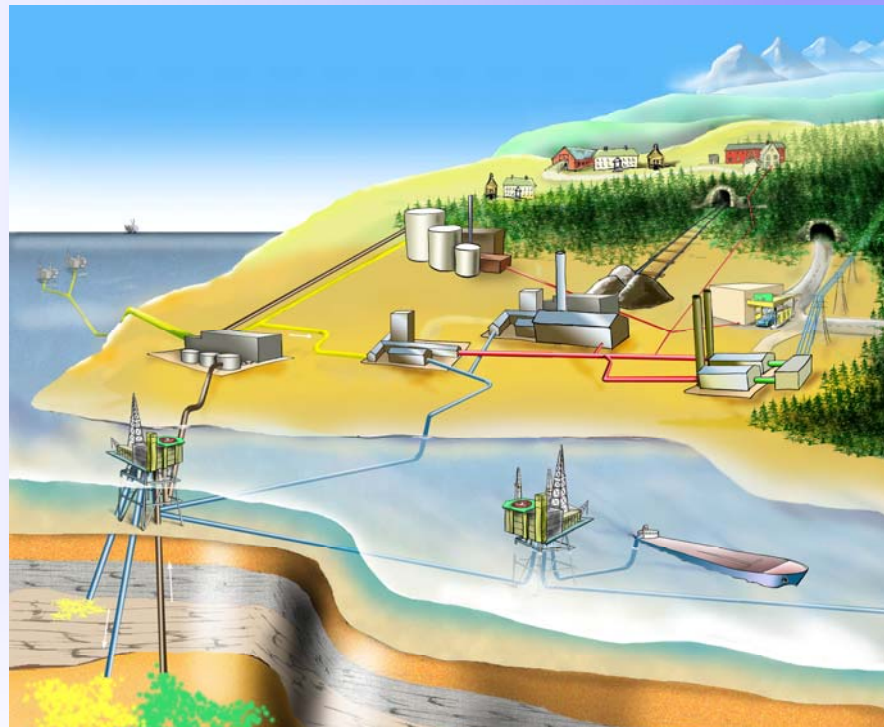


# DYNAMIS

## Towards Hydrogen Production with CO<sub>2</sub> Management

CSLF Meeting in Cape Town, South Africa 16th April 2008

Nils A. Røkke – Co-ordinator - SINTEF



Presented by Nick Otter Chair of CSLF PIRT

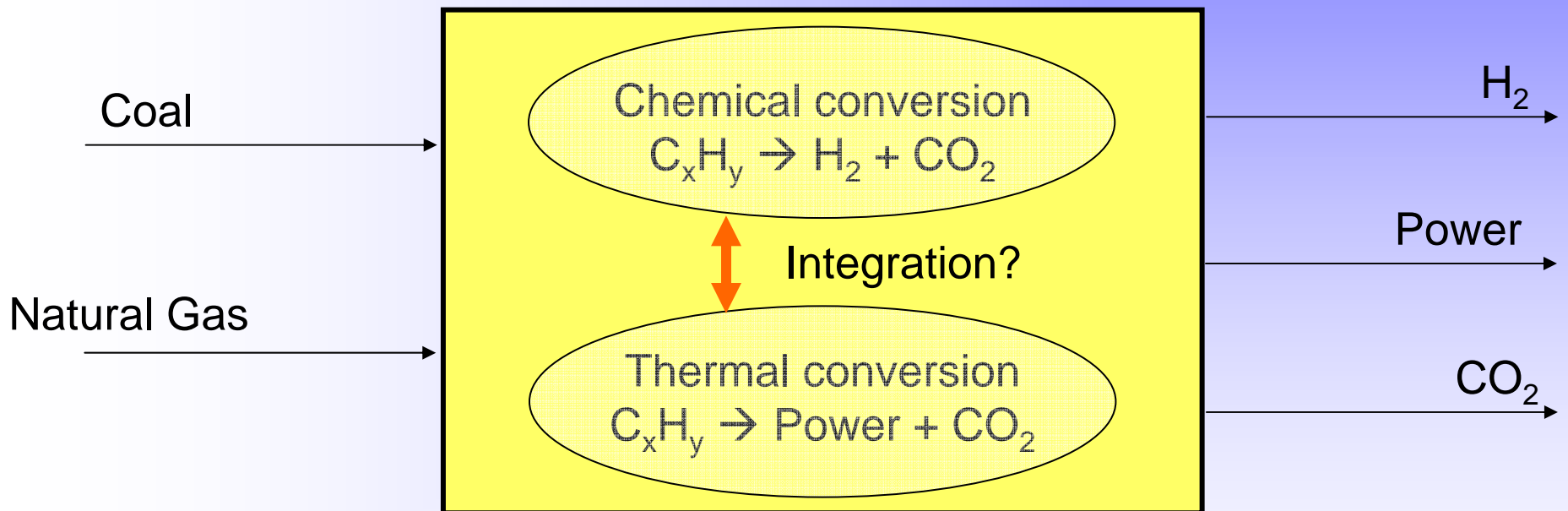
# DYNAMIS

*"Towards Hydrogen and Electricity Production with Carbon Dioxide Capture and Storage"*

Identifying options for the future

- Co-funded by the European Commission (FP6)
- Contract no.: 019672
- Project duration: 2006-2009 (36 months)
