ULTIMATE

WATER SMART INDUSTRIAL SYMBIOSIS

Policy Brief

Supporting Water-Smart Industrial Symbiosis

Author(s): Water Europe

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Recommendations

Disclaimer

Due to confidentiality measures, the project is unable to disclose all the data supporting the recommendations. However, for further information within the boundaries of this confidentiality framework, the project consortium can be contacted at loic.charpentier@watereurope.eu.

Introduction

ULTIMATE is a 4-year project, funded by Horizon2020, aiming to enhance sustainability and create economic value by improving water and energy efficiency, and harnessing resources in the water cycle.

In progressing "Water Smart Industrial Symbiosis" (WSIS), ULTIMATE demonstrates the synergies that can found in the systematic reuse of water. Establishing WSIS as a vector for energy through heat recovery, a means of material extraction and sustainable energy production, and a catalyst for water treatment and reuse, all within a socio-economic and business-oriented framework. In addition, industrial symbiosis offers potential cost-competitive resources and diversification of the supply chain for European industries.

Building on the initial policy brief, ULTIMATE looks to create networks within industrial ecosystems, focusing on:

- **Water reuse** - recovering, processing, and redistributing wastewater for use by industries and local utilities.
- **Exploitation of energy** - extracting and deploying energy via integrated water-energy management, leveraging water for heat transfer, storage and recovery.
- **Material recovery** - Extracting and repurposing nutrients, along with reclaiming and reusing valuable compounds.

Beyond the aspects associated with competitiveness, there are also a range of social benefits, including but not limited to:

- **Improvement in quality of life:** Positive impacts on health and well-being stemming from improvements in the treatment system and the quality of discharged water.
- **Socio-economic gain:** Tax increase mitigation due to better pollution management, financial savings from waste recycling initiatives, growth in tourist economy linked to improved environmental conditions and biodiversity.
- **Employment opportunities:** Development of new skills and job creation in sectors associated with circular schemes such as recycling, renewable energy, and sustainable water management.

Case study	Water Smart Industrial Symbiosis	Resources	Closing the cycles of WATER, ENERGY, MATERIAL
CS1 Tarragona (ES)	Internal symbiosis within multi-industry utility: municipal and industrial WWTP & urban WRP	Municipal wastewater and industrial wastewater from the petrochemical complex	✓
CS2 Nieuw Prinsenland (NL)	Internal symbiosis within cooperative: greenhouses & water treatment facility	Drain water from greenhouses; residual and geothermal heat	✓ ✓ ✓
CS3 Rosignano (IT)	Municipal utility, multi-industry utility & SME: Sewer system, municipal WWTP, WRP	Municipal wastewater mixed with seawater due to an undesired intrusion of the seawater; byproducts from industry for reuse in water treatment	✓ ✓
CS4 Nafplio (EL)	Industrial utility & SME: industrial WWTP	Wastewater from fruit processing industry	✓ ✓
CS5 Lleida (ES)	Municipal utility & multi-industry utility: industrial WWTP & municipal WWTP	Wastewater from brewery & municipal wastewater	✓ ✓ ✓
CS6 Karmiel/ Shafdan (IL)	Municipal utility & two SMEs: two municipal WWTPs & WRP	Wastewater from olive oil production, slaughter-houses and wineries & municipal wastewater	✓
CS7 Tain (UK)	Distillery, water company, & SME: industrial WWTP	Wastewater from whiskey distillery	✓ ✓ ✓
CS8 Chem. Platform Roussillion (FR)	Internal symbiosis within multi-industry utility: Industrial WWTP	Wastewater from chemical industry	✓ ✓
CS9 Kalundborg (DK)	Municipal utility & multi-industry utility: municipal WWTP & industrial WWTP	Wastewater from pharma & biotech industry and municipal wastewater	✓ ✓ ✓

Table 1: Case studies within the ULTIMATE project (Source: ULTIMATE D1.1)

1. A Supportive Political Context

The European Union has made several legislative changes promoting the reuse of water and a more circular economy in general. Notably, the Circular Economy Action Plan of 2020 highlights the EU Commission's commitment to advancing circular approaches across a range of economic sectors. The revised Industrial Emissions Directive, in addition to the new Urban Wastewater Treatment Directive, aims to promote water reuse and leverage resource recovery, particularly with the inclusion of industrial actors in mind. The project has developed specific recommendations for the energy recovery from biogas and HT-ATES in annex 1.

