



Membrane scale up for chemical industries

LET'S MEET THE MEASURED PROJECT

MEASURED - Membrane Scale Up for Chemical Industries, started on January 1st, 2023, funded by the European Union's Horizon Europe research and innovation program under Grant Agreement N° 101091887.

MEASURED addresses the call topic HORIZON-CL4-2022-RESILIENCE-01-14: Membranes for gas separations - membrane distillation, and it is aimed at developing and demonstrating advanced membrane materials for Pervaporation (PV), Membrane Distillation (MD) and Gas Separation (GS) technologies applied to acrylic ester production, treatment of waste streams from membrane manufacturing and methane separation from a carbon capture & utilization (CCU) stream. The primary goal of MEASURED is

to revolutionize membrane technologies, paving the way for future commercialization of technologically advanced and environmentally friendly solutions across the entire value chain. By the end of the project, the integrated MEASURED technologies will undergo a TRL7 demonstration, accumulating more than 20,000 hours of operation under real industrial conditions. MEASURED encompasses comprehensive multiscale modeling and simulation techniques, including a thorough Life Cycle Assessment, to ensure a holistic understanding of the technology's impact. Furthermore, the project aims to address societal implications, enhance acceptance, and further prepare the market for widespread adoption.



€ 7.971.409
BUDGET



48
MONTHS



9
COUNTRIES



17
PARTNERS

MEASURED will:

- Design and set up a broad and complete network of value chains with world-class industrial partners, universities, research centers to develop the key building blocks for membrane applications. MEASURED will connect material developers with key players in the chemical industry, thereby matching existing needs and new products with the essential link provided by innovative organizations that can develop advanced membrane technologies that will meet the challenges of the coming years.
- Develop a set of flexible cost-effective and environmentally friendly membranes that can be easily tailored for different applications (cross-fertilization).

- Lay the foundations for new business opportunities, including:
 - The development of novel ceramic, carbon molecular sieve (CMSM) and polymeric membranes for their integration in newly designed membrane modules for three applications.
 - The development of 3 new prototypes for the testing of the membranes in different applications at TRL7.
 - The creation of a spinoff company for the commercialization of CMSM for different applications.



The [MEASURED consortium](#) - coordinated by Eindhoven University of Technology (TU/e) - consisting of 17 participants, is an interdisciplinary collaboration comprising 2 SMEs, 7 industries, and 8 universities/research centers. Together, they will conduct in-depth research on the development of advanced materials, reactor design, and process configuration. Their comprehensive studies aim to identify the most sustainable options, considering demonstration, techno-economic

factors, and environmental considerations.

EINDHOVEN UNIVERSITY OF TECHNOLOGY (TU/e)

<https://www.tue.nl/en>

Eindhoven University of Technology (TU/e) is a research university specializing in engineering science & technology. Our education, research and knowledge valorization contribute to: science for society:



PROJECT COORDINATOR

- solving the major societal issues and boosting prosperity and welfare by focusing on the Strategic Areas of Energy, Health and Smart Mobility
- science for industry: the development of technological innovation in cooperation with industry
- science for science: progress in engineering sciences through excellence in key research cores and innovation in education.

The research group Sustainable Process Engineering is part of the faculty of Chemical Engineering and Chemistry at the Eindhoven University of Technology. The main objective of the research group is the development of novel integrated reactor concepts (such as Membrane Reactors, micro reactors, structured catalysts and reactors) based on improved fundamental knowledge using validated advanced (multi-phase) reactor models. This is achieved by employing a combination of state-of-the-art numerical models (at different levels of detail using the multi-level modelling approach), advanced (non-invasive) experimental techniques and experimental demonstration of novel reactor concepts (proof of concept).

Role in the project: TUE will be responsible of: Project coordination; Gas separation membranes and modules development and demonstration; System modelling. Conceptual engineering studies for full scale industrial plants of MEASURED.

