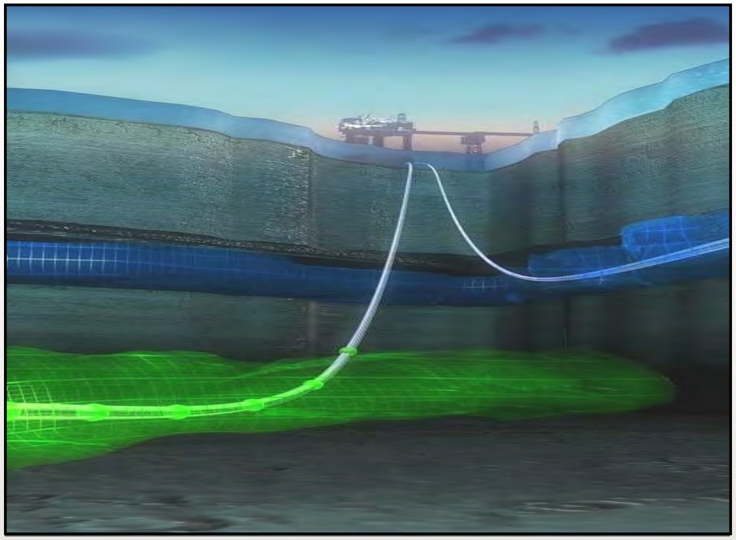


Carbon Capture & Storage – where are we now?

