BioCycle energy

PIPELINE TRANSFER

DIRECTED BIOGAS TO POWER FUEL CELLS

A change in California's Public Utility Commission rule to allow injection of purified biomethane into natural gas pipelines opened the door for on-site power projects in San Diego.

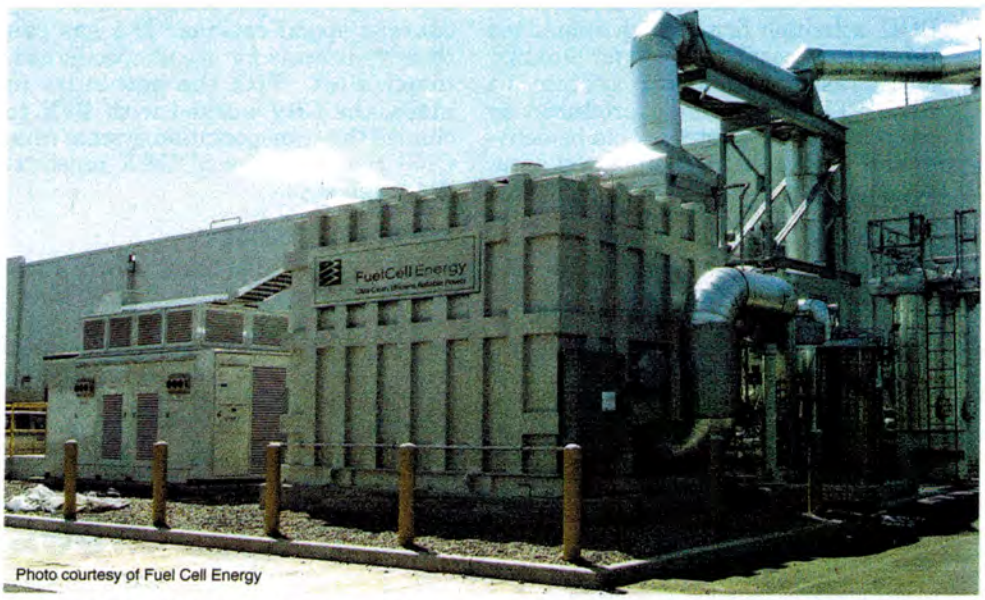


Photo courtesy of Fuel Cell Energy

The South Bay Water Reclamation plant is installing a 1.4 MW fuel cell (similar to one pictured) using directed biogas from the Point Loma Wastewater Treatment Plant digesters.

Diane Greer

BIOFUELS Energy, LLC (BFE) in Encinitas, California, started construction late last year on a $45 million project to purify biogas produced at the Point Loma Wastewater Treatment Plant (PLWWTP) in San Diego. The purified biogas will be delivered via natural gas pipeline to three fuel cells generating 4.5-megawatts (MW) of power. The project is slated for completion in November 2011.

The project uses a concept known as "directed biogas," where purified biogas (biomethane) injected into pipelines is delivered off-site from where the biogas is produced. The utility transporting the gas does not deliver the identical gas injected into the pipeline but instead delivers gas to designated customer sites on a therm-for-therm basis. In this case the directed biogas will power BFE's fuel cells producing renewable energy at the City of San Diego's South Bay Water Reclamation Plant and the University of California, San Diego (UCSD). A third fuel cell will produce power for the biogas purification system at the PLWWTP.

The directed biogas project is the brainchild of Frank Mazanec, managing director at BFE. Mazanec is interested in finding alternative uses for biogas generated at landfills and anaerobic digesters at wastewater treatment plants and other locations. About five years ago, he approached the City of San Diego about using excess biogas produced at PLWWTP. The Point Loma plant is San Diego's largest wastewater treatment facility, processing 175-million-gallons of wastewater a day.

The plant flares over 1.3 million cubic feet/day of digester gas, about a third of its total biogas production. The volume of flared biogas is due to better than expected results from plant upgrades, completed in 1998, that included improvements to the anaerobic digester system and an expansion of the electrical generation capacity from 2.6-MW to 4.5-MW at the plant's biogas utilization facility. "Our digesters ended up being more effective at producing biogas then was projected," explains Tom Alspaugh, senior mechanical engineer with the City of San Diego.

"Therefore we had our flares running more than we expected."

