EUROPEAN ALLIANCE TO SAVE ENERGY

Creating an Energy-Efficient Europe

ENERGY-WATER NEXUS: ACCELERATING ENERGY SAVINGS FOR THE CLEAN ENERGY TRANSITION

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EXECUTIVE SUMMARY

The link between energy and water consumption across sectors has been so far widely neglected, despite the economic and environmental benefits it can bring to European citizens and businesses. Water and energy are interdependent and should be considered in all EU policies with the goals to make Europe's waters more resilient, affordable and accessible, and to support Europe's energy efficiency objectives.

Smart Water management across the water sector and across the industrial, commercial, and residential water cycles can lead to important energy savings. The key is in understanding the energy-water nexus and its ability to generate water and energy efficiencies. The opportunity to tap into the potential of this nexus is present with existing technologies and thus it is ripe for policy-makers to accelerate European efforts toward a clean energy transition.

This Paper highlights the views of a cross-sectoral alliance of businesses united by the shared vision that smart water management can generate energy and water efficiencies and be a driver for a cost-efficient, competitive and decarbonised economy. It also provides policy recommendations for the EU to accelerate this opportunity, which is right in front of us.

ENERGY EFFICIENCY FIRST

The Energy Efficiency First principle is a powerful instrument to meet our climate goals at the least cost possible. According to the International Energy Agency, 76% of the GHG emissions reductions required in the European Union (EU) for alignment with the Paris Agreement will need to be achieved through energy efficiency measures[1]. This means that energy waste must be stopped in every sector without exception.

Energy plays a key role in production, transfer, distribution and treatment of water and wastewater, yet none of the key water-related legislation comprising the water regulatory framework – the Water Framework Directive, the Drinking Water Directive, the Urban Waste-Water Treatment Directive, Water Reuse Regulation - addresses energy efficiency or the opportunity for energy savings from water efficiency. Likewise, the Energy Efficiency Directive does not address directly the energy savings potential of water.

For Energy Efficiency First to achieve its full potential in supporting EU climate ambitions, it is necessary for EU policy-makers to look beyond water as an end-of-the-pipe quality issue to the important linkage between energy and water across all sectors and cycles. This linkage – the "energy-water nexus" – offers multiple opportunities to connect water efficiencies to energy savings and provide an additional and effective means to address climate change mitigation and adaptation.

[1]IEA.(2016). Energy, Climate Change and Environment: 2016 Insights. Retrieved from http://www.iea.org/publications/freepublications/publication/ECCE2016.pdf

SMART WATER MANAGEMENT SAVES ENERGY

The smart and efficient management of water can make a significant contribution to energy savings and can integrate circular economy principles. Smart water management encapsulates activities at many different levels, including:

- the collection of real-time data and the use of artificial intelligence to produce new information that generates systematic efficiencies while ensuring the required process effectiveness
- the minimisation of water usage and the optimisation of energy in industrial processes
- the elimination of water and wastewater leakages in water collection and distribution systems
- the optimisation of energy in municipal water and wastewater management
- the improved resilience against stormwater through green infrastructure
- the improvement of combined sewage overflow management
- the reduction in domestic water and energy consumptions through water recirculation

CASE IN POINT

A large wastewater utility in Northern Germany has the objective to reduce its energy cost through the optimization of their control system and ensure compliance in the quality of the treated water discharged. Xylem Inc. offered to implement innovative smart solutions, including predictive model software, known as Artificial Neural Networks (ANN). In the absence of physical sensors, virtual sensors were created in the ANN to estimate the incoming nutrient and carbon loads to the plant and improve the performance of the treatment processes while meeting regulatory compliances. The implementation of the new process control resulted in the reduction of energy use by 26%, equivalent to savings of nearly 1,100 Mwh annually and ensured that the plant effluent quality remains reliably within legal limits without any investment in new infrastructure.

ENABLING INDUSTRY FOR GROWTH AND COMPETITIVENESS

The increased demand for energy and water on the part of industry requires us to maximise the benefits of the water-energy nexus. As water for industrial uses will come into increased competition with communities and agriculture uses due to its limited availability, fostering and enabling the nexus will ensure sustainable growth of the industry whilst capturing all the cost and environmental benefits that efficiencies in energy and water brings.

