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Bridging the Water Innovation Gap

Introduction

For most Americans, access to clean drinking water is as effortless as turning on the tap. At a cost that is typically less than a penny per gallon, clean water is often taken for granted rather than being viewed as a critical resource. The network of pipes that makes it so easy for 300 million Americans to take our clean water for granted spans 700,000 miles and is more than four times the length of the National Highway System. Some of these pipes – originally intended to survive 50 to 75 years – have been in service for more than 100 years. Most water companies have traditionally focused on managing their assets to maintain serviceability and reduce costs rather than on service improvement through technical innovation¹.

Water utilities around the world are faced with enormous infrastructure challenges that will demand better strategies for delivering the expected efficiencies that have become the standard within other more progressive industry environments. And like all companies, American Water is challenged to find innovative ways to operate at the lowest possible cost for the benefit of the company and its customers.

Barriers to Innovation

While technological innovations will be required to comply with new treatment regulations, utilize poor quality source water, increase energy efficiency and create zero discharge utilities, the challenge is bringing innovation to the marketplace. According to *Global Water Intelligence Magazine*, it takes seven years for a new technology to enter the water market and there are many examples of where it took decades.²

Innovations in water technology are vital to finding solutions to the industry challenges we face today: climate change, ageing infrastructure, urbanization, resource shortages, the economic and financial crisis, new emerging substances, the need for sustainable development, demographic changes, etc.

The water industry is conservative and cautious in adopting new technologies for several reasons³:

- Need to protect public health
- Long term investment
- High priority on compliance

In addition, the severe fragmentation of the U.S. water industry poses serious challenges to meeting the great and growing water needs of Americans. There are approximately 52,000 community water systems, but just eight percent of those systems (4,132) serve 82 percent of the population.⁴ Only seven percent of

1 Council for Science and Technology. "Improving Innovation in the Water Industry: 21st Challenges and Opportunities." March 2009;

<http://www.bis.gov.uk/assets/cst/docs/files/whats-new/09-1632-improving-innovation-water-industry>

2 Dayton Water Conference. "Bridging the Innovation Gap" Presentation by: Paul Gagliardo, M.P.H., P.E., Manager of Innovation Development at American Water.

3 Dayton Water Conference. "Bridging the Innovation Gap" Presentation by: Paul Gagliardo, M.P.H., P.E., Manager of Innovation Development at American Water.

4 U.S. Environmental Protection Agency, Factoids: Drinking Water and Groundwater Statistics for 2009

the country's systems serve populations of over 10,000 and a mere one percent of the systems serve populations of over 100,000.⁵

The complex municipal procurement process, consisting of consultants, contractors, city engineers and elected or appointed officials is another issue that challenges companies to adopt new technologies, as well as no return on capital invested and little incentive to increase operational performance.

Helping to resolve these challenges requires a formal process and dedicated team.

Background in IDP

American Water has taken a proactive approach to leverage the company's position and expertise to validate innovations using the company's large and geographically diverse footprint, ultimately becoming an early-adopter of new technologies for industry use. This unique program is called the Innovation Development Process (IDP).

The IDP program fills a vital need to seek innovative, cost effective, and sustainable solutions that can benefit all water utilities. It combines research and development, technical expertise, and infrastructure assets with innovations from both within American Water and from external business partners to create greater efficiencies in the areas of drinking water and wastewater.

The IDP identifies and develops ideas which drive efficiencies into American Water's existing regulated and market-based businesses, while identifying opportunities that increase shareholder value. The IDP ensures American Water has visibility to the innovation trends, new products and services in the water space and can therefore make business decisions to adopt these as appropriate. The IDP provides a conduit for innovators to allow their technologies to be evaluated and to accelerate the adoption and market penetration of products or services that help solve pressing needs within the water industry.

IDP Process

American Water has adopted an open collaboration model to make it easier to work with companies developing innovative technologies, allowing them to benefit from the resources, experience and expertise and scope of an industry leader. Potential areas of collaboration include water treatment and distribution, wastewater treatment and collection, biosolids management and energy management at water-energy nexus.

American Water took a proactive approach with this program to seek out, vet, validate, develop and deploy water industry related innovations using the "Stage Gate" process. The process is a four step sequence known for filtering and developing ideas. Each step involves a stage (a piece of work) and a gate (an approval to move to the next stage).

