

Give plastic wastes from the production of hollow fibre membranes a second life



Water scarcity affected 29 per cent of the EU territory during at least one season in 2019. Despite water abstraction declining by 15 per cent in the EU between 2000 and 2019, there has been no overall reduction in the area affected by water scarcity conditions. In fact, since 2010 there has been a worsening of the situation. This, compounded with the fact that climate change is expected to further increase the frequency, intensity and impacts of drought events, makes it somewhat unlikely that water scarcity will be reduced by 2030. Additional effort is needed to ensure sustainable water use.

European Environment Agency, 2023

Freshwater resources are essential for human health, nature and the functioning of economies and societies. However, across the EU, these resources are threatened by multiple pressures.

To address this, the Water Framework Directive—Council Directive 2000/60/EC' (2000)—requires member states to promote the sustainable use of water resources and protect the available ones.

LIFE REMEMBRANCE strives to enhance sustainable water resource use, protect available water sources, and promote human health through a water purification solution developed from secondary raw materials, in line with circularity principles for sustainable economic growth.

The project's priority is reducing or eliminating discharges of emerging pollutants and/or pathogens by developing a portfolio of technologies for drinking water and urban potabilisation treatment systems through resource-efficient industrial processes for water services.

This project addresses global water challenges, prompting collaboration among sector players, prospective industrial actors, academies, institutions, technology providers, health institutes and utilities. The goal is to develop scalable, efficient, ESG sustainable and regulatory-compliant systemic solutions, making them practical and feasible.

LIFE REMEMBRANCE's main objective is the circular production and commercialisation of safe, innovative granules and cartridges derived from the recycling of high-value industrial waste derived from HFM (hollow fibre membranes) filter production. The aim is to offer an efficient drinking water purification system for emerging and known contaminants, aligning with the Chemical Strategy for Sustainability (European Chemicals Agency, no date) and new EU-wide hygiene standards for materials and products in contact with water (European Commission, 2024).

The link to DRINKING WATER directive 2020/2184/EU is direct as, by January 2024 (European Commission, 2024), the EU Commission shall establish technical guidelines regarding methods of analysis for monitoring PFASs (already achieved), and by January 2026, member states will need to ensure that water intended for human consumption complies with directive 2020/2184/EU.

Towards this objective, Medica SpA and CNR-ISOF at Bologna CNR Institute partnered to develop a cooperation programme to which LIFE Remembrance belongs. The programme consists of four main areas of work.

- Convert HFM plastic process wastes into granular sorbents of defined size to promote selective sorption of contaminants such as perfluorochemicals (e.g. PFAS, PFOAS), antibiotics (ciprofloxacin), speciality chemical additives (bisphenol A), heavy metals (Pb) towards which crude granular sorbents have already shown an interesting performance at laboratory level. Figures 2–4 clearly show the shift from the state-of-the-art plastic process waste end of life (incineration, which was about two tons of scraps of fibres in 2023 only at Medica Group!) to the LIFE REMEMBRANCE regeneration.

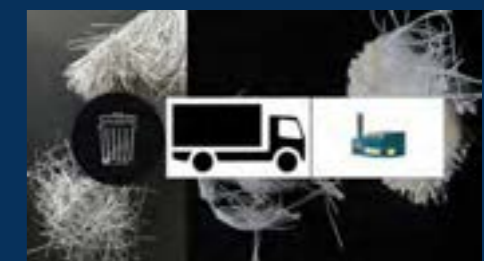


Figure 2: The state-of-the-art end of life of plastic scraps deriving from the fibres and membranes production processes at Medica SpA.



Figure 3: The state-of-the-art plastic waste formation from the fibres and membranes production processes at Medica SpA, plastic wastes to be regenerated rather than incinerated.



Figure 4: The LIFE REMEMBRANCE granular absorber selective system, pure and combined with different polymeric matrices.



Figure 1: The hollow fibres membranes, which are the basis for the design and development of selective disposable medical devices, membranes and filters.

