HiPerCap - High Performance Capture

FP7 Grant agreement n° 608555

HiPerCap Overview

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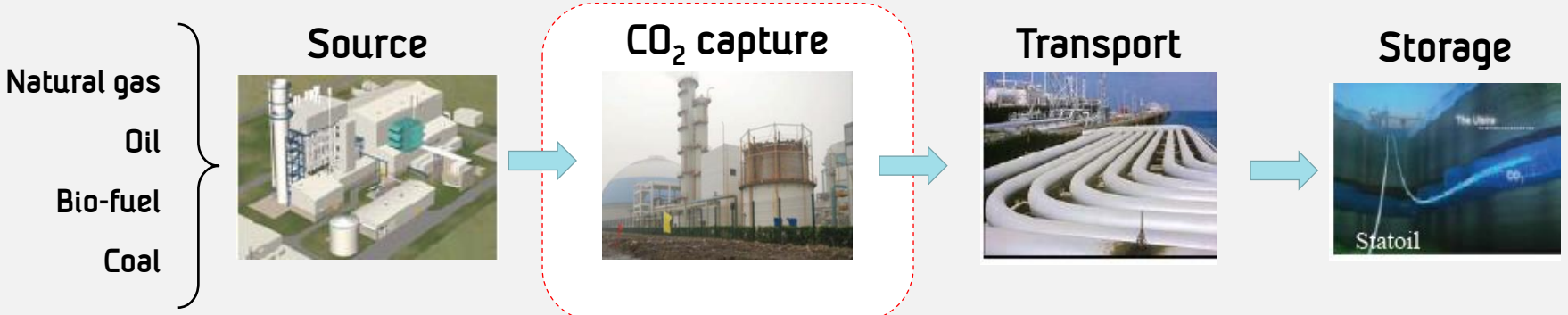


Content

- Main facts
- Project partners
- Main objectives
- Overview work-packages
- Dissemination

Main facts

- HiPerCap is funded by EU
  - ✓ Call specifically important twinning with Australian partners and projects
  - ✓ Integrated with 5 other projects within the same call
- Budget:
  - ✓ Total: 7.7 M€
  - ✓ From EU: 4.9 M€
- Duration:
  - ✓ 4 years started January 2014
    - ➢ WP1-4: year 1-3
    - ➢ WP5: year 4

Project partners:

HiPerCap CO_2

SINTEF

NTNU

TNO innovation for life

MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD

CSIC

INSTITUTO NACIONAL DEL CARBÓN

PROCEDE

CSIRO

TIPS RAS

MAST

DNV·GL

EDF

CNRS CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE

CO_2 SOLUTIONS

Algae-Tech™

e·on

ANDRITZ

gasNatural fenosa

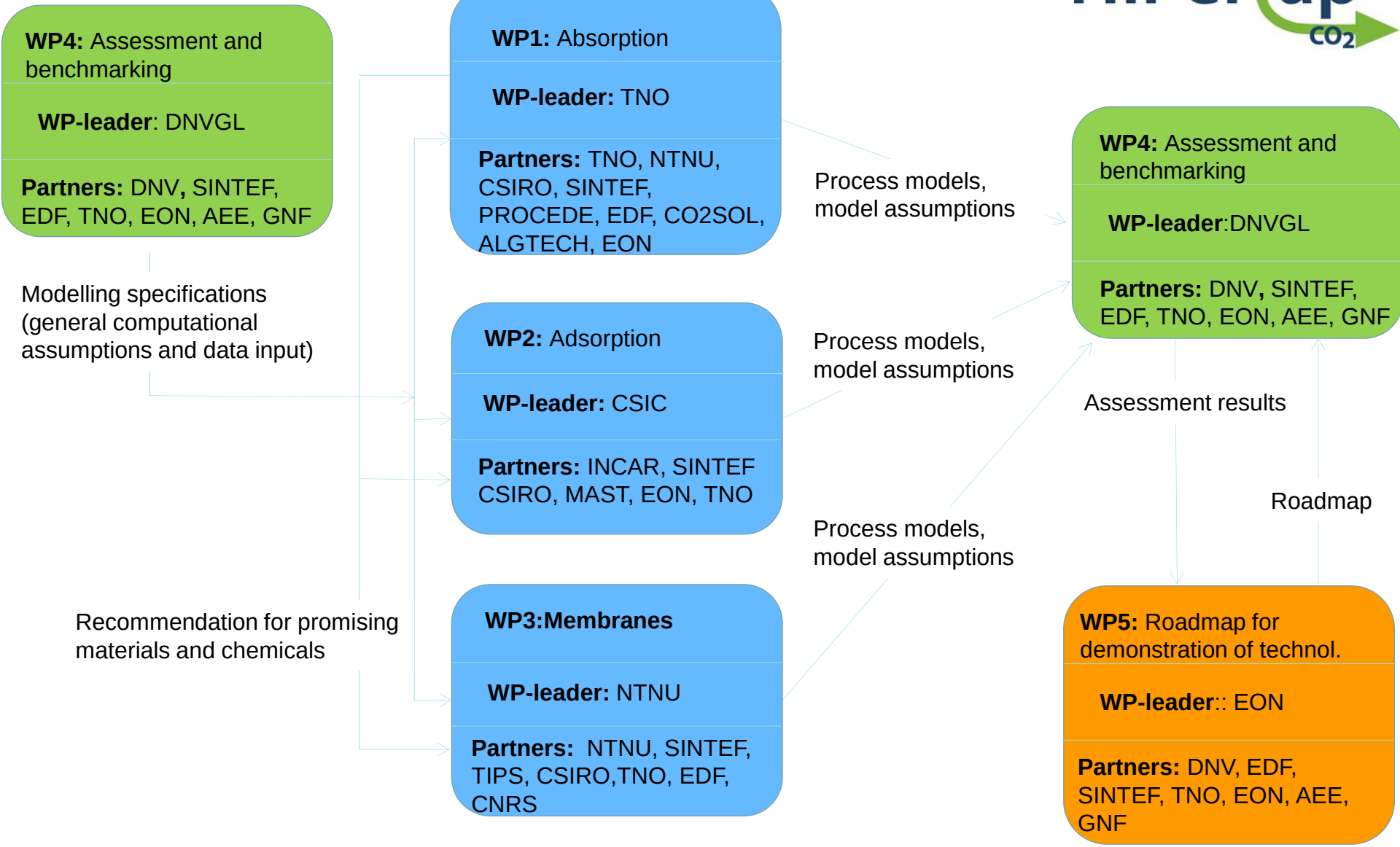
Main objectives

1. Develop environmentally benign energy- and cost-efficient technologies for post-combustion capture
   - ✓ Absorption
   - ✓ Adsorption
   - ✓ Membranes

2. Develop a methodology for fair comparison and benchmarking of the technologies

Objectives - more specifically:

- Reduce the total efficiency penalty by 25% compared to state-of-the-art capture technology
  - ✓ demonstrated in the EU project CESAR
- Deliver proof-of-concepts for each technology
- Improve the process designs to reduce capital and operating costs, considering aspects such as :
  - ✓ environmental impact
  - ✓ operability and flexibility
  - ✓ size of equipment
  - ✓ choice of materials
- Assess technologies and processes for selection:
  - Two most promising breakthrough capture processes
- Establish a technological roadmap for the further development


WP4: Assessment and benchmarking
WP-leader: DNVGL
Partners: DNV, SINTEF, EDF, TNO, EON, AEE, GNF
Modelling specifications (general computational assumptions and data input)
Recommendation for promising materials and chemicals
WP1: Absorption
WP-leader: TNO
Partners: TNO, NTNU, CSIRO, SINTEF, PROCEDE, EDF, CO2SOL, ALGTECH, EON
WP2: Adsorption
WP-leader: CSIC
Partners: INCAR, SINTEF CSIRO, MAST, EON, TNO
WP3:Membranes
WP-leader: NTNU
Partners: NTNU, SINTEF, TIPS, CSIRO,TNO, EDF, CNRS
Process models, model assumptions
Process models, model assumptions
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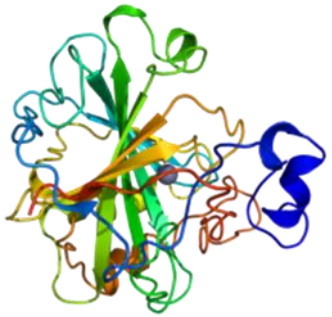
WP4: Assessment and benchmarking
WP-leader:DNVGL
Partners: DNV, SINTEF, EDF, TNO, EON, AEE, GNF
Assessment results
Roadmap
WP5: Roadmap for demonstration of technol.
WP-leader:: EON
Partners: DNV, EDF, SINTEF, TNO, EON, AEE, GNF

WP1 Absorption based technologies (1)

(WP-leader: Peter van Os from TNO)

