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CO2RR

Carbon Rhine Route project

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Summary

The Carbon Rhine Route (CO2RR) project addresses the growing need for scalable and cost-effective carbon capture and storage (CCS) and carbon dioxide removal (CDR) solutions for small- to medium-sized biogenic CO_2 emitters in inland Europe. While CCS/CDR deployment has traditionally focused on large fossil emitters, CO2RR demonstrates the potential of bioenergy with carbon capture and storage (BECCS) to deliver negative emissions from sources such as waste-to-energy, biogas and biomass plants. Supported by the EU's Clean Energy Transition Partnership (CETP), the Swiss Federal Office of Energy (SFOE) and ADEME, the project aims to establish by 2026 the first commercial, multi-modal CO_2 transport and storage value chain connecting inland emitters to permanent storage sites in the North Sea.

CO2RR develops a flexible, replicable model that uses existing transport modes – truck, rail, barge and ship – to enable early deployment ahead of large-scale pipeline networks. The project also explores collaboration frameworks with storage operators and innovative financial structures to lower costs and de-risk participation for smaller emitters. Its five work packages address the full CO_2 value chain: emitter engagement and roadmap development, transport logistics and contracting, geological storage access, business and risk-sharing models, and dissemination of results to facilitate replication across Europe.

By 2025, the project has advanced from design to practical implementation. Key milestones include the onboarding of a growing network of emitters, completion of the first full transport and storage agreements and the development of a risk management and finance toolkit. These achievements confirm the feasibility of an integrated, commercial-scale CO_2 management chain for smaller emitters. CO2RR thus contributes to a concrete blueprint for regional decarbonisation and carbon removal, supporting the capture and storage of up to one million tonnes of CO_2 per year by 2030 and paving the way for wider adoption of BECCS and CCS solutions across Europe.

Zusammenfassung

Das Carbon Rhine Route (CO2RR)-Projekt adressiert den wachsenden Bedarf an skalierbaren und kosteneffizienten Lösungen für CO_2-Abscheidung und -Speicherung (CCS) sowie CO_2-Entnahme (CDR) für kleine und mittlere biogene CO_2-Emittenten im Binnenraum Europas. Während sich die Umsetzung von CCS/CDR bislang vorwiegend auf große fossile Emittenten konzentriert hat, zeigt CO2RR das Potenzial von Bioenergie mit CO_2-Abscheidung und -Speicherung (BECCS) auf, um negative Emissionen aus Quellen wie Kehrichtverwertungsanlagen, Biogasanlagen und Biomassekraftwerken zu erzielen. Unterstützt durch die Clean Energy Transition Partnership (CETP) der EU, das Bundesamt für Energie (BFE) und ADEME, zielt das Projekt darauf ab, bis 2026 die erste kommerzielle, multimodale CO_2-Transport- und Speicherwertschöpfungskette aufzubauen, die Emittenten im Binnenland mit dauerhaften Speicherstätten in der Nordsee verbindet.

CO2RR entwickelt ein flexibles und replizierbares Modell, bestehende Transportmittel – Lkw, Bahn, Binnenschiff und Seeschiff – nutzt, um eine frühe Umsetzung zu ermöglichen, noch bevor großangelegte Pipelines verfügbar sind. Zudem werden Kooperationsrahmen mit Speicherbetreibern und innovative Finanzierungsstrukturen erarbeitet, um Kosten zu senken und die Teilnahme kleinerer Emittenten zu erleichtern. Die fünf Arbeitspakete decken die gesamte CO_2-Wertschöpfungskette ab: Einbindung und Roadmap-Entwicklung für Emittenten, Transportlogistik und Vertragsgestaltung, Zugang zu geologischen Speichern, Geschäfts- und Risikoteilungsmodelle sowie die Verbreitung der Ergebnisse zur Förderung der Replikation in Europa.

Bis 2025 ist das Projekt von der Konzeptphase zur praktischen Umsetzung übergegangen. Zu den wichtigsten Meilensteinen zählen der Aufbau eines wachsenden Netzwerks von Emittenten, der Abschluss der ersten vollständigen Transport- und Speicherverträge sowie die Entwicklung eines Risikomanagement- und Finanzierungstools. Diese Fortschritte bestätigen die Machbarkeit einer integrierten, kommerziell umsetzbaren CO_2-Wertschöpfungskette für kleinere Emittenten. CO2RR liefert damit einen konkreten Beitrag zu regionaler Dekarbonisierung und CO_2-Entnahme, unterstützt

die Abscheidung und Speicherung von bis zu einer Million Tonnen CO_2 pro Jahr bis 2030 und ebnet den Weg für eine breitere Einführung von BECCS- und CCS-Lösungen in Europa.

Résumé

Le projet Carbon Rhine Route (CO2RR) répond au besoin croissant de solutions de captage et de stockage du carbone (CSC) et d'élimination du dioxyde de carbone (CDR), à la fois évolutives et économiquement viables, pour les petits et moyens émetteurs biogéniques situés à l'intérieur du continent européen. Alors que le déploiement du CSC/CDR s'est jusqu'à présent concentré sur les grands émetteurs fossiles, CO_2RR démontre le potentiel de la bioénergie avec captage et stockage du carbone (BECSC) pour générer des émissions négatives à partir de sources telles que les usines d'incinération des déchets, les unités de biogaz et les centrales à biomasse. Soutenu par le partenariat européen Clean Energy Transition Partnership (CETP), l'Office fédéral suisse de l'énergie (OFEN) et l'ADEME, le projet vise à établir d'ici 2026 la première chaîne de valeur commerciale et multimodale de transport et de stockage du CO_2, reliant les émetteurs continentaux aux sites de stockage permanents situés en mer du Nord.

CO2RR développe un modèle flexible et réplicable qui s'appuie sur les moyens de transport existants – camion, rail, barge et navire – afin de permettre un déploiement anticipé avant la mise en service de grands réseaux de pipelines. Le projet explore également des cadres de collaboration avec les opérateurs de stockage ainsi que des structures financières innovantes visant à réduire les coûts et les risques pour les petits émetteurs. Ses cinq lots de travaux couvrent l'ensemble de la chaîne de valeur du CO_2 : mobilisation des émetteurs et élaboration de feuilles de route, logistique et contractualisation du transport, accès au stockage géologique, modèles économiques et de partage des risques, ainsi que diffusion des résultats pour favoriser la reproduction du modèle en Europe.

En 2025, le projet est passé de la conception à la mise en œuvre concrète. Parmi les principales réalisations figurent la constitution d'un réseau croissant d'émetteurs, la conclusion des premiers contrats complets de transport et de stockage, et le développement d'un outil de gestion des risques et de financement. Ces résultats confirment la faisabilité d'une chaîne de gestion du CO_2 intégrée et à l'échelle commerciale pour les petits émetteurs. CO2RR constitue ainsi un plan d'action concret pour la décarbonation régionale et l'élimination du carbone, soutenant la capture et le stockage de jusqu'à un million de tonnes de CO_2 par an d'ici 2030, et ouvrant la voie à une adoption plus large des solutions BECSC et CSC en Europe.

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ADEME	French Environment and Energy Management Agency
AFEN	French Association for Negative Emissions
BECCS	Bioenergy with carbon capture and storage
CCS	Carbon capture and storage
CCUS	Carbon capture, utilisation and storage
CDR	Carbon dioxide removal
CETP	Clean Energy Transition Partnership
CO2	Carbon dioxide
CO2RR	Carbon Rhine Route
DISCCO	Digital Integrated System for Communication, Collaboration and Coordination
DVNE	German Association for Negative Emissions
ETS	Emission trading scheme
EU	European Union
FID	Final investment decision
FOEN	Swiss Federal Office for the Environment
IPCC	Intergovernmental Panel on Climate Change
IRR	Internal rate of return
KIG	Swiss Climate Protection and Innovation Act
LoI	Letter of intent
NPV	Net present value
RfP	Request for proposal
RWB	RegionalWerke Baden
SFOE	Swiss Federal Office of Energy
tCO2	Tonne of carbon dioxide
T&S	CO2 transport and storage
VBSA	Association of Operators of Swiss Waste-to-Energy Plants
WP	Work package
WtE	Waste-to-energy

1 Introduction

1.1 Context and motivation

The Carbon Rhine Route project (CO2RR) addresses the growing need for scalable, efficient carbon capture and storage (CCS) solutions, particularly for small- to medium-sized biogenic CO2 emitters in Europe. While CCS is expanding in Europe, it has primarily been applied to reducing hard-to-abate emissions from large fossil fuel emitters. However, CCS also plays a critical role in generating negative emissions when combined with biogenic carbon sources through processes such as bioenergy with carbon capture and storage (BECCS). These processes capture CO2 from biomass sources – from facilities such as biogas plants, waste-to-energy facilities and biomass combustion plants – effectively removing CO2 from the atmosphere. As the world works toward limiting global warming to 1.5°C, the IPCC estimates that between 5 and 16 billion tonnes of CO2 must be removed annually by 2050 via carbon dioxide removal (CDR), including BECCS. CO2RR aims to bring these smaller emitters into the fold by creating the first commercial, multi-modal CO2 transport and storage value chain, operational by 2026.

One of the key challenges facing smaller emitters is the lack of access to dedicated CO2 transport infrastructure, which are typically developed for larger industries (mainly pipeline networks). Building such infrastructure is costly and time-intensive, with large-scale networks not expected until 2030 or later. CO2RR will instead use existing transport modalities – such as trucks, rail, barges and ships – creating a flexible, cost-effective network to move captured CO2 to storage sites in the North Sea.

Another challenge is the high cost of CCS for smaller emitters, who lack the economies of scale which benefit larger emitters. The project addresses this by exploring the pooling of CO2 from multiple emitters, enabling shared transport and storage infrastructure, which has the potential to reduce per-tonne costs. This approach is particularly valuable for biogenic CO2 emitters, as it provides them with a viable pathway to participate in CCS despite their smaller volumes.

Additionally, the lack of accessible and secure CO2 storage capacity poses a significant hurdle. Confirmed storage solutions are limited and small emitters typically lack the negotiating power to secure bilateral agreements with storage providers. To address this, the project aims to establish open-access framework agreements with storage operators, simplifying the process for emitters to reserve storage capacity as early as 2026.

From a business perspective, CCS projects face financial risks, particularly in light of fluctuating energy and material prices. CO2RR seeks to mitigate these risks by developing innovative business models and risk-sharing mechanisms that align the incentives of all value chain participants, including emitters, transport providers and storage operators. By spreading financial risk across stakeholders and creating a clear economic framework, the project aims to catalyse early-stage investments and make CCS and CDR financially sustainable for small- to medium-sized emitters.

In summary, CO2RR offers a comprehensive solution to the technical, financial and logistical barriers facing small-scale CCS and CDR, with the potential to accelerate decarbonisation in inland Europe and serve as a model for future transnational CCS initiatives.

CO2RR is being implemented under the EU's Clean Energy Transition Partnership (CETP) and is co-funded by the European Union, the Swiss Federal Office of Energy (SFOE) and the French Environment and Energy Management Agency (ADEME).

1.2 Project objectives

CO2RR seeks to establish the first commercial CO_2 transport and storage network that will allow small- to medium-sized biogenic CO_2 emitters to effectively capture, transport and store CO_2 by 2026. The project's primary objective is to demonstrate the feasibility of a multi-modal CO_2 transport system that addresses the unique challenges faced by these emitters, who are typically excluded from larger-scale CCS projects due to cost, logistical and infrastructural limitations. By creating a viable CO2 value chain, the project will offer a replicable model for inland Europe and set the stage for broader adoption of CCS across the continent.

