INSTITUTO DE TECNOLOGÍA QUÍMICA

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CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS

Direct electrocatalytic conversion of CO_2 into chemical energy carriers in a co-ionic membrane reactor

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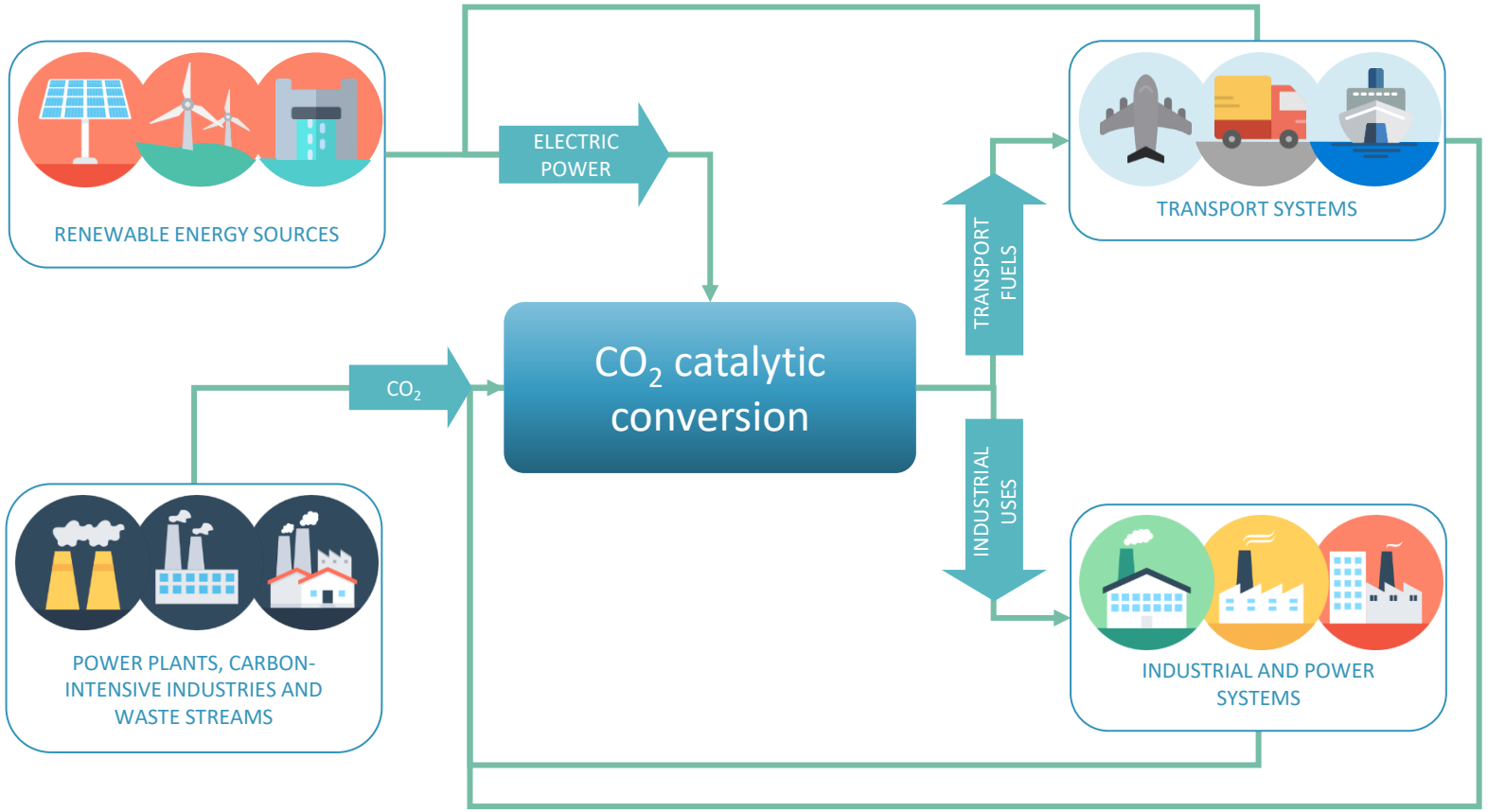
SPIRE
Sustainable Process Industry through Resource and Energy Efficiency

This project has received European Union's Horizon 2020 research and innovation funding under grant agreement Nº 838077.

