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Embracing Circularity in Industrial Water Use

Policy Brief

Unlocking Industrial Water Reuse and Resource Recovery to build a water-smart industry

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1. Introduction

The RESURGENCE project is an EU-funded project that aims to make industries use resources like water and energy more wisely and reduces waste. At the core of RESURGENCE project lies the concept of *Seeds of Hubs for Circularity (S4Cs)*—strategic, replicable industrial ecosystems designed to integrate water, energy, and resource circularity. S4Cs act as a foundational instrument to pave the way for future large-scale *Hubs for Circularity*, driving climate neutrality, enhancing industrial competitiveness, and fostering sustainable resource use across water, energy, and feedstock.

These solutions target three key process industries—pulp and paper in Portugal, chemicals in Turkey, and steel in Poland—as well as an industrial-urban symbiosis use case in Spain.

This brief aims to provide targeted recommendation to key dossiers under discussion at the EU level to stimulate industrial water reuse:

- The upcoming **Circular Economy Act**, especially its provisions on secondary raw materials, circularity incentives, and market barriers.
- The upcoming **Digitalisation Action Plan**, especially for the deployment of digital tools for water reuse
- Priorities for the **2028–2034 Multiannual Financial Framework (MFF)**[1], including Horizon Europe's successor, Innovation Fund, LIFE+, and cohesion funding.

RESURGENCE emphasises the strategic potential of industrial wastewater as a multi-resource stream and it is currently running research activities to develop recovery technologies, that could simultaneously supply reused water, critical nutrients, salts and recoverable biogas and heat[2].There is an opportunity for Europe as it remains far from reaching its full potential:

- **Only <2.4% of total treated wastewater is reused across the EU** while over 40 billion m^3/year of urban wastewater is treated[3]. In Algeciras Bay, reusing municipal wastewater could respond to the current industrial water while providing a surplus of ~4.5 Hm^3/year available for agriculture or municipal uses[4].

[1] European Commission. *Mid-Term Revision of the Multiannual Financial Framework 2021–2027 and Orientations for the MFF 2028–2034*. COM(2025) 330 final, July 3, 2025. Brussels.
[2] RESURGENCE Project. *D1.1 Lab scale test of each technology with synthetic water: assessment of water and solutes recovery efficiency*. CETIM, 2025.
[3] European Commission SWD(2018) 249 final, Impact Assessment for the Water Reuse Regulation
[4] RESURGENCE Project. *D7.8 Analysis of the Local Context and Industrial Requirements for Campo de Gibraltar and Algeciras Bay Area Water Reuse Case*. Aqualia, May 30, 2025.

- **The EU circular material use rate was just 11.8% in 2023**, with fragmented markets for secondary raw materials and weak uptake due to regulatory and economic barriers[5].

RESURGENCE aims to address this blind spot by deploying different tools: sensor-based water and energy modelling digital twins, AI-based decision support tool, membranes, electrochemical technologies, adsorbents, advanced oxidation processes, hybrid biological systems and rotating heat exchanger. By creating regional circularity hubs and cross-sector symbiosis, RESURGENCE aims to achieve:

- **Climate Neutrality**: through energy recovery (e.g., heat, biogas, hydrogen) and digital optimisation tools to minimise resource use and emissions.
- **Circularity**: through modular technologies enabling water reuse, energy recovery, and resource valorisation (nutrients, metals, bio-based compounds).
- **Competitiveness:** by improving process efficiency, reducing dependence on virgin resources, and fostering scalable industrial cooperation through S4Cs.

Recommendations

Circular Economy Act

- Develop market and economic incentives for resource recovery
- Provide clarification and harmonisation of secondary raw material and end-of-waste criteria
- Promote circularity hubs for water-smart industrial symbiosis

Digitalisation Action Plan

- Support interoperable digital twins to improve reusable rate and interoperability at cluster level
- Support the deployment of resource recovery monitoring tools, particularly for industrial cluster to stimulate reuse processes

2028–2034 Multiannual Financial Framework (MFF)

- Support strategic integration in EU programmes of resource recovery objectives particularly in the competitiveness section.
- Require Selective Removal Materials (SRM) integration and reuse planning in all EU-funded industrial, urban, and infrastructure projects.

Disclaimer: Due to the ongoing activities of the project, some information and deliverables that confirm the recommendations are not available. You can contact the project coordinator or the project partner to get additional information or to be put in contact with the relevant partner.

[5] European Commission. *Call for Evidence for an Impact Assessment: Circular Economy Act*. Brussels: Directorate-General for Environment and Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, July 2025.

