Biosolids-to-Energy Project Leads to 15-MW Power Facility

Stamford waste gasification system will produce power, opens new market for biosolids

Stamford, Conn., has proven that when gasification — a century-old technology known for its role in "clean coal" — is combined with biosolids, it produces power.

About 6 years of research, design, and testing for the Stamford project has culminated in the design of a 15-MW biosolids gasification facility. This first-of-a-kind project in the United States may increase the value of wastewater facilities and assist with energy independence.

"I came out as a skeptic, but I became a believer," said Jeff Fournier, a senior project manager with Carlan Contracting (Waterford, Conn.).

Biomass gasification has been used in Europe and Japan to generate energy but has not been embraced in the United States. "It's a relatively new market," said Brian Gackstatter, a senior project manager for CH2M Hill (Englewood, Colo.).

Search for Power

Stamford sits in an electrical congestion zone, where power costs are high. The city needed a power solution and also had the desire to be a green community, said Jeanette Brown, executive director of the Stamford Water Pollution Control Authority.

Brown proposed the waste gasification project when Stamford Mayor Dan Malloy was discussing renewable energy. Malloy then brought the idea to U.S. Sens. Lieberman and Dodd, who advocated for the cause in Washington, D.C. As a result, the city received $3 million in grant money from the U.S. Department of Energy to research the project.

"I've been very aggressive on [the project's] behalf," Malloy said. "We're going to prove this technology."

Over the last 2.5 years the project team has researched, designed, and built a solids drying facility; constructed a pilot reactor; and performed full-scale testing.

The team is completing its assessment and beginning the design of a 15-MW power plant — the first in the country to turn human biomass pellets into energy. The power plant will supply enough electricity to operate Stamford's wastewater treatment plant — approximately 1 MW — and sell the rest.

A new gasification system has recently been designed in Stamford, Conn. The system shown above is located in the fabrication shop where the project team constructure the pilot-scale research plant. The pilot plant was built between April and June 2008. Photo courtesy of Carlin Contracting Co. Inc. (Waterford, Conn.). Click for larger image.

Moving Solids Disposal to Profit

The proposed facility offers an alternative to land application and other disposal methods, and will use more biosolids than the city generates. Neighboring communities could use the facility as a disposal outlet.

"Biosolids disposal can be a problem and this may be another way to dispose of it with a very beneficial use," Brown said.

Fournier noted that waste gasification is not the most efficient way to make energy, but, he added, “it’s revolutionary in the management of our oldest waste.” With gasification, biosolids mass is reduced 95%, he explained. “Waste management is moved from cost to income.”

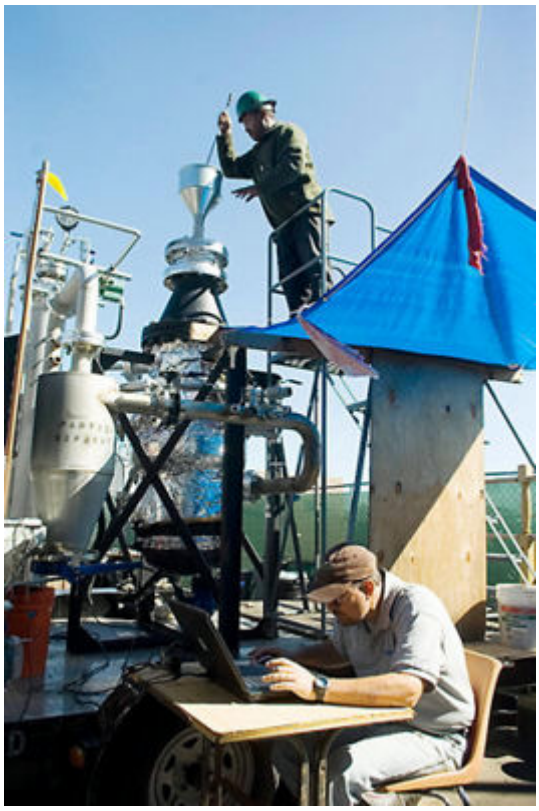
The greatest savings may be that energy-intensive anaerobic digestion, which reduces the volatile content of waste activated sludge, can be eliminated from the wastewater process, Brown said. While any biomass containing carbon can be used for gasification, high volatile content is needed to generate the highest Btu product.

