Solutions for a Water-Scarce Future

XYLEM'S CONTRIBUTION TO URBAN RESILIENCE

ISSUE NO. 2

xylem
Let's Solve Water

Letter from Xylem's President and CEO

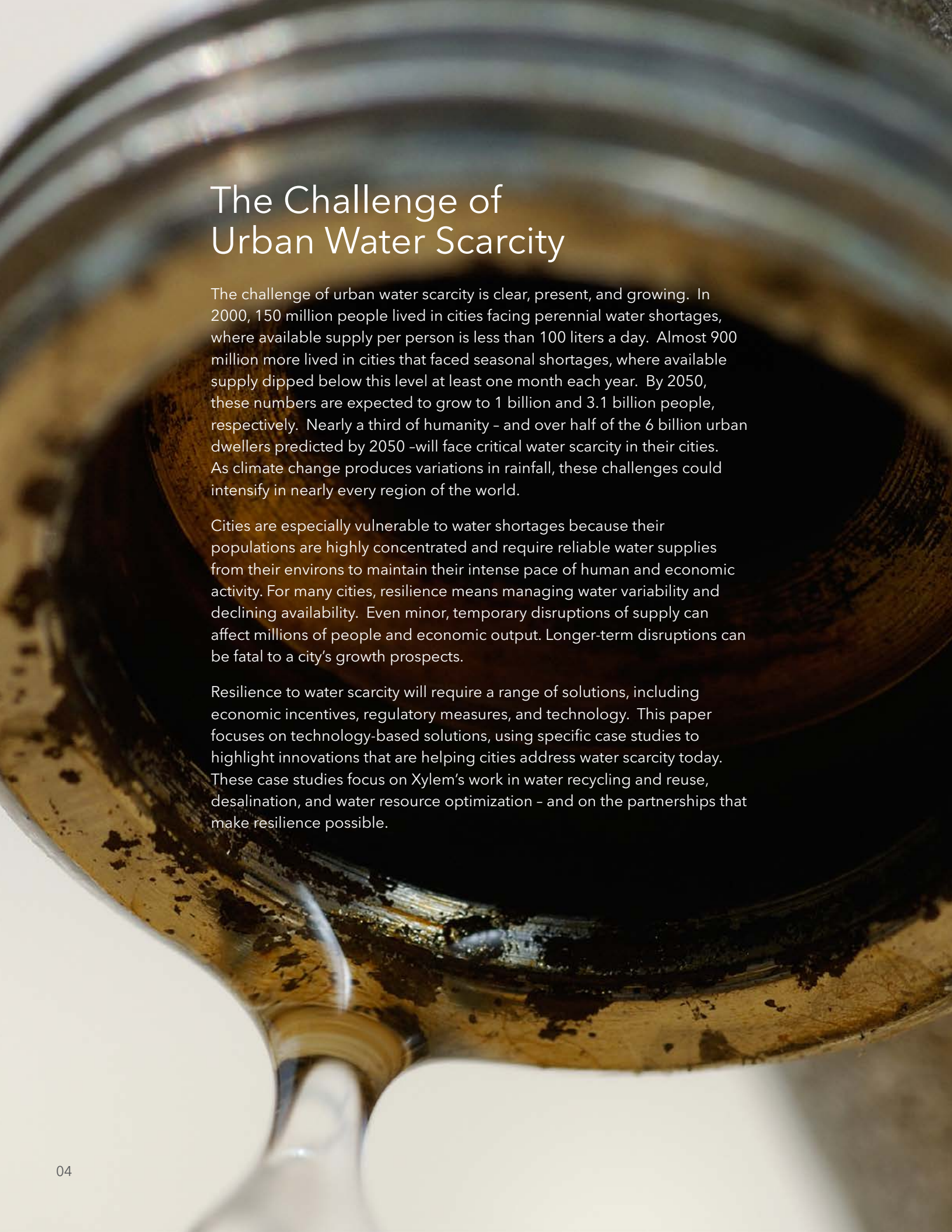
Of the many challenges facing cities around the world, water scarcity is one of the most pervasive. Municipal authorities are well aware of the highly visible dangers of floods, mudslides, tsunamis, and storm surges that have captured headlines around the world. But just as dangerous to the future of a city is the silent, creeping threat of water scarcity.

At the turn of the millennium, 150 million people lived in cities facing perennial water shortages. The outlook is even more challenging – by 2050, we will inhabit a world of nine billion people. Population growth and increasing water consumption will put even greater strain on nature's capacity and challenge our ability to deliver fresh, safe and clean water where it is needed. Left unaddressed, water scarcity will lead to hardship, conflict, and diminished futures.

But there is another scenario, one characterized by resilience and renewal. Investments in resilient water infrastructure – including water reuse, sustainable development of new water sources, and water resource optimization – can help cities meet growing needs and reduce vulnerability to variability and drought. While building resilience will be challenging, the good news for municipal leaders is that they are not alone.

All around the world, Xylem's employees are committed to applying our distinctive water technologies, proven application expertise, and innovative thinking to create solutions for a water-scarce future. From wastewater reuse to smart water networks to desalination, the following stories demonstrate the breadth and depth of our experience in addressing water scarcity. As a trusted partner in countries around the world, Xylem is ready to help cities become more resilient by "solving water." We hope you will contact us to partner on your city's water future.

Patrick K. Decker
President and CEO
Xylem Inc.



