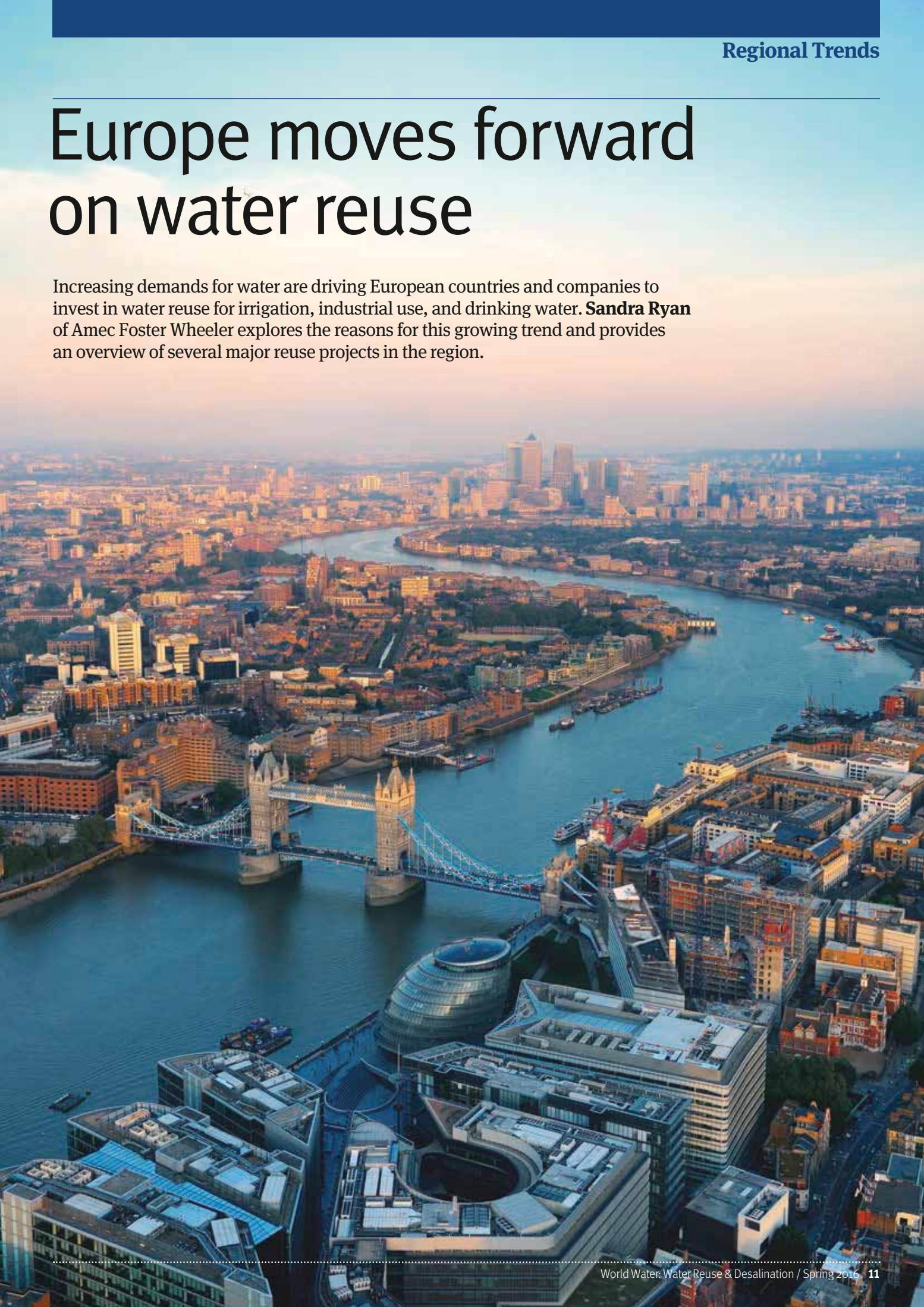
Europe moves forward on water reuse

Increasing demands for water are driving European countries and companies to invest in water reuse for irrigation, industrial use, and drinking water. **Sandra Ryan** of Amec Foster Wheeler explores the reasons for this growing trend and provides an overview of several major reuse projects in the region.