- Test, optimise and scale up the granulation process to demonstrate its environmental, social and economic sustainability at industrial pilot level.
- Determine the best design and operating conditions. A descriptive scheme of the developed technology and the principles of the designed novel process have been successfully published in an article in *Research Ae:ther*.
- Pilot and replicate the solution at an external industrial site—the potabilisation treatment plant at HERA GROUP in Pontelagoscuro. A pilot has been tested at Menù srl, a company in the food processing sector. The scheduled pilot installation, aligned with the wastewater treatment plant of Hera group at Pontelagoscuro, is set for 5 March 2024. On this date, multiple stakeholders from the community, policy-making clusters, academia, industry, water service companies

and educational system providers will convene, demonstrating the value of an interdisciplinary approach to the development of an industrially scalable systemic solution for long-term, successful water resources management.

From a direct environmental perspective, the partnership between Medica SpA and CNR ISPOF aims to:

- reduce PFASs chemical contaminants in water
- demonstrate the reduction of MEDICA membrane waste (5–10 per cent of production in weight)
- reduce plastic waste in the long term by adapting the process to a larger variety of plastic wastes
- offer an LCA-furnished plant and process technology to quantitatively demonstrate its carbon footprint and decarbonisation contribution

- increase the circularity of the core process for producing the HFM in Medica Group.

Indeed, the synergy between the two partners and the project itself is expected to provide a cascade effect in terms of:

- additional systemic initiatives to show the feasibility of novel circular business models towards sustainability and growth by widening the achieved results (also in terms of implemented know how) to other sectors, such as:
 - textiles and coating industry process water treatment systems where the regeneration of secondary textile fibres paradoxically generates augmented contamination
 - delocalised hospitals and health centres' wastewater treatment systems towards preliminary water disinfection before converging into the main urban WWTPs
 - urban and not urban mining sectors to reduce the NORMs (naturally occurring radioactive materials)
 - e-mobility linked battery recycling plants, by providing alternative systems to efficiently remove and recover rare earth elements as well as other relevant valuable materials
 - food processing for extracting and removing the contaminants generated by the thermal processes.

To achieve these goals, cross-sectoral stakeholder meetings are underway and will be implemented in the next 15 months (refer to: <https://liferemembrance.eu>).



Figure 5: The Ae:ther LIFE REMEMBRANCE publication.



Figure 6: Pilot testing installation at Menù srl: food processing sector.

Pilot 1: Menù srl

Food industry with high water consumption rate, close to Medica facility in Medolla (MO).

Water savings → test of flow rates and lifetime on a pilot installed between tap water inlet in Menù plant and industrial RO.

Advantages: testing conducted in real tap water without water waste.



Figure 7: LIFE REMEMBRANCE TEAM meets the stakeholders: Dissemination event at AQUATECH, Amsterdam 6–9 November 2023.



Figure 8: LIFE REMEMBRANCE Cartridges are publicly shown at AQUATECH 2023, Amsterdam 6–9 November 2023.



Figure 9: LIFE REMEMBRANCE Team joins the stakeholders at AQUATECH, Amsterdam 2023.



Figure 10: LIFE REMEMBRANCE and Human Capital Medica SpA meets the H2O-People organisation and the WORLD WATER ACADEMY, AQUATECH Amsterdam 2023.

By fostering collaboration across industries, creating a supportive environment for water projects, and actively highlighting the significance of the water sector, we aim to enhance the project's visibility within the EU context. This will empower Medica to strengthen its efforts in the water segment, positioning itself as the primary interlocutor with key water stakeholders for seamless integration into the segment.

To this purpose, a continuous confrontation with the external market and any novel proposed solution is mandatory. The partners, Medica SpA and the CNR-ISOF, have been very active both on the academic and the market stages, promoting the project content as well as exploring the water treatment innovations at an international level. Aquatech 2023, for instance, played a crucial role in exploring global trends, unveiling innovations from LIFE REMEMBRANCE, connecting with the European Junior Water Programme (EJWP), and setting the stage for future initiatives (<https://www.isof.cnr.it/aquatech-2023-isof-researchers-explore-global-trends-and-launching-innovations/>).

From a technology perspective, the versatility of the technology makes it possible to combine the specific granular sorbent with other polymeric matrices to amplify the efficiency and the applicability of the LIFE REMEMBRANCE solution and to properly position the product in comparison with the other available technologies in the sector. Specifically, the project will perform a complete evaluation of several existing technologies, such as:

- GAC (granular activated carbon), which is a proven option to remove certain chemicals, particularly organic chemicals, from water, but with several ethical and environmental issues
- selective ion exchange resins, effective only for PFAS and which might undergo irreversible saturation.
- reverse osmosis nano filtration membranes, which require high water consumption during operations



Figure 11: A clear image of the Granular activated carbons technology.