Context

CO_2 catalytic conversion

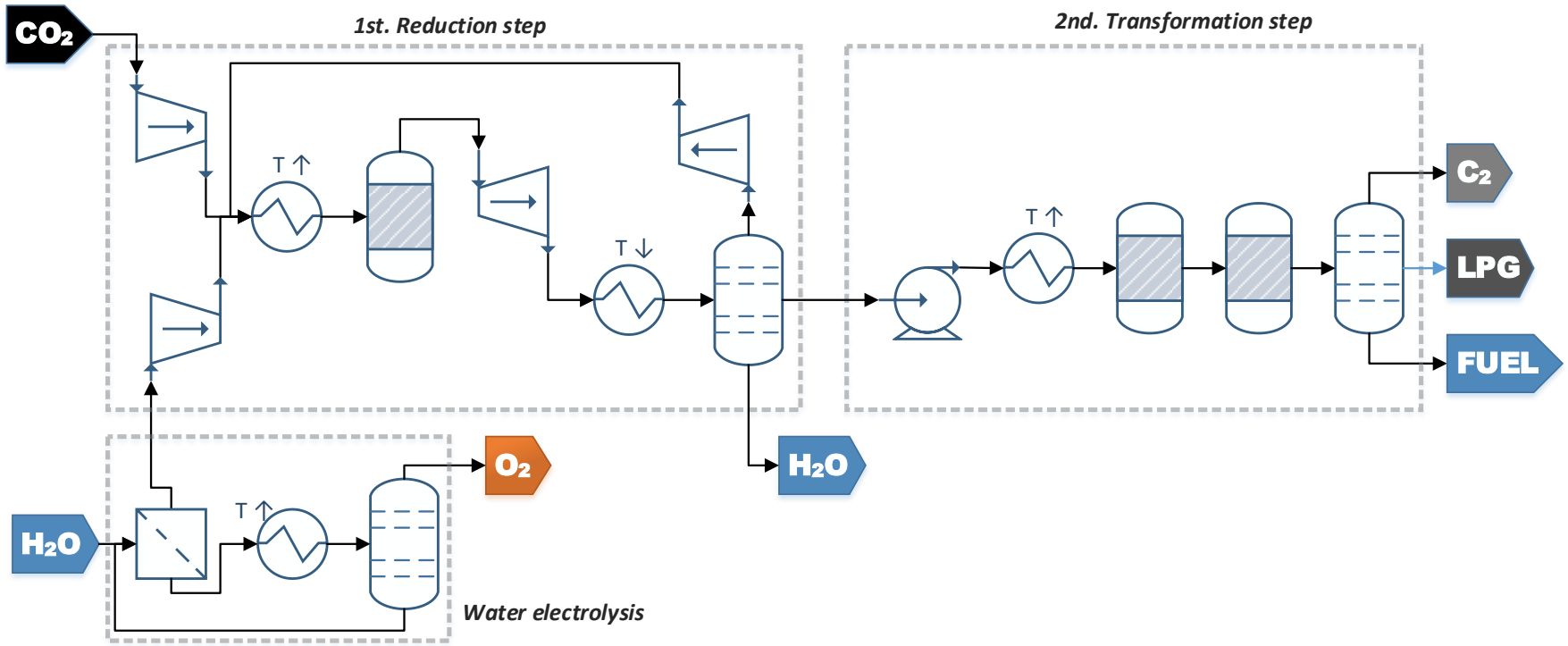
combined solution for energy storage and carbon footprint reduction



