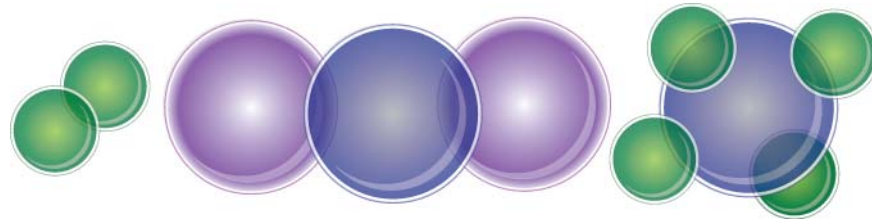


CCS European projects in FP7 coordinated by SINTEF: ECCO, DECARBIT and DYNAMIS



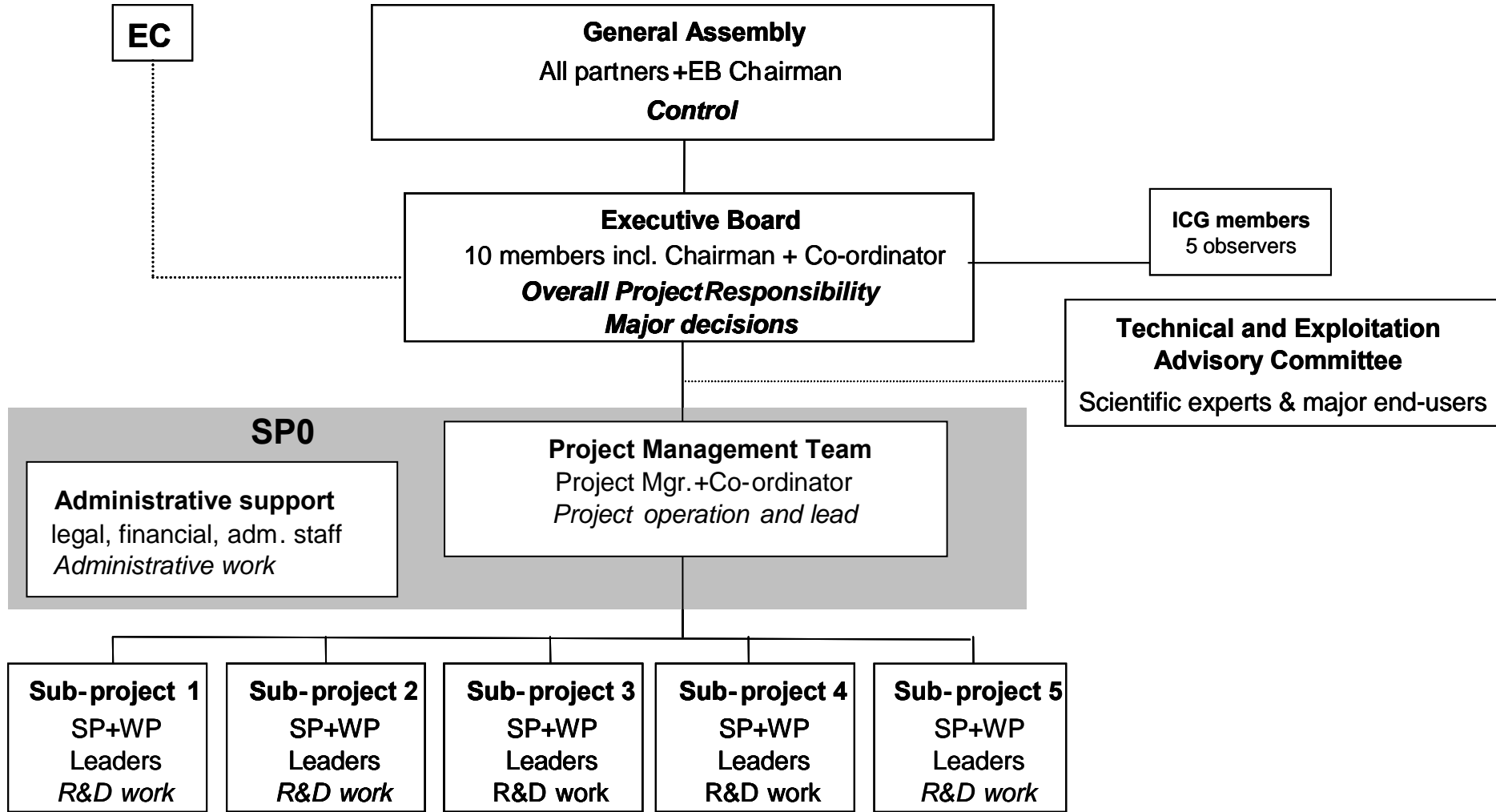
Maria Barrio
Vice President Gas Technology
Gas Technology Centre, SINTEF/NTNU, Norway

Bratislava, 4th March 2009

Contributors to presentation:

Petter Røkke (SINTEF); Marie Bysveen (SINTEF), Charles Eickhoff (Progressive Energy)

Management structure



e-Room

DECARBit - Microsoft Internet Explorer

Address: <https://project.sintef.no/eRoom/energy/DECARBit>

SINTEF

My eRooms > DECARBit

DECARBit edit

an eRoom created on 9 Feb 07

create search meetings & events members

Status

Welcome to the DECARBit eRoom

The DECARBit eRoom enables partners of DECARBit to share project information. Defined access rights regulate to what extent eRoom members can read and edit the documents in the eRoom

The folder structure of the DECARBit eRoom is seen to the left.

Open FP7 information related to the call which the proposal addresses is available in the folder Documents&Web_pages. To the extent possible links to relevant web-pages are made instead of downloading documents. By using links we ensure that the eRoom contains only updated information.

== Quick guide for users
100 SP1
000 Meeting Calendar
300 SP3
011 Budgets
040 Meetings
000 NEWS
400 SP4
500 SP5
050 Deliverables (approved)
070 Status Reports
080 Periodic Reports to EC
090 Project Review
020 General Information
030 Overall Plans
200 SP2
060 Publications
010 Contracts and Documents
Recycle Bin

Your Hidden Items

Documents&web_pages
Proposal writing

create add file mark read commands

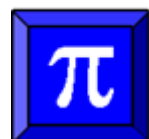
Announcements add an announcement

- Daily project administration and management
- All consortium members have access

ECCO European value chain for CO₂



NTNU



Fortum Oyj

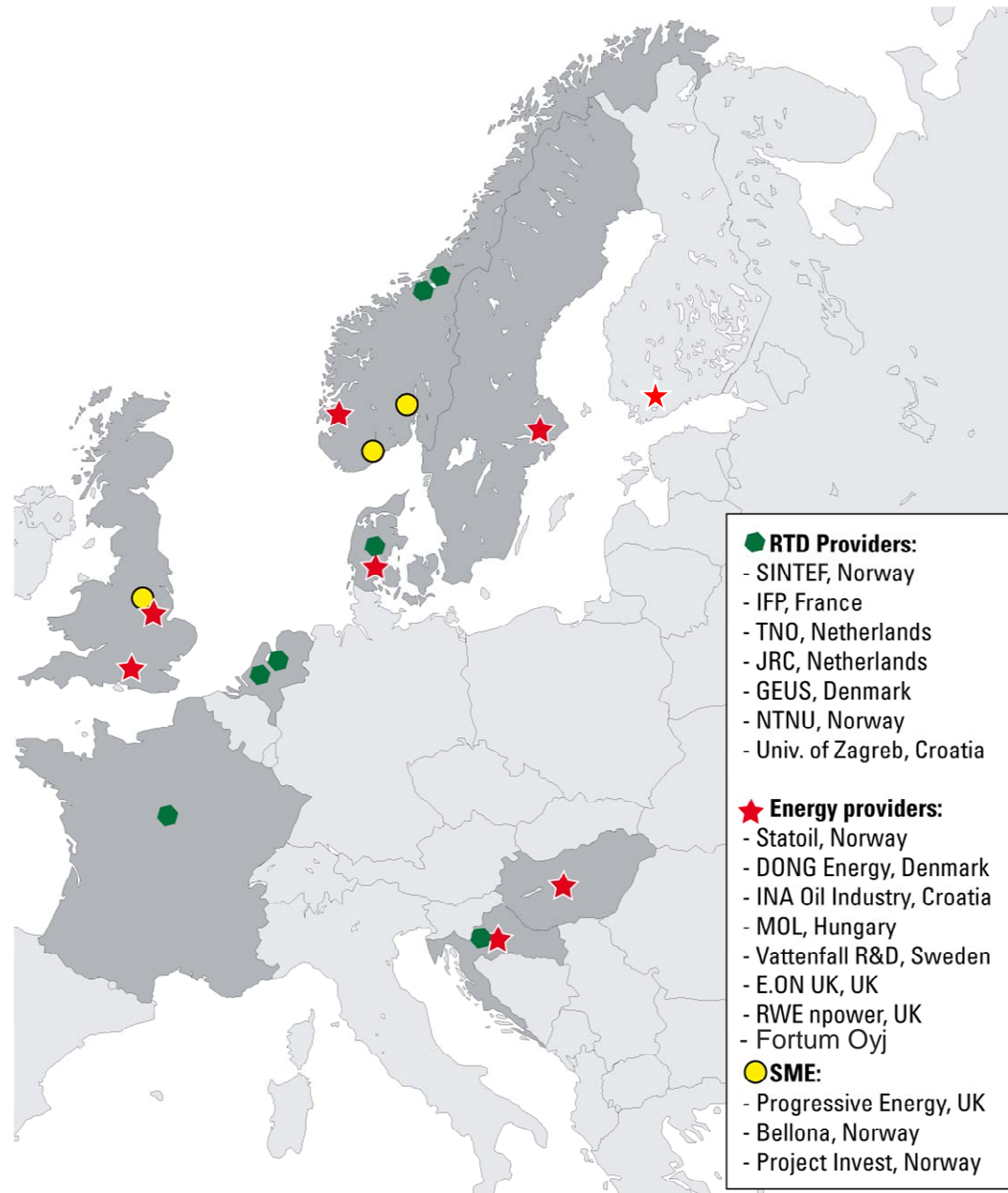
Project objectives and expected results

Facilitate robust strategic decision making regarding early and future implementation of CO₂ value chains in the face of uncertainty.