Using the excess biogas to produce electricity was not cost-effective. The plant already generates more electricity than it uses, selling about 3.5 MW to San Diego Gas & Electric (SDG&E). (The plant consumes 2.0 MW. Total power production, including the Point Loma hydroelectric facility, is 5.5 MW.) Exporting additional electricity required expansion of the cogeneration facility and an expensive upgrade of the onsite SDG&E substation to increase its export transmission capacity.

In response to inquiries from Mazanec and others, the City of San Diego started a RFQ/RFP process in 2006 to solicit proposals from third parties interested in buying the excess biogas.

BFE was the local representative of BOC, a British firm, which submitted the only proposal. It called for building a biogas purification system at PLWWTP. Biomethane produced by the purification system would be delivered to customers in compressed natural gas (CNG) trucks. At the time, SDG&E did not permit pipeline injection of biomethane.

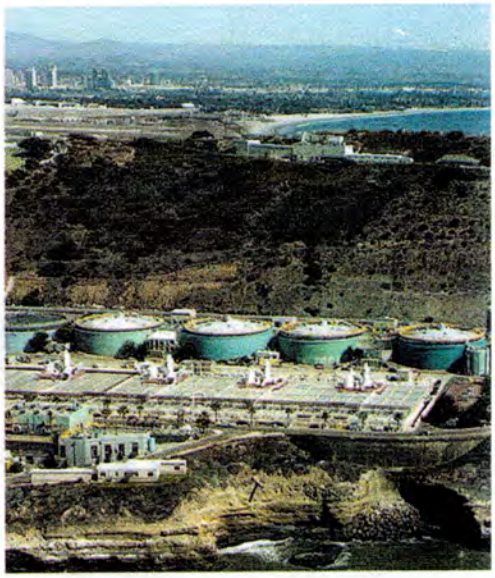
During the course of project development BOC was acquired by the Linde Group in Munich, Germany. Linde subsequently ran into problems financing the project. BFE arranged alternative financing and took over the project. Under the contract with San Diego, BFE secured the long-term rights to purchase 270,000 MMBTUs of biogas annually (about a third of PLWWTP's daily production). The city will receive about $300,000 a year for the gas.

Not long after BFE took over the project in 2009, individuals from the surrounding community raised concerns about CNG trucks passing through their neighborhood. The issues surfaced despite a two-year effort by the project team working with neighborhood representatives to design trucking routes and address safety concerns.

That same week (in August 2009) the California Public Utilities Commission revised Rule 30, which dealt with the transportation of customer-owned gas in utility pipelines. The revised rule allows injection of biomethane into natural gas pipelines as long as the gas meets stringent gas quality and energy content specifications. The gas can then be directed for use at specific customer sites. With the new rules in place, the City worked with BFE to change the transportation system from CNG trucks to the SDG&E pipeline, Alspaugh says.

BIOGAS PURIFICATION

BFE tapped SCS Engineers in Long Beach, California, to design, build and operate the biogas purification system at PLWWTP. The system will process up to 1,100-scfm of biogas and produce biomethane meeting the gas standards specified in Rule 30. The average flow



of gas is expected to be between 900- and 1,000-scfm.

Rule 30 requires the energy content of the gas to be between 990 and 1,100 Btus/scf. "That is the most stringent standard we have seen for BTUs," says Jeff Pierce, SCS senior vice president. Carbon dioxide content can't exceed 3 percent by volume, oxygen must be less than 0.2 percent by volume and water vapor can't exceed 7 lbs/mmscf at 800 PSIG. Hydrogen sulfide (H_2S) levels must be 4-ppm or less. VOCs (volatile organic compounds) and siloxanes have limits down in ppm or ppb (parts per billion) range.

ALTERNATIVE DIRECTED BIOGAS PROJECTS

WHETHER it will be possible to do another directed biogas project with fuel cells is up in the air. California is currently looking at changing its Self-Generation Incentive Program (SGIP). "Directed biogas may actually be excluded from receiving SGIP monies at the same incentive levels going forward," Frank Mazanec of Biofuels Energy LLC. If so, directed biogas project using fuel cells may not be economically viable.