Sustainable Process Industry through Resource and Energy Efficiency

Context

Current CO_2-to-fuel technologies



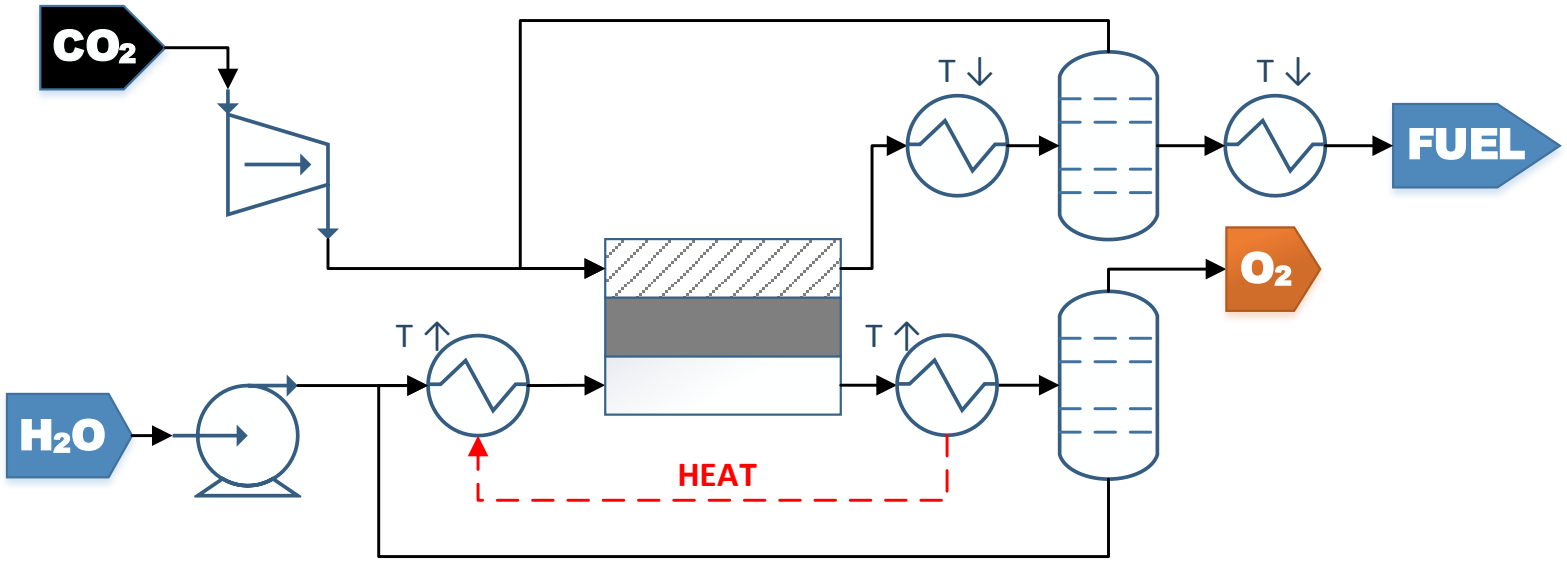
Multi-step approach
involves a sequence of separated processes

