

The Zero Emission Platform (ZEP) and the DYNAMIS project as a potential bridge between ZEP and FCH-JU



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■ NTNU: The Norwegian University of Science and Technology

- Educates nearly all graduates and PhDs within technology in Norway
- 20000 full-time students, 935 Scientific employees
- 149 Post graduate students, 731 PhD Students
- Located in Trondheim

■ SINTEF: Norway's largest research institute

- Among the largest in Europe, 1300 researchers
- Co-located with NTNU
- Focus on technology
- Performs contract research

European Technology Platform for Zero Emission Fossil Fuel Power Plants



ZEP's Objective

**Enable commercial availability
of Carbon Capture and Storage by 2020 and
kick-start widespread deployment**

- Initiated by the European Commission in 2005
- Unique coalition of stakeholders:
 - European utilities, petroleum companies, equipment suppliers, scientists, academics and environmental NGOs
- Over 200 members from 19 countries

World's First CCS Demo Programme!

2007 EU calls for CCS demo programme by 2015



2007 ZEP Vision for EU
CCS demo programme



**2008 ZEP proposal for
CCS demo programme**



**2009 ZEP recommendations
on NER funding**



**2009 ZEP CCS knowledge
sharing proposal**

➤ **2008** EU agrees to
co-fund programme

2009 EU passes legislation
on CO₂ geological storage

➤ **CCS Project Network launch**

Source: General Assembly ZEP, September 2009

EU CCS Demonstration Programme



Objective:

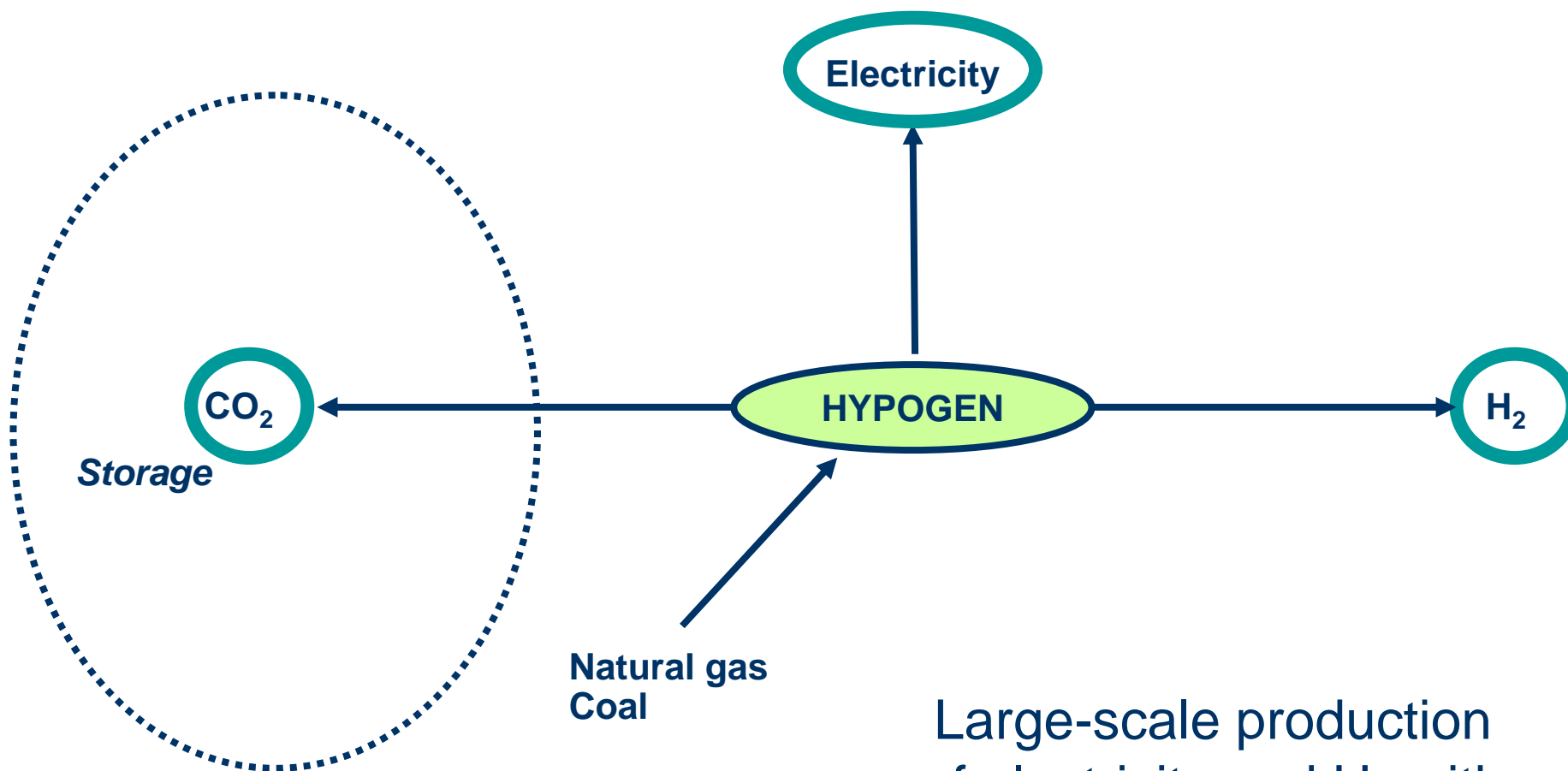
Enable commercial availability of CCS by 2020