Further to this, the new political cycle 2024-2029 is particularly focused on water and European competitiveness. Both the Draghi report and the Antwerp Declaration cause us to consider industrial symbiosis and recognize water as a crucial resource for the European economy. The EU Economic and Social Committee opinion demonstrates the need to provide examples of best practice. These positions have culminated in the announcement of a Water Resilience

Strategy by President von der Leyen in the **Political Guidelines 2024-2029**.

Lastly, ULTIMATE recognises the vital role of local and regional authorities and stakeholders' in implementing industrial symbiosis. Considering the increasing interest in the Committee of Regions on this topic, especially with the opinion in June, the conclusions of this policy brief must be disseminated to the local authorities through the relevant institutions.

The water sector stands as a pivotal industry in the global pursuit for sustainability, going beyond the provision of drinking water and sanitation services. Water is an essential piece of the puzzle to boost and maintain the competitiveness of the European economy. Water risks that could significantly affect business were noted by almost 70% of the firms according to a CDP survey and consequently, demonstrates the invest for a water-smart economy in Europe.

Further to the EU water sector commitments to reduce CO_2 consumption within the sector, the ambition for a competitive and strategically autonomous European Union is based on industries which are highly water and energy intensive. This includes but is not limited to semiconductors, carbon capture and storage, hydrogen, and EV batteries.

The EU Commission communication on managing climate risks underlines that such risks could manifest in "general increased competition over water resources across sectors and uses, including potential risk of conflicts within and among the Member States over transboundary water resources."