To directly address the challenges outlined in Section 1.1, CO2RR has set the following concrete objectives:

- Establish a multi-modal CO_2 transport network: The project is developing a flexible transport infrastructure using trucks, rail, barges and ships to move CO_2 from emitters in inland Europe to offshore storage sites in the North Sea region. This network will be designed to accommodate varying volumes of CO_2 and adapt to future needs as additional emitters come online. The use of existing transport modes will enable early deployment, bypassing the long lead times required for dedicated bulk CO_2 ships or CO_2 pipelines.
- Aggregate CO_2 from small- to medium-sized emitters: By exploring the pooling of CO_2 emissions from multiple biogenic emitters, the project aims to find a lower per-tonne cost scenario for transport and storage. The goal is to capture and store at least 1 million tonnes of CO_2 by 2030, with a clear roadmap of increasing volumes from emitters as they reach final investment decisions (FID). The initial focus will be on biogenic CO_2 sources, but the framework is designed to expand to fossil and atmospheric CO_2 in the future.
- Develop framework agreements for CO_2 storage: The project is securing framework agreements with storage providers, such as Northern Lights, to ensure that emitters can reserve future storage capacity without the need for complex individual negotiations. This provides emitters with the certainty they need to invest in CCS technologies, knowing that viable storage options are available.
- Innovative business models and risk sharing: One of the central objectives is to create financial structures that align the interests of emitters, transport providers and storage operators. The project is exploring risk-sharing models that reduce financial uncertainty, such as dynamic pricing mechanisms that reward transport providers as costs decrease, or multi-party agreements that share risks across the value chain. These models will help de-risk early-stage projects and promote investment in CCS technologies.
- Enable replicability and scalability across Europe: A key objective is to create a replicable and scalable model for CO_2 transport and storage that can be adopted by others in Europe. Over its three-year timeline, the project publishes its outputs and develops open-access agreement templates, transparent cost structures and shared best practices to enable emitters in other inland regions to implement similar multi-modal transport solutions. This will help accelerate the development of CCS infrastructure across Europe.

Expected results

By 2026, CO2RR aims to achieve the following:

- Operational multi-modal CO2 transport network capable of moving the first captured tonnes of CO_2 to long-term storage.
- Commitments from key emitters to capture CO_2, starting with biogenic sources like waste-to-energy and biogas plants, which will capture at least 1,000,000 tCO_2 by 2030.
- Scalable framework agreements for storage, facilitating future growth and providing access to storage for emitters beyond the project's initial scope.
- Lowered costs of CCS for small- to medium-sized emitters through economies of scale and risk-sharing mechanisms, proving the economic viability of CCS at smaller scales.

By successfully achieving these objectives, the project will create a blueprint for small and medium-scale CCS deployment across Europe, particularly in inland regions where infrastructure is currently limited.

2 Approach, method, results and discussion

2.1 Approach

CO2RR is structured around five key work packages (WPs), each focused on a different aspect of establishing the first commercial CO_2 transport and storage value chain for small- to medium-sized biogenic emitters in Europe (Figure 1). The combined efforts of these work packages will ensure the development of an efficient, scalable and financially viable solution for capturing, transporting and storing CO_2, with initial operations starting in 2026. Figure 1 and Figure 2 below provide a detailed overview of the approach based on these work packages as well as a multi-year timeline.

Figure 1: CO2RR approach and work packages

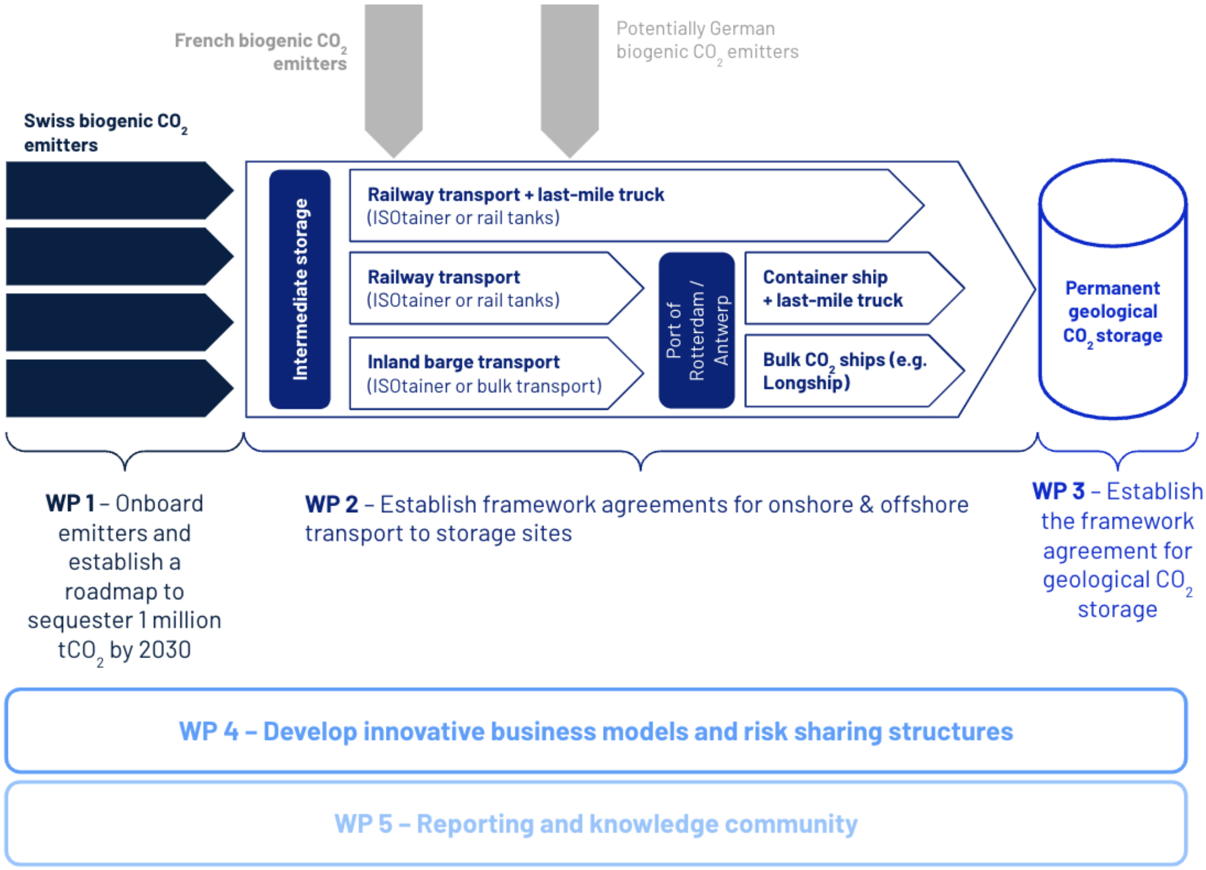
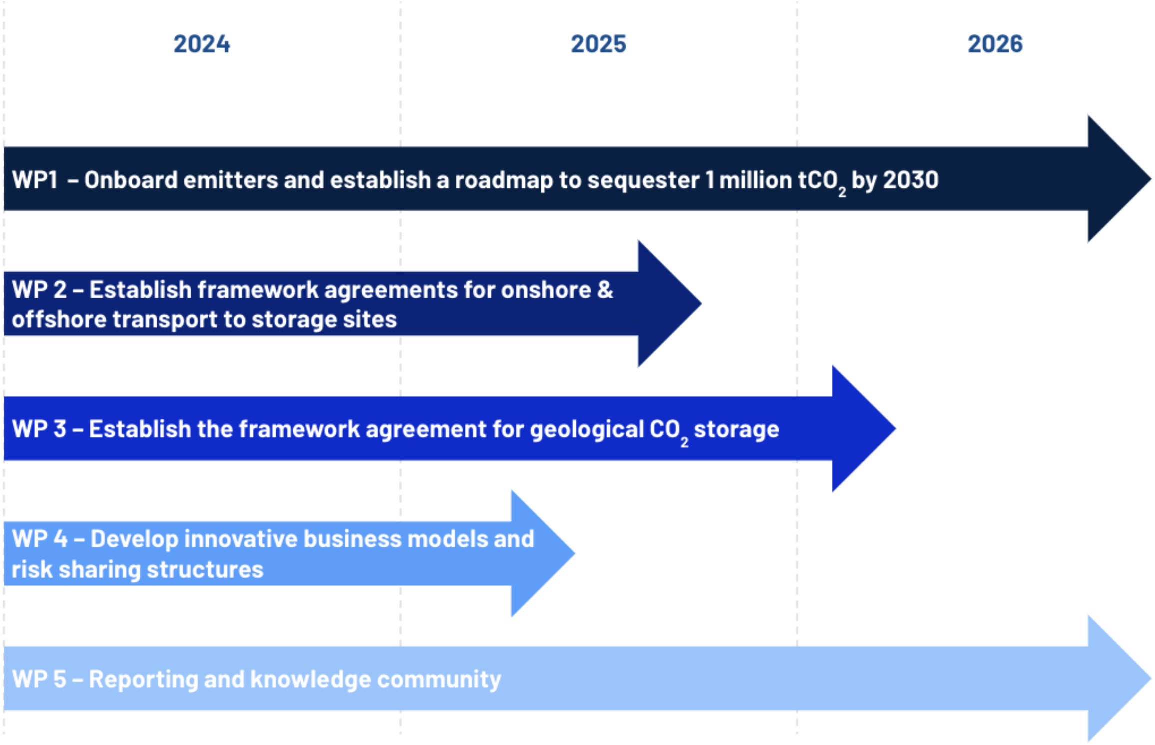


Figure 2: CO2RR timeline



WP1: Onboard emitters and establish a roadmap to sequester 1 million tCO2 by 2030

This work package focuses on engaging and supporting biogenic and industrial CO_2 emitters in Switzerland, France and neighbouring regions along the Rhine corridor to accelerate the development of capture and permanent storage projects. The overall goal is to onboard a portfolio of emitters – including biogas, waste-to-energy and biomass facilities – that together will enable the capture and sequestration of at least 1 million tonnes of CO_2 by 2030.

The first step is to identify and accompany emitters that are ready to explore capture options and assess the technical, financial and regulatory conditions required for project development. WP1 provides tailored onboarding support, including guidance on technology choices, policy alignment and engagement with transport and storage providers. Particular emphasis is placed on smaller emitters that require practical assistance to progress from early concept to feasibility stage, ensuring they can participate effectively in CO_2 removal initiatives. This year, closer engagement with municipalities and municipal utilities has taken place.

Where relevant, WP1 also facilitates cooperation between emitters whose geographical proximity or shared interests allow for common solutions – for instance, coordinated transport access points or shared intermediate storage. These synergies are assessed pragmatically to optimise costs and leverage existing infrastructure.

In parallel, the work package develops a comprehensive CO_2 volume roadmap that tracks emitters' capture potential and readiness levels across Switzerland, France and Germany. The roadmap forms the basis for prioritising engagement and planning the ramp-up to 2030. WP1 also delivers a new *Guide to Getting Started with BECCS*, an onboarding toolkit designed to help emitters and regional authorities identify priority stakeholders, align project timelines and integrate BECCS into long-term decarbonisation strategies.

Finally, beyond the Rhine corridor, WP1 is engaging with selected emitters in other European regions that can complement the value chain through access to storage capacity or shared CO_2 handling infrastructure, such as quality verification units or multimodal loading facilities. These engagements help ensure that lessons learned in the core project regions contribute to scaling up CO_2 transport and storage solutions across Europe.

WP2: Establish framework agreements for onshore & offshore transport to storage sites

WP2 focuses on developing reliable and cost-effective transport solutions that link CO_2 emitters to geological storage sites. The project engages logistics providers across multiple modalities – trucks, dedicated rail, inland barges and ISOtainers on ships – to ensure small- and medium-scale emitters can access storage capacity without relying solely on pipelines.