High costs
up to 300 €/ MWh CAPEX and 750 €/MWh OPEX

Highly energy intensive
with overall energy efficiency values around 60%

eCOCO$_2$ Approach

(Intensified) Single-step electrolysis and one-pot catalytic conversion



Product:
Jet fuel

Efficiency:
> 85%

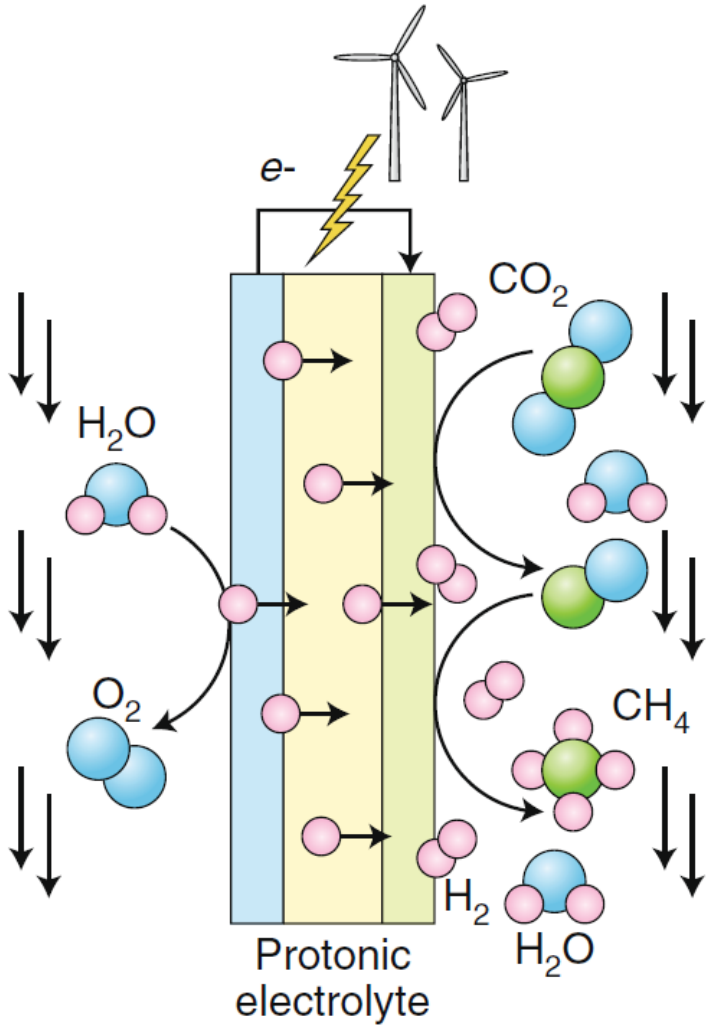
Full integration:
compact sized reactor

Final TRL:
5

Set-up a technology for conversion of CO_2, using renewable electricity and water steam, to carbon-neutral jet fuel, at high energy efficiency, very high CO_2 conversion rate and moderate-to-low cost.