Task 1.1 Enzyme catalysis of CO_2 absorption



- **Idea:** Enzymes in the solvents can drastically accelerate the capture of CO_2
- **In the project:** test carbonic anhydrase and developed an optimized process
- **Challenges:** keep the enzymes stable throughout the whole process and separation of enzymes prior the desorption

Task 1.2: Precipitating solvent systems

- **Idea:** Only the CO_2 part (small stream) of the total solvent system needs regeneration and higher regeneration pressure (lower CO_2 compression work) and no harmful emission (amino acids)
- **In the project:** developed an optimized process
- **Challenge:** Control absorption and precipitation and development of large scale slurry process

WP1 Absorption based technologies (2)

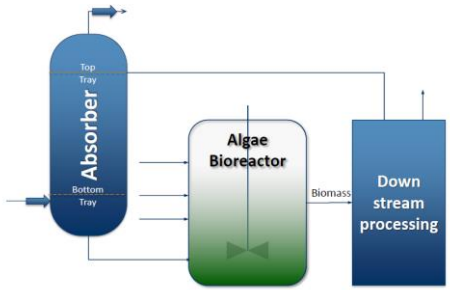
(WP-leader: Peter van Os from TNO)

Task 1.3: Strong bicarbonate forming solvents

- **Idea:** Bicarbonate forming amines with a high pKa will accelerate reactions kinetics and also allows to regenerate at lower temperatures
- **In the project:** Determine 2-3 promising candidates for detail studies
- **Challenge:** Many candidates. Potentially low absorption rates. A promoter might be required.

Task 1.4: Integration of CO_2 absorption with CO_2 utilization

- **Idea:** use the loaded solvent as "food" for the algae, which will eat the CO_2 and then produce biomass
- **In the project:** Test a combination of an absorber and a bioreactor and select a suitable algae strain
- **Challenge:** Selection of solvent which is attractive to the algae, but not eaten by the algae.



WP1 Absorption based technologies (3)

(WP-leader: Peter van Os from TNO)

Task 1.5: Study of bio-mimicking systems

- **Idea:** Fundamental study of CO_2 binding mechanisms in nature and determine processes for utilization industrially. Input to development in other tasks (1.1, 1.2, and 3.1).
- **In the project:** Reviewing and assessment of potential applicability of biological CO_2 binding processes. Some screening experiments
- **Challenges:** define possible systems
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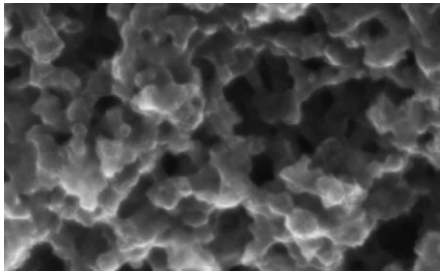
Task 1.6: Process modelling and simulation

- **In the project:** Model and simulate concepts from tasks 1.1, 1.2, and 1.3 as input to benchmarking in WP4
- **Challenges:** interactions with the other tasks and WP4, lack of proper data and modelling assumptions

WP2 Adsorption based technologies

WP-leader: Cova Pevida from CSIC

Task 2.1: Sorbent development



- **Idea:**
  Development of low temperature solid sorbents:
  1. High surface area
  2. Low-cost carbon-based
- **In the project:** production and characterization
- **Challenges:** attain the performance targets

Task 2.2: Process development

- **Idea:** Two temperature swing processes:
  1. Fixed beds
  2. Moving beds
- **In the project:** Lab and semi-pilot testing
- **Challenge:** the process heat efficiency strongly depend on the selected design

WP2 Adsorption based technologies

WP-leader: Cova Pevida from CSIC

Task 2.3: Process modelling

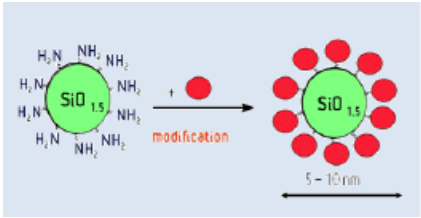
- **In the project:** Model and simulate concepts based on work in Tasks 2.1 and 2.2 as input to benchmarking in WP4
- **Challenges:** interactions with the other tasks and WP4, lack of proper data and modelling assumptions