FUNDACION TECNALIA RESEARCH & INNOVATION (TECNALIA)

<https://www.tecnalia.com>

Fundación TECNALIA Research & Innovation is the largest private, non-profit applied research centre in Spain, and member of the Basque Research and Technology Alliance (BRTA). Employs around 1,472 people (287 PhDs) with an income of €120 million in 2021. TECNALIA is a key agent in the European Research Area. TECNALIA actively participates in the governing bodies of several European Technology Platforms, PPPs and JTIs (EEB, FOF, SPIRE, ARTEMIS...) and associations. The Membrane Technology and Process Intensification group of the Material and Processes Dept. develops advanced membranes and membrane reactors for Industrial Gas and Liquid Separation such as, H₂ purification and production, CO₂ Capture and conversion, natural gas processing, biogas upgrading among others.

tecnalia

MEMBER OF BASQUE RESEARCH
& TECHNOLOGY ALLIANCE

Role in the project: TECNALIA will work mainly in the develop and characterization of carbon molecular sieves membranes for gas separation, mainly in the polishing of CH₄ product of the methanation of CO₂.

NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK TNO (TNO)

<https://www.tno.nl/en/>

TNO is an independent research organization. We connect people and knowledge to create innovations that boost the sustainable competitive strength of industry and well-being of society. TNO Energy Transition has an extensive and well-known background in preparation, testing, up scaling and implementing membranes for molecular separations and in process design

TNO innovation
for life

of e.g., separation technologies. The membrane expertise includes pervaporation; vapour permeation and nanofiltration. TNO has done pervaporation tests for multiple applications in the dehydration of organic components and methanol separation from organics on lab scale and pilot scale. Details can be found on: <https://www.hybsi.com/>.

Role in the project: TNO is in charge of Work Package 3 (Membranes development and Scale-up), dedicated to the preparation of custom-made new generation membranes with exceptional separation performance and/or superior properties, crucial for accomplishing the objectives of the European Green Deal, followed by characterization of their performance under industrial conditions to facilitate the design of field tests and validation of models, and finally, up-scaling the membrane preparation (1-1.2 m²) for pilot demonstration in WP5.

THE NATIONAL INSTITUTE OF CHEMISTRY (NIC)

<https://www.ki.si/en/>

The National Institute of Chemistry is a scientifically excellent, established and breakthrough research institution based in Europe. With our cutting-edge research, we are enriching the global treasury of knowledge by solving the most pressing challenges facing society including: health, sustainable energy, climate change, a circular economy and safe food. Our research goals push the boundaries of science and create new values. We successfully transfer knowledge to industry and, in the long-term, support the role of science in the development of society.



Role in project: Building upon the inventory of selected (near) commercial membranes, their atom-mesoscale Digital Twin model will be produced by a seamlessly linked density functional theory (DFT)/molecular dynamics (MD) simulations/kinetic Monte Carlo (KMC)/ computational fluid dynamics (CFD) (iteratively).

UNIVERSITÀ DELLA CALABRIA (UNICAL)

<https://diam.unical.it/>

The Department of Environmental Engineering (DIAM) of the University of Calabria (UNICAL) is composed by 36 professors and researchers, 12 technical-administrative units and several PhD and postdoc students. With more than 3,000 m² of laboratory space, DIAM proves a well-recognized expertise in the field of Membrane Technology, Integrated Membrane Systems for Process Intensification, Membrane Contactors systems including Membrane Distillation-Crystallization, Membrane Reactor and Electrochemical Membrane Processes.



The Research Unit at DIAM has a long and internationally recognized expertise in the field of membrane engineering with focus on the development of advanced membranes and the prototyping of integrated membrane processes for water treatment.

Role in the project: in the MEASURED project, UNICAL will contribute to the development and the characterization of environmental-friendly polymeric membranes for Membrane Distillation and to design the Membrane Distillation demonstration unit.

RAUSCHERT KLOSTER VEILSDORF GMBH (RAUSCHERT)

<https://rauschert.com/en/>

Rauschert is a leading global manufacturer of technical ceramics, molded plastic parts and functional components. We have been a competent and reliable partner and



innovative problem solver for our customers for more than 120 years. If we learned one thing in this time, it is that nothing is as constant as change. That is why we try to widen our skills every day. Our know-how today is the result of decades of learning. This is why we are participating in the Measured project with membranes from our Inopor brand.