- “ECCO Strategies for CO₂ value chain deployment”.
- CO₂ value chain assessment tool
- Reservoir technology for EOR and EGR
- Methodology for CO₂ value chain assessment

ECCO – European Value Chain for CO₂ The Consortium

- FP7 RTD
- Total budget:
5,36 M€
- Commission
funding:
3,85 M€
- Duration: 3 yrs
(36 months)
- Start date :
1st Sept 2008



ECCO – European Value Chain for CO₂

Strategy – key questions

■ What might be the future CO₂ world?

– Scenario analysis → 2-3 scenarios

- Exist infrastructure?
- Who owns infrastructure?
- How will parameters affecting oil/gas/el market develop?
- What are the incentives/regulations for CCS?

→ **IMPORTANT** – best guess - qualified experts opinion

■ How to identify feasible CO₂ chain options?

– Formulation & analysis of cases

- Relevant questions/problem formulation
- Cases reflecting the scenarios
- Cases illustrating the effect and importance of various parameters – sensitivity analysis
- **Integrated multiple source/sink systems**

→ **IMPORTANT** – relevant cases - “smart use of tool”

■ How to evaluate the CO₂ chain options and choose the most promising solutions for CCS?

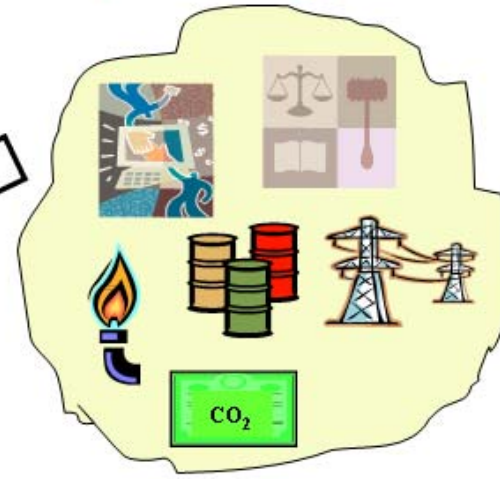
– Tool for economic analysis of CO₂ chain

→ **IMPORTANT** – simple **BUT** high quality input data & consistent implementation

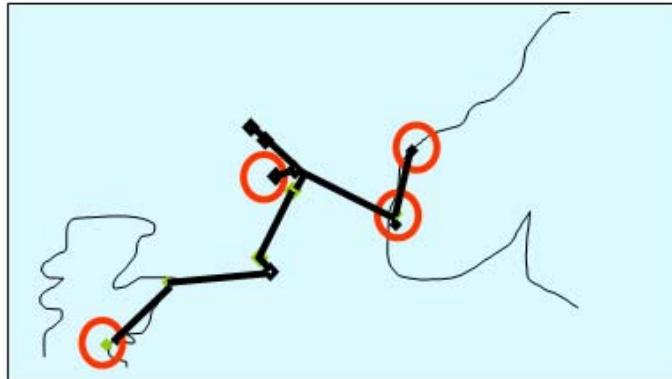


The iteration process...

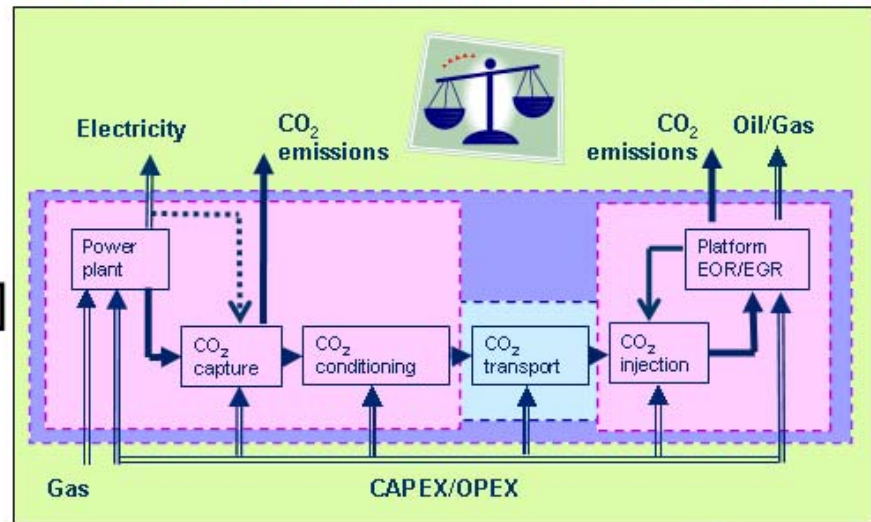
1. Scenario – “predicting” future CO₂ world



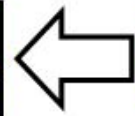
2. Case study – defining options



3. Economic analysis – profit vs. costs



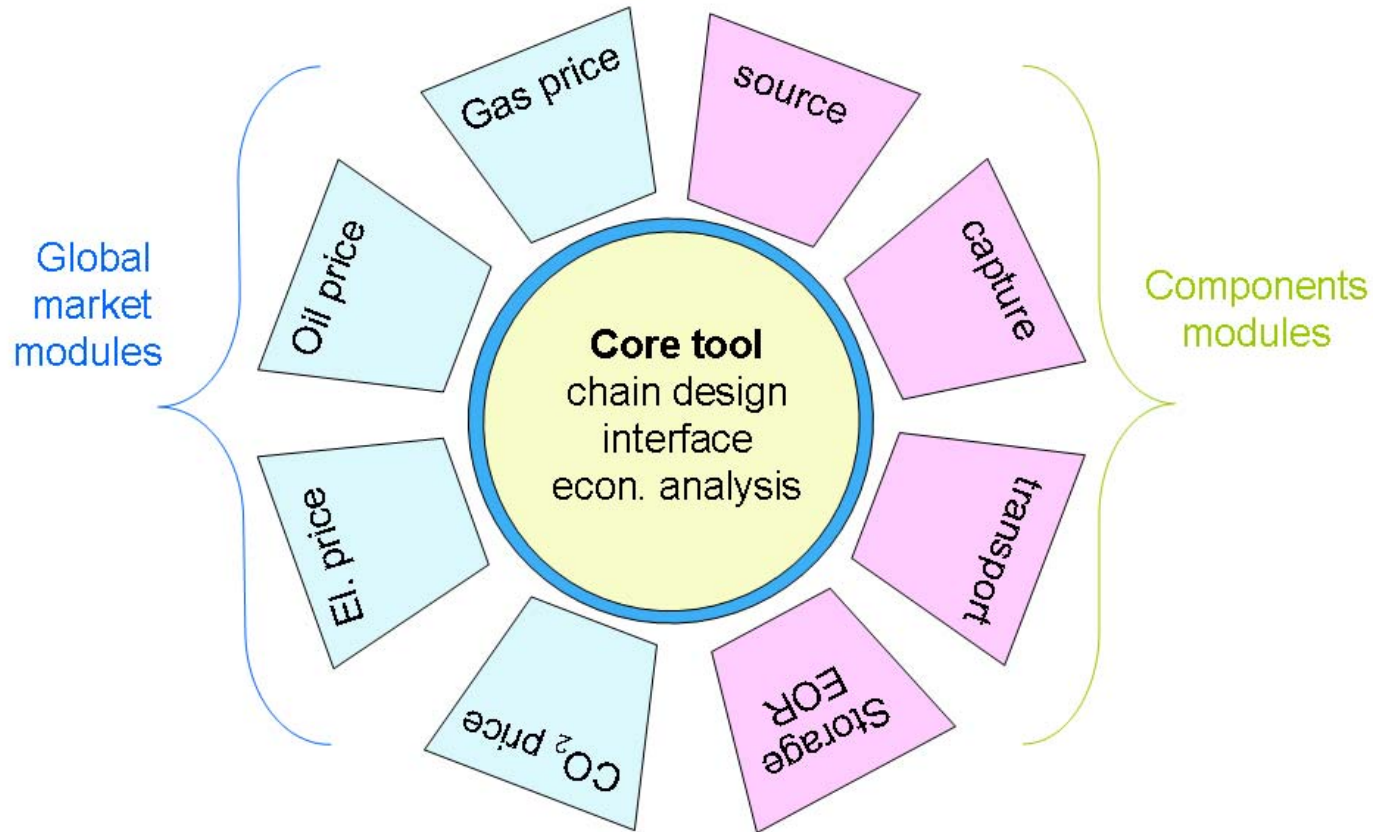
4. Case study – evaluating options & recommendations