Figure 13: A picture of RO filtration membranes.



Figure 12: A generic picture of ion exchange resins.



Figure 14: A piloting sample of LIFE REMEMBRANCE absorbing system (pure and combined with graphene).

Compared to these aforementioned scaled technologies, the LIFE REMEMBRANCE solution is expected to provide a simultaneous removal of various contaminants more sustainably from a natural resources consumption, environmental and energy perspective.

In the short term, LIFE REMEMBRANCE will make it possible to provide safe drinking water to a panel of 112 citizens by 2024 and 1M by 2029!

At a glance

From a technology perspective, the project will contribute to:

- **circularity** through the recycle of high-value industrial waste deriving from HFM filter production
- **know how and cross fertilisation implementation** by cross-sectoral hollow fibre spinning technology
- **systemic business model** actualisation by implementing the LIFE REMEMBRANCE fibre scraps

recycling technology from internal waste consumption to a more generic multisectoral plastic waste regeneration.

From a sustainability 3P (Planet, People, Purpose) perspective, Figure 15 shows how it is possible to achieve these goals.

The organisation itself will be shifted to a life-centred chemical ecosystem through a disruptive, responsible production strategy based on a symbiotic circular value chain centred on waste, with a strong contribution from an academic institution such as CNR-ISOF.

This transition will provide a tangible benefit to the planet through:

- a stable, continuous production with no shortage
- a decentralised supply chain with low C-footprint
- no dangerous emissions and the preservation of natural ecosystems
- a quantitatively assessed contribution to sustainable water management
- a catalytic effect on spillover diffusion
- a profitable ecosystemic, integrated novel value chain.

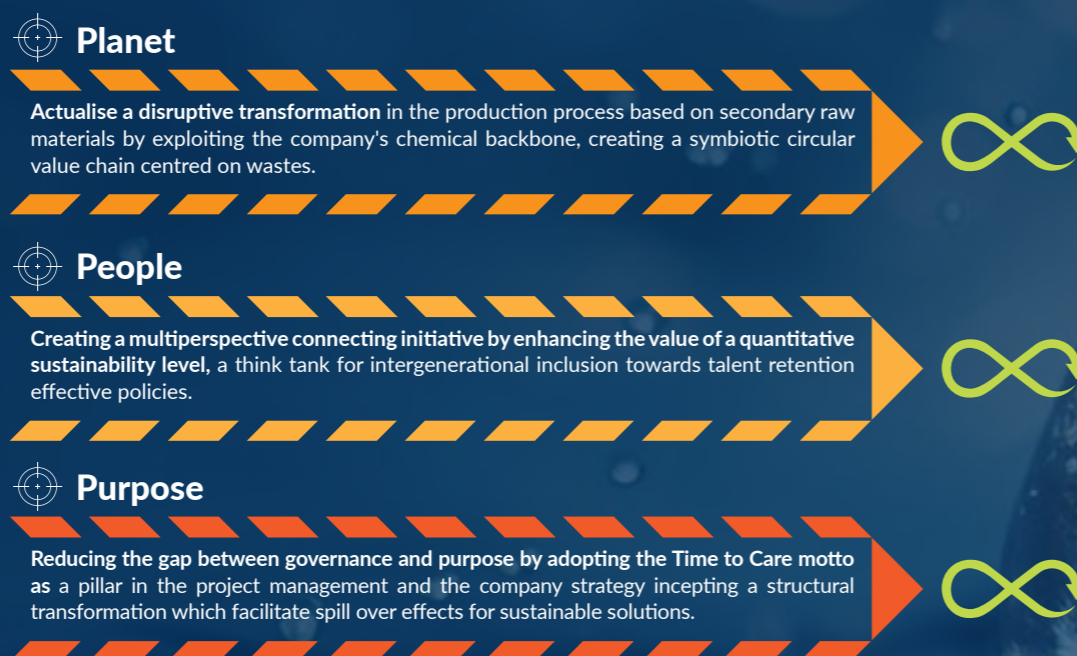


Figure 15: The 3P goals of LIFE REMEMBRANCE towards sustainability improvement.