The Challenge of Urban Water Scarcity

The challenge of urban water scarcity is clear, present, and growing. In 2000, 150 million people lived in cities facing perennial water shortages, where available supply per person is less than 100 liters a day. Almost 900 million more lived in cities that faced seasonal shortages, where available supply dipped below this level at least one month each year. By 2050, these numbers are expected to grow to 1 billion and 3.1 billion people, respectively. Nearly a third of humanity – and over half of the 6 billion urban dwellers predicted by 2050 –will face critical water scarcity in their cities. As climate change produces variations in rainfall, these challenges could intensify in nearly every region of the world.

Cities are especially vulnerable to water shortages because their populations are highly concentrated and require reliable water supplies from their environs to maintain their intense pace of human and economic activity. For many cities, resilience means managing water variability and declining availability. Even minor, temporary disruptions of supply can affect millions of people and economic output. Longer-term disruptions can be fatal to a city's growth prospects.

Resilience to water scarcity will require a range of solutions, including economic incentives, regulatory measures, and technology. This paper focuses on technology-based solutions, using specific case studies to highlight innovations that are helping cities address water scarcity today. These case studies focus on Xylem's work in water recycling and reuse, desalination, and water resource optimization – and on the partnerships that make resilience possible.

Water Reclamation and Reuse

Today, many cities capture water from surrounding lakes, rivers, or reservoirs, pour millions of dollars into treating and transporting that water to homes and business, and then discard that water after a single use. In water-scarce environments, this "disposable water" approach is wasteful and destructive. Over-extraction of surface and groundwater can reduce ecosystem function, cause land subsidence, and fuel conflict. It also strains public budgets, channeling funds into water supply projects that would be unnecessary with more efficient use of existing resources.

Not surprisingly, water reuse is becoming one of the fastest-growing trends in the water sector. For years, Xylem has helped municipalities around the world give their precious water resources a second life, taking used water from municipal and industrial systems and recycling it in homes, farmland, landscaping, and new industrial processes. Xylem's Flygt pumps and mixers, Sanitaire biological treatment systems, Leopold filters, WEDECO UV and ozone disinfection technologies, Goulds Water Technology and Lowara pumps, and analytic instrumentation are helping municipalities extract value from wastewater – while ensuring consumer safety, renewing the environment, and saving money.

CASE STUDY 1

Mumbai's Metro Rail System

Few countries face a water-scarce future as severe as India, home to sixteen percent of the world's population but only four percent of the world's fresh water. India's spectacular growth has fueled a population and consumption boom, which is increasing demand for municipal, industrial and agricultural water. Water reclamation and reuse are vital to India's future.

Mumbai is India's financial capital, and with twenty million people is nearly the size of Australia. Any city this large faces complex challenges, ranging from efficient municipal transportation to ensuring adequate water supply. Xylem is helping Mumbai manage its growth by helping to make its mass transportation system more sustainable and water-efficient.

When Mumbai began designing its metro rail project, planners made sure to include a water reuse and recycling system in design requirements. They realized Mumbai would need a reliable treatment system that could turn the metro system's nearly 1.2 million daily liters of wastewater into clean water for new uses such as washing and irrigation in a cost-effective way.

To turn this vision into reality, Mumbai's metro rail team selected advanced wastewater treatment solutions from Xylem, including the Sanitaire continuous flow Intermittent Cycle Extended Aeration System (ICEAS) process, which has been installed in nearly 1,000 sewage and treatment installations around the world. ICEAS treats water by aerating, settling, and decanting the water in a single system with reliable, energy-efficient, and cost-effective technologies, followed by integrated disk filtration and disinfection. Xylem's engineering capabilities ensured this compact water reuse plant would fit in the small space available; the project is scheduled to be completed in early 2014.

"This is a unique application where state-of-the-art process technologies are system-integrated in a very limited footprint," said Rahul Sonawane, Xylem India's General Manager for Treatment. "It is the most cost-effective way to produce non-potable reusable water for the Mumbai Metro Rail authorities."

Another initiative underway in India is Xylem's first water reuse plant to turn wastewater into potable drinking water, located in Vadodara, Gujarat. The plant integrates the ICEAS process with ultra-filtration membranes and a UV disinfection system. "When I speak in public, I make sure to talk about the need for governments and private companies to make forward-looking investments in water reuse," says Colin Sabol, Xylem's Chief Strategy and Growth Officer. "If they think you can't create a true water reuse system that lets you drink treated wastewater, we can point to our plant and say, 'Yes, you can.'"

India's government recently identified infrastructure as the critical bottleneck to India's future, pointing to the need to ensure delivery of vital services that will underpin growth and human development. Cities around the country are facing severe water shortages and Xylem India is eager to support them in meeting the challenge. "India's cities need to be looking closely at water reuse," says Sabol, "and when they get there, we'll be waiting to help them make it a cost-effective reality."

CASE STUDY 2

The World's Largest Water Reuse Plant in Kuwait

The coastal nation of Kuwait sits on the shores of the Arabian Gulf in the Middle East, a region that represents five percent of the world's population, but holds less than one percent of its water resources. About 75 percent of Kuwait's potable water must be desalinated or imported. In a land this dry, active water stewardship is critical to a prosperous and stable future.

To conserve its limited water supply, Kuwait built the Sulaibiya wastewater reuse plant, the world's largest water reclamation and reuse center. Xylem's Flygt, Sanitaire, and Lowara products work together to recycle water in this flagship facility that treats sixty percent of Kuwait's domestic wastewater, with a capacity of up to 600 million liters per day.