In 2025, WP2 completed a full request-for-proposal and negotiation process for a Swiss emitter, resulting in the successful selection of a transport provider. This process highlighted key lessons on transparent tendering, contract design, operational risk management and the interface between transport and storage operations.

The consortium has also secured letters of intent from one other logistics company for two Swiss projects and continues collaboration with Chemoil, which has indicated interest in additional CO_2 volumes. WP2 has tested a portfolio of transport scenarios linking emitters to storage sites with different reception modalities. This aims to establish a fully operational transport network ready to handle CO_2 volumes from the first wave of emitters by 2026, with plans to scale as more emitters join. Practical testing has revealed that manual scenario analysis currently offers more reliable insights than automated tools due to the high complexity and variability of project-specific factors.

Finally, WP2 has gained practical experience in aligning schedules, technical specifications and risk-sharing mechanisms between emitters, transporters and storage operators. These insights are informing operational procedures, future contracts and coordination across the full CO_2 value chain.

WP3: Establish the framework agreement for geological CO2 storage

WP3 focuses on the final stage of the CO_2 value chain: permanent geological storage. The project continues to work with a range of storage providers around the North Sea – including Northern Lights, Greensand and other providers at earlier stages of development – to secure long-term storage capacity for its emitters. Several of these facilities are expected to begin receiving CO_2 from 2026 onwards, forming the backbone of the project's storage portfolio.

The work package aims to establish framework agreements that provide emitters with reliable access to storage capacity while streamlining negotiations and standardising key contract terms. This approach benefits not only the emitters but also storage companies, which can negotiate with one aggregated organisation rather than managing complex bilateral negotiations with multiple small entities. In 2025, the consortium successfully completed a first full negotiation on behalf of a Swiss emitter, gaining important experience in areas such as financial guarantees, liability management and credit ownership. These lessons are now being consolidated into a common set of contractual principles to guide future agreements and reduce complexity for smaller emitters.

In parallel, WP3 contributes to the exploration of local and decentralised storage solutions in France and Switzerland. While large-scale local storage is unlikely to be operational by 2026, the project engages with governments and industry stakeholders to lay the groundwork for these future options. While currently limited in scale, they could provide early or transitional routes for smaller emitters and complement larger offshore capacity in the long term.

Finally, an important learning in 2025 has been the technical and contractual interface between emitters, transport operators and storage sites, particularly in the necessary alignment regarding approaches to scheduling and delivery coordination. WP3 has been closely linked with WP2 and WP4 to clarify operational procedures and integrate these findings into the project's storage-related risk assessment, ensuring smooth coordination across the entire CO_2 value chain.

WP4: Develop innovative business models and risk-sharing structures

WP4 focuses on the economic backbone of the CO_2 value chain, developing the business models, risk management frameworks and financial tools needed to make BECCS projects bankable – particularly for small- and medium-sized emitters. The work aims to ensure that these emitters, often operating in the waste-to-energy, biogas and biomass sectors, can participate in carbon removal initiatives through fair and transparent risk-sharing arrangements.

In 2025, the work package advanced in translating earlier risk mapping into practical instruments and applied methodologies. This included the creation of a risk management tool template, designed to help project developers and emitters systematically identify, assess and mitigate risks along the full carbon removal value chain. The tool provides a structured approach to evaluating technical, financial and regulatory risks, helping to ensure that key exposures are addressed early in project design and contracting.

Parallel to this, WP4 continues to explore dynamic pricing and risk-sharing models. This includes investigating mechanisms where transport costs might decrease as volumes increase, or where costs are distributed between operators based on volume milestones. The work package also explores concepts such as insurance-based risk coverage to shield first-generation BECCS projects from excessive value-chain risk.

Furthermore, WP4 assesses opportunities to monetise negative emissions through carbon markets and local regulatory mechanisms. This involves exploring voluntary carbon markets and buyer clubs, which could provide critical revenue streams for emitters looking to invest in CCS technology. These mechanisms are starting to be tested in collaboration with partners through real-world contracting exercises.

Finally, WP4's findings are closely connected with those of WP2 and WP3, ensuring that financial, contractual and risk management principles align with the realities of CO_2 transport and storage implementation.

WP5: Reporting and knowledge community

The final work package ensures that the knowledge and experiences gained from CO2RR are widely shared across Europe, facilitating the replication and scaling of the project model. WP5 focuses on both targeted dissemination to industry stakeholders and broader public communication. Details about ongoing and planned work under this WP is provided in the *Publications and other communications* section.

This work package will involve regular reporting of project progress, participation in industry conferences and collaboration with CCS working groups across Europe. Consortium members will publish reports, case studies and lessons learned, with a focus on encouraging the adoption of CCS among small- to medium-sized emitters in other regions.

In addition to sharing technical and business model insights, WP5 continues to engage policymakers and regulatory bodies to advocate for more supportive frameworks for CCS development. The goal is to ensure that the CO_2 transport and storage model created by CO2RR is both scalable and adaptable to other inland regions, contributing to Europe's broader climate goals.

CO2RR takes a comprehensive approach by addressing every stage of the CO_2 value chain – from capture at the emitter level, to transport and long-term storage – through the strategic collaboration of emitters, logistics providers and storage operators. Each work package plays a crucial role in creating a fully integrated, replicable and scalable CCS solution that will enable the capture and storage of CO_2 from biogenic emitters across Europe.

The following subsections delve into the specific methods used, results generated and discussions on each of the work packages to date.

2.2 Onboarding emitters and establishing a roadmap to sequester 1 million tCO_2 by 2030

2.2.1 Methods used

WP1 continues to advance the objectives of CO2RR by engaging biogenic and industrial CO_2 emitters across Switzerland, France and Germany to accelerate the deployment of BECCS and CCS solutions. The work focuses on helping emitters understand capture feasibility, identify appropriate transport and storage pathways and connect with relevant partners and regulatory frameworks. There has been increased engagement with municipalities and municipal utilities to explore BECCS projects through collaboration with the EU's NetZeroCities programme.

The approach combines direct technical support to emitters with strategic analysis of regional synergies, ensuring that where opportunities exist for cooperation or shared infrastructure, they are assessed pragmatically. This ensures that CO_2 management solutions remain cost-effective, tailored to local conditions and aligned with national policy frameworks.

To facilitate this, WP1 has developed a new practical deliverable – a *Guide to Getting Started with BECCS* – which serves as an onboarding toolkit for emitters and regional stakeholders. The guide supports the identification of priority sites and timelines, offers guidance on integrating BECCS into corporate strategies and outlines the alignment of project development stages with available policy and financial instruments.

The updated CO_2 volume roadmap incorporates new emitters identified in 2025 across Switzerland, France and Germany and reflects their readiness levels, indicative capture volumes and potential for collaboration in transport and storage.

2.2.2 Activities carried out

Switzerland

In Switzerland, activities have been strongly influenced by the entry into force of the Climate Protection and Innovation Act (Klimaschutz- und Innovationsgesetz, KIG). The law has created clearer frameworks for negative-emission projects and has triggered an increase in emitter interest in developing CO_2 capture projects.

WP1 supported several emitters and consortia in assessing technical and financial feasibility and in preparing applications under the KIG framework:

- Gevag, Axpo and Holcim (Rheintal cluster): Pre-feasibility assessments initiated, exploring shared transport and storage (T&S) concepts.
- Swiss building materials company: Early-stage engagement on transport and storage integration.
- Regionalwerke Baden (RWB) region: Three BECCS pre-proposals submitted, with one advanced to full proposal stage (BAC-BKW project), reflecting increasing maturity and commitment from emitters. At least one of the other projects will be submitted as a direct submission under the KIG in 2026.
- Association representing local biogas producers: Pre-feasibility assessment initiated, exploring possible business models for small-scale BECCS projects (less than 1,000 tCO_2/year).

Basel cluster case study: The project continues to leverage the strategic importance of the Basel region as both a capture cluster and a transport hub. An initial assessment conducted by Airfix for a feasibility study led by Cargo Sous Terrain identified nine key emitters (including WtE and biogas), producing approximately 735,000 tonnes of CO_2 per year. As part of this work, the consortium contributed to developing an operating model for a CO_2 hub at Auhafen Muttenz with an annual capacity of 500,000

tCO_2. In this concept, major emitters would connect via pipeline to the hub for liquefaction and intermediate storage, before shipment via specialised barges to Rotterdam.

Pilot progress: The BECCS Niederwil project of RegionalWerke Baden (RWB) remains a key pilot within the Swiss portfolio. Having reached a final investment decision in 2024, the project is now registered under the FOEN standard for certification and expects to begin implementation in 2026. It is serving as a reference for small-scale BECCS deployment, providing critical lessons on financing structures, procurement of transport and storage services and regulatory coordination. In addition to the above-mentioned BAC-BKW project, RWB, with the support of Airfix, has also initiated partnerships with two additional biomass incineration plants (~50,000 tCO_2/year) to explore expansion opportunities. While the first project of ~10,000 tCO_2/year is designed as a conventional BECCS project, the second project of ~40,000 tCO_2/year involves an early-stage methanol synthesis concept using captured CO_2.

Learnings from the Swiss context:

- The KIG has created strong momentum for early CCS/BECCS engagement but also introduced complexity in project structuring and ownership. Particularly challenging for negative emission projects, including BECCS, is the fact that only removed CO2 and accounted for in SFOE net-zero roadmaps qualifies for subsidies.
- Another positive signal was the signature of bilateral agreements between Switzerland and Denmark, as well as Switzerland and Norway, enabling the storage of Swiss CO2 offshore in both countries under the London Protocol.
- The design of cost recovery mechanisms and sustainable business models for BECCS projects – particularly where hub infrastructure is included – remains a challenge due to the lack of an agreed CO2 Law after 2030. Existing funding mechanisms, such as the Climate Cent Foundation will likely not be available. Moreover the Swiss Federal Council proposes a new emission trading mechanism for the buildings, transport and industrial sectors which is capped at CHF 120 for heating oil and CHF 20 for fuels. If implemented, this will not lead to additional revenues and prices will remain significantly below (BE)CCS costs. Securing a committed lead emitter is critical to ensuring bankability and alignment across partners.
- In parallel, dialogue continues with waste-to-energy and cement operators. However, several WtE emitters remain dependent on clarification of the VBSA–FOEN framework, while cement producers face uncertainty due to the lack of a CBAM (Carbon Border Adjustment Mechanism) in Switzerland
- A positive development is that the Swiss Federal Council wants to accelerate the expansion of CO_2 removal and storage through a new framework law that harmonises the rules for developing the necessary CO_2 pipelines and underground storage sites. In addition, measures in the post 2030 CO_2 Act will aim to increase investment security for CO_2 removal and storage, for example through targeted financial support.

France

In France, WP1 has continued working with smaller biogenic emitters (including biomethane plants) while approaching larger biomass and WtE operators. The geographic scope has expanded beyond the initial central and eastern regions to include areas potentially benefitting from future infrastructure projects such as Pycasso (onshore storage), Rhone CO2 and GOCO2 (transport network and export terminals).

Key activities include:

- Collaboration with a major energy operator to assess CO_2 capture at a biomethane facility.
- Continued development of a mini-network of three biomethane emitters (~10,000 tCO_2/year), now progressing towards detailed feasibility and off-take identification. Preliminary geologic investigations are being conducted to explore the potential of innovative sequestration methods aligned with the need of small emitters.

- Early scoping of new emitters in the Rhône-Alpes and Hauts-de-France regions to expand the CO_2 volume base and explore potential synergies in transport and storage.
- Support for two waste-to-energy plants owned by the same company to explore the feasibility of capturing, transporting and storing CO2, and defining a potential viable business model.
- Early engagement with a cluster of biomethane plants near an onshore storage project under development in the Paris area (in Grandpuits).
- Support of a municipally owned biomass based district heating network in the identification of use cases for biogenic CO2 capture with the identification of potential technology partners willing to deploy pilot projects (using solid sorbent methods).

