Advanced MEMBranes and membrane assisted processes for pre- and post- combustion CO_2 captuRe

Summary and Concept

Currently, more than 80% of global primary energy use is fossil based. Over the last decade, 85% of the increase in global use of energy was fossil based. In the transition to a fully low-carbon economy, the Carbon Capture and Storage (CCS) technology is one of the key ways to reconcile the rising demand for fossil fuels, with the need to reduce greenhouse gas emissions. Globally, CCS is likely to be a necessity in order to keep the average global temperature rise below 2 degrees.

The main challenge of including CCS in power generation or other industrial sectors is related to the energy consumed by the separation processes needed to achieve low carbon emissions (e.g. heat for solvent regeneration). This energy requirement is the major reason for the reduced overall net efficiencies. The lower efficiency turns into higher fuel consumption and higher fuel cost. Together with the increased CAPEX, due to additional equipment (separation processes or chemical reactors), It determines the substantial increase of the cost of electricity or of an industrial product when CO_2 capture is included.

In order to reduce this energy penalty, MEMBER targets three advanced solutions based on: Innovative MOF -MMMs for pre- and post- combustion CO_2 capture in power plants, and an intensified reforming process combining high temperature solid CO_2 sorbent and dense Pd membranes for pure H_2 production with integrated CO_2 capture (MA-SER).

MEMBER aims to demonstrate state-of-the-art capture technologies in an industrially relevant environment (TRL 6). To achieve this, MEMBER will scale-up and manufacture advanced materials and will prove their added value in terms of sustainability and performance in novel membrane based technologies that outperform current technologies for pre- and post-combustion CO_2 capture in power plants as well as H_2 generation with integrated CO_2 capture and meet the targets of the European SET plan.

In both cases, a significant decrease of the total cost of CO_2 capture will be achieved. MEMBER targets CO_2 capture technologies that separate >90% CO_2 at a cost below 40€/ton for post combustion and below 30€/ton for pre-combustion and H_2 production.

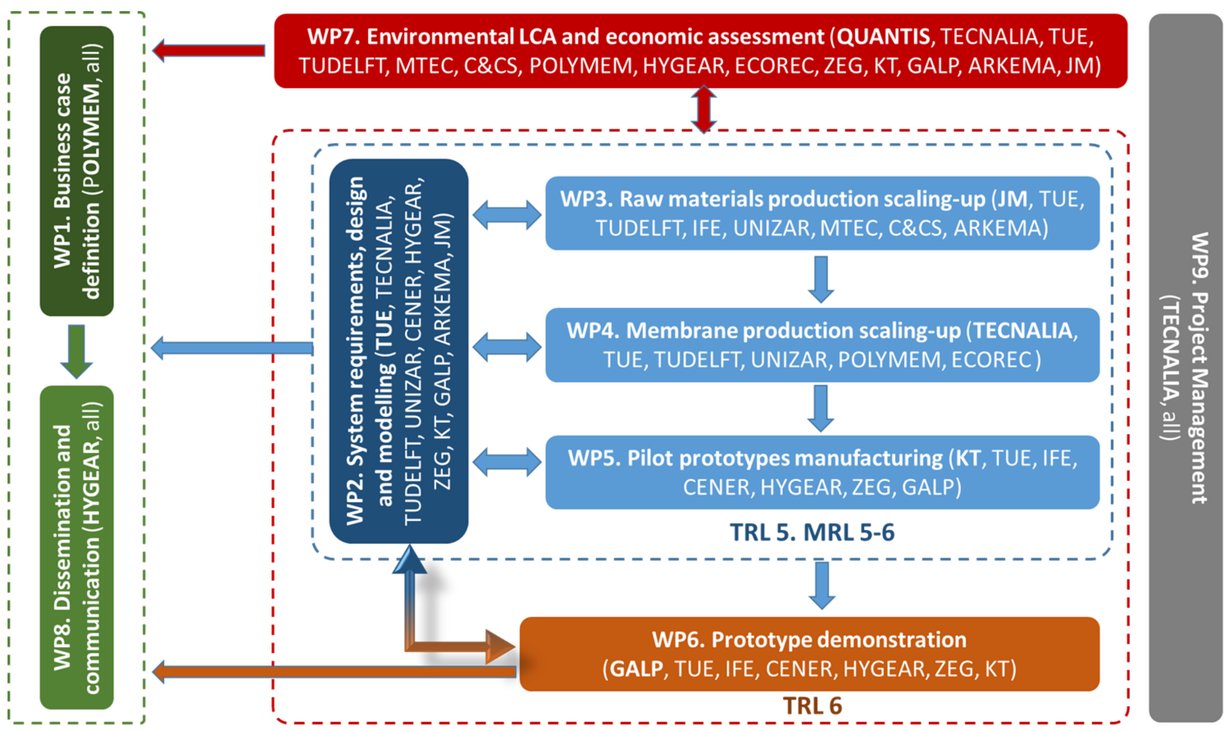
Performance targets for the MEMBER prototypes

	Technology	CO_2 Capture [%]	Capture cost [€/ton]	Demo site
Pre-combustion (Power plant)	MMM	> 90	< 30	CENER
Post-combustion (Power plant)	MMM	> 90	< 40	GALP
H_2 with integrated CO_2 capture	MA-SER	> 90	< 30	IFE-HYNOR

MEMBER has been built on the basis of the best materials and technologies developed in three former FP7 projects, ASCENT, M4CO2 and FluidCELL. In particular, special attention will be paid to the manufacturing processes scale up of key materials and products such as Metal Organic Frameworks (MOFs), polymers, membranes and sorbents.