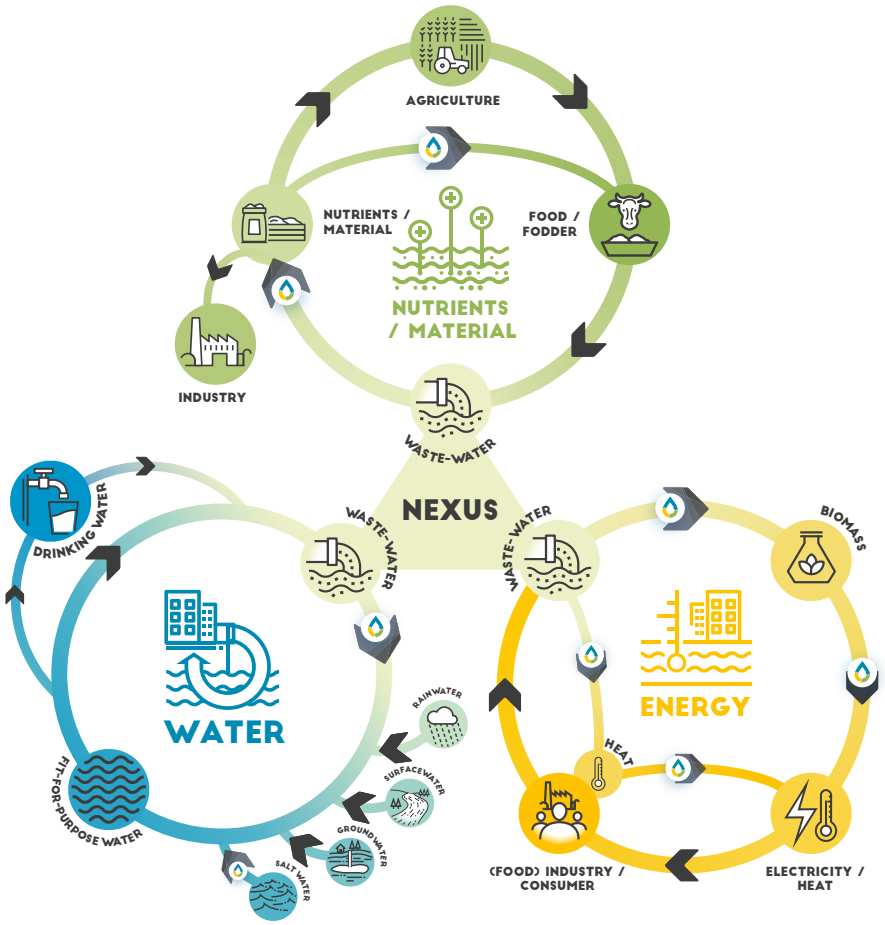

Figure 1: overview of the objectives of ULTIMATE project

2. From the Case Studies: Overcoming barriers

Beyond the water risks (e.g. droughts) and the legal incentives, using a clearer business case for water-smart industrial symbiosis (WSIS) is key to investment. Particularly for the best deployment of symbiosis technology, a more economic approach must be adopted. Despite the high amount of investment required to transition economic value chains from a linear to a circular process, the table below clearly demonstrates the advantages of a circular value chain:

Table 2: Sum-up of environmental impact of some synergies on 9 CS

CS	Value chain	Environmental impact
CS1	Reclaimed water	**Positive:** more available water for local communities (+9,000 000 m^3/year) **Negative:** additional CO_2 emissions (+32,000 tons/year)
CS2	Reclaimed water and nutrients	**Positive:** more available water for local communities (+70,000 m^3/year), Potassium and Nitrogen recovery (0.1m^3/ day) **Negative:** additional CO_2 emissions (+53 tons/year)
CS3	Reclaimed water	**Positive:** more available water for local communities (+200,000 m^3/year) **Negative:** additional CO_2 emissions (+4,430 tons/year)
	Coagulant/adsorbent	**Positive:** less raw materials extraction and by-product disposal (150 tons/year), Savings of 1.9 tons/year of CO_2 emissions
CS4	Reclaimed water and polyphenols recovery	**Positive:** more available water for local communities **Negative:** additional CO_2 emissions
CS5	Reclaimed water	**Positive:** more available water for local communities (+87,000 m_3/year) **Negative:** additional CO_2 emissions (+22 tons/year)
	Biogas recovery	**Positive:** use of biogas instead of fossil fuels, CO_2 emissions savings of 67 tons/year
CS6	Polyphenols recovery	**Positive:** biogas production, improved water quality and avoids pollution **Negative:** additional CO_2 emissions
CS7	Circular materials recovery	**Positive:** improved water quality and avoids pollution **Negative:** additional CO_2 emissions
	Reclaimed water	**Positive:** more available water for local communities (+35,000 m^3/year) **Negative:** additional CO_2 emissions
CS8	Sodium bisulphite recovery	**Positive:** improved water and air quality **Negative:** include CO_2 footprint
CS9	Reclaimed water	**Positive:** more available water for local communities (+3,000,000 m^3/year), Avoids 960 tons/year of CO_2 compared to water desalination solution **Negative:** additional CO_2 emissions (+960 tons/year) compared to current situation

To adequately integrate circular processes into value chain models for the water sector, ULTIMATE project has identified recommendations for policymakers:

- Increase political support of water reuse for industrial purposes across Europe
- Adapt regulations to the real needs to foster water reuse across Europe
- Use international experience to define ambitious vision
- Create regulations and a governance framework for material recovery purposes across Europe
- Create incentives to manage the price of the regenerated water
- Create economic incentives to promote circular solutions

- Create a framework promoting circular value chains and supporting the transition towards circular value chain for traditional business cases
- Explore potential other sources of fundings

2.1. Increase political support of water reuse for industrial purposes across Europe

As industry is a major consumer of water in Europe, Water Reuse Regulation must be updated to include industrial purposes. The recently revised Industrial Emissions Directive and Urban Wastewater Treatment Directive lack the potential to unlock economic activity through water reuse. Both directives do not overcome important barriers , yet will be fully implemented in several years.