- Budget: 7,4 million €
- Co-ordinator: Nils A. Røkke, SINTEF Energy Research, Trondheim Norway

# DYNAMIS Scheme



# EU-DYNAMIS/HYPOGEN Overall Timeline & Budget

- Phase 0 Feasibility Study by JRC (2004)
  - Phase 1 Measures within FP6, DYNAMIS (2006-2009) 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€
- Total ~1300 M€**



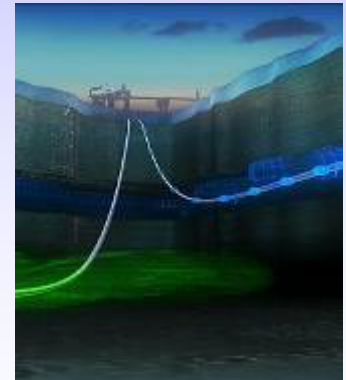
Pic. Siemens



Pic. Vattenfall



Ill. Statoil









# Consortium - 32 partners from 12 countries

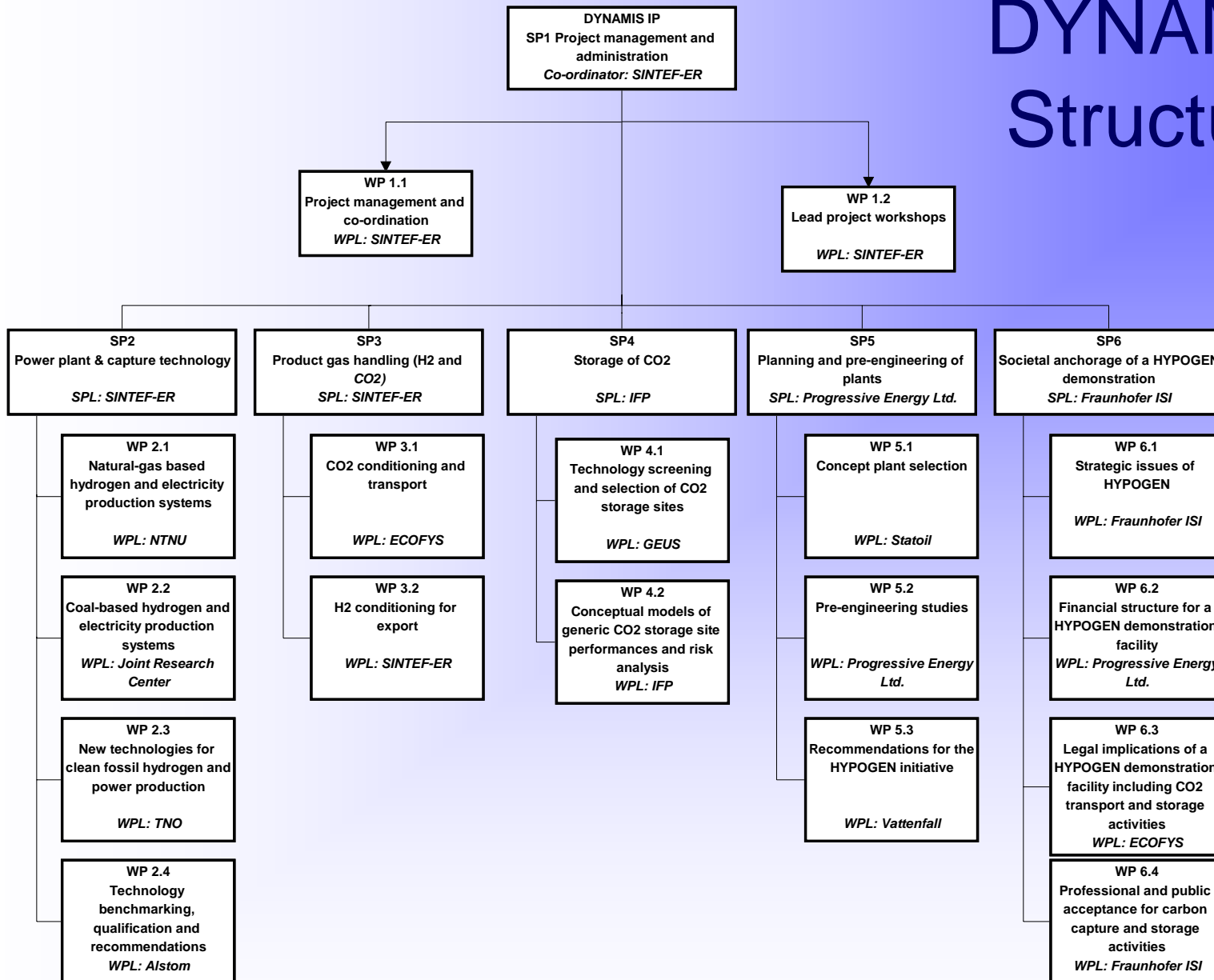
## Co-ordinator:

 SINTEF Energy Research

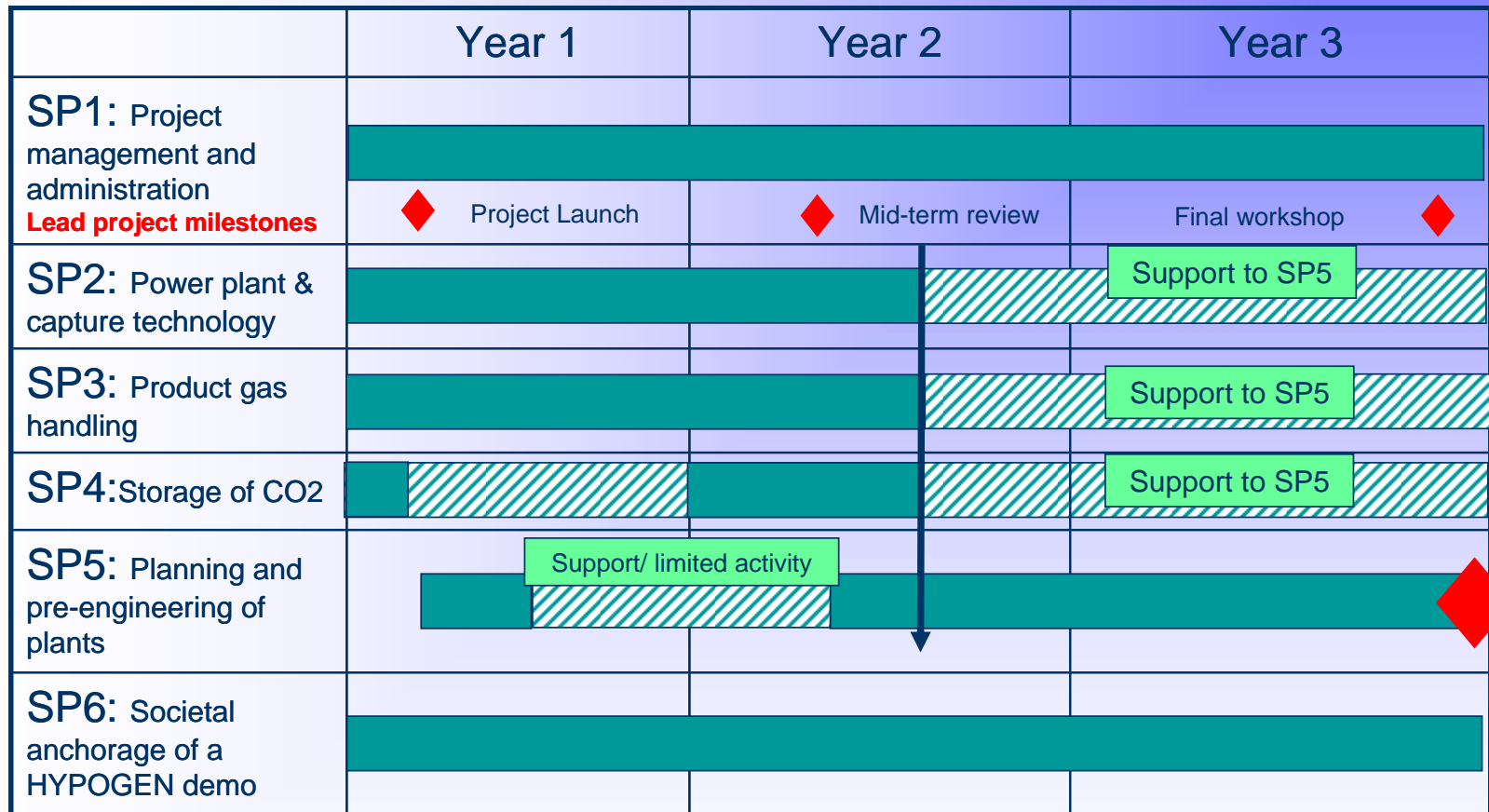
## Partners:

-  ALSTOM (Schweiz) AG
-  ALSTOM Power Centrales
-  ALSTOM Power Environment ECS France
-  BP International Ltd
-  Bundesanstalt für Geowissenschaften und Rohstoffe
-  E.ON UK plc
-  Ecofys b.v.
-  ENDESA Generación S.A.
-  ENEL Produzione S.p.a.
-  Etudes et Productions Schlumberger
-  European Commission - DG JRC – Institute for Energy
-  Fraunhofer Institute for Systems and Innovation Research
-  Geological survey of Denmark and Greenland
-  IEA Greenhouse Gas R&D Programme
-  Institut Français du Pétrole
-  L'AIR LIQUIDE
-  Natural Environment Research Council (British Geological Survey)
-  Netherlands Organisation for applied Scientific Research (TNO)
-  Norsk Hydro ASA
-  Norwegian University of Science and Technology
-  Progressive Energy Ltd
-  Siemens Aktiengesellschaft
-  SINTEF
-  SINTEF Energy Research
-  SINTEF Petroleumsforskning AS
-  Société Générale London Branch
-  Statoil
-  Store Norske Spitsbergen Kulkompani AS
-  Technical University of Sofia
-  Vattenfall AB
-  Vattenfall Research and Development AB
-  Shell Hydrogen BV