Even with methane recovery systems working in concert with anaerobic digesters, Brown added, there is still solids disposal to deal with. According to Fournier, “about 60%” remains.

How It Works

In Stamford, biosolids are dried and pelletized, then converted to a charcoal-like substance by pyrolysis. Then, the matter is converted to synthetic gas, or “thin gas,” at temperatures between 875°C and 925°C (1600°F and 1700°F). The product of gasification can then be fed to a generator to produce power. Gasification results in a very high Btu gas, composed of hydrogen, carbon monoxide, and methane.

Fine tuning the temperature range is essential; if the temperature is too low, there is too much tar; if it is too high and exceeds the fusion point, then “you make moon rocks,” Fournier said.



A member of the project team loads palletized solids feedstock into the top of the system. The team ignites the pyrolysis zone from the top. Photo courtesy of Carlin Contracting. Click for larger image.

The process also uses “virtually zero energy” to reach the high temperatures, all that is required is a 1.5-hp blower, Fournier said. "No external heat sources is required, and the working temperature of 900 degrees Celsius is easily achieved with a small blower or vacuum." The blower pulls air through the system during gasification so that the reactor reaches the desired temperature. “And that’s the amazing part,” he added.

Going Green

“Gasification is really a clean technology” because there is no carbon dioxide released into the air from the gasifier, said Brown. Other processes, such as incineration, result in carbon dioxide emissions, she added.

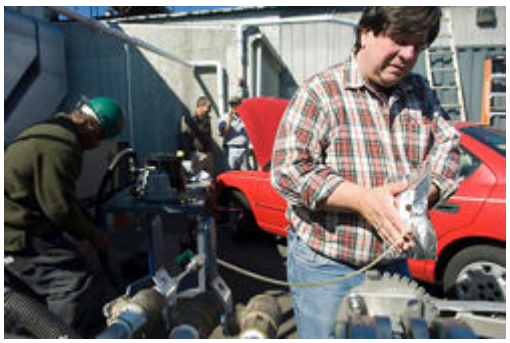
Other typical byproducts from power generation — nitrogen and sulfur oxides — will be included under a modified version of Stamford’s existing air quality permit for the pelletizer.

An ash byproduct from the gasification process contains the carbon dioxide and metal oxides in solid form. The byproduct can be reused in asphalt, concrete, and possibly ceramic tile.

The team is also looking at capturing waste heat from the process to preheat air going into the pelletizer and using cogeneration to heat wastewater treatment facilities, lowering reliance on natural gas.

“Our goal is to use everything beneficially,” Brown said, explaining that her team looks at the wastewater process holistically, and adding gasification reduces the city’s carbon footprint.

A Dodge Neon, donated to the project by the Stamford Vehicle Maintenance Department, is used to demonstrate that the motor can be run using gas derived from a pelletized fuel source. The project team piped Syngas (primarily hydrogen and carbon monoxide) to the inlet throttle body of the car to successfully power the car. Click here to see a video showing the car in operation. Photo courtesy of Carlin Contracting. Click for larger image.



Issues to be Resolved
Currently the project team is selecting the gasifier style and vendor for the Stamford installation. Because most gasifiers are designed for large coal-powered energy facilities, Stamford’s choices are limited, Gackstatter said. In terms of scale, vendors’ testing units are about the right size for Stamford’s proposed plant.

The team is choosing between updraft and fluidized bed technologies, finalizing power generation requirements, and exploring gas cooling and conditioning equipment.

“Gas cleanup in the process is really important,” Fournier said. “The program has developed a proprietary cleaning measure. It’s incredibly unique. It removes tar and moisture from the gas stream.” Unpolished gas, which the team tested in Oklahoma, creates steam with emissions, he noted.

Next Steps
Brown is hopeful that grant money will be available to help finance construction of the 15-MW plant — a $60 million project — so the city can sell its energy at a low cost.

The success of the testing has attracted attention, according to the team. “There are other clients around the country looking at this,” Gackstatter said. “The technology is developing. There will be a market, in my opinion, an expanding market in the future.”

“We probably know more about biosolids gasification than perhaps anyone in the world,” Brown said. “I’m hoping our project is really the impetus for other people looking at this.”

When venture capitalists are calling, “you know you are close to a breakthrough,” Fournier said.

— **Andrea Fox**, *WEF Highlights*