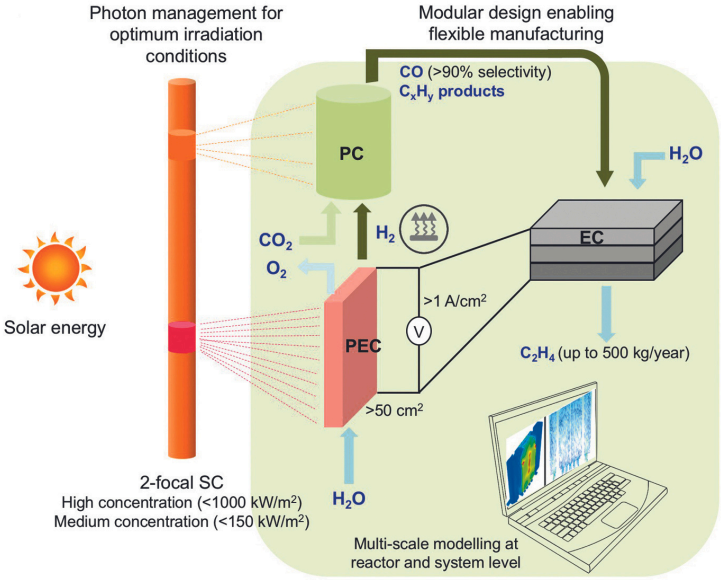
Sustainable Chemicals from Sunlight and Carbon Dioxide

FlowPhotoChem is a multi-national, EU-funded research project developing new and better ways to manufacture chemicals using carbon dioxide and sunlight. Solar energy and advanced catalysts can be used to convert carbon dioxide into fuels and useful chemicals, replacing current fossil fuel-based approaches.

FlowPhotoChem addressed the key challenges to achieving more sustainable chemical manufacturing – more effective solar light management, more efficient reactors, and more durable catalysts. The project assembled many of Europe's leading R&D teams in this and related fields, from computer scientists and modellers to chemists, reactor designers and catalyst companies.

This brochure highlights the achievements of and benefits for our industry partners. To learn more about FlowPhotoChem technologies, visit the project website (www.flowphotochem.eu).



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"FlowPhotoChem has demonstrated that direct solar energy conversion technologies can be used to produce green ethylene as a key compound for the chemical industry. The demonstrator, made up of modular reactors, paves the way for a range of other green chemicals produced solely from water and carbon dioxide. Industry partners have both contributed to and benefitted from the project, as we share here."

FlowPhotoChem Coordinator
Dr Pau Farràs, University of Galway, Ireland

Ollscoil na Gaillimhe University of Galway

Ollscoil na Gaillimhe University of Galway

SZTE University of Szeged

Johnson Matthey Inspiring science, enhancing life

EPFL

ICIQ

DLR Deutsches Zentrum für Luft- und Raumfahrt German Aerospace Center

HZB Helmholtz Zentrum Berlin

Universiteit van Amsterdam

eChemicles

SoHHytec

LEITAT managing technologies

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membrasenz

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SoHHytec were involved in the continuous enhancement of the photo-electrochemical (PEC) reactor in the FlowPhotoChem system.

SoHHytec SA (sohhytec.com) is a Swiss cleantech company with unique technology for the onsite and cost-effective production of solar hydrogen while co-generating oxygen, electricity and heat, without any carbon dioxide emissions and with unprecedented solar-to-hydrogen conversion efficiency, requiring minimal maintenance. SoHHytec's innovative patented technology is based on a novel integrated photo-electrochemical device working with concentrated solar irradiation.

SoHHytec's research group is comprised of CEO, Dr Saurabh Tembhurne, overseeing management and finance aspects, Head of R&D Dr Ehsan Rezaei, leading technical endeavours, and Process Engineer, Mr. Guilherme da Silveira, contributing expertise in technical implementation and development.

Through SoHHytec's involvement in FlowPhotoChem, the company demonstrated the robustness of their reactor through extensive testing under various seasonal conditions, showcasing its reliability. Additionally, areas for improvement were identified and upgrades, particularly enhancing optical and thermal management components successfully implemented, thereby optimising reactor performance. Furthermore, in collaboration with other systems, SoHHytec showcased the integration of their reactor to produce sustainable ethylene, demonstrating the compatibility of their technology and potential for broader applications in renewable energy systems.

membrasenz

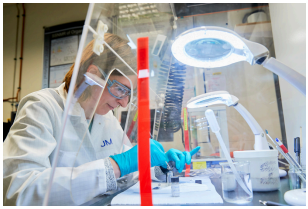
MEMBRASENZ, led by CEO Dr Jelena Stojadinovic produced and tested membranes for FlowPhotoChem's energy conversion systems.

