SunCOChem:

PHOTOELECTROCATALYTIC DEVICE FOR SUN-DRIVEN CO_2 CONVERSION INTO GREEN CHEMICALS

Shapping the future: renewable fuels and chemicals from solar energy

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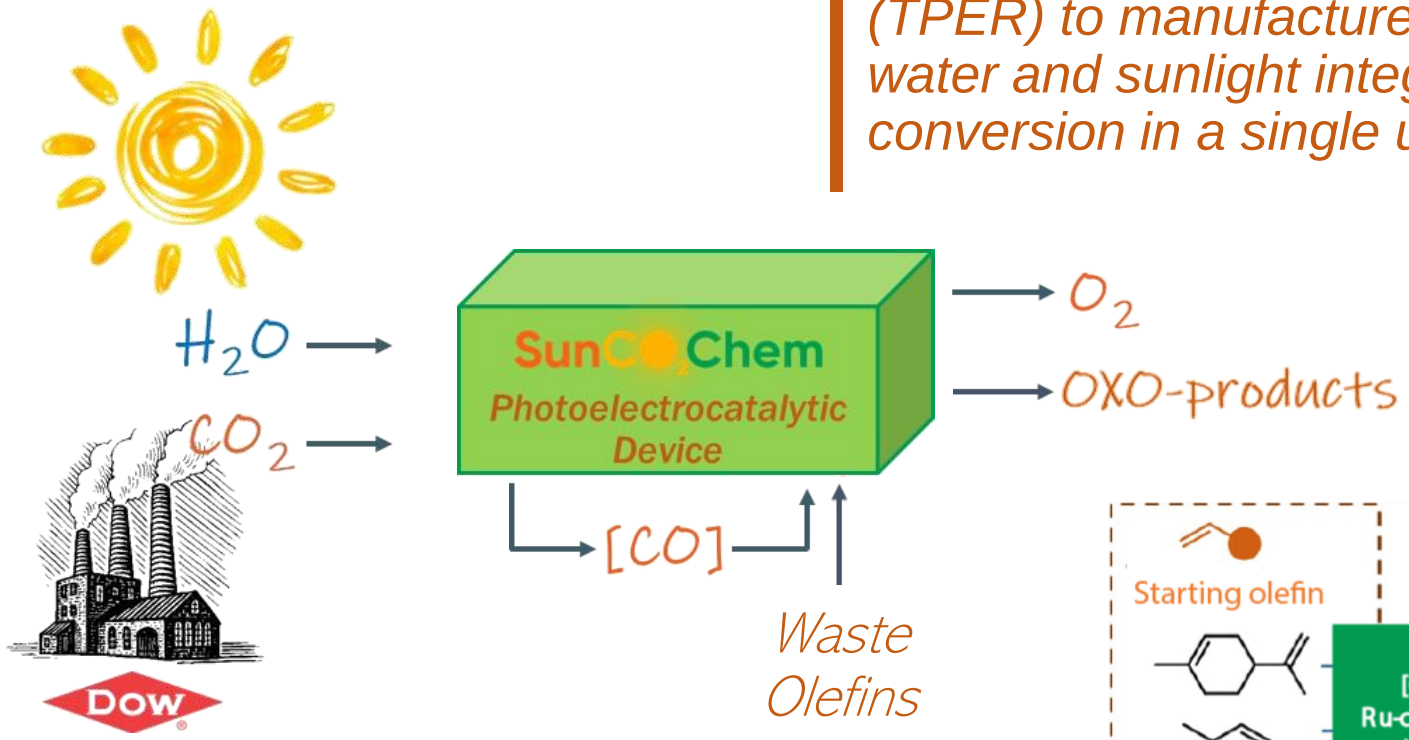
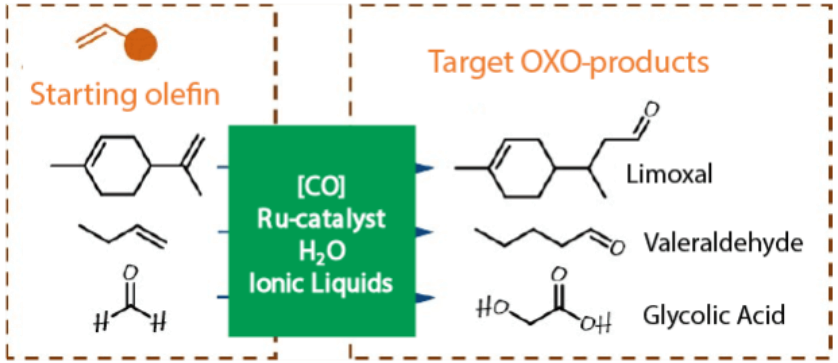
CONCEPT

SUN-driven production of high-value chemicals

Self-biased tandem photoelectrocatalytic reactor (TPER) to manufacture oxo-chemicals from CO_2, water and sunlight integrating CO_2 capture and conversion in a single unit.





