SunCO2Chem

PhotoElectroCatalytic Device for Sun-Driven CO_2 conversion into Green Chemicals

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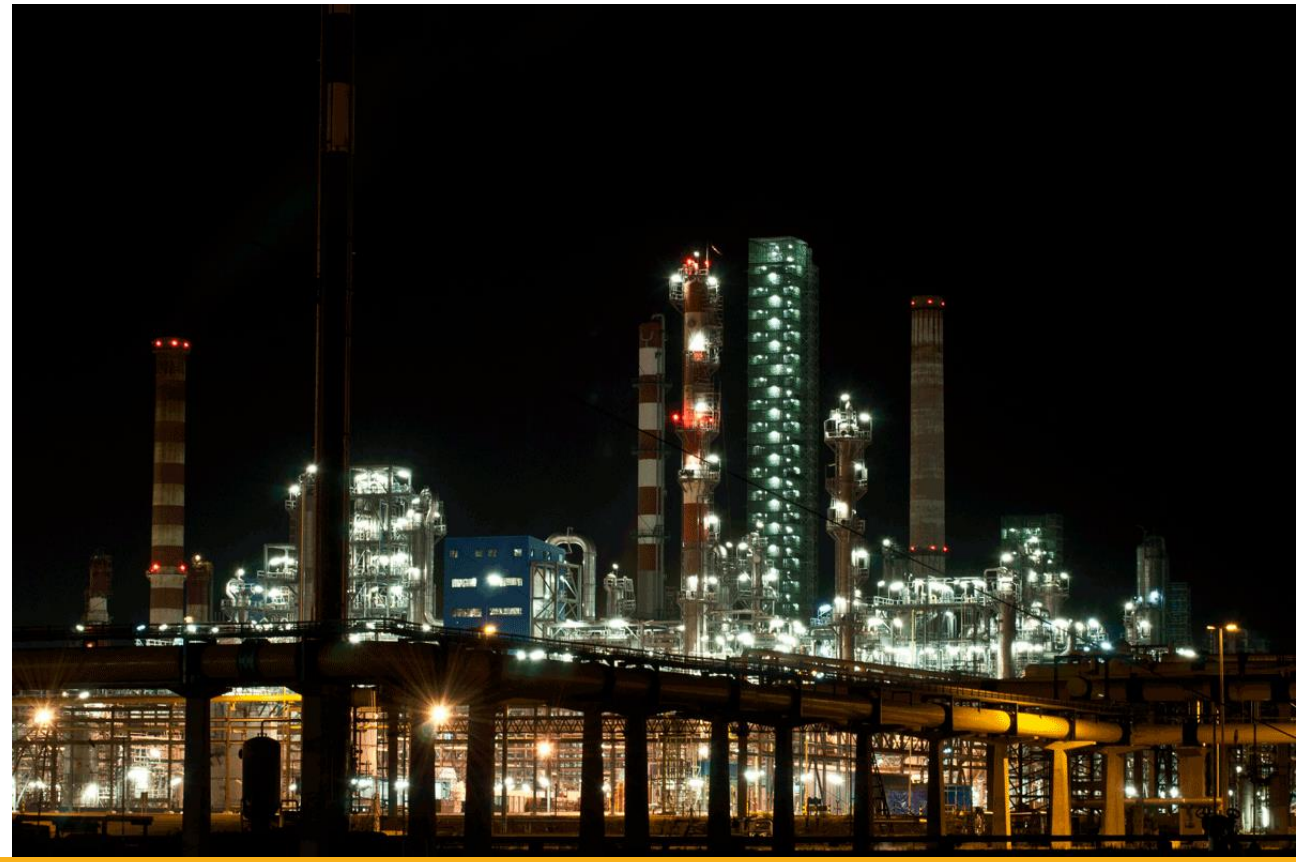
SunCoChem general overview

Development of a photoelectrocatalytic device for solar-driven CO_2 conversion into green chemicals

