4.5 million gallons/day sludge

75,000 ft<sup>3</sup>/day of biogas

Biogas is 60% CH<sub>4</sub> and 10<sup>3</sup> ppm H<sub>2</sub>S  
plus traces of siloxane

4 Capstone microturbines, 30 kW each  
producing 2,500 kWh per day at peak production  
plus 28,000 Btu/day of heat



Use of the system results in energy generation as well as the reduction of energy costs.

