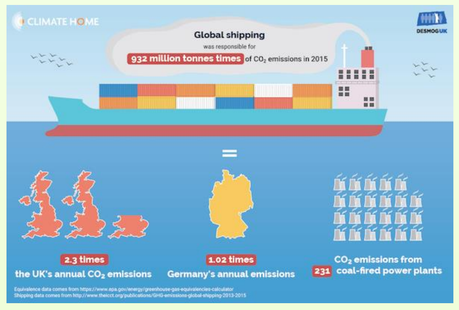
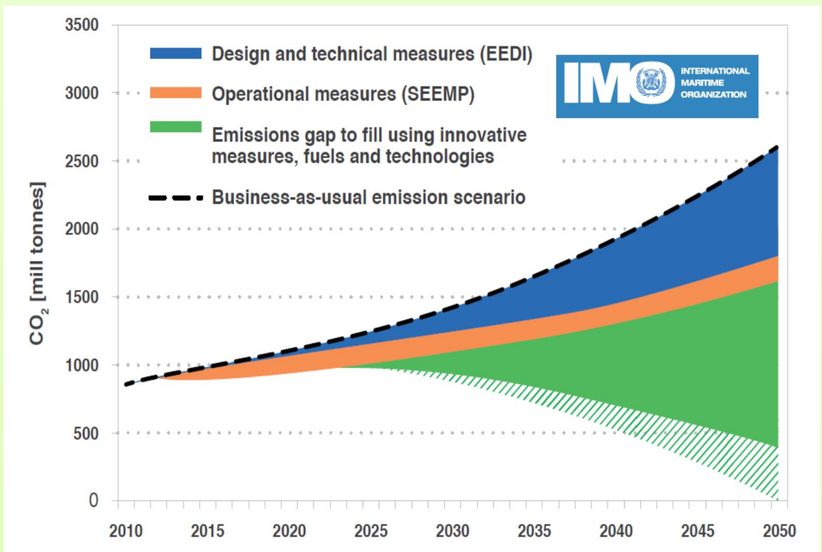
Decarbonizing the maritime industry

The global share of CO_2 emissions from the shipping industry is expected to reach **17%** by 2050 from approximately **2.5%** currently.



A 50% reduction of total annual GHG emissions requires approximately **85% CO_2 reduction per ship** by 2050.

For the shipping industry to deliver GHG mitigation in line with the Paris Agreement, virtually **full decarbonization needs to be achieved**



- **No alternative to large diesel engines at least for long-distance shipping**
- Switching 50% of the international marine bunker fuel mix to LNG reduces GHG emissions by only 10% (IEA, 2017)
- Non-carbon fuels (hydrogen, ammonia): Need for low-carbon hydrogen production, Global refueling infrastructure network, Safety issues (hydrogen), Poor combustion properties (ammonia)
- Potential for carbon capture on-board ships needs to take into account (energy) costs and space limitations.

Impact

CAPEX reductions may exceed 25% (on the basis of biogas upgrading to biomethane) compared to conventional amine-based solutions.

Specific surface area of membrane systems in excess of **1000 m^2/m^3** resulting to a **ten-fold decrease in absorber size** compared to conventional absorption packed columns.

Minimized environmental impact from seawater-based solvents

Assessment of carbon storage options (e.g. liquefaction, underwater storage, storage ashore)

Commercialization

Innovative ceramic/polymeric/hybrid will open a new segment in a rapidly expanding market (expected size **2.6 billion USD by 2022** with an annual growth of 7.2%).

