WHITE PAPER

AMERICAN WATER

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Creating Operational Efficiencies in the Water Industry

Introduction

In an era of increased concern about limited water supplies, energy consumption, water quality and climate change, the pressure on water utilities to deliver greater efficiency and operational effectiveness is greater than ever for this energy-intensive industry.

According to the Environmental Protection Agency (EPA), water utilities across the United States and elsewhere in North America are saving substantial amounts of water through efficiency programs. These savings often translate into capital and operating savings, which allow systems to defer or avoid significant expenditures for water supply facilities and wastewater facilities. Drinking water systems can implement efficiency measures and still deliver an unchanged or improved level of service to consumers.

Energy Efficiency

According to a report by the U.S. Government Accountability Office (GAO), technologies and systems exist to help improve the energy efficiency of the drinking water & wastewater industry, but costs and competing priorities have slowed their implementation. The report focused on the amount of energy needed to supply, use and treat water. GAO found a variety of approaches can improve the energy efficiency of drinking water and wastewater processes, but determining the most appropriate solution depends on the circumstances of a particular system and requires an understanding of the system's current energy use.

Drinking water and wastewater systems account for about two percent of the energy use in the United States, according to the Electric Power Research Institute[1]. Some 52,000 water systems produce 42 billion gallons of water per day, while 16,320 wastewater treatment facilities treat 34.8 billion gallons per day.

The vast majority of energy consumed by water utilities is used to pump water. American Water facilities consume approximately 1 million MWh per year of electricity with over 95% used for pumping water. Because of the importance of this energy-water nexus, American Water actively manages its fuel and power usage through energy and water efficiency programs, the development of alternative energy supplies, energy audits, and pump, motor and pipeline renewal programs. These energy management programs yield environmental benefits including the reduction in greenhouse gas emissions.

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1 "Electricity Use and Management in the Municipal Water Supply and Wastewater Industries." EPRI and Water Research Foundation. November 2013

Much of American Water's energy efficiency work concentrates on improving pump efficiencies through refurbishment and/or replacement. Programs include:

Energy Usage Index (EUI) metric: American Water manages its energy program using this metric derived by dividing total power usage in megawatt-hours (MWh) by the volume of water sold in million gallons (MG) during a discrete period of time. The current baseline for this metric is 2.86 based on 2011-2013 operating data.

The EUI data is collected and monitored to serve as a barometer for the condition of the pump fleet. Specifically, as pumps age, they wear and become less hydraulically efficient, which translates to more power required to deliver the same volume of water. American Water's pumping fleet is comprised of about 7,500 centrifugal pumping units. Of this, it is estimated that about 20% of the largest pumps consume 80% of American Water's total power usage.

Wire-to-Water Pumping Efficiency Tests: American Water conducts wire-to-water efficiency testing to monitor the efficiency of pumps and motors. We deliver billions of gallons of water each year, so even a small increase in efficiency can yield energy savings. Research has shown that the average "wire-to-water" efficiency of existing "in-field" water utility pumps is about 55 percent. New installations are designed to achieve efficiency ratings of between 76 percent and 82 percent. American Water sees this as a major opportunity to decrease its carbon footprint. By replacing or refurbishing older pumps, studies have shown that pump efficiency can be restored to their original efficiencies of 76-82%. This often means a 10-20% improvement, or more.

Pump Refurbishment: American Water programs maintain, repair and replace pumps, motors and vfd equipment. The cost of pump replacement/refurbishment to recover capacity and improve efficiency is weighed against the typical decline in efficiency/capacity over time. American Water has vibration analysts on staff to extend pump service life through predictive maintenance. A total of 52 pump refurbishment / replacements were completed from 2011-2013, at a cost of approximately $6 million, and provided a EUI reduction of 0.8%.

Variable Frequency Drives (VFD): American Water has installed numerous variable frequency drives to vary pump speed/output. Variable speed pumping can reduce electrical consumption where a throttling valve would otherwise be used to control pumping rate.

Hydraulic Modeling: Distribution systems are modeled to analyze current and future hydraulic conditions to enable efficient pump selection.

Alternative Fuels: Natural gas and diesel powered engines also provide power for pumping water at a number of sites. These facilities provide a diversity of power supply during emergency conditions.

