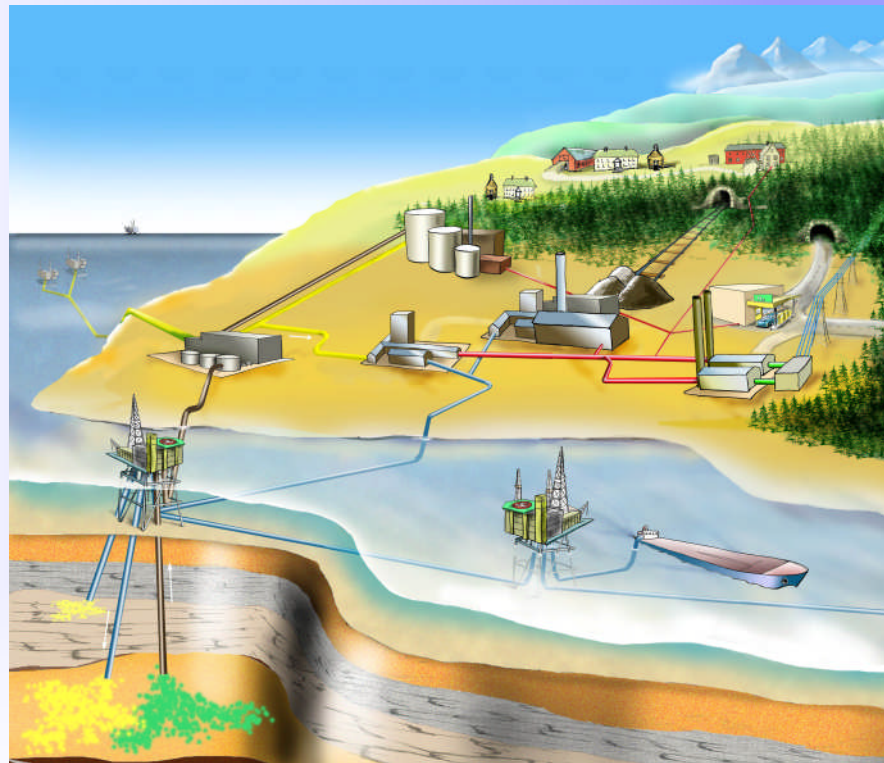


DYNAMIS

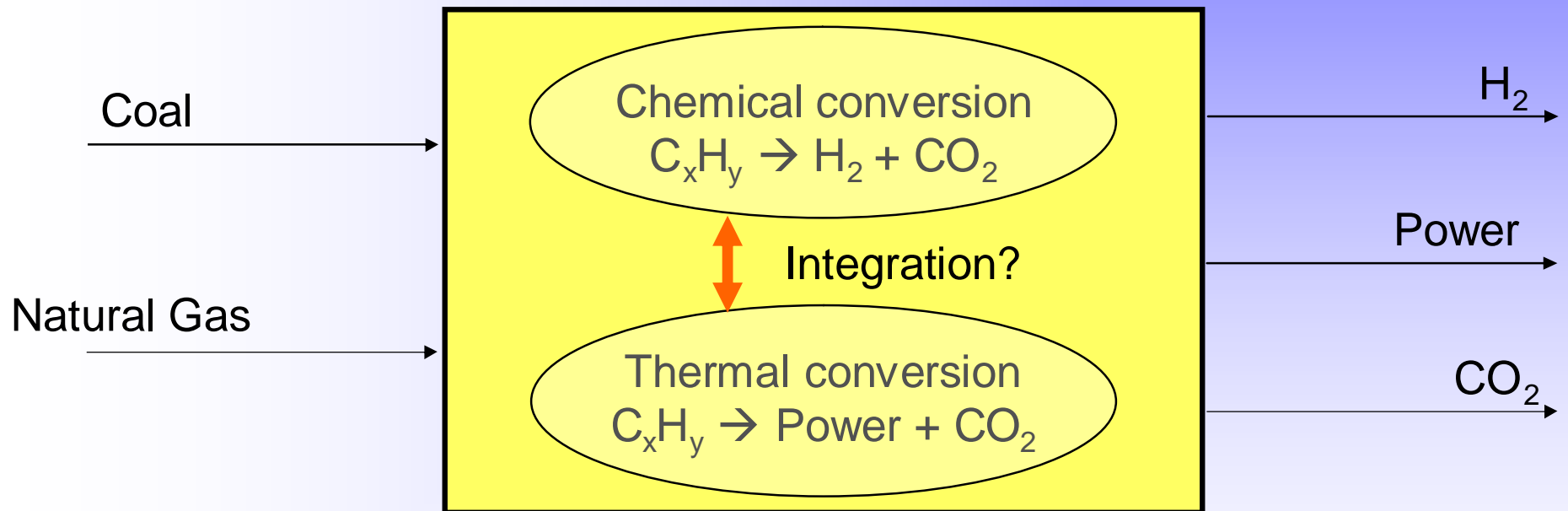
Towards Hydrogen Production with CO₂ Management

