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Case Study – Sheboygan, WI
Energy Efficiency in Wastewater Treatment Plant

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In Brief

Location: City of Sheboygan, Wisconsin
Policy type: Water and Wastewater, Distributed Generation, Government Lead by Example, Financial Incentives for Energy Efficiency
Sector: Infrastructure / Industrial
Start Date: 2002
Summary: The Sheboygan Wastewater Treatment Plant (WWTP) is recognized as a nationwide leader in energy efficiency in the water and wastewater treatment sector. Sheboygan WWTP has implemented numerous energy-saving measures, mostly by replacing aging equipment with energy-efficient models.
Impact: The plant now uses 20% less energy compared to a baseline figure in 2003 and ranges from 70-90% energy self sufficient due to the energy produced on-site.

Overview

Early on in his role as Plant Superintendent, Dale Doerr recognized that while he could not control the cost of energy, he certainly could control its usage. The facility in Sheboygan is a primary and secondary waste treatment facility built 30 years ago with continuous need for improvement. Beginning with a study focused on the energy efficiency and renewable energy potential at its facility conducted in 2002, Sheboygan Wastewater Treatment Plant (WWTP) has closely focused on energy usage at its facility with the goal of eventually becoming energy self-sufficient. Sheboygan WWTP has undertaken numerous initiatives to reduce energy consumption and produce energy on-site. The "unwritten policy" at Sheboygan WWTP is to consider energy use whenever an equipment or process upgrade is needed. The plant now uses 20% less energy compared to a baseline figure in 2003 and ranges from 70-90% energy self-sufficient due to the energy produced on-site.

Aerial View of Sheboygan Wastewater Treatment Plant
(Photo provided courtesy of Sheboygan Regional WWTP)

Management and Funding

Capital investment recommendations for Sheboygan's WWTP made by Mr. Doerr must be approved by the Director or Deputy Director of Wastewater and, at times, the Director of the City of Sheboygan Department of Public Works, the Mayor, or City Council. Sheboygan's initiative to save energy and produce it on-site derived mostly from his leadership and the staff at the plant level. Funding for these investments is provided mostly by the city. Wisconsin Focus on Energy (FOE), the statewide ratepayer-funded energy efficiency program, has played an important role by providing technical assistance and financing the energy efficiency measures with grants. Opportunities for energy efficiency investments had

to be presented to City representatives with all the facts laid bare, including benefits as well as the upfront costs, expected paybacks, and any uncertainty involved. In order to conduct this type of presentation, data collection and benchmarking energy consumption plays a major role in order to understand the energy impact of new measures. Sheboygan WWTP benefits from the effective use of nine power meters that feed information into the plant SCADA (Supervisory Control And Data Acquisition) system. Plant management has also used the *EPA Portfolio Manager Tool for Wastewater Facilities*.

Most of the credit for the energy efficiency measures undertaken in Sheboygan rests with the Plant personnel and city officials, who have leveraged resources from the local utility, FOE, and vendors to achieve impressive energy efficiency and cost savings for the city. Statewide, Wisconsin has taken a more proactive approach to energy efficiency in its regulations on wastewater treatment facilities than most states. Following the release of the *Water and Wastewater Energy Best Practice Guidebook* by Focus on Energy in 2006, the Wisconsin Department of Natural Resources issued a statement that encouraged energy considerations to be included in the required project cost-effectiveness calculations (included in Appendix B of the Guidebook).

Performance

Combined Heat and Power Project

Aside from stakeholders at the plant and in local government, Alliant Energy (AE), the electric utility serving Sheboygan WWTP, has also been an important partner for the plant's combined heat and power (CHP) projects that generates electricity and heat onsite. When a boiler upgrade was planned in late 2005, plant leadership directed personnel to research how the facility might be able to use its bio-gas – a by-product of the wastewater treatment process- to produce electricity and heat. The Plant decided to partner with AE, a distributor of Capstone™ Micro-Turbines, to install ten 30 kW micro-turbines, along with heat exchangers and gas conditioning equipment. The project was completed in 2006. The micro-turbines allow the plant to burn biogas from its anaerobic digesters to produce 2,300 MW of electricity annually (resulting in about $78,000 in energy cost savings per year) and produce 84,000 therms of heat, valued at over $60,000 per year at today's natural gas rates. The biogas fuel is provided by the plant, the electricity produced is sold by AE to the city and the heat is used by the plant to maintain the proper temperature in the digesters. As Mr. Doerr explains, the motivation was all about the bottom-line: "With energy costs increasing each year, we were actively looking at different ways to reduce our total energy bill. Since we were wasting excess biogas produced at the wastewater treatment plant, it became evident that we could use the excess biogas as fuel for the Capstone Micro-Turbines and reduce our energy cost. Our partnership with Alliant Energy made this project a reality."

