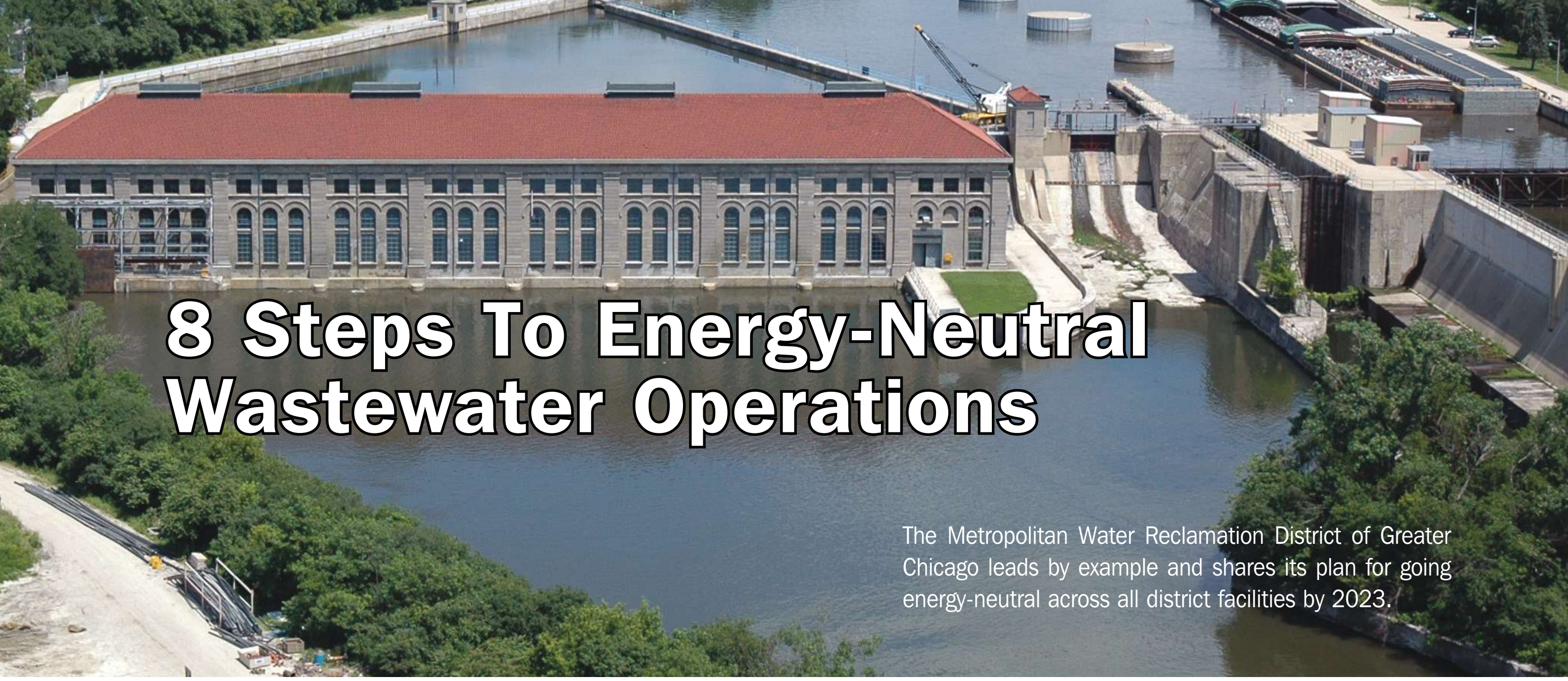
8 Steps To Energy-Neutral Wastewater Operations



The Metropolitan Water Reclamation District of Greater Chicago leads by example and shares its plan for going energy-neutral across all district facilities by 2023.

By Allison Fore

When the Metropolitan Water Reclamation District of Greater Chicago (MWRD) was created in 1889, street lights were gas-lit, and waste flowed freely into Lake Michigan, the source of the area's drinking water. Advances in technology have helped achieve the mission of protecting the lake, which is done primarily by operating seven water reclamation plants (WRPs). While the MWRD designs and operates treatment processes with an eye toward energy efficiency, the agency aspires to become energy-neutral by 2023. This accomplishment will provide a return on investment that will benefit taxpayers and the environment.

Across the country, water and wastewater collection, treatment, and distribution accounts for 35 percent, on average, of a municipality's energy budget. The MWRD consumes approximately 600 million kWh per year of electricity to operate the treatment plants and 22 pumping stations. To meet the 2023 target, the MWRD is pursuing a range of actions to reduce energy consumption while increasing production of renewable energy.

Energy-Reduction Projects

Building Audits

The MWRD hired an energy services contractor to audit and identify opportunities for energy reduction at its facilities through operational changes and/or replacement of outdated equipment or materials with new, energy-efficient equipment. Several recommendations are being implemented, such as upgrading LED interior lighting and controls, insulating steam blankets, and replacing boilers. Once completed, the MWRD will realize energy savings of approximately $800,000 a year.