J. P. Jakobsen SINTEF

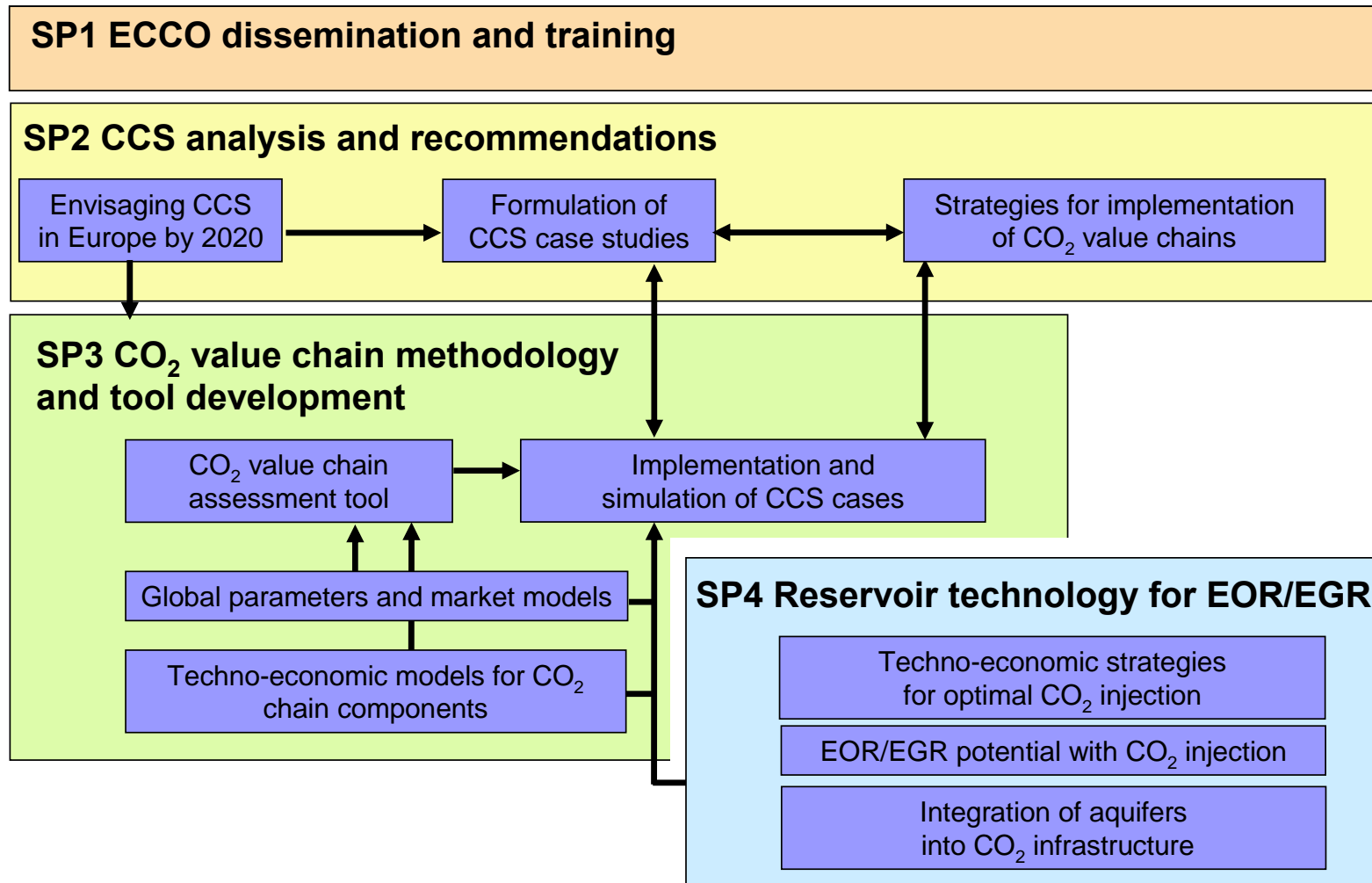
ECCO – European Value Chain for CO₂

Object oriented code



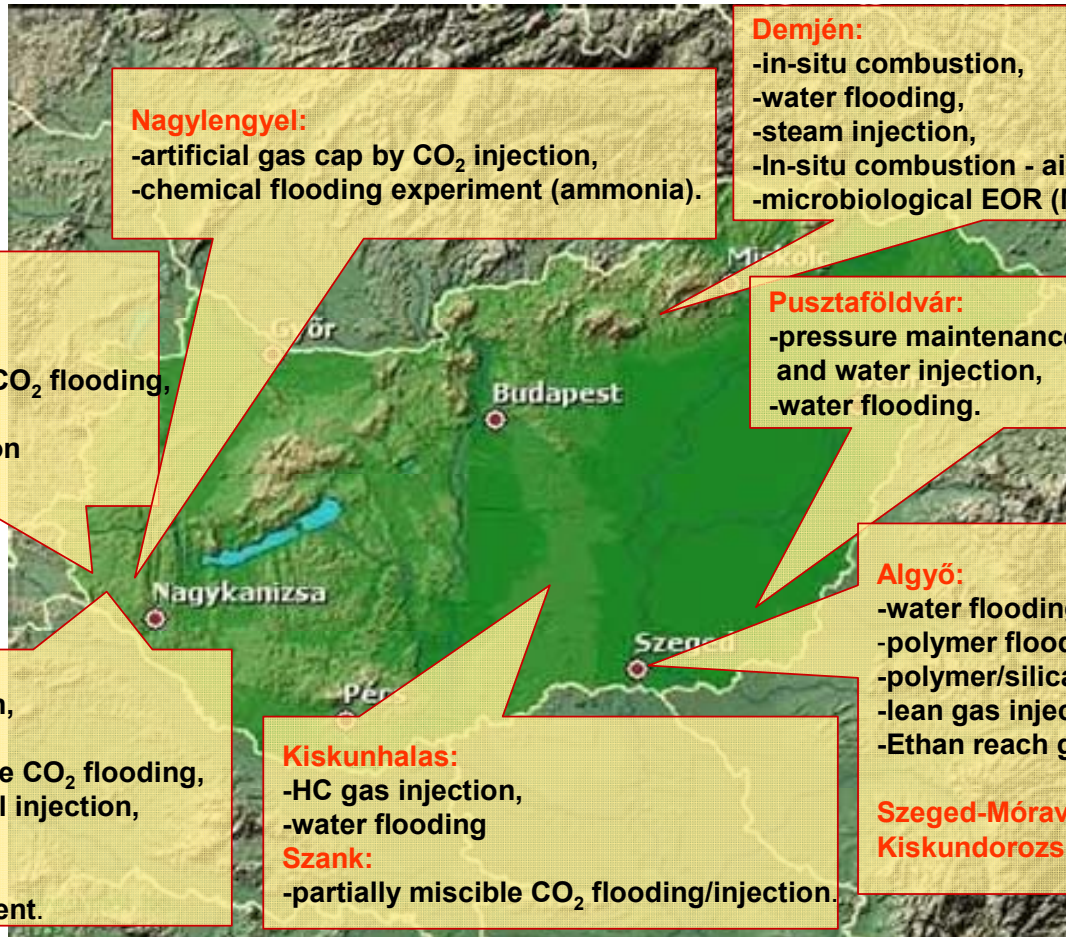
J. P. Jakobsen © SINTEF

ECCO – European value Chain for CO₂ Implementation



EOR/IOR applications in Hungary

30 years Experience in EOR/IOR technologies



Nagylengyel:

- artificial gas cap by CO₂ injection,
- chemical flooding experiment (ammonia).

Demjén:

- in-situ combustion,
- water flooding,
- steam injection,
- In-situ combustion - air injection
- microbiological EOR (MEOR) experiment.

Lovászi:

- HC gas injection,
- water flooding,
- partially miscible CO₂ flooding,
- WAG,
- silicate gel injection
- in-fill wells.

Pusztaföldvár:

- pressure maintenance by non-miscible CO₂ and water injection,
- water flooding.

Budafa:

- HC gas injection,
- water flooding,
- partially miscible CO₂ flooding,
- WAG silicate gel injection,
- in-fill wells.

Algyő:

- water flooding,
- polymer flooding experiment
- polymer/silicate gel treatment,
- lean gas injection and vaporization,
- Ethan reach gas injection.

Újfalu:

- MEOR experiment.

Kiskunhalas:

- HC gas injection,
- water flooding

Szank:

- partially miscible CO₂ flooding/injection.

Szeged-Móraváros and

- Kiskundorozsma: water flooding.

