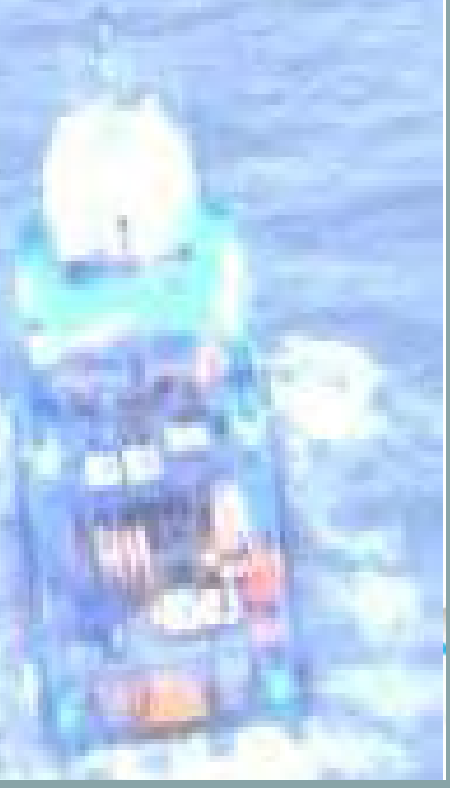
International Workshop on Offshore Geologic CO_2 Storage

Tim Dixon/A D Surridge
IEA GHG R&D Programme
CSLF Technical Group, 28 June 2016



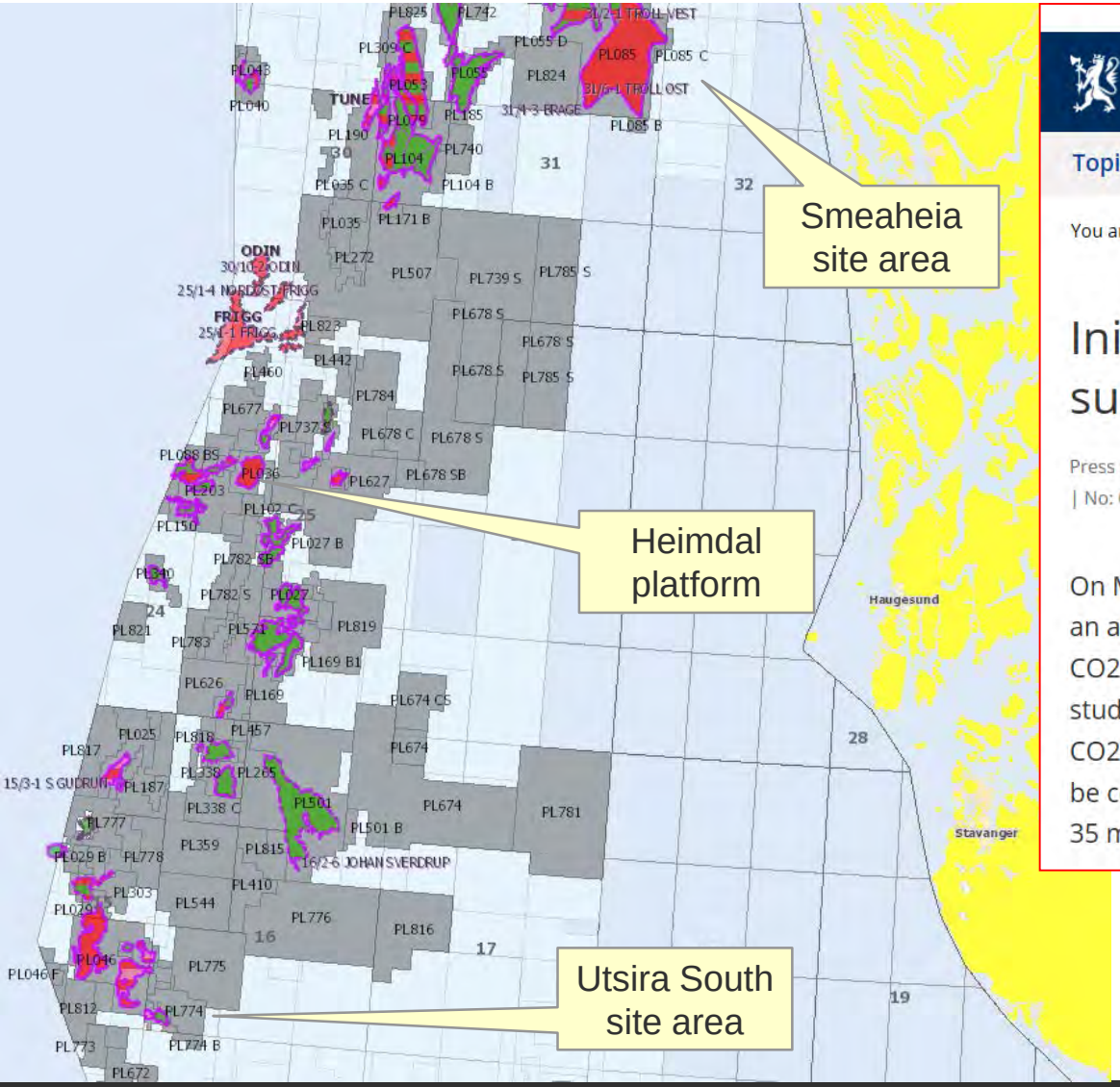
FEEDBACK FROM WORKSHOP ON OFFSHORE CO_2 STORAGE