- European project funded under the topic: *CE-NMBP-25-2019 – Photocatalytic synthesis (RIA)*
- **4 years** duration, from 1/05/2020 to 30/04/2024
- **Budget**: 6,7 M€, of which 6,6M€ funded by the EC
- **14 partners** from **8** different **European countries**
- Coordinated by **Eurecat,** RTO
- **Grant agreement ID**: 862192



SunCO2Chem Consortium

14 partners from 8 European countries

6	3	1	3	1
Research institutions	R&D SMEs	Standardisation body	Chemical industries	EU International Cooperation partner

eurecat
avantium
DOW
HZB Helmholtz Zentrum Berlin
HYSYTECH
iff
iit ISTITUTO ITALIANO DI TECNOLOGIA
POLITECNICO DI TORINO
INTERNATIONAL HELLENIC UNIVERSITY
UNE NormalizaciónEspañola
SOLARONIX
cnrs advancing the frontiers
io·li·tec Ionic Liquids Technologies
laurentia technologies

SunCO$_2$Chem The European Chemical Industry

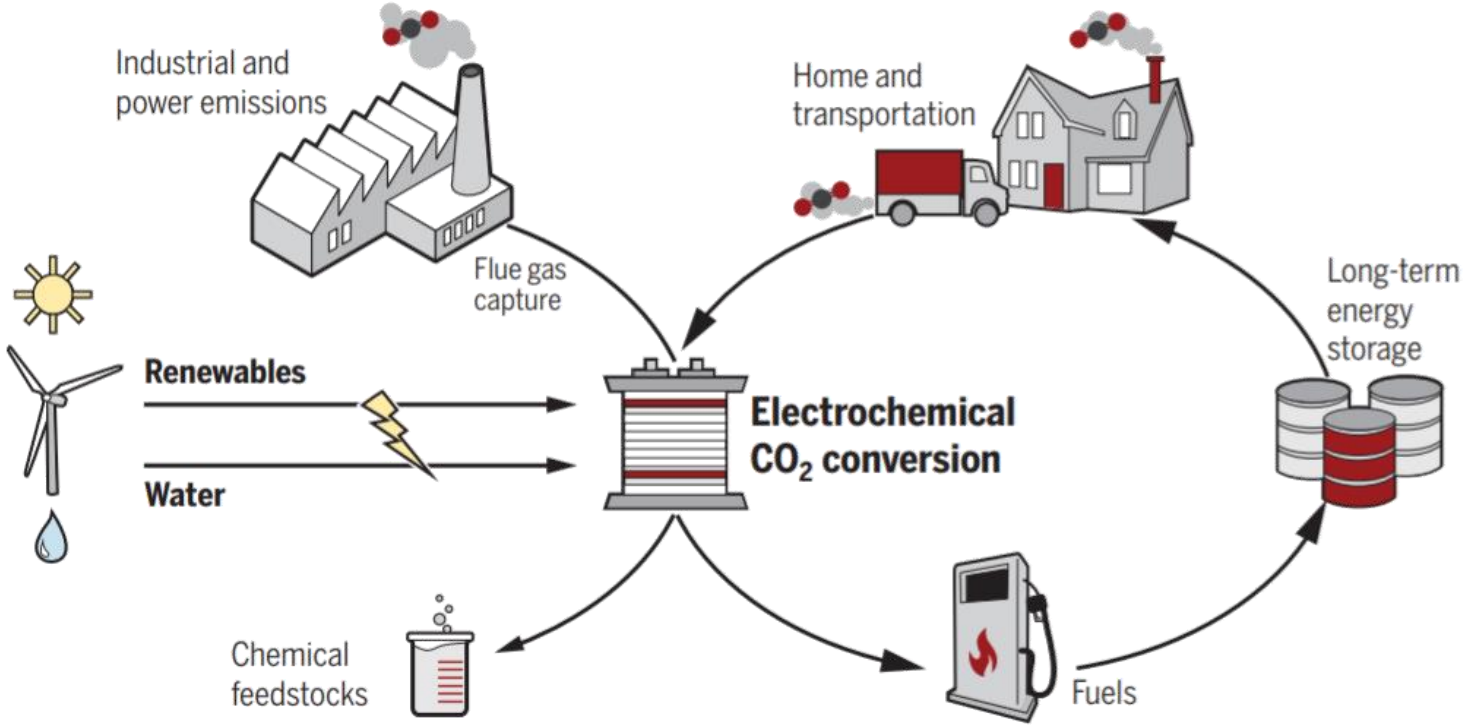
Transition towards low-emission energy technologies

