Hybrid biofuel production systems employing microorganisms and CO_2

By 2050, the European Union should reach an ambitious objective: being the first climate-neutral continent. To do so, we have to overcome several challenges, such as

- Use renewable and sustainable feedstocks for fuels and chemical productions
- Capture, store and convert CO_2 with no extra energy source
- Implement technologies that do not include the use of metals and rare materials

To overcome these challenges, the **Photo2Fuel** team is advancing in the research of solar fuels. **Photo2Fuel** aims to develop a breakthrough technology that converts CO_2 into useful fuels and chemicals employing microorganisms and using only sunlight as an energy source.

The main system of **Photo2Fuel** is composed of microorganisms (Moorella thermoacetica bacteria & Methanosarcina barkeri archaea), photosensitisers and captured CO_2. This hybrid system is fed into a reactor that works only with sunlight and special LEDs at night and in variable weather conditions. Methanosarcina barkeri archaea will develop into methane, recovered directly as a gas. Moorella thermoacetica bacteria will produce acetic acid, which will be recovered after a process of product separation.

The obtained products are targeted to various end-use applications, such as chemical, transport and other high-energy-consuming industries.

Photo2Fuel is a project bringing together 8 partners from 6 countries (Spain, The Netherlands, Germany, Sweden, China, Switzerland). 5 universities, 2 research and technology organisations and 1 SME are working together to cover all phases for the development of **Photo2Fuel**'s methodology which focuses on the sustainable production of biofuels and biochemicals.

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PHOTO2FUEL

Artificial photosynthesis to produce fuels and chemicals

Hybrid systems with microorganisms for improved light harvesting and CO_2 reduction

OVERALL PROJECT BUDGET: € 2.493.171
START DATE: 1 September 2022
END DATE: 31 August 2025
TOTAL MONTHS: 36

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Objectives of Photo2Fuel

1. To develop devices that convert CO_2 into fuels and chemicals using microorganisms and sunlight.
2. Maximising the efficiency of CO_2 capture and conversion for the systems being developed.
3. Scaling up a prototype of a carbon-neutral solar mini plant following a multidisciplinary optimization approach.
4. To simulate the functioning of the prototype as a carbon-neutral solar mini plant for a duration of one year at a target location to optimize its efficiency.
5. Evaluation of the **Photo2Fuel** technology from a stakeholder's perspective, in comparison to fossil fuel alternatives and negative CO_2 emissions technologies.
6. Delivering a detailed evaluation of the environmental and social LCAs and techno-economic assessment of the developed devices.
7. The provision of a roadmap for future research.

Developing new solutions for CO_2 storage and reuse

The EU has adopted the ambitious goal of achieving net-zero greenhouse gas emissions by 2050. Most attention has been devoted to carbon capture and storage, but CO_2 utilisation and reuse can play an equally important role in reaching the target. In **Photo2Fuel**, the potential of reusing CO_2 is demonstrated by focusing on the use of this compound for chemicals and fuels production (acetic acid/methane), developing a prototype by the end of the project.

Contributing to a sustainable energy transition

Photo2Fuel responds to the need for developing breakthrough technologies for sustainable energy production to achieve a climate neutral Europe by 2050.

Photo2Fuel's provides a technology for biofuels and biochemicals production based on organic materials, using CO_2 as a feedstock. The system will contribute to finding scalable solutions to produce energy in a sustainable way that are not relyiant upon fossil fuels or any other critical raw materials.

The viability of the system will be assessed at lab scale, and the large scale potential will be simulated using a mathematical model. The overall sustainability and potential market uptake will also be analysed.