Role in the project: our task in the project will be the production of semi-finished products that will be modified by our project partners to be used as selective gas separation membranes, with focus on CMSM.

CONSIGLIO NAZIONALE DELLE RICERCHE (CNR)

www.itm.cnr.it | www.istec.cnr.it

The Institute on Membrane Technology (ITM) and the Institute of Science, Technology and Sustainability for Ceramics (ISSMC) belong to the Department of Chemical Sciences and Materials Technology of the National Research Council of Italy (CNR) and are two of the 88 Research Institutes of CNR. CNR is the largest public research organization in Italy with ca. 6000 R&D personnel staff for a total of ca. 8500 employees. CNR-ITM is active in the field of membrane science, technology and engineering. The research activities aim to promote knowledge, innovation, and high-level training in the field of membranes preparation and characterization, and their application in water treatment, gas separation, bioartificial organs, biotechnology, food and agriculture. CNR-ISSMC is among the largest Institution in the world fully devoted to the development and processing of ceramics, as structural or components solutions for many different applications.



Consiglio
Nazionale
delle Ricerche

Role in the project: CNR-ITM will be involved in WP3 (Membrane development and scale-up) and will support the design and implementation of the MD demonstration unit (WP4 - Engineering and Construction and WP5 -

Technology demonstration) and will organize a Workshop/Webinar on “Introduction to novel membrane technologies” within WP7. CNR-ISSMC will be involved in WP3 (Membrane development and scale-up).

GVS SPA (GVS SPA)

www.gvs.com

GVS Group is one of the world’s leading manufacturers of filter solutions for applications in the Healthcare & Life Sciences, Energy & Mobility and Health & Safety sectors. In over 40 years of history, GVS has evolved from a supplier of components for the healthcare sector to a global Group that produces highly technological diversified filtration solutions. The Group has always paid great attention to research, development and innovation of its products and processes and has shown a strong trend towards development in global markets since its foundation. Thanks to pioneering strategic choices, a growing volume of R&D investments, and an ecosystem of multifunctional skills, the Group has developed successful products and excellent processes. GVS boasts state-of-the-art equipment and technical systems, essential to support its technological research and development programs and to design and offer its customers a wide range of services and products distinguished by their high quality and reliability.



Role in the project: GVS is Leader of WP 1 “Exploitation and Business Plan”. The goal is the market analysis and business model definition to build a reliable go to market strategy up. GVS will also host a membrane distillation demo plant in its own plant located in Bologna to check and validate the technology.

ENGIE (ENGIE)

<https://www.engie.com/en>

Engie is a global reference in low-carbon energy and services company. Engie is committed to accelerate the transition towards a carbon-neutral world, through reduced energy consumption and more environmentally friendly solutions.

Engie aim to reconcile economic performance with a positive impact on people and the planet, building on our key businesses (gas, renewable energy, services) to offer competitive solutions to Engie's customers. Within the ENGIE company, the ENGIE Lab CRIGEN, a corporate R&D center of ENGIE dedicated to new gases and energies, conducts operational R&D projects and develops pilots for the Business Units and corporate entities of ENGIE as well as external customers, in an effort to master tomorrow's technologies, bring them to maturity, and prepare the Energy Transition. ENGIE Lab CRIGEN creates value through innovative low-carbon solutions for ENGIE's customers and innovative solutions to improve operational excellence of industrial assets based on three different pillars:

- New gases (biogas, biomethane, hydrogen, Power to gas and Power to Liquid, LNG and retail LNG)
- New uses of energy (energy storage, future building and cities, future industry, green mobility, societal and environmental impacts)
- Digital and Enabling Technologies (Drones and robot, artificial intelligence and computer science, nanotechnologies and sensors)

Regarding hydrogen ENGIE Lab CRIGEN is involved from more than 15 years in the whole value chain, on technological R&D and expertise (production, transport, distribution and uses), process modelling and simulation, tools development implemented in pilots and demonstrators.