These initiatives have also provided insight into project financing and market development conditions in France, supporting the alignment of future BECCS deployment with national decarbonisation priorities.

Germany

In Germany, WP1 has focused on extending the CO_2 volume roadmap to include new emitters and exploring cross-border coordination along the Rhine corridor. Progress includes initiating dialogue with new emitters along the Rhine corridor – mostly in the waste-to-energy and biomass incineration sector, including public utilities – with a combined CO2 volume above 1 million tCO_2/year (both biogenic and fossil). Discussion focuses primarily on T&S, monetisation of negative emissions and carbon asset development.

The project specifically explored cross-border coordination for CO_2 management between German emitters and the Swiss cluster. For instance, an emitter in Grenzach-Wyhlen (~110,000 tCO_2/year) has been identified as a promising candidate for cross-border collaboration, given its proximity to the Basel hub concept.

Across geographies engagement with carbon capture technology and solutions providers as part of pre-feasibility studies is also ongoing, allowing for a better understanding of technology trends, technical issues faced by projects, financial impacts and outlook for actual implementations.

2.2.3 Results obtained

Europe's CCUS project pipeline is growing rapidly, with over 200 emitters in various stages of development and 60 MtCO2 of capture capacity per year expected by 2030, exceeding EU targets as set by the Net-Zero Industry Act and the Industrial Carbon Management strategy. An updated CO2RR volume roadmap has been compiled, now including newly identified emitters and reflecting their level of maturity and indicative capture potential. The total CO_2 volume represented in ongoing discussions across the three countries exceeds 2.4 million tCO_2/year. Of this, confirmed projects only represent 19,500 tCO2/year, and ongoing discussions (at varying stages) 2,478,000 tCO2/year. Additional relevant emitters representing 1,152,300 tCO2/year have been identified but not yet engaged through the project.

Table 1: Status of discussions with emitters in Switzerland, France and Germany (anonymised; CO_2 emissions grouped in ranges, tCO_2 per year).

Type of plant	Location	CO_2 origin	Annual CO_2 emissions	Status of discussions
Biomethane	Aargau canton, CH	Biogenic	< 15	Confirmed
Biomethane	Meurthe-et-Moselle, FR	Biogenic	< 15	Confirmed
Biomethane	Loiret, FR	Biogenic	< 15	Confirmed
Biomethane	Aargau canton, CH	Biogenic	< 15	Confirmed
Waste-to-energy	Basel-Stadt canton, CH	Biogenic & fossil	200–400	Ongoing discussion

Type of plant	Location	CO_2 origin	Annual CO_2 emissions	Status of discussions
Biomass cogeneration	Basel-Stadt canton, CH	Biogenic	100–200	Ongoing discussion
Heat	Basel-Stadt canton, CH	Fossil	15–50	Ongoing discussion
Heat	Basel-Stadt canton, CH	Fossil	15–50	Ongoing discussion
Waste-to-energy	Glarus canton, CH	Biogenic & fossil	100–200	Ongoing discussion
Cement	Aargau canton, CH	Fossil	> 400	Ongoing discussion
Waste-to-energy	Zürich canton, CH	Biogenic & fossil	> 400	Ongoing discussion
Biomethane	Drôme, FR	Biogenic	15–50	Ongoing discussion
Biomethane	Tarn, FR	Biogenic	< 15	Ongoing discussion
Biomethane	Indre-et-Loire, FR	Biogenic	< 15	Ongoing discussion
Industry	Gard, FR	Biogenic	15–50	Ongoing discussion
Biomass cogeneration	Drôme, FR	Biogenic	< 15	Ongoing discussion
Biomass cogeneration	Drôme, FR	Biogenic	100–200	Ongoing discussion
Biomass cogeneration	Oise, FR	Biogenic	< 15	Ongoing discussion
Biomass cogeneration	Allier, FR	Biogenic	100–200	Ongoing discussion
Waste-to-energy	Graubünden canton, CH	Biogenic & fossil	100–200	Ongoing discussion
Biomass cogeneration	Graubünden canton, CH	Biogenic	100–200	Ongoing discussion
Biomass cogeneration	Aargau canton, CH	Biogenic	15–50	Ongoing discussion
Biomass cogeneration	St. Gallen canton, CH	Biogenic	< 15	Ongoing discussion
Biomass cogeneration	Zürich canton, CH	Biogenic	15–50	Ongoing discussion
Waste-to-energy	Meurthe-et-Moselle, FR	Biogenic & fossil	100–200	Ongoing discussion
Waste-to-energy	Vaucluse, FR	Biogenic & fossil	100–200	Ongoing discussion
Cement	Graubünden canton, CH	Fossil	> 400	Initial contact
Biomethane	Seine-et-Marne	Biogenic	< 15	Initial contact
Sewage incineration	Basel-Stadt canton, CH	Biogenic & fossil	15–50	Prospective
Waste-to-energy	Aargau canton, CH	Biogenic & fossil	100–200	Prospective
Industry	Baden-Württemberg, DE	Fossil	100–200	Prospective
Industry	Basel-Landschaft canton, CH	Fossil	100–200	Prospective
Sewage incineration	Basel-Landschaft canton, CH	Biogenic & fossil	< 15	Prospective
Biomethane	Basel-Landschaft canton, CH	Biogenic	< 15	Prospective
Cement	Aargau canton, CH	Fossil	> 400	Prospective
Industry	Aargau canton, CH	Fossil	50–100	Prospective
Waste-to-energy	Aargau canton, CH	Biogenic & fossil	100–200	Prospective

Mutualisation opportunities identified:

The work to date has highlighted specific areas where infrastructure mutualisation is feasible vs. where it is challenging:

- CO$_2$ liquefaction: This has proven to only be feasible in very close proximity, as it requires transporting gas CO$_2$ via pipeline first. The current concentration of emitters makes this option complicated to implement.
- Intermediate storage and loading infrastructure: For CO$_2$ bulk barge transport in Basel, collecting CO$_2$ from several emitters at the Port of Basel to reach the minimal critical values enabling barge transport and mutualising the costs of the loading infrastructure. For CO$_2$ transport by train next to KVA Linth, where other smaller emitters could connect to the infrastructure developed by the waste-to-energy plant.
- CO$_2$ quality verification: There have been discussions between the Swiss pilot project and projects closer to the North Sea storage sites to mutualise CO$_2$ quality check material, which can cost ~EUR 500,000 per scanner. The challenge is the transport costs incurred even if quality is below the requirements. This solution should continue to be explored with local emitters.
- Project financing: The biomethane cluster seeks to encompass three projects under one legal structure, securing project financing and other project milestones for all three plants at once.

Deliverables:

Deliverable 1.1 Cluster organisational structure – Details current concept of emitter clusters, summarising governance and operational frameworks and coordination mechanisms to facilitate engagement.

Deliverable 1.2 Summary of CO2 volume roadmap – Outlines the status CO$_2$ capture volumes from engaged emitters, mapped to timelines and milestones, including indicative progress of discussions towards commitment.

Deliverable 1.3 Case study on the clustering of biogas plants in France was published in 2024. It presents insights from the clustering of three biogas emitters in France, focusing on feasibility, coordination and scalability challenges and lessons learned for replicating similar initiatives elsewhere

Deliverable 1.4 Capture technology – market monitoring tracks advancements in CO$_2$ capture technologies for biogenic emitters, evaluating cost, efficiency and scalability to support informed decisions for future projects. Liquid solvent technologies (in particular amine based) remain the reference solution for post-combustion capture; however, the associated technical challenges (e.g. impurities handling, energy penalty, footprint) open spaces for other options such as cryogenic capture which does not require a source of heat (either waste or dedicated). Solid sorbent and membrane solutions are also climbing the TRL ladder but starting from a lower maturity.

The "*Guide to Getting Started with BECCS*" provides a foundation for scaling up emitter onboarding and harmonising engagement processes across regions.

These deliverables are attached to this report and will be further disseminated publicly by CO2RR consortium partners.

2.2.4 Critical analysis

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. In this context, tailored technical assistance, clear policy signals and practical onboarding materials have proven key to moving projects from concept to feasibility.

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.

Several cross-cutting lessons have emerged:

- **Policy interaction**: The KIG framework has generated strong project interest but also highlighted the need for clarity on cost treatment and ownership models.
- **Lead emitter engagement**: The presence of a committed industrial partner remains decisive in determining project viability and momentum.
- **Cross-border integration**: The Rhine corridor continues to present strategic potential for connecting emitters to transport and storage solutions, though regulatory alignment remains essential.
- **Market linkages**: Interest from e-fuel and synthetic fuel producers is growing, but most initiatives remain at concept stage.

In the coming year, WP1 will prioritise finalising the updated CO_2 volume roadmap, advancing pre-feasibility studies to completion and deepening collaboration to align project financing with national CDR strategies.

2.3 Establish framework agreements for onshore & offshore transport to storage sites

2.3.1 Methods used

WP2 focuses on developing a multi-modal CO_2 transport network that integrates different transport modalities – trucks, dedicated rail, inland barges and ISOtainers on ships – to connect emitters in Switzerland and neighbouring countries to offshore storage sites in Northern Europe. The objective remains to establish a cost-effective, scalable and low-carbon transport network that allows small- and medium-sized emitters to access storage solutions even in the absence of pipeline infrastructure.

This approach aligns with recommendations from the EU's Joint Research Center (JRC), which emphasises the need for multiple transport modes to link smaller emitters into the CO_2 'backbone' network. A critical consideration in selecting these modalities is their relative environmental impact, as highlighted by recent studies (e.g. Oeuvray et al., 2024). While trucks offer flexibility for smaller emitters, they carry higher per-tonne CO_2 emissions compared to rail or inland barges, which offer significantly better efficiency per tonne-kilometre.

This year, the work advanced significantly in the below areas:

- Most significantly, a **full Request for Proposals (RfP) process** was conducted for a Swiss emitter, leading to the successful selection of a transport provider after competitive tendering and negotiation. This process yielded very relevant learnings to improve the tendering for future projects.
- A new **risk and contingency section** was created, analysing operational, contractual and regulatory risks associated with CO_2 transport.

In parallel, collaboration and engagement with logistics providers continued. Chemoil as a member of the CO2RR remains an active partner in transport discussions, supported the development of the transport tender and continues to support the development of new CO2 transport scenarios. One other logistics provider issued Letters of Intent (LoIs) for two projects and Chemoil expressed an indication of interest for additional CO_2 transport initiatives. These engagements form the backbone of a growing network of potential CO_2 logistics partners across Europe.

2.3.2 Activities carried out

RfP and negotiation process

A rigorous RfP procedure was implemented on behalf of a Swiss emitter, aiming for transparent and comparable evaluation of proposals. This included standardised bid forms, clear scoring criteria and detailed assessment of real transport costs (beyond nominal quotes). The process demonstrated the importance of harmonised tender documentation and yielded valuable lessons for future procurement rounds. Key evaluation factors included:

- **Standardisation & comparability**: uniform templates and rating systems to prevent non-comparable offers.
- **Transport concept quality**: clarity on route design, transfer points, required assets and backup options.
- **True cost analysis**: inclusion of hidden costs (e.g. loading/unloading, intermediate storage, asset maintenance) to estimate real cost per tonne of CO_2.
- **Provider capacity & experience**: verification of track record in hazardous or CO_2 transport, asset availability and compliance.
- **Sustainability**: carbon footprint of the proposed solution and the provider's plan to reduce transport emissions.
- **Interruption management**: clear contractual clauses defining responsibilities in case of temporary disruptions or unavailability of storage sites.

