A Different Look at Water: Part I

Water for Cities and the Water-Energy Nexus

Source: Thinkstock

This year's United Nations World Water Day is dedicated to Water for Cities: responding to the urban challenge. Our society is going through a tectonic shift from largely agrarian and rural living to dense urban living. According to *Triumph of the City*,[1] more than half of the population in 2011 will be urban. Along with the benefits of urbanization including lower environmental impact come challenges such as how to provide large, dense and growing populations with clean water for an increasingly growing middle-class society with corresponding expectations. This paper from Dow Water and Process suggests that along with smart governance and policy, innovation plays a major role in ensuring a clean safe and affordable supply of water so cities can in fact triumph.

Cities in the Developed and Developing World are Water-challenged

It should be no surprise that the demand for water outstrips its ready supply everywhere around the world. As global population soars, food, energy and freshwater are becoming increasingly scarce. Water, whether for potable or industrial use, is limited, and some supplies are not useable. Under an average economic growth scenario and without efficiency gains, global water requirements will grow from 4,500 billion cubic meters today to nearly 7,000 billion cubic meters—more than half of all the water in Lake Superior and a 50% increase in only twenty years. By 2030, some analysts predict that available water supplies will satisfy only 60% of demand.[2] According to the World

Source: Masterfile

Economic Forum, nearly 60% of the world's population will be living in cities by that time, causing a shortage of clean water for people and business in the urban environment worldwide.[3] In that time, a third of humanity will have only half the water required to meet basic needs,[4] which is likely to impact food production through its effect on agriculture which accounts for more than 70% of water usage.[5] Clearly, this scenario poses serious challenges to local communities wherever they may be.

In the developing world, the challenge to municipalities is making the limited amount of fresh water clean enough to drink for millions. In no place is this playing out more intensely than China, which by 2025 will build 221 cities with a million or more people and fifteen mega cities with populations of over 10 million. Today China has approximately 300 million people with no access to water. Even though China has 6% of the world's total water resources, its large population means that the country only has 25% of the world's average water resources per capita. The UN lists China as one of 13 countries that is experiencing serious water scarcity. Of the 661 cities in China, 33% are scarce of water, while 17% of China is regarded as badly scarce of water.[6] The World Health Organization states that 1/6 of the world's population does not have access to safe water for drinking. This translates into 1.1 billion people globally who do not have access to clean drinkable water.[2]

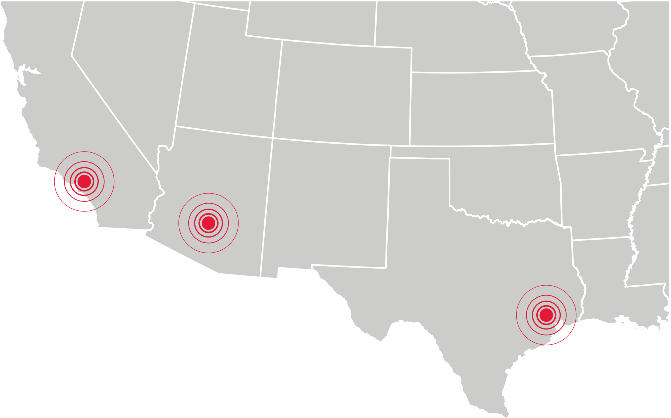
While the challenges in the developing world seem to overshadow water issues in places like the United States and Europe they are just as real. In established cities where infrastructure already exists, municipal planners are faced with aging pipes and pumps, falling water tables and new regulations that place an additional cost burden on already stretched resources for treating current water supplies.

Ceres, an environmental research and sustainability group, 24/7 Wall St, and the National Resources Defense Council declare that 10 of America's biggest cities are in severe danger of water shortages in the relatively near future. The top three cities in danger are:

- **Los Angeles, California**, via hundreds of miles of aqueducts, the fastest growing city in the United States, Los Angeles relies on bringing in water from the Colorado River;
- **Houston, Texas**, located in a high drought area, draws its municipal water from nearby Lake Houston and Lake Conroe; and
- **Phoenix, Arizona**—adopting an aggressive campaign to recycle water, replenish groundwater and discourage over-consumption.[7]

Another more psychological factor in cities with established infrastructure is the population itself and its attitudes and feelings about water's cost and appropriate use.

Top Three Cities in Danger in U.S.