- Technology class: Photo(electro)chemical CO_2 conversion
- Timeline: 2020 – 2024
- From TRL3 to TRL5

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 862192.

CIRCULAR ECONOMY GOAL

Production of three sustainable oxo-products from CO_2

SunCO2Chem

GLYCOLIC ACID
Hydroformylation of formaldehyde

Building block applied in dying and tanning, flavouring preservative and emulsion additive.

avantium

VALERALDHEYDE
Hydroformylation of Butene
(DOW waste by-product)

Building block applied as food flavouring, in resin and rubber products.

DOW®

LIMOXAL ™
Hydroformylation of limonene

Building block applied as a perfuming agent, in personal care and house cleaning products.

iff

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PROJECT PHASES

SunCO2Chem

7 WPs in 48 months (2020 – 2022)

TRL3 → Development of materials and components of the TPER cell → Upscaling, testing and validation of the TPER device → Integration and optimisation of materials and components → Socio-economic and environmental impact assessment → ***TRL5***

WP1
PEC Cell Materials Development

HZB Helmholtz Zentrum Berlin · laurentia technologies · eurecat

WP3
TPER Components Integration

Politecnico di Torino · SOLARONIX

WP4
Design, assembling and testing of final TPER prototype

HYSYTECH

WP5
Impact Assessment

eurecat · avantium

WP2
CO_2 Capture and Concentration Materials Development

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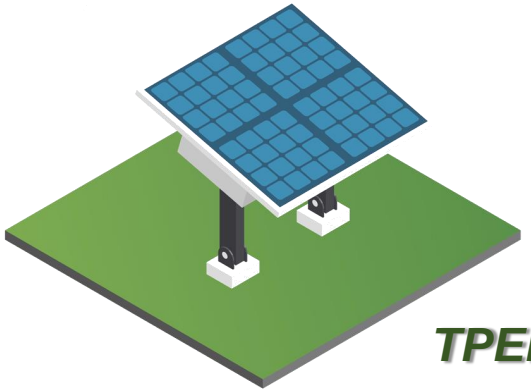

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TPER (1m²) validation

WP6
Exploitation and Dissemination

International Hellenic University · UNE Normalización Española

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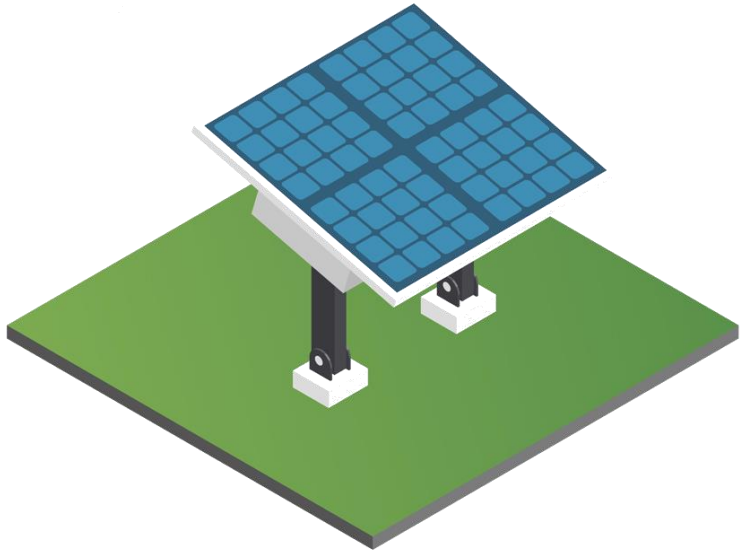
Novelty/Unique Selling point