- Organised by the Bureau of Economic Geology (BEG) at The University of Texas at Austin in collaboration with the South African Centre for CCS at SANEDI, IEAGHG (Chair of the International Steering Committee) and with financial support from CSLF and UNFCCC's CTCN
- To facilitate sharing of knowledge and experiences among those who are doing offshore storage and those who may be interested
- 19-21 April 2016, at the BEG, University of Texas, Austin
- 13 countries attended (7 developing countries)

Experts who ‘do’ offshore

- **Norway**
  - New work on storage assessments and shipping
  - Subsea engineering

CO_2 storage feasibility study in Norway



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Topics | Documents | What's new | Ministries

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Initiates feasibility study on subsea CO2 storage

Press release | Published: 2016-01-04
| No: 001/16

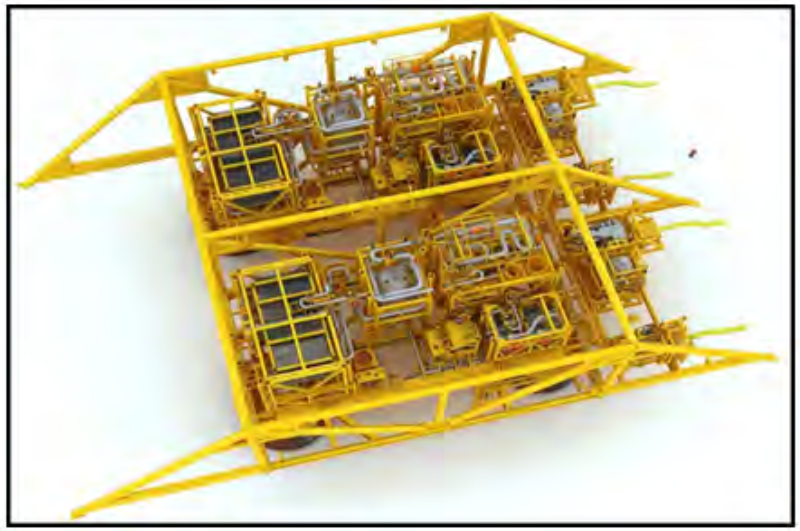
On Monday, the Ministry og Petroleum and Energy signed an agreement with Statoil on a feasibility study regarding CO2 storage on the Norwegian Continental Shelf (NCS). The study will include various development concepts for storing CO2 at three different locations on the NCS. The study is to be completed by 1 June 2016 and is budgeted at about NOK 35 million (USD 4 mill.).

- Statoil is currently evaluating three sites as part of this feasibility study

Statoil

Two important subsea building blocks

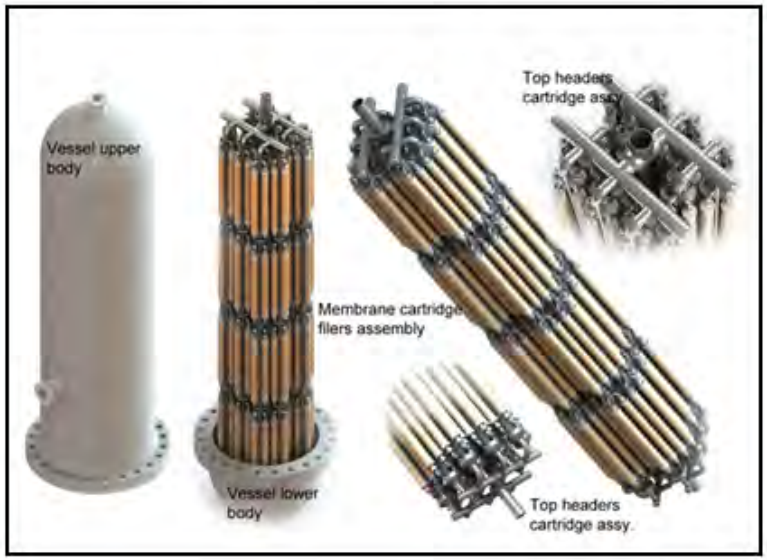
Compression System



2010 – 2015 Åsgard:

- 21 MSm^3/d flow rate
- 2 x 11.5 MW compressor power
- 300 m water depth
- 40 km step-out distance
- Topside Variable Speed Drives, Circuit breakers and UPS
- Delivered by Aker Solutions

Compact membrane packing



- Onshore stacking not feasible subsea
- Compact packing arrangement developed by AKSO

