CCUS projects in Europe

Overview of existing and planned CCUS facilities

Norway
1. Sleipner CO₂ Storage*
2. Snøhvit CO₂ Storage*
3. Northern Lights*

Republic of Ireland
4. ERVIA

UK
5. Acorn*
6. Caledonia Clean Energy
7. H21 North of England*
8. Liverpool-Manchester Hydrogen Cluster
9. Net Zero Teesside*
10. Humber Zero Carbon Cluster*
11. Liverpool Bay Area CCS Project*

France
12. Lacq*
13. DMX Demonstration in Dunkirk*

Belgium
14. Leilac
15. Port of Antwerp*

The Netherlands
17. Porthos (Port of Rotterdam)*
18. Athos (Ijmond)
19. Aramis (Den Helder)
20. Magnum (Eemshaven)*

Sweden
16. Preem CCS*

Italy
24. CCS Ravenna Hub*

Croatia
21. iCORD*
22. CO₂ EOR Project Croatia*

* Project where IOGP members are involved
Projects listed in bold are in operation
<table>
<thead>
<tr>
<th>LOCATION</th>
<th>PROJECT NAME</th>
<th>PROJECT TYPE</th>
<th>DESCRIPTION</th>
<th>CO2 CAPTURED/YEAR</th>
<th>STARTING DATE (OPERATION)</th>
<th>STATUS OF THE PROJECT</th>
<th>PARTICIPANTS</th>
<th>IOGP MEMBERS INVOLVED</th>
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<tbody>
<tr>
<td>Belgium</td>
<td>Leilac</td>
<td>Industrial Capture</td>
<td>Cement plant carbon capture (pilot project)</td>
<td>N/A</td>
<td>2019-2020</td>
<td>2 year CO2 capture test</td>
<td>HeidelbergCement, Cala</td>
<td>N/A</td>
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<tr>
<td></td>
<td>Port of Antwerp</td>
<td>Industrial Capture</td>
<td>CCS-equipped industrial cluster, CO2 transportation and storage in the North Sea and reuse</td>
<td>N/A</td>
<td>N/A</td>
<td>Feasibility study</td>
<td>Air Liquide, BASF, Bowelin, (NEEDS, ExxonMobil), Fluxys, Port of Antwerp and Total</td>
<td>ExxonMobil, Total</td>
</tr>
<tr>
<td>Croatia</td>
<td>ICORD</td>
<td>Industrial Capture</td>
<td>Capturing the CO2 produced at a fertilizer plant at Location in central Croatia and at a concrete production plant at Location in eastern Croatia, and storing it at Moslavina basin oil fields and Pannonia basin oil fields as part of INA EOR project.</td>
<td>0.540 Mt/y</td>
<td>2025</td>
<td>Feasibility Study to be ordered by end of 2019, FS to be prepared by end of Q3 2020.</td>
<td>INA MOL</td>
<td>MOL</td>
</tr>
<tr>
<td></td>
<td>CO2 EOR Project Croatia</td>
<td>EOR</td>
<td>EOR project started in 2014, Injected 1.400 kt CO2 in the EOR fields Ivanić and Žutica near Ivančić Grad (Zagreb County, 61 km from Zagreb). The pipeline Moslavina-hv is 88 km long (30 bar)</td>
<td>0.06 Mt/y</td>
<td>2020</td>
<td>Signing the contracts for basic design and technology selection</td>
<td>INA MOL</td>
<td>MOL</td>
</tr>
<tr>
<td></td>
<td>P-Ba Refinery Project</td>
<td>Industrial Capture</td>
<td>Bio-Renewable plant (bio-Ethanol production) on the Snlok Renewables location (Snlok- Moslavina County, Snlok 60 km from Zagreb). On the existing pipeline route, new pipes of 16 km will be built for CO2 storage, for the yearly production of 60 kt of CO2, plus potential 300-400 kt of biogenic CO2 from CHP.</td>
<td>Total</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>France</td>
<td>Laqc</td>
<td>Capture Storage (dry fuel combustion)</td>
<td>CCS dry fuel combustion CO2 captured and storage in depleted natural gas field at Rousse (Pyrænes)</td>
<td>Approx. total 50,000 tonnes</td>
<td>2009</td>
<td>Capture and storage phase ended on 15/03/2013</td>
<td>Total</td>
<td>Total</td>
</tr>
<tr>
<td></td>
<td>DMX Demonstration in Dunkirk</td>
<td>Industrial Capture</td>