This process also allows employees to get involved by being the "eyes and ears" of the IDP. If an employee comes across a new technology that could benefit American Water, they let the appropriate contact know and if applicable, American Water can then develop a business relationship with the company that created the new product.

IDP Roles and Teams

There are six key roles/teams involved the IDP:

- Idea Owner - The entity who owns or part owns an idea, intellectual property or innovation (e.g. entrepreneur, innovator, partnership, venture capital firm or a company).

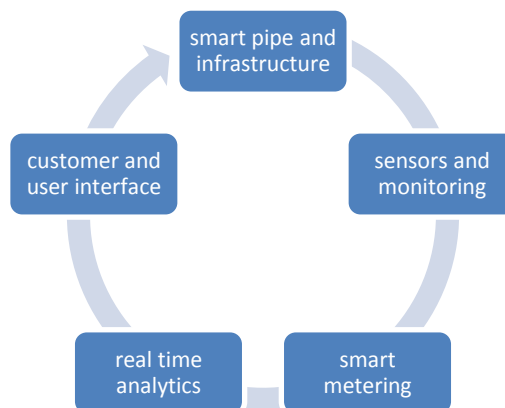
⁵ U.S. Environmental Protection Agency, Factoids: Drinking Water and Groundwater Statistics for 2009

- IDP Manager - The American Water manager responsible for harnessing new ideas and driving them through the IDP process.
- Idea Champion - An American Water employee designated as having business responsibility for a given idea (responsible for pilot testing and/or implementation).
- Advisory Board - A small group comprising leadership from the American Water Regulated business, the non-regulated business and the Innovation and Environmental Stewardship group who meet quarterly to prioritize ideas to be developed.
- Stage Gate Committee - Comprised of the three senior American Water Executives accountable for the entire IDP process and responsible for the allocation of resources for pilot testing and also implementation.
- Host Site - Operational location where idea will be tested.

IDP Innovations

Through its IDP, the company has tested new approaches and technologies to create greater efficiencies in water reuse, desalination, wastewater operations, and bioenergy. The initiative is set to reap significant results given numerous innovative approaches that range from connecting to the Smart Grid through ENBALA Power Networks to investing in the development of NPXpress, a more sustainable and affordable wastewater treatment method to remove nutrients.

ENBALA: The first innovation produced through the IDP is a partnership with ENBALA Power Networks, which establishes American Water as the first U.S. water utility to use ENBALA's Smart Grid technology to harness the flexibility of the company's demand-side assets to deliver Grid Balance to the electric power system. Since water and energy are so interconnected, finding ways to better manage these critical services benefits both industries and their customers.



ENBALA's innovative technology connects the demand-side assets of industrial and institutional electricity users to the Smart Grid to provide Grid Balance to electricity system operators. The technology manages the way electrical equipment – which in this case is American Water's treatment plants and pumps – uses power without impacting the efficiency of its process or its operational costs. Instead of adjusting power generation to match second by second changes in electrical demand, the ENBALA Power Network adjusts the demand of the pumps and operational equipment so that generation can be operated at optimal levels and efficiency. Participation in this Smart Grid technology provides a cash payment in exchange for the return of energy to the grid.

American Water and ENBALA completed a successful pilot program at Pennsylvania American Water's Shire Oaks pumping system to test this groundbreaking technology. The study showed that the water company SCADA system (computers that control the treatment process) could respond within seconds and that the entire demand-response process was seamless to the water plant operator. Because of the inherent flexibility of water plant operations, the ENBALA Power network could slow down or speed up pumping (and other electrical use) without any observable impact on plant operation. Of course the operator could always override the control system if a certain tasks needed to be done, but no such event occurred during the pilot testing.

NPXpress: Patented in September 2011, American Water's patented NPXpress process reduced aeration energy consumption by up to 50 percent and supplemental carbon source by 100 percent at two

full-scale wastewater treatment plants in Mapleton and Jefferson Peaks, N.J. The technology has been installed at six other American Water wastewater treatment plants as part of the company's overall initiative to achieve sustainable, energy-neutral wastewater treatment.

Approximately half of the total energy consumed in a typical wastewater treatment plant is used to maintain a high-dissolved oxygen concentration in the aeration tank to remove the organic matter and ammonia in wastewater. Membrane bioreactors are increasingly popular in wastewater treatment due to their capability to produce high quality treated effluent. However, membrane technology increases aeration energy intensity because membranes require periodic cleaning. Further, a supplemental carbon source, such as methanol, may be added to the system to enhance removal of nitrogen, further increasing costs and carbon footprint.