Prior to Sulaibiya's construction, Kuwait's water network faced two major problems. First, the existing wastewater treatment plant at nearby Ardiya had reached capacity. Second, the country's brackish water resources were no longer sufficient to meet the growing demand for landscaping, agriculture, and other non-potable uses. The Sulaibiya project was designed to resolve both of these issues.

Wastewater flows from Kuwait City and the surrounding area to the Ardiya plant for pre-treatment, then moves to the Sulaibiya plant, where it is treated to potable water standards. The Sulaibiya plant includes three phases, starting with secondary treatment and biological nutrient removal, followed by ultra-filtration (UF) reverse osmosis tertiary treatment, and a final polishing stage. Xylem was chosen to supply and commission critical equipment in the oxidation ditches and digesters, including the aeration, mixing, and pumping systems designed to ensure high-quality secondary treatment effluent.

Any project of this scale requires deep collaboration, and Xylem Project Manager Trevor Day and his team of Xylem engineers worked closely with Kuwait's National Company for Mechanical & Electrical Works and with ILF, an Austrian engineering and consulting firm, to ensure precise installation of more than 50,000 Xylem Sanitaire Silver Series Diffusers and almost 2,600 Xylem Sanitaire Coarse Bubble Diffusers. They also oversaw the installation of thirteen blowers, 45 mixers, 72 flow boosters, 27 recirculation pumps, and more than 25 kilometers of air main and pipe work throughout the facility.

The water produced from Sulaibiya irrigates landscapes along highways, roads, and public gardens in Kuwait City, and supplies farms to support local agricultural production. Outside of the plant, vertical multistage pumps from Xylem are driving the first phase of this irrigation scheme. The plant was deemed such a success in supporting lives and livelihoods and in improving the public acceptance of wastewater reuse as an important component of a water resource portfolio, that there is a planned expansion underway to meet the growing population and water demands of the Kuwaiti people. All told, the Sulaibiya reuse plan will generate $11 billion in cost savings to the country over its lifetime - in addition to the environmental benefits and societal benefits Kuwait will enjoy from having a reliable source of clean, recycled water.

CASE STUDY 3

Water Reuse System for a Food Processing Plant in Australia

Australia is the driest of the populated continents on the planet, with only 53 centimeters of precipitation a year - most of which falls far from major population centers. Compounding this challenge, in the last decade, Australia experienced the worst drought in its modern history. At the height of the drought, water levels in reservoirs, rivers, and lakes fell well below critical levels, sending water planners, public leaders, and business owners in search of solutions.

Located on the Adelaide Plains of southern Australia, the Piscioneri Brothers' vegetable-washing plant is an example of how business leaders can invest in water technologies to help protect against a future of greater climate volatility. The food processor and distributor invested in a new water reuse system to lower total water consumption and protect against the risk of future scarcity.

Michael Vigor, the general manager of the local irrigation consultancy that designed the system, described how the project came into being. "In Australia, water conservation issues are very, very important. Wasting water is not something you do. We were approached by the Piscioneri Brothers to come up with a solution to their produce-washing prior going to market." The Piscioneri Brothers needed a recycling system that would extend the useful life of their water as long as possible.

Vigor describes Xylem pumps at work in the solution, "We have two [Xylem] Lowara marine-grade bronze pumps that move water into a bailing filter separation device that will take out all the solids down to sixty microns." After treatment, the water then is stored for future use. Vigor continues, "We then have a packaged pump set made up of Lowara SV33 vertical multi-stage pumps and a SV805 jacking pump that suck [water] out of the 45,000 liter tank and deliver it to the washing plant. The staff then loads the bunched produce onto the conveyor belt that passes through the washing system and then it's packed into bins, ready for market."

In March 2011, less than a year after construction the plant was already generating huge savings. "The whole thing has come to together really well," Vigor says, "and, as a result, the grower effectively has close to 60,000 liters of water which recirculates through the washing plant. They're operating at anywhere from 500 to 1500 liters a minute when they're washing, so they're turning that water over quite often." This savings translates immediately to an advantage relative to nearby competitors. Vigor further explains, "We've never run out of water and never experienced any issues with deterioration of quality, whereas most other washing plants are adding possibly 50,000-60,000 liters an hour to the system. It was something new - there is very little even close to it in the area."

According to Vigor, Xylem's on-site expertise was crucial to the plant's success, "They have tech guys who come and give advice on programming hydrovalves or any specialized setups we need to use. Right through the process Xylem has been involved; I don't think you can ask for anything more than that."

With the right technology and installation support, the reuse system in this food processing plant has reduced the company's exposure to the risk of drought, created a source of advantage in a competitive market, and helped relieve pressure on a stressed water ecosystem. Solutions like these, replicated at greater scale, are part of making Australian industry more resilient to drought.

CASE STUDY 4

Overcoming Water Scarcity in Peru

Peru's supply of freshwater is dwindling, a trend that threatens the country's thriving agricultural industry. An emerging economy and home to thirty million people, Peru is so mountainous and arid that only three percent of the country's land is considered arable, and yet agriculture accounts for eighty percent of the country's freshwater usage. To address this challenge of limited land and water, Peru's leaders have turned to wastewater reuse as a source of water supply for the agricultural and livestock industries. Observing rapid growth in water reuse, the Government of Peru enacted a new set of regulations in July 2008 to raise water quality standards.