AkerSolutions™

Experts who ‘do’ offshore

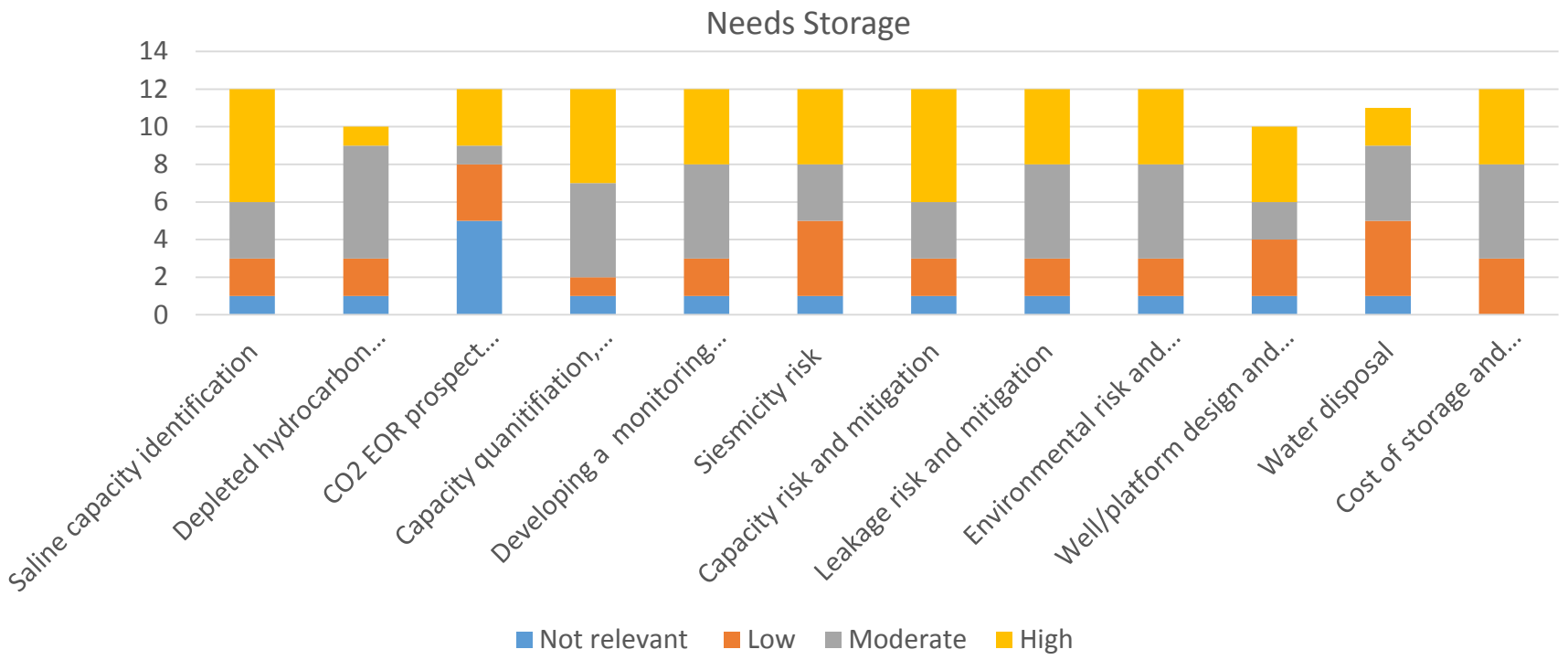
- Norway
  - New work on storage assessments and shipping
  - Subsea engineering
- Netherlands – K12B and shipping
- Brazil – offshore deepwater EOR
- Japan – Tomakomai – 3 year injection programme
- UK – Risk management for Goldeneye

Those on the path to ‘doing’

Status and Needs

- 25 responses to pre-workshop survey
- 10 presentations:
  - South Africa
  - China
  - USA
  - Nigeria
  - Ghana
  - Korea
  - Mexico
  - Australia
  - SE Asia CCOP initiative
  - CGS Baltic project

