Water Europe

Technology & Innovation

WATER SMART INDUSTRY

WHITE PAPER


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Prologue

Water Europe (WE) is the recognized voice and promotor of water-related innovation and RTD in Europe. WE is a value-based multi-stakeholder association that represents the whole diversity of the innovative water ecosystem. WE was initiated by the European Commission as a European Technology Platform in 2004. All WE activities are guided by its Water Vision and the ambition to achieve a Water-Smart Society.

The Water Europe White Papers are aimed at informing readers about complex water-related topics in a concise and targeted way, and presenting WE's vision and philosophy on the matter. They present evidence-based opinions on multiple water-related challenges and on ways to overcome them. WE White Papers are produced as part of the WE Collaboration Programme by the WE Vision Leadership Teams and the WE Working Groups. They target a wide variety of potential audiences, including the EU institutions, international organisations, the water industry, water users and water-related strategic stakeholders, the economic sectors, as well as media, analysts, regulatory and governing bodies, citizens and society at large.

Durk Krol
Water Europe Executive director

The Water Europe vision for a Water-Smart Society

The human right to water encompasses five requirements: 1) availability, 2) accessibility, 3) affordability, 4) acceptability, and 5) quality and safety. These must be fulfilled to satisfy the human rights to water and sanitation, and protect the health of users and the general public, regardless of their identity, location or ability to pay.
Adapted from the UN Water website, 2022.

This Water Europe Vision document charts the pathways towards society's better use, valorisation and stewardship of our water resources, and the development of resilient and sustainable solutions to address our key water challenges. It describes how these challenges can be transformed into opportunities for developing and deploying new European technologies, solutions, businesses and governance models for the Water-Smart Society of the future. It projects a future of comprehensive water security, sustainability and resilience for all societal functions, and of full environmental protection. It is a vision in which all relevant stakeholders are involved in the sustainable governance of our water system, in a way that meets ecological, social and economic needs, without compromising the ability to meet these needs in the future; water scarcity and pollution of European groundwater and surface water are avoided, while biodiversity is restored; water, energy and resource loops are largely closed to foster a circular economy; the water system is resilient and robust against demographic pressure and climate change events; and European water-dependent businesses thrive, thanks to forward-looking research and innovation. Although the vision is focused on the European situation, many of its features are relevant to realising Water-Smart Societies all over the world.

A paradigm shift towards an inclusive Water-Smart Society

The Water-Smart Society envisaged by Water Europe entails a paradigm shift in the way the value of water is recognised and realised, water-smart solutions are developed and deployed, and our future society organised and managed with regard to water. This shift calls for bold and courageous decisions, investments, changes, and new types of stakeholder partnerships at all levels of society, involving citizens, public authorities at all levels, scientists, industries and farmers, as well as the stewards of the natural environment. It will require the development of a dual migration path to introduce both new solutions and governance practices, with the involvement of all relevant stakeholders at urban, regional, inter-regional, national and international level.

The Water-Smart Society will leverage both the dramatically increased manageability made possible by the emerging cyber-physical environment and 'digital water' technologies, as well as the increased availability of 'multiple waters' to complement freshwater sources. It will also be characterised by much deeper levels of awareness, integration and collaboration between organisations and citizens.

Since the migration towards the Water-Smart Society will demand significant investment in redesigned and adapted infrastructure, as well as innovative technologies, it comprises a complex mix of challenges and opportunities for European industry. These will demand a longer-term programme to drive a stable and successful migration towards the future Water-Smart Society.

