Use of existing infrastructure and knowledge: Examples from Northern Lights project

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Using material from Northern Lights project team and Equinor R&T Storage scale-up team
Northern Lights Overview

Setting:
• The Northern Lights project is focused on CO₂ captured from industrial sites
• The project will use saline aquifer storage
• However, the project benefits from technology and insights acquired though oil and gas activities

Question?
How can the CCS industry benefit from the oil and gas industry
So what are we learning for CCS and how does it save on costs?

<table>
<thead>
<tr>
<th>Technology arena</th>
<th>What benefits?</th>
<th>What cost savings?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface infrastructure</td>
<td>Huge leanings from oil and gas operations</td>
<td>Very substantial</td>
</tr>
<tr>
<td>Wells</td>
<td>Slightly modified standard well technology</td>
<td>Substantial</td>
</tr>
<tr>
<td>Exploration</td>
<td>Use of exploration well databases, 3D seismic and geological knowledge</td>
<td>Nearly priceless!</td>
</tr>
<tr>
<td>Reservoir technology</td>
<td>Modified reservoir modelling tools and approaches</td>
<td>Substantial</td>
</tr>
</tbody>
</table>
**Northern Lights Infrastructure**

**Ship**
- One ship per capture site
- 7,500m³ of CO₂ per ship

**Pipeline**
- 110km 12 inch pipeline

**Subsea injection well**
- Injection of CO₂ into reservoir at ~3000m depth

**Shipping, pipeline and well technology** are all based on oil and gas technology.
CO₂ storage exploration ‘piggy-backed’ on HC exploration

- Equinor and license partners drilled exploration well 32/4-2 in PL921 in August 2019
- The main target was petroleum exploration
- A CO₂ data acquisition programme was added with agreement of partners
- No hydrocarbons were found
- The well confirmed good saline aquifer storage potential
Quantifying storage risks

In support of the Northern Lights project and for future storage scale up, Equinor and many partners are working on:

• Fault mapping from seismic
• Fault Seal and fault permeability
• Pressure communication
• 3D geological modelling
• Geomechanics and strain
• Micro-seismic monitoring
• Flow simulation

Uses seismic datasets and wells to develop a CO₂ storage play alongside an historic hydrocarbon play

Long Wu et al (2019), EAGE Fault & Top Seal Conference
Reservoir modelling and simulation

Future storage prospects at Smeaheia being quantified using detailed reservoir models:

- simulation of different injection well concepts and effects of pressure communication across faults

Regional 3D geomodel of Smeahiea prospects

Cross section of property model – Gladsheim prospect

Secondary Storage Complex: Dunlin Group sandstones

Primary Storage Complex: Viking Group sandstones
Taking the challenge to the global scale

Global distribution and thickness of sediment accumulations on continental margins, with largest oilfields and main river systems (Ringrose & Meckel, 2019, Scientific Reports)
**∆P basin pressure model for global storage development**

- Initial and final pressure per well can be used to estimate capacity

Mean capacity is ~17Mt per well

### Generic ‘basin ∆P’ approach:
Integration of the injectivity equation over the project lifetime:

\[
V_{\text{project}} = Ic \left[ p_{\text{well}} - p_{\text{init}} + \int_{t_i}^{t_f} A p_D(t_D) \right] + F_b
\]

where,
- \( V_{\text{project}} \) = estimated volume stored
- \( Ic \) = injectivity
- \( p_{\text{well}} \) = injection well pressure
- \( p_{\text{init}} \) = initial reservoir pressure
- \( A p_D(t_D) \) = characteristic pressure function
- \( F_b \) = volume flux boundary condition

Ringrose & Meckel (2019)
Application of ΔP method to basin-scale developments

- Projected growth of CO₂ injection wells based on historical hydrocarbon well developments.
- Concept captures industrial maturation phases for global CO₂ storage.
- Uncertainty range based on bounds (P10 - P90) from empirical injection rates.

Main finding:
We will need ~12,000 CO₂ injection wells by 2050 to achieve 2DS goal.

Ringrose & Meckel (2019)
Summary

• CCS projects already making good use of experience and knowledge from hydrocarbon activities:
  ➢ Infrastructure
  ➢ Wells
  ➢ Exploration
  ➢ Reservoir technology

• We can use this foundation to rapidly and cost-effectively scale up CCS (especially storage)

• Number of wells needed for climate goals (2DS) is small compared to historic oil and gas industry

Northern Lights is an important next step in building out the infrastructure for future CCS
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