30
gigatons of CO_2 emitted yearly

95%
Chemicals based on fossil fuels

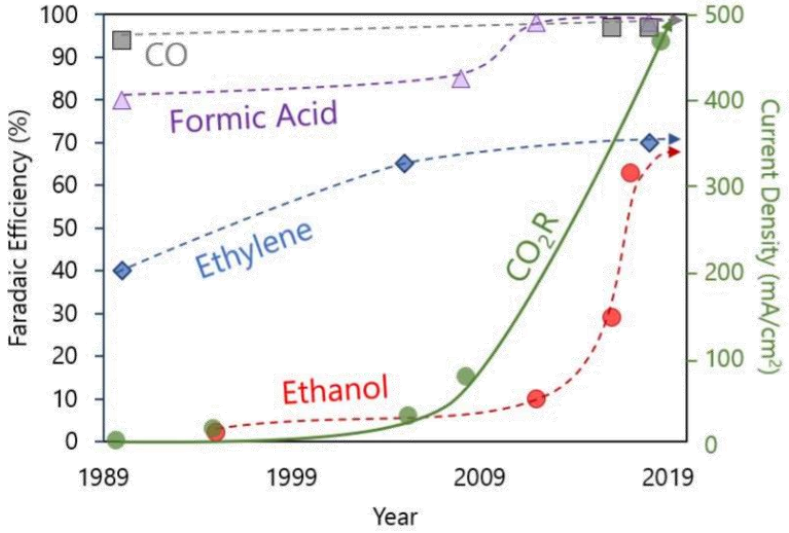
The Chemical Industry is the third larger greenhouse gas emitter in Europe, with over 30 $GtCO_2$ yearly.

Renewable electrochemical conversion of CO_2



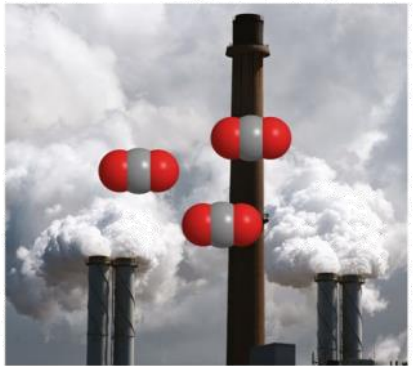
Images from: De Luna et al., *Science*, **2019**, 364, eaav3506

Sequential pathways to higher chemicals *via* CO electrosynthesis



Higher CO selectivity and conversion efficiencies in comparison with other products

CO as C1-building block for introducing carbonyl functionalities



Carbon dioxide waste

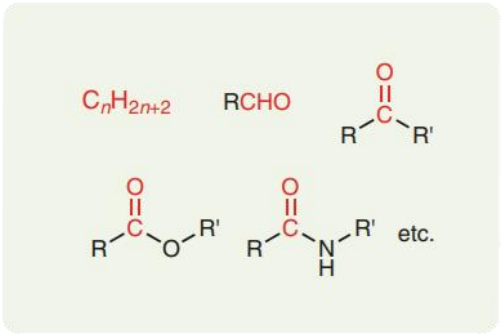
electrochemical reduction

Carbon monoxide

Synthesis

Fischer–Tropsch process
Hydroformylation
Carbonylation
etcetera.

