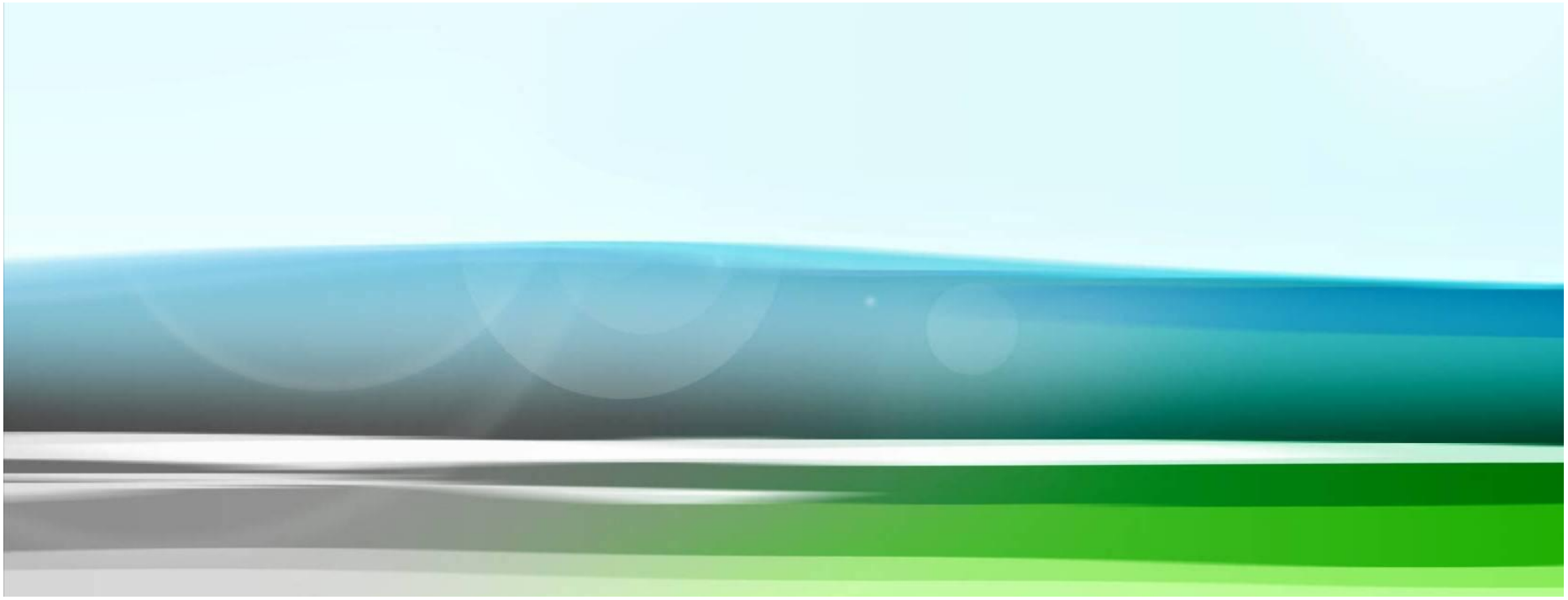


7th Annual EOR Carbon Management Workshop
Houston, Texas December 7-8, 2009

CCS Project Development and Public Acceptance Roundtable

David Coleman

Business Development Leader, Carbon Capture & Storage

DNV Energy North America

MANAGING RISK DNV

DNV – an independent foundation

DNV (Det Norske Veritas) was established in 1864 in Norway

DNV more than 145 years of international experience managing risk

Broad experience in the energy industry

Deep and ultra-deep water field development

Natural gas/LNG

Wind energy

Pipeline transport

Managing risk

Carbon capture and storage

Refining and petrochemicals

Arctic operations and technology

CCS Project Development Roundtable

- *Eric Redman* – Summit Power – West Texas Project
- *Dale Simbeck* – SFA Pacific – Gasification issues
- *Marty Dubois* – Cap-CO2 – Kansas Project
- *Sara Wade* – Partner AJW, Inc – Issues of Public Acceptance

CCS – the bridge to the future low carbon society

Accepting CCS as one of the tools for climate change mitigation

MANAGING RISK

CO_2 capture risks

THE COST OF CAPTURE CO_2

- Status:
  - There is to date no full scale CO_2 capture plant for cleaning of flue gas in operation
  - Current cost estimates indicate that the capture plant contributes with the largest part of the costs in the CCS value chain, firstly due to energy consumption
  - The capture plant is where we find the highest potential for cost reductions through development of new technology

- The main concerns are related to:
  - Up-scaling of existing technology
  - Technology enhancements for cost reductions
  - Introduction of new technologies
  - Accidental discharge and dispersion of concentrated CO_2
  - Solvent handling
  - Costs of energy for the capture process
  - Future value of avoided CO_2 emissions