An optimised portfolio is essential

Source: General Assembly ZEP, September 2009

HYPOGEN Plant



Large-scale production
of electricity and H₂ with
CO₂ capture and storage



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SIXTH FRAMEWORK PROGRAMME

HYPOGEN overall timeline & budget

- Phase 0 Feasibility Study by JRC (2004)
- Phase 1 Measures within FP6, DYNAMIS (2006-2008) 7.5 M€
- Phase 2 Pilot Scale Demonstrations (2008-2010) 290 M€
- Phase 3 Demonstration Plant Construction (2008 – 2012) 800 M€
- Phase 4 Operation and validation (2012-2015) 200 M€

SUM

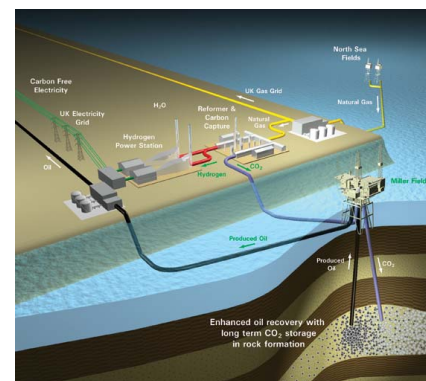
~1300 M€



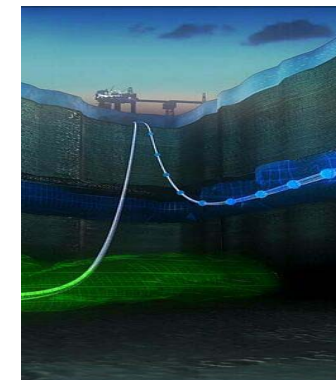
Pic. Siemens



Pic. Vattenfall



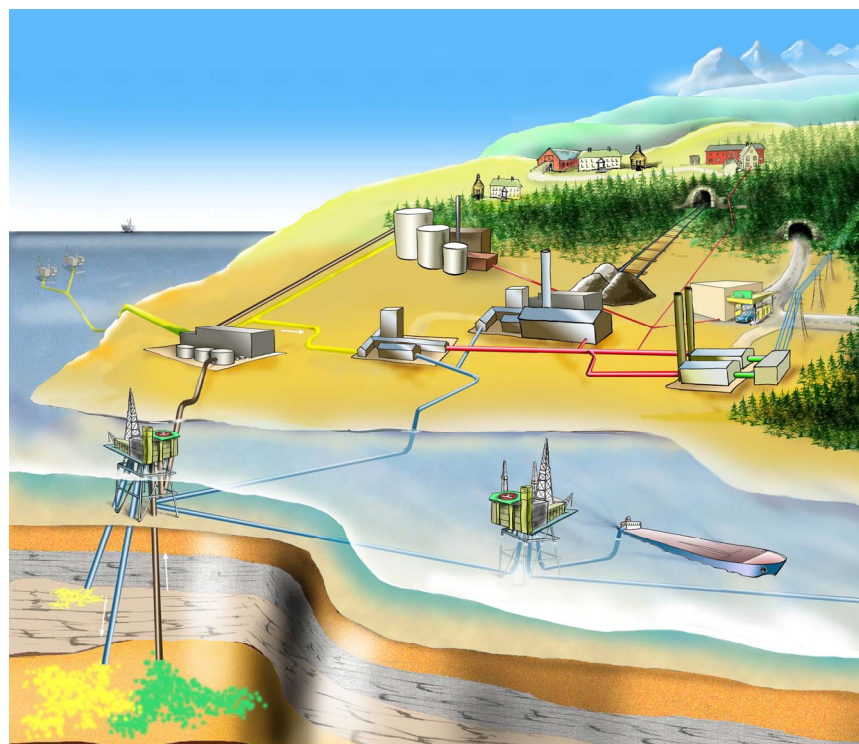
Pic. BP



Pic. Statoil



Towards Hydrogen and Electricity Production with Carbon Dioxide Capture and Storage



