D05 Site Selection Report – Annex 3 Site Selection Posters
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Site A: Brae North Condensate Field

Location of Site

Brae Formation accumulations within Brae North – Bremen, 2003

Cross section in the Brae North and Brae fields – Bremen, 2003

Time interpretation of the near Top Middle Jurassic in the Brae North Condensate Field area – Alcock, 2017. Shape guidance from CO2 stored.

Proprieties

Porosity is the Main Channel reservoir varies from 16 to 22% in clean sandstones (average 17.6%) and between 13 and 15% in conglomerates (average 12.7%). Average permeability is 300 mD.

Storage Efficiency Appraisal

Unit Designer Storage Unit Type Reference
Non Condensate Reservoir Porous Rock A scalable A scalable
Non Condensate Reservoir Fractured Rock A scalable A scalable

Development Cost

Storage Efficiency (%) Levelised cost in storage efficiency calculated for eight sites from the ETI sand Project. Brae North Condensate Field estimated position in orange.

Key Risk Summary

Capacity (MT)

Capacity

Storage Efficiency

Brae North

Brae North Condensate Field is covered by the 3D seismic from the CNS PGS MegaSurvey. The data quality is generally good.

CO2 Density

Sensitivity Analysis

Upside

Downside

Storage Efficiency

Time interpretation of the near Top Middle Jurassic in the Brae North Condensate Field area – Alcock, 2017. Shape guidance from CO2 stored.

Data

Brae North Condensate Field is covered by the 3D seismic from the CNS PGS MegaSurvey. The data quality is generally good.

CO2 data is available over the Brae North Condensate Field and surrounding areas. There are a total of 34 wells in the area divided in 1 discovery well, 8 appraisal wells and 27 development wells. Abandoned wells in the area are likely well prepared to avoid vertical CO2 migration from the Brae Formation, so are probably well suited to the storage of CO2.

Stability

The site is located below the Hallimend Sandstone, another of the top 6 sites considered in this project, and could be a secondary containment in this site.

References


ETI S4AP 2016. Progressing Development of the UK’s Strategic Carbon Dioxide Storage Resource: A Summary of Results from the Strategic UK CO2 Storage Approval Project.
Site B: Grid Sandstone Member – West and East Grid

**Location of the Grid Sandstone Member in relation with the Miller Gas Field (Yellow), the Western Area Gas Evacuation System (WAGES - Green) or the Goldeneye (OY - Blue) areas. Source: Google Earth Pro Pipeline and field data from Oil and Gas Authority [https://www.ogauthority.co.uk/].**

**Graph showing the PGS CNS mega-slices showing the PGS MegaSurvey data coverage in the Grid area - timeslice showing the PGS MegaSurvey data coverage in the Grid area.**

**Image showing location of West Grid and East Grid - East Grid.**

**Storage Efficiency Appraisal**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>West Grid</th>
<th>East Grid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Rock Volume Low</td>
<td>65,550</td>
<td>96,450</td>
</tr>
<tr>
<td>MMCUM Mid</td>
<td>131,100</td>
<td>192,900</td>
</tr>
</tbody>
</table>

**CO2 Storage Efficiency**

<table>
<thead>
<tr>
<th>Porosity</th>
<th>Net to Gross Ratio</th>
<th>CO2 Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.69</td>
<td>0.36</td>
<td>0.79</td>
</tr>
</tbody>
</table>

**Sensitivity Analysis**

<table>
<thead>
<tr>
<th>Upside</th>
<th>Downside</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.33</td>
<td>0.10</td>
</tr>
</tbody>
</table>

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The ACT Acorn consortium is led by Blue Dot Energy and includes Benthal Foundation, Heriot-Watt University, Radboud University, Scottish Carbon Capture & Storage (SCCS), University of Aberdeen, Edinburgh and University of Liverpool.