Over 65% of the global membrane market share is currently located outside the EU. **Investment in innovation can increase the market share of EU companies.**

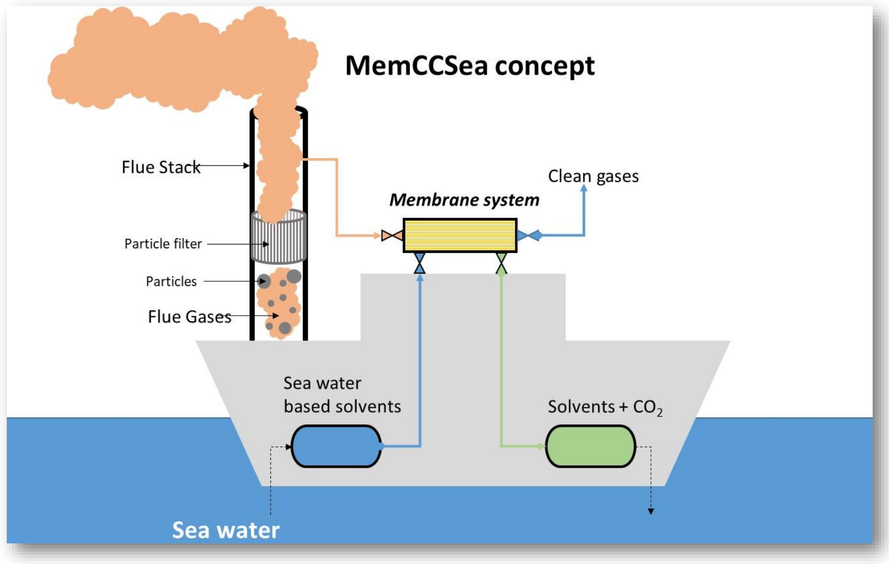
The MemCCSea membranes do not include any rare or unusual elements/components.

The MemCCSea solutions (membrane synthesis, membrane evaluation protocols, solvent regeneration, system design) will be **fully transferable to other CO_2 capture applications.**

MemCCSea

Innovative membrane systems for CO_2 capture and storage at sea

Hyper compact membrane systems for flexible operational and cost-effective **post-combustion CO_2 capture** in **maritime and off-shore applications.**



Key targets

Recovery of the **main engine CO_2 emissions greater than 90%**

Overall CO_2 emissions reduction (including added emissions by the capture plant and utilities) **greater than 50%**

A 10-fold reduction of system volume and a **reduction of operating costs greater than 25%** compared to a conventional amine-based scrubbing system.

Key innovation

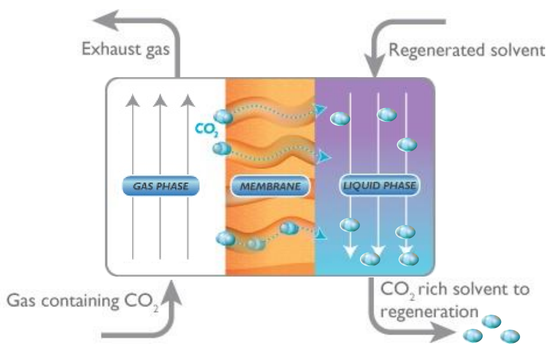
Advanced **customized ceramic and polymeric** high performance, high stability **membranes**

On-board **membrane-based solvent regeneration**

Process marinization addressing the unique challenges of maritime environment.

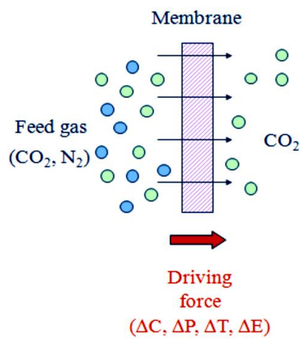
Innovation and S&T challenges

Gas-liquid Contactors



Cross section of a porous hollow fiber wall

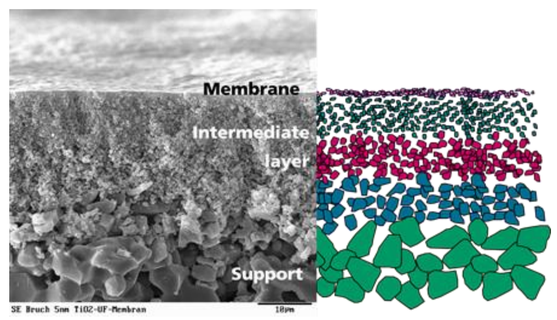
Membrane Permeators



Cross section of a dense membrane wall

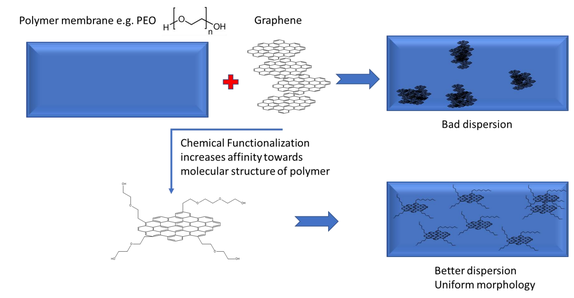
Re-design and optimization of membranes materials