Additional information needed to progress toward CCS decision? Storage



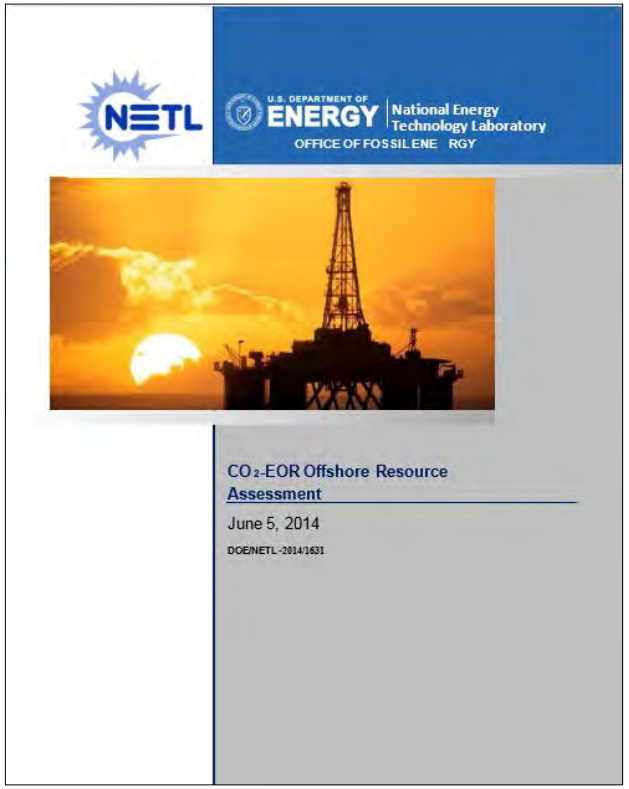
DOE Carbon Storage R&D Program

- **Initial ad hoc Assessments**
  - SECARB Offshore Storage Assessment (Southeast Regional Carbon Sequestration Partnership)
  - American Recovery and Reinvestment Act – 2 projects
    - Texas Gulf Coast; Los Angeles Basin
- **Systems Engineering & Analysis**
  - Saline Storage Cost Model (under development) for Offshore Saline Storage
  - Associated Storage- CO_2 EOR Performance and cost modeling
- **Assessment of U.S. offshore areas with highest potential for economical, large-scale CO_2 storage**
  - Mid-Atlantic (Battelle Memorial Institute)
  - South Atlantic; East Gulf of Mexico (Southern States Energy Board)
  - Northern and Western Gulf of Mexico – State and Federal waters (NITEC, LLC; Univ. of Texas – Austin; GeoMechanics Technologies)
- **MoU with various countries on Offshore Storage**

CO_2 EOR Offshore Challenges

- **Installation of CO_2 recycling facilities**
  - Modular subsea facilities
  - Large volume facility on central platform
  - Onshore recycling
- **Retrofitting of wells and facilities for corrosion**
- **Optimal well placement**
- **Reservoir characterization to reduce uncertainty**
- **Adequate and affordable CO_2 supply**
  - Tax credits for capture and storage
  - Royalty relief for EOR
- **Subsea Technology**

CO_2 EOR Offshore Assessment (6/5/2014)



CO_2 EOR potential (CO_2 Required):

- 810 MMB (310 MMT CO2)
- 14,920 MMB (3,910 MMT)