Tor Fjæran

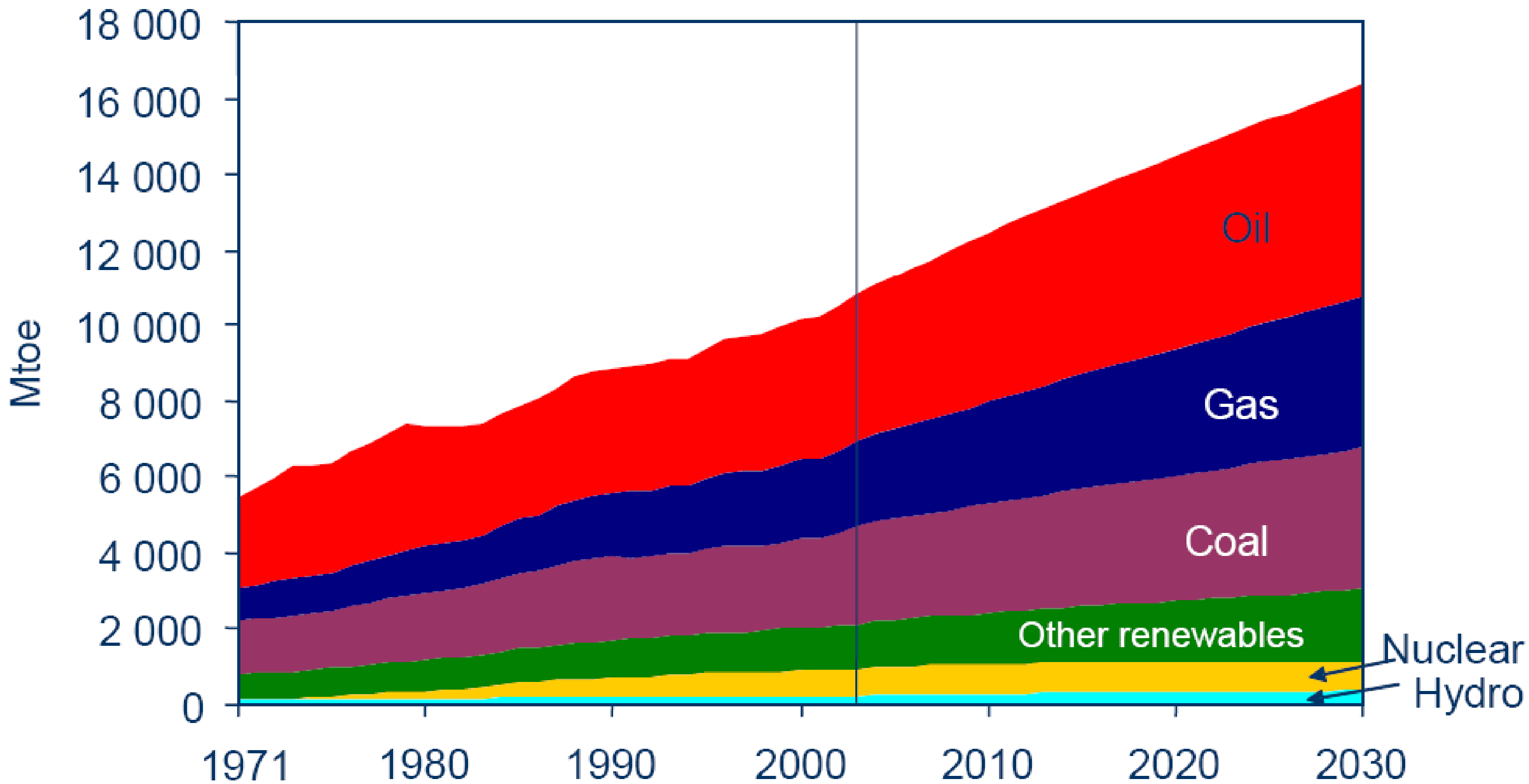
President Director

StatoilHydro Indonesia

EPPM Launching Seminar, Bangkok 9-10 October 2008

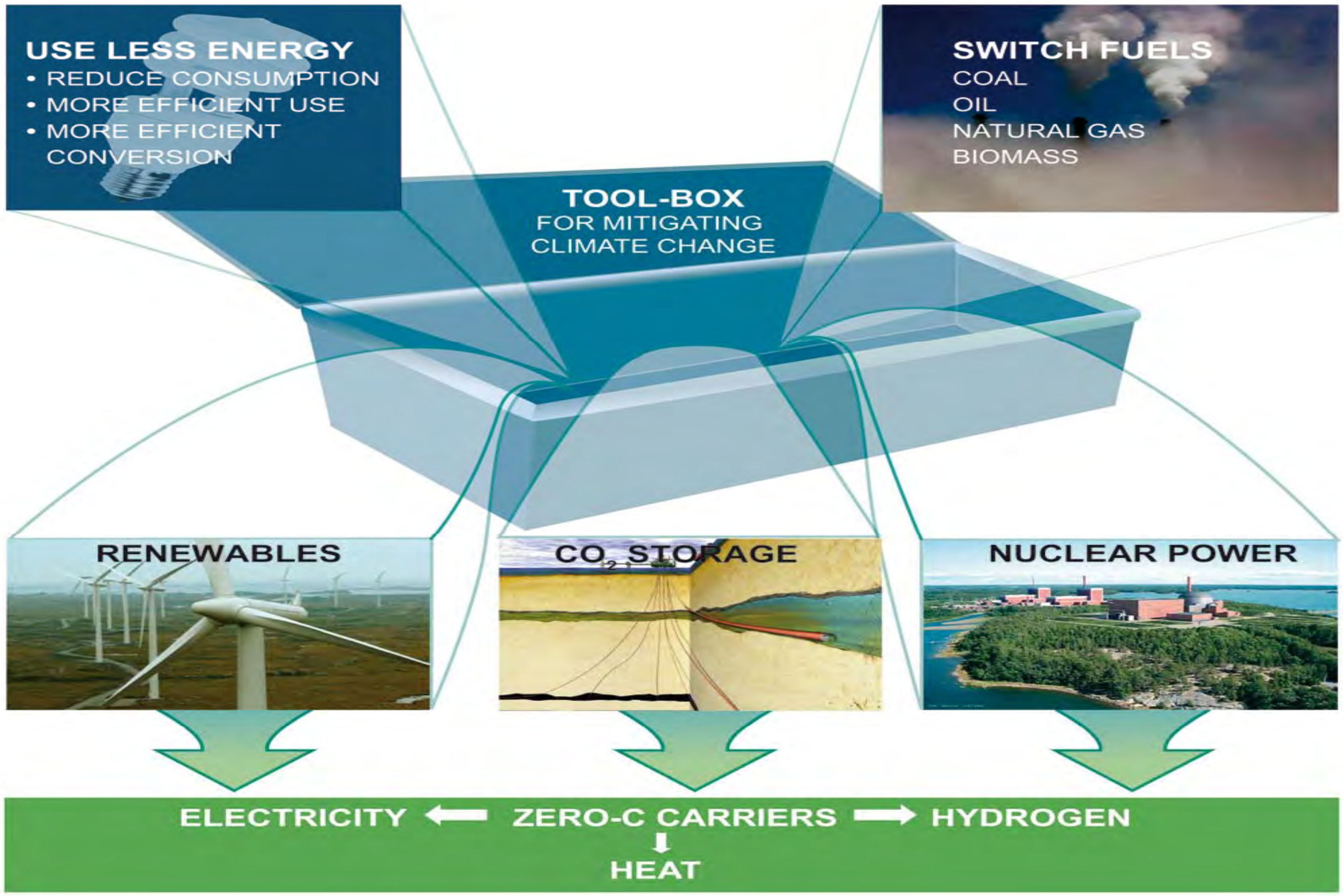
StatoilHydro

World's energy demand towards 2030
- 2/3 of increase from developing nations

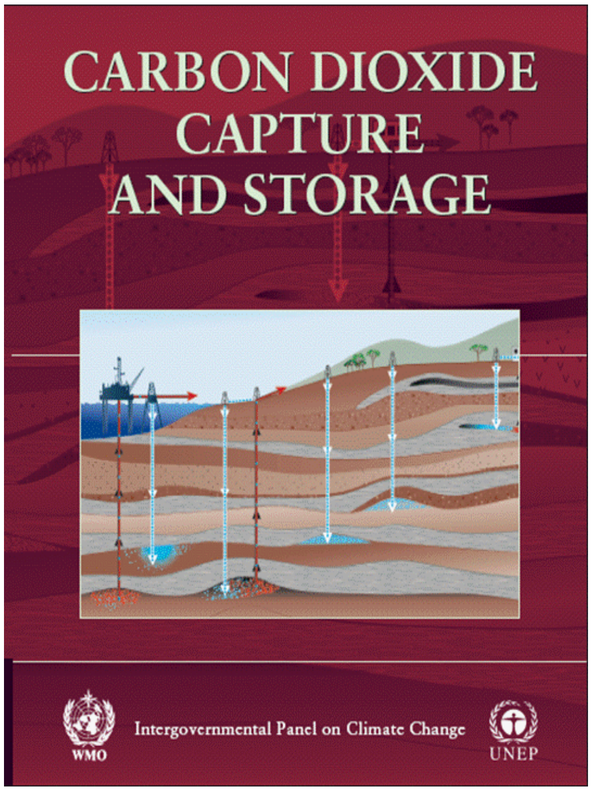


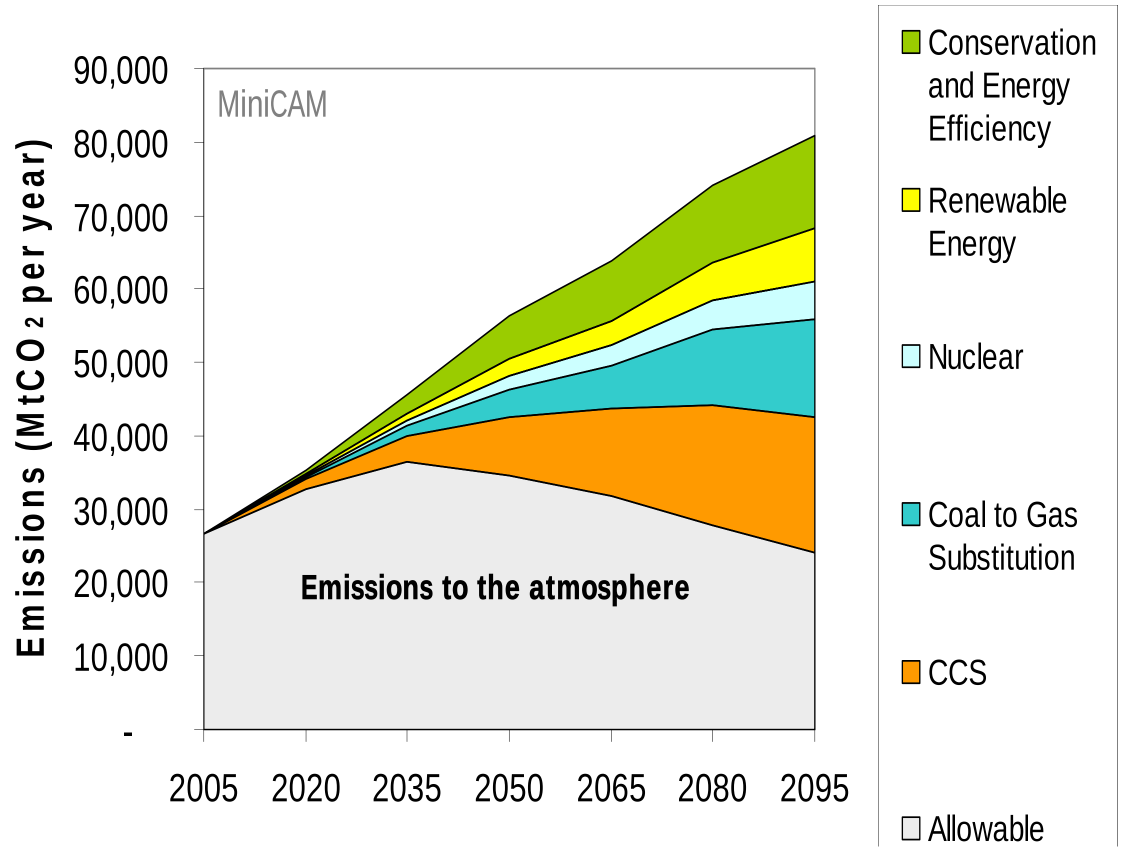
Source: International Energy Agency (IEA) Energy Technology Perspectives to 2050