Development of **customized ceramic membranes** with favourable performance characteristics (hydrophobicity, LEP, pore size)

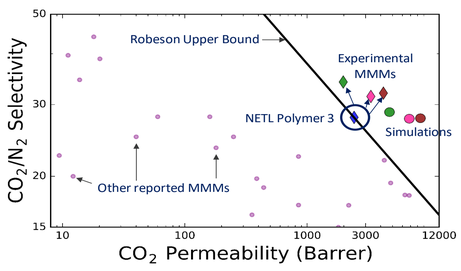


Development of **novel carbon nanostructured-based materials** as additives (e.g. Graphene/Graphene oxide coatings) to enhance polymeric membrane performance

Schematic representation of graphene/polymer blends



Development of **mixed matrix membranes (MMM)** with improved CO_2 separation performance (polymer/MOF filler particles)

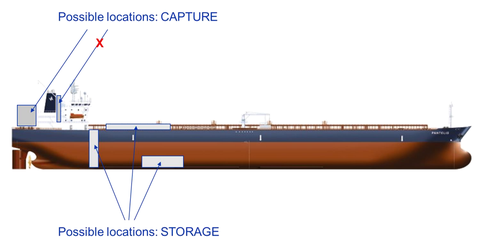


NETL MMMs show performance above the Robeson Upper Bound with ultra-high permeability.

Process marinization

Design and utilization of environmentally-friendly, **seawater-based solvents** modified with CO_2 capture promoters (e.g. CaO, NaOH)

Address **unique challenges of maritime environment** (operational and safety requirements, energy efficiency, on-site solvent regeneration etc)



Modelling and simulation activities

Modelling and simulation of **transport phenomena in gas-liquid contactors and membrane permeators** incorporating accurate material properties and physico-chemical properties of the solvent mixture.

Model-based assessment and optimization of the marine energy system with carbon capture (COSSMOS software).

NATIONAL ENERGY TECHNOLOGY LABORATORY
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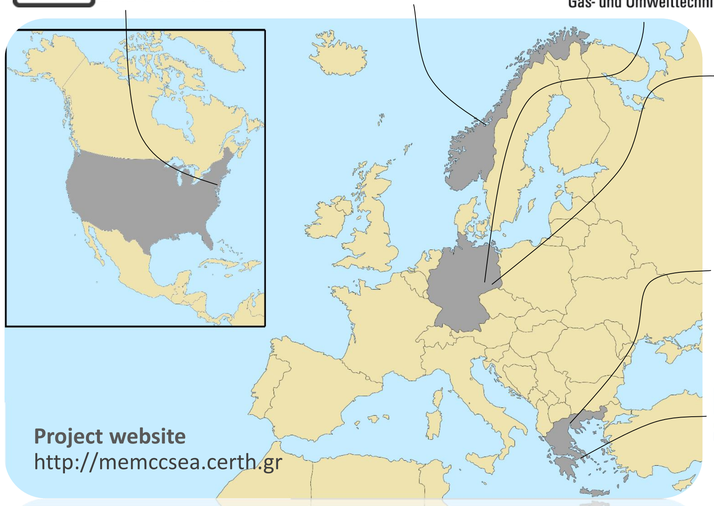
DBI GUT Gas- und Umwelttechnik GmbH
Fraunhofer IKTS
CERTH CENTRE FOR RESEARCH & TECHNOLOGY HELLAS
CPERI Chemical Process and Energy Resources Institute
DNV·GL

Project duration
1/11/2019 – 30/4/2022 (30M)

Budget
1.98 M€



Project website
http://memccsea.certh.gr

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Accelerating CCS Technologies

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