Challenging



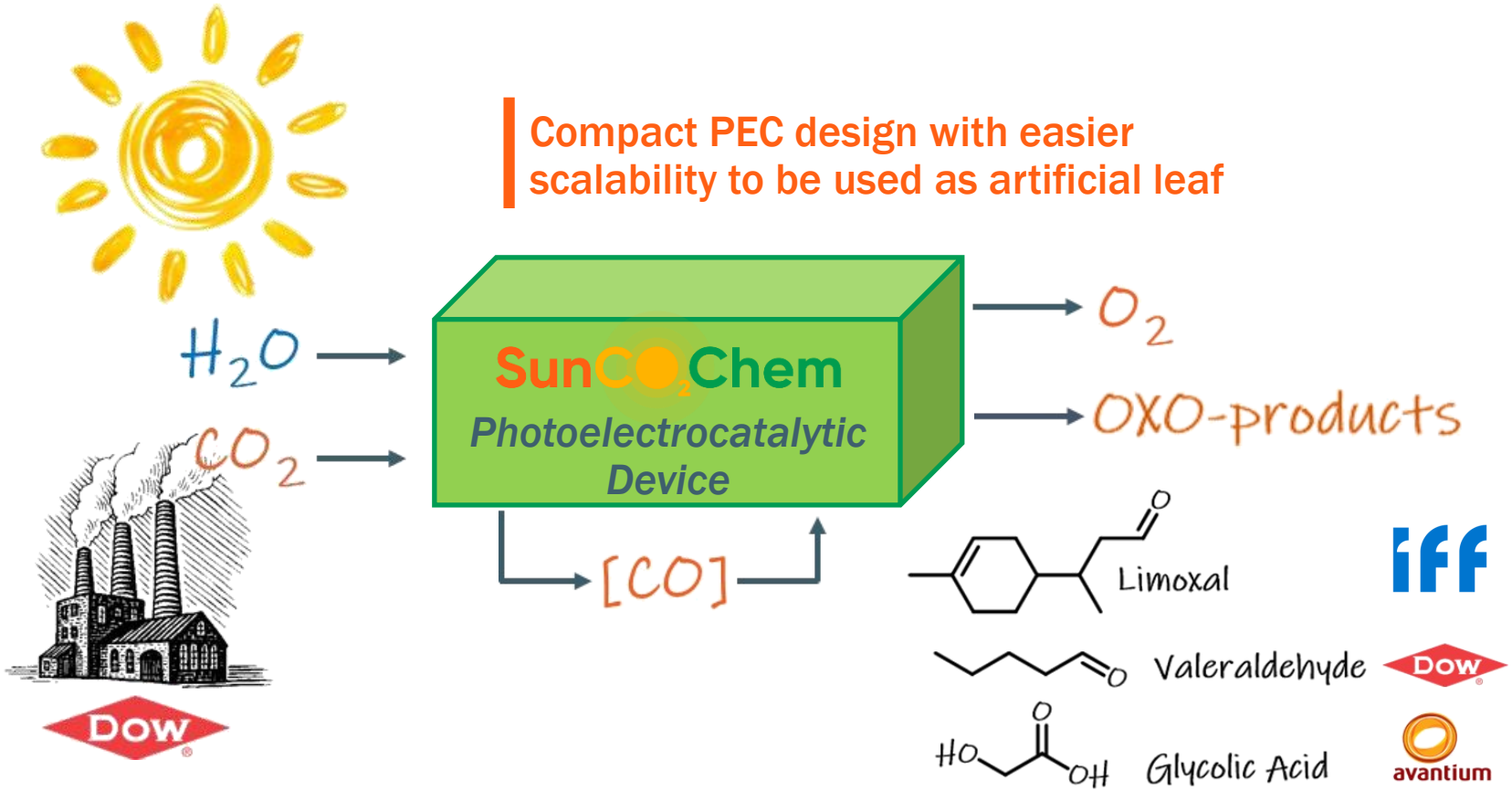
Value-added chemicals

Troels Skrydstrup, *Nature Catalysis*, **2018**, 1, 244-254

SunCO2Chem Concept

SUN-driven production of energy and high-value chemicals

- The project develops a photoelectrocatalytic tandem reactor (TPER) to manufacture **valuable chemical oxo-products from renewable energies** based on **CO_2, H_2O and solar energy.**



