DYNAMIS- Paving the road for CCS plants in Europe

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CO$_2$ capture from power generation

**Post-combustion capture**

Fuel $\rightarrow$ Power & Heat $\rightarrow$ Flue gas $\rightarrow$ CO$_2$ separation $\rightarrow$ N$_2$, O$_2$, H$_2$O

**Pre-combustion capture**

Fuel $\rightarrow$ Gasification or partial oxidation shift + CO$_2$ separation $\rightarrow$ H$_2$ $\rightarrow$ Power & Heat $\rightarrow$ N$_2$, O$_2$, H$_2$O $\rightarrow$ CO$_2$ $\rightarrow$ CO$_2$ (H$_2$O)

Fuel $\rightarrow$ O$_2$ $\rightarrow$ Air separation $\rightarrow$ N$_2$ $\rightarrow$ CO$_2$ dehydation, compression, transport and storage

**O$_2$/CO$_2$ recycle (oxyfuel) combustion capture**

Fuel $\rightarrow$ Power & Heat $\rightarrow$ Recycle (CO$_2$, H$_2$O) $\rightarrow$ O$_2$ $\rightarrow$ Air separation $\rightarrow$ N$_2$ $\rightarrow$ DYNAMIS/HYPOGEN
The DYNAMIS and HYPOGEN Vision
EU - DYNAMIS/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€
The DYNAMIS Consortium

ENERGY PROVIDERS
- Statoil
- Hydro
- BP

R&D PROVIDERS
- SINTEF
- NTNU
- British Geological Survey
- ECOFYS
- European Patent Office
- Enel

MANUFACTURERS,
ENGINEERING,
FINANCING
- Alstom
- Air Liquide
- Société Générale
- Schlumberger
- Progressive Energy

POWER COMPANIES
- E.ON
- Vattenfall

Funded by the European Union, Sixth Framework Programme
DYNAMIS – Partner Nationalities
DYNAMIS in Short

Key words for DYNAMIS
- Decarbonised power production
- H₂ separation and production
- Novel power cycles
- Safe storage of CO₂
- Societal anchorage including judicial, funding and other public requirements
DYNAMIS - Main objective

Investigate viable routes for large-scale cost-effective combined H2 and electricity production with integrated CO2 capture and storage, possibly combined with EOR.
DYNAMIS – Sub-projects

SP5 – Integration
SP2 – Capture Technologies
SP3 - Transport Technologies
SP4 – Storage Options
SP6 – Societal Anchorage

Market, Environment and Financing Options
Permitting and Public Acceptance

Technology Data and Characteristics
System Data and Characteristics
Aspects of HYPOGEN

- Transport arrangements
- Risk of leakage
- Specification
- Geological formations on the short-middle term

EOR/EGR market
- Price
- Specification

CO₂

Storage
- Tanked, piped, shipped CO₂
- Tanked, piped, shipped H₂ in gaseous and liquid phase

HYPOGEN Plant Configuration

- Fuel supply
  - Availability / logistics
    - Coal
    - Natural gas

Electricity
- Grid connection

H₂ market / demand
- Product specification
- Volumes
- Transport arrangements

Thermal heat
- Energy quality requirement

Heat integration
Technology selection

- Natural gas reforming
  - ATR, SMR
  - Solvents for high pressure CO$_2$ capture
- Coal gasification
  - Coal specification with focus on H$_2$ production, not only syngas production
- Gas turbines for H$_2$ rich fuel
  - Alstom & Siemens are partners
  - Commercially available technology only
- Gas conditioning (H$_2$ and CO$_2$)
Product specifications

- $\text{H}_2$ specification for transport market in 2012
- $\text{CO}_2$ transport – long distances
- $\text{CO}_2$ quality for storage/EOR
Site selection

• Fuel availability
  – Coal mines, natural gas pipelines

• Markets
  – Electricity, H₂

• Distance to possible storage/EOR locations
  – 30 year operation:
    • 45 Mt CO₂ with a NGCC power plant
    • 70 Mt CO₂ with a IGCC power plant
What will DYNAMIS deliver?

A coherent view of

- Options for CCS plants in Europe
  - Fuels
  - Preferred Technology
  - Example locations
  - Storage and EOR possibilities
  - Financing schemes
  - Regulatory restraints and possibilities

- Non-technical barriers
  - Societal views of a Hypogen demonstration

A pre-engineering basis suitable for uptake in the next phase of Hypogen
DYNAMIS was called for in 2004 and started in 2006—what has happened in between?
Projects timeline
Futuregen is happening!

Plant Online 2012

Alliance Is here

Futuregen in action!
What is Europe asking for?

Quote from” COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN COUNCIL AND THE EUROPEAN PARLIAMENT - AN ENERGY POLICY FOR EUROPE”

As set out in its Sustainable Power Generation Communication 24, the Commission will in 2007 start work to:

• Design a mechanism to stimulate the construction and operation by 2015 of up to 12 large scale demonstrations of sustainable fossil fuels technologies in commercial power generation in the EU25.
• Provide a clear perspective when coal- and gas-fired plants will need to install CO2 capture and storage. On the basis of existing information, the Commission believes that by 2020 all new coal-fired plants should to be fitted with CO2 capture and storage and existing plants should then progressively follow the same approach.
• Proposed a committment of 20% cuts by 2020 in GHG emissions and to push for 50% cuts globally by 2050
How does everything fit together?

Existing National Programmes

Member State Co-ordination Action (FENCO)

Future National Programmes

Large Scale Commercial Demos

FP6 IP’s

DYNAMIS

SRA/SDD

ZEP

EU DEMOS: 1 - 5

6-10..

China?

India??

Incentives Required

Regulatory

RTD support

Financial
How can HYPOGEN happen?

2005/06

Interface 1

DYNAMIS
HYPOGEN Ph 1
DYNAMIS Consortium
Deliverables x, y, z
Integrated outcome open for industrial up-take

2008/09

Interface 2

PILOTS?
HYPOGEN Ph 2
Consortium?
Deliverables Availability?

2011/12

Interface 3

LARGE SCALE PLANT
HYPOGEN Ph 3
Industrial Consortium/Owner
Targets erection of new plant

2015/16

Interface 3

OPERATION
HYPOGEN Ph 4
Commercial?
Show-case

20XX–>

Industry
EU and Governments
JTI?

Industry Governments and EU
Definitively 1 or more JTI’s
Summary

- DYNAMIS is the vehicle for HYPOGEN
- It has the promise of uniting the hydrogen and the low carbon economy
- DYNAMIS is eager to play in role in establishing CCS plants in Europe
- DYNAMIS will deliver a basis for further CCS development in Europe consistent with the recommendations of ZEP