The climate change mitigation toolbox



Emission reduction potential



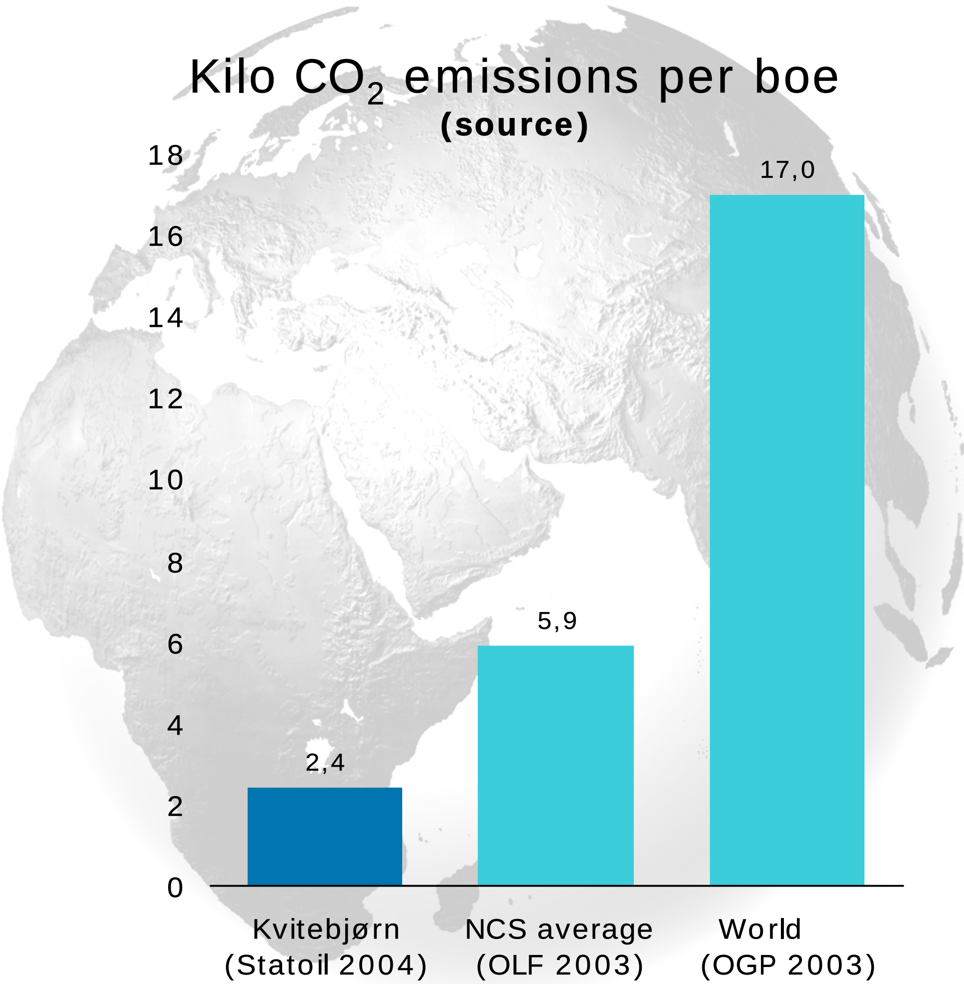


Source: International Panel on Climate Change - SRCCS (2005)

StatoilHydro's climate policy

StatoilHydro's strategy to reduce greenhouse gas emissions:

- – Energy efficiency in own operations
- – Emissions trading
- – Renewable energy
- – Carbon capture and storage