To meet the growing demand for reused water and to address the more stringent regulations facing the process, Lima's water resource agency, Sedapal, turned to Xylem to provide treatment technologies for a new wastewater reuse plant. Working with the project contractor, Abengoa, Xylem was responsible for process design, engineering, equipment supply, electro-mechanical installation, and the first six months of operation of the new treatment plant, located in Peru's Manchay district near Lima.

The plant's original plans underwent a complete redesign with Xylem to meet new Peruvian effluent requirements for wastewater treatment plants. The central challenge was reducing biochemical oxygen demand (BOD5) and total suspended solids (TSS) content in the wastewater effluent by seventy percent and decreasing the concentration of parasites generally resistant to current forms of oxidizers and disinfectant technologies to less than 1/100 ml. Xylem offered a comprehensive solution, converting the new facility to an activated sludge plant on the three hectares of available land.

The treatment plant incorporates Xylem's Sanitaire, Flygt, WEDECO, and Leopold products into an ICEAS Sequential Batch Reactor (SBR) treatment system, which incorporates the ICEAS process, a modified SBR process, and tertiary filtration using a rapid gravity sand filter. The end result is a user-friendly treatment plant with higher oxygen transfer efficiency and lower operating costs that provides high-quality, disinfected, non-potable water.

The plant now treats wastewater from the 90,000 residents of Manchay and uses it to irrigate 1,000 acres of farmland each day. In addition to generating the reusable water, the plant produces about 900 kilograms of dried biosolids extracted from the wastewater on a daily basis. The biosolids are used to enrich agricultural soil and to stabilize landfill cover, further benefiting the local community.

Lake in the Cordillera Mountains, Peru

Advancing the Frontiers of Water Recycling and Reuse

As demand for water recycling and reuse grows, Xylem is working with universities, research institutes and government agencies around the world to accelerate vital research and development efforts.

CASE STUDY 1

Sweden

In Stockholm, Sweden, Xylem has established a two-year water reuse research partnership with the Swedish Environmental Institute (IVL) and the Royal Institute of Technology (KTH) to develop a pilot plant and test bed for advanced process technologies that enable water reuse.

Stockholm's Hammarby Sjöstadsverk is a pilot wastewater plant with a unique history. The site opened in October 2003 as a research facility and in 2008 opened its doors to partners to facilitate long-term cooperation between researchers, municipal water treatment plants, and industry. Xylem immediately became a leading investor and contributor to the project.

In 2011, Xylem and IVL announced a significant long-term partnership in research and development in water reuse. A key element of this investment was design, installation, and commissioning of the reuse pilot plant, which became operational in July 2012. "We invested in this project because it makes it possible to undertake pioneering research and development with partners who understand the need to develop efficient and scalable solutions," said Colin Sabol, Xylem's Chief Strategy and Growth Officer. "Since the global need for sustainable and cost-effective solutions is enormous, we hope to extend and share these essential technologies around the world."

At Sjöstadsverk, Xylem is demonstrating a number of different technologies that can contribute to the world's growing need for improved water treatment and reuse. Primary, secondary, and tertiary disinfection and advanced oxidation processes (AOP) are combined to create treatment systems that can be adapted to local and regional requirements and conditions. The primary goals are: 1) to optimize treatment processes and systems for non-potable (non-drinking) water reuse applications worldwide, 2) to achieve the best possible reduction of micropollutants such as pharmaceuticals and endocrine disruptors, and 3) to optimize treatment processes to minimize lifecycle costs. Xylem is using the Sjöstadsverk facility as a test bed to fine-tune and validate innovations in each of these areas.

"We are making great technological advances with regard to sustainable and optimized reuse treatment," says Glen Trickle, who is responsible for Treatment Research & Development for Xylem. "This water reuse pilot and test facility enables us to demonstrate to customers our different processes and technologies, both individually and as part of an integrated process."

Siva Sankaramanchi, Director of Biological Treatment Business Development at Xylem, believes innovation is needed to keep pace with increasingly stringent regulations governing water reuse around the world. "Innovation in this area is important," he says. "Findings from these studies and our own in-house research will lead to even greater advances in the global issue of finding smart and economical ways to generate top-quality reusable water." Xylem regularly welcomes municipal officials to visit this site to learn more about applying advanced process solutions to the challenge of water reuse.

CASE STUDY 2

United States

Similar research into water reuse is underway in the United States. In Florida, recent legislation mandates that sixty percent of treated wastewater be reclaimed by 2025. High-quality treated effluent is already being used in some Florida communities for commercial irrigation and by homeowners as a second water supply for irrigation. The Water Reuse Research Foundation is working with water utilities in Southern California to find more economical treatment processes for indirect potable reuse.

Consumers need solutions that ensure that water is free not only from pathogens and particulates, but also from emerging contaminants, including pharmaceuticals and endocrine disruptors. Xylem is working with local stakeholders in pilot programs to demonstrate the effectiveness of advanced treatment processes, using Xylem's MiPro containerized Advanced Oxidation Process (AOP) solution. Each shipping container includes an integrated selection of Xylem WEDECO products including ozone, UV, and Promix, a system that removes unwanted contaminants while limiting potentially dangerous bromate formation. Each unit includes a fully automatic control system; parallel or series operation of UV and ozone; dose control; online dissolved oxygen monitoring; upstream and downstream online UV percent transmittance (UVT) analysis; and Ethernet connectivity to enable real-time remote monitoring and control.