DECARBIT

”Decarbonise it”

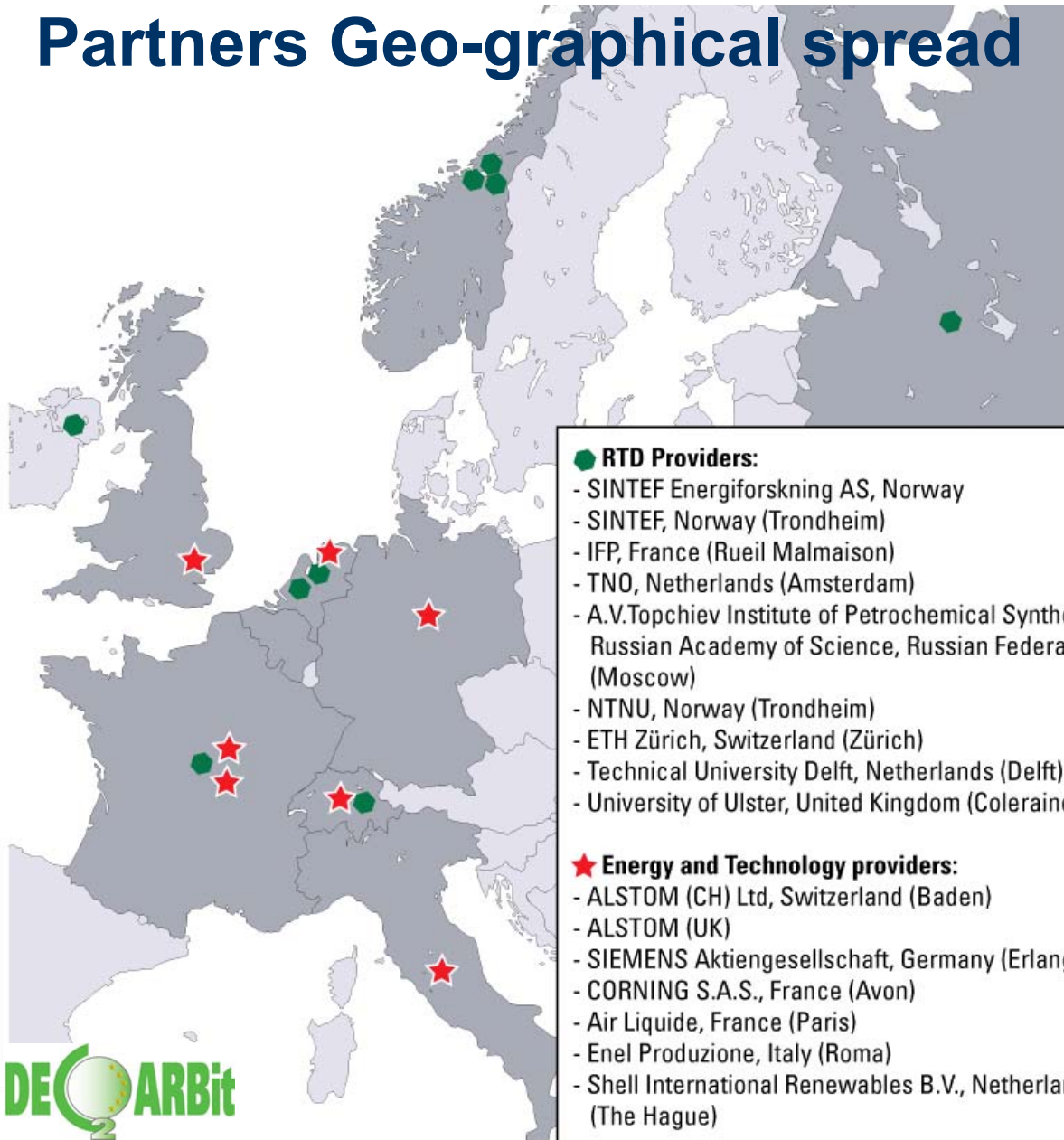


DECARBit objective

- DECARBit responds to the urgent need for **further research and development** in **advanced pre-combustion capture techniques** to substantially reduce emissions of greenhouse gases from fossil fuel power plants.
- **Cost reduced pre-combustion capture of CO₂** promoting the development and deployment of large scale CCS plants (10-12 by 2020).
- Need **efficiency improvement** and reduced investment
- Builds on the European project ENCAP



Partners Geo-graphical spread



● RTD Providers:

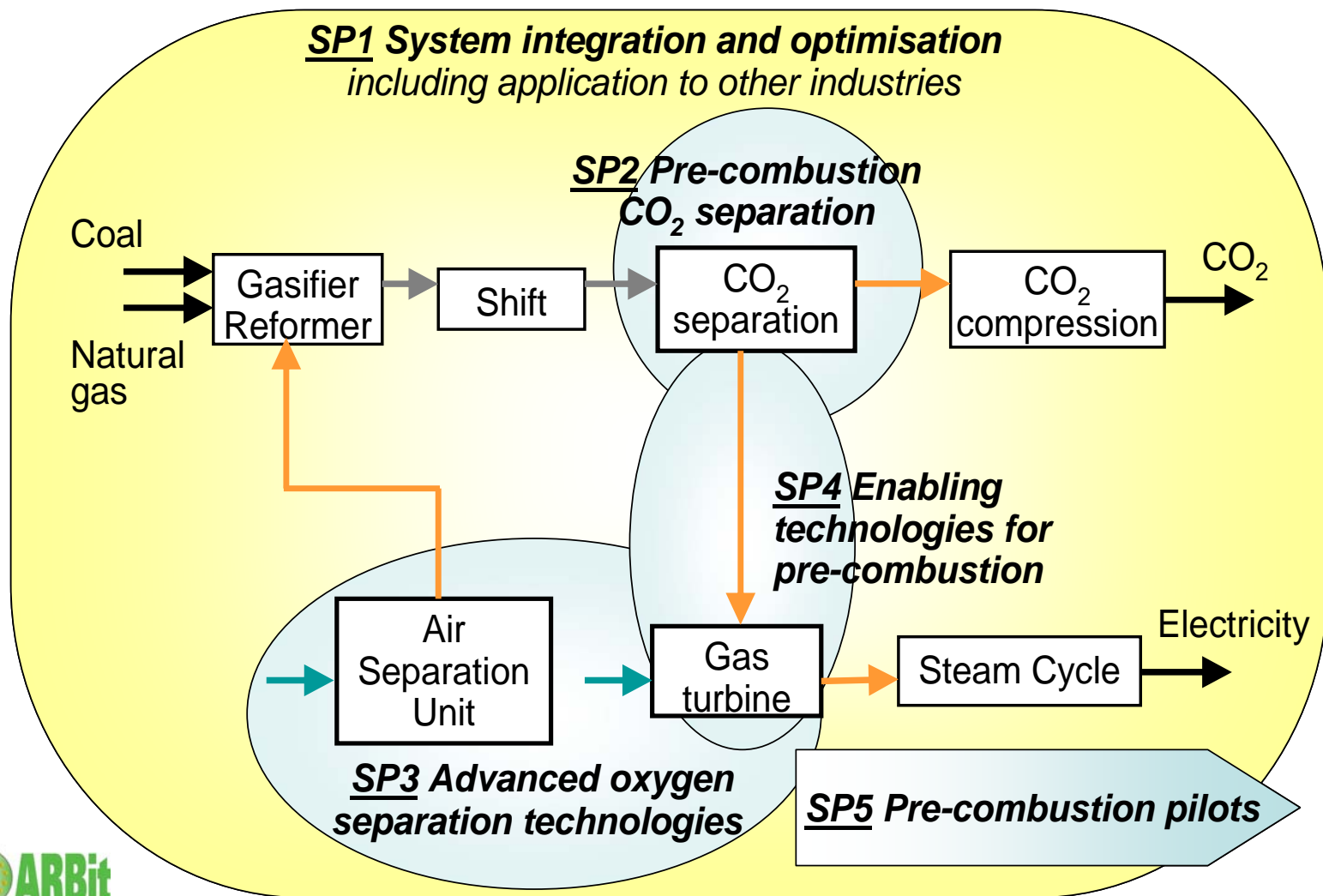
- SINTEF Energiforskning AS, Norway
- SINTEF, Norway (Trondheim)
- IFP, France (Rueil Malmaison)
- TNO, Netherlands (Amsterdam)
- A.V.Topchiev Institute of Petrochemical Synthesis, Russian Academy of Science, Russian Federation (Moscow)
- NTNU, Norway (Trondheim)
- ETH Zürich, Switzerland (Zürich)
- Technical University Delft, Netherlands (Delft)
- University of Ulster, United Kingdom (Coleraine)

★ Energy and Technology providers:

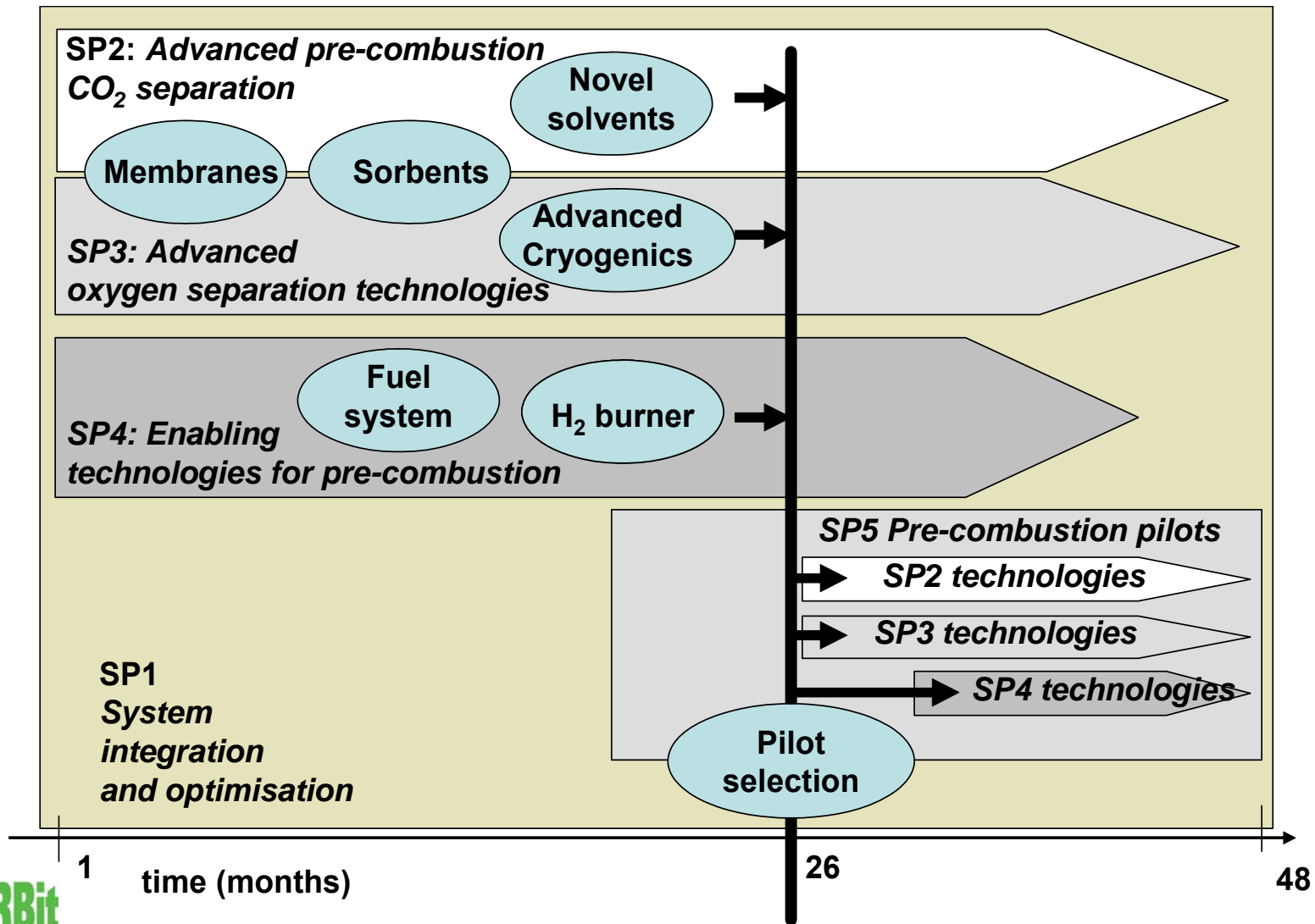
- ALSTOM (CH) Ltd, Switzerland (Baden)
- ALSTOM (UK)
- SIEMENS Aktiengesellschaft, Germany (Erlangen)
- CORNING S.A.S., France (Avon)
- Air Liquide, France (Paris)
- Enel Produzione, Italy (Roma)
- Shell International Renewables B.V., Netherlands (The Hague)

- FP7 RTD
- Total budget: 15,49 M€
- Commission funding: 10,22 M€
- Duration: 4 yrs (48 months)
- Start date : 1 Jan 2008

DECARBit – Integration of the tasks

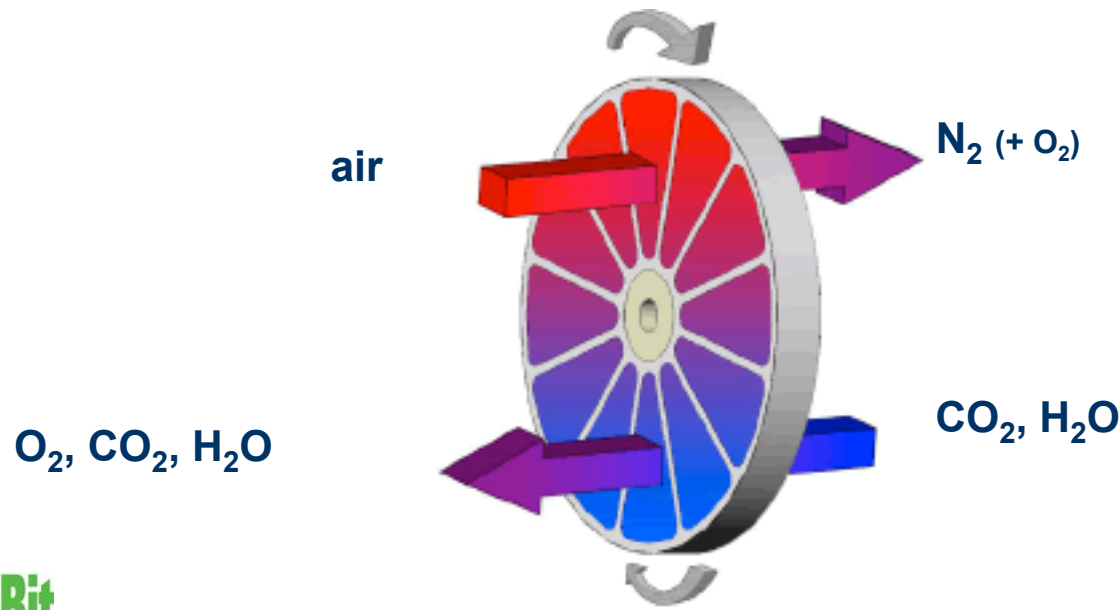


Schedule and decision gates

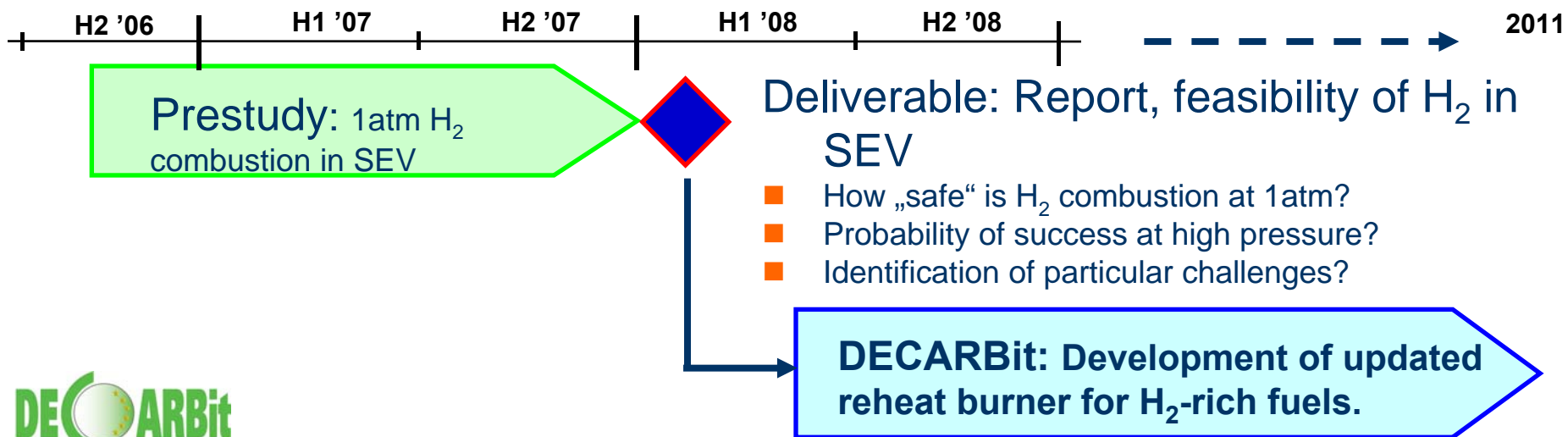
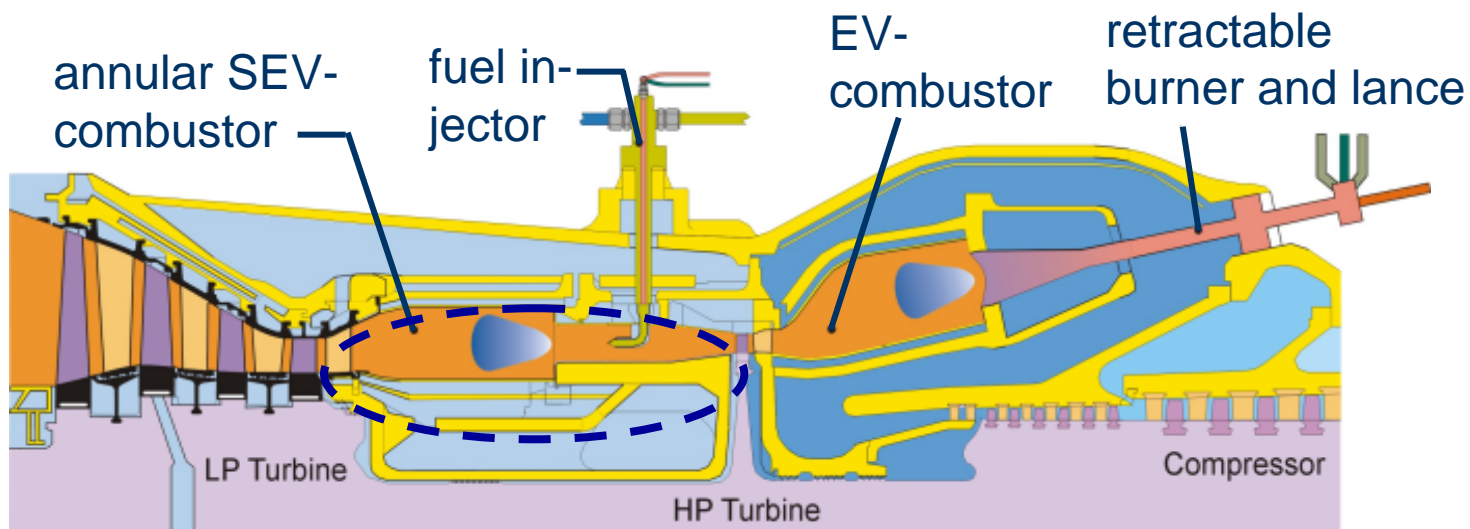


WP 3.2 Sorbent based technologies - Objective

- investigate a process for oxygen separation from air using novel sorbents at temperatures below 600 °C in a rotating adsorption /desorption reactor.