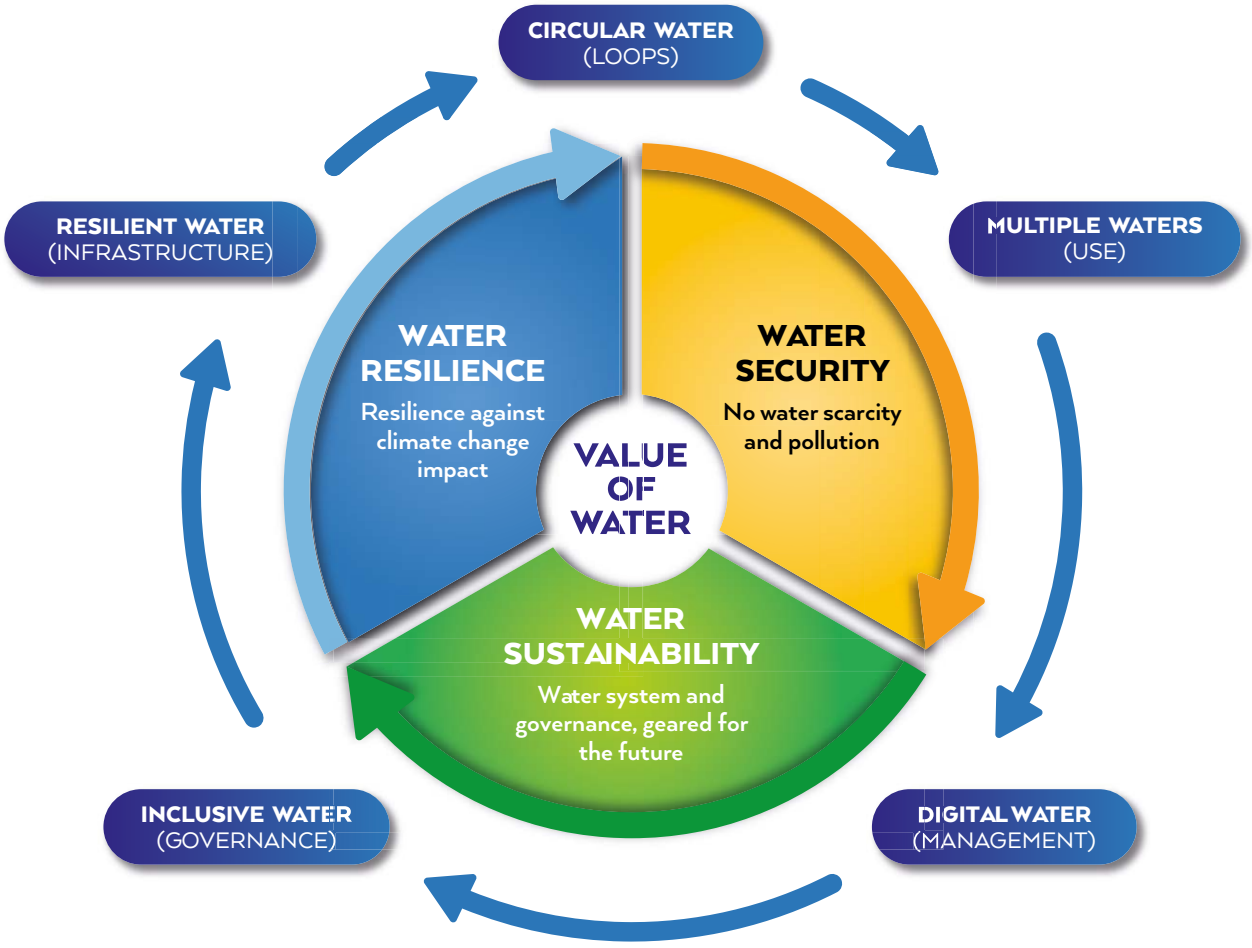
A Water-Smart Society

A Water-Smart Society is one in which the value of water is recognised and realised to ensure water security, sustainability, and resilience; all available water sources are managed so that water scarcity and pollution are avoided; water and resource loops are largely closed to foster a circular economy and optimal resource efficiency; the water system is resilient against the impact of climate and demographic change; and all relevant stakeholders are engaged in guaranteeing sustainable water governance.

The Water-Smart Society Model

Water Europe has developed a model for a Water-Smart Society to illustrate its key objectives, and the different elements involved in the above paradigm shift as well as their inter-relationships. As presented below, the model consists of one core value, three key objectives that need to be achieved to realise the core value, and five specific innovation concepts that are crucial to realising the objectives. The model indicates how the innovation concepts and key objectives are interrelated, and together generate a 'flying wheel' effect that drives the process towards the Water-Smart Society.

