Emitter clusters: structure

CETP CO2RR — Deliverable 1.1 [*interim*]

October 2025

Co-funded by the European Union

Acknowledgement

This research was funded by CETPartnership, the Clean Energy Transition Partnership under the 2022 CETPartnership joint call for research proposals, co-funded by the European Commission (GA N°101069750) and with the funding organizations detailed on https://cetpartnership.eu/funding-agencies-and-call-modules.

The project is supported by the French Environment and Energy Management Agency ADEME and the Swiss Federal Office of Energy SFOE.

Context and introduction

Maximising CDR and CCUS potential through emitter clusters

Background

- While deep emission reductions should always be prioritised within any net-zero strategy, the European and Swiss climate strategies depends on the development at scale of carbon capture utilisation and/or storage (CCUS) for hard-to-abate sectors and for the creation of negative emissions.
- "*Failure to create momentum in this formative phase will contribute to a widening gap in 2050 and beyond*."
- However, the current costs of CCUS, lack of adequate regulatory framework and appropriate business models is impeding the development of the sector.

Emitter cluster concept

- The objective of emitter clusters is to create a common space for emitters in geographical proximity to exchange on their needs and interests relative to CCUS, discuss potential common infrastructure, co-finance targeted studies and advocate in one voice to local and national governments (which could also have a proactive or observer role in the cluster).

Source: Langfristige Klimastrategie 2050 (2021); EU Climate strategies and targets (2024) The State of CDR (2023)

Defining emitter clusters along the Carbon Rhine Route

Purpose

- This presentation outlines the organisational structure of potential emitter clusters.
- It aims to provide an understanding of how clusters could operate in Switzerland and France, the roles and responsibilities within clusters, and what opportunities and challenges they present.

Key points

- Active emitter engagement is underway in Switzerland and France, focusing on optimizing CCUS and CDR through local emission sources and regional support.
- Emitter clusters can reduce individual costs through shared infrastructure and collective investment in carbon capture technologies.
- Clusters facilitate better coordination among emitters, improving operational efficiency and fostering shared expertise in carbon management.
- A cluster approach strengthens advocacy efforts, leading to more effective engagement with local and national governments on regulatory and financial support.
- There are important commonalities between clusters to be established in Switzerland and France, but adaptation to local context is essential.
- Collaborative planning within clusters allows for the development of centralized infrastructure for CO_2 capture, transport, and storage, tailored to regional needs.

Concept and structure

Reducing CCUS and CDR barriers through a cluster approach

- Individual Swiss and European CO_2 emitters – particularly small and medium-sized emitters – encounter significant upfront costs and face technical and knowledge challenges in developing a complete carbon management value chain. This value chain encompasses capture, compression, transport, permanent storage, monitoring, verification, and monetisation of CO_2.

- Experience from other countries demonstrates that these barriers can be mitigated through a clustering approach. By sharing CCS infrastructure and expertise, multiple CO_2 emitters can lower their costs and streamline the process compared to each facility managing emissions reduction independently.

- Clustering enables the creation of a network of emitters and centralizes shared CCS infrastructure components, significantly reducing individual costs and enhancing overall efficiency.

- It also contributed to shaping a shared vision for – and disseminating a collective voice on – the sector development in a local area.

Cluster activities

- **Share CO_2 capture technology:** Exchange information on current and innovative capture technologies.
- **Discuss business models:** Evaluate effective business models for CCUS and CDR.
- **Coordinate CO_2 transport:** Collaborate on transport solutions and address local needs, such as rail loading stations.
- **Develop shared infrastructure:** Create centralised hubs for CO_2 collection, compression, storage, and shipping.
- **Pool storage bids:** Combine storage bids to secure capacity and reduce costs for emitters.
- **Advocate for CCUS and CDR:** Promote needs to local and national governments.
- **Explore monetisation:** Consider joint efforts to monetise captured CO_2 through carbon markets or other schemes.

Benefits

- **Enhanced government support:** A first-mover coalition signals to the federal government that emitters are progressing, encouraging timely action on financing and regulatory issues.
- **Regional leadership:** Positioning local area as a pioneer in CCUS and CDR enhances its reputation and influence.
- **Shared learning:** Peer-to-peer exchanges facilitate understanding of CCUS and CDR opportunities and challenges, fostering collaborative growth.
- **Cost efficiency:** Leveraging shared infrastructure and knowledge, along with economies of scale, results in significant cost savings.
- **Accessibility for smaller emitters:** Facilitates CCUS adoption by lowering CAPEX/OPEX for smaller emitters, reducing entry barriers.
- **Reduced risk:** Coordinating transport and storage bids minimises risks associated with these processes.
- **Greater negotiating power:** Increased leverage in negotiations with transport, storage providers, and government leads to better terms and support.