Energy Curtailment

MWRD electricity draws have a noticeable impact on the local power grid. When the grid experiences peak demand, the MWRD voluntarily curtails electricity usage by turning down or shutting off equipment and storing sewage in the interceptors in order to assist the local power company with managing the load. In exchange, the power company provides a cash rebate offsetting the cost of operations. For the 2015-2016 program year, the MWRD will receive $1.9 million in curtailment revenue.

Biosolids Drying

The MWRD produces 165,000 dry tons of biosolids each year and is working to diversify the biosolids management portfolio, which consists of beneficial reuse of biosolids by application on farmland, use of dried biosolids on parks and golf courses, and a pelletizer facility producing pellets for commercial fertilizer usage. The MWRD is installing a composting facility that requires less energy than heat drying. By using tree debris as a bulking agent, the composting process raises the temperature of the biosolids and wood chip mixture, killing off pathogens to create a Class A biosolids product. The MWRD has a goal of producing 10,000 tons of composted material in 2016.

New Process Technologies

Excess nitrogen in the form of ammonia discharged to waterways can contribute to water quality degradation. Traditional removal of ammonia from wastewater via aeration is energy-intensive. New approaches to ammonia removal focus on manipulating the presence or absence of oxygen in the wastewater to allow certain types of beneficial bacteria to grow. These bacteria convert the ammonia to less environmentally degrading forms of nitrogen. Called "deammonification" and "short-cut nitrification," less aeration is required for these approaches; therefore, less energy is consumed. The MWRD is constructing a deammonification process called ANITA™ Mox on the centrate sidestream at the Egan WRP in Schaumburg, IL. It will be operational in the spring of 2016.

ANITA Mox is a single-stage nitrogen removal process with low carbon footprint based on moving bed biofilm reactor (MBBR) technology. The ANITA Mox process is specially developed for treatment of streams highly loaded in ammonia, such as centrifuge centrate at the Egan WRP. The process is designed to achieve ammonia removal higher than 90

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percent and total nitrogen removal in the range of 75 to 85 percent, without external carbon addition and at a low energy cost compared to conventional nitrification-denitrification. The process at the Egan WRP utilizes existing dissolved air flotation tanks that are repurposed for this application. The Egan WRP treats the solids from both the Egan (50 MGD) and Kirie (72 MGD) WRPs. Because of process limitations, however, the centrate has had to be diverted from the Egan WRP to the O'Brien WRP, about 15 miles away, which exacerbates odor and corrosion in the collection system. The ANITA Mox process will allow centrate treatment to remain on-site at the Egan WRP in an energy-efficient manner.

The MWRD is conducting research to apply deammonification to the mainstream treatment process. If successful, this process will completely change the way nitrogen is removed from wastewater. It will reduce energy usage by 40 percent, saving 120 million kWh annually, the equivalent energy provided by 15 utility-scale wind turbines or enough energy for 4,500 homes.

In another application of leading-edge technology, the MWRD is working with GE Water and Process Technologies to evaluate the performance of a new membrane-aerated biofilm reactor (MABR) technology called ZeeLung™. The MABR process employs a gas-transfer membrane to deliver oxygen to a biofilm that is attached to the surface of the membrane. The technology is being evaluated for its potential to increase existing aeration tank capacity by providing nitrification in a smaller tank volume than that required by conventional activated sludge (CAS). This will expand the existing aeration tank capacity to institute enhanced biological phosphorus removal (EBPR) to meet future effluent phosphorus limits without the need to construct additional infrastructure. The MABR also improves performance for total suspended solids (TSS) and ammonia removal during stressed conditions (specifically cold-temperature peak-flow periods). A significant benefit of this MABR technology is the potential to reduce the energy consumption required for aeration by about 40 percent compared to the current CAS mode of operation.

The study involves deploying a full-scale ZeeLung gas-transfer membrane cassette in a sidestream configuration at the O'Brien WRP in Skokie, IL. The goal of the pilot project is to determine and optimize the nitrification rate, oxygen transfer rate, and aeration efficiency of the MABR technology. Results from this year-long pilot test will be used for projecting the performance and installation costs of a full-scale configuration at the O'Brien WRP, which treats nearly 250 MGD of water typically and up to 450 MGD during wet weather or peak times. Initial projections show that electricity usage will be reduced by 15 million kWh per year if the technology is fully deployed at the O'Brien WRP. With the reduction in electricity usage comes a reduction in greenhouse gases.