Role in the project: in the framework of MEASURED project, Engie will design and construct the gas separation system in collaboration with TUE. Engie is also in charge of testing the gas separation prototype on its GAYA platform in Saint Fons (France) for upgrading gas stream from CO₂ methanation.

ARKEMA FRANCE SA (ARKEMA)

<https://www.arkema.com/global/fr/>

Arkema is one of the Speciality Material leaders offering the most innovative and sustainable solutions to address our customers current and future challenges with closed to 20000 passionate employees around the globe. Among Others, in Acrylic Acid and Monomers derivatives, with 1.1MMT/year Arkema is the second major competitor and is always in research of clear process advancement with respect to the outstanding existing technical solutions limited by lower efficiency, higher toxicity of production process as well as low purity of commercially attractive chemicals.

The logo for ARKEMA, featuring the word "ARKEMA" in a bold, sans-serif font. The letters "A", "R", "K", "E", and "M" are in a dark blue color, while the letters "A" and "A" at the end are in a light teal color.

Role in the project: Measured project's is to make greener and more efficient membrane technologies for acrylic ester production, with lower operating expense and inherently safer process. Within this project Arkema will run the Demo Plant for this pervaporation application.

ORELIS ENVIRONNEMENT SAS (OE)

<https://alsys-group.business.site>

ORELIS ENVIRONNEMENT (Orelis) is an industrial company capable of designing highquality filtration units. It is important to highlight Orelis' expertise and competence



in the development of filtration pilot systems. It's ability to understand specific customer needs and translate them into innovative filtration solutions is essential in this research program. The filtration units designed by Orelis are characterized by their reliability, high performance, and durability, making them first-choice products for companies in various sectors. The quality of these filtration units is a testament to the company's technical expertise and commitment to providing superior products. Orelis also stands out for its strong competence in pervaporation technology, offering technical support to ensure that their customers receive the best service possible. We can only praise its expertise in liquid and gas filtration.

Role in the project: Orelis is in Work Package 4 and in charge of the development of the pervaporation pilot.

CIAOTECH – PNO GROUP

www.pnoconsultants.com/it

The PNO Group (aka PNO Consultants), established in 1984, is a European group, made up of a pool of more than 400 professionals across 9 Member States. Every year, PNO supports more than 3.000 clients in their R&D processes, realizing original data-driven and expert-driven analysis and creating over 300 cutting-edge R&D projects – changing the world for the better. PNO has drafted and successfully executed dissemination and exploitation plans of a great number of European projects in various sectors. In this project, PNO is represented by CIAOTECH S.r.l., the Italian branch of PNO Consultants, specialized in R&D Advisory, Innovation Management and funding procurement, providing consultancy services to private and public organizations.



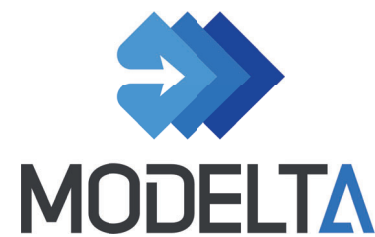
Role in the project: CIAOTECH is the leader of Work Package 7, Dissemination

and Communication, and is involved in WP2, Exploitation & Business Plan, which will set the foundation for effective development and exploitation of results into the market.

MODELTA BV (LCMR)

www.modelta.nl | www.modelta.eu

Modelta B.V. is a technical spin-off company specialized in providing modelling services and consultancy around membrane technology, membrane reactors and their system integration. Modelta was initially formed as an initiative within the MACBETH EU project and is a spin-off from the Technical University of Eindhoven (TU/e) and Politecnico di Milano (Polimi). We provide our services using mathematical models developed in-house, with 10+ years of expertise acquired from TU/e, Polimi and the MACBETH consortium. Typical problems we tackle are process design & optimization, upscaling, techno - economic analyses, modelling & simulation of membrane - and membrane reactors systems.



Role in the project: Modelta's role within MEASURED is to be Work Package Leader for WP6: Modelling. We will guide modelling activities and coordinate general WP6 progress and collaboration. Modelta is also in charge of Tasks 6.3 and 6.4, namely techno-economic analyses at full-scale with replication studies as well as a social acceptance and market readiness analysis for MEASURED solutions. Through close collaboration with all other partners in WP6, Modelta will take the lead in successfully completing these tasks.

