CSLF Technical Group

Project Interaction and Review Team
CSLF Project Position

Al Khobar, Saudi Arabia
27th January 2008

Nick Otter
United Kingdom

PIRT : CSLF Projects

as of 27th January 2008

- **Current Project Portfolio**

  19 in total, update contained in CSLF SPIR of January 2008

  ……. 2 now completed

  2004 : 10 Melbourne

  2005 : 7 Berlin

  2007 : 2 Paris

  2008 : 1? Cape Town

- **Proposed Project : DYNAMIS**

  "Towards Hydrogen production with CO_2 Management"

  Sponsored by EC and Norway

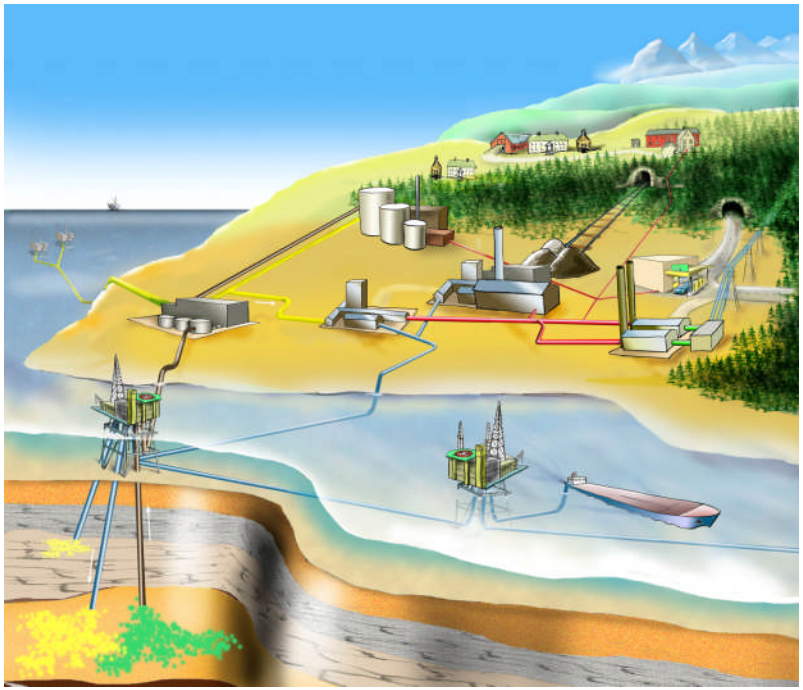
  Led by Nils Rokke of SINTEF from Norway

DYNAMIS

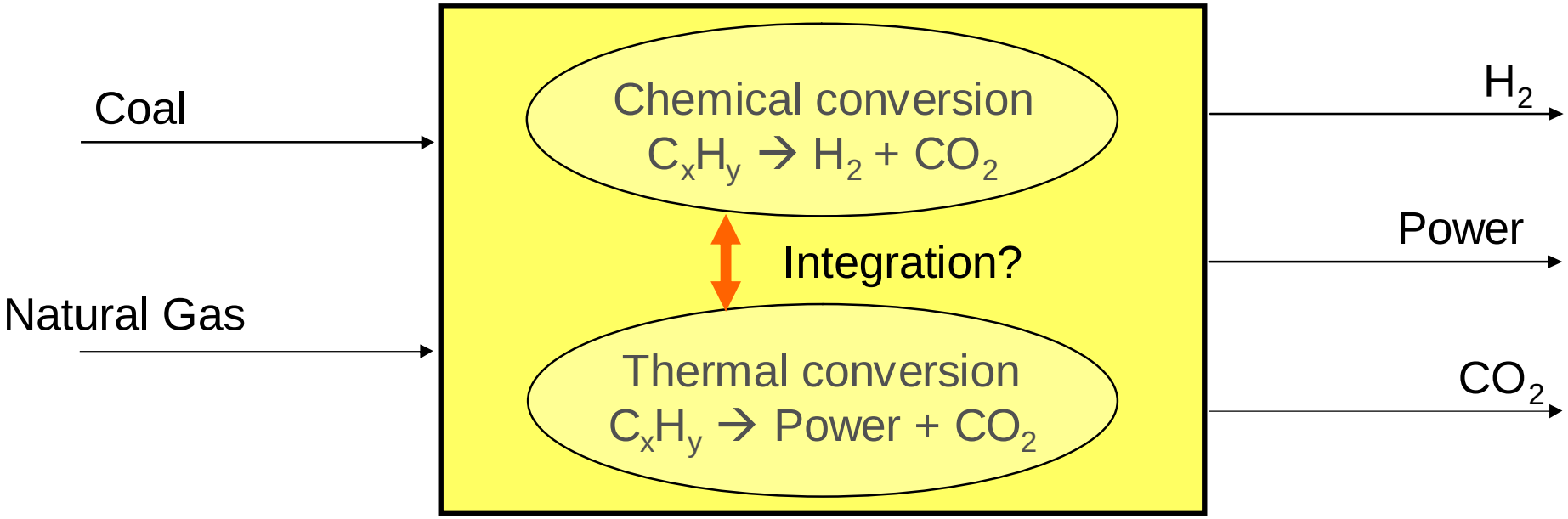
Towards Hydrogen production with CO_2 Management