Five of the ten 30 kW microturbines (photo courtesy of Sheboygan WWTP)

Premium Motors

Sheboygan WWTP has also replaced many of its motors with efficient models installed with variable frequency drives. A replacement of two motors with two 200 horsepower (hp) NEMA Premium™ motors at its influent pump station in 2006 cost $170,000. As with many of the Plant's other energy-efficiency efforts, Focus on Energy provided technical assistance and for this particular project, along with a grant for $3,861. The new motors reduce energy use by 157,000 kWh (over $5,300 in energy cost savings) per year.

Another project that replaced motors with two new 125 hp NEMA Premium™ Motors in 2004 cost $150,000. The project received a Focus on Energy grant of $6,142, offsetting the higher costs for the higher efficiency motors. The energy savings for the first year exceeded $12,000. The average monthly reduction in kilowatt hours consumed for the first 10 months of operation was 6,595 kWh (Focus on Energy 2006).

Blowers and Dissolved Oxygen Controls

Another major upgrade, featured in an EPA best practice document (2010), was the replacement of four older, less efficient blowers with more efficient units.[1] After realizing that without control valves, dissolved oxygen levels in the individual aeration basins could not be controlled, the plant installed control valves in 2009. Details of the costs and savings from these two investments are described in the tables below.

Table 1: Blower Implementation Cost

Cost Category	Cost (in Y2005 $)
Capital Cost	504,000
Installation Cost	286,000
Focus on Energy Grant	-17,000
Total Cost	**773,000**

Source: EPA 2010

Table 2: Control Valve Implementation Cost

Cost Category	Cost (in Y2009 $)
Capital Cost	60,000
Installation Cost	68,000
Total Cost	**128,000**

Source: EPA 2010

Table 3: Blower and Control Valve Implementation Electrical Energy Savings

Year	Energy Consumption and Savings		Energy Costs and Savings	
	kWh Used	kWh Annual Reduction	Rate ($0.00/kWh)	Annual Savings
Pre ECM Implementation				
2004	2,760,000	Baseline Year	$0.0538	Baseline Year Cost = $148,8888
Post ECM Implementation				
2006*	2,402,000	358,000 (13%)	$0.0665	$23,807
2007*	2,402,000	358,000 (13%)	$0.0720	$25,776
2008*	2,402,000	358,000 (13%)	$0.0764	$27,350
2009**	1,943,000	817,000 (30%)	$0.0782	$63,889

*Electrical energy savings, from blower upgrade only, estimated by utility – blower electrical energy not sub-metered
** Electrical energy savings from blower upgrade and air control valve combined, estimated by utility – blower electrical energy not sub-metered
Source: EPA 2010, Estimated annual energy cost savings provided by Sheboygan WWTP Superintendent

Lessons Learned

Staff commitment to measurement and optimization has been critical for the success of energy initiatives at Sheboygan WWTP. A key component of the staff engagement has been the easy display and monitoring of energy usage in the plant. Sheboygan WWTP greatly benefits from nine power meters that feed information into the plant SCADA (Supervisory Control and Data Acquisition) system, which is capable of monitoring performance of equipment and processes throughout the entire plant. While many facilities use SCADA, Sheboygan uses the tool innovatively by connecting the system to its DO controls to improve feedback of energy usage information. The SCADA system allows plant operators to monitor status and make process adjustments from various terminals located throughout the plant, as well as from

[1] Replacement of 250 hp positive displacement blowers with two single-stage centrifugal blowers equipped with 350 HP NEMA Premium™ motors.

one central location at the wastewater treatment plant. Critical to its success, Sheboygan has not only made investments in high-efficiency technologies, but has paired the investments with continuous engagement and commitment to measurement and optimization, enabled by control technologies.

Staff evaluates the lifecycle cost of all projects, instead of implementing the least capital cost fix for replacing failing equipment. The proactive approach taken by the staff—engaging numerous stakeholders including utilities, equipment vendors, and energy efficiency service providers such as FOE—and the thorough analysis undertaken to make the business case for energy efficiency is critical to Sheboygan's success. The local governmental officials ultimately responsible for approving projects need straightforward, reliable data on projected costs and benefits to make the proper decision. The more prepared facility staff is to make the case for energy efficiency, the more likely they will win approval.

Related Resources

ACEEE Local Policy Toolkit: Energy Efficiency in Water and Wastewater Facilities.

U.S. EPA. 2010. Evaluation of Energy Conservation Measures for Wastewater Treatment Facilities. Washington, D.C.: U.S. Environmental Protection Agency.

Focus on Energy. 2006. Water and Wastewater Energy Best Practice Guidebook. Prepared by Science Applications International Corporation (SAIC).

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