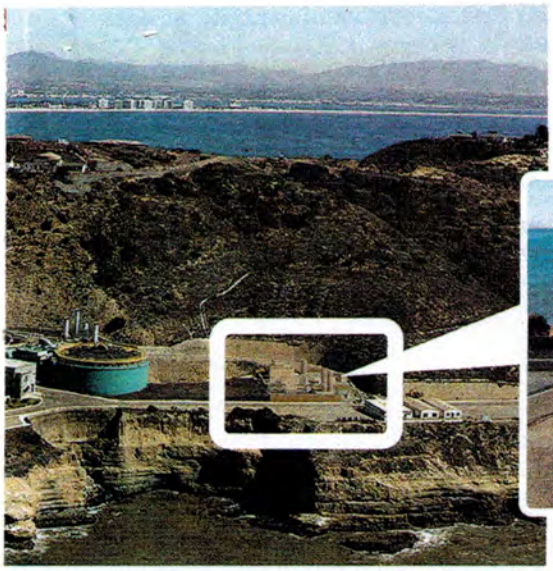
Even if the use of directed biogas in fuel cells is eliminated from the SGIP, directed biogas is still feasible in other applications. "You can still take the gas and clean is up for use as transportation fuel, sell it to a utility to fuel existing generation units to meet RPS goals or utilize other energy generation technology," Mazanec explains.

Jeff Pierce of SCS Engineers notes that some states are talking about requiring low carbon standards for vehicle fuel. Companies like Clean Energy Fuels, a provider of natural gas fuel, could add green gas (biomethane) to its product to reduce its carbon intensity. "Compressed natural gas (CNG) has more value than natural gas so there would be even more of a premium value associated with green gas used in that kind of market," says Pierce.

While using biomethane as vehicle fuel is appealing, there are problems from a project development standpoint. Biomethane meeting CNG vehicle fuel standards costs about $1.70 a diesel gallon equivalent whereas gasoline right now is hovering about $4 per gallon, Mazanec says. "As overwhelming as these numbers sound, the difficulty in developing a project is getting enough vehicles to commit on a long term basis. You need upwards of 1,000 CNG vehicles committed for 10 years to take that fuel."

Directed biogas may offer a cost-effective and efficient solution for utilities seeking to meet state Renewable Portfolio Standards (RPS). Many utilities run larger, very efficient natural gas power plants, which are significantly more efficient than smaller renewable power plants generating electricity, Pierce explains. "Substituting only 5 percent of the natural gas with 'green gas,' even if you are paying $10 MMBTU, is a less expensive way to get your green power than going out and paying $0.10 per kWh to buy green power off of someone producing it in some other way."

In other words, it may be much more cost-effective for utilities with large natural gas plants to meet their RPS requirements with directed biogas to fuel their own engines as opposed to purchasing green electricity produced by a small distributed generation system located at a wastewater treatment plant or dairy. Both options will satisfy state RPS requirements (assuming the state RPS allows directed biogas to qualify for the renewable energy credits).



The aerial view of the digesters at the Point Loma WWTP (left) highlights where the biogas purification plant will be sited. Installation of the purification system (rendering below) begins this month.

Images courtesy of SCS Engineers

The biogas produced by PLWWTP is about 60 percent methane. The H_2S levels are low at about 50-ppm. PLWWTP, like most California wastewater treatment plants, adds ferric chloride to its digesters to reduce H_2S levels, Pierce explains. Siloxane levels are typical for a municipal wastewater treatment plant, averaging around 30mg/m^3.

Biogas entering the purification system is refrigerated to remove moisture and compressed to 200-psi. Moisture is removed to protect the compressors. "You want to make sure the moisture does not condense out as a result of the pressurization process," Pierce says. The pressurized gas is fed to a purification skid, supplied by Air Liquide Advanced Technologies. The first two components on the skid, a pressure swing absorption unit (PSA) and a non-regenerative activated carbon unit, act as a pretreatment system for the gas. "When most people think of PSA they think CO_2 removal," Pierce says. "The PSA is only there to selectively rough out VOC's, H_2S and moisture. It then goes to the activated carbon."

The pretreatment process protects the third component on the skid, the membrane separation unit. This unit employs a polymeric hollow fiber membrane to selectively separate the methane gas from CO_2, H_2S and water vapor. Biogas exiting the membrane already meets reasonable standards for siloxanes and VOCs but to insure gas quality the biomethane is put through two stages of activated carbon. "That is a polishing step to provide absolute protection," Pierce explains. Propane spiking is employed to increase the energy content of the gas if the BTU content is below spec.