Green Roof Installation

A 33,000 sq. ft. roofing system was installed at the Racine Avenue Pumping Station (RAPS) in 2014. The roof consists of two parts: a 29,300 sq. ft. reflective, "Energy Star"-rated aggregate surface with a solar reflective index of 86 and a 3,700 sq. ft. vegetative roof system incorporating eight plant varieties. A reflective roof reduces energy demand by lowering air-conditioning loads through reduction of the amount of heat absorbed through the roof. The vegetation reduces heat transfer through the roof during the summer and acts as an insulator during the winter. The vegetative green roof also reduces stormwater surface runoff, removes air pollutants, filters water pollutants, and creates microclimates for insects and birds.

Careful consideration: MWRD is piloting GE's ZeeLung membrane-aerated biofilm reactor.

Renewable Energy Generation

Hydroelectric Power

In 1899, the MWRD constructed the Lockport Controlling Works on the new Chicago Sanitary and Ship Canal (CSSC), a 30-mile-long canal designed to convey stormwater and sanitary sewage away from the city of Chicago. In 1907, the MWRD constructed the Lockport Powerhouse at the confluence of the CSSC and the Des Plaines River to take advantage of the 38-foot drop in water elevation from the canal to the river. Over the years, this hydroelectric power plant has produced clean, renewable electricity. Today, the Lockport Powerhouse has two 6 MW turbines that produce 40 million kWh per year of hydroelectric power, which is sold to the local power company.

Co-Digestion And Methane Utilization

Organic material removed from the wastewater streams at the MWRD's WRPs is stabilized and biologically broken down

Anaerobic digesters produce biogas for energy production at the Calumet facility.

in reactors called anaerobic digesters. The MWRD has 46 anaerobic digesters at four of its WRPs to handle the organic solids from all seven WRPs. A byproduct of the anaerobic digestion process is called biogas, containing about 60 percent methane, 35 percent carbon dioxide, plus small amounts of other compounds such as sulfur and siloxane. Because of the high methane content, biogas is a valuable fuel the MWRD uses to fuel boilers that produce steam or hot water used for heating buildings and processes at the WRPs. The MWRD is increasing the use and production of biogas.

To boost this production, the MWRD is importing organic waste produced in industrial and commercial processes into the anaerobic digesters as feedstock. Organic wastes may be either liquid wastes high in organic content from food processing plants, breweries, dairies, and biodiesel plants or from oils and greases produced at restaurants and rendering plants. This organic feedstock can be added to the anaerobic digesters along with the organic matter removed from the wastewater streams in a process called “co-digestion.” The MWRD is designing a receiving station at the Calumet WRP for tanker trucks hauling liquid organic wastes. The additional organic feedstock can increase biogas production in the Calumet WRP’s 12 anaerobic digesters up to 75 percent more than current production. The MWRD also plans to build a facility that will clean and transform the biogas into biomethane for conversion into compressed natural gas (CNG) fuel for vehicles, thus reducing gasoline use and the resulting greenhouse gases. The revenue from biomethane sales and tipping fees collected from the liquid organic waste feedstock will help reduce the MWRD’s operating costs.

A similar co-digestion operation at the Stickney WRP in Cicero, IL is under way. The 24 anaerobic digesters at the Stickney WRP have the capacity to receive up to one million gallons of organic feedstock per day. The MWRD is investigating the possibility of collecting food waste from local restaurants and grocery stores. This food waste, or “source separated organics” (SSO), has a higher biogas yield than liquid organics and could increase biogas production 100 percent. If successful, the MWRD could produce up to three million decatherms of biomethane per year or the equivalent of 20 million gallons of gasoline.

Thermal Energy Projects

In 2012, the MWRD began converting solar heat into usable hot water at the Egan WRP. The MWRD installed roof-mounted solar panels that generate 2,040 therms annually. The system provides preheated boiler makeup water, hot water for solids treatment, and other hot water needs at the plant. The treated water leaving a wastewater treatment plant runs at a near constant 55°F, making this a potential heat source for heat transfer. The MWRD installed heat pumps at the Kirie WRP in Des Plaines, IL, using the plant water as a heat source in the winter and a heat sink in the summer. Staff dubbed this evaporation-condensation system of energy production as “sewerthermal.” This system is used to heat and cool a portion of the Kirie WRP administration building; as a result, electricity usage was reduced by 50 percent for heating and cooling needs for that building unit.

Conclusion

These exciting innovations in renewable energy and energy savings provide another illustrious chapter in the MWRD’s history in which no small plans are made. Working toward a goal of energy neutrality will reap major benefits, but, more importantly, will reduce greenhouse gases and promote a cleaner and more sustainable environment for the entire region. By exploring and embracing technology, the MWRD is taking control of its energy future and moving toward its next technological adventure. ■

About The Author

Allison Fore has served as the Public & Intergovernmental Affairs Officer at the MWRD for more than four years. She has 20 years’ experience in government communications, having also worked for the Illinois State Treasurer, Illinois General Assembly, Indiana Secretary of State, and Indiana Department of Environmental Management. She received her bachelor of science degree from Indiana University’s School of Public and Environmental Affairs and master of arts degree from University of Chicago’s School of Social Service Administration.