SunCO2Chem Objective

Three sustainable oxo-products produced from CO_2

- Oxo-products **produced from the use of CO_2** as a renewable carbon source, in comparison to actual routes based on fossil fuels.

GLYCOLIC ACID
Hydroformylation of formaldehyde

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

avantium

VALERALDHEYDE
Hydroformylation of Butene (DOW waste by-product)

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

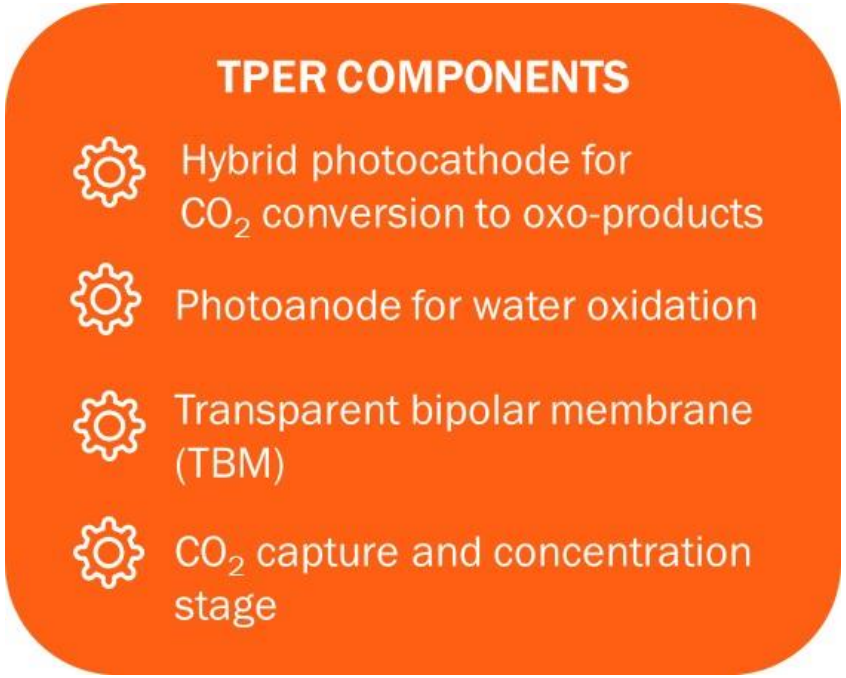
DOW®

LIMOXAL ™
Hydroformylation of limonene

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

iff

SunCO$_2$Chem TPEC Device



Three-chamber configuration:

ANODIC CHAMBER

- 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

Ionic Liquids electrolytes

MEA *via* a transparent bipolar membrane

Low-cost PV solar cells to boost internal photo-voltage

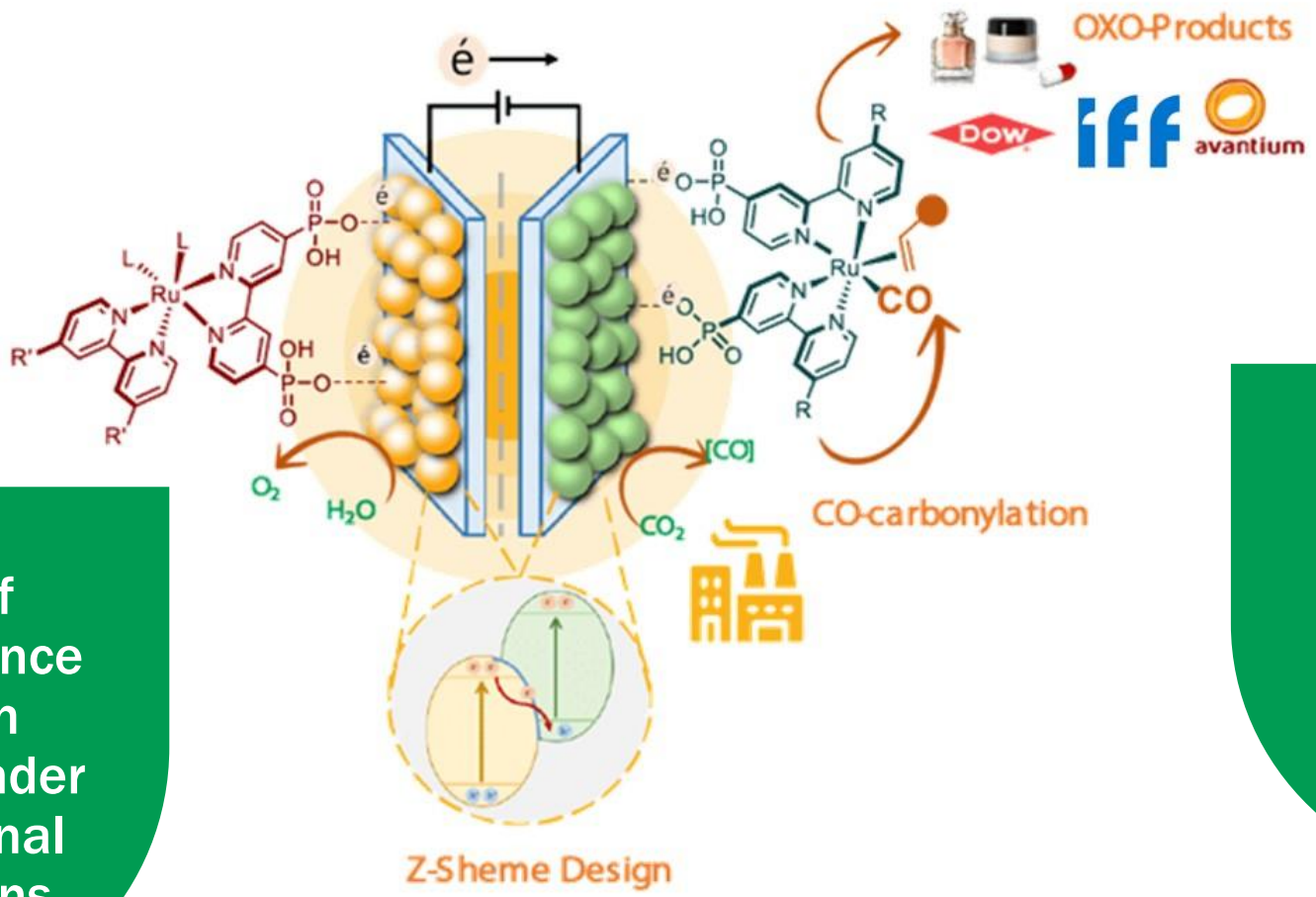
FLUE GAS & CO_2 CAPTURE CHAMBER

- CO_2 capture from flue gas stream with an asymmetric polysulfone membrane
- CO_2 concentration in Ionic Liquids