# DYNAMIS Structure



# Overall Project Schedule

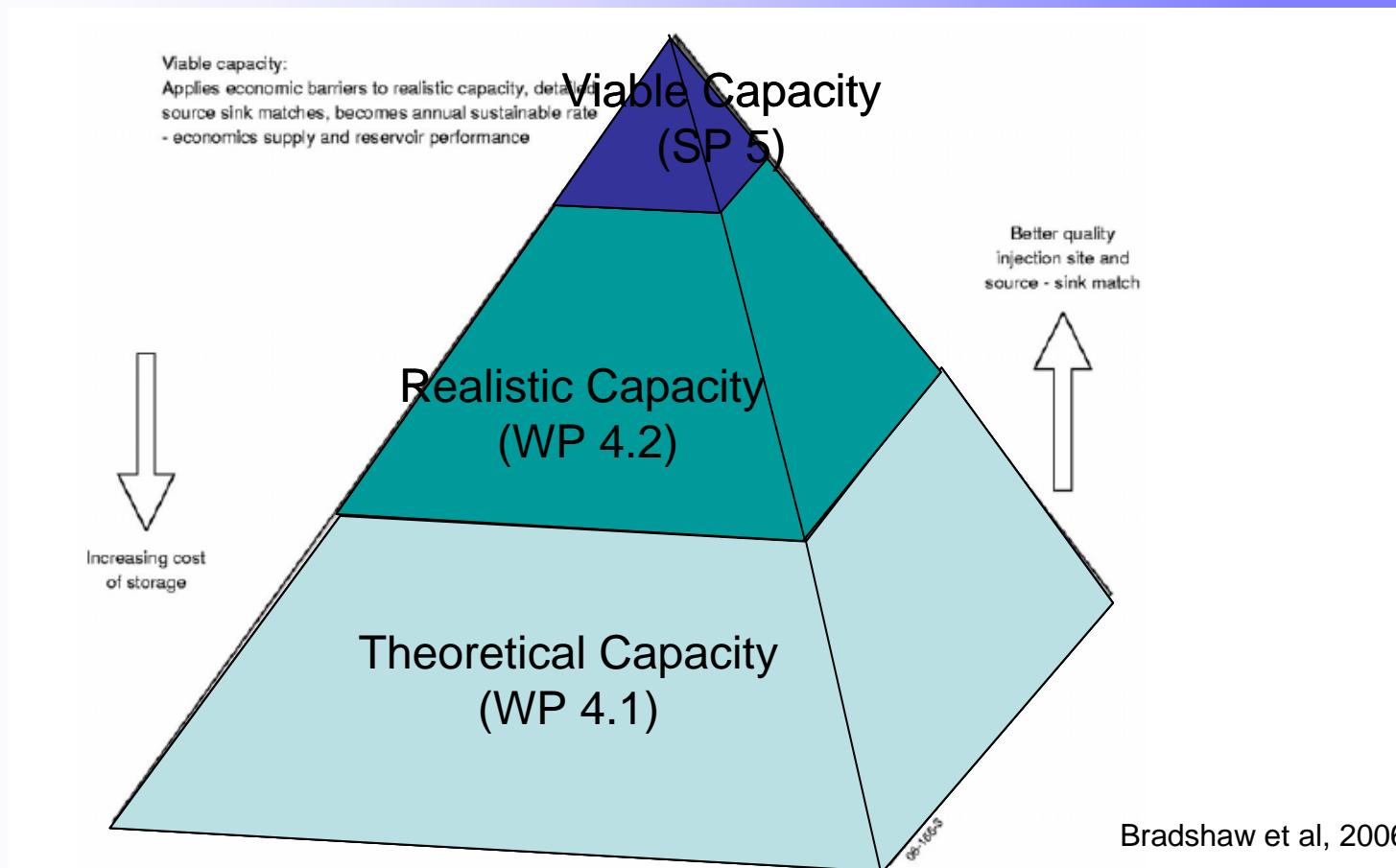


# Selection Issues

- Geographic Aspects
  - Site specifics
  - Fuels availability
  - Power and heat sales
  - CO<sub>2</sub> conditioning and storage
  - Hydrogen demand
- Technical Aspects
  - Overall 90% CO<sub>2</sub> extraction, 400 MW<sub>e</sub> and 0-50 MW H<sub>2</sub> export
  - Methane/Coal reforming/gasiifcation technology
  - Syngas Separation and Conditioning
  - GT's and train configuration(SIEMENS V94.2K, ALSTOM GT13E)
- Financial Aspects
  - CAPEX, OPEX
  - Financial risk : Technical, Financial (loans and interest, bankability),EIB role
- Political & Legal Aspects
  - Framework
  - Concensus and joint undertakings
  - Storage risk and acceptance

