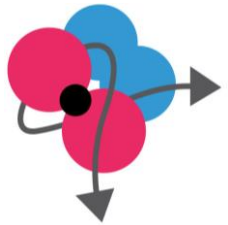


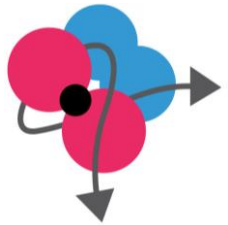
Enabling a Low-Carbon Economy via Hydrogen and CCS

Svend Tollak Munkejord, SINTEF Energy Research, project coordinator

http://www.elegancy.no/

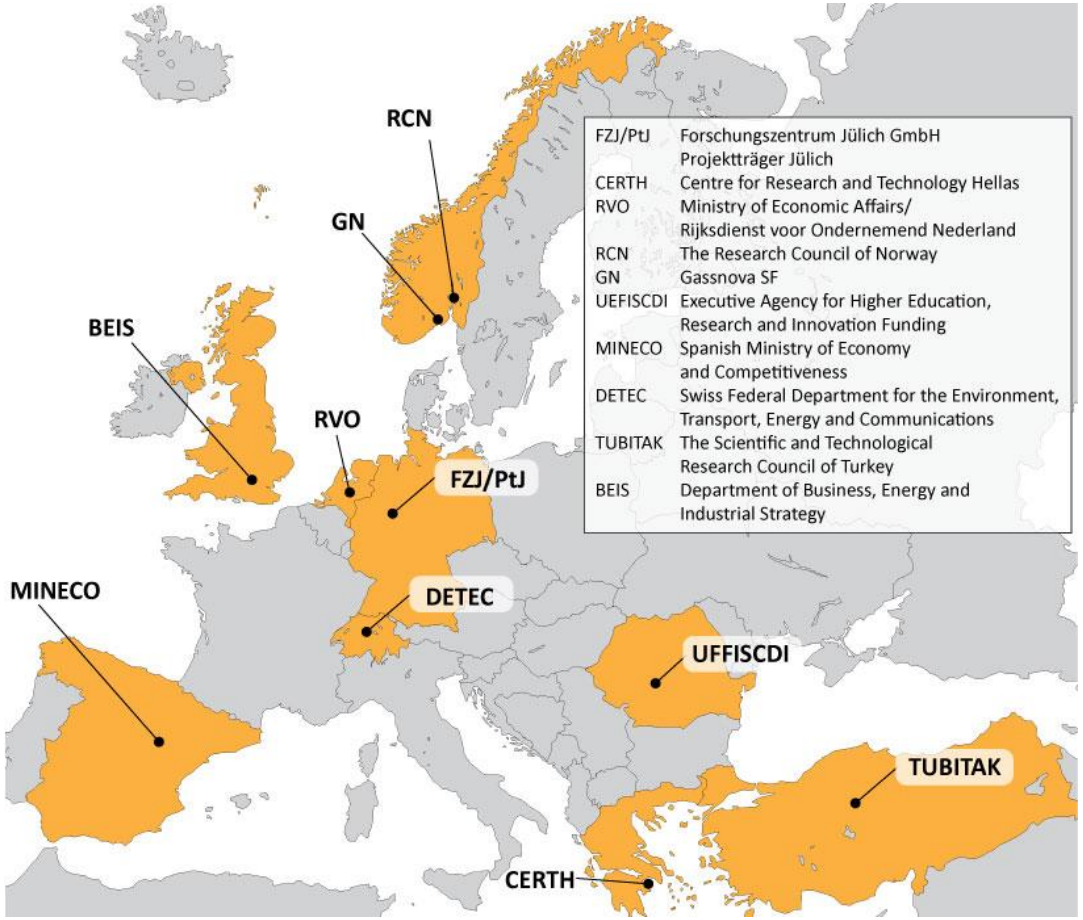
ELEGANCY Conference, Brussels, 2018-11-08

Outline of presentation



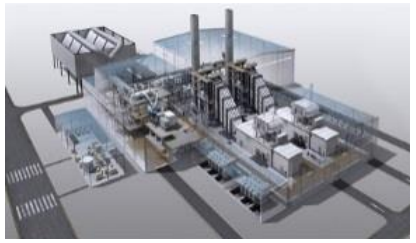
- ELEGANCY
  - Aim
  - Approach
  - Some highlights