2. Support Circular Processes in EU Industrial Activities

Develop market and economic incentives for resource recovery

The European Commission has acknowledged that secondary raw materials (SRMs) struggle to compete economically with primary raw materials due to higher production costs, variable quality, and low market demand. Incentive like better consideration of innovation for circular process in public procurement, VAT exemption could stimulate the market of resource recovery.

Technologies like An-FOMBR[6] and CDI[7] could positively support benefit-cost ratios, particularly when phosphate and energy recovery are monetised. While CAPEX remains high and early LCC results point to cost inefficiencies at laboratory scale, they also indicate clear pathways for improvement at industrial scale, under which these systems could achieve long-term economic returns in suitable market conditions [8].

Provide clarification and harmonisation of secondary raw material and end-of-waste criteria

There is a need to measure and understand to build water-smart industrial symbiosis processes. Measurement and data collection are key to extract as much as possible secondary raw materials while ensuring the right quality.

Therefore, better clarification of the criterias within the Waste Framework Directive as well as a better integration of circular technologies in BREFs of the industrial emissions Directive would be valuable to stimulate circular processes.

Legal fragmentation in defining secondary raw materials and end-of-waste criteria creates uncertainty for technology deployment and cross-border resource flows. This hinders innovation and limits SRM uptake. In Algeciras urban-industrial symbiosis case[9], treated municipal water from 3 WWTPs could fully replace industrial water needs (17

[6] Anaerobic Fluidized (or Fixed) Organic Membrane Bioreactor. An advanced Anaerobic Membrane Bioreactor (AnMBR) configuration, where fluidized media or biofilm carriers enhance biomass retention and pollutant removal, while reducing membrane fouling.
[7] Capacitive Deionization is an electrochemical water desalination / softening technology that removes ions using charged electrodes. It is more energy-efficient than reverse osmosis for brackish water or partial desalination.
[8] RESURGENCE Project. *D5.3 Initial Economic Impact Assessment of RESURGENCE Technologies*. CETIM, 2025.
[9] RESURGENCE Project. *D7.8 Analysis of the Local Context and Industrial Requirements for Campo de Gibraltar and Algeciras Bay Area Water Reuse Case*. Aqualia, 2025.

Hm³/year), but this depends on legal recognition and harmonisation across regional actors.

Recovered water in all three industrial case studies consistently met reuse thresholds[10]. Moreover, secondary raw materials could be recovered. Phosphate, magnesium and sodium salts were recovered through CDI and Electrodialysis[11] with stable purity ranges and could potentially be qualified as SRMs[12].

Promote circularity hubs for water-smart industrial symbiosis

The Commission highlights the need to overcome fragmented waste/resource flows and promote cross-sector reuse. Promote water-smart circularity hubs through EU regional strategies and national recovery plans with trans municipal permitting frameworks for reuse loops across urban and industrial zones would be beneficial to deploy the relevant solutions and build water-smart processes.

RESURGENCE aims to demonstrate the benefits of clustering industrial activities around water-smart industrial symbiosis with treated effluents as SRMs[13], particularly in the case of Algeciras. It shows that clusters can optimise reuse, reduce peak loads, and integrate energy-water flows when coordinated.

3. Encourage the digitalisation of water-smart industrial symbiosis complex at cluster level

Support interoperable digital twins to improve reusable rate and interoperability at cluster level

Industrial water systems are complex and cross multiple operators. Without Scenario-to-contract toolchain, reuse projects could be limited instead of creating water-smart

[10] RESURGENCE Project. *D4.1 Water, Energy and Resource Analysis of Three Industries*. OK, 2025.
[11] A membrane-based desalination and ion separation process driven by an electric field. Useful for nutrient recovery, water reuse, and selective removal of salts/minerals.
[12] These results have been obtained at laboratory scale with synthetic wastewater. RESURGENCE Project. *D1.1 Lab scale test of each technology with synthetic water: assessment of water and solutes recovery efficiency*. CETIM, 2025
[13] RESURGENCE Project. *D2.1 First Physical-Based Water Circuits Models*. SSSA, 2025 ; RESURGENCE Project. *D2.4 Residual Industrial Plant Consumption Modelling*. UZAG, 2025.

industrial symbiosis hub that could benefit a whole eco-system, cutting risk and CAPEX/OPEX uncertainty.

RESURGENCE is developing dynamic models of the full water circuits for three industrial sites (steel, pulp & paper, and chemicals sites). These twins map unit processes, quantify bottlenecks, and test "what-if" reuse scenarios before deployment at cluster level[14]. With the AI forecasting, RESURGENCE could add a tool to manage "residual" plant consumption outside the WWTP boundary, enabling day-ahead scheduling and better coupling of water and energy operations across the site.

