Combined Heat and Power Case Study

Site Description

The Cities of Gloversville and Johnstown, New York operate a Joint Wastewater Treatment Facility to treat up to 13.8 mg of domestic sanitary sewage daily. The Gloversville-Johnstown Joint Sewer Board (GJJSB) manages the facility located 35 miles west of Albany, NY and also treats a large, variable industrial wastewater discharge from food manufacturers, leather tanning and finishing, metal finishing, textile and other major industries.

The Cities have developed a strategy to use CHP technologies integrated with advanced activated sludge systems to achieve energy independence in the facility by 2010. Because CHP systems are so flexible in design and operation, use of the technologies has enabled this approach since GJJSB must be able to treat up to 30 MGD (peak) due to the variable industrial wastewater input to the treatment facility from industries in the area.

This strategy is built on previous CHP applications and operational experience. GJJSB staff believe their new design improvements and the construction now underway will more than double the facility's capacity for on-site electric power generation by boosting production of digester methane to fuel an expanded combined heat and power (CHP) system that will achieve the goal of generating all facility electricity needs on-site by early 2010.

Gloversville-Johnstown Joint Wastewater Treatment Facility

BioGas-Fired Engine Electricity Generation and Heat Recovery

Evolution of CHP Systems at GJJWTF – 1999-2006

The plant improvements under construction today are the result of design changes forced by a number of factors beginning in the late 1990s. The need to hold down costs became critical a few years later because industrial use of the facility was at an all-time low after several area plants closed and energy costs were increasing. Funds from the New York State Energy Research and Development Authority (NYSERDA) were used to hire a consultant to reduce power consumption.

Aeration System Efficiency Improvements –

That analysis identified the aeration system as the biggest energy user consuming two-thirds of the facility electricity. The aeration system had been sized when industrial

loadings were high, the plant treated industrial discharges 24 hours every day, and energy was relatively cheap. The study demonstrated the plant needed to automate the aeration system to cope more efficiently with fluctuations in organic loading. Beginning in 2002, a number of upgrades to the aeration system reduced annual electricity usage by 30 percent, saving more than 1.3 million kWh per year ($195,000) from an investment of about $1 million.

Increased Biogas Generation –

A second study funded in part by NYSERDA, focused on improving anaerobic digestion to increase production of biogas for on-site electricity generation. Again, the existing digesters had been built when natural gas and electricity costs were low. Plant staff eliminated gas leaks in the secondary digester, built a separate 50,000 cubic-foot dual-membrane gasholder, installed bubble gun mixers and replaced older mixing systems in the primary and secondary digesters, and also built a 90,000-gallon equalization tank for high-strength waste. The changes enabled staff to maintain a steady digester input and control digestion rates to achieve a more efficient and predictable output of biogas. 2005 data show digester biogas generation between 100,000 and 145,000 cf/d.

Dual-Membrane Gasholder

Rebuild Existing Engine Generators –
After the steps to make the aeration system more efficient and to improve digester performance and increase biogas production, the existing 20-year-old CHP system was substantially improved by rebuilding the two 150-kW engine-generators. The modification enabled staff to operate both engines continuously, rather than one at a time per the original design.

After the improvements and modifications, the unit now generates 1.8 million kWh annually (800,000 kWh previously). The 1.8 million kWh generated on-site saves $273,000 in electricity costs each year in addition to the $195,000 saved from the efficiency improvements to the aeration system operation. In addition to these savings, which total over 40 percent of the plant's electricity needs, heat is recovered from the engines to provide process heat for the digesters and the facility's Energy Recovery Building. The recovered heat also eliminates the need to purchase natural gas to heat the digesters.

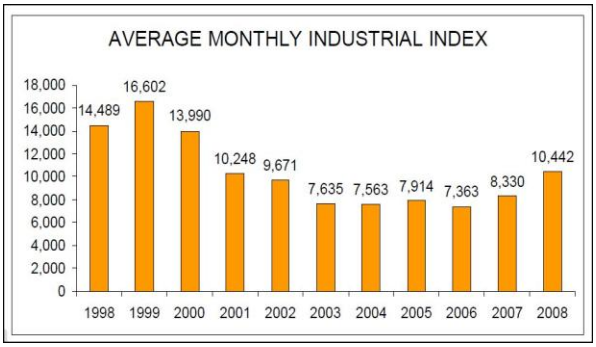
GJJWTF Existing Engine Generator System

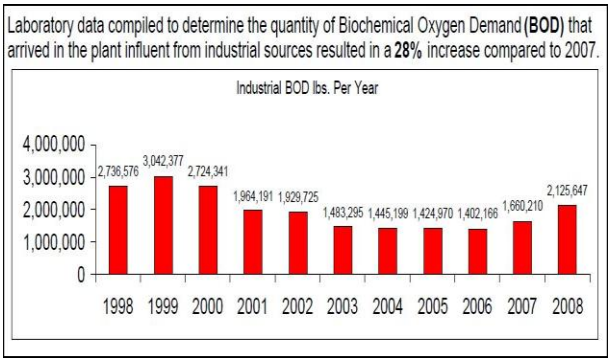
These process efficiency and CHP system improvements reduced facility electricity consumption by nearly 50 percent through 2006.