Source: Ceres, 24/7 Wall St. and National Resources Defense Council

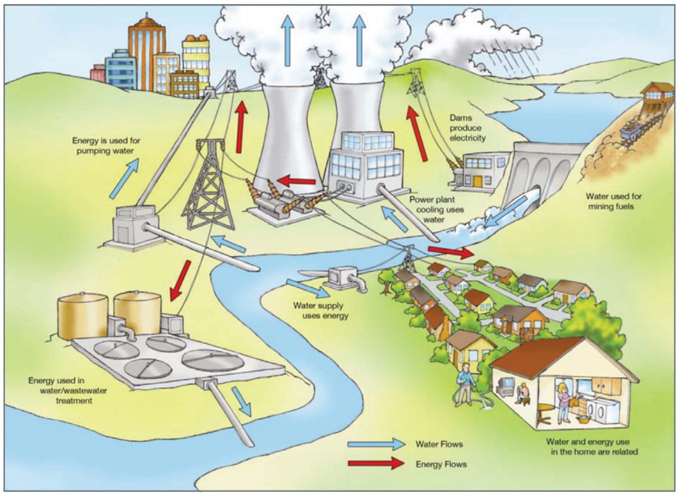
The Water-Energy Nexus Plays a Central Role for Municipal Water Planners

Compounding this issue for all municipal planners whether they have existing or need new infrastructure is the fact that water and energy are interconnected in a nexus of resource planning —energy is needed to secure water resources, water availability impacts energy generation, and so on. A large amount of energy is needed to extract, treat, and deliver potable water. Energy is also required to collect, treat, and dispose of wastewater. In the United States, 4% of all power generation is used for water supply and treatment and 75% of the cost of the municipal water processing and distribution is electricity. As a result, in the U.S. several states now have statutes that recognize this water-energy nexus, including Arizona which requires legislative authorization for appropriation or use of water to generate over 18,000 kilowatts of electric energy.[2] Conversely, energy is required to make use of water, whether to extract, move, treat, deliver, use or dispose of it. This is primarily in the form of mechanical or electrical energy, and is sometimes as simple as human or animal power.

Source: istockphoto

To constituents, especially in the U.S., it may seem that abundant, drinkable water is a given. But what is the source and what is the cost to purify it? As our communities grow adding to the demands on water and energy resources, the pressure is on to reduce the cost while increasing the supply of both. At the same time, the public demands greater accountability for how we manage our watersheds. Water tables are going down as more wells are drilled and formerly pristine watersheds are now no longer clean. To meet all their water needs, whether for human consumption, agricultural or industrial use, large municipal areas facing population growth now need to consider how best to manage multiple sources: ground water, surface water and even water reuse. All of these things impact how water is treated, and the only certainty is that one solution will never fit every scenario. Unfortunately this water-energy nexus can become a vicious cycle, as lack of technology, poor management or inefficiencies in use in one area can affect the sustainability of the other. For instance, power plant inefficiencies can result in increased water use to generate the needed amounts of electricity. It all adds up to a confusing morass of often conflicting priorities to factor at the municipal level, with increasing regulatory requirements adding more to the mandate every day.

Interdependency of Water and Energy



Source: U.S. Department of Energy

Unraveling the Complexity

Getting a handle on this problem is rather like squeezing a water balloon: get a tight enough grip on one end, and the other side expands beyond capacity. Municipal water planners have to innovate, work with both regulators and end customers and make use of proven technologies to optimize both energy and water all while not disturbing… in fact improving… the quality of life. Clearly, an understanding of the interplay between water and energy against key factors such as infrastructure and quality will have a profound effect on sustainable use of both water and energy and will allow us to plan for the needs of today's population as well as the burgeoning needs of the future. But how do local communities know where to apply that innovation for optimal benefit?

The aim of this paper is to begin to unravel some of this complexity by taking a fresh look at some key considerations for city planners against the backdrop of the water-energy nexus. First, we will look at new versus existing infrastructure. Second, we look at the interplay between water quality requirements and water use and reuse.

NEW AND EXISTING BUILD

Source: Thinkstock

When anticipating community water needs, planners need to solve the energy-water equation in both directions. Whether the scope formally includes just one resource or the other, proper project planning must account for both considerations.

If the project involves an upgrade to existing infrastructure, the decisions and considerations will be very different compared to a new build project. Building new infrastructure allows the planner to fully integrate water and energy considerations at every stage with the most up to date technologies. If additional water is required or must be treated differently due to a new regulations in the case of existing infrastructure, there are a number of tradeoffs to balance depending on how the problem is approached.