Support the deployment of resource recovery monitoring tools, particularly for industrial cluster to stimulate reuse processes

Markets won't buy SRMs (recovered water, nutrients, salts) without trusted monitoring of quantity, quality, and continuity. Monitoring is also the backbone for certification, end-of-waste status, and performance-based finance.

RESURGENCE digital tool will integrate online parameters that are decision-critical for real-time acceptance of recovered outputs[15]. The tool will also define impact and cost KPIs that can be fed by online monitoring (energy per m^3, recovery yields, reagent intensity, avoided abstraction) to become the Monitoring, Reporting, and Verification spine for procurement, EPR rewards, or green finance[16]. This solution will also allow predictive analytics that can flag deviations, enabling automated dispatch between reuse streams at cluster scale[17].

[14] RESURGENCE Project. *D2.1 First Physical-Based Water Circuits Models*. UZAG, 2025
[15] RESURGENCE Project. *D1.1 Lab scale test of each technology with synthetic water: assessment of water and solutes recovery efficiency*. CETIM, 2025
[16] RESURGENCE Project. *D5.1 Initial Environmental Impact of RESURGENCE Technologies*.,CETIM 2025 ; RESURGENCE Project. *D5.3 Initial Economic Impact Assessment of RESURGENCE Technologies*. CETIM, 2025.
[17] RESURGENCE Project. *D2.4 Residual Industrial Plant Consumption Modelling*. UZAG, 2025.

4. Use the 2028-2034 MFF to actively transform the EU industry into circular industrial clusters

Support strategic integration in EU programmes of resource recovery objectives, particularly in the competitiveness section

As the European Union aims to invest in the EU competitiveness, inclusion of financial provisions to stimulate circular processes through the competitiveness funds as well as the research fund can contribute to:

- Economic benefits: reduce dependency on imported raw materials (phosphorus, magnesium, sodium salts).
- Environmental benefits: lower water abstraction and GHG emissions.
- Technological benefits: strengthen EU leadership in circular water technologies.

System like An-FOMBR and CDI should be deployed as they show positive cost-benefit ratios when resource recovery is monetised, supporting competitiveness in high water/energy cost sectors[18]. Moreover, Algeciras case aims to show that water reuse can fully meet industrial water demand (17 Hm^3/year), freeing freshwater resources for other economic uses[19].

Require SRM integration and reuse plan in EU-funded industrial, urban, and infrastructure projects whenever possible.

Mandating SRM planning avoids stranded assets that miss reuse opportunities in infrastructure update or development. RESURGENCE aims to demonstrate the untapped reuse potential in all three cases of the project[20]:

[18] RESURGENCE Project. *D5.3 Initial Economic Impact Assessment of RESURGENCE Technologies*. CETIM, 2025.
[19] RESURGENCE Project. *D7.8 Analysis of the Local Context and Industrial Requirements for Campo de Gibraltar and Algeciras Bay Area Water Reuse Case*. Aqualia, 2025
[20] RESURGENCE Project. *D4.1 Water, Energy and Resource Analysis of Three Industries*. OK, 2025.

Organik Kimya (chemistry)

- **Current situation**: Treats ~180 m³/day of wastewater, with only 35% recycled; wastewater mainly contains polymers from filling and cleaning.
- **Current treatment**: Ultrafiltration (UF) for polymer separation, sludge dewatering, Sequencing Batch Reactors (SBR) and Membrane Bioreactors (MBR) for achieving dischargeable water.
- **Expected improvements**: Treatment optimisation to increase water recovery, reduce freshwater intake, save energy, and minimise waste.

CELSA (steel)

- **Current situation**: Water flow 180–365 m³/h; ~236–350 m³/h recirculated, crucial for continuous casting cooling; discharge occurs mainly in rainy periods.
- **Current treatment**: Mechanical treatment (MOS plant) with oil separation
- **Expected improvements**: Improve control of rainwater entry and oil contamination; apply advanced filtration or others to enhance water quality, cut chemical use, and further reduce discharges.

Navigator (P&P)

- **Current situation**: Freshwater intake ~65,000 m³/day, effluent discharge ~55,000 m³/day; 84% of water demand met by reused streams, especially for pulp washing and cooling.
- **Current treatment**: Neutralization basin, primary clarifiers, cooling tower, aeration basin with activated sludge, secondary clarifiers.
- **Expected improvements**: Reuse alkaline bleaching effluent for unbleached pulp washing, saving ~200 m³/h of water and lowering WWTP load.

Pro-active analysis of the water reuse opportunities could raise awareness about the business opportunities for industries and regional and local authorities.

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Contact Us

Due to the ongoing activities of the project, some information and deliverables that confirm the recommendations are not available. You can contact the project coordinator or the project partner to get additional information or to be put in contact with the relevant partner.

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