Greensand Project

CO2 Transport and Storage
INEOS Energy & Wintershall Dea
By Søren Reinhold Poulsen, Greensand Project Director

Ship-based CCS concept
Phase 2 Pilot Project
Greensand Phase 2 Work Package Set-up – derisking further before the Final Investment Decision

- Learn for others (industry and academia) through collaboration
- But further confidence and experience is required
- An offshore CO2 injection pilot test is therefore in the planning
Greensand Pilot: Subsurface

What do we know?

- **Containment**
  - Siri Area reservoir seals proven

- **Capacity**
  - Storage capacity/volumes quantified through production

- **CO2 Injectivity**
  - Upscaled CO2 injectivity unknown

Pilot Injectivity Test

- **Well**
  - Injectivity and Integrity issues due to **thermal cycling**

- **Reservoir**
  - Mineral reactions & Multiphase behaviour issues

- **Measure, Monitor & Manage**
  - Pressure, Temperature, Rates
  - Seismic monitoring of the plume
Nini West CCS

- Cyclic injection following pilot test
- 1D sand, proven high water injectivity
- Depleted saturations but reservoir $p > p_{\text{init}}$
- Extensive aquifer
- Storage target: 0.5 MTA above FWL and aquifer

### Pilot/Full scale CCS design

<table>
<thead>
<tr>
<th></th>
<th>No. of cycles</th>
<th>Injection rate/cycle $Q_i$ (tonnes/day)</th>
<th>Injection time, $t_{\text{inj}}$</th>
<th>Shut-in time, $t_{\text{SI}}$</th>
<th>Initial reservoir pressure, $p_{\text{init}}$ (bara)</th>
<th>Initial reservoir temp. $T_{\text{init}}$ (deg.C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PILOT</td>
<td>14</td>
<td>1.000</td>
<td>15 hrs</td>
<td>6 days</td>
<td>210-220</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Existing well</td>
<td></td>
</tr>
<tr>
<td>FULL SCALE</td>
<td>50/yr</td>
<td>10.000</td>
<td>12-24 hrs</td>
<td>6 days</td>
<td>210-220</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>New CO2 injector</td>
<td></td>
</tr>
</tbody>
</table>
Pilot Injection Expected Phase Behaviour

WH: Wellhead
BH: Bottomhole
Monitoring & Modelling

Expected pressure behaviour from compositional simulations
Nini West CCS Key Challenges

**CYCLICITY**
- Phase change in well during injection and shut-in
- CO2 mobility changes in reservoir
- Near-wellbore events affecting injectivity
- Salt precipitation
- Residual CO2 trapping
- Injection pressure management
- Logistics chain

**HIGH INJECTION RATES**
- High daily discharge rate due to cyclic injection
- Well length/count
- Reservoir, caprock and well integrity

Comparable yearly storage rates but very high instantaneous injection rates due to cyclicity.
Thank you for your attention and please visit www.projectgreensand.com