WHITE PAPER

AMERICAN WATER

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Water-Energy Convergence: Efficiency Challenges and Opportunities

Introduction

Water and energy are essential to almost every aspect of our lives, and we consume tremendous quantities of each. Although most Americans now recognize the importance of being water and energy efficient, many do not fully appreciate the interdependence of water and energy services. Meeting energy needs requires water, often in large quantities, for mining, fuel production, hydropower, and power plant cooling, and energy is needed for pumping, treatment, and distribution of water and for collection, treatment, and discharge of wastewater.[1] The interdependence of water and energy forms a nexus or convergence that means efficiency measures in one area have the potential to produce additional efficiencies in the other, thus benefiting both water and electric utility customers as well as the environment. Historically, this potential has not been fully realized due to the lack of awareness of the water-energy convergence. A growing appreciation of the nexus among companies and policymakers is starting to produce greater efficiency efforts and innovation.

This paper helps explain the water-energy nexus and highlights ways of improving water and energy efficiency.

Background

Water is essential for human survival and prosperity, whether used for drinking, sanitation, industrial processing, irrigation, or power generation. And every step in the water supply process uses energy.

The growing awareness of the water-energy convergence is partially spurred on by the impact of scarcity and demand. For example, water scarcity in the western states and beyond has led many policymakers to examine the impact that droughts have on energy generation; when severe drought affected more than a third of the United States in 2012, limited water availability constrained the operation of some power plants and other energy production activities. Nexus-related scarcity challenges will only increase in the future. As cities continue to grow, particularly in regions already experiencing water scarcity,[2] the link between water and energy use is becoming more important. A growing community needs more power, which requires additional water.

1 Congressional Research Service. "Energy-Water Nexus: The Water Sector's Energy Use." January 24, 2017.

2 US Department of Energy. "The Water-Energy Nexus: Challenges and Opportunities." June 2014.

Between 2011 and 2040, it is estimated that the U.S. population will grow by 22 percent; electricity consumption will increase by 28 percent; natural gas production will expand by 67 percent; oil production will be 32 percent higher than the 2011 level; and ethanol consumption for transportation fuel will increase by 18 percent.[3] Water is critical in supporting growth in all of these areas.

Electricity plays a critical role in producing, treating and delivering the safe, clean, reliable water we use in our homes every day. The Environmental Protection Agency estimates that 3 to 4 percent of national electricity consumption, equivalent to approximately 56 billion kilowatts, or $4 billion, is used to provide drinking water and wastewater services each year.[4] In addition, households use considerable amounts of energy to heat water for bathing, cooking, cleaning and other uses. On the flip side, it also takes water to create energy. Approximately 40% of all fresh water withdrawn from water sources is used to cool thermoelectric power plants.

The Report on Freshwater Supply from the Government Office of Accountability states that according to state water managers, experts, and literature GAO reviewed, freshwater shortages are expected to continue into the future. In particular, 40 of 50 state water managers expected shortages in some portion of their states under average conditions in the next 10 years. Given this fact, using water efficiently and minimizing waste is fundamental to ensuring water availability in the future and lessening the effects of a limited water supply. Since very little of our water is used for drinking, there is significant room to find more efficient ways to manage our water use and reduce energy consumption.

Given this interrelationship between water and energy, one of the best ways to save energy across the country is to use water more efficiently.[5] In addition to reducing energy use directly, efficient water practices can stretch the adequacy of existing water supplies. This may reduce the need for new facilities, thereby mitigating or eliminating the environmental impacts of constructing those facilities. In addition, water efficiency measures minimize strain on sewage treatment facilities and reduce greenhouse gas emissions.

Along with ensuring the availability of water, affordability also poses a significant challenge, with the costs of providing water on the rise. Future spending for public water and wastewater systems has been estimated to range between $2.5 and $4.8 trillion over the 20-year period of 2009 to 2028.[6]

Finding Solutions

Customer-Driven Solutions

Communities, businesses, industries and farms all have diverse water and energy needs and must find ways to share limited, fluctuating supplies of these essential resources. Water efficiency

3 EIA, "Annual Energy Outlook" (2014).

4 Environmental Protection Agency. "Water and Energy Efficiency at Utilities and in the Home."

5 Environmental Protection Agency's WaterSense publication. "Saving Water Saves Energy: Make the Drop-to-Watts Connection."