Europe, and particularly northern Europe, is not recognized by most as a region that needs to invest in water reuse. After all, it is generally a temperate region with abundant water resources, but it does not have ample water everywhere and certainly not all the time. It may seem surprising that northern European countries have taken the lead to reuse wastewater to support potable demands, and a growing number of industrial users are exploring reuse to minimize their risks from the water environment. However, northern Europe's temperate climate belies the severity of water stress pushing the region toward reuse, and reusing water has long been a customary irrigation technique employed throughout the dry Mediterranean region.

Supplying 60,000 people with drinking water from treated effluent since 2003, the Torreele/St. André reclaimed wastewater groundwater recharge project in Belgium was the first major municipal reuse plant in Europe. Treated effluent has been used to reverse and protect the aquifer against saline intrusion since the 1960s. North Belgium is one of the most water stressed areas in Europe, largely due to its lack of internal water resources; in response to this, the Intercommunale Waterleidingsmaatschappij van Veurne-Ambacht (IWVA) began the long process in the early 1990s to upgrade to a reuse system. It took until 2003 for the site to begin pumping reclaimed water from the Torreele wastewater treatment works into the aquifer infiltration zone. Reclaimed water now provides more than 40 percent of the total volume of water put into supply, and this volume continues to increase.

An exciting year for municipal reuse in Europe, 2003 marked the region's second major reuse system when the Langford water recycling plant was launched in Essex, United Kingdom (UK) to provide additional drinking water supplies during drought. The Langford launch almost did not happen due to the many obstacles that most potential reuse projects face, including scepticism and reluctance to new operational methods. However, the project was completed, and Langford has continued to quietly and successfully augment supplies during droughts. The municipal reuse agenda has been fairly quiet since 2003, but plans for London, one of the world's largest cities, to have its drinking water supplied with treated effluent have reignited interest.

Competition for resources

While it is true that Belgium and England, along with the rest of Europe, do experience long dry periods and droughts, water reuse is not being driven by aridity. Rainfall in London averages 557 millimeters per year, which makes it as dry as parts of Texas, but with more than 10 million people squeezing into the city, there is less rainfall per Londoner than for people in Dallas, Rome, or Istanbul. It should come as no surprise then that Thames Water, the water and wastewater company serving London, has forecast a deficit in its supply-demand balance of 150 million liters per day by 2025 and has confirmed that water reuse will be a principal component of its solution to secure drinking water supply to the city. What is surprising is that no other major European city has followed suit.

Intense competition for water resources, from people and from the environment, is driving the European demand for water reuse. The region is experiencing major population growth, which in turn is driving the demand for new home construction, food, electricity, and jobs, all of which require water from resources that are already at capacity–and diminishing. Changing weather patterns are at odds with water resource systems' traditional demand and recharge profiles, reducing their ability to provide what is needed. The volume of water that can be abstracted from traditional sources is under threat from the European Water Framework Directive (WFD), which came into effect in 2000. By exerting their power to reduce licensed abstractions, regulatory agencies are forcing water utilities to find alternative ways to provide water supplies. It is increasingly accepted that Europe may have reached peak environmental water, which means that all natural water resources being used to their full capacity. Europeans are literally squeezing every last drop out of existing systems, so more resilient alternative options are needed.

European policy

The European Union's *Blueprint to Safeguard Europe's Water Resources* (2012) makes clear that reuse for irrigation or industrial use is the one alternative supply option requiring European attention. The potential to relieve pressure on stressed freshwater systems is huge, but concerted and targeted action is required to actively increase uptake. Data from the 2007 EU-funded AQUAREC study reported that only 2.4 percent of wastewater (about 1 billion cubic meters) was being actively reused (that is less than 0.5 percent of annual EU freshwater abstraction). The vast majority of that volume was used for agricultural irrigation in Spain and Italy while the industrial and municipal demands of the rest of Europe continue to put pressure on the limited freshwater resources.