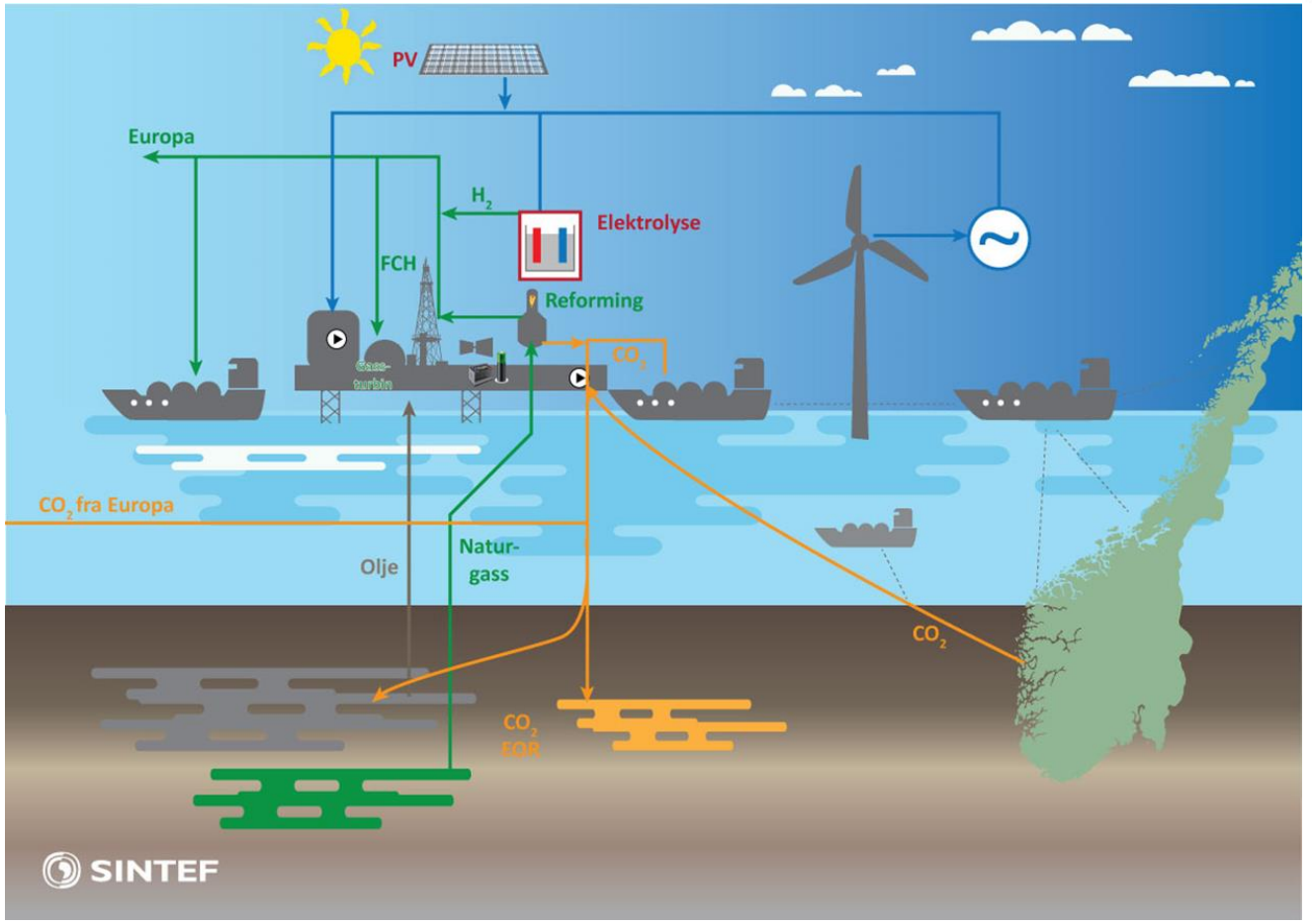
ERA-NET ACT



- Accelerating CCS Technologies
- H2020
- Ten European countries and USA
- Led by The Research Council of Norway
- First call budget: 41 MEUR