ACT Acorn, project 27146, has received funding from BEIS (UK), RVO (NO) and RVO (NL), and is co-funded by the European Commission under the ERA-NET ACT instrument of the Horizon 2020 programme. ACT Grant number 691712.
**Site C: Heimdal Sandstone Member – East Heimdal**

**Location of Site**

- **CO2 Point Sources (No. 5):** Oil and Gas Authority.
- **Saline aquifer:** West of Flugga.
- **Dissolved hydrogen sulfur fields:** Sites 1 to 10.

**Gross Rock Volume**

- **Low:** 135,000 m³
  - **Assume thickness of 300m (lower end of range given in Millennium Atlas).**
- **Mid:** 492 m³
  - **Assume thickness of 492 m³.**
- **High:** 7,000 m³

**Porosity**

- **Low:** 0.20
  - **Recommend average of low and high.**
- **Mid:** 0.76
  - **Average of low and high.**
- **High:** 0.76

**Net to Gross Ratio**

- **Low:** 0.100
- **Mid:** 0.21
- **High:** 0.58

**CO2 Density**

- **Low:** 0.005
- **Mid:** 0.08
- **High:** 0.58

**Sensitivity Analysis**

- **Upside:** 110%
  - **Low = 1.**
  - **Mid = 2.**
  - **High = 3.**

**Proximal Upside Potential**

- **East Heimdal:**
  - **CO2 Stored:**
    - **Site A:**
      - **Area:** 0.759
      - **Storage efficiency:** 100%
      - **Storage capacity:** 7,000 m³ CO2
      - **CO2 Density:** 0.08
      - **Injection capacity:** 0.100
    - **Site B:**
      - **Area:** 0.759
      - **Storage efficiency:** 100%
      - **Storage capacity:** 7,000 m³ CO2
      - **CO2 Density:** 0.08
      - **Injection capacity:** 0.100
    - **Site C:** Heimdal Sandstone Member
      - **Area:** 0.759
      - **Storage efficiency:** 100%
      - **Storage capacity:** 7,000 m³ CO2
      - **CO2 Density:** 0.08
      - **Injection capacity:** 0.100

**CO2 Storage Efficiency**

- **Low:** 0.005
- **Mid:** 0.08
- **High:** 0.58

**Developmental Cost**

<table>
<thead>
<tr>
<th>Pipeline</th>
<th>Borehole</th>
<th>Total Cost (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>£1.000</td>
<td>£0.900</td>
<td>£1.900</td>
</tr>
</tbody>
</table>

**Storage Efficiency Summary**

- **89.7%**

**Key Risk Summary**

- **Risk:** High
- **Effect:** Significant
- **Likelihood:** High

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**ACT Acorn project:**

- **Funded by the UK’s Department for Business, Energy and Industrial Strategy.**
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**Co-Commission:**

- **European Commission under the ERA-NET ACT Instrument of the Horizon 2020 programme.**
- **ACT Grant number:** 691712
Site D(a): West Mey 5

**OVERVIEW**

For the purpose of containment, the fluid disposal system has not addressed this site, but has drawn the following observations:

- **Location**: Site D(a) is near the West Mey area and is therefore considered an area of low concern. However, it is important to note that this area is subject to the same environmental regulations as other sites.

- **Geology**: The geological setting of Site D(a) is similar to Forties 5 and Captain X. The presence of a suitable seal is important for the containment of any CO2 injection.

- **Water Depth**: The site is located at a water depth of approximately 91 m.

- **Faulting**: There is a small fault zone located near the containment area at the western end of the site. This may affect the integrity of the containment system and therefore needs to be considered during the design phase.

- **Injection System**: The injection system is designed to ensure that the injection pressure and flow rates are controlled to prevent any unintended releases.

**CO2 Storage Capacity**

The storage capacity for Site D(a) is estimated to be 108,199 mm^3 of CO2.