Oil = $90/bbl

CO_2 price = $50 / mt

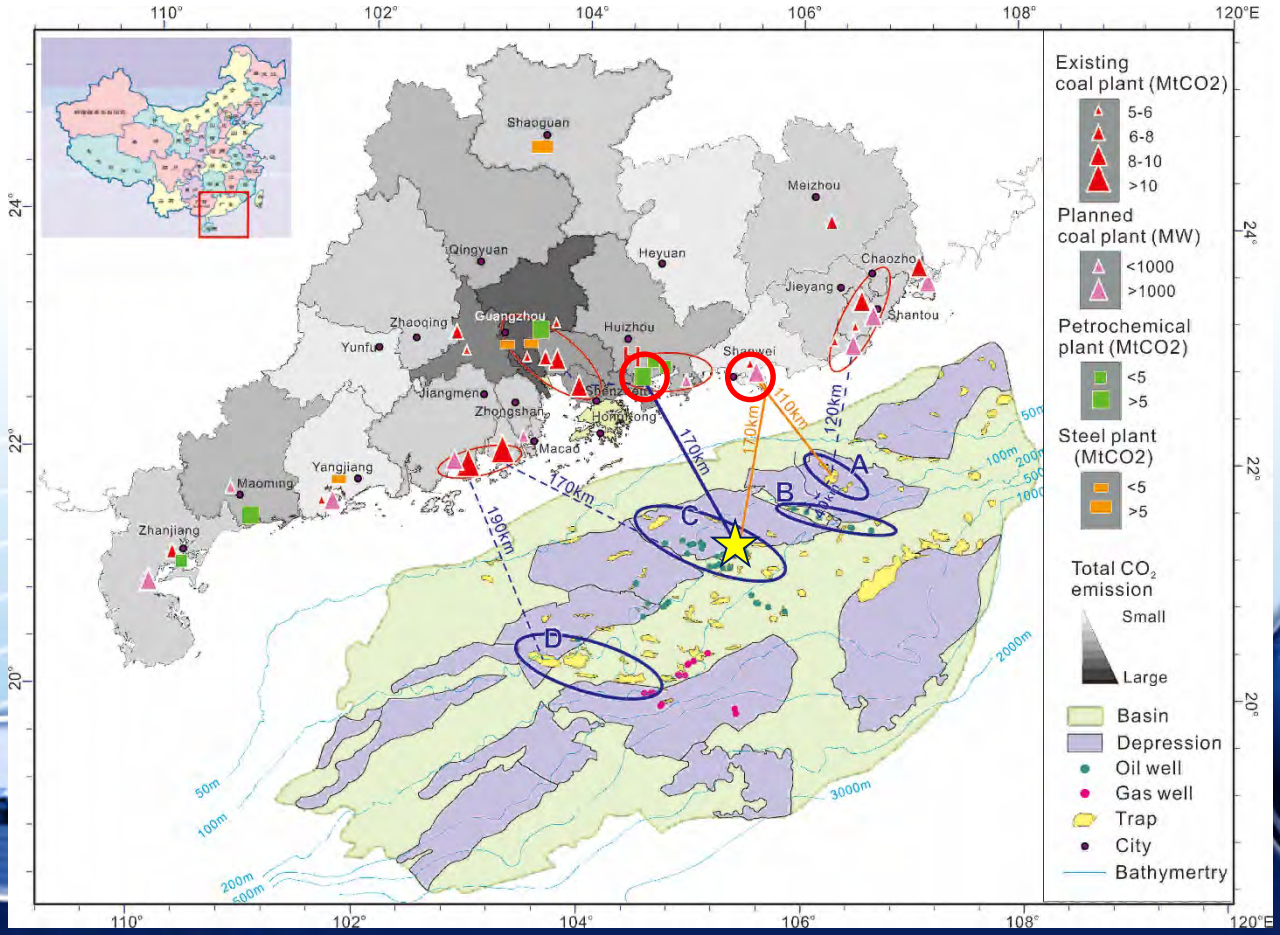
Offshore Future Research Opportunities

- **Risk Assessment, Management and Mitigation**
  - Understanding of Risk associated with offshore Carbon Storage, Enhanced Oil Recovery (EOR) and Oil and Natural Gas Exploration/Exploitation
- **CO_2-EOR Potential in the Gulf of Mexico (GOM)**
  - Near-term opportunity to utilize existing and to-be-decommissioned infrastructure for CO_2 storage "Associated" with currently bypassed oil production
- **Carbon Storage in subsurface saline and depleted oil and natural gas reservoirs**
  - Offshore saline storage cost model (OPEX, CAPEX) and future regulations
  - Storage and MVA technology development and validation in the offshore environment
  - Large-scale and Commercial-scale field project(s)
- **Collaborative "Big Data" Analyses in GOM**

Offshore Future Research Opportunities

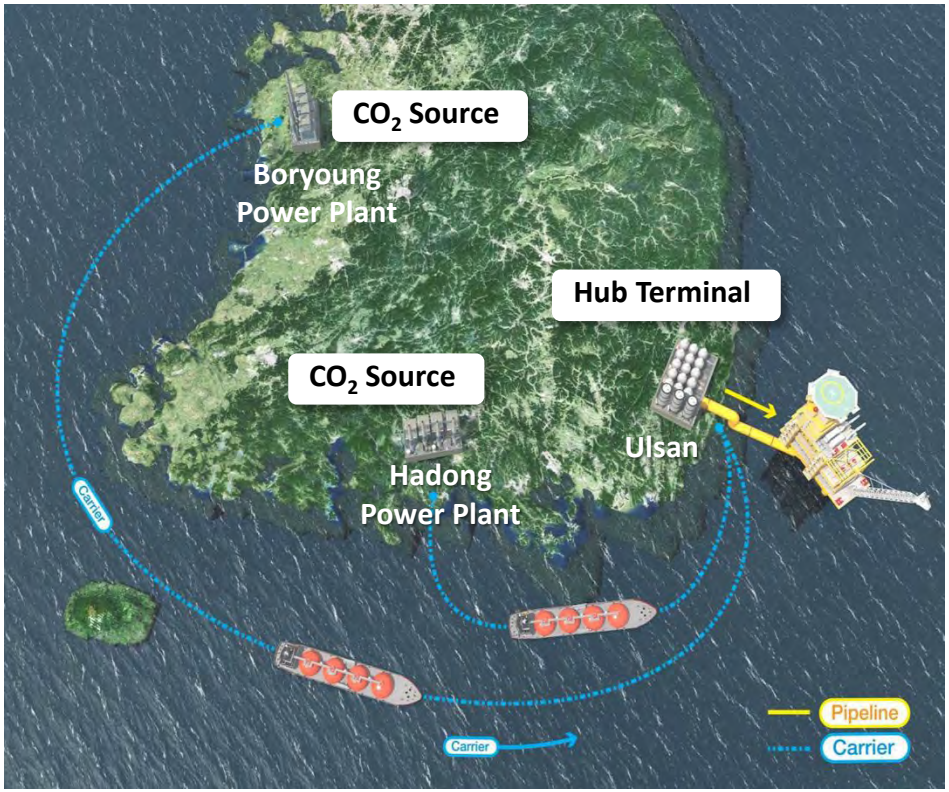
- **Carbon Storage Resource Assessments**
- **Monitoring, Verification and Accounting Field Site**
  - Develop and validate technologies for offshore environment
- **Large-scale and/or Commercial-scale Injection Project**
  - Understand and manage risks, existing infrastructure and validated technologies future deployment of commercial projects in offshore environment (subsea)
- **Offshore Analyses**
  - Resource assessment of potential carbon storage associated with enhanced oil recovery, modification to CO_2 Prophet Model for offshore, and Saline and EOR Cost and Performance models

- Coastal sources match well with offshore storage sites
- The first CCUS Demo Project of Guangdong province:
  - 1 MtCO2/a from coal-fired power plant and petrochemical plant
  - Store in offshore oil fields for EOR and sequestration