New Build and Desalination

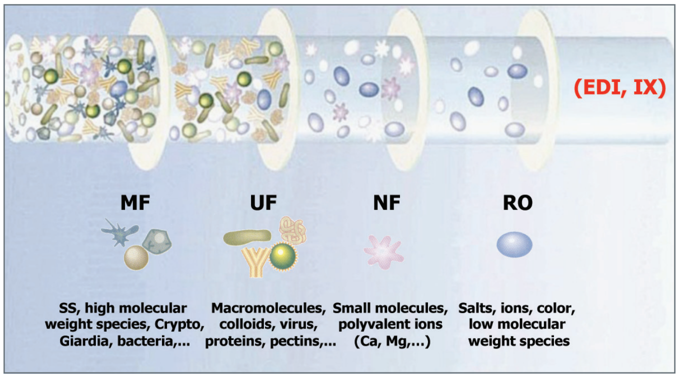
As water resources become scarcer, seawater desalination is gaining prominence both in the developing and developed world to ensure against drought. The single largest cost for seawater desalination is the energy cost. This has been a factor in public, environmentalist and political resistance to desalinization plants in areas that have other options. For example, in 2007, London's then mayor Ken Livingston launched a High Court challenge against a desalinization plant planned by Thames Water in Beckton dubbing it "gas guzzling desalination." Livingston's successor, Mayor Boris Johnson, withdrew the case as one of his first acts in office concurrent with a series of measures announced by Thames Water including using 100% renewable fuel to power the plant.

In the Middle East, desalination is sometimes the only option to generate a source of clean water. In Saudi Arabia, subsidized oil is used to power desalinization plants, but even in this oil-rich country, planners are starting to look at other options to provide cleaner energy to power desalination operations. In Australia, wind, wave and tidal energy sources are employed to power desalinization plants. Whatever the power source, reducing the overall energy intensity of the process can lower the electricity burden and subsequently the cost of any desalinization plant.

Reverse osmosis is the lowest cost method for desalinating seawater. However, it is only 20% thermodynamically efficient. Current methods require anywhere from 8 to 20 kilowatt-hours of energy to produce 1,000 gallons of desalinated seawater, because a large amount of energy must create high pressure to force the water through the membrane for separation. This means that four gallons of desalinated seawater could require as much power as running a light bulb for an hour. For a plant producing thousands of gallons every hour, the costs mount quickly. Using a thinner membrane can reduce energy requirements; upfront planning that can lower ongoing costs.

One important energy-saver is using brine waste to pressurize incoming seawater instead of simply discharging it. This innovation increases the complexity of the water purification

Pressure-driven Membrane Separation



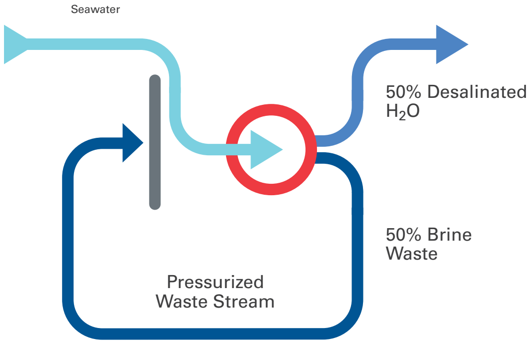
Source: Dow Water & Process Solutions

Energy Cost Efficiency in Desalination

The single largest cost for sea water desalinization is the energy cost. Large amounts of energy are needed to generate the high pressure that forces the water through the membrane. Current methods require anywhere for 3 to 14 kilowatt-hours of energy to produce 1,000 gallons of desalinated seawater. This depends on the quality of water to be treated.

However, gains can be achieved through the separation unit. The loss here is the energy needed to push the water through the membrane. The most significant waste sources are pumps and piping systems at 39.7% and the separation unit is 36.2%. Little can be done to reduce the 39.7% of the energy that is lost due to inefficiencies in pumping motors and friction and pressure drop losses in pipes. This can be reduced by designing a thinner membrane as part of a better filter system.

Recovering Energy Loss in Desalination



Pressurized waste stream is used to pressurize incoming seawater resulting in 95-99% energy recovery.

Source: Dow Water & Process Solutions

facility but loosens the knot between energy and water. Normally about half of the seawater that passes through a membrane must be discharged with the brine waste, carrying away the materials that are purified out of salt water to make it potable. That means wasting half of the energy used to pressurize incoming water. However, by transferring the pressure in the outgoing brine waste directly to the incoming seawater, system operators can recover up to 99% of the energy that was lost before.

The Ashkelon Seawater reverse osmosis plant is the largest desalinization plant in the world and is an example of how these water-energy innovations work in concert to reduce cost. This plant provides greater than 15% of the water needs of Israel from the Mediterranean Sea.[2] The plant produces clean water at a cost of 60-70 U.S. cts/m^3 compared to most desalinization plants, which cost out at 80-90 cts/m^3.