Encourage translation of EU directives into national law without compromising the effective implementation of the directive.

2.2. Adapt regulations to the real needs to foster water reuse across Europe

Adaption of pollution-related parameters to unlock water reuse from substance concentration (mg/L) to thresholds in discharged load (t/a). An adaptation of regulation to the receiving water bodies (in case of discharge) or specific application (in case of reuse) would be also positive, as the effect of pollutants will vary depending on those.

The Example of Tarragona

The challenge of concentration versus discharged load

The industrial complex must reduce their water consumption by 25%. A new Near Zero Liquid Discharge (nZLD) Treatment System was expected to be tested on brine effluents from the WRP to produce reclaimed water for the petrochemical complex. A strong regulatory issue, as threshold are fixed in terms of concentration (g/L) and not in terms of load (t/a), has blocked the water-smart investment.

The challenge of the energy-efficiency first principle

A second potential issue require additional assessment on the energy-efficiency first principle (EEFP) including in the new Energy Efficiency Directive. Setting up such a project reduces water withdraw of the petrochemical platform by around 970 m3/hour, which represents about 9M m3/year. It ensures that natural ecosystems and population will have more water for their use. However, water reuse installation creates an average additional CO_2 emissions of 32 000 tons CO_2 per year, which could ultimately block such investment due to the EEFP.

Assess the opportunity to create a European forum involving industry and the EU institution on industrial symbiosis. A better collaboration between EU policy makers and technical experts of the water sector would unlock technical potentials and ensure a stronger alignment between policies and needs on the field.

2.3. Use international experience to define ambitious vision

Anticipate potential barriers by assessing international experience. The ULTIMATE project has two non-EU case studies that experience specific barriers. For instance, the current Israeli regulation does not allow mixing of agro-industrial wastewater within domestic system blocking the deployment of WSIS solutions.

The Example of Karmiel and Shafdan

Build on the international experience

The Symbiosis initiative in Karmiel and Shafdan establishes a connection between two small and medium-sized enterprises (SMEs) in the agro-food sector and a public wastewater utility, linking an industrial wastewater treatment plant (WWTP) with a municipal WWTP to tackle water risks by developing water reuse. The ULTIMATE project also aims to enhance energy and material efficiency like biogas production and polyphenols recovery.

Three main barriers have been identified:

- Strong financial cost to upscale the plant for biogas production and polyphenol recovery, including connection with the natural gas grid.
- Additional research and innovation is required to identify a more cost-effective process for polyphenols extraction, separation and purification.
- Regulation does not allow mixing of agro-industrial wastewater within a domestic system.

2.4. Create regulations and a governance framework for material recovery purposes across Europe

Develop European-wide standards and guidance to ensure and promote the safe implementation of circular value chains. Particularly, the waste hierarchy system should be assessed to unlock a circular approach regarding waste ownership, liability, and responsibility.

Harmonise the end-of-waste status across EU countries to strengthen industrial symbiosis and the EU single market. Currently, this status is mainly defined by national legislation, creating obstacles to reusing secondary phosphorus-containing products and weakening the EU single market.

Assess the opportunity of Eco-labels and certification schemes for circular by-products. This may also be an opportunity to foster material recovery purposes in Europe through the promotion of best practices to the consumers.

2.5. Create incentives to manage the price of the regenerated water

Encourage discussion on water pricing in support of water reuse. The environmental and social impact of water stress is not considered financially in the price of potable water. This makes the cost of potable water typically too low for regenerated water to be competitive, even for non-potable purposes. To combat this, water pricing that accommodates the cost of the water treatment for reuse could present a viable strategy.