Potential cluster participants

Secretariat
(coordinating the cluster activities)

- Waste-to-Energy
- Cement
- Biomass
- Biogas
- Local government
- Transport company
- Other emitters and/or CO_2 users
- Others

Potential cluster structure

Option	Description	Comments
Cooperation agreement	All parties sign a binding cooperation agreement allocating funding for the secretariat tasks and defining the main objectives and purpose of the cluster.	Can be set up flexibly and quickly with a focus on 'soft' activities (research projects, lobbying, etc.)
Association	A non-profit entity is created to represent interests of its members and (if desired) undertake joint-procurement.	In the ICT sector, there are several successful examples of conducting joint ICT procurement / negotiating framework agreements with ICT suppliers.
Special purpose vehicle or Joint-venture	A new legal entity is created in which each member of the cluster owns an equal share, to represent the emitters legally in exchanges with governments and transport or storage providers.	Depending on time-horizon, a SPV (short-term) or joint-venture (long-term) enable the development, construction and operation of shared infrastructure.

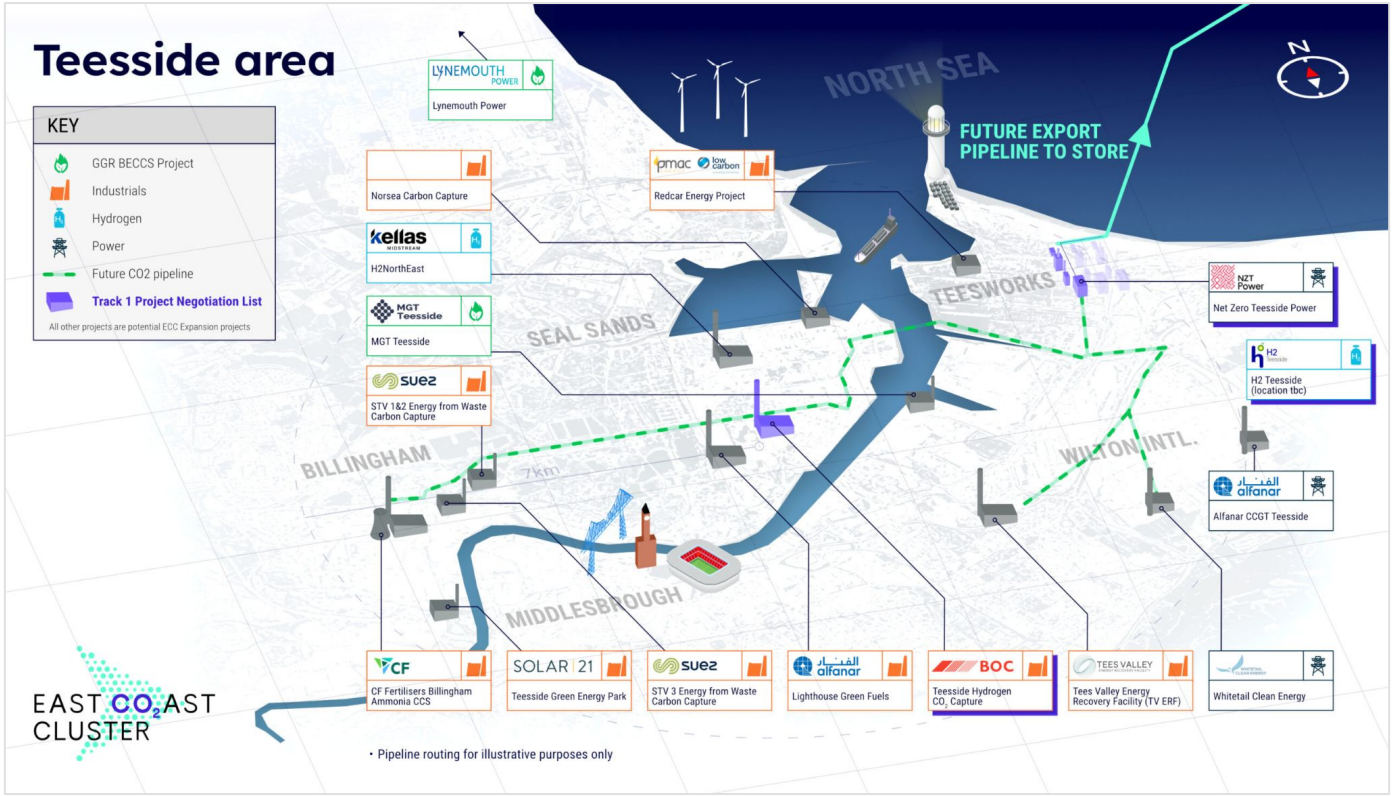
Case studies

Net Zero Teesside (United Kingdom)

Status	In planning (FID planned in 2025); expected operation in 2027
Location	Teeside, United Kingdom
Project types	Separation; transport; storage
Target sectors	Local industrial CO2 sources
Volumes	Up to 2 million tCO2 per year (target: 10 million tCO2 per year)
Governance/ legal structure	Net Zero Teesside is part of Net Zero Teesside Power (JV between BP and Equinor for the construction and operation of a gas-fired power plant with carbon capture). Northern Endurance Partnership (NEP) was formed in 2020 as a carbon transport and storage company that will provide the onshore and offshore infrastructure required to capture carbon from a range of emitters across Teesside and the Humber and transport it for offshore storage at the Endurance facility. NEP is a partnership between BP, Equinor and TotalEnergies
Wichtige Key stakeholders	BP, Eni, Equinor, Shell, TotalEnergies, Teeside Valley Authority, Suez, BOC, sembcorp,CF, Lotte Chemical, Nepic, UK BEIS