Ashkelon, Israel

Existing infrastructure

Even with existing infrastructure, planners can improve the interlocking relationship between energy and water, with upgrades and improvements but the decision isn't always clear, particularly when new regulations require additional treatment. For cities with growing populations, sometimes the decision comes down to tapping a new well or upgrading existing infrastructure. Since part of the challenge is our diminishing ability to tap into new wells in the first place, new opportunity often stems from finding new ways to make infrastructure upgrades more affordable and efficient and therefore valuable. A more holistic systems view can indicate when reducing the cost of energy can maximize value by minimizing impact of the new build cost of retrofitting a plant. For instance, an upgrade to an existing facility with a reverse osmosis or an ion exchange process requires initial capital investment but can save on energy costs and environmental impact, particularly important if local conditions increase power prices or reduce availability of electricity. In some implementations, simply replacing an 8-inch filter with the latest iteration of the product can reduce energy costs of the whole plant by as much as 50%!

In the developing world infrastructure exists but is inadequate, new innovations are the only option for a clean pathogen-free water supply to the home. In some cities in India and China, for example, the water pressure is simply too low to apply a standard reverse osmosis process. Growing populations connecting to the same aging infrastructure only exacerbates the low pressure problem as the pressure available has to stretch across more homes. These are poor communities without the ability to purchase high pressure pumps so one solution they could employ is a low-pressure osmosis technology.

Power Play

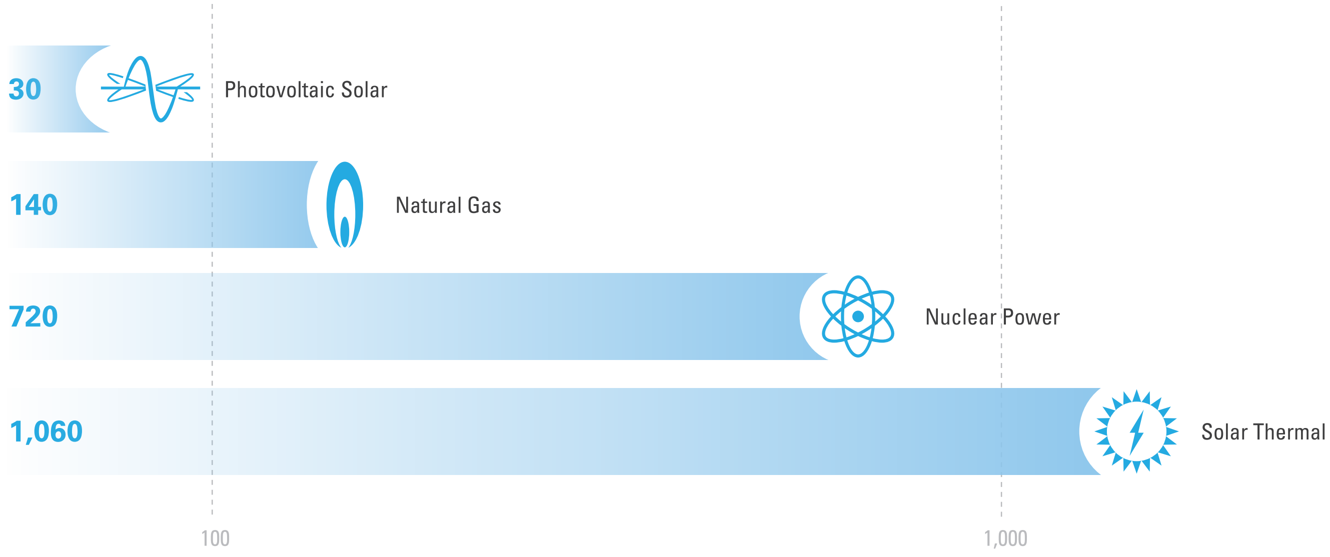
When building new power capacity, project managers can chose energy projects that minimize water use, such as natural gas instead of nuclear power, or photovoltaic solar instead of solar thermal power. A natural gas power plant uses just 140 gallons of water per megawatt-hour of power produced, while a nuclear power plant uses up to 720 gallons to produce the same megawatt-hour of electricity. Even different types of green solar power can vary on their water use. Solar photovoltaic plants use just 30 gallons of water per megawatt-hour, while large-scale solar thermal plants use about 1060 gallons of water per megawatt-hour.[2]

According to the National Renewable Energy Lab, American electricity production from fossil fuels and nuclear energy requires 190,000 million gallons of water per day, accounting for 39% of all freshwater withdraws in the nation.[8] In many regions of the country, Americans use as much water turning on the lights and running electric appliances in our homes, as we use in taking showers and watering lawns.

Where feasible, using cooling water from a lake or river or a natural pond, instead of a cooling tower, can lower costs and construction requirements. This type of cooling can save the cost of a cooling tower and may have lower energy costs for pumping cooling water through the plant's heat exchangers. Power plants using natural bodies of water for cooling must be designed to minimize their impact on the surroundings. This can include protecting organisms from intake and reducing the temperature of the discharged water before returning it to the natural environment.

By selecting a low-water use energy technology like solar photovoltaic or natural gas, more water can serve the population. In some U.S. states, power planners must take water concerns into account by law, but even when that is not the case, all municipal planners can ensure the future of their projects by considering both sides of the water-energy equation.