Objective of WP4.1



DECARBit- Summary

- So far the largest FP7 project within CCS
- Key for enabling pre-combustion CCS plants through in-depth R&D in
 - CO₂ separation
 - Oxygen separation
 - Hydrogen combustion and systems
 - Pilots and small scale unit testing for subsequent industrial uptake
- Key for making consistent benchmarking of units, cycles and plants – European Benchmarking Taskforce
- Strong and strategic partnership



Towards Hydrogen and Electricity Production with Carbon Dioxide Capture and Storage

StatoilHydro



bp



SIEMENS

ALSTOM



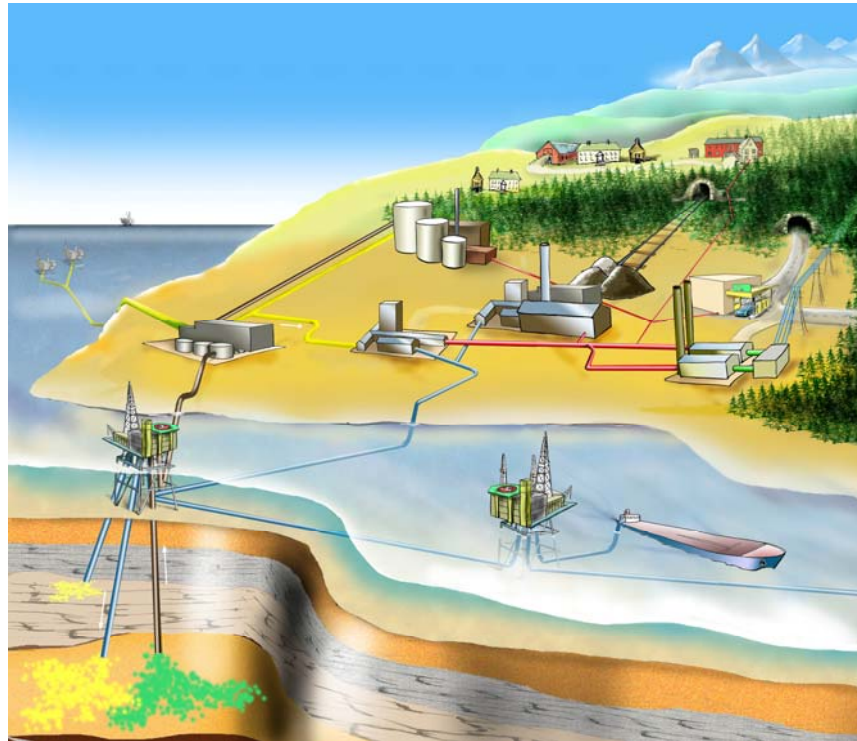
Schlumberger

SOCIETE GENERALE



endesa

VATTENFALL



NTNU



ie
Institute for Energy

ECOFYS



Bundesanstalt für Geowissenschaften und Rohstoffe

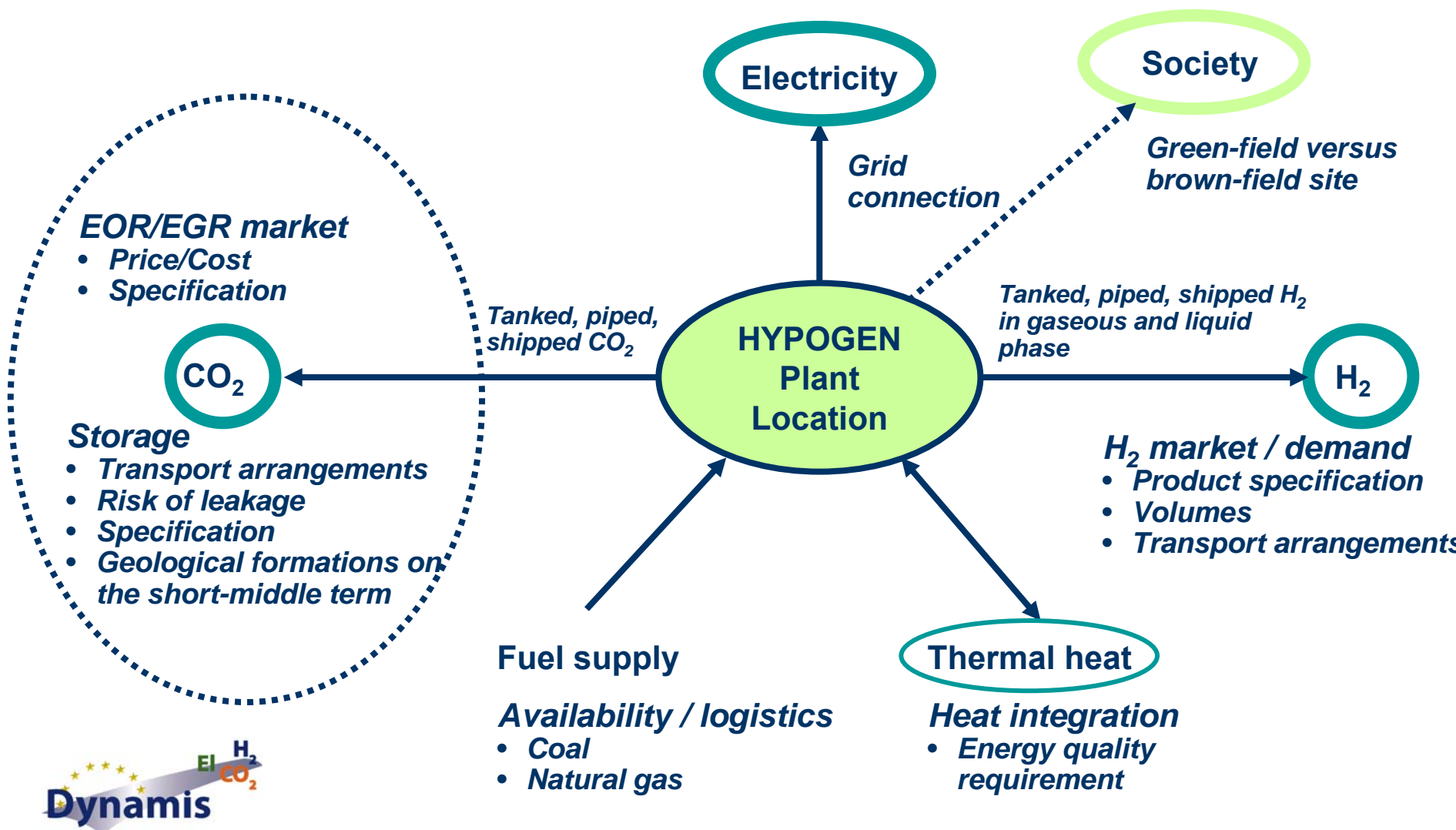


British Geological Survey

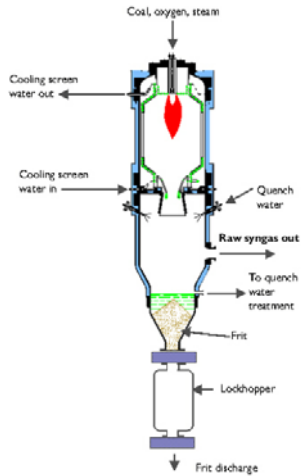
NATURAL ENVIRONMENT RESEARCH COUNCIL



HYPOGEN Plant



Technology Choices - Gasifiers

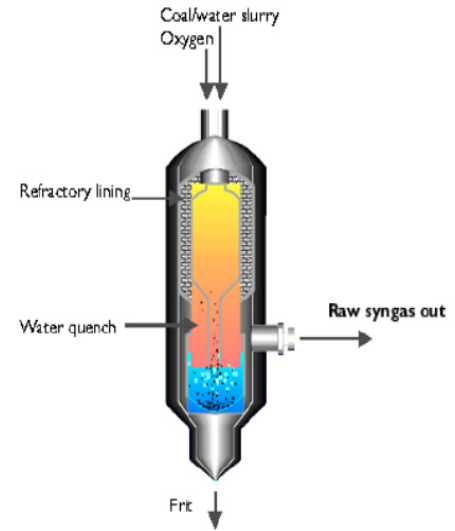


Coal recommendations

- Shell
- Siemens