Figure 1. The Water-Smart Society model



Source: Water Europe

One core value

The Value of Water is at the heart of Water Europe's vision for a Water-Smart Society. This core value reflects the centrality of water as a human right and its fundamental role in our society. A multifaceted role that includes enabling all economic activities, underpinning societal functions related to citizen health and well-being, while also representing a source of economic value generated from the extraction and valorisation of raw materials and energy contained in water systems, thereby offering a unique sustainable source to serve a circular economy.

3 objectives

1. Water Security: safeguarding sustainable access to sufficient quantities of affordable and fit-for-purpose water, in order to preserve the health of the population and ecosystems, foster the socio-economic development of society, and ensure their protection against water-related disasters, such as those resulting from climate change.

2. Water Sustainability: ensuring water infrastructure, management and use that are economically and environmentally sustainable, in a way that meets current ecological, social and economic needs, without compromising the ability to meet these needs in the future.

3. Water Resilience: achieving long-term resilience, so that natural and anthropogenic water systems can withstand unexpected disruptive events, averting serious consequences, such as droughts and floods, while guaranteeing the reliability of the water system.

Five Innovation concepts

1. Circular Water: circular water system that minimises water losses, captures and exploits the value in water, and fosters water security, sustainability and resilience.

2. Multiple Waters: incorporate a wide range of water sources and qualities (groundwater and surface water, rainwater, brackish water, brine, grey water, black water, recycled water) into a water-secure, resilient and sustainable water system.

3. Digital Water: exploit the benefits of the extreme interconnectivity of people, devices and processes, and create capillary networks capable of monitoring the water system, starting at its multiple sources through to the individual end-user, thus generating continuous flows of valuable data for innovative decision-support systems at different governance levels.

4. Inclusive Water: establish a water system whose governance balances the interests of all stakeholders in its design, management and maintenance.

5. Resilient Water: create a resilient and reliable hybrid grey and green water system, designed to withstand severe external and internal shocks – such as climate-change induced floods and droughts – without compromising essential functions.

Transitioning to a Water-Smart Society

In short, Water Europe envisions a significant transformation of the current European water sector. The innovation concepts outlined above, along with measurable objectives and key impact parameters for water security, sustainability and resilience, will drive decision-makers to realise this transition and build new water-smart economies. This will be enabled primarily by innovative governance models, new technologies created within inclusive, open innovation environments, such as innovation-enhancing Water-Oriented Living Labs (WOLLs), and by a transformed and updated water infrastructure serving the Water-Smart Society.

Overall, the Water Europe water vision aims at the implementation of a set of innovations which will result in a 50% reduction in the demand pressure exerted on our groundwater and surface water resources, thereby eliminating water scarcity in Europe.

By 2030, the transition to a Water-Smart Society will be in full swing, driven by visionary front-running industries, cities and rural areas. These will have taken the lead in laying out the migration paths towards the Water-Smart Society of the future. They will have implemented ambitious long-term investment and innovation programmes, as well as real-life WOLL experimental areas. WOLLs will have created a European network of fertile and inclusive innovation ecosystems, where solution developers, researchers, forward-looking water users and water governing bodies will develop the leading solutions of the future. In Water Europe's vision WOLLs will play an important enabling role in driving the transition to the Water-Smart Society. They will boost Europe's competitiveness in the global water market, creating numerous new green jobs in Europe, while making significant contributions towards achieving Europe's Green Deal targets and the UN's Sustainable Development Goal 6 (Clean Water and Sanitation) and other water-related SDGs.

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1. Introduction

Water Europe's Water-Smart Industry Vertical Leadership Team (VLT) is pursuing the development of migration pathways to the future Water-Smart Society with a focus on industrial needs and the circular economy.

The VLT defines benchmarks for supporting multi-stakeholder collaboration in realising the WE Vision by making available large-scale real-life industrial representative environments and/or Water Orientated Living Labs (WOLLs), in which combined research and innovation, as well as governance, economic and financial models can be validated and taken to the market. The development of inclusive, systemic strategies for water management with the Urban and Rural environments will also be part of the VLT Programme.

The focus of this White Paper is to highlight the gaps and opportunities to create a water-smart industry for Europe.