Transport scenarios and portfolio development

WP2 developed a portfolio of transport scenarios for 6 capture sites combining various modes and linked these with potential storage sites offering different receiving modalities. Specific modalities evaluated include:

- ISOtainers on trucks: Road freight transport using ISOtainers.
- Dedicated CO_2 trains: Trains designed for CO_2 transport using rail tanks or ISOtainers.
- Inland container barges: Utilising waterways for cheaper bulk transport.
- ISOtainers on ships: Flexible options bridging inland and offshore transport.

Scenarios were compared based on cost, emissions, timing, flexibility and cross-border feasibility. This work aims to provide a foundation for emitter-specific route assessments, which will help standardise future evaluations. One aim of the CO2RR consortium is to compile and consolidate all gathered information into a digital repository, including technical concepts, provider details and mode characteristics. Once created, such a repository could serve as a reference database to support emitters and streamline future tender processes.

Regarding pipelines, France, Germany, Italy and the Netherlands are planning regional or national onshore CO2 pipeline networks. Even as pipelines are deployed over the next couple of decades, Europe's CO2 network will likely continue to depend on the use of other transport modes, and key transport hubs needed to transition between them, because of their flexibility and suitability for smaller or more isolated emitters.

Transport scenario analysis tool

In 2024, the project initiated the development of a dynamic scenario modelling tool. However, following initial attempts, it was concluded that the large number of variables (e.g., site-specific constraints, volume variability, mode availability) made a fully automated tool difficult to operationalise at this stage. The team has therefore shifted to a manual, case-by-case analysis approach, which currently offers more reliable insights, while keeping the option open for a simplified digital tool in future iterations.

Risk assessment

A dedicated transport-related risk matrix was introduced this year, capturing key categories such as operational delays, asset unavailability, cross-border permitting, cost escalation and contract termination scenarios. Mitigation strategies and contractual safeguards are being embedded into standard templates. Selected transport-specific risks and identified mitigation measures can be found in Appendix 1.

2.3.3 Results obtained

Pilot provider selection and contracting

The full RfP process led to the selection of a transport provider for a Swiss emitter, with final contractual elements currently being negotiated. This marks a concrete step toward implementation and provides a benchmark for future procurements.

Cost analysis & reduction strategies

Early analysis confirms that transport remains the largest cost driver in the value chain (often >50%). This is consistent with findings from Oeuvray, Becattini and Mazzotti (2022). Current transport costs for Swiss emitters to the North Sea are estimated in the range of EUR 200–400 per tonne, depending on the mode and volume. However, cost reduction strategies identified by WP2 suggest significant potential savings:

- **Bulk transport**: Transitioning to bulk barges and shipping could lower costs significantly as volumes scale.
- **Railtanks vs. ISOtainers**: Comparing fixed railtanks vs. flexible ISOtainers to optimise unit costs.
- **Future projections**: Analysis suggests transport costs could decrease by over 40% by 2028–2030 as efficient modalities become available, with further reductions possible post-2035 via pipelines.

Expanded collaboration network

Advanced discussions between consortium partners Airfix and Chemoil (collaboration agreement under preparation) and the receipt of LoIs from other partners have broadened the provider base. This engagement has also facilitated the drafting of logistical frameworks for cross-border CO_2 transport, helping to clarify the administrative requirements for moving CO_2 between jurisdictions.

Deliverables:

Deliverable 2.1 Report on transport & storage cost evolution analyses the considerations of various transport modalities (including costs, emissions impact and others), proposing an optimised combination for an example case, tailored to the evolving value chain.

Deliverable 2.2 Signed framework agreement with transport provider has been completed. As a confidential contractual document, it is not available publicly. However, outputs have been published in the form of a *Guide to CO2 transport tenders*, which provides a description, key contractual considerations and lessons learned from the transport tendering process. This is accompanied by the actual *CO2 transport tender documents* which were used in the process to select a provider.

These deliverables are attached to this report and will be further disseminated publicly by CO2RR consortium partners.

2.3.4 Critical analysis

While WP2 has transitioned from conceptual development to practical implementation, several challenges remain (as below) and building on the findings of DemoUpCARMA and associated works (e.g. Becattini *et al.* [2022]) will be critical to advance the state-of-the-art.

Cost & complexity: Transport costs remain high for small-scale emitters. While the project has identified strategies for cost reduction (e.g. bulk transport), realising these savings depends on volume aggregation which takes time. Furthermore, the complexity of cross-border logistics continues to hinder rapid deployment, requiring harmonised procedures between emitters and authorities.

Scenario tool limitations: The initial vision for an automated scenario tool proved premature due to excessive input variability. However, the lessons from this effort inform the current robust manual methodology, ensuring that emitter-specific route assessments remain accurate.

Sustainability: Providers' commitments to low-carbon logistics solutions (e.g. electric trucks, alternative fuels) must be tracked closely. Emissions from transport could undermine the lifecycle carbon reduction of CCS projects if high-emission modes like diesel trucks dominate for extended periods.

In summary, WP2 has progressed significantly – from exploratory analysis to active procurement. The RfP execution, repository creation and risk framework represent concrete progress toward building a standardised CO_2 transport ecosystem capable of supporting the scale-up of carbon management projects across Switzerland and beyond.

2.4 Establish the framework agreement for geological CO_2 storage

2.4.1 Methods used

WP3 focuses on securing long-term and diversified geological storage solutions for captured CO_2 and on ensuring that storage agreements adequately protect emitters' interests while safeguarding the environmental integrity of the project's removals. The work involves technical, legal and commercial coordination across the entire CO_2 value chain – from capture and logistics to injection and verification.

The project's approach combines:

- Direct negotiations with major offshore storage providers (including Northern Lights, Greensand and others).
- Engagement with smaller, decentralised storage developers in Switzerland and France to identify near-term or transitional options.
- Continuous market intelligence through a storage solutions repository.

This repository aims to gather and standardise data on capacity, expected start dates, accepted delivery modes (truck, rail, ship, pipeline), pricing ranges and eligibility for negative-emission projects. It serves as a living reference to support emitter onboarding (WP1) and transport planning (WP2).

2.4.2 Activities carried out

Negotiation of storage agreements

In 2025, WP3 reached a significant milestone with the successful conclusion of storage negotiations on behalf of a Swiss emitter with a Danish storage provider, marking the first such agreement facilitated by the consortium. This process, in addition to previous negotiation of term sheets or application to public tenders with other storage sites, provided valuable insight into the commercial and legal structures underpinning CO_2 storage contracts and their implications for smaller emitters. The negotiation covered key issues such as financial guarantees, liability allocation, operational flexibility and ownership of negative-emission credits.

Key lessons from exposure to storage contract negotiation include:

- **Financial guarantees**: Operators may require guarantees of 15–25% of the contract value or 1–2.5 years of storage fees; acceptable formats (bank, parent company or prepayment) should be planned early.
- **Conditions precedent**: Contract validity typically depends on milestones such as FID, licensing or environmental clearance; project timelines must align accordingly.
- **Storage and emitter liability**: Contracts are usually take-or-pay; emitters must negotiate broad force majeure clauses and clarify responsibility for service interruptions. To date, storage providers are not liable towards the emitter for interruptions in storage, which leaves a considerable risk for emitters to bear.
- **CO_2 quality and delivery**: Quality control procedures (purity, pressure, temperature) require clearly defined responsibility across the transport chain.
- **Carbon credit rights**: Emitters should retain ownership of carbon removal credits even when physical CO_2 ownership transfers to the storage operator.
- **Leakage and incident management**: Under EU law, the storage operator bears the cost of leaks (based on EU ETS prices), but the emitter must be informed of any incident.

These learnings have been synthesised into a draft template of critical storage contract terms, to be shared across WPs and used in future emitter negotiations.

Status of discussions with providers

The consortium has maintained and expanded active dialogue with major European storage initiatives, including Northern Lights, Greensand (INEOS), Horisont, Aramis, Poseidon, as well as Stenlille (Gas Storage Denmark) and emerging operators in France, Italy, Hungary and the North Sea region.

This broad engagement ensures a diversified storage portfolio and mitigates the risk of delays in any single project. Three non-binding term sheets were signed over the past two years, one of which is now leading to a full-term agreement, while the others await progress on the FID of the storage site or their receiving terminal.

Local and decentralised storage initiatives

Alongside large-scale offshore storage, WP3 has contributed to ongoing work with decentralised or smaller-scale storage developers such as Recoal and C-Questra and other initiatives in France and Switzerland. These projects, while limited in capacity, offer valuable near-term or transitional options for emitters seeking cost-effective and low-transport-distance solutions. ETH Zürich is expected to test a storage site. This project will be monitored to determine if it could be replicated. WP3 continues to assess their technical compatibility, permanence assurance and scalability potential.

Interface with logistics and risk management

A key insight from 2025 has been the importance of the interface between storage and logistics operations, both technically and contractually. The coordination of responsibilities between emitters, transporters and storage operators – particularly regarding CO_2 quality, timing of deliveries and force majeure events – has proven to be one of the most complex aspects of the value chain. These findings informed the storage-related risk section developed jointly with WP4, ensuring that key contractual, operational and reputational risks are systematically identified and mitigated. Selected storage-specific risks and identified mitigation measures can be found in Appendix 2.

2.4.3 Results obtained

The main outcome of WP3 in 2025 is the successful conclusion of one full-scale storage negotiation. The negotiation process yielded a replicable contractual framework and significantly strengthened the consortium's understanding of the commercial, regulatory and technical requirements of permanent CO_2 storage. Lessons learned from the process, along with key terms, their implications and associated risks are attached to this report and will be further disseminated by the CO2RR consortium in the coming year.

Similarly to WP2, a future effort of WP3 will be to consolidate knowledge and experience in a storage repository, which will serve as a transparent overview of available and upcoming storage options, enabling emitters to plan capture and transport projects with a realistic understanding of timing, capacity and cost. This tool, coupled with the lessons learned from negotiations, should improve the project's ability to match emitters with suitable storage pathways as early as the feasibility stage.

One of the key benefits of the ongoing negotiations is the identification of operators open to flexible delivery modes. While major hubs often require ship/pipeline access, securing partners willing to accept ISOtainers or truck deliveries lowers entry barriers for inland emitters who cannot yet access large-scale infrastructure. The collaboration with local storage developers (e.g. Recoal, C-Questra) has also demonstrated that decentralised storage can complement large-scale offshore projects, particularly for early movers or demonstration-scale activities.

Deliverables:

Deliverable 3.2 Signed framework agreement with storage provider has been completed. As a confidential contractual document, it is not available publicly. However, learnings from the process have been distilled and repackaged in the form of *Storage framework agreements: Key terms*, which provides a description, key contractual considerations and lessons learned from the storage contract negotiation process.

Deliverable 3.3 Status update projects and storage providers provides an overview of active storage providers to date – including capacity, reception modalities, FID status, acceptance of smaller CO2 volumes – and the consortium's discussion status with each.

These deliverables are attached to this report and will be further disseminated publicly by CO2RR consortium partners.

2.4.4 Critical analysis

Despite strong progress, several challenges remain.

Licensing and timeline uncertainty: Uncertainty in licensing timelines continues to affect several European storage projects. For example, setbacks such as Gas Storage Denmark's previous challenges in securing an onshore operating license highlight the fragility of projected timelines. The Zero Emissions Platform notes that as of 2025, only three CO_2 storage projects are operational in Europe (all in Norway). This underscores the limited capacity available to EU emitters and the need for a diversified portfolio to manage delay risks.

Contractual complexity: The contractual complexity of take-or-pay structures and liability chains represents a barrier for smaller emitters. As noted in the results, the risk regarding CDR certificate invalidation during service interruptions remains a sticking point that requires more balanced contracting models.