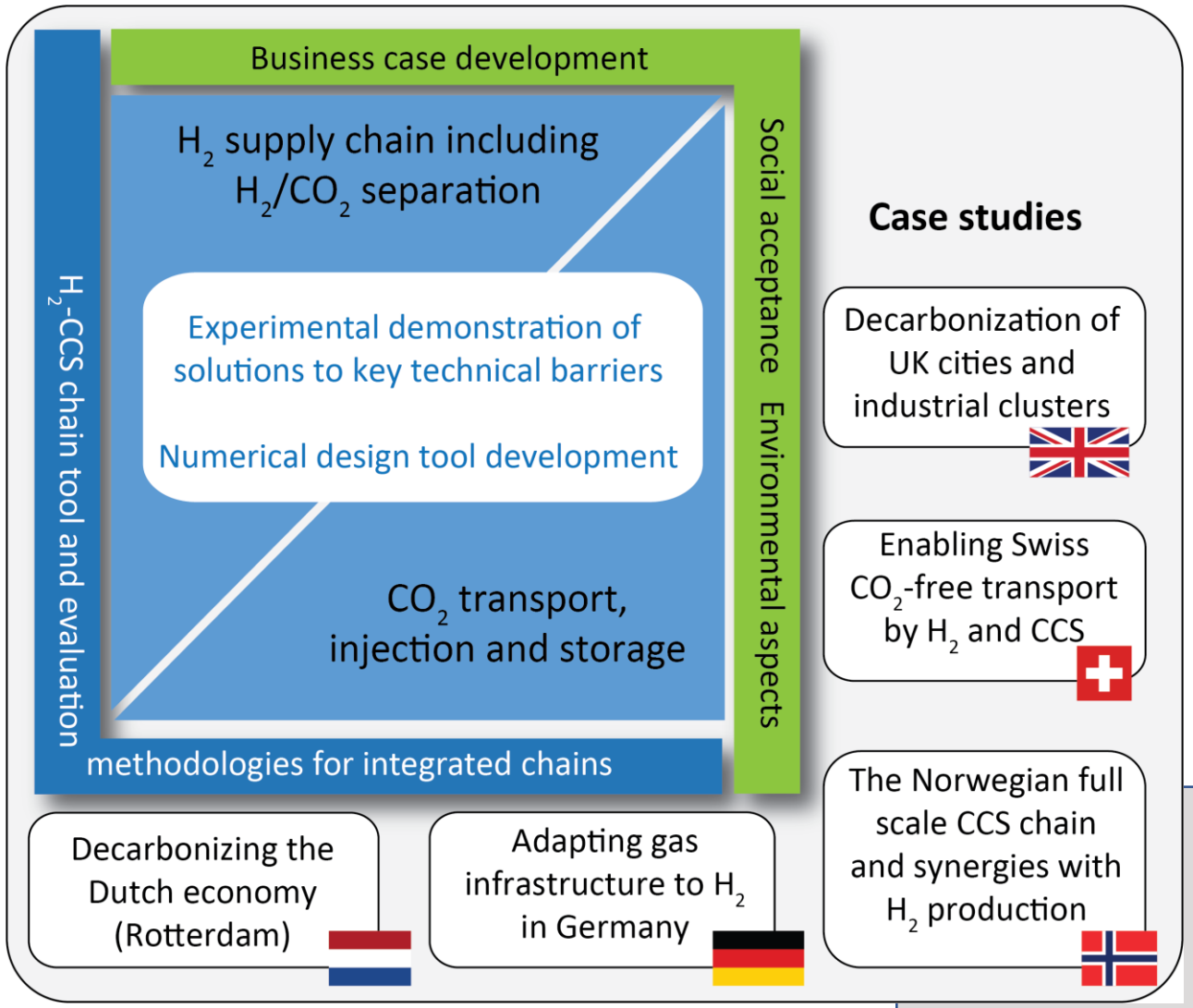
ELEGANCY – context





- The low-carbon economy needs H_2
- The low-carbon economy needs CCS
- Combining hydrogen with CCS offers an exciting opportunity for synergies and value creation
- ELEGANCY aims at contributing to fast-track the decarbonization of the European energy system