The Florida system will be piloted at the Hollywood Waste & Water Treatment Plant, while the California package was delivered to the Los Angeles County Sanitation District and Upper San Gabriel Valley Water District in mid-January 2013.

XYLEM'S REUSE SOLUTIONS AROUND THE WORLD

CANADA In Neepawa, Manitoba, a large pork processing facility produces a watery waste that includes high levels of biological and organic materials, as well as high levels of dissolved solids. This waste would require special handling for it to be discharged to the local wastewater treatment plant. Xylem's Water Equipment Technologies group supplied a reverse osmosis (RO) system that treats over 750,000 liters per day of this wastewater (after pre-treatment in a membrane bio-reactor), producing over 500,000 liters per day of water that can be used for other non-potable applications throughout the facility. This Xylem solution reduced the amount of wastewater for disposal by over 70% while preventing discharge of potentially harmful pollutants.

CHINA Xylem is leading by example in China, where our Nanjing pump manufacturing facility uses a water reuse system built with Xylem equipment. One part of the system treats and recycles all of the wastewater generated by the plant each day, and the other part treats and disinfects the plant's drinking water supply. More than 20,000 liters of water flow through the system each day, cutting the site's water use and serving as an example for potential customers and other companies in China that want to recycle water.

QATAR In the Arabian Gulf, the country of Qatar faces water scarcity challenges similar to Kuwait's. Here, Xylem designed the treatment process and is working on the construction of the Doha South wastewater and reuse facility funded by Ashghal, the Public Works Authority of the Qatari government, on the construction of the Doha South wastewater facility. The facility is expected to capture, treat, and transport 200 million liters of water per day to feed the country's growing urban irrigation needs.

OMAN In Muscat, Oman, the A'Seeb sewage treatment plant is the largest water reuse plant under construction in the country. Xylem designed the entire secondary treatment stage employing the ICEAS process to produce superior effluent quality suitable for the follow-on tertiary membrane filtration and disinfection. The plant is expected to produce 65 million liters of reusable water per day for landscape irrigation when it opens in 2014.

AUSTRALIA In Australia's largest city, Sydney, Xylem water treatment products are helping the international airport to treat and recycle stormwater runoff and sewage. The system treats storm and sewer water from Terminal 1 and the nearby parking lot to be used in non-potable water applications elsewhere in the terminal. This water is now being used to flush toilets, wash vehicles, irrigate the surrounding landscape, and feed the cooling towers for air conditioning, saving the facility about 350 million liters of fresh water a year.

Desalination Technologies

While seventy percent of the Earth's surface is water, 97 percent of it is saltwater. This number matters to urban areas because seventy percent of the world's largest and fastest-growing cities are located on or near the ocean's shores, and many of these cities face challenges in ensuring sufficient freshwater supply. Water-starved cities with coastline access will need to consider desalination as one component of their broader water resource plan to protect against severe, chronic drought. Xylem's technology offerings are a critical component of energy-efficient and sustainable desalination systems.

CASE STUDY 1

Pre-treatment in Saudi Arabia

In Saudi Arabia, surface water is scarce and rain is infrequent. Below ground, Saudi Arabia's deposits of crude petroleum fuel economic activity in the country, but groundwater resources are increasingly depleted by the needs of industry, human consumption, and food security. However, the country's long coastlines provide access to plentiful seawater, and to solve its water supply challenges, Saudi Arabia has turned to desalination technologies. In 1927, Saudi Arabia installed its first desalination facility and since then has increased its desalination production from 300 million liters per day to more than five billion liters per day today. So when Saudi Arabia's second largest city, Jeddah, located on the western Red Sea coast, began to face the dangerous combination of water scarcity and growing water demand, the city's leaders turned once again to seawater desalination as a solution.

The Jeddah Phase 3 Plant, which is owned by the Saline Water Conversion Corporation, Kingdom of Saudi Arabia, produces 690 million liters per day of potable water to feed the city's needs. The water is treated by reverse osmosis (RO) membrane technology, which extracts salt from seawater, creating high quality potable water. RO membranes are intended for removing salt and dissolved ions, but seawater is a soup of debris, silt, aquatic life, and other materials that can rapidly clog membranes, increasing energy consumption or stopping membrane function outright. Pre-treatment technologies are critical to ensure that reverse osmosis systems function reliably and efficiently over time.

To solve the pre-treatment challenges of the Jeddah plant, Doosan Heavy Industries and Construction Company, the prime contractor, selected Xylem's Leopold filter technology. The 28 Leopold FilterWorx filters consisting of Leopold Type S underdrain, washwater troughs, penstocks, air blowers, and filter media pre-treat source water from the Red Sea, removing debris and contaminants that could disrupt the final stage of treatment. By optimizing plant function, Xylem's reliable and durable Leopold pre-treatment filters are helping Jeddah meet the needs of a thirsty and growing population.

Racks of filters in a desalination plant.

DESALINATION AROUND THE WORLD

DUBAI, UAE In Dubai, Xylem's technology is at work in one of the world's ten largest seawater reverse osmosis desalination plants. Each day this plant transforms salt water from the Arabian Sea into 113 million liters of drinking water. In 2004, Xylem (then ITT Water) was selected by PAL Technologies, the local engineer, procurer and contractor that supplied the turnkey desalination plant package. Xylem designed, manufactured, supplied, and installed all products for the plant, taking responsibility for the entire desalination process from intake pump station and pre-filtration to the RO membranes and the distribution pump station, including instrumentation and controls.