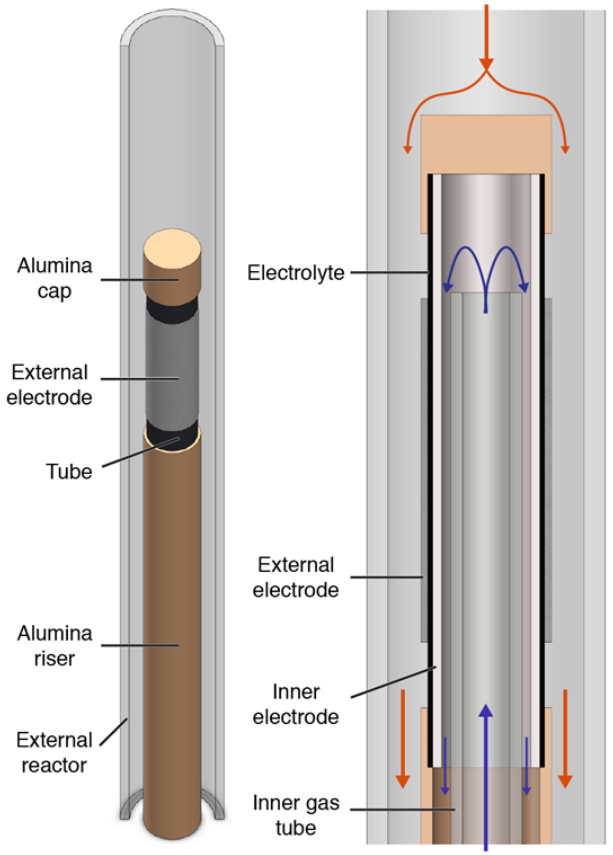
eCOCO$_2$ Approach

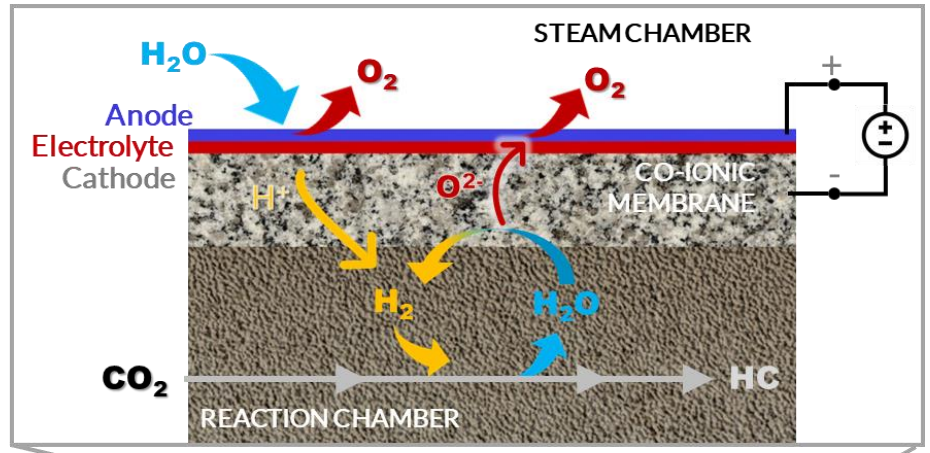
Single-step electrolysis and one-pot catalytic conversion

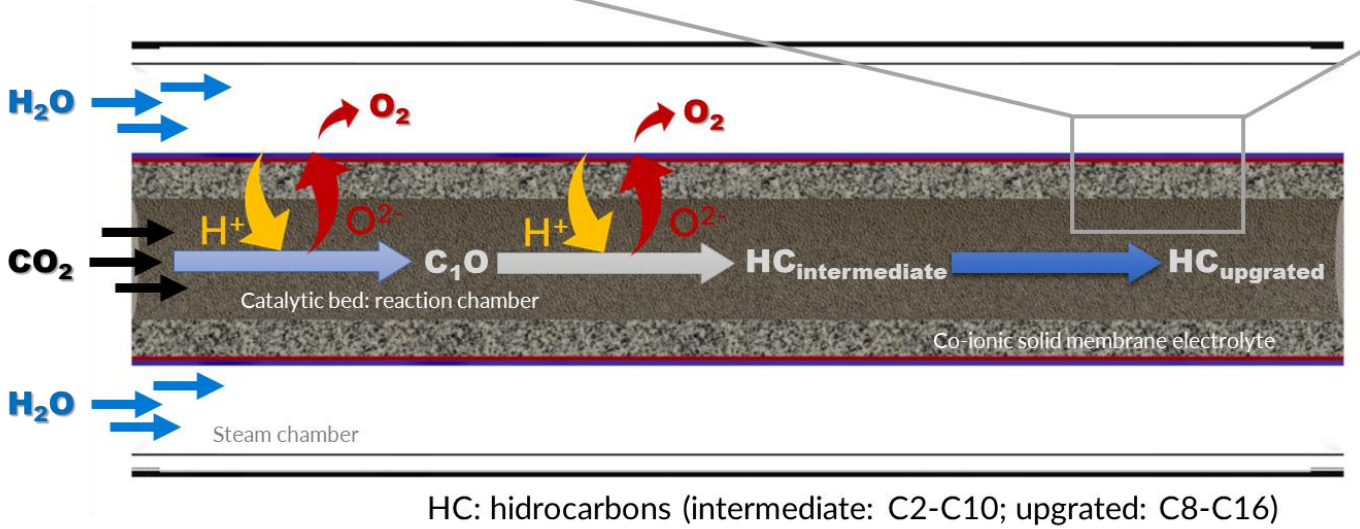


"Electrifying chemistry with protonic cells", **Nature Energy** 4 (3) (**2019**) 178-179

eCOCO$_2$ Approach



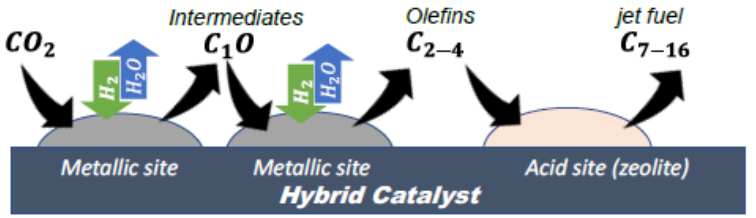




HC: hidrocarbons (intermediate: C2-C10; upgrated: C8-C16)