TPER device

Compact and easily scalable design to be used as artificial leaf



HYSYTECH

ANODIC CHAMBER

Smart photoelectrodes

- Water oxidation to O_2

CATHODIC CHAMBER

Photo- and *non*-photoassisted coupled reactions

- Selective PEC CO_2 reduction to CO
- CO-hydroformylation of OXO-products

High CO_2 conversion via *Ionic Liquids* electrolytes

Stable & efficient MEA *via* a *transparent bipolar membrane*

Integrated FLUE GAS Cleaning & CO_2 CAPTURE CHAMBER

CO_2 capture from flue gas stream with

- Asymmetric polysulfone membrane
- CO_2 concentration in *Ionic Liquids*

Low-cost **PEROVSKITE SOLAR CELLS** to boost internal photo-voltage

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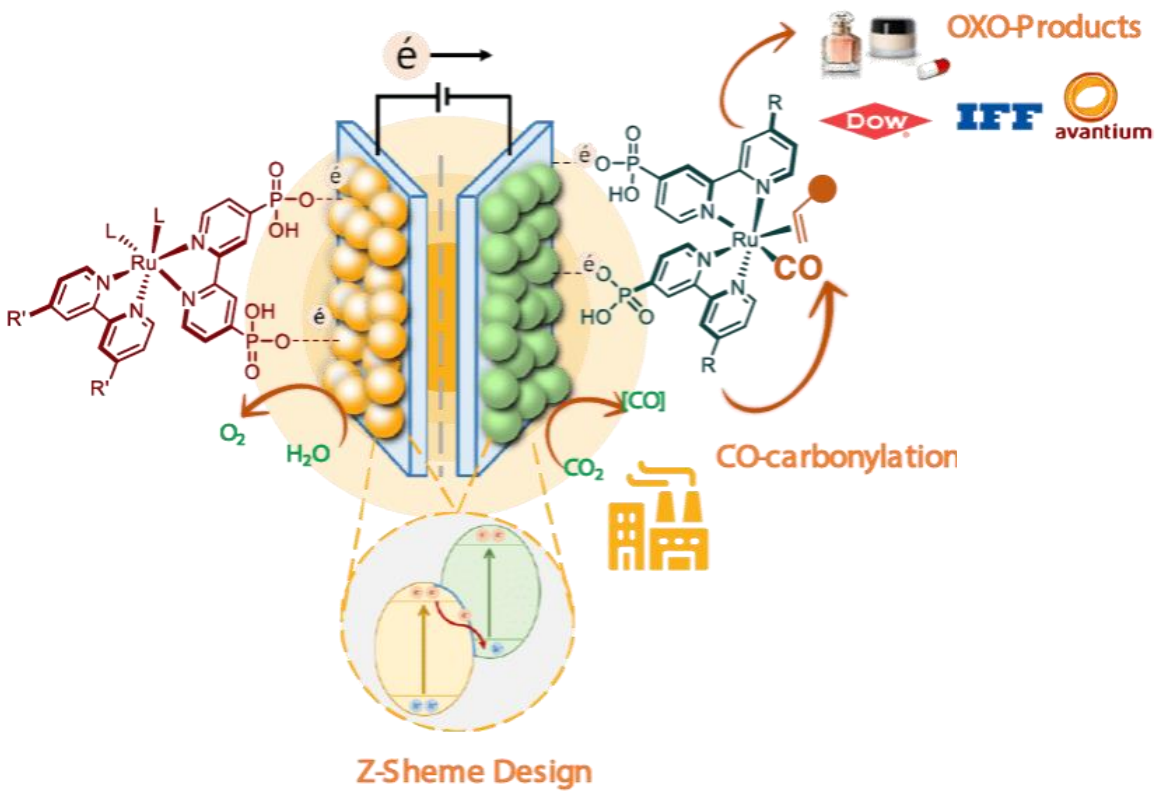
Novelty/Unique Selling point

TPER components



Multi-heterojunction photoelectrodes for Z-scheme mimicking:

- Metal oxide nanoparticles
- Molecular organometallic chromophores
- Molecular catalysts for water oxidation, CO_2 reduction and hydroformylation

Transparent Bipolar Membranes

Bipolar Membrane-Electrode Assembly to maximize catalyst performance:

- Constant pH and ionic gradients at both compartments
- Use of different electrolytes

Ionic Liquid's for CO_2 capture and conversion

- Good CO_2 absorption
- Low viscosity
- High CO_2 and organic reagents solubility
- High electrochemical stability
- High CO_2 conversion ability