AUSTRALIA A large desalination plant in Adelaide, Australia, being built by Acciona Agua of Spain will use eighteen Flygt submersible pumps from Xylem to move 100 million liters of seawater and brine per day for the treatment process. Xylem has extensive experience screening, treating, and pumping seawater for desalination, in addition to a wide array of applications such as cooling systems, drainage, and fish farming.

SPAIN Prior to the Adelaide Plant, Xylem supplied the Alicante II desalination plant in Spain. Its eight Xylem Flygt CP (375 kW) pumps send seawater to pre-treatment before reverse osmosis. For urban areas in need of desalination, reliability and durability is critical; this is why cities around the world have turned to Xylem's submersible pumps to support their water supply through desalination.

TURKS AND CAICOS Providenciales Island is the most populated of the Turks & Caicos Islands, located in the Atlantic two hundred miles north of the Dominican Republic. Due to the lack of natural freshwater and negligible rainfall, nearly 100 percent of the water used by the islands industry, tourists, and residents comes from a reverse osmosis desalination plant with an annual capacity of more than 1.13 billion gallons.

This facility takes salt water from wells drilled into the coral beneath the island and forces it at high pressure through ten reverse osmosis membrane packages, which remove 99.9% of the salt. In 2007, the local utility asked Xylem's Flowtronex brand to replace the plant's overworked pumping system and add a booster pumping station to the distribution system, helping to extend the life of this Caribbean nation's crucial source of water.

Water Resource Management: Measuring, Monitoring, and Managing Valuable Water Supplies

While reuse and desalination are important tools, building resilience to water scarcity will require new solutions to optimize the use of water resources by making improvements in measurement, monitoring, and management.

In Singapore, Xylem's technologies are providing new ways of combining sensing technologies, monitoring software, and environmental monitoring tools to detect leaks and disruptions in the municipal water system. Xylem sensors are also providing the information backbone for a water market in Australia that uses market forces to optimize water allocation in an irrigation basin. And Xylem treatment technology supports an aquifer storage and recovery project designed to optimize the long-term balance of surface and groundwater resources in a city in America's heartland.

CASE STUDY 1

Leak Detection and Environmental Monitoring with Smart Systems in Singapore

In Singapore, smart water management is a national priority. With few domestic water resources of its own, Singapore has invested in innovative ways to manage its water supply. One area it has aggressively targeted is leak detection and remediation, since unresolved leaks waste significant amounts of precious water and energy each year in municipal water systems around the world.

Xylem partnered with Singapore's Public Utilities Board (PUB) and Visenti, a small technology company, to implement an end-to-end, real-time monitoring solution to help Singapore optimize energy consumption, water quality, and leakage detection. The partners deployed forty wireless sensor nodes based on Xylem's YSI EXO multi-parameter sonde, linking them to the PUB's supervisory control and data acquisition (SCADA) system and storing the data in cloud servers. Xylem's sensors and Visenti's software provide PUB's water operations and planning teams with decision support services including event detection (leaks, bursts), system modeling, demand prediction, and operational simulation, all accessible through the cloud.

The system has successfully detected several pipe bursts by sensing pressure abnormalities related to both planned and unplanned system operations. It has also enabled real-time trouble-shooting. Real time data from the Xylem YSI EXO sondes provide immediate feedback to help isolate complaints of low pressure in high consumption areas, saving time and frustration. In one example, a commercial customer was complaining of low pressure, prompting a field team to begin a search for leaks in the surrounding area. Pressure traces collected by a nearby sensor node did not show any unusual activity, prompting the field team to return to the consumer, confident that there was no leak or burst in the vicinity. It was eventually determined that the commercial building's tank was too small to provide adequate supply for the demand during peak consumption.

The real-time hydraulic network model has provided PUB with an up-to-the minute view on demand and consumption in the network. This insight helps system operations optimize long-term reservoir maintenance activities. Furthermore, PUB engineers have used the simulation interface to test-run numerous scenarios and complex crises and better prepare for future risks.

Outside of the municipal water grid, Xylem and Singapore's PUB have partnered to expand the country's ability to monitor its surface water supply. The PUB uses YSI water quality sensors, which measure dissolved oxygen, turbidity, chlorophyll, pH, conductivity, and other parameters, in lakes and reservoirs to monitor water quality before water enters treatment plants for processing. These water quality sensors are also used to ensure the health and safety of water in rivers and harbors.

For example, PUB is also using YSI's EcoMapper Autonomous Underwater Vehicle (AUV) to monitor water conditions in reservoirs. The self-propelled submarine-like unit can "swim" around reservoirs to test and collect water quality data automatically. The deployment route is defined in advance using software and GPS technology, and resulting data create a complete water quality profile far more sophisticated than manual spot sampling can provide. The EcoMapper used by PUB also includes a sonar feature that is used to create a complete image of the lake floor - information that is critical for monitoring erosion and environmental effects over time.

Finally, YSI offers a variety of integrated systems such as monitoring buoys that provide floating platforms in waterways, lakes, or reservoirs to monitor physical, chemical and biological parameters in real time. Taken together, this data can help users anticipate problems, such as algae blooms, and enable remedial actions that save time, energy and maintenance costs. From the municipal grid to the surrounding environment, Xylem is partnering with Singapore to help manage precious water resources, saving money and securing the country's future.