- GE (Texaco) – lower efficiency due to slurry feed

Lignite recommendations

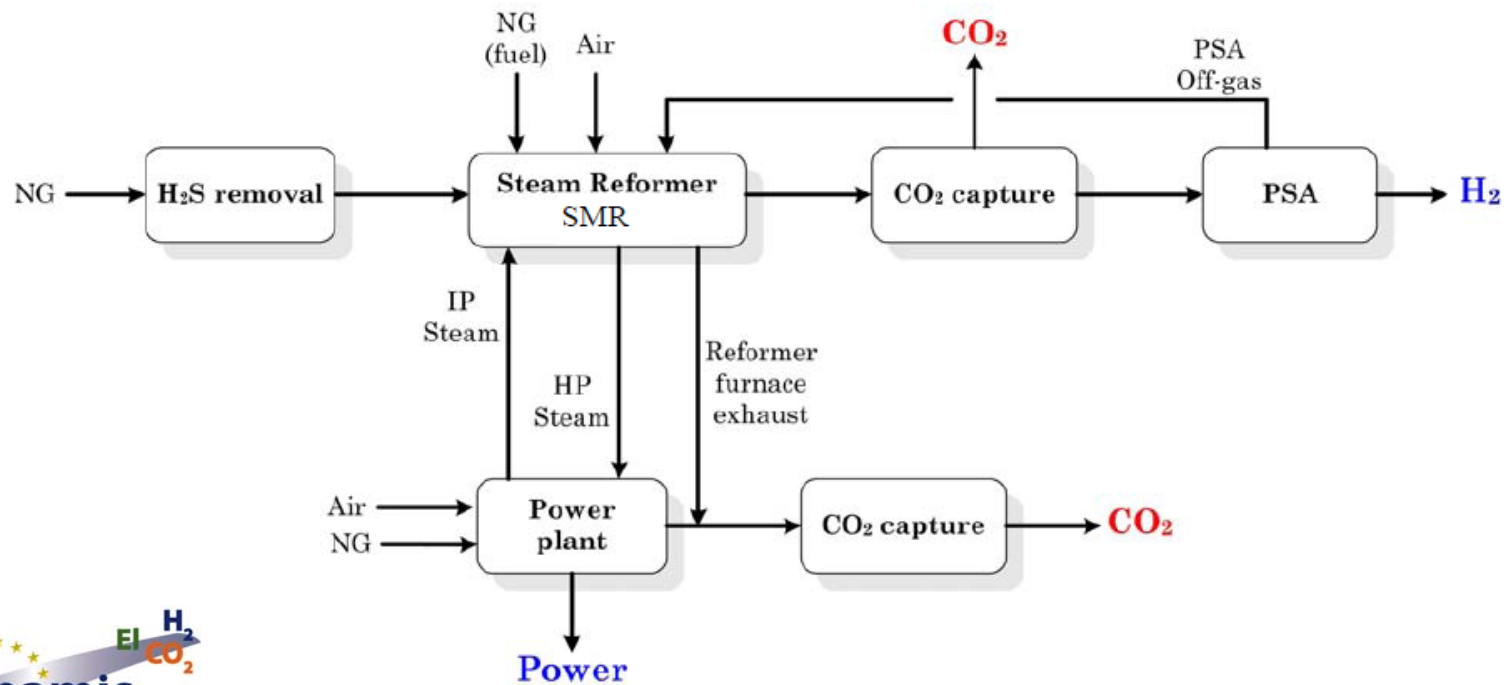
- Siemens
- HighTemp Winkler
- BG Lurgi



Technology Choices - Gas

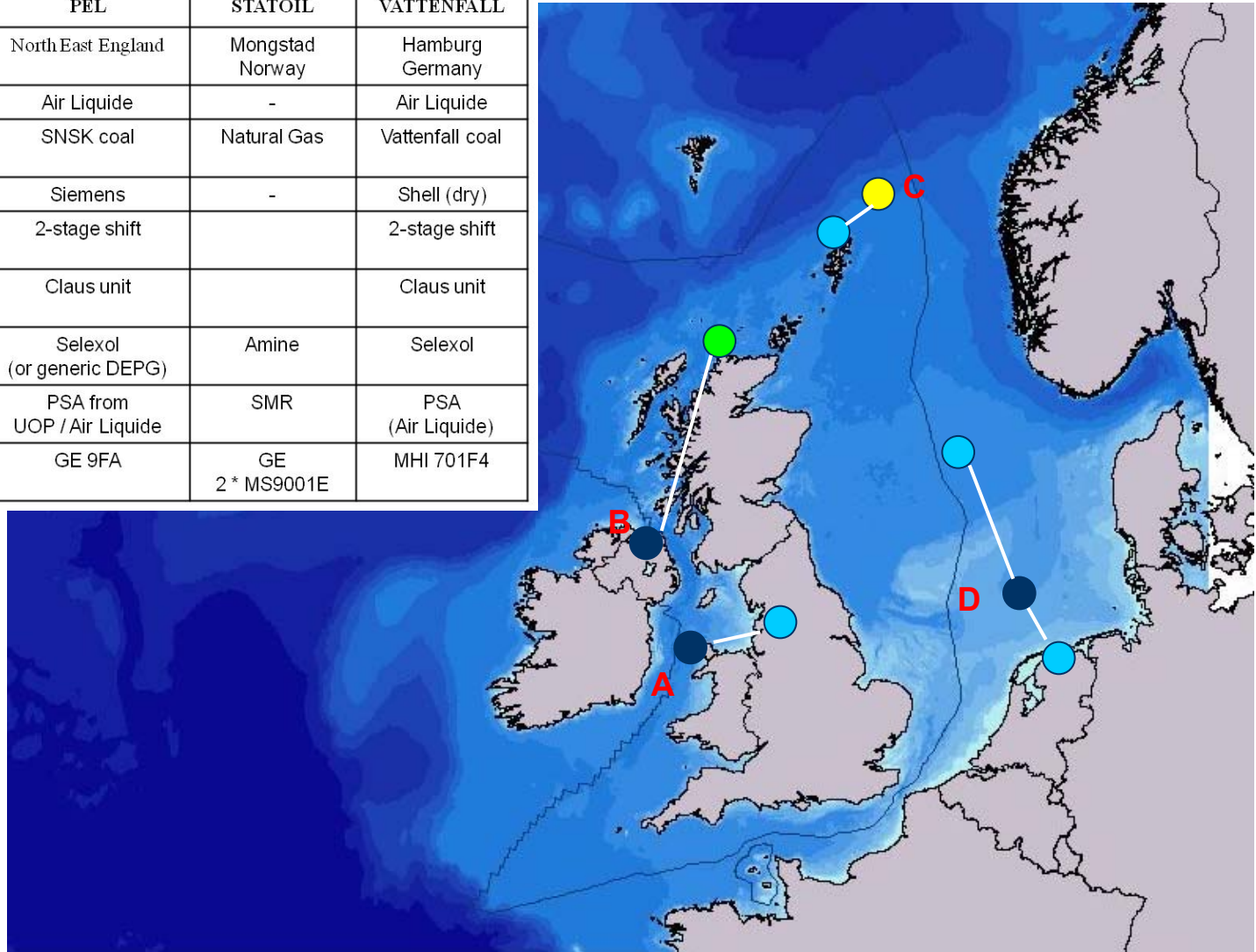
Process

- Post-combustion capture and parallel H_2 production most efficient
 - Driven largely by F-class turbine choice on NG



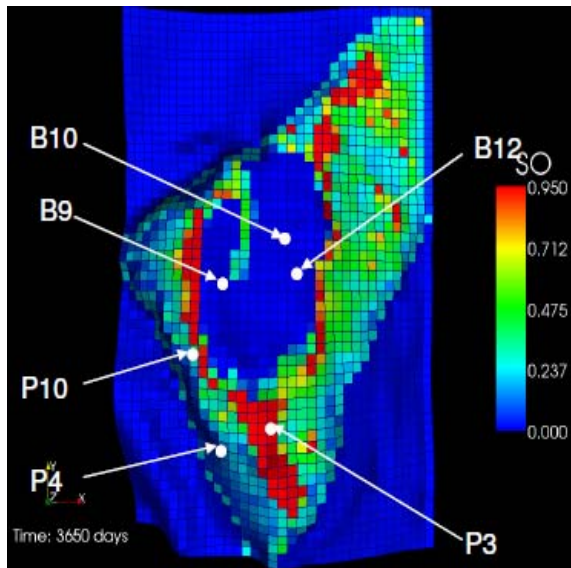
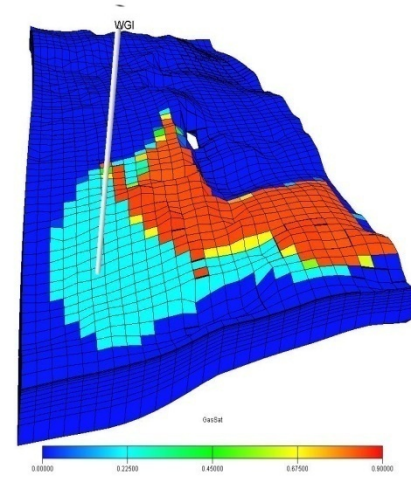
Case Studies: outlines and locations

Case Study	A EON	B PEL	C STATOIL	D VATTENFALL
Location	East England	North East England	Mongstad Norway	Hamburg Germany
ASU	Generic	Air Liquide	-	Air Liquide
Feedstock	Eon - El Cerrejon	SNSK coal	Natural Gas	Vattenfall coal
Gasifier	Siemens	Siemens	-	Shell (dry)
Shift / Conversion	2-stage shift	2-stage shift		2-stage shift
Sulphur Removal	Claus unit	Claus unit		Claus unit
Acid Gas Removal	Rectisol – Linde/Lurgi	Selexol (or generic DEPG)	Amine	Selexol
H ₂ Separation / Production		PSA from UOP / Air Liquide	SMR	PSA (Air Liquide)
Gas Turbine	MHI 701F4	GE 9FA	GE 2 * MS9001E	MHI 701F4