<td>CCS-equipped steel-making plant, CO2 transportation and storage in the North Sea</td>
<td>Approx. 1 Mt/y</td>
<td>2025</td>
<td>Prefeasibility Study</td>
<td>Euri</td>
<td>Euri</td>
</tr>
<tr>
<td>Italy</td>
<td>CCS Ravenna Hub</td>
<td>Power and capture (post-combustion), Blue Hydrogen</td>
<td>CO2 capture in North of Italy (Piancola Padana Area from Industrial Complex ‘E. Ravenna’ and transportation to depleted Reservoirs in Ravenna Hub)</td>
<td>0.05-0.5 Mt/y phased program</td>
<td>2025-2028</td>
<td>Feasibility Study</td>
<td>Gasunie, the Port Authority and EBN</td>
<td>BP, Shell</td>
</tr>
<tr>
<td>The Netherlands</td>
<td>Perthes (Port of Rotterdam)</td>
<td>Industrial Capture</td>
<td>CCS-equipped industrial cluster, CO2 transportation and storage in the North Sea</td>
<td>Approx. 5 Mt/y</td>
<td>2024</td>
<td>Feasibility Study</td>
<td>Gasunie, the Port Authority and EBN</td>
<td>BP, Shell</td>
</tr>
<tr>
<td></td>
<td>Athes (Ijmond)</td>
<td>Industrial Capture</td>
<td>CCUS Network capturing CO2 from TATA Steel plant and reusing it or storing it in empty gas fields under the North Sea</td>
<td>7.5 Mt CO2 per year</td>
<td>2030</td>
<td>Feasibility Study</td>
<td>Gasunie, EBN, Port of Amsterdam and Tata Steel</td>
<td>BP, Shell</td>
</tr>
<tr>
<td></td>
<td>Aransa (Don Helder)</td>
<td>Industrial Capture</td>
<td>CO2 supplied by third parties from Don Helder and stored in the North Sea floor. This CO2 can be brought to Don Helder by boat or by pipeline (for example from Limurado)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Norway</td>
<td>Magnus (Samneshaven)</td>
<td>Natural Gas-to-H2 (pre-combustion)</td>
<td>CCS-equipped production of hydrogen for power generation, CO2 transportation and storage in the North Sea</td>
<td>Approx. 6 Mt/y</td>
<td>2023</td>
<td>Feasibility Study</td>
<td>Equinor, Vattenfall, Gasunie, MHPS</td>
<td>Equinor</td>
</tr>
<tr>
<td></td>
<td>Sleipner CO2 Storage</td>
<td>Industrial Capture</td>
<td>CCS-equipped natural gas production, CO2 directly injected into North Sea reservoirs</td>
<td>Approx. 1 Mt/y, and over 17 million tonnes has been injected since inception to date.</td>
<td>1996</td>
<td>Operational</td>
<td>Equinor (operator)</td>
<td>Equinor, Vík Energy, Total</td>
</tr>
<tr>
<td></td>
<td>Snøhvit CO2 Storage</td>
<td>Industrial Capture</td>
<td>CCS-equipped LNS facility, CO2 transportation and storage in the Barents Sea</td>
<td>0.70 Mt/y</td>
<td>2008</td>
<td>Operational</td>
<td>Equinor (operator)</td>
<td>Equinor, Total, Hess Norway</td>
</tr>
<tr>
<td></td>
<td>Northern Lights</td>
<td>Industrial Capture</td>
<td>CCS-equipped industrial capture, CO2 transportation and storage in the North Sea</td>
<td>0.8 Mt/y from possible 2 industrial plants: cement and waste to energy</td>
<td>2023-2024</td>
<td>Final Investment Decision (FID)</td>
<td>Shell, Equinor, Total</td>
<td>Shell, Equinor, Total</td>
</tr>
<tr>
<td>Sweden</td>
<td>ERVRA</td>
<td>Power &amp; Capture (post-combustion)</td>
<td>CCS-equipped CCTs and refinery, CO2 transportation and storage in the Celtic Sea</td>
<td>2 Mt/y</td>
<td>2028</td>
<td>Feasibility Study</td>
<td>Equinor</td>
<td>Equinor</td>
</tr>
<tr>
<td></td>
<td>Preem CCS</td>
<td>Industrial Capture</td>
<td>CCS-equipped refinery, CO2 transportation and storage in the North Sea (pilot study)</td>
<td>500,000 tonnes</td>
<td>N/A</td>
<td>Pre-study</td>
<td>Preem, Chalmers University of Technology, SINTEF Energy Research, Equinor and Aker Solutions</td>
<td>Equinor, Aker Solutions</td>