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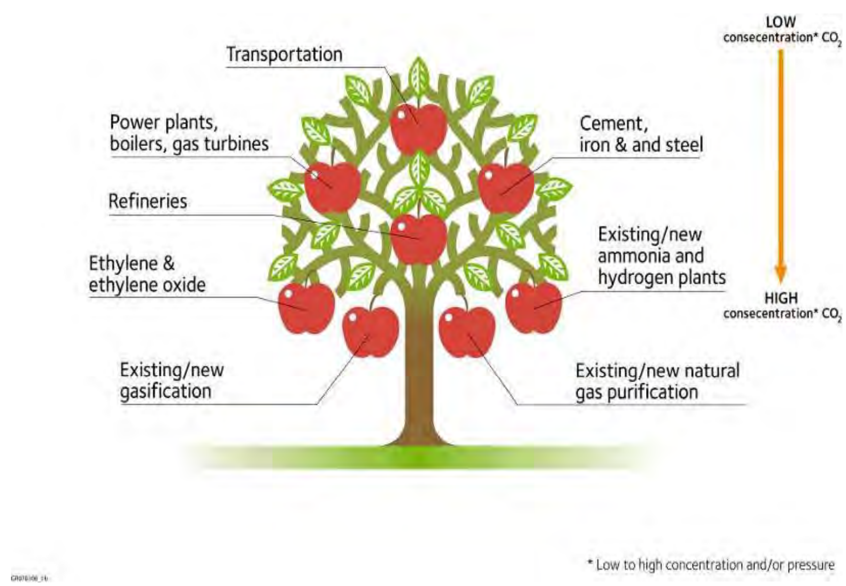
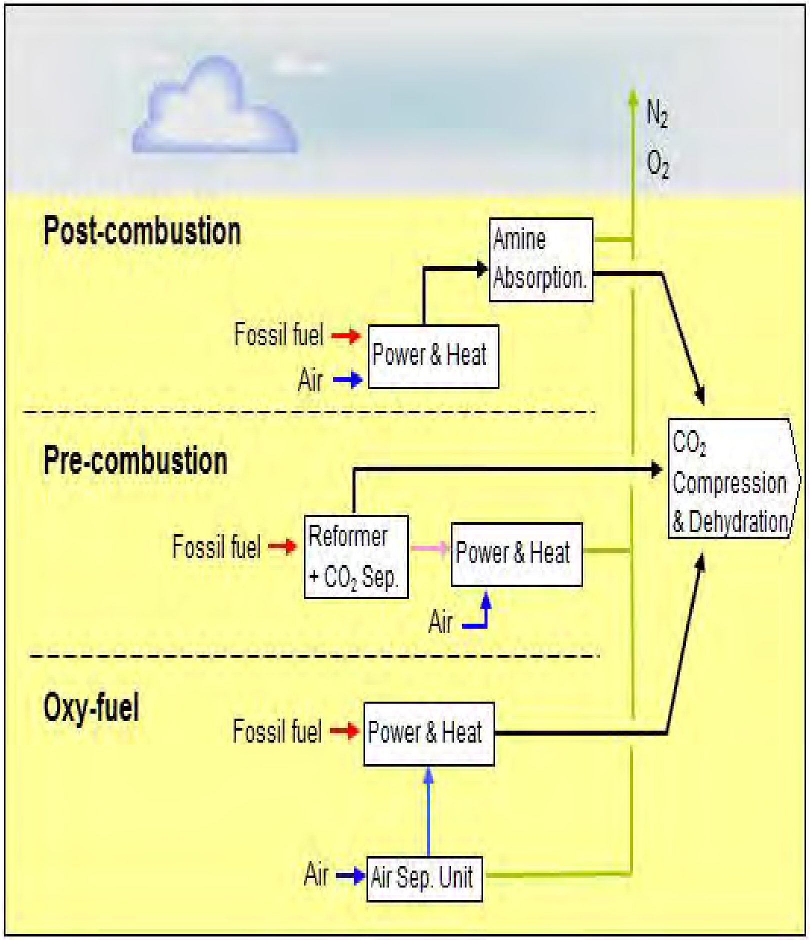
Capture technologies and cost

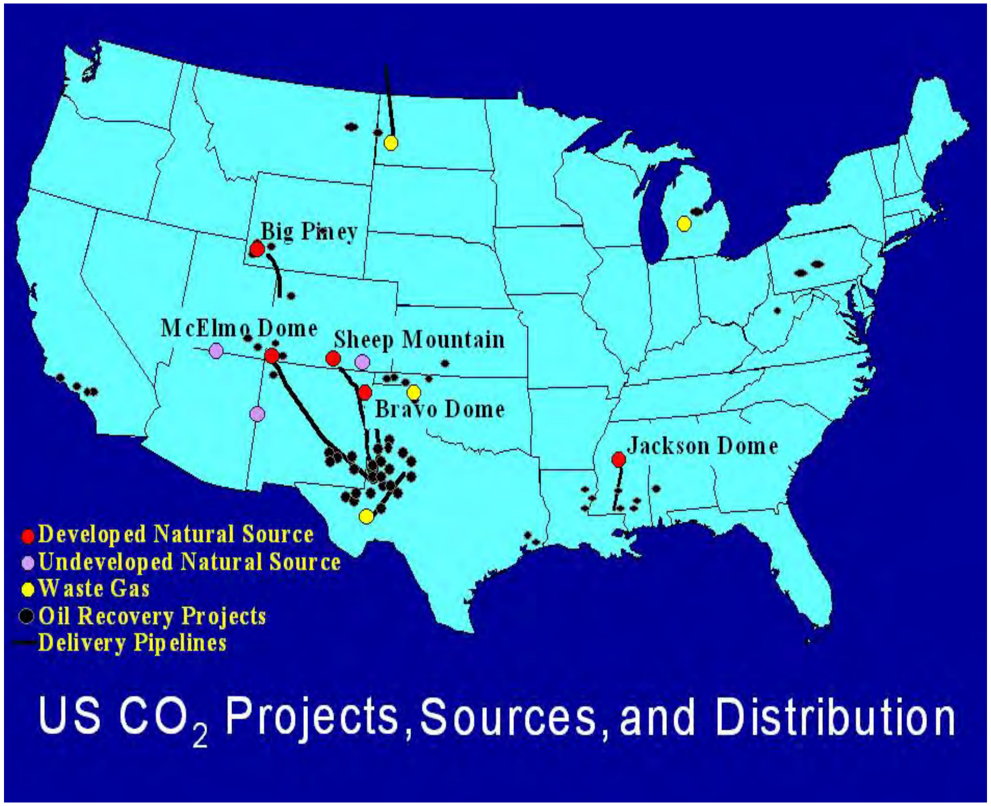
- Capture from flue gas
- Capture from natural gas
- "Lower hanging fruits"

Increasing capture cost





CO_2 for enhanced oil recovery well known on land



- Background & inspiration
- Over 80 fields ongoing
- For more than 30 years
- About 30 Mt injected annually, from naturally CO_2-fields
- Large long CO_2 -pipelines
- But not focus on climate
- Very profitable at today oil prices
- Norwegian fields – cost too high

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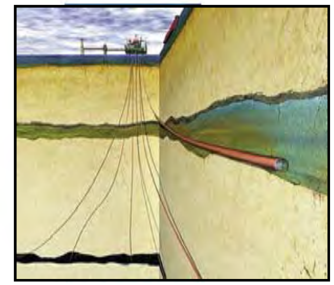
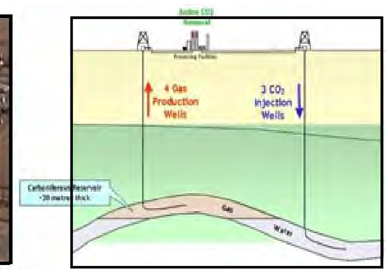
StatoilHydro Carbon Capture & Storage Projects

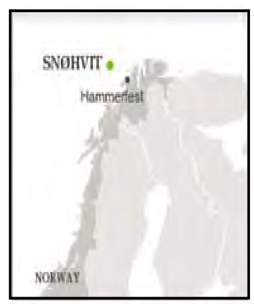
- Sleipner field , North Sea
- 1 million tons CO_2 annually
- Start-up 1996

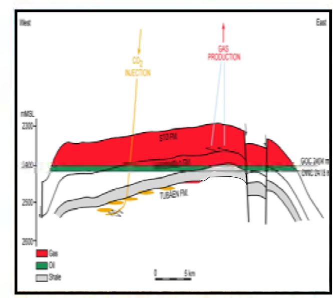



- In Salah field, Algeria
- 1,2 million tons CO_2 annually
- Start-up: 2004

- Snøhvit field, Barents Sea, Arctic
- 0.7 million tons CO_2 annually
- Start-up 2007