CASE STUDY 2

Measurement and Optimization: Australia's Murray-Darling Basin

It is often said that you cannot manage what you cannot measure. In Australia, Xylem provides the measurement and analytical tools behind one of the world's most innovative initiatives to increase agricultural water efficiency. Data from these tools help leaders from Australia's public and private sector optimize water allocations across an entire agricultural basin.

Market mechanisms are becoming an increasingly common approach to resource management. One market where water trading is helping increase efficiency is in the Murray-Darling Basin of Australia, where landowners can trade the right to extract water from rivers in an open marketplace. During droughts, farmers of water-intensive crops – like rice or sugar cane – can sell their water rights to higher value-added agricultural producers – like vineyards and dairy farms – for a higher return than their crops would have produced. Measuring flow in the Murray-Darling Basin is a task of national importance, since farmers in the basin generate 39 percent of Australia's agricultural income. Xylem's YSI Sontek-IQ flow meters form the backbone of this marketplace, providing crucial measurements throughout the basin to support optimal allocation of water resources.

To run an effective market, operators need to assess the total quantity of water available. However, measurement in the Murray-Darling Basin presented hydrographers with a challenge because the area is extremely flat. Tens of thousands of square kilometers are braided by slow-flowing rivers and streams with virtually no fall in their channels. With such a flat profile, the backwater effect of confluences, fallen trees, slumped banks, and even algal blooms can dramatically impact flow and affect measurement.

"Over the years, we have struggled to manage the hydrographic data for water users," says Danny Hannon, Hydrometric Coordinator for the South West Region for the New South Wales (NSW) Office of Water. "The challenges of providing accurate, repeatable data have been costly in both manpower and dollars."

Previously, measurements were taken only eight times a year and were highly variable and prone to inaccurate readings of overall flow due to downstream debris and other disturbances. In October 2011, Hannon and his team began testing a Xylem YSI SonTek-IQ shallow flow meter. The objective was to provide a continuous level reading flow profile – even in slow-moving water and shallow conditions – that could provide remote, 3D, real-time measurement capability.

Following a survey of the bed and banks of Colombo Creek at the flow measurement site, Danny's team deployed the Xylem YSI Sontek-IQ shallow flow meter. The SonTek-IQ flow meter employs five, pulsed Doppler beams – one paired with a pressure sensor to provide level data and four more to create a 3D measurement of water velocity in the channel. A specially developed algorithm constantly adapts the acoustic pulse to depth, velocity, and turbulence conditions, enhancing the instrument's accuracy in the low-velocity conditions that make the Murray-Darling Basin such a challenge. This on-board processing yields high-resolution volume and flow data, with readings relayed hourly to the Office of Water database via modem. Maintenance requirements are minimal because the flow meter has a long battery life and a power demand of just 0.5 watts, so operators can depend on low-cost, highly reliable readings.

Danny and his team have been delighted with the results and expect to deploy more SonTek-IQ flow meters around the Murray-Darling Basin. Continuous monitoring will improve accuracy, reduce costs, and shed light on water movement in the basin. With enhanced measurement and monitoring capabilities, Xylem has helped the Murray-Darling Basin optimize agricultural water use in an inspiring example of how policymakers, basin managers, farmers, and technology companies can collaborate to solve complex water challenges.

Darling River, Australia

CASE STUDY 3

Aquifer Storage and Recovery in Wichita, KS

Optimizing water supply sometimes requires more than measuring and monitoring – it can also call for physical management of water resources. Underground aquifers are an important source of supply for many cities around the world, especially when rainfall is scarce and surface water becomes unavailable. In times of plenty, they can also serve as storage sites to save water for the future. But many aquifers face challenges such as over-exploitation, saltwater intrusion, and industrial pollution.

These are the very problems that Wichita, Kansas faces in the Equus Beds Aquifer. In the last fifty years, this historically plentiful source of water has come under threat. The brackish Arkansas River is intruding into the aquifer, making salty what was once fresh. Second, nearby energy production has led to brine intrusion from oil fields, raising chloride levels in the aquifer to dangerous levels. Third, continual overdraft by the 1,620 wells in the region has led to steadily declining groundwater levels.

Local leaders, in concert with the U.S. Department of the Interior's Bureau of Reclamation, reacted to this trend by seeking to replenish and restore the aquifer. The solution they found was aquifer recharge, the injection of surface water into underground aquifers to restore and optimize water levels, dilute residual minerals, resist the incursion of brackish water, and protect water from evaporation. To succeed, they needed to ensure that the recharge water was of the highest possible quality, since injecting the aquifer with dirty water could pollute the entire groundwater resource.

In project specifications, the City of Wichita ensured that recharge water would be treated to prevent groundwater contamination. Together with partners such as Air Products and Chemicals, Inc. and APT Water, Xylem supplied WEDECO ozone generators as part of a complete Advanced Oxidation Process solution to remove micro-pollutants such as endocrine disrupting compounds (EDCs), which can affect hormone function in humans and other animals. EDCs can often be traced to disposal of pharmaceuticals, personal care products, and runoff of agricultural chemicals. Wichita's leaders designed this project specifically to address atrazine, a pesticide used in local farms.

The City of Wichita selected WEDECO PDO Series ozone generators, with each unit producing 2,100 pounds of ozone per day. This energy-efficient, fully instrumented system utilizes industry-leading WEDECO EFFIZON® HP electrodes and variable frequency power supply technology to ensure reliable and cost-effective production of ozone that oxidizes harmful compounds such as atrazine and kills pathogens while mitigating formation of bromates, a potentially harmful byproduct of water treatment.