CERAMIQUES TECHNIQUES ET INDUSTRIELLES (CTI)

<https://www.ctisa.fr/eng/>

CERAMIQUES TECHNIQUES ET INDUSTRIELLES (CTI) is an industrial company focused on the production of ceramic products. One of CTI's businesses is the manufacture of ceramic oxide membranes. The membranes range from MF/UF to gas filtration. The manufacturing includes processes such as co-sintering. A ceramic membrane is formed by a mixture of ceramic oxide powders with binders and other agents. The technique involves extrusion to give the final shape of the membrane, followed by drying and sintering steps to create a solid structure. In some cases, CTI uses hybrid membranes (for example, Hybsi®). Hybrid ceramic membranes have a ceramic oxide structure as a support. The support is coated with a polymer layer. These membranes combine the advantages of both ceramic and polymeric materials. Hybrid ceramic membranes can be used for many applications, including pervaporation, as they have high temperature resistance and high permeability.



Role in the project: CTI is involved in Work Package 3, whose objective is to scale up pervaporation ceramic membranes.

AIX-MARSEILLE UNIVERSITY (AMU)

<https://www.univ-amu.fr/en>

Aix-Marseille University (AMU) is the largest multidisciplinary French-speaking University in France, with 80,000 students and more than 10,000 staff on five large campuses that meet international standards.



M2P2 (mechanics modeling and clean processes) is a research unit is attached to the University of Aix-Marseille, CNRS Institute of Engineering and Systems Sciences (INSIS) and Centrale Marseille school. The laboratory has an original position with research covering the fields of Computational Fluid Mechanics and Chemical Engineering.

Role in the project: the Membrane process team will be mainly involved in the pervaporation line, with lab scale optimization of the process using the best new membranes developed by other partners.

FUNDACIO EURECAT (EURECAT)

www.eurecat.org

Eurecat is the main Research & Technology Organisation in Catalonia and the second largest private research organization in southern Europe. It brings together the experience of more than 650 professionals who generate an annual turnover of 52 million euros and provides services to more than 2,000 companies. Applied R&D, technological services, highly specialized training, technological consultancy or valorisation and exploitation of industrial property are some of the services that Eurecat offers for both large and small and medium-sized enterprises in all sectors. The technology center participates in more than 200 large national and international consortium projects of high strategic R&I and has 153 patents and 7 spin-offs. The added value provided by Eurecat accelerates innovation, reduces spending on scientific and technological infrastructures, reduces risks and provides specialized knowledge tailored to each company. It has eleven centres in Catalonia (Spain) and one in Chile (LATAM).



Role in the project: For MEASURED, Eurecat will be contributing to several Work Packages (WP), playing an active role especially in WP3 (Membranes

development and Scale-up) in which lifetime and end-of-life recyclability studies on the different membrane materials developed during the project will be evaluated. will be performed. In WP 5 (Technology demonstration), Eurecat will evaluate the developed membranes in terms of selectivity and permeabilities for water and target compounds and, in addition, membranes will also be characterised microscopically for any degradation of fouling tendency. Finally, in WP6 (Modelling), Eurecat will perform an integrated analysis of the new technologies based on sustainability pillars and circularity analysis of the MEASURED solutions based on LCA and Social-LCA approaches.