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

Nils A. Røkke – Co-ordinator - SINTEF



DYNAMIS Scheme



EU-DYNAMIS/HYPOGEN

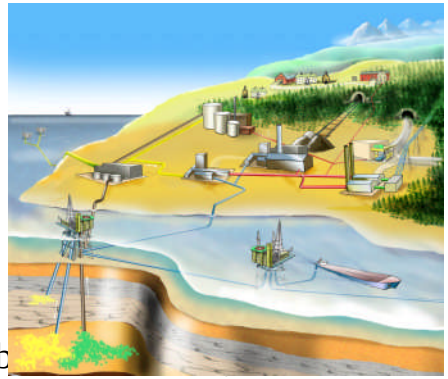
Overall Timeline & Budget

- 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€
TOTAL	**~1300 M€**

Pic. Siemens

Pic. Vattenfall



Pic. Vattenfall

Ill. Statoil

DYNAMIS Consortium

- 32 partners from 12 countries

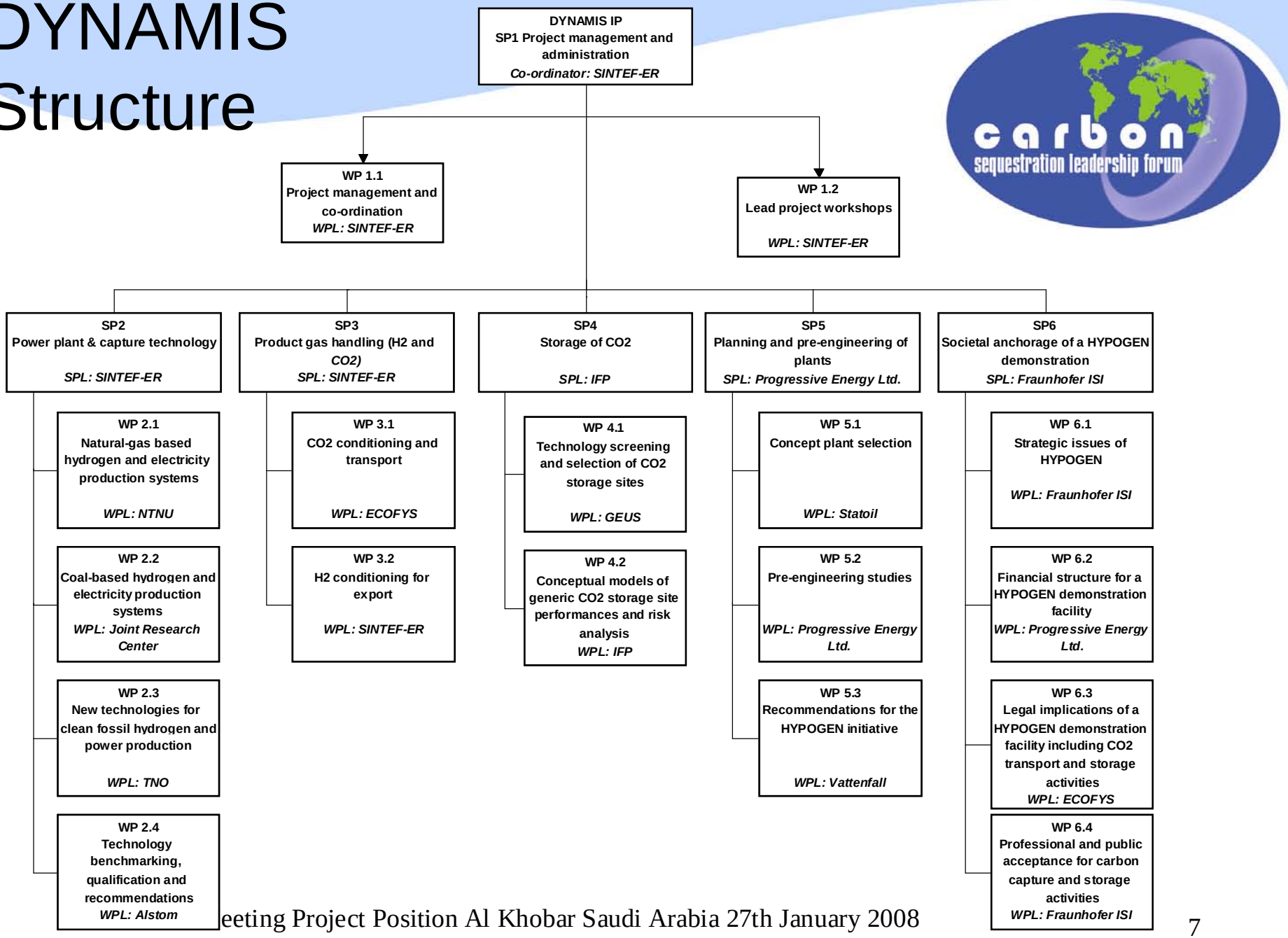
Co-ordinator:

SINTEF Energy Research

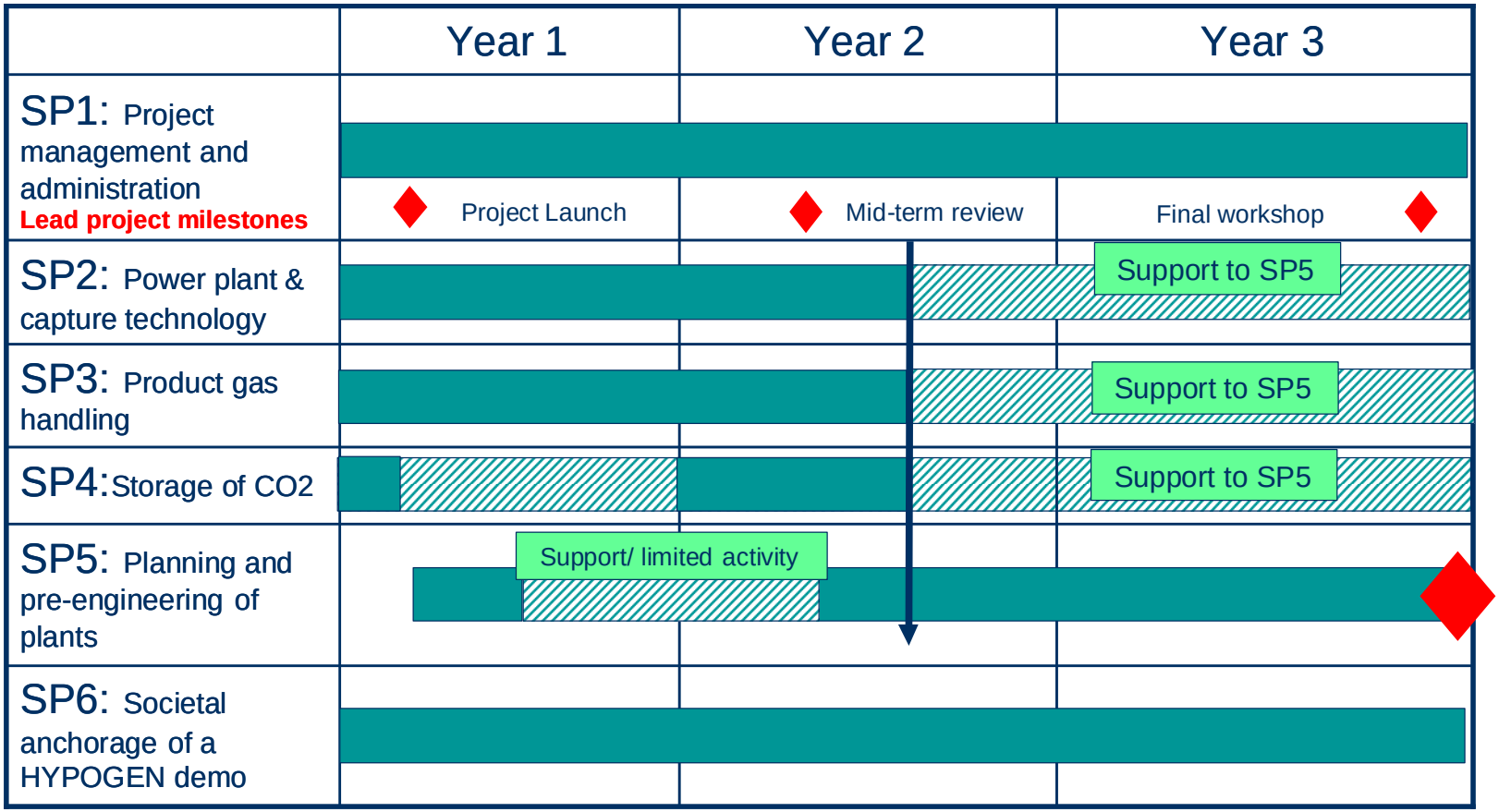
Partners:

- 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



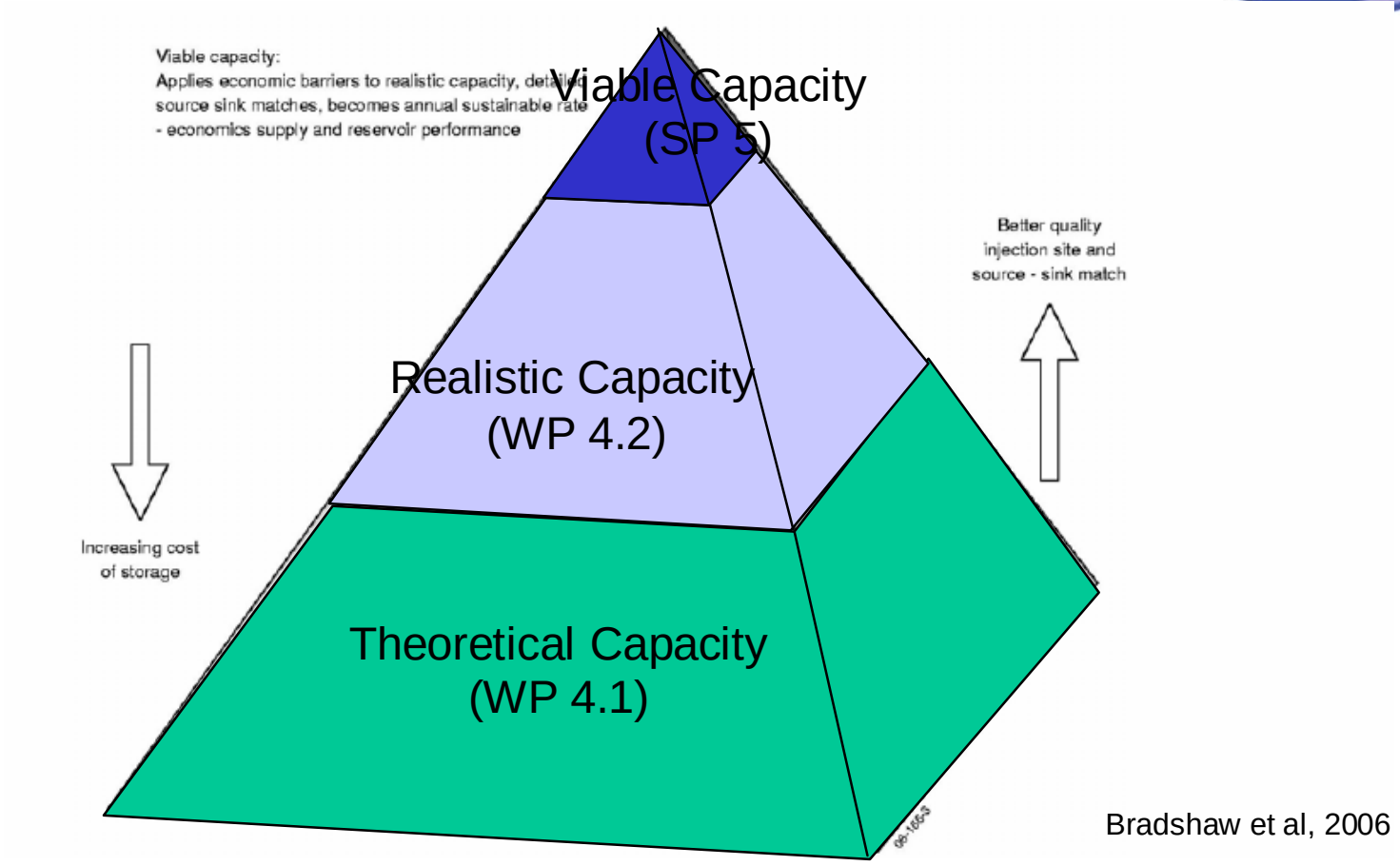
Overall Project Schedule



Criteria for Selection

- Geographic Aspects
  - Site specifics
  - Fuels availability
  - Power and heat sales
  - CO_2 conditioning and storage
  - Hydrogen demand
- Technical Issues
  - Overall 90% CO_2 extraction, 400 MW_e and 0-50 MW H_2 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 - CO_2 Storage

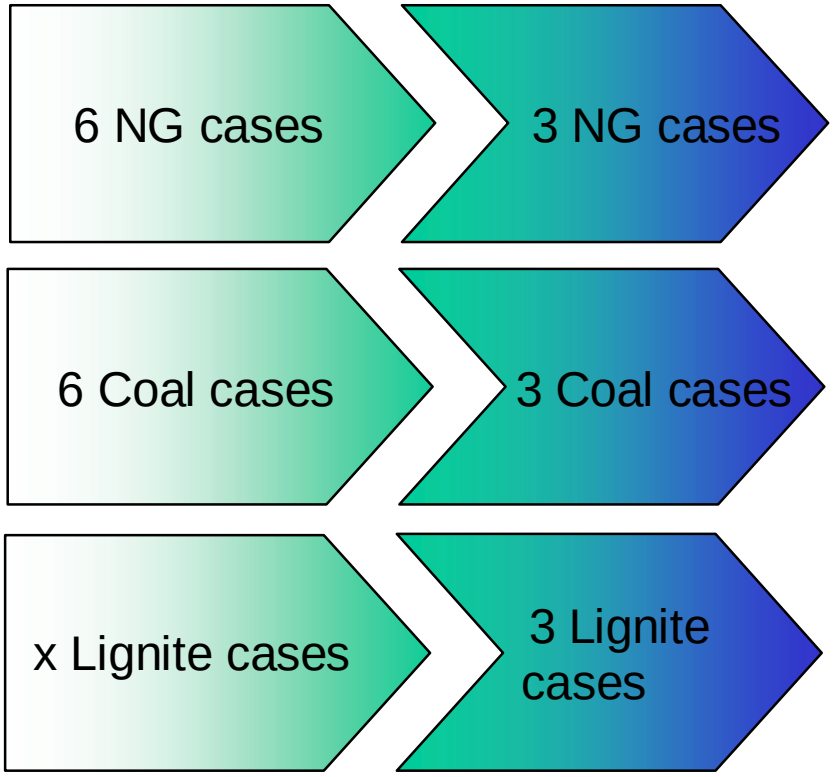


Bradshaw et al, 2006

Criteria List

- Depth > 800 m or P-init > 80 bar or Supercritical CO_2
- Total storage capacity > 60 Mt CO2
- Injectivity > 2.0 Mt CO_2 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



GT26, Post-C, SMR, Pre-C – integration
GT13E2, ASU, ATR, Pre-C – integration
GT13E2, ATR, Pre-C - integration

Shell gasifier
Siemens/Future Energy gasifier
GE/Texaco gasifier
All cases: GT13E2, Selexol

TBD – in progress – 3 cases initially
HTW gasifier included, instead of GE/Texaco

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 parallell H_2 production and CO_2 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 CO_2 storage.
- **Hamburg region, Germany**, suggested by Vattenfall; Bituminous coal based plant with onshore or offshore CO_2 storage
- **East Midlands, England**, suggested by E.ON UK; Bituminous coal based plant with offshore CO_2 storage
- **North East UK**, suggested by PEL; Bituminous coal based plant with offshore CO_2 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 by the end of DYNAMIS, i.e. March 2009.
- Much is now dependent upon the industrial commitment and support of the specific sites.

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PIRT recommends the acceptance of DYNAMIS

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27th January 2008

END