Gallons of Water Needed per Megawatt-hour of Power[2]



Source: Dow Water & Process Solutions

QUALITY AND REUSE

The impacts of the water-energy nexus are cyclical. In addition to considering the energy and infrastructure requirements of a municipal water plan, there are constraints and resources inherent in the water supply itself. Specifically:

- What is the source of the water, and its quality?
- Can water be reused, and how?

Carefully assessing the spectrum of unique variables at the local level can help municipalities expand the range of possible solutions available to them, and the innovations that may help optimize their water use.

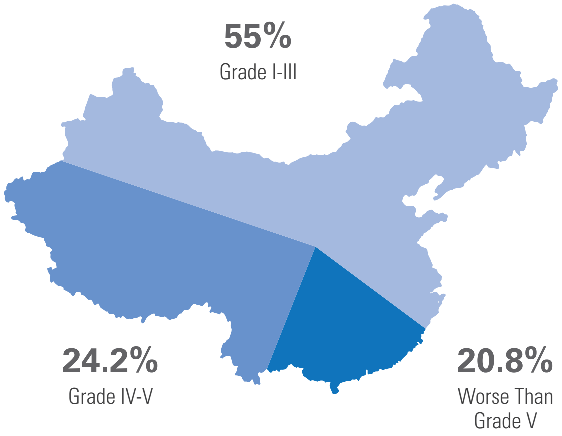
What is the Source of the Water… and its Clarity?

Where will the water come from? It may be more available than feared. Yes, groundwater and aquifers and snowmelt are common choices to fill reservoirs in the industrialized West, but all too often in the developed world, communities fail to consider the basic question: can water be reused? Of course it can. The real question isn't "if" but "how?" Seawater can also be desalinated. Water already claimed by humans for agriculture, industrial and even domestic use can be purified of contaminants and used again safely.

For one thing, there are many levels of water quality, with many ways to measure it depending on its intended use, the presence of metered contaminants, and compliance with various regulations. The Safe Water Drinking Act in the U.S. requires the Environmental Protection agency (EPA) to establish National Primary Drinking Water Regulations for various contaminants that may cause adverse health effects if ingested. The National Resources Defense Council (NRDC) has introduced its own system to grade municipalities' water quality and compliance with regulatory standards, ranging five grades from "Failing" to "Excellent."

But purity standards affect reuse for more than just human consumption around the world. For instance, the government of China has committed nearly $151 billion to improve its urban water infrastructure over the next two decades, in order to address pollution taxing its supply of water to fast-growing population… and industrial... centers. In China's classification system, Grade I refers to the natural water resources protected by the state. Grade II and III also refer to water resources that could be used to make drinking water and to sustain the aquatic eco-system. Of the seven water systems in China, 55% of the water had a water quality grade of I-III in 2008. 24.2% of China's water was graded IV-V, while 20.8% of the water received a grade worse than V. Grade IV water is deemed suitable only for industrial use, and grade V water is only for agricultural use. Any grade considered worse than V is unsuitable for use.[6]

China's Water Quality Classification



Source: Dow Water & Process Solutions

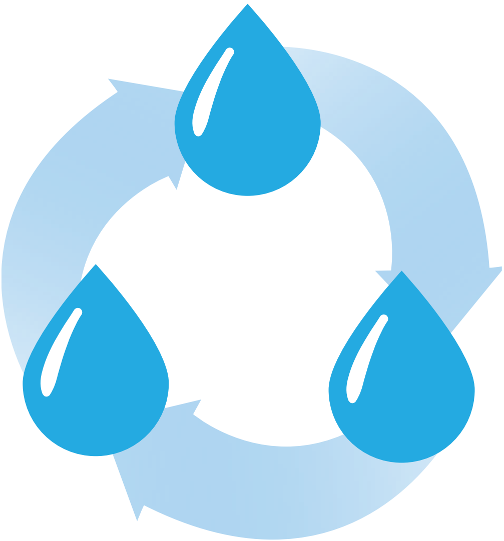
Water Use… and Reuse

Once a source exists, it can be reused, but what is driving the water needs of the community in the first place? A growing suburb managing a need for drinkable water may have a very different attitude toward water reuse than an agricultural town with a lowering water table. Whether available water can and will be purified to meet municipal needs depends greatly on what needs the water supply must serve, and the barriers, both technological and cultural, to its reuse.

One significant driver of growing municipal water needs around the world is agriculture, which is often the biggest user and point of water loss in the system. For instance, water consumption in the western United States is much higher due to agricultural issues. Over 1 million gallons of water per year is used to irrigate one acre of farmland in the west due to arid conditions—enough to satisfy the water needs of all 11,000 students at the University of North Colorado for a day.[2] China's projections are even more challenging, with water demand expected to reach 818 billion m^3 by 2030. Agricultural use accounts for more than 50%, and nearly half is for growing rice.