Technical Requirements

Overall sunlight to chemical conversion CO efficiency > 10%

Loss of performance < 5% in 1000h under operational conditions



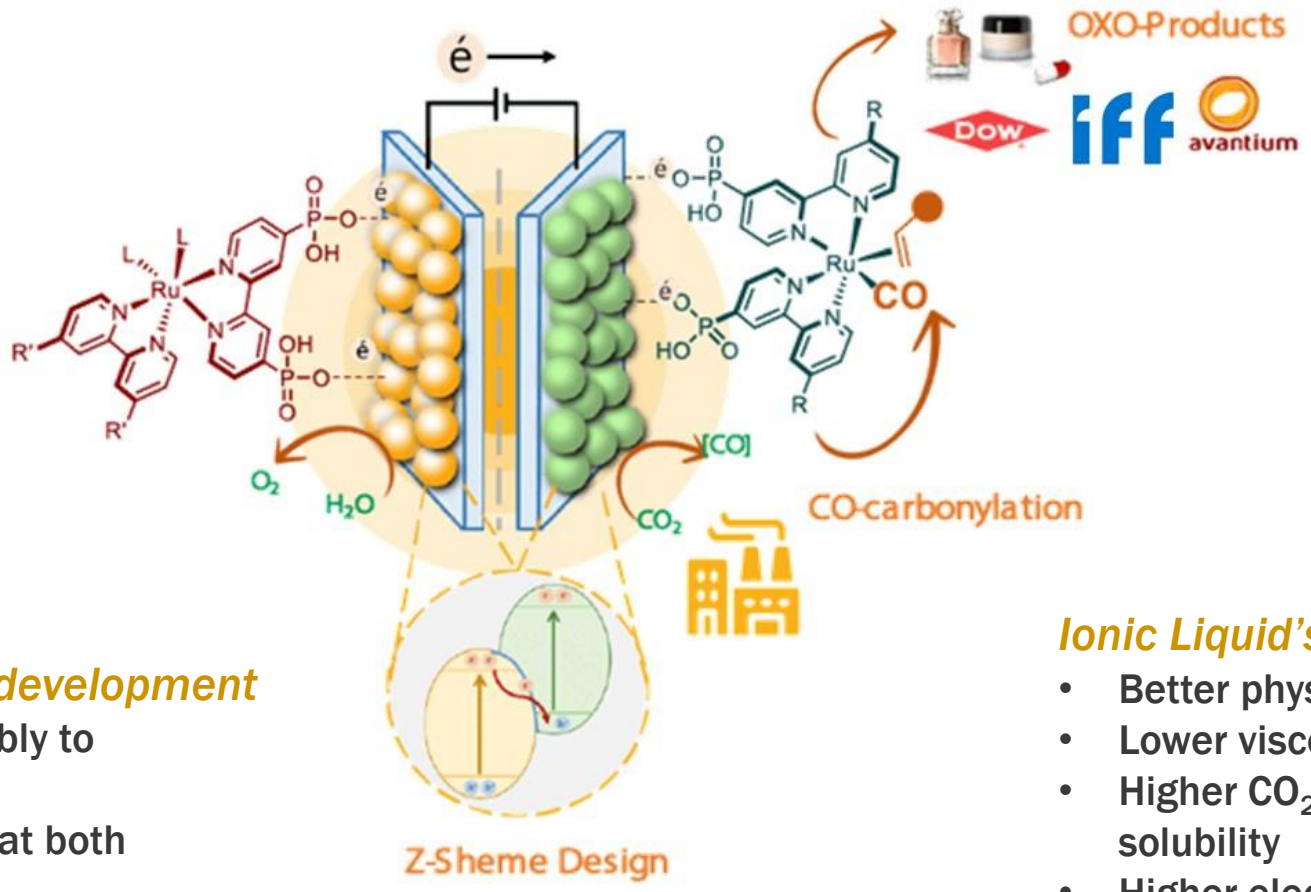
< 50% CO_2 emissions comparable to actual route from fossil fuels

Technical Challenges

Photo-electrodes development

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 membrane development

Bipolar Membrane-electrode assembly to maximize catalyst performance:

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

Ionic Liquid's development

- Better physical sorption
- Lower viscosity
- Higher CO_2 and organic reagent solubility
- Higher electrochemical stability window

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Thank you!

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A project coordinated by:

eurecat

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