2. Context

While the first industrial revolution from an agricultural, rural society to an industrialized society has in general led to more prosperity, improved human health and higher standards of living, significant downsides have developed that need to be addressed.

At the macro level, today's society is faced with three main crises that are all interlinked through water.

Firstly, **climate change** and its unpredictable impact on the frequency, duration and intensity of droughts and flooding. Secondly, related to this is the **energy crisis**, given the energy intensity of many industrial processes, and the associated impact on energy demand especially fossil fuels and their CO_2 emissions in recent centuries. Energy production requires significant inputs of freshwater. In Western Europe, over a third of all abstracted water is used for this purpose. Thirdly is **the collapse of biodiversity**, particularly for freshwater species that have seen an 83% decline globally since 1970. With 40% of the world's species reliant in some way on wetlands, the loss of these valuable places is forcing many species to the brink of extinction. This highlights how nature needs a lot of water for planet, people and business health and how a water crisis is typically well established and causing considerable impacts a long time before losing water at the tap.

Climate change is one of the main drivers of biodiversity loss, but the destruction of ecosystems undermines nature's ability to regulate greenhouse gas emissions and protect against extreme weather, thus accelerating climate change and increasing vulnerability to it. This explains why these crises must be tackled together with holistic policies that address both issues simultaneously and not in silos. Water is central to this holistic strategy, and we will fail on climate change if we do not solve it. Wetlands are where water, climate and biodiversity most strongly converge and therefore they deserve special consideration in terms of the water they require to maintain their vital function. Therefore one cannot say that sustainable water use has been achieved at a particular location unless wetlands have the environmental flows they need to support biodiversity and carbon sequestration. 90% of Europe's wetlands are gone, so the focus should be on large-scale restoration

3. Impact from Industry

There is an increasing gap between freshwater consumption and natural replenishment. Industry accounts for ~ 50 % of freshwater withdrawal in Europe, and therefore it can a significant impact on availability of water for nature, municipal use, and agriculture. The rate of growth of water-related risks in many places across Europe is far outpacing the efforts being made to mitigate them. This ever-widening disparity is attracting the attention of investors, shareholders, and regulators. To address this it is essential to improve water management governance at the local level, given the gap between supply and demand is a function of various local factors such as weather, geology, soil, evapotranspiration as well as a specific anthropogenic water use.

In addition, industry can have a notable impact on water quality, through emissions and effluent discharge. Pollutants in effluent water can adversely impact aquatic life and ecosystems.

4. Impact on Industry

Water and energy are business imperatives, enabling industrial production, growth and profitability and thus competitiveness. Water availability and quality are fundamental to efficient and reliable heating, cooling, cleaning as well as pumping and transportation.

Pressure on water availability therefore directly translates to impacts on production volume and product quality, and therefore insufficient access to water and/or water quality is rapidly becoming a significant business risk in Europe. During droughts industries may be driven (or mandated) to limit their industrial output. Also, industrial expansion will increasingly be limited in some territories due to water scarcity. Climate scenarios projections are important when considering future industrial development.

We cannot forecast resource requirements accurately without understanding the interconnectivity between resource types. In the past, water, food, and energy were typically dealt with as separate issues.

Adopting a nexus approach especially highlights the importance of the water-energy component. Water is needed for energy production, and energy is crucial for the provision and treatment of water. The considerable amounts of energy associated with abstracting, pumping, treating, heating, cooling, and cleaning water greatly magnify the impact of industrial water use. When we consider the energy demand of water, pumping is a good place to start as it consumes around a quarter of all electricity on many industrial sites. The overwhelming majority of pumps operate inefficiently. There can be multiple reasons for this, such as being over-sized or having partially worn impellers or motors. Comparing the actual performance with the design pump curve often demonstrates that low-efficiency and/or worn pumps can consume up to 40% more energy than its design (World Pumps, 2015).

This water energy-nexus is equally relevant to the energy transition toward renewable energy given green hydrogen production, fourth generation nuclear energy[vii,viii], bionergy[ix] and carbon capture[i] typically have a considerable water demand.