ELEGANCY – key information



- Duration: 2017-08-31 to 2020-08-31.
- Budget: 15 599 kEUR

ELEGANCY – project-management team

Svend T. Munkejord
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ELEGANCY – work packages

Case studies incl. social acceptance, environmental aspects and CCS-H_2 market considerations: UK (large-scale decarbonization), Netherlands (Rotterdam decarbonization), Norway (full scale CCS chain and H_2 production), Switzerland (decarbonization of transport sector), Germany (adapting gas infrastructure and processes to H_2) **WP5**

H_2-CCS chain tool and evaluation methodologies for integrated chains: (ICL, SINTEF, PSI, RUB, TNO) **WP4**

Business case development: (UiO,FirstClimate,SDL) **WP3**

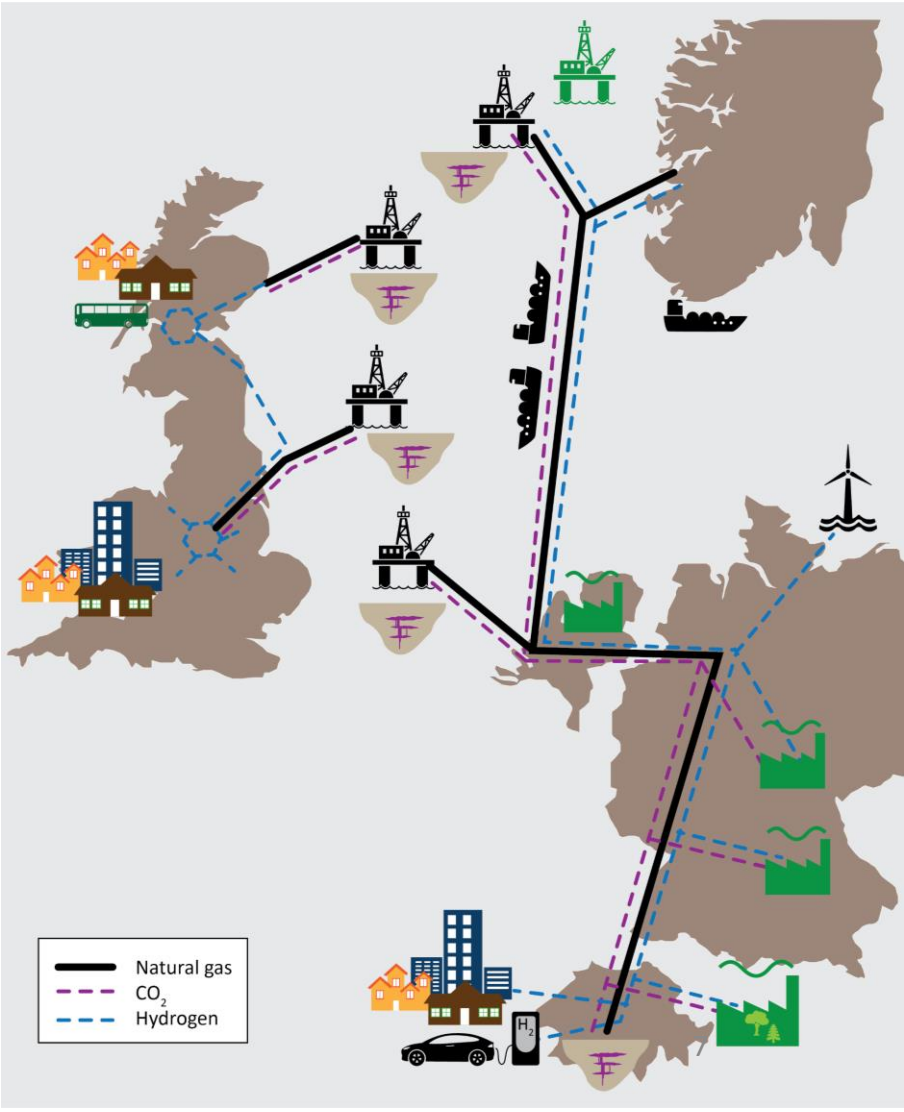
H_2 supply chain including H_2/CO_2 separation **WP1**