Logistical interface: Finally, while offshore storage capacity appears sufficient in the long term, the logistical interface – particularly regarding truck or multimodal delivery options – remains a critical bottleneck. The fragmented nature of the market means emitters must navigate different specifications for every provider, which will be further addressed through joint work with WP2.

In conclusion, WP3 has substantially strengthened the project's storage dimension by securing one full agreement and documenting key legal lessons. These advances position the consortium to finalise additional agreements in 2026–2027, ensuring emitters have access to reliable storage solutions.

2.5 Develop innovative business models and risk-sharing structures

2.5.1 Methods used

WP4 focuses on developing business models and risk-sharing frameworks that enable financially viable CO_2 capture, transport and storage projects for small- to medium-sized emitters. These emitters – particularly in the waste-to-energy (WtE), biogas and biomass sectors – face substantial technical, financial, market and regulatory risks that need to be systematically identified, allocated and mitigated.

The EU, in its Innovation Fund Knowledge Sharing Report, highlights financing hurdles for small BECCS projects, noting that securing investment often requires early dialogue with funders and extra equity guarantees. This aligns with findings from other key studies leveraged by the project (e.g. Quadrature Climate Foundation, CO2RE – The Greenhouse Has Removal Hub, Boston Consulting Group, Swiss Re and The State of Carbon Dioxide Removal), which emphasise that explicit risk-sharing is essential due to scarce storage options and nascent value chains.

The focus of the WP in 2024 was risk mapping and evaluation, which began with a workshop that gathered key stakeholders from across the CO_2 value chain, including emitters, carbon capture technology experts, transport and storage providers, and public entities such as the Swiss Federal Office for the Environment (BAFU). This workshop served to identify and map risks across the value chain, as well as the initial risk mitigation development process. This has since informed the development of business models and risk-sharing frameworks. The workshop focused on identifying risks related to capture, transport, storage and the overall project lifecycle. The assessment and development of mitigation strategies was also touched upon.

This year's work transitioned from foundational risk mapping toward structured tools and applied frameworks:

- Development of a risk management tool template, designed to help emitters and project developers systematically identify, assess and mitigate risks across the value chain and project development stages.
- Advancement of the deliverables on business models and risk-sharing, including specific analysis of risk allocation mechanisms and insurance-based solutions for early-stage BECCS projects.
- Dedicated analysis of sector-specific business models, notably for waste-to-energy, identifying where contractual risk mitigation or financial guarantees are most effective.

WP4 continues to integrate knowledge and data from WP1–3 to align business model structures with technical and contractual realities (e.g. transport and storage framework agreements, permitting and cost models).

2.5.2 Activities carried out

Risk management and mitigation

The foundation of this work was a multi-stakeholder workshop involving key partners (Airfix, Carbon Impact, FOEN, ChemOil, Northern Lights, RegionalWerke Baden). This session identified and mapped risks across the full lifecycle – construction, operation and post-closure. This workshop was designed to initiate a comprehensive risk analysis for BECCS projects, focusing on the financial, operational and regulatory risks that stakeholders face. The workshop brought together a diverse group of stakeholders, each with different priorities and views on risk, to ensure that the entire spectrum of risks across the CO_2 capture, transport, and storage processes was thoroughly discussed. This also included the political and regulatory landscape. The participants were: Airfix; Carbon Impact, BAFU; ChemOil; Northern Lights; RegionalWerke Baden. The workshop was run in three sections:

- Risk identification: identifying all the different risks of a BECCS project that stakeholders had identified. The risks identified during the workshop were organised into categories and evaluated for potential impacts on cost, time, scope, and quality. For example:
    - Regulatory and political risks: Changes in CO_2 regulations and cross-border legal requirements could delay transport and storage projects, affecting project timelines and costs.
    - Technological risks: Issues with CO_2 capture technology could lead to operational inefficiencies or the need for additional investment.
    - Environmental and health risks: Public perception of environmental risks and potential harm to human health could impact the long-term viability of projects, especially if stakeholder reputation risks are not properly managed.
- Risk mapping: assessing each risk identified to determine a likelihood of occurrence and a magnitude of impact, in order to highlight the most prominent risks.
- Risk mitigation: exploring and discussing potential mitigation measures (e.g. through contractual agreements, insurance, government support) and which party would be responsible for each measure.

During the workshop, participants categorised risks into several areas, including regulatory, financial, technological, supply chain, and environmental risks. A key focus was placed on how risks could propagate along the value chain – for example, how a delay in CO_2 transport could affect storage timelines, or how regulatory risks in one country might impact cross-border CO_2 transport. These risks were mapped across the capture, transport and storage phases, as well as the full lifecycle of a BECCS project, from construction to post-closure.

In 2025, these findings were converted into a structured Risk Management Framework. The resulting tool applies a scoring system based on probability and impact (derived from earlier Risk Heat Map exercises) to help emitters prioritise mitigation.

A dedicated section of work focused on insurance mechanisms to shield first-generation BECCS projects. Several options were reviewed, including commercial insurance products for transport and storage interruption. These approaches are being assessed for practicality in small-scale projects where traditional risk allocation (e.g., "take-or-pay" penalties) might otherwise prevent investment.

<u>Sector-specific business model development</u>

WP4 continued to refine business models tailored to specific emitter profiles:

- **Waste-to-energy (WtE)**: The model was explored further, mapping revenue streams (carbon credits, avoided ETS costs, waste handling fees) and risks. It highlights how CCS could be financed through shared funding via WtE fees or advanced disposal fees.
- **Biogas & biomass**: Specific risks identified in 2024 – such as fluctuating CDR demand for biogas plants versus regulatory/political risks for WtE – were integrated into the models.
- **Sustainability & certification**: Ongoing work addresses biomass sustainability risks. WP4 is comparing the sustainability criteria of key certification schemes (Figure 3). The analysis identifies convergence and gaps between standards and explores their implications for project eligibility.

Figure 3: Comparative overview of biomass sustainability in carbon standards for BECCS methodologies.

Requirements	VCS	Puro.earth	Isometric	GCC	Gold Standard	ACR*
Biomass requirements (where applicable)						
Sustainability requirements	++	++	++	–	+	N/A
Market leakage consideration	++	+	++	++	++	N/A
Counterfactual consideration	–	+	++	–	+	N/A
Demonstration for biomass requirements						
Sustainability certification	++	++	+	N/A	++	N/A
Regulatory compliance	++	++	+	N/A	++	N/A
Specific evidences of the project	–	+	++	N/A	+	N/A
Traceability requirements	++	++	+	N/A	+	N/A
Conclusion: reliability of biomass requirements	++	++	++	–	+	N/A

Legend:
++ (High): The methodology includes extensive requirements
+ (Medium): The methodology includes moderate requirements
– (Low): The requirement is absent or only lightly addressed.

++ high + medium – low

*The ACR guidance on sourcing sustainable biomass has not been published yet, so an evaluation cannot be made at this time.

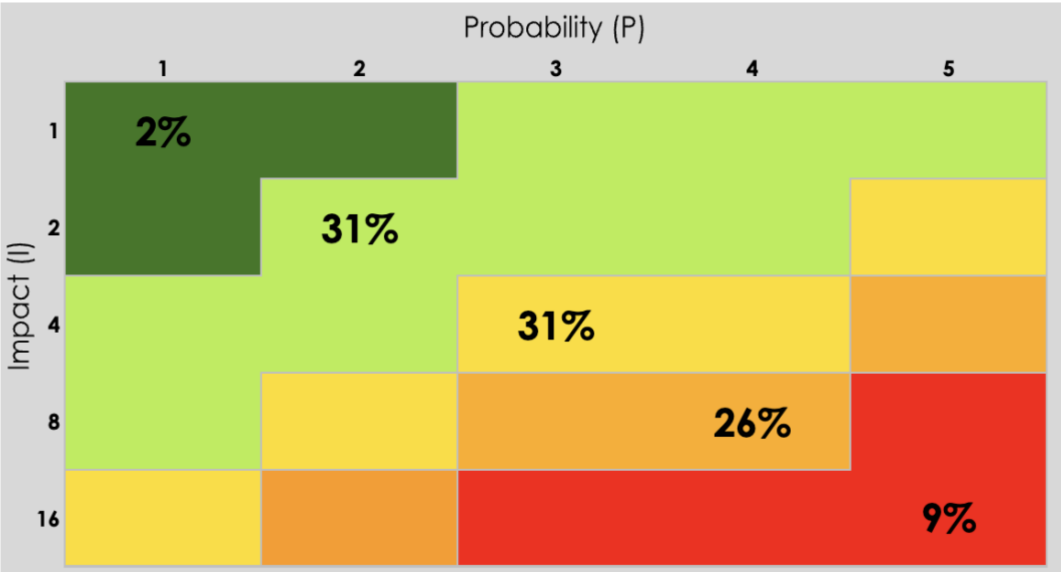
Beyond standards setters and certification initiatives, CO2RR has also engaged non-profit, non-governmental civil society organisations in Europe (e.g. Fern) to discuss their criticisms of BECCS projects and their expectations for carbon removal generation.

2.5.3 Results obtained

- Comprehensive risk map: The workshop produced a detailed risk map (Figure 4) that categorises risks by phase (construction, operation, post-closure), type and stakeholder. This risk map provides an overview of the various risks each stakeholder faces at different stages of the project. It also highlights the interconnected nature of risks across the value chain, which will help ensure that mitigation strategies are comprehensive and that decisions in one area do not inadvertently increase risks elsewhere. This will be a living document and will be continuously updated with new risks that are identified as the projects enter new phases (e.g. construction, operation). A selected number of risks have been collated in Table 2, including risk identification indicators (Due to a cause or condition, a risk event may occur that has an impact on either the cost, time, scope or quality) and quantitative risk assessment assigning a level of impact and likelihood of occurrence.
- Risk management framework: The template for the risk management tool is complete in draft form. Feedback from emitters will be integrated into the next iteration.
- Insurance and guarantees: Blending commercial insurance with contractual guarantees can meaningfully de-risk early BECCS projects by covering performance and interruption risk along the CO_2 chain.
- Sectoral business models: WP4's initial analysis aims to provide insights into the sector-specific challenges faced by waste-to-energy, biogas and biomass emitters. This sector-based approach will inform the development of tailored business models that can be adapted to each sector's needs and risk profile. For example, waste-to-energy plants may benefit from government-backed subsidies for carbon capture technologies, while biogas plants might focus on monetising negative emissions through voluntary carbon markets. The WtE case study demonstrates the financial and operational viability of capture projects when supported by structured risk-sharing.

- <u>Risk-sharing in practice</u>: Early discussions during the workshop have begun on possible risk-sharing mechanisms. For example, emitters might share transport and storage risks through collective agreements with transport providers, while technology providers may take on more risk related to CO_2 capture technology performance. Public entities like BAFU are also expected to play a role in mitigating regulatory and political risks by providing supportive policies and regulatory frameworks. CO2RR partners are working directly with emitters and project developers on risk allocation, including biomass sustainability requirements.