CASE IN POINT

Evaporative cooling towers are often the largest heat exchangers on industrial sites and a significant user of water. The efficiency of the heat rejection has the greatest impact on the total cost of the operating system. A European manufacturer of specialty chemicals produces plastics in polymerization reactors with cooling from a chilled water system where the compressors are by far the largest consumer of electricity at the plant. Smart water management, provided by Nalco Water, helped to design new process flows allowing for more efficient cooling of the condensors to maximise energy performance. This translated into significant reductions in electricity consumption (3,155 Mwh) with a cost savings of €163,000 per year. It also avoided 1,964 tonnes of CO_2 emissions per year.

WHEN WASTEWATER BECOMES A RESOURCE: MAKING THE WHOLE WATER CYCLE ENERGY EFFICIENT

In municipalities, water and waste water facilities account for the largest consumption of electricity, representing 30-40% of local authorities' total electricity bill. It is realistic to cut the energy use of the wastewater treatment facilities by up to 50%, depending on the starting point. A broad range of services and solutions are available to tap into this potential and they produce a high return on investments with varied pay-back-time. A non-exhaustive list of these services and solutions include water piping infrastructures geared to current use, distribution systems, variable speed drives, better (industrial) process control and more efficient compressors and demand-oriented pumps.

Pioneering efforts, led by some municipalities in the EU and US, have shown that improving energy efficiency in the water sector and harnessing embedded energy can generate significant savings and entirely satisfy energy needs with own generation. Danish authorities, for example, are now no longer referring to wastewater but to "resource water". In fact, utilising the energy embedded in wastewater alone can meet more than twice the electricity required at a wastewater treatment plant.

CASE IN POINT

The city of Aarhus has succeeded in making the whole water cycle energy neutral thanks to e.g. Danfoss technologies. This was achieved in the wastewater treatment plant of Aarhus, located in Marselisborg, Denmark, that services around 200,000 people. The treatment plant produces more than 200% of the energy it needs to operate through investments made in efficient real time process control. On top of that, the transformation to more energy efficient operation which started in 2010 also led to a reduction of water losses by around 6% and of water price for consumers by 9%. Further, the carbon footprint of the plant has been reduced by 35%. Such results have been achieved through the digitalization of the water facilities, incl. a much higher use of sensors, variable speed drives and advanced process control, offering both energy savings and increased energy production from the household wastewater.

REDUCING WATER LEAKAGE

A significant amount of energy could be saved by reducing water leakage. Energy to pump and distribute billions of cubic meters of water, that are lost through leaking pipes, is used in vain every day. According to McKinsey, US $167 billion of waste due to water leakages in cities around the world could be avoided by 2030[2]. The European Commission estimates that on average 23% of treated water in the EU is lost in public water supplies; in some European municipalities, leakage rates can rise up to 60%. In addition, the WHO points out that leakages are also an opportunity for hazardous substances or microbes to enter the pipes, making leakages a health issue. As such, the reduction of leakages across Europe will lead to energy savings and also reduce health risks.

Leakage can typically be reduced by at least 30-40% by implementing pressure management control and using technologies to detect the exact location of water leaks and pipe weaknesses. Network condition assessment can be done without major investments and without interrupting water distribution and provides operators with the intelligence needed to prioritise investments, reduce energy use, and address water leakage prior to the failure of the distribution network.

[2]http://www.mckinsey.com/insights/energy_resources_materials/resource_revolution

REDUCING THE NEEDS FOR EXTRA WASTEWATER COLLECTION AND TREATMENT CAPACITIES

The majority of big EU cities have century-old wastewater infrastructure systems and many of them do not even have the two-tier systems – one for wastewater and another for storm water. Consequently, storm water and wastewater are combined into a single collection system, which is treated together in the wastewater treatment plants. During significant rainfall, a massive amount of storm water instantly enters into wastewater systems and requires extreme efforts from wastewater treatment plants, generating increased energy consumption and related costs. This means that extra capacities need to be utilised at the plants under extreme conditions and additional energy is required during the peak rain events. Even worse, during massive storms when waste water treatment facilities cannot cope with huge inflow, some non-treated waste water is re-routed directly in to the local rivers and creeks polluting the areas around them.