Prior to pipeline injection the biomethane is sampled to determine if it meets pipeline quality specifications. The sampling unit continuously monitors the gas for methane, CO_2, H_2S, O_2 and moisture content. If the gas does not meet the specification, even for a minute, the unit will shut down the flow to the pipeline until the gas again meets spec.

To prevent shutdowns the purification system analyzes methane, CO_2, moisture and O_2 levels prior to the gas reaching the sampling system. "If we see we are going off spec then we put the plant into recycle mode before it hits the pipeline and they shut us off," Pierce explains. SCS will operate and maintain the system for 10 years. An operator will man the system 40 hours a week. During other times a SCADA system permits remote monitoring and operation from a PC. Construction of the foundation for the biogas purification system started in late 2010. Installation will begin in June.

BIOMETHANE UTILIZATION

BFE decided to direct the purified biogas (biomethane) it puts into SDG&E's pipeline to power fuel cells based on available incentives. "The question is what is the highest and best use of the biogas," Mazanec says. "I came to the conclusion that the use of biogas in fuel cells, as a result of California's Self-Generation Incentive Program (SGIP), and other Federal incentives, made the most economic sense."

SGIP offers rebates for the installation of new, qualifying self-generation equipment, such as fuel cells and wind turbines, providing a portion of a customer's electric load. Rebates for fuel cells using renewable fuels are based on installed generation capacity and

set at $4,500/kW for the first megawatt of capacity at each site, $2,250/kW for capacity between 1-MW and 2-MW and $1,125/kW for capacity between 2-MW and 3-MW. Under the incentive structure a 2.8-MW fuel cell will receive a rebate of $7.65 million. "The program effectively pays for the initial purchase of the generation equipment," Mazanec says.

Fuel Cell Energy in Danbury, Connecticut is supplying the molten carbonate fuel cells for the project. "They had the breadth of experience when you look at the number of units installed to get the funders comfortable with the technology," Mazanec explains. "Secondly the sizing of the units fit the application really well."

A 2.8-MW DFC3000 fuel cell will be installed at UCSD and supply about 8 percent of the campus' electrical needs under a 10-year power purchase agreement. Currently the campus generates about 85 percent of its own power. "The University was looking for a green project and the concept of having a fuel cell powered with renewable energy was very unique," Mazanec says. The price was also attractive. BFE is selling electricity for less than the retail rates paid by UCSD.

Waste heat from the fuel cell will not initially be used. The transaction is structured such that the University can use the waste heat for free, although it will need to purchase the incremental equipment required to capture and distribute the heat.

A 1.4-MW DFC1500 fuel cell plant is under construction at the city's South Bay pump station that does not generate its own biogas. San Diego will purchase the power generated by the fuel cell at a discounted rate for 10 years. Alspaugh estimates the City will save about $80,000 in electricity costs annually. As with the UCSD contract the City holds the rights to use the waste heat generated by the fuel cell. A third 300-KW DFC fuel cell at PLWWTP will provide the electricity for the biogas purification system.

FINANCING AND PROJECT ECONOMICS

Hanover, New Hampshire-based New Energy Capital teamed with the CleanTech Alliance Fund, managed by Minneapolis-based North Sky Capital, to finance the BFE project through a complex combination of equity, tax credits and incentives. The project is taking advantage of $14.4 million in SGIP incentives along with federal Investment Tax Credits (ITC) and New Market Tax Credits. US Bancorp provided tax credit financing in collaboration with New Markets Community Capital, a division of TELACU.

The federal ITCs provide 30 percent of the net project cost (after SGIP rebates) as a tax credit or a grant (awarded when the facility is completed) for projects started before the end of 2010. The New Market Tax Credits were established in 2000 to encourage investment in low-income communities with poverty rates of at least 20 percent. (BFE's project is located in a low-income community as defined by the New Markets Tax Credit rules.) The program provides federal tax credits equal to 39 percent of the qualified equity investment (after the SGIP) over a 7-year period and can be sold to a third party.

Further funding was provided by the California Pollution Control Financing Authority, which approved $12 million in tax-exempt bonds for the project. "I have been involved in projects valued at hundreds of million dollars and they do not compare to the complexity of this project," Mazanec says. "New Energy Capital really took the concept to heart and went the extra mile. Most other investment companies would not have persevered."

Revenues for the project come from the sale of electricity generated by the fuel cells and renewable energy credits. Revenue from the energy credits are partly shared with the City of San Diego and UCSD. UCSD owns the last five years of their portion of the credits. ■

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