Figure 4: Risk heat-map developed during risk assessment workshop and risk key (June 2024)



P-I value • 1 – 80		Number
1 – 2	Negligible	1
3 – 8	Small	17
10 – 16	Moderate	17
20 – 32	High	14
40 – 80	Critical	5

Total Risks	54
of which "Threat"	49
of which "Opportunity"	4

Probability 1-5	Impact 1-16
1 - Rare	1 - Insignificant
2 - Unlikely	2 - Minor
3 - Possible	4 - Moderate
4 - Probable	8 - Large
5 - Almost certain	16 - Heavy

Table 2: Selected examples of 'high' risks identified and evaluated by workshop participants (June 2024)

Risk identification ("Due to a cause or condition, a risk event may occur that has an impact on either the cost, time, scope or quality").					Quantitative risk assessment		
Phase	**Risk category**	**Risk event**	**Cause / Condition**	**Impact**	**Probability (1-2-3-4-5)**	**Impact (1-2-4-8-16)**	**P*I**
Operation	**CDR market risks**	**Oversupply of CDRs in the EU region**	A large number of large BECCS projects in the EU are close to FID and are looking for future buyers of larger volumes of CDRs	Hard to secure long-term offtake agreements. Competes with cheaper CDR providers (lower biomass/transport costs).	3	16	48
Operation	**Transportation risks**	**Delays in CO_2 transportation**	Short-term strikes, route closures, or cross-border coordination issues delay transport.	If transported in tank wagons: CO_2 must be released into the atmosphere. Storage commitments (take-or-pay) are unfulfilled.	3	16	48
Operation	**Regulatory & political risks**	**New national or international safety requirements for handling CO2**	Tighter rules on CO_2 rail transport (e.g., fewer wagons, smaller storage near settlements).	Increases logistics costs, reducing economies of scale (e.g., pooling CO2, dedicated CO_2 trains).	2	16	32
Construc tion	**Financial risks**	**Access to subsidies**	Planned or existing national or international funding programs for BECCS are suspended or cancelled	Planned funding lost; Internal rate of return becomes too low. FID delayed until financing is secured.	2	16	32
Operation	**Supplier risks**	**Biomass availability**	Delays or shortages in biomass delivery.	Plant operation reduced (energy and CO_2 separation affected).	4	8	32
Operation	**Environmental risks**	**Nitrosamine or other emissions**	Emissions exceed allowed limits, either generally or due to incidents.	Health risks, bad publicity, or shutdown of CO_2 capture plant.	2	16	32
Operation	**Transportation risks**	**Delays in CO_2 transportation**	Logistics provider fails to deliver due to internal issues (availability, maintenance, etc.).	CO_2 transport disrupted; plant shutdown if intermediate storage is full.	4	8	32

<u>Deliverables:</u>

Deliverable 4.1 Workshop to map out and evaluate risks along the value chain contains the workshop presentation and the risk mapping exercise results.

Deliverable 4.2 Summary of risk-sharing options summarises risk-sharing and incentive-alignment models considered for the value chain, with evidence where relevant of successful implementation of most viable options. It will be further updated and expanded in the final year of the project.

The update of *Deliverable 4.3 Analysis of business model options* has focused on exploring the specific case for waste-to-energy, and includes the identification of financing solutions. A one-pager version has also been published by CO2RR partners on social media.

Additionally, a practical *Risk management tool* template has been developed, along with an educational piece on insurance and guarantee mechanisms for BECCS projects ("*Shielding first-generation small-scale BECCS projects from excessive value-chain risk*").

These deliverables are attached to this report and will be further disseminated publicly by CO2RR consortium partners.

2.5.4 Critical analysis

WP4's work this year has moved from conceptual mapping to applied frameworks and practical instruments. However, several challenges remain:

- **Complexity of value-chain risk allocation**: First-generation BECCS projects can involve multiple small partners, each with limited capacity to assume liability. Balancing risk exposure across emitters, transport and storage providers remains a delicate task.
- **Insurance and finance gaps**: While insurance concepts are promising, market products for BECCS-specific risks are still emerging. Closer dialogue with insurance and public guarantee providers is needed.
- **Regulatory and sustainability uncertainty:** Regulatory uncertainty remains a major risk. Changes in national or international regulations (e.g. cross-border transport legality or biomass sustainability criteria) can impact project timelines. Differing carbon standard requirements (permanence, additionality) further complicate project certification and monetisation.
- **Financial viability**: Ensuring the financial viability of BECCS projects remains a critical focus of WP4. While risk-sharing mechanisms can help reduce financial burdens on individual stakeholders, the overall cost of BECCS projects – particularly in terms of CO_2 capture and transport – must be carefully managed. Various WP4 instruments will need to be aligned into a coherent package to support end-to-end project assessment. A project finance tool would go a long way to providing emitters support for early stage assessments.

In conclusion, WP4 has made progress toward operationalising risk management and business model innovation for small- and medium-scale CO_2 removal projects. The deliverables developed this year – including the risk management tool, insurance and guarantee piece and sector-specific business model case study – contribute to the foundation for practical risk allocation and financial viability across the BECCS value chain. The forthcoming project finance tool will complete this integrated suite of resources, supporting emitters and project developers in structuring bankable, resilient BECCS projects.

3 Conclusions and outlook

CO2RR has generally shifted from planning toward implementation. Concrete progress in emitter engagement, logistics contracting, storage negotiation and risk management demonstrates the project's capacity to translate strategic intent into operational reality. The next steps will focus on replication, integration and standardisation – ensuring that small- and medium-sized emitters across Europe can access practical, financially viable and environmentally robust CO_2 management solutions that contribute meaningfully to 2030–2050 climate targets.

3.1 Key findings

Accelerating emitter onboarding and regional coordination

In 2025, CO2RR transitioned from conceptual development to practical implementation. Across Switzerland, France and Germany, direct engagement with emitters has proven the most effective method for accelerating early-stage BECCS and CCS deployment.

- **Volume & clusters**: WP1 successfully expanded the emitter base and compiled an updated CO_2 volume roadmap that now represents more than 4 million tCO_2/year of potential capture capacity. This builds on earlier granular analysis, such as the identification of nine key emitters in the Basel region alone (collectively accounting for ~735,000 tCO_2/year) and the establishment of a biogas cluster in France.
- **Tooling & policy**: The forthcoming "Guide to Getting Started with BECCS" will serve as a practical toolkit for emitters, consolidating technical, financial and policy guidance. The Climate Protection and Innovation Act (KIG) in Switzerland has created tangible momentum, reflected in the launch of several BECCS pre-feasibility studies and the continued progress of the Niederwil pilot.

Advances in CO_2 transport logistics and risk management

WP2 has made a major step forward by completing the first full Request for Proposals (RfP) for a Swiss emitter, leading to the selection of a transport provider and establishing a replicable procurement process.

- **Cost trajectory**: Preliminary analyses suggest that while costs remain high today, transport costs for Swiss emitters could decrease by over 40% by 2028–2030 through the introduction of bulk options (barges, dedicated trains), eventually achieving reductions of over 50% with the introduction of pipeline infrastructure.
- **Operational readiness**: The development of a digital repository of multimodal transport solutions consolidates critical market intelligence. A new risk and contingency framework strengthens operational readiness by addressing risk identification, contractual safeguards and sustainability criteria.

Securing geological storage access

WP3 achieved a milestone with the successful negotiation of a full storage agreement for a Swiss emitter – the first completed under the CO2RR project. This builds on previous work securing term sheets for multiple projects, effectively giving emitters a clear pathway for long-term sequestration.

- **Contractual standards**: The lessons from this process have been distilled into a draft set of model terms, clarifying financial guarantees, liability allocation, CO_2 ownership and carbon credit rights.

- **Portfolio approach**: The consortium's repository of European and regional storage sites now offers a transparent overview of capacity, timelines and compatibility. Work with local storage developers has also confirmed that decentralised storage can complement offshore options, particularly for early-mover projects.

Progress in business models and risk-sharing frameworks

WP4 advanced from conceptual mapping to applied instruments that enable more bankable project structures. A risk management tool template now provides a framework for emitters to assess and prioritise risks systematically across the value chain. In parallel, work on insurance and guarantee mechanisms demonstrates that a blend of contractual and commercial risk mitigation can make first-generation BECCS projects more investable. The waste-to-energy sector case study confirms the potential for viable business models when appropriate risk allocation and credit monetisation mechanisms are in place.

3.2 Outlook and next steps

Building on the progress achieved to date, the next phase of CO2RR will focus on consolidating tools, formalising agreements and expanding implementation readiness across the network of emitters and partners.

Key priorities for 2026 include:

- Start operations for the first Swiss BECCS project by supporting the finalisation of contractual elements, and following construction to enable first CO_2 capture, transport and storage activities in early 2026, demonstrating project operationality and "debugging" value chain.
- Finalising the CO_2 volume roadmap to 2030 and publishing the *Guide to Getting Started with BECCS* to scale emitter engagement and harmonise regional onboarding processes.
- Completing additional pre-feasibility studies under the KIG framework and advancing selected projects toward the investment decision stage.
- Executing further transport procurement processes using the refined tender and risk templates developed by WP2, while continuing to explore the benefit of framework agreements vs single agreements with logistics providers.
- Engage storage providers to discuss at least one additional storage agreement and apply lessons learned from 2025 to streamline contractual and regulatory negotiations.
- Operationalising the WP4 risk management and finance tools, integrating them into a unified decision-support package for emitters and investors; and exploring/piloting alternative business models.
- Strengthening cross-border coordination along the Rhine corridor, including harmonisation of permitting processes and dialogue with authorities in neighbouring EU member states.

Collectively, these steps aim to translate methodological progress into concrete, investable CO_2 management pathways capable of supporting up to 1 million tonnes of captured and stored CO_2 per year by 2030.

3.3 Open questions and further work

Despite tangible progress, several open questions remain that will shape the next phase of CO2RR and related initiatives:

- **Policy and regulatory clarity**: While the KIG has improved the policy environment for negative emissions in Switzerland, uncertainty remains regarding post-2030 funding mechanisms and the final design of the revised CO2 Act. Ensuring stable, long-term regulatory and financial conditions is essential to support project bankability and infrastructure investment.

- **Cross-border integration**: Administrative and permitting barriers for cross-border CO_2 transport continue to impede progress. Alignment of national frameworks and recognition of negative-emission credits under EU and Swiss schemes remain critical priorities.
- **Market and finance mechanisms**: The limited maturity of BECCS-specific insurance and financing instruments constrains early-stage investment. Further engagement with financial institutions, insurers and public guarantee schemes will be necessary to create a functioning risk-sharing environment.
- **Sustainability and certification**: Variability in biomass sustainability and carbon credit standards poses challenges for consistent project eligibility and market access. Continued harmonisation of standards and transparent monitoring of permanence, leakage and additionality will be key to ensuring environmental integrity.
- **Scalability and cost reduction**: While progress has been made on transport and storage frameworks, cost competitiveness for small emitters remains a challenge. Collaborative infrastructure models and clustering will remain central to achieving economies of scale.

4 National and international cooperation

CO2RR involves extensive collaboration at national and international levels, as well as across public, civil and private sectors. Partners from Switzerland, France and Norway are working closely to ensure the project's success. Northern Lights plays a critical role as a storage partner, while the project also benefits from the expertise of transport and logistics providers across Europe. Coordination with EU working groups and national CCS forums ensures alignment with broader European decarbonisation goals.

In parallel, the consortium has been supporting the EU NetZeroCities programme, notably through the Climate City Capital Hub, which assists cities and municipal utilities in accessing financing, developing investment plans and conducting feasibility studies for climate projects, including BECCS. Within this framework, CO2RR has conducted market studies, risk assessments, transport & storage scenario analyses and project finance evaluations, in collaboration with Bankers without Boundaries, South Pole and the Stockholm Environment Institute. Beyond NetZeroCities, CO2RR partners are also engaging directly with German and Swiss municipalities and municipal utilities to explore local BECCS opportunities and integration into regional decarbonisation pathways.