**Storage Efficiency**

- **Low**: 108,199 mm^3
- **Mid**: 400,000 mm^3
- **High**: 6,000,000 mm^3

**Porosity**

- **Low**: 0.28
- **Mid**: 0.4
- **High**: 0.6

**Net to Gross Ratio**

- **Low**: 0.28
- **Mid**: 0.4
- **High**: 0.6

**CO2 Density**

- **Low**: 1,000 g/m^3
- **Mid**: 2,000 g/m^3
- **High**: 5,000 g/m^3

**Sensitivity Analysis**

- **Upside**: 58.20
- **Downside**: 3,281

**References**

Within 15 km of one of the three potentially recoverable reservoirs, there are 1,269 wells/km in the area. Of these, 90% are expected to be viable in terms of gas availability.

The Mey sandstone fairway covers a very large area of the Central North Sea. In the context of Acorn, this has been reduced to an area of 15 to 25 km. The injectivity is 10^210^2 mDm which is considered to be good.

Saved database (ETI, 2016).

The injectivity is 10^210^2 mDm which is considered to be good.

As the Mey is a mature oil producing reservoir, abandonment procedures are designed to eliminate the escape of oil and gas from the field. Following abandonment, the reservoir is expected to maintain a high density of brine, which will provide a significant degree of containment through the natural reduction in pressure and gas solubility. The reservoir is also expected to require minimal artificial lift to maintain a sustainable pressure.

The area is considered to be a potential CO₂ storage site due to its proximity to existing infrastructure and its large area of suitable subsurface capacity. The estimated storage capacity is 10^10^10^10-10^10^10^10 m^3, with a Net to Gross Ratio of approximately 70%. The storage efficiency is estimated to be 90%.

Key Risk Summary

-Vulnerability
-2023
-2023

Development Cost

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Initial Capital</td>
<td>£5.00</td>
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<tr>
<td>Operating Costs</td>
<td>£3.00</td>
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<tr>
<td>Total Cost</td>
<td>£8.00</td>
</tr>
</tbody>
</table>

Key Risk

-MacCulloch paper plus MacCulloch field data on CCS project

A significant amount of well data is available over the East Mey and surrounding areas, available at CDA. East Mey has been subjected to a hydrocarbon field and pipeline data source: Oil and Gas Authority.

A scalability framework is in place to provide a framework for future development of the project. The framework allows for flexibility in the design and implementation of future development phases, ensuring that the project can be scaled up or down as required.

Duration

-3 years

Site D(b): East Mey 5

- north of the terminal (green) and west of the terminal. The terminal is located approximately 75 km from the shore.

The terminal is located approximately 75 km from the shore.

Storage Efficiency Appraisal

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net to Gross Ratio</td>
<td>0.70</td>
</tr>
<tr>
<td>CO₂ Storage Efficiency</td>
<td>0.90</td>
</tr>
</tbody>
</table>
Site E: Dornoch Formation – West and East Dornoch

Overview
The Dornoch Formation is comprised of soft and debris sediments from Late Palaeocene-Early Eocene age. It is the equivalent of the Fortan Sandstone Member in the Moray Firth. It contains carbonates (Dornoch Lias) and mudstone (Dornoch Mudstone). To the East, the formation thins into upper and lower Dornoch Sandstones, separated by mudstones.

Site Selection
In order to restrict the potential location of the CO2 storage site within the Dornoch Formation, a 15 km corridor across the pipeline was created (Right figure, in text). This corridor goes across the gap in seismic coverage from the PGS MegaSurvey (white polygons), leaving two sides of the Dornoch Formation within 15 km of the pipeline and with seismic coverage in: East Dornoch and West Dornoch. East Dornoch has a 23% smaller area than the West Dornoch. Furthermore, well log data in East Dornoch shows that the Dornoch Sandstone reservoir is divided into Upper and Lower Dornoch by a 150 ft thick mudstone layer. This has a strong impact in the capacity of East Dornoch, and therefore it has been ruled out in favour of West Dornoch, which will be taken as the main potential site.