The Example of the Rosignano Industrial Plants

Providing the relevant economic incentive and fundings

In 2001, a consortium, named "ARETUSA", was established, bringing together an urban water utility (ASA Azienda Servizi Ambientali Spa), a technology provider (TME Termomeccanica Ecologia Spa) and an industrial site (Solvay Chimica Italia Spa), to replace high-quality groundwater with fit-for-purpose treated municipal wastewater for industrial use (up to 3.8 million cubic meters of treated municipal wastewater annually).

However, returns on investment are estimated to be realised only in the long term. The high costs due to reverse osmosis (+870k€/year) and upgrade of the ARETUSA plant (around 4.2 M€) require a new blend of financial tools. Potential public subsidies, increasing the price of water, finding long term financial sources etc.

2.6. Create economic incentives to promote circular solutions

Increase financial support and additional funding from public sources. As stressed by the EU Blue Deal of the EU Economic and Social Committee, a Blue transition fund is required to leverage water reuse in industrial activities as business cases are not yet self-sustaining. (As demonstrated by Rosignano case study).

2.7. Create a framework promoting circular value chains and supporting the transition towards circular value chain for traditional business cases

Legal and financial incentives shall be fully leveraged to build a water-smart industry, including licence allocation and taxation. Traditional linear chains and companies often resist the emergence of new circular value chains and

may even attempt to obstruct them. From a business standpoint, this resistance is understandable because the assets in these traditional chains are purpose-built and often expensive (such as landfill sites or incineration lines). Recognizing and redirecting these flows signifies a disinvestment for them. To prevent these asset owners from becoming casualties of the circular economy, support measures are necessary.

2.8. Explore potential other sources of fundings

Promote other financial tools including private investment. The reluctance of the banking system to provide loans for industrial symbiosis-related investment is threatening the green transition in Europe. Similarly to the EU Blue Deal Declaration, the EU Commission could use the Water Resilience Initiative to evaluate the potential establishment of private financial tools in the next Multiannual Financial Framework of the European Union. Several examples might be explored:

- **Professional investors:** conventional source of finance for startups, equity investors (which includes Business Angels and Venture Capitalists) buy shares in these firms with the expectation of a high return when they exit.
- **European cleantech investors:** these investors focus their investment portfolio on businesses in cleantech, targeting a strong positive environmental impact.
- **European Investment Bank (EIB):** the new annual €4 billion water programme in a provisional version of the European Investment Bank's roadmap for the period 2024-2027 is very welcome . This kind of programme must also be open for industrial activities along with infrastructure, bioeconomy, and agriculture.
- **Crowdfunding:** Crowdfunding could also be used as a financial source for cleantech ventures.

Annex – Recommendations on Biogas and HT-ATES

This annex presents four key recommendations derived from the ULTIMATE conclusions. These recommendations are especially pertinent to the Industrial Emissions Directive, focusing on biogas production and valorization, as well as High-Temperature Aquifer Thermal Energy Storage (HT-ATES).

Replication and EC support for biogas related technologies

1. To replicate biogas production and valorisation technologies in Europe, stable prices for upgraded biogas and electricity, produced from biogas, are needed for a period of at least five years to amortise the plant. Another five years would be beneficial, after a potential adaption of the price on the energy market as further incentive to invest in such plants. To bridge a potential gap between the guaranteed price and the actual market price, subsidies might be needed.
2. A minimum quota for upgraded bio-methane in the gas grid can further support the willingness of investors to implement biogas production technologies and upgrading units.

Replication and EC support for HT-ATES

1. Test drillings to characterise the subsurface are expensive and time consuming. They are considered as a barrier for an easy market uptake of this technology. Hence, more research and demonstration projects are recommended to establish inexpensive, reliable and innovative technologies in order to avoid uncertainties during planning of an HT-ATES and to accelerate the planning process.
2. The highest risks are considered to be uncertain permit procedures and public perception. Furthermore, the permit procedure for a HT-ATES requires usually several years. We strongly suggest to accelerate this procedure and to promote the demonstration of full-scale pilot systems in order to develop suitable policies and to enhance the reputation of HT-ATES in the public perception.

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