SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

Task 72
Solar photoreactors for the production of fuels and chemicals

Developing photo reactors driven by real sunlight

Areas of Work

Solar photoreactors use light activation (photon energy) to convert low-value feedstock (water, CO_2, available bio-feedstock) directly to fuels and chemicals via photochemical processes. While these processes have been well studied in the past years under artificial light, the operation of such technologies under real sunlight and research of all related challenges is still in its infancy. Little effort has been taken to foster the combination of expertise between photochemical scientists, process engineers and the solar industry, in order to synergize inter-disciplinary know-how to develop market-deployable „solar photo reactors“. The IEA SHC Task 72 has been initiated to overcome this gap, establishing an inter-disciplinary expert network.

Solar photo reactors can produce fuels and chemicals bypassing the electricity grid and using sunlight as sole energy source. However, land-use management, and convert solar energy as efficiently as possible to products must be considered. To foster such development of solar photo reactors, IEA SHC Task 72 is working on **standardized testing procedures and design guidelines,** as well as **harmonized evaluation metrics** for 3 research levels of solar photo reactors:

Subtask A Material Development

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(1) Exchange on the development of photoactive materials based on non-critical elements with enhanced conversion efficiency for different reactions (overall water splitting, using waste/sea water, CO_2 valorization/reduction, N_2 fixation to ammonia, biomass upgrading, sustainable chemicals…)
(2) Design and synthesize multifunctional junctions to improve the light harvesting across the full sun-spectrum
(3) Standardized protocols to characterize and evaluate the synthesized materials
(4) Automatized methodologies to produce, characterize and scale up materials

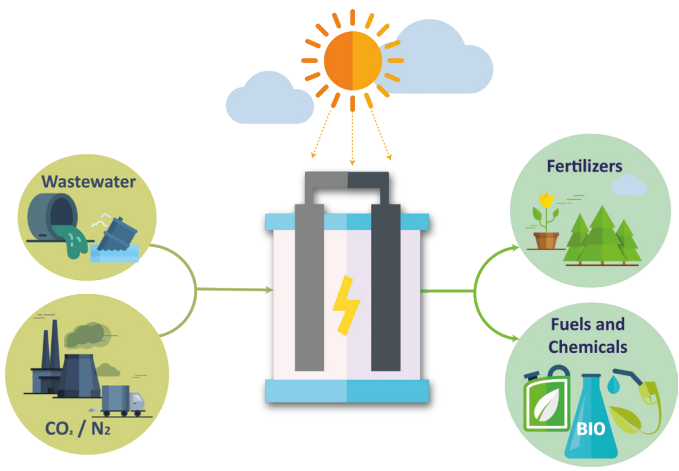

Figure 1. Scheme of the multifactional reactor developed within the EU project HySolChem: A (photo) cathode based on copper semiconductors (right) and a dark anode designed with a unique architecture to boost the oxidation of organic pollutants and microplastics in waste water (left) Graphic: HySolChem/ IMDEA

Subtask B Solar Photoreactor Design

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(1) Investigation and Analysis of existing solar photo-reactor designs, provision of fundamental understanding of process limitations
(3) Discussion of optimization potential and open research questions to increase efficiencies in solar photoreactors
(4) Promotion of collaborative initiatives for reactor studies under defined conditions (reaction, photon flux/solar receivers)
(5) Common definition of key performance indicators for reactor assessment

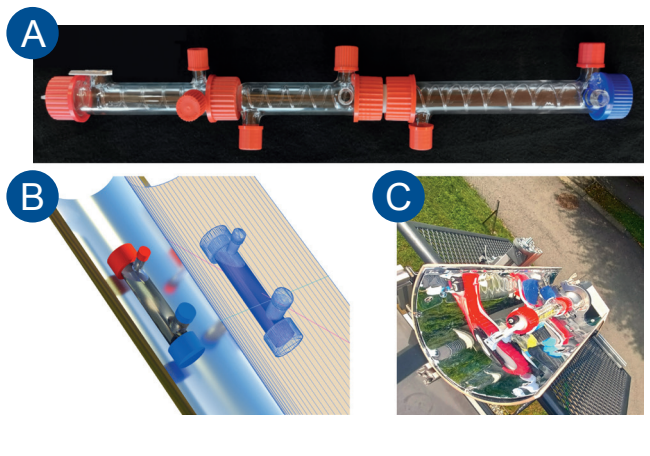

Figure 2: Cylindrical solar photoreactor design. A) Modular glass tubes of varying lengths and volumes, allowing serial or parallel configuration. B) and C) Photoreactor integrated into a parabolic mirror structure – the reflective surface is engineered to focus incident sunlight onto the outer surface of the reactor tubes, thereby enhancing the effective photon flux available for reactions. Graphics: AEE INTEC

Subtask C System Integration

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(1) Developing and collecting Preliminary piping and instrumentation design, incl. Issues and safety requirements from pilot plants
(2) Standardized procedures for the testing of integrated systems at least at pilot scale
(3) Draft Life Cycle Assessment (LCA) based, for the moment, on pilot plant results.
(4) Evaluation of solar to photofuel conversion standardization

Figure 3: Solar photocatalytic pilot plant for hydrogen production Graphics: CIEMAT P.S.A

Duration

November 2024 – October 2028

Participating Countries

Australia
Austria
Canada
Germany
Italy
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