

Importance of Energy Efficiency to the Water and Wastewater Sector

by Matthew Yonkin, Katherine Clubine and Kathleen O'Connor

The municipal water and wastewater sector in New York State is energy intensive. Energy costs to pump, treat, deliver and collect water can comprise up to one-third of a municipality's energy bill, representing one of the highest operating costs. Increasing energy prices, coupled with greater infrastructure demands and dwindling resources, are placing heavy burdens on municipal leaders.

NYSERDA Statewide Energy Assessment

The New York State Energy Research and Development Authority (NYSERDA) funded a multi-year study that resulted in the most comprehensive assessment to date of energy use and improvement opportunities within New York's water and wastewater sector. The study began in early 2005, with issuance of the final report expected this spring. Partial findings have been presented at a variety of conferences throughout the duration of the study.

Based on the study results, it is estimated that the sector consumes nearly 3.0 billion kilowatt-hours per year (kWh/yr) of electricity, of which roughly two-thirds is consumed by the wastewater sector. To put the magnitude of the sector's consumption into perspective, the 7.1 million households in New York consumed a total of 42.3 billion kilowatt-hours of electricity in 2001, or 5,974 kWh/yr per household (Energy Information Administration, January 3, 2006). Based on these statistics, sector electricity consumption is equivalent to more than 500,000 New York households – more than the number of households in the cities of Buffalo, Rochester, Syracuse, Albany, Binghamton and Yonkers combined.

New York's Wastewater Sector

Flow rate and biochemical oxygen demand (BOD) are the two primary design criteria for wastewater treatment plants (WWTPs). In practice, New York's larger facilities demonstrate greater energy efficiency on a per-gallon-treated basis than their smaller counterparts. However, on a basis of per pound of influent BOD removed,



Photo courtesy of Malcolm Pirnie

Aeration accounts for approximately two-thirds of the total electricity use at traditional activated sludge wastewater treatment plants and should be one of the first processes evaluated when implementing an energy conservation program.

energy efficiency decreases slightly at the largest WWTPs. **Table 1** shows a comparison of the percentage of statewide treatment capacity, the percentage of wastewater sector electricity use and the unit electricity use for each of the size categories considered.

With an average electricity use of 1,480 kWh/MG (per million gallons), New York's wastewater sector uses approximately 25 percent more electricity on a per unit basis than the national average of 1,200 kWh/MG. New York's higher energy use is partially due to the widespread use of activated sludge, an energy intensive process for secondary treatment, as well as compliance with stringent NYS effluent limits, which often require tertiary or advanced treatment. Additionally, the predominance of combined sewer systems at the largest facilities, coupled with significant inflow and infiltration, result in extremely large variations in influent flow rates and loading, making efficient operation difficult.

New York's Drinking Water Sector

Typically, processing (treatment) and distribution (pumping) comprise the bulk of energy consumption in the drinking water sector. However, energy use in New York's largest water supply systems (serving over 100,000 people) is extremely low. Nearly 50 percent of the state's population is served by two drinking water systems that are operating under Filtration Avoidance Determinations issued by the US Environmental Protection Agency so that conventional treatment is not required for their source surface waters. In addition, many facilities incorporate gravity distribution systems for at least a portion of their service area, significantly reducing energy consumption and costs attributed to pumping.

In New York State, small to mid-sized communities (serving 3,300 to 50,000 people) account for the greatest proportion of energy use. **Table 2** shows a comparison of the percentage of statewide population served by public water systems, the percentage of drinking water sector electricity use, and the unit electricity use for each of the size categories considered.

Excluding the systems that operate under Filtration Avoidance Determinations, New York's drinking water sector consumes an average of 580 kWh/MG, which is nearly 70 percent less energy than the national average of 1,400 kWh/MG. When New York City's water supply system, one of the two operating under a Filtration Avoidance Determination, is included in the assessment, the average unit electricity consumption for this sector drops to 360 kWh/MG.



Photo courtesy of Malcolm Pirnie

Pumping accounts for over 80 percent of the electricity used by a typical drinking water supply. The installation of variable speed drives and operation of large motors at off peak times can be an effective way to reduce electricity costs and the strain placed on New York's electric grid.

Potential for Energy Reduction

Aging infrastructure, both at treatment facilities and within collection and distribution systems, has the potential to significantly influence energy use within the sector. Outdated treatment processes, obsolete controls, and end-of-life equipment can result in greater than necessary energy consumption. Inflow, infiltration and combined sewers result in greater pumping both within the collection system and at the WWTP. Leaking distribution systems have a direct effect on the energy use at drinking water facilities, as lost water forces utilities to produce a greater volume of finished water, affecting raw water pumping, treatment and distribution energy use.

Technology trends have the potential to both increase and decrease energy usage. More efficient motors, innovative treatment processes and improved user friendly advanced control systems may decrease energy consumption. However, as regulatory requirements become more stringent and as the type of targeted contaminants and micro-organisms evolve, treatment processes may employ more energy intensive treatment processes, such as ultraviolet disinfection, ozone treatment, and membrane filtration. Consideration of energy requirements is imperative as new technologies emerge.

Benefits of Energy Efficiency

The statewide assessment revealed that there are significant opportunities for New York's water and wastewater facilities to reduce energy consumption. For many, energy efficiency improvements – from simple operational changes to complex capital projects – are the key to compliance, sustainability and savings. In order to continue to provide a high level of service to water and wastewater ratepayers, innovative solutions to control operating costs are



Photo courtesy of Malcolm Pirnie

The Gloversville-Johnstown Joint Wastewater Treatment Plant in Johnstown, NY has an anaerobic digester facility and a dual membrane biogas holder (dome) which is the first to be constructed at a municipal treatment plant in New York State. This biogas holder provides a low cost alternative to replacing the floating steel gasholder cover and enables the facility to maximize biogas recovery and electric production.

Table 1. Comparison of Treatment Capacity to Energy Use – Wastewater Sector

Size Category	% of Sector Wide Treatment Capacity	% of Sector Wide Energy Use ¹	UNIT ENERGY USE	
			kWh/MG ¹	kWh/lb BOD Removed ²
Less than 1 MGD	3.8	11.0	4,620	3.8
1 to 5 MGD	7.5	8.5	1,580	1.6
5 to 20 MGD	13.1	14.0	1,740	1.6
20 to 75 MGD	23.8	26.8	1,700	1.2
Greater than 75 MGD	51.8	39.7	1,100	2.0

¹kWh/MG = kilowatt-hours per million gallons. Values shown include collection system usage.

²Values shown include only electricity use at the WWTP.

Table 2. Comparison of Treatment Capacity to Energy Use – Water Sector

Size Category	% of Sector Wide Population Served	% of Sector Wide Energy Use ¹	Unit Energy Use (kWh/MG) ^{1,2}
Less than 3,300	3.8	13.1	1,080
3,300 to 50,000	21.6	70.2	980
50,000 to 100,000	4.7	7.2	810
Greater than 100,000 (including NYC)	69.8	9.5	250 (230) ³

¹Values shown include estimated distribution system usage.

²Based on average per capita water use of 200 gallons per day.

³Value shown in parenthesis excludes New York City's Catskill/Delaware System.

needed. New York's water and wastewater sector only stands to gain long-term economic, environmental and operational benefits from energy efficient processes and products.

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