Today, the nexus is extended to consider water-energy-food-ecosystem interrelationships , as water and energy are mutually connected to agriculture, food production and processing as well as the ecosystem.

Europe's policy to increase its security and digital transformation through its strategic autonomy initiatives will also exacerbate demand in some locations given the water intensity of high-tech industry such as chip manufacturing, datacentres, and EV battery production.

The business risk associated with these forms of increasing water demand could stifle long term investment and may be felt over a shorter time frame if existing production sites struggle to adapt to water impacts and/or pending legislative requirements. Water could significantly impact Europe's competitiveness on the global market.

5. Towards a Water-Smart industry

Industry is commencing an incredible transformation as it pursues greater resource/energy efficiency, the transition to renewable energy, the move from fossil-based raw materials and animal proteins to more sustainable equivalents and the principles of the circular economy. While water is integral to this industry transformation, in many cases it is not given sufficient consideration. To make industry more resilient in the future, water strategies should be developed for each of the incorporating topics:

1. Water scarcity
2. Water-energy-food-ecosystem nexus
3. Water pollution

The following gaps need to be addressed in the industrial transition to a water-smart society:

- The current inability to adequately determine the sustainable use of water at a particular location represents one of the greatest obstacles to progress in water management and its stewardship. Even in the face of climate change, resilient businesses are those that identify, monetise, and mitigate water-related risks in a cost-proportionate way, while appreciating that water is a fundamental enabler of value creation. Key to building such resiliency is ensuring that the impacts on water resources are within the capacity of the local catchment. This is vital as to date water reduction activity has been largely self-determined rather than setting robust and meaningful water targets that take into account the unique local contexts of the basins in which companies operate. These Context Based Water Targets (CBWT's), as they are known, are considered the most credible indicator of sustainable water use and therefore the level of exposure to risk at a given locality. They are key to working towards an end state that ensures long-term business viability for operations and supply chains. Once the destination is known, one can set about planning the journey, producing the frameworks and deploying the technologies that ensure that a production site's performance is within the capacity of the basin's renewable supply of water and ability to assimilate pollutants.

  If we cannot quantify location-specific sustainable water use and determine its value socially, environmentally, and economically how can we develop an adequate understanding of the impacts of population growth, climate change, urbanisation, land use change or the much-needed insights into the water-energy-food nexus?

- As the water crisis looms large, advocating water-saving solutions must be complemented with the ability to characterise the level of water performance that is needed to be achieved now and in the future. Innovation that supports the robust quantification of sustainable water use will, in turn, drive the breakthrough innovations in water saving or enabling technologies that we still need. The one flows from the other.

- Until we fully grasp the magnitude of the gap between actual and sustainable water use, we cannot determine whether we are under or over-investing in enabling technologies nor will we be able to truly calculate the value they create and their return on investment. Underpinning all this is the key requisite of confidence. Confidence in the framework, the algorithms, the economic evaluations of 'value add' and, of course, the data. Without a high level of confidence, there will not be the significant investments necessary to reduce, reuse, and/or recycle the volumes of water required to achieve sustainable water use. This connectivity between confidence and achieving sustainable water use is clear.

- There is a need to accelerate the adoption of new technologies that provide invaluable insights on sustainable water use. Examples include i) satellite imagery and other forms of earth observation, combined with remote sensing can increasingly enable accurate quantification of evapotranspiration rates associated with land use as well as soil moisture levels, ii) tools enable the quantification and communication of water risk (Water Risk Monetizer, Ecolab, 2022), and then identify and implement solutions to manage it accordingly. These include technologies that disseminate common catchment goals and thereby help communicate the local water management ambition. In turn, this can help drive the cooperation and collaboration between local stakeholders – a vital component of a robust water stewardship strategy, especially in water stressed areas. iii) blockchain-based technology which could fundamentally transform the way water resources are managed reducing the risk of corruption and the information asymmetry that can blight water management. Crucially, this technology could enable everyone to access the same data on water quality and quantity and make more informed decisions (Stinson, 2018).

- Water and energy efficiency are strongly dependent on the age and performance of the associated assets on site, how they are operated, treated and maintained, and the impact that one production system has on another. Given the number and complexity of the factors involved here, optimization is very reliant on sensor technology and digital-enabled insights. Consequently, these technologies must be further developed and deployed.