National cooperation and engagement efforts to date include:

- Participation in the Swiss Carbon Removal Platform
- Participation in the German Association for Negative Emissions (DVNE)
- Participation in the French Association for Negative Emissions (AFEN)
- Participation in the Club CO2 (French association of CCS actors)
- Participation in the Swiss Green Economy Symposium
- Continuous engagement with Swiss municipal and cantonal administrations
- Continuous engagement with the Swiss Federal Office for the Environment and Swiss Federal Office of Energy
- Continuous engagement with the Association of Operators of Swiss Waste-to-Energy Plants (VBSA)
- Engagement with other CETP research projects, such as the BUCK$$$ project (Brine Utilisation for CO_2 sequestration), to share knowledge on mineralisation and process optimisation.
- First participation in COP30 leveraging our members presence in the CDR Pavilion in the Blue Zone

5 Publications and other communications

The fifth work package (WP5) focuses on the dissemination of project outcomes, ensuring that knowledge is shared widely among emitters, industry stakeholders, policymakers and the scientific community.

A central channel for this knowledge exchange is the **Clean Energy Transition Partnership (CETP) Knowledge Community**, where CO_2RR contributes through the **DISCCO (Digital Integrated System for Communication, Collaboration and Coordination)** platform. Now fully operational, DISCCO serves as the main digital repository for CETP projects, allowing members to upload and maintain living documents, spotlights and policy briefs. Deliverables referenced in this report are available on the DISCCO platform, providing open access to other CETP projects and external stakeholders engaged in CCUS and CDR activities.

Beyond CETP, CO_2RR has maintained a strong public communication presence. Through its **LinkedIn channels**, the consortium shares updates on milestones, technical progress and event participation, actively engaging a professional audience of CCS, CDR and BECCS practitioners, researchers and investors. This online visibility complements participation in a range of **industry conferences and workshops**, including **Bio360Expo (France)**, where Airfix presented challenges and opportunities across the CO_2 value chain; the **NetZeroCities Annual Event (Vilnius)**, where project representatives led a workshop on city-led BECCS deployment; the **AFEN CDR Days (Paris)**, where the project's 2025 learnings were presented to an audience of policymakers, researchers and industry actors such as ADEME, Crédit Agricole, GRDF and Verso Energy; and **COP30** where Airifx and Carbon Impact organised a master class around the project learnings to the global climate community during a virtual side event hosted by the CDR Pavilion (CDR30).

The consortium also contributed actively to **CETP cross-cutting workshops**, including the September 2025 event *"From Source to Sink: Achievements and Learnings of the Carbon Rhine Route Project"* in Leipzig. During this in-person session, CO2RR presented key results and engaged in discussion with fellow CCUS project representatives. The session confirmed that transport and storage of CO_2 for small emitters is technically and commercially feasible today, with first projects expected to start operations in 2026. Broader insights from parallel sessions with CETP projects such as ACLOUD, CTS and BRINE-CARB provided valuable benchmarking on capture, shipping and storage innovations.

In addition to CETP engagement, the project participated in **major European climate and energy forums**, including *EU Public Funding for Permanent Carbon Removal* (Brussels, January 2025), *E-World* (Essen, February 2025), *Produrable* (Paris, October 2025) and *AFEN CDR Days* (Paris, October 2025). These events have strengthened connections with policymakers, financiers and industrial partners.

CO2RR partners have also contributed to the **EU NetZeroCities programme**, notably through the **Climate City Capital Hub**, which supports municipalities in accessing financing, developing investment pipelines and conducting feasibility studies, including for BECCS deployment. In collaboration with **Bankers without Boundaries** and the **Stockholm Environment Institute**, the team has delivered market analyses, risk assessments, transport and storage scenario studies and project finance evaluations. These activities extend beyond NetZeroCities to direct engagement with **German and Swiss municipalities and municipal utilities**, helping to align local decarbonisation planning with emerging CCS and CDR opportunities.

Public outreach has been reinforced through thought-leadership articles published on Airfix's website, including *"Decisive Progress Highlighted at Visit of Groundbreaking Swiss BECCS Project"*, *"Act Now or Pay Later: The Time Value of Carbon and the Urgent Case for Removals"*, and *"BECCS: A Key to France's Carbon Strategy."* These publications have contributed to wider public understanding of the potential of BECCS and the CO2RR approach.

Looking ahead, the next phase of the project through October 2026 will prioritise the **systematic dissemination** of project results through concise, visual and accessible materials such as infographics, summary toolkits and open templates. A **comprehensive dissemination strategy** will be finalised to ensure the publication of actionable outputs on **ARAMIS**, the **DISCCO platform** and other relevant channels, as the project comes to an end. This will include generic versions of key contractual templates and term sheets, preserving confidentiality while sharing best practices for future BECCS developers. By combining structured communication, stakeholder feedback and collaborative engagement, CO2RR aims to maximise its impact as a replicable model for small-scale CCS and CDR deployment across Europe.

6 Appendices

6.1 Appendix 1: Selected transport-specific risks and identified mitigation measures

Risk identification ("Due to a cause or condition, a risk event may occur that has an impact on either the cost, time, scope or quality").				Quantitative risk assessment			Risk mitigation	
Phase	**Risk event**	**Cause / Condition**	**Impact**	**Probability (1-2-3-4-5)**	**Impact (1-2-4-8-16)**	**P*I**	**Mitigation strategy**	**Mitigation measure**
Operation	**Delays in CO_2 transportation**	Unforeseen short-term strike or temporary route closure, or delay in build-up of cross-border CO_2-pipeline due to coordination issues	If transported in tank wagons: CO_2 must be released into the atmosphere. Booked storage capacities cannot be fulfilled (take-or-pay). In addition, there may be additional holding times/standing fees and temporary storage costs that apply during the delays.	**3**	**16**	**48**	Reduce or mitigate risk	Identify alternative transport routes at an early stage, plan for sufficient interim storage, force majeure clause in contracts with storage providers
Operation	**Delays in CO_2 transportation**	Logistics service provider cannot provide the transportation service as agreed for internal reasons (lack of availability, maintenance problems, etc.)	CO_2 cannot be transported from the intermediate storage facility. If intermediate storage is full, capture plant must be shut down. In addition, there may be additional holding times/standing fees and temporary storage costs that apply during the delays.	**4**	**8**	**32**	Transfer risk	Contractual security vis-à-vis transport providers (penalty payments if obligation cannot be fulfilled would be ideal but generally not accepted by transport companies – at least cover standing fees / temporary storage). Ensuring from the start that the provider has an alternative route option is critical. Regular monitoring of offers from alternative transport providers. Depends a lot on the requirements of the storage company and how strict they are on delivery schedules.
Operation	**CO_2 cannot be picked up from emitter or cannot be delivered to storage site**	Either due to an interruption at the capture facility or the storage facility	Low-to-medium volumes: if using existing transport routes, typically transport contracts can be paused / cancelled relatively swiftly (~2-4 weeks). However, the leased transport assets (e.g. ISOtainers) cannot be cancelled so quickly. Typically, they require 6-12 months notice.	**3**	**4**	**12**	Reduce or mitigate risk	Align the interruption modalities for asset leasing as much as possible with the interruption modalities of the storage contract. In addition, the emitter can insure against the potential extra asset leasing costs that it cannot avoid.

			High volumes: if using dedicated transport routes / assets, typically the assets are stranded for the duration of the interruption					
Operation	**CO_2 handling**	CO_2 leakage during capture, temporary storage or transportation	Accidents, injuries, fatalities during operational activities.	**2**	**4**	**8**	Avoid risk	Ensure strict compliance with safety regulations. Regular training and safety checks, emergency plans for CO_2 leaks
Operation	**Leakage of CO_2 during transport**	Failure of the transport assets or during transitions between different transport modalities lead to leakage of CO_2	Low-to-medium volumes: CO_2 loss meaning the costs of capture, transport and storage cannot be recovered through certificates. High volumes: can cause a short-term local health risk	**2**	**4**	**8**	Transfer risk	Part of the liability can be transferred to the logistics service provider, to cover at least part of the lost value. However, it is unlikely that a service provider would accept the full risk of the loss of CDRs.
Operation	**CO_2 is held at export or import Customs**	The customs and all necessary documentation have not been delivered correctly to the Customs office.	Delays in CO_2 transport will lead to standing fees and temporary storage costs.	**3**	**2**	**6**	Reduce or mitigate risk	Work with customs agents that have strong connections with local customs or include in the transport tender that customs clearance should be the responsibility of the logistics provider.
Operation	**CO_2 pipeline comes earlier than planned**	Earlier-than-expected deployment of a CO_2 pipeline requires a shift from planned liquefied CO_2 transport to pipeline transport	Conversion costs for liquefaction plant - lower transportation costs; but additional conversion costs	**1**	**2**	**2**	Accept risk	n/a

6.2 Appendix 2: Selected storage-specific risks and identified mitigation measures

Risk identification ("Due to a cause or condition, a risk event may occur that has an impact on either the cost, time, scope or quality").				Quantitative risk assessment			Risk mitigation	
Phase	**Risk event**	**Cause / Condition**	**Impact**	**Probability (1-2-3-4-5)**	**Impact (1-2-4-8-16)**	**P*I**	**Mitigation strategy**	**Mitigation measure**
Construc tion	**Storage operating licence not delivered by local authorities**	Typically due to environmental or operational risks that cannot be mitigated, the local authorities may not deliver the operational licence to the contracted storage provider (even though they had the exploration licence)	The project is on pause until it can find an alternative storage option or until a new permit application is processed	**3**	**16**	**48**	Transfer risk	Contractual security vis-à-vis transport providers (penalty payments if obligation cannot be fulfilled would be ideal but generally not accepted by transport companies – at least cover standing fees / temporary storage). Ensuring from the start that the provider has an alternative route option is critical. Regular monitoring of offers from alternative transport providers. Depends a lot on the requirements of the storage company and how strict they are on delivery schedules.
Construc tion	**Storage rights not secured**	It is not possible to secure sufficient storage rights / capacities in good time (before FID) (lack of supply, difficulty in securing the necessary bank guarantees in good time) Also: risk of not having enough storage capacity built up in line with capture volumes	FID is delayed.	**3**	**8**	**24**	Reduce or mitigate risk	Identify alternative transport routes at an early stage, plan for sufficient interim storage, force majeure clause in contracts with storage providers
Operation	**Failure of project owner to deliver CO2 for storage**	This can be due to issues at the capture or transport stage of the value chain	Despite no CO_2 being stored, the storage services is paid for (take-or-pay contract which is currently the standard among storage providers)	**3**	**8**	**24**	Transfer risk	Part of the liability can be transferred to the logistics service provider, to cover at least part of the lost value. However, it is unlikely that a service provider would accept the full risk of the loss of CDRs.
Operation	**CO2 purity inadequate**	Project owner delivers offspec CO_2 to the storage facility	The storage facility is damaged due to the delivery of off-spec CO_2 , leading to repairs and interruptions.	**1**	**8**	**8**	Avoid risk	Ensure strict compliance with safety regulations. Regular training and safety checks, emergency plans for CO_2 leaks
Operation	**CO2 leakage after the end of project**	Geologically stored CO_2 is released via cracks	Sink capacity is partially canceled out.	**1**	**8**	**8**	Accept risk	n/a

Operation	**CO2 purity requirements**	Storage providers are increasing the requirements in terms of CO_2 purity (higher than the current purity of the captured CO_2).	CO_2 can no longer be stored. Systems must be technically retrofitted.	**3**	**2**	**6**	Reduce or mitigate risk	Align the interruption modalities for asset leasing as much as possible with the interruption modalities of the storage contract. In addition, the emitter can insure against the potential extra asset leasing costs that it cannot avoid.
Operation	**Lower injection capacity**	Lack of injection capacity and/or CO_2 leakage during injection	Storage provider is unable to meet the contractually guaranteed CO_2 volumes.	**1**	**4**	**4**	Reduce or mitigate risk	Work with customs agents that have strong connections with local customs or include in the transport tender that customs clearance should be the responsibility of the logistics provider.