Municipal and domestic energy use can be significantly reduced by implementing green infrastructure practices, such as green roofs which can retain up to 80% of rainwater and consequently reduce the storm water volume rate of run off entering the drainage system. In addition, solutions such as real time monitoring of the collection systems and use of intelligence software and analytics can provide the intelligence needed for redirecting water where hydraulic capacity is available in the wastewater collection system prior to important rain events. Such intelligence automatically prevents combined sewage overflows, allowing buffering the water flow that enters the treatment plant, reduced failure in the treatment process and excessive energy use.

CASE IN POINT

Urbanscape Green Roof technology, provided by Knauf Insulation, covered 8,300 m2 of roof surface of a commercial building in France. The system, installed in only 8 days, generates cost savings and environmental benefits by storing more than 4,800m3 of rainwater every year – the equivalent of almost two 2,500m3 Olympic swimming pools of water every year - and consequently saving on real rainwater treatment energy cost. Considering average energy consumption on a yearly base in Waste Water Treatment Plants, up to 2.9 MWh of energy are saved. In addition, it contributes to cool down the building during summer months, reduces heat island effect, improves urban biodiversity and help with the absorption of air pollution.

RECYCLING WATER AT END-USER LEVEL

In parallel to improving water's distribution and infrastructure, it is possible to reuse up to 90% of the water consumed in the domestic sector and consequently save the energy required to heat water in residential buildings. Water that has left the tap is typically classified as grey water, due to hygienic concerns, and is currently restricted from reuse. However, innovative products and existing smart sensor technology can purify and recycle water to a hygienic standard similar to or better than water delivered from the pipes. The regulatory framework should therefore provide exemptions for purified water to be reused and create a paradigm shift in daily water usage.

CASE IN POINT

Orbital System water saving recirculating solution for showers saved up to 90% of water and 80% of related energy in a hotel in Malmö, Sweden. The system collects the water that would normally go down the drain, analyses its quality, cleans, heats it and reuses it in the same shower cycle. The sensors in the systems analyse the quality of water up to 20 times per second and decide whether it is good to be sent back for re-use. The purification is done by a micron filter and a UV light. The system also collects data on water quality and usage that can be monitored by a mobile app.

OVERCOMING MARKET FAILURES

The business case for making energy savings through water efficiency is clear, yet investments remain sub-optimal due to market failures such as lack of transparency on energy waste and leakage, lack of awareness of the savings potential and lack of know-how. More importantly, the main market failure lies with the current regulatory framework that does not address energy efficiency or link energy and water at all. This means that the entire water value chain has no incentive to improve energy efficiency or water efficiency and thus understandably focuses primarily on compliance with existing EU requirements such as water quality. Policy action is urgently needed to overcome these market failures and fix this missing dimension of our regulatory framework.

AN OPPORTUNITY THAT SHALL NOT BE MISSED

Overall, with the right set of policy measures, the IEA World Energy Outlook predicts possible global energy savings of 270 TWh and the generation of an additional 70 TWh of electricity by 2040 – equivalent to around 70 large (800 MW) coal-fired power stations3. This is achievable with today technologies and know-how and could free valuable resources for the needed investments in water infrastructure in the short, medium or longer term. The European Court of Auditors reported, for example, an investment gap for water infrastructures of 6 billion euros up to 2020 in three Member States alone4.

CASE IN POINT

Kolding is a medium-sized Danish city which wanted to enhance the environmental and recreational values of its streams and fjord waters. With AQUAVISTA(TM) implemented in the sewer network and at four wastewater treatment plants, the combined sewer overflow (CSO) volumes discharged to the fjord is now reduced thanks to a Dynamic Overflow Risk Assessment solution, which uses the real time data from the network combined with rain forecast to optimise the operation of gates, weirs and pumps in the combined sewer network. The number of overflows is reduced by two thirds, and the energy consumption in the wastewater treatment plants by 23%.