- Several technologies central to decarbonization and the use of renewable energy, such as green hydrogen, biofuels, carbon capture, require significant amounts of water. Companies need to assess the impact of such installations while the technologies are still under development. It is imperative that water use becomes an integral part of new process design rather than an 'add-on' once most of the design has been completed. The same holds for energy storage and recovery systems such as heat pumps which require further developed for industrial applications. Practical knowledge exchange and sharing operational experiences between various, cross sectorial industries can be very beneficial to accelerate the implementation of new technologies.

- Similarly, as part of the movement towards a circular economy, new techniques and processes are being developed for recycling plastic, e-waste, critical raw materials, and other process waste streams that contain valuable, secondary raw materials. These new processes can also be water intensive as well as presenting a significant risk of pollution.

- It is important to highlight the central role that water can play in Industrial Symbiosis. The latter is an innovative approach that brings together companies from different sectors with the objective of promoting the valorisation of waste, improving resource efficiency, and reducing environmental impact.

- Water use efficiency and zero net environmental pollution may be addressed through water reuse and recycle programs. Only 3% of wastewater is reclaimed today – the impact of increasing this to 10% would be enormous. For example, new technologies are enabling wastewater to be used directly in cooling systems. However, without proper management, wastewater can increase the risk of reliability impacts on such systems whether these be from localised corrosion or excessive microbiological growth. This highlights the importance of understanding the interrelationships between efficiency and reliability. Consequently, while water recycle is feasible with existing technologies in the market, the right selection of these, and the associated cost-benefit of their operation must be optimized using the true cost of water. Risks for using reclaimed water can be high and need to be mitigated.

- Regulatory barriers preventing the use of recycled water especially in food and beverage industries is another area to address. In addition to water, the scarcity of other critical and strategic raw materials is also a big concern for industries. Through a circular approach, the recovery of materials and energy from wastewater may also lead to new opportunities including their use as raw materials in adjacent industries. Many of these opportunities highlight the connectivity between climate resilience, biodiversity/zero-pollution and circularity.

- The slow pace and lack of alignment when implementing new regulations and measures creates its own management risk. There is a fundamental need to move society and industry from incremental improvements to disruptive transformation. However, with this is a risk of creating an unbalance between existing and future state that is too steep and/or too long such that the appropriate resources, budgets, business cases, and governance systems are not in place to manage all the changes at once. A balance needs to be struck as regulatory pressure can result in an increasing number of administrative duties for industries, including multiple reports and data collection efforts, making Europe a difficult place to operate in. This could ultimately lead to industry moving out of Europe.

- While water is a local resource, in certain regions, e.g. Mediterranean, water transfer may take place between basins, as is the case for example in the Po Valley region. Here it is important to identify the holistic strategies that maximise biodiversity through improved environmental flows and reduction in saltwater ingress etc.

- The impacts of concentrated brines that are produced during desalination and water reclamation process also need to be considered. There is a risk that the associated regulatory frameworks can lead to conflicts. For example, recycling more water leads to lower brine volumes but with higher salt concentrations. Discharging these more concentrated brines may not be approved by the authority providing discharge permits, especially for sites which are not located in coastal area.

It is the VLT's vision that the following three key focus areas will address the majority of the above gaps and lead to a faster adoption of a water smart industry. In order of priority:

1. Define sustainable water use.

- Significant amounts of data are already available on the supply and demand of water at many specific locations, and this should be utilized to the fullest extent possible.
- This process needs to include quantitative aspects about the true value of water, such as measurable biodiversity impact, economic growth driven by new job opportunities, health cost reduction and improvements to well-being etc.
- Create adaptive tools suitable for use by (local) policy makers and industrial users both at the local and global corporation level.