Yet today, current supply amounts to just over 618 billion m^3 with industrial and domestic wastewater pollution making the supply-demand gap even larger than the quantity. Essentially, 21% of available surface water resources in China are unfit even for agriculture by its own standards, which means that some form of water purification and reuse is an important part of its future supply.[6] Everywhere around the world, municipal water reuse for agricultural purposes is already an accepted reality. Wastewater treated with Dow components is used for agriculture and landscape irrigation, groundwater replenishment and industrial processes. The most significant barrier in that use case is price. The key to successful reclamation of water for agricultural reuse is that the cost to municipalities of its potential recovery and treatment must be kept low. Innovative separation technologies are helping to address global water shortages—allowing communities and industries to turn wastewater into a valuable resource through reclamation processes that are energy-efficient and cost effective.

Water Reuse



Source: Dow Water & Process Solutions

Industrial use of reclaimed and treated water is another widely accepted reality, with many innovative technologies helping to reduce the energy cost needed to make it economically feasible. For instance, reverse osmosis—one of the primary technologies behind seawater desalination—is also used for wastewater treatment and recycling. As a result reverse osmosis membranes are being used in three major wastewater reclamation and reuse facilities in the city of Beijing with the aim of reaping the same energy harvest benefit as in the desalinization case. There they will be used to treat 45,000 cubic meters of water per day at three sites—BeiXiaoHe Wastewater Treatment Plant, Beijing International Airport and the Beijing Economic-Technological Development Area—to help the city reach its goal of reusing half of its water, significantly extending this limited natural resource.[6]

Similarly, Singapore recovers a high percentage of its water from domestic use, which it purifies and sells to industry for a price. This allows the island nation to effectively manage a closed loop on industrialized and urbanized water. As a self-contained city state, this measure helped reduce reliance on water imported from Malaysia and is deemed an important development for national resource independence. Although primarily produced for industrial use, the water is purified to drinking quality using dual membrane microfiltration and reverse osmosis technologies, and marketed as bottled water for human consumption under the consumer brand NEWater.

Clearly, the great barrier to reuse of water from "toilet to tap" for human consumption is a psychological one requiring as much innovation in marketing and education as in purification technology to overcome. Singapore's use of social marketing addresses the barriers to municipal reuse of water for human consumption, which has traditionally faced steeper barriers to acceptance in the developed world. Far from being the exclusive domain of space-age closed-system biosphere experiments and arid communities in dire straits, purifying available water to drinkable standards is a fact of mainstream life even in the developed world. For decades cities across Europe and the U.S. have purified river water for human consumption. The fact that this is the same river receiving treated waste from all the towns upstream, however, is a conveniently located blind-spot in our collective mind's eye. Furthermore, use of so-called "grey water"—domestic waste water from uses like laundry, dishes and bathing—is already gaining mainstream acceptance as an option for watering plants and washing dishes. Such water conservation measures could reduce household demand in developed countries by 70%, according to Dr. Nicholas Ashbolt, from the US Environmental Protection Agency (EPA).[4] Given that technology exists to recycle such water on-site, the obstacles to domestic water independence are market- not technology-driven. The low cost of water in the West is discouraging this technology from gaining a foothold in home development. With the right incentives, however, water systems available today could be integrated into ordinary homes to full supply domestic water needs around a household water "allotment." But what are the factors that would drive us to household allotment and reuse? Contamination? Shortage?

Technology Fueling the Innovation Nexus

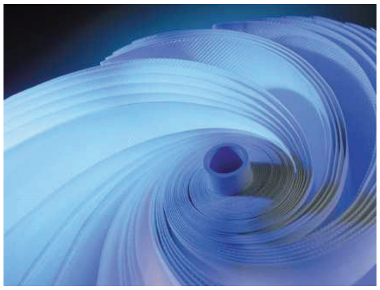
Three key technologies for water treatment are reverse osmosis, ion exchange and ultrafiltration. The precise technology that will drive water innovation in any given community varies according to the unique mix of energy and water resources that community can bring into play. We can look at how various sources and costs combine in different implementations to better understand how these factors can create innovative outcomes in different environments.