E. Vøllestad, et al. "Mixed Proton and Electron Conducting Double Perovskite Anodes for Stable and Efficient Tubular Proton Ceramic Electrolysers", **Nature Materials 2019**

- **Heat integration**
- **Equilibrium Shift – Water control**
- **Catalysis**



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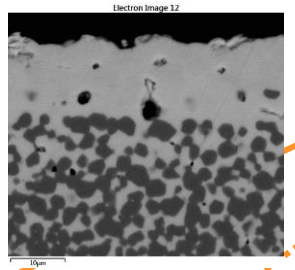
Objectives

1 Co-ionic electrolyte
Adequate H^+/O^{2-} conductivity

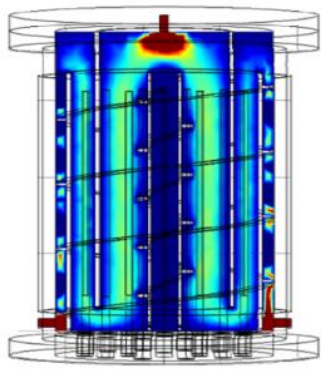
2 Electrodes
Active, selective and stable

3 Hybrid catalyst
In-situ reduction of CO_2 to jet fuel hydrocarbon fractions

4 Electrochemical cells
Manufacturing demonstration



Tubular reactors
Composed by electrochemical cells and structured catalyst



5 Multi-tube reactor
Stable and effective operation demonstration

6 Integrated process
Techno-economical and environmental validation

7 Societal perception
Assessment, model and prediction

Partners

The consortium is formed by well balance of reference research and academic institutions:

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UNIVERSITAS OSLOENSIS MDCCCXI

UNIVERSITAT POLITÈCNICA DE VALÈNCIA

RWTH AACHEN UNIVERSITY

九州大学
KYUSHU UNIVERSITY

UNIVERSITAS AMOIENSIS

SINTEF

and leader companies:

CoorsTek
MEMBRANE SCIENCES

HERA

CEMEX

ArcelorMittal

Shell

SPIRE
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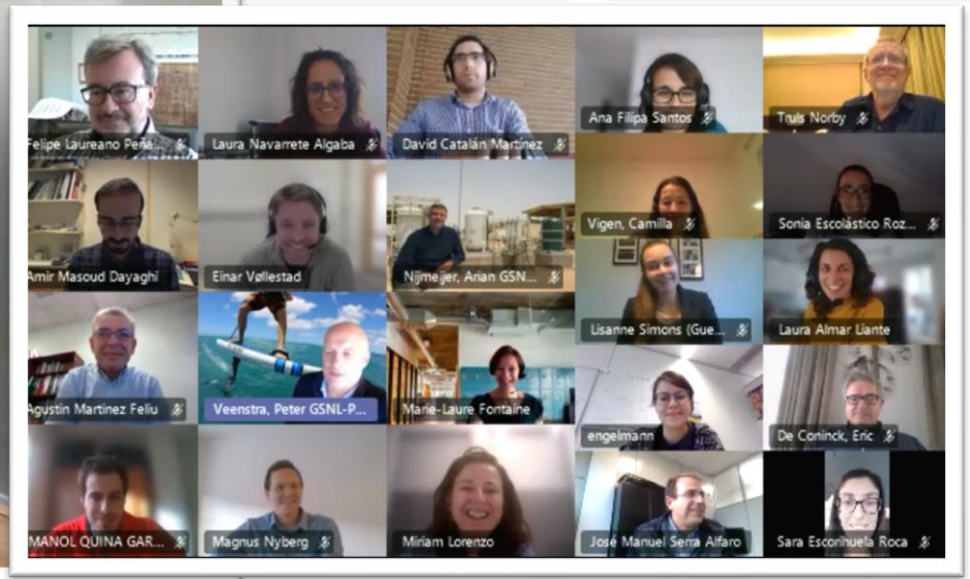
Team