Financing	Extensive public funding from City Deal and UK Research & Innovation, including for the pre-FEED feasibility study, conceptual design study and infrastructure components. Further support from the Department for Energy Security and Net Zero is expected.
Additional information	Part of a series of clusters being developed in the UK with government support

Source: Net Zero Teesside (2024); UKRI (2023)

Net Zero Teesside: Map and key emitters



Source: Net Zero Teesside (2024)

Net Zero Teesside: Linkage to storage site (NEP)

Source: Net Zero Teesside (2024)

C4 Carbon Capture Cluster Copenhagen (Denmark)

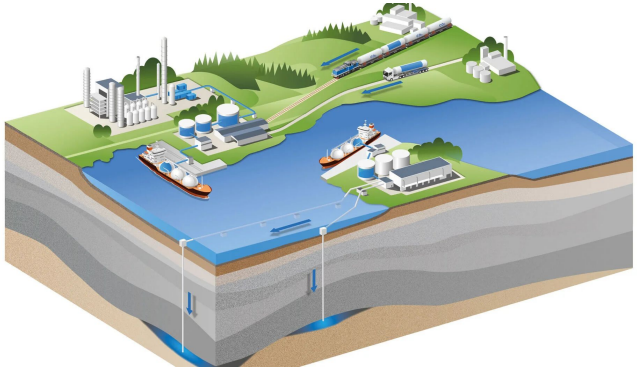
Carbon Capture Cluster Copenhagen

Status	In planning; expected operation in 2025
Location	Greater Copenhagen, Denmark
Project types	Separation; transport; storage
Target sectors	Waste-to-energy (including biomass); electricity and hear (including district heating; water
Volumes	Up to 3 million tCO2 per year
Governance/ legal structure	Strategic cooperation between large private utilities and commercial ports
Wichtige Key stakeholders	ARC, ARGO, BIOFOS, Copenhagen Malmö Port, CTR, HOFOR, Vestforbrænding, VEKS, Ørsted
Financing	Extensive public funding from City Deal and UK Research & Innovation, including for the pre-FEED feasibility study, conceptual design study and infrastructure components. Further support from the Department for Energy Security and Net Zero is expected.
Additional information	Part of a series of clusters being developed in the UK with government support

Source: C4CPH (2024); State of Green (2021); ARC (2024)

CinfraCap (Sweden)

Status	In planning; expected operation in 2026
Location	Gothenburg, Sweden
Project types	Transport
Target sectors	n/a
Volumes	Up to 1.5 million tCO2 per year
Governance/ legal structure	Cooperation between energy companies and city port
Wichtige Key stakeholders	Göteborg Energi, Nordion Energi, Preem, St1, Renova, Port of Gothenburg
Financing	Partially financed by the Swedish Energy Agency
Additional information	Started in 2020. The second phase was completed in 2022 with a feasibility study on the technical design and the draft of a business model. The goal of the next development phase is to be able to make investment decisions.