Perhaps the answer is something far more constructive: economic opportunity. The right combinations of community need and industrial opportunity can give rise to a nexus of community innovation that stands in counterpoint to the persistent challenge of the water-energy nexus and its cycle of scarcity. Take for instance, the Nexus of Community Innovation that grew up around Intel's Fab. 32 and the city of Chandler, Arizona. As part of its LEED certification, Intel partnered with this fast-growing metropolitan area to achieve aggressive water conservation goals that would benefit both the business and the arid community whose water supply it shared. As a result of internally reclaiming much of its own industrial waste water for uses ranging from its fab to its cooling towers and even its landscaping irrigation, Intel's Ocotillo campus recycles and reuses upward of 75% of its water.[9] It has worked with the city's own reverse osmosis plant to recharge upward of 3.5 billion gallons of drinking-quality water back into Arizona aquifers. Over the last ten years, that $100 million water conservation investment has recycled some 90,000 acre feet of water, enough water for more than 280,000 homes for a year and the equivalent of all the water that goes over Niagara Falls in 11 hours.[10] When innovation is the driving force, the market of scarcity can create opportunity. Perhaps the better question is what are the real costs to society for not embracing innovation like Singapore and Arizona?

Reverse Osmosis and the Energy Cost of Cleaning Water

As we saw in the instance of the Beijing Airport, reverse osmosis (RO) can be used for everything from wastewater treatment and recycling to desalinization of seawater for human consumption.

Dow Reverse Osmosis Membrane



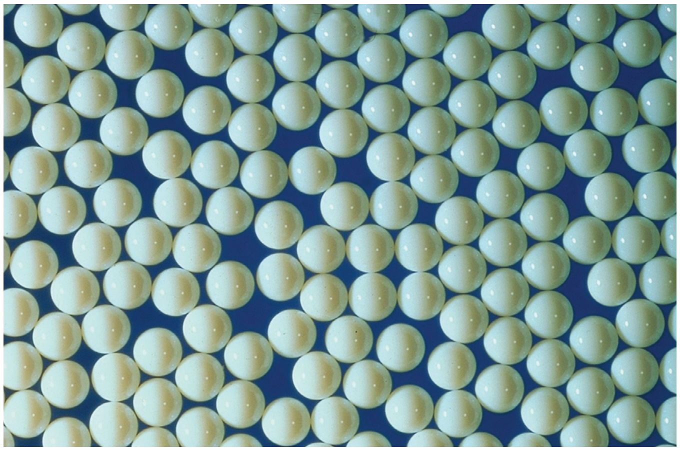
Source: Dow Water & Process Solutions

Such solutions can be implemented both locally (Dow provides elements for home drinking water systems) and systemically. For instance, the drinking water directives of the European Union limit fluoride concentration in drinking water to 1.5 mg/L. The natural fluoride level in the soil of southern Finland is relatively high and, as a result, the fluoride concentration in the water increases to values up to 1.8 mg/L. Several treatment systems to remove fluoride from the water were pilot tested, but because of the good biological quality of the groundwater, the Kuivala water treatment plant selected extremely low energy reverse osmosis membranes to treat part of the artificial groundwater supply. By blending RO permeate with the groundwater, the fluoride concentration can be adjusted while minimizing the capital costs of the plant due to membranes that operate at very low pressure. As a result, the plant removes more than 98% of the fluoride at cost for permeate water that is as low as 0.09 €/m³.[11]

Ion Exchange for Arsenic Removal

Ion exchange technology involves the reversible exchange of ions between a solid (the ion exchange resin) and a liquid. This technology is ideally suited for removal of contaminants and provides a wide variety of treatment solutions for healthcare, nutrition, food and beverage, mining, chemical processing, industrial water and municipal water. Ion exchange resins can be used to demineralize water for fossil and nuclear power plant boiler feedwater, cooling tower water treatment and feedwater for industrial boilers and cogeneration plants. They are also used in condensate polishing, which allows the reuse of steam condensate from power plant boilers to reduce the overall cost of producing purified boiler feedwater. These resins also help uranium mining operations use less water and generate less waste and enable the production of high purity uranium used in nuclear power applications, helping meet the increasing global demand for energy.