StatoilHydro



SIEMENS

ALSTOM



Schlumberger



NTNU



ECOFYS



Bundesanstalt für
Geowissenschaften
und Rohstoffe

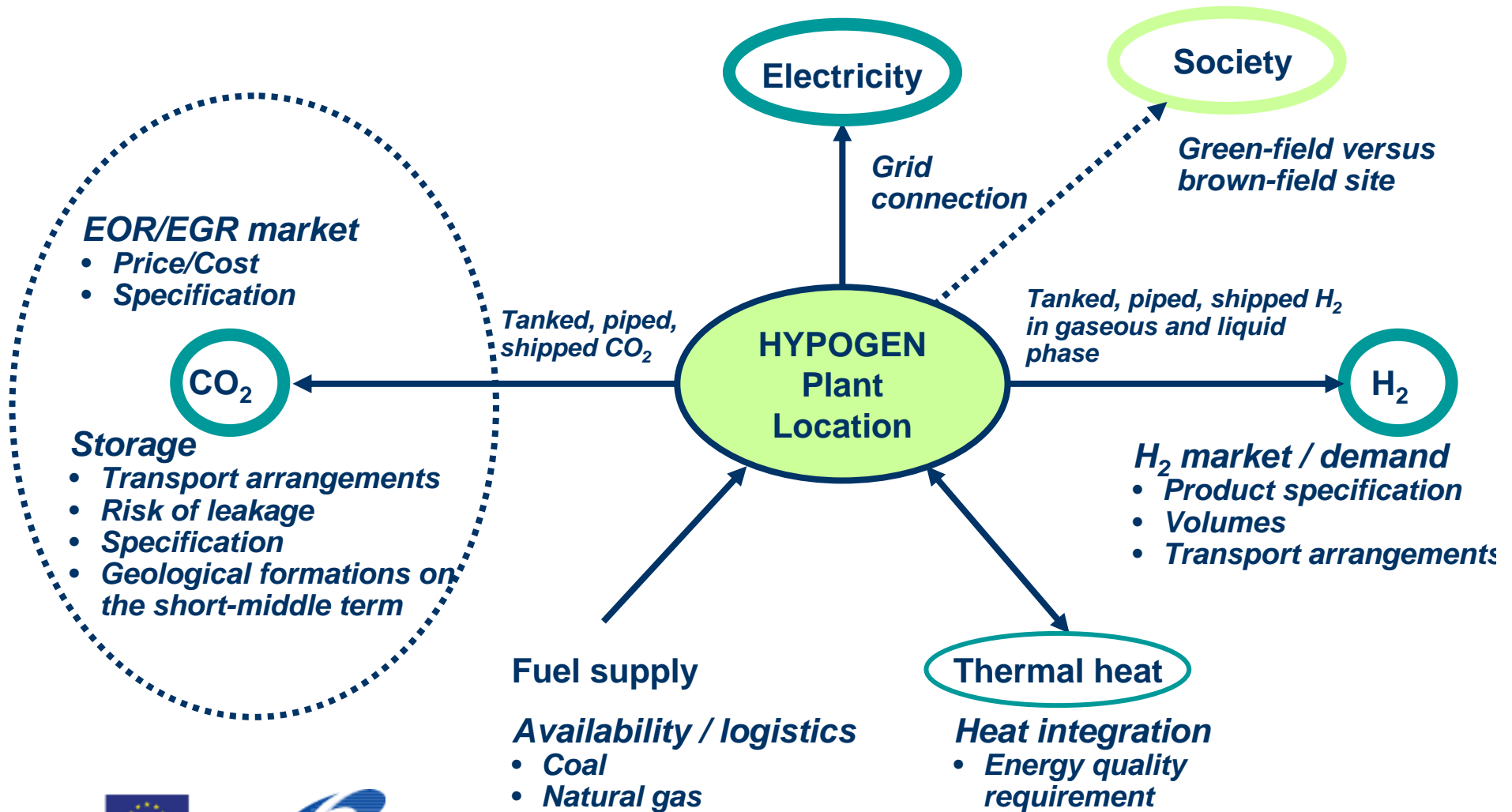


Recognition Award from the Carbon Sequestration Leadership Forum, October 2009



- Sverre Aam, CEO, SINTEF Energy Research
- Terje Riis-Johansen
Oil and Energy
Minister of Norway
- Barbara McKee,
Director, Office of Coal
& Power, Import &
Export, DoE-USA