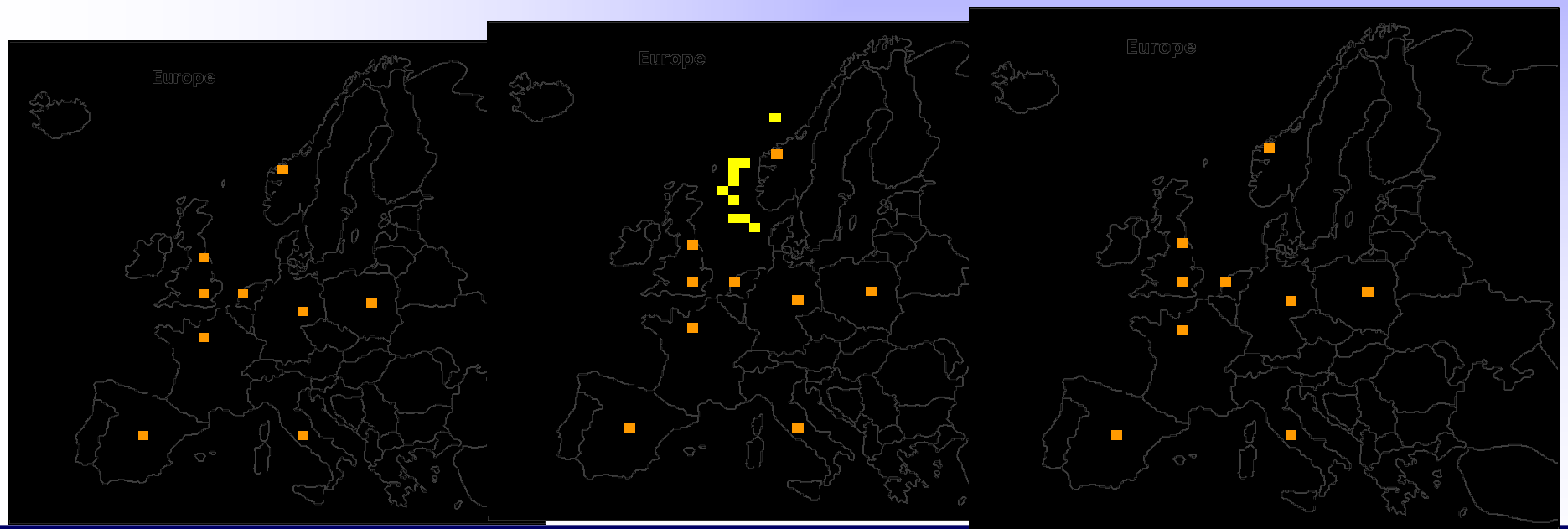


# Critical Criterion - CO<sub>2</sub> Storage



# Storing CO<sub>2</sub> - Matching with sinks

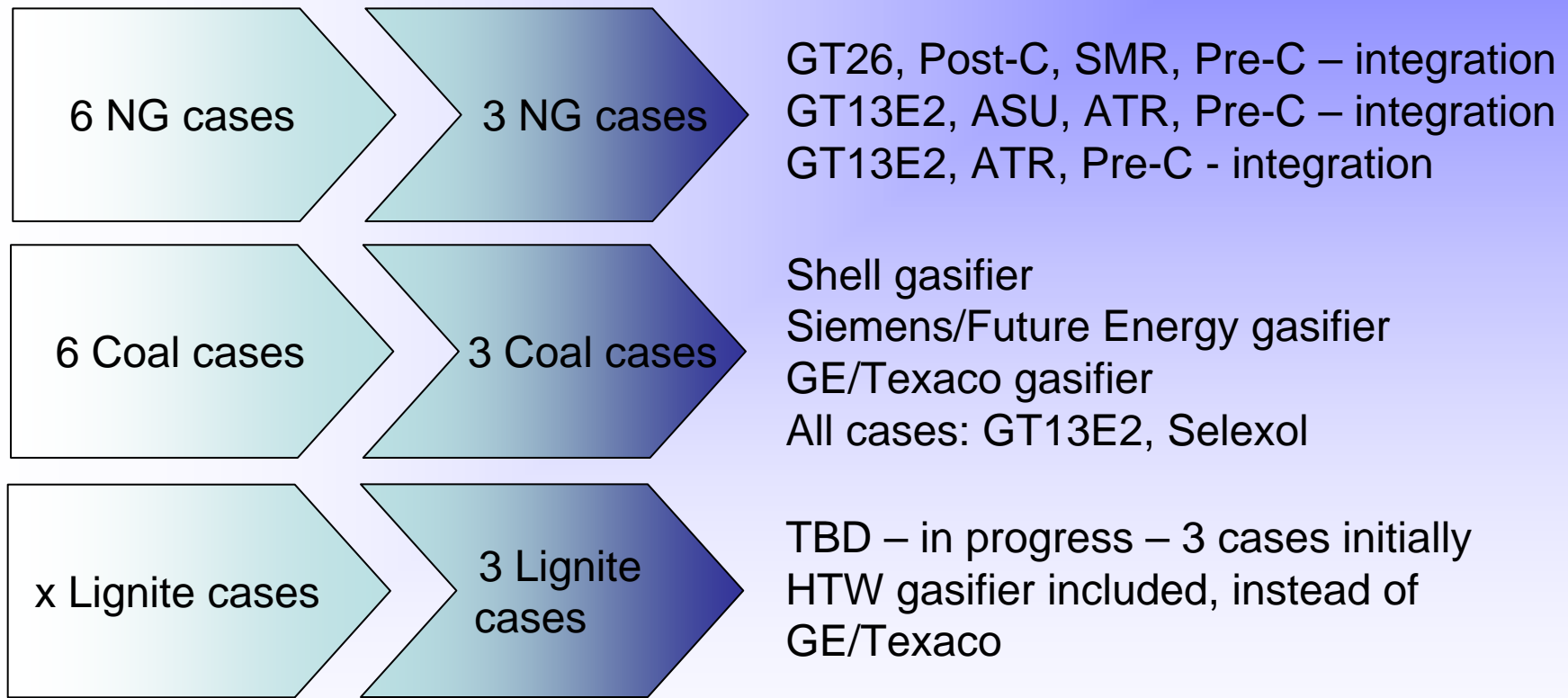
An initial data trawl of possible CO<sub>2</sub> storage locations showed EOR with at least 60mt CO<sub>2</sub> capacity is limited to North Sea while gas fields and aquifers are more widely spread