6 U.S. Conference of Mayors, "Trends in Local Government Expenditures on Public Water and Wastewater Services and Infrastructure: Past, Present and Future. 15 March 2010.

measures are the most cost-effective and environmentally sound way to reduce demand for water and can substantially reduce the nation's energy consumption.

As we confront the challenges posed by climate variability, persistent droughts, and high-energy prices across the country, nearly everyone is looking for ways to conserve resources and cut costs. Fortunately, there are many simple techniques consumers can employ to use water more efficiently and, at the same time, conserve energy, thus preserving our nation's resources for future generations. These solutions not only make environmental sense, they make economic sense as well:

- Check for and repair leaks throughout your home or business.
- Install a U.S. Environmental Protection Agency (EPA) EnergyStar[7] rated demand hot water system.
- Install U.S.EPA WaterSense[8] rated low flow shower heads, faucet aerators, and High Efficiency Toilets (HETs). HETs use just 1.28 gallons per flush (gpf) or less as compared to the 3.5 gpf or more for toilets sold prior to 1994.
- Lower your water heater thermostat to 120 degrees. Some manufacturers set water heater thermostats at 140 degrees. Lowering the temperature would reduce water heating costs by 6 to 10 percent. However, if you have a dishwasher without a booster heater, it may require a water temperature within a range of 130-140 for optimum cleaning.[9]
- Search for pipes that are not insulated, or that pass through unheated spaces such as crawlspaces, basements or garages. Wrap them with pre-molded foam rubber sleeves or fiberglass insulation, available at hardware stores.
- Use energy and water efficient appliances (e.g., U.S. EPA EnergyStar and WaterSense rated dishwashers and clothes washers).
- Use drip irrigation systems in gardens and landscaping rather than hose sprayers or sprinklers.
- Wrap your water heater in an insulation blanket to help reduce heat loss. Nearly 20 percent of an average home energy bill goes to heating water.

Water-Energy Efficiency Initiatives

Just as other industries have been "going green" in recent years, the water industry has likewise developed ways to use its resources more efficiently. There is growing recognition that "saving water saves energy." Energy efficiency initiatives offer opportunities for delivering significant water savings, and likewise, water efficiency initiatives offer opportunities for delivering significant energy savings. In addition, saving water also reduces carbon emissions by saving energy otherwise generated to move and treat water.[10]

American Water is committed to water and energy efficiency and has deployed various technologies and practices to help our customers use water with greater efficiency, prevent leaks

7 Reference the USEPA Energy Star Web site for more information: http://www.energystar.gov/.

8 Reference USEPA WaterSense Web site for more information: http://www.epa.gov/WaterSense/.

9 Department of Energy

10 Congressional Research Service. "Energy-Water Nexus: The Water Sector's Energy Use." January 24, 2017

and ultimately save energy. Some examples of American Water's efficiency pilots and projects include:

Geothermal – American Water's New York affiliate has recently launched a geothermal pilot project with the William L. Buck Elementary School in Valley Stream, N.Y. In a unique turn, rather than harvesting heating and cooling from underground the water from the public supply is being used to provide low cost, low carbon heating and cooling to the school. The system allowed the school to save 41,000 BTU /square foot/year in addition to adding air conditioning.

Construction – Several water treatment plants are being designed and constructed to obtain Leadership in Energy and Environmental Design (LEED) Certification. The design team considers all environmental, energy efficient and sustainable aspects as they pertain to the individual building and structure on the project. Energy modeling is used to evaluate the relative importance of construction materials, such as glazing or insulation and to optimize building shell design to reduce long-term operating costs of the facility. American Water's new Headquarters building currently under construction in Camden, N.J. includes water efficiency measures such as rainwater collection and re-use and waterless urinals.

Leak detection – American Water has deployed over 2,000 fixed-base acoustic leak detectors, which are identifying non-surfacing leaks in four state affiliate districts. American Water helped develop this technology in 2009, piloted prototypes in 2013-14 and purchased the first commercially available units in 2015. Reducing treated water loss translates to greater water and energy efficiency. More information can be found in American Water's *Leveraging Technology Innovation to Detect Leaks* white paper.