HYPOGEN Plant



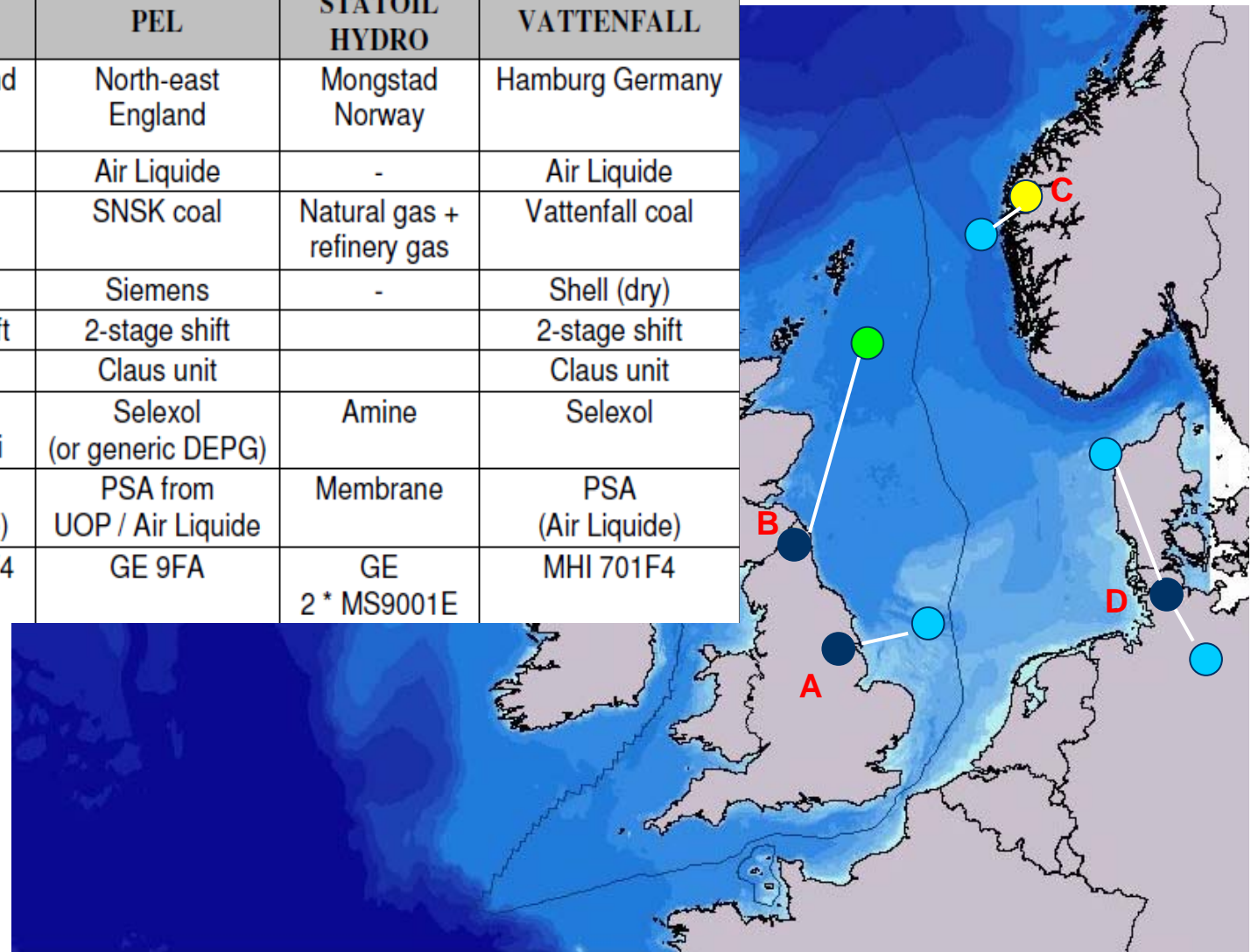
FUNDED BY THE EUROPEAN UNION



SIXTH FRAMEWORK PROGRAMME

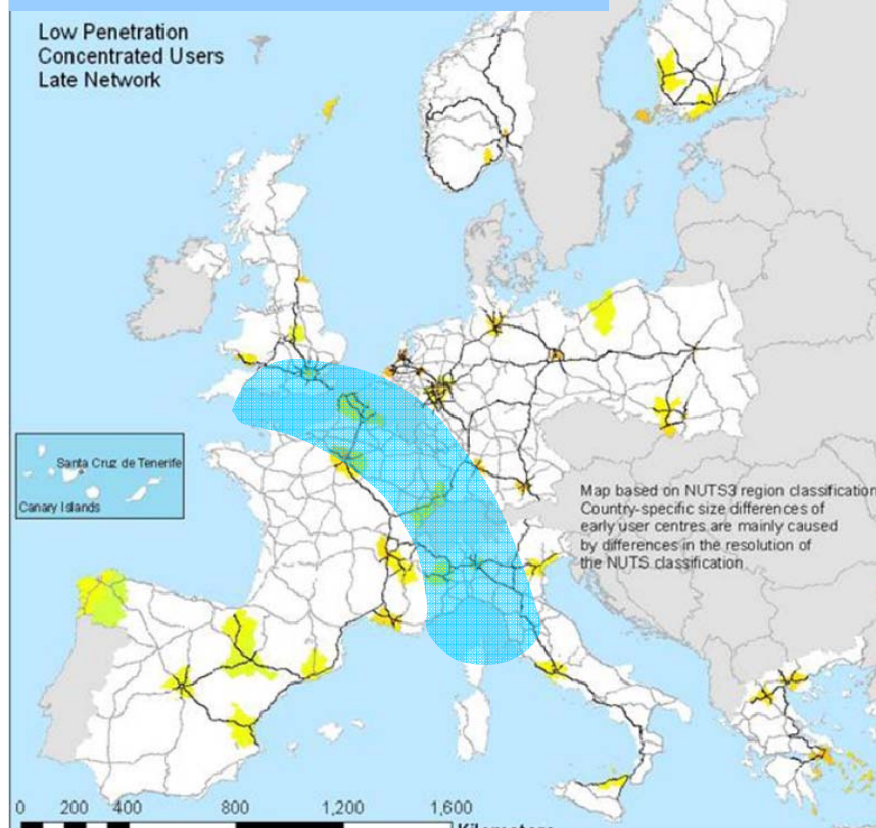
Case Studies: outlines and locations

Case Study	A EON	B PEL	C STATOIL HYDRO	D VATTENFALL
Location	East England	North-east England	Mongstad Norway	Hamburg Germany
ASU	Generic	Air Liquide	-	Air Liquide
Feedstock	Eon - EI Cerrejon	SNSK coal	Natural gas + refinery 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
H2 Separation / Production	PSA (Air Liquide)	PSA from UOP / Air Liquide	Membrane	PSA (Air Liquide)
Gas Turbine	MHI M701F4	GE 9FA	GE 2 * MS9001E	MHI 701F4



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 Tyneside	Moderate	Good
Mongstad Norway	Low	Excellent
Hamburg	Moderate	Moderate

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EOCH5

I prefer if you write Low for transport instead of poor

Ochoa-Fernández, Esther; 4/02/2009

Input for discussion

- HYPOGEN to be placed/revitalised within the CCS and H₂ strategies of Europe (via pilots or full scale demo?)
- Hydrogen – key or pacing in a CCS context?
- Ownership for fossil-fuel H₂?
- Energy sources for large scale H₂ systems?
- Dynamis as vehicle for bridging FCH and ZEP?
- Are the driving forces behind H₂ and CCS different? (size, impact,...)
- H₂ interface issues: specifications, market, etc

References

■ Dynamis project (concluded):

- www.DYNAMIS-hypogen.com
- Coordinator: SINTEF Energy Research, Norway, www.sintef.no/energy
- Contact: Nils Røkke, +47 73 59 72 00

■ Publications:

- Public brochure with main findings
- Open reports at www.DYNAMIS-hypogen.com
- H₂ related:

"Hydrogen quality from decarbonized fossil fuels to fuel cells"

Besancon et al., International Journal of Hydrogen Energy 34 (2009), 2350-2360