# Storage Criteria List

- Depth > 800 m or P-init > 80 bar or Supercritical CO<sub>2</sub>
- Total storage capacity > 60 Mt CO<sub>2</sub>
- Injectivity > 2.0 Mt CO<sub>2</sub> per year or permeability > 200mD
- Integrity of seal in terms of thickness, faults etc.
- Location of site compared to Power/Hydrogen Market
- Geographical representation of sites
- Availability of geological data
- Availability of site by 2012
- Variety of geological conditions
- Variety of storage types

# Power Plant and Capture Technologies – Cases Studied



# Technology Selection

- Natural Gas with Pre-C capture
- Natural Gas with Post-C capture and NG reforming of H<sub>2</sub>
- Coal and/or lignite with Pre-C – (ZE)IGCC
- Coal/lignite with parallel H<sub>2</sub> production and CO<sub>2</sub> capture (oxy-fuel or Post-C) not pursued due to efficiency and thus cost issues

# Site Decision Recommendations

Using the DYNAMIS requirements of cost efficient production of H<sub>2</sub>, electricity and CO<sub>2</sub> storage, 4 sites are recommended for further studies in the second phase of DYNAMIS:

- **Mongstad, Norway**, suggested by Statoil: Natural gas based plant with offshore CO<sub>2</sub> storage.
- **Hamburg region, Germany**, suggested by Vattenfall; Bituminous coal based plant with onshore or offshore CO<sub>2</sub> storage
- **East Midlands, England**, suggested by E.ON UK; Bituminous coal based plant with offshore CO<sub>2</sub> storage
- **North East UK**, suggested by PEL; Bituminous coal based plant with offshore CO<sub>2</sub> storage

These plants represent a reasonable spread of fuel types, storage types and location and hydrogen utilisation/export possibilities.

# Summary and Conclusions

- 4 sites have been identified as candidate plants for the HYPOGEN initiative - these have all been proposed by an industrial partner.
- A case like study of the process required to sites and technologies.
- Further work will involve to further develop these cases with pre-engineering studies and preparatory measures
- Target is to develop these cases ready for potential project launch : by the end of DYNAMIS in March 2009.
- Much is now dependent upon the industrial commitment and support of the specific sites .... potential candidates for EU ZEP Flagship CCS Demonstration Programme.

# DYNAMIS

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