CSLF Task Force
on
CO₂ Hubs and Infrastructure

Results and recommendation from Phase 0

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Norway
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Definitions of concepts

• Cluster From GCCSI, 2016)
  – An industry cluster is a geographic concentration of interconnected businesses, suppliers, and associated institutions in a particular field. Clusters can emerge for many different reasons, including proximity to raw materials, to transport options such as ports, to labour supply, and to markets.

• Hub (from GCCSI, 2016)
  – CCS hubs are the central collection or distribution points for CO2. One hub would service the collection of CO2 from a capture cluster or distribution of CO2 to a storage cluster
  – Hubs could be located at the capture end or the storage end of a multi-user pipeline (forming capture/collection or storage hubs), or both.

• Network (from GCCSI, 2016)
  – A CCS hub and cluster network (network for short) brings together many of the elements along the CCS value chain (CO2 source, capture, transport, injection, storage) with multiple co-located (clustered) source capture facilities (of the same or different types) supplying CO2 to a shared ‘oversized’ transport and storage system.

• Infrastructure
  – The physical parts of the network (single or shared capture facilities; temporary storage facilities; injection facilities, pipelines, ships)

Definitions apply onshore as well as offshore.

According to these definitions, a plant or facility can be part of network without being part of a cluster.
TRM 2017: Targets and recommendations

Priority Recommendation:

Facilitate CCS infrastructure development.

• Governments and industry should work together to:

• Towards 2020
  – Design and initiate large-scale CO₂ hubs that integrate capture, transport, and storage, including matching of sources and sinks.
  – Develop commercial models for industrial and power CCS chains.

• Towards 2025:
  – Implement the first large-scale (i.e., >10 Mt CO₂/year aggregate throughput) CCS chains in power, industrial, and bio-CCS, in industrial regions that have the potential to share infrastructure.
  – Implement initial shared infrastructure for a limited number of plants within industrial clusters.

• Towards 2035:
  – Continue progressive rollout and expansion of full-scale CCS chains and clusters in power, industrial, and bio-CCS. This includes large-scale CO₂ transport networks that integrate CO₂ capture, transport, and storage, including matching of sources and sinks.
Potential benefits of CCS networks (from TRM 2017)

- Lowering costs in building early infrastructure by utilizing benefits of connecting low-cost industrial sources with storage sites.
- Lowering costs by sharing infrastructure.
- Lowering the entry barriers for participating CCS projects, such as emitters with small-volume sources and emitters with limited or no access to local storage.
- Securing sufficient CO₂ for CO₂-EOR projects, which is likely to be an important element of some clusters because of the revenue it can contribute.
- Minimizing the environmental impacts associated with infrastructure development, as well as the impact on communities.
- Minimizing and streamlining efforts in relation to planning and regulatory approvals, negotiations with landowners, and public consultations.
- Sharing and utilizing surplus heat in the capture processes of industrial clusters.
Few technology gaps for implementing CCS networks
(GSSCI, ZEP, IEA, IEAGHG)

• Gaps, risks, and challenges are commercial and political and may include:
  – Cooperation of different industries across the CCS value chain
  – Lack of project-on-project confidence
  – Completion of projects on cost and on schedule,
  – Operational availability, flexibility, reliability
  – Financing and political aspects, and last but not least
  – Lack of business models for larger CCS systems.
Three operational networks

The Denver City    Gulf Coast    Rocky Mountains

One under construction
Alberta CO$_2$ Trunk Line
A Brazilian offshore CO$_2$ network

A set of FPSOs unit that incorporates CO$_2$ separation and injection facilities, specifically, CO$_2$ capture from natural gas and reinjection system for enhanced oil recovery (EOR) purposes.
Hubs, clusters and networks
Some additions after TRM 2017

Alberta CO₂ Trunk Line (ACTL) 14.6 Mta

Dunkirk CO₂ cluster
Le Havre cluster (CCATE) 14.5 Mta

UK Clusters: South Wales, Merseyside, Humberside, Scottish,
Networks: ACORN/CO₂SSapling, HyNet, H21 North of England,

Ireland Ervia Cork CCS

Netherlands Rotterdam, Magnum

Norway Full scale project

Europe: Align

China Sinopec Zhongyu Refining and Chemical plants

South Korea In revised national CCS Master Action Plan

Skagerrak/Kallegel cluster 14 Mta

Rotterdam climate project (RCP) 17.5 Mta

Australia South West Hub CarbonNet CTSCo

Rocky Mountain cluster 9.5 Mta

Offshore Pre-Salt Santos Basin project

Denver City Hub cluster 8.4 Mta

Gulf Coast GoMCarb

Marseille cluster (VASC) 35.5 Mta

Shenzhen City cluster 43 Mta
Some documents not in TRM on hubs, clusters and infrastructure
Conclusions

• Only one offshore CCUS network has come online the last 15 years, no onshore infrastructure/network projects
• Only one CCUS network is in construction, with anticipated start up in 2019, increasing capacity by several Mt CO$_2$/y
• No project passed the Final Investment Decision (FID) gate in 2018
• Projects in advanced or early development will only add 35 - 40 Mt CO$_2$/y by 2025, at best.
• Progress on infrastructure development is lacking behind what is necessary to reach the storage target. Strong action is required.
A clear message from the UK CCUS Cost Challenge Taskforce Report July 2018