- H_2 from natural gas (ETH, PSI)
- H_2 from other sources (ECN)
- Characterization of CO_2-CO-H_2 mixtures (RUB)

CO_2 transport, injection and storage **WP2**

- CO_2-brine model (RUB,ICL)
- CO_2 transport-injection interface (SINTEF)
- Storage-site characterization and selection (ICL)
- Mt. Terri decametre scale experiment (ETH)
- Impact of H_2 in the CO_2 stream on storage (BGS)
- De-risking storage

ELEGANCY project management, network building and dissemination (SINTEF) **WP6**

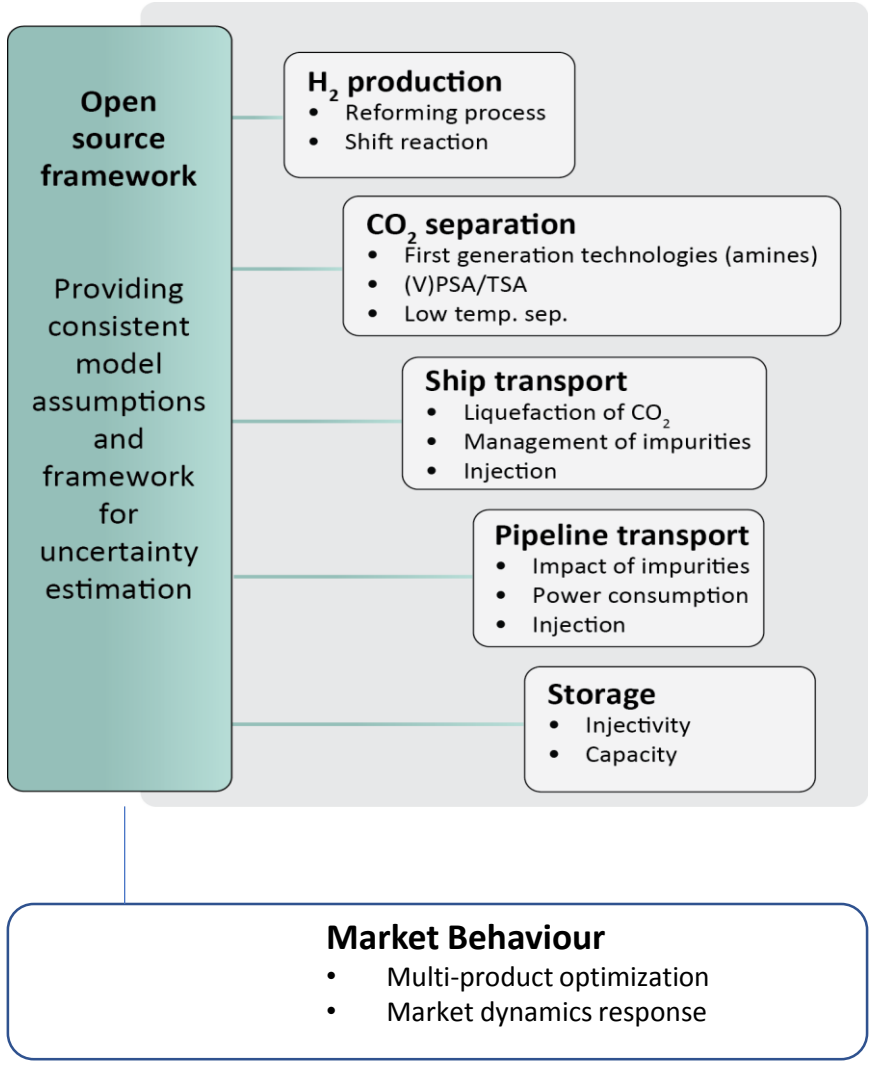


World-class research infrastructure

Description	Scale	Partner
Adsorption infrastructure (ECCSEL)	Lab-scale	ETH
Cycling adsorbent analyser	Lab-scale	ECN
Single- and multi-column reactive PSA/TSA equipment	Pre-pilot, TRL 5	ECN
Equipment for measurements of density, speed of sound and dielectric permittivity	Lab-scale	RUB
Vertical flow facility	Pilot-scale	SINTEF