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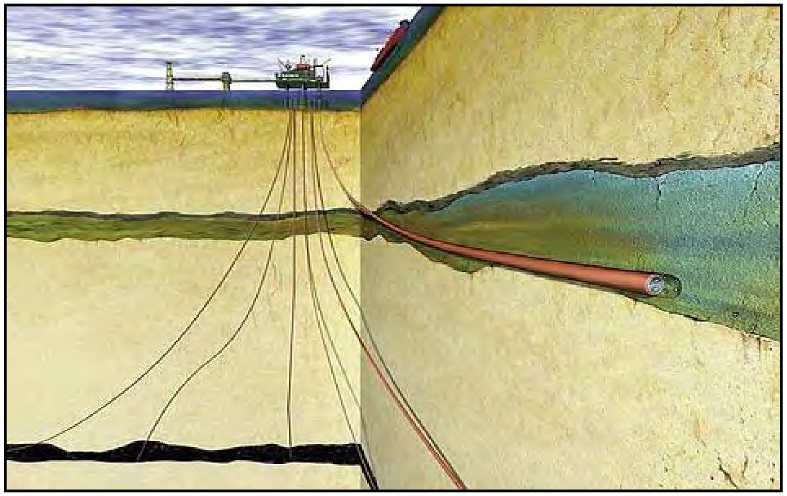
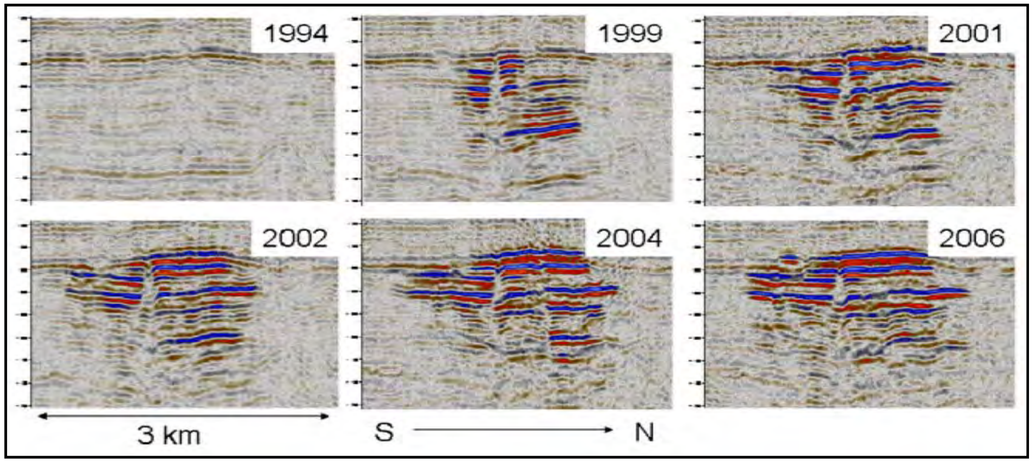
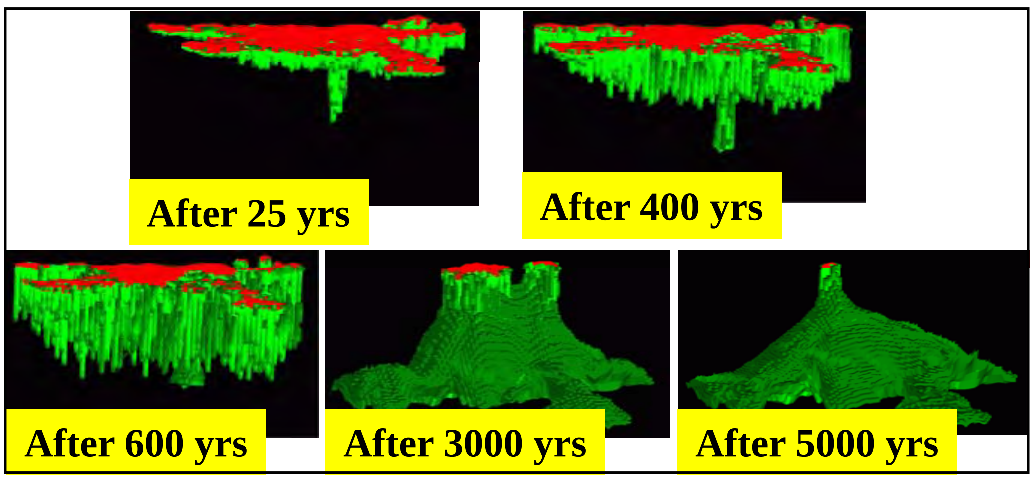
The Sleipner CO_2 injection – StatoilHydro's starting point

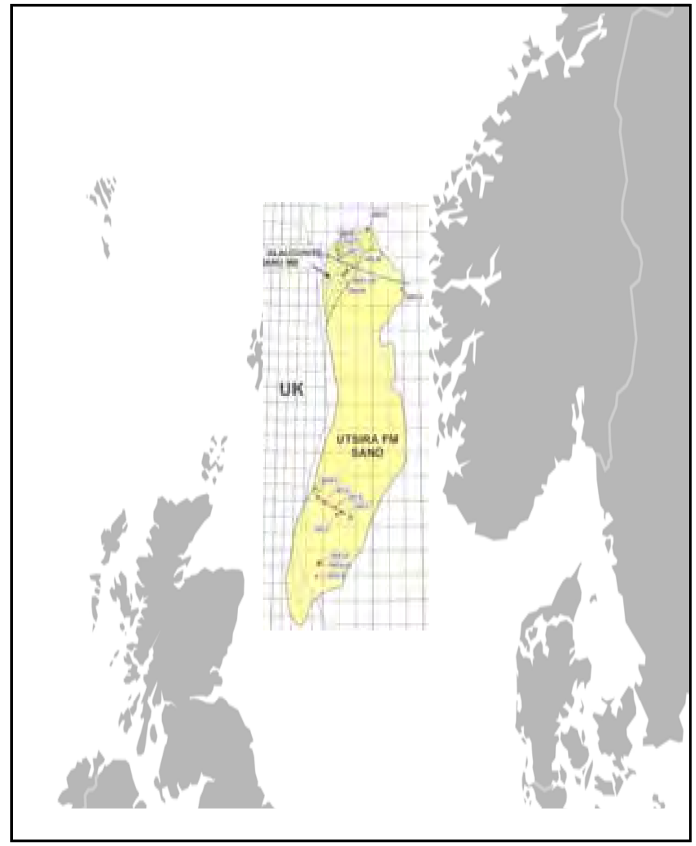
- **Started in 1996 – more than 12 years of experience**
- **Natural gas with 9% CO_2. Sales spec 2.5 % CO_2**
- **CO_2 is removed from the natural gas offshore by an amine process (MDEA)**
- **Separating and injecting nearly 1 mill. tons CO_2 annually**
- **Storing in saline sandstone aquifer above natural gas reservoir**
- **Driver & incentive: CO_2-tax**
- **Several large EU-wide R&D programs**