Data
About 60% of the Dornoch Formation site is covered by the 3D seismic from the CNS PGS MegaSurvey. This site is located above several oil and gas fields (including Piper Oil Field), especially in the central part. There is a major gas gap in the seismic coverage right at the intersection with the MGS pipeline.

Proximal Uplift Potential
West Dornoch is located right on top of West Mex (one of the top 6 sites selected in the Project), and on top of the Goldeneye Field, which has been studied by Shell as a potential site for CCS in the Forehead-Goldeneye Project (Spence et al., 2014).

Analysis
Storage efficiency appraisal

Unit appraisal

Storage Unit Type

Saline Aquifer

Identified structure

None

Male – Storage efficiency assumed to be similar to Captain X and Forties 5 (ETI SSAP Project).

Proximal Uplift Potential

West Dornoch is located right on top of West Mex (one of the top 6 sites selected in the Project), and on top of the Goldeneye Field, which has been studied by Shell as a potential site for CCS in the Forehead-Goldeneye Project (Spence et al., 2014).

Site summary

Satellite

Indian Ocean

Area (km²)

11,595

Depth (m)

800

Porosity

0.25

CO2 Density

0.79

Injectivity (2)

0.25

Gross Rock Volume

Low 33,035

Medium 89,804

High 121,184.47

CO2 Storage Efficiency

Low=1          Medium=2            High=3

Average Cost

CO2 density

0.08

SCS Block

14.15 – 19 - 26

Water depth

1,200 m

Reservoir depth

1,000 m

Georisk

2.2

Geochemical Reactivity

15.10

Development Cost

30

Net to Gross Ratio

0.58

Cost

CO2 Density

10% 50% 60% 70%

Gross Rock Volume

Low 33,035

Medium 89,804

High 121,184.47

CO2 Storage Efficiency

Low=1          Medium=2            High=3

Average Cost

CO2 density

0.08

SCS Block

14.15 – 19 - 26

Water depth

1,200 m

Reservoir depth

1,000 m

Georisk

2.2

Geochemical Reactivity

15.10

Development Cost

30

Net to Gross Ratio

0.58

Cost

CO2 Density

10% 50% 60% 70%

Reference


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ACT Acorn, project P1105, has received funding from BEIS (UK), RNO (IN) and RVO (NL), and is co-funded by the European Commission under the ERA-NET ACT instrument of the Horizon 2020 programme. ACT Acorn Grant number 681712.
The Piper field is a major oil field in the UK North Sea, located in UKCS Block 21/21. The field is located in the Piper Sandstone sequence, which is a Jurassic-aged sandstone reservoir. The Piper field has been operated by Woodside Energy since 1976.

**Overview**

The Piper field is located in the Forties Field Area, which is a major oil field in the UK North Sea. The field is located in the Piper Sandstone sequence, which is a Jurassic-aged sandstone reservoir. The Piper field has been operated by Woodside Energy since 1976.

**Location of Site**

The Piper field is located in the Forties Field Area, which is a major oil field in the UK North Sea. The field is located in the Piper Sandstone sequence, which is a Jurassic-aged sandstone reservoir. The Piper field has been operated by Woodside Energy since 1976.

**Storage Efficiency Appraisal**

- **Net to Gross Ratio**: 0.74
- **CO2 Density**: 0.81
- **CO2 Storage Efficiency**: 0.81
- **Porosity**: 0.54

**Development Cost**

- **Total Cost**: £15.2 million
- **Levelised Cost**: £0.8 million
- **Dual Objective capacity estimate**: 0.5 million t CO2

**CO2 Capacity of Piper**

- **Net**: 1.2 million t CO2
- **Gross**: 2.4 million t CO2
- **Storage Efficiency**: 0.74

**Proximal Upside Potential**

- **Latiude**: 59.46
- **Longitude**: 0.26
- **PPO3**: 317
- **PPO5**: 500

**References**