CSLF Meetings in Al Khobar, Daudi Arabia 27-29th January 2008

Nils A. Røkke – Co-ordinator - SINTEF



DYNAMIS Scheme



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€**



Pic. Siemens



Pic. Vattenfall












Ill. Statoil

Consortium - 32 partners from 12 countries

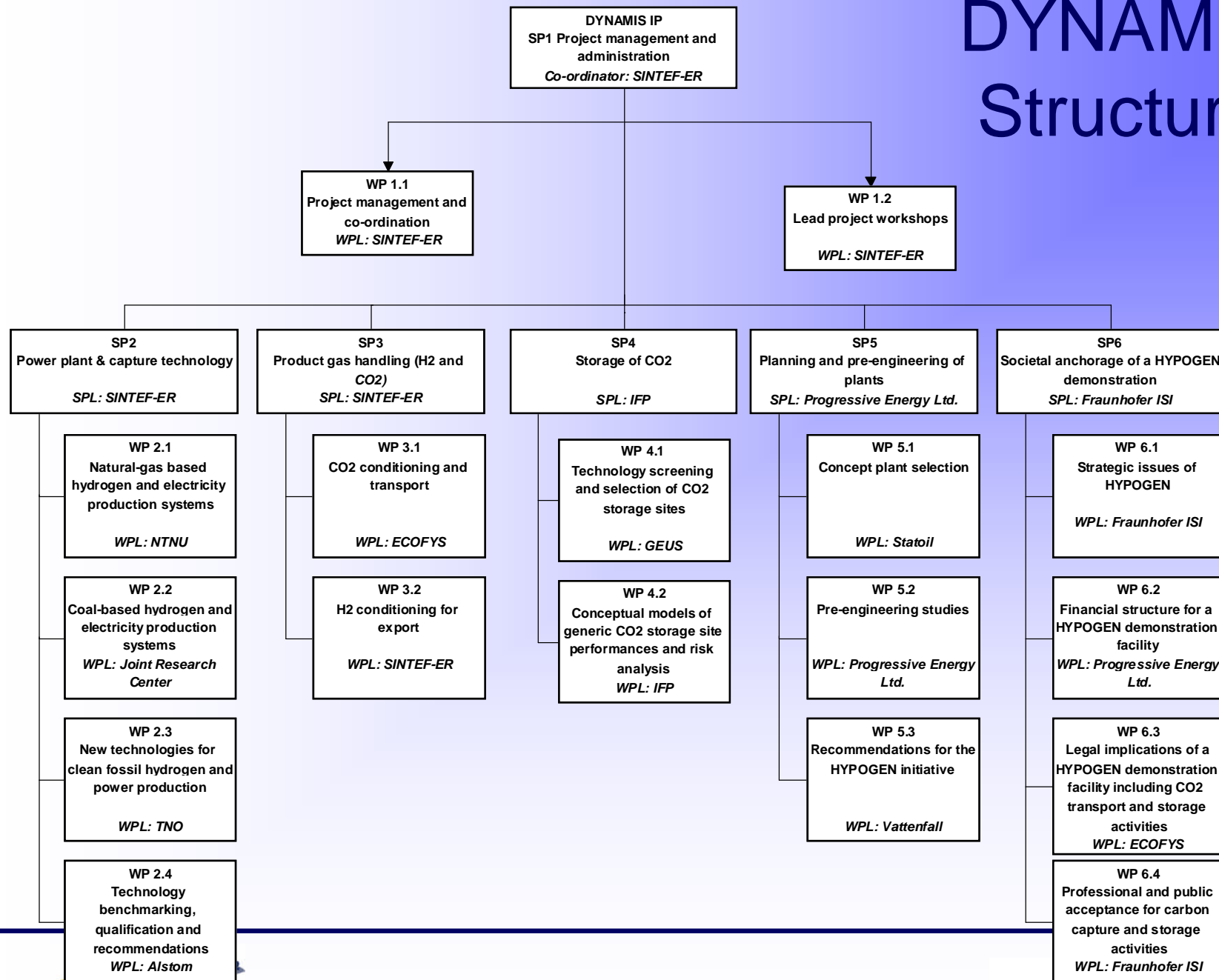
Co-ordinator:

 SINTEF Energy Research

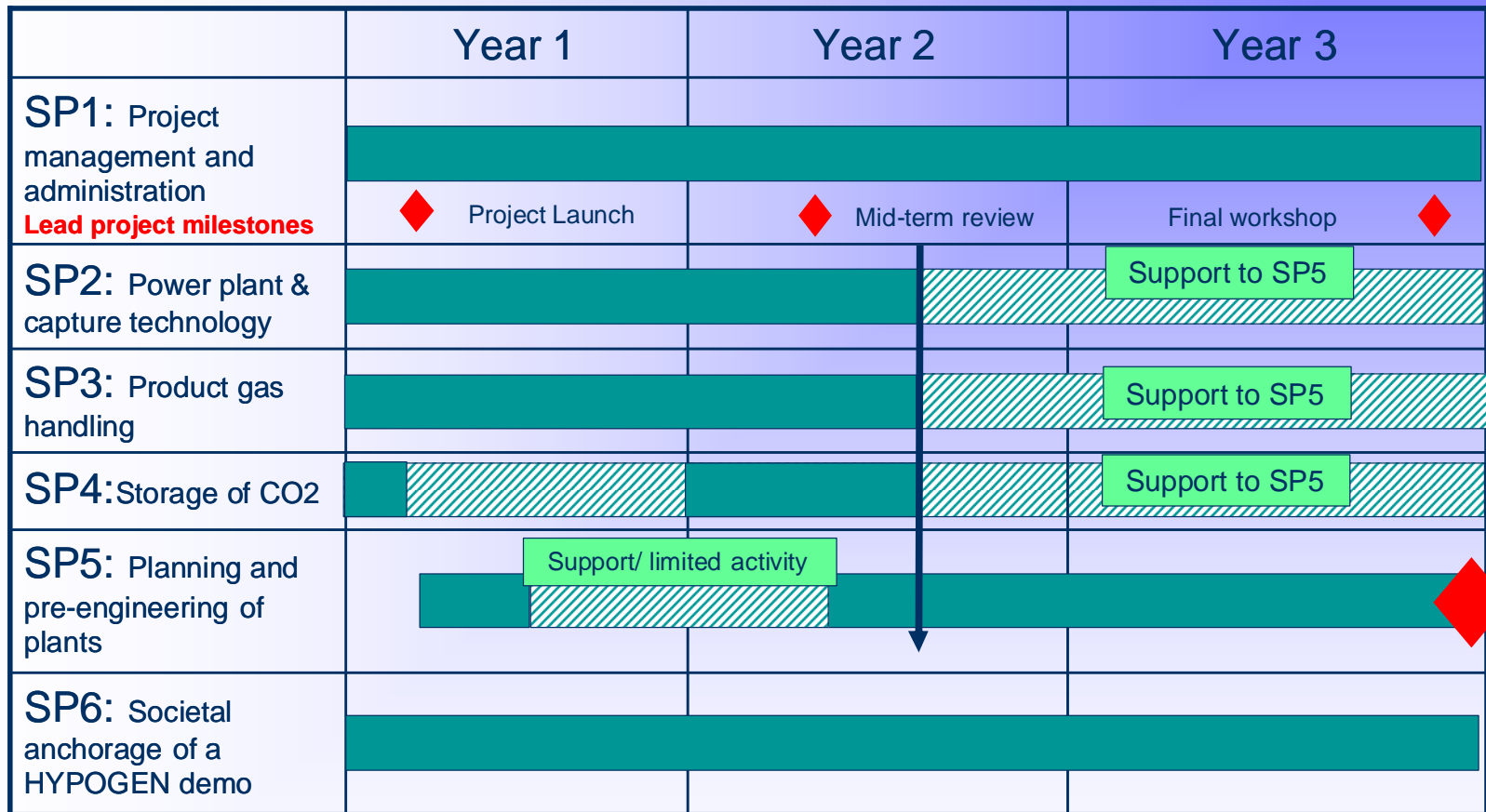
Partners:

-  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



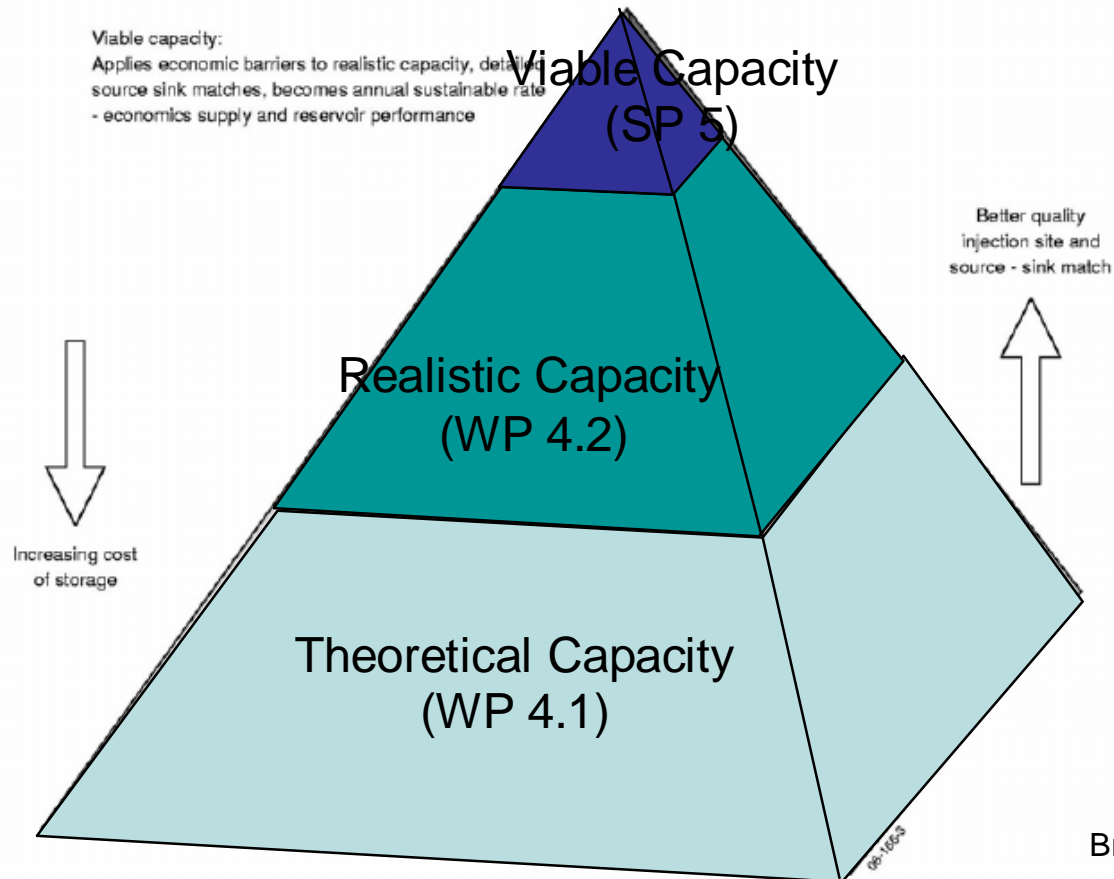
Overall Project Schedule



Criteria for Selection

- Geographic Aspects
 - Site specifics
 - Fuels availability
 - Power and heat sales
 - CO₂ conditioning and storage
 - Hydrogen demand
- Technical Issues
 - Overall 90% CO₂ extraction, 400 MW_e and 0-50 MW H₂ export
 - Methane/Coal reforming/gasiifcation technology
 - Syngas Separation and Conditioning
 - GT's and train configuration(SIEMENS V94.2K, ALSTOM GT13E)
- Financial Issues
 - CAPEX, OPEX
 - Financial risk(Technical, Financial (loans and interest, bankability),EIB role)
- Political & Legal
 - Framework
 - Concensus and joint undertakings
 - Storage risk and acceptance