The Utsira formation – the global storage demo

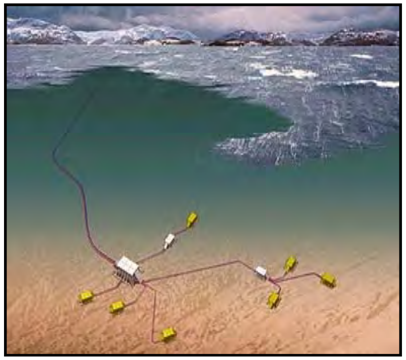


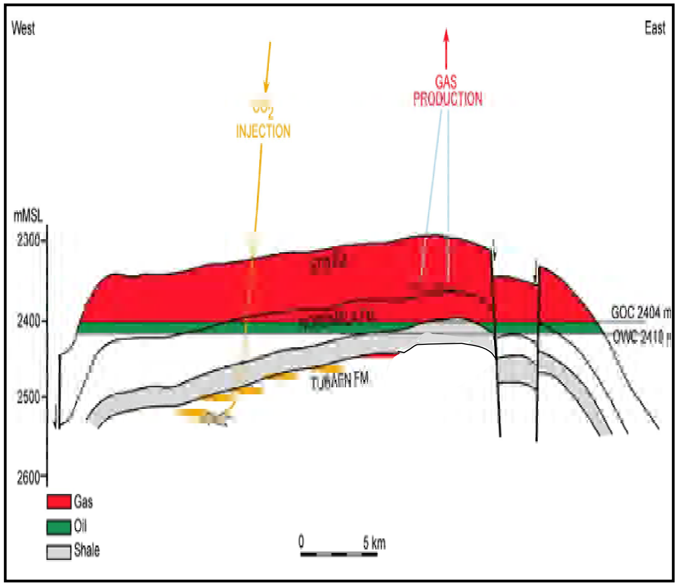




Snøhvit LNG – CO_2 piping & reinjection

- Start-up 2007
- CO_2 is removed from the natural gas (7%) onshore by an amine process (aMDEA) to 50 ppmv CO_2 for LNG – at onshore LNG plant
- CO_2 piped back offshore for injection into a sandstone below the natural gas reservoir
- Storing 700.000 tons CO_2 annually





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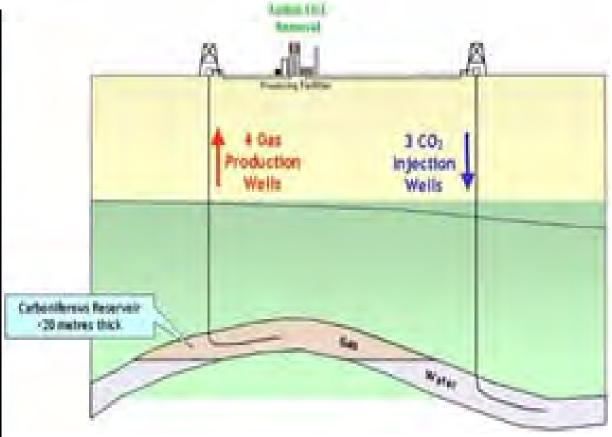
In Salah CCS project - Algeria

- Started in 2004
- BP with Sonatrach & Statoil
- Natural gas with 5.5% CO_2. Pipeline spec is 0.3% CO_2
- CO_2 is removed from the natural gas onshore by an amine process (aMDEA)
- Re-injecting 1,2 mill. tons CO_2 annually into reservoir aquifer



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The Halten CO_2 project

- Starts 2011/2012 if sanctioned
- StatoilHydro/Shell
- CO_2 from gas power plant
- Separating, transporting and storing up to 2,5 mill. tons CO_2 annually
- Storage site mapping underway
- **Driver:** Regional power deficit and offshore electrification

CO_2-EOR part of the project was terminated due to poor results from reservoir study.

Work on CCS continuing.

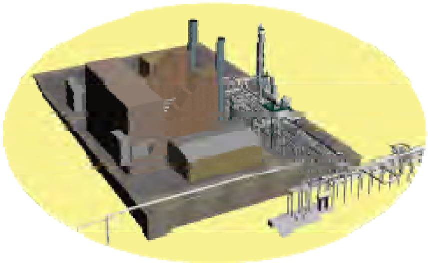
Mongstad CO_2 – technology development to drive CCS implementation