[3]IEA, World Energy Outlook 2016
[4]http://publications.europa.eu/webpub/eca/special-reports/drinking-water-12-2017/en/

EIGHT POLICY RECOMMENDATIONS FOR TAPPING INTO THE WATER-ENERGY NEXUS

1 Secure that the energy efficiency first principle applies to the energy-water nexus

As already specified, energy efficiency of the drinking and wastewater sectors is not addressed by the current regulatory framework despite the significant energy savings potential. It is important to make sure that the energy efficiency first principle is enshrined systematically across the relevant EU water legislation. It is equally important that the energy efficiency directive (EED) recognises the opportunity provided by water efficiency. Energy savings through water efficiency measures should be counted as eligible measures under Articles 7 and 14 of the EED.

2 Set transparency requirements to enhance the energy efficiency of the water cycle

The current revision of water-related legislation is a unique opportunity to address the lack of transparency and available data on the energy efficiency of water management. Requirements to have transparent and publicly available information on the energy performance, i.e. kwh/m3, of utilities operating along the drinking water and waste water chain should be introduced. This would highlight to the operators the opportunities for additional operational costs savings and encourage them to invest in energy efficient technologies.

3 Incentivise the reduction of leakage rates at local level

Member States should ensure that competent authorities analyse the potential for leakage reduction and draw up multi-annual plans to untap that potential where such reduction is found economically and environmentally viable. The implementation of such plans should be streamlined with the use of EU funds.

4 Reduce the amount of storm water being directly released into wastewater treatment infrastructures

Revision of the water-related regulatory framework should implement measures aiming at reducing the amount of the rainwater being released from public and private surfaces into the water infrastructure systems and limiting the number of events of combined sewage overflows. These measures not only help lower the amount of storm water being released, but play a vital role in peek-flow reduction which consequently limits the need to put extra wastewater treatment capacities in place during extreme rain events.

5 Develop communication standards for data sharing across the water cycle

The water regulatory framework should promote the standardisation of communication and data sharing methodologies. Such measures would prevent the operation of national and regional entities working in siloes and allow for the optimisation of the management of their natural resources. Transparency and free-flow of data across EU on water quality and availability, water leakages, system capacity and energy use and performance are the true enablers of the Water-Energy Nexus.

6 Include the water and wastewater sectors in Member States' energy and climate plans

Given the high electricity consumption of water and wastewater cycles as well as their energy saving potential, it makes sense that National Energy and Climate Plans required under the Governance Regulation include a multi-annual strategy and roadmap targeting water and energy efficiency across sectors.

7 Include incentives for energy savings targeting the energy-water nexus in the Energy Efficiency Directive

Energy savings from the energy-water nexus are a low-hanging fruit and, if properly organised and measured under the EED, can help Member States meet their energy efficiency targets for 2020 and 2030. Member States should be informed of opportunities to capture energy savings from water efficiency measures in the water and wastewater sector and across water processes in industrial, commercial and residential settings. In addition, including energy savings through water efficiency measures among the eligible measures for energy efficiency obligation schemes (EEOS) will facilitate the development of new business models.

8 Integrate energy efficiency requirements in the water regulatory framework

The current revision of the water-related regulatory framework - the Water Framework Directive, the Drinking Water Directive, the Urban Waste-Water Treatment Directive and the Water Reuse Regulation must integrate EU climate, environment and energy policies using circular economy principles. Doing so will allow actions targeting the energy-water nexus to unleash the energy efficiency potentials across the whole of the water cycle.

ABOUT THE EUROPEAN ALLIANCE TO SAVE ENERGY

EU-ASE was established in December 2010 by some of Europe's leading multinational companies. The Alliance creates a platform from which our companies (Danfoss, Kingspan, Knauf Insulation, Nalco Water, Orbital Systems, Saint-Gobain, Schneider Electric, Siemens, Signify, Veolia and Xylem Inc.) can join with politicians and thought leaders to ensure the voice of energy efficiency is heard from across the business and political community.

EU-ASE members have operations across the 28 Member States of the European Union, employ over 340.000 people in Europe and have an aggregated annual turnover of €115 billion.

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