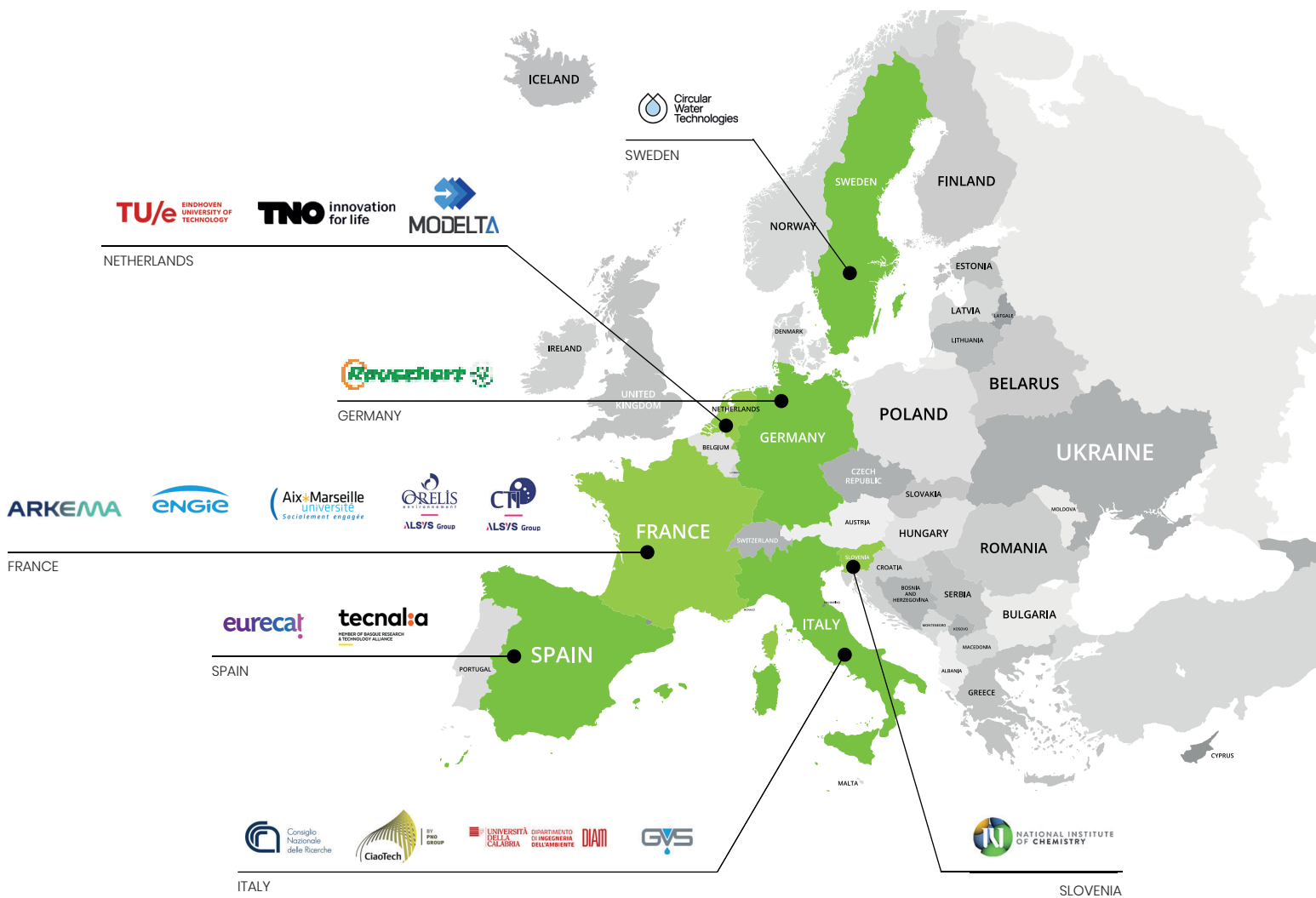
CIRCULAR WATER TECHNOLOGIES AB (CIRCULARWATER)