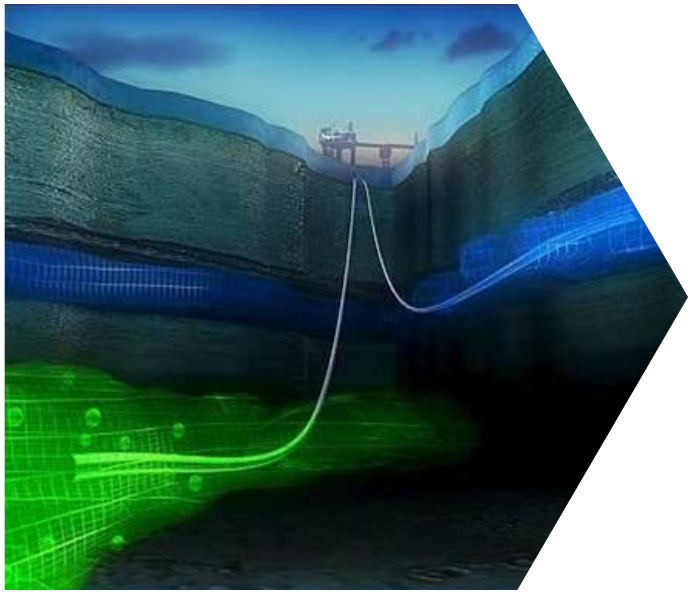
CO_2 transportation risks

EXPOSURE OF CONCENTRATED CO_2 TO LARGE POPULATIONS

- Status:
  - *Pipeline transmission* of CO_2 is not fundamentally different from transmission of NG, for which we have long experience.
    CO_2 pipelines have been in use for decades (mainly USA), but in smaller quantities than for NG.
    However, there are differences to be aware of.
  - *Ship transportation* of merchandised CO_2 is done today, e.g. for the beverage and welding industries. However, the world market of merchandised CO_2 is very small, and so are the ships sizes.

- The main concerns are related to:
  - Accidental discharge and dispersion of concentrated CO_2
  - Corrosion in case of accidental uptake of humidity
  - Ductile Fracture (crack arrest)
  - Material compatibility (elastomers, polymers)
  - Pipeline operational issues

CO_2 storage risks



PROVING SAFE STORAGE FOR THOUSANDS OF YEARS

- Status:
  - There are a many EOR projects – no leakages reported.
  - Experience with CO_2 storage in aquifers is being gained from the Sleipner and Snøhvit projects
  - There is a considerable public concern related to how safe geological storage will be over thousands of years
  - In USA contamination of fresh water reservoirs is a major concern.

- The main concerns are related to:
  - Component failure of the injection well causing release of concentrated CO2
  - Long term leakage into fresh water reservoirs
  - Long term leakage to the environment
    - Loss of intended positive effect
    - Acidification of seawater

Risk manage the whole CCS value chain

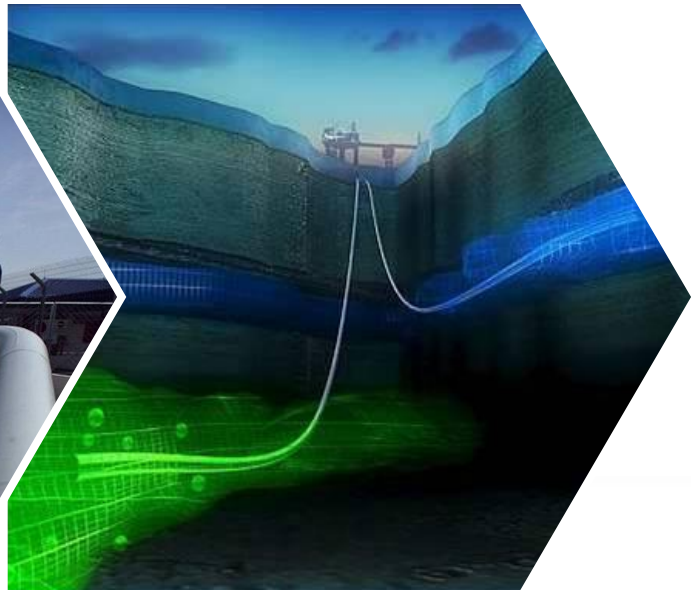
Capture

- Fossil power plants
- Natural Gas CO_2 reduction
- Other industrial processes

Transport

- Pipelines
- Ships

Storage



- Empty oil or gas reservoirs
- Saline aquifers
- Enhanced Oil Recovery

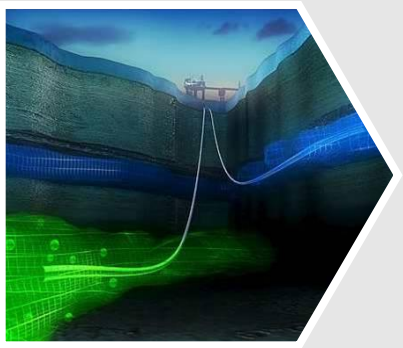
independent guidelines for CCS

- Qualification of new CO_2 capture technology
  - JIP kicked-off in December 2006
  - Project guideline issued autumn 2008
  - DNV Recommended Practice public April 2010

Partners: Gassnova, StatoilHydro, Statkraft, Aker Clean Carbon / Aker Solutions, DNV

- Transmission of dense, high pressure CO_2 in submarine and onshore pipelines (CO2PIPETRANS)
  - JIP kicked-off autumn 2008
  - Project guideline issued autumn 2009
  - DNV Recommended Practice public April 2010

Partners: Gassnova (50%), Gassco, Vattenfall, StatoilHydro, BP, Shell, ArcelorMittal, Dong Energy, ILF, Petrobras, British Gas, Chevron
Observers: PTil (NO), HSE (UK), MINEZ (NL)
Sub-contractors: SINTEF, IFE, Polytec



- Qualification of Sites and Projects for Geological Storage of CO_2 (CO2QUALSTORE)
  - JIP kicked-off autumn 2008
  - Project guideline to be issued autumn 2009
  - DNV Recommended Practice public April 2010

Partners: Gassnova, IEA GHG, Shlumberger, StatoilHydro, Dong, BP, Shell, Vattenfall, RWE, British Gas, Gassco, Petrobras
Observers: Regulators invited.