Source: Port of Gothenburg (2024); Nordion Energi (2023)

Summary: cluster case studies

- Volumes between 1.5–10 million tCO2/year
- Clusters are usually initiated and operated by oil and gas companies or major emitters.
- A broad group of stakeholders is involved in all clusters - partly including NGOs.
- Net Zero Teesside and CinfraCap rely on significant government support. C4 in Denmark is planned without government support.
- Lead times of 3-5 years are the norm.
- All clusters have a direct sea connection / storage in relative proximity.

Emitter cluster: Switzerland

Potential Swiss cluster for the Carbon Rhine Route

- Basel city and countryside are ideally positioned in Switzerland to establish a carbon capture cluster, as this would bring together the critical mass of emitters in combination with local political support (including ambitious net-zero targets) and the necessary financial resources.

- The Canton of Basel-Stadt is pursuing a net zero 2037 target. To achieve this goal:
  - Fossil CO2 from the waste incineration plant and from the heating (power) plants must be separated and permanently stored; and
  - Biogenic CO2 from the combined heat and power plants and the waste incineration plant can play an important role in compensating for unavoidable residual emissions.

- Alternatively (or at a later date), the cluster could be expanded to include CO2 point sources in the cantons of Aargau and Zürich.

- The activities of such a cluster could be tailored to the specific needs of the first participants. It should be taken into account that Basel will not only be a CO2 emitter cluster, but also a CO2 transport hub from large parts of Switzerland towards the north. This fact must be taken into account when dimensioning the capacities of the infrastructure to be planned.

Mapping point sources: Switzerland

- Initial assessment of the potential of waste-to-energy, wood-fired power, energy, biogas and sewage sludge incineration plants in the Basel city and countryside area, and in the immediate vicinity of the border shows:
  - 9 point sources were identifies, with a combined volume of ~735,000 tCO2 per year (~50% biogenic)

- Additional sources were identified in the greater Basel area, including via cross-border coordination in France and Germany.

- Consortium partners are engaging with these emitter on a continuous basis to onboard them.

- A comprehensive list of point sources being engaged will be compiled in ***Deliverable 1.2****: Short summary of the CO2 volume roadmap with commitment in principle from emitters.* This mapping will include the following indicators: name; location; type; expected volumes (tCO_2 per year); and expected start of operation.

Emitter cluster: France

French cluster: updates

- In France, efforts are underway to develop a network of emitters focused on BECCS projects.
  - Several independent biomethane facilities are exploring opportunities, each handling smaller quantities of CO_2.
  - A comprehensive study on BECCS potential has been conducted for the French gas network operator in Central France, with plans to extend this analysis to the eastern regions.
  - Discussions are ongoing with a major energy player to capture CO_2 from one of their biomethane facilities.
  - A feasibility study is in progress with a major group concerning multiple bioenergy plants across France, each with varying CO_2 capture capacities.
- **The strategy for biogas involves establishing local clusters initially in Eastern and Central France, building on existing projects in these regions.**
- Proposals are being developed for BECCS feasibility studies at biomass facilities in both Southern and Central France, addressing different scales of CO_2 capture.
- Additionally, discussions are underway with a Spanish company owning several biogas and biomass plants to explore BECCS potential.
- **For biomass, efforts are primarily opportunistic, engaging with interested plant owners across the country to identify viable projects.**

Mapping point sources: France

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2025 insights

2025 insights on emitter clusters

- Progress during the reporting period has confirmed that direct engagement with emitters is the most effective way to accelerate the early stages of CCS and BECCS development.
  - However, **the clustering model faces real-world friction**, particularly the difficulty of aligning timelines across emitters and the lack of leadership or risk-taking capacity among larger actors.
  - Emitters may not be willing or able to synchronise their development schedules, which slows cluster formation and complicates shared infrastructure planning.

- **Timeline and independence challenges:**
  - Experience suggests that developing fully integrated clusters typically takes three to five years, requiring sustained support to meet 2030 targets.
  - A key learning has been that some emitters, particularly Waste-to-Energy plants, prefer to minimise reliance on other projects.
  - Driven by ambitious, legally mandated deadlines, these operators often perceive dependence on external cluster partners as an additional risk.
  - Therefore, scalable concepts must be flexible enough to accommodate emitters with varying legal obligations and timelines.