<https://circularwatertechnologies.com/>

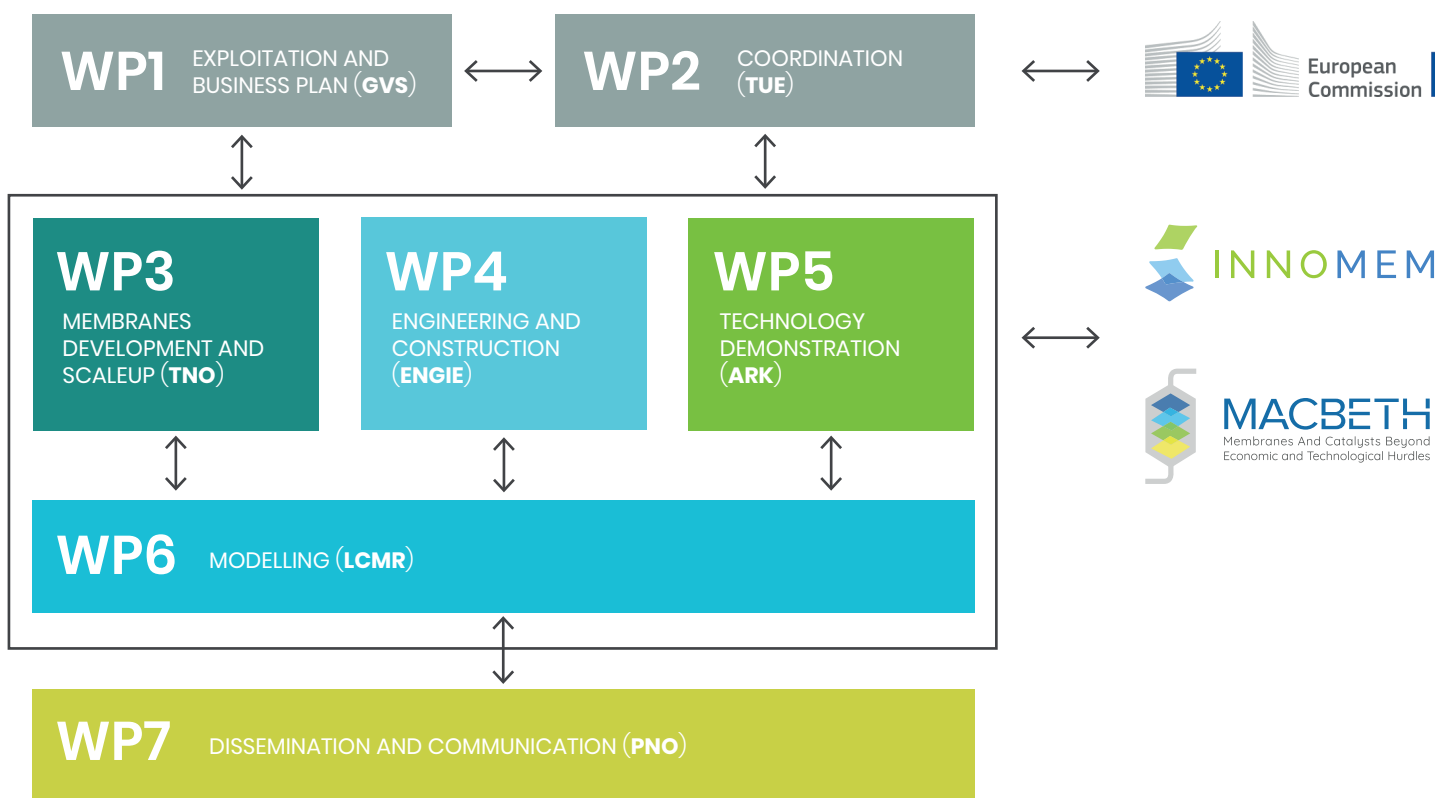
Circular Water Technologies (CWT) is a Swedish research and development company, founded in 2020. It's part of a group of companies within Scarab Development AB and aims to contribute to the green transition, advancing sustainability and the Hydrogen Economy by providing a superior ultrapure water solutions. CWT uses Scarab's proprietary technology to mimics a natural phenomenon and produces UPW trough thermal pervaporation, removing EVERYTHING from any type of feed water using waste heat. CWT through its solution offers reduced process complexity in UPW production, reduced factory footprint, circular use of water and the possibility to recover valuable resources from industrial wastewater. The company has always worked closely with academic institutions, such as the Royal Institute of Technology (KTH), and include other partners like University of Calabria, ABB, Interuniversity Microelectronics Center – imec, Technical University of Dresden and Fortum.



Role in the project: CWT will be responsible for designing and construction of pilot for Membrane Distillation unit. Moreover, CWT will assist in research and development of membranes to be used for purification of feed used during the project.