5 Women
WP Leaders

Challenges and Opportunities for CO_2 utilization

- **Economic sustainability of the process**
  - Associated costs, including capital costs and operating costs (mainly energy consumption), and the expected savings and revenues.
- **Dependence on capture technologies**
- **Public perception and acceptance of the technology**
- **Regulatory barriers. Future of C-based fuels?**
- **Will CO_2 be the raw materials of chemistry in future?**

  From industry o from Air? And when?
- **Need to align: C-addicted industry, Energy companies, Bulk chemistry**

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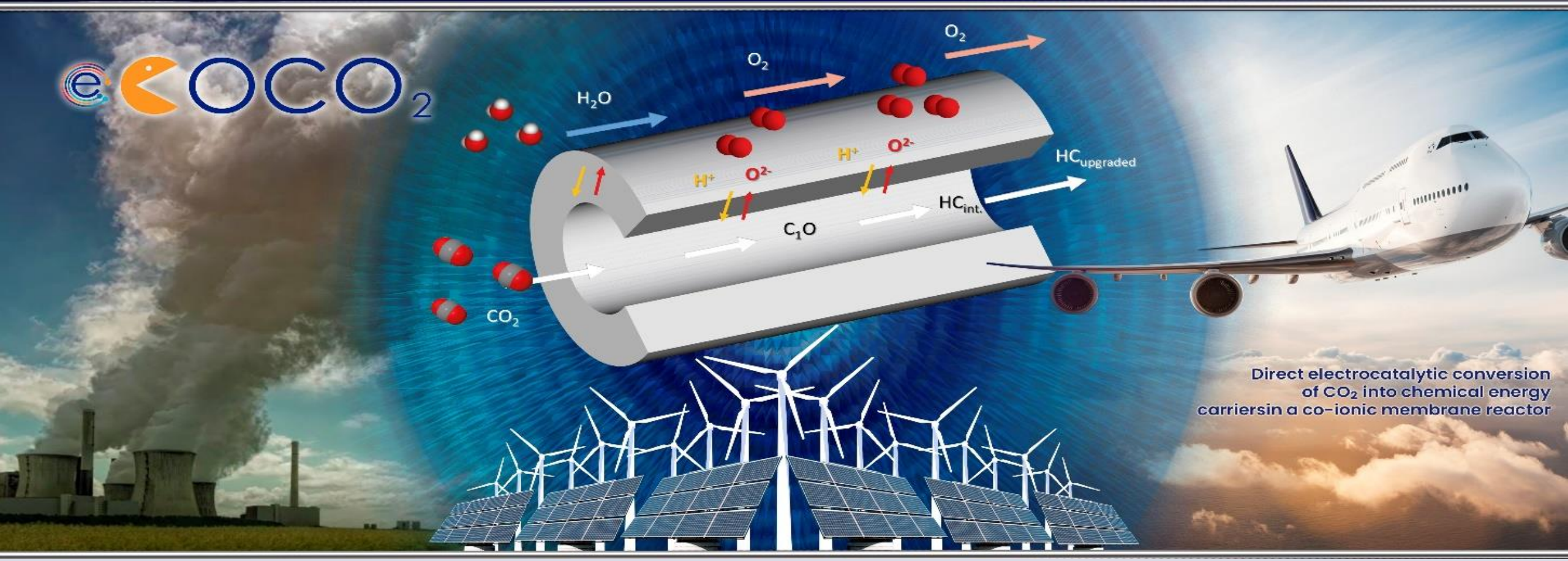

Thanks! Questions?

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