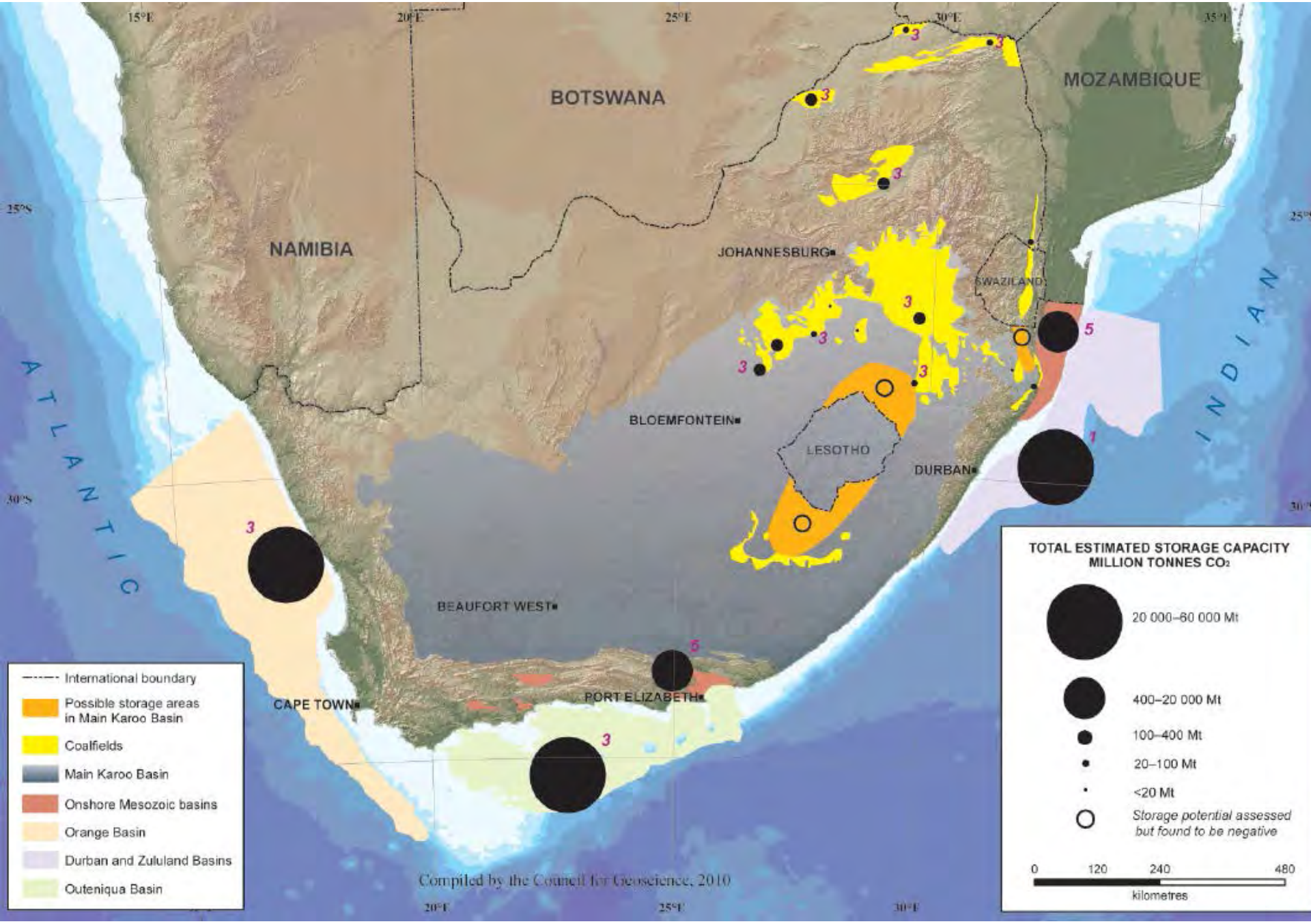


Status of Transportation Assessment

- Major coal-used power plants for large-scale CO_2 source in the western and southern coastal areas: long distance to promising storage sites
- Less public acceptance about CO_2 transportation/storage in land



- Onshore pipeline transportation: expensive cost and less public acceptance
- Ship transportation from CO_2 sources to Hub terminal
- Offshore pipeline transportation from Hub terminal to storage sites


15°E
20°E
25°E
30°E
35°E
25°S
30°S
BOTSWANA
MOZAMBIQUE
NAMIBIA
JOHANNESBURG
SWAZILAND
BLOEMFONTEIN
LESOTHO
DURBAN
BEAUFORT WEST
CAPE TOWN
PORT ELIZABETH
ATLANTIC
INDIAN
3
5
1
International boundary
Possible storage areas in Main Karoo Basin
Coalfields
Main Karoo Basin
Onshore Mesozoic basins
Orange Basin
Durban and Zululand Basins
Outeniqua Basin
TOTAL ESTIMATED STORAGE CAPACITY
MILLION TONNES CO2
20 000–60 000 Mt
400–20 000 Mt
100–400 Mt
20–100 Mt
<20 Mt
Storage potential assessed but found to be negative
0
120
240
480
kilometres
Compiled by the Council for Geoscience, 2010

Geological similarities with Brazil's pre-salt attract investments to Western Africa