Today, this project draws 113 million liters of excess water each day from the Little Arkansas River, treats it, and injects it into the underground aquifers to ensure that wells in the surrounding area will continue to supply clean water. Xylem is proud to have partnered with the City of Wichita to renew its water supply without creating new challenges along the way.

Partnering to Support the Most Vulnerable

Through the Xylem Watermark corporate citizenship program, Xylem supports humanitarian efforts to provide and protect clean water where it is needed most. In partnership with several leading non-profits and other international and local partners, Xylem Watermark is helping large cities provide their most vulnerable residents with safe water.

CASE STUDY 1

Drilling New Wells in Jordan

In Jordan, Xylem Watermark supports its partner Mercy Corps in constructing wells in refugee camps that are swelling as a result of the ongoing civil conflict in Syria. In Zataari, Jordan, Mercy Corps, with Xylem's support, began by establishing storage tanks and pumps that distributed water brought in on daily truck deliveries. But the cornerstone of the project was a deep well. This well taps veins of water in the underground aquifer that are clean, cool, and reliable for this struggling refugee population.

Jordan, one of the ten poorest countries in terms of water resources, is in need of solutions to its water crisis. A properly installed and conscientiously maintained well will create benefits for many years, serving not only the refugees of the Zaatari camp, but also tens of thousands of local residents – the Jordanians hosting the refugees – who have struggled for years to find a reliable water source.

"Everybody here is looking forward to having easier access to clean water," said Elena Buryan, head of Mercy Corps' emergency response team in Jordan. "The current water and sanitation set-up is not great." As Mort Anushinavani, the water engineer who runs Mercy Corps' infrastructure team, noted, "We usually joke about how our best work is buried underground." For people in need, the well is tapping into something tremendous: providing clean, reliable water for more than 65,000 people each day.

CASE STUDY 2

Building Cisterns in Semi-arid Brazil

Brazil is home to the world's largest river, the Amazon, which is in turn surrounded by the world's largest rainforest. But much of the country struggles with water scarcity. During the dry season in northeastern Brazil, families must rely on either the muddy remnants of surface water in dams, rivers, and ponds or on expensive, inefficient, and unreliable trucked-in water. Despite impressive recent economic growth, forty million people in Brazil still lack access to adequate water and sanitation. And, as in most areas of the world where water scarcity is an issue, there is a disproportionate impact on women and children, who are forced to walk miles every day to find the nearest water source, depriving them of educational opportunities that would help lift them out of poverty.

Xylem Watermark saw this challenge as an opportunity to find a long-term solution. Partnering with regional development non-profit Avina, Xylem supported construction of rainwater capture and storage cisterns for schools in Brazil. All told, in 2013, 25 schools have each received a 52,000-liter rainwater storage tank providing a new and improved source of water and healthier conditions for more than 2,600 children and teachers. More than 11,900 people, representing the families of the students, are indirect beneficiaries of these projects. With the water held in the cool, dark, sheltered cisterns, very little is lost to evaporation or groundwater seepage, meaning that these students will have clean water supplies even in the dry season.

Accompanying this infrastructure development is a targeted education program to teach the children and community members about water, sanitation, and hygiene (WASH) measures that are some of the highest-return investments in developing communities. As rural populations grow, developing economies slow, and the climate continues to change, these sorts of decentralized, sustainable, and simple solutions to water scarcity will only become more important.

In the Philippines, Cambodia, India, and China, Xylem Watermark works with Planet Water Foundation to install water filtration towers schools in order to provide children with access to clean water. Xylem Watermark has also partnered with Water For People in India and Latin America and China Women's Development Foundation in China to provide safe water to schools and communities where water is scarce or polluted, while bringing critical WASH education to students. Since Watermark launched in 2008, the program has made a difference in the lives of more than two million people in locations around the globe.

Working Together to Solve Water Scarcity

Water scarcity will be a defining resource challenge of this century. Surmounting this challenge requires building resilience with an all-hands-on-deck approach from public leaders, civic organizations, and the private sector. While water scarcity is a global problem, water issues are by their very nature deeply local, and the water scarcity challenge is in fact a vast array of local crises played out over and over again around the world.

City leaders need water solutions as diverse as the challenges they face, and Xylem aspires to be a helpful partner in "solving water." Around the world and over the years, Xylem has worked with cities and communities to manage water scarcity. Whether by reusing and reclaiming wastewater, developing new supplies, identifying and preventing leaks and loss, improving efficiency, or monitoring the entire system, Xylem has the capability, know-how, and passion for solving water issues in partnership with public leaders, communities and the private sector. Let's join together to confront these challenges – and let's solve water.

Xylem |'zīləm|

1) The tissue in plants that brings water upward from the roots;
2) a leading global water technology company.

We're more than 12,700 people unified in a common purpose: creating innovative solutions to meet our world's water needs. Developing new technologies that will improve the way water is used, conserved, and re-used in the future is central to our work. We move, treat, analyze, and return water to the environment, and we help people use water efficiently, in their homes, buildings, factories and farms. In more than 150 countries, we have strong, long-standing relationships with customers who know us for our powerful combination of leading product brands and applications expertise, backed by a legacy of innovation.

For more information on how Xylem can help you, go to www.xyleminc.com.

xylem
Let's Solve Water

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