Reducing Energy Usage In Water And Wastewater Facilities

Energy action plans, power monitoring, and data monitoring help determine where energy is being used, leading to significant energy and cost savings.

BY GRANT VAN HEMERT, PE

In 2003, a research study by Frost and Sullivan[1] examined criteria used by water and wastewater facilities in making purchasing decisions. Out of 12 criteria listed, the overall operational cost, including energy usage, ranked as the seventh priority. Therefore, energy usage has received only moderate attention in equipment purchasing decisions.

However, recent events are changing how energy usage is perceived. One example is the post-Katrina volatility in the energy market. Some events are more indirect, such as the testimony of Jeannette Brown, vice president of the Water Environment Federation, to a U.S. House of Representatives subcommittee on Feb. 4, 2009,[2] or the entry of the Energy Star program into the water and wastewater industry.[3] These events demonstrate that energy is becoming a major concern.

Approximately one-third of a municipality's energy bill represents water and wastewater treatment costs. Additionally, more than $4 billion is spent each year in the United States on energy for water and wastewater. A 10% reduction in energy usage would result in 5 billion kilowatt-hours (kwh) saved annually and approximately $400 million in savings to cash-strapped municipalities.[4] A reduction of 5 billion kwh would lead to a reduction in water usage by thirsty power plants, reducing stress on overburdened water resources. An understanding of where energy is spent enables facilities to evaluate how to reduce power consumption.

Energy Action Plans

Energy action plans, or energy studies, identify and analyze energy usage in a water system's major processes. That information, supplemented by discussions with facility staff members and historical energy consumption data, provides a framework for analysis. Energy savings recommendations are made by matching a plant's utility profile with technologies and process improvements that have been successfully applied in similar environments. The result is a plan that can be implemented to save energy. For example, a Schneider Electric Energy Study for Ocean County Utilities Authority in New Jersey found a potential annual energy savings of $566,000.

The PowerLogic meter continuously logs power usage, allowing for complete analysis that will lead to energy savings. The Surgelogic meter protects equipment from surges, helping protect reliability.

Power Monitoring

A facility is billed only by its connection to the power utility. However, monitoring power at this point exclusively is inadequate for a detailed power consumption study. For instance, various causes, such as an inefficient pump or the processing of biosolids, may lead to a 15% increase in power consumption. With a single point of data collection, it can be difficult to determine the exact cause of power usage changes. Only a fully integrated power monitoring system can determine what occurred at a given point in time. Power monitoring cannot directly save energy, but it can reveal opportunities to reduce energy usage, such as changes in operations or equipment.

Data Monitoring

Process integrity is one of the most important concerns in a treatment facility. Energy usage is the largest operating expense; yet, most process Supervisory Control and Data Acquisition (SCADA) systems do not have adequate power analysis tools. Only power SCADA software has the tools for power monitoring and tools for proper process control and monitoring. This software enables correlation of processes with power consumption. For instance, an operator can determine the dissolved oxygen level, how long a particular rotor has been operating, how much power the rotor is consuming, and if the power consumption has changed during the last six months. Only when a facility's SCADA system is properly configured can the process be correlated with power consumption, resulting in process and power optimization to reduce costs and tax burden.

Energy action plans, power monitoring, and data monitoring help determine where energy is being used. Understanding areas that impact power usage and quality can lead to significant energy and cost savings.

Clipsal control pads help manage lighting usage, thus controlling costs.

Process And Procedural Changes

Some facilities may be able to save money by shifting operations. Although this may not save energy, it can reduce the expenditure a utility pays for power. For instance, a water treatment facility may have a policy of pumping water into the towers at 4 p.m. every day in anticipation of the 5 p.m. rush hour. However, utility demand charges may decrease at 5 p.m. If it is possible to shift the tower filling to 5 p.m., the demand charge is reduced, thus saving money.

Pumping And Blowers

Variable frequency drives (VFDs) can provide better control over blowers and pumps, leading to power savings in one of the areas that consume the largest amounts of power. Affinity Laws state that when speed increases, power must increase by the cube. This means that decreasing a pump speed to 80% of full capacity uses only half of the power. However, just putting a VFD on a pump or blower will not guarantee savings. The speed must be regulated. Some facilities will manually change speed at night during lower flows and then raise it during the day. Although this offers some savings, a properly developed automatic control scheme will provide optimum savings by determining the desired speed with desired output.

Ultraviolet And Ozone

With the leak, storage, transportation, and disinfection byproduct concerns related to chlorine, ultraviolet (UV) and ozone are becoming more attractive disinfectants. However, UV and ozone consume large amounts of power and need a reliable power source during the entire time the plant is operating. They also can create electrical distortion on the power lines. From an energy perspective, these systems need to be continually monitored. Bulbs, sensors, and electrodes must be properly maintained to ensure efficiency. Monitoring power consumption on these systems must be vigilant. If energy consumption starts to rise, the reason should be determined.

Perhaps one of the most important aspects of power control in a UV and ozone system is the automatic controls that are part of the package. The quality of the algorithm implemented can have a great deal to do with the amount of power consumed. A tight algorithm may better manage energy, while a looser algorithm may default to overilluminating or overproducing.