“CCUS infrastructure is key to unlocking huge clean growth potential in the UK and can contribute to a cost-effective pathway for reducing UK CO₂ emissions”
Recommendations

CSLF:

• The Task Force continues to monitor the development of networks for CCUS, including clusters, hubs and infrastructure.
• The Task force presents updates on an annual basis (no need for an extensive Task Force report)
• CSLF should consider organising workshops in cooperation with GCCSI, IEAGHG, International CCS Knowledge Centre, CO2GeoNet, MI

Decision makers:

• The CEM Ministers and decision makers from industry should

  **Facilitate (e.g., through co-funding) cross-industry projects to ensure lowest total cost for the combined capture, transportation, utilization and/or storage infrastructure and networks.**

This because CCUS networks are important to reach the target.
Back up
EU SET plan CCUS Implementation

• Target 4 in Plan
  – At least 1 active Project of Common European Interest for CO2 transport infrastructure, for example related to storage in the North Sea
  – Mechanism: EU Projects of Common Interest (PCI) for CO2 transport infrastructure
  – Status. Four applicants, two received grants

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<thead>
<tr>
<th>Project</th>
<th>Promoter</th>
<th>Status</th>
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</thead>
<tbody>
<tr>
<td>Teesside CO2 Hub</td>
<td>Tees Valley</td>
<td></td>
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<tr>
<td>CO2 Sapling Transport and infrastructures</td>
<td>Pale Blue Dot Energy Ltd</td>
<td>Funded by EC</td>
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<tr>
<td>Port of Rotterdam</td>
<td>Rotterdam Port Authority</td>
<td>Funded by EC</td>
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<tr>
<td>CO2 cross-border</td>
<td>Equinor</td>
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## Encouraging developments infrastructure projects

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<tr>
<th>Country</th>
<th>Project</th>
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<th>Comments</th>
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<tbody>
<tr>
<td>Norway</td>
<td>Norway industrial CCS hub</td>
<td>FEED, working towards FID in 2020</td>
<td>FEED funding from government, exploitation permit storage site</td>
</tr>
<tr>
<td>UK</td>
<td>CO2Sapling</td>
<td>Feasibility study, working towards start of FEED in 2019</td>
<td>€ 3.0 mill from EU as PCI project</td>
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<tr>
<td>Netherlands</td>
<td>Port of Rotterdam</td>
<td>Feasibility study completed in April 2008, continue to consolidate business case towards investment decision in 2019</td>
<td>€ 6.5 mill from EU as PCI project</td>
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<tr>
<td>UK</td>
<td>H21 North of England</td>
<td>Feasibility study delivered November 2018</td>
<td>Converting gas network to CCS decarbonised hydrogen</td>
</tr>
<tr>
<td>France</td>
<td>Dunkirk CO₂ cluster</td>
<td>In planning, pilot demonstration 2Q2021-3Q2022</td>
<td>CO₂ from steel plant and other ind. sources</td>
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### Other developments infrastructure projects

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<tr>
<td>Australia</td>
<td>CarboNet</td>
<td>Includes multiple CO₂ capture projects in Victoria's Latrobe Valley, a shared pipeline and offshore storage in Gippsland</td>
<td>Several studies published; Project development, funded until 2020</td>
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<td></td>
<td>Southwest Hub</td>
<td>Staged project to test a potential feasibility of geologic formations as reservoir for CO₂ from industrial sources</td>
<td>Extensive geologic studies completed</td>
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<tr>
<td>EU</td>
<td>Align</td>
<td>European RD&amp;D project to transform six industrial regions into CCUS centres</td>
<td>Funded</td>
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<tr>
<td>China</td>
<td>Sinopec Zhongyuan</td>
<td>CO₂ from refining and chemical plants for EOR</td>
<td>Operational</td>
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<tr>
<td>Ireland</td>
<td>Ervia Cork CCS</td>
<td>Collecting CO$_2$ from power and refining</td>
<td>Studies</td>
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<tr>
<td>UK</td>
<td>HyNet</td>
<td>CCUS-equipped hydrogen network</td>
<td>Bids delivered for funding og Phase 1 - planning</td>
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<td></td>
<td>Teesside, Humberside, Merseyside, Scottish and South Wales clusters</td>
<td>Clusters of energy intensive industries with offshore storage</td>
<td>Extensive studies</td>
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<tr>
<td>US</td>
<td>Gomcarb (w/Seacarb)</td>
<td>Storage offshore Gulf of Mexico, includes transport options and existing infrastructure</td>
<td>Funded by US DoE</td>
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<td></td>
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<td><strong>Workshop on siting regulatory issues for CCUS infrastructure</strong></td>
<td>Workshop report January 2017</td>
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<tr>
<td>Korea</td>
<td></td>
<td>Infrastructure taken into CCS Master Action Plan</td>
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