Pipe and vessel depressurization (ECCSEL)	Lab-scale	SINTEF
Core-flooding laboratory	Lab-scale	ICL
Batch-reactor for mineral-dissolution kinetics	Lab-scale	ICL
Equipment for measurements of CO_2-brine-mineral contact angle, interfacial tension and phase behaviour	Lab-scale	ICL
Hydrothermal laboratory (ECCSEL)	Lab-scale	BGS
Geo-microbiology laboratory (ECCSEL)	Lab-scale	BGS
Rock deformation laboratory (ECCSEL)	Lab-scale	SCCER
Micro-seismic monitoring arrays	Lab-scale	SCCER
Mt. Terri research rock laboratory (EPOS)	Pilot-scale	SCCER

H_2-CCS chain tool and evaluation methodologies for integrated chains

- Open-source framework
  - More widespread use
  - More dynamic
- ‘Open’ or ‘closed’ modules
- Stationary-design mode
- Dynamic-operation mode
- Multi-scale models for the chain components

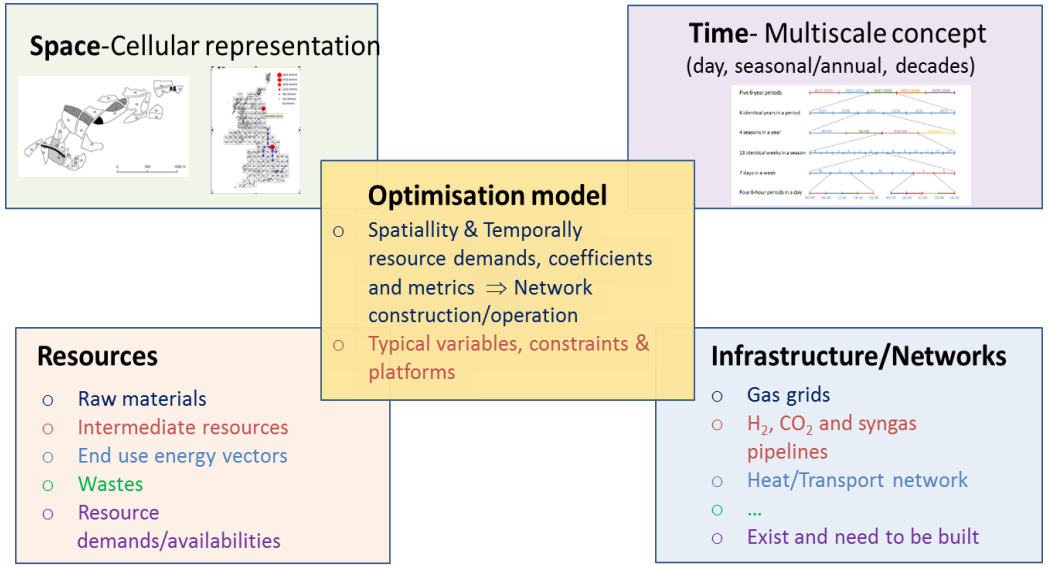


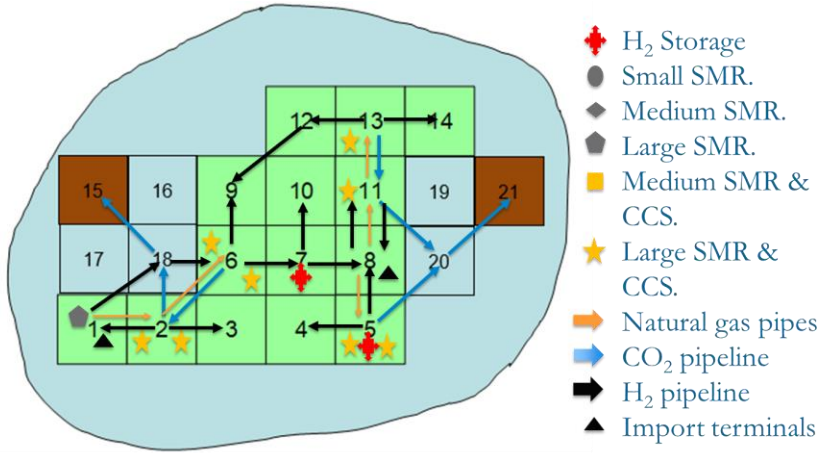
H_2-CCS chain tool

Design mode:

- Able to represent “real world” scenarios using past data.
- Capable of designing infrastructure for all key resources, whilst ensuring that CO_2 emissions are constrained as the total cost of the network is minimized.
- The model incorporates geographical input data relating to H_2 demands, geological storage volumes, natural gas infrastructure, to be used in the optimization.

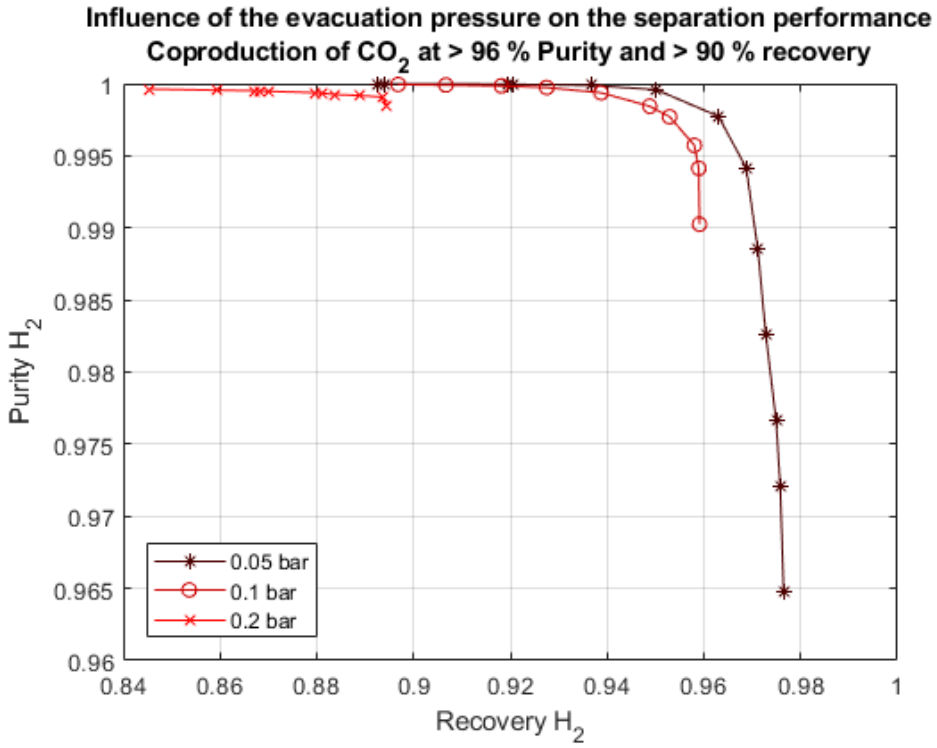
Resource Technology Framework:





H_2 supply chain and H_2-CO_2 separation

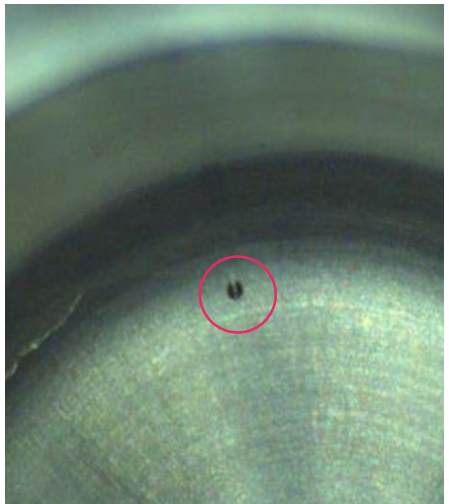
- Optimized VPSA cycles developed for SMR syngas (ETH – presented at GHGT-14)



