IRIS

Site selection and qualification

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International Research Institute of Stavanger

December 10, 2012

Short introduction

- Independent research institute with a 40 years of history
- $>$ 150 scientists ($>$ 60% with PhD) in Energy, Social Sciences and Environmental Studies
- Main topis in Energy department are drilling automation and multiphase reservoir flow
- Have own lab and full scale drilling test / evaluation rig
- CCUS is a logical extension of our key expertise
- National and international projects and partnerships for more than 10 years

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Overview

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- Where to begin
- First screening
- Data and information needed
- Tools and expertise needed
- Sample workflow
- Concluding remarks

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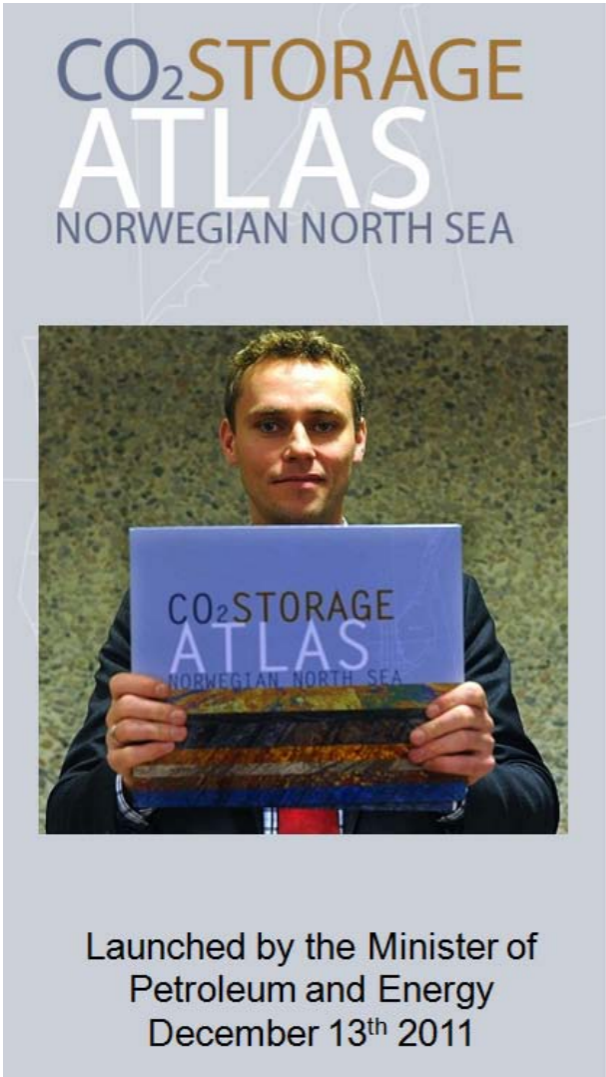
Important note

IRIS

Here we are talking about site selection and qualification for particular project, not in general!

Things like this are *great* to have

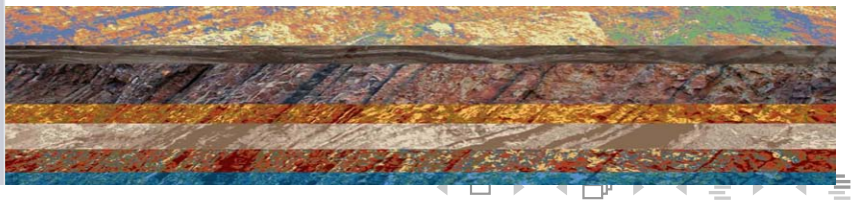
IRIS



NPD

Objectives and requirements

- Find the safe and effective areas for storage of CO_2
- No interference with the petroleum activity
- Build on the accumulated knowledge from the Norwegian petroleum activity
- Build on the experience we have with storage of CO_2
- Mapping and volume calculations should be verifiable
- The work will define relevant storage areas and estimated storage capacities
- The evaluation will form the basis for any terms and conditions set for a development of a storage site



Screening

IRIS

- Think full cycle: Capture - Transport - Utilization - Storage
- Many sides involved: Emitting, transporting and storing industries, goverment, community
  - Legislation
  - Responsibility transfer
  - Cost sharing
  - Public acceptance
- Location of sources and potential storage sites
  - Transport: materials (stream composition)
  - Transport: costs

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- Interference with other industries:
  - Landuse: Farming? Production? Residential?
  - Offshore: Fishing? Oil and gas?

Technological questions

- Depleted fields vs aquifers
  - Data availability
  - Geological and geophysical properties
  - Uncertainties and risks during capacity evaluation
- Injectivity
  - Uncertainties in properties, other effects
- Storage safety
  - Migration paths, potential leakage scenarios

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Previous two slides is a long list of complex questions

There is no industry pull to develop technology at the moment

Legislation, costs, acceptance, technological gaps all provide challenges

To resolve this:

- Technological push via governmental involvement and research commitment
- Synergy between R&D entities, across industries, and national borders

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Carbon Capture Utilisation and Storage

CCS fulfils ecological goal, but "wastes" energy used to compress CO_2 and it's effectiveness to displace oil.

EOR recovers more oil and would help to at least partially pay for storage

Problem is:

- Anthropogenic CO_2 would come over long period of time at constant rate (t/year)
- CO_2 EOR process requires less and less CO_2 as it stars to be backproduced and cycled
- There must be large scale storage project supporting several EOR applications

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IRIS

- Centralised transport in place that could be easily expended with capacity and be hooked up to
- One of big storage issue: over-pressurising the aquifer (low compressibility) during injection
- One of big O&G production issues: pressure support
- Could we "link" those two together and organise "cross-flow" of water from aquifer into the reservoir...
- ... gradually going from water injection into carbonated water and CO_2 EOR?

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Data and information

The more data the merrier ... but more costly as well.

Our models could only be as good as data actually is (garbage in - garbage out)

We need flexible and simple solutions :

- Some seismic is always available - otherwise we would not knew that reservoir are there...
- Wells must be flexible explore - (produce) - inject - monitor
- Costs are critical: we cant drill around to explore. We need wells with downhole gauges to measure and monitor
- Every peace of data is valuable: combined interpretation approaches.

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We need champions to drive the process forward in:

- government legislation and actions (we need more than just words!)
- public awareness, acceptance and trust (public should be aware of what we do, not scared of it!)
- cross-industrial relationships (emitter - transporter - user)
- closing technological gaps (focus on applied R&D)
- ... And finally someone who will go and do it!

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Sample workflow

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High level screening (like NPD's Atlas):

- What are the potential storage site globally (province, country, region)
- Availability of data for those sites
- Screening of storage capacity / integrity etc.

Sample workflow

IRIS

Technical study on potential candidates

Storage

- Capacity
- Injectivity
- Safety
- ...

Other

- Legislation
- Acceptance
- Transport
- ...

Sample workflow

IRIS

Site development

- Well placement, injection strategy
- Pressure relieve
- Materials
- Monitoring program
- ...