Dow Ion Exchange Resin Beads



Source: Dow Water & Process Solutions

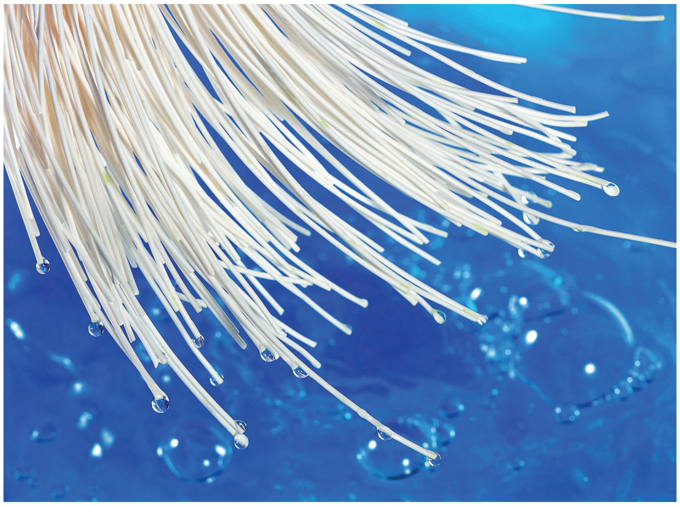
However in Black Canyon City, Arizona, Ion exchange technology was used to bring arsenic levels in line with recently revised U.S. Environmental Protection Agency (EPA) regulation. Cold Water Canyon Water Company, the company responsible for Black Rock City's drinking water, selected an arsenic removal system to reduce the arsenic to non-detectable levels at the site, bringing the well into accordance with the EPA standard. Since installation in August 2006, the system has generated more than 3.5 million gallons of potable water with no increase in pressure drop across the bed observed. Since the system can operate for long periods of time without backwash, it exceeded the projected media service lifetime of one year by over 25%.[12] Whether you need removal of a single contaminant or a particular combination of contaminants, ion exchange is particularly suited to selectively removing certain contaminants in the water stream including arsenic, antimony, chromium, nitrates and fluoride.

Ultrafiltration for Consistent Quality

Ultrafiltration (UF) is a pressure driven membrane separation process that separates particulate matter from soluble components in the carrier fluid (such as water). UF membranes typically have pore sizes in the range of 0.01– 0.10 µm and have a high removal capability for bacteria and most viruses, colloids and silt. Interestingly, one of the key applications of ultrafiltration with reverse osmosis technology is in the production of ultra pure water for fossil fuel and nuclear power generation. These water treatment technologies help power plants utilize available water supplies efficiently. Ultrafiltration, used in many municipal potable water plants, is even less costly purifying up to a trillion pounds of water per year at a cost of 1/1000 of a cent per pound.[2] That means UF pretreatment is becoming increasingly cost competitive and can be a preferred option when large supplies of water of consistent purity are needed.

Consider the beverage industry in Eastern Europe which requires high quality water often exceeding the potable water quality standards for consistent flavor. Bottlers typically used several filtering and other treatment techniques to remove impurities and standardize the water used to make soft drinks. Reverse osmosis (RO) system was a prevalent technology applied in the beverage industry. However integrating UF technology into the RO pretreatment means better filtered water quality and the ability to decrease environmental chemicals and sludge quantities. One bottling plant in East Europe, receiving raw water from a bore now reliably supplies 2,160 m^3/day of high quality water for a soft drink production factory.[13] The flow and rejection performances of the UF and RO units have been as expected and constant since the start-up.

Dow Ultrafiltration Fibers



Source: Dow Water & Process Solutions

CONCLUSION

With pressure mounting on every side, the challenge facing the municipal planner assessing the water and energy needs of a community is a daunting one, and their questions are many. Energy requirements will likely increase by 50% over the next 25 years to meet the needs of a growing population, 60% of which will live in cities. China alone poses a significant driver of this need, having 221 cities with a population of a million or more. How do I plan for a world where water will be scarcer? How will my choices today impact energy use requirements for water? How can I future proof my water management system for a different contaminant profile or regulatory environment? How can that system be flexible enough for unanticipated or changing future needs? How can I provide more clean water using less energy and lower cost while providing a better quality of life for a growing population?

To turn the Water-Energy Nexus into one of innovation requires more than technology and civil engineering expertise. It requires a trusted partner, one that can match the unique resources and constraints of a total community to available technologies, that can help them think about water (and energy) management differently to improve quality of life and reduce environmental impacts. Not all water and process solutions are created equal, however. In choosing an innovation partner to help your community respond to such questions, make sure they offer the right solutions for this new world. For instance:

- **Energy Cost Innovation**— Examine your provider's track record of reducing energy costs for its customers.
- **Technology Innovation**— Has your provider developed proprietary and effective technologies for water reuse and energy conservation, or does it rely on the leadership of others?
- **Water Treatment Flexibility and Innovation**— Make sure any provider you contract with has the required flexibility to convert incoming water of any quality into the standards required for your intended use.

In addition to providing the right water solutions, it will be important to address the cost of those solutions. There is enough water in the world for everyone, but water is currently priced below its true value. Technology providers and municipalities will continue to develop solutions and provide clean water, but at what cost and to whom? With a growing global population, it is easy to imagine a tipping point at which the market forces populations to ask the hard question about how to value water innovation in a sustainable way.

As you prepare to weather the storm that is coming, capabilities and questions like these should be considered table stakes for anyone claiming to be an innovation leader.

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† Toll-free telephone number for the following countries: Austria, Belgium, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, The Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom

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NOTICE: The use of this product in and of itself does not necessarily guarantee the removal of cysts and pathogens from water. Effective cyst and pathogen reduction is dependent on the complete system design and on the operation and maintenance of the system.

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