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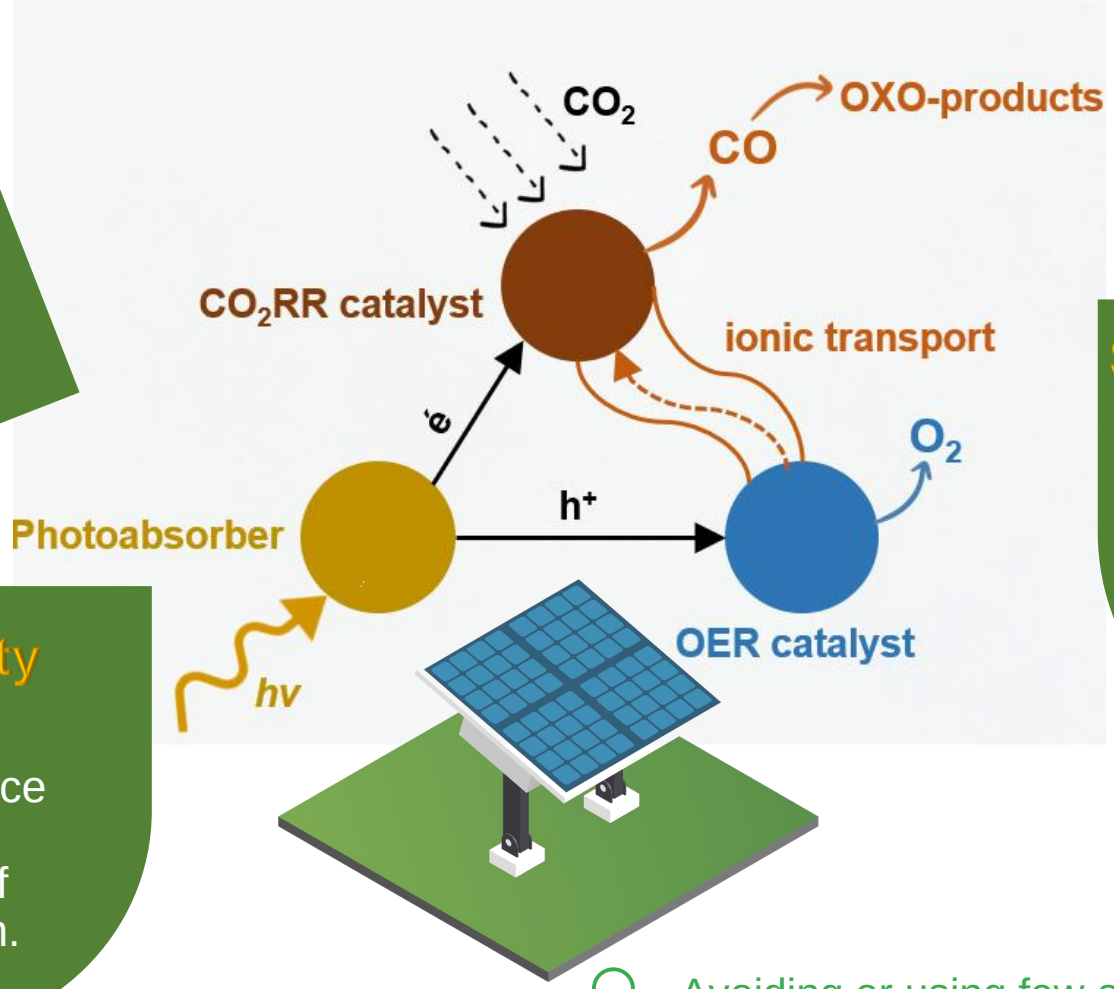
TECHNICAL CHALLENGES

Targets & Sustainability criteria

Efficiency

> 10% of Sunlight to CO conversion efficiency with a current density of 20 mA·cm^2



Sustainability

< 50% CO_2 emissions versus actual routes from fossil fuels

Stability

< 5% of performance loss in 1000h of operation.

- Avoiding or using few amounts of critical raw materials
- Valorizing industrial wastewater and CO_2 streams

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Exploitation Outcomes

SunCO$_2$Chem

7 Key Exploitable Results out of 14 SUNCOCHEM results (M22/M48)

- ***New multifunctional*** *molecular based-****photo/electrocatalyst*** *and* ***photoelectrodes*** *for solar-driven organic processes*
- ***New transparent and porous conductive substrates***
- ***New ionic liquids*** *for CO_2 reduction, their synthesis and purification*
- *Cost-effective* ***Sun-driven Tandem Reactor*** *for CO_2 conversion into chemicals*
- *New* ***cost-competitive process*** *to produce high value products & valorise CO_2 exhaust streams*
- *Innovative electrochemical technologies for CO_2 reduction and* ***production of >C_2 chemicals***
- *Identification of new processes for* ***electrochemical conversion of CO_2 to CO***

✓ **End-users**:
Scientific community, chemical, goods and CO_2 producing industries, among others

✓ **Time-to-market:**
4-15 years depending on the result

✓ **Exploitation routes**:
IP licensing, direct industrial use, further research and TRL increase

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TEAM

14 partners from 8 European countries

SunCO2Chem

SUN ERGY

European Innovation Council

Shapping the future: renewable fuels and chemicals from solar energy

ROAD 2 GREENCHEM

Projects involved

DECADE www.decadeproject.eu

FLOW PHOTO CHEM www.flowphotochem.eu

SunCO2Chem www.suncochem.eu

ReCO2DE www.recodeh2020.eu

SOLAR CHEM www.solar2chem.eu

ocean www.spire2030.eu/ocean

See: https://www.youtube.com/watch?v=6o20jLzIoFA

eurecat HZB Helmholtz Zentrum Berlin HYSYTECH io·li·tec Ionic Liquids Technologies UNE avantium DOW

Politecnico di Torino cnrs iit ISTITUTO ITALIANO DI TECNOLOGIA SOLARONIX INTERNATIONAL HELLENIC UNIVERSITY laurentia technologies iff

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