In the case of a nonfunctioning control system, a utility may decide to turn on all UV bulbs or operate all ozone generators. Although these approaches will ensure enough disinfection capability, they waste power. Thus, rapid repair to a nonfunctioning system is extremely critical.

Some wastewater applications may not need UV during the winter. Some utilities may decide to keep the UV system in service — even at a reduced dosage — to ensure disinfection. While this does add a layer of protection, it also causes an unneeded expenditure in power and increases operating expenses. Shutting down the unit, if possible, may decrease expenses.

Pump Stations

With the Energy Star program's entry into the water and wastewater industry, total power consumption reduction goals will be increasingly implemented in treatment facilities and pump stations. A lot has been said about the benefits of a power monitoring system. However, these systems can be cost-prohibitive in small- to medium-sized pump stations. They are typically located outdoors with a stand-alone control panel. Power monitoring at each individual motor was usually cost-prohibitive in these systems; thus, power monitoring was limited to the meter at the utility's power pole.

With recent advances, it is now economically possible to add power monitoring capability to a starter, and the power monitoring benefits mentioned above can now be seen on these remote stations. Some of the more progressive units can fit in the same spacing as an overload. With an additional side-mounted module, power monitoring can be achieved on a per motor basis, so every motor in all pump stations can be monitored individually. By monitoring power at each motor in a facility and pump station, power can be fully optimized, and the maximum benefit realized.

Lighting

Although process power uses the most energy, lighting cannot be overlooked. In office buildings, lighting represents one of the largest power consumers.[5] Many treatment facilities have office space, control rooms, and other areas with general lighting. Approximately 90% of the energy consumed by an incandescent light bulb is converted to heat,[6] while a fluorescent bulb converts 78% of its energy to heat. Changing to fluorescent lighting can generate savings in three key ways:

1. The fluorescent equivalent of an incandescent bulb uses less energy.
2. The extra heat produced by incandescent bulbs makes air conditioning systems work harder. By reducing the heat load, the air conditioning system will not need to work as hard.
3. Finally, a light bulb is not an efficient heater. By reducing this heat load, a furnace or heat pump will have to make up for the loss of BTUs. However, the superior efficiency of a furnace or heat pump compared with a light bulb could still result in energy usage reduction.

With the advent of compact fluorescent bulbs, almost any incandescent fixture can be converted to fluorescent duty. Compact fluorescent bulbs initially cost more than incandescent bulbs. However, evidence suggests their overall cost is less when considering energy consumption and replacement costs.

Changing from incandescent to compact fluorescent lighting is only part of the equation. Management of lighting using a SCADA system offers more opportunities to save energy. For example, a track lighting system that relies on LED power can reduce energy by as much as 87.5% compared with xenon bulbs. Lighting control sensors can automatically turn lights on and off in response to space occupation or according to preset schedules. Other systems allow lights and other circuits to be turned off remotely via the SCADA system.

Power Factor Correction

Reduction in power consumption has two main goals: reduce energy usage and decrease expenditures. Reduced energy usage directly impacts the monthly energy bill but is not the only way to lower an energy bill.

Different devices utilize power differently. Motors and transformers are inductive, while lighting, instrumentation, and computers are resistive. Power utilities strive for a uniform resistive power loading, which inductive loads tend to skew, leading to higher bills from the utility. Power factor correction starts with a parameter called power factor, which is a measurement found in a power monitoring system. A power factor correction system can help the power load look as resistive as possible and can lower an energy bill.

Conclusion

Water and wastewater agencies and municipalities have an unspoken mandate to keep the environment clean. After all, that is the very purpose of their existence. However, according to BlueSkyModel.org, 1 lb of carbon dioxide is produced for each kwh of electricity used in the United States.[7] Properly managing power in a water or wastewater agency not only increases reliability and reduces operating cost but has a direct impact on the amount of greenhouse gases produced, helping meet the unspoken mandate of green operations. Understanding and managing energy usage ensures energy is utilized in the most efficient manner. ■

References

1. Frost & Sullivan (2003). United States Water Wastewater Treatment Markets — End User Analysis. A571-15, p. 5-2, 5.1.
2. Water and Wastewater Digest (http://www.wwdmag.com/WEF-Vice-President-Testifies-at-House-Water-Resources-Hearing--NewsPiece17535)
3. EPA Energy Star in Water and Wastewater Web Site (http://www.energystar.gov/index.cfm?c=government.wastewater_focus)
4. EPA Energy Star in Water and Wastewater fact sheet (http://www.energystar.gov/ia/business/government/wastewater_fs.pdf)
5. Gulf Coast CHP Application Center (http://www.gulfcoastchp.org/Markets/Commercial/OfficeBuildings)
6. Incandescent Light Bulb Wikipedia page (http://en.wikipedia.org/wiki/Incandescent_light_bulb#Comparison_of_electricity_cost)
7. BlueSkyModel.org (http://www.stewartmarion.com/carbon-footprint/html/carbon-footprint-kilowatt-hour.html)

Grant Van Hemert, PE, *works for the Schneider Electric Water and Wastewater Competency Center. He has 13 years of experience in water and wastewater automation and another five years in automation and control engineering. He is a registered professional engineer in the state of North Carolina and is the chairperson for the American Water Works Association Instrumentation and Control Committee.*