GEOGRAGHICAL AREAS CONSIDERED CONT'D

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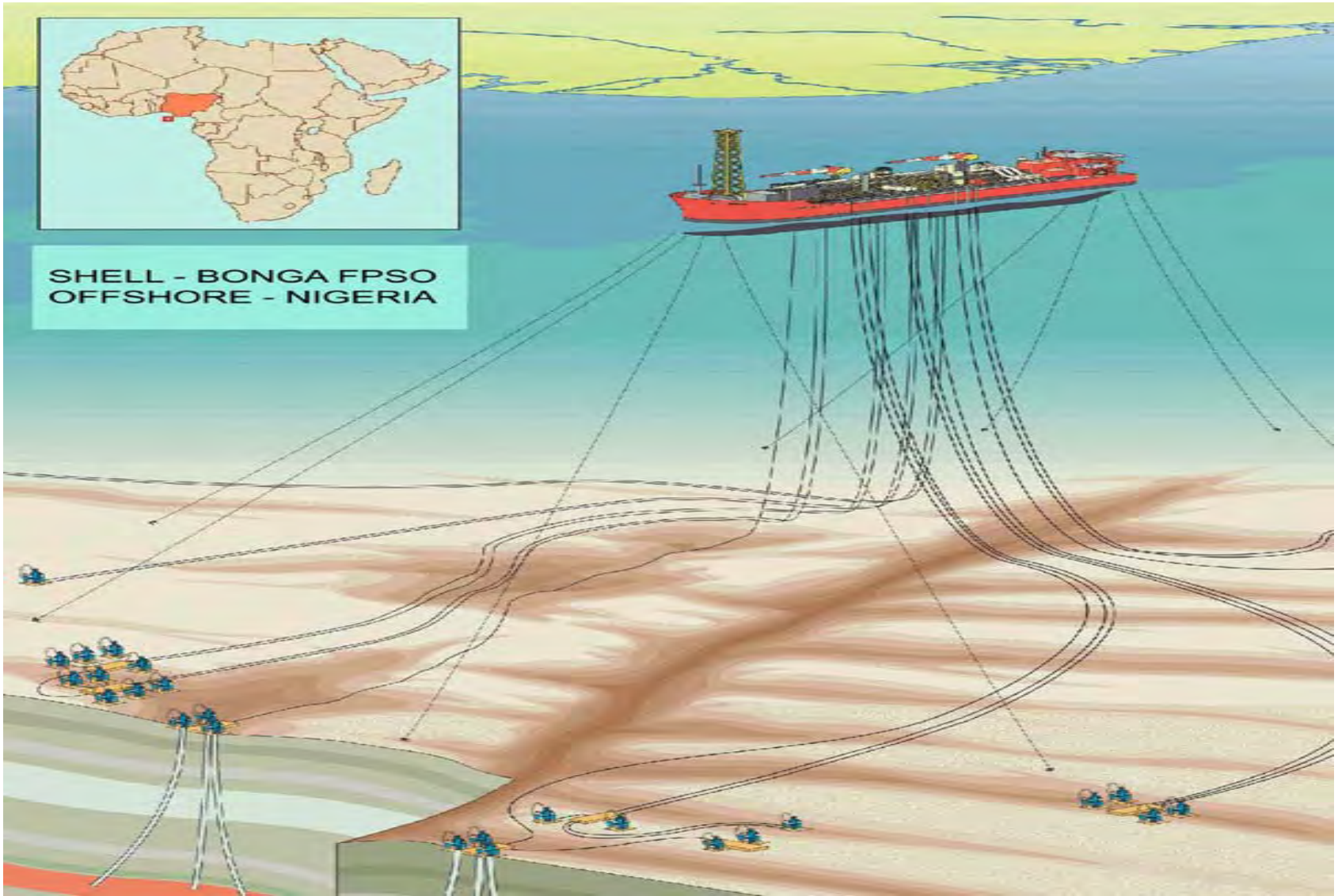