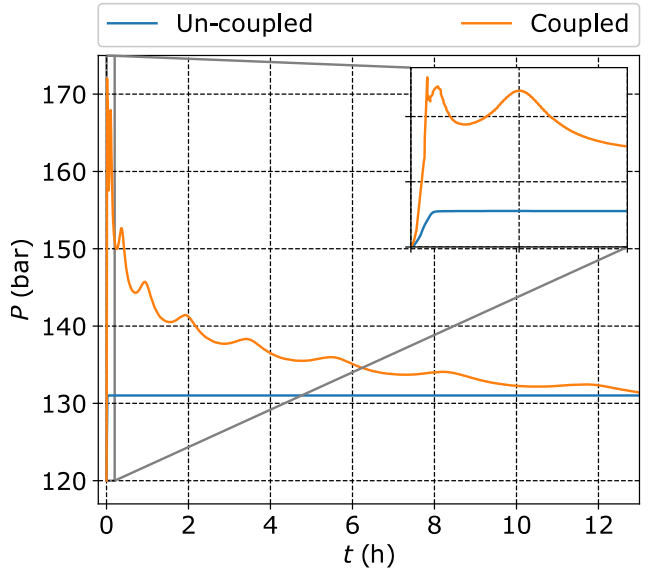
- Coproduction of high purity H_2 and CO_2 within a single VPSA cycle is possible
- Hydrogen purities > 99.97 % can be reached → PEM fuel cell purity
- Decreasing the evacuation pressure increases the separation performance
- Best energy consumption falls within range of MDEA energy consumption

CO_2 transport, injection and storage

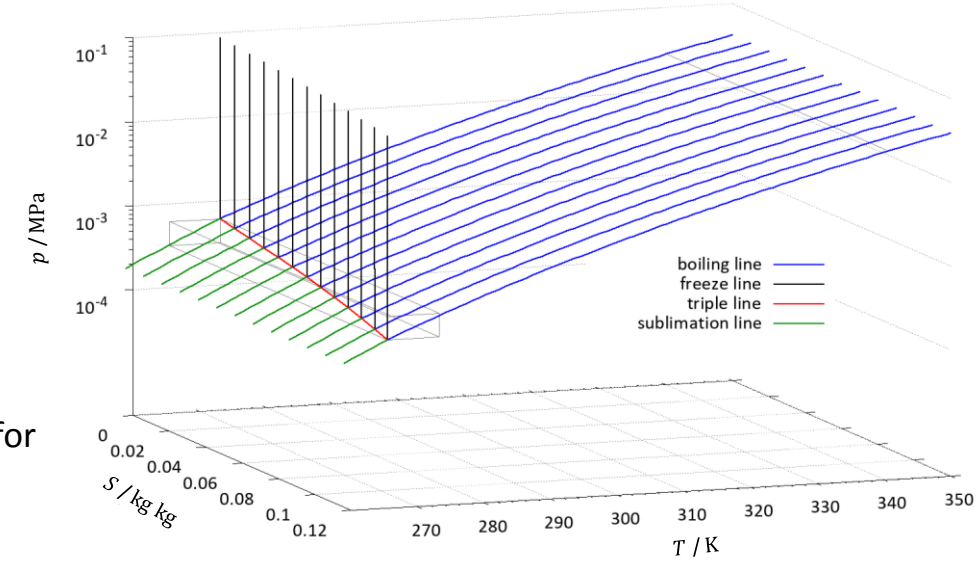
- Construction and assembly completed for the apparatus to be used in the study of gas solubility in brines at high pressures – initial testing started (ICL – below)
- Combination of seawater EOS (Feistel) with Helmholtz EOS (EOS-CG) in progress (RUB – bottom right)
- First version of coupled well-reservoir (near-well) model is running – presented at GHGT-14 (SINTEF – far right)



Small gas bubble on the point of dissolution.



Bottom-hole pressure in CO_2 injection well: The inclusion of a near-well model significantly impacts pressure dynamics.



PT diagram for different salinities.

Conclusion

- ELEGANCY aims to fast-track Europe's energy system by combining CCS and H_2
  - By overcoming specific scientific, technological and economic/legal barriers
  - By undertaking five national case studies adapted to the conditions in the partner countries.

Acknowledgement

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ELEGANCY

Accelerating CCS Technologies

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