The increasing cost of energy and carbon sources and stringent environmental regulations restricting wastewater discharge of nitrogen and phosphorus are the main drivers for large water/wastewater utilities to explore opportunities for sustainable design and operation of their wastewater treatment plants. NPXpress produces high quality treated effluent while using much less oxygen and minimal or no additional carbon. The unique operating condition of the NPXpress promotes growth of certain microorganisms that remove nitrogen and phosphorus in wastewater. These microorganisms require much less oxygen and carbon to convert ammonia nitrogen to nitrogen gas compared to conventional bacteria found in wastewater treatment systems.

American Water and Abengoa, an international company that applies innovative technology solutions for sustainability in the energy and environment sectors, signed a worldwide licensing agreement in 2014 for American Water's patented NPXpress technology. The agreement will enable Abengoa to use NPXpress while American Water will retain all rights with respect to its technology. This is the first time American Water has licensed an internally generated technology achieved through its IDP.

FATHOM (formerly Smart Earth Technologies): Due to requirements by local Public Utilities Commissions, American Water's three million customer meters must be replaced every 10-20 years, requiring \$40-\$50 million per year of capital outlays. In addition, American Water is upgrading its meter system by using remote meter reading technologies instead of touch pad or manual read meters. The FATHOM Meter Data Management (MDM) hosted solution creates a standardized communications platform, creating interoperability among meter manufacturers without the need for radical modifications to their products. This allows for a seamless transition of replacement meters as well as inclusion of all legacy meters into the network with minimal impact.

The FATHOM MDM platform, which incorporates a Universal Data Translator (UDT), is able to receive many kinds of data from the water distribution network, including pressure, water quality, leak detection and flow, not just meters. This fact makes the FATHOM solution a powerful tool not only for meter reading and billing purposes, but for the collection of real-time system data from which predictive analytics can be performed to better manage and operate the distribution network.

Mixing of meter types and vendors within a service area adds complexity and cost without interoperability, since economies of scale are lost. Interoperability drives incumbent meter vendor prices to alignment with best-in-class pricing models as a result of direct competition. Competition also drives innovation regarding accuracy and precision at very low and high flows, which in turn reduces non-revenue water losses.

In addition to collecting meter data, a UDT also creates the foundation so all other end points in the system can be read and analyzed via the same system to make a truly intelligent grid for the water system of tomorrow.

In addition, an upgrade to the FATHOM MDM program is being implemented enterprise wide to provide real time access to data, alarms and information such as leaks, stopped meters, meter tampering, and backflow, that will enhance the efficiency of the meter reading process and improve customer service.

Stream Control Research Project: Increasing operational efficiency by reducing water waste is a major priority at American Water and for many utilities around the world. Each year, upwards of 1 trillion gallons

of water is wasted due to leaks in distribution systems across the United States. Reducing water pressure is a key approach recommended in the water industry to reduce leakage.

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. 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 this advanced pressure management system.

Biologically Active Filters: American Water is operating granular activated carbon (GAC) as biologically active filters to allow the bacteria to grow on the filter and break down contaminants. The GAC in the filters is primarily used for controlling tastes and odors (T&O) in water that result from algae growth in the source waters. When biologically active, the taste and odor compounds are readily degraded by the bacteria.

In the past, the media in the filters was replaced on a 3-4 year cycle. However, while the new media is effective for removing T&O compounds, it tends to operate at slightly shorter filter run lengths (requiring more frequent back washing), slightly higher turbidity levels and higher head loss. Moreover, it can take a period of time before the microbial populations colonize the filters so they can be biologically active. Thus, by not replacing the filter media, we save the expense of media replacement (both operational expenditure and capital expenditure) without compromising water quality.

Conclusion

As new challenges in the water industry arise, so will the opportunity to increase collaboration and innovation between companies. A particular concern in the water industry is that water is traditionally a low technology industry⁶. This needs to change and innovation within the industry needs to rise to meet the challenges of the 21st century. American Water uses its expertise and research capabilities to evaluate new technology and its facilities to pilot test and become early adopters. As a result, the company is not only benefitting from an innovation, but also helping to bring a valuable new technology to the rest of the water industry.

⁶ Council for Science and Technology. "Improving Innovation in the Water Industry: 21st Challenges and Opportunities." March 2009; <http://www.bis.gov.uk/assets/cst/docs/files/whats-new/09-1632-improving-innovation-water-industry>

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