Critical Criterion - CO₂ Storage

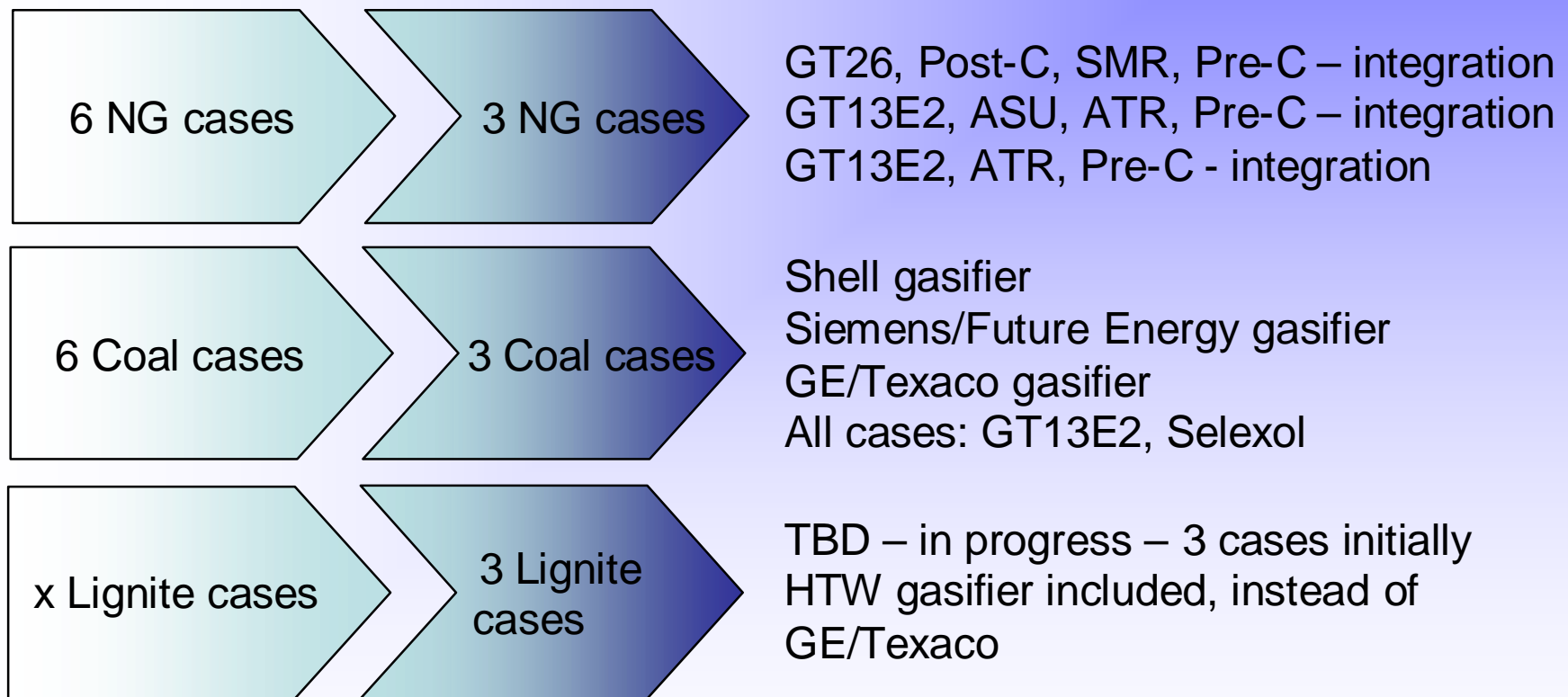


Bradshaw et al, 2006

Criteria List

- Depth > 800 m or P-init > 80 bar or Supercritical CO₂
- Total storage capacity > 60 Mt CO₂
- Injectivity > 2.0 Mt CO₂ per year or permeability > 200 mD
- 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 H₂
- Coal and/or lignite with Pre-C – (ZE)IGCC
- Coal/lignite with parallel H₂ production and CO₂ capture (oxy-fu or Post-C) not pursued due to efficiency and thus cost issues

Site Decision Recommendations

Using the DYNAMIS requirements of cost efficient production of H₂, electricity and CO₂ 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 CO₂ storage.
- **Hamburg region, Germany**, suggested by Vattenfall; Bituminous coal based plant with onshore or offshore CO₂ storage
- **East Midlands, England**, suggested by E.ON UK; Bituminous coal based plant with offshore CO₂ storage
- **North East UK**, suggested by PEL; Bituminous coal based plant with offshore CO₂ 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.
- Further work will involve to further develop these cases with pre-engineering studies and preparatory measures (EIAS,...)
- Target is to have developed these cases to ready for project launch by the end of DYNAMIS, i.e. March 2009.
- Much is now dependent upon the industrial commitment and support of the specific sites.

DYNAMIS

Towards Hydrogen Production with CO₂ Management

CSLF Meetings in Al Khobar, Daudi Arabia 27-29th January 2008

Nils A. Røkke – Co-ordinator - SINTEF