Energy Independence Strategy

A 2005 evaluation of the facility by Malcolm Pirnie, Inc. sponsored by NYSERDA provided the GJJSB with options for further

reducing electricity costs. The evaluation and its recommendations were timely because local and regional economic development efforts had begun to bring industrial companies back to the area, in particular the food manufacturing sector, which demanded high-quality, reliable waste treatment processes. Industrial plant loadings began to increase in 2007, but as shown in the two graphs below significant increases in 2008 gave the GJJSB the impetus needed to implement an aggressive strategy to improve the facility so that all electricity needed to treat the combined municipal and industrial waste streams could be generated on-site.





With higher loadings and more biogas resulting from the process improvements made earlier in the decade, there was little question that the plant could generate 100 percent of its own electricity.

The strategy to generate all facility electricity on-site has three components with the CHP portion being the critical element that leverages the other two. The first project in the new strategy will pre-treat the food manufacturers' wastewater to reduce loadings to the aeration tanks. Two dissolved air flotation (DAF) tanks will be added to the system to reduce the large industrial organic load that is now piped directly to the aeration tanks. The DAF addition will float fats, oils and grease (FOG) that are a major component of the industrial waste for skimming and transport directly to the digesters. The clarified effluent, greatly reduced in BOD, will be fed to the aeration tanks for further treatment.

The second project in this strategy will build on previous efforts to increase anaerobic digestion efficiency to capitalize on the increased loadings. The new process addition will utilize a new gravity belt and high-pressure rollers to remove as much water as possible before primary and secondary sludge enters the primary digester. An existing gravity thickener and a rotary drum thickener will be replaced and the new design will recycle a portion of the liquid from the gravity belt process and feed it back to the digester. The intent is to closely control the BOD loading into the digester to convert more of the sludge to gas (more input to CHP) and also reduce hauling costs for excess sludge to area landfills.

The last and critical component in the new design to accomplish energy independence at the facility is based on CHP and will provide a significant increase in the capacity of the engine generators now in use at the GJJWTF. Ten percent of the biogas from the digesters was routinely flared in 2007, but by midyear 2008 50 percent of the valuable digester byproduct fuel was flared even with the two existing engine-generators running at full capacity. The new strategy uses a design and has allocated funds to replace the two existing 150kW engine generators and purchase two new 350-kW units to handle the peak electric load of 700 kW. Waste heat recovery

components from the engines will continue to recover engine heat for supply to the digesters. The new process and CHP systems will allow the plant to produce all the electricity needed for on-site facility power. The facility will still purchase some natural gas, but only to heat the administration and garage facilities.

GJJSB Investments and Benefits – 1999-2006

Cost:

- Aeration System Upgrade
- Digester Process Improvements
- Rebuild Existing Engine Generators

= $3,500,000

Annual Savings: (includes reduction of natural gas used to heat digesters)

= $468,000

Energy Independence Strategy Planned Investments – 2009-2010

Cost Estimate: = $7,000,000

The GJJSB has already secured about half the funding for the project through state and federal grants:

- U.S. Economic Development Administration grant award = $2,200,000
- NYSERDA grant = $1,400,000

In addition, the City of Johnstown has arranged a $7 million loan to complete the project outlay requirements. The two Cities have also requested ARRA Stimulus Funds in the amount of $4,800,000 to reduce the amount of loan obligation needed to complete the project.

Lessons Learned

1) To gain the greatest impact from CHP technologies, it is imperative that older treatment facilities review original design assumptions from days of less expensive energy:
    a. GJJWTF has made significant modifications to other process subsystems to reduce the amount of electricity needed to run the facility;
    b. All process subsystems need to be analyzed to determine how to produce the greatest amount of biogas from digesters. GJJWTF has substantially improved operation of both aeration and digester processes to control BOD loadings and produce more biogas for feed to CHP engine generators;

2) GJJWTF has relied heavily on support organizations (NYSERDA) for assistance in analyzing and acquiring funds to improve plant operations. Doing so helps deploy the latest, most efficient process technology and leverage CHP technologies to reduce facility electricity costs (and reduce emissions from fossil-fueled utility electricity generation that is offset).

Involved CHP Organizations:

Cities of Gloversville and Johnstown, New York; Gloversville-Johnstown Joint Sewer Board; operations and project management

NY State Energy Research and Development Authority (NYSERDA)

- Energy Evaluation
- Project Grant Funding;

US Economic Development Administration; funding assistance

Malcolm Pirnie, Inc.; NYSERDA Contractor for Energy Evaluation Study

Niagara Mohawk Power Corporation; electric utility

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