Project Objectives

MEMBER project structure work plan



- Increase the manufacturing readiness level (from MRL 4-5 to MRL 6) of a portfolio of materials for the production of Mixed Matrix Membranes for pre- and post-combustion CO_2 capture in power plants (H_2/CO_2 and N_2/CO_2 separation).
- Increase the manufacturing readiness level (from MRL 4-5 to MRL 6) of hydrogen membranes, reforming catalysts and CO_2 sorbents materials, and integrating them into an advanced Membrane Assisted Sorption Enhanced Reforming (MA-SER) process for pure H_2 production with CO_2 capture.
- .Develop a software tool to simulate MEMBER components, the processes and CO_2 capture energy performance.
- Design and construct 3 prototypes for CO_2 capture for testing of the developed materials in relevant operating conditions at TRL6.
- Demonstrate the MEMBER systems and related business models in 3 representative demonstration sites across Europe, covering different sectors, membrane based technologies and CO_2 containing streams:
  - Prototype A targeted for pre-combustion in a gasification power plant using MMM at the facilities of CENER (BIO-CCS).
  - Prototype B targeted for post-combustion in power plants using MMM at the facilities of GALP.
  - Prototype C targeted for pure hydrogen production with integrated CO_2 capture using (MA-SER) at the facilities of IFE-HyNor.
- Quantify the environmental impacts of the proposed holistic solutions through life cycle assessment.
- The exploitation of the results including the definition of a targeted and quantified development roadmap to bring the technologies to the market.
- Overcome CCS market barriers with an ambitious set of CCS solutions.

Project details

Project details
Start Date: 1 January 2018
Duration: 4 years
Project Cost: 9,596,541 Euro
Project Funding: 7,918,901 Euro

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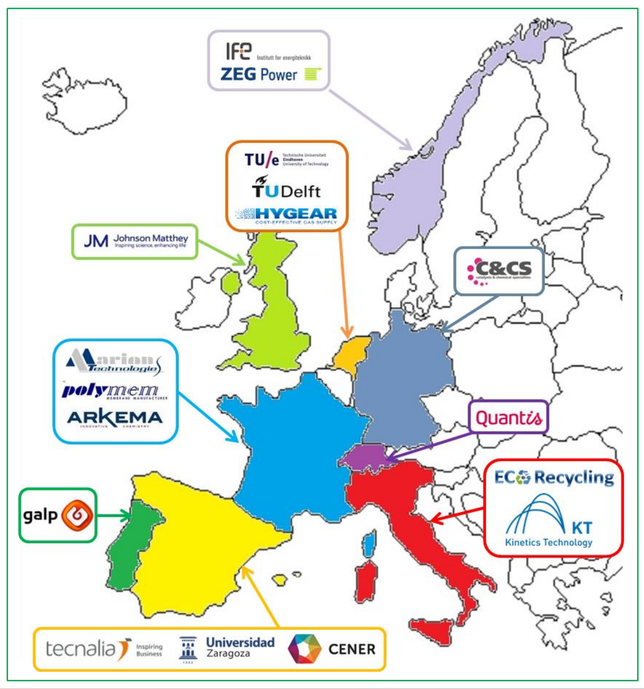
Consortium

The consortium brings together multidisciplinary expertise on the entire value chain: material development (MOFs, polymers, sorbents and catalyst), membrane development (MMMs, Pd based membranes); chemical and process engineering, modelling (from thermodynamics to unit operation modelling to system integration), membrane modules and reactors development, recycling, LCA and industrial study, innovation management and exploitation.

The consortium is composed of 17 partners from 9 countries: 6 RTO/HES and 11 SMEs/INDs (65%) it is an industrial oriented consortium, including 7 innovative SMEs (41%) and 4 Large industries (24%).

1 TECNALIA, Spain
2 TUE, Netherlands
3 TUDELFT, Netherlands
4 IFE, Norway
5 UNIZAR, Spain
6 CENER, Spain
7 MTEC, France
8 C&CS, Germany
9 POLYMEM, France
10 HYGEAR, Netherland
11 ECOREC, Italy
12 ZEG, Norway
13 QUANTIS, Switzerland
14 KT, Italy
15 GALP, Portugal
16 ARKEMA, France
17 JM, United Kingdom



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