Capture test centre

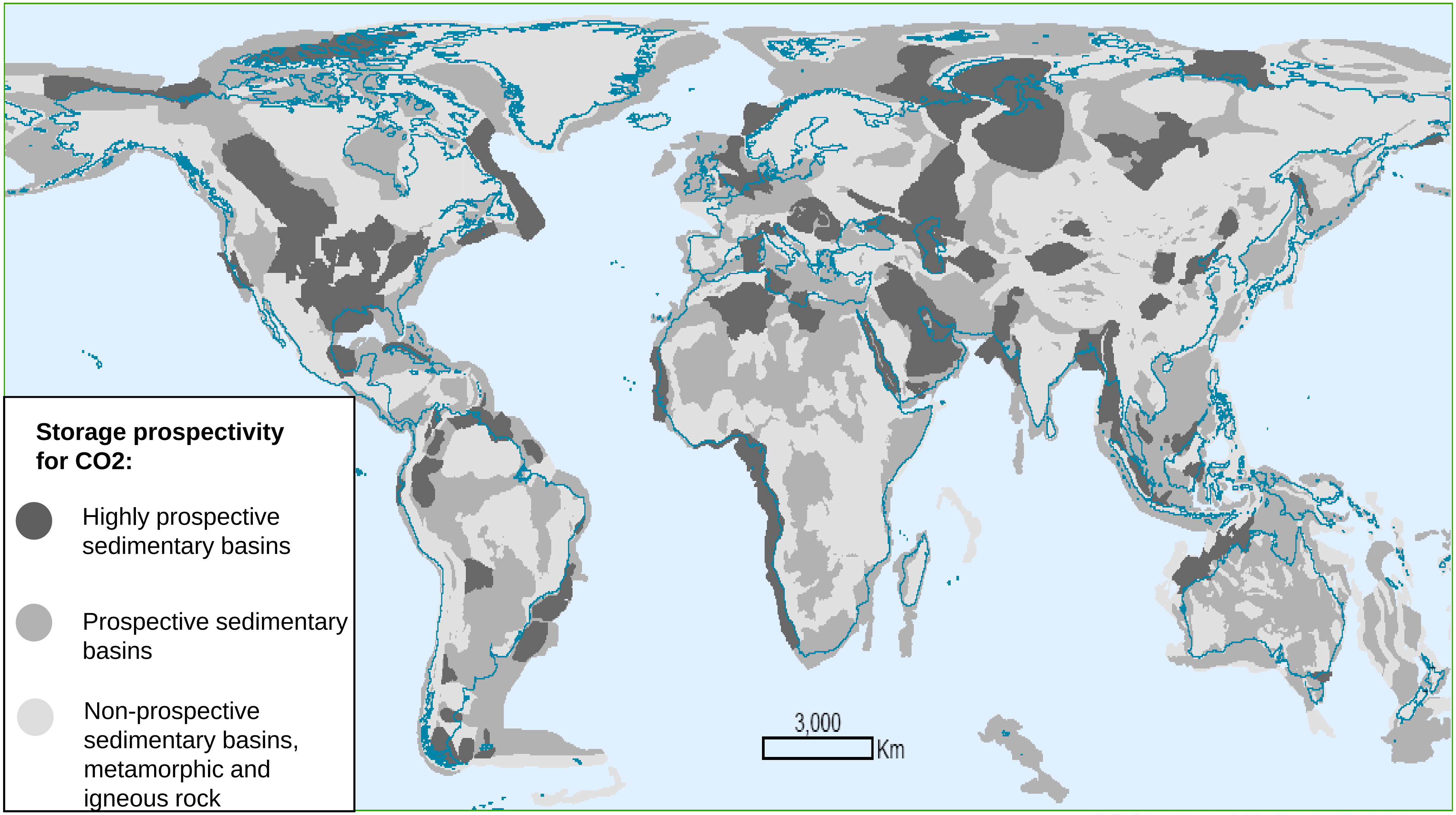
- Starts late 2010
- StatoilHydro, partners and authorities
- Source: CO_2 from gas power plant and refinery cracker gas
- Separating, transporting and storing 0,1 mill. tons CO_2 annually
- Transportation and injection site not yet identified
- Driver: Technology development, qualification and cost reduction. Authorities to bear cost of transport and storage.

Full scale capture

- Project sanction 2012
- StatoilHydro on behalf of authorities
- Source: CO_2 from gas power plant and refinery cracker gas
- Separating, transporting and storing up to 2,5 mill. tons CO_2 annually
- Injection site not yet identified
- Driver: CCS costs fully covered by authorities



Sedimentary basins & CO_2-storage prospectivity



Source: IPCC Report on CCS, 2005

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CCS – not fully accepted yet

- Political issues
- Legal issues
- Scientific issues
- Technology and cost issues
- Public acceptance

Potential barriers or enablers	International (I), Regional (R), National (N)	Expected time until solved	
		< 2 years	2-5 years
UNFCC-IPCC National Inventories	N, I	● (green)	● (green)
Kyoto Protocol (CDM and JI)	I	● (red)	● (yellow)
UNCLOS	I	● (green)	● (green)
London Convention and Protocol	I	● (green)	● (green)
OSPAR	R	● (yellow)	● (green)
Trans-boundary movement and/or damage	I	● (yellow)	● (yellow)
The Aarhus Convention	I	● (green)	● (green)
EU ETS	R	● (yellow)	● (green)
EU enabling legal framework	R	● (red)	● (green)
UK regulations and CCS	N	● (yellow)	● (green)
Norway regulations and CCS	N	● (yellow)	● (green)
Long-term liability	N, R, I	● (red)	● (red)
Risk assessment methods	I	● (yellow)	● (green)
Risk acceptance, including site approval criteria	I	● (red)	● (yellow)
Monitoring and verification	I	● (red)	● (yellow)
Public support	I	● (yellow)	● (yellow)
Accounting and certification of credits	I	● (yellow)	● (green)
Costs and economics	I	● (red)	● (yellow)
Incentives	I/R/N	● (red)	● (yellow)
Technology maturity	I	● (green)	● (green)