Storage Assessment and Modelling

- Variety of sites assessed with detailed reservoir modelling
- Injection schemes devised to match plant (1.9 – 3.2 Mt/a)
- EOR provides significant benefit and can justify longer transport
- Key issues: overpressure / boundary conditions, geological risk

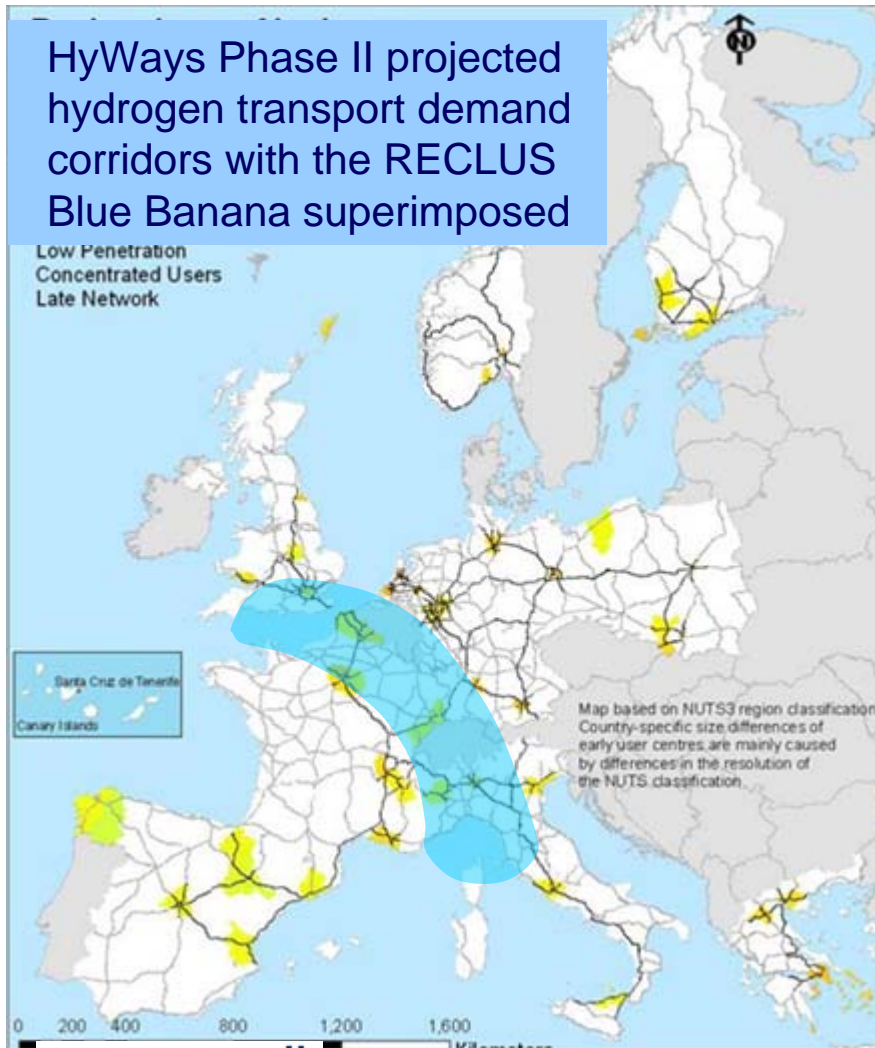


Case	Location	Type	Structure
A	Southern NS	Aquifer	Anticline
B	Central NS	EOR	Fault block
C	Offshore Mongstad	Aquifer	Tilted
D	Onshore Hamburg	Aquifer	Dome
D	Danish NS	Aquifer	Anticline



Hydrogen Supply Prospects

HyWays Phase II projected hydrogen transport demand corridors with the RECLUS Blue Banana superimposed



Demand for bulk hydrogen is likely to develop slowly in the transport sector, but good interim industrial demand in key locations.

For the Case Studies:

Hydrogen Demand	Transport	Industry
East England	Low	Good
N.E. England	Moderate Tyneside	Good
Mongstad Norway	Poor	Excellent
Hamburg	Moderate	Moderate

EIS topics peculiar to IGCC / CCS:

- Safety case for CO₂ in transport / storage
 - Onshore (proximity) and Offshore
- Impact of marine CO₂ leaks
- Additional water use
- Chemical solvents
- Syngas / CO₂ flaring
- Other impacts similar to regular power stations

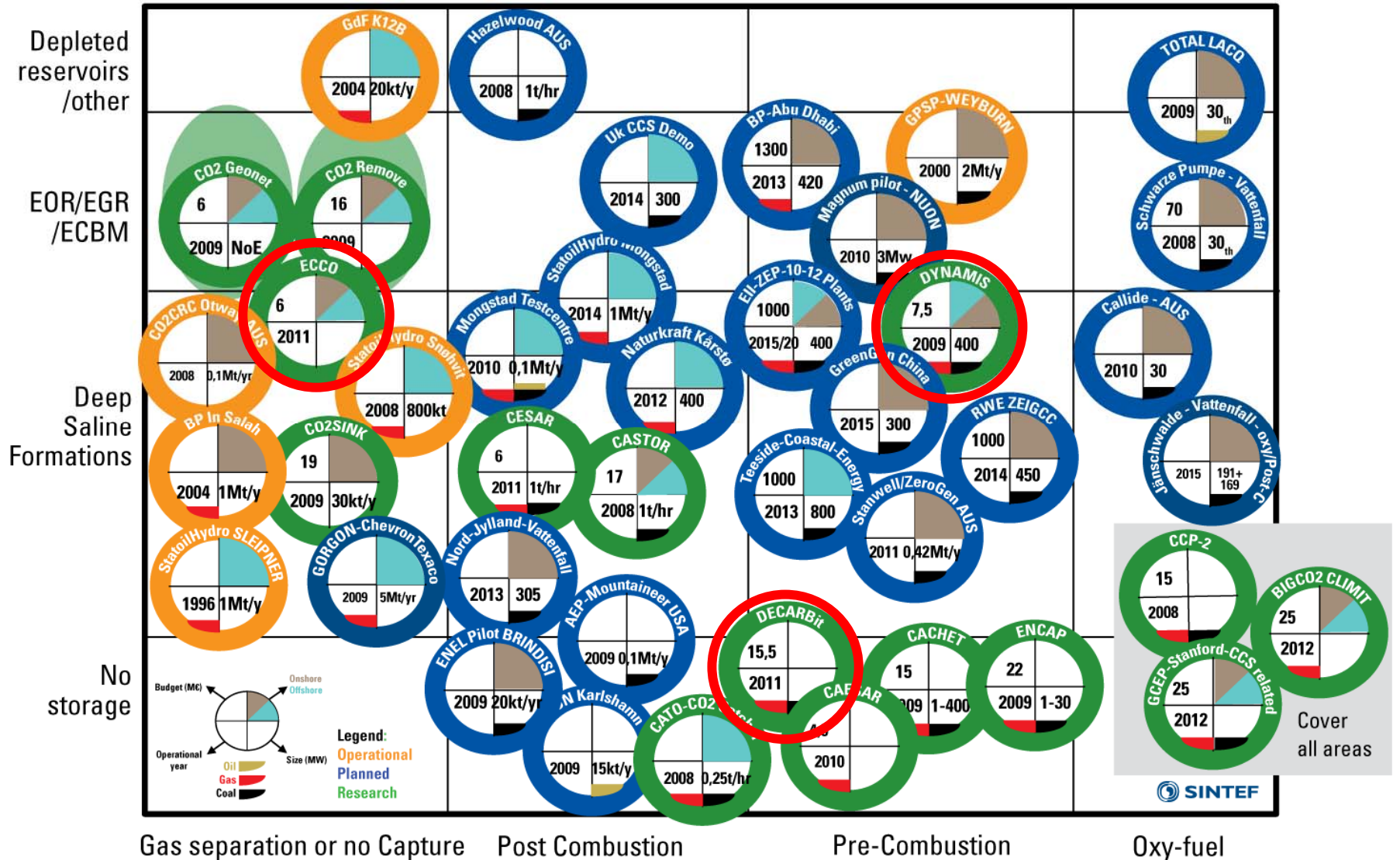
CO₂ storage sub-sea issues being addressed (OSPAR, LC); also cross-border pipelines.



Societal anchorage

- **Economics and financeability**
 - Support from banks and shareholders
 - Credit availability
 - Scenario based financial modelling
- **Plant key risks**
 - Large absolute capital
 - Capture first of a kind technology risk
 - Inmaturity of EU ETS prices
 - Inmaturity of performance guarantees for IGCC
- **Support mechanisms**
- **Public opinion**

CCS project portfolio (some of it...)



Contact information

■ ECCO

- Coordinator: Dr. Petter E. Røkke
- petter.e.rokke@sintef.no
- <http://ecco.sintef.no>

■ DECARBIT

- Coordinators: Dr. Nils A. Røkke/ Dr. Marie Bysveen
- Nils.a.rokke@sintef.no and marie.bysveen@sintef.no
- <http://www.DECARBit.com>



■ DYNAMIS

- Coordinator: Dr. Nils A. Røkke
- Dynamis-coordinator@sintef.no
- <http://www.dynamis-hypogen.com>



Thank you for your attention !