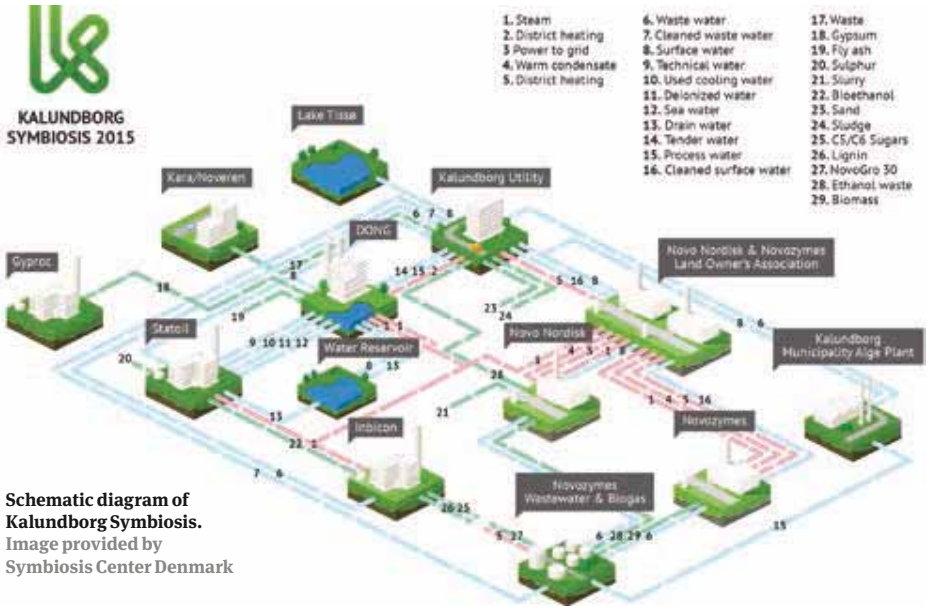
As part of its mission to enable utilities and communities to take advantage of reuse opportunities, the European Commission is funding the "DEMOWARE Project: Innovation Demonstration for a Competitive and Innovative European Water Reuse Sector." Its aim is to promote collaboration through which the evolving European reuse sector can demonstrate consistency in the costs and benefits of reuse, thereby instilling confidence in reuse as a solution for Europe. On a wider scale, the European Commission is currently expanding options to develop policy that will accelerate uptake of non-potable reuse and reduce the pressure on freshwater resources.

The concept of circular economy is a popular topic in Europe right now. Emerging from the waste management sector, it is an alternative to the traditional, linear economy in which products are made, used, and disposed. One aim of the circular economy involves valuing resources at all stages in the product lifecycle, which is akin to the 5R principles of Reduce, Reuse, Recycle, Recover, and Replenish applied in sustainable urban water management. The 4th European Water Conference, held in Brussels on 23-24 March 2015, the day after World Water Day, featured several speakers and panellists who outlined the need for much more water reuse activity. As well as calling for European reuse regulations, discussions at this event identified opportunities for water management to fully embrace the circular economy through policy through instruments promoting the effective reuse of water.

Where is the investment?

Agricultural reuse in Mediterranean countries continues to dominate European investment priorities due to the historical legacy of reuse for irrigation. Globally, the focus is on increasing water efficiency in food production, as highlighted during the International Water Week in Amsterdam in November 2015. The

Reverse osmosis in the Torreele advanced water treatment plant, Belgium. Photo by Sandra Ryan



Schematic diagram of Kalundborg Symbiosis. Image provided by Symbiosis Center Denmark

The Torreele advanced water treatment plant, Belgium. Photo by Sandra Ryan

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agricultural sector has continued to push the reuse research agenda in terms of water quality standards for agricultural use, refining treatment trains to achieve specific desired water qualities and developing more flexible systems that can be scaled-up from small to large applications.

The industrial sector is catching on, but activity varies between individual companies implementing relatively simple site-specific reuse and major demonstration schemes designed to build confidence in the technology and its application. Food production companies such as Ardo and Agristo in Belgium collect and treat their own process water and reuse it for irrigation, improving productivity.