MEMBRASENZ (membrasenz.com) is engaged in the development, production and commercialisation of anion conductive membranes to be used in alkaline and AEM electrolysers, as well as in other energy conversion systems. The properties of composite membrane material developed by MEMBRASENZ, such as ionic conductivity and thermal stability, surpass the performance of other competitors in the market.

MEMBRASENZ's role in FlowPhotoChem was the development of membranes for PEC and electrochemical (EC) reactors. Alongside the founder of MEMBRASENZ, Dr Jelena Stojadinovic, who was actively involved in R&D activities, Dr Anna Igual and Dr Vincent Cremet worked on laboratory testing and membrane digital twin generation. Results obtained from testing of membranes at the Helmholtz Zentrum Berlin, University of Szeged and EPFL during the project helped improve membrane performance. Collaboration with partners Leitat and Johnson Matthey on Life Cycle Analysis and Techno-economic Analysis enabled the identification of optimal materials and strategies for new products' exploitation.

As a partner in the project, MEMBRASENZ had the possibility to develop membrane products for the commodity chemicals market in addition to the company's initially targeted hydrogen production market. Moreover, MEMBRASENZ had a chance to learn about many aspects of EU projects from the partners, renowned academic and industrial entities and members of the Scientific Advisory Board.

Johnson Matthey provided expertise in advanced material development and helped identify and characterise business opportunities.

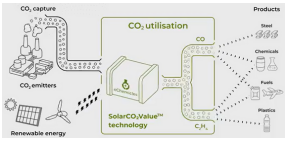


Johnson Matthey (JM) (matthey.com) is a global leader in sustainable technologies. Many of the world's leading energy, chemicals and automotive companies depend on JM's technology and expertise to decarbonise, reduce harmful emissions and improve their sustainability. As the world faces the challenges of climate change, energy supply and resource scarcity, through inspiring science and continued innovation, JM are catalysing the net zero transition for their customers and for society.

JM led the development of cathode catalysts. In-house material development was supported by partners who tested the performance of JM's catalysts and electrodes. The technical know-how obtained within the project, including catalyst ink and electrode preparation, cell and test stand design, and test conditions, will be used in further technology development. Additionally, exploring the market opportunities for the FlowPhotoChem system gave JM a greater understanding of the current landscape of solar fuels and chemicals and related technologies.

Participation in the FlowPhotoChem project enabled JM to assess the available opportunities in the solar fuels and chemicals landscape in a collaborative effort, working together with top academic groups and SMEs. The major technical benefits include practical know-how and capabilities in catalyst development and testing for carbon dioxide and carbon monoxide electrochemical reduction, a growing area of R&D being explored for the decarbonisation of the fuels and chemicals industry.

eChemicles were involved in reactor design, system integration and techno-economic evaluation of the integrated FlowPhotoChem system.



eChemicles (echemicles.com) is a start-up company developing innovative sustainable electrolyser solutions to enable the chemical industry to reduce its environmental impact profitably. In FlowPhotoChem, the company mainly contributed to the development of the photocatalytic (PC) and electrocatalytic (EC) reactors, as well as to activities that prepare future higher technology readiness level (TRL) development and the eventual exploitation of the developed technologies.

Within FlowPhotoChem, eChemicles developed a new continuous photoreactor capable of operating in an almost unattached parameter space, up to a temperature of 250 °C, pressure of 50 bar and simulated concentrated solar irradiation up to 5 Sun intensity. This unique photoreactor allows catalyst testing in a wide parameter space. The scale-up activity of electrolysers for carbon monoxide reduction towards ethylene formation resulted in an approximately 12-fold increase in geometric area in a stackable way resulting in an overall 40-fold increase in conversion capacity. Demonstration of scalability and robustness of the technology is extremely important for industrial utilisation.

Participation in FlowPhotoChem has led eChemicles to be even better integrated into the electrochemical and catalysis communities, raising awareness of the most recent scientific trends. Joint developments with academic consortium partners have brought up-to-date knowledge in-house and created opportunities for strong collaborations.

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