WP3 Membrane based technologies

WP-leader: May-Britt Hägg from NTNU

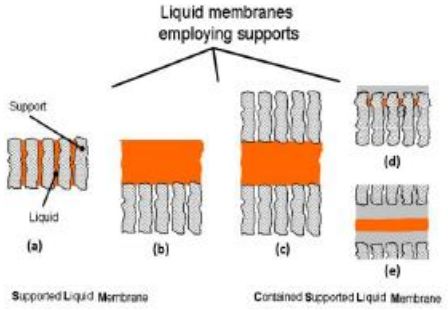
Task 3.1: Hybrid membrane development

- **Idea:** Develop a high flux mixed matrix membrane based on incorporation of nanoparticles in a polymer
- **In the project:** production and study on transport phenomena
- **Challenges:** attain the performance targets



Task 3.2: Supported ionic liquid membranes (SILMs) development

- **Idea:** Develop supported ionic liquid membranes
- **In the project:** development and preparation and performance testing
- **Challenges:** attain the performance targets



WP3 Membrane based technologies

WP-leader: May-Britt Hägg from NTNU

Task 3.3 : Process modelling and simulation

- **In the project:** Model and simulate concepts based on work in Tasks 3.1 and 3.2 as input to benchmarking in WP4
- **Challenges:** interactions with the other tasks and WP4, lack of proper data and modelling assumptions

WP4 Assessment of CO_2 capture technologies (1)

WP-leader: Jock Brown from DNVGL

Task 4.1: Establishment of assessment methodology

- **Idea:**
  1. Screening on basic information availability
     - ✓ Creating a minimum level of principle and conceptual knowledge of a capture process
  2. Bring the concepts and technologies to the level of a process or applications
     - ✓ The novel capture technology imbedded in an application or process
  3. Consistent way of scaling up to representative scale of application
     - ✓ Using modelling and/or engineering approaches
- **In the project:** Definition of base case(s), reference capture technology, system boundaries, modeling approaches/assumptions, comparison criteria etc.
- **Challenge:** define a methodology which is really fair for all technologies involved

WP4 Assessment of CO2 capture technologies (2)

WP-leader: Jock Brown from DNVGL

Task 4.2: Data collection of capture technologies studied in WP1-3

- **Idea:** Assist WP1-3 in gathering the data for showing the technical feasibility of each technology.
- **In the project:** Define how to communicate with the other WPs (i.e. questionnaire, interest group, integrated workshops) and collection of the necessary data determined in Task 4.1
- **Challenge:** Communication with WP1-3

WP4 Assessment of CO2 capture technologies (3)

WP-leader: Jock Brown from DNVGL

Task 4.3: Assessment of capture technologies studied in WP1-3

- **Idea:** 3 steps procedure
- **In the project:**
  1. Assessment of each technology
  2. Comparison and benchmarking against the reference technology
  3. Assessment and if necessary update of the chosen methodology (input to Task 4.1)
- **Challenge:** Uncertainty range for the various technologies

WP4 Assessment of CO2 capture technologies (4)

WP-leader: Jock Brown from DNVGL

Task 4.4: Guidelines for selection and benchmarking of the two breakthrough technologies studied in WP5

- **Idea:** Establish guidelines for selection of two promising technologies for further studies and benchmarking (selection will be supported by all partners)
- **In the project:** The guidelines will be based on the previous work in the other tasks and results from 4.3, but also discussed in the interest group and with the whole consortium
- **Challenge:** agreed guidelines supported by all partners in the consortium

WP5 Study of breakthrough processes for pilot testing WP-leader: Adam Al-Azki from E.ON

Task 5.1 Detailed study of selected capture technology 1

Task 5.2 Detailed study of selected capture technology 2

For both tasks:

- **Idea:** Establish a roadmap for demonstration of the technology
- **In the project:** Identification of any knowledge gaps and plan for demonstration at industrial pilot plant. Other activities might be additional experiments in the lab, improved models and further optimization.
- **Challenge:** Limited budget

WP and task structure

- WP6: Project Management
  - ✓ WP-leader: Hanne Kvamsdal
- WP7: Dissemination outside of the consortium
  - ✓ WP-leader: Hanne Kvamsdal
  - ✓ Arranging two workshops (Australia 2015, Europe 2017)
  - ✓ Presentations at international conferences (GHGT-12, PCCC-3 and others)
  - ✓ Web-site: www.sintef.no/hipercap
- WP8: Collaboration with an Australian partner
  - ✓ WP-leader: Paul Feron in CSIRO
  - ✓ CSIRO will be a working partner in HiPerCap and contribute to WP 1, 2, 3, and 7.

Acknowledgement:

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