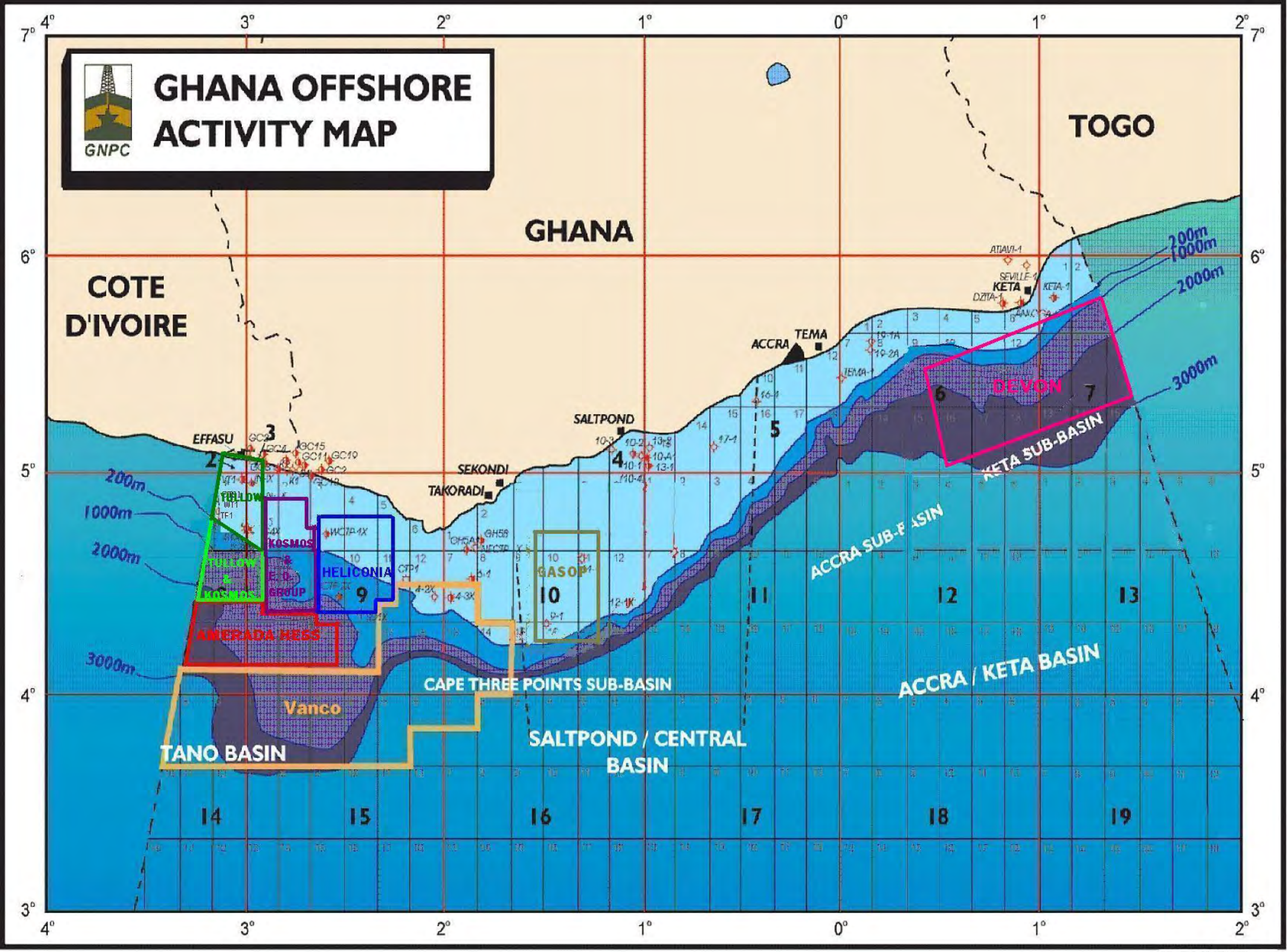
GHANA OFFSHORE
ACTIVITY MAP
GNPC
GHANA
COTE D'IVOIRE
TOGO
EFFASU
SALTPOND
SEKONDI
TAKORADI
ACCRA
TEMA
KETA
TULLOW
TULLOW & KOSMOS
KOSMOS & E.O. GROUP
HELICONIA
GASOP
AMERADA HESS
Vanco
DEVON
KETA SUB-BASIN
ACCRA SUB-BASIN
ACCRA / KETA BASIN
CAPE THREE POINTS SUB-BASIN
SALTPOND / CENTRAL BASIN
TANO BASIN
200m
1000m
2000m
3000m
August 2006

Ghana - Status of Offshore Geologic Storage Assessment

- **Identification of prospective offshore geologic storage locations?** None yet
- **Evaluation of storage sites?** None yet
- **Risk assessment?** None yet
- Engineering readiness? None yet
- **Monitoring strategy?** None yet
- **Rank offshore versus onshore options?** None yet

Conclusions

- Each country is at a different place on the path to offshore CCS, but with common interests
- Benefits of existing oil and gas infrastructure
- Environmental Impacts and Monitoring: the more we study, the more we learn, the greater the reassurance and confidence

Recommendations

- Workshop/training - Technical “deep dive” offshore storage
- Workshop/Task Force on infrastructure – assessment, new vs re-use, technology developments, shipping vs pipelines
- Workshop/training on storage resource assessment
- Workshop on funding tools/sources for early stages of CCS resource assessment in Developing Countries

- International collaboration and funding mechanism for demo project (like IODP)
- Develop infrastructure test programme/pilot project

Recommendations

- Study on project success/failure as a means of assessing offshore regulatory framework
- Resource page with links to key information sources
- Common language on storage
- Create an ongoing Offshore Network (IEAGHG?)

UNFCC Climate Technology Centre and Network (CTCN)

CTCN
CLIMATE TECHNOLOGY CENTRE & NETWORK

- Funded delegates from Nigeria and Ghana - first ever funding on a CCS activity – relevance and precedent for IEAGHG members

- Mini-workshop on CTCN for DCs
- Nigeria – significance: national workshop and plan on CCS
- Ghana – significance: early stage typical of many countries
- for IEAGHG – CTCN funded DC participation in a typical IEAGHG activity

Thank you


I fixed it!