The Kalundborg Symbiosis water reuse ecosystem in Denmark demonstrates how sharing costs among multiple enterprises can maximize investment returns. This process is inherently more complex and challenging than simply cascading water through a single system, and Kalundborg remains Europe's, as well as the world's, first and only major example of a successful inter-enterprise water reuse system. The European Union continues to invest in research to promote industrial water reuse.

In Spain, the Tarragona Petrochemical Complex is one of the European Commission's DEMOWARE test sites exploring the water chemistry effects of combining reverse osmosis water, produced at the Camp de Tarragona Advanced Water Reclamation Plant, with the River Ebro. Additionally, the site will provide insight into the implications of using treated high-quality effluent for industrial cooling processes.

Municipal sector investment continues to focus on the evidence and feasibility of reuse. UK Water Industry Research (UKWIR) recently completed a project titled "Establishing a Robust Case for Final Effluent Reuse," collated an international evidence base grounded in more than 2,000 reuse case studies. The project results show that reuse is proven as a technically viable water source in a range of applications, geographies, and scales. Its availability is relatively unresponsive to climate change, which makes it a source that could significantly enhance the resilience of water supply systems. Unfortunately, the project shows that ultra-treatment remains a key component in much of the existing evidence base, the energy intensity of which is at odds with European legislation on carbon emissions. Inevitably, trade-offs remain among energy demand, carbon footprint, costs, and performance that European reuse practitioners have to navigate. Phase 2 of that project tested the performance of the existing UK regulatory framework to effectively regulate reuse and identified eight aspects where gaps in the regulations may need to be mitigated to support wider uptake of reuse in the UK. The region will continue to monitor ever-improving technologies and the changing landscape of costs and energy requirements.

Growth trends

The European market is still emerging. In the short term, individual industrial companies will continue to invest in their own systems while state- or sector-level investment is likely to continue developing evidence and innovation in technology and application. The low cost of water, in addition to uncertainty in performance and cost-effectiveness, may be inhibiting mainstream industry acceptance.

Similarly, municipal water utilities are likely to set priorities in investment in relatively small-scale demonstration systems to boost confidence in their own bespoke circumstances. Stalled inertia can plague public and private regulated utilities, but plans may be accelerated as regulators seek innovation and as the regulatory tone shifts toward actively encouraging reuse. This type of momentum is essential for resolving some of the barriers that delayed the Torreele scheme for several years.

Regulator-led targets helped increase reuse in Australia, but Europe is less fond of this arbitrary authoritative approach. As the research matures and the pressures of scarce water and increasing demands continue to be felt, it is likely that more water utilities will follow Thames Water's lead and begin to plan and develop their own major strategic water reuse systems.

Industrial and municipal uptake of reuse will undoubtedly increase as process performance and costs are better understood. European policy encouraging non-potable reuse within the context of the circular economy could have a major influence, but inevitably it may turn out to be the accelerating power of drought that will most significantly drive the market.

Conclusion

There is significant potential for a range of reuse applications to be part of our journey going forward. The European reuse agenda is definitely gaining traction, but widespread implementation beyond existing agricultural use is likely to take many years, and the rate of change will undoubtedly be influenced by the occurrence (or absence) of drought as well as continued developments in technology and regulatory practice in other parts of the world.

Wastewater must be considered as a resource in its entirety when planning for the future. Rather than thinking about the cost to remove substances from wastewater as a necessary evil, the focus should be placed on the combined net benefits of recovering energy and other valuable materials within wastewater as part of a reuse system. For this reason, the phrase "wastewater treatment plants" is being replaced in the water sector by "water resource recovery plants" in order to better describe the expanded functions made possible by advanced treatment processes that can recover water, energy, and nutrients.

Author's Note

Sandra Ryan is a UK-based water resource planner at Amec Foster Wheeler, a global environmental, engineering, and project management consultancy. She has supported Thames Water's review of its water reuse research and development program, project-managed the UK Water Industry Research evidence-base projects, and is supporting the European Commission in its mission to develop reuse policy. Sandra holds bachelor and masters degrees in physical geography from the University of Hull, UK.