2. Set water smart targets on local level.

- Explore options to achieve more effective governance at the catchment/basin level to support local policy makers and industry to set specific targets for sustainable water use.
- Work toward aligning all water users in a basin toward these common targets & enable data sharing as part of effective local governance.
- It is important to recognise that large global corporations (including their upstream and downstream stakeholders) often face the complexity of managing local factories with very different water and regulatory targets and the impact of these on competitiveness.
- Set internal water efficiency related goals, aligned to these common, context-based targets. As part of this, assess and quantify water-related risks in financial terms and set water withdrawal and water quality targets to manage water use risk.
- Achieve these targets via the appropriate deployment of technologies including data-driven insights. Explore the use of alternative water resources and implement best practices and solutions to reduce, reuse and recycle water.

3. Develop showcases and communicate achieved successes.

- Leverage Water-Oriented Living Labs (WOLL) and other European-funded programs to demonstrate to industry, policymakers and society how water smart industries can be achieved.
- Showcase experiences that adopt alternative/new water resources.
- Demonstrate water efficiency improvement technologies, processes that do not use water as well as fully monitored and controlled closed (circular) production cycles.

6. Role of Water Europe and its working groups to create a water-smart industry

The industry transformation to a water-smart industry requires collaboration of many actors along the value chain. Intensifying the collaboration between industry, academia, educational institutions, and policy makers will ultimately enable the water smart industry. Through its working groups and extensive network in the EU, Water Europe offers a unique platform where knowledge can be shared, opportunity gaps elevated, and successful good practice distributed. Processes4Planet provides examples of good practice within industry, detailing specific actions and partnerships.

By discussing concrete industrial cases amongst peers one can gain insights on the various aspects of water-smart strategies, such as technical approaches, the value of human capital, new competences required, and how novel, interdisciplinary systemic knowledge can be used to address topics such as water scarcity, pollution, and water-energy-food-ecosystem nexus. This will allow industries to transition at a faster rate. Needs that cannot readily be addressed by learning from others can be elevated to appropriate policy makers, research institutes and financing institutes.

An exploitable instrument developed by Water Europe to address the Water Vision pillars of resilience, security and sustainability in a systematic way are the WOLLs. WOLLs are pragmatic and realistic tools for guiding industry, society and politics to accelerate the transition to an inclusive water-smart industry and society. Leveraging WOLLS, proper instruments can be developed to address the KPIs by global ESGs , such as monitoring biodiversity and the development of scenarios. The following types of new approaches through experimentation and implementation (co-creation) should be explored through WOLLs:

- Evaluation of collaboration and communication strategies involving all regional stakeholders in setting sustainable watershed targets, fostering sharing water between water users in the same basin and setting up local KPIs for climate actions and biodiversity. Various opportunities exist for industries to make their ESG effort more tangible, acceptable, and appreciated by the public.

- While price is usually a mechanism to limit the use of scarce raw materials, this cannot readily be applied to water as access to drinking water is a fundamental human right. However, for industry resilience, the price of water becomes irrelevant if there is no water, -- - hence there is also a price for 'no water'. The WOLLs can produce data for a quantitative water risk analysis, identify and test other mechanisms within local watersheds to drive sustainable use of water at fair cost (true cost of water) and set well-thought ESG objectives at local level, with a joint vision for connectivity (symbiotic exchange and "servitisation"/outcome as a service) of water, energy, emissions and waste heat at its heart.

- Technology evaluation of innovative, technical approaches to address sustainable water use that are economical and robust, e.g. the WOLL of project Ultimate in Tarragona.

Water Europe provides a platform where regulators and authorities can work together with industry to advance the transition to a water smart industry via pragmatic solution development. A fundamental role of Water Europe is also to ensure that all its Working Groups are aligned, to avoid competition within industry. This requires a systemic action within the Water Europe community.

The extent to which industry can manage by itself the speed and magnitude of change required is limited. As industry is operating in a global market, European industry should be protected against unfair competition from regions where no ESG investments are made. Here is a role for Water Europe to ensure that policy makers ensure strategic autonomy of the European industry, including a competitive perspective, creating a level playing field to foster future growth and well-paid jobs in Europe, as well as leading to global transition by proposing novel, radical, virtuous changes.

Another area where Water Europe can play a pivotal role is to frame Water stewardship and water risk in a similar manner as CO_2 emission reduction. This can be a potential topic in a separate white paper.

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Colophon

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