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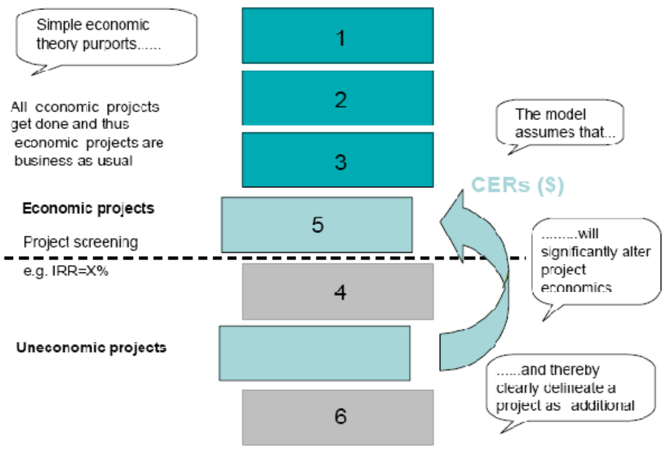
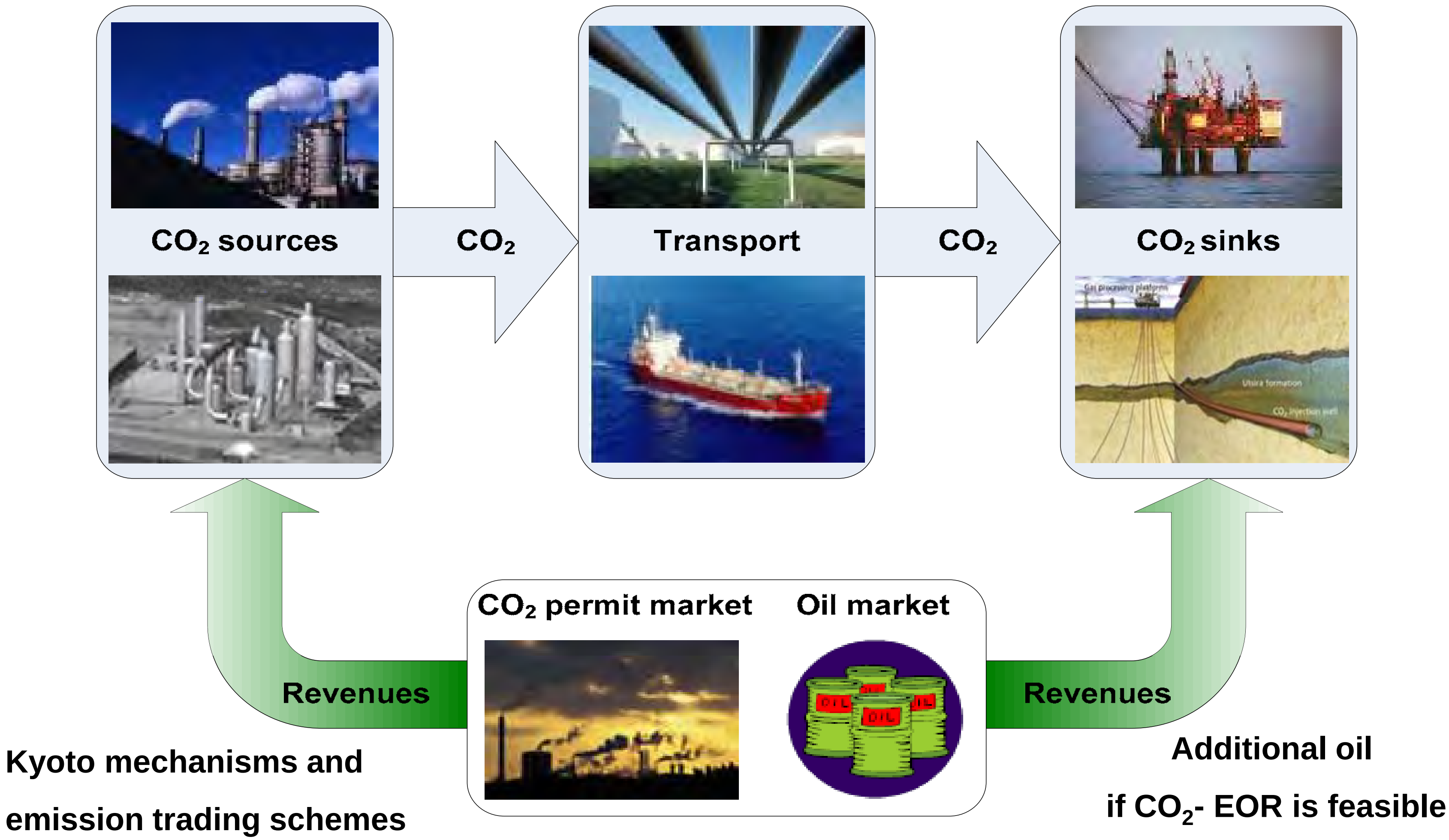
Kyoto Mechanisms



- **Incentives key for success**
  - **Norwegian CO_2 tax**
  - **EU Emission trading scheme**
  - **Kyoto Mechanisms**
    - **Clean Development Mechanisms (CDM)**
    - **Joint Implementation projects (JI)**
  - **Very complex approval processes**

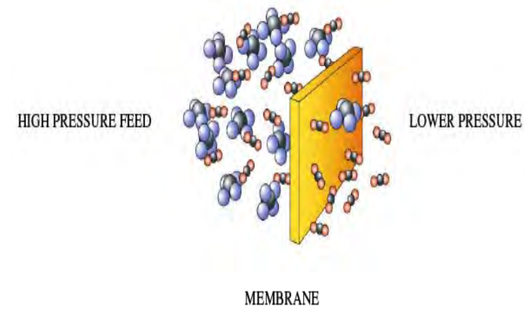

The World Bank/GGFR
Indonesia Associated Gas Survey –
Final Summary Report
10 December 2007
GGFR

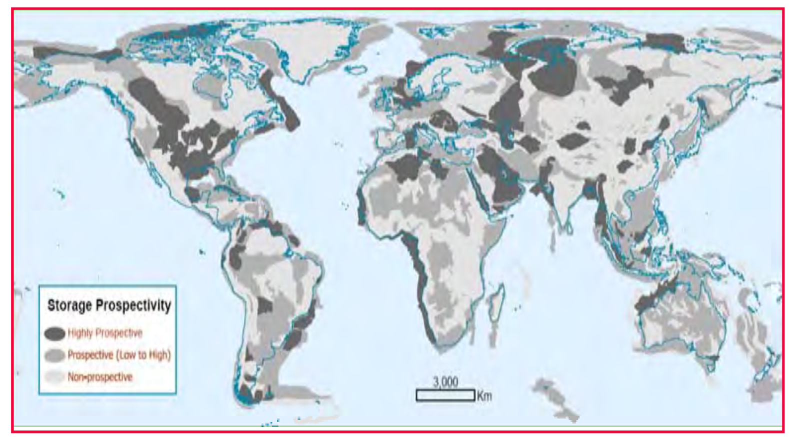
CO_2 value chain with revenue streams → income is needed!



Technology development needed

- To reduce cost - Mainly capture
- To upscale & increase capacity - CCS value chain
- To test & implement - CCS value chain
- To build trust - Storage





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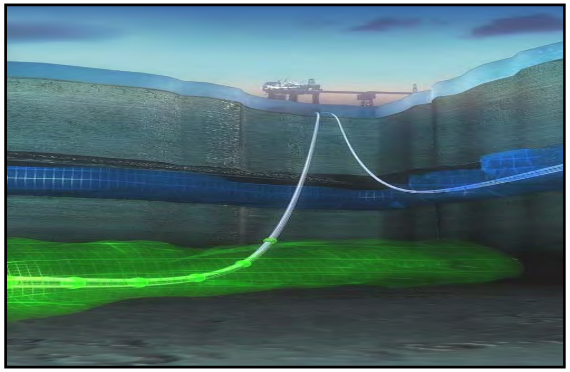
Summary & Conclusions



- **Over 30 proposed full-scale power plant projects with CO_2 capture in Europe.**
- **About 10 commercial and demonstration CO_2 storage projects**

•Very large storage capacity worldwide

•CCS technology – develop- upscale- implement

•Regulations for CCS slowly coming in place

•CCS expected to become an important element in meeting the global climate challenge

•CDM and JI as energy efficiency tools in our industry

•Incentives key in making progress

•Building trust necessary

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Seismic monitoring of Sleipner CO_2 storage