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<tr>
<td></td>
<td>Acorn</td>
<td>Industrial Capture</td>
<td>CCS-equipped natural gas processing plant, CO2 transportation and storage in the North Sea</td>
<td>The Reference Case assumes a flat rate of 200,000T/y can be captured from one of the gas terminals at St Fergus</td>
<td>2023</td>
<td>Feasibility Study</td>
<td>Project is led by Pale Blue Dot Energy, with funding and support from industry partners (Chrysaor, Shell and Total) and the UK and Scottish Governments</td>
<td>Chrysaor, Shell, Total</td>
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<tr>
<td></td>
<td>Caledonia Clean Energy</td>
<td>Power &amp; Capture (post-combustion)</td>
<td>CCS-equipped natural gas power plant, CO2 transportation and storage in the North Sea</td>
<td>3 Mt/y</td>
<td>2023</td>
<td>Feasibility Study</td>
<td>Summit Power</td>
<td>N/A</td>
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<tr>
<td></td>
<td>H21 North of England</td>
<td>Natural Gas-to-H2 (pre-combustion)</td>
<td>Natural gas-to-hydrogen conversion with CCS, CO2 transportation and storage in the North Sea and salt caverns</td>
<td>Approx. 3 Mt/y</td>
<td>2020s</td>
<td>Feasibility Study</td>
<td>Northern Gas Networks, Cadent and Equinor</td>
<td>Equinor</td>
</tr>
<tr>
<td></td>
<td>Liverpool-Manchester Hydrogen Cluster</td>
<td>Natural Gas-to-H2 (pre-combustion)</td>
<td>Natural gas-to-hydrogen conversion with CCS, CO2 transportation and storage in the North Sea</td>
<td>1.5 Mt/y (10% H2) - 9.5 Mt/y (100% H2)</td>
<td>2020s</td>
<td>Feasibility study</td>
<td>Cadent</td>
<td>Equinor</td>
</tr>
<tr>
<td></td>
<td>Net Zero Teesside</td>
<td>Power &amp; Capture (pre-combustion)</td>
<td>CCS-equipped natural gas power plant, CO2 transportation and storage in the North Sea</td>
<td>5 Mt/y</td>
<td>2024</td>
<td>Technical evaluation and business model options</td>
<td>BP, OSCI</td>
<td>BP, ENI, Repsol, Shell, Equinor, Total</td>
</tr>
<tr>
<td></td>
<td>Humber Zero Carbon Cluster</td>
<td>Industrial Capture, Natural Gas-to-H2, Power &amp; Capture</td>
<td>CCS-equipped industrial cluster, CCS-equipped hydrogen production, bioenergy with CCS (BECICS), CO2 transportation and storage in the North Sea</td>
<td>N/A</td>
<td>2020s</td>
<td>Technical evaluation and business model options</td>
<td>Orica Group, Equinor, National Grid Ventures</td>
<td>Equinor</td>
</tr>
<tr>
<td></td>
<td>Liverpool Bay Area CCS Project</td>
<td>Carbon Capture. Sepacarbonization</td>
<td>CO2 capture from the existing industrial facilities and new hydrogen production plant in the North West of England</td>
<td>1.3 Mt/y phased program</td>
<td>2025</td>
<td>Concept Selection Phase</td>
<td>Euri</td>
<td>Euri</td>
</tr>
</tbody>
</table>

**PARTICIPANTS IOGP MEMBERS INVOLVED**

- ExxonMobil, Total
- ING, Shell, Total
- Total
- ENI, Repsol, Shell, Equinor, Total
- Equinor, Aker Solutions
- Equinor, Cadent and Equinor
- Northern Gas Networks, Cadent
- Palm Blue Dot Energy
- Chrysaor, Shell and Total
- UK and Scottish Governments
- Shell, Equinor, Total
- Equinor, Vík Energy, Total
- Equinor (operator)
- Equinor (operator)
- Eni
- Equinor (operator)
- Equinor, Vattenfall, Gasunie, MHPS
- Equinor, Vík Energy, Total
- Equinor
- Shell, Equinor, Total
- Equinor
- Eni
- Gasunie, the Port Authority and EBN
- BP, Shell
- Gasunie, the Port Authority and EBN
- BP, Shell
- Shell, Equinor, Total
- Equinor
- ExxonMobil, Total
- HeidelbergCement, Cala