References

- Council directive 2000/60/EC on establishing a framework for Community action in the field of water policy (2000) *Eur-Lex*. L327, pp. 1-173.
- European Chemicals Agency (no date) *Chemical Strategy for Sustainability*. Available at: <https://echa.europa.eu/hot-topics/chemicals-strategy-for-sustainability>.
- European Commission (2024) *Drinking water to become safer thanks to new EU-wide hygiene standards for materials and products in contact with water*. Available at: https://ec.europa.eu/commission/presscorner/detail/en/ip_24_350.
- European Environment Agency (2023) *Water scarcity conditions in Europe (Water exploitation index plus)*. Available at: <https://www.eea.europa.eu/en/analysis/indicators/use-of-freshwater-resources-in-europe-1>.

PROJECT CONTACTS

Manuela Melucci

Senior Research Scientist at CNR, Institute for Organic Synthesis and Photoreactivity (ISOF), CNR-ISOF, Via Gobetti 101, Bologna, Italy

- +39 051 639 8271 / 8254
- manuela.melucci@isof.cnr.it
- [/manuela-melucci-254646121/](https://www.linkedin.com/in/manuela-melucci-254646121/)

Letizia Bocchi

Research Laboratory Manager, R&D Membranes & Filters and board member (Intellectual Property Manager) Medica SpA Via Degli Artigiani, 7 - 41036 Medolla (MO), Italy

- +39 053 551 159 - int. 217
- letizia.bocchi@medica-spa.com

Alberto Goldoni

Sales Marketing Manager, Medica Water Division Medica SpA Via Degli Artigiani, 7 - 41036 Medolla (MO), Italy

- +39 392 445 6368
- alberto.goldoni@medica-spa.com

«OKM» G_Local Supply Network	Upstream Inclusivity
Natural Sources Preservation	Life-Centred Economic Model
Wastes Reduction	Emissions Gain
Performance Metric System-based Profitability	Catalytic Effect
Co-partnering Skills	Relationships and Connectedness
Accelerated Deployment Talented Ideas	Catalysts of Transformation
External Stakeholders' Inclusion (Schools, Utilities, Policy Makers)	Responsiveness to Ecosystems Demands
Experimental LL Pilot at Water Operator	Clarity-based Governance Models
The Value of Powers' Distribution & Stakeholders Engagement	The Resources Free Up for New Challenges

PROJECT NAME

LIFE REMEMBRANCE - Give plastic wastes from the production of hollow fiber membranes a second life

PROJECT SUMMARY

LIFE REMEMBRANCE's ambition is a demonstrated circular production process of safe and innovative granules and cartridges for drinking water purification from emerging contaminants. The objectives will be achieved through the development of a novel technology based on the recycling of high-value industrial waste, deriving from hollow fibre membranes (HFM) filter production and validated with the collaboration of an internationally recognised utilities company.

PROJECT PARTNERS

LIFE REMEMBRANCE counts on an academic and industrial partnership formed by Consiglio Nazionale delle Ricerche (CNR), CNR-ISOF Department (Bologna), specialised in materials characterisation and water treatment technology validation, and Medica SpA, operating in the sector of disposable medical devices, hollow fibre membranes and filters for blood and water purification, always on the global market with innovative solutions and technologies.

PROJECT LEAD PROFILE

Dr PhD Letizia Bocchi, received her PhD in Biochemistry, Biotechnology and Molecular Biology at the Università degli Studi di Ferrara. Employed in Medica R&D from 2010, her main achievements can be summarised in inventive activity (relevant patents about filtering membranes for multisectoral applications from biomedical devices to water management), set-up of cutting-edge laboratory dedicated to filters performance characterisation in vitro, set-up and successful upkeeping of a deep scientific cooperation with CNR- ISOF; Coordinator of GRAPHIL which participates to the Graphene Flagship. Coauthor of 18 peer-reviewed scientific publications ranging from biotechnology to advanced materials topics.



FUNDING

The LIFE REMEMBRANCE project has received funding from the LIFE programme of the European Union under grant agreement No. LIFE20 ENV/IT001001.