Lighting – American Water has been retrofitting lighting at its facilities across the state subsidiaries and corporate offices for several years. Recently, the Hershey and Norristown Water Treatment Plants in Pa. and several facilities in N.J. were retrofitted with occupancy sensors and high efficiency fluorescent lighting and/ or LED lighting.

Pumping water – American Water has increased the use of variable frequency drives (VFDs) on pumps by installing them on at least one pump in many of our plants, allowing the plants to vary the pumping rate to optimally meet system demands, thus saving energy. American Water also launched a pump efficiency initiative that identifies inefficient pumps and either replaces or rehabilitates them to improve efficiency.

Alternative energy – American Water maintains a portfolio of alternative energy supplies. This portfolio includes solar, wind and biomass facilities. It is estimated that this portfolio saves over 2,500 metric tons of CO2 annually. The company has installed over 3.1 MWdc of solar generating capacity at 11 facilities across three states (New Jersey, Illinois and Missouri), with plans for additional facilities.

Most recently, Indiana American Water broke ground on a new $1.4 million solar energy project at its Newburgh Operations and Treatment Center. This project will cut the company's cost for electricity by approximately $65,000 annually. The project, which will include 1,360 panels, will abate nearly 500 tons of CO2 emissions a year.

Additionally, New Jersey American Water installed the state's largest ground-mounted solar electric system at its Canal Road Water Treatment Plant in Somerset, N.J., as part of an energy savings initiative. The system, which can produce up to 730,000 kilowatt-hours of energy a year, supplements 20 percent of the peak usage power needed to run the plant. Reducing energy usage by 585,000 kilowatt-hours a year prevents 1,577 pounds of nitrogen oxide, 4,875 pounds of sulfur dioxide and 699,856 pounds of carbon dioxide from being emitted into the air. This savings in carbon dioxide pollution is equivalent to planting 94 acres of tree seedlings or preserving 2.6 acres of land from deforestation.[11] This facility celebrated 10-years of continuous "green" service in 2015.

And in 2011, New Jersey American Water installed solar modules on a reservoir at the Canoe Brook Water Treatment Plant in Millburn, N.J. This was the first solar array on the East Coast on a body of water designed to withstand a freeze/thaw environment. The 400 solar modules, 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 then converted to AC (alternating current) power. Annually, the solar field produces 135,000 kilowatt hours per year, or approximately two percent of the plant's power.

Through American Water's Technology and Innovation division, the company has tested new approaches and technologies to create greater efficiencies in water reuse, desalination, wastewater operations, and bioenergy. Specifically, the company has introduced:

Demand-side Energy Management (Shire Oaks Pumping Station, Pa.) – 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. Instantaneous water pumpage are aligned with the instantaneous electrical demand of the grid. The water utility shares in the savings created by this short-term "peak shaving" The successful pilot program at Pennsylvania American Water's Shire Oaks Pumping Station offset 2-3 percent of the site's total energy cost.

A Patent for Optimized Nutrient Removal from Wastewater – American Water has been awarded three patents for a technology called NPXpress, which reduces aeration energy consumption – the process that uses the most energy during wastewater treatment. NPXpress reduced energy consumption by up to 50 percent and supplemental carbon source by 100 percent. This technology has been implemented at seven full-scale wastewater treatment plants in New Jersey and New York, and is currently being implemented at a system in California as part of the company's overall initiative to achieve sustainable, energy-neutral wastewater treatment.

More information can be found in American Water's *Innovations In Energy Use* white paper.

Conclusion

As discussed, vast amounts of energy are used to pump, treat, deliver, and heat our nation's water every day, while tremendous quantities of water are used to generate its energy. American Water will continue to leverage the nexus between water and energy efficiency and reduce our energy usage through alternative energy, the deployment of energy-efficient infrastructure, leak detection and other green solutions that decrease the company's carbon footprint and save

11 According to the Environmental Protection Agency and the U.S. Climate Technology Cooperation

energy. Together through our collective efficiency efforts, we can reduce carbon emissions and preserve water and energy resources for future generations.

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