The project work plan identifies and organizes the logical phases of the implementation of the project and includes consortium management, assessment of progress and results, as well as dissemination and exploitation of results. The overall strategy of the work plan is designed to carry out detailed investigations into the scientific topics identified as necessary to bring the concept beyond state of the art and reach the expected innovation objectives. To achieve the objectives in an efficient way, MEASURED has been divided into 7 work packages:



UPDATES FROM THE CONSORTIUM!

MEASURED M6 MEETING IN CALABRIA, ITALY

On July 4-5, the MEASURED consortium met in Calabria (Italy) for the first General Assembly of the project, to review the preliminary results attained within each Work Package. The partners also shared their plans for the forthcoming months, outlining the exciting steps ahead in the development and demonstration of advanced membrane materials.



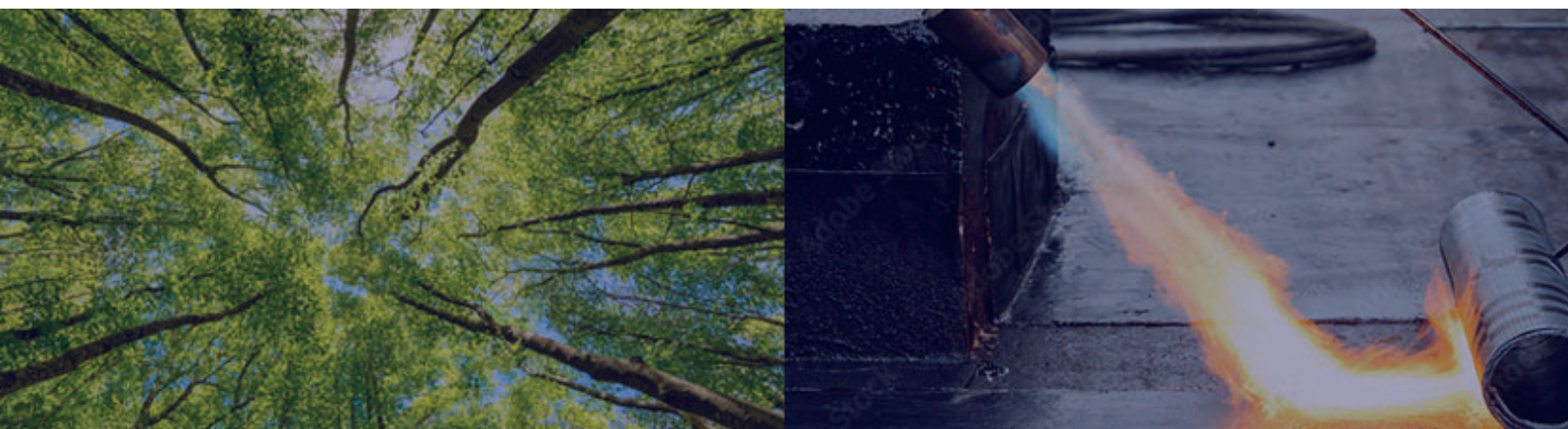
MEASURED PRESENTED AT ICOM2023

Margot Llosa Tanco from the Tecnalia Membrane Technology group participated in the 13th International Congress on Membranes and Membrane Processes (ICOM2023) held from July 9th–July 14th, 2023, at Makuhari Messe, Chiba, Japan. Margot Llosa Tanco gave the oral presentation: “Aluminium–carbon molecular sieves membranes (Al-CMSM) for CH₄ polishing obtained from methanation of CO₂”, an investigation carried out within MEASURED. She was also invited to chair a session and was asked to judge the student oral and poster awards.

NEXT APPOINTMENTS!

MEASURED WILL BE SHOWCASED AT THE ICCMR

Next October 16-18, 2023, the 16th International Conference on Catalysis in Membrane Reactors will take place in San Sebastian, Spain, to promote the research and progress in catalytic membrane systems by bringing together academic scientists and industry working in the membrane, catalysis and process engineering fields. The meeting will highlight recent developments, bring new ideas, help making contacts and create a platform for discussion between academics and practitioners. In this framework, our coordinator TU/e has submitted the abstract “*MEASURED: Membrane Scale-Up for Chemical Industries*”.



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