New, renewable energy technologies hold the other key to reducing the emissions that contribute to climate change. American Water maintains a portfolio of alternative energy supplies to reduce greenhouse gas emissions. This portfolio includes power from solar, wind and biomass facilities. It is estimated that this portfolio saves over 2,500 metric tons of CO2 annually.

Solar energy generates electricity without producing harmful greenhouse gases, and produces maximum output at times of peak demand, when electricity is of highest value. Solar energy can be purchased from a third-party supplier or owned outright. In addition to environmental benefits, solar energy affords a financial hedge against rising energy costs, as well as new revenue streams through the sale of tradable solar renewable energy credits. Financial incentives may also be available in the form of rebates and tax credits from local utilities and local, state and federal government.

American Water has installed over 3.1 MWdc of solar generating capacity at eleven facilities across three states (New Jersey, Illinois and Missouri), with plans for additional facilities. The first solar installation was a 500-kW facility constructed in N.J. in 2005. This facility will celebrate 10-years of continuous "green" service in 2015. Today, that same expanded facility (698 kWdc) generates 818,000 kilowatt-hours per year of clean energy and provides 20 percent of the peak usage power to run the water treatment plant.

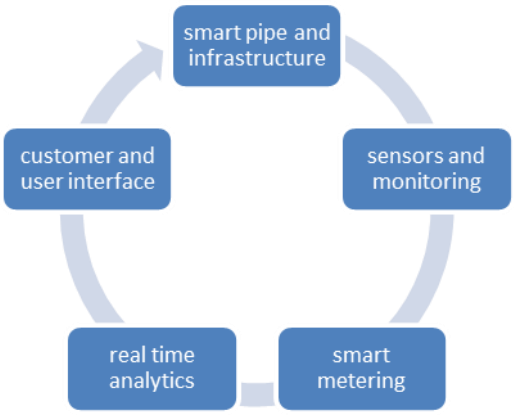
In 2011, New Jersey American Water installed solar panels on a reservoir at the Canoe Brook Water Treatment Plant in Millburn, N.J. This is the first solar array on the East Coast on a body of water designed to withstand a freeze/thaw environment. The 400 solar panels, measure 110 ft. by 110 ft and rest on a docking station designed to float on the water's surface. The array generates 112 kilowatts of DC (direct current) power, which is converted to AC (alternating current) power. This solar installation produces 135,000 kilowatt-hours of energy each year, saving over 56 tons of carbon emissions.

American Water also utilizes solar power in smaller applications including solar panels with batteries at various remote SCADA monitoring sites where access can be difficult during storm events. In an application to enhance safety and promote conservation, solar powered utility carts are used at a several large treatment facilities and solar powered arrow boards are used at some construction sites.

Local **wind farms** produce clean, renewable energy with no design, construction, operation or maintenance commitments on the part of the utility. Since wind power is feeding energy to the electricity service provider's grid, there is no perceivable difference in the energy being provided to the company. Because wind power is generated off-site, enrolling in a wind energy program is ideal for smaller utilities that want to commit to greener operations but can't undertake the level of commitment required by solar installations. Pennsylvania American Water purchases 1.4 million kWh of wind energy per year in Yardley, Pa. saving 1.6 million pounds of CO2 per year. The program was recently expanded in 2014 to purchase an additional 3.2 million kWh per year.

Additionally, American Water subsidiary, EMC, designed, built, operates and maintains a 300,000 gallon-per-day industrial anaerobic wastewater treatment and biogas recovery system in Texas providing an average of 100,000 cubic feet of biogas per day, replacing 15% of the natural gas demand.

American Water is the first U.S. water utility to use the **Smart Grid technology** of ENBALA Power Networks. This innovative technology manages the way American Water's treatment plants and pumps use electrical power. Instead of adjusting electrical generation to match changes in electrical demand, the network adjusts demand, enabling electrical equipment to consume more energy when demand is low and less when it is high. This provides Grid Balance to electricity system operators. A successful pilot program at Pennsylvania American Water's Shire Oaks Pumping Station offset 2-3 percent of the site's total energy bill and has led to a larger partnership between American Water and ENBALA Power Networks that will bring ENBALA's Grid Balance technology to large treatment facilities throughout American Water.



Water Loss Control

For water utilities, detecting and repairing leaks is one of their main components for water conservation. Deteriorating infrastructure, fluctuating water temperatures, soil movement, vibrations and water pressure changes are just some of the factors contributing to water leakage.

And not only do leaks account for lost water, but they can also allow contaminants into the system that can endanger public health. It is estimated that up to 10 billion gallons of raw sewage is released into our waterways every year as a result of blocked or broken sewer pipes.[5]

According to the American Society of Civil Engineers Report Card for America's Infrastructure, national drinking water/wastewater systems received a grade of a D.[6] Over the last several years, many studies have been undertaken to estimate water loss. Regions of developing countries are experiencing greater water loss than regions in developed countries. Non-revenue water levels average just over 20% in the United States.

Water conservation is also crucial. Due to their low rate of replacement, broken and leaking pipes currently result in 1.7 trillion gallons of water ($2.6 billion) lost every year.[2] Early detection and repair of leaks saves water and energy and reduces repair costs.[3]

Finding and stopping leaks quickly reduces repair costs, chemical use, energy consumption, and associated greenhouse gas emissions. With enhanced metering systems, we are better positioned to educate our customers about how they can save water and money by taking steps to conserve. Building upon our pioneering work with acoustic leak detection systems and improved metering techniques, American Water has intensified our efforts to find leaks in our systems more rapidly and reduce water lost due to leaks (non-revenue water).

American Water is a partner in a two-year award from the Israel- U.S. Binational Industrial Research and Development (BIRD) Foundation along with Stream Control Ltd., an Israeli start-up company, for the development of an advanced pressure management system. The Stream Control Research Project will demonstrate the feasibility of installing modifications on existing distribution system pressure controls that could reduce pressure in a system as a function of reduced customer demand. International efforts to reduce leakage have confirmed that reducing excessive pressure not only reduces the volume of leaks through pipes but reduces the frequency of pipe failures. The expected outcome of the project will be a significant reduction of water leakage.

Supply Chain Efficiency

Many people tend to limit their view of supply chain management to a hard goods environment such as manufacturing and distribution. In fact, a supply chain can be abstracted to a series of transactional boundaries where value is exchanged for compensation, and it may consist of only a single supplier and customer.[4]

The supply chain agenda at leading utilities has changed substantially in recent years. The original focus on cost savings and organizational efficiency has evolved, with increases in activity across all utility sectors, to include the challenges of cost containment, supply assurance, and risk management.[5]

The most significant benefit of centralizing supply chain activity in a utility comes from strategically sourcing the goods and services that are purchased. American Water is building a leading Supply Chain organization to address the increasing challenges of managing its supply chain in a sustainable, reliable, and cost effective manner. This has resulted in a number of efficiency improvements, such as:

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[2] "Value of Water Survey," ITT Corporation, 2010. http://www.itt.com/valueofwater/

[3] Young, John. "The 'Greening of Water: American Water Takes Aim at Climate Change Through Reducing Greenhouse Gas Emissions, Increasing Efficiency." Journal AWWA. June 2010

[4] Water Online: (http://www.wateronline.com/doc/competitive-water-utilities-can-benefit-from-0001)

[5] booz&company. "Utility Supply Chain Management, The New Agenda"

- Consolidation of purchasing volumes across the company has resulted in significant savings for commonly purchased items ranging from water treatment chemicals to construction services.
- Materials such as pipe, valves and water meters have been standardized with resulting savings in both the initial purchase price and on-going maintenance costs. Changes in meter reading technology are reducing the effort required to read meters and the rework associated with missed reads.
- Ongoing work to source American Water's fleet of vehicles has resulted in a 10% reduction in the number of cars and trucks the company maintains while removing older, less fuel efficient vehicles from the fleet and better aligning vehicle specifications to the needs of the work force.
- As noted above, ENBALA's Smart Grid Technology is being used to help better manage energy consumption. Other efforts are reducing consumption of things as diverse as office paper and laboratory services.

Conclusion

As discussed in this paper, water utilities are faced with enormous challenges, and efficiency remains a top priority. And like all companies, American Water is challenged to find innovative ways to operate efficiently for the benefit of the company and its customers. In reducing its own carbon footprint, American Water has introduced innovations that